BEAR 2008

Building Resilience

CIB International Conference on Building Education and Research

Building Resilience

Heritance Kandalama, Sri Lanka, 11th – 15th February 2008

Conference Proceedings

Edited By : Dr Richard Haigh

Professor Dilanthi Amaratunga

Organisers :

School of the Built Environment, University of Salford, UK

CIB, International Council for Research & Innovation in Building and Construction

Local Organisers and Hosts :

Department of Building Economics, University of Moratuwa, Sri Lanka

Department of Civil and Environmental Engineering, Sri Lanka, University of Ruhuna

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BUILDING RESILIENCE

CIB W89 International Conference on Building Education and Research, in conjunction with CIB W113, CIB TG53, CIB TG63, CIB TG67, CIB TG68, and CIB TG69

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Dr Richard Haigh & Professor Dilanthi Amaratunga

School of the Built Environment
The University of Salford
UK
February 2008

Dr Richard Haigh and Professor Dilanthi Amaratunga *(edited by)*
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Preface

This proceedings contains the full papers of keynotes and papers submitted to, peer reviewed and accepted for the CIB International Conference on Building Education and Research (BEAR 2008), held from 11th – 15th February 2008 at Heritance Kandalama, Sri Lanka. The contributions reflect the call for papers of the following CIB Working Commissions and
Task Groups:

CIB W89 (Building Education and Research)
CIB W113 (Law and Dispute Resolution)
CIB TG53 (Postgraduate Research Training in Building and Construction)
CIB TG63 (Disasters and the Built Environment)
CIB TG67 (Statutory Adjudication in Construction)
CIB TG68 (Construction Mediation)
CIB TG69 (Green Buildings and the Law)

BEAR 2008 was collaboration by a number of CIB commissions: CIB W89, W113, TG53, TG63, TG67, TG68 and TG69, CIB International Student Chapters, and EURASIA, a three year EU Asia-Link programme funded project that aims to improve capacity in training, teaching and research activities associated with the creation and long-term management of public and commercial facilities and infrastructure in selected Higher Educational Institutes in Asia and Europe. All EURASIA partners - University of Moratuwa and University of Ruhuna in Sri Lanka, Tallinn University of Technology in Estonia, and Vilnius Gediminas Technical University in Lithuania – were able to join the University of Salford for this event.

In line with the Asia Link EURASIA concept, a major theme for the 2008 BEAR Conference was to promote built environment related education and research towards a more expansive view of the life cycle of infrastructure projects, one that extends beyond the traditional cycle of feasibility analysis, planning, design, construction, operation, maintenance and divestiture. This revised life cycle should encompass the building and construction professional's ability to anticipate and respond to unexpected events that damage or destroy an infrastructure project – from earthquakes and climate change to terrorist attacks – and reflect construction's ongoing responsibility toward an infrastructure's users. The role of building and construction industry professionals and local communities in developing resilience to these types of disasters can be viewed as two separate yet interrelated aspects: To create a built environment that is not vulnerable to a disaster or disruptive challenge. This relates to the resilience of the physical state of infrastructure, buildings and cities as well as developing policies, legal and regulatory controls, and practices that govern the building industry to build safe structures. Essentially this means building cities or infrastructure that will not be affected by a disaster, and to develop organisational structures, capacities through education and training, and construction systems, that can react in the event a disruptive challenge does occur. This means responding to the immediate after effects of a disaster to restore operational conditions of infrastructure or the built environment as quickly as possible. This means also to aid in the speedy recovery of the region through sustainable reconstruction, post-disaster building or other related projects.

It is evident that the CIB network of experts and member organisations active in the research community, in industry and in education, has a wide range of expertise to offer in addressing disaster related challenges. The BEAR Conference was an intriguing opportunity to bring together the interests and expertise of these wide-ranging Working Commissions and Task Groups to discuss and attempt to address the complex and global problems associated with anticipating and responding to unexpected events that damage or destroy an infrastructure project. The Conference provided an ideal backdrop for CIB members to identify challenges and opportunities, develop synergy, and collaborate on future work. It is hoped that a series of cross-commission and task group initiatives and workings may ensue.

The conference was held in Sri Lanka, an island situated in the Indian Ocean, at the base of the Indian Sub-Continent. It is a multi-ethnic, multi-religious country with a diverse and rich culture. Sri Lanka was severely affected by the tsunami on 26 December 2004, which killed some 40,000 people and displaced 400 – 500 thousand people along two thirds of the northeast, south and south-west coastline. Half the fishing fleet was destroyed, and a quarter of hotels in the affected areas sustained serious damage. It is our hope that Sri Lanka will benefit greatly from the research and activities of W89 and commissions and task groups, and that the country provided an appropriate backdrop for tackling challenging questions on built environment education and research.

The Conference provided a forum for researchers worldwide to debate and exchange ideas and experiences on a broad range of issues related to built and human environment research. All of the papers were selected on the basis of strict review by the Scientific Committee members to ensure a good quality standard. The conference had a broad scope and covered wide ranging topics which were organised around the following themes:

Capacity Building
Construction Management
Cost Planning and Control
Curriculum Development
Design
Developing the Law Curriculum in Built
Environment Education
Disaster Mitigation
Education
E-learning
Environmental Management
Facilities Management
Information and Communication Technology
International and Comparative Law in the Built Environment
Legal Scholarship and Research within the Built Environment Discipline
Post-Disaster Reconstruction
Post-Disaster Relief
Procurement
Skill Development
Sustainability

The conference program and the structure of this proceedings all reflect these themes. The papers on this proceedings were developed by authors which includes background issues, literature reviews, problem-solving processes, decisions and conclusions. All papers appearing in the proceedings were reviewed in their entirety, prior to publication, by the International Scientific Committee comprising independent, qualified experts. Editors would like to extend their sincere gratitude to all the authors of the published contributions for their excellent work and participants at BEAR 2008. Executive summaries of the papers included within this proceedings can be fund as a bound book, produced separately.

There were five keynote addresses from leading academics: Professor Peter Barrett, President of the CIB; Professor Malik Ranasinghe, Vice Chancellor, The University of Moratuwa, Sri Lanka; Professor John Ratcliffe, Director of the Faculty of the Built Environment, Dublin Institute of Technology, The Republic of Ireland; Conrad de Tissera UN HABITAT Programme Manager for Sri Lanka, United Nations Human Settlements Programme Colombo, Sri Lanka; and, Associate Professor Vasantha Abeysekera, Programme Leader Construction Management Programmes, AUT University, Auckland, New Zealand. These keynote addresses provide a global perspective and vision for built environment research, as the, "development of research and other skills" has permeated the whole higher education sector.

Editors

Dr Richard Haigh
Professor Dilanthi Amaratunga

February 2008

About the Editors

Dr Richard Haigh is a lecturer at the School of the Built Environment, University of Salford, UK and an active researcher in disaster management with a particular interest in capacity building and corporate social responsibility. Richard is also the Programme Director for a new Disaster Mitigation and Reconstruction Masters programme that the School is launching in autumn 2008, and joint-coordinator of CIB Task Group 63: Disasters and the Built Environment, a network of 58 Higher Education Institutes across 27 countries. Richard is joint principal investigator of EURASIA, an EU Asia-Link funded network project that aims to enhance the capacity of the partner institutions for training, teaching and research activities required for the creation and long-term management of public and commercial facilities and infrastructure.

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Professor Dilanthi Amaratunga holds a chair at the School of the Built Environment at the University of Salford, UK. She is an active researcher in the field of capability and capacity building in the built environment, with a particular interest in disaster management. She has nearly 200 published papers, and has successfully managed several research projects. She is the Coordinator of CIB TG53, which aims to improve the availability of skilled researchers in building education and research through the development of researchers' capacity to produce, transfer and utilise knowledge. She is also the Co-chair of World Bank/UN HABITAT supported working group on Disaster Management in Developing CountriesHer other research interests are: gender, disasters and construction; research informed teaching.

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Conference Organisers

The Conference was organised by:

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CIB, International Council for Research and Innovation in Building and Construction

Local Organisers and Hosts

Department of Building Economics, University of Moratuwa, Sri Lanka
Department of Civil and Environmental Engineering, University of Ruhuna, Sri Lanka

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EURASIA European and Asian Infrastructure Advantage, and the EU's Asia Link Programme
CEBE Centre for Education in the Built Environment, UK
CIOB Chartered Institute of Building
Lanka Bell, Sri Lanka
Emerald Property Journals, UK
Routledge, Taylor and Francis Group, UK

Endorsements

AIQS Australian Institute of Quantity Surveyors
CEBE Centre for Education in the Built Environment
HFH Habitat for Humanity
ICTAD Institute of Construction Training and Development, Sri Lanka
IESL Institution of Engineers, Sri Lanka
ISR Institute of Sustainable Resources
Ministry of Education, Sri Lanka
RICS Royal Institution of Chartered Surveyors
SLIA Sri Lanka Institute of Architects
Sri Lanka Convention Bureau
Sri Lanka Institute of Quantity Surveyors
UGC University Grants Commission, Sri Lanka
World Bank

EURASIA (European and Asian Infrastructure Advantage)

The 2008 Building Education and Research Conference was held in association with EURASIA (European and Asian Infrastructure Advantage).The EURASIA project is an International research collaboration between Asia and Europe. The partnership includes: University of Salford, UK; University of Moratuwa, Sri Lanka; University of Ruhuna, Sri Lanka; Tallinn University of Technology, Estonia; and, Vilnius Gediminas Technical University, Lithuania.

There is growing recognition of a need to enhance the capacities of Higher Education Institutions (HEIs) worldwide to cater for the challenges facing the world today. In particular, the increasing numbers of disasters that impact communities across the world make it an imperative that knowledge on facilities and infrastructure management is developed to meet the demands of disaster mitigation and reconstruction challenges. In response, the EURASIA project aims to improve capacity in training, teaching and research activities associated with the creation and long-term management of public and commercial facilities and infrastructure in selected HEIs in Asia and Europe. In response, the programme specifically aims to enhance the capacity of the partner institutions for training, teaching and research activities required for the creation and long term management of public and commercial facilities and infrastructure. In doing so, the project will support the ongoing recovery programmes set up in Sri Lanka following the Indian Ocean Tsunami of December 2004. Overall, the Tsunami affected 2/3rds of the coastline of Sri Lanka. It resulted in the destruction of more than 100,000 houses and the discontinuance of several livelihoods such as fishing, farming, tourism and handicrafts-related activities. The post-Tsunami rehabilitation operation has been affected due to unprepared local government institutions with poor response capacities to address the needs of such a magnitude. This is mainly because, before the Tsunami, Sri Lanka was known to be a safe haven where outrages of nature scarcely occurred except for occasional floods and landslides during the rainy seasons. Thus, by enhancing the capacities of partner institutions, specifically in Sri Lanka, it is anticipated that Sri Lanka will be able to take up the challenge of post tsunami recovery more strongly and successfully. The major activities of this research programme include:

- Development of a professionally accredited postgraduate curriculum on the creation and long term management of public and commercial facilities and elements of infrastructure, to be used in all the partner institutions
- A split-site PhD programme for nominated staff of Sri Lankan partner Universities to enhance their capacity for teaching and research in the field of Disaster management
- A major International Conference in Sri Lanka with a theme of creation and long-term management of public and commercial facilities and infrastructure
- Developing and improving the professional and research skills of partner Institutions' staff and postgraduate students
- Improving and consolidating academic networks through systematic exchanges so as to establish a sustainable link between EU and Sri Lankan partner Universities
- Disseminating knowledge and interpreting information through joint publications, lectures, seminars and conferences

EURASIA is funded through the EU's Asia Link Programme, dedicated to fostering regional and multilateral networking between Higher Education institutions in the EU and Asia. As part of the project, a Virtual Environment for Built Environment Researchers (VEBER) has been set up which provides a broad range of functionality that will facilitate research activities among the partner institutions. The Salford team, in collaboration with its Sri Lankan partners, is now working towards setting up a web portal to share information on the post-tsunami response, with specific reference to case material in Sri Lanka. This work will be linked with other disaster management initiatives undertaken by the Salford team, such as activities associated with the recently established CIB Task Group 63: Disaster Management and the Built Environment.

Further information on EURASIA can be obtained from: www.eurasia.buhu.salford.ac.uk.

The Asia Link Programme

The Asia-Link Programme was launched at the beginning of 2002 as an initiative by the European Union (EU) to foster regional and multilateral networking between higher education institutions in European Union Member States and South Asia, Southeast Asia and China. This five-year programme, which has a total budget of £40 million, aims to provide support to European and Asian higher education institutions in the areas of human resource development, curriculum development and institutional and systems development.

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and can under no circumstances be regarded as reflecting the position of the European Union.

Keynote Speakers

Professor Peter Barrett

CIB President & Pro-Vice-Chancellor Research, University of Salford

Professor Barrett is Pro-Vice Chancellor for Research and Graduate Studies at the University of Salford where he is also a long-time member and ex-director of Salford's 6* (top) rated Research Institute for the Built and Human Environment. He is also Chairman of SCRI, a £5M programme of research funded by the UK research council. He has been active in the CIB for many years, including as coordinator of W65 (organisation and management of construction). More recently he was Chair of the CIB Programme Committee and has now been elected President of the CIB for 2007 - 2010. Peter has led numerous construction management research projects over the last 15 years and has published over one hundred and sixty single volume reports and refereed papers. After becoming the first Chartered Building Surveyor to gain a PhD, Peter established the postgraduate programme of research at Salford which now supports around 160 research students. He is currently championing the CIB's proactive theme of Revaluing Construction, an important element of which is the "Awareness of the Systemic Contribution" of the built environment.

Professor Malik Ranasinghe

Vice Chancellor, The University of Moratuwa, Sri Lanka

Professor Ranasinghe is the Vice Chancellor and a Professor in Civil Engineering at the University of Moratuwa (UoM). He is the immediate past Dean, Faculty of Engineering and a former Chairman, Centre of Excellence in Project Management at UoM. Prof. Ranasinghe is a Professional and Chartered Engineer, a Fellow of the Institution of Engineers, Sri Lanka and the National Academy of Science, Sri Lanka. He is also a Director on the Board of Directors of The Colombo Stock Exchange, Sri Lanka. In March 2000, Prof. Ranasinghe was appointed as the Head of the Department of Civil Engineering at the UoM, where he lead and managed the largest academic Department with over 40 senior academic staff. As a result of his unobtrusive leadership as Head of the Department of Civil Engineering, the Faculty of Engineering elected him unanimously to be their Dean in March 2001. The Faculty of Engineering at UoM is the largest Engineering Faculty in Sri Lanka with over 3500 undergraduate and postgraduate students. Prof. Ranasinghe's vision as the Vice Chancellor is to produce world class graduates at the UoM, in an environment that provides a rewarding experience for its students and staff.

Professor John Ratcliffe

Director of the Faculty of the Built Environment, Dublin Institute of Technology, The Republic of Ireland

John Ratcliffe is a chartered planning and development surveyor with almost forty years experience as a consultant and academic in the fields of urban planning and real estate development. Currently he is Director and Dean of the Faculty of the Built Environment at the Dublin Institute of Technology, which is the largest university level institution in the Republic of Ireland, and Founder and Chairman of The Futures Academy there. He is also an Honorary Visiting Professor at the University of Salford and the University of Lincoln as well as an Associate of the futures consultancy Outsights in the UK. Over the past decade he has acquired a particular expertise in the futures field, with special reference to the sustainable development of city regions. A special interest of Professor Ratcliffe at the moment is the nature and development of responsible business practice.

Conrad de Tissera

UN HABITAT Programme Manager for Sri Lanka, United Nations Human Settlements Programme Colombo, Sri Lanka

UN–HABITAT has a long history of cooperation in Sri Lanka and has pioneered innovative approaches in community rebuilding of housing and basic urban services and infrastructure delivery. As the UNHABITAT Programme Manager, Conrad de Tissera currently leads several post tsunami rebuilding community infrastructure & shelter projects, enabling the target communities to rebuild essential physical facilities, including shelter, so that they can restart functioning as normal communities, helping to create wage employment from the investment of the rebuilding process as a way of contributing to the recovery of the local economy and rebuilding self-confidence and restoring human dignity. Conrad has a B Sc. Engineering and a M Sc. in Soil Mechanics and Foundation Engineering, and has served as the head of the National Building Research Organisation in Sri Lanka. He further has over 40 years of construction industry experience and has been the Director General of the Institute of Construction Training and Development of Sri Lanka and Secretary of the Ministry of Housing and Construction during his long standing career. In his role as a visiting lecturer, he has also shared his practical experience with university graduates whenever he has had the opportunity.

Associate Professor Vasantha Abeysekera

Programme Leader, Construction Management Programmes, AUT University, Auckland, New Zealand

Dr Vasantha Abeysekera is a Sri Lankan New Zealander. He is the Associate Professor of Construction Management at AUT University in Auckland in New Zealand and heads the construction management programmes. He graduated with a first class in civil engineer from the University of Moratuwa and obtained his master's and doctorate in construction management from the Loughborough University, UK. He maintains professional memberships with engineering and quantity surveying associations in addition to various other professional bodies. In a career spanning over 25 years, with almost half in industry and the rest in academia, Dr Abeysekera has been involved in diverse roles in Asia, Africa and Oceania, He currently focusses on teaching and research with RD&D interests in, security of payment and contract retentions, health and safety, and time management.

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KEYNOTE ADDRESSES

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Keynote synopsis

"Complexity, Connections and Consciousness"

Professor Peter Barrett
President of the CIB; Pro Vice-Chancellor, University of Salford, UK
(email: p.s.barrett@salford.ac.uk)

Complexity, Connections and Consciousness

Professor Peter Barrett,
President of the CIB

Abstract

This presentation will seek to link thematically the areas of disaster management (DM), education in the built environment and the activities and aspirations of the CIB.

In recent years DM has rightly come into focus for many construction researchers. It has, however, become apparent that, although the disaster itself is the most evident aspect that demands attention, it is important not to overlook the periods before and after the disaster. It is in these times that there is the opportunity to mitigate or at least prepare before a disaster and afterwards there is the long haul back to a new normality. Both of these periods deserve attention and broaden considerably the scope of DM research.

Implicit in this view is the need to educate people so that there is the technical and organisational capacity to respond. This involves being able to:

- analyse potentially hazardous situations
- engineer technical solutions
- organise the delivery of these solutions
- handle the associated social and economic issues
- sustain the effort through very different phases, that will last several years

The scope of the last two of this list in particular highlight the complexity of the skills required. Technical issues must be addressed in fractured social contexts, which are both shifting through radically different phases, once the initial basic demands have been met. So the education of construction professionals must fit these people to be able to deal with this *complexity*, both individually and collectively. Interestingly, the characteristics evident for DM are quite generally needed amongst construction professionals. The need to deal coherently with complexity links to the necessity of making *connections*, both in terms of connecting specialists in multi-disciplinary working and strongly connecting the processes into and out of the construction phase.

These dimensions of connection lead to consideration of the mind-set those involved have towards the scope of the issues involved. Everyone involved needs to have strong specialist knowledge and skills to contribute, but they equally need a broad *consciousness* of the purposes of construction as a contributor to and part of society more generally. This is most easily evident around understanding and responding to the role of clients and users of buildings and built

infrastructure, but extends to wider social, environmental and economic issues. This has challenging implications for the education of built environment professionals.

The CIB brings together over 2000 experts in 60 countries and has for over 50 years covered a wide range of hard, technical and soft, social topics, through around 50 working groups. Central to the CIB is an acceptance of the *complexity* of construction related issues and to work to address this by making *connections* between relevant experts. Over recent years there has been a deepening understanding that this connectivity has to run powerfully through the whole life cycle of a building / facility strongly addressing the contribution made to clients, users and society. This trend involves a shift in *consciousness* that sees construction as a key means to creating value, but not an end in itself. Thus, the four CIB priority themes that cross-cut the work of the working groups, address both the demand side, with emphases on sustainable development and clients' needs, and the supply side, with pushes in the areas of "revaluing" the capacity of construction industries and achieving integrated design solutions at the project level.

And of course, the CIB also has working groups specialising in education and disaster management!

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Keynote paper

“Stakeholder Consultation in the Decision Making for Development Projects using Educated Trade-offs”

Professor Malik Ranasinghe
Vice-Chancellor, University of Moratuwa, Sri Lanka
(email: vc@mrt.ac.lk)

Stakeholder Consultation in the Decision Making for Development Projects using Educated Trade-offs

Professor Malik Ranasinghe
Vice-Chancellor, University of Moratuwa, Sri Lanka
(email: vc@mrt.ac.lk)

Abstract

The recovery from the Tsunami that struck Sri Lanka in 2004 was hampered by a decision taken by the Government of Sri Lanka (GOSL) not to permit reconstruction of any building 100 meters from the coastline, even if the property right was privately owned and the reconstruction/rehabilitation was carried out without any support from the GOSL. This decision taken without any consultation with those who were affected, the stakeholders, severely delayed the recovery from the Tsunami.

When resources are scares, stakeholders' judgments on trade-offs between different resource uses tend to be emotional than rational. As such, stakeholders need to be well informed on all aspects of conflicting issues, to make rational decisions on trade-offs between limited natural resources. A five-step framework to formulate 'educated trade-offs' is proposed which can be used as a tool for effective stakeholder consultation in the decision making of development projects. This paper focuses on the application of the framework to the conflicting issues related to clay mining in Sri Lanka.

The term 'educated trade-off' means that stakeholders are able to engage in technically, economically and environmentally (including socially) informed (educated) decision-making between the critical resource uses (trade-offs) in development projects. The conflicting uses/issues of the development project are identified through the consultation of key stakeholders. The critical bounds of the technical requirements of the conflicting resource uses/issues identified are first estimated. The economic value and the environmental value of the respective critical bound of the technical requirements are then estimated. Combining the economic and the environmental value of critical bounds, "educated trade-offs" for stakeholder consultations are established.

Keywords: educated trade-offs, stakeholder consultation, economic values, environmental values, clay mining

1. Introduction

The recovery from the devastating Tsunami that struck Sri Lanka on 26 December 2004 was severely hampered by a decision taken by the Government of Sri Lanka (GOSL) not to permit reconstruction of any building 100 meters from the coastline, even if the property right was privately owned and the reconstruction/rehabilitation was carried out without any support from the GOSL. This decision taken without any consultation with those who were affected, the stakeholders, delayed the recovery from the Tsunami. Even though this decision was subsequently revoked by the GOSL, it caused numerous hardship and anxiety to those stakeholders who were in a position to return and reconstruct their damaged property themselves.

Stakeholder involvement (consultation and participation) is an essential but an often-ignored aspect of decision making for development projects in all sectors. In the past, most development activities were planned and implemented independently, where the decisions were based on sectoral interests (e.g. hydropower, irrigation, mining of clay on river banks) and were primarily for economic or political benefit.

The environmental and social impacts of such sectoral activities, especially impacts on other stakeholders are generally not known and are often neglected at the design and planning stages [1]. Most of the negative long-term impacts including adverse effects of degradation of the environment and other ecological problems of such activities/projects are realized only long after the projects have been implemented [2].

With the realization of the importance of the social and environmental impacts of development projects, stakeholder involvement has been identified as an aspect that goes hand in hand with the technical development of a project enabling adjustments needed from time to time. With attempts at 'integrated river basin management', a wider stakeholder involvement has been used increasingly in the recent past in river basin projects [3], [4], [5], [6], [7].

There are two important recent research projects on stakeholder participation in integrated river basin management, European Union HarmoniCOP (Harmonising Collaborative Planning) Project [8] consisting of nine European countries and Illinois River basin study consisting of three states in the United States of America [9].

The EU HarmoniCOP project attempts to give a comprehensive overview and analysis of the state of the art in participatory River Basin Management Planning (RBMP) in Europe, using a social-learning perspective. It also addresses scale issue in public participation and RBMP in a systematic way and uses information and information tools as a means for social learning in participatory RBMP in different national, cultural, geographical, institutional and legal contexts [8]. The Illinois River basin study attempts to advance stakeholder consensus through an interactive process of communication, analysis, education and deliberation by providing stakeholders with sufficient information, analysis and imagery to enable them to arrive at a consensus on polices that can be successfully adapted and implemented [9].

With motivation from the above two studies, [8], [9], a framework is formulated to estimate the 'educated trade-offs' which is a tool for the stakeholders of development projects to make intelligent decisions between the different uses of limited natural resources [10]. The term 'educated trade-offs' means that stakeholders are able to engage in technically, economically and environmentally (including socially) informed (educated) decision-making between the critical resource uses/issues (trade-offs). The framework attempts to identify the key impacted stakeholders, the key social and environmental impacts and then to value them.

The objective of this paper is to describe and demonstrate the versatility of the framework developed to formulate ‘educated trade-offs’, which can be used as a tool for effective stakeholder consultation in the decision making of development projects. The next section describes the framework. The conflicting issues related to clay mining on the lower reaches of the Ma Oya river basin in Sri Lanka is used to demonstrate the versatility of the framework in the third section. The conclusions on the application of the developed framework to clay mining in Sri Lanka are stated in the fourth section.

2. Educated Trade-off Framework

1. The framework consisting of the five steps to determine educated trade-offs is as follows.
2. Identify the multiple stakeholders and the resource uses/issues that need stakeholder consultation for the development project.
3. Bound technical requirements of the resource uses/issues.
4. Estimate economic value of the critical bound of the technical requirement of the resource uses/issues.
5. Estimate environmental (including social) value of the critical bound of the technical requirement of the resource uses/issues

Estimate net value of the critical bound of the technical requirement of the resource uses/issues by combining the economic and environmental (including social) values.

2.1 Step 1 - Identify the Multiple Stakeholders and the Resource Uses/ Issues that need Stakeholder Participation

This step identifies the multiple stakeholders and the resource uses/issues, which need to be addressed through stakeholder consultation. Development projects are complex and in that they involve many different stakeholders with divergent views and expectations [11]. For example in a river basin, the interest of stakeholders could be of many folds; how they are linked to the basin, use of resources, restrictions faced by them with respect to the use of resources, awareness of negative impacts of their uses, concern for environment and other uses. The stakeholders also represent a variety of sectors such as government administrative authorities, line ministries and agencies, NGO’s, other formal and informal groups, and as individuals. Besides the education level, age and gender are also important factors to be considered in selecting a representative group of stakeholders for data collection as well as for decision-making.

In any development project four main categories of stakeholders are possible [11].

- Directly affected people: those who reside and derive their living from areas where the project will have a direct impact.
- Indirectly affected people –Those who reside near project area or relies on resources in the project area and will have to change or adjust their livelihoods.
- Government and public sector agencies – Ministries, provincial, district or local government agencies such as those responsible for land, water resources, agriculture.
- Other stakeholders – project donors, NGOs with a direct interest in the project, external advisors, consultants and private sector.

In the case of a new development project, the identification should include all present resource use sectors, possible future developments and environmental concerns and to screen for the sectors, which will be significantly impacted by the development project. For existing issues, like clay mining the concerns raised by the different categories of stakeholders are the starting point to apply the framework.

For example, the critical issues in the Ma Oya river basin at the mid reaches are sand mining, discharging of pollutants by industries, extraction of water to supply urban areas. At the lower reaches the above issues are expanded to include clay mining and maintaining the ground water level to provide fertility to the lands in the basin. Decisions with regard to limitations in critical issues such as sand and clay mining and the allocations for water extraction/consumption issues will have to be made using educated trade-offs starting through stakeholder consultation.

2.2 Step 2 - Bound Technical Requirements of Natural Resource Uses/Issues

In this step, the engineering knowledge is utilized to estimate the critical bounds of the technical requirements for utilization of the different resource uses of the development project. For example in the Ma Oya river basin issues dominated by water such as requirements for human consumption, water supply and environmental needs would have the volume of required water as the technical measure with the minimum volume to satisfy the requirements being the critical bound. Other river basin uses such as sand mining, clay mining and discharging of pollutants would have the volume of clay or sand extracted and volume of pollutant discharged as the technical measure with the maximum volume not to exceed assimilative capacity of the river basin being the critical bound.

The estimates for critical bounds could then be used to educate the stakeholders technically, on minimum/maximum requirements of resources (upper/lower bounds) for different use sectors.

2.3 Step 3 - Estimate Economic Value of the Critical Bound of the Technical Requirement of Resource Uses/ Issues

The upper/lower bounds of the economic values of different resource uses are estimated in this step of the framework. The starting point of the economic analysis of a resource use is the financial analysis of that resource use.

The financial analysis measures the receipts (benefits) and payments (costs) relevant to the investors or owners of the resource/project. It is a tool that provides investors with the information required to decide whether to undertake an investment. Hence, the objectives of the financial analysis are to determine, analyse and interpret all financial consequences that may be relevant to and significant for investment and financing decisions.

The economic analysis is of exactly the same nature as a financial analysis, except the benefits and costs are measured from the viewpoint of the economy. Instead of relying solely on cash flow techniques to measure benefits and costs as in the case of the financial analysis, economic valuation requires the use of economic techniques of measurement. The economic net present value (*ENPV*) of a resource use can be expressed as [12];

$$ENPV = \sum_{i=0}^{n} \frac{B_i - C_i}{(1+r)^i} \qquad (1)$$

where B_i and C_i are the benefits and costs of the resource uses in the i^{th} year, 'n' is the duration of the project period and r is the discount rate.

For example in the Ma Oya river basin uses/issues dominated by water such as requirements for human consumption, water supply and environmental needs, the economic value would be the value of the volume required to satisfy the minimum water requirements of that use/issue. For other river basin uses such as sand mining, clay mining and discharging of pollution the economic value would be estimated at the critical bound which is the maximum volume of the damage not to exceed the assimilative capacity of the river basin (or the replacement value to restore the damaged resource).

2.4 Step 4 - Estimate Environmental Value of the Critical Bound of the Technical Requirement of Resource Uses/ Issues

Implementing a new development project or prioritizing a resource allocation could cause imbalance in the existing system and create social and environmental impacts on other users. Valuations of such impacts as environmental and social costs or benefits are carried out at this step.

Then all of the environmental benefits and costs of impacts valued in constant value terms become line items in the economic analysis. The present value of the environmental costs (*PVofEC*) can then be obtained as;

$$PVofEC = \sum_{i=0}^{n} \frac{E_i}{(1+r)^i} \qquad (2)$$

where Ei is the net environmental costs of the resource uses in the ith year, 'n' is the duration of the project period and r is the discount rate [2].

The economic costs and net environmental costs are separated in order to focus on environmental costs and benefits. As suggested by Pearce and Warford [2], present value of the EnvioPV is construed to be a cost, but in a number of cases EnvioPV may well be a benefit. The present value of environmental costs of the next best alternative (i.e. externalities of the alternative that is not adopted) is considered to be environmental benefits of the preferred alternative due to the avoided environmental costs [13].

The net environmental costs referred to here are those, which are either not quantified or underestimated in the economic analysis as part of normal engineering practice. Economists use a range of primary and secondary valuation methods to assign values to environmental impacts and the methodologies to evaluate environmental values are based on them [14].

2.5 Step 5 - Estimate Net Value of the Critical Bound of the Technical Requirement of Resource Uses/Issues by combining the Economic and Environmental Values.

The combined value of the technical bound can be estimated from the extended net present value (*ExNPV*), process by which indirect costs are included into the economic analysis, as [13],

$$ExNPV = \sum_{i=0}^{n} \frac{B_i - C_i}{(1+r)^i} - \sum_{i=0}^{n} \frac{E_i}{(1+r)^i} \qquad (3)$$

Knowing the combined net economic value at the critical bound of the technical requirements (*ExNPV*), helps stakeholders to make decisions based on educated trade-offs on the issues/uses that need to be prioritized.

3. Application of the Framework to Clay Mining in Sri Lanka

Until the 1980s, the mining of clay for the production of bricks and roof tiles in Sri Lanka was done manually during the dry months. With the increase in the demand for building materials during the eighties and nineties, the mining process for clay was mechanised. This resulted in large clay pits, some over fifty feet deep, which fill with water during the wet season. Since pumping water after the wet season for further mining becomes expensive, the miner attempts to remove as much clay as possible during a single dry season. Hence, the environment is changed drastically within a short period. The impacts of this change identified by stakeholders can be seen in [15]:

- large areas of abandoned clay pits along the Ma Oya River banks;
- loss of productivity of adjoining agricultural lands - abandoned rice fields are visible where clay mining has been carried out;
- an increase in the incidence of health problems such as malaria and respiratory diseases.
- lowering of water levels in the dug wells used by villagers.

The people in the affected areas feel that social costs of clay mining are so great that the only solution is to ban clay mining. While clay miners acknowledge that there is an impact on the environment due to clay mining, they argue that they are carrying out a necessary economic activity after paying the required fee [15].

The developed framework for educated trade-offs is applied to the conflicting issues related to clay mining in the Ma Oya river basin. The next section analyses the viewpoint of the miner by developing a condition for private (financial) profitability (feasibility) of clay mining. The third section analyses clay mining from the viewpoint of the economy by developing a condition for economic feasibility. This analysis excludes social (environmental and non-environmental) costs of clay mining. In the fourth section damage to roads as non-environmental costs; and health costs and costs of productivity loss as environmental costs are estimated. This provides the lower bound for cost of clay mining. The condition to analyse the social profitability (feasibility) of clay mining is developed in the fifth section by including the social costs to the economic feasibility for the extended benefit cost analysis.

3.1 Private Profitability of Clay Mining

Study Area

The focus area of the study was the Dankotuwa Divisional Secretariat which is located in the Puttlam District in the North Western Province of Sri Lanka. It is the area where the largest volume of clay on the Ma Oya river basin has been and is being mined. The study area consists mostly of privately owned coconut and rice lands. In the areas of clay mining there are no forests and no endangered wildlife. See Ranasinghe [15], [16], [17] for details of the study.

The average depth of clay pits in different local administrative areas in the study area ranged between 8 to 24 feet with an overall average depth of 17.5 feet. Since the depths of individual clay pits were elicited from clay pit owners and village officers, the estimates were generally believed to be lower than the actual depths. A sample clay pit, 1 acre in area and 20 feet in depth, was used throughout the study for estimation purposes [15]. That allowed all estimations to be compared for the same volume of clay and/or pit size. The in-situ volume of the sample pit is 8,712 cubes (1 cube = 100 cubic feet). All estimations used British Imperial units because the market prices for clay and transport are per cubes in the study area.

Condition for Private Profitability

The condition that will ensure clay mining to continue as a private economic activity is,

$$- MCL + PB_c - PC_c > 0 \qquad (4)$$

where MCL is the market cost of the clay land to the miner, PB_c and PC_c are the private benefits and the private costs of clay mining at time zero, respectively.

Private Benefit

The market price of a cube of clay at the time of the study was US$ 4.80 (today it is approximately US$ 23). The insitu volume of the sample clay pit is 8712 cubes. However, during excavation there is bulking of clay. The value for bulking that is generally used in Sri Lanka is 40%. For all estimations in this case study, 40% of bulking on excavation is assumed. Then, the volume of clay sold from the sample pit is 12,190 cubes and private benefit to the miner is US$ 58,512 [15].

Market Cost of Clay Land

According to Harischandra [18], the market value of an acre of clay in the sample study areas where mining is not prohibited was approximately US$ 16,000 [15] (today it is approximately US$ 27,200).

Direct Production Costs of Clay Mining

The mechanized operation to mine clay requires in general, an hydraulic excavating machine, a skilled machine operator for the hydraulic excavating machine, an unskilled labourer to assist the machine operator, and a supervisor to be in charge in general and to keep count of the volume of clay that is sold from the clay pit. The machine cost was estimated at US$ 17,066 and labour cost at US$ 1740 per sample clay pit [15]. Therefore, the direct production cost to mine the sample clay pit of 20 acre feet was estimated at US$ 18,806 [15].

Analysis

The market rate for capital is used as the discount rate. The average market rate for capital available to the private sector was assumed at 24% for the study [15]. As shown earlier, this analysis assumes that the mining operations and the sale of clay in the sample pit are completed within six months. Hence, there is no impact of inflation on the discount rate. For discounting, it is assumed that benefits and costs of clay mining will occur at the mid point (three months) of the six month mining operation. Then, the net present value equation for private profitability can be written as,

$$NPV = - MCL + \frac{PB_c}{(1+i)^{0.25}} - \frac{PC_c}{(1+i)^{0.25}} \qquad (5)$$

The estimated benefits and costs of the sample clay pit for the private profitability condition are depicted in Figure 1. The net present value from equation (5) when the discount rate is 24% is US$ 21, 627. The benefit cost ratio is 1.64 [15].

3.2 Economic Feasibility Of Clay Mining

The objective of an economic feasibility analysis is to ascertain whether an activity can be expected to create more net benefits to the economy than any other mutually exclusive alternatives, including the option of not doing it. In principle, the economic analysis should take into account all benefits and costs to the economy, and it is generally confined to inputs and outputs incurred or produced directly by the activity or the project [12].

This analysis required shadow priced clay sold from the pit, shadow priced labour and equipment cost, opportunity cost of clay land and economic discount rate. The economic discount rate of 6%, recommended to the National Planning Department, Sri Lanka by Curry and Lucking [19], was used for the economic analysis.

Condition for Economic Feasibility

The condition for economic feasibility of clay mining is,

$$- OCL + PEB_c - PEC_c > 0 \quad (6)$$

where OCL is the opportunity cost of the clay land, PEB_c and PEC_c are the economic benefits and the economic costs of clay mining, at time zero, respectively. Similar to the previous analysis, it is assumed that mining and sale of clay in the sample pit will be completed within six months of commencing mining operations.

Economic Benefit

Since there is no taxation on sale of clay and sale of clay is carried out by private individuals, the market price was assumed as the economic price. Thus, the economic benefit from the sale of clay in the sample clay pit of 20 acre feet was US$ 58,512 [15].

Opportunity Cost of Clay Land

The opportunity cost of a clay land is defined as the cost of the next best use of that land [20]. The opportunity cost of clay land, cost for using it for housing, was assumed as US$ 8000 [15].

Economic Costs of Clay Mining

The direct production cost of clay mining in economic costs was estimated by converting the market prices to shadow prices. The economic machine cost was estimated at US$ 15,115 while the total economic labour cost to excavate the sample pit was estimated at US$ 1349 [15]. Therefore, the economic production cost to excavate a sample clay pit of 20 acre feet was estimated at US$ 16,464 [15].

Analysis

The net present value equation for economic feasibility can be written from equation (1) as,

$$ENPV = - OCL + \frac{PEB_c}{(1+i)^{0.25}} - \frac{PEC_c}{(1+i)^{0.25}} \quad (7)$$

The estimated economic benefits and costs for the sample clay pit are depicted in Figure 2

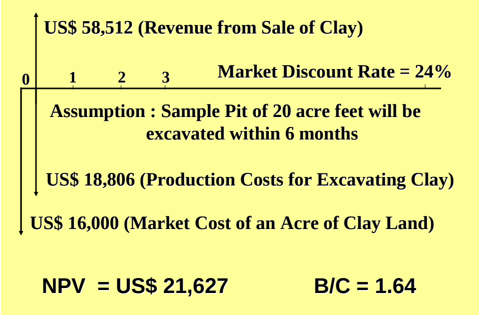

Figure 1. Private Profitability of Clay Mining

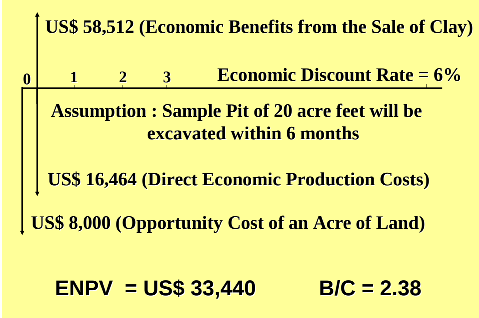

Figure 2. Economic Feasibility of Clay Mining

Assuming 6% economic discount rate [19], the economic net present value by mining the sample pit from equation (7) was estimated as US$ 33,440. The benefit cost ratio is 2.38 [15].

3.3 Environmental and Social Costs of Clay Mining

There are no conceivable environmental or social benefits from a mined clay pit. However, it could be argued that a mined clay pit could be converted to a fishpond, or used to dispose of solid waste. For the clay pit to be converted to a feasible fishpond, the depth should not exceed six feet, and there is hardly any clay pit in this category. Also, fishponds might not be acceptable in the study area for religious and cultural reasons [15]. Since these clay pits are located in a rural area, there is hardly any solid waste to dispose of. However, low-grade compost from solid waste in the Greater Colombo area could be a feasible fill material in the future. On the other hand, there are environmental costs of an excavated clay pit. Two environmental costs have been identified: health costs as loss of earnings and medical costs of the residents in the affected area, and costs due to productivity loss of adjoining rice fields and coconut lands. Costs due to the deterioration of village roads are identified as non-environmental social costs [15].

Environmental Costs

Health and productivity loss costs were identified as main environmental costs associated with clay mining. While the list could be extended to include loss of biodiversity, the study area consists of coconut and rice lands of small extents, which have been occupied by villagers for generations and there are no known habitats in the area. An acre of land, if it is well cultivated would loose approximately 65 coconut trees due to excavation [15].

The study on environmental costs of clay mining was done in two stages. First a detailed questionnaire survey was conducted in 280 households. Secondly, statistics were gathered from institutions such as Anti-Malaria Campaign Directorate, Respiratory Disease Control Directorate, and respective Medical Officers of Health (MOH) offices along both sides of the

Ma Oya River for health cost, Agrarian Services and Coconut Research Institute for productivity loss [15].

Health Cost

The stakeholders believed that incidence of Malaria and respiratory diseases have increased since the increase of mechanised clay mining. Doctors practicing both western medicine and native medicine confirmed this belief [15]. A questionnaire surveyed incidences of malaria and incidences of respiratory diseases from 280 households. From this data, health cost was estimated at US$ 1832, US$ 2.56, US$ 165.2 as maximum, minimum and average health cost of malaria due to the sample clay pit of 20 acre feet per annum respectively [15].

Increases in the common cough, wheezing and asthma were identified as the main impacts due to transportation of clay. These respiratory diseases occur more frequently during the dry season when clay transportation occurs. The estimated maximum, minimum and average health cost due to the sample clay pit were respectively, US$ 13.6, US$ 0.72, and US$ 4.0 [15].

Productivity Loss

A pilot survey revealed that stakeholders in the study area believe that there is a significant loss of productivity of rice fields and coconut lands adjacent to areas of clay mining. Abandoned rice fields are clearly visible in the area [15].

When asked in the questionnaire survey whether there was an impact on rice fields due to clay mining, 96% of the stakeholders involved in rice cultivation said that there was. The survey revealed that 46% of the rice fields have been abandoned. The reason attributed for this action is that the rate of drying up of water in the rice fields during the dry season is too severe for rice production. The cause for this rapid drying is that the Ma Oya river bed which, determine the level of the groundwater table during the dry seasons is now deeper due to extensive sand mining. This situation is aggravated by the large and deep clay pits that are located along the river [21]. The annual productivity loss in rice due to the sample clay pit was estimated to be US$ 34.80 [15].

The second aspect of the survey was to find out the impact on coconut lands due to clay mining. When inquired, 93% of the households were of the view that there was an impact. The annual productivity loss in coconuts due to the excavated sample clay pit of 20 Acft was estimated as US$ 400 [15]. Thus, the annual productivity loss in rice and coconuts due to the excavated sample clay pit of 20 acre feet in the study area is estimated at US$ 434.80 [15].

Non-Environmental Social Costs

The deterioration of village roads due to the transport of clay was identified as the main non-environmental social cost due to clay mining, where most of the village roads are classified as Class C or below. These roads were designed for low traffic volumes and, for economic reasons, nominal (which means non-existent) maintenance. Because of clay excavation, traffic in these roads has increased way beyond design volumes. Since about half of these trips are with clay, there is a rapid deterioration, long before normal design life. Hence, the annual non-environmental social cost due to the sample clay pit of 20 acre feet was estimated as US$ 5.80 [15].

Analysis

For analysis purposes a study period, *n*, of fifty years is assumed. Then, the equation for the Present Value of the Environmental Costs (*PVofEC*) can be written from equation (2) as,

$$PVofEC = \frac{ECT}{(1+i)^{0.5}} + ECA * \frac{(1+i)^n - 1}{i(1+i)^n} \qquad (8)$$

where *ECT* are the annual social costs due to transportation of clay assumed to occur during the middle of the first year and *ECA* are the annual environmental costs assumed to occur as long as the sample clay pit remains starting from the end of the first year.

It is assumed that the social costs due to transportation of clay, *ECT*, consists of annual health cost due to respiratory diseases (US$ 4) and the non environmental cost due to deterioration of village roads (US$ 5.8). The environmental costs per annum, *ECA*, are annual health cost due to malaria (US$ 165.2) and annual productivity loss (US$ 434.8). The estimated environmental and non-environmental costs for the sample clay pit are depicted in Figure 3.

Assuming 6% as the extended discount rate, the present value of the social costs due to transportation of clay is US$ 10; and of annual environmental costs is US$ 9457, respectively. Then, the present value of the environmental and social costs caused by the sample clay pit from equation (8) is approximately US$ 9,467 [15]. This is the minimum amount the affected stakeholders, the villagers and adjoining land-owners, should be compensated for the change caused by mining the sample clay pit. In other words, it is the lower bound of the stakeholder viewpoint of the cost of clay mining the sample pit as shown by Figure 4.

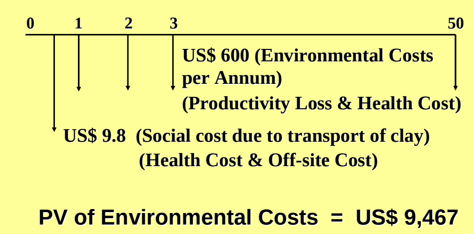

Figure 3. Social (Environmental/Non-Environmental) Costs of Clay Mining

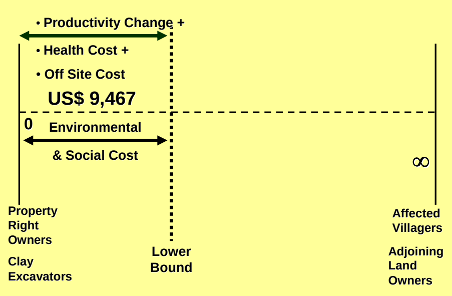

Figure 4. Stakeholder Viewpoint of the Cost of Clay Mining

3.4 Social Profitability of Clay Mining

Even though in principle, the economic analysis should take into account all benefits and costs to the economy due to an activity, little attention is paid to long term environmental impacts of that activity [12], [22], [23], [24]. At present, many indirect costs are included in the economic analyses by means of environmental and or non-market valuation [25]. This process is called the extended benefit cost analysis. Munasinghe [23] states that the first step in doing environmentally sound economic analyses is to determine the environmental and natural resource impacts of the project, and these physical impacts should be determined by comparing the "with project" and the "without project" scenarios. The second step involves valuing the identified physical impacts and relationships because an environmental impact can result in a measurable change in production and/or change in environmental quality.

This analysis included damage to roads as non environmental social costs; and health costs and costs of productivity loss as environmental costs; to the economic feasibility analysis to determine the social profitability of clay mining.

Condition for Social Profitability

The condition for social profitability of clay mining is,

$- OCL + NPB_c - SC_c > 0$ (9)

where OCL is the opportunity cost of the clay land, NPB_c $(= PEB_c - PEC_c)$ is net economic benefits of clay mining and SC_c is social (non environmental and environmental) costs of clay mining.

Only if this condition is positive, should clay mining be permitted in Sri Lanka. In addition, miners should either be required to restore the pits, or pay some sort of compensation to the local communities for the change they are causing to the environment. Clay miners may object to these requirements, but it is better than simply banning the industry because of its negative environmental impacts.

Analysis

For analysis purposes a study period, n, of fifty years is assumed. Then, the extended net present value ($ExNPV$) equation for this scenario can be written from equation (3) as,

$$ExNPV = - OCL + \frac{NPB_c}{(1+i)^{0.25}} - \frac{ECT}{(1+i)^{0.5}} - ECA * \frac{(1+i)^n - 1}{i(1+i)^n} \qquad - (10)$$

where OCL is the opportunity cost of clay land, NPB_c is net economic benefits of clay mining assumed to occur at the mid point of the six months mining operation for discounting, ECT are the annual social costs due to transportation of clay assumed to occur during the middle of the first year and *ECA* are the annual environmental costs assumed to occur as long as the sample clay pit remains starting from the end of the first year. The values are shown in Figure 5.

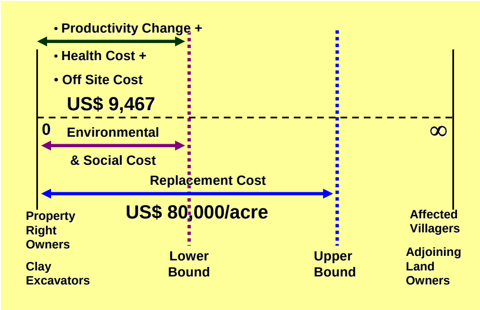

Figure 6. Stakeholder Viewpoint of the Cost of Clay Mining

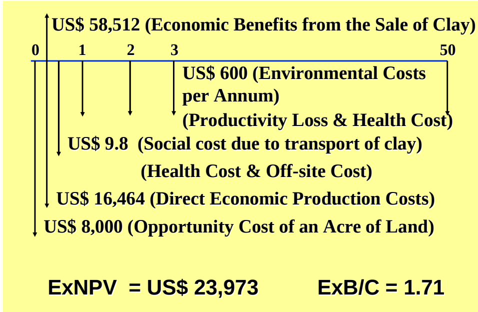

Figure 5. Social Profitability of Clay Mining

From equation (10), the net present value from mining the sample clay pit when the extended discount rate was 6% is US$ 23,973. The benefit cost ratio was 1.71 [15]. Therefore, clay mining in Sri Lanka is socially profitable. In other words it is not possible to justify banning clay mining on environmental concerns. However, the regulations that stem from the Minerals and Mining Act No. 33 of 1992 should be properly enforced to compensate the affected stakeholders and to internalize the externality caused by clay mining. Refilling of the clay pit after excavation would internalize the externality caused by clay mining. The replacement cost of the sample clay pit of 20 acre feet was estimated at US$ 80,000 [15].

4. Conclusions on Application of the Framework to Clay Mining

The following conclusions can be derived from the application of the framework developed for educated trade-offs to the conflicting issues of clay mining in the lower reaches of the Ma Oya.

1. Clay mining is privately profitable (feasible) as the discounted net private benefits of clay mining are positive and the benefit cost ratio was 1.64. Therefore, no matter what "command and control" measure is imposed clay mining will continue as a private economic activity.
2. Clay mining is economically feasible as the discounted net economic benefits are positive and the benefit cost ratio was 2.38. In other words, clay mining will create more net benefits to the economy than any other mutually exclusive alternatives from the clay land.
3. Clay mining is socially profitable (feasible) as the present value of net economic benefits are greater than the present value of social (environmental and non-environmental) costs of clay mining and the benefit cost ratio was 1.71. Therefore, regulated clay mining should continue as an economic activity in Sri Lanka.
4. Unregulated large scale clay and sand mining over a long period (about 25 years), primarily due to corruption, pressure from the politicians and official lethargy have destroyed the fertile land around the river banks of the lower reaches of Ma Oya.

5. The lower value of social (environmental and non-environmental) costs caused by a clay pit of 20 acre feet was approximately US$ 9,467. If the clay miners are not required to restore (refill) clay pits after mining, then the authorities should and must ensure that the miners pay compensation at least equivalent to the social costs to local communities to compensate for the change they are causing to the environment. The cumulative effect on the environment from a number of open clay pits can be significant.
6. The main contribution of the application of the framework is the bounding of an emotional problem on the Ma Oya basin as shown in Figure 6. The clay excavators now accept that there is a cost to be paid for changing the environment by clay mining. The affected villagers and adjoining land-owners accept that regulated clay mining could go on as long as the clay pits are rehabilitated. An emotional issue has been bounded, with upper and lower limits, as educated trade-offs, for rational decision making regarding clay mining in the Ma Oya river basin of Sri Lanka.

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Keynote paper

"*21st Century Hazards and the Built Environment : How Futures Thinking and the Foresight Principle Can Prepare Us*"

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21st Century Hazards and the Built Environment : How Futures Thinking and the Foresight Principle Can Prepare Us

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Abstract

There is the challenge to the professions of the built environment to create a mindset and a skillset within its ranks that promotes a greater awareness of risk and an improved facility in hazard appraisal and disaster management.

The aims of the paper are fivefold.

- To explain why 21st Century hazards are different.
- To explore the global hazards we face.
- To examine the attributes of global challenges.
- To evaluate the nature of 'foresight' and the potential role of 'futures techniques' in preparing for hazard appraisal and risk management.
- To espouse a futures-oriented mindset among built environment researchers, educators an practitioners in facing and addressing the natural, man-made and environmental hazards that lie ahead.

The overriding rationale being that:

"No problem can be solved from the same level of consciousness that created it. We must learn to see the world anew" [Albert Einstein].

Keywords: 21st Century challenges. Hazards. Foresight Principle. Futures thinking. Prospective

1. Exordium

There is a growing awareness that humankind is on a non-sustainable course which could lead to "grandscale catastrophes" [e.g. Lovelock, 2006; Rees, 2004]. At the same time, however, we are unlocking formidable new capabilities. This could be humanity's last century, or a century that sets the world on a new course towards a spectacular future. Echoing the warnings of Hawken *et al* (2000), and their promotion of 'natural capitalism' as a necessary fundamental change in the way of doing business, the global economy seems to be outgrowing the capacity of the earth to support it. As part of all this, there is also generally the need to understand, prepare for, and respond to natural, man-made and environmental disasters. Most particularly, in the context of this conference, there is the challenge to the professions of the built environment to create both a mindset and a skillset within its ranks that promotes a greater awareness of risk and an improved facility in disaster management. This paper proposes that 'futures thinking' through the adoption of the 'foresight principle' and the employment of 'scenario planning techniques' can contribute significantly to research and education in this field.

2. 21st Century Challenges

There is widespread recognition that we live in an era of rapid change in which new discoveries, philosophies and technologies play an ever more prominent part in shaping social and economic development. The world is becoming increasingly complex, more competitive and better connected. There is economic internationalistation on the one hand, yet cultural decentralisation on the other. Society has shifted from an industrial base to an information and knowledge orientation. Advances in genetics, materials, energy, computing, robotics, miniaturisation, medicines, therapies and communication proceed apace. The developed world is getting smaller, older and wealthier, whilst the developing world grows bigger, younger and relatively poorer. A blurring of boundaries between disciplines, industries and social enterprises is taking place. And, as those boundaries fade, the lines connecting the constituent parts become more critical, so that networks, systems and holistic thinking are more meaningful. Moreover, crucial issues on a global level – demographic, natural resources, the environment and human culture – have to be addressed. All in all, a veritable transformation, or great disruption, is occurring. Something old is coming apart at the seams, and something new is emerging.

2.1 Why the 21st Century is Different

Until relatively recently humankind retained a simplistic view of the world. Back in the 1960's, and early 1970's, it seemed possible to keep an overview of development, take future changes into account and make five to ten year planning proposals based on ten to twenty year forecasts. It was a period of trend projection, time series, network analysis and mathematical modelling. Above all, perhaps, it was an era with a belief that tomorrow would mostly resemble today. The future was a given, and planning of all kinds sought to adapt current trends to meet that predestined condition. During the 1970's, and into the 1980's, however, the view of the future changed. With sudden and significant economic disruptions and social upheavals the future did not seem as predictable as had previously been imagined. Indeed, it became recognised as uncertain. There was no longer only one likely future path of development, but several different and possible futures. All these futures, moreover, would be shaped by a number of **critical challenges.**

- ***Too many people***. As the world's population grows to about 9 billion around 2050, global tensions will climb as a result of dropping water tables, rising and changing consumer demand, uncontrolled migratory movements, demands for equality in healthcare, pollution, famine, congestion, unemployment, poverty, disease, starvation, social violence and the like. *The challenge is to determine and achieve a stable and sustainable population for the earth.*
- ***Not enough resources***. Conflict over valuable resources – and the power and wealth they confer – is fast becoming a prominent feature of the global landscape. International security experts argue that in the early decades of the new millennium, wars will be fought not over ideology, but over dwindling supplies of precious natural commodities. *The challenge is to shift economic thinking from an emphasis on human productivity to a radical increase in resource productivity through the concept of natural capitalism.*
- ***It takes time***. Many, if not most, of the major 'momentum trends' for the 21st Century are long-term in their formation, impact and necessary control. We need to 'stand in the future' and create a strategic view that is unrestricted by the exigencies of the present – imagine ahead and plan backwards. Whilst we cannot predict the future in detail or with surety, we can study the alternative directions it might take and how to influence them over time. *The challenge is to learn how to handle long-term, intergenerational, lead-times.*
- ***There will be new technologies***. With 20th Century technology, there was a massive gulf between natures systems and man-made systems. At the dawn of a new century we are witnessing new discoveries, innovations and adaptations that combine living and non-living systems. There are new forms of medicine and farming. There is also the prospect of new forms of 'artificial life'. *The challenge is to decide how to use these technologies responsibly and harness them to create a better world.*
- ***What's the risk?*** Risk in the future could reach magnitudes of harm unimaginable hitherto in modern times. Due to the interdependence of economics and societies, risks in one country can spread rapidly to others, so the notion of risk needs to be broadened and precautions put in place at global, regional and national scales. Vital systems need greater protection and citizens need to be more fully involved as partners in decisions. *The challenge is to build trust and share the burden between the public and those in charge.*
- ***Redefining the enemy.*** Increasingly we are at war not with enemy states or foreign armies but with small groups of people or specific individuals: fugitive terrorists, drug traffickers, warlords, dangerous dictators, rogue scientists, villainous zealouts and the like. The needs of safety, security and defence are different. Yet powerful institutional barriers to fundamental change remain. *The challenge is to alter radically how we organise to defend and to fight.*
- ***Economics are complex.*** When viewed in out-of-equilibrium formation, economic patterns are all too often simplified into the facile equilibrium of standard economic models. In reality, economics are everchanging, showing perpetually novel behaviour and emergent phenomena. *The challenge is to portray the economy not as*

deterministic, predictable and mechanistic; but as complex, process-dependent, organic and continually evolving.

- ***Détente with dilemma.*** Well-schooled in solving problems, governance at all scales needs to re-educate itself in the art of acting intelligently, and also compassionately, in situations that have no solution. Agencies and organisations of all kinds will have to find tools and processes for teasing-out the first-, second-, and third-order dilemmas in these situations. They will also have to reconcile multiple stakeholders and design processes that generate new value out of apparent conflicts of interest. *The challenge is to reach some kind of détente with dilemma in a world with no externalities.*
- ***Running the show.*** There will be a redistribution and relayering of power and governance at all scales and across all sectors of society. Representative government is fine in theory, but frequently fails in practice. Why? Three reasons are suggested. First, populations tend to elect the average. Second, elected representatives tend to be members of short-sighted, self-serving political parties. And third, large numbers of people in the democracies' feel alienated from the political process. *The challenge is to promote more effective leadership, bring about a step change in the degree of collaboration between key players in a process, and foster a deeper engagement between local people and large organisations.*
- ***There will be surprises.*** Wildcards or jokers will be played from time-to-time. Some of these might be totally unexpected – some could be unlikely yet predictable. Leaders in organisations at all levels, and in all situations, need to collect the information, study the signs and confront the issues surrounding the degree of probability and scale of impact of macro-uncertainties that might impinge upon their areas of responsibility. *The challenge is to avoid tragedy by both anticipating and preparing to mitigate damage done by 'predictable surprises'.*

Perhaps the main difference that distinguishes the 21st Century from those that proceeded it is *the need to develop a mindset that can tackle the conscious design of large systems* – cities, communities, corporations, countries, cultures, domains and the earth itself.

2.2 The Hazards We Face

All the dimensions of change – frequency, magnitude, complexity, rapidity and visibility – are happening at an ever-accelerating pace. In the past, there has been a discernible pattern to change. This time, however, it is different, for change is far less sequential and certain, showing much greater discontinuity and unpredictability. Evolutionary change, however, is largely in human hands, and humanity, it is argued, must learn the rules in order to see a transition during this century to a planet managed well enough to make its long-term survival more likely [Martin, 2006]. A starting point, in the context of 21C hazards, is some form of classification of the hazards we face. The following ordering has been compiled by the author from several authorative sources [Canton, 2006; Glenn and Gordon, 2006; Leggat, 2006; Martin, 2006]. It identifies the five most significant hazards in each sector – economic, environmental, geopolitical, societal and technological.

2.2.1 Economic

World Trade. Widening disparities in wealth and welfare could cause serious disruptions unless a global partnership emerges based on ethical market economies to reduce the gap between rich and poor.

Rising Energy Demand. World energy demand will probably increase by about 60% between now and 2030, so the time has come for an Appollo-like programme to increase the global supply of non-polluting energy safely and efficiently.

Extreme Poverty. Market economics and globalisation are lifting the bulk of humanity out of extreme poverty, but special measures are needed, funded by affluent countries, over the next few decades to help the planets 1 billion indigent populations out of conditions of dire poverty.

Natural Capitalism. A fresh economic paradigm is starting to emerge founded on four central strategies of radical resource productivity, biomimicry, service and flow relationships between producers and consumers, and investment in natural capital.

Corporate Responsible Behaviour. How companies manage their strategic, tactical and operational activities to produce an overall positive impact on society is becoming a powerful imperative in the world's economy.

2.2.2 Environmental

- *Global Warming.* Further exacerbated by the induced release of methane from the permafrost or from clathrates on the continental shelves.
- *Biota Extinction.* The eruption of continental flood basalts leads to the mass extinction of 95% of biota.
- *A New Ice Age.* Caused either by natural cycles or by abrupt climate change from reduced Atlantic thermohaline circulation, leading to a loss of 65% of current land biomass.
- *Quakes and Eruptions.* Especially the super-eruption of somewhere like Yellowstone, producing a five to seven year volcanic winter reducing solar and wind power.
- *Water Resources.* Ensuring that everyone, everywhere can have access to sufficient clean water without conflict.

2.2.3 Geopolitical

- *Peace and Security.* At the extreme, preventing war among nations using weapons of mass destruction. But also determining when it is right to use force to intervene in the affairs of another country.
- *Terrorism and Ethnic Conflict.* Promoting a set of shared values and new security strategies to reduce the means and motivations for terrorism and ethnic conflict.

- *Organised Crime.* In contrast to military spending of around $1 trillion a year, annual income for organised crime has passed $2 trillion and is impeding governments' ability to act.
- *Leadership and Ethics.* Global ethical standards are merging from a variety of sources, but the education and development of decision-making for policy makers is lagging well behind.
- *Global communication.* The use, control and reliability of the internet and any successor information system will be crucial as the majority of the world's population becomes connected.

2.2.4 Societal

- *Health and Medicines.* Reducing the threat of new and re-emerging diseases and immune micro-organisms that could threaten civilisation, and slashing the costs of treating the world's most devastating illnesses.
- *Population Growth.* Balancing population growth, resource availability and sustainable development is a key issue with inherent risk. As humanity swells toward nine billion in the next half century it will undergo historic changes in the balance between young and old, rich and poor, urban and rural, so that choices now and in the years ahead will determine how well we cope with our coming of age.
- *Opportunity and Capability.* Developing the capability latent in everyone, with particular emphasis on changing the status of women to improve the human condition, and helping young people everywhere understand the meaning of the 21C.
- *Decision Making.* Making policy formulation more sensitive to long-term prospectives, improving the capacity to decide as the nature of work and institutions change and incorporating more routinely ethical considerations into decisions at all levels.
- *Biodiversity.* Developing a new understanding of how species become extinct, and how to preserve them, is a hallmark of a civilised society.

2.2.5 Technological

- *Scientific Experimentation.* There is the danger that some scientific developments could change the fundamental fabric of the universe in a way not previously seen in nature.
- *Nanotechnology.* The theoretical threat exists of planet-wide spread of exponentially self-replicating nano-machines utilising DNA/chlorophyll ('green goo'), or bio-vorous fully artificial nanoreplictors ('grey goo').
- *Acclerating Technology.* Factors causing the acceleration of scientific/technological innovation are themselves accelerating, to such an extent that perhaps an international Sci/Tech agency or organisation may be needed to examine the potential consequences.
- *ICT Convergence.* Hazards prevail in determining how the global convergence of information and communications technologies can work for the benefit of everyone and be safeguarded from corruption, distortion and criminality.
- *The Singularity.* A number of scientists believe machine intelligence will surpass human intelligence within a few decades, leading to what has become known as the

‘singularity’, and producing in the words of Ray Kurzweil (2005) technological change so rapid and profound it could create a rupture in the very fabric of human history. What we have to do perhaps is understand how any ‘transhumanist’ changes to Homo sapiens can be made without negative consequences.

Then, of course, there are the real *‘wild cards’,* such as an asteroid or comet over 10km striking the earth, or the collapse of a supermassive star causing an intense pulse of x-rays, cosmic rays and muon particles. A ‘wild card’, however, need not necessarily be bad, it can be marvellous – a ‘benestrophe’ rather than a catastrophe [Cornish, 2004]. Those might include : war fades from history; energy that is almost free; a happiness pill is perfected; death becomes an ecstatic experience; permanent human settlements in space; drugs to boost human intelligence; a really effective ‘youth treatment’ is found; or a ‘world brain’ is constructed. But perhaps such ‘benestrophes’ raise more questions than catastrophes?

3. The Foresight Principle

3.1 Futures-oriented Thinking

Foresight is the principle producing the prime methodology for the practice of futures studies. The main purposes of adopting a futures approach have been listed elsewhere as follows [Gannon and Ratcliffe, 2006].

- Extending thinking beyond the conventional and fostering more forward thinking as a result.
- Forcing thoughts and stimulating conversations about the future.
- Helping identify assumptions about the future that might require examination, testing and subsequent modification.
- Encouraging people to have regard for the positive possibilities and opportunities that tomorrow might hold, as well as the potential threats and disasters.
- Making more intelligent decisions today concerning the future by focusing the mind on the most important questions that must be resolved in order to formulate better policy.
- Inspiring people to ‘think outside the box’.
- Widening perspectives and increasing the number of options available for exercising more deliberate decision-making towards positive change.
- Preparing for, and managing change better by enhancing the capacity to learn.
- Making response times to actual future events much shorter and reactions more relevant.
- Fostering active participation in strategic thinking leading to decision-making.

In the context of major disaster management, the use of futures methods offers a rigorous, comprehensive and integrated approach towards anticipating, planning and implementing recovery and reconstruction operations, relying, as it does, more on intuition, participation and adaptability than conventional strategic thinking and planning systems. Most excitingly, a futures approach can constitute an effective platform for collaborative planning. A collaborative futures process helps to develop successful solutions and ensures that the ownership of these solutions is embedded in the community so that they have a greater chance of implementation. It also enables the development of preferred visions of community futures through mobilisation – bringing together and facilitating the network of key stakeholders and sources of knowledge. Above all, perhaps, foresighting reduces risk. Thus, the 'foresight principle' enacted through 'foresight programmes' provides an opportune, seductive and feasible approach for studying the hazards that lie ahead and preparing ourselves to meet and overcome them.

3.2 The Foresight Process

Foresight is a systematic, participatory, future-intelligence-gathering and medium-to-long-term vision building process aimed at present day decisions and mobilising joint actions [FOREN, 2001]. There are said to be five essential elements of foresight – anticipation, participation, networking, vision and action (*ibid).* And the most important aspects of the Foresight process have been précised as being [Irvine and Martin, 1984]:

- communication between parties concerned;
- concentration on the longer term;
- co-ordination of research and development;
- consensus created on future directions and policies; and
- commitment generated among those responsible for implementation of policy.

A defining characteristic of foresight is that, in essence, it is a human capacity to think ahead and to forecast possible outcomes of present decisions. Turning towards the practical operation of the process, the stages of a strategic foresight activity, together with the relevant objectives for each stage and the intended outcomes are shown in Exhibit 1.

STAGE	OBJECTIVES	OUTPUT
Framing	Scoping the project : attitude, audience, work environment, rationale and purpose, objectives and teams.	Focal Issue
Scanning	Collecting the information : the system, history and context of the issue and how to scan for information regarding the future of issue.	Information
Forecasting	Describing baseline and alternative futures : drivers and uncertainties, tools, diverging and converging approaches, and alternatives.	Baseline and Alternative Futures
Visioning	Choosing a preferred future : implications of the forecast, and envisioning desired outcomes.	Preferred Future
Planning	Organising to achieve the vision : strategy, options and plans.	Strategy and Plans
Acting	Implementing the plan : communicating the results, developing action agenda and institutionalising strategic thinking and intelligence systems.	Action

Exhibit 1 : A Strategic Foresight Activity (Bishop and Hines, 2006)

Central to the use of Foresight, however, is a strong dose of common-sense. It is, at heart, about avoiding danger, reducing risk, optimising opportunity and developing a strategy to reach a preferred future.

3.3 Prospective Through Scenarios

A particularly progressive and proactive form of foresight is to be found in *prospective.* The prospective, or more familiarly "la prospective", has French origins, but is now bring more popularly applied across Europe in a variety of strategic planning settings. In the francophone context, however, 'prospective' refers to a much wider approach and activity than other futures methodologies as it comprises not only the study of the future, and an evaluation of alternative outcomes against given policy decisions, but also the will to influence the future and to shape it according to society's wishes. Furthermore, it is a very formalised, inclusive, comprehensive and rigorous methodology when compared to more generalised future studies. In many ways, it is similar to foresighting, but would be better understood as a specific means of applying the foresight approach.

One of the most popular and persuasive techniques used in futures studies and foresighting is *scenario analysis.* Scenarios have long been used by government planners, corporate strategists and military analysts as powerful tools to aid in decision making in the face of uncertainty. They are instruments for ordering people's perceptions about alternative future environments in which today's decisions might play out. In practice, scenarios resemble a set of stories built around carefully constructed plots. Such stories can express multiple perspectives on complex events, with the scenarios themselves giving meaning to these events.

Despite their story-like qualities, scenarios follow systematic and recognisable phases. The process is highly interactive, intense and imaginative. It begins by isolating the decision to be made, rigorously challenging the mental maps that shape people's perceptions, and hunting and gathering information, often from unorthodox sources. The next steps are more analytical : identifying the driving forces, the predetermined elements and the critical uncertainties. These factors are then prioritised according to importance and uncertainty. Subsequently, three or four thoughtfully composed scenario 'plots', each representing a plausible alternative future, against which policy options can be tested and implications identified, are developed. Then, the deeper structures and systems behind the scenario stories, and their underlying logics, are elaborated to explain them and reveal their crucial differences. Finally, the key events, or turning points, that would channel the future towards one scenario rather than another are identified.

At The Futures Academy, in DIT, an approach has been developed which combines the above methodologies and is known as Prospective Through Scenarios. It has been applied across a wide range of policy issues over the past ten years, and is confidently put forward as an effective means of getting those concerned with hazard appraisal and risk management to think, talk, plan and act, creatively and differently, together. This particular process is described in Exhibit 2.

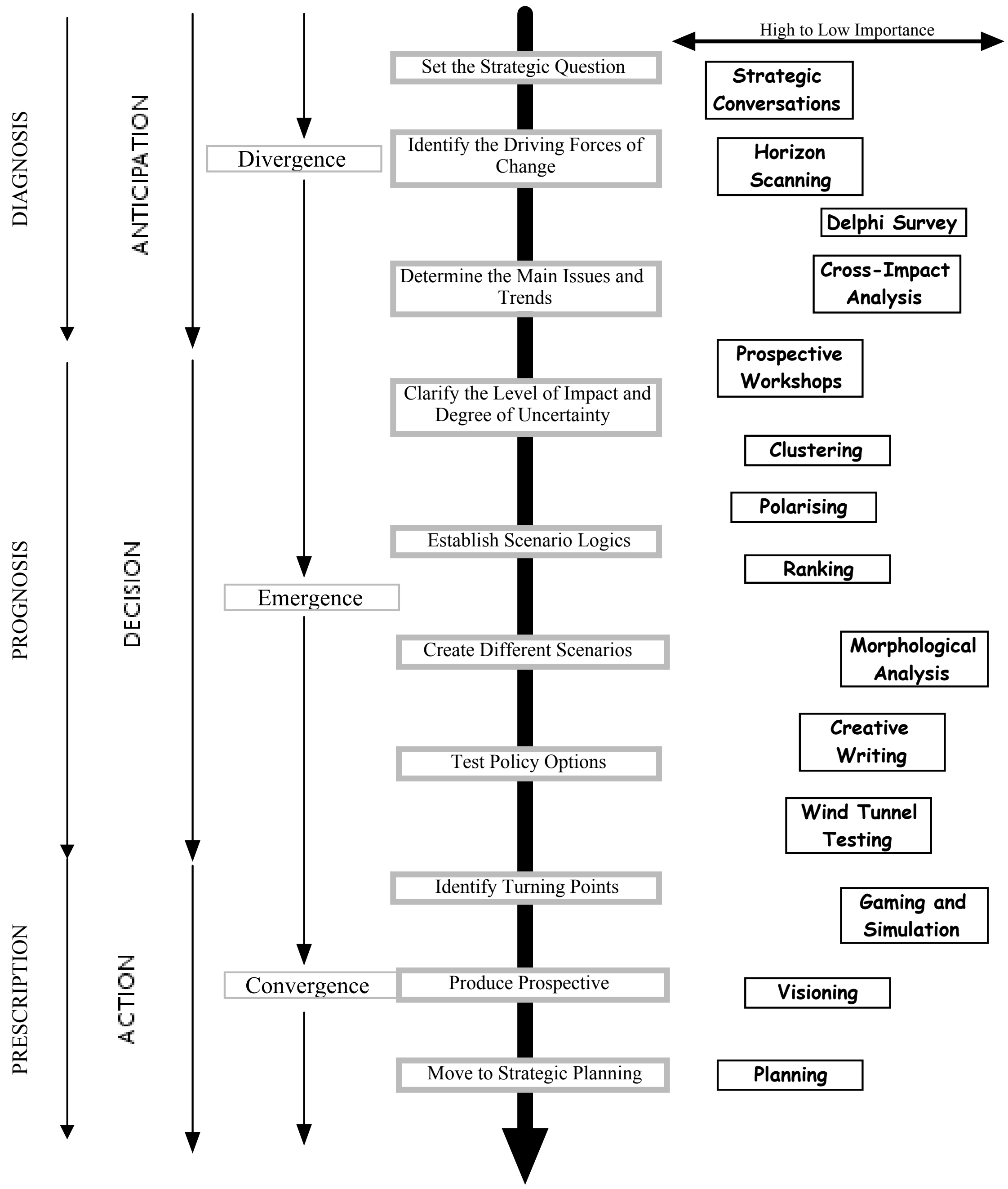

Exhibit 2: "Prospective through Scenarios' - Source: Ratcliffe and Sirr (2003).

4. Built Environment Foresight

The world is changing at a pace hitherto unknown, and previously unimagined. There is a need for academic institutions and professional bodies in the field of the built environment to play a more positive role in addressing the 21C hazards we face, and the potential disasters that might ensue. Some of the tasks that might be tackled include the following.

- Raising issues of common concern that may be overlooked taking the traditional short-term view.
- Highlighting dangers, alternatives and choices that require attention before they become critical.
- Publicising the emerging picture of the near-term future in order to involve the public and contribute to present-day decision-making.
- Contributing to a body of knowledge about foresight and the macro-processes of change and continuity that frame the future.
- Identifying the dynamics and policy implications of the transition to sustainability.
- Helping to identify aspects of a new world order so as to place these on the global political agenda.
- Facilitating the development and application of social innovations.
- Helping people to deal with fears and become genuinely empowered to participate in creating the future.
- Assisting organisations to evolve in appropriate ways.
- Providing institutional shelters for innovative futures work which might not be carried out elsewhere.

In proselytizing the simple yet profound message that we do not have to walk blindly into the hazards we face surrounding the future of the built environment, it is possible to pose a few questions to participants at this conference, or readers of this paper:

- How flexible is your organisation in adapting to change, and does it use outside 'visionaries' to question the basic assumptions held internally?
- Since planning invariably takes longer than events to happen, is enough time spent on contingency or parallel planning?
- Does your organisation devote enough time to 'relationship management', both internally for colleagues, and externally for actual or potential customers and collaborators?
- How ready is your organisation for significant shifts of 'culture' in the environment within which it operates – exploring the way people think, believe and behave?
- Is your organisation managing efficiently and effectively its intellectual capital and knowledge base to think and plan creatively and collaboratively?

5. Propositum

What does the future hold? Are we living at a turning point in human history? Can we master the hazards ahead, or does a new Dark Age menace? Contemplating the critical trends, issues and threats raised earlier in the paper, let alone their possible convergence, it is tempting starkly to suggest that without rapid and positive action we could actually be bringing history to an end. As one leading futurist, James Martin (*op cit*), succinctly states:

"We are travelling at breakneck speed into an era of extremes – extremes of wealth and poverty, extremes in technology, extremes in globalisation. If we are to survive, we must learn to manage them all"

Turning to another prominent futurist, Dr. Patrick Dixon [2004], it is imperative, he argues, to become 'futurewise'. It is an extraordinary time to be alive. The world is being transformed before our eyes from a technological twentieth century society into something altogether new and different. Either we take hold of the future, he concludes, or the future will take hold of us. At a practical level, Dr. Dixon offers ten proposals for organisations facing the hazards of planning and managing their affairs in the 21C.

1. Prepare for the unexpected.
2. Generate faster reactions times.
3. Create flatter structures.
4. Build teams and forge partnerships.
5. Learn to live in the global village.
6. Become more culturally aware.
7. Invest in technology.
8. Foster a family feeling with a sense of identity, value and belonging.
9. Develop purpose and meaning.
10. Recognise that leadership will be everything.

It is largely futures thinking through foresighting that helps achieve this.

On a more personal note, this paper ends with the proposition that to face the Grand Challenge of the 21st Century a more informed, structured and imaginative approach towards the study of the future is demanded of those professions concerned with the stewardship of the built environment and the promotion of sustainable urban development, and that this can most effectively be provided by the Futures Studies field through the adoption and adaptation of the Foresight Principle through Scenario Planning and associated techniques. We need a new mindset – a futures-oriented mindset.

"We are made wise not by the recollection of the past but by the responsibility for the future!"

[George Bernard Shaw].

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Key ote synopsis

"International Community Perspectives in Disaster Mitigation in Developing Countries"

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International Community Perspectives in Disaster Mitigation in Developing Countries

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Abstract

Disasters are exceptional events with overwhelming loss of lives and property. Natural disasters continue to strike and increase in magnitude, complexity, frequency and economic impact. Whilst the natural phenomena causing disasters are in most cases beyond human control, vulnerability is generally a result of human activity.

Today the world is increasingly interdependent. As a result the global community needs to act in a new spirit of partnership to build a safer world based on common interests and shared responsibility to save human lives. Natural disasters do not respect borders or countries whether developing or developed. Disaster prevention, mitigation, preparedness and relief are four elements which contribute to and gain from the implementation of sustainable development policies. Therefore, nations should incorporate them in their development plans and ensure efficient follow-up measures at the community, national, sub-regional, and international levels.

The Geneva Mandate for the world body on disaster reduction stresses the importance of developing and strengthening regional approaches dedicated to disaster reduction in order to take account of local specificity and needs. It emphasizes the need to support initiatives for strengthening regional, national and local capabilities, and applied research initiatives to ensure that prevention and mitigation policies and programmes for disaster management are in place in all countries particularly developing countries.

An example to demonstrate translation of these intentions into action by the international community can be seen in Sri Lanka where UN support in Landslide Hazard Mapping Project (LHMP) for local capacity building provided necessary technical expertise and assistance in introduction of standards, guidelines and codes of practice for human settlements planning and site selection for developments in hilly areas that are vulnerable to landslides. This included using state-of-art technology for preparation of Landslide Hazard Maps, early warning systems, dissemination of information relating to causes, identification of telltale signs, remedial measures etc. which has enabled Sri Lanka to decrease its vulnerability in relation to landslide disasters in the future.

This paper focuses on the International Communities commitment, their mandate and their interventions with regard to disaster mitigation in developing nations and the lessons learned in a case study where access to and application of advanced technology in natural disaster management was facilitated by such interventions.

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Keynote paper

"Building Theories for the Built Environment: The Case of Monetary Retentions"

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Building Theory for the Built Environment: The Case of Monetary Retentions

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Abstract

This study explores the notions of *theory as science*, and *practice as science*, in the pursuit of theory for the built environment. Whilst endorsing these notions, practice is differentiated with *scientific practice* suggesting that latter is part of theory, and that theory should be seen as science. The need for building theory for professional disciplines such as construction management is urged by reflecting on the engineering profession pointing out that practice without theory is akin to *action without thinking* or the practice of a quack-doctor.

The meaning of *theory* and *scientific practice* is explained in preference to definitions, portraying *theory* as *knowing* but of a particular kind of knowing, which is different to other ways of knowing such as authority, intuition, and experience, whereby logic (reason) is applied to questions. Theory is explained as *justified beliefs* as well. There is also a need to develop a structure with an accompanying narrative on *stories* about phenomena in the built environment in a way that it condenses knowledge, and informs practice.

Theory consists of answers to four elements, namely, 'what, how, why and so-what' with *what* identifying the phenomena, the *how* providing explanation (and prediction) and the *why* providing understanding. Other elements to include are responses to *when, where, who,* which are considered to be the limiting parameters (i.e. the context). Criteria for judging the value of theory are also given including a brief description of methodologies for building theory. By reflecting on the profession of engineering, it is proposed that theory for the built environment should consist of theory in the different professional disciplines (which often overlap) in an interactive and integrated manner.

With this synthesis of theory and practice, an 'unusual' phenomenon that has spanned well over a century is investigated with the intention of building theory. This phenomenon is the practice of holding a portion of the moneys due to a service provider from each and every payment until the project is fully completed. It is a practice which was originally enforced through legislation (in New Zealand), later abolished, and then re-enforced through contract.

Having explored different methodologies for building theory, metaphors was found to be a convenient and a powerful approach for building theory particularly for channelling knowledge, give it structure, and develop narrative, in a way that it condensed knowledge and facilitated practice. Accordingly, five theories were presented under *Images of Retentions* – an unfolding

story about the practice of retention. These theories were named as *Cash-Cow*, *Steroid*, *Beast*, *Stress*, and as *Chaos*. They were seen as providing a deeper understanding of the reasons for this phenomenon along with new insights on retentions.

These theories are accounts of *justified beliefs*; they describe, explain, and predict what might happen if certain courses of actions are taken, particularly in a New Zealand context. These must be criticised and modified, and refined as necessary in the pursuit of deeper understanding: this is the nature of theory; theory is neither complete nor perfect.

Individually, these 'theories' tell us a one-sided story by highlighting certain interpretations and forcing others to the background. This needs to be understood but importantly the theories needs to be viewed together as a collection rather than in isolation, understanding the opposing and complementary points of view, along with their interactions.

The theory (and theories) presented herein on retentions are not exhaustive. There are still a number of issues pertaining to retentions that need to be understood. However, it is believed that these theories should provide a good foundation for further deliberation and research. In this regard, the use of metaphor as a methodology cannot be underestimated; it is an interesting, valuable, and an exciting approach for building theory as evidenced through this study.

This is only a beginning of a *story on retentions*; there is much to be understood about this *'unwanted essential'*!

Keywords: built environment, construction management, theory and practice, monetary retentions

1. Background

2007 saw an important milestone achieved with the first symposium on 'theory for the built environment' held at the University of Salford. The call for papers re-kindled a dormant desire – to tell a "story" about a phenomenon that has been witnessed since the dawn of civilisation. Just over a decade ago, as I wrote the final chapter of my PhD thesis on strategies for managing the chaos in Sri Lankan brickwork, I mooted the idea for a 'theory of brickwork' [1]: Sri Lankan brickwork is unique in many respects. The environment within which this phenomenon is seen is rich in that it permits the study of forgone – taken for granted fundamentals - of building with bricks. If I were to write a book on brickwork today, its *structure* would very likely be different to the structure of a traditional text book where the focus to a large extent has been on 'how' than 'why'. I realised that many issues had been taken at the face value influenced by colonial traditions failing to realise the local context without a real *understanding* of, particularly production management issues, connected with time–cost–quality issues. The practice in Sri Lanka has been to prescribe English brickwork over 'Sri Lankan brickwork'! Delegates to this conference would no doubt see how chaotic Sri Lankan brickwork is but surprisingly enough there is an underlying order only if you care to understand *why.* And if you do, there is much opportunity to improve its productivity and economy, thus saving billions of dollars.

I believe, it is the case with 'monetary retentions' as well. It is this desire that I hope to explore in this paper on a phenomenon that has spanned over a century, enforced by legislation and through contractual provisions, with the hope of laying a foundation for understanding it better, through what I will refer to as a 'theory on contract retentions': Some countries have outlawed this practice, others have tried to follow suite but failed, yet others seem to find it useful and are content with the status-quo, which raises important questions on why this is the case.

During my undergraduate studies in engineering, *theory* was the order of the day. However, when I specialised in construction management, I realised that there was hardly any 'theory' to help make decisions as one would do in engineering; there wasn't a right or wrong way of doing things. It was, in this sense, a somewhat difficult and uncomfortable realisation, often having to draw on experience, intuition, and insight for managing projects. As I look back, I ask myself the question, could we not condense such knowledge into a form that we could classify as 'theory' which will assist in decision making, practice not for the sake of practice but with sound reason, and guide future research and help move our knowledge forward on important questions confronting the profession of construction management.

2. Theory as Science

No doubt, it is pertinent to raise the question as to what is meant by 'theory'. In engineering, theory is the foundation for many applications whether it is the design of a bridge, a building, or a road and so on which are part of the built environment. Not only does theory help to understand how these structures should be built and the reasons for it but also for their planning and maintenance from a technical perspective. In this regard, those from a background in engineering would find it easy to see the value and the relevance of 'theory'. If not for theory, one would have to use experience, intuition, and judgement instead, to create the built environment we live in, no doubt, with much trial and error, inefficiency, and waste.

If my perception is correct, *theory in civil engineering* (as it appears to me) is about understanding, explaining, and predicting how the natural world and the built environment interface with each other in an interactive and integrated way with particular relevance to the planning, design, construction, and maintenance of man-made facilities and services provided for and by human kind for their benefit. But what is *theory* and how has it been developed...?

In common usage, the word 'theory' is often used to signify an opinion as in "he has a theory that wearing hats makes men go bald". In fact, many of us seem to have theories about many things on how to 'choose a bait, a date, or mate' as eloquently put by Shoemaker *et al* [2]. In this **usage**, theory is not necessarily based on facts; and is not required to be consistent with true descriptions of reality. Such usage of the term 'theory' is confusing, incorrect and inappropriate for a professional discipline such as engineering or for that matter any other discipline that help fashion the built environment. However, this usage shows us that theory helps us to ***know*** but this is not enough; **it must work in practice** too. However, knowing is much more than this.

Interestingly, according to the Webster's New World Dictionary, the word science which is derived from the Latin word *sciens* means "knowing". However, it is the particular way of knowing that appears to distinguish 'science' from other ways of knowing such as authority, intuition, tenacity or even experience. Moreover, what makes science different to other ways of knowing is that 'science applies logic [reason] to questions constantly' for right understanding [3]. I propose therefore that **theory must be science** if it is to be of value to professions involved with the built environment. Professions that are backed by theory (as science) could then be referred to as scientific, as in scientific engineering (as against engineering) analogous with 'scientific medicine' or 'scientific farming' [4].

A widely held belief is that science uses the *scientific method* for building theory which is another reason why science is different to other ways of knowing. Additionally, science uses other *methods* and *methodologies* which may differ from profession to profession [5]. However, whichever methodology is used, it is useful to echo the sentiments of Nobel Laureate biologist Peter Medawar in relation to *scientific inquiry and method*:

> *'[The Scientific method]... is a potentiation of common sense, exercised with a specially **firm determination not to persist in error** if any exertion of hand or mind can deliver us from it. Like other exploratory processes, it can be resolved into a dialogue between fact and fancy, the actual and the possible; between what could be true and what is in fact the case. The purpose of scientific enquiry is not to compile an inventory of factual information, nor to build up a totalitarian world picture of Natural Laws in which every event that is not compulsory is forbidden. We should think of it rather as a logically articulated structure of **justifiable beliefs** about nature [i.e. with explanations as to why the belief is a true one]. It begins as a story about a Possible World—a story which we invent and criticise and modify as we go along, so that it ends by being, as nearly as we can make it, a story about real life."* [6]

What then is *theory...*? According to a definition given in the Oxford Learner's Dictionary (1989), theory is a 'set of *reasoned ideas* intended to *explain facts or events*' which aligns well with the above description, particularly with reference to 'justified beliefs'. However, Ron Weber, the Editor of MIS Quarterly explains that it is 'notoriously difficult' to define what 'theory' is, claiming that 'any definition … is sure to evoke disagreement among scholars' [11]. He states further that 'some even see the notion of theory as an anachronism – an idea that reflects earlier, naïve notions about our abilities to understand the world (the so called "modernist" view of the world)'. In fact, it is also claimed that *theory* has number of distinct meanings in different fields of *knowledge*, depending on their *methodologies* and context of *discussion* [4]. Furthermore, an online dictionary on medicine defines theory (of medicine) as '*science*, as distinguished from the *art*, or *practice'* (of medicine). Thus, it is not surprising why it is not easy to come to a universally agreed definition. Moreover, experience shows that definitions are difficult to come by. And even if it does, reaching agreement on controversial words such as *theory* is difficult. However, just as much as it is difficult to define an elephant as compared with explaining what an elephant looks like, there is no difficulty in explaining what *theory* is. In this regard, as argued before, *theory* is seen as *science*.

3. Practice as Science

"Actions without thinking, practice without theory are unimaginable..." [7], [8]

The main product of almost all professions associated with the built environment is practice whether it is engineering, medicine, architecture or construction management. I believe all these professions can be practiced by people, for example, by learning on the job, and is nothing new. Ask a bricklayer to build a wall and he will. Ask him *why* uses a particular size he might explain but ask him why it should be used for a wall which is plastered on both side and one without any openings, he might think hard, and he might not give a plausible answer (see [1]). He might even challenge the importance of this question! Consider another scenario – the application of critical path methods in project planning and control. Talk to a construction manager and he might explain how he uses these. This is *skilful mastery*. However, ask for reasons for choosing this particular technique over so many other techniques, he might be less able to provide a satisfactory answer unless there is a good theoretical understanding of the techniques. If he fails, his practice is not scientific. Indeed, practice that is not driven by science is akin to a quack-doctor practicing medicine [9]: there is a need to transform the 'art' of practice into a 'science'.

So what characteristics must be displayed before practice can be considered as science? According to one explanation, 'practice is science' when the practitioner can explain it in terms of 'knowledge, logic and prior experience' [4], [10]. However, this is not sufficient: The reasons for practice must be justifiable and indisputable. And, ideally, such reasons must be established and/or verifiable (and undisputable) according to an established standard of evaluation though it might prove difficult. This is part of the challenge of 'practice as science'. Practice without such evidence cannot be regarded as science.

There is a need to embrace *scientific practice* as against practice, in which case practice becomes part of theory! When practice-based professions accept scientific practice as fundamental to their profession, it no doubt strengthens professional identity. This is an important consideration for emerging fields such as construction management.

4. Building Blocks of Theory

As mentioned before, *theory* is about "knowing". Theory is also about *justified beliefs* (as noted before) where explanation of the reasons for a phenomenon or practice is fundamental. However, theory is much more; for instance, theory is expected to 'explain in order to predict' which is essentially about understanding [2]. Thus, understanding entails 'considerably more than explanation (or prediction): Ancient astronomers made excellent predictions of the future positions of the planets but were unable to say *why* (understanding) the planets behaved this way because they lacked understanding [12].

Well known scholars such as Abraham Kaplan and Robert Merton have asserted that *theory* is the answer to the questions of *why* [13]. Whilst this is fundamental, a complete theory should include answers to not only *why* but also to w*hat* and *how* viz. what factors should be considered to explain the phenomena, how these factors are related, and why this particular phenomena be accepted; while *what* and *how* describe and provide a framework for interpretation, *why* supplies the explanation[14]. These are not the only elements; a theory should include responses to *when/where/who,* which are considered to be the limiting parameters defining the applicable population of actions, actors, etc. This is what Weber [15] has referred to as the 'state space of a theory' and the 'event space of a theory', or the 'boundary conditions' (i.e. the context). The last element of theory is which is referred to as the "*so what"* element, which was thought to be necessary to demonstrate the implications and consequences of a proposed 'theory' [16]. To summarise (and as noted immediately below), we wish to take the position that a theory should respond to ***"what, how, why, and so-what'*** elements with ***'when, where, and who'*** describing the limiting or the contextual elements. As such, theory in the built environment should form the basis for explaining and understanding phenomena in the built environment. In fact, such understanding would serve a better purpose if they also respond to the *so-what* element referred to above.

5. Theory for the Built Environment

So what constitute *theory* for the built environment? What does *theory* look like...? How could we build and present *theory* in a way that it condenses scientific knowledge, permits practical applications, and guide research...? These are important questions that need to be looked at.

It was argued earlier that *theory* should be viewed as *science*. Moreover, it was also argued that *scientific practice* should also be part of *theory* separating practice which is not scientific as *practice*. Discerning readers would no doubt have noted that theory in the built environment (as discussed in this paper) is a collection of *theory* in the different professional disciplines which often overlap. Theory includes frameworks, concepts, facts, laws, models, rules and regulations (codes of practice) etc. integrated together that includes various 'theories' as well, such as theories on motivation, theories on chaos, and so on depending on the nature of the professional discipline.

According to Shoemaker *et al* [19], the beginning point of building theory would be a problem. These could be intellectual problems or practical problems, or a combination of both. Concepts (such as 'retentions') could also be a starting point for theory building particularly if they are problematic. Such concepts could lead to hypotheses (opinions) which could be tested for validity and thereby provide greater understanding. It is also possible that theory building could start with a hypothesis or even with a question about something that needs better understanding. Another possible beginning point for building theory would be to start with an area in which theory is vague or lacking. This is clearly the case with 'contract retentions'.

Theory building is said to be an ongoing process; it does not come to an end though it may come reach a point where it is useful and can be applied to solving problems [17]. Various *methods* (qualitative, quantitative, mixed-approaches, learning by doing) and *methodologies* (such as positivism and constructivism) have been, and are being, used for building theory. Such theories could be displayed through charts, graphs, diagrams or even mathematical equations as mentioned before. However, according to Shoemaker *et al* the creative side of theory building has often been neglected in textbooks and classes [18]. As an aide, they provide 12 ‘techniques of creativity’ that might be helpful for building theory, namely, attribute listing, forced relationships, morphological analysis, brainstorming, lists of ideas, lateral thinking, random input, setting up provocations, creative hit lists, visualization, writing techniques, and letting the unconscious (mind) do some work. Although not mentioned as a technique, these authors claim that metaphors may also play a very useful role by assisting the theory builder, particularly for expressing ideas or insights that have not yet been verbalised, for gaining new insights and fresh illuminations, and for formulating new theories on old themes.

Finally, if as noted before *theory* should respond to the questions of ‘what, how, why and so-what’ in relation to phenomena, how does one judge or evaluate theory? Shoemaker *et al* [19] provide ten criteria, namely, testability, falsifiability (i.e. capability of being criticised by observational reports), parsimony (least complex explanation for an observation), explanatory power, predictive power, scope, cumulative nature, degree of formal development, heuristic value (generate ideas for research and other theoretical ideas), and aesthetics (expressing the value of a theory by the application of aesthetic principles such as by referring to an idea as “beautiful”) noting that it is unlikely that all these criteria can be fulfilled simultaneously.

6. A Theory: Images of Retentions

The experience of moving from engineering to a practice-driven profession like construction management led to the observation that there was hardly any theory to inform practice. The situation is not much different today: educational curricula rarely if ever focus on theory. Part of the problem is that there has not been an attempt to differentiate practice with scientific practice. Moreover, neither has there been an attempt to build theory nor appreciate the need for it. Given this background, it is the intention here to explore and examine, monetary retentions, a practice that has spanned a century, a practice that was enforced through legislation in New Zealand (for almost a century), later abolished only to find that the practice is reinforced through contractual provisions, interestingly with a new imperative which is significantly different to the old imperative, in a manner that protects people who seek services as against those who provide services!

What is this practice...? As it stands today, those who seek services (principals) hold on to a portion of money usually in the range of 5 – 10% from every payment they make to those who provide services (contractors and subcontractors). When the project is over, only a part is returned at the end of the construction period (usually around 50%) with the balance retuned at the end of the defects liability period.

As mentioned before, some countries have outlawed this practice, others have tried to follow suite but failed, yet others seem to find it useful and are content with the status-quo, which indeed raises much curiosity as to why this is so. Could we have a better understanding of the issues at stake by attempting to develop theory...? There is no indication to suggest that there is a scientific basis for the practice of retention. No doubt, it is an enormously important concept to the extent that there have been parliamentary select committees commissioned (in the UK) to investigate whether or not to abolish retentions. Yet, there isn't a single book on construction management that appear to have a chapter on this issue. Not surprisingly, there is very little research done on this area. As such, the intention herein is to build theory, and hopefully lay the foundation for a better and deeper understanding of this practice.

One of the mind-boggling problems that arose initially was on a suitable *methodology* to build theory with the little that was known about retentions. An obvious choice was to use the six elements described as the 'building blocks' of theory using the 'attribute listing' and the 'forced relationship' techniques mentioned earlier. This approach generated interesting and useful avenues for understanding issues on retention; it appeared as a useful approach to set up a research agenda but for communicating theory to practitioners, it was found to be too unwieldy even with the use of visual methods (incorporating mind-maps). An attempt was also made to use taxonomies without success [20]. It was only then that the technique of using metaphors was explored as advocated by Shoemaker [23].

Investigations on, and experimentations with metaphors, was exciting as it became easier to give structure to thoughts on retentions. On pursuit of further knowledge on this area, the discovery of an interesting and a provocative book became a source of inspiration: 'Images of Organisations' by Gareth Morgan, a book which shows how it would be possible to 'see, understand, and manage organisations in new ways' cemented the approach contemplated.

Morgan's book is based on a simple premise: 'that all theories of organisation and management are based on implicit images or metaphors that lead us to see, understand, and manage organizations in distinctively yet partial ways'. It soon dawned that the use of metaphor was a powerful *way of thinking* and *seeing* to make us understand more about the world around us. He quotes as follows [21]:

> *'Each chapter invites you to engage in a mode of thinking that generates important insights while having major limitations. You are likely to be attracted to certain metaphors and be impatient with others. Or you may find competing metaphors equally compelling or attractive. As you pursue a favoured perspective you are going to find insights of others eliminated from view...In this way, the book invites you to explore and deal with the paradox of metaphor. So, absorb and enjoy the process. Gain comfort in dealing with competing viewpoints, for this is one of the key competencies that need to be developed as a basis for effective management.'*

He does not stop here. In the last three chapters of the book, he explains how managerial insights gained from the use of different metaphors could be integrated. In fact, it is this *methodology* that has been followed in the development of a set of theories on retentions.

6.1 Retention as Cash Cow

This expression is a metaphor for a dairy cow that can be milked on an ongoing basis with little expense after being acquired. In business, it is something that generates unusually high profit margins to the extent that it far exceeds the amount necessary to maintain cash-cow business, and the excess is used by the business for other purposes [24]. Likewise, in construction, retention is such a powerful facility that head contractors in New Zealand would very much like to protect.

It is well known in the construction industry as far back as the early 1940s, the sum of subcontract retentions deducted by the head contract would significantly exceed the head contract retention sum deducted by the employer [25]. However, this is not guaranteed unless the organisational buying behaviour is such that the level of outsourcing is high and the 'retention differential' (i.e. the difference between the rate imposed by principals on head contractors and the rate imposed by contractors on subcontractors) is considerable. In fact, there are many strategies that could be adopted to nest a large surplus of cash with no investment at all for contractors who outsource bulk of their work [26].

Under one of the retention regimes suggested in NZS 3910 [27], retentions are capped at $200,000 (see Table 6). This works out to a contract price of $9M. Not surprisingly, a project over this value entails an effective retention rate less than 2.2% (see Table 6). When compared with a retention rate of 10% that might be levied on subcontractors (for work less than $ 200,000 and when back to back contract terms with the retention regime shown in Table 6), there is a significant opportunity to generate surplus cash especially when head contractors negotiate for no retentions or when they have the opportunity to provide retentions bonds: Greater the retention differential, greater is the opportunity to generate surplus cash. This is what Abeysekera has labelled as the 'retention differentiation' strategy [26]. The surplus of cash so generated could be utilised for various purposes including short-term investments. No longer is it necessary for head- contractors to add financing costs for retention moneys. Planned profits are realised long before the project is over as a result of having access to surplus cash when the retention differentiation strategy is used!

It was mentioned earlier that a number of strategies could be adopted to increase the pool of cash. Consider the practice of offering back-to-back contract terms to subcontractors. This is often portrayed as a fair practice by head contractors. However, with a 'declining' retention regime (see Table 6), some head contractors deliberately limit the size of subcontract packages to $200,000 to ensure that subcontractors would be on the highest rate of retention (i.e. 10%) which in effect allows them to maximise the pool of cash to unprecedented levels. In an environment where outsourcing is high, head contractors would benefit tremendously to the extent that they would not have to borrow any funds from commercial banks. This is an interesting option particularly because commercial banks have constantly failed to understand construction when it comes to providing various facilities. There is no doubt that when retentions are used in this manner, it is a 'cash cow'. It would be surprising (and foolish) if large to medium scale head contractors fail to capitalise on this bountiful opportunity.

Given this background, it is easy to understand why head contractors in New Zealand are not keen to abolish retentions [28]; any attempts are likely to be met with stiff resistance. Interestingly, a survey of structural steel subcontractors in NZ have revealed that they do not mind retentions either, other than for expressing concerns about high rates, and the manner in which retentions are deducted and released [29]. This is in stark contrast to the views emerging from some other countries – particularly from the UK. Thus, head contractors cannot be expected to be complacent about this facility; they need to ensure that this opportunity is not taken away from them. However, as to what percentage of contractors in NZ actually use this strategy is unknown. According to business literature, cash-cow products seem to be common in markets with high growth rates, i.e. in immature markets. Whether this is the reason in NZ for the use of retentions as a cash-cow is matter that needs investigation.

Interestingly, retention regimes are fixed by people who seek services: principals or their professional advisors do so in contracts with contractors (and contractors have nothing to do with it!), whilst head-contractors do so with subcontractors. In the case of the former, investigations reveal that although the standard declining retention regime is a popular choice, other regimes are also being used (see Table 6); surprisingly, there is no rationale for setting up of such regimes; it is more an art than a science at present!

6.2 Retention as Steroid

Societies around the world have used performance enhancing substances for thousands of years. However, it is only in the recent past that this issue has received much attention, particularly with the use of Anabolic steroids (AAS) in sports as a means of increasing muscle mass and physical strength to gain a competitive advantage: The sports world was shocked when sprinters Canadian sprinter Ben Johnson was denied his 1988 Olympic gold medal, and just recently Marian Jones's was stripped off her 2000 Olympic gold medal, as a result of using AAS, which is a banned substance. However, anabolic steroids continue to be used for medical and non-medical purposes. Means of coping with adverse effects of such use have and are being developed. Given that the value of monetary retentions as an incentive for performance has been well argued for some time, it will be interesting to reflect on the metaphor of 'retention as steroid' to investigate new ways of using retentions, particularly for enhancing performance of subcontractors.

One such initiative is worthy of mention wherein an attempt has been made to 'marry' 'retentions' and 'performance' [30]: This initiative was based on the premise that subcontractors who perform well must receive better (favourable) retention regimes as a reward for their performance and as an incentive for achieving even higher levels of performance. The organisation for which this schemed was developed (by the author and a fellow researcher) had a performance database on subcontractors which was regularly updated as and when projects were completed. A number of different retention schemes were developed (see first column in Table 1) with the aim of developing a one-one to correspondence with a set of 'performance scores'. Take the 'discounted (retention) percentage' regime. In this, high performance scores were linked to discounted retention rates. As mentioned before a number of such schemes were developed and narrowed down to just five having first discussed the preferences with a wide cross section of executives (in the firm for which the scheme was developed). Thereafter, an attempt was made to reach consensus on a suitable set of schemes acceptable to the firm which were then shown to the subcontractors in order to exclude schemes which were not acceptable to them or as seen valuable. Subsequently, preferences of both the executives within the firm, and the subcontractors, were sought (using a scale rating). Then, the scores of both the executives and the subcontractors were added and ranked to select the most preferred (see Table 1). Positive and negative comments about this interesting scheme are shown in Table 2.

Table 1: Retention regime ranking summary [30]

Retention regimes	Firm	Subs	Total	Rank
Discounted percentage	14	12	26	1
Deduction Timing	23	20	43	4
Release Mechanism	12	16	28	2
Project Cap	17	17	34	3
Aggregated Project Cap	24	24	48	5

Table 2: Positive and Negatives [30]

Positives	Negatives
Improved performance for firm	More administration for firm
Improved performance for industry	Could impact adversely on company's cash flow
Early retentions fair for early trades	Creates unfair competitive between subcontractors
Reduced costs	Higher financial risk for firm if the subcontractor does not perform or goes into liquidation
Strengthen relationships with subs	
Clients aware of weeding off bad subs	
Encourages subs to give their 'A' team	
Increased desire to work for firm	
Client comfort knowing that they have high performing subs	
Better sub performance a financial gain for firm through less management	

What this study shows is that the metaphor of 'retention as steroid' brings to light a powerful message – one that is appealing not only to the head contractor but also to the subcontractor, one that is attractive but also repulsive to the head contractor. Used with caution minimising adverse effects, companies might just have an edge over those not contemplating such options. If embraced by the industry, perhaps, it might loose value at which point of time, a new scheme might have to be developed.

6.3 Retention as Beast

The word beast is used in many contexts – as an animal; as an irrational or aggressive part of somebody's personality; as somebody cruel or aggressive; or for something that is difficult or unpleasant. Do retentions display such characteristics...? If so, does this metaphor bring about new ways of understanding retentions?

There are many beastly characteristics of retentions to say the least. There is enough evidence to suggest that retentions are being abused. “Yes, it has come to the point that subcontractors now have to virtually add their retentions onto their costing… They’re not confident of ever getting them back. A lot of subcontractors will say that to me that they’re – whether they perceive their retentions to be is at least their profit. They cannot ever work on the assumption that they’ll see their retention because some of the builders will try to negotiate their last payment which will be a discharge against the monies that they’re owed. Some of them are quite unashamed about how they do it. They’ll basically say to the subcontractor, I owe $10,000 in retention, I’ll hold onto it, think up hundreds of excuses as to why I shouldn’t pay it to you. But, if you accept $5000 I’ll give you a cheque now. A lot of subcontractors would say, for god’s sake give me the $5000 and I’ll go, which effectively means that the main contractor has just extorted $5000 out of it. But that’s the way some main contractors behave!” [31]

There is also the issue that they may loose all their retention moneys (and this includes head-contractors too) if people to whom they provide services, go into liquidation, which raises serious concerns about security of payment. Financial failures often occur suddenly and unexpectedly [32] with no recourse to their funds. Such risks are accentuated by harsh retention regimes and release mechanisms. For instance, it is not common in the construction industry for head contractors to link the release of subcontractor retentions to theirs with the use of back-to-back contract terms; this is an overly long time to wait. Whilst there are good reasons for this, the practice is similar to the now illegal practice (i.e. in NZ and some other parts of the world) of the use of contractual clauses such as ‘pay-when-paid’. However, contractors (and also subcontractors in NZ) could seek the protection of the Construction Contracts Act 2003 in the event of payment delays with retentions. So how does one deal with this ‘beast’...? There are number of logical possibilities from shooting it down, to confining it, or taming it, and putting it for good use! It is an interesting way of understanding the nature of retentions.

Table 3: Strategies for coping with beastly features of retentions

Dealing with the beast	Dealing with retentions
Shoot it down	Abolish retentions #
Confine it	Use when essential
Tame it	Use retention bonds, payment bonds, trust accounts
Put to good use	Induce high performance (see Steroid Theory) **Set up a retention fund as a ‘construction bank’** [33], [34]

Research in NZ shows the contractors and subcontractors do not favour this option [28]

As mentioned before, what is interesting about using the ‘retention as beast’ metaphor is that it provides new ways of understanding issues related to retentions and gain new insights and new options for dealing with retentions. Consider the ‘put to good use’ strategy and the related option of a *central retention fund*. According to Hughes [35] such an approach is considered to be a revolutionary option, one that is 'new, and perhaps a radical approach' to moneys 'otherwise dissipated and diluted to such an extent that they are of little use to a nation'. This is an interesting and exciting option given that commercial banks have consistently failed to understand construction. Some of the main benefits of such a fund are shown in Table 4 [33].

Table 4: Benefits of a Central Retention Fund

The Costs and Benefits of a Retention-based Fund
i. Security of payment as cash retentions are held by an independent body. ii. Ownership in the hands of contractors and subcontractors provide greater opportunity to introduce construction-friendly services. iii. Reduced prices to clients. iv. Bonds and guarantees at cheaper prices (with nil/minimal collateral). v. Elimination of retention bonds. vi. Work in capital loans to subcontractors/contractors, secured on retentions held by the fund. vii. Higher leverage on retention-based investment (e.g. loans factored many times its value) viii. Higher returns with larger pools of money utilising expert fund managers ix. Use of contract receivables as collateral x. Trade bonding for 'performance' with 'retention' build up xi. Use of a third party for dispute resolution. xii. Targeted training for members xiii. An outward orientation (as a service than profit) with a greater focus on member development xiv. Use of innovative, contractor-friendly approaches understanding the nature of construction.

6.4 Retention as Stress

Interestingly, just as much as retentions display beastly characteristics, it displays stressful characteristics for almost the same reasons given above. To give an analogy as to what stress is like, consider the case of a concrete column. Increase the load, the column will take up the stresses but only up to point beyond which it will fail. This is very similar to what happens with human beings when subject to stress; the repercussions are well documented. This perspective suggests that retentions are acceptable up to a point beyond which there is bound to be adverse impacts. If so, there is a need to develop strategies to minimise such effects, if at all possible (Note: see 'retention as chaos'; stress a means by which systems could be move to 'edge of chaos'). Some of the strategies that could be adopted to minimise stress levels of humans in a work setting are shown in Table 5. Interestingly, when one reflects on these strategies, new insights can be gleaned. Indicative responses are given in Table 5.

Table 5: Strategies for dealing with retentions with the stress metaphor

Stress prevention at workplace [22]	Strategies for dealing with retentions
• 'Ensure workload is in line with workers' capabilities and resources	• Tailor retentions to suit contractor/ subcontractor capabilities
• Design jobs to provide meaning, stimulation, and opportunities for workers to use their skills	• Develop retention regimes to induce performance (see 'retention as steroid'); price discounts for nil retentions
• Clearly define workers' roles and responsibilities	• Define purpose of retentions (at present it is ambiguous as mentioned before)
• Give workers opportunities to participate in decisions and actions affecting their jobs	• Opportunity to negotiate retention regimes
• Improve communications-reduce uncertainty about career development and future employment prospects	• Tie-up retentions with current and future jobs; take a relationship-based approach
• Provide opportunities for social interaction among workers	• Transparent retention regimes
• Establish work schedules that are compatible with demands and responsibilities outside the job'	• Establish (fair/favourable) retention regimes by taking into account of work undertaken on other projects (e.g. cap total retentions when a contractor/subcontractor works on number of projects for the same client)

6.5 Retention as Chaos

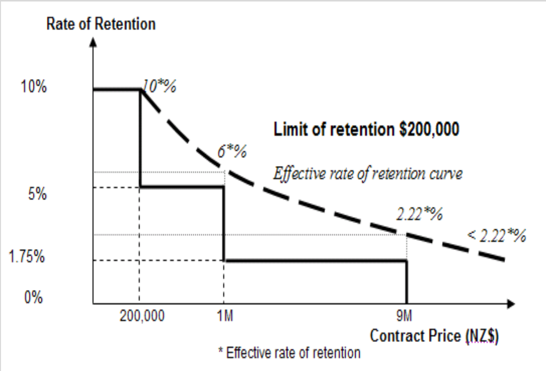
As mentioned before, the retention phenomenon examined in this paper, has spanned over a century in NZ. It was initially introduced through legislation in 1892 and then abolished with the repeal of the Contractor's and Workmen's Liens Act in 1982 (after amendments in 1908 and 1939) [36] but carried on through using contractual provisions which is used in almost all contracts in the commercial sector of construction. Moreover, the old and the new imperatives are very different; earlier, the emphasis of creating a retention fund was to protect those who were providing services, but today, it is used for protecting those who seek services from others [37]! Clearly, issues connected with retentions seems to be perennial; the sentiments expressed by Rt. Hon. Geoffrey Palmer, the then Minister of Justice, at the third reading of the 1987 Lines Act Repeal Bill sums it all: "I am completely satisfied that it is not possible to reach agreement with industry on the reform of the revised Liens Act, and the reason is that the interests of contractors and subcontractors are diametrically opposed to each other. Contractors prefer to hang on to retention money for as long as possible and subcontractors prefer to be paid as soon as possible. The time has arrived to let the building industry work out its own solutions…" [38].

Nothing significantly has changed since the repeal of the original Act but for the introduction of the Construction Contracts Act 2003 with the aim of dealing with payment delays. However, the practice of using retentions has continued unabated particularly with the sliding retention regime notwithstanding others (see Table 6). Despite its extensive use, there is no rationale for setting up such retention regimes whether it is about rates, limits - capped or otherwise, release mechanisms (amounts released on practical completion) and the length of time held. Moreover, different standard form contracts specify different clauses in relation to retentions. There aren't any explanatory or guidance notes on how to set up such schemes. Moreover, most contracts are silent on how to provide security for retentions monies but for a few specifying the use of trust accounts whether interest bearing or not!

Table 6: Retention regimes used in New Zealand

Work connected with head contractors

Sliding retention regime [27]



Project 1:	$4M - 5% of Contract Price with a limit of $ 125,000; Defects liability retention (DLR) 50%
Project 2:	$100 M - 10% on first $15M + 5% on next 30M + 2.5% thereafter; Limit of retention $3.5M; DLR 50% from last separable portion
Project 3:	$ 25M - Retention rate 10%; Limit of retention 5%; DLR 50% from last separable portion

Work connected with subcontract work [39]

TRADES	Current Practice									
	Retention %					DLP (months)				
	0	5	10	15	20	0	1	3	6	12
	% Of Respondents									
Front End Trades										
Demolition	40	10	50			40	20	30	10	
Excavation	10	20	70			30	20	40	10	
Piling		10	90			20	20	50	10	
Concrete work	40	30	30			40	20	30	10	
Pre Cast conc.	50	20	30			50	10	30	10	
Reinforcement Steel	80		20			80		20		
Structural Steel		20	80					70	20	10
Brick & Block Work	10	10	80			10		60	20	10
Drainage		10	90				10	50		40
Mid Trades										
Metal Windows & Doors			100					70	20	10
Carpentry	40	30	30			40	10	40	10	
Joinery	10	10	80			10	10	70	10	
Roofing		10	90					70	20	10
Plumbing & Gas		10	90					50	10	40
Mech. Services		10	90					40	10	50
Fire Protection		10	90					40	10	50
Electrical Services		10	90					40	10	50
Back End Trades										
Solid Plaster / Cladding			100					80	10	10
GIB Fix & Stop	20	20	60			20	10	60	10	
Suspended grid ceilings		20	80				10	80	10	
Floor Coverings		10	90				10	80	10	
Painting & Sp. finishes		10	90					80	10	10

None of the standard form contracts used in NZ define the purpose of retentions. Part of the problem lies in not understanding or agreement on what retentions are for: whether it is for performance, for defective workmanship, or not. Often contracts specify 'performance bonds' in addition to retentions. If these are for performance related matters during construction (including any defective work), the case for withholding moneys from progress payments is weak. The whole issue of who owns retentions (i.e. the principal or the contractor) is a matter for debate.

Consider the case of performance bonds valid until the end of the defects liability period. If so, is there a real need for monetary retentions? Some may argue that there is given that the 'power' of cash retentions far exceeds the power of bonds when it comes to getting contractors on site to finish defective work. It is also not clear whether retentions are for those defects arising during construction, or for those arising during the defects liability period, or both. Latent defects would, of course, not enter the fray (as the contract would be non-existent) by then. However, as to whether retentions relate to defects due to materials is a contentious matter particularly for materials specified by the designers which are found to be defective. Perhaps, these would be covered separately through material warranties and guarantees.

The practices differ significantly with subcontract work, particularly in the building sector. High rates of retentions (Table 6), excessively long periods of release, price discounts for retention-free contracts, trade related retention regimes are some examples [39].

In short, the manner in which retentions have been used is ‘chaotic’!

Given this state of affairs, it is interesting to explore an interesting and novel way of reflecting on retentions by making use of various theories on chaos in order to develop new insights on how to ‘live with chaos’ or to bring ‘order’. All the theories described thus far, such as the ‘cash-cow’ and the ‘beast’ theories indicate how to ‘live with chaos’ but not the latter. Before, such possibilities are explored, it is necessary to understand what chaos theory is about.

According to Hall ‘unlike relativity and quantum mechanics, chaos is a science of everyday things – of art and economics, of biological rhythms and traffic jams, of waterfalls and weather..., and is a new line of scientific inquiry which has caught the popular imagination [40]. Many would consider the hallmark of ‘chaos’ to be what is popular known as the “Butterfly Effect” after Edward Lorenzo’s paper on “Predictability: Does the flap of a butterfly’s wings in Brazil set off a tornado in Texas?” As the title suggests, a small alteration in the state of a dynamical system will cause subsequent states to differ greatly from the state that would have followed without the alteration [41]. To put it differently: it is about the small that can produce the great, or what others have referred to as ‘sensitive dependence on initial conditions’.

So what is the relevance of these observations...? The very nature of ‘sensitive dependency to initial conditions’ suggests outcomes which are apparently random and chancy [42]. However, this is a paradox [43] in that chaos is deterministic; meaning that later states evolve from earlier states according to fixed rules or laws. Nevertheless, minute uncertainties are amplified with the effect that even though the outcomes are predictable in the short term, these are unpredictable in the long term: Two paper cups floating side by side on top of a waterfall may well end up far apart at the bottom. This is considered to be one of the significant discoveries about chaos (related to dynamical systems; in fact, construction industry can be considered to be one such [1]). When these findings are translated into situations connected with retentions, it might mean that despite having the same retention regimes, slight differences in other project characteristics will result in significantly different outcomes! In fact, it can be very easily shown that this is very much the case in relation to say costs and benefits either to the client, contractor or to the subcontractor.

Another feature of chaos is that despite its randomness, there is ‘order’! It is this promise of finding a fundamental order and structure behind complex events that has aroused much interest in chaos. This randomness is said to have an underlying geometric form(s) or what is known as “attractor(s)” (pattern) [44]. Could such patterns be identified in relation to retentions...? Could these chaotic events be moved to a different attractor...? Interesting as it may be, these findings provide new insights on how 'retention chaos' could be resolved.

It must be pointed out that both chaos and order can be observed in juxtaposition within the same system with much interest in finding out how systems progress from chaos to order and vice-versa, as when water in a steady-flow state moves into turbulence (with eddies and whirlpools). According to Feiganbaum [45], there is astonishing regularity in the route to chaos, which he refers to as 'universality'. What is this route...? What are its characteristics...? If these can be found, we might be able to gain new insights on how to deal with retentions.

There has also been much interest in finding how systems could be moved from a chaotic state to an orderly state. Stacey [46] points out that 'when non-linear feedback systems in nature are pushed far from equilibrium into chaos, they are capable of creating a complex new order'. For example, atoms in a gas when subjected to an external impetus (say heat), can 'spontaneously re-organise' to create a complex new order [46]. However, it has also been found that as systems proceed through chaos, some options may represent yet further chaos whilst others may lead to more orderly forms, but which will occur is said to be unpredictable. Suppose for instance, the local association of consulting engineers issues a directive to the effect that subcontractors' retention moneys should be deposited in a trust account. This change is to be made through contractual clauses. If the consulting community adopted the change, what chaos theory points out is that it is not possible to predict the outcome (as this a feature of systems in chaos). Take another example. Suppose for instance the government introduced legislation stating that it is illegal to use the 'sliding retention regime' in an attempt to minimise the benefits of using the retention-differentiation strategy. Once again, the understanding provided by the chaos theory is that it is not possible to predict the outcome. However, if systems are pushed to the 'edge of chaos' through such interventions, the chances are that there may be a possibility of creating a complex new order. Consider the following example:

> *'Mediaeval bricks in the U.K. were burnt with wood fuel in kilns or clamps and from early 13th century sizes had varied from district to district 10 -15" long, 5-7.5" wide and 3 1/4" thick [which is chaotic]. Flemish bricks were smaller, nearer to the present day bricks 8 - 9 3/4" long, 3 3/4 - 4 3/4" wide and 1 3/4" thick. ... [T]hese latter sizes were used almost universally until 1784 when the tax of that date imposed on bricks produced an increase in size, as large bricks paid the same duty as small. When in 1803 the duty was doubled on bricks over 150 cubic inches in volume, the size settled down to approximately the present day dimensions, being that most suitable for handling by the bricklayer. This duty was ultimately repealed in 1850.'* [47]

The situation described is similar to the 'spontaneous self organisation' concept; the unexpected increase in the size of the brick by manufacturers (spontaneous self-organisation) caused revenue to drop as a consequence of the imposition of a duty (an external impetus) and the subsequent modification of the duty structure (for short-living the dissipative structure) resulted in the re-manufacture of smaller size bricks (spontaneous re-organisation to an orderly state).

Understanding behaviour of chaotic systems assists in taking new approaches for understanding, coping, and combating the 'retention chaos'.

7. Implications for theory and practice

> *"The purpose of scientific enquiry is not to compile an inventory of factual information, nor to build up a totalitarian world picture of Natural Laws in which every event that is not compulsory is forbidden. We should think of it rather as a logically articulated structure of* ***justifiable beliefs*** *about nature [i.e. with explanations as to why the belief is a true one]. It begins as a story about a Possible World—a story which we invent and criticise and modify as we go along, so that it ends by being, as nearly as we can make it, a story about real life."* [6]

Images of Retentions was an attempt to write a story about a practice that has spanned well over a century. Specifically, this was attempt to build a story through 'facts' in a way that it condenses what we know, capture and provide new insights, and facilitate scientific practice. The Cash-Cow Theory explains the value of monetary retentions for those who outsource their work with a desire to capitalise on the cash benefits on offer. It also explains how they may do so. Embedded within the theory are the responses to all the theory building elements discussed earlier. Furthermore, it also explains why contractors should not show any complacency in protecting the 'cash-cow'. The Steroid Theory of Retention explains the power of retentions to act as a catalyst for high performance (and not just performance). The Beast Theory highlights the woeful implications of retentions and how beastly features can be put into to good use. The Stress Theory defines the impact of its use, particularly extensive use, and strategies that may be used to minimise the adverse impacts in addition to providing various new insights as was the case with other theories. Finally, the Chaos Theory on Retentions portrays retentions as a chaotic phenomenon, and how features of chaos could be used to gain new insights particularly for moving retentions to a new order. These theories are accounts of *justified* beliefs; they describe, explain, and predict what might happen if certain courses of actions are taken, particularly in a New Zealand context. These are not perfect; there is opportunity to criticise and modify as we develop understanding: this is the nature of theory.

Individually, these 'theories' tell us a one-sided story by highlighting certain interpretations and forcing others to the background. This needs to be understood but importantly the theories need to be viewed together rather than in isolation, understanding the opposing and complementary points of view, along with their interactions. For example, if the aim is to 'live with chaos', each of these theories tells us how one might to do so in a way that betters current practice. On the other hand, if the intention is to bring order, each of these theories might be used for this purpose; create more chaos and push the current state to the 'edge of chaos' with the hope of producing a new order through 'spontaneous re-organisation'.

This is only a beginning; there is more to be understood about this *'unwanted essential'*!

8. Implications for Research

Theory is neither complete nor perfect! So are the *theories* that go to build *theory*. There is a need for such an appreciation through which new theories could be developed, or existing ones modified, thereby refining our understanding in a way that informs practice: The theories presented herein should be a good foundation to undertake further investigation and exploration.

The theory (and theories) presented on retentions are not exhaustive: These theories do not explain, for instance, why retentions are mainly used in commercial construction and not residential construction or why retentions are not used in supply contracts. Nor does it explain why it is only meant to protect those who seek services and not those who provide services. There is a need for further explorations with the aim of building theory and theories. In this regard, the use of metaphors as a methodology cannot be underestimated; in deed, it is an interesting, valuable, and an exciting approach for building theory, as evidenced in this study.

> *'Theory building is difficult because it requires both great discipline and great creativity, and although a person may possess one of these attributes, few people seem to possess both. In fact, we suspect that those who possess one of these attributes are likely not to possess the other – that those characteristics that make for a great disciplinarian do not make for great creativity, and vice-versa. But that is just an untested hypothesis we have. What we do know, tried and tested from many personal experiences, is that theory building requires excruciating attention to detail coupled with wild flights of imagination. About the only solace we can give you is that it probably won't kill you and that if it doesn't kill you it probably will make you stronger'* [48]

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SECTION II

COST PLANNING AND CONTROL

Security of Payment and Payment Bonds: A New Zealand Perspective

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Abstract

Security of payment legislation does not seem to provide any protection for the contracting community when the principal or the funding institution goes into liquidation. Losses arising out of such failures are a major concern for such communities of practice and this study examines this issue from a New Zealand context, particularly as to whether a statutory bonding mechanism would be a way forward. In this regard, the practice of using 'payment bonds' in the USA is examined which is found to be of less value for the two types of payment losses this study focuses on, namely, the loss of interim payments, and retention monies. Thus, in order to find a suitable solution to this problem, the nature of the risks associated with these losses is examined. It is found that the risks associated with interim payments and retentions are significantly different. As such, the provision of two different types of bonds, i.e. 'principal bonds' and 'retentions bonds' (as prescribed in NZ standard form contracts) appears to be a sensible approach when compared with the 'payment bonds' used in the USA. Nevertheless, these are of little value as they are rarely ever used: Examination of industry practices reveal various ad-hoc arrangements which are mainly of value to main contractors but not to subcontractors. Given the power of cash-retentions and the many benefits that it offers to main contractors when employed with the 'retention-differentiation' strategy (in an environment where large volume of work is outsourced) given a unique and a comparatively 'contractor-friendly' retention regime used in NZ, there is little opportunity for the subcontractors to manage the retention risk. Given this background, the industry has the opportunity to lobby the government for a solution (i.e. for a statutory bonding mechanism through the Construction Contracts Act 2002 or otherwise) if the benefits far outweigh the costs, and also by lobbying the consulting and project management community for a solution through contract documents. In the alternative, industry could self-regulate through a central retention fund (either public or private) which would no doubt provide security for retention monies and also for interim payments (by the issue of suitable bonds or otherwise); such an approach has the potential to usher a new era for the construction industry through a construction bank that better understands the commercial realities of construction. Further investigation is necessary before a sustainable solution can be found to a major national problem.

Keywords: guarantee, payment bond, retentions, security of payment

1. Introduction

Security of payment is a major concern of contractors, subcontractors, and suppliers alike in an industry that is widely perceived to be risky. In a breakthrough piece of legislation, contractors (including subcontractors) and some suppliers can now seek the protection of an Act of Parliament known as the Construction Contracts Act 2002 [1]. The main intention of the Act is to facilitate progress payments and to set in place a mechanism by which related disputes could be resolved speedily. In particular, a major relief for the subcontracting community was the abolition of pay-if-paid and pay-when-paid contractual provisions making it illegal to use even if the parties agreed to.

Whilst such legislation exists in number of countries, they seem to fall short in providing protection to contractors, subcontractors and suppliers when the 'principal' or the 'funding institution' ceases to exist. This is the case in New Zealand. Indeed, the situation is such that many construction companies, some first tier companies have gone bankrupt particularly during the last decade leaving the subcontracting community to absorb the perils of such failure with a detrimental impact on an industry that is well known for its high rate of bankruptcy. With outsourcing a common practice in NZ, the impact of such failures place huge strains on this community. As Meng [2] has pointed out, such strains, shuns the development of an industry that is so vital for national development: It is timely, and logical, that this issue be investigated further.

Interestingly enough, as far back as 1892, New Zealand had legislation that protected contractors, subcontractors and workmen for the payments due to them. Known as the Contractors' and Workmen's Liens Act, at the time the Act was enacted, there was no equivalent legislation either in the United Kingdom or in Australia although similar legislation was widespread in the United States and Canada on which the NZ Act was based [3]. The provision of security for contractual debt was such that the Act provided a right of payment to any contractor, subcontractor, supplier of materials, or workman by way of security given over money (called a charge) or security given over the owner's interest in land or chattels (called a 'lien'). The Act required a percentage of the value of the work (i.e. 25% of the money payable) be retained by the payer (the owner, employer, or builder) for a specified period of time (i.e. 31 days after the completion of the work), out of the monies that would othe payable for the work, so providing a fund against which the charge could operate. Whilst these percentages reduced over the years, the Act was repealed in 1987 as there were many problems with its implementation [4]. Almost after 15 years since its repeal, there is a new Act in force (as mentioned before), which provides various protections for payments in the construction industry but not when the principal or the funding institution goes into liquidation. The 'principal' as referred to herein can either by the client (in the case of the client-contractor relationship) or the contractor (in the case of the contractor-subcontractor relationship).

2. The Problem and a Standard Solution

Payment risks are mainly of two types, firstly, those due to payment delays, and secondly, those due to 'payment losses' (PL) when the principal or the funding institution goes bankrupt. This study focuses on the latter type of risk, as it has no protection under the CCA when compared with the former. What possible solutions exist for the latter problem...? Indeed, one of the simplest would be the use 'payment bonds' (PBs).

In essence, a PB is a ‘surety’ bond wherein one party, i.e. the surety (an insurance company or a bank) guarantees to another, the obligee (say the contractor), that a third party (say the principal) will perform a contract in accordance with the contract documents [5]. In the event the principal fails to perform all obligations diligently, the surety agrees to compensate the obligee with financial costs, up to an agreed limit [6]. As to what this agreed limit needs further investigation. In the USA, it seems to be not less than the penal sum of the performance bond with regard to the contract [7].

According to Powelson [8], a payment bond (in the USA) is intended to guarantee the employer (i.e. the client employing the contractor) that subcontractors and suppliers will be paid the monies that are due from the contractor. In certain states in the US, this is a statutory requirement as per the Miller Act [9]. Understandably, such a bond would no doubt be in the interest of the project (and of course the client) to ensure that project progress is not hampered by payment delays. Moreover, if it extends to situations where the contractor goes bankrupt, the client and the subcontractors including suppliers are further protected. If so, the PB (as used in the US) appears to provide an opportunity for wider protection than available in NZ. However, there does not appear to be any evidence to suggest that clients reciprocate such arrangements by giving a similar bond to contractors. In fact, as noted by Powelson [8], the practice in US is such that it is the main contractor that guarantees payment to certain subcontractors, workers and suppliers and not the client to the contractor. However, note that only first-tier subcontractors and suppliers who contract directly with the main contractor and certain second tier parties are entitled to a payment bond’s protection.

This raises the question as to whether a PB could not be used as a means of ensuring security of payment to main contractors in the USA, or more to the point, in NZ. Interestingly enough, the practice in NZ seems to be different in relation to who provides the bond and its coverage. The main standard form of contract for building and civil engineering works, i.e. NZS 3910 [10], provides a format for a guarantee (vide Fourth Schedule) where the security comes in the form of a bond referred to as the Principal’s Bond (and not payment bond) to ensure the performance of the Principal’s (i.e. the client’s) obligations under the Contract. As per Cl. 2(b), the expectation is that the Surety shall pay to the contractor up to the ‘amount of the bond any unpaid balance of the Contract Price and of any other monies payable under the Contract Documents, and of the damages sustained by the Contractor in respect of all default by the Principal’. However, it is not clear whether this bond could be used in situations where the principal goes bankrupt; it will be necessary to investigate the bond conditions. Moreover, as things stand, it is neither mandatory nor enforceable as it is left to the discretion of the Principal to agree. Furthermore, it is not clear whether banks/funding institution would accede to terms and conditions referred to therein. In fact, according to Kangari and Bakheet [11], the process involved in assessing risks for underwriting purposes is complicated wherein factors such as financial strength of the contractor, performance reputation, contractor’s capacity and project characteristics, and business continuity and the like, need to be considered. Thus, the situation in NZ is such that contractors, subcontractors and suppliers are exposed to a particular kind of risk without a ready mechanism to deal with such types of risk, i.e. loss of payment for work performed (including consequential losses and retentions) when the principal or the financing institution goes bankrupt. Hence, one of the questions that spring to mind at this stage is as to what type of bond could be used either through contract provisions or through other arrangements.

3. The Focus of This Study

In order to understand the use of PBs for PLs, it is important to understand the nature of the PL risk, and as to how the industry has responded to it this far. In fact, this is a risk that cuts across all communities of practice including the contracting and consulting communities which includes contractors, subcontractors, suppliers and consultants. Given the widely held belief that it is the contracting community (i.e. contractors, subcontractors and to a lesser extent suppliers) that is heavily exposed to this risk, this study focuses on the contracting community (excluding suppliers). It is expected that on completion of this preliminary study, it would be possible to establish a broad set of objectives for a much in-depth study to ascertain the feasibility of using PBs to provide security for PLs.

4. The Nature of the Payment Risk

In order to understand whether or not PBs are an effective strategy for dealing with the security of contractual debt related to PLs, there is a need to understand the nature of the risks involved. Number of issues and factors impacting on this are considered in the following sections.

5. Types of payment and payment risks

There are three types of payments to be considered when focussing on payment risks through bankruptcy: The first relates to interim payments (i.e. for work done during a particular period, say a month). The second relates to payments made for materials (either on or off site, or on order) and finally, the third relates to sums of moneys retained from interim payments generally as a protection against poor workmanship. However, according to Hughes [12], such sums are held partly as security in the case of non-performance, and partly as leverage to persuade them to come back and complete the final few items of work after practical completion. The actual intentions may need to be gleaned through contract provisions and statutory provisions. The type of payment risk with respect to the contractual relationship is shown in Table 1.

Table 1- Payment risks

Relationship	Community at risk	Defaulting party	Payment risk
Principal-Contractor	Contractors	Principal (P)/ Funding Institution (FI)	Interim payments Retention moneys Payment for materials (on or off site, or on order)
	Principal	Contractor	Advance payment#
Contractor-Subcontractor	Subcontractor	Contractor	Interim payments Retention moneys
	Contractor	Subcontractor	Over payment
Contractor – Supplier	Supplier	Contractor	Materials on credit

Rare in New Zealand; hence, not discussed.

5.1 Types of principals

The practice of obtaining a PB from the principal who in fact selects the service providers seems an unusual and unpopular preposition as there does not seem to be any benefit to the principal other than perhaps to secure the services of a top quality provider in times of high demand. Moreover, principals have different risk profiles; some more risky than others. For example, when the government commissions projects, it is rare for them to go into liquidation or fall short of funds for payment. Whist this may be the case in New Zealand (or for that matter in the developed world), it is not an uncommon in developing countries to fall short of funds as they sometimes budget for more projects than for which funds are available (in order to counteract underperforming projects), or when funds already pledged do not materialise. On the hand, private sector clients, especially property developers in comparison with government clients, are considered to be less trustworthy at least on the face of anecdotal evidence. Thus, there is a need to understand the ***payment risk profile of principals*** in order to make decisions on strategies for dealing with payment losses (described earlier).

5.2 Construction sectors

Main contractors operate across many sectors of the industry from residential, commercial to infrastructure. Clearly, the risks of working across these different sectors are not the same. For instance, there is anecdotal evidence that those who work in the property development sector are exposed to a greater level of payment risk than in other sectors. Such differences need to be understood before any attempt is made to promote solutions to payment risks. The situation is much the same when it comes to subcontractors with further differences depending on the type of work they do (say different trades in building projects) and also depend on whether it is labour only, or a full contract, or whether nominated or otherwise.

5.3 Project characteristics and interim payments

Big or small, projects vary in length. Interestingly, the size of the projects and its duration is linked with the nature of the payment risk. Interim payments of a project which is 10 months long would roughly be 1/10th of the contract sum which appears to a large sum of money to lose when compared with general profit margins; and in the case of a 5 month long project, this may be roughly 1/5th. Clearly, the nature of the payment risk would be higher in the latter than the former for projects of similar value. On the other hand, the payment risk in a larger project with the same duration would be comparatively larger than a smaller project. In other words, larger the rate of turnover, larger appears to be the payment risk (in relation to interim payments). However, as for retentions, the risk would appear to be different with larger and longer duration projects (with longer defects liability periods) having a larger risk. Thus, with such different profiles of payment risks, applying a single PB seems unsuitable, unless of course the PB is geared to reflect the nature of the risk that is currently being understood.

5.4 Types of work and nature of trades

First consider the case of the subcontractors in the building industry. According to the findings of a study by Abeysekera and Soysa [13], contractors do not view all trades as equally risky which would mean that the amount of retention moneys held would also be different. Results of the study mentioned earlier show that contractors do reflect on trade-risk when fixing retention rates and release mechanisms. As to whether this is the case with civil engineering work is unknown and needs to be investigated.

5.5 Type of sub-contract and the time lag

The type of sub-contract seems to have an impact on payment risk. For example, if the work is labour-only, it is usual (in NZ) to receive payments on a fortnightly basis but given that the first payment is received only after about a week or two, the payment risk period is approximately 3 to 4 weeks. When compared with work involving ‘labour and material’ there is a significant difference as payments for such work are made usually on a monthly basis which amounts to a payment risk period of around 2 months. If this period can be reduced, then the risk involved could also be reduced.

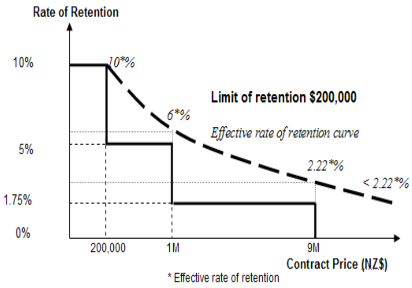
The question of whether this period is either too long or too short may depend partly on whether the principal is seen as creditworthy; in other words, the risk profile of the principal. Thus, in order to understand the issues at stake, it appears necessary to investigate how businesses assess creditworthiness of their customers (which may also impact on the price-discounts they may or may not secure for say material purchases). However, in the case of construction contractors (or subcontractors as the case may be), they may not have much of a choice other than to make a decision whether or not to take the job depending of course on market conditions. If so, they would have to accept the risk which may have unfortunate and debilitating repercussions in the event the risk eventuates.

5.6 Retention regimes

Take the case of retention regimes imposed by clients on main contractors. Examinations reveal that the commonest regime used in NZ is a sliding one as shown in Table 2. Accordingly, as the contract price increases, the effective rate of retention reduces. Of course, this is not the only regime used. Other examples are given in Table 2. It appears that there isn’t a rational explanation as to why such regimes are being used.

In formal construction, it is common for main contractors to enforce back to back terms on subcontractors; in essence, smaller the value of the subcontract, larger is the rate of retention. For example, if the value of the subcontract package is less than $ 200,000, the applicable retention rate would be 10%. This creates a retention differential as noted by Abeysekera [14] which in essence creates a surplus of cash for the main contractor. This is indeed the case if main contractors adopt the same retention release mechanisms that are applicable to them. However, examinations show that this is not the case always as some trades, particularly the front end trades in the building industry have been able to get their retentions released after a stipulated period from their practical completion as against main contractor’s practical completion [13]. It is not clear whether this is a common practice or not. Nevertheless, what is clear is that subcontractors are exposed to a comparatively higher financial risk than main contractors, and if the main contractor goes bankrupt, the amount of retention moneys held by clients may not be sufficient to meet subcontractors’ retention monies, particularly after taking into account of other debts a contractor may have when they liquidate.

Table 2- Retention Regimes

<table>
<tr><td rowspan="4">

The contractor-friendly sliding-scale retention regime used in New Zealand</td><td>Project (2005)</td><td>Retention Regime</td></tr>
<tr><td>A</td><td>$4M; 5% of Contract Price with a limit of $ 125,000; Defects liability retention 50%</td></tr>
<tr><td>B</td><td>$25M; Retention rate 10%; Limit of retention 5%; Defects liability retention 50% from last separable portion</td></tr>
<tr><td>C</td><td>$ 100M; 10% on first $15M + 5% on next 30M + 2.5% thereafter; Limit of retention $3.5M; Defects liability retention 50% from last separable portion</td></tr>
</table>

6. Risk Management Strategies: Current Practices

There is no doubt that contractors and suppliers adopt various strategies to cope with payment risks, from receiving payment in advance (before work/supply is completed) undertaking work only to the extent of funds made available, and many others which will be described later. However, as mentioned before, one of the solutions used particularly in the United States (see Miller Act) is to use payment bonds (i.e. principal bonds) for the protection of not only contractors and subcontractors but also suppliers (although not much is known about its success or failure). Of course, such a payment bond could theoretically provide protection for retention moneys as well, but the risks involved for regular payments and retentions moneys are *significantly different* as explained earlier which will require different type of payment bonds and release mechanisms.

6.1 Principal-contractor relationship

One of the solutions that have been used in large scale projects is to enter into a tripartite agreement wherein the funding institution is included as a party to the traditional bi-party agreement between the principal and the contractor. This seems to be a common practice in large property development projects. Though there is a possibility of using Principal Bonds (as made available through NZS 3910), not surprisingly, there does not appear to be any evidence of it being used.

With regard to retention moneys, top tier contractors in NZ would no doubt attempt to exclude retentions from contracts they enter into leveraging their reputation particularly if a performance bond is called for. Of course, they could also seek to submit a bond in lieu of retentions (referred to hereinafter as retention bonds as in NZS 3910) thereby eliminating the retention-payment risks altogether. However, the principal has to agree to it in the first place (and not otherwise) which appears to be a much easier option than a Principal Bond. However, it would obviously fall short of protecting contractors with respect to interim payments risks. Moreover, as to whether PBs would be valid when the contractor has gone bankrupt needs to be established.

The fact that standard form contracts in NZ provide for the above mentioned bonds (i.e. principal bonds and retention bonds) is interesting. Moreover, it is an impetus to a solution through a bonding mechanism. However, given that there is no evidence that PBs have ever been used in NZ (and that

RBs seem to have been used sparingly), there is, perhaps, a need to investigate why these have not been used (by main contractors) despite being available at least through standard form contracts.

With regard to retention moneys, there is a number of risk management strategies which go beyond RBs including the use of trust accounts (whether interest bearing or not) and also whether as a combined performance and retention bond [15]. Another option would be to channel all retention moneys to a central repository [16] which according to Hughes [12] is a ‘new, and perhaps radical’ approach to moneys ‘otherwise dissipated and diluted to such an extent that they are of little use to a nation’. These ‘new’ strategies have not been seriously explored in NZ construction industry but for an initial attempt by Abeysekera [17]. Of course, there is also an extreme option, i.e. the abolishment of retentions altogether – an option which is unlikely to be accepted by the contracting community in NZ which perceives retentions as being a fair practice [15] perhaps given the many benefits available to them through the ‘retention differentiation’ strategy [18]. The extent of its use as a business strategy is unknown (across different construction sectors) in order to weigh the benefits of the retention differentiation strategy against the costs of losing retentions in the event the principal goes bankrupt. In other words, there is a need to understand the costs and benefits of using retentions in order to make a decision on whether or not to use (a) a payment bond which provides protection for both interim and retention payments, (b) whether two different types of bonds, one for interim payments and the other for retention payments should be used given the different nature of the risks involved (as explained earlier), and (c) a strategy for implementing such bonds (as for instance, through contract documents or through legislation).

There is of course another option than the use of bonds, i.e. letters of credit which is used extensively when importing materials and to a lesser extent domestically. This is another option that needs to be investigated fully.

6.2 Contractor-subcontractor relationship

Subcontractors appear to be at a higher level of risk when compared with main contractors both with respect to interim payments and retention moneys partly because they do not seem to have access to either PBs or RBs even when such facilities are available to main contractors. Moreover, there is evidence that retention moneys in the hands of some contractors have been abused increasing the risk of non-payment [17]. This seems to be the case even with the CCA in force which raises the question whether the Act itself needs to be amended, which in essence is a legal solution to the issue of security of payment.

In relation to retentions (as against regular payments), it is interesting to point out that NZ subcontractors are not totally averse to the concept of retentions. Abeysekera and Price [19], seeking the views of structural steel fabricators found that most were at ease with retentions but for the manner in which retentions were used (larger rates, smaller contract packages to increase the differentiation of retention rates, lack of security, etc.). In fact, some large steel fabricators saw retentions as a positive business strategy which allows them to compete with smaller fabricators! However, whether the trade-off is so significant to the extent that they would not mind losing interim and retention payments in the event of a collapse of a contractor is unknown.

Just as much as main contractors negotiate for better deals with clients by using their reputation for example, subcontractors too negotiate favourable retention regimes with contractors but large many still find it difficult. Some subcontractors have attempted to provide price discounts in lieu of retentions as a way of managing this risk. Others, particularly those involved in specific trades (i.e. front-end trades in the building industry) have been able to obtain lower retention rates and better than normal retention release mechanisms [13]. Thus it seems there are more issues impacting on the retention-payment risk and consequently on its magnitude (i.e. the combined effect of exposure, severity, and likelihood) when compared with the interim payment risk. What seems to be emerging is that the risks connected with interim and retentions payments are significantly different and as such having one type of bond for both types of risks may not be commercially viable option particularly with regards to risks faced by subcontractors.

Whilst this may be so, the power of cash retentions through the retention differentiation strategy [18] appears to be very strong to the extent that it is difficult to see how contractors would let go of cash retentions (without the possibility of having access to cash either through a trust-account or may even be a central retention fund). Thus, it seems doubtful that subcontractors would be successful in obtaining PBs or RBs unless the clients insist that they do so. If they do, no doubt, clients will have to pay extra (for the bonds, and also for financing costs); there does not appear to be any real incentive for them to do so. Thus, to move forward the agenda for the use of PBs, there appears to be a need for government intervention. However, if the industry is to self-regulate (or be regulated by the government), the solution may come through a 'retention fund' which could (a) provide protection for retention moneys whilst providing a return, and (b) issue PBs using retention moneys as collateral and also through funds generated by investing retention moneys, whilst serving as a bank that understands construction. This seems to very interesting and promising option that must be evaluated.

There are other possibilities. For example, subcontractors could explore the use of performance bonds in lieu of retentions although there is no evidence to suggest that it has been tried out. The downside is that obtaining a performance bond from a bank is not easy (without collateral). Moreover, bank bonds usually drain working capital facilities provided by banks which in turn restrict the ability of a subcontractor to undertake new work. Although insurance bonds may be a more welcoming solution, contractors may be sceptical about bonds from insurance companies.

It should be clear from the above discussions that there are various risk management strategies that contracting parties adopt. However, there is little understanding on which of these would be better for the long term sustainability of the industry. Moreover, as to whether these approaches increase the overall costs of construction without commensurate benefits need investigation too. Furthermore, whether existing financial institutions would provide bonding facilities (and at what price) need investigation. In the alternative, whether a new organisation which serves as a central repository of retention funds whilst providing various facilities for the contracting community including the issue of various bonds could usher a new era for the construction industry needs further investigation. Clearly, there are many issues impacting on the security of payment problem without a clear cut strategy emerging from the above discussions; there is a need for greater understanding to find a sustainable business solution.

7. Conclusions

Security of payment is a fundamental premise for creating a sustainable business environment. The CCA is a major piece of legislation in that direction but fails short when it comes to meeting this important premise. Over the last decade, a number of well known construction companies have gone bankrupt raising the need for an effective strategy for managing this risk, the risk of losing interim payments and also retention payments.

It was seen earlier that the nature of the interim payment and the retention payment risk appears to be significantly different which raised the issue of whether or not one type of bond would be suitable. The practice adopted in NZS 3910 is to create two types of bonds, one for interim payments and the other for retention payments; the former to be given by the principal and the latter by the contractor. The former deals with both the interim payment and retention payment risks and is therefore comprehensive. The need for such bonds and costs of such bonds would no doubt depend on the nature of the risk as explained earlier. Given that it is difficult to imagine principals voluntarily agreeing to such bonds, one option would be for the government to intervene through legislation. This would not be a reality unless there is a strong case for it. On the other hand, if industry prefers a hands-off approach, it could create a climate for such bonds through enforceable contractual provisions (or otherwise) particularly if benefits outweigh costs. Additionally, industry could self-regulate itself by channelling all retention moneys to a central repository which would certainly provide security for retentions, and also for interim payments through a cost-effective arrangement for PBs whilst providing various other services as noted by Abeysekera [16]; in essence, such an arrangement would act as a (private) bank exclusively for the use and benefit of the construction industry. The government could also be part of such a mechanism. Given that commercial banks have consistently failed to understand construction, this is an interesting option to be evaluated; indeed, an option that Hughes [20] has labelled as a ‘new, and perhaps radical’ approach to moneys ‘otherwise dissipated and diluted to such an extent that they are of little use to a nation’.

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Estimation of contractor's project overhead rate as research on building cost

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Abstract

The contractor's project overhead costs are the on-site related costs for production support in undertaking a project, such as those for supervision, office, utilities and services. Unlike direct costs, they are not directly connected with the performance of any particular element of a project, but are required for running the project as a whole. Despite the recommended practice of estimating the contractor's field overhead for a project as line items, the alternative method of applying a selected rate as a percentage of direct cost still is used widely. As an ongoing research on building cost, Empirical models of project overhead rate have been developed from historical data in the present study. The nature and significance of the contractor's project overhead are first explored, along with factors that have an influence on the overhead rate. The bid data for 173 building projects collected from a large construction firm in Taiwan covering a variety of work is analyzed and a classification is established whereby the projects' overhead rates range between 0.0171 and 0.2912. The data is divided into two parts for model development and model testing according to order of time. Then, two methods of estimation are compared in their modeling and prediction errors: the cluster center method of categorizing projects into 24 groups and the multiple regression method using four variables, i.e. size, duration, type of work, and location. Either method can achieve an average error of about 3% of direct cost in modeling as well as in prediction. An improvement on the subjective rate-applying method, the model may coexist with the itemized estimation method as a checking mechanism and is potentially useful to contractors as well as owners and consultants. Implications for the building industry and recommendations for future research are also discussed.

Keywords: cost estimation, project overhead, empirical model, statistics

1. Introduction

The contractor's project overhead costs are the on-site related costs for production support in undertaking a project. Unlike direct costs, they are not directly connected with the performance of any particular element of a project, but are required for running the project as a whole. Depending on the practice of categorizing costs, they generally include costs of supervision, office, utilities and services, insurance, safety etc. The sum of direct costs and project overhead costs is the contractor's project construction cost representing all expenditures internal to a project and essential for completing it according to specifications. In contrast, the project's share of the contractor's home- office overhead costs and profit (so called the bid markup) is business-oriented and external to the project, for which a higher or lower level may be charged as deemed appropriate. Since the project overhead costs often constitute a greater part of the contract price than the markup, project overhead estimation deserves no less attention than markup determination. Even the owner in preparing the budget of a project should not overlook the importance of a fair estimate of project overhead costs. Traditionally, to obtain a reasonably accurate estimate of the contractor's project overhead costs, the formal practice is to establish line items and calculate how much is needed for each item, based on a plan that meets project conditions and requirements. For example, salaries of management and supervision are estimated according to the planned field office organization and the durations of the positions. Costs of various categories of insurance and bonds are estimated individually as a percentage of the estimated bid price and relevant direct costs. Usually the estimator is assisted by a checklist and evaluates each possible item in turn. Detailed examples can be found in McCaffer and Baldwin [9], Halpin [7], and Diamant [6] etc.

However, precise definition of project overhead charges is time consuming and may not guarantee the correctness of the results. Hence, when all estimates are complete, often the ratio of project overhead to direct cost (referred to herein simply as "project overhead rate") is calculated as representing the level of project overhead and compared with those for past similar projects as a check on abnormality. On the other hand, the alternative method of applying an experience-based rate (say 10%) to cover the contractor's project overhead costs still is used widely. Some contractors and owners/ consultants even fix all the contractor's overheads and profit as a percentage (say 20%) of the estimated direct cost to arrive at the bid price or budget for a project. Naturally, such a simple method is prone to inaccuracy, as the applied rate often is selected without the support of a modeling methodology. To remedy the rate-applying method's subjectivity and to improve its accuracy, this paper presents a research that set out to develop more reliable models founded on historical data, which can be used for estimating or checking for coming projects. Establishing the relationships between project attributes and project overhead rate, two empirical methods, i.e. cluster center and linear regression, are compared about their performance in modeling and prediction, based on a contractor's past bid data. The objective is to find out what would be the best method and how accurate the best method could be according to some error measures for evaluation. Related researches and factors influencing project overhead are reviewed prior to describing the data and the models. Model results are discussed and model limitations addressed at the end.

2. Related researches

Holland and Hobson [8] found from a survey that there is a lack of consistency among construction firms concerning categorization of costs as direct costs and indirect costs, i.e. project and home-office overheads. For example, the construction manager is equally likely categorized as project overhead or home-office overhead, whereas field engineers may be categorized as direct cost as well as project overhead. However, the inconsistency of different firms does not affect the models in the present study, since they are oriented towards one firm, as long as it has its own way of categorization and categorizes costs consistently for different projects. In any case, to avoid confusion, the firm in provision of data for model development has to be specific as to what constitutes project overhead costs to it.

Determination of the bid markup rate to be applied on top of the estimated project construction cost has attracted much research interest over the past decades. For example, Ahmad and Minkarah [1], Chua and Li [4] studied factors that influence the markup, which can be categorized broadly into internal and external factors, or environment, company, and project factors. Using identified factors as inputs, many markup models built upon past bid experiences, case data, or experts' opinion have been proposed, such as those in Chua et al [5], Chao and Liou [2], and Chao [3]. Although they serve a different purpose from the present study, the modeling methodology employed may be referred to, since both deal with very complex estimation problems.

3. Factors influencing project overhead

Like direct costs, the project overhead costs are entirely project-oriented and consumed on site. The project overhead rate presumably varies according to some project conditions and project features as reviewed broadly below. Generic project factors identified by previous researches to have an effect on the bid markup may also influence the level of project overhead, e.g. a small size project located in a remote area with a long duration area is likely to have both a high bid markup and a high project overhead rate. First, common to all construction projects, many overhead costs exhibit economies of scale, e.g. the larger the work, the lower the manpower required for supervision per unit of work due to a more efficient deployment, and so the project size as represented by total direct cost could be a factor. Next, the charges for several items of overhead costs such as office rents and utility fees are mostly in proportion to the time that a project lasts, and hence project duration is likely another factor. Average direct cost per month derived from the above two factors can indicate the intensity of activity and may be considered as an alternative measurement of project size.

The main type of work of a project, i.e. road, building, etc, influences the number of specialty trades involved, the proportion of labor cost, and the character of the site, concentrated or spreading, and thus has an effect on supervision, coordination, and transportation requirements, which impact on the overhead rate. Similarly, the project location, urban or rural, influences setting-up and maintenance costs of offices, shops, and quarters. In particular, the country in which a project is located is an important factor as the contractor's operation is subject to customs, practices, and laws applicable. In developing countries, numerous taxes and fees are levied on a construction project by various authorities, resulting in higher overhead costs in some categories that have to be allowed for in estimates. In a large country, China, for example, there are even regional differences in this regard.

Other possibly relevant project attributes include scope of contract, i.e. construction only or design and build (D/B), and proportion of subcontracted work. D/B and subcontracting affect resources distribution and lead to changes in interfaces and communication links with effects on costs for attendance, coordination, and engineering in support of production. Last but certainly not least, the quality level required of a project is believed to impact significantly on the staff and documentation efforts for quality control and hence overhead costs. The quality level is to some extent implied by work type and project size, e.g. large mass rapid transit contracts tend to require higher quality than common road contracts. However, it would be better to stand as a separate factor since same size facilities such as buildings can have very varied qualities.

4. Description of data

Ideally, actual costs of completing projects should be used for model development. However, estimated costs of a firm in preparing bids were the only data available to this study and so the models built later would try to capture knowledge containing in the firm's estimates, whose consistency and level of noise would affect model performance. The estimate summaries of 200 projects comprising bids submitted between March 2000 and March 2006 were collected from a large general contractor whose business spreads all over Taiwan covering a variety of types of work. For each project, the data shows project name, owner, project address, bid date, project duration, and a summary of various categories of direct costs, project overhead costs, and markups. Although the firm has standardized cost classification and reporting forms for use by all estimators, some problems in the data were found upon close examination. For example, safety costs for some projects are missing as a result of being bill items and conveniently included in direct costs, while a few projects have major materials as owner-supplied and hence a lower direct cost, which would artificially jack up project overhead rates. Since detailed estimates were not available for corrections, the data for 27 projects was discarded and a usable collection of 173 projects was complied at last.

Numbered from one to 173 in chronological order, the sample projects range between 60 millions and 30 billions NT$ in bid amount (note: 1NT$ ≈ 0.03 US$) and between 3 months and 106 months in duration. The following are classified in this study as project overhead costs: salaries for administration and supervision, office and shops, utilities and services, insurance and bonds, transport, safety, surveys and tests, environmental protection, and public relation. The calculated project overhead rates range between 0.0171 and 0.2912, with a mean of 0.0793 and a standard deviation of 0.0428.

All the projects were located domestically and of the construction-only contract. As the firm has long since adopted a policy of subcontracting almost entire work, there is little difference in proportion of subcontracting among the projects. Moreover, the data available gives very limited project information that does not allow a separate indicator for quality level to be set up. Therefore, only the following factors were considered as inputs in modeling: total direct cost, total duration, mean direct cost per month, classification of work, and classification of location. First, the coefficients of correlation among the quantifiable factors and project overhead rate for the projects as shown in Table 1 were examined. The strong and positive correlations among direct cost, duration, and mean direct cost and between duration and overhead rate appear reasonable. The weak correlation of project overhead rate with either direct cost or direct cost per month may be explained by the lessening of effects of economies of scale by large projects' more demanding quality and other factors at the same time, e.g. the overhead rates of the largest ten projects with a concentration of metros and tunnels average 0.0964 versus the overall mean of 0.0793.

A classification scheme is required for the two categorical attributes, type of work and location. With respect to type of work, a project is classified according to limited project description available into one of eight groups (Table 2). With respect to location, a project is placed into one of three classifications based on its address in Taiwan (Table 3). Tables 2 and 3 also show the statistics of each group ranked in order of increasing mean project overhead rate. Standard deviations within the groups are quite large and statistical tests of the difference between the mean overhead rates of any two adjoining groups conclude that the null (equality) hypotheses all cannot be rejected except for work type groups #5 and #6, suggesting that different groupings may be used.

Table 1- Coefficients of correlation among quantifiable factors and project overhead rate for sample projects

	Total direct cost	Total duration	Mean direct cost per month	Project overhead rate
Total direct cost	1			
Total duration	0.4697	1		
Mean direct cost per month	0.9289	0.2838	1	
Project overhead rate	0.1059	0.3613	-0.0537	1

Table 2- Statistics of project overhead rates for sample projects by type of work

Group number (type of work)	Number of projects	Mean project overhead rate	Standard deviation of project overhead rate
1 (Site works/parks)	16	0.0573	0.0277
2 (Buildings)	30	0.0597	0.0249
3 (Highways/airfields)	52	0.0665	0.0213
4 (Water structures)	5	0.0726	0.0167
5 (Bridges)	33	0.0728	0.0292
6 (Ports/marine facilities)	9	0.1072	0.0488
7 (Tunnels)	11	0.1217	0.0633
8 (Metros/high-speed rails)	17	0.1465	0.0510

Table 3- of project overhead rates for sample projects by project location

Group number (location)	Number of projects	Mean project overhead rate	Standard deviation of project overhead rate
1 (Cities/townships)	89	0.0730	0.0419
2 (Metropolitan areas)	62	0.0820	0.0360
3 (Remote areas)	22	0.0976	0.0577

5. Description of models

5.1 Data representation

While project overhead rate is the model output and project duration a model input, whether direct cost or mean direct cost per month represents project size, another input, requires consideration. Trials later showed that the conversion of direct cost to mean direct cost per month did not enhance model performance. Furthermore, in the presence of duration, mean direct cost per month is somewhat redundant for modeling the estimation. Therefore, it is direct cost that is used as an input to represent project size. As direct cost, duration, and project overhead rate are quantitatively defined, they are suitably represented by their measurements.

For the other two inputs, type of work and location, both categorical, two ways of representation, decimal and binary, are used. With decimal representation each input is assigned a number according to the order of mean overhead rates, i.e. group numbers in Tables 2 and 3, meaning that an increase in the value of each input variable corresponds to an increase in the overhead rate. With binary representation a series (number of categories minus one) of 0/1 variables are used for each input: seven for work type and two for location, bringing the total number of input variables to 11.

5.2 Arrangement of data for model development

The readied data is arranged into two sets for developing and testing models: 152 cases from 03/2000 to 03/2005 and 21 cases from 03/2005 to 03/2006. Data for the first five years are used as a large base of estimates from which a model is developed. Data for the last year is external to the model being developed and is used as future cases for testing its prediction performance in estimating overhead rates. The above arrangement agrees with the fact that a contractor makes estimates for coming projects based on experiences from various kinds of prior projects, which grow with time. Because disruption of time sequence will violate the reality and a model's prediction performance cannot be fairly tested with a completely new case, for each model shown later the steps of modeling and prediction will use the two successive data sets strictly in chronological order of the bids.

5.3 Error measures for performance evaluation

Three error measures are used to evaluate modeling and prediction performance: root of mean squared error (RMSE), mean absolute error (MAE), and mean absolute percent error (MAPE), as defined below:

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(outputted_i - applied_i)^2} \qquad (1)$$

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left|outputted_i - applied_i\right| \qquad (2)$$

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\frac{|outputted_i - applied_i|}{applied_i} \quad (3)$$

where n = number of cases used in the evaluation; $outputted_i$ = overhead rate produced for case i by the model; $applied_i$ = overhead rate actually applied to case i according to the firm's estimates.

RMSE inherits the efficacy of mean squared error (MSE), which is used by most algorithms including regression to represent overall system error to be minimized in modeling. Furthermore, RMSE refers directly to the deviation between model output and target output like MAE. It is therefore a consistent and convenient performance indicator for the present single output problem. In the following, RMSE is used as the main evaluator to measure model accuracy in monitoring performance and comparing different models, while MAE and MAPE are used as secondary measures.

5.4 Cluster center and regression methods

Two methods, cluster center and regression, were used to model overhead rates for a comparison. Using the cluster center method, the projects are classified according to combinations of work type and location into clusters, with the maximum number of clusters at 8x3=24. The mean overhead rates for each cluster are calculated as the modeled rates. Where there is a missing cluster, the mean for the work-type group is used in its stead. Using the regression method, two multiple regression equations involving all four inputs were built: one with the decimal representation and a total of four independent variables and the other with the binary representation and a total of 11 independent variables. The built equations are then used to produce overhead rates for cases within the modeling set as modeled rates and those for cases within the testing set as predicted rates.

For each model above, the RMSE, MAE, and MAPE of modeling representing closeness of fit and those of prediction representing test accuracy are calculated using (1), (2), and (3), respectively. The results are shown in Table 4.

Table 4- RMSE, MAE, and MAPE of modeling (152 cases) and prediction (21 cases)

Models	RMSE of modeling	RMSE of prediction	MAE of modeling	MAE of prediction	MAPE of modeling	MAPE of prediction
Cluster center method	0.0289	0.0395	0.0207	0.0273	0.2870	0.3673
Regression with decimal rep.	0.0336	0.0373	0.0243	0.0273	0.3291	0.4377
Regression with binary rep.	0.0305	0.0409	0.0218	0.0266	0.3099	0.4202

6. Discussion and conclusions

Compared with the large standard deviation (0.0428) of overhead rates, all of the three models represent a significant improvement (error reduction by more than 1% of direct cost) as a result of explaining factors being introduced, meaning that the input factors are relevant for modeling. Overall, the cluster center method outperforms the regression method and the regression model with binary representation outperforms the regression model with decimal representation. This indicates that linear regression with decimal representation is unsuitable for the problem as it fails to improve performance by picking up the extra factors of project size and duration left out by the cluster center method.

An empirical model's accuracy is inevitably affected by the level of noise in the data used for developing the model, so its performance must be judged considering this influence. For the present study, noises in the overhead rates for the sample projects come from over- or under-estimates of direct cost (inaccuracies in the denominators) and over- or under-estimates of overhead cost (inaccuracies in the numerators), both causing the rates to deviate from what they should be. Since a project's cost estimate can achieve ±3 percent accuracy with the total design available [7] and the direct cost constitutes the bulk of it, the best result of about 3 percent error of direct cost achieved by either the cluster center method or the regression method with binary representation is considered acceptable for the problem, although there is room for improvement. However, the fact that the cluster center method using only two factors achieves comparable or better performance in closeness of fit and test accuracy than the regression method with binary representation requires further consideration.

Although the overhead costs of a project have a lot to do with its legal and business environments and have to be considered within a local context, the presented approach is general and can be applied in any country. As the data used for model development relates to a firm's costs, the models constructed are intended for use by that particular firm, but other organizations can use their own data to the same effect. While subject to limited availability of data with a lot of noise, heuristics from this study suggest that suitable factor selection and data representation are required for producing better results. Continual model updates with the buildup of estimates would be helpful for improving performance as the base of cases expands with time.

Because of the exploratory nature of this research, the presented models are just prototypes that still need to be refined and improved. As their effectiveness is limited by the correctness of the bid data, it is suggested that future researches collect actual costs for use in model development. However, even actual cost data is available, it may not be more dependable than estimate data because of errors in assigning and reporting costs. Checking the data's consistency is important whichever is used. As the present study left out some potentially significant factors affecting model accuracy, such as level of required project quality and type of contract, they can be considered for inclusion as well as more detailed classification schemes for work type and location. Based on the findings of this study, the use of a nonlinear model such as artificial neural networks for dealing with the complex relations existing between the inputs and output of the stated problem is called for in attempts to improve modeling and prediction performance.

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Risk Allocation of Road Projects in Sri Lanka

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Abstract

Proper risk allocation in construction contracts is emerged to be prominent, because risk identification and risk allocation are influential factors in risk handling decisions. To handle risks properly, it is necessary to identify risks and properly allocate them. This can only be achieved if all parties do comprehend their risk responsibilities, risk event conditions and risk management capabilities. This paper reports a study carried out using multiple case studies, to identify various risks inherent in Sri Lankan road projects and the allocation of those risks between contractual parties. Semi-structured interviews were used as the primary data collection method and documentary evidence has also been used. Data analysis was approached using the code-based content analysis. The study revealed that road projects are dealing with many risk sources, and parties not allocated with some risks through contract clauses also happen to bear consequences of those risks, urging all contractual parties to have a thorough understanding on such risk events.

Keywords: Risk Identification, Risk Allocation, Road Projects, Contractual Parties

1. Background

Dey and Ogunlana [1] have stated that every human endeavour involves risk and that the success or failure of any venture depends crucially on how we deal with it. Therefore, it is apparent that risk and uncertainty are inherent in all construction work, and as it has been stressed by Flanagan and Norman [2], ‘the construction industry is subject to more risk and uncertainty than many other industries.’ This nature of uncertainty in a construction project is emerged by the long and complex process from its inception to completion and presence of various kinds of people with various ideas, experience, skills and interests. There are many ways of defining and classifying risks. Chapman and Cooper (cited in [3]) defined risk as ‘exposure to the possibility of economic or financial loss or gains, physical damage or injury or delay as a consequence of the uncertainty associated with pursuing a course of action'.

Having realized the ever increasing tendency of traffic volume, the Road Development Authority (RDA) of Sri Lanka has planned for the future development of the national highway network [4]. However, road projects are exposed to the uncertain environment because of such factors as, presence of various interest groups, resource availability, climatic environment, economic and political environment and statutory regulations, etc.

The aim of this research study is to be of assist to Sri Lankan road contractors and employers to identify risk sources inherent in road projects and understand their risk responsibilities so that they would be able to optimize the scarce resources and enhance the socio-economic value of Sri Lankan road projects. Against this background, the study objectives are to identify risk sources associated with Sri Lankan road projects, and the proper allocation of those risk sources among the contractual parties.

The paper is organized into several sections. Starting with the background to the research followed by the methodological framework, the next two sections discuss the theoretical framework. The fifth section discusses the analysis of risks in Sri Lankan road projects and the allocation of those risks based on two case studies whilst the sixth section concludes the paper.

2. Methodology

The research was conducted by means of the case study approach. In this research study, two foreign funded road projects which had significantly been completed were deployed. The Contract Sum was more than Sri Lankan rupees 500 million in each project. Multiple sources of evidence comprising of semi-structured interviews, documents such as letters, weather records, bills of quantities, claim reports, non-conformity reports, variation orders, project programme, public complaint reports, certified monthly bills, monthly progress reports, and also archival records such as past weather records have been used in this study for the collection of data. The list of interviewees, which represents the three contractual parties, namely the Employer, Contractor and Consultant in two cases, Case 1 and Case 2, is shown in the Table 1. The party to whom an interviewee had belonged to is indicated against the designation of the interviewee.

Table 1: List of interviewees

Case 1	Case 2
Additional Director (Employer) Project Manager (Contractor) Quantity Surveyor (Consultant) Site Engineer (Contractor) Quantity Surveyor (Contractor) Quantity Surveyor (Contractor) Insurance Manager (Contractor)	Chief Engineer (Employer) Quantity Surveyor (Consultant) Planning Engineer (Contractor) Public Officer (Contractor)

Triangulation, which is the rationale in using multiple sources of evidence, has been addressed here. The content analysis was used to analyse data, in which the software named QSR NVivo1.0 was used to codify interview transcripts and results were arrived at after a cross case analysis. The methodological framework was discussed in this section, and a literature synthesis has been made in next two sections in order to assimilate knowledge in fields of risk management in construction and risks in road projects.

3. Risk Management in Construction

Bufaied (cited in [5]) has described the risk in relation to construction as, 'a variable in the process of a construction project whose variation results in uncertainty as to the final cost, duration and quality of the project', and Dey [3] has argued that, such a variation is due to absence of risk management techniques in project management. Hence, risk management refers to a procedure which controls the level of risk and that mitigates its effect, as it had been comprehended by Toakley (cited in [6]). Important elements of this procedure are discussed within this section, with regard to the stipulated objectives of this research.

3.1 Risk identification and classification

According to Flanagan and Norman [2], a risk management framework would consist of: risk identification, risk classification, risk analysis, risk attitude and risk response. Therefore, risk identification and classification become important in minimizing the probability and consequences of adverse events. Dawood (cited in [7]) describes that a systematic risk management allows the early detection of risks. Therefore, there is no need for contingency plans to cover almost every eventuality. Risk identification involves identifying the source and type of risks. According to Flanagan and Norman [2] an identified risk is not a risk, but a management problem. It is also said that a bad definition of a risk will breed further risks. What is significant here is that having a clear view of a risk event is the first requirement, focussing on the sources of risk and the effect of the event. Risk identification is influenced by the risk perception of the risk management team, which again is influenced by belief, attitudes, judgement and feelings of the people.

Classifying risks is by identifying the consequence, type and impact of risk. Wiguna and Scott [8] have derived a risk hierarchy under four risk categories: external and site condition risks, economic and financial risks, technical and contractual risks, and managerial risks. This classification of risks has been adopted in this study. According to Bunni [9], when a risk has been identified, assessed and analysed, it must be allocated to various parties in order to keep them under control, prevent the occurrence of harmful consequences. Therefore, it is required to study the allocation of those risks.

3.2 Risk allocation

Andi [10] converses that, 'construction risks, however, can hardly ever be eliminated. They can merely be transferred or shared from one party to another through contract clauses.' The above statement is further strengthened, as Mak and Picken [11] have stressed that contractors are required to accept a certain level of risk due to unforeseen costs they incur during construction and that, the risk is also an issue for clients. The consultant may also carry certain risks depending on his role and the scope of work assigned to him. Hence, the significance of risk allocation is emphasized and such allocation of risk becomes a part of the risk management process.

Thompson and Perry [12] suggest that the careful analysis for a contract strategy will also lead to the selection of the right allocation of responsibilities in the same way which determines the type of contract and tendering procedure for a project. This gives an understanding that the significance of the role of each constituent in the contract, such as the contract agreement, Particular and General Conditions of Contract, specifications, preamble notes, bills of quantities and drawings are the determinants to the allocation of risks. Risks can also be transferred beyond the limits of contract clauses also but with the consensus of both parties as it becomes evident from the study of Wang and Chou [13].

Thus, a party to whom a risk is allocated is considered to have the “ownership of risk” and according to Godfrey (cited in [7]) it has several meanings. They are: having a stake in the benefit or harm that may arise from the activity that leads to the risk, responsibility for the risk, accountability for the control of risk, and financial responsibility for the whole or part of the harm arising from the risk should it materialize. Hartman (cited in [7]) further suggests that the principle in determining whether a risk should be transferred is whether the receiving party has both the competence to fairly assess the risk and the expertise necessary to control or minimize it. Contracting parties who do not have a shared understanding of its accountability may mismanage the risk event by assuming the event or its consequences are not their responsibility.

Section 4 describes risks in relation to road projects and especially the consideration has been given to such projects in Sri Lanka. Having realized the importance of risk identification, risk classification and risk allocation, there is the potential to operate on risks with minimal conflicts among interests of contractual parties.

4. Risks in Road Projects

The development of basic physical infrastructure becomes a pre-requisite to underpin the main types of real estate investment and especially investments in roads are large-scale so that their success or failures will have long-term implications. According to Kitazume, Miyamoto and Sato [14] road projects are social capital development projects and are subject to various risks throughout their life cycle. The reason behind that is the long construction and maintenance periods and wide geographical coverage. The longer the time scale, the more likely that there will be some interference or outside events those affect the project.

When Sri Lankan road projects are considered, their sources of risks might be specific because of its developing nature and the geography. In this type of an environment, there are evidences that contractors and owners do not pay much attention to those risks, thereby causing schedule delay, cost overrun and poor workmanship. In the recent past, many Sri Lankan roads have been reconstructed or rehabilitated mainly due to deterioration where continued maintenance was not sufficient to bring them back to standard and increase in traffic to the point where widening or realignment was necessary in certain sections. This process will be never ending and is happening so intensively at present too. Therefore, this tendency has to be realized and risks involved in this process of construction are also required to be identified and properly allocated to contractual parties in order to make them understood regarding their risk responsibilities so that the aim of the research is properly addressed.

5. Results and Findings

5.1 Risk sources associated with road projects

Identification of risk sources in Sri Lankan road project is the first finding of the research. The study started with 26 risk sources which were gathered through the literature review and concepts generated from interview transcripts. However, it could be found out that 23 risk sources were pertinent to the two cases. Those 23 risk sources have been classified in Figure 1 under four types of risk sources in order to formulate a risk classification framework based on the literature review. Those risk sources could be identified as it has been discussed within this section.

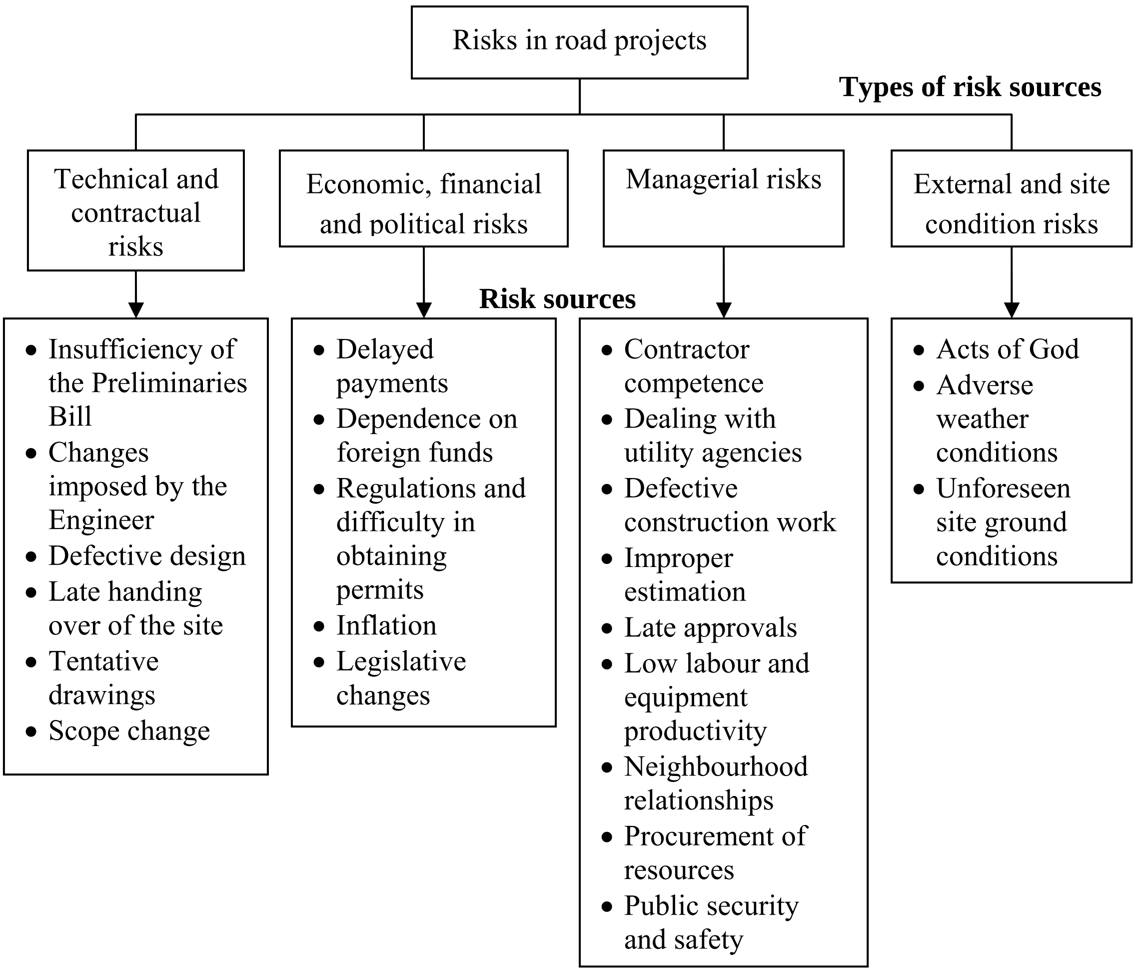

Figure 1- Risk classification framework

There were only two risk sources those were not common in two cases. They were **delayed payments** and **insufficiency of the preliminaries bill**. There had been a delay in two interim payments in one case and contractor's facilities had not been included in the preliminaries bill of that same case. In one case, construction activities had to be halted for few days after the Tsunami disaster and with regard to the other, there were several earth slips. That was the impact of **Acts of God**. The impact of **adverse weather conditions** was such that, there were materials washed away, and critical works affected due to the unexpected rainfall. Though the **contractor competence** was not much significant in relation to these two cases, this required much attention or otherwise there could have been more adversarial impacts. **Changes imposed by the Engineer** was much more significant causing many difficulties to the Contractor, and it was the same with **dealing with utility agencies, late handing over of the site** and **late approvals**. Obtaining approvals had more often been late for the reason that, not enough laboratory assistants had been there in the site to carry on required tests.

Defective construction work was marginal encountering only a few non-conforming works. The risk of **defective design** could not be underestimated since this could certainly lead to poor performance of the completed road and it could be identified such defects in the design. The **dependence on foreign funds** too was a risk as the contract sum in both projects had exceeded the forecasted sum and the amount of funds was limited. **Insufficient estimation** was a risk mainly because price escalation had not been considered for recurrent preliminary items. The increase of contract sum by more than fifty percent was due to the **inflation. Legislative changes** were also significant as there was a change in labour act requiring salaries of labourers to be increased, fuel adjustment charges on electricity bills, and also the removal of VAT (Value Added Tax) from diesel while the market price of diesel was remaining unchanged due to escalation. Thus, the possibility of claiming price escalation for diesel was restricted since the price increase had not been reflected in price indices.

Special attention had been given to overcome the risks of **low labour and equipment productivity** and **procurement of resources**. With regard to **neighbourhood relationships** a lot of complaints had been received from the neighbourhood such as, house damages due to cracks, damages to boundary walls and access paths, and land fill, endangered houses due to land cutting, accumulation of waste in paddy lands. The risk of **public security and safety** was also a major risk in this type of an infrastructure project. **Regulations and difficulty in obtaining permits** was also a risk as it was required to obtain permits for use of explosives in road works and in the quarry, and to pay royalty as the quarry that was used had been in a forest land. **Scope change** was another risk which contributed the most to the cost and time overrun in both cases. Increase of the road width, change of the road surfacing from DBST (double bituminous surface treatment) to asphalt paving in one case, and addition of a binder course layer and introduction of hard shoulder instead of the earth shoulder in the other case were due to the change in scope. **Tentative drawings** in one case had caused lot of difficulties to the Contractor because of frequent changes to dimensions and levels during constructions. Eventually, the risk of **unforeseen site ground conditions** was also significant as the difficulty in identifying underground cables, changes in sub grade to use rock fill or type-1 soil in areas where the water table was high, extra excavations for places where soil conditions were weak, difficulty in identifying underground cables because of the presence of boulders thus, ultimately requiring additional excavations.

Having identified risk sources, the proper allocation of them becomes the second finding.

5.2 Risk allocation in actual

The Conditions of Contract that had been used in both projects was the Conditions of Contract published by the International Federation of Consulting Engineers [7]. Since risks are allocated to contracting parties through contract clauses, the administration of construction risks was first analysed using the Conditions of Contract used in two cases. Since the Conditions of Contract used in the two cases was the same, it provided a similar basis for the analysis. The actual allocation of these risks was also analysed according to views of respondents and archival analysis in particular.

The risk of **adverse weather conditions** was a risk to the Employer by the sub clause 20.4(h) and from the sub clause 21.1[*Insurance of Works and Contractor's Equipment*] the Contractor was also allocated with this risk. **Changes imposed by the Engineer** is a risk to the Contractor under sub clauses 51.1[*Variations*] and 7.1[*Supplementary Drawings and Instructions*]. The Employer is also allocated with this risk under clauses 52 and 53. The risk of **contractor competence** is allocated to the Contractor by the sub clauses 39.2 [*Default of Contractor in Compliance*] and 10.1 [*Performance Security*]. By the sub clause 8 [*Co-operation with Utilities*] and in particular conditions the risk of **dealing with utility agencies** had become a risk to both the Employer and the Contractor. The risk of **inflation** as per the sub clause 70.1 [*Increase or Decrease of Cost*] of Particular Conditions of Contract in both cases, had been allocated to both the Employer and the Contractor. The former had accepted this risk in both cases while the latter in one case too had to bear this risk because of the nature of funding arrangements and due to the unexpected inflation prevalent in the country. Through the sub clause 22.1(b) [*Damage to Persons and Property*] and 32.1 [*Contractor to Keep Site Clear*] the risk of **neighbourhood relationships** had been allocated to the Contractor while the sub clause 23.1 [*Third Party Insurance- including Employer's Property*] had allocated the risk to both parties and to the Employer though the sub clause 22.2 [*Exceptions*]. The assignment of risk in **regulations and difficulty in obtaining permits** was through the sub clause 26.1 [*Compliance with Statutes, Regulations*] to both the Employer and the Contractor. It was revealed in this study, that these risk sources had been shared by both the Employer and the Contractor as it had been allocated through contract clauses.

The sub clause 8.1, 36.1 and 13.1 have delineated that the risk of **defective construction** has to be taken by the Contractor, and it was the same with the risk of **insufficient estimation** which was allocated to the Contractor through the sub clause 12.1 [*Sufficiency of Tender*]. The latter also allocated the risk of **insufficiency of the preliminaries bill** to the Contractor. The ownership to the risk sources of **Low labour and equipment productivity a**ccording to sub clauses 16.1, 54.2 and 20.1, and **procurement of resources** according to sub clauses 8.1 [*Contractor's General Responsibilities*], 28.2 [*Royalties*], 34.1 [*Engagement of Staff and*

Labour] and 36.1(a) [*Quality of Materials, Plant and Workmanship*] have been allocated to the Contractor. It was also found out that all these risks had been borne by the Contractor.

The risk of **Acts of God** becomes a risk to the Employer through the sub clause 20.4(h) [*Employer's Risks*]. However, it was revealed that the Contractor too had to share this risk. Although the risk of **late handing over of the site** had been allocated to the Employer under the sub clause 42.2 [*Failure to Give Possession*], the Contractor too had to share this risk because of irrecoverable difficulties he had to face. The Employer had borne the risk of **scope change** in both projects as in the sub clause 52.3 [*Variations Exceeding 15 per cent*], while the Contractor too had to carry a certain risk with him by delaying the project to complete. Thus, all these three risks have been shared by the two parties though the allocation was only to the Employer through contract clauses.

The Employer was supposed to undertake the risk of **delayed payments** if the Employer fails to make any interim payment as in the sub clause 60.10 [*Time for Payment*]. It is the responsibility of the Employer being dependent on a limited fund for not going into insolvency according to the sub clause 69.1(c) [*Default of Employer*]. Thus the risk of **dependence on foreign funds** has been assigned to the Employer. The Contractor was also entitled to claim increased costs due to **legislative changes** in both of these cases under the sub clause 70.2 [*Subsequent Legislation*]. Therefore, the effects of all these risk were borne by the Employer. Hence, it was the Employer, who had assumed these risk sources in actual.

According to sub clause 20.4(g) [*Employer's Risks*], loss or damage to the extent that it is due to the design of the Works other than any part of the design provided by the Contractor or for which the Contractor is responsible, **defective design** constitutes a risk to the Employer. The risk also lies with the Contractor according to the sub clause 8.1 [*Contractor's General Responsibilities*]. However, in both cases this risk had been transferred to the Consultant through a separate agreement between the Employer and the Consultant since the Consultant had been appointed as an independent party and also, it could be seen that the Employer in one case had taken measures before the start of the project in eliminating design defects. Accordingly this risk had been shared by all three parties in actual. In accordance with sub paragraphs (a), and (b) of sub clause 19.1 [*Safety, Security and Protection of the Environment*] and the sub clause 22.1(a) [*Damage to Persons and Property*], the risk of **public security and safety** lies with the Contractor and as in the sub clause 23.1 [*Third Party Insurance*], it is a risk to both the Employer and Contractor. With regard to the two cases it could be clearly seen that this risk was borne by these two parties including the Consultant also.

The risk related to **unforeseen site ground conditions** has been allocated to the Contractor through the sub clause 11.1 [*Inspection of Site*] and as well as to the Employer through the sub clause 12.2 [*Not Foreseeable Physical Obstructions or Conditions*]. It was also evident that this risk had also been shared by all three parties. The risk of **late approvals** has been allocated to the Engineer as per the sub clause 37.3 [*Dates for Inspection and Testing*], but they were the Employer and the Contractor who were happened to carry the risk. It could be considered that the risk of **tentative drawings** is assigned with the Contractor according to the sub clause 7.1

[*Supplementary Drawings and Instructions*]. However, all three parties had borne this risk with regard to two cases.

The Table 2, shown below compares the actual risk allocation (denoted by the dark circle - ●) against risk allocation through contract clauses (denoted by the light circle - ○).

Table 2- Actual risk allocation against risk allocation through contract clauses

Sources of risks	Risk allocation		
	Employer	Contractor	Engineer
1. Acts of God	●		
	○	○	
2. Adverse weather conditions	●	●	
	○	○	
3. Changes imposed by the Engineer	●	●	
	○	○	
4. Contractor competence		●	
		○	
5. Dealing with utility agencies	●	●	
	○	○	
6. Defective construction work		●	
		○	
7. Defective design	●	●	
	○	○	○
8. Delayed payments	●		
	○		
9. Dependence on foreign funds	●		
	○		
10.Insufficient estimation		●	
		○	
11.Inflation	●	●	
	○	○	
12.Insufficiency of the Preliminaries Bill		●	
		○	
13.Late approvals			●
	○	○	
14.Late handing over of the site	●		
	○	○	
15.Legislative changes	●		
	○		
16.Low labour and equipment productivity		●	
		○	
17.Neighbourhood relationships	●	●	
	○	○	

Sources of risks	Risk allocation		
	Employer	Contractor	Engineer
18.Procurement of resources		●	
		○	
19.Public security and safety	●	●	
	○	○	○
20.Regulations and difficulty in obtaining permits	●	●	
	○	○	
21.Scope change	●		
	○	○	
22.Tentative Drawings		●	
	○	○	○
23.Unforeseen site ground conditions	●	●	
	○	○	○

6. Conclusions

The research was initially begun with twenty six risk sources, and during the analysis it was found out that there were very few trivial or irrelevant risks with regard to the two cases that were studied. As it had been realized through the literature review, the observance of real cases revealed the nature of the environment within which the construction works were operated, being exposed to many risks throughout their entire construction process.

It could be seen that the relatedness of Acts of God was specific to the geographical location of the construction project, so that any party to a contract in a construction project is expected to identify the probability of occurrence of such events. In the same way, the effect of dependence on foreign funds was also specific to each project as the terms of funding arrangement are not the same in different projects.

Only the project risks of delayed payments and insufficiency of the Preliminaries Bill were not common in the two cases. The risks of defective construction works, insufficiency of the preliminaries bill, low labour and equipment productivity, project programme and Contractor competence were not much significant.

Risks of defective design, late approvals, late handing over of the site, tentative drawings, and unforeseen site ground conditions had thwarted the Contractor in many occasions. Other than that, neighbourhood relationships, and public security and safety, were also of the essence in pursuing these social capital development projects. Inflation of the country and the scope change were also deterministic factors in failing to confine to the cost and time limits of the two cases. Therefore, these risks were identified as more vital.

Another important aspect in risk identification is that, the contractual parties have to have a continuous learning approach. Past projects and past events are real scenarios to gain a good experience in liaison with this, so that probable risks that might be encountered in a new project could be identified beforehand to avoid triggering of a those risk events. Thus, early identification of a risk source was felt much essential in its proper allocation.

It is a fact that the Employer allocates construction risks through contract clauses before the contract is awarded, and this urges Contractors to have a clear understanding on risks they are allocated with. Disagreements may also occur from the absence of related contract clauses, unclear stipulations and queries about the fairness of risk allocation.

In most of the situations, though some risks had been specifically allocated to a party through contract clauses, it could be realized that, the party who was assigned with those risks was not carrying the consequences on his alone, but the other parties were also happened to bear the consequences arisen because of those risks. Acts of God, defective design, late approvals, late handing over of the site, public security and safety, scope change, tentative drawings and unforeseen site ground conditions are examples for such risk sources.

The risks of delayed payments, dependence on foreign funds, and legislative changes had been borne by the Employer himself while the risks of contractor competence, defective construction work, insufficient estimation, insufficiency of the Preliminaries bill, low labour and equipment productivity, and procurement of resources had been borne by the Contractor.

Risk sharing had proved to be more effective with regard to dealing with utility agencies, neighbourhood relationships, regulations and difficulty in obtaining permits. Those risks, including adverse weather conditions, changes imposed by the Engineer, and inflation were shared by the Employer and the Contractor.

The study helps the contractual parties to identify and classify risk sources and also to improve their understanding on proper allocation of those risk sources.

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Practical Standard Methods of Measurement Cost Estimating in the Design Stage

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Abstract

For accurate cost estimating in the initial design stage of a project, various factors related to the characteristics of the project should be reflected in the cost planning. It is impossible, however, to reflect all the side factors on the construction cost. Therefore, at least the cost factors from similar conditions in similar projects must be reflected. For the effective method used at this time, the unit price for the measurement of the quantity could be the most suitable cost model. This research aims to study the utilization goal and the current utilization status of the standard methods of measurement of some countries, and to propose new directions for the domestic standard methods of measurement. Not only are the standard methods of measurement utilized in the detailed design stage, but a method of interconnecting the information to be utilized in the initial design stage is also required.

Keywords: SMM(Standard Methods of Measurement), Cost Estimating, Design Stage

1. Background and Goal

Cost planning model can be applied to cost factors based on quality methods of measurement with respect to the characteristics of the construction project. Many studies have been performed in domestic until now, but they have various problems regarding their utilization in practice.

Therefore, this study propos the cost model, through it is compared and analyzed with the standard methods of measurement(SMM) of developed countries and that can reflect the construction cost factors based on quantities unit by design stage.

This cost model is to support decision-making by the owner and the architecture considering cost and design simultaneously

This study first examined the primary theoretical base for performing the conceptual cost calculation model, and then studied the prototype of the calculation system as an advanced study. This study is meant to be a practical study that will make possible systemization and computerization through consistent review of and complementation by succeeding research.

1.1 Research Process

This study examined the methods of utilization of standard methods of cost measurement and calculation by stage based on related literature and standard methods of cost measurement in other developed countries.

(1) Study of the Cost Calculation Method by Design Stage

(2) Study of the Current Status of Advanced Foreign Countries' Standard Methods of Measurement

(3) Analysis of the Cost Estimating Utilization Model in the Planning Stage with the Standard Methods of Measurement in the Construction Documents Stage.

The abovementioned research process aimed to study the utilization of standard methods of measurement and the method of connecting cost calculation methods in the construction documents stage and the initial design stage based on the quantities of unit or elements.

2. Cost Estimating Method by Design Stage

The cost estimation method is generally classified into three types. The first type is the Conceptual Estimation Method, which is used for incomplete designs.

For example, the conceptual estimation method is used in the planning stage or the schematic design stage. The second type is a combination of the conceptual estimation method and the semi-detailed cost estimation method. The semi-detailed cost estimation method is generally used in the design development stage. The design development stage is the stage in which the entire plan design is completed even as other designs in other construction-type projects are still partly uncompleted. Lastly, the construction documents stage is calculating the Quantities Take

Off from the complete plan and specifications. The following sections examine the cost estimation method by design stage.

2.1 Planning Stage

There are three types of conceptual estimation methods in the planning and schematic design stages. The first method is the ROM (rough –order –of magnitude) method, or the calculation method by pyeong or ㎡. This calculation method estimates the construction cost based on the total gross area. The second method is the assemblies cost estimation method, which estimates the cost based on the database of the costs of the individual components of a building such as the base, roof, upper structure, lower structure, exterior wall, interior wall, interior, machine and electricity, etc. The third method is the calculation method by cost index. This method estimates the cost using region, time series, or construction economy indices of similar types of projects.

2.2 Design Development Stage

The semi-detailed cost estimation method was developed for use in decision-making on the design within the budget of the owner. The major decisions related to the construction, including the outline of the project, the use of each room, and the land arrangement. However, Some parts of design or engineering construction are generally yet determined. Cost estimation is possible only when the design has been complete. Therefore it is used with conceptual estimation, when the design is incomplete or has yet been completed. This means that for incomplete designs, cost estimation can be performed using the actual results database; (reference historical data). And in complete designs, detailed cost estimation is performed through the market price or labor cost calculation method, take off quantities. In other words, the semi-detailed cost estimation method is applicable depending on the completeness level of the development design. Both methods are practically performed in a mixed manner in each type of design stage.

2.3 Construction Documents Stage

Detailed cost estimation is performed when the design specifications have been completed. The estimator performing quantities take off all types of construction materials used in the project and adds indirect costs to calculate the total construction cost.

In Korea, public and private organizations differ to the Standard Methods of Measurement. In the USA, both types of calculation standards are used. The types are more widely known as Uniformat(GSA) and Masterformat(CSI) in Korea. The selection of the format depends on the personal preference or the strategy of the detailed estimation.

3. Current Status of the SMM in Developed Countries

3.1 Status of SMM in Developed Countries

The details of the standard methods of measurement of other developed countries are based on the study of AIQS (The Australian Institute of Quantity Surveyors) and RICS (Royal Institution of Chartered Surveyors). The purpose of this study is to examine the current status of utilization by developed countries of standard methods of measurement (SMM) and the roles of these SMMs. Through this, it aimed to propose new domestic standard methods of cost measurement and utilization SMM methods through a review of the current SMM. In the case of Australia, it has about 10 years of history in SMM, and it went through four times the revision process. In the case of the UK, three main concepts on SMM were introduced in the 1970s, and a calculation concept related to the calculation method, time and quantities was proposed. In the case of the UK, where the level of utilization of SMM is high, it aimed to enhance the utilization level with respect to the integrated information concept of the project. The details were introduced in SMM 7, which was announced through CPI (Coordinate Project Information) in 2000. CPI aims to integrate all the factors related to quantities measurement details to reduce repetitive and wasteful factors, specifications and plans and to use them as a cooperative information system.

3.2 Comparative Analysis of the SMM

The results of the current status of the SMM of each country are shown in Table 1. The results explain the concrete details of the standard methods of measurement. In the case of Singapore, the analytical details are shown in Table 1 (Singapore ; Purpose of SMM is to provide a uniform basis of measurement, and Enabling the exchange of date between SMM, National Productivity and Quality Specifications CAD drawings)

Table 1- General Rules and Recommendations – Identified similarities and differences

classification country	Comparison analysis
Australia	Purpose of SMM is to provide a uniform basis of measurement
Canada	Work measured as net in position
Ireland	Allows for the provision of Location Drawing and Bill Diagrams to aid the descriptions of time
United Kingdom	Location to be provided in descriptions unless evident from drawings or other information required to be provided by these rules
Singapore	Purpose of SMM is to provide a uniform basis of measurement Enabling the exchange of date between SMM, National Productivity and Quality Specifications CAD drawings

3.3 The Prototype of Cost Estimating by Utilized SMM in Initial Design Stage and Construction Documents Stage.

The details of estimation, it is necessary to operate the Masterformat in the construction documents stage. The Uniformat is able to utilization of the standard methods of measurement in the schematic design and design development stages. The figure 1 is concept of utilization SMM for cost estimating which is connecting in the construction documents stage and the initial design stage through with the quantities take off (figure 1.) It is connecting labor cost and equipment cost with the Quantities Take Off the works in each design stages.

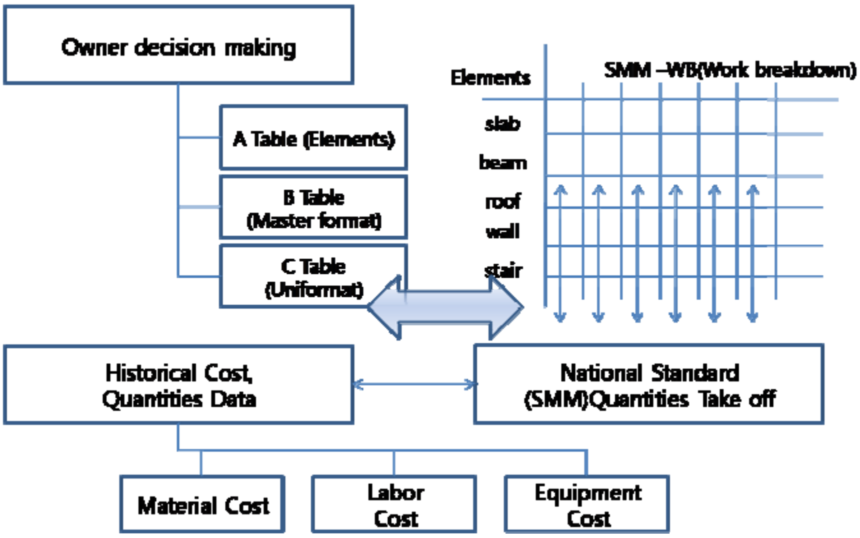

Figure 1- The concept of cost estimating by connected SMM in design stage.

Table 2 - Sample historical cost and quantities date – Connected Materformat and Unit format

010103 reinforced concrete											
		unit	**quantities**	**material**		**labor**		**expense**		**sum**	
ready mix [structure]	25-270-15	M3	15903.97	0	0	0	0	0	0	0	0
ready mix [structure]	25-240-15	M3	6244.6	0	0	0	0	0	0	0	0
pump car (25/20)	100M3 slump～12cm	M3	2670.06	775	2,069,296	8,138	21,728,948	3,622	9,670,957	12,535	33,469,201
reinforcing rod	HD10	ton	174.06	0	0	0	0	0	0	0	0
reinforcing rod	HD13	ton	566.38	0	0	0	0	0	0	0	0
reinforcing rod	HD16	ton	112.46	0	0	0	0	0	0	0	0
reinforcing rod	HD19	ton	72.93	0	0	0	0	0	0	0	0
cutting and assemble	general	ton	2633.72	10,400	27,390,688	336,600	886,510,152	0	0	347,000	913,900,840
Circle form	1th	M2	1716	8,600	14,757,600	36,600	62,805,600	0	0	45,200	77,563,200
Board form	3th	M2	24747	3,900	96,443,100	17,200	425,338,800	0	0	21,100	521,781,900
Uro-form	wall	M2	34237	2,500	85,592,500	15,300	523,826,100	0	0	17,800	609,418,600
vibrator		M3	21929	241	5,284,889	0	0	30	657,870	271	5,942,759

Table 3 - Sample cost on market and quantities take off data – Masterformat

Unit/Works (Quantities)	**Board Form (3th)**	**Circle Form**	**Uro-Form**	**Concrete (M3)**
FT	216		360	7,754
FT	216	0	360	7,754
B2	10,117		8,498	3,590
B1	10,941		8,061	4,464
Substructure	21,058	0	16,559	8,054
1	500	273	2,958	935
2	356	198	1,717	689
3	356	198	1,776	744
4	360	198	1,712	739
5	363	198	1,687	762
6	447	178	2,347	767
7	460	200	1,433	564
8	132	137	1,795	428
9	194	117	1,110	289
PH1	305		881	267
Superstructure	3,473	1,695	17,417	6,183
Total	24,747	1,695	34,335	21,991
Total compound cost	524,672,600	77,563,200	609,418,600	351,360,749

4. Conclusions

The Uniformat is a standard method of measurement that can be used as a semi-detailed cost estimation method by forecasted the quantities take off in the initial design stage. It is to used subject to building components of the base, superstructure, substructure, the exterior walls and finishing, etc. In spite of even in dazzling construction development in korea, effective cost estimating methods such as Uniformat standard methods of measurement haven't practically been established yet. To enhance the accuracy of cost estimating in the planning design and the development design stage, the quantities measurement methods of transforming from the Masterformat to the Unitformat should first be performed. This study aims to encourage future studies on a method of connecting the Masterformat and the Unitformat through case studies with the historical data.

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Project Factors Influencing the Accuracy of Early Stage Estimates

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Abstract

Cost estimates at the pre-tender stage of project development could determine whether a project is dropped or continued. Thus accuracy of early stage estimate is an important piece of information needed for decision-making at the pre-tender stage. This study explores project-related factors which influence variance between conceptual cost estimate and tender sum and in that regard investigates how the accuracy of early stage estimates could be improved. The research comprised a postal questionnaire survey of quantity surveyors in Australia. The main findings are: (1) the majority of the respondents believed that early stage estimating was either an important or very important facet of the service offered by a Quantity Surveyor with between 10% and 40% of the total workload of their company being early stage estimating. However, the majority were dissatisfied with the current level of estimating accuracy in Australia Construction Industry (2) the three most important project-related factors influencing bias in early stage estimate were project procurement method, location and project size while consistency in estimates was believed to be mostly influenced by the three factors but with project size ranking first, followed by project procurement method and location (3) Quantity surveyors slightly agree on the relative effectiveness of 13 methods for improving accuracy of estimates. The three most effective methods were: ensuring sufficient information is available at the time of estimating, followed by 'increased cost planning and control during the design phase' and 'checking all assumptions with clients and consultants during the estimating period'. Quantity Surveyors should note that there may be need for different approach to estimating projects of different complexities, different location, with different procurement method. They should also take note of the most effective ways of improving estimate accuracy identified in this study.

Keywords: Estimating, Conceptual cost, Estimate, Tender sum, Quantity Surveyors, Australia

1. Background

A large part of the Quantity Surveyor's role in the construction industry is to provide certainty of cost through estimating process. Estimates are typically carried out by the Quantity Surveyor early in the project at the design and feasibility stage and again at tender stage. When the project is finished, the Quantity Surveyor is often left with three figures namely the initial (conceptual) cost estimate, the tender estimate and the final completion cost. These three figures are often different, raising the question of estimate accuracy.

Early stage estimating accuracy is particularly important as these estimates are often prepared within a limited timeframe, without the aid of a finalised project scope. Decisions with large consequences regarding project and investment are often based largely on the outcome of this estimate. Biases in estimates can be attributed to two areas associated with the process, namely, biases associated with the project itself (will be the same regardless of the estimator) and biases associated with the estimating technique and environment (which would change depending on the estimator). This aim of this research is to explore project characteristics influencing the variances between conceptual cost estimate and tender estimate and in that regard investigate the most effective ways of improving the accuracy of early stage estimates.

This study is important because the knowledge gained could help quantity surveyors and estimators so that they are aware of which project areas may need special attention and what information or practices would be most effective in improving the accuracy of their estimates.

2. Theoretical Framework

2.1 What is Early Stage Estimating Accuracy

Serpell defines conceptual (early stage) estimating as "the forecasting of project costs that is performed before any significant amount of information is available from detailed design and with still incomplete work scope definition" [1]. (Skitmore describes the accuracy of early stage estimates as a comprising three aspects, namely bias, consistency and accuracy of the estimate when comparing the forecast (estimate) with the contract price [2]. Bias is concerned with "the average of differences between prices and forecasts", measures of consistency are concerned with "the degree of variation around the average" and accuracy is considered as an overall combination of both bias and consistency. This study examined accuracy of early stage estimate in terms of bias and consistency and is concerned with the variances between forecast and the accepted tender or contract sum.

2.2 Importance of Early Stage Estimate

After an early stage estimate has been produced, it will serve many purposes for the client. The estimate becomes one of the most important pieces of information for decision making at the conceptual stage [1]. It determines whether the project proceeds or is scrapped. The estimate provides initial information that are used to (a) decide on the financial feasibility of the project (b) evaluate alternatives to the project [3] and when the project proceeds, the estimate will (a) serve as a tool for budgetary control and (b) serve as a management tool [4]. Should further estimates on the project be required, the accuracy of the initial estimate is important, as Trost and Oberlender stated – "Early estimates, even when grossly inaccurate, often become the basis upon which all future estimates are judged"[5]. However, if estimates are inaccurate, they lose their effectiveness as tool for these outlined purposes. Clearly, an estimating error at early stage of the project development cycle could lead to misguided business decisions being made, which may not only jeopardize the success of the investment but could also have long term consequences for the performance of the investor.

Therefore, in order to enhance clients' satisfaction in the Quantity Surveyor's professional services, there is a growing need to provide accurate early stage estimates, so that cost certainty from the early stages of project development is assured.

2.3 Factors Driving the Accuracy of Early Stage Estimate

Gunner and Skitmore summarised the factors relating to accuracy, bias and consistency identified in previous studies [6]. These were building function, type of contract, conditions of contract, contract sum, price intensity, contract period, number of bidders, good/bad years, procurement basis, sector, number of priced items, number of drawings and price forecast. When analysis was performed on 181 projects from the office of a Singapore Quantity Surveyor, the results found that bias existed for the vast majority of the variables measured. Ling and Boo found similar results when they compared 5 variables against Gunner and Skitmore's work using 42 traditional procured projects from the offices of a Singapore Quantity Surveyor [7]. Skitmore and Picken studied the effect that four independent variables (building type, project size, sector and year) had on estimating accuracy and tested these variables against 217 projects from a Quantity Surveyor based in the USA [8]. They found that bias existed in project size and year, and consistency errors existed in project type, size and year. Trost and Oberlender in their study of 67 process industry construction projects from around the world, identified 45 variables contributing to early stage estimate accuracy and arranged them into 11 orthogonal elements affecting accuracy, the five most important being basic process design, team experience and cost information, time allowed to prepare the estimate, site requirements, bidding and labour climate [5]. Together, these studies tend to all suggest that a large number of variables substantially contribute to early stage estimating accuracy. The present study investigates project-related factors influencing the accuracy of early stage estimate.

2.4 Methods for Improving the Accuracy of Early Stage Estimate

Ling and Boo investigated the causes and suggest 13 measures to improve estimate accuracy [7]. When industry professionals were surveyed, ensuring proper design documentation and information management was found to be the most popular measure to improving estimate accuracy, followed by checking all assumptions during the estimating process and thirdly, providing a realistic timeframe in which to undertake the estimate. However, a possible shortfall exists in this research, as the respondents appear to have only been able to select from the thirteen options, which may have restricted some responses

3. Research Method

3.1 Data Collection and Sampling

A quantitative research method was adopted to address the objectives of the study. A questionnaire was designed for data collection. The questions relates to the profile of the individual completing the questionnaire and the company profile; respondent's views regarding importance of early stage estimate; respondent's company workload on early stage estimate and whether they are satisfied with current level of estimate accuracy; respondent's views regarding 7 project characteristics that could influence the accuracy of early stage estimate and 12 potential methods for improving the estimates. Depending on the nature of the question, respondents were asked to indicate their answers on a five-point Likert scale. To anchor the Likert Scale, relevant nomenclatures were assigned to the response options.

The questionnaires were sent to Quantity Surveying firms around Australia. The respondents were selected from the list maintained by the Australian Institute of Quantity Surveyors (AIQS), the most recognised Quantity Surveying body in Australia [the list may be accessed at www.aiqs.com.au/Find_a_member/QSFirms.asp). Sampling for the survey was done at random, with two out of every three Quantity Surveying firms listed by the AIQS selected to be surveyed, starting with the first company listed. Surveys were mailed to 102 Quantity Surveying firms and included an invitation/plain language statement and a stamped self addressed return envelope.

3.2 Response Rate and Characteristics of Sample

Of the 102 quantity surveying firms sampled, 41 responded representing a response rate of 41%. Figure 1 shows the questionnaire distribution and response rate according to 8 states in Australia. Return rates were greatest for Western Australia and Queensland, with 54.5% and 54.1% return rates respectively. Seventy-three percent of the firms have more than 6 technical staff. Ninety percent of survey responses were completed by either a Director or Associate of the firms. Eighty-one percent of survey respondents have had over 15 years experience as a Quantity Surveyor.

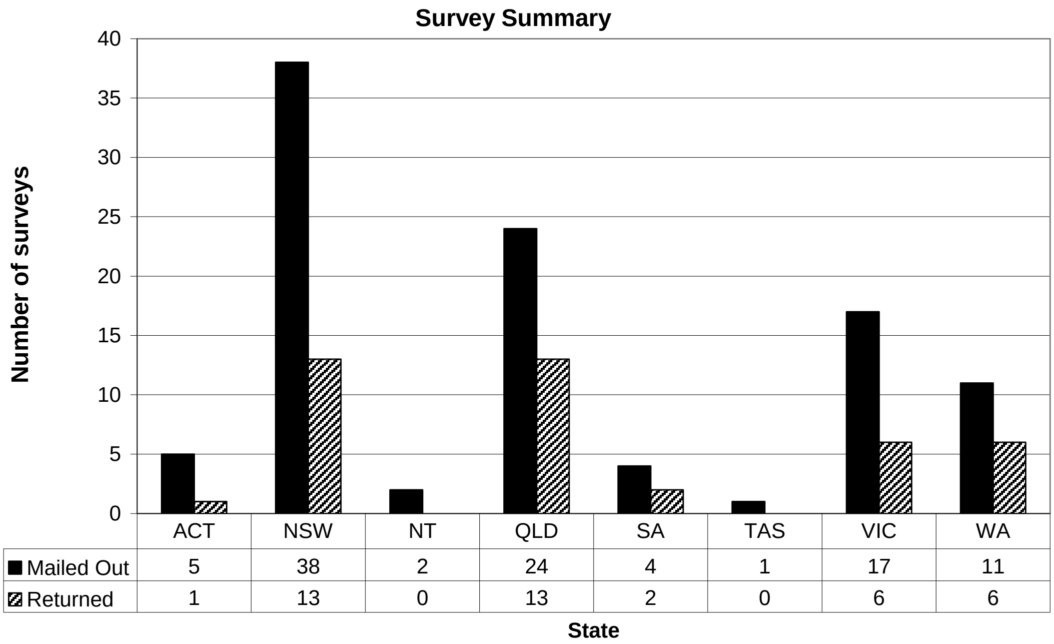


Figure 1- Questionnaire Distribution and Response

With the experience of the respondents and their designations in their respective firm, it was understood that the data came from the highest echelon of the Quantity Surveying profession in Australia, and can therefore be relied upon with confidence.

3.3 Data Analysis Approach

Relative Importance Indices were determined and used to rank methods identified to contribute to bias and inconsistencies in early stage estimate, and methods used to improve early stage estimating accuracy. Relative importance Indices was computed for each factor or method using the following expression:

$$\mathrm{RII} = \frac{A}{B \times C}$$

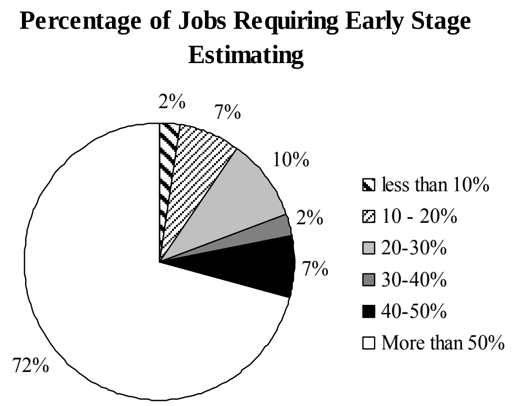
A = total Score; B = highest response option; C = total Number of responses

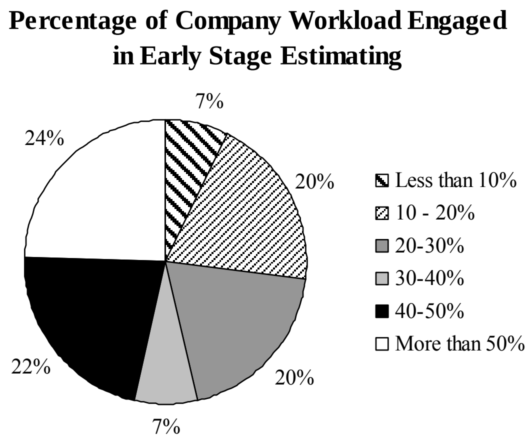
Agreement among Quantity Surveyors regarding the ranking of the methods for improving early stage estimating accuracy was tested using Fleiss' kappa statistics. Fleiss' kappa statistics is a measure of inter-rater reliability and is able compare multiple sources of data.

4. Results

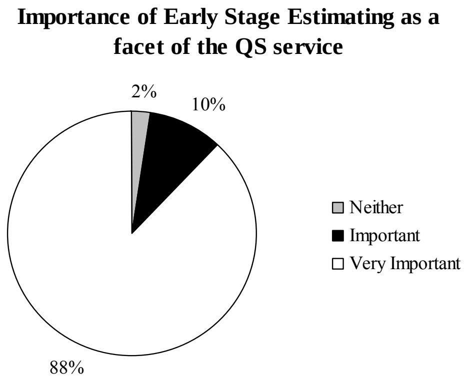
4.1 Importance of Early Stage Estimating and Workload of Respondents' Firms

Analysis of survey questions revealed that for 71% of the respondents, more than 50% of the projects brought to them by clients included some form of early stage estimate. For 68% of respondents, between 10% and 40% of the total workload of their firm is on early stage estimating. Based on these results, it was understood that the respondents and respondents company have sufficient experience on early stage estimating. Thus their responses can be relied upon.



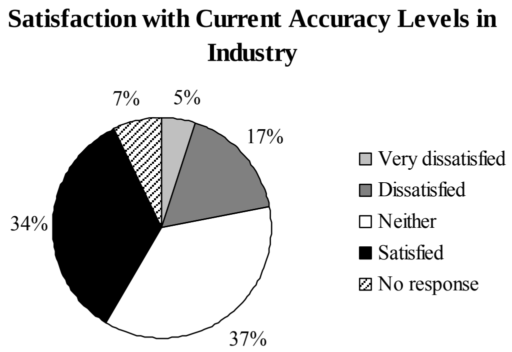


Ninety-eight percent believed that early stage estimating was either an important or very important facet of the service offered by a quantity surveyor. Similarly, 98% indicated that accurate early stage estimates were either important or very important in terms of overall project success.



4.2 Satisfaction with the Current level of Estimating Accuracy and Acceptable Tolerance level

When the respondent were asked on their satisfaction with the current level of estimate accuracy in the industry, 63% indicated they were either very dissatisfied, dissatisfied or neither satisfied nor dissatisfied. No respondents indicated they were very satisfied with current levels of early stage estimate accuracy. The results suggest that the respondents are not satisfied with the current level of estimating accuracy. When asked about acceptable tolerances in terms of deviation between early stage estimate and accepted tender price or contract sum, 78% of respondent indicated that a deviation of ±10% is acceptable.



To explore the accuracy of early stage estimate, sample cost data on 56 projects completed in the last 10 years was analysed. The contract value of the projects range from A$712,774 to A$543,875,324 and have a combined value of A$1,805,681,596 when brought to 31 December 2006 price. The projects have gross floor area (GFA) ranging from 168 m^2 to 276,094 m^2 while the combined GFA for all the projects stands at 1,103,223 m^2. It was found that the early stage estimates of the projects are on the average biased and are overestimated by 4.29%.

While the findings suggests that the accuracy of early stage estimate is unsatisfactory in practice, the level of bias in the estimate of the sampled projects seamed to fall within the tolerance level ±10%. The reason for the inconsistency may be because the cost data used are from projects procured in Melbourne while survey data is from quantity surveyors across

Australia with only 14% from Melbourne (Victoria). Thus the accuracy of the cost data is limited to projects in Melbourne. Future research need to make use of cost data from around Australia so as to obtain accuracy level that may be generalised for Australia.

4.3 Factors Influencing Bias and Consistency of Early Stage Estimate

Table 1 shows the results of Relative Importance Indices analysis of the respondents' perceived extent to which different factors (project characteristics) contribute to systematic bias and consistency of early stage estimates.

Table 1 Project Factors Influencing the Accuracy of Estimate

	Bias				**Consistency**			
Project Characteristics	**Mean Score**	**Total Score**	**RII_c**	**Rank**	**Mean**	**Total**	**RII_c**	**Rank**
Project Size	3.59	140	0.718	3	3.78	151	0.755	1
Type	3.10	121	0.621	5	3.38	135	0.675	5
Procurement Route	3.74	146	0.749	1	3.75	150	0.750	2
Year of Construction	3.49	136	0.697	4	3.55	142	0.710	4
Sector	2.92	114	0.585	6	2.98	119	0.595	6
Location	3.69	144	0.738	2	3.75	150	0.750	2
Principle Structural Material	2.90	113	0.579	7	2.95	118	0.590	7

RII_{fi} = Relative Importance Indices of factor

The results (Table 1) indicate the way a project is procured, followed by its location and size would contribute most to overall bias experienced in the early stage estimate. These three factors were also perceived to have the most significant effect on consistency of estimates, with the size of project ranking first followed by the way it is procured and location. The principal structural material and the project sector were perceived to contribute least to both bias and consistency of early stage estimates when compared to the other factors.

4.4 Effectiveness of Methods for Improving the Accuracy of Early Stage Estimate

Results in Table 2 indicate that 'ensuring sufficient information is available at the time of estimating' is the most effective method of improving early stage estimating accuracy. This is followed by 'increased cost planning and control during the design phase' and 'checking all assumptions with clients and consultants during the estimating period'.

Table 2 Ranking and T test of Methods for Improving the Accuracy of Early Stage Estimate

Improvement Method	Mean	Total Score	RII_M	Rank	t test (one tailed) (t > 3)	
					t value	p value
M_1	4.13	157	0.826	5	6.85	0.0000
M_2	4.18	167	0.835	4	8.23	0.0000
M_3	4.62	180	0.923	1	14.98	0.0000
M_4	4.20	172	0.839	3	7.81	0.0000
M_5	3.65	146	0.730	10	4.11	0.0001
M_6	3.88	155	0.775	7	6.49	0.0000
M_7	3.44	134	0.687	11	2.74	0.0047
M_8	3.38	132	0.660	12	2.07	0.0230
M_9	3.82	149	0.745	8	5.14	0.0000
M_{10}	4.33	169	0.845	2	9.27	0.0000
M_{11}	3.82	145	0.744	9	6.57	0.0000
M_{12}	4.03	153	0.785	6	7.15	0.0000

RII_{Mi} - Relative Importance Indices of Method

Legend:

- M_1 - Ensure proper design documentation
- M_2 - Establish effective communication and co-ordination between members of the project team
- M_3 - Ensure sufficient information is available for estimating
- M_4 - Check all assumptions with clients and consultants
- M_5 - Establish formal feedback for design and estimating activities
- M_6 - Provide a realistic timeframe for estimating activity
- M_7 - Use a more rigorous method of estimating
- M_8 - Incorporate market sentiments and economic conditions into the estimate by way of simulations, probability and utility functions
- M_9 - Incorporate other market sentiments and economic conditions into the estimate
- M_{10} - Increase cost planning and control activities during the design stage
- M_{11} - Improve methods of selection, adjustments and application of cost data
- M_{12} - Update cost database with new cost analyses and provide feedback for improving estimate accuracy

The result is different from findings of Ling and Boo in Singapore where

4.4.1 Testing for Agreements

To check whether all quantity surveyors agreed with the raking of the effectiveness of methods used to improve accuracy, Fleiss' kappa statistical measurement (κ) was estimated. The result of Fleiss' kappa statistical measurement shows that:

$\kappa = 0.045$

According to Landis and Koch agreement between respondent is Almost Perfect if $\kappa = 0.81 - 1.00$; Moderate if $\kappa = 0.41 - 0.60$; Fair if $\kappa = 0.21 - 0.40$; Slight if $\kappa = 0.0 - 0.20$ and Poor if $\kappa < 0.00$ [9]. In this study the measurement $\kappa = 0.045$ indicates that quantity surveyors only slightly agree with each other on the effectiveness of methods for improving early stage estimating accuracy. However, a one sample t test (table 2) shows that all the methods are effective (mean greater than 3 at $p < 0.05$). Thus it is likely that quantity surveyors consider all method to be an effective means of increasing the accuracy of early stage estimates. However, each firm uses a differing combination of improvement methods, which could explain the slight value of agreement between firms.

5. Conclusion and Recommendations

Early stage estimating is an important or very important facet of the service offered by a quantity surveyor. The accuracy of early stage estimates is important in terms of overall project success and it forms a substantial part of quantity surveying firms' workload in Australia. Despite the importance, there is dissatisfaction with the current levels of early stage estimating accuracy within the Australia construction industry. Project procurement method, location of project and project size are the three most important project-related factors driving the level of bias and inconsistencies in early stage estimates when compare with the accepted tender sum. Quantity surveyors should note that there may be need for different estimating approach and process when working with project of varying size and complexities, varying procurement method and in different locations in Australia. Also, the accuracy of early stage estimate could be improved by ensuring that sufficient information is available at the time of estimating, increasing cost planning and control during the design phase and checking all assumptions with clients and consultants during the estimating period. More time and effort should be directed at understanding client's requirements during early stage estimating process. Accuracy of estimates could be improved using other methods such as giving adequate time for estimating, effective communication between project team, rigour in estimating process, adequate update of cost data base.

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Techniques for Calculating Unabsorbed Overhead

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Abstract

The technique for calculation of home office overhead damages, a claim category on construction projects, has been widely debated. The Eichleay Formula is a well known technique for such claims, that evolved over the past 47 years. This paper provides concepts of compensable home office overhead damage due to a project delay, the evolution and required prerequisites for using the Eichleay formula, and alternate formulas and techniques used. A "Direct Method" is proposed, which is simpler to apply. In the final analysis, obtaining a 100% accurate estimate of home office expenses is impractical, if not infeasible.

Keywords: Eichleay, Compensable, Home Office, Claim

1. Introduction

Home office overhead expense damages incurred due to project delay are called 'unabsorbed overhead'. The most commonly applied method for calculating home office overhead claims for damages due to delay is the "Eichleay Formula". This paper focuses on several areas relating to the Eichleay Formula and its evolution, and provides an explanation of the elements of the formula and alternate formulae for calculating unabsorbed overhead. The paper will present criticism surrounding the use of the Eichleay Formula. Various techniques for calculating unabsorbed home office overhead will be presented, and the results will be compared and analyzed. All known techniques have been pulled together in this study.

2. Items in Home Office Overhead

Home office overhead normally consists of costs such as rent, utilities, furnishings, office equipment, executive staff salaries, support and clerical staff salaries, project related staff (engineers, estimators, schedulers), mortgage costs, outside legal and accounting expenses, depreciation, auto travel, professional trade licenses and fees, employee recruitment, relocation, training and education, photocopying, entertainment, contributions, donations, postage, cost of preparing bids, review of submittals, taxes, advertising, insurance premiums, interest costs, and data processing/computer costs. The contractor needs to pay or recover these costs by allocating these costs to the projects it performs (Taam and Singh, 2003). The unabsorbed home office overhead that will be discussed here consists of the home office overhead for which the contractor is not paid for work that is really compensable.

3. Evolution of the Eichleay Formula

3.1 History of the Formula

Before 1940, unless expressly permitted by the contract, the contractor could not recover consequential damages for government delay (*McCord v. United States)* [i]. The bias towards owners is found to increase as one checks case law further back in history. The U.S. government's position in earlier centuries was simply that it had paid for the right to change the contract. In 1945, however, in the case of *Fred R. Comb Co. v. United States* [ii], the Court of Claims found the government liable to the contractor for home office damages caused by delay. The court also found that the government, having breached its contract, had no right to state that a contractor will go uncompensated. This laid the foundation for the emergence of the Eichleay formula, which set up criteria and formulae for calculating compensation due to the contractor.

The Eichleay Formula originated from a decision by the Armed Services Board of Contract Appeals in 1960, *Eichleay Corporation v. United States* [iii]. In its appeal before the Board, the Eichleay Corporation proposed a formula for calculating the damages. The Board accepted this formula as a reasonable method for calculating the damages (Trauner, 1990).

3.2 The Eichleay Formula

The Eichleay formula is a three-step process as per the following formulae:

(Actual Billings for Delayed Contract x Total Actual Billings for Period (All Contractor Contracts)) ÷ Total Home Office Overhead for Period = Overhead Allocable to Delayed Contract (OACD) -(1)

OACD ÷ Days of Performance = Daily Contract Overhead for Delayed Contract -(2)

Daily Contract Overhead for Delayed Contract x Number of Days Delay = Overhead Claim Amount for Delayed Contract -(3)

A step-by-step example of the Eichleay Formula, using the data in the example shown later, yields a value of $6,667.

The Eichleay Formula first determines the allocation of home office overhead for a particular project. Next, it takes a portion of the allocation and applies it to the total days of performance, which results in a daily home office overhead cost. Finally, the Eichleay Formula calculates compensation due to a contractor for an owner-caused delay by multiplying the daily overhead rate with the days delayed. The formula is an attempt to provide a realistic basis for allocating home office overhead costs.

3.3 Acceptance of the Eichleay Formula

Since its inception, the Eichleay Formula has gained considerable acceptance, but courts and boards have generated numerous opinions concerning its application, going alternately back and forth on it. For example, in *Excavation-Construction, Inc. v. United States* [iv], the board recognized the use of the Eichleay Formula to determine the cost not only of a suspension of work, but also of a delay caused by extra work. In *Wickham Contracting Co. v. Fischer* [v], the 3rd Federal Circuit held that the Eichleay formula was the exclusive means available for calculating unabsorbed overhead, overruling the earlier decision by the GSBCA (General Services Board of Contract Appeals). In *Capital Electric Co. v. United States*[vi], 1984, the 2nd Federal Circuit reaffirmed the applicability of Eichleay. However, disputes continued as to whether the Eichleay formula was the only correct method and whether other formulas led to a more accurate calculation of unabsorbed overhead (Peckar and Abramson, 1999).

3.4 Arguments against the Eichleay Formula

The most common argument against the use of the Eichleay Formula is that the contractor is already compensated for home office overhead in his markup of direct costs on changes, and therefore, requires no further compensation. The problem with this argument is that a contractor receives the markup regardless of whether or not the change causes a delay.

The Eichleay formula is often challenged and criticized in two principal areas by auditors, private and government attorneys, and judges. These two areas are (1) the overall concept of unabsorbed overhead, as covered in the Eichleay formula; and (2) the accuracy of the formula. In *Wickham Contracting Co. v. U. S. Dept of Defense* [vii], the GSBCA claimed that Eichleay was entirely theoretical, and that *the Eichleay formula, which is a simple proration, cannot give a correct result because it has no mechanism for allocating wasted overhead where there are two or more delay sources* (Kaufmann and Holman, 1995).

Cibinic (1991) also took issue with the Eichleay formula by stating:

> *The Eichleay formula does not take into consideration the first and most important factor --- how much fixed overhead would have been allocated to the contract. In addition, it calls for a determination of the total overhead incurred during the contract period. This too, is defective; since fixed overhead (the subject of unabsorbed overhead) is incurred for accounting periods (usually the contractor's fiscal year), not contract periods (which would equate with the contractor's fiscal year in only the most rare and unusual coincidence).*

3.5 Abrasion and Reinstatement of the Eichleay Formula

As a result, courts minimized the formula in the late 1970's and early 1980's. A judge for the GSBCA predicted its complete demise. Non-government contract forums were the first to reject the use of the Eichleay formula; courts in New York[viii] and Texas[ix] both refused to apply it in construction delay cases. The low point for Eichleay was the GSBCA decision in *Capital Electric Co.*[x], where Judge Lieblich stated:

[We can be confident] … that the government will never again go along with any payment to a contractor for "extended overhead" nor will it ever again agree to the application of the Eichleay formula to any overhead calculation in a construction case. Whether distinguished or overruled, those prior decisions will be dead letters hereafter.

Within one year, however, the U.S. Court of Appeals for the 2nd Federal Circuit reversed the *Capital Electric* decision and reinstated the contractor's right to utilize Eichleay.

3.6 Compensability Criteria for the Eichleay Formula

Since the inception of Eichleay in 1960, courts have required prerequisite criteria to determine whether a particular situation would qualify for application of the Eichleay Formula. The first criteria is the uncertainty of the delay or standby period, and the second criteria is the "practicality" and "possibility" for the contractor to take on additional work, which would "absorb" the home office expenses during the period of delay. "Standby" is defined as an order by a contracting office to not perform any further work on a contract until requested to do so by the contracting officer.

The first criteria was upheld in *Community Heating & Plumbing Co., Inc. v. Kelso* [xi]. Again, in *C.B.C. Enterprises, Inc. v. United States* [xii], the contractor appealed the Navy's denial of an extended overhead claim. The courts found that there was no suspension, delay, or disruption of work and that the period of performance was known. Recovery is permitted only when a "cloud of uncertainty" exists regarding the period of performance.

In *Interstate General Government Contractors v. West* [xiii], the contractor claimed unabsorbed overhead costs because of government-caused delay subsequent to a standby. In this case, the project was completed 13 days early, but the standby was prolonged. The Federal Circuit implemented a three-part test that needed to be met whenever a contractor completes a contract early:

- The contractor must prove that it intended to complete the contract early.
- the contractor must prove that it had the capability to do so, and
- It must prove that it actually would have completed early, but for the government's action.

The test is to assure prevention of a contractor receiving double payment on its overhead claim.[xiv] However the universal rationality of this test does not seem to have been established. The test is much like the victim of an injury in torts having to prove he had no intention to injure himself, a requirement that is not entertained in modern tort law.

In *Wickham Contracting Co. vs. Fischer*, the Federal Circuit court affirmed that the Eichleay Formula was the exclusive formula to use to calculate home office overhead damages when the Eichleay prerequisites were met. The prerequisites for use of the Eichleay formula are standby with uncertainty, and the impractical ability to take on additional work during the delay period to absorb the home office overhead. Since Wickham, the question in most government delay damage cases has been more a question of entitlement instead of a contractor having to prove damages in order for use of Eichleay.

In *West v. All-State Boiler* [xv], the court found that the government could not meet its burden by showing either: "(1) that it was not impractical for the contractor to obtain other work to which it could reallocate its indirect costs; or (2) that the contractor's inability to obtain other work was not caused by the government's suspension…" This decision further clarified the second prerequisite of a contractor not having to prove that it was impossible to take on new work, but only that it was impractical to do so (Peckar and Abramson, 1999).

In *Melka Marine, Inc. v. United States* [xvi], the Court further clarified that when the government identifies with certainty the date on which its delay will end, the standby test is not met. Standby requires an uncertain delay period where the government can require the contractor to resume work.

Naturally, many of these prerequisites are harsh and unwarranted, making recovery quite an onerous task for the contractor.

4. Alternate Techniques and Formulas

4.1 Other Formulae and Techniques

Critics of the Eichleay formula have suggested the use of various formulae and methods for use in calculating unabsorbed overhead damages, depending on the situation. Alternate techniques include ten methods, including one designed by the authors. These are the Comparative Absorption Rate Method (CARM), Burden Fluctuation Method, Carteret Method, Allegheny Method, Canadian Method, Modified Eichleay Method, Calculation based on Actual Records, Total Direct Cost Allocation Method (DCAM), Specific Base Allocation Method (SBAM), and Direct Method. Not all the methods can be discussed here for want of space, but the most important and representative ones will be described. The interesting factor about these alternate techniques is that they do not come with strings attached, such as the prerequisite criteria of Eichleay. Such is the nature of case law on this topic.

The following example will be applied to above methods to calculate unabsorbed home office overhead (McDonald and Baldwin, 1989). A summary of the results for comparison purposes is provided later.

4.2 Example Situation

The example applied to the formulas and methods to follow, is described: A project could have been performed by the contractor for a price of $400,000 over a four-month duration assuming no change orders were issued, and no suspensions of work or other delays were encountered. The contractor, in this example, has a fixed home office overhead rate of $40,000 per month, has $100,000 of monthly billings on this contract, has $400,000 per month from other contracts, and thus regularly does $500,000 worth of total business per month including the contract in question.

Under the contractor's "potential performance," contract billings are made through months 1 and 4 (both inclusive). Total billings stay at $500,000 for all months and reflect what would have happened but for any changes or delays by the owner on this project.

In the "actual performance", there is a one-month suspension in the third month: the contractor has to forego contract billings for that month, but still must carry a home office overhead. Thus, while total billings are $500,000 for all months, they fall by $100,000 in month 3.

4.3 4.3 Burden Fluctuation Method

This method determines unabsorbed overhead by finding the increase in the absorption rate and allocating that increase to the non-contract work, which was forced to bear more than its fair share of overhead expenses. The burden fluctuation method has been used by courts and boards to calculate manufacturers' unabsorbed overhead claims.

Total Billings - Contract Billings = Other Contract Billings -(4)

Actual Overhead Rate - Potential Overhead Rate = Burden Fluctuation -(5)

Burden Fluctuation x Other Contract Billings = Unabsorbed Overhead Claim -(6)

Under the Burden Fluctuation Method, the contractor could claim a 0.33 percent increase in his overhead rate for the example considered, resulting in a claimed amount of $6,600.

4.4 Modified Eichleay Method

The Eichleay Formula tends to understate the overhead rate because it considers and includes the delay period in the formula calculation for the disputed contract. The Modified Eichleay Method changes this by deleting the days of delay from the number of days in the contract performance period (Equation 8). The result will be a higher Daily Overhead Rate. The Modified Eichleay Formula is provided below. A simple calculation yields unabsorbed overhead = $8,333.

Actual Billings for Delayed Contract ÷ Tot. Actual Billings for Period (All Contractor Contracts) x Total Home Office Overhead for Period = OADC - (7)

OADC ÷ Days of Performance (less delay period) = Daily Contract Overhead for

Delayed Contract - (8)

Daily Contract Overhead for Delayed Contract x Number of Days Delay = Overhead Claim Amount for Delayed Contract - (9)

4.5 The Canadian Method

This method is used extensively in Canada (Trauner, 1990). The Canadian Method uses the contractor's actual markup for overhead in its calculation. This markup is based on bid documents or audit records. An audit of the contractor's records will determine a percentage based on history. The result for the example is $8,000.

Percentage Markup (from bid docs or audit) x Original Contract Sum ÷ Original Number of Days in the Contract = Daily Overhead Rate - (10)

Daily Overhead x Number of Days of Compensable Delay = Compensation for Home Office Overhead - (11)

4.6 The Allegheny Method[xvii]

This formula focuses on the difference in overhead rates between the actual period of performance and the originally expected period of performance. The excess overhead rate is multiplied by the contract base costs to determine the unabsorbed overhead amount. This method yields only a rough order of magnitude estimate of the damage, since the two periods will be intermixed and the excess overhead is calculated on the costs of the contract amount (Cibinic, 1991). For the example, unabsorbed overhead = 0.33% * $2,400,000 = $7,920.

Incurred Overhead Rate during Actual Period - Incurred Overhead Rate for Projected Performance Period = Excess Rate of Overhead - (12)

Excess rate of Overhead x Base Costs of all Contracts = Unabsorbed Overhead - (13)

4.7 Total Direct Cost Allocation Method

The Total Direct Cost Allocation Method allocates the direct costs incurred to calculate the overhead rather than what has been billed (Hewitt, 1986). The calculation for the method is as follows. For the example, unabsorbed overhead = $10,000 * 1 = $10,000.

Overhead Applicable to the Disputed Contract, OHDC = Disputed Contract Direct Costs x Total Company Overhead ÷ All Other Contract Direct Costs - (14)

Daily Overhead Rate, DOR = OHDC ÷ Days of Contract Performance (less delay days)- (15)
Overhead Cost Claimed, COH = DOR x Days of Delay - (16)

The total direct cost approach suffers from a number of weaknesses. It does not consider the differences in the cost components from a contractor's various projects. The methodology assigns the same overhead rate calculation to every project. Normally, rates are determined based on the type of work involved in the contract. Overhead rates would vary based on the level of effort required.

4.8 Specific Base Allocation Method (SBAM)

SBAM is a substantially accurate allocation approach, but is also considered the most complicated and expensive to use (Hewitt, 1986). SBAM allocates overhead costs based on the specific characteristics of a job and each overhead cost element. SBAM would only be a practical approach if the methodology for collecting data was already in place or when the claim amount can justify the analysis expense. The method involves creating indirect cost pool accounts and a basis for allocating the accounts to each contract. This involves developing, comparing, and establishing cost relationships for all elements. The costs for overhead items are allocated to each job based on the established percentages of the overall item cost. Of the various established techniques, SBAM comes closest to counting the dollars in detail the exact way they are allocated. This is, of course, time consuming and tedious. For the example, unabsorbed overhead = $8,000.

Allocation Basis (AB) = Allocation Item Cost on Disputed Jobs ÷ Allocation Item Cost on All Jobs - (17)

Allocated Overhead of Pool Account (AH) = Pool Account Cost x AB -(18)

Average Daily Overhead (ADOH) = AH ÷ Total Contract Days - (19)

Claimed Overhead Cost s= ADOH x Days of Delay - (20)

4.9 Calculation Based on Actual Records

In the calculation of damages based on actual records, the contractor needs to provide detailed accurate records of his home office overhead expenses that will support his claim. In providing the records, the contractor will need to determine the percentage of effort expended for this project performance period or during the delay period. This percentage can be applied to the fixed home office costs, which will result in an allocation for the particular project (Trauner, 1990). This procedure requires detailed accounting procedures, from a record-keeping standpoint, which can be quite onerous. However, the effort may produce substantial benefits to the contractor, which might otherwise not be realized (Ernstrom and Essler, 1982). This method is very accurate if used precisely, and requires no formulas, which is a welcome benefit.

4.10 The Direct Method

The Direct Method is a method proposed by the authors, since it espouses a one-step calculation.

Planned Overhead Rate x Planned Earnings during the delay period = Unabsorbed Overhead - (21)

For the example, unabsorbed overhead = 8.00% * $100,000 = $8,000. The calculation of unabsorbed overhead should really not be more complex than this, and this reflects exactly what the contractor would have earned on the home office overhead had there been no delay or standby. The expected (i.e. planned) production during period of delay can be known from client-approved contractor schedules, the information for which should be readily available. On complex, high-volume projects, especially those of the Department of Defense, earned value reports are mandatory, so the expected earnings should be available and easily acquired. For this particular example, the result of the Direct Method agrees with the Canadian, Comparative Absorption Rate, the Carteret, and Specific Base Allocation Methods. The important factor in the "Direct Method" is that the planned earnings are based on the latest updated schedule. There needn't be any interference from Total Billings in the calculation of unabsorbed overhead for a specific project, and the Direct Method has taken this into account. The Direct Method is much less convoluted than the other methods presented. It consequently appears evident that attorneys and judges, in their ignorance of construction engineering and management, have made a simple process as complicated as possible.

5. Summary of Unabsorbed Overhead Calculations

The results for unabsorbed home office overhead damage calculations for each alternative are provided below:

Burden Fluctuation Method	$6,600
Eichleay Method	$6,667
Allegheny Method	$7,920
Canadian Method, CARM, Carteret, SBAM and Direct Methods	$8,000
Modified Eichleay Method	$8,333
Direct Cost Allocation Method	$10,000

6. Discussion

The median result of all methods is $8,000. The mode is the same, as well. The Eichleay Formula calculation, at $6,667, is approximately 20% lower than the median. It appears that various claimants have used different, but rational approaches to calculate the value of unabsorbed home office overhead, each which have been upheld by courts and boards.

Results for the various alternatives and methods vary, predicated by the particular situation, conditions, and assumptions used in each particular method. All the alternative methods have been used at some time or the other to calculate *compensable damages for unabsorbed home office overhead due to delay*. Each alternative and technique is based on assumptions, have their own formulas, their individual issues and weaknesses, and they all result in estimates or approximations of the damage.

7. Summary and Conclusions

The history and evolution of the Eichleay formula for unabsorbed overhead expenses, first developed in 1960, were presented and discussed. The calculation of unabsorbed overhead still continues to dog owners and contractors alike. Multiple issues and criticism has risen on the use and application of Eichleay. Case law and court decisions that shaped the prerequisite criteria for use of the Eichleay were studied, and alternate methods and formulae for the calculation of damages for unabsorbed home office overhead due to delay were presented. The calculation of the results were summarized and discussed.

The alternate methods have similarities and differences. Even critics of the Eichleay formula acknowledge the difficulty in the determination and calculation of delay overhead damage costs. However, many of these alternate methods utilize questionable assumptions, end up approximating the damages, and often result in some of the same problems alleged against the Eichleay formula.

An exact method or calculation is probably quite impossible to develop, unless actual overhead expenses are accepted, in which case dividing the extra expenses from contractual expenses can be a knotty problem. Therefore, the goal, given the circumstances, is to determine a fair allocation for compensating a contractor for the delay. Consequently, the Direct Method is proposed as an alternate method for the calculation of unabsorbed overhead. The Direct Method is a simple, straightforward, and realistic method for calculating unabsorbed overhead damages and is simpler to use and apply, using, as it is, only a one-step process. Subsequent to all the convoluted techniques studied, it appears reasonable to recommend the straightforward Direct Method, better even than the widely adopted Eichleay.

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Factors that Influence Contractor's Risk Response Planning in Controlling Cost of Road Construction Project in Indonesia

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Abstract

Infrastructure projects, such as road construction, are one of the most important projects In Indonesia. They contribute significantly to the national economic growth. Data from Indonesian Bureau of Statistics shows that budget for road construction project is still the largest compared to other infrastructure projects. Effective cost control in Indonesia's road infrastructure project need to be done in order to better support the economic development. Controlling cost overrun can be done in several ways. Before-process variance is the most effective way because cost overrun is measured early in the beginning of project phase. This makes contractor can focus to develop option of responses planning to avoid such cost overrun through risk avoidance, risk transfer, risk reduction, or risk absorption. This paper discuss the factors that influence contractor's risk response planning in controlling and monitoring cost of road construction project in Indonesia. The research was done using case study in two major contractors in Indonesia. Data analysis is done by Analytic Hierarchy Process (AHP) method in order to obtain priority of the factors. The analysis indicates that personnel's risk attitude as the most influence factor. Risk identification and macro level external factor have the equal rank in second place, and project level external factor is the least influencing factor in construction contractors' risks response planning.

Keywords: Infrastructure, road, construction, risk response, cost control

1. Introduction

Infrastructure projects, such as road construction, are important part of Indonesian economic development. It provides infrastructure for other economic sectors such as agriculture, tourism, manufacturing, trade and others.

Road construction project is the highest government annual spending in terms of providing public infrastructure. In 2005, for example, road construction projects constitute about 15 percent of government budget [1]. Therefore it is important to effectively control the cost of road construction.

Road construction project is susceptible to risks and uncertainties, which could affect project cost performances. Road construction contractors respond differently to those risks. Their responses could be to absorb, transfer, reduce or avoid the risks. Decision to select the type of risk response to be performed is influenced by several factors which include attitude toward risk. As contractors responsible for the construction phase of road construction projects, their respond toward risks would affect the project cost performance. The better the risk response the better the project cost performance.

The purpose of this paper is to identify factors that influence contractor's risk response planning in controlling and monitoring the cost of road construction projects in Indonesia. Case studies on state owned construction companies, which specialised in road construction was used to identify those factors. The paper starts with a review the risk response as a tool for project cost control. Following these reviews, the paper describes the method use to collect and analyse the data. Finally, the paper presents and discusses the research findings.

2. Risk Response Planning as a Tool for Project Cost Control

Project cost control is important to project management as it provides early detection of actual or potential cost overruns. This early detection provides the opportunity to initiate remedial actions and increases the chances of eliminating such cost overruns or minimising their impact [2].

Cost control for road construction project can be divided into control for direct cost and indirect costs. Direct cost includes labours, materials, equipment and subcontractors cost. Indirect cost includes cost related to general condition, tax, risk and overhead [3]. Control for project cost variance includes controlling labours, materials, equipments, subcontractors and overhead [4].

According to Zahn [4], based on the timing of their identification, project cost variances can be divided into three layers: before-process variance, in-process variance and after-process variance. Before-process variances mostly occur in the planning stage before actual construction starts. In-process variances happen during the process or before the measurement results are known. After-process variance is reactive and after-the-fact, but reflects the project performance most realistically, provided that accurate data are captured.

Zahn [4] further stated that before-process variances and in-process variances should be the major targets of a project management team who wants to effectively manage a project in a proactive, aggressive, and professional way. One approach that should be considered to do this is risk management approach. By identifying and assessing risks that can cause project cost variance, project management team can develop a risk response plan.

Risk response planning is a process of developing options and determining actions to enhance opportunities and reduce threats to the project's objectives. It also identifies and assigns individuals or parties that responsible for particular risks. Risk response planning must be appropriate to the severity of the risk, cost effective in meeting the challenge, timely to be successful, realistic within the project context, agreed upon by all parties involved, and owned by a responsible person [5].

Risk response planning can be used as a tool for controlling construction project cost. As part of risk management activities, risk response planning can be used to deal with risks and uncertainties in construction project cost [6]. It can be implemented in every phase of construction project.

Construction projects, including road construction, are affected by risks and uncertainties. Risks and uncertainties occur due to the limitation of knowledge in forecasting, which lead to favourable products (opportunities) as well as unfavourable products (risks). Risk management is often used to change risks to opportunities. Construction risks which related to human factors and technology, for example, if managed properly can reduce the negative impact to projects cost or even improve project cost performance.

Risk management process starts with risk identification, which is identifying the type and the source of risks. It continues with classifying the types of risks and their impact to the project. Risk analysis will filter and prioritise the identified risks. Following the risk analysis, risk response plan is then developed. During project implementation, the risks identified and their responses are monitored and reviewed [7].

Response to risks can be done in the followings [7]:

- Risk absorption, which is accepting the risks and preparing the cost for such risks if happened
- Risk reduction, which is reducing the impact of the risks by implementing preventive or corrective actions
- Risk transfer, which is transferring the risks to another party based on agreement
- Risk avoidance, which involves changing project management plan

The selection of the type of response will be influenced by management attitude toward the risks.

Any individual or organisation can have different risk attitude toward a particular risk, which will be influenced by time, situation, condition, experience and its environment [8]. Webb [9] stated that risk attitude can be influenced by: maturity of management in communication; credibility and flexibility of management behaviour related to disciplinary, compliant to conditions and requirements, proactive in identifying problems and using structured approach in solving the problems; and management preparedness in facing possible changes.

In general, risk attitude can be grouped into four types: [9]

- Risk averse, tend to avoid a risk
- Risk neutral, to consider benefit and losses due to the risk occurrence
- Risk seeking, to find or challenge the risk
- Risk tending, to manage the risk by developing available responses

3. Research Method

Case studies were used to identify factors that influence road construction contractors in developing their response plan. The case studies were performed on two state-owned construction companies, which are specialised in infrastructure construction projects.

The factors are grouped into internal and external factors. Internal factors related to risk management aspects of the project, which mainly related to risk identification and risk attitude. The external factors are divided into project level and macro level. Table 1 list the variables under each group.

Table 1 - Research variables

NO.	Research variables
1.	Internal Factors
1.1	Risk Identification X1 = project size X2 = project location in relation to sources of materials X3 = project complexity X4 = project duration X5 = condition of exist traffic in relation to traffic management X6 = construction method X7 = resources availability (professionals, skills, materials and equipments) X8 = local weather condition
1.2	RISK ATTITUDE X9 = maturity in communication X10 = preparedness in facing possible changes X11 = discipline of project personnel X12 = compliant to conditions and requirements X13 = proactive in identifying problems X14 = using structured approach in solving the problems
2.	External Factors
2.1	Macro level X15 = level of market competition X16 = economic condition X17 = political condition X18 = uncertainty in legal enforcement
2.2	Project level X19 = historical database in similar project X20 = availability of other project stakeholders (subcontractor, supplier and insurance) X21 = capabilities and experience of other project stakeholders (subcontractor, supplier and insurance) X22 = liquidity of project owner X23 = state of technology development

Data collection was done using structured interview to five senior project managers from the two state-own companies. The questionnaire for the interview was designed as such so it can be analysed using Analytic Hierarchy Processes (AHP).

AHP is a multi-criteria decision making method which is developed by Saaty in 1970 [10]. AHP was used because there are multi criteria that have to be considered in selecting a risk response. It will recommend priorities based on the criteria used.

AHP uses a pair-wise comparison in its mathematical formulation. Several analysis and assessment which are performed in AHP include calculating weight factors, assessing consistency and analysing rank correlation. For any comparison matrix which has consistency ration (CR) more than 10%, a clarification was made to respected respondents.

Data analysis was done using a computer application 'Expert Choice', which is an application that was designed to perform AHP analysis.

4. Factors Influencing Risk Response

Data analysis shows that most of the responses have consistency ratios (CR) less than 10%, which within the requirement. Only one response that resulted in a CR of more than 10%. After clarification with the respondent, the CR result is less than 10%. Table 2 shows the consistency ratios of the responses.

Table 2- Consistency Ratio

Pair-wise comparison matrix	Respondent				
	1	2	3	4	5
Criteria toward goal	0.06	0.02	0.09	0.05	0.04
Sub-criteria toward risk identification	0.09	0.09	0.07	0.06	0.08
Sub-criteria toward risk attitude	0.08	0.07	0.09	0.08	0.09
Sub-criteria toward macro level factors	0.04	0.07	0.03	0.08	0.09
Sub-criteria toward project level factors	0.04	0.07	0.05	0.04	0.02
OVERALL	0.07	0.05	0.07	0.06	0.06

Table 3 to 7 show the pair-wise comparison matrix at criteria (factors) and sub-criteria (variables) levels. The coefficients in the matrices are based on the median of the responses.

Table 3- Pair-wise comparison matrix toward goal

	Risk identification	Risk Attitude	External Macro	External Project
Risk identification	1	½	1	2
Risk Attitude		1	2	2
External Macro			1	2
External Project				1

Table 4- Pair-wise comparison matrix toward risk identification

	X1	X2	X3	X4	X5	X6	X7	X8
X1: Project size	1	½	1/3	1	1/3	1/5	¼	½
X2: Project location		1	1/3	3	2	¼	1/3	½

X3: Project duration			1	3	2	1/3	½	½
X4: Traffic condition				1	1/3	¼	1/3	½
X5: Construction method					1	½	1	1
X6: Resource availability						1	2	3
X7: Weather condition							1	2
X8: Complexity								1

Table 5- Pair-wise comparison matrix toward risk attitude

	X9	X10	X11	X12	X13	X14
X9: maturity	1	½	½	½	1	½
X10: preparedness		1	1	1/3	½	1
X11: discipline			1	1	2	2
X12: compliance				1	3	2
X13: proactive					1	2
X14: structure						1

Table 6- Pair-wise comparison matrix toward external factors (Macro level)

	X15	X16	X17	X18
X15: level of market competition	1	1/3	1/3	½
X16: economic condition		1	½	2
X17: political condition			1	3
X18: uncertainty in legal enforcement				1

Table 7- Pair-wise comparison matrix toward external factors (Project level)

	X19	X20	X21	X22	X23
X19: historical database	1	1/3	1/3	1/6	½
X20: availability of other stakeholders		1	1	1/5	2
X21: capabilities & experience of other stakeholders			1	1/5	2
X22: liquidity of project owner				1	5
X23: technology					1

The matrix coefficients from Table 3-7 were used as input for AHP analysis using Expert Choice software. Figure 1 shows the results of the analysis. It can be seen from Figure 1 that the first ten variables contribute about eighty percent toward risk response planning.

The ten variables that influence the risk response plan, on the descending order, are:

1. compliant to conditions and requirements (X12)
2. discipline of project personnel (X11)
3. political condition (X17)
4. resources availability (X7)
5. proactive in identifying problems (X13)
6. preparedness in facing possible changes (X10)
7. using structured approach in solving the problems (X14)
8. local weather condition (X8)

9. economic condition (X16)
10. liquidity of project owner (X22)

From the ten main variables, five are part of risk attitudes factor (X12, X11, X13, X10 & X14). There are two variables (X7 & X8) from risk identification factor and also two variables (X16 & X17) are considered external factors at macro level. There is only one variable (X22) from the external factor at project level. The respondents agreed with the results when these variable factors were validated to them.

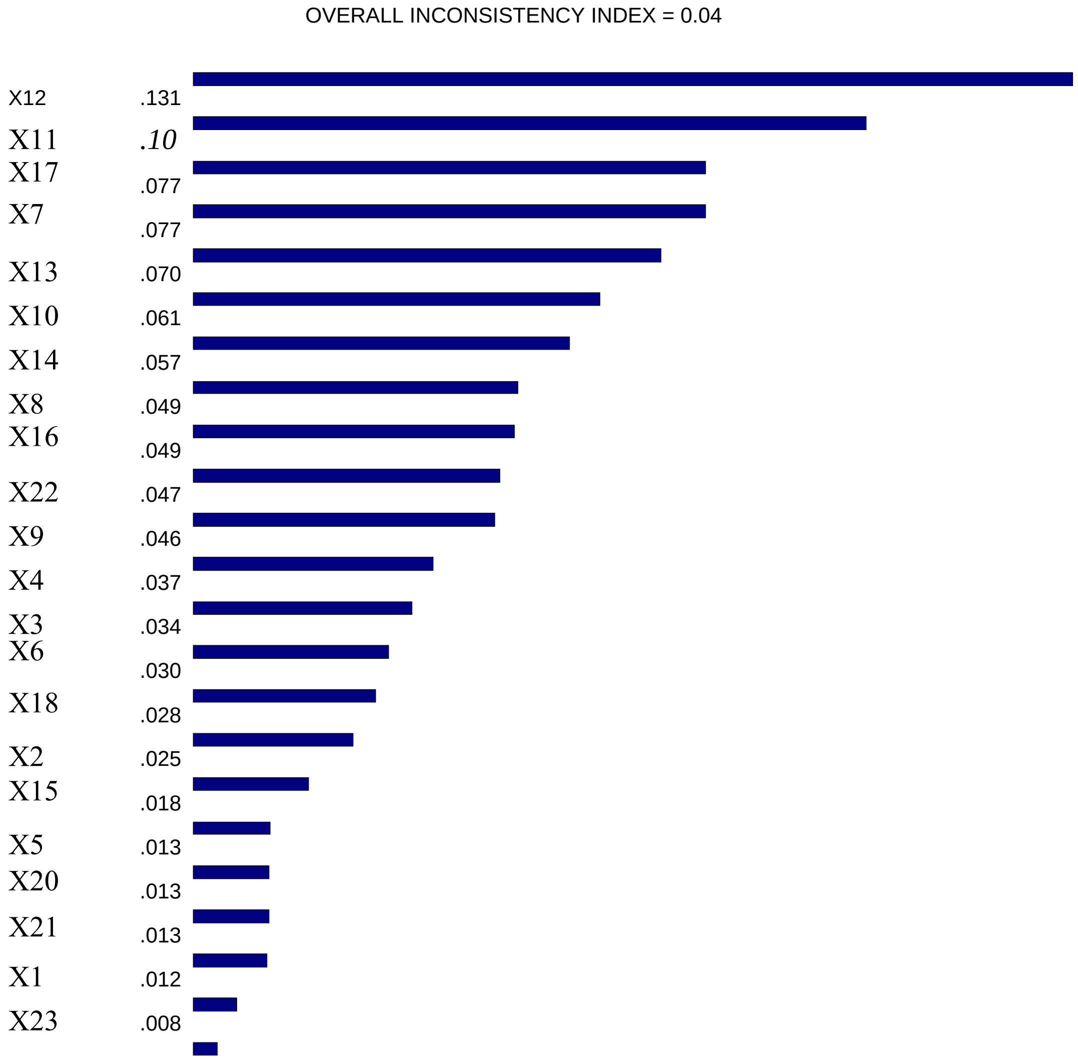
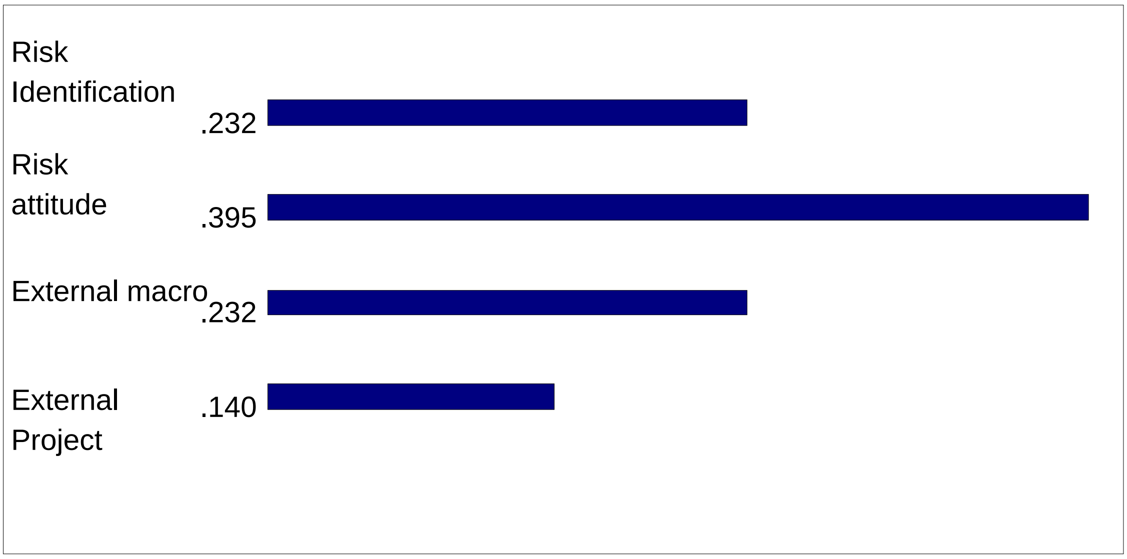


Figure 1- AHP Analysis Result at sub-criteria (variables) levels

At the criteria (factors) level, as shown in Figure 2, risk attitude contribute about forty percent toward the risk response plan. This result indicates that risk attitudes is the main factor in selecting a response plan It is not surprising as attitude toward the risks would most likely influence selection of response to particular risks. The attitude would be influenced by project team compliance to conditions and requirements, project personnel discipline, proactive attitude toward problem identification and project team preparedness in facing any possible changes.

Most of the respondents agreed that project team personnel compliance to conditions and requirements, their discipline and proactive attitude toward problem identification are important variable not only for selecting a response plan but also for identifying and assessing the risks. Conditions and requirements to be complied with include project contracts, company's policies as well as government rules and regulations.



Inconsistency Ratio =0.02

Figure 2 AHP Analysis Result at criteria (factor) level

The external factor at the macro level and the risk identification has the same contribution of about twenty-three percent each toward the risk response planning. The main variables affecting the external factor at macro level are the political and economic condition. Indonesia has just changed from a centralised government into more regional autonomy. This condition, unquestionably, is affecting the way construction companies select their risks response as the condition in different region can be different.

The main variables that need to be considered in risk identification for road construction projects in Indonesia include availability of resources and local weather conditions. Road construction is affected by water, therefore weather prediction need to be done intensively and continuously to schedule the activities that required dry condition. As road construction performed across the country, availability of resources becomes important factor.

The least influencing factor in developing response plan is the external factor at project level. The main variable that affects this factor is the project owner liquidity. Road construction projects are mostly considered public sector project. The fiscal year adopted by the Indonesian government has an effect to budget disbursement which is the main source of project payment.

5. Conclusions

Road construction is an important aspect of infrastructure development in Indonesia. It is the highest government annual spending for infrastructure projects, which contribute about 15% of overall government budget. Controlling road construction projects costs is, therefore, very important.

Risk response planning can be used as a tool for road constructions project cost control. The paper shows that risk attitude is the most influence factor in developing risk response planning in road construction projects. The risk attitude is influenced by project team compliance to conditions and requirements, project personnel discipline, proactive attitude toward problem identification and project team preparedness in facing any possible changes. The least influencing factor is the external factors at project level.

The study reported in this paper was limited to two state-owned construction companies that specialising in infrastructure project. The future study need to expand the scope to more construction companies.

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SECTION III

CONSTRUCTION MANAGEMENT

Measuring Quality: how does this improve construction performance?

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Abstract

The paper charts the history and development of the Hong Kong Housing Department (HKHD) Performance Assessment Scoring System (PASS) from 1990 to the present day and examines its effect on facilitating change to the quality of construction work of building contractors engaged in the production of public sector housing projects Hong Kong. The paper builds partly on empirical research carried out by the author as part of a doctoral thesis from 2000 to 2005, on experiential knowledge and also on some relevant case studies. The outcomes from this earlier research and validation of PASS based on results derived from the system since the research was originally undertaken are of benefit to practitioners and academics working and studying in the areas of performance assessment and organisational culture and change. The conclusions presented in the paper further underpin the connection established in previous research between strong organisational culture and project and corporate success. Organisational culture was measured using a survey instrument originally developed by Denison and Neale (1994), adapted for the environment of the study, and corporate success was measured by the PASS system mentioned above. The major results of the original study indicate that there is significant linkage between strong organisational cultures and business success and the detailed findings were that, (1) strong organisational culture was positively associated a high level of company effectiveness, (2) a high level of company effectiveness was positively associated with the cultural traits of 'consistency', 'adaptability' and 'mission', and (3) a high level of company effectiveness was positively associated with the combined cultural traits represented by the dimensions of 'external focus' and 'stable culture'. Several opportunities to take forward this research have been identified, including extending the study to other countries and also longitudinally re-evaluating some of the original case studies to ascertain how organisational cultures have changed or further developed in relation to the changing construction climate in Hong Kong.

Keywords: Public housing construction, performance measurement, organisational culture, procurement, quality.

1. Background

1.1 Public housing in Hong Kong – a brief history

Public housing in Hong Kong has a fairly modern history, which began in 1953 with a fire at Shek Kip Mei that destroyed a large area of 'squatter' huts housing predominantly families of refugees from China who had descended on the territory between 1947 and 1949 following the civil war on the mainland (Leung, 1999: 23). This fire left over 60,00 people homeless overnight and the story of how this tragedy was one of the triggers that over the next 55 years has lead to the roll-out of one of the largest and most successful public housing programmes in the world is well documented (Agassi, 1969; Drakakis-Smith, 1979; Bristow, 1984; Leung, 1999). Whilst fascinating, this is not the topic of this paper, but the story that maybe does require telling here (albeit very briefly) is a description of what happened to the quality of public sector housing construction during the late 1970s and early 1980s, that then leads us to a consideration of the topics covered in this paper.

Early on in the housing construction efforts that occurred after 1953, familiar low-rise building techniques were prevalent (*the Bowring Bungalows)* and much assistance was rendered by the British Army and a small dedicated band of professionals employed by the Public Works Department to overcome the immediate housing problems of those made homeless by the original fire disaster. However, as more and more refugees continued to flow down from the mainland of China, the problems of where and how to house thousands of people meant that the early temporary barrack-style accommodation would not suffice in the longer term. A series of simple low-rise multi-storey buildings were developed and constructed and in various forms formed a workable solution until the late 1960s; amongst these were the 'H' shape resettlement blocks built on the site of the original fire in Shek Kip Mei. With land in urban Hong Kong being in such short supply, it was maybe logical that planning densities should be maximized and taller buildings constructed to house more people in a shorter programme time. However, this approach was not without its downside, much of which was not immediately visible at the time the new 'high-rise' apartments were actually handed over and it would only be a decade down the timeline when the devastating problems of these buildings would become horrifyingly obvious. Lack of technical expertise by the construction companies which had sprung up in Hong Kong over the preceding 20 years, coupled with insufficient financial resources and a small number of qualified supervisory professionals meant that the core superstructure and rather poor standards of very basic finishes did not possess the structural integrity or durability needed for the task in hand.

An increasing spate of serious maintenance issues began to grow in intensity in the early 1970s and after investigation by the new breed of architects, engineers and surveyors who had been recruited from overseas by the HK government or had been employed by private developers to lead the new private housing boom that was taking off in the territory, 26 multi-storey low and high rise blocks were deemed to have serious or dangerous structural deficiencies. They were classified into several distinct types according to severity of the defects and placed on short-term, median and long-term demolition schedules with the worst being demolished almost immediately. Once this disastrous situation became public knowledge, all government departments and especially the Hong Kong Housing Authority (HKHA) and it's executive arm, the Hong Kong Housing Department (HKHD), were forced to reconsider their construction quality control systems to assure a distraught public that this could never happen again.

1.2 Ensuring the quality of public housing in Hong Kong

Whilst the HKHA was now firmly committed to obtaining good quality, because of public funding, this needed to be at a fair price and was driven by a belief that quality assurance starts at the beginning of a project not at the end. New leadership in the HKHA and highly- qualified professional staff in the HKHD were committed to a vision that quality is not something which is applied by rectifying defects in buildings found at the final inspection, it requires managing from the top downwards and throughout the life of the project. The unprecedented levels of public housing expenditure on capital works that was now being provided to the local construction and allied industries, entitled the HKHA to expect and receive full value for money. The underlying philosophy has always been, certainly since the late 1980s, "quality is a value and will not be foregone" (Mortiboys, 1991: 4).

At this time, contractors from the Works Branch (WB) List I and II were employed by the Authority on its building contracts, which meant that up to 220 (Group A, B & C) firms were invited to tender by means of open gazette and usually at least 50 tenders were returned for every major contract. Whilst this method of tender invitation ensured that the whole process could be deemed 'fair' and 'competitive', it also meant that companies with reasonably unknown or even poor track records in building work could tender and be awarded quite sizeable contracts. Although any known past performance was taken into account when appraising firms for the award of contracts, the methodology for assessing such performance was somewhat crude and subjective, relying on a simple tick-box grading system based on appraising just a few major building elements..

As by 1989, the HKHA was the major user of the larger Group C companies on the WB List, the establishment of the Authority's own list of contractors seemed a logical development. It was also apparent by that time that some contractors tended to concentrate only on the work of the Authority and had set up specialized operations within their companies to handle such work.

A list of contractors was therefore promulgated in April 1990, which was to be dedicated only to the HKHA works. A comprehensive set of *Rules for Administration of the List* (the "Rules") was produced to regulate all listing matters. Using only companies from its own list meant that the HKHA could exercise direct control in the vetting, prequalification and subsequent performance monitoring of these companies. It also allowed the Authority to operate a reward and penalty mechanism for good and bad performance.

In order to be admitted onto the HA List, contractors were required to fulfill the following basic criteria as advocated in the "Rules':

(a) Certified to of ISO 9000.
(b) Ability to meet List financial requirements
(c) Company organization and staff resources capable of taking on work in the appropriate List group and category and of a relevant value.
(d) A good relevant performance track record.

Once listed into various categories (i.e. new works or maintenance), contractors were then subdivided into groups based on thresholds related to the financial workload limits that accountancy and organisational checks determined they could safely work within without serious risk of causing disruption to the HKHA's all-important housing programme. Should the companies fail to deliver on time, cost and quality, they would be seriously censured including being removed from the List. The new list of contractors was administered by three high-level committees of the HKHA and HKHD shown in Figure 1 below:

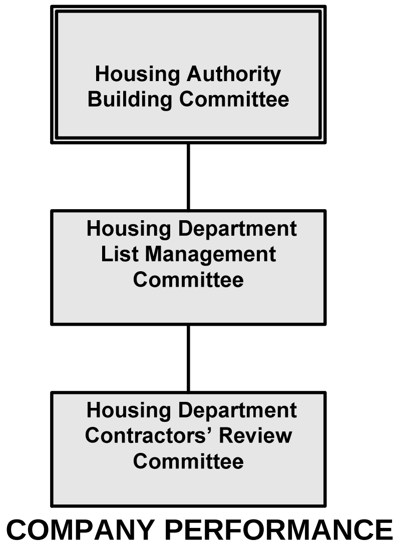

Figure 1- The Hong Kong Housing Authority and Department committee structure

As the 'owner' of the list, the HKHA;s Building Committee (BC) approved all recommendations from HKHD's List Management Committee (LMC) regarding new contractors to be admitted onto the list and changes to the listing status of the existing listed contractors. It set out the "Rules" and executed the authority to implement the laid down policies, and approve disciplinary actions against contractors.

On a quarterly basis, the LMC selects eligible tenderers for upcoming new works contractors and awards tendering opportunities based on previous 6 months performance as measured under a robust and objective performance-based methodology known as the Performance Assessment Scoring System (PASS). The Housing Department Contractors' Performance Review Committee (HDCPRC), on a quarterly basis considers project performance and provides project scores and recommendations on performance and penalty/reward consideration to the LMC.

1.3 The Performance Assessment Scoring System (PASS)

A simplified model of the constituent measures used in PASS 1997 to generate an effectiveness (i.e. performance) score is shown in Figure 2 below.

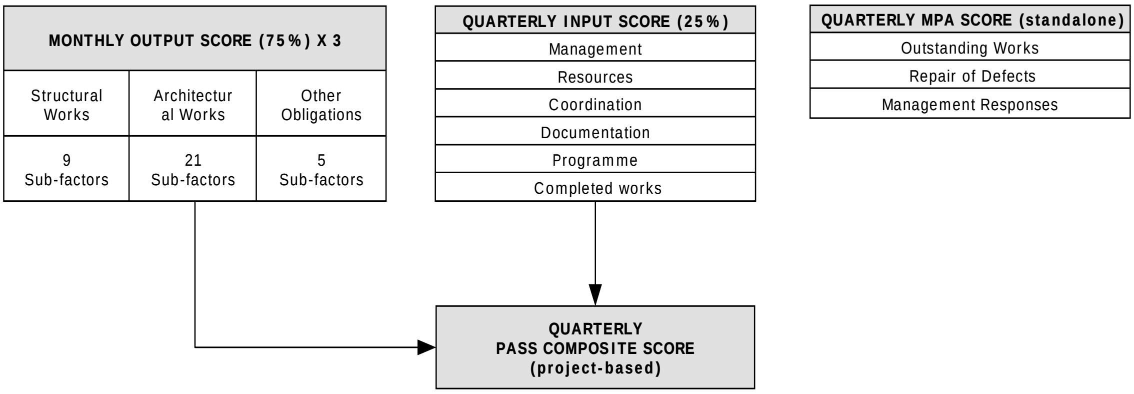

Figure 2 - Simplified model of PASS 1997 Version

Every 3 months, the Quarterly PASS Composite Scores (QPCS) of all projects being undertaken by individual contractors are then amalgamated to form a Quarterly Contractor Score for each active company, an important component of the PASS Contractors' Score-league measuring the comparative achievement of building contractors across all of their public housing contract works, as follows:

a) <u>Project League</u> – shown in Table 1 below, reflects contractors' performance on individual projects. It triggers discussion of, or action on, poor performance of a contractor for a particular project. The league is categorized into three bands with two benchmark lines:

- Composite Target Quality Score (CTQS) is drawn at the upper quartile (25 percentile) of the league.
- Composite Lower Score Threshold (CLST) is drawn at the lower quartile (75 percentile).

Table 1- Sample of the Quarterly Project Score League

Project	Contractor	QPCS	
Project 1	Contractor A	93.05	
Project 2	Contractor A	92.90	
:	:	:	
Project 9	Contractor B	91.25	
Project 10	Contractor B	91.09	Composite Target Quality Score (CTQS)
Project 11	Contractor B	90.89	
Project 12	Contractor C	89.20	
Project 13	Contractor C	89.14	
Project 14	Contractor B	87.38	
Project 15	Contractor D	87.25	
:	:	:	
Project 27	Contractor D	87.01	
Project 28	Contractor E	86.86	
Project 29	Contractor E	*6.68	
Project 30	Contractor F	86.08	Composite Lower Score Threshold (CLST)
Project 31	Contractor F	85.60	
Project 32	Contractor A	85.27	
:	:	:	
Project 39	Contractor B	84.18	
Project 40	Contractor C	83.50	

b) Contractors' League – shown in Table 2 below, considers overall performance of contractors across all projects being undertaken (i.e. a contractor's composite score would be the average of all it's individual project scores).

The CTQS and CLST lines, drawn from the Project League, are superimposed onto the Contractors' League. Higher tendering opportunities would be given to those contractors who fall in the upper band of this league (i.e. above CTQS). These contractors will normally be invited to tender for all upcoming contracts in the next quarter, whereas contractors in the lower band, i.e. below CLST, will not be invited to tender for any projects during the next quarter. Those contractors falling between CTQS and CLST will be given varying tendering opportunities, as decided by the LMC.

Table 2- Sample of the Quarterly Contractors' Score League

Contractor	Composite Score	Eligibility to Tender	Based on 6 Projects to tender in the Quarter under Consideration
Contractor A	92.98	6	
Contractor B	91.03		Composite Target Quality Score (CTQS)
Contractor C	90.01	4	
Contractor D	87.11		
Contractor E	86.55		
Contractor F	86.01		
Contractor G	85.89	2	
Contractor H	85.77		
Contractor I	85.01		
Contractor J	84.69		Composite Lower Score Threshold (CLST)
Contractor K	84.12	NIL	
Contractor L	84.01		

1.4 The impact of PASS on performance of contractors

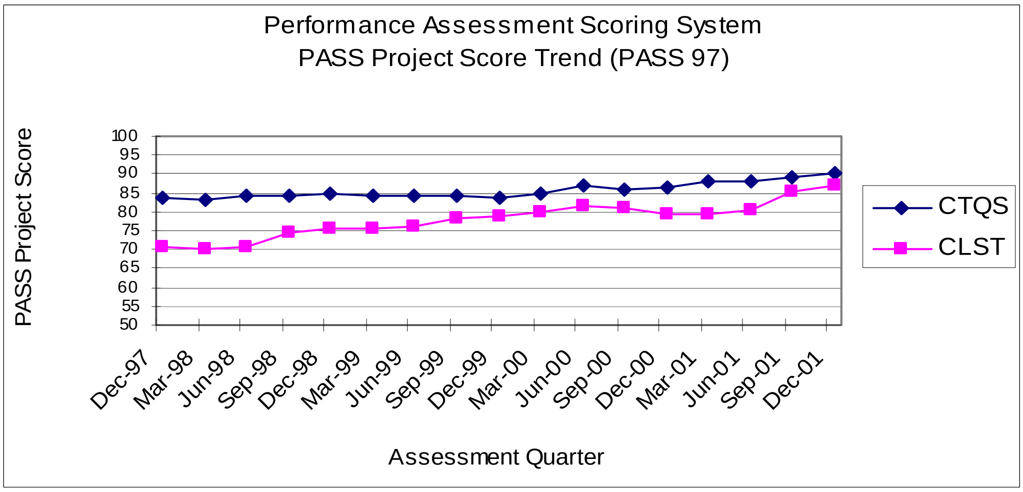

Figure 3- PASS Score Trend 1997- 2001

Figure 3 above clearly demonstrates the overall performance improvement of contractors on projects during the first four years of introducing PASS 1997. This improvement was in part due to the reward component of the system, but also to the disciplinary actions imposed on poor performers. These actions ranged from a 3-month restriction from tendering through to longer periods of formal suspension, and in extreme cases, removal from the list. With the exception of the removal in 1993 of 63 companies, due to their not attaining the required ISO 9000 Standard certification by the official deadline date set by HKHD, the actual number of removals from the HA list and suspensions for disciplinary reasons of companies on the list has been quite small. However, the numbers of contractors restricted from tendering for a prescribed 3-month interval due to poor PASS results since 1997 has been much more significant. Given the existence of quality problems described in the earlier section of this paper that directly affected both the business success of companies involved in the construction of public housing as well as the customer satisfaction of recipients of their product, the possession and maintenance of a robust and accurate performance monitoring system is one important of the most important assets to the HKHD's construction managers and project teams.

1.5 PASS – The future

To ensure the continued effective operation of PASS, HD has needed to constantly monitor, review and enhance the system, the last major review being undertaken in 1997. The reviews identify the main areas of performance shortcomings revealed on projects and raised by assessors, contractors and client. In 1998, following concerns expressed by the Building Committee, HD's senior management decided that a major system review and if necessary, system overhaul should occur. Various system reviews have occurred since the introduction of the 1997 version of the system and the latest review was undertaken in early 2006. In a bid to streamline the system operation and facilitate project teams to concentrate on managing projects, all major monthly PASS assessments are now carried out by dedicated independent teams and project teams contribute by way of daily site inspection records and Management Input scores on a quarterly basis. Figure 4 below shows how the newest major version of the system (i.e., PASS 2000) has continued to improve performance in the years following 2001:

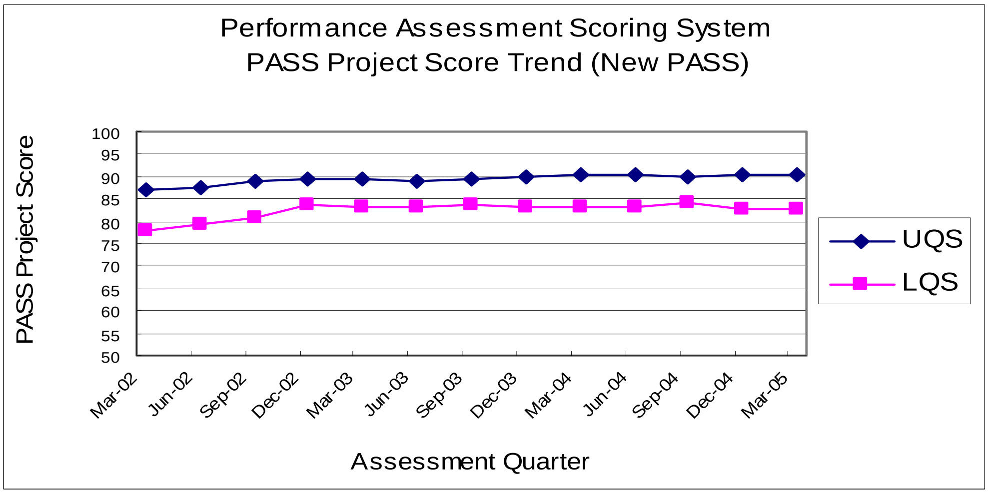

Figure 4- PASS Score trends 2001 – 2004

Given such a robust system, it was logical to use the measured performance outcomes as a basis for determining the varying organisational and business success of HKHA listed companies. However, given that by the mid-1990s all companies were constructing a highly standardized product (i.e., public housing was using standardized modular building types and identical construction methods, particularly mechanized formwork and large-panel precast facades), what determined the differences in performance, as there certainly were such differences? It was clear to the author (who was managing projects at this time) that the largest determinant of differing performance appeared to be due to the different cultures, approaches and attitudes of the various companies and so the research problem evolved from this consideration. The next major question became "how to ascertain a suitable methodology for measuring organisational culture?"

1.6 Measuring Organisational Culture

Following a detailed investigation of the wide range of definitions of 'organisational culture' that exist in the extant literature, a fairly concise operational definition of culture taken from Bates and Plog (1990) was used for this study "Culture is the system of shared beliefs, values, customs, behaviours, and artefacts that the members of society use to cope with their world and with one another, and that are transmitted from generation to generation through learning."

Several methodologies and instruments used previously for measuring organisational culture were examined and the Denison Organizational Culture Survey (DOCS) was eventually selected as being the most suitable to use in the context of this research due to its suitability for use in, and wide acceptability by, the business environment. Based on 15 years of research drawn from data obtained from over 1,000 high and low-performing organizations, Denison and Mishra (1996) found that the following four culture traits have a significant impact on organisational performance:

- Involvement
- Consistency
- Adaptability
- Mission

Figure 5 below shows the operational dimensions of the Denison Organizational Culture model, which has been derived from the DOCS results over a period of years:

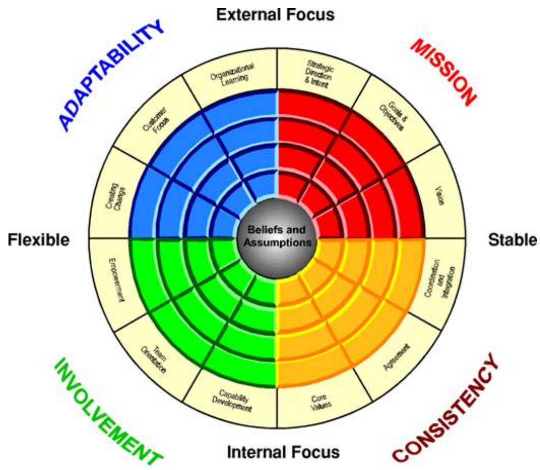

Figure 5- Denison Organizational Culture Model Denison, Cho and Young (2000)

According to Brislin (1976), there are problems relating to the use of such instruments outside of their ethnic development environment due to the difference in *emic* and *etic* perspectives and as it was necessary to allow respondents to DOCS to input in English and/or Chinese and in order to overcome any potential translational equivalence problems, DOCS was taken through a de-centering and back-translation process as shown diagrammatically in Figure 6 below:

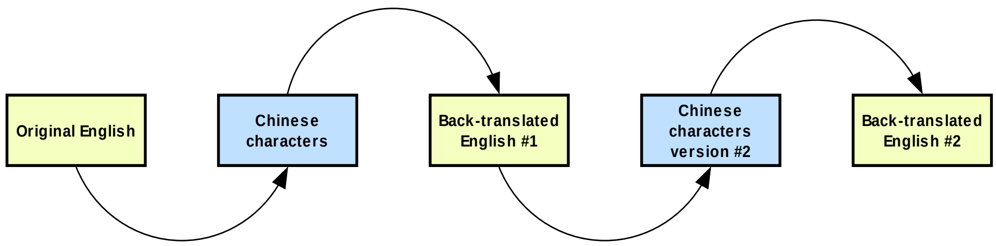

Figure 6 - Adaptation of DOCS for use in Hong Kong

1.7 Measuring corporate performance

As discussed briefly in the introduction of this paper, much of the previous research on organisational effectiveness undertaken since the early 1970s has relied on the use of financial measures to determine performance levels, typically individual accounting indices such as return on investment (ROI), return on assets (ROA) and return on equity (ROE) have been used (Grinyer & Norburn 1975; Karger & Malik 1975; Thune & House 1970). Longitudinally measured multiple financial accounting indices were used in some later studies (Hitt, Ireland, & Stadter 1982; Rumelt 1974) and the capital asset pricing model performance indicators evolved by Lubatkin (1983) were also used as a basis for research by Hitt and Ireland (1984). Despite the popularity of such models and indicators, their use to represent organisational effectiveness has been criticized over the last twenty years. Hitt (1998: 30) notes that they "have deficiencies as 'true' indicators" and their use "does not capture the essence of organizational effectiveness." As had been the case with the lack of consensus amongst both researchers and managers on defining organisational effectiveness, a similar dilemma existed in relation to agreement on the most effective measurements of the phenomena (Bourgeois 1980; Cunningham 1977; Hrebiniak 1978; Molnar & Rogers 1976; Steers 1975; Tsui 1990). Some researchers questioned whether in view of the lack of agreement on such fundamental questions as definitions and measures, organisational effectiveness should even be researched at all Hannan and Freeman, 1977; Bluedorn, 1980).

In an attempt to utilise measures which were determined on a non-financial basis and also reflected ‘customer satisfaction’, the objective *dependent variables* used to operationalise ‘organisational effectiveness’ in this research were the success ratings of building contractors employed on public sector housing contracts awarded and operated by the HKHA. These variables were drawn from the component assessments of the HKHD’s PASS scores of contractors and based therefore on quantitative and objective evaluation and measurement of the real-time quality of built output against the specification requirements, over the period from 1997 to 2002.

1.8 The link between organisational culture and performance

Several researchers and authors have presumed a link between organisational culture and corporate performance and some of these research studies have established evidence of such a link and thus concluded that it does indeed exist Denison (1990), Gordon & DiTomaso (1992), Kotter & Heskett (1992); Petty et al. (1995) and Wilderom & van den Berg (2000). However, other critical reviews of the methodologies and findings used in such research challenge such conclusions, Lim (1995).

Following a detailed examination of 10 studies conducted into the OC performance link in Europe and the United States since 1990, Wilderom, Glunk & Maslowski (2000, p. 201) state “Nevertheless, the great intuitive appeal of the C-P linkage, the preliminary evidence found so far and the many research challenges involved in obtaining the evidence give some reason to still believe in this link.” These authors observed that whilst there are some similarities in the organisational culture dimensions investigated/measured, of the variety of performance measures used, most relied on financially based data sets.

It was this previous predominant use of financial measures to evaluate company success, coupled with the criticisms evident in the extant literature on measuring organisational effectiveness in this manner that prompted me to use a different measurement base, particularly in view of the fact that companies being evaluated were in the construction sector and there was an apparent lack of available financial information specifically related to their work in the public housing sector (i.e., most of the companies were not publicly listed and had parent companies whose financial results were generated based on their total development sector performance).

2. The Research

2.1 The research model

Based on the research objectives and main research problem described in the introduction of this paper, the three resultant research questions were:

Question 1: Do Hong Kong construction companies possessing relatively high combined levels of the four organizational cultural ‘traits’ i.e. adaptability, involvement, consistency and mission (as indicated by the Denison Organizational Culture Model) perform more successfully on public housing projects than those exhibiting lower levels of those traits?

Question 2: Are any of the four traits more significant in contributing to success levels than others?

Question 3: Are any combinations of the four traits, based on a horizontal or vertical split of the Denison Organizational Culture Model, more significant in contributing to success levels than others?

Figure 7 below presents the research model developed and used in the study, however in a short paper it is not possible to fully state all of the nine hypotheses which constitute the model and so the description which follows is restricted only to the three basic research questions giving rise to the various hypotheses.

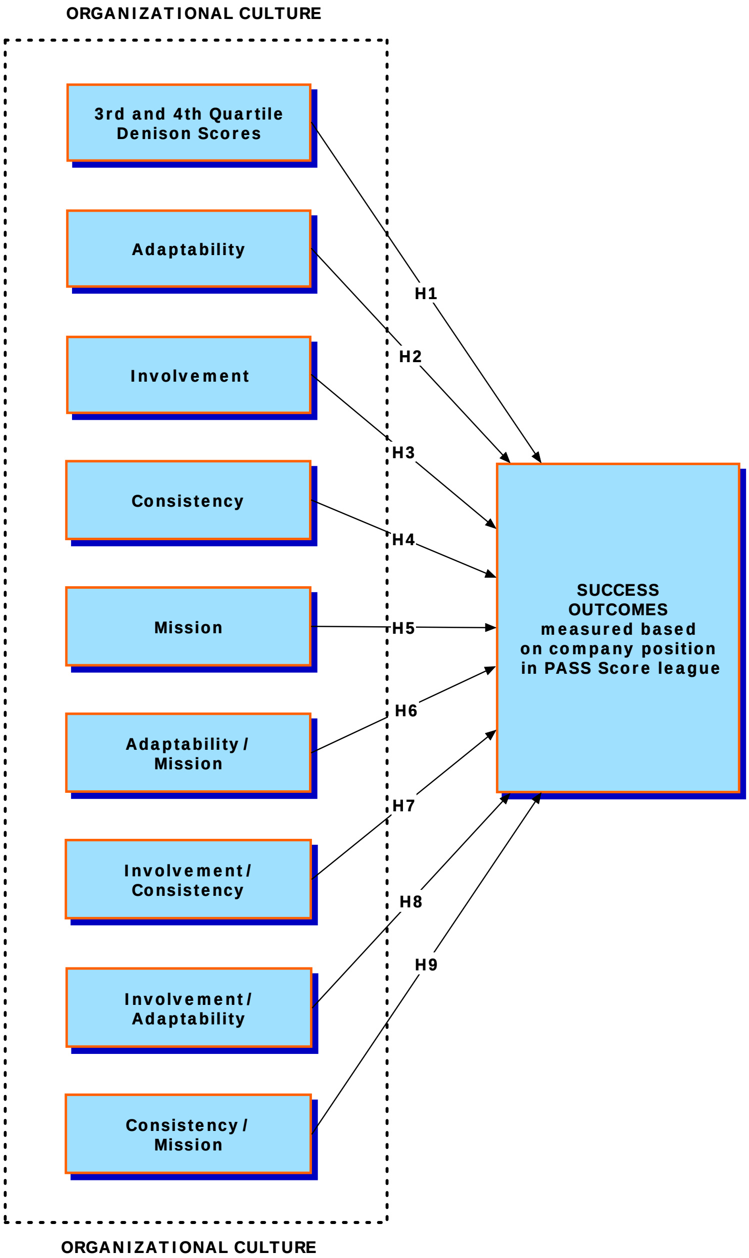

Figure 7- The research model

The nine research hypotheses associated with the questions described above were:

(a) *Question 1 associated hypothesis* -

H$_1$: Position of 'successful' building contractors on the PASS score-league, is significantly associated with high (i.e. third and fourth quartile) combined organisational culture scores, as measured by 'The Denison Organisational Culture Model'.

(b) *Question 2 associated hypo*theses -

H_2: Position of 'successful' building contractors on the PASS score-league, is significantly associated with 'adaptability' in their organisational culture as measured by 'The Denison Organisational Culture Model'.

H_3: Position of 'successful' building contractors on the PASS score-league, is significantly associated with 'involvement' in their organisational culture as measured by 'The Denison Organisational Culture Model'.

H_4: Position of 'successful' building contractors on the PASS score-league, is significantly associated with the 'consistency' measure in their organisational culture as measured by 'The Denison Organisational Culture Model'.

H_5: Position of 'successful' building contractors on the PASS score-league, is significantly associated with the perception of 'mission' in their organisational culture as measured by 'The Denison Organisational Culture Model'.

(c) *Question 3 associated hypotheses* -

H_6: Position of 'successful' building contractors on the PASS score-league, is significantly associated with third and fourth quartile 'Denison' rankings in 'adaptability/mission'.

H_7: Position of 'successful' building contractors on the PASS score-league, is significantly associated with third and fourth quartile 'Denison' rankings in 'involvement/consistency'.

H_8: Position of 'successful' building contractors on the PASS score-league, is significantly associated with third and fourth quartile 'Denison' rankings in 'involvement/adaptability'.

H_9: Position of 'successful' building contractors on the PASS score-league, is significantly associated with third and fourth quartile 'Denison' rankings in 'consistency/mission'.

Sample

The DOCS was distributed to all 53 building contractors on the HKHA's list in the Building (New Works) Category and the total number of returned survey sets was 29 (54.7%) and of these some 23 sets were eventually useable in the study data set (43.40%), based on post-return established cut-off criteria. As each company provided several returns drawn from different levels of management and control with in the company, there were some 159 useable returns overall.

3. Results And Analysis

Question 1 explores the overall theoretical concept of a presumed link between organisational culture (OC) and organisational performance (OP) and so correlation was investigated between the *overall* organisational culture raw scores of contractors and their PASS-measured performance.

Table 3- Pearson correlation results for overall organisational culture and overall performance scores

Correlations

		Overall Cultural Score	Overall PASS Score (00-01)
Overall Cultural Score	Pearson Correlation	1.000	.532*
	Sig. (2-tailed)	.	.019
	N	23	19
Overall PASS Score (00-01)	Pearson Correlation	.532*	1.000
	Sig. (2-tailed)	.019	.
	N	19	19

*. Correlation is significant at the 0.05 level (2-tailed).

As can be seen in Table 3 above, the results show that in companies possessing high combined DOCS scores, their 'strong' organisational culture is positively and significantly associated with high levels of organisational performance measured by PASS. Based on the above results, hypothesis $\mathbf{H_1}$ is supported. Question 2 explored the original concept proposed by Denison (1990) and further developed with Neale (Denison & Neale, 1994) that the four cultural traits of 'Mission', 'Consistency', 'Involvement' and 'Adaptability' have a strong influence on organisational performance. The four cultural trait scores obtained from the DOCS and success levels of the respondent contractors measured as their overall PASS scores was tested and the results are shown in Table 4 below:

Table 4- Pearson correlation results for four organisational culture traits and overall performance scores

Correlations

		Overall PASS Score (00-01)	Involvement	Consistency	Adaptability	Mission
Overall PASS Score (00-01)	Pearson Correlation	1.000	.367	.522*	.543*	.526*
	Sig. (2-tailed)	.	.123	.022	.016	.021
	N	19	19	19	19	19
Involvement	Pearson Correlation	.367	1.000	.796**	.795**	.756**
	Sig. (2-tailed)	.123	.	.000	.000	.000
	N	19	23	23	23	23
Consistency	Pearson Correlation	.522*	.796**	1.000	.737**	.798**
	Sig. (2-tailed)	.022	.000	.	.000	.000
	N	19	23	23	23	23
Adaptability	Pearson Correlation	.543*	.795**	.737**	1.000	.820**
	Sig. (2-tailed)	.016	.000	.000	.	.000
	N	19	23	23	23	23
Mission	Pearson Correlation	.526*	.756**	.798**	.820**	1.000
	Sig. (2-tailed)	.021	.000	.000	.000	.
	N	19	23	23	23	23

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation analysis shows a positive relationship between each of 3 cultural traits of 'Consistency', 'Adaptability' and 'Mission' with the overall PASS score at the 5% significance level. Out of these three trait measures of organizational culture strength, 'Adaptability' has the strongest correlation; 'Consistency' has the least correlation, whilst 'Mission' is of moderate significance. Only the correlation between 'Involvement' and overall PASS score cannot be justified in this research study. Adaptability', according to Denison

(2000), is the organisational trait that demonstrates the capability of a company to receive, interpret, and translate signals from its environment into internal behavioral changes that increase its chances for survival, growth and development, i.e., to turn the demands of the business environment into productive and effective action. Three aspects of adaptability impact an organisation's effectiveness and these are:

- Creating Change
- Customer Focus
- Organizational Learning

The high significance of the relationship between 'adaptability' and performance strongly underpins the fact that in a sector such as the construction industry, where the business environment is so volatile and subject to massive and often swift changes, the companies most able to survive are those that are most capable of adapting to these changes. This is particularly pertinent in relation to the public housing sector where housing production levels, cost yardsticks and competitiveness are so dependent on public policy, as well as being directed and driven by altered public sentiment, peoples' increasing aspirations and media and political pressure.

The significant relationship between the traits of 'consistency' and 'mission' and performance highlights the necessity for successful companies to possess core values that are understood by all players and well integrated throughout the organisation through commonly shared goals and objectives and a strong agreed strategic direction. These traits are strongly related to the stability of companies, that creates well-being, loyalty and satisfaction amongst staff. This stability must importantly be reflected in a long-term mission focus which although it may have to adapt, should not significantly change over short spans of time. Denison (2000: 356-7) states that "The most troubled organizations are often those that have had to change their basic mission…when an organization's underlying mission changes, corresponding changes in strategy, structure, culture, and behaviour are also required."

The low significance of the relationship between 'involvement' and performance is an interesting and somewhat surprising result as according to Denison (2000), organisational cultures characterized as "highly involved" strongly encourage employee involvement and create a sense of ownership and responsibility. Their internal management systems are based on informal, voluntary and implied control rather than on formal, explicit or bureaucratic control and strong commitment to an organisation develops from a sense of personal ownership and an increasing capacity for autonomy. Highly involved organisations seek input from their members in order to improve the quality of the decisions made and their subsequent implementation.

Question 3 explores the generic theoretical concept proposed by Denison and others (Denison, Cho & Young 2000; Denison, Hoojiberg, & Quinn 1995; Denison & Mishra 1996) that there are a set of tensions and contradictions existing within organization, which depending on if they are well or badly managed, also have a significant effect on organisational performance. In DOCS, four meaningful combinations of the cultural traits and their directions of influence can be made as follows:

- External focus: Adaptability + Mission
- Internal focus: Involvement + Consistency
- Flexible: Adaptability + Involvement
- Stable: Mission + Consistency

Measurement of the four combinations was obtained by taking average of the corresponding constituent cultural scores. The correlation was then investigated between them and company success represented by overall PASS score. The results of the correlation test are summarised in Table 5 below.

Table 5- Pearson correlation results for four combined organisational culture traits and overall performance scores

Correlations

		Overall PASS Score (00-01)	External Focus Culture	Internal Focus Culture	Flexible Culture	Stable Culture
Overall PASS Score (00-01)	Pearson Correlation	1.000	.552*	.463*	.486*	.543*
	Sig. (2-tailed)	.	.014	.046	.035	.016
	N	19	19	19	19	19
External Focus Culture	Pearson Correlation	.552*	1.000	.853**	.927**	.952**
	Sig. (2-tailed)	.014	.	.000	.000	.000
	N	19	23	23	23	23
Internal Focus Culture	Pearson Correlation	.463*	.853**	1.000	.925**	.911**
	Sig. (2-tailed)	.046	.000	.	.000	.000
	N	19	23	23	23	23
Flexible Culture	Pearson Correlation	.486*	.927**	.925**	1.000	.866**
	Sig. (2-tailed)	.035	.000	.000	.	.000
	N	19	23	23	23	23
Stable Culture	Pearson Correlation	.543*	.952**	.911**	.866**	1.000
	Sig. (2-tailed)	.016	.000	.000	.000	.
	N	19	23	23	23	23

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

From these results, it can be seen that all four combinations of the cultural traits correlate positively with the overall PASS score at 0.05 significance level, but comparatively, 'external focus' and 'stable culture' correlate more significantly than do 'flexible' company structures' and 'internally focused' companies. The purpose of examining these combined cultural trait combinations and their relationship with performance levels was to ascertain whether companies that could manage these apparently contradictory competing dimensions of the Denison Organisational Culture model performed better than those companies that did not handle them well. Denison (2000: 357) states that "Effective organizations find a way to resolve these dynamic contradictions without relying on a simple trade-off." The trade-offs are:

- Stability versus flexibility;
- Internal versus external focus;
- Internal consistency versus external adaptation; and,
- Top-down mission versus bottom-up involvement.

4. Conclusions

4.1 Major findings

The main findings from the research are:

- A high level of company effectiveness is positively associated with strong organisational culture;
- A high level of company effectiveness is positively associated with the cultural traits of ‘consistency’, ‘adaptability’ and ‘mission’ but not with “involvement” trait; and,
- A high level of company effectiveness is positively associated with the combined cultural traits represented by the dimensions of ‘external focus” and “stable culture’.

These findings support the previous research of (Denison 1990; Gordon & DiTomaso 1992; Kotter & Heskett 1992; Petty, Beadles, Lowery, Chapman, & Connell 1995; Wilderom & van den Berg) and underpin the robustness and reliability of the DOCS for use in multi-cultural settings and in a technological business sector (construction) other than those such as commerce, production, manufacturing and information technology where the instrument had been previously tested.

The results of this research add to theory in the following areas:

- They support the outcomes of work of other researchers who have investigated the presumed link between organizational culture and organizational performance, in that there appears to be a strong association between the two constructs;
- They use an entirely new set of measures to operationalise business success and performance (i.e. the HKHD’s PASS scoring system) in a new sector of research (i.e. the construction industry) in which robust research effort is only recently beginning (e.g., CIB TG23 and CIB W112 initiatives);
- The original DOCS instrument of Denison and Neale (1994) has undergone a rigorous process of decentering and back-translation to better adapt it for use in a new research environment, i.e., Hong Kong, Construction, Public Sector Housing;
- Support for mixed method research approaches is provided by way of the use of simple qualitative enquiry to underpin quantitatively obtained data; and,
- These results posit the possibility to further develop the DOCS for specific use in the construction industry setting and as a longitudinal metric for change measurement in this dynamic industry.

4.2 Further research opportunities

Further research is needed to obtain a more detailed and deeper understanding of the organisational culture of the construction industry where study has so far been somewhat limited and longitudinal use of the DOCS and PASS in the research population established for this research would develop and hopefully strengthen the findings described in this paper. The organisational culture (OC) and organisational performance (OC) link

a) The organisational culture and performance link

Whilst much has been achieved by way of research into the OC-OP link since the late 1980s, many authors share the view expressed by Sparrow (2001:102) that “…in taking the more functionalist and positivist perspective of high performance culture research, it is important to stress that this form of assessment [*i.e., the OC-OP research perspective*] need not be limited to quantitative methodologies. Qualitative tools and techniques can sit just as easily in the consultant's toolkit…there must be room for culture and climate diagnostics, informed by richer – and in some instances more qualitative–investigation, that tap the most relevant individual sense making processes." Certainly, the qualitative investigation carried out for this thesis clearly indicated a rich source of alternative data to better inform the purely quantitative results of using an organisational culture measuring instrument and this accords with the view of the said instruments author who stated (Denison, 2000: 367) "Perceptive insiders and outsiders need to be involved in order to help translate the findings from a model-based analysis of the culture…depth of analysis is needed to support the insights from the survey data and bring them to life." Clearly then, there is a need for more qualitative work to be linked with quantitative studies to increase our knowledge of organisational structure, culture and its affect on performance and although current studies are beginning to move us more swiftly in this direction, further work is required to strengthen this whole field of study.

b) The metrics of organisational performance

Hopefully, this thesis has clearly demonstrated the benefits of considering alternative ways to operationalise organisational performance other than by the use of purely financial measures. As mentioned previously, Kennerley and Neely (20021) have summarised the main components of an effective performance measurement system as follows:

- Must provide a "balance" picture of the business,
- Needs to present a succinct overview of the organisation's performance;
- Should be multi-dimensional;
- Requires comprehensiveness;
- Must be integrated both across the organisation's functions and through its hierarchy; and,
- Business results need to be seen as function of the measured determinates.

Andy Neely's own integrated and stakeholder-focused 2001 performance measurement model, the Performance Prism, appears to satisfy the parameters described above and should be more widely used, together with other instruments such as the Balanced Scorecard (Kaplan and Norton, 1992), in order to become more universally accepted measures of organisational effectiveness. This would then allow the development of local, national and global performance databases for use by both researchers in academic studies but by businesses themselves for benchmarking and setting up strategic organisational change programmes.

c) The Hong Kong Construction Industry

Researching the culture of the 23 companies involved in constructing public sector housing in Hong Kong has been a first step only into an area where more research is clearly needed (Root, Hancock & Chapman 1996; Chinowsky and Meredith,, 2000; Fellows and Seymour 2002), however the results of this research need to be extended both laterally (i.e., launched into construction companies outside public sector housing) and longitudinally (i.e., how have the organisational cultures of companies surveyed using DOCS changed since the time of the original study and what affect have changes had on organisational performance as a result?). Through the efforts of the CIB Task Group TG23 and later CIB W112, research into organisational and corporate culture in the construction industry is now progressing ahead and this will be at a global as well national level of consideration. It is interesting to note in this context that the chosen instrument of culture measurement is the Organisational Culture Inventory (Cooke and Rousseau, 1983) and this methodology promises to build up a global database of cultural profiles of construction organisations user-friendly and highly useable at a national and global level for research purposes. The measures and instruments used for determining organisational culture traits and strengths matter less than the actual studying of what differentiates one company in an industry from another and hopefully this author's research has added to the extant knowledge of this, particularly in the construction field.

4.3 Final reflections

The topic extracted from this author's thesis and embodied in this paper was conceived from the researcher's interest and belief in the existence of a demonstrable link between the cultures of organisations and the impact that different levels of cultural strength may have upon effectiveness and performance of these organisations. Building on the theory which has developed out of the many studies carried out in the last decade or so that have demonstrated such a link exists (Denison, 1990; Gordon and DiTomaso, 1992; Kotter and Heskett, 1992; Chapman and Connell, 1995; Wilderom and van den Berg, 1998), whilst at the same time recognising the important contribution of other studies which have been critical of the validity of such presumptions (Saffold, 1988; Siehl and Martin, 1990; Lim, 1995; Wilderom et al, 2000), this research thesis was designed to test both sets of views.

A large part of the doubt expressed by the latter group of authors related to the measures of organisational culture and effectiveness currently being used in such research, in particular the reliance on financially-based measures of effectiveness rather than other tangible metrics. This discussion on differing theoretical opinions, methodologies and measurement tools for investigating the existence of the culture-performance link, presented a fascinating opportunity for further research and given this researcher's long-time experience and specific placement in the construction industry since 1977, a topic developed that not only examined the organisational culture and performance link, but also carried the research specifically into construction industry organisations and public sector building projects, which according to some authors, (Chinowsky and Meredith, 2000), is a sector of business where a need exists for more research into those management and organisational issues that impact on the efficacy of construction companies to perform more effectively. The basic research question addressed within this thesis was born, i.e., why are some companies able to produce built output that better satisfies their customers, when many others cannot and does the organisational culture of the construction company impact on its performance?

Using the list of new works building contractors of the Hong Kong Housing Authority (HKHA), secondary data drawn from that organisation's objective quality measurement tool known as the Performance Assessment Scoring System (PASS) as an alternative objective measure of effectiveness and the *Denison Organisational Culture Survey* (DOCS) instrument developed in 1984 by Dr. Daniel Denison, research was then undertaken on the relationship between organisational culture and organisational performance.

The outcome of the research was that a link does indeed exist between the two and that also there is significant correlation between the strength of an organisation's culture and its comparative effectiveness in performance terms when investigated in the specific setting of Hong Kong. The thesis makes a contribution to theory by further validating the work by Denison (1990) and others not only in that it successfully demonstrates a link between organisational culture and performance, but it also contributes to management and public policy by identifying particular cultural factors in organisations that appear to be significantly responsible for achieving successful outcomes and reveals opportunities for further research into the organisational culture of construction companies.

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Challenges faced by the construction industry in Sri Lanka: perspective of clients and contractors

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Abstract

The construction industry is a major contributor to the development of economies in Sri Lanka. However, it faces significant challenges and difficulties which are unique to the specific industry. Therefore, it is a vital role to recognise them and offer solutions. This paper presents findings of a research which was carried out to identify challenges face by the Sri Lankan construction industry and effective mechanisms / motives to overcome such aspects from the consultants' and contractors' perspectives. An industry-wide questionnaire survey was carried out to observe the views of professionals in the building construction industry during June-July 2005. Forty six critical challenges which need immediate attention were identified. Further, 20 mechanisms and motivators were tested to explore solutions in overcoming the above challenges to enhance the image of the construction industry. Thirteen mechanisms were identified and five effective factors were extracted and recommended for up-lifting the image of the construction industry.

Keywords: Construction industry, Challengers, Sri Lanka, Developing countries

1. Introduction

It has been documented that the construction industry is being faced many problems and challenges. In developing countries, these problems are compounded alongside a general situation of socio-economic stress, chronic resource shortages, institutional weaknesses and a general inability to deal with the key issues by inadequate investment plans and changing government priorities due to various sociological, economic and political constraints [1-3]. Some studies evidenced that these problems have become greater in extent and severe in recent years in many countries [4-5]. In Sri Lanka, the fluctuating construction workload, unfair competition by foreign contractors, skills drain and shortages and high cost of developing skills were the main identified problems [6].

However, in Sri Lanka, the construction industry places a vital role in economical and physical development. Further in Sri Lankan economy, construction is the fourth highest sector after services, manufacturing and agriculture [7]. Therefore it is important to consider the present context of the industry to identify precincts and to get counteractive measures in order to uplift the industry to meet the future challenges. This research has focused to identify critical challengers which need immediate attention and effective mechanisms for development of the construction industry in Sri Lanka.

2. Research Design

Research was designed to identify its objectives through an industry-wide questionnaire survey. Since consultants, contractors, suppliers and specialist contactors are the main parties dominating the construction industry, it was decided to elicit their knowledge as experts views to explore the research objectives. However, due to the limited time and other several constrains, suppliers and specialist contracts were omitted. The vacuum in the knowledge extraction due to omission of suppliers and specialist contracts from the survey was minimised by selecting experts from large consultant and contractor organizations (eg. Grade 1 to Grade 2), which handle a wide variety of construction activities.

2.1 Sample Selection

The survey sample was selected randomly (using simple sampling methods). The contact list of leading consultants (Architects, Engineers and Quantity Surveyors) was obtained from the yellow pages of the telephone directory and from respective professional institutions. Contractors were selected from the Institute for Construction Training and Development (ICTAD) registered contracting organisations under Grade 1 to Grade 2, either from the field of building construction works or civil engineering construction works. The sample size for each group was selected as 40.

2.2 Questionnaire Design and Questionnaire Survey

The questionnaire was developed into three sections. Several important questions were grouped under section one to identify the profile of the respondent. Section two was focused to identify challenges and problems of the construction industry. In this section 61 existing challenges and problems obtained from the literature were shown under 10 areas including, financial, government policies /practices, technology, management and coordination, research and development (R&D), resources, safety, training and development, social, and skills [4, 8-16]. In the third section, 20 motivators to improve the image of the industry were listed. A seven-point “likert” scale where 1 represented “very critical” or “very effective”, 4 indicated “neutral”, and 7 stood for “not critical at all” or “not effective at all” was used in the sections 2 and 3 to solicit the judgment of respondents regarding the criticality, effectiveness and efficiency of the proposed (listed) industry challengers, and motivators.

The questionnaire survey was started from a pilot survey which was carried out to ensure the reliability of the survey. Three experts were involved in this task and their feedbacks were used to fine-tune the format of the questionnaire. The improved version of the questionnaires was distributed among the selected group. Hand delivery was used to deliver and collect the questionnaires to increase the rate of return.

3. Discussion

T-test was used as a tool to identify the significant challengers, and motivators. Evaluation was carried out by using "Statistical Package for Social Science" (SPSS) software. To test the null hypothesis Ho: $\mu = \mu_o$ against the alternative hypothesis H1: $\mu < \mu_o$, where μ_o is the population mean. μ_o is the critical rating above which the issue was considered agreeable or ineffective. In this analysis, μ_o was fixed at 4 because, by definition, given in the rating scale, 4 is neutral.

Further, factor analysis was carried out to understand how the significant challengers and motivators work together. Here, the most effective and leading factors that could change the current practices in the industry to achieve a good image can be established using factor analysis (FA). In this analysis, the important factors were established from those whose Eigenvalues are greater than or equal to 1, since an Eigenvalue is a measure of how a standard variable contributes to the principal components. A component with an Eigenvalue of less than 1 is considered as less important and can therefore be ignored and omitted [17].

3.1 Critical Industry Challengers

Forty six significant challengers identified through the t-test are listed in the Table 1. They are grouped under ten different areas including financial, government policies, technology, management and coordination, R&D, resource, safety, training and development social and skill levels.

Table 1 - Significant Challengers

No	Challenge	Mean	Sd.	T	Sig.
A.	Financial				
01	Rapid changes in the national economy	5.05	0.91	7.59	0.000
02	Inadequate support from banking sector	4.84	0.96	5.79	0.000
03	High inflation rate	4.82	0.99	5.46	0.000
04	Narrow profit margins	4.82	1.04	5.22	0.000
05	High interest rates	4.77	1.12	4.59	0.000
06	Limited credit facilities	4.39	1.17	2.20	0.033
B.	Government Policies / Practices				
07	Government policies on taxes	5.09	1.18	6.15	0.000
08	Political instability	4.84	1.2	4.65	0.000
09	Low level of government support on construction	4.89	1.33	4.41	0.000

No	Challenge	Mean	Sd.	T	Sig.
10	Bribe/corruption and favourism	4.59	1.09	3.61	0.001
C.	Technology				
11	Low level of new technological development	5.02	1.09	6.23	0.000
12	Inadequate technological knowledge	4.68	0.80	5.65	0.000
13	Low level of technology transfer	4.61	1.13	3.62	0.001
14	Low level of usage of IT	4.41	0.97	2.79	0.008
D.	Management and Coordination				
15	Poor cost planning	4.8	0.88	6.01	0.000
16	Poor documentation process	4.64	1.10	3.83	0.000
17	Extensive time slippage in contracts	4.55	1.00	3.62	0.001
18	Poor communication	4.55	1.04	3.46	0.001
19	Lack of progress monitoring	4.41	0.97	2.79	0.008
20	Low level of administrative flexibility	3.66	1.01	2.24	0.03
F.	Research and Development				
21	Government involvement in R&D	5.02	1.13	6.00	0.000
22	Limited allocation of funds for R&D	4.91	1.03	5.85	0.000
23	Lack of opportunities for R&D	4.86	1.03	5.59	0.000
24	Reluctant in using innovative building materials	4.68	1.12	4.05	0.000
25	Low level of participation of institutes in industrial oriented R&D	4.7	1.30	3.58	0.001
G.	Resource				
26	High labour turnover	4.73	0.87	5.53	0.000
27	Insufficient integration on design and built operation	4.89	1.13	5.23	0.000
28	Lack of high technical construction equipment	4.8	1.05	5.04	0.000
H.	Safety				
29	Inadequate safety precautions	4.86	0.82	6.95	0.000
30	Undefined specification of construction safety	4.86	0.85	6.73	0.000
31	Improper implementation of safety rules	4.7	0.79	5.88	0.000
32	Limited funds for safety precautions	4.59	0.76	5.18	0.000
33	Low level of employment of safety officers	4.77	1.01	5.08	0.000
34	Limited knowledge on safety precautions	4.59	1.15	3.42	0.001
I.	Training and Development				
35	Limited allocation of funds for employee trainings	4.93	0.87	7.08	0.000
36	Inadequate carrier development programmes	4.93	0.95	6.51	0.000
37	Inadequate support from Institutional organisations	4.66	1.08	4.06	0.000
38	Currently practicing government grading systems	4.27	1.11	1.63	0.110
J.	Social				
39	Inadequate health on construction sites	4.41	0.87	3.12	0.003
40	Low level of facilities provided for workers	4.3	0.73	2.67	0.011
41	High environmental impact	4.34	1.03	2.19	0.034
K.	Skill				
42	Inadequate skill development programmes	4.86	1.03	5.59	0.000

No	Challenge	Mean	Sd.	T	Sig.
43	Availability of professionals	4.73	0.92	5.22	0.000
44	Low level of skilled workers	4.7	0.90	5.17	0.000
45	Skills of fresh graduates joint in the field	4.84	1.10	5.08	0.000
46	Scarcity of skills availability in the construction	4.59	0.95	4.14	0.000

Financial – Six financial challengers were shown as significant. Financial health of clients and contractors is very important for the success a project. However, respondents felt that it can deteriorate due to other external factors such as rapid changes in the national economy which is a most critical challenge observed from the t-test, followed by inadequate support from the banking sector, high inflation rate, narrow profit margins, high interest rates, and limited credit facilities.

The construction industry has always had a close relationship with the banking system since the money transferring is enormous. However, in Sri Lanka, most of the bankers behave only as money lenders in extending financial facilities. Further, obtaining of a loan from a bank is a tedious procedure which, in some cases, takes months. This longer time period discourages the contractor who requires short term bridging finance. Respondents felt that the higher interest rates of the lending institutions too have made national practitioners not competitive with foreign counterparts who are able to get loans from their bankers with undercutting rates of interest. Further, many contractors do not have reasonable access to commercial borrowings and other facilities at reasonable and comparable rates as available in the developed countries. The lack of credit facilities is another constraint. Short term financing sometimes is available to construction enterprises from local banks, and is expensive. Most enterprises, therefore, operate without access to credit facilities.

Government Policies – It is identified that the construction industry has been experiencing lot of difficulties due to the lack of government policies or ineffective policies to support the construction industry. For instance, government tender procedures based on low price-based are sometimes shown very inefficient [18]. According to respondents, tax policies are another one of main concerns. Political instability of the country created rapid changes of certain policy decisions taken by the previous governments. For instance, decisions to awarding of contacts were revised in many instances. Therefore, the political instability of the government can affect the construction industry and its productivity. Therefore, the government of Sri Lanka should consider that there is a need for clear and effective policies for the construction sector. These policies should be developed by identifying objectives of national construction priorities and for providing guidance for the mobilization of investment. Further, such policies are able to provide a framework for enabling and facilitating the development of the domestic construction sector through professional development, business enterprise and productivity enhancement. However, corruption and favourism is one of the main drawbacks created with the open economic policies in many countries.

Technology – Historically, Sri Lanka has developed largely a craft based construction technology, emanating from the experience gathered over 2000 years. This level of technology was sufficient to meet the construction needs even in the post-independence era. However the large scale rapid development projects such as irrigation, power and industrial building construction work that were launched in the fifties; demanded a high level of technology input. The local industry was not fully geared to meet the entirety of this increased technological demand as such; some of the large scale construction projects were carried out by foreign contractors due to lack of technological development, knowledge and transfer. For example, during the phase of the "accelerated Mahaweli development programme", in late 70's, the foreign contractors had dominated the industry. Further, a conscious effort does not appear to have been made to ensure a sufficient degree of local participation and technology transfer. However, during the last decade, it appears that a fair degree of technology transfer was achieved with a fairly well equipped technology and management base. But, still there is a lot more to achieve. Making use of IT in the construction industry is still at its adolescence stage though the IT industry is booming very fast. This was identified as one barrier for its development.

Management and Co-ordination – Management and co-ordination of projects are shown as great difficulties in the construction industry. In this survey, cost planning, documentation management, time management, communication, progress monitoring, administrative issues were shown in high profile. The cost planning plays a significant role in ensuring that company objectives are compatible with its resources. Poor cost planning of both parties due to lack of proper budgeting results in poor quality of work. For instance, for a contractor to use his mobilisation advance payment to purchase equipment which he cannot depreciate entirely on the particular job or even for other purposes outside the contract, leaving little or nothing to finance the work. A proper documentation process which can be transparent to all parties in the process is another important fact yet not practised in many construction projects. Further, proper time management and progress monitoring strategies are yet to develop to make sure of its delivery on time.

Research and Development – Lack of initiatives, funds, opportunities and attitudes were identified as major issues for inculcating R&D culture in the construction industry. It was identified that most of the firms were reluctant to carry out R&D programs. This may be due to the fact that benefits are not quick and straightforward. Further, most of the practitioners believed that the government should encourage more on R&D as the construction industry plays a major role in the economy. Research projects conducted in universities can be more focused on industrial needs, rather than basic researches. Also, staff members who are carrying out these projects should be encouraged and recognised within the university system. Research forums and awareness programmes can be organised by training institutes for researchers highlighting the research areas to be needed, and providing various sources of funding for these researches.

Resource – Lack of labour, equipment, knowledge and integration are observed in this survey. Today, many construction workers are hired on a project basis and made redundant on project completion. This is a common fact to most of developing countries [8]. As a result, the construction industry is characterized by a pool of labours who works for a variety of contractors in different types of construction. Lack of integration on D&B operations for improving the industry performance is another main challenge. This may be due to lack of experience and knowledge. However, knowledge can be improved by getting various exposures from different projects carried out specially by foreign firms to a certain level.

Safety – The extent of construction accidents is more severe when compared to other industries [19-20]. From the survey results, inadequate safety precautions, lack of implementation of rules, limited fund; knowledge and qualified officers were identified for the extent of unexpected accidents and social problems in the construction industry. Further, the annual report published in 2002 by ICTAD also highlighted that the safety practices that are being adopted at construction sites are far below acceptable standards. On the other hand, low educational levels of many construction workers may be one of a main barriers to imply the safety at sites. Most of the workers do not understand the importance of the site safety rules for their health and safety.

Training and Development – Training and development was highlighted as another significant issue among other concerns. Limited allocation of funds for employee training is one of major barriers of many organisations. On the other hand, the existing situation of many organisations is rather depressing for the employees, due to the reluctance in allocating funds for training and development. At the moment with the government involvement National Apprentice and Industrial Training Authority (NAITA), ICTAD, and a few other technical training institutes are conducting training and developing programs. But this support is not enough to satisfy the demand. In this regard, technical institutes, universities, etc., can take, as part of its responsibility to win the challenge.

Social – There are many social factors being neglected at the site level. They are highlighted in the survey as poor health, hygienic and welfare facilities for the workers. On the other hand, low educational level and attitudes of many workers may be responsible for the poor performance of health and hygiene at the site. This is another area that researchers should focus on finding mechanism to improve the existing conditions. Due to Low profit margins of contactors often intend to complete the projects with minimum supply of facilities to their workers. This may sometimes result even unacceptable hygienic conditions within the site.

Skill – The construction industry suffers from inadequate supply of professionals, less skill levels of fresh graduates and skilled labour force. High demand for the professionals in many countries and low level of salary schemes in the local industry may reduce the number of professionals retained in the local construction industry. This problem is not confined to the local industry, but is a common fact in many developing countries [1]. Less skill levels of fresh graduates may be due to inadequacy of the industry oriented training obtained during the degree programme. Further, it was revealed that less than 4% of the workers in Sri Lanka have been systematically trained and carry certificates that are indicative of their skill [21]. Lower skilled workers may be due to several reasons such as lack of training opportunities provided by the organisations and lack of comprehensive training courses, skill development short courses and individuals less interest on attending such courses.

3.1 Industry Motivators

Out of 20 motivators shown in the questionnaire, 13 were shown as significant and they were further grouped using factor analysis to explore further relationships. Factor analysis was carried out to ascertain if there is any further relationship among the motivators to help the construction industry enhance its image. By using the principal component analysis as the extraction method, four factors with Eigenvalue greater than 1 were extracted (Table 2). The Eigenvalue corresponding to the each factor is shown below to the factor number in the Table 2. The Table 2 also shows the rotated factor loadings. A factor loading can be expressed as a correlation coefficient between an original variable and an extracted factor. To increase the factor loadings which indicates which variables were highly related to each factor, factor rotation was carried out with "varimax" rotation.

Table 2- Industry motivation factors

Motivators	Factor 1(2.33)	Factor 2(2.22)	Factor 3(1.87)	Factor 4(1.56)	Factor 5(1.01)
Enhancing R&D	0.90				
Increase skill levels of employees	0.82				
Promote joint-ventures with foreign construction companies	0.64				
Construction safety practice		0.84			
Offering incentives for encouragement of employees		0.87			
Institute involvement in training and development		0.51			
Opportunities for career development programmes			0.80		
Increase buildability practices			0.73		
Maintain the construction quality standards			0.66		
Improve the professional standards				0.74	
Enhancing the relationship between construction companies				0.73	
Offer knowledge on industry at the primary education system				0.61	
Introduction of new forms of procurement systems					0.90

These five factors are as follows,

Factor 1: enhancing skills and efficiency

Factor 2: adopting incentive awarding mechanism

Factor 3: imposing quality practices

Factor 4: improving professionalism

Factor 5: improving procurement strategies

Enhancing Skills and Efficiency – Enhancing skills and efficiency was identified as the first factor. Respondents felt that the enhancing skills and efficiency in many ways could improve the image of the construction industry. It is noted that, it can be achieved through improving the skill levels of employees, R&D and promoting joint-venture. Individual organisations can take the leading role in improving skills of the employees. Further, they can initiate R&D to identify effective mechanisms of improving the efficiency of organisations. Different case study researches can be carried-out with especially international organisations that have shown great success in their business activities. Respondents have built-up their faith on promoting joint-venture with foreign companies to improve the skills and efficiency. This may be due to the different exposures and experiences gained through foreign companies to improve their current practices.

Adopting Incentive Awarding Mechanism – Respondents felt the incentives can help employees to encourage and motivate themselves. Incentives can be given as performance bonuses or providing training opportunities to improve their knowledge and skills. The organisation can provide financial incentives for staff to undertake long-term training programmes and continuously, professional development programmes such as short courses, seminars, conferences are also be considered. Further, respondents felt that giving incentives for practising and improving health and safety is important to develop the image of the construction industry. This can be implemented at two levels; government and individual organisational level. At the organisational level, incentives can be offered to their workers who observe health and safety rules. These practices can help the management to inculcate health and safety habits. However, this issue should be addressed by the government together with organisations as industry as a whole is performing far behind the acceptable levels of health and safety rules [22]. Further, the government could take a leading role in promoting organisations to adopt safety and health rules through introducing different incentive awarding mechanisms to organisations.

Imposing Quality Practices – According to respondents, the quality of the construction works can be enhanced through improving quality of woks, employees, and quality standards. Pre-defined quality standards of a construction work can be easily achieved if the work is well defined which, in turn, reduces the errors. Respondents felt that the construction errors can be minimised or eliminated, adopting highly buildable designs. In order to raise the buildability, there should be closer cooperation among designers, contractors, specialist contractors, material suppliers and component manufacturers during the design and construction stages. Quality standards play a great role in guiding the construction team to achieve the pre-defined quality of the final product. Therefore, existing quality standards should be reviewed, maintained and improved yearly. The strategies like total quality management mechanisms can be implemented. Further, respondents also felt that the career development of the construction team would help to improve the quality. For instance, career development programmes can improve employees' carrier achieving quality outputs. Further, organisations can identify individuals' career paths and help them to develop their careers to motivate them to retain in the same organisation which in-turn raise the performance levels of the organisation.

Improving Professionalism – Improving professionalism was identified as the fourth factor. Respondents felt that professionalism can improve through enhancing professional practices, relationships and knowledge. Respondents proposed that the improving knowledge of professionalism can be started at the primary education level and continuously carried out up to the practitioner level. At school and institutional education, several modules can be included to their curriculums, where, as at the practitioner level, individuals can convert their knowledge in to practice. Further, certain guidance can be given through codes of conduct and exposures through making various relationships between different parties in the industry.

Improving Procurement Strategies – In the fifth factor, improving procurement strategies was observed. In Sri Lanka most of the contracts are based on traditional procurement method. Other procurement systems like joint-ventures, partnering, etc., are still at a very low profile. However, respondents felt that if these new strategies are developed, it will lead the industry towards the international market.

4. Conclusions

The research revealed that currently, there are many problems faced by the construction industry in Sri Lanka as seen by consultants and contractors. Sixty one challengers were tested and 46 are shown significant. They are from ten different areas including financial, government policies, technology, management and coordination, R&D, resource, safety, training and development social and skill levels. Further, the research identified 13 main motivators to help construction industry participants to improve the performance. Among these motivators, factor analysis revealed that some sub-factors were more important than others. Based on Eigenvalues, the five important factors were established to enable the construction industry to enhance its image. They are: enhancing industry skills and efficiency, adopting incentive awarding mechanism, imposing quality practices, improving professionalism, improving procurement strategies. These findings will create a momentum to all who are in the construction industry to look back on their existing practices and performance. Further, the recommendations given by identified factors will provide a simple guidance raising the image of the construction industry.

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Construction project teams and their development: The case in Sri Lanka

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Abstract

Construction industry is highly susceptible to be benefited from teams as the construction products are delivered by a collection of diverse professionals. However, effective teams cannot be created at a stroke, and, they need time and opportunity to mature. This is normally referred as team development; and, this area has been subjected to various researches. However, there is a deficiency in published researches on team development with regards to construction teams and none is reported in Sri Lanka. Therefore, this study explored how the construction project teams in Sri Lanka go through team development process. This research problem was approached through case studies of three construction projects, which were operating under the traditional procurement method with re-measurement contracts. Semi-structured interviews were conducted with five distinct participants of construction team during data collection. Based on findings, a new model of team development with regards to Sri Lankan construction teams was developed. The new model indicates that construction teams progress basically in a linear sequence (forming-storming-norming-performing-adjourning) as suggested in the literature. However, the study unearthed that within this basic linear sequence, several cycles can be created due to the conflicts that may occur when the team is at performing level. The results further revealed that construction teams in Sri Lanka lacking with mutual accountability; and, formal attempts to get long-term benefits.

Keywords: Construction teams, Sri Lanka, Construction Industry, Team Development

1. Background

Even though, issues on teamwork has been frequently addressed by the contemporary management researchers in a more structured way, the practice of teamwork has its roots spanned up to the very beginning of human life. For example, according to Cornick and Mather [1],

“when early man started to hunt something that was bigger than any one person could handle, he started to do it with others. The hunting party was a group with a very important common goal- to obtain food to survive.”

Various researchers have defined the term "team" in various ways. However, amongst the different definitions for team, the following given by Katzanbach and Smith [2] is one of the commonly cited:

"a team is a small number of people with complementary skills, who are committed to a common purpose, performance goals and approach for which they hold themselves mutually accountable."

This definition by Katzanbach and Smith [1] is clear and comprehensive to an acceptable extent.

Researchers all over the world have highlighted the significance of teams in organisational perspective. Most organisations which seek improved efficiency have embraced teams in the belief that they are the way to meet the demands of a turbulent and challenging market place [3]. A research carried out by Bacon and Blyton [4] indicated that teamworking has a greater positive impact upon both organisational performance and human resource outcomes. Further, usage of teams in organisations results in increased productivity [5]. In addition, Murray and Moses [6] have stressed the idea that teams play a central role in organisational learning process.

This concept of "teamwork" is very much appropriate for the construction industry as the construction products are delivered by a collection of professionals. Various authors have highlighted the importance of teamwork in construction. In a survey of AEC (Architectural/ Engineering/ Construction) companies in the U.S., Arditi and Gunaydın [7] has identified that collaboration among parties in the design team was ranked first among the many factors that affect quality in design phase. Further, according to Albanse [8], teambuilding approaches in projects has contributed to lower the total project cost by avoiding rework; improving trust; reducing scope definition problems; lowering variation order rates; and, improving understanding of project objectives. In addition, improved teamwork in construction projects will increase the project participants' job satisfaction [9].

Since, teams offer numerous benefits both in organisational and construction perspectives; the knowledge on how teams develop is of paramount importance for team leaders. Over the years, many researchers intended to identify how teams in general organisational perspective develop, and, offered different models to represent this process. According to Gersick [10], amongst these models, the model developed by B.W. Tuckman in 1965 is frequently cited today in management literature. According Tuckman's model, a team has to go through four stages called **forming** (team comes together and gets the initial awareness about the each other), **storming** (conflict and the competition within the team rise to higher level), **norming** (team members try to set norms for appropriate behaviours) and **performing** (team maturing as an effective team) during its life.

Later, in 1977, Tuckman and Jenson have revised this model and proposed a new model of team development with the addition of adjourning stage which occurs after the performing stage (see Figure 1). Moreover, by addressing the issues untouched by Tuckman (1965), several other researchers too have come up with different team development models. These models include; five faces model [11], two barriers model [12] and integrated team development model [13]. Amongst aforesaid team development models, the model of Tuckman and Jenson remains more appropriate for the construction context since, it is based on the fundamental assumption that teams has a finite life.

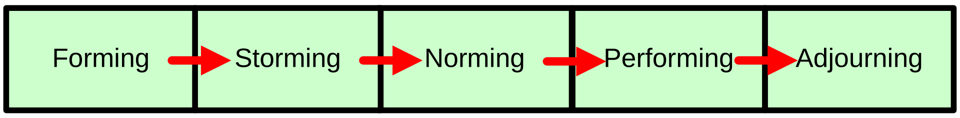

Figure 1- Tuckman-Jenson model (1977) Source: Rickards and Moger [13]

However, Winch [14], highlighted that members in construction teams are lacking with mutual accountability and a mutual objective. Some researchers have identified that the teams in construction are virtual in nature since, they have to work together from many different locations over the life of the project [1] [15]. Further, Cornick and Mather [1] and Walker [16] suggest that since, construction project teams comprises of members from different organisations, it can also be regarded as inter-organisational team. In addition, there is sufficient evidence in the literature regarding construction teams to argue that construction team is a cross-functional team [16].

When reviewing the construction related literature, it was evident that a little consideration has been given to the issues relating to team development. By looking at the characteristics of construction teams, it is evident that it deviates from the ideal team definition of Katzanbach and Smith [2]. Therefore, team development models which have been developed in general organisation perspective can not be solely applied in construction context. However, if the construction team leaders are knowledgeable about the issues relating to nature and types of teams; and, team development in construction, they are in a better position to determine what types of resources and support will be most helpful to the team, based on the specific challenges they are facing in each stage. Thus, this research intends to fill the research gap by studying how the concepts of team and team development applied in Sri Lankan construction context.

2. Method Of Study

The empirical study consisted of cases studies of three building construction projects namely projects A, B and C which are operating under the traditional procurement method with re-measurement contracts; and, whose construction duration is more than one year. Data collection was mainly done by conducting semi-structured interviews with five key participants of the construction project team: client or his representative, contractor’s site manager, architect, structural consultant and the cost consultant (quantity surveyor). The data gathered from the interviews were analysed by code-based content analysis with the assistance of computer soft ware called N-vivo. In the same time, cognitive maps were developed in order to enhance the data displaying capabilities of the findings. Finally, conclusions about the overall research problem were drawn by critically analysing the findings.

3. Research Findings

The findings reveal the nature of the team; types of teams; and, team development with regards to Sri Lankan construction context. These are discussed in detail in the following sections.

3.1 Nature of the Construction Team

The nature of the construction team is discussed in terms of disciplines of the members, team leader, accountability, interdependencies, consistency of the members, and, objectives of the members as illustrated below.

Disciplines of the Members

Case studies had identified that the construction team consists of the members from various disciplines. Projects which were selected in this study were either very large projects or very complex ones. Project A and Project B has high contract sums. Project C which has the lowest contract sum (170 millions), was a very complex project. Therefore, it can be argued that these issues contributed significantly to the existence of members from various disciplines.

Team Leader

The empirical data disclosed that in construction teams, the leader's role is significantly governed by the contractual conditions. For example, the structural engineer of the project C indicated "*the leader did not have much work to do rather than just a facilitator or a coordinator. We all have obligations and responsibilities under the contract and there were penalties set up in case of breach of those obligations. Therefore, we all know what is expected from us and there was not much need for the leader to supervise us*." Therefore, it is evident that in construction teams, the leader's role was substituted by the contractual obligations up to some extent and hence, leadership positions become decreased importance.

Accountability

The case study findings revealed that in most of the situations the accountability within the team was at the organisation level. Most of the members were from different organisations and each organisation's accountability was clearly documented in the contractual conditions. Therefore, most of the time mistakes by each member were treated based on the contractual obligations. For example, the Architect from Project C stated "*since, there were several organisations, they are accountable at organisation wise. Accountability of each party is specified in the contract documents. Therefore, each member's mistake is treated based on that*".

Interdependencies

Most of the interviewees disclosed that they have to depend on other team members to a higher extent when performing their tasks. As explained earlier, projects within the case study sample were either very large projects or very complex ones and, hence, various people with various expertises are required to handle such projects. But, the tasks of these members were interrelated and each member needs inputs from other members to carry out their functions. Therefore, higher level of interdependency among members was evident in Sri Lankan construction project teams.

Consistency of the Members

Case study data revealed that most of the construction project teams were not much consistent through out the life of the project in terms of parties. The projects selected in the study were adapting traditional (separated) procurement method. Because of that, some of the team members came into the team at various stages and even, some had completed their work and went away prior to the project completion. But, if the integrated (design and build) method was adapted some kind of consistency of parties can be expected as there is only one party to carry out both design and construction (design and built contractor), and, also due to fact that the design and built contractor is selected at early stage in the design process.

Objectives of the Members

Case study findings showed that the objectives of most of the members were inline with the project objectives. But, there were some situations where the contractors have experienced some sort of a conflict between their business objective and the project objective. When compared to the jobs undertaking by the other members the contractor's job is somewhat risky than the others. Therefore, their financial objective is quite strong and that objective sometimes found incompatible with the project objectives. The contractor's site manager from Project C explained this "*normally our main objective is to fulfill the client's requirement which is the objective of the project. We also have another objective to have a reasonable profit for the works we executed. But, there were some situations, where we felt that we were not paid enough for our work especially, during variations. In such situations, those two objectives were clashed a bit*."

3.2 Types of teams in Construction

The types of teams construction is discussed in terms virtual, cross-functional, and, inter-organisational teams.

Virtual Teams

As per the definition given by DeSanctis and Poole [17], geographically, temporally, and/or organisationally dispersion and, the communication through information and communication technologies can be seen as the main features of virtual teams.

The empirical data revealed that construction team members were from different organisations. Thus, the teams can be regarded as organisationally dispersed. Further, since most of the members were from different organisations and also they were involved in various projects simultaneously, they have to work from different locations. Therefore, team can be viewed as geographically dispersed. In addition, despite the fact that they were geographically dispersed, the team members managed to meet each other at least once a week. Therefore, those teams can also be viewed as temporarily dispersed.

Since, the construction teams were geographically dispersed; they used information and communication technologies such as telephone, E-mail and faxes to maintain communication between them. Therefore, by looking at all of above empirical findings the construction teams can be viewed as virtual teams.

Cross-functional Teams

As per Ford and Randolph [18], Cross-functional team usually works together for a limited time, team members are also members of other teams and members have reporting relationship to functional managers as well as multiple team or project leaders.

Majority of the interviewees unveiled that they were involved in various projects simultaneously. Further, due to the fact that the construction teams consisted of members from different organisations, in addition to reporting to the project leadership they also has to report to the management in their parent organisations. For example, the Quantity surveyor of the Project A indicated "In my organisation I have to report to the chairman of my organisation and in the project; I have to report to the project leader." Therefore, it is evident that they had multiple reporting relationships.

Because of above two reasons and also due to the fact that construction teams have a finite life, the construction teams can be regarded as Cross-functional teams.

Inter-organisational Teams

Inter-organisational team refers to the team, which is made up of representatives from various organisations who are involved together in producing the results [8].

The case study findings revealed that almost all the team members were from different organisations. Further, it is obvious that those team members were drawn together to produce a result (get the project done). Therefore, the construction team can also be considered as an inter-organisational team.

Based on the findings under the sections 'Nature of the construction team'; and 'Types of teams in construction', the definition for the ideal team given by Katzanbach and Smith [2] can be altered in the Sri Lankan construction context as follows.

> *"The construction team is a collection of two or more people with complementary skills, who come from different disciplines and organisations, to perform a common objective, but with individual objectives and, operating from different locations with multiple reporting relationships, whose accountability and leadership are significantly governed by the contractual arrangements."*

3.3 Team Development

The issues relating to team development with regards to Sri Lankan construction teams were identified by testing the Tuckman and Jenson model (1977). This model was selected after an extensive evaluation process due its high compatibility with construction teams. The 'feelings and thoughts of the members' and 'observable behaviours of the members' at different stages of team development as suggested by Tuckman and Jenson were questioned during the interviews to know about the existence of each stage.

The empirical findings disclosed that Forming and Storming stages were not experienced by the construction team members to the same extent as suggested by Tuckman and Jenson. However, Norming, Performing and Adjourning were almost identical to the Tuckman and Jenson. The Observed feeling and thoughts of the members; and, Observable behaviours of members at each stage of team development were illustrated in Table 1 and Table 2 respectively.

The interviewees were in general agreement that aforesaid stages were incurred in sequence as Forming-Storming-Norming-Performing-Adjourning in the selected projects. They further mentioned that when the team was at the performing stage, it has undergone some conflicts. Therefore, the team was fallen again into storming stage and then has to follow the same sequence to become an effective team. This scenario has happened in several occasions and led to creation of several cycles within the team development process. For example the architect of the project A stated that "*it has this leaner sequence. But, some times when the team is functioning as an effective team it went through some conflict situations. Then it followed the same sequence to become an effective team. This created several cycles between stages.*"

Most of the members perceived that those conflicts occurred when the new team members joined the team. For example the client's project manager of the project C stated that "*this happened mainly due to the arrival of new team members at different stages. For example, when a subcontractor joined the team at latter stages, it is very difficult to maintain coordination between them since they were not familiar with the existing way of working. It was a very significant issue in this particular project as there were about twelve subcontractors and they were responsible for almost half of the work.*"

However, some members indicated that conflicts occurred when the team is transferring from design to construction or from one trade of works to another. For example, the client's representative of the Project B denoted "*it happened normally when the existing way of working changed. For example, when the team is transferring from design to construction stages or when scope is changing from structural work to finishes or from finishes to services*." When the team is transferring from design to construction the contractor came into the scenario. Further, when the team is transferring from one trade of works to another such as structural to finishes or from finishes to services new subcontractors came into the team. Therefore, it can be argued that those conflicts were due to entrance of new members than any thing else.

Quite a high proportion of team members indicated that the changes to the existing scope of work such as variations also gave a reasonable contribution to such conflicts. For example, the contractor's project manager of project B indicated that "*these conflicts were mainly arisen when the existing scope of the project changed. For example, if the client requested a huge variation, then it was difficult to rearrange the works, agreeing to a rate and agreeing for time extensions, etc. those things normally led to conflicts*."

Table 1- Observed feeling and thoughts of the members at each stage of team development during the case studies

Stage	Forming	Storming	Norming	Performing	Adjourning
Feeling and Thoughts of the Members	• Optimistic and full of anticipation • Pride in being chosen for the team	• Confusion and loss of interest on the team • Fluctuations in attitude about the team	• Sense of belonging to a team • High confidence • Feel a new ability to express criticism constructively • Acceptance of all members in the team • General sense of trust • Assured that everything is going to work out okay	• Freedom to express and contribute • High commitment • Fun, excitement and creativity • General sense of satisfaction • Continual discovery of how to sustain feelings of momentum and enthusiasm • Empathy for one another • Trusting friendships with others	• Think about life after the project • Pride about your contribution for the team • Sadness about loosing relationship with the other team members.

Table 2- Observable behaviours of members at each stage of team development during the case studies

Stage	Forming	Storming	Norming	Performing	Adjourning
Observable Behaviours of Members	• Attempts to define tasks, processes and how it will be decided • Politeness • Orienting with others personally	• Arguing among members • Differences in points of view and personal style • Lack of progress • Establishment of unrealistic goals • Concern over excessive work	• Agreeing of processes and procedures • Attempts to make consensus decisions • focus and energy on tasks • Setting and achieving task milestones • Shared problem solving • developing routines • Comfort with relationships • Effective conflict resolution skills	• Functioning fully as team • Clear and interdependent roles • Ability of the team members to organize themselves • Flexibility and well-functioning individually • Better understanding of each other's strengths and weaknesses and insights into group processes	• Recognition and celebrating of accomplishments of team • Seeking to learn from mistakes of the team • Expressing appreciation for each other's contributions • Evaluating results • Preparing to move on

Life of the Team after Adjourning Stage

Case study findings revealed that majority of the team members were involved in various projects simultaneously. Therefore, they continued with those projects after the adjourning stage. Further, since all the team members were permanent employees in their respective organisations they were assigned to new jobs and they were engaging on those as well. Since, the team in the project B was repeatedly used in next two phases of the project B, they were involving in those two phases. But, the members from the other two projects mentioned that there was not any formal arrangement in their projects to get long-term benefits from the team.

Based on the findings of the empirical study, Tuckman-Jenson Model (1977) has been altered in the construction context as shown in the Figure 2. This can be presented as a new model of team development with regards to Sri Lankan construction teams.

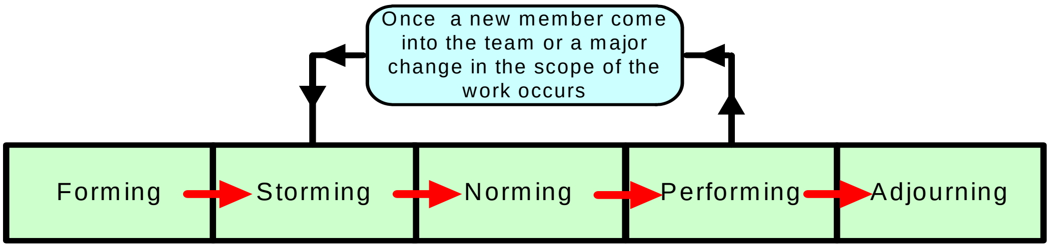

Figure 2- Revised Tuckman-Jenson Model in construction context

The model represents the cyclical nature of the team development process through the backward link from performing to storming. Conclusions drawn from this study will be discussed in the next section.

4. Conclusions

It is clear that construction teams are fairly different from the ideal teams mainly due to the lack of mutual accountability and common objective. Further, it was also evident that most of the key issues relating to construction teams such the leadership and the accountability were significantly governed by the contractual conditions. In addition, construction teams possess characteristics of virtual, cross-functional, and, inter-organisational teams.

Construction teams undergo a team development process fairly similar to the process suggested by the Tuckman and Jenson model (1977). However, the forming and storming stages are not experienced by the team members to the same extent as suggested by the Tuckman and Jenson. The basic linear sequence of the team development stages was identical with Tuckman and Jenson. But, within this linear sequence, several cycles existed due to the conflicts that occurred when the team was at performing level.

The model suggested by this study is important for construction team leaders to have better allocation of resources and leadership support for the team based on the specific challenges which the team is facing in each stage of team development.

It was also identified that progression through team development process has a strong positive relationship with the team learning Thus, after carrying out this research it seemed appropriate that further research may focus on team learning in Sri Lankan construction context.

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From project-oriented to process-oriented risk management in construction

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Abstract

The paper sets out the results of a questionnaire survey and a series of interviews with clients, contractors and consultants involved in nine construction projects recently undertaken in Sweden. Despite the fact that risk management was a part of each project, many projects suffered from variations in cost affecting one or more actors. Risk management was not carried out systematically in those projects. Both identified and unforeseen risks often occurred in the projects and generally had a significant effect on the project cost. The purpose of the paper is to examine project risk management in practice and to understand how managing project risks from a process-oriented perspective could improve the situation. In particular, the involvement of the actors in risk management in individual projects is examined. Risk transfer and communication of risks between the project phases are explored. Finally, the factors that determine whether or not the actors consider an open discussion on risk management and risk sharing as beneficial are analysed. The main conclusion is that a shift from project-oriented to process-oriented risk management is required.

Keywords: Risk management, construction, Sweden, process modelling

1. Introduction

According to a report of the Swedish Construction Commission [1], increased construction costs, project delays and deviations in quality are the most common problems in the construction industry. Risk management is a process that aims to maximise opportunities and minimise the consequences of a risk event and is an important part of the project management process. As such, it is intended to help in safeguarding project objectives, even to increase their value to the client. When considering the effect that risk management has on the project's goals in terms of quality and cost, it would be reasonable to expect that it was an open process across all phases of the project. Furthermore, a specific project risk should be managed by the actor who is best able to deal with it. Instead, it is often the case that the various actors try to avoid risks as far as possible and let somebody else in the value chain deal with them. Relatively little attention has been paid in the Swedish research community to deeper investigation of the possible changes in the traditional construction process in which each actor focuses on short-term economic results and protects his/her own interests rather than the whole project. The purpose of the paper is to examine project risk management in practice and to understand how managing project risks from a process-oriented perspective could improve the situation.

The paper sets out the results of a questionnaire survey and a series of interviews with clients, contractors and consultants involved in nine construction projects recently undertaken in Sweden. The objective of the study is to explore the factors that lead, more or less, to effective risk management in the projects. In particular, we examine the actors' understanding of risk management process and their involvement in risk management in individual projects. We analyse risk transfer and communication of risks between the project phases. Finally, the factors that determine whether or not the actors consider an open discussion on risk management and risk sharing as beneficial are analysed. Since the paper focuses on the findings of research, most space here is given to reporting empirically-derived findings instead of presenting familiar arguments on the nature of risk and the purpose of the risk management process. Nonetheless, we outline the critical issues connected with the risk management process and its application within the construction industry.

Project risks are uncertain events or conditions that may have an impact on project objectives [2, 3]. A risk has a cause and, if it is triggered, also a consequence. A questionnaire survey conducted by Akintoye and MacLeod [4] shows that the majority of project actors perceive risk as a negative event. Ward and Chapman [5] discuss the concept of risk in detail and suggest using the more general concept of *uncertainty*. Risk management is a formal process directed towards the identification, assessment and response to project risks [2, 5, 6]. Risk identification is aimed at determining potential risks, i.e. those that may affect the project. There are several approaches to classifying project risks and risk sources [7-10]. In general, the sources of risk in construction projects may be divided into external risks (e.g. financial, economic, political, legal and environmental), internal risks (e.g. design, construction, management and relationships) and force majeure risks. Several surveys conducted among construction industry actors [4, 11, 12] show that checklists and brainstorming are the most often used techniques in risk identification. During risk assessment, identified risks are evaluated and ranked. The goal is to prioritise risks for management. Several authors [4, 11, 12] cite subjective judgment, intuition and experience as being most commonly used in risk assessment. The risk response process is directed to identifying a way of dealing with project risks and consists of three main techniques: risk reduction, risk transfer and risk retention [13]. Baker et al. [14] identified risk reduction as the most frequently used technique within the construction industry in the UK. Our treatment of risk management in this paper follows broadly along the lines outlined above in terms of the recognised stages in that process.

2. Research Approach

The main part of the study was a questionnaire survey followed by a series of interviews with project actors. The survey sample comprised clients, contractors and consultants who employed risk management in a given project. The respondents from the client's side were the representative signing the contract and the project manager. From the contractor's side the respondents were the representative signing the contract, site manager and estimator. Finally, the respondent from the consultant's side was the architect or design manager.

A draft questionnaire was developed consisting of five sections. The first section contained general questions about the respondent. In the second section, aspects of the risk management process through the different phases of the project were covered. The third section investigated relationships between the actors in the project. The fourth section focused on software management systems, which the company used in the risk management process. The fifth section was a concluding one for miscellaneous comments regarding the risk management process in the project. In total, 54 questionnaires were sent and 36 completed, usable responses were received, representing a two-thirds' response rate.

Based on the compiled results of this questionnaire survey, 18 interviews across eight projects were then conducted. The objective of the interviews was a deeper analysis of the risk management process in the projects. Since it was impossible to interview all survey respondents within the time constraints, the number of interviewees was limited to the two or three persons responsible for risk management in the project. From the client side, it was a project manager, from the contractor side a site manager and from the consultant side an architect or design manager. Each interview took approximately one and a half hours and consisted of three main parts. First, the important definitions in risk management were discussed. Since the questionnaire contains the terms risk, risk management, risk identification, risk assessment, risk response etc., it is important to understand the perception of these terms by the respondents. Next, the results of the survey were presented and the respondents were asked to explain their answers. Finally, the respondents were given an opportunity to express their thoughts about risk management in the project.

3. Description of Construction Projects

The study involves nine construction projects recently undertaken in Sweden.

Project 1 included the new construction of a house for meetings at the university campus in the northern part of Sweden. The project was executed over 15 months between 2003 and 2004. The contract sum was 41.1 MSEK and the final cost was 43.5 MSEK. Design-build, with a lump sum payment mechanism, was the chosen form of procurement. The project implementation was very good in terms of time and fairly good in terms of quality. In terms of budget, the project was very good for the client and fairly bad for the contractor. The identified risks occurred in the project, but their effect on the project cost was fairly small. The unforeseen risks during the project execution led to a fairly large increase in the project cost.

Project 2 included the rebuilding, refurbishment and additional construction of university premises, located in the northern part of Sweden. The project was undertaken between 2004 and 2005 and took 10 months to complete. The contract sum was 17.9 MSEK and the final cost of the project was 19.6 MSEK. A lump sum payment mechanism was chosen and a performance-based contract was signed between the client and the contractor. The technical characteristics of the final product were evaluated as high and the time constraints for project execution were kept. However, the poor quality of design documents increased the contractor’s costs significantly. Identified risks occurred in the project and had a large effect on the project cost; even so, the consequences of unforeseen risks were fairly small.

Project 3 included the construction of infrastructure in the north of Sweden. The project was executed over 13 months in 2006 and 2007. The contract sum was 53 MSEK and design-build procurement, with a lump sum payment mechanism, was chosen. The project execution in terms of function, time and cost was fairly good. Both identified and unforeseen risks occurred in the project and had a moderate effect on the project cost.

Project 4 included the construction of a road in the north of Sweden and was performed under 14 months between 2005 and 2006. The contract sum was 19.7 MSEK and the final cost was 24.5 MSEK. The contractor was procured on a performance-based basis, with a lump sum payment mechanism. The project implementation was fairly good in terms of cost and function and very good in terms of time. Both identified and unforeseen risks occurred in the project and had a fairly large effect on the contractor’s cost.

Project 5 included the construction of road in the north of Sweden and took 10 months between 2005 and 2006 to complete. The contract sum was 4.9 MSEK and the final sum was 4.7 MSEK. The performance-based form of procurement with a lump sum payment mechanism was chosen. The project execution was fairly good in terms of function and cost and fairly bad in terms of time. An insufficient geotechnical survey led to identified risks occurring in the project, but their effect on the project cost was fairly small. No unforeseen risks occurred.

Project 6 included the construction of a residential building in Stockholm. The project was executed between 2005 and 2006 and took 17 months. The contract sum was 81 MSEK and the final sum was 84 MSEK. The procurement form was design-build, with a lump sum payment mechanism. The quality of the final product was evaluated as very good, time constraints were kept to a fairly good level. In terms of cost, the client evaluated the project execution as very good while the contractor’s evaluation was fairly bad. Both identified and unforeseen risks occurred in the project, but had a fairly small effect on the project cost.

Project 7 included the reconstruction of a residential building in Stockholm and was executed over 12 months between 2004 and 2005. The contract sum was 47.7 MSEK and design-build procurement, with a lump sum payment mechanism, was chosen. The project implementation was very good in terms of time and function, very good in terms of cost for the client and fairly good for the contractor. Neither identified nor unforeseen risks occurred during the project execution.

Project 8 included the reconstruction of infrastructure facilities in Stockholm. The building period was three years between 2004 and 2007. A performance-based contract with a lump sum payment mechanism was chosen for the project. The contract sum was 95 MSEK. In terms of cost, project implementation was very good for the contractor and very bad for the client.

Unforeseen risks caused significant delays and high costs for the client. The quality of the final product was fairly good. The identified risks occurred and had an impact on project cost.

Project 9 included the reconstruction of a residential building, located in Stockholm. The reconstruction was executed in 2005 and took 6 months. The project was implemented as a form of partnering with a cost reimbursable payment mechanism. The contract sum was 15 MSEK. The project implementation in terms of function, cost and time was good. Together, the client and the contractor succeeded in decreasing project costs. Both identified and unforeseen risks occurred in the project, but did not have a large effect on the project total cost.

4. Results

Despite the fact that risk management was a part of each project, many projects suffered from variations in cost for one or several actors. Risk management was not carried out systematically in those projects. Both identified and unforeseen risks often occurred in the projects and generally had a significant effect on the project cost. In sections below we discuss the factors that lead to more or less effective risk management.

4.1 Understanding of risk management

The majority of respondents have what might be described as a fair understanding or knowledge of risk management and did not have any special training in the subject. Experience within construction industry is the main source of knowledge. To quote from three respondents:

"I have worked very long time in construction; no one can do it better than me". (Client in project 7)

"Experience takes over, you learn during all these years of working in construction". (Contractor in project 7)

"I have only my experience; it would be good to get more theoretical knowledge". (Consultant in project 9)

Some companies organised internal courses in risk management but most respondents identified the lack of the theoretical understanding or knowledge. Many companies have a set of procedures to follow in the risk management process. The largest problem identified with the procedures is their complexity and documentation requirements.

"To do risk management systematically on paper is a big problem. We get a lot of documents from the system and nobody looks at them later". (Client in project 4)

"Many people do not like to fill in papers; therefore they skip documentation of risks". (Contractor in project 6)

In the risk management process, simple tools are familiar to the respondents: checklists and brainstorming for risk identification; probability-consequence judgment in risk assessment; and risk transfer as a way to respond to risk. In practice, the use of theoretical tools was limited.

"When assessing risks we do not use any theoretical tools but [instead use] experience, feelings and relationship with the client". (Contractor in project 2)

Insights into this more theoretical view of risk management is shown in figure 1, which is based on best practice advice informed by numerous studies and reapplied from one project to the next.

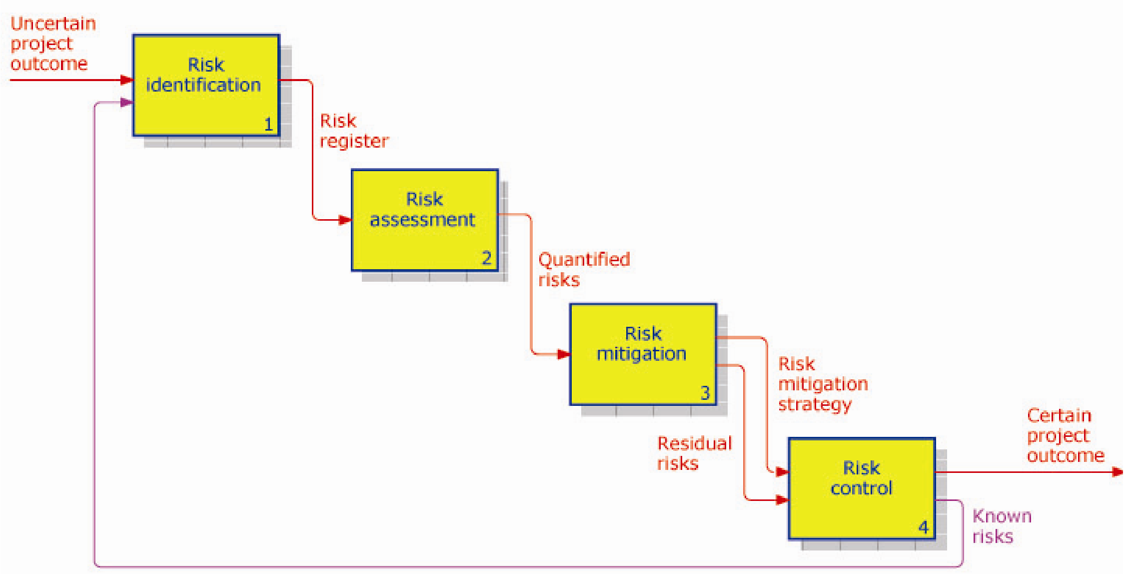

Figure 1 - A more theoretical and formal treatment of the risk management process.

Figure 2 decomposes the higher level activity of risk identification into a lower level of analysis.

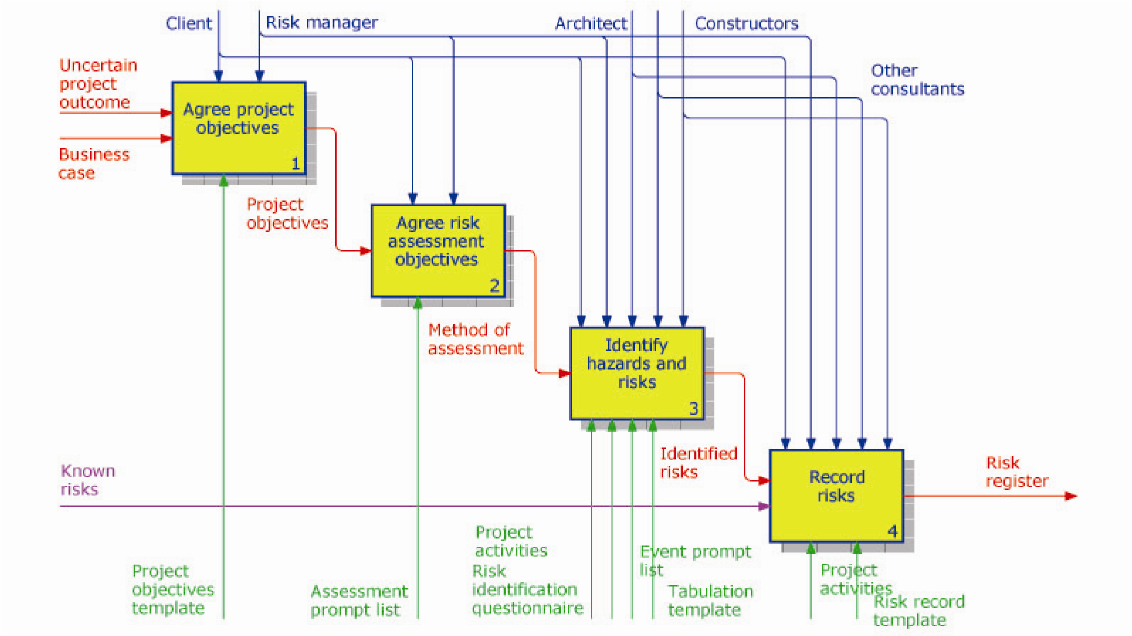

Figure 2- Decomposition of the risk identification activity.

4.2 Participation in different project phases

A construction process is sequential by nature and many actors are involved only in some project phases and focus on their own part of work rather than on the whole project. This leads to the less effective communication of identified risks and the loss of knowledge between the phases.

"It happens very often that people involved in different phases do not see the overall picture". (Client in project 7)

There was a very low participation in the programming (planning) phase overall. In particular, no contractors participated in this phase of the projects. However, the respondents recognised that the early involvement of the contractor is important for effective risk management. It allows the actors to choose the best technical solutions, decrease costs and obtain a deeper understanding of the potential problems.

"The sooner we get the contractor's expertise in the project, the greater is a chance to avoid the problems in production". (Client in project 4)

"We lose a lot of important information if we join the project when design is done". (Contractor in project 2)

The actors felt that the newer organisational forms like partnering can help in ensuring early involvement of the actors and, therefore, better understanding of project risks.

4.3 Risk identification, assessment and response

Systematic scrutiny of potential and possible risks in the project was identified by interviewees as a very important factor for successful risk management. Systematic means that risk identification, assessment and response are performed in each phase of the project and the results of the processes are communicated between the project actors. However, in just one project were these steps in the risk management processes carried out systematically.

"We identify and assess risk, fill in the template and it's done! Then we start construction, everybody is busy and forgets about risk management and early assessments". (Contractor in project 1)

The design and production phases are critical for risk management. Risk identification, assessment and response were mostly performed in these phases. Despite the recognised importance of the programming (planning) phase, very little work in risk management was performed.

"The programming phase is very important… We did not work systematically in the programming phase; we did not talk in terms of risks". (Client in project 1)

"Historically we have not worked with risks in the programming phase, but now it is coming". (Client in project 8)

"We have little focus on risks in the programming phase because the project is very abstract". (Contractor in project 2)

Within three groups of actors, contractors were the most active in performing risk identification, assessment and response in the project. Almost all contractors documented potential project risks and preventive measures. Moreover, contractors had the largest influence on risk management in the project.

"Contractors have to deal with most risks; we are forced to be active in risk management". (Contractor in project 2)

Consultants were not involved sufficiently in work with risks and had a low influence on risk management. The actors agreed that consultants should play a more important role in risk management, because design-related risks can affect the project's performance significantly.

"Consultants still have a passive behaviour when it comes to risk management. Risk management is not a part of their assignment". (Client in project 2)

"I think our competence is not used by 100%, probably we have to start talking that we are good and can much more". (Consultant in project 1)

The role of the client in risk management depends on the form of contract. In the performance-based projects, where the clients were responsible for a design, they had a larger influence on risk management and were more active in risk identification and risk response. The clients concurred that even in design-build projects, where the contractor is responsible for a design, the client has to play an active role in risk management.

"The client is always responsible for commitment of other actors. I don't believe in 'good' contractors and consultants, they adapt to the clients' requirements". (Client in project 8)

Risk identification, assessment and response are needed in each phase of the project. This iterative approach, as illustrated in figure 3, is at odds with the previous portrayal of the risk management process in figure 1, which tends to regard the risk management process as a rather sequential activity running across the project phases.

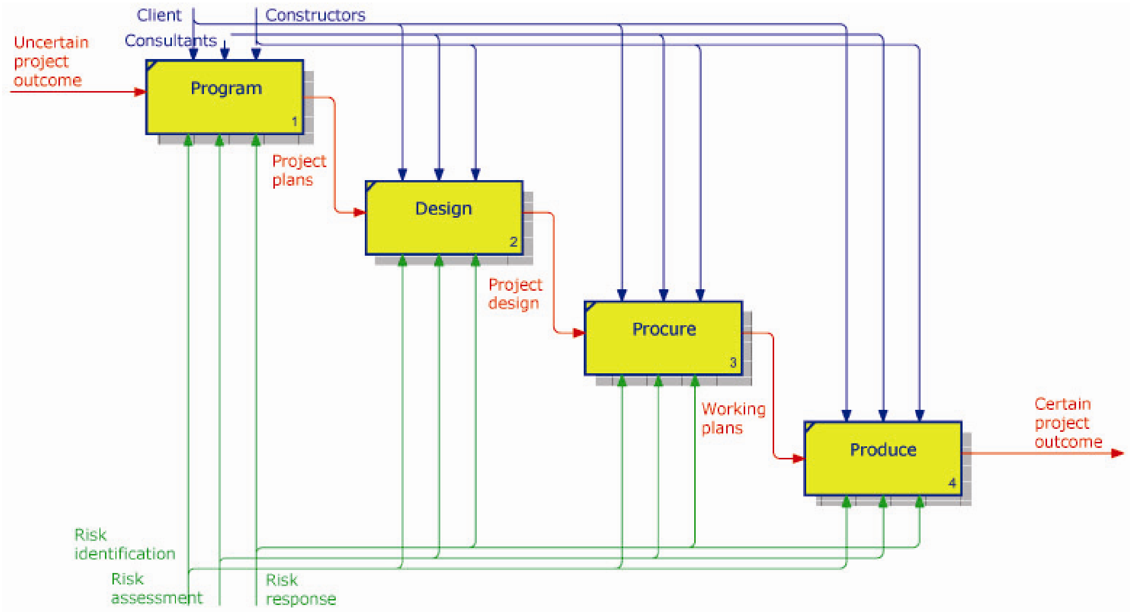

Figure 3- An iterative view of the risk management process to be applied at each phase in the project life cycle

4.4 Risk transfer and communication of risks

The majority of respondents agreed that the risks always are transferred between the project's actors. Clients transfer risk to contractors because they believe that they, the contractors, have better ability to manage risks. Some risks stay with the client, for example environmental and market risks.

Two ways of risk transfer were identified by the actors: positive and negative. A positive way means that the risk is identified and the actor who will manage the risk is aware of it. This way demands open dialogue about known risks between the actors. A negative way implies, for example, that the client lowers the cost by omitting important investigations and information before the project start date with the effect that risks appear in the production phase.

"Prior investigations are expensive and sometimes the client does not do all necessary investigations". (Client in project 4)

The contractor transfers risks to the subcontractors and sometimes back to the client; for example, design risks in those cases where the client was responsible for the design. The majority of contractors are convinced that the client tries to transfer all possible risks to the contractor. Despite the fact that risk allocation is formalised by general contract conditions, which are used in all projects, clients tend to make some changes and include special conditions which imply more risk allocated to the contractors.

"The client's way of thinking is 'risks to the contractor, opportunities to us!'". (Contractor in project 2)

The communication of known risks in the procurement phase was very low from both the client and the contractor. Two opposite views were shown: one group stated that it is a strategic choice not to show all risks in the procurement phase in order to keep the bid price at a lower level.

"The client feels that he can transfer risks to the contractor and pay a lower price. The contractor thinks there is a possibility for earning more money and keeps silent". (Contractor in project 8)

The other group said that it happens because the actors, especially the client, are not aware of all possible risks. Both groups agreed that there is a need to change the situation. When risks are not communicated at a detailed level, the chance that they will occur is much higher and their consequences can impact more.

"In any case somebody pays for mistakes made by others". (Client in project 7)

"We can put more money to the risk pot but in this case the client will pay higher price for those risks which never will happen". (Contractor in project 2)

Due to the limited participation of the actors in some project phases, the communication of project risks between them does not function properly. Many problems appear when the consultant and client are not involved in the production phase. Additionally, risk management processes are carried out most intensively in the production phase, which implies more responsibility in managing risks for the contractor and more passive behaviour by other actors.

4.5 Joint risk management

According to the respondents, joint risk management means that each actor is aware of all project risks and takes responsibility for them. It is important to start risk discussions early in the project and risks are discussed continuously. Known risks should be communicated at a detailed level between the actors and the project's phases. Fair sharing of both risks and opportunities is an important driving force for joint management of risks.

In seven of the projects, the actors had good collaboration in risk management. The actors in two projects stated that there was no joint risk management. Most of the actors responded that collaboration existed in the risk identification and risk assessment processes. The risk response process had a lower degree of collaboration according to the contractors. They stated that contractors are usually forced to manage most of risks alone.

To achieve good collaboration in risk management and an open discussion of project risks and risk sharing, the following factors are considered important:

- Active participation of all project actors in discussions on risk and risks;
- Open and effective communication and information exchange: all risks are "placed on the table":
- Project actors' ability to raise the problems as soon as they appear, dare to ask questions and work without prestige;
- Personal commitment, motivation and responsibility;
- Trust;
- Respect for each others' roles and competence;
- Fair distribution of opportunities.

5. Conclusions

The findings of our research show that risk management is not carried out systematically in all phases of a project. The actors' participation in the risk management process is generally limited by their roles in the project. The absence of systematic risk management is especially noted in the programming (planning) phase, where it arguably has the greatest potential impact. The production phase is where most interest and activity is to be found. Unfortunately, this can easily prove to be too late in the day to mitigate some risks, including those that might have been avoided at an earlier phase. Whilst this is self-evident, scant attention to early identification of risks confirms this practice as commonplace. As a concept and matter of practice, the communication of risks between the actors simply does not work to the extent that it must if projects are to be delivered with certainty, irrespective of the form of procurement. If risks are to be properly managed, it is also self-evident that the risk management process must be present, transparent and activated within each phase. It is the lack of an iterative approach to risk management that is a weakness in current procurement practices and this aspect must be addressed if the risk management process is to serve projects and, thus, their clients. Implicit in this thinking is that the project's other actors will be better able to cope with circumstances that might threaten the time, cost or function of the project if they can be engaged in the risk management process from the outset. A shift from project-oriented to process-oriented risk management is required in order to manage project risks successfully.

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Factors affecting the use of sustainable waste management practices in small and medium sized construction enterprises

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Abstract

Sustainable construction practices amongst all members of the building project production supply chain are being introduced in an incremental fashion. This paper explores the current state of awareness related to sustainable building production practices amongst small and medium sized construction enterprises (SMEs) located in Edinburgh, Scotland, UK. The work was funded by a donation from the Edinburgh and District Master Builders Charitable Trust. The paper reports in particular on the practices involved in site waste management amongst the industry participants indicated above. The different strands of sustainable practices although identified are not considered in this paper.

A qualitative methodology was used for the research using semi-structured interviews with eight practitioners located in construction SMEs to seek out information from carefully selected respondents in the industry. The results from these interviews were then analysed for similarities, disparities, and patterns. The findings from the study found that there was awareness of the significance of good site waste management and recycling practices towards the achievement of sustainability in building production but that overarching factors of organisational size, project specifics, and time availability and costs were affecting such SMEs potential to adopt such practices on a consistent basis. The study is limited in scope, depth of data collection and geographic location but nonetheless offers an insight into the state of the art in this aspect of the overall agenda related to sustainable site based construction practices

Keywords : site waste management, factors, implementation, SMEs

1. Introduction

Work that contributes either directly or indirectly to the implementation of change in the practices and approaches of the UK construction industry is at the core of built environment research. The broad multi-headed research agenda related to sustainability and its application, implementation and evaluation in the practices of the construction industry is well established and tackled by large scale publicly funded research initiatives. It is posited that holistic solutions are required that address issues across the themes of waste management, energy management, supply chain management and lean thinking are required to respond to the need to achieve cultural change. Nonetheless, individual small scale research projects that focus on a single aspect of the sustainable research agenda can also make a contribution. One such study is reported in this paper. This paper reports on an exploratory postgraduate study that was funded by the Edinburgh and District Master Builders Charitable Trust. The work contributes to the agenda on sustainable construction by examining how small and medium sized construction enterprises (SMEs) in the Edinburgh region of the UK can best adopt sustainable practices within their work approaches. In particular, this work places emphasis on exploring factors affecting the implementation of site waste management and recycling practices as a means of making a contribution to the implementation of more general sustainable construction practices.

A qualitative research design was used as the research approach for the study and data were collected from a series of case studies that involved site observations and interviews with key decision makers involved in the project delivery team. The initial section of the paper analyses relevant literature so as to identify potential measures and overarching strategies could be used to develop better construction production practice in relation to waste management and recycling. The analysis of literature allowed a conceptual model to be developed that was used as the initial data analysis framework for the data collected. The paper concludes by advancing a framework of factors found to affect SMEs looking to optimise their performance in terms of this area of sustainable production practices.

2. Literature Review

The then DETR (1999) conducted a review of existing guidelines on sustainable development and identified environment, social and economic themes as areas in which all sustainability measures could be classified, targets identified and performance measured. These three strands are interlocking and generally form the core of issues to be addressed in the achievement of sustainable development in general and construction project sustainable practice in particular. Talbot and Addis, (2001) identified four main priority areas for organisations operating within the European Union (EU) which included; (a) climate change, (b) nature and bio-diversity, (c) environment and health, and (d) natural resources and waste. The identification of such broad themes and overall frameworks are thought to have proved to be beneficial in communicating the concept of sustainable practice across industry participants. In terms of the construction industry specific targets subsequently emerged (DETR 1999) in three major areas, namely, (a) reducing resource and energy use, (b) minimizing pollution and waste, and (c) enhancing economic efficiency and social objectives. These targets were to be achieved through a re-engineering of the construction process to take full advantage of lean construction principles. In terms of (b), which is the sub area of the overall sustainability agenda at the core of this paper, there emerged the need to think in terms of the whole life use of the buildings and structures. This included especially the assessment of the consequences of recycling and/or final disposal, efficient manufacture/use of construction materials and general waste management during and after building project production completion.

Brownhill and Rao, (2002) report the development of a plethora of checklists for action, such as the BREEAM, EcoHome, and others (Building Research Enterprise, DTi, etc). However, this study adopts the position that notwithstanding such checklists the construction industry is still finding it difficult to adopt sustainable practises and especially those organisations that are classified small and medium sized enterprises. Urooj *et al*, (2006), commented that such checklists are in themselves inadequate and but suggested that there was a need for knowledge-based decision mechanisms that can be used by SMEs to effect change.

The UK construction industry is characterised by its reliance on large numbers of small sized business organisations combining together through a recognised procurement system to physically produce a building project. Given this business landscape it became inevitable that if the targets and improvements called for by Government agencies were to be met then awareness and preparedness to implement changed practices needed to become embedded in the myriad of small and medium sized construction enterprises (SMEs) that make up typical supply chains involved in the project delivery cycles of projects located in the UK.

In response to the above change agenda designs are more and more emerging with a range of features included in them that are focussed on the achievement of more sustainable building project practices. Such initiatives include measures to achieve zero carbon emissions, eco-buildings, zero waste, and lean site waste management practices. Of the common design initiatives indicated it is measures related to site waste management and recycling that are the most resonant with the SMEs that make up typical building project production supply chains. In particular academe is calling for such organisations to devise and implement strategies that make savings in or eliminate waste, or reduce it, or re-use it, or re-cycle it and dispose of it only when necessary.

3. Conceptual Approaches To Waste Management

The effective management of waste has been identified as one of the most important priorities towards achieving sustainable developments. However it is difficult to define waste itself as it is sometimes subjective. (Wills, 1995) gives a definition of waste as being, “Any substance which constitutes a scrap material or an effluent or other unwanted surplus substance arising from the application of any process; and any substance or article which is required to be disposed of as being broke, worn out, contaminated or otherwise spoiled”. The Scottish Environmental Protection Agency (SEPA, 2006) highlighted that the concept of waste cannot be interpreted restrictively and case law defines that whether something is waste must be determined by reference to all the circumstances, having regard to the waste framework directive and the need to ensure its effectiveness is not undermined. This suggests that waste maybe determinable upon circumstances and already established legislation or even precedence. Waste generation by the UK construction industry is significant in terms of its direct cost to the industry itself and its relative contribution to the overall national waste burden (Saunders and Wynn, 2004).

Given the above wide ranging definition of waste it can be accepted that the current waste statistics in the UK (Hyder, 2007), suggest that the construction, refurbishment and demolition of our buildings and structures produce around 120 million tonnes of waste in the UK each year, which is 33% of all UK waste and 21% of all UK hazardous waste. Of these overall figures it has been estimated that some 13 million tonnes of materials that delivered to building project sites and never used and that such resource inefficiency is significantly affecting the profit margins and image of the industry.

This situation is being addressed at high levels by the introduction of mandatory site waste management plans (SWMPs) for the overall construction sites. There is some evidence of eco-management waste policies being developed at organizational levels and such policies are seen as being aids through which project stakeholders can act in a structured manner to assess construction site activities to ensure that they are carried out to an environmentally acceptable standard (Yahya and Boussabaine, 2006). These policies if they are to be successfully translated into changed practices should include site activities and encourage industry participants, irrespective of organizational type, size, and classification to focus on the importance of effective waste minimization and its benefits throughout the lifecycle of building asset design, production, and operation. Such approaches are increasingly being seen as opportunities to lever competitive advantage across building production supply chains. (Yahya and Boussabaine, 2006).

Other work by Dainty and Brooke, (2004) has demonstrated that careful consideration of waste issues combined with effective education of the workforce and robust audit procedures have the potential to result in radical improvements to waste minimization performance. However despite governmental efforts at promoting benefits and savings of effective waste minimization strategies, there is evidence that such initiatives have been met with the some scepticism within the industry. There is a lack of consensus on the causes of the site based waste as according to Yahya and Boussabaine, (2006) the main causes of waste generation could include among, (a) errors in contract documents, (b) changes to design, (c) materials ordering errors, (d) accidents, (e) lack of site control, (f) lack of waste management, (g) damage during transportation and (h) off-cuts from having to cut materials to length. No matter the causes of site based waste there is some agreement in what Denton, (1996) suggested that "pro-active companies which see the environment as a cost, rather than as a chance to gain a competitive advantage are perhaps missing the best opportunity to develop leverage and gain increased business".

Other factors that are suspected to be instrumental in the achievement of sustainable building production waste management practices relate to the capacity of the SMEs within a project production supply chain to adopt lean thinking and supply chain management principles. Similarly Douglas *et al* (2001) suggested that the sector within the SME operates, especially if it is operating within a brown field / demolition / refurbishment project environment may well have an influence on the capability of the SME to adopt work practices and so enhance its profile as an organisation with capacity to deliver changed practices towards sustainability. The literature reviewed above indicates a range of factors that are thought to impact on the capacity of SMEs within the UK construction industry to plan for, adopt, and implement site based work practices that could achieve change in the approach of the construction industry towards sustainability. The study reported in this paper now addresses an exploration of actuality in the field through a data collection and analysis exercise that was focussed on the Edinburgh region of the UK. This region was selected due to funding opportunity offered by the Edinburgh and District Master Builders Charitable Trust. This body has its membership drawn from locally operating SMEs and so its involvement in terms of funding the work set the geographical boundaries for the work.

4. Research Approach, Data Collection Processes

The nature of the problem identified above and the composition of the target population of SMEs within the UK were overwhelming factors that resulted in the study adopting an explorative, qualitative research design. Fellows and Liu (1997) and Denzin and Lincoln (2001) set other factors that impacted on the selection of this strategy namely, (a) the ability to capture an individual participants point of view, (b) the capacity to uncover and gain an understanding of the constraints faced by a participants everyday life, and (c) the opportunity of gaining rich, deep data from which understanding and theory refinement can be achieved. Of the data collection approaches appropriate to this research strategy it was resolved to adopt a case study approach within which semi structured interviews were conducted with key project participants so as to optimise the collection of relevant data. As an approach this research strategy focuses on understanding the dynamics present within single organizational settings (business unit and project environment) and as such the results of the exploration are limited in terms of reliability, validity and generalisability as acknowledged by Amaratunga *et al*, (2002).

4.1 Participant selection and data analysis processes

The respondents interviewed were all industry professionals in the form of three construction managers, three directors of construction, and two site managers. The interviews were conducted and analysed in two waves (1-2) and (3-8). For the purpose of this study the interviewees were numbered 1-8. All respondents had an interest in the area of sustainable development and had also prior experiences of working on projects which had either had a theme of sustainability involved, or had some sustainable criteria as part of the key performance indicators or as clients' success criteria. The data obtained resulted from the following processes, namely the use of descriptive questions, the use of compare and contrast questions, and the use of probing questions about the way projects are currently carried out with respect to sustainability practices within SMEs being set as a major success criterion.

Data analysis started by examining the raw data to search for patterns (Fellows & Liu, 1997). Similarities and dissimilarities were identified in the nature of the respondents interviewed and the organisations they worked for towards creating concepts to act as a backbone support for the data analysis. Patterns were broken down as (Howard & Sharp, 1996) into (a) those showing association amongst variables, (b) those showing groupings, and (c) those showing order or precedence relationships between variables. The findings from the first wave of interviews (Ints 1 and 2) were as follows,

Interviewee 1 immediately associated sustainable practices to site waste management and commented on how his organisation was working actively to reduce the amounts of waste generated on site and they were currently using a waste contractor to calculate the amounts of waste generated on a monthly basis to try and determine patterns in their waste generation on site. He commented that *"You get different types of waste on site, you get plaster wood, you get the metal off cuts, and you get timber and your fifth package if you like, is probably anywhere packaging"*.

It was explained that everything now comes with packaging which is waste in itself, even parts of block, brick and plaster board all comes in with shrink wrap on it. He further commented that although it was their sub-contractors who brought such waste materials to the site it was their responsibility to deal with all this waste and he opined, *"Long term, what obviously will have to happen is, the brick layer will have to bring in his own bricks/blocks, and eventually whoever brings in the material will be held responsible for the wastage generated"*. In terms of waste segregation it was found that at the moment what we've got are dedicated skips for different types of waste material generated on the project. Such metal skips and recycling bags were then removed by specialist waste contractors who were also used to develop strategies towards minimizing waste on site.

Interviewee 2 also followed a similar pattern highlighting the use of skips for segregation as well but with a note of caution suggesting that segregation of waste us sometimes limited by the nature of the sites and the projects they work on; he commented that *"whilst the intentions may be best in terms of planning towards waste segregation their were constraints such as size of the site, its location and the cost implications to be considered"* He went further to suggest that sometimes on the smaller sites it can be difficult to bring in as many skips as would be needed for the segregation of waste. The he suggested was the use of smaller sized skips and use strategically placed shutes to pass waste into them. However he also quickly pointed out that these was only possible on smaller sites and for the larger sites the only option may be the use of very frequent waste contractors to collect waste from site.

The second wave of data analysis followed the same pattern and Interviewee 3 opined that his organisation had fully adopted the principles of waste management including re-use, reduction and recycling. In his view organisations have had to look for ways of recycling waste materials to reduce the costs of their disposal which he claimed were also passed onto clients. Interviewee 4 also commented that cost savings were a huge incentive for them. He opined that *"The highly competitive nature of the industry means we as an organisation have to ensure we look at opportunities to make savings on every project without compromising on the clients requirements"*. Recycling was also seen as a means of solving some of the issues depending upon site / project circumstances. Interviewee 5 on the same topic of waste management also commented in similar terms suggesting that his organisation had an integrated management system for their sites (IMS). For instance *"within our IMS there are very specific rules and regulations laid down to how we manage a building site, and it includes things like dust pollution, air pollution, noise pollution, and the way that we store materials on site, for example they way that we deal with chemicals on site"*

Interviewee 6 elaborated further on site waste management practices by commenting that the nature of the activities carried out by his organisation meant they were dealing with huge amounts of different forms of waste from the different sections of the organization. In his case the organisation had a timber section, a construction section and a housing section as well. He suggested that they have had to look for solutions to deal with the different wastes produced by these sections, and when asked on the drivers pushing this inventiveness, he simply replied “costs”. This same organisation recycled timber off cuts from its timber producing unit to be used by the building unit for material such as MDF (a form plastic wood which is suitable for details and finishing), also using materials from demolition in the construction unit to be processed into alternative materials for other sites an example being processed aggregate stones suitable for foundation works. However they did highlight that major stumbling blocks to the advancement of these opportunities for recycling was the issue of getting these recycled products accredited and approved by the industry. Interviewees 7 and 8 both had similar ideas in terms of site waste management and suggested that a lot more needs to be done by the sub-contractors and they would need to come on board with the main contractors in reducing the amounts of waste generated on these construction sites. Citing that waste contractors tend to benefit when they take waste away from construction sites, firstly by means of the payment they charge to take the waste away and secondly as a result of the usefulness of the recycled product to them. They also agreed with earlier respondents that a major factor which affected the effectiveness of site waste management was the size and location of the site.

Interviewee 7 suggested that the cost implication of recycling waste on site was sometimes not profitable to the organisation particularly when it was for an external client, whilst also identifying that time could sometimes not allow for the proper segregation of these materials on site. He however suggested that on their housing sites where there were building houses for resale they had much more control over these sites in terms of cost and time factors and were thus able to practice these site waste management activities more effectively.

5. Findings

All the respondents interviewed had identified different solutions to address waste management on their sites. There seemed to be a general enthusiasm when this topic was mentioned and most of the respondents were also aware of the recent introductions of the proposed site waste management plans by the government. It was the view of the generality of the respondents that a lot of these practices were already being carried out by their respective organisations over the years and were all actively seeking ways to ensure that waste generated on their sites did not end up at land fills. However the approach to waste management was found to be varied. The respondents who restricted their view on site waste management highlighted the use of skips to segregate waste on site (which involved the classification of the different wastes generated on site and classifying these using criteria such as hazardous and non-hazardous materials).

They also highlighted the use of waste management contractors who took the already segregated waste from their sites to be recycled and processed, and also identified the possibility of partnering with suppliers and sub-contractors in terms of returning packaging and the possibilities of returns of unused materials. They however highlighted that a major factor which affected the effectiveness of site waste management was the size and location of the site. It was found that the larger sized organizations in the study had a wider ranger of operations and not only practiced all the processes identified above but only used their waste management contractors as a last resort. A lot of the organisations in this size category had extensive waste management processes within the organisation which can be associated to recycling at various levels. An example was a respondent organisation who and sub-units within the organisation to reflect its activities; However it was highlighted that major stumbling blocks to the advancement of these opportunities for recycling was the issue of getting these recycled products accredited and approved by the industry. Also another constraint identified was time and cost implications. One respondent suggested that the cost implication of recycling waste on site was sometimes not profitable to the organisation particularly when it was for an external client. A further factor identified as impacting on practice was that time could sometimes not allow for the proper segregation of these materials on site.

6. Conclusions

This small scale regional study has shown that there is general awareness of site based waste management issues and the impact that effective policies could make to the delivery of sustainable construction practices amongst the SMEs involved in the building project production supply chain. The study has revealed the impact that organizational size and project circumstances have on the opportunities to contribute in this area of the sustainable construction practices agenda. The study recognizes the need for holistic approaches to be adopted across all sectors of the building project production supply chain and the potential that a knowledge based decision support framework could have on the opportunity to improve practice in this area.

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The role of tacit knowledge in the construction industry: towards a definition

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Abstract

The construction industry is perceived as one of the knowledge-based value creating sectors of the economy; however, it faces many challenges, especially in terms of performance, due to its intrinsic nature. Different knowledge-based solutions have been proposed in the past to overcome this problem. However, the process-based solutions, enhancing personalisation strategies and interactions between construction workers to generate and share tacit knowledge, would be much more relevant to overcome KM problems in construction organisations. As the initial step towards the management of tacit knowledge, this paper examines the nature and importance of tacit knowledge in the construction industry. Based on research findings a definition for tacit knowledge is synthesised to: understanding, capabilities, skills and the experiences of individuals; often expressed in human actions in the form of thoughts, points of view, evaluation and advice; generated and acquired through past experiences, individuals, and repositories; utilised for the benefit of individual and organisational development.

Keywords: Tacit knowledge, Construction industry, Generation and utilisation.

1. Background

Despite various definitions and classifications of knowledge, work by Polanyi [1], Nonaka and Takeuchi [2], divided knowledge into tacit and explicit. Although knowledge could be classified into personal, shared and public; practical and theoretical; hard and soft; internal and external; foreground and background, the classification of tacit and explicit knowledge remains the most common. As Nonaka *et al.*, [3] defined; tacit knowledge represents knowledge based on the experience of individuals, expressed in human actions in the form of evaluation, attitudes, points of view, commitment and motivation. Recent discussions on knowledge reflect on two perspectives: 'knowledge as an asset' and 'knowing as a process.' When knowledge is seen as a 'thing', codification strategies, which specifically disseminate explicit knowledge through person-to-document approaches, are considered; whilst personalised strategies, which specifically disseminate tacit knowledge through person-to-person approaches, are considered when knowledge is seen as a 'flow'. Accordingly, two distinct strategies have been identified for developing Knowledge Management (KM) systems: codification and personalisation [4]. A codification strategy revolves around explicit knowledge, captured and leveraged using IT-tools i.e. software such as expert systems, artificial intelligence and data mining tools, which are known as 'KM technologies' [5]. Personalisation, at the other extreme, revolves around tacit knowledge, using non-IT tools or human interactive systems such as knowledge sharing networks [6], communities of practice [7], brainstorming, action learning, post- project reviews and so forth, which are known as 'KM techniques'.

Different knowledge based solutions have been proposed in the construction industry to promote knowledge sharing. However, previous work on KM in the industry has concentrated heavily on the delivery of technological solutions [8,9], hence also on KM technologies, mainly due to the increased focus on IT during the past decade. The tacit knowledge of construction employees has often been ignored or placed with less importance, as evident from the current focus on KM in the construction industry [9], and inadequate empirical studies carried out in the construction industry. In the context of the knowledge economy, the utilisation of tacit knowledge is considered to be the real driver for the performance of the industry [10]. A number of authors, such as Egbu *et al*., [9], Carrillo *et al*., [11], Robinson *et al*., [12], Pathirage *et al*., [13], have highlighted the importance of the tacit knowledge of employees in the construction industry. An understanding of what constitutes tacit knowledge would be central to its effective management.

The paper aims to explore the nature and importance of tacit knowledge in the construction industry, based on a doctoral study that investigated the process of tacit knowledge management in a construction organisation. Accordingly, the paper is broadly divided into four sections. Initially, tacit knowledge, and its generation and utilisation are discussed. Secondly the paper introduces the research methodology followed for the research. Next, findings from the pilot interviews and case study investigation are presented. Finally, the paper culminates with a discussion on the nature and importance of tacit knowledge in the construction industry.

2. Tacit Knowledge

As Herrgard [14] and Empson [15,16] contended, organisations' knowledge resources can be described as an iceberg. The structured, explicit knowledge is the visible top of the iceberg, which is easy to find and recognise and therefore also easier to share. Beneath the surface, invisible and hard to express, is the momentous part of the iceberg. This hidden part applies to tacit knowledge resources in organisations. It cannot be managed and taught in the same manner as explicit knowledge, which is often defined as codified knowledge. Even if coded knowledge is easier to diffuse, the role of tacit knowledge is often essential for being able to use coded knowledge. Tacit knowledge could further be classified into two dimensions knowingly: the technical and the cognitive dimension [14]. The technical dimension encompasses information and expertise in relation to 'know-how' and the cognitive dimension consists of mental models, beliefs and values [17], in short, conception of reality. Thus, this division in tacit knowledge could be explained by considering the underpinning epistemological differences in Western and Japanese thinking on tacit knowledge, its codification and diffusion. Literature reveals two fundamentally different and competing schools of thought regarding diffusion and codification of such knowledge. One believes that tacit knowledge can and must be made explicit for sharing and the other regards tacit knowledge as always being tacit, representing the Japanese and Western thinking respectively.

Polanyi [1] sees tacit knowledge as a personal form of knowledge, which individuals can only obtain from direct experience in a given domain. Further, he encapsulates the essence of tacit knowledge in the well-known phrase ‘‘we know more than we can tell’’. According to Polanyi [1], this knowledge is held in a non-verbal form, and therefore, the holder cannot provide a useful verbal explanation to another individual. Moreover, as he contends, tacit knowing is such an elusive and subjective awareness of the individual that it cannot be articulated in words. It is from Polanyi’s argument that the differentiation between tacitness and implicitness was apparent, and from his terminology, tacitness was evidently different from implicitness. Implicitness, another form of expressing knowing, does exist. It implies that one can articulate it but is unwilling to do that because of specific reasons under certain settings such as, intrinsic behaviour in perception, cultural custom, or organisational style. [18]. Therefore, by describing implicit knowledge, Polanyi was referring to the technical dimension of the tacit knowledge, whereas cognitive dimension purely represented the tacit knowledge that he considered as always being tacit.

In Japanese thinking, knowledge is traditionally seen primarily as something not easily visible and expressible, that is, tacit by its nature. Nonaka and Takeuchi asserted that their view on knowledge was human knowledge, and they defined knowledge as a dynamic human process of justifying personal belief toward the ‘‘truth’’ [2]:

“...we classify human knowledge into two kinds. One is explicit knowledge, which can be articulated in formal language including grammatical statements, mathematical expressions, specifications, manuals, and so forth.... A more important kind of knowledge is tacit knowledge, which is hard to articulate with formal language. It is personal knowledge embedded in individual experience and involves intangible factors such as personal belief, perspective, and the value system” (p.viii).

When Nonaka and Takeuchi used Polanyi’s dichotomy of knowledge in their well known SECI (Socialisation, Externalisation, Combination and Internalisation) model, they did not make any distinction between tacitness and implicitness. Therefore, what they referred to as tacit knowledge included implicit knowledge, which they believed to be made explicit for sharing through externalisation. Since implicit knowledge, which resides in human beings, is converted to explicit knowledge through externalisation, Nonaka and Takeuchi perceived explicit knowledge as human knowledge too. This explains the two fundamentally different schools of thought regarding diffusion and codification of tacit knowledge; however, it is important to examine the cognitive human process to understand better tacit knowledge, and how it is generated and utilised.

3. Tacit Knowledge Generation And Utilisation

Researchers like Varela *et al*., [19], von Krogh & Roos [20] and Venzin *et al*., [21] have based their work on cognitive science, which has been the most influential [22] for scientists studying organisational knowledge. Accordingly, three different epistemologies are suggested i.e. Cognitivist epistemology (represented by Simon, [23]), Connectionistic epistemology (represented by Zander and Kogut, [24]) and Autopoietic epistemology (introduced by Maturana and Varela, [25]), to explain some core questions such as; what is knowledge, how is it generated, and what are the conditions for knowledge to generate? Cognitivist epistemology considers organisations as open systems that develop knowledge by formulating increasingly accurate representation of their predefined world. Data accumulation and dissemination are the major knowledge development activities, the more data that can be gathered the closer the representation is to reality. Hence, as Koskinen [22] asserts, this approach equates knowledge with information and data. In Connectionistic epistemology, however, the rules on how to process information are not universal, but vary depending on the relationship. Organisations are seen as self-organised networks composed of relationships and driven by communication. Similar to the cognitivist, information processing is the basic activity of the system, yet relationships and communication are the most important facets of cognition. Autopoietic epistemology provides a fundamentally different understanding of the inputs into a system. Input is regarded as data only. Autopoietic systems are thus both closed and open i.e. open to data, but closed to information and knowledge, both of which have to be interpreted inside the system. These systems are self-referring and the world is thus not seen as fixed and objective; the world is constructed within the system and it is therefore not possible to ‘represent’ reality [26]. Vicari and Troilo [27] describe this epistemology with the following example;

“When a teacher delivers a speech, two students build different knowledge according to their own attitudes, intelligence and previous knowledge. The transmission by the teacher is the same for the two of them, but the knowledge produced is different” (p. 5).

Hence, Autopoiesis epistemology claims that cognition is a creative function and knowledge is a component of the autopoietic, i.e. self-productive process [19]. This closely relates to the cognitive process of tacit knowledge, thus autopoietic epistemology is embraced as the philosophical basis of understanding tacit knowledge generation. To assist organisations to generate and utilise their tacit knowledge resources, it is necessary to focus on ‘how’ to support the generation of tacit knowledge held by individuals who work in an organisation. The construction industry is characterised with on-the-job learning and experience [28,29]. Kolb’s [30] experiential learning model describes learning through ‘doing’. Hence, Kolb’s four-stage cognitive model (refer to Figure 1), which expounds the theory that learning is cyclical, closely resembles tacit knowledge generation and utilisation in construction employees, which has been widely used and respected for its validity and reliability.

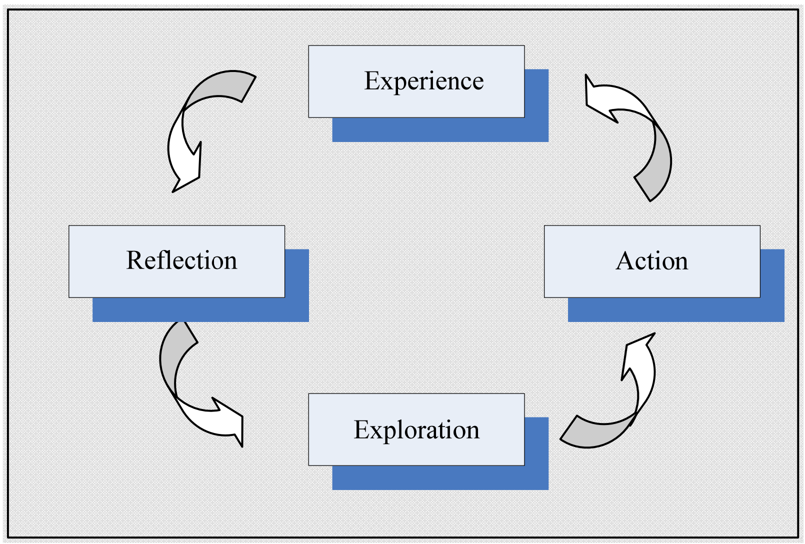

Figure 1: Kolb's Experiential Learning Model
(Adopted from Kolb, [30])

These four stages could be described as: Experience - provides the basis or trigger for the tacit knowledge generation process e.g. active involvement, new problem; Reflection - gains an understanding of the current experience and process it in a way that makes sense of the experience; Exploration - assimilates and distils the observations and reflections into theory or concept; Action - based upon knowledge gained, develops a way to use and start to put into action. According to Kolb [30], reflection after experience is paramount in order to learn from the past lessons and to generate tacit knowledge. This is further described by Schon [31] who explains how practitioners reflect, based on their tacit knowing. Therefore, Kolb's experiential learning model is embraced within this study to represent the cognitive process of the tacit knowledge generation and utilisation of construction employees.

4. Research Methodology

The researcher took the view that more work needs to be done in terms of managing tacit knowledge in construction organisations. However, due to the paucity of literature relating to tacit knowledge management, particularly construction industry related, it was decided that pilot interviews should be carried out to identify the nature and role of tacit knowledge in the construction industry. Accordingly, four leading academics that had extensive knowledge and experience in the subject areas were interviewed. All the respondents were actively involved in the areas of KM and also had close collaboration with respective industries. Three of the academics had backgrounds in the construction industry, whilst one had a background in general management. In addition, the case study approach was selected to investigate tacit knowledge management with a construction organisation. Due to the need for an in-depth, critical, longitudinal examination of the phenomenon, the single holistic case study design was preferred, through which a holistic emphasis on tacit knowledge management process was placed. The study opted for a theoretical sampling strategy to select a theoretically significant and representative construction company. The selected case study was a UK company employing nearly 8,500 employees, involved in building and infrastructure projects, including facilities management. The overall case study investigation included two phases: an exploratory phase and an explanatory phase. However, this paper reports the findings based on the exploratory phase of the case study investigation only. Eight interviews with company employees representing different levels of the staff i.e. senior level (two directors), middle level (two managers) and operational level (four line employees) were carried out to explore the nature of tacit knowledge.

Interviews, both unstructured and semi-structured, were used as the main research technique for data collection in this study. Unstructured interviews were carried out during the pilot interview phase and semi-structured interviews were used during the exploratory phase of the case study. Exploratory phase interviews were carried out among all three levels of the staff, representing different departments. Hence, the research deployed a triangulation of data combining more than one source of data collection; to develop converging lines of inquiry. A combination of textual analysis and mapping technique, aided by computer software, was used as the main research techniques of data analysis for data collected from unstructured and semi-structured interviews. This began with qualitative content analysis, which is the main technique for analysing data under textual analysis, with the aid of NVivo software (version 2.0) to generate codes, based on related concepts from data collected. Later, cognitive mapping was undertaken, which is the main technique for analysing data under mapping techniques, using Decision Explorer software (academic version 3.1.2) to build relationships among concepts and for better data presentation. This triangulation of data analysis techniques enabled the rigor of structuring, organising and analysing multiple sources of data, and maintenance of the richness of original data.

5. Pilot Interview Results

In recent years, the importance of tacit knowledge has been discovered, rather than invented, with the popularisation of the concept of the knowledge worker. Interviewees described tacit knowledge as the knowledge that resides within the ‘knower’ - i.e. the person - which is very sticky and messy, problematic to codify, transfer and share, and also difficult to exploit; which is attributable to the person’s experience, exposure and context. According to the interviewees, examples of tacit knowledge within the construction industry can be related to project and organisational level, and from senior management level to operational employee level. These included the talents and skills of construction trade specialists such as plumbers, masons, and electricians, acquired over time; skills to manage project teams, knowledge of construction tender markets, interaction with clients/customers and project team members in the supply chain, as well as understanding design and production information. Within the context of construction, tacit knowledge production is triggered through ‘learning how’ and ‘learning why’, when faced with complex projects. As interviewees argued, problem solving is considered the main trigger for tacit knowledge generation, which incorporates both learning how and why, within the industry. Moreover, interviewees agreed that workers fall back on experiences, friendship and collaboration when faced with real complex projects, as they are the first to know that IT is not working. Hence, it is contended that explicit knowledge is not highly useful when dealing with complex problem solving situations. All the interviewees therefore recognised the importance of tacit knowledge within the construction industry, and the fact that it is not fully exploited by the construction industry. They considered tacit knowledge as the key to the performance of the industry. As one of the interviewees highlighted:

"…if one tries to find out the types of knowledge that contribute more to innovation and competitiveness, it is tacit knowledge as opposed to explicit knowledge. So there is a need to say tacit knowledge is important and there is even more need to explore that fully, because we still haven't learned how this sticky knowledge works, especially when you look at knowledge as a stock or a flow across chains, supply chain and networks, intra and inter…"

Furthermore, interview respondents acknowledged that most of the KM initiatives within the construction industry have concentrated on explicit knowledge, whilst the necessity is for tacit knowledge. As they explained, this was due to several reasons, but mainly due to the fact that the origin of modern KM issues has been driven by a technocrat approach, hence driven by IT. Thus, KM has been considered as a mere extension of data management, information management, and knowledge-based systems, and this legacy is still considered to be in existence. In providing further insights on this, one interviewee cited the fact that:

"there is a good reason to suggest that explicit types of knowledge lend themselves more readily to the use of IT and exploitation of IT than the tacit form of knowledge and also, due to the simple reason that explicit knowledge is more codifiable, you can feel it, you can hold it and you can mess around with it"

In summary, interviewees provided insights on tacit knowledge in the construction industry, also admitting the importance of tacit knowledge and the fact that existing KM work in the construction industry is driven by IT.

6. Case Study Findings

Key concepts on tacit knowledge were elicited from the interview participants (representing directors, managers and operational level employees) of the case study company. The identified concepts were categorised into three aspects of tacit knowledge: 'what' constitutes tacit knowledge; 'how' can tacit knowledge be generated and acquired; and 'why' tacit knowledge should be generated and acquired or utilised.

Tacit knowledge was frequently referred to as the understanding, capabilities, skills, abilities, intelligence and experience gained, which often expresses itself in human actions in the form of thoughts, points of view, evaluations and advice. Understandings, capabilities, skills, abilities and experiences varied dependent upon each individual, however, all related to employment within the case study company. An understanding of work activities, processes, procedures and pressures were mostly cited among operational level employees, whilst directors and managers mostly referred to their skill and capability to manage, coach, mentor the team members together with their understanding of business opportunities and new markets. Thereby, at operational level, understanding and capabilities, hence tacit knowledge, was more concerned with the internally focused activities of the company; whereas at senior level, tacit knowledge seemed to be more concerned with the externally focused activities. However, the ability to provide thoughts, points of view, evaluations and advice was apparent from all levels of employees.

Different sources and triggers of tacit knowledge were explored with the interview participants. Sources of tacit knowledge acquisition included education, training, colleagues, repositories, and prior experiences, whilst new challenges and first time experiences were cited as main triggers for tacit knowledge generation. Directors and managers had sufficient educational background or extensive prior experience to fall back on when faced with problems. Further, they had the greatest opportunity to undergo training programmes and directors mainly participated in external seminars, workshops and training programmes. Hence, they interacted with external peers and maintained a good network, through which they could acquire tacit knowledge. However, for operational level employees, colleagues and peer groups were considered as the major source for acquiring tacit knowledge within the company. Despite the contextual differences of problems, the tacit knowledge acquired from colleagues was considered as highly beneficial to overcome such problems. Moreover, operational level employees relied on their past experiences and rarely on repositories such as company manuals, documents and intranet. An analysis of tacit knowledge sources is given in Figure 2 based on individual and organisational level considerations.

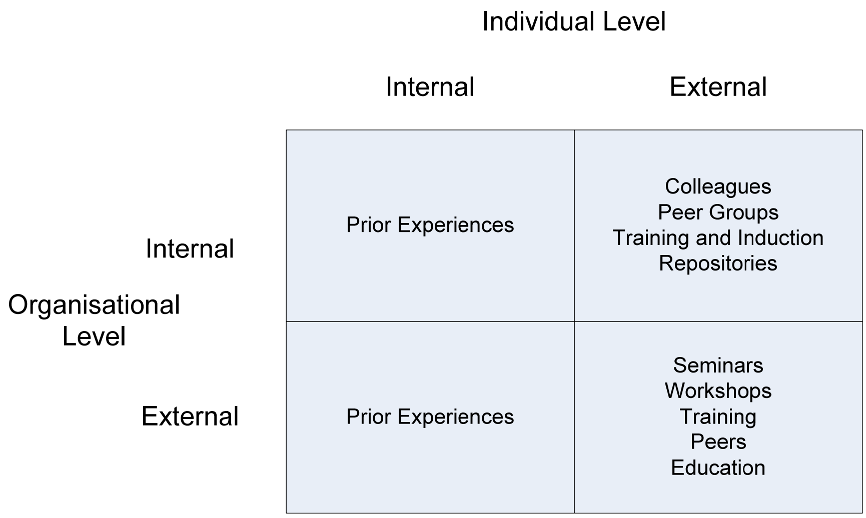

Figure 2: Analysis of sources of tacit knowledge

Overall, it was common among directors of the company to acquire tacit knowledge from external sources (seminars, workshops, training, peers), whilst internal sources (colleagues, peer groups, training, repositories) were widely used by operational level employees to acquire tacit knowledge. However, reliance on prior experience, both internal and external to the company, was prevalent at all different levels as a source of tacit knowledge. In general, new challenges; to overcome weakness in a system or to become familiar with a change in the system, and new experiences; when faced with complex projects or a request from a client; were cited as the main triggers for tacit knowledge generation.

The motivation for employees to generate and acquire tacit knowledge presented some diverse views among different interview respondents. However, the general consensus on this was the ultimate improvement in business performance through enhanced efficiency and effectiveness, in addition to personal development. For operational level employees the motivation to generate and acquire tacit knowledge was mainly driven by the desire to perform their tasks more efficiently. Hence, they highly valued different opinions, advice, points of view, evaluations, experience; mainly from their colleagues, which could improve the performance of their day-to-day activities.

Table 1: A summary of key concepts elicited on the role and importance of tacit knowledge

	Directors'	Managers'	Operational Level Employees'
What? What constitutes tacit knowledge	• Understanding of external markets and business opportunities, focused on external activities	• Ability to manage the team members	• Understanding of work activities, processes, procedures and pressures, mainly focused on internal activities
	Ability to provide thoughts, points of view and advice		
How? How can tacit knowledge be generated and acquired	• External peers, seminars, workshops, training and education as major sources of acquisition	• Training and colleagues as main sources of acquisition	• Internal colleagues, peer groups, training and repositories as major sources of acquisition
	Reliance on prior experience both internal and external to company		
Why? Why should tacit knowledge be generated and acquired	• Drivers mainly focused on enhancing business effectiveness, innovation and growth	• Drivers mainly focused on cost savings and avoiding costs to meet customer requirements efficiently	• Drivers mainly focused on enhancing efficiency in discharging day-to-day activities
	Enhance and broaden understanding of work		

Managers were mainly concerned with meeting customer requirements efficiently by cost savings and cost avoiding, through the exploration of different means of achieving customer requirements. Noticeably, the directors' motivation to generate and acquire tacit knowledge was focused on enhancing effectiveness, innovation and business growth. In that context, they were mainly concerned with finding best practices, new ideas and ways of working, mostly acquired through external sources. Therefore, in general, motivation to generate and acquire tacit knowledge varied from 'effectiveness focused drivers' at senior level to 'efficiency focused drivers' at operational level. However, the personal development; through enhanced and broadened understanding of work, was cited by all levels of respondents as a major benefit from the generation and acquisition of tacit knowledge. Table 1 illustrates the summary of key concepts elicited on the role and importance of tacit knowledge, from different levels of staff.

7. Discussion

The importance of tacit knowledge within the construction industry can be highlighted from two points: due to intrinsic characteristics of the construction industry, and the popularisation of the 'knowledge worker' concept. The unique, complex, relatively low-tech and labour intensive nature of construction projects, and the limited ability to codify construction knowledge are considered as leading features of the industry, which supports tacit knowledge generation and utilisation. The importance of the 'knowledge worker' is highlighted by the fact that industry relies on skills, experience and capabilities of construction employees when delivering the products and services. In the context of construction, examples of tacit knowledge included estimating and tendering skills acquired over time through hands-on experience of preparing bids, understanding the construction process, interaction with clients/customers and project team members in the construction supply chain, as well as understanding tender markets. The importance of tacit knowledge in the construction industry was further highlighted by the interviewees in the pilot study. They believed that employees do fall back on experiences, friendship and collaboration when faced with complex projects or challenging situations, as the use of explicit knowledge or IT in such situations is considered to be minimal. Several interviewees believed that tacit knowledge is the key to the performance of the construction industry due to its intrinsic characteristics, and it has recognised the contribution of tacit knowledge towards innovation and competitiveness. In addition, the interviewees stressed the need to fully explore tacit knowledge within the construction industry, since the industry as a whole has not learned how the 'sticky and messy' knowledge works.

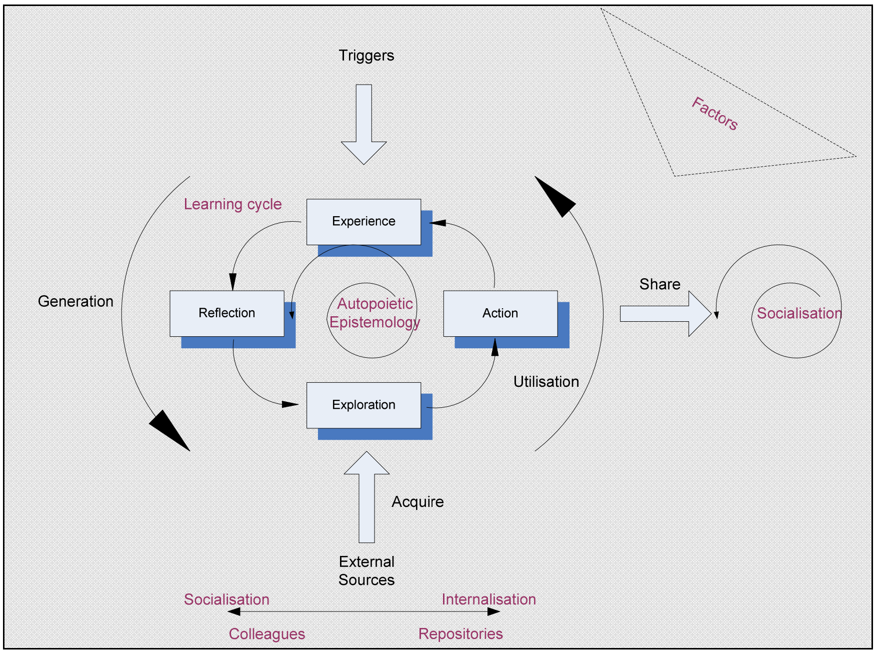

Figure 3: Tacit knowledge generation and utilisation process

The exploratory phase case study findings added rich insights into the different facets of tacit knowledge: 'what' constitutes tacit knowledge; 'how' can tacit knowledge be generated and acquired; and 'why' tacit knowledge should be generated and utilised. In order to articulate the process of tacit knowledge generation and utilisation, the study integrated theories of experiential learning, cognitive science and knowledge creation. The autopoietic epistemology was preferred as the philosophical basis of understanding tacit knowledge generation and utilisation; whilst Kolb's [30] experiential learning model was considered in terms of the stages that followed within the cognitive process of tacit knowledge generation and utilisation. Figure 3 summarises the sources of tacit knowledge generation and acquisition together with the individual cognitive process based on case study findings.

Tacit knowledge has been defined as the unarticulated knowledge that resides in human beings, based on experience and expressed in the form of attitudes, points of view and commitment [3,14,22]. This definition of tacit knowledge was used extensively throughout the study; however, the pilot interview outcomes and case study findings provided richer insights on what tacit knowledge is in an organisational context, hence the following definition is synthesised:

Tacit knowledge constitutes understanding, capabilities, skills and the experiences of individuals; often expressed in human actions in the form of thoughts, points of view, evaluations and advice; generated and acquired through past experiences, individuals, and repositories; utilised for the benefit of individual and organisational development.

8. Conclusion

Due to the intrinsic characteristics of the construction industry, tacit knowledge of the workers and their social interactions has gained increasing importance within the industry. As the industry is very much centred on tacit knowledge and experience of construction workers, it is biased towards the process-based view of knowledge. Hence, the process-based solutions, enhancing personalisation strategies and interactions between construction workers to generate and share tacit knowledge, would be much more relevant to overcome KM problems in construction organisations. Understanding what tacit knowledge is, its generation and utilisation are central to its effective management. Accordingly, this paper explored and discussed the nature and importance of tacit knowledge in the construction industry, based on a doctoral study which investigated the process of tacit knowledge management in a construction organisation.

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The effect of contractors' learning on performance

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Abstract

It has been suggested that the contracting organizations can capitalize on experienced based learning, thus performance change is not simply incidental. There are good reasons to hypothesize that learning plays a part in performance improvement. The lack of reported studies in this regard prompted this study. Learning curves are used in this study to demonstrate the effect of contracting organizations' learning on performance. This involves fitting of longitudinal performance data with a number of well-established learning curve models. Data on performance was provided by a major public housing provider in Hong Kong. Applying the Least Square Curve Fitting Analysis, it was found that the collected performance data fit well with the 3-parameter hyperbolic model. It was found that some contracting organizations in the sample displayed performance deterioration over time until reaching the asymptotic performance level. This is in line with the underlying learning theory of the 3-parameter hyperbolic model.

Keywords: learning effect, contracting organizations, performance

1. Introduction

Competition in today's construction engineering sector is no longer inter-firm but among supply chains formed by networks of organizations [1]. Within these networks, the main contractor is responsible in converting the design into practical reality [2]. His ability to deliver the project directly affects the client's satisfaction and value of the facilities. This ability is an invaluable competitive advantage to compete in the fierce construction market [2]. In this connection, a vast amount of studies pinpointed the importance of enabling a main contractor to attain continuous improvement [3].

nevertheless, several industry reviews reported the declining quality of contractors' performance in terms of the lowering productivity, profitability, as well as deteriorating relationships with other organizations within the supply chain [4-5]. Worse still, main contractors are often considered as inflexible and slow to respond to clients' changing demands. Such a trend is believed to be continuing [6]. In addressing such problems several studies have pinpointed that contractor's practices should be changed from perpetuating obsolete procedures to continuously imbibing knowledge from both the internal and external environments for more efficient and effective ways of working [7-8]. The significance of integrating learning as part of the contractors' daily routines has previously been addressed in a number of studies [6, 9-10].

Researchers have long advocated the positive effect of learning on contractors' performance [11-12]. For example, based on a review of literature, Thomas et al. [13] pinpointed that a contractor can capitalize on the lessons learnt from experience. Everett and Farghal [14] extended the work of Thomas et al. [13] and suggested that increase in productivity is possible if a contractor can learn from repetitive operations – a phenomenon often described as learning effect. Based on interviews, Franco et al. [11] revealed that the improved performance in construction project is related to contractors' learning from the performance feedback. Supported by views obtained of construction practitioners in Hong Kong, Wong and Cheung [12] demonstrated empirically the effect of performance improvement is contingent on contracting organizations' practice of and engagement in learning.

Whilst many of these studies were based on reviews of literatures and the perceptive views of the practitioners, there seems to be a general agreement among researchers that performance change of contractors is not incidental [7-8]. To certain extent, it can be an outcome of a subtle learning process, notwithstanding that little attention has been paid on addressing what exactly the contractors have been learning [7-8]. Nevertheless, such proposition has yet been backed with sufficient empirical evidences [15]. Moreover, it is understandable that there are a variety of ways by which performance improvement can be achieved [16]. For example, performance of contractors may be improved by their productivity gain during the course of construction, the management capability of their project manager, as well as their ability to manipulate project monitoring outcomes [6, 14]. In this perspective, it seems unreasonable for researchers to advocate that performance change is exclusively a product of learning. As such, evidences of the effect of learning on performance change remained obscure and want of quantitative research.

2. The Research Objectives

This paper reports a study which seeks to demonstrate the development and application of a quantitative approach to make learning effect, if any, observable by fitting longitudinal performance data with well established learning curve models. The longitudinal performance data required for accomplishing the above research objective were obtained from real project data from Performance Assessment Scoring System (PASS), a system implemented by the Housing Department of the Hong Kong Government to gauge performance .Their fitness with some classical learning curve models was analyzed by the least square curve fitting analysis methodology (LSCFA hereafter) [14, 17-21]. The analysis may help to deepen the understanding of the relationship between the performance and learning of the contractors. Furthermore, this provides an objective and quantitative means for the researchers to explore the possible learning dimensions that may affect the contractors' performance change.

3. Research Methodology

LSCFA was employed to analyze whether the effect of contractors' learning can be tracked by the use of longitudinal performance data [21]. Indeed, this method has been employed to identify the learning effect of organizations in a number of previous studies [13, 17-21]. Table 1 lists five theoretical learning curve models that are recognized as appropriate for the demonstration of learning effects of organizations in construction and other engineering fields. The mathematical formulae and brief descriptions of these theoretical learning curve models are also presented.

LSCFA can be described as an evaluation of fitness of a learning curve model to describe the change patterns of the performance data longitudinally across the project span [17]. The evaluation can be described by Eq. 1.

$y = f(x,\theta) + \varepsilon$ - (Eq. 1)

Where

- x = the performance data set throughout a specified period of time
- θ = the parameter(s) of the theoretical model
- ε = the error term
- y = respective values agreeing with the theoretical model throughout the specified period of time

The fitness of the learning curve model for describing the performance change can be identified by the residual errors (ε) (i.e. the difference between the values of parameters x and y throughout a specified period of time) [21]. The lower the ε value, the more 'effective' is the theoretical model in describing the change in performance data [21]. The ε value determined by the LSCFA is presented as the means-squared error (MSE) value. The equation for computing the MSE value is presented as follows:

$$\text{MSE} = \frac{\sum_{j=1}^{N} (x_j - y_j)^2}{N}$$

Where

- N = Number of contractors' performance data
- yj = Respective value agreeing with the learning curve model at the jth quarter
- xj = Contractors' performance data at the jth quarter

Table 1: Learning curve models appropriate to demonstrate the learning effects

Learning curve model	Form	Definition of the parameters	Use	References
Log-linear (negative slope)	$Y=AX^{-B}$	Y= the average cost (or time) required to produce x units; A= the cost (or time) of the first production unit; X=the amount of the production units; B=the slope of the logarithmic curve	To express the learning effect by decreasing average cost (or time) of production over cumulative period	Thomas *et al.* [13], Everett and Farghal [14, 17-18]. Farghal and Everett [19]
(positive slope)	$y = ax^{b}$	y = the productivity (or the cumulative performance score) after x cycles of work, a= Productivity (performance score)of the first cycle of work x= cycles of work b= The learning rate	To express the learning effect by the performance improvements over time	Emir [22], Blancett [23]
3-parameter Exponential	$y= k(1-e^{-(x+p)/r})$	y = the work performance k = an estimate of the maximum performance level that is projected after all improvement has taken place x = the cumulative time p = an estimate of the accumulated prior experience r = time required to reach the performance level equal to k / 2	To express learning as a process to replace incorrect responses by correct ones (considering the effect of the learners' prior experience to the performance)	Uzumeria and Nembhard [20], Mazur and Hastie [24]

2-parameter Exponential	$y = k(1-e^{-x/r})$	Ditto	Ditto (without considering the effect of the learners' prior experience to the performance)	Ditto
3-parameter hyperbolic	$y = k((x + p) / (x + p + r))$	y = the work performance k = an estimate of the maximum performance level that is projected after all improvement has taken place x = the cumulative time p = an estimate of the accumulated prior experience r = time required to reach the performance level equal to k / 2	To express learning as a process 'by which correct response tendencies increase steadily with practice and compete with the incorrect tendencies, which are constant' (considering the effect of the learners' prior experience to the performance)	Ditto
2-parameter hyperbolic	$y = k(x / (x + r))$	Ditto	Ditto (without considering the effect of the learners' prior experience to the performance)	Ditto

*Remark: Popular models like the Stanford-B Model, the DeJong Model and the S-curve Model are also derived from the Log-linear learning curve model to describe some particular learning scenarios in the manufacturing and automotive industries. They are not specifically introduced in this connection.

In this study, the LSCFA determines the MSE values when a contractors' performance data set is fitted to the various types of learning curve model. Nembhard and Uzumeri [20] used the following criteria in evaluating the effectiveness of the learning curve models in their studies:

(1) Testing the 'Efficiency' by comparing the mean MSE values (i.e. averaging the MSE values of the entire data sets) of the learning curve models. The lower mean MSE value represents the better fit of the data sets to that particular model.

(2) Testing the 'Stability' by comparing the degree of variation of the standard deviations of the mean MSE values. It is because a particular learning curve model may fit well with some data sets but not others. Yet, 'a stable model will not be overly dependent on some specific learning episodes to obtain good model fit' [21]. The lower standard deviation of the mean MSE values represents the better fit of the data sets to that particular model [21, 25]

Generally, the methodology employed in this study follows the approach which has been adopted by Nembhard and Uzumeri [21]. Nevertheless, in order to demonstrate the fitness of the learning curve models to describe the data sets, their respective percentage error values are measured by the following equation:

$$\text{Percentage error} = \frac{\sqrt{\text{MSE}}}{\text{Max. scoring of the assessment scale}} * 100\%$$

4. Programming Tool For The Lscfa

In this study, MATLAB 6.1 is used as a programming tool. Indeed, MATLAB has long been recognized as an effective tool to conduct least square curve fitting analyses [26]. The 'polyfit' and the 'lsqcurvefit' functions of MATLAB are adopted to determine the fitness of the contractors' performance data to various learning curve models. Furthermore, 2–dimensional plots that illustrate the fitness of the learning curve models to describe the tested data in a graphical format are generated [26].

5. Data Collection

The success of this study depends very much on the availability of longitudinal performance data. Nevertheless, such data is not easy to obtain as it is not a standard practice to keep such data in construction. Examining the monitoring practices of the private sector projects in Hong Kong, contractors' performance assessment is usually conducted by the architect and/or the project manager. Nonetheless, comprehensive monitoring systems for regular tracking and recording of contractor's performance are rarely installed in the construction industry. In the public sector, for accountability purposes, more formalized and elaborate monitoring systems have been implemented for gauging contractors' performance throughout the construction stage. Among these developed systems, the Performance Assessment Scoring System (PASS) has been identified as one of the most comprehensive systems [27]. This system has been designed to keep track of contractors' performances during the course of construction. PASS has been used in over one hundred public housing projects since early 90's. The research team is grateful for the support rendered by the Hong Kong Housing Department (HKHD) in providing valuable contractors' performance data captured from PASS for this study. The Hong Kong Housing Authority (HKHA) is the executive arm of the HKHD that is responsible for providing public housing to the needy. In Hong Kong, there is a strong demand for public housing. As such the HKHA, as the sole provider, is the largest building client in Hong Kong. The collection of PASS data that records contractors' project performance during the course of construction is a unique and rare wealth of data for the kind of study reported in this paper.

In essence, PASS presents the monitoring results in terms of the contractor's performance score (described as PASS score hereafter) in a project. The system aims to provide a more 'objective' basis for gauging and monitoring the contractors' performances on the public construction engineering projects. PASS scores are performance records that comprise monthly Works Assessment scores and quarterly General Assessment scores. The relative weighting between Works and General Assessments is 70% and 30%. It has been suggested that performance records with remarks by the management team can highlight the causes of underperformance and thus help improvement with contractors taking appropriate actions [7-8]. As such, contractors in each project monitored under PASS would be notified by the PASS Control Unit of the HKHD about their quarterly PASS scores regularly. This ensures that contractors are provided with monitoring results in a standardized format. The composition of PASS score is shown in Figure 1.

In this study, the PASS scores of 38 public housing projects were examined. Each of the data sets contain at least 8 quarterly (i.e. 2 years) PASS scores. These data were then fit to several established learning curve models.

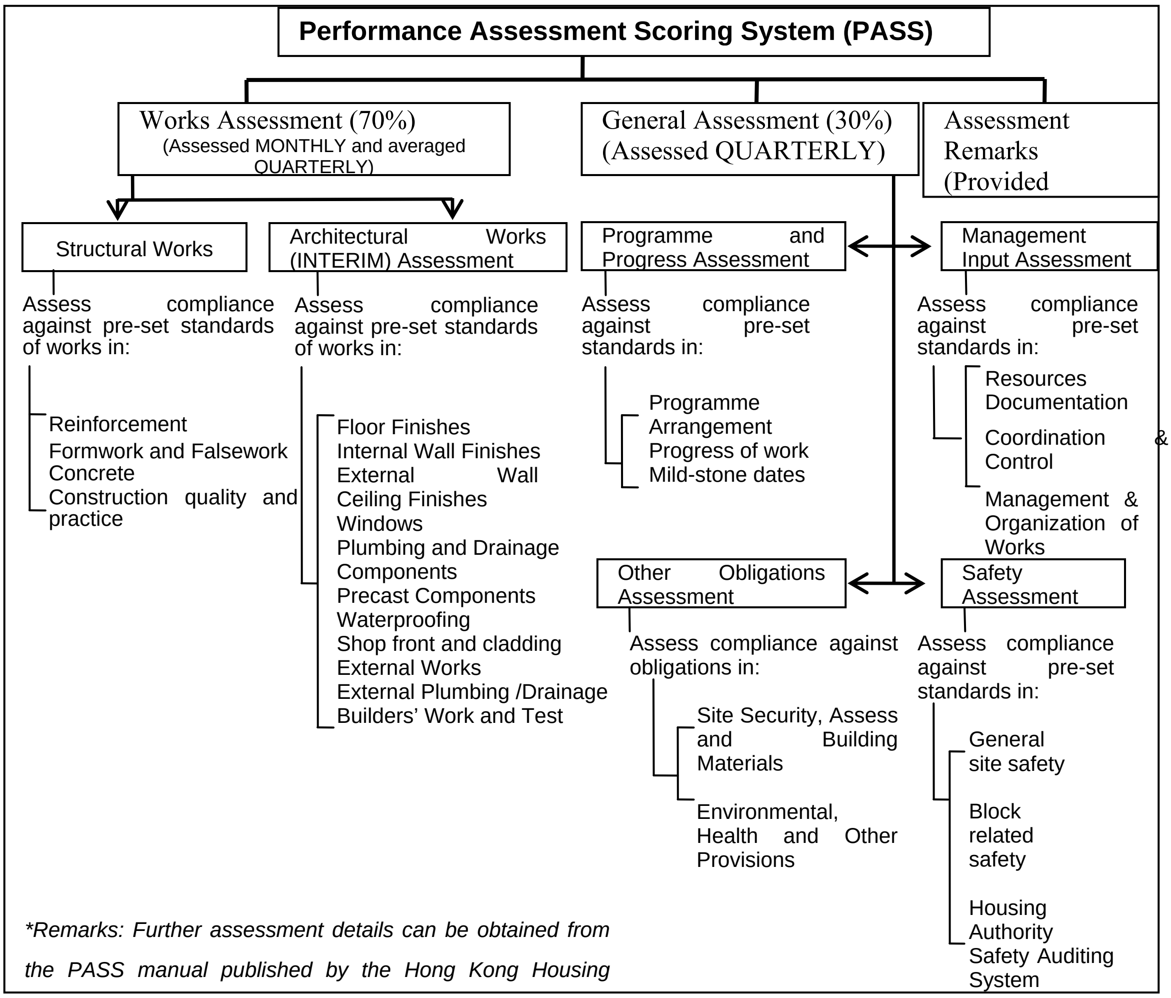

Figure 1: Composition of PASS

6. Results and Discussions

6.1 Collecting the analyzed results – an illustrative example

The results of the LSCFA of the learning curve models are presented in this section. The efficiency, stability and percentage errors of the models are also discussed. The results of fitting the PASS scores of one of the 38 tested projects to the various learning curve models (described as Project P1 hereafter) are detailed to illustrate the working involved. The outputs of the least square curve fitting analyses of Project P1 are shown in Figure 2. 'loglinearmse' represents the MSE value when fitting the log linear learning curve model to the contractor's performance data of Project P1. c values (Figure 2 refers) are the estimated values of the parameters of the log linear learning curve model calculated by the MATLAB 'lsqcurvefit' function. They are presented according to their sequence of appearance in their respective learning curve equations. The mathematical equation of the log linear learning curve model is:

$y= ax^b$

Where

- y= the cumulative performance score after x cycles of work
- a= Performance score of the first cycle of work
- x= the cumulative performance score after x cycles of work
- b= the learning rate

As shown in Figure 2, the first c value (79.5992) in the output refers to the estimated Performance score of the first cycle of work (i.e. parameter ‘a’) and the second c value (0.5414) refers to the learning rate of the contractor With reference to the outputs of Project P1 (Figure 2 refers), the contractors’ learning rate is higher than 0. This suggests that the respective contractor performed positive learning and improved his performance throughout the project [21]. In addition, the lowest MSE value is found when fitting the contractor’s performance data to the 3-parameter hyperbolic model. In other words, the organizational learning pattern as presented by this learning curve model appears to be the most appropriate, among others, in describing the OL patterns of the contractor of Project P1. The fitting results are also illustrated in Figure 3, the 3-parameter hyperbolic curve is also found to give a good fit for the performance scores.

The same set of procedures was applied to each of the 38 projects with PASS scores. The ‘Efficiency’ and ‘Stability’ of the learning curve models used for fitting are reported in the next section.

```
>> P1_PS

 c = 79.5992                    0.5414

loglinearmse =  2.0529e+004

c =     84.8922    0.0842

hyperbolic2mse =    9.2702
```

Figure 2: Outputs of LSCFA of Project P1

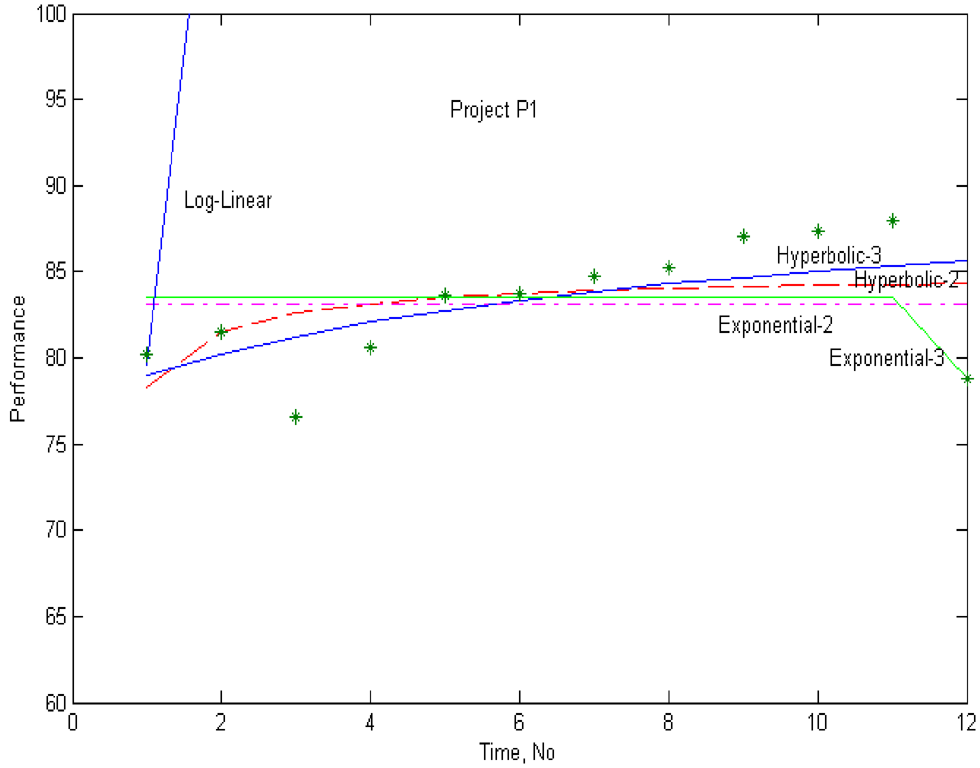

Figure 3 -: PASS scores of Project P1 fitted to various theoretical learning curve models

6.2 Efficiency and Stability of fitting contractors' PASS scores to different learning curves

The views expressed in this section are solely those of the authors and do not represent the view of the HKHA or HKHD. The results of the LSCFA indicate that the data sets fit well to most of the earning curve models (Table 2 refers). Among these, 3-parameter hyperbolic model was found the most efficient and stable model (Mean MSE= 9.2033, Standard deviation of MSE= 6.3725) [20-21]. In this connection, it is suggested that the learning pattern underlying the LSCFA is a good description of the learning element involved.

Furthermore, satisfactory results were also found while fitting the same set of data to the 2-parameter hyperbolic model (Mean MSE= 10.8758, Standard deviation of MSE= 8.3876), 2-parameter exponential (Mean MSE=13.4929, Standard deviation of MSE= 9.3311) and 3-parameter exponential (Mean MSE=12.5082, Standard deviation of MSE= 7.7335) models. Nevertheless, a relatively unsatisfactory result was found when data sets were fitted against the log-linear model (Mean MSE= 22392.3392, Standard deviation of MSE= 49402.8666).

In search for an explanation, the underlying bases of learning of the models are examined. The log linear learning curve model assumes a linear relationship between performance and time (i.e. the PASS scores are assumed to improve continuously with the same learning rate throughout the project) [21].

Nevertheless, in reviewing the data sets, it was found that contractors' performance change often flattened at the later part of the project. Such performance change pattern matches with the assumptions of the hyperbolic and exponential models. Organizations with these learning patterns would improve or deteriorate over time until reaching the asymptotic performance level [14, 17-18].

The fitness of the PASS scores to be explained by the exponential and hyperbolic learning curve models in this study suggests that contractors' performance change is not incidental but has a learning element [6, 12]. Furthermore, the 3-parameter hyperbolic model is identified as a comparatively 'efficient' and 'stable' learning curve model in describing the PASS scores. Nembhard and Uzumeri [21] emphasized that the theoretical bases and assumptions of the best-fit learning curve model may be instrumental for a search of possible factors which characterized the patterns of performance change of the contractors. Further investigations on the performance change patterns of the HKHA contractors in terms of the project characteristics and the estimated output parameter values of the 3-parameter hyperbolic model are recommended.

7. The Concluding Remarks

Whilst studies were based on the perceptive views of the practitioners, findings from previous studies typically suggested that learning may have positive effect on contractors' performance. The study reported in this paper employed the LSCFA to track the effect of learning from the performance data of contractors during the course of construction. PASS scores from 38 HKHA projects were fitted to five well-established learning curve models. The findings of this study highlight some interesting patterns displayed by contractors who were subjected to regular performance assessment. PASS scores effectively fit the exponential and hyperbolic learning curve models. This indicates that performance change of a contractor may have a learning element. This study paves the path for further exploration on the possible learning dimensions that may affect performance change of the contractors.

8. Acknowledgement

The work described in this paper was fully supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China [Project No. 111606].

Table 2. Mean Square Error (MSE) and Percentage error of fitting various learning curve models to the contractors' PASS scores

	Log Linear		2-parameter hyperbolic		3-parameter hyperbolic		2-parameter exponential		3-parameter exponential	
Project	MSE	% error	MSE	% error	MSE	% error	MSE	% error	MSE	% error
1	20529.0000	204.68%	9.2702	4.35%	9.2702	4.35%	11.9150	4.93%	10.2041	4.56%
2	4084.5000	91.30%	18.1858	6.09%	13.5361	5.26%	25.1889	7.17%	25.1889	7.17%
3	174750.0000	597.19%	46.9945	9.79%	31.7018	8.04%	49.3284	10.03%	31.6459	8.04%
4	1156.2000	48.58%	12.3201	5.01%	11.8302	4.91%	12.6133	5.07%	12.6133	5.07%
5	952.0866	44.08%	12.5966	5.07%	11.8108	4.91%	12.6176	5.07%	12.4550	5.04%
6	229.7819	21.66%	16.8036	5.86%	16.7901	5.85%	16.7939	5.85%	16.7972	5.85%
7	2846.0000	76.21%	3.5801	2.70%	3.5293	2.68%	4.0548	2.88%	7.0123	3.78%
8	1657.8000	58.17%	9.2962	4.36%	9.0400	4.30%	9.3901	4.38%	9.1104	4.31%
9	104.8397	14.63%	3.2709	2.58%	3.1265	2.53%	3.4147	2.64%	3.4147	2.64%
10	42.8844	9.36%	14.0389	5.35%	14.0290	5.35%	17.2980	5.94%	17.2980	5.94%
11	75619.0000	392.84%	16.2512	5.76%	15.7298	5.67%	15.2248	5.57%	15.7026	5.66%
12	2436.4000	70.51%	8.3044	4.12%	7.7039	3.97%	8.3160	4.12%	8.3160	4.12%
13	1041.2000	46.10%	21.4854	6.62%	16.9890	5.89%	28.5572	7.63%	28.5572	7.63%
14	3529.4000	84.87%	24.4096	7.06%	22.8450	6.83%	30.3643	7.87%	30.3643	7.87%
15	31559.0000	253.78%	8.7456	4.22%	5.7608	3.43%	9.5886	4.42%	9.5886	4.42%
16	3383.1000	83.09%	2.9540	2.46%	2.6632	2.33%	10.1298	4.55%	10.1298	4.55%
17	2952.4000	77.62%	7.5538	3.93%	5.9627	3.49%	9.6447	4.44%	9.6447	4.44%
18	13.8201	5.31%	3.6290	2.72%	3.6286	2.72%	3.7370	2.76%	3.7370	2.76%
19	436.9621	29.86%	20.9895	6.54%	20.8372	6.52%	24.7041	7.10%	24.7041	7.10%
20	2226.7000	67.41%	5.9444	3.48%	5.9377	3.48%	10.2275	4.57%	10.2275	4.57%
21	108170.0000	469.85%	18.0738	6.07%	10.9404	4.73%	18.7046	6.18%	10.7751	4.69%
22	3865.8000	88.82%	12.8902	5.13%	8.7867	4.23%	13.6589	5.28%	13.6589	5.28%
23	50289.0000	320.36%	6.1309	3.54%	5.8834	3.47%	8.2367	4.10%	12.0126	4.95%
24	3947.6000	89.76%	10.9494	4.73%	10.0045	4.52%	11.1162	4.76%	10.0246	4.52%
25	100.9902	14.36%	8.9399	4.27%	7.9588	4.03%	10.8416	4.70%	10.8416	4.70%
26	373.7227	27.62%	9.3050	4.36%	8.8911	4.26%	13.3091	5.21%	13.3091	5.21%
27	42846.0000	295.70%	4.7780	3.12%	4.9605	3.18%	4.9940	3.19%	4.9782	3.19%
28	127.0000	16.10%	1.5247	1.76%	1.4096	1.70%	1.8323	1.93%	1.8323	1.93%
29	1547.6000	56.20%	3.5625	2.70%	3.1185	2.52%	3.5629	2.70%	3.1810	2.55%
30	78030.0000	399.06%	10.5522	4.64%	7.0670	3.80%	12.6879	5.09%	7.0152	3.78%
31	969.9233	44.49%	10.2294	4.57%	8.7837	4.23%	20.3942	6.45%	20.3942	6.45%
32	17.6251	6.00%	7.3402	3.87%	6.7240	3.70%	8.5247	4.17%	8.5247	4.17%
33	31.1261	7.97%	2.5814	2.30%	1.1611	1.54%	4.0031	2.86%	4.0031	2.86%
34	222250.0000	673.48%	15.9287	5.70%	8.2555	4.10%	18.0121	6.06%	8.3061	4.12%
35	457.7270	30.56%	5.2364	3.27%	4.9225	3.17%	6.9359	3.76%	6.9359	3.76%
36	2224.6000	67.38%	4.9659	3.18%	4.9308	3.17%	10.7756	4.69%	10.7756	4.69%
37	1892.6000	62.15%	3.6287	2.72%	3.3421	2.61%	7.9978	4.04%	7.9978	4.04%
38	4216.5000	92.76%	10.0382	4.53%	9.8623	4.49%	24.0329	7.00%	24.0329	7.00%
(Ave.)	22392.3392	132.63%	10.8758	4.44%	9.2033	4.10%	13.4929	4.98%	12.5082	4.83%
(S.D.)	49402.8666		8.3876		6.3725		9.3311		7.7335	

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SECTION IV

EDUCATION

Resourcing programmes in the built environment

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Abstract

This paper is based upon a survey carried out for the UK Heads of Department group, CHOBE (Council of Heads of Built Environment Departments). Its membership represents approximately 45 departments in the UK that offer programmes in construction, property and surveying. The survey was aimed at finding out the perceptions of these heads of department on a range of topics that influence the resourcing of these departments. The survey asked questions about staffing, students, curricula, research, accreditation and assessment. Respondents were also asked to identify the three most important issues facing these disciplines at the beginning of the twenty-first century. It was not surprising that recruitment and retention of appropriately skilled and knowledgeable staff were identified as the most common and important issues facing these disciplines. This was followed closely by links with industry and industry engagement. Whilst there were some differences in opinion expressed between those departments that are research-led compared with those that concentrate more on the delivery of programmes, such differences were not in some cases distinctive.

Keywords: Departments, Education, Resourcing, Staffing, Students,

1. Introduction

Within the United Kingdom the heads of subject disciplines are encouraged to form associations with other similar heads to discuss current trends, share best practices and examine issues facing their schools or departments. Historically Surveying Departments and Building (Construction) Departments were managed as separate entities, especially in the new universities. This was the pattern of their formation during the early 1970s and different Heads Groups represented these disciplines.

During the 1990s, with the creation of the new universities in 1992, university vice-chancellors began an ongoing process of reorganisation of provision across all departments. In some institutions the number of Faculty's were reduced and the smaller departments were amalgamated with others to form more coherent academic subject areas. It was not surprising therefore that the existing departments of surveying and building were merged to create new and larger departments of the built environment, since much of their work had common elements. In 2004, the former Heads of Department of Surveying and the former Council of Professors of Building agreed to merge their respective bodies to become the Council of Heads of Department of the Built Environment (CHOBE). Whilst its title is broader than its practice, it was a title that was chosen as being aspirational. At the present time CHOBE represents the disciplines of Construction, Property and Surveying and has links with a number of chartered professional bodies.

CHOBE represents some 45 departments in the UK. Its vision is to support and represent with a voice of influence those with strategic responsibility for the development and delivery of graduate and postgraduate education and research within these disciplines.

In support of the vision CHOBE aims to provide:

- Networking opportunities for Respondents to share and inform each other in respect of knowledge and good practice.
- A means of mutual support at individual and institutional level.
- A forum in which to discuss and solve problems of mutual concern,
- The opportunity to foster relationships to achieve educational and research aims.
- Representation on professional bodies and other organizations in order to strengthen knowledge of the disciplines and their contribution to the economy and to lobby on behalf of our members; and
- The primary point of *consultation* by external stakeholders for education in our sector

There are proposals to allow similar departments overseas to become affiliate members of CHOBE, to help in sharing good practice, trends and issues associated with managing the range of provision.

2. CHOBE Heads of Department Survey

In 2007, the Executive Group of CHOBE decided to initiate a survey amongst its constituent members about their perceptions on a range of topics that influence the resourcing of its schools or departments. Twenty-two of the departments responded to the survey and their findings are discussed below.

2.1 Staffing

By far the greatest discussion point amongst UK heads of department is academic staff. Refer also to the *Other Concerns* towards the end of this paper. At the present time there is a difficulty of recruiting staff with the appropriate qualifications and experience who closely match the programme provision and curriculum content and the necessary underpinning research needs. Sometimes teaching and research staff compatibility remain at odds with each other.

In the present economic climate, industry and commerce are seen by most as being much more attractive than the work of an academic; at least measured on the basis of salary and other financial packages. This has probably always have been the case, but the gap is now perceived to be much wider. Also the majority of undergraduate students' aims and expectations are for a good, long-term career in practice. Current evidence in the UK indicates a dwindling ability to attract UK nationals to academic positions in construction, property or surveying. This is also often coupled with applicants from overseas having better academic qualifications.

The first question in the survey was about the age profile of departments. Figure 1 shows the age distribution of the 22 departments for their full-time academic staff. Columns 24 and 25 represent the average data from this sample. Column 24 represents the average of all departments and column 25 the average of the six departments with the highest age profile.

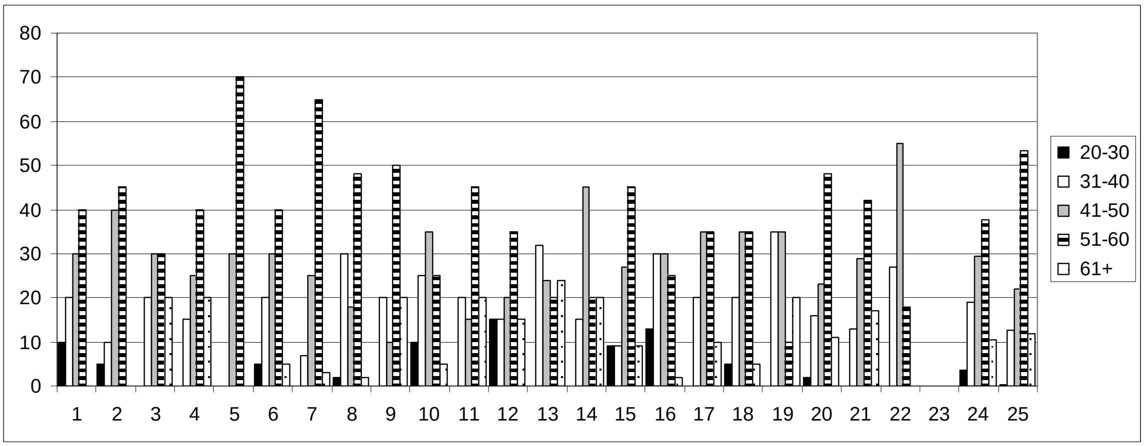

Figure 1- Age distribution of staff with in 22 departments

In twelve of these departments, over half (55%) of the departments, there was no academic staff employed who were under 30 years of age. On average only 3% of the academic staff were less 30 years of age. At the other end of the age spectrum almost half (48%) the staff were over 50 years of age. Ten per cent were aged over 60 years of age. In the early 1990s, a newspaper report commented that to teach architecture properly required maturity. At that time it was stated that that the average age of architectural academic was 48 years, but wasn't this just too mature when

at that same time staff were being offered redundancy packages by the age of 50. Coincidentally the average age of lecturers in CHOBE departments is now of a similar age, but most of these will now be expected to work in to their early 60s.

Figure 2 illustrates the percentages of academic staff in departments over the age of 50 years. Column 24 represents the average for all departments and column 25 represents the six departments having the highest age profile.

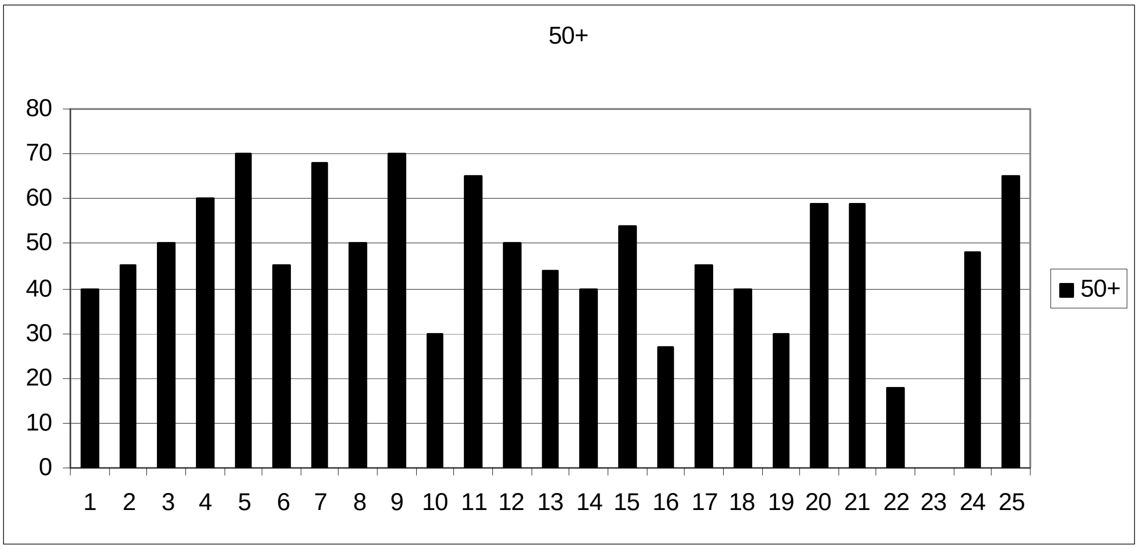

Figure 2- Percentage of staff within departments over 50 years of age

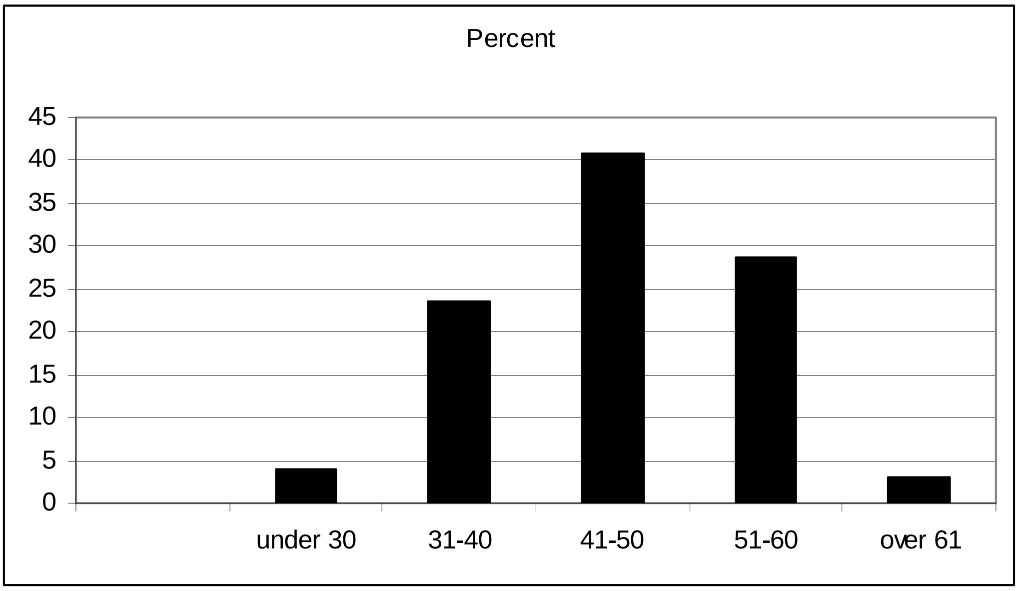

Figure 3- Example of a former polytechnic academic staff age profile (Source: HMI 1989)

Twenty-five years ago a Report (HMI, 1992) stated that the average age of full-time built environment lecturers in the former polytechnics was 45. In 1989 a report on the then English polytechnics (HMI, 1989) showed an age profile for comparison with that of CHOBE departments in 2007 (figure 3).

Table 2 compares the 1989 HMI data with the 2007 CHOBE data. It can be observed that CHOBE data indicates comparably fewer younger academic staff. Staff under 40 years of age are 27% and 22% respectively. Today there are three times more staff over 60 years of age than in 1989 (3 and 10%).

Table 1- Comparison of HMI (1989) with CHOBE departments (2007)

	HMI (1989)	CHOBE (2007)
Under 30	4	3
31-40	23	19
41-50	41	38
51-60	29	30
Over 61	3	10

The question of course may be asked whether the age profile of academic staff matters? Is it preferable to have a department with a spread of ages or a department with predominantly young staff? Also is it a comparable profile to that of industry or commerce? Ellis and Wood (2006) have shown a similar profile to those who are employed in industry and commerce. The profile matters in terms of succession planning and the generation and development of new ideas. There also comes a time in everyone's career when they peak in terms of workload and indeed stamina.

Thirty-five years ago, in the early 1970s, was an expansion period for UK higher education. Departments recruited heavily to match the changes in their provision and in the author's own experience there were a significant number of staff then under the age of thirty. This was significantly higher than the 3% who are now in this age group. Also a great many of these academic staff are now in their late 50s and early 60s and are due to retire or already have done so.

Figure 4 gives some indication of the difficulties in recruiting staff in the different core subject disciplines. This is not to discount the very valid contribution made by other subject disciplines on these programmes. Some of the disciplines are not represented in all departments and this may have the effect of distorting the figures marginally. The subject disciplines that recorded the greatest difficulties in terms of their recruitment were building surveyors (with 82% of departments reporting difficulties) quantity surveyors (73%) general practice surveyors (55%) and construction managers (50%).

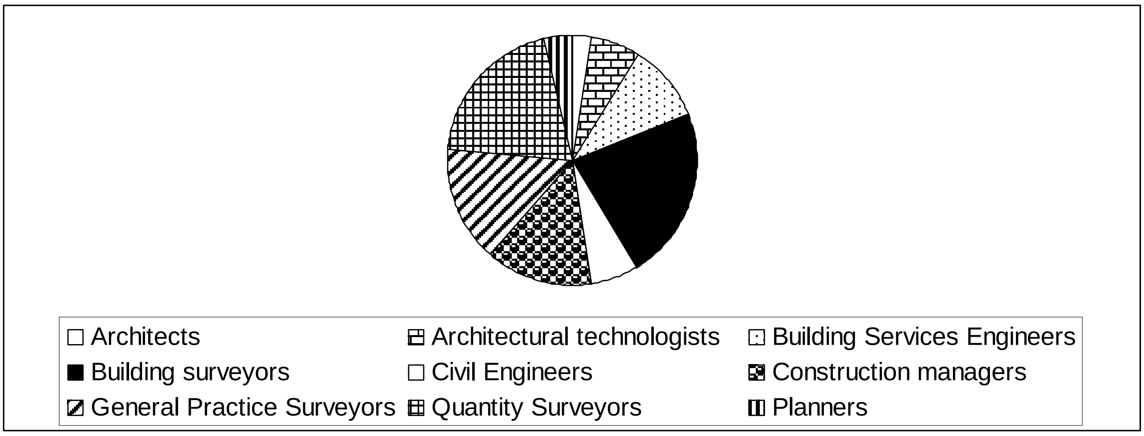

Figure 4- Difficulty recruiting staff

2.2 Staffing qualifications and experience

Compared with 40 years ago there has been a marked shift in academic staff and qualifications and experience. Forty years ago you it would have been unusual to have found anyone teaching these vocational programmes without prior and *related* experience of working in industry or commerce. The vast majority would also have relied exclusively on their professional qualifications as means of evidence of their capabilities. It was not until the late 1970s that undergraduate degrees became the norm rather than the exception. Four questions were asked of respondents about the importance of qualifications and experience when appointing new staff today. The responses to these are shown in table 2.

Table 2- Importance of staff qualifications and experience (percentages)

	Highly Important	Important	Neutral	Unimportant	Unimportant Highly
Professional qualifications	45	50	0	0	5
Work experience	27	68	0	5	0
Higher degrees	32	59	9	0	0
Research capability	27	4	53	3	5

These indicate a high degree of agreement amongst respondents for first three of the questions. The vast majority still continue to recognise the importance of chartered professional qualifications and relevant experience of industry and commerce when appointing new academic staff. Departments do have different criteria and this will to some extent be dependent upon their existing staff complement and the need to balance this with the criteria when actually appointing new staff. There is also some general agreement about the importance of staff now having higher degrees. This will become much more important in the future when perhaps half of the population will have acquired an undergraduate degree and something more will be required to distinguish between prospective applicants.

Where a significant difference was identified was in research capability. One respondent stated that this depends not just on an existing track record, but also the potential for future performance in research. The research-led university departments, of which there are relatively few in these subject areas, naturally rated this characteristic highly. For some, this would also be considered to be the highest of these four characteristics. However, somewhat surprisingly, over half of all the respondents felt no more than neutral about this aspect and overall only a quarter of the replies rated it as highly important. This raises significant questions about the interface between teaching and research.

2.3 Students

Historically most of those who joined the construction and property industries forty years ago would have done so through some form of part-time study, either at a college or through what is now described as distance learning. The 1970s changed much of this, firstly by introducing undergraduate degree programmes and secondly, until at least until the early 1980s, these were only available on either a full-time or sandwich basis. Undergraduate degrees by part-time study only came in to existence with the demise of external examinations provided by the professional bodies in the mid-1980s.

The shift of undergraduate students from full-time or sandwich modes of study to part-time is most noticeable amongst quantity surveying students. Almost 40% of respondents stated this. The percentage increases to over 50% in those departments that offer this discipline. There is a noticeable shift amongst other subjects such as building surveying and construction management although this is not quite so distinctive. Respondents generally did not record much, if any, of shift from part-time to full-time. This to a large extent reflects the good state of commerce and industry with the opportunities to students to learn and earn at the same time.

In terms of postgraduate education there has been an increase in programmes in most of the surveying subject disciplines in many universities. Construction management Masters' programmes have been available since the late 1960s. Conversion masters' programmes are now popular with many students. They are also much sought after by the larger employers. Some employers have stated that they now typically recruit 40% of their new staff from such programmes.

Figure 5 indicates the percentage of students entering undergraduate degrees in construction, property and surveying with qualifications other than GCE Advanced Level qualifications. The UK Government is keen to widen the access to students to all programmes and to increase participation rates in higher education. By 2010, Government expects that over 50% of the cohort will be taking this opportunity. It is unlikely that there are many programmes in this discipline that recruit entirely from students with GCE Advanced Level qualifications. Figure 5 indicates that somewhere between 10-25% of students will have other qualifications which will include further education level 3 qualifications and mature students. This percentage is higher for students on construction management programmes and lower for those general practice surveying programmes. Differences will also exist between programmes that are full-time or part-time and across the different institutions.

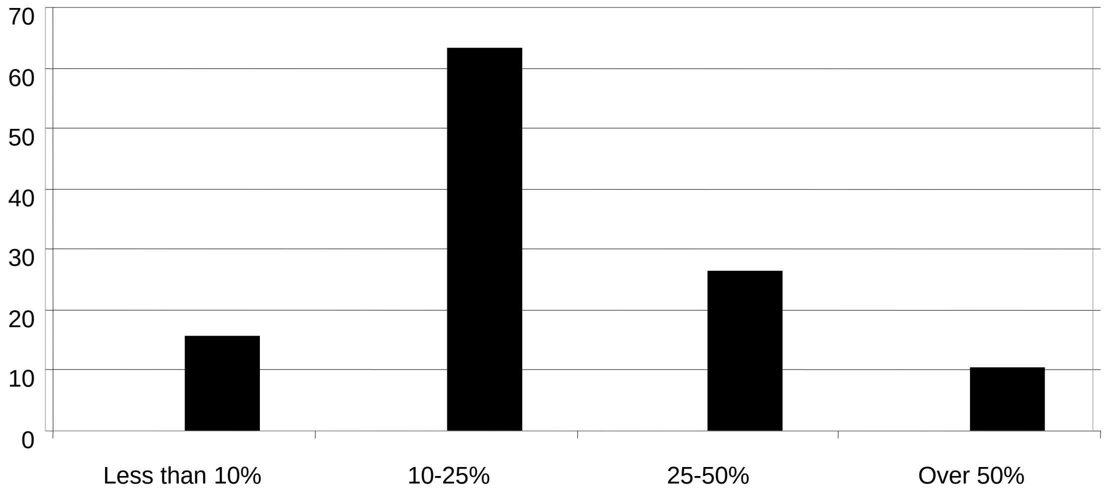

Figure 5- Non-standard student entry qualifications

2.4 Curricula

The curricula for these programmes continues to evolve through changes in practice and new knowledge derived from research. Comparison with the curricula in the past shows that programme leaders are dynamic in the evolution of their programmes through their periodic review. Departments' responses to Leitch (2006) indicate that they anticipate making only minor changes to comply with the Report's expectations. Most feel that they are already doing what Leitch expects of them in terms of the employability of graduates. This is currently very high, with students often being offered more than one job. These programmes do not within the current economic climate envisage any unemployment even for the weaker students. Respondents felt that curricula would continue to change. Subject knowledge and skills would be enhanced, replaced or removed from the curricula. An examination of the curricula over the past 30 years confirms this to be the case in the past.

Respondents stated that employers already influence the programme design through employers' liaison groups, their contribution to delivery of programmes and as external examiners. A majority felt assured that they could easily satisfy any expectations or requirements of the various sectors skills councils. There is likely to be an increasingly emphasis on flexible delivery and the recognition of work based learning and the assessment of in-house training, especially amongst the larger companies. There could be pressure to focus programmes to a greater extent on the immediate needs of employers. This might allow learners to select the elements of learning in which they are interested and combine this with credit from work-based learning towards qualifications. However, other employers are more interested in the intellectual strengths of their new employees and are less focused on the detailed knowledge base. This latter view has been expressed by some of the larger employers.

The curricula is determined largely through a combination of professional body requirements and expectations, industry practices because of the vocational nature of the subject and, the academic staff who deliver it. There are tensions in just what knowledge and skills should be developed. Universities have consistently argued that their main focus should be education and mind training. Professional training should be more properly and easily be provided through work placements, work based learning and training programmes in practice.

One respondent suggested that universities should be able to develop the curricula that they feel offers students the best opportunities. The interference, especially by professional bodies, was considered to be unnecessary and a hang up from the time when they controlled external professional examinations.

2.5 Research and consultancy

The Research Assessment Exercise (RAE) has been a common feature of UK academia since the early 1990s. Its purpose is to reward departments, both financially and through a rating, for the research that has been carried out over a previous four year period. In the past this assessment has been based on citations and has for the past three RAEs been based on a peer group assessment of research outputs. Evidence indicates that over the past few years, a greater proportion of the funding has been allocated to fewer departments generally across all disciplines. One of the aims of Government in the late 1980s was to create teaching only universities and research-led universities. Whilst this policy has not yet been achieved in practice, the RAE mechanism has gone some way towards achieving this result. It has recently been announced that the principles of the RAE in 2012 is likely to be on citations.

Given this background to the two survey questions about research and consultancy the respondents’ comments are perhaps not entirely surprising, although these more than any of the other questions resulted in comments being added by the respondents. Those departments that aspire to being more research intensive also expressed different views to others who felt that applied research was a key direction for them. One respondent questioned the ability or desire of graduates from these undergraduate programmes to effectively undertake research that would be funded either by government, industry or commerce. It was suggested by some that most the students leaving these programmes had no interest at all in research.

However, over half of the respondents thought that the RAE had beneficial effects on both teaching and increasing scholarship within departments. A quarter thought it was unhelpful to their departments and the remainder that it was not really applicable to them at the present time. More specifically respondents were divided almost equally three ways, on whether it was a positive feature, unhelpful or not applicable to their circumstances at the present time.

The attitude to consultancy or updating and links to industry and practice were more positive. All the respondents thought that practice and industry were important in the context of ongoing staff development. Those who were especially research active claimed that they worked closely with industry and that this offered benefits all round. Almost 80% suggested that a good and current understanding of industry and practice was of major importance to their departments, with the remaining 20% indicating that it was of minor importance. None indicated that it was not a priority for them.

2.6 Programme Accreditation

The accreditation of programmes in property, surveying and construction in the UK is important. Without this many programmes would fail to recruit students, since becoming a member of a professional body is a long-term goal of many students. This importance is emphasised if we examine the growth in membership of the chartered professional bodies. The RICS, for example has increased its members to in excess of 130,000 today, from just over 90,000 ten years ago and less than 60,000 25 years ago. Other UK construction and property professional bodies have also gown but perhaps not at the same rate.

The survey asked respondents three questions about accreditation. These were about the prescriptive nature of professional bodies, the possibility of common frameworks across the different professional bodies and the continued importance of accreditation.

It needs to be recognised that the different professional bodies each have different and in some cases distinct requirements regarding the programmes that they accredit. Some are highly prescriptive about curriculum content or in meeting the specified core competencies of the professional that they produce. Others rely more heavily on a final external assessment prior to awarding an individual membership status. Some are prescriptive about threshold requirements in respect of, for example, the entry qualifications of students joining programmes or the research capabilities of the academics who teach on the accredited programmes. Overwhelmingly, some 77% of respondents were neutral about the level of prescription. Some added comments that referred to the different professional bodies. In some cases universities would like a greater freedom but recognised the importance of all programmes that were accredited met certain standards. About one-fifth (18%) of respondents would prefer less prescription to be applied.

The introduction of common frameworks for the accreditation of programmes or even joint visits would help to reduce an academic's preparation and time commitment to accreditation. However, there was no general agreement for this as shown in table 3. Perhaps there was a concern that the most stringent rules would be applied! Respondents reacted very differently to the three questions in Question 16 with no overall pattern emerging. Joint visits which would reduce the need for multiple visits were not considered to be important by 82% of the respondents.

Table 3- Professional accreditation

Q16. Should the professional bodies be encouraged to develop a common framework of course accreditation?			
	Important	Neutral	Unimportant
Common framework	45%	45%	10%
Joint visit	18%	41%	41%
Extended accreditation periods	41%	50%	9%

Extending the accreditation period for programmes although considered by 41% of the respondents to be important half of them were unequivocal and a further 9% thought that this was unimportant.

Table 4 - Accreditation of undergraduate programmes

Q17. How important is it that professional bodies continue to accredit undergraduate level programmes?			
	Important	Neutral	Unimportant
Short term	82	13	5
Long term	59	36	5

As stated earlier the accreditation of programmes is important for the continued health of a programme. Without accreditation and, especially in times of recession, programmes will fail to attract sufficient students to make them viable. It was not surprising therefore to find that 82% of respondents thought that the continued accreditation of undergraduate programmes was important. The fact that 50% of 18 year olds are now studying in higher education may cause professional bodies to review the accreditation of undergraduate programmes at some point and concentrate on postgraduate programmes only, remains a distinct possibility in the future. This is partially recognised by these respondents where a shift in their views is shown in table 4.

2.7 Assessment

There was a distinct feeling amongst half of the respondents that assessments under some form of controlled conditions would be increased in the future. This was possibly due as much to the problems of plagiarism than to any real shift because of educational reasons. It is felt by some that staff are finding that with the considerable increase in student recruitment, the marking of course assignments in their current form is becoming unmanageable. A majority of the respondents (64%) felt that there would be no shift either way with unseen student assessments. However, approximately 45% of respondents indicated that there was likely to be an increase in continuous assessments.

Sixty percent of respondents thought that work based learning should be more formally assessed. Respondents with high numbers of students on part-time programmes were more likely to consider that some of the assessment might be carried out through work based learning. Respondents from those departments that had relatively few students on part-time programmes recognised that unless some form of work based learning was introduced on a full-time programme this would not be possible. Also those respondents who were more representative of property were more likely to feel neutral about this question.

2.8 Other Concerns

Respondents were asked to identify the three most important issues facing the disciplines of construction property and surveying education. The four most identified issues are listed in table 5. The numbers indicate how often this issue was raised amongst the 22 respondents.

Table 5- Major issues identified by respondents affecting construction, property and surveying education

Staffing (18)
• Recruiting the right calibre (experience and research) of staff
• Maintaining quality academic teams
• Difficulty in recruiting staff with strong research records
• Succession Planning re academic staff
Commerce and Industry (11)
• Work based learning
• Engagement with industry and practice
• The skills gap agenda
• Training v education
Students (7)
• Demographic Trends 2010 - 2020
• Attitudes and expectations between full-time and part-time students
• Enhancing the student experience
• Increasing the number of female students on these programmes
Research (5)
• Integration of research with practice.
• Importance of research-led teaching materials
• Difficulty of creating and developing research active staff
• Post-RAE research strategy

By far the greatest issue revolved around staff; the key resource. Most departments faced the same issues of recruiting staff who had work experience and who wanted to both teach and undertake research. Some departments are considering enhancing salaries in order to entice staff in to an academic career. This has been tried, with some success, in other subject areas. Retaining staff was less of an issue although maintaining academic teams in the future is of concern. Ellis and Wood (2006) commented in their report, *The future of surveying education in universities*, that half of all academics under the age of 45 were considering leaving their academic positions.

The second most important issue that was raised by respondents was the links between universities and practice. Whether teaching-led or research-led this was considered to be an important issue since such links provide relevance to programmes and students and to the research focus. Student matters, was the next consensus issue with a range of issues that included the different attitudes and expectations between full-time and part-time students. Research and the difficulty, for example, of both creating and developing research active staff was a concern of a number of respondents. Other issues included the following:

- The cyclical nature of education.

- Recognition within universities about the importance of construction, property and surveying.
- The tensions between education and training and producing students who were fit for purpose.
- Competition from other professions.
- The belief that architecture and civil engineering had higher profiles within universities and clearer objectives in practice.
- The recognition that these programmes straggle technology and business yet do not fit easily in to either.

3. Conclusions

There are of course many other questions that could have been asked of respondents of department in managing their departments in today's educational climate. Reading the foregoing could represent a view that all is doom and gloom, yet this is far from the truth. Whereas ten years ago many such departments were under threat of closure and some did cease to exist, today the picture is very different where such departments represent a net gain to universities. But there are warning signs that departments need to address. Some of these have been identified above from this survey of Heads.

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Academic Workloads and the Socio-Temporal Contract

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Abstract

Surveys carried out in recent years in higher education have shown staff suffering from high levels of stress with many finding their workloads unmanageable. This paper reports findings on workload allocation (WLA) practices in higher education based on sixty-two interviews across seven UK universities, two overseas universities and two other knowledge-intensive organisations.

The focus is on the social aspects of the process through cross-case analyses of: the role of the Head of Department/School (HoD/S) and issues of equity and transparency. The complex dynamics between these factors is revealed using a cognitive mapping technique, which highlights that, in addition to technical issues, consultation is pivotal. This has consequences to both the WLA process itself and underlying aspects such as trust and equity.

The paper concludes with a set of connected recommendations. The dynamic, interactive approach proposed should help to facilitate a collegial response to enhance WLA, anchored on the basis of a *Socio-Temporal Contract*, where work is not viewed in just the one dimension of time, but rather as part of a richer network of relationships that require attention.

Keywords: Higher education**,** Workload allocation, Consultation, Equity, Socio-temporal contract.

1. Background

The challenges facing the HE sector have been much commented on [1-3] with many pressures within it, not only from resource issues [4], but from factors such as the move to a mass market, tuition fee increases, and pressures from quality review systems. This presents a challenge for leaders and the style of leadership appropriate to various contexts has been widely discussed [5, 6]. It has also been recognised that special problems exist for leaders at the level of the HoD/S, because of a dual identity as manager and colleague [7, 8]. Various surveys have also been done on academic staff, both in this country [9] and in Australia [10, 11], whose HE sector has parallels with the UK. These surveys, although large, had fairly poor response rates of around

25%. Although this raises questions on representativeness, the findings make interesting reading. For example the Kinman and Jones survey [12] found that 69% agreed or strongly agreed with the statement 'I find my work stressful'. Further strain indicators showed that 50% of the sample had borderline levels of psychological distress (p27). However, interestingly, the psychological well being measures used (Goldberg D, 1981,) showed surprisingly low correlations (0.12) with the average number of hours worked in term time (p63). Most pertinent to this study was that in answer to an open question on improvements to minimise work related stress one of the most commonly mentioned items was 'the need for a managed allocation of workloads and transparency in workload planning' (p47).

The study by Winefield et al [5] also explored the area of strain and looked to factors such as the balance between demands and control at work, [13] and models that look at mismatches between worker's ability and job demands [14]. This individual response, or interpretation, of environmental stressors is felt by many to be pivotal [10, 15-19]. It might explain the complex and often unexpected relations between stressors and outcomes, and the problem of identifying the actual source of a strain. The findings of these surveys go some way to show the complex issues at play in relation to work strains and job satisfaction for academics.

Burgess [20] has carried out one of the few studies on workload planning in higher education looking at three establishments. The study concluded on three key criteria for systems: equity, transparency and the alignment of staff with strategic goals of the institution. These findings together with the survey results suggest the importance of the social aspects of workload allocation, for example on communication and trust. Much work has been done on these mechanisms, such as how information flows affect commitment. Thornhill and colleagues [21] look at how this commitment is also affected by a range of other factors such as personal characteristics, role characteristics-including aspects such as role conflict and autonomy, and also to expectations in terms of fairness over decisions and leadership styles. Thornhill's study looks at the relationship between the nature and style of communication and reports a significant, but not causal relationship with staff commitment. Another related study [22] looks at what commitment is focused around, for example agents or values, and describes how this dynamic may have a part in reinforcing social arrangements. However an interesting area in workload allocation might be to look at when the foundations for commitment diverge, for example divergence between commitment to an agent, such as a Head of Department/School, and to a value such as equity. Situations can, and do, occur when a WLA model is not seen to be completely fair, but commitment to a HoD/S makes staff disinclined to object. Trust and expectations of behaviour are at the heart of these issues [12, 23] and are a vital aspect of the HoD/S and staff dynamic. These studies reveal the complexity that will lie behind workload allocation processes, which have to operate beyond the merely technical aspects of allocating work.

2. Methodology

Out of the initial literature synthesis a loose framework of issues emerged surrounding the subject of workload allocation, but as this particular field was relatively undeveloped the approach had to be one of theory building rather than testing. Having reviewed the various alternative ways of analysing qualitative material Grounded Theory [24] was chosen as being appropriate methodology to such a complex social issue, founded on multiple perspectives of a real world with an emphasis on theory building. It involves inductively building up theory through comparisons of the same event or process, but in different situations, with findings emerging progressively through the various analyses. Within this a case study framework seemed the most fitting way to capture the interaction between university and department/school level rather than interviewing discreet individuals, and with interviews the best method to capture the rich material. In order to strengthen the research approach it was felt that it would be helpful to compare these practical findings with related theoretical works as described in Soft Systems theory [25]. Further to create a focus in the study, in line with Checkland's theories [25], it was useful to identify the particular *Weltanschauung*, or world view. This could be individual staff members, university leaders, heads of departments or schools (HoD/S), union representatives and so on. As the study was involved with the interfaces between individuals, departments and university the most appropriate perspective seemed to be HoD/S.

3. Fieldwork and Analysis

To maximise the robustness of the findings, the research design stressed achieving triangulation from a rich variety of sources [26]. So the universities themselves were not selected randomly, rather they were chosen to give a broad picture across the sector, so that size, geographical location and type of university grouping were taken into account, using the groupings as set out in the UUK 'Patterns of Higher Education Institutions in the UK: Third report' [27].

Further to help to get a broad view of the process the interviews were designed to cover a range of staff at each university. In each, two lecturers and their respective HoD/Ss were interviewed as well as a senior University staff member, and representatives from Personnel and the union body. A semi-structured questionnaire was used as a prompt rather than as a directive tool. Ethical procedures were followed throughout: in the interviews, their recording, and storage and use of material.

The general procedures set out by Strauss and Corbin [15] provided a guide to help with the coding of the documents using NVivo software. This involved the comparing of phenomena leading to groupings under general category names (open coding). After completion of the coding, case analyses for each university were written, covering the main phenomena, such as allocation methods and equity. Following on from this a cross case analysis (axial coding) was carried out looking at these phenomena, in all the cases. Then, building from this a framework was developed of the contexts, actions and consequences (C/A/C) pertaining to phenomena. This helped with the final phase of Selective coding in which narratives are constructed about the central phenomenon. In this case the core focus on workload allocation had been clear from the start and, drawing from the C/A/C framework described above, Decision Explorer software [21] was used to develop cognitive maps to help show the major relationships between the various categories around this focus.

An earlier paper [4] has concentrated on the more technical aspects of the findings. In summary three main approaches to workload allocation were identified: *informal models* relying on the HoD/S to share out work taking into account preferences, specialisms and competence issues, *partial models* that put only some aspects of the work into a model, and *comprehensive models* that included all the main work types, of research teaching and administration, in their models. The focus here will be on the social aspect including: Head of Department and the consultation process; issues of equity and transparency; and the individual response, using cognitive maps to illustrate their relationship. Finally a longitudinal case study was carried out to see the how perceptions changed a few years after a new model had been implemented.

4. Findings

4.1 Head of Department and Consultation

HoD/S did feel workloads were high and felt that WLA models were needed to help achieve equity. Yet there was also a feeling that not only did HoD/S themselves need the discretion to make adjustments, but ultimately staff had to make their own assessment of work priorities. Most HoD/S felt that they had been consultative over the introduction of, or amendment to, WLA models, discussing aspects such as weightings for roles (cases 1a, 1b, 2b, 3b, 4a, 4b, 5a, 5b, 6a, 6b, 7a, 8), although this process was not always successful. Even when there was consultation HoD/S noted how difficult it was to know all the issues, with size of department an important element here. However where staff had become actively involved in the overall process their awareness of the complexities of the problem of WLA had made them more supportive. Often HoD/S had inherited a model and continued to run it without too many problems (cases 1a, 2b, 3a, 8a, 8b), but there was often resistance to any changes to the existing system. Indeed the introduction of new WLA models was often greeted with suspicion.

Heads discussed their role in mentoring staff, encouraging and at times challenging those who were not fully engaged. They also frequently discussed the issue of personalities, often this was in relation to staff who were motivated and almost overstretching themselves (cases 1a, 7b). Although HoD/S stressed how hard it was to find time to fine-tune the allocations to individuals, and some delegated this aspect. The importance of this local monitoring was highlighted in one of the universities studies that ran a ‘Well Being’ survey every year, which revealed large variations in stress levels. Not only did academic staff have significantly higher stress levels than other staff groups, but also that these levels varied between faculties, so that some faculties had double the average rating of others.

Staff interviewed seemed to generally have good relations with their Head of department and quite high levels of trust appeared to be operating, although feelings on the system used were often less positive. Honesty and openness were appreciated, but there were a few instances of staff feeling unsure of the plans of their HoD/S (cases 1b, 2a, 3a), and others did suggest that communication of plans was sluggish (3a, 4a, 7b). Where staff had had anxieties and concerns over their work, the reassurance given by HoD/S had done a lot to mitigate the stress of the situation. There was, reportedly, a degree of conflict between a small minority of staff and their

HoD/S in a few academic units, often focused on problems surrounding workload allocation, sometimes in relation to contracts of employment (cases 3b, 8b), or the details of the model, such as marking allocations.

4.2 Issues of Transparency and Equity

Although many saw transparent systems as means to reduce tensions and to see the contribution of others, as with many things this could be seen from other angles. Some saw a danger of transparency, particularly if the model was detailed, as it could encourage staff to bicker over the details through divisive comparisons (cases 2, 5 and 8). The definition of a transparent system was also open to interpretation and there was a range between systems that named individuals and listed all their duties, to approaches involving just a summary document of the range of duties. Another aspect that emerged was that, even where decisions were transparent, the criteria for arriving at them was less so, for example why particular individuals got certain roles and how weightings for tasks were decided upon.

There was generally a belief that things were handled fairly within schools and departments, however this was somewhat hazier where systems were less transparent. The Head was pivotal to perceptions of trust and equity, rather than the WLA model itself. Further there was quite a lot of discussion about staff who tried to do the minimum and those efficient, amenable and diligent members that always picked up any extra tasks, each HoD/S had at least one such colleague. Work associated with research was mentioned frequently as the aspect that accounted for the most diversity in loads. In teaching, marking and assessment were also areas frequently highlighted as being potential problem areas in relation to equity, because of differences in class sizes and so on. Additionally most staff seen felt that there was an unwelcome rise in the amount of administrative work that they had to do.

4.3 Relationships between factors

As described in the methodology section case study data and *the context actions, consequences framework* were used to create cognitive maps. These led to an understanding of how the various categories interacted and built to a broader picture of the mechanisms and relationships at play. A range of different maps were produced, for example a complex one showing the entire set of relationships and another type of map that identified a main perspective or W*eltanschauung* for the analysis [25]. In this paper the HoD/S view was chosen as this seemed to be central to the process. See Figure 1 below.

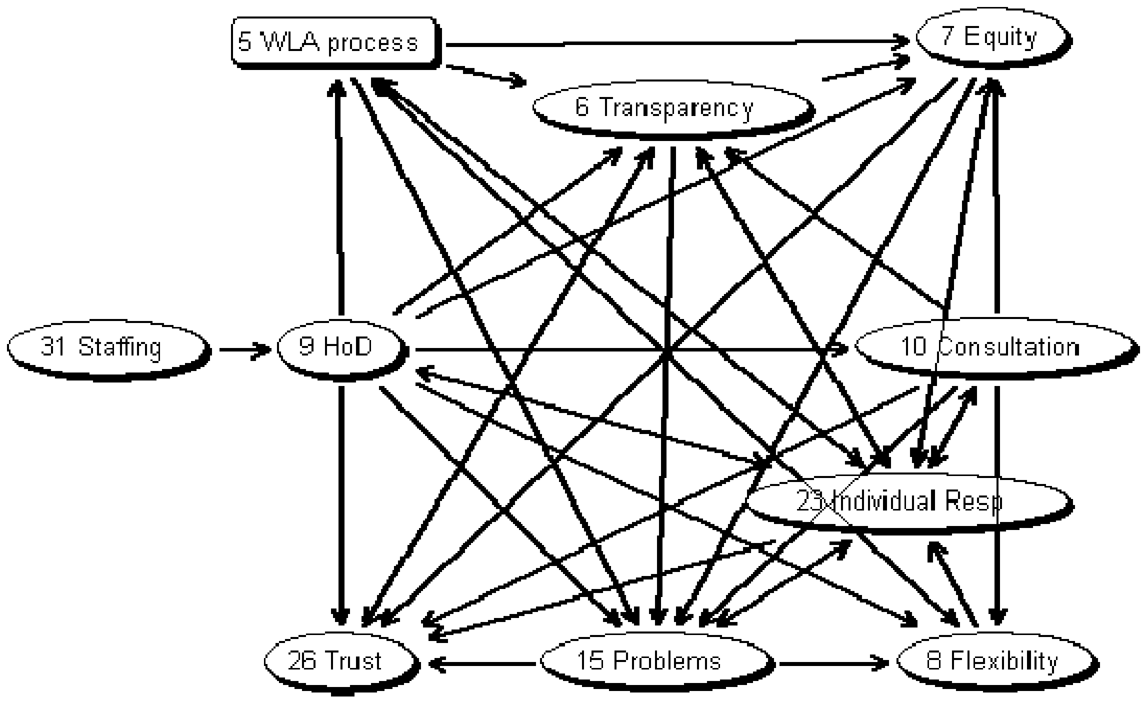

Figure 1: "HoD/S" View (excluding organisational factors)

This map shows factors involved such as Trust, Equity, Flexibility, Consultation and Staffing. However the university Organisational factors and Systems nodes that connect to just about everything have been hidden from this view in order to see the more direct influences more clearly. The broad split is between 'hard' factors, such as the calculation and allocation of workloads, and 'soft' factors, such as transparency and equity. Staffing is a contextual factor for the HoD/S, but the node Consultation, driven by the HoD/S can be seen to impact on many of the other nodes: WLA Process, Trust, Equity, Transparency, Flexibility and Problems and the central Individual Response. However the Trust node also follows as a consequence from HoD/S, Equity and Transparency nodes, but without a direct connection from WLA process itself, suggesting the importance of these 'soft' mediating elements within the process. The frequency with which these elements are connected with reciprocal links illustrates the dynamic interrelationships, where past actions and their consequences create the conditions for future exercises mediated particularly through the absence or otherwise of trust.

So the map, taking the perspective of the HoD/S, reveals consultation to be pivotal, with consequences to both the WLA process and factors such as trust and equity. This finding was then reviewed using data from the case studies. Perceptions on equity and trust surrounding the HoD/S allocations were evaluated in relation to the consultation process involved in the development of a WLA model and also and the fine tuning of allocations to individuals. A summary table show these findings below.

Table 1: Social Aspects of Model Development within Academic Units Against Perceptions on Equity and Trust, by Technical Model Groupings

Group	Case	Developing model (unit level)	Fine tuning to Individual	Perceptions on Equity	Perceptions on Trust
Informal Model	2a	Negative	Negative	Neutral	Neutral
	3b	Negative	Neutral	Negative	Neutral
	6b	Neutral	Positive	Positive	Positive
	7a	Neutral	Positive	Positive	Positive
	7b	Negative	Neutral	Negative	Neutral
Partial Model	1a	Positive	Positive	Positive	Positive
	1b	Positive	Neutral	Neutral	Neutral
	3a	Negative	Neutral	Neutral	Neutral
	4b	Positive	Positive	Positive	Positive
Comprehensive Model	2b	Positive	Positive	Positive	Positive
	4a	Neutral	Positive	Positive	Positive
	5a	Positive	Positive	Neutral	Neutral
	5b	Positive	Positive	Neutral	Neutral
	6a	Positive	Neutral	Positive	Positive
	8a	Neutral	Positive	Positive	Positive
	8b	Neutral	Neutral	Neutral	Positive

It must be noted that the findings do not indicate any absolute values and work off comparative, subjective assessments of the researcher, looking across all the data. Neutral responses were often non-committal responses made due to a felt lack of evidence, for example on the loads of others in relation to equity.

- The actual type of technical model alone used seems to be relatively independent of beliefs on equity, as all three model types had cases showing positive perceptions on equity and trust at unit level, although only the informal model had any negative perceptions.

- A fairly consistent relationship operates between perceptions on equity and those on trust at academic unit level.

- However a far more complicated relationship appears to be operating beyond the technical aspects that involve perceptions about the HoD/S and areas such as fine tuning or individualising the allocation, that is the, social aspects. So for example where fine-tuning to individuals has been positively addressed this almost invariably leads to positive perceptions on equity and trust. Notably within the Informal model neutral or negative responses are more random and reflect the absence of any objective measures for individuals.

- The comprehensive and partial models did have higher positive perceptions of equity than the informal model with 57% and 50% respectively, compared to 40% positive response in the informal cases. These tendencies might be related to more inclusive social procedures (see above), suggesting that these HoD/S have not relied alone on the technical aspects of their model, and perhaps that its development had facilitated the social process and the ongoing more transparent process. However as many of these systems were fairly recent the permanence of this effect will need to be assessed.

- The notable exception to this general trend is case 5 where in both cases perceptions on equity were lower than might be anticipated from the fine tuning and development processes, this was due to perceptions generally that online teaching methods were causing problems that were not being addressed. This issue alerted us to the potential for deterioration in the process as a consequence of some contextual change, and the need to test this out looking from a longitudinal perspective.

- A longitudinal case study was carried out and this revealed that the consultation and fine-tuning process had been neglected in the years after the model had been developed and that this had had some adverse effects on perceptions on equity.

5. Conclusions

Despite the variety in practices there was broad agreement on ideal principles in relation to these methods, for example on equity and transparency. The findings suggest, irrespective of the technical model used, that consultation processes play a large part in forming perceptions on equity, which seem to have a strong relationship with the trust operating.

Moving from the current position and informed by the analyses reported in this paper a set of connected recommendations will now be put forward.

5.1 University level

Universities often had a policy on workload allocation that called for equity and transparency in the systems, but guidance needs to given at a more practical level to overcome the potential problems in choices between aspects such as quality and equity, and the problem, frequently seen, of overloading competent and more cooperative staff.

A framework for workload allocation might assist HoD/S in the development of their model, but training and advice for Heads is required on how to customise the framework model to their department through consultation processes.

5.2 Academic Unit Level

As shown from the cognitive mapping in Figure 1, consultation should be central to the development, and use, of whatever system is used to allocate work, as can be seen from the related outcomes in the areas of equity, trust and transparency. Case evidence has shown that where radical changes are being made this process benefits from an approach that incorporates a pilot study, with feedback and modifications. Such a double loop process seems to facilitate staff engagement with the process, and reassure those staff resistant to change.

Further this process need not be seen as monolithic, as individual consultation should also be done between staff and HoD/Ss, or their representative, so that using judgement and discretion the overall model can be fine tuned to optimise equity within it. However if the HoD/S does delegate this aspect to another, such as subject group leader, the HoD/S will need to review workloads over all the areas to ensure that equity is operating across the spread of work engaged in.

A danger with a comprehensive model seems to be overdependence on the technical aspect and less emphasis on the consultation and review aspects. A model might be perfectly equitable, but staff need to have some idea of how decisions are made and what impact their representations have had to their overall allocation. This longitudinal case highlights the importance of the fine tuning aspect, but interestingly the benefits possibly derived from the initial act of collectively creating a model can be lost if those social dimensions are neglected and there is not an ongoing, collective, dynamic ownership of the system. Such monitoring might pick up disquiet for example brought on by contextual changes, such as a move to more online teaching, that alter perceptions on equity.

Through these processes consideration could be given beyond just the technical model and the overall balancing of work to aspects such as how the work arrives, patterns and distribution of work. For example case studies showed that workload peaks caused stressful conditions for staff that some HoD/S had actively managed by working with central university. This sort of understanding could form the basis of a *Socio-Temporal Contract*, where work is not viewed in just the one dimension of time, but rather as part of a richer network of relationships that require attention. This of course draws on the notion of psychological contracts, an idea with a long history starting with Agyris [28], carrying notions of organisations and their staff negotiating a "social as well as an economic exchange" (p114). The specific idea here draws from Vischer [29] where the analogous "social-spatial contract" is introduced, highlighting the social complexities of managing work-spaces for staff.

In relation to workloads the "temporal" aspect expresses the more subjective experience of time. For example teaching contact hours are not just objective measures, but are informed by other aspects such as whether the teaching material is new or repeat, how the contact hours are distributed through the week and the diversity of tasks involved. This type of approach with a broad understanding of what is fair and reasonable built up across the department/school (the "socio" part) and supported by a consensually agreed model could assist in delivering allocations that are perceived as fair and are effective in practice.

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Accelerating Innovation in the Built Environment by Research and Education in UK

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Abstract

Awareness of climate change and adaptations of building stock play a key role in the UK government's environmental agenda. While some European countries and countries like Japan move forward by bringing their sustainability agenda to the public sector, the UK seems to be slow in embracing these ideas and long term sustainability in improved products and processes for better performance, efficiency and innovative application of renewable technology is yet to come. While funding remains a major constraint research show that a number of detrimental issues including; organisation, risk, mind sets of the stakeholders, planning constraints, reluctance to accept change and the unexploited markets are major contributing factors. Most of these barriers can be overcome with research, development and information and knowledge transfer techniques. Educating all stakeholders can act as an accelerator for innovation. This paper examines innovation in the built environment and how research and education can stimulate this process. It explores drivers and barriers for innovation and how research and education in construction, design, engineering and project management can enhance this process. It presents and discusses lessons learnt from two action research projects in relation to innovation.

Keywords: Research, Education, Innovation, Built Environment, Accelerators of Innovation

1. Background

The current UK government believes that climate change is the greatest long-term challenge facing the world today [1] and has led the way with innovative policies, such as the Climate Change Levy and agreements, Renewable Obligation and Energy Efficiency Commitment. In its new climate change programme, the government set itself many targets that are to be achieved in each sector. In the timely 'Climate Change Review', Stern states that the first essential element of climate change policy is carbon pricing, followed by technology policy, which is vital to bring forward the range of low-carbon and high-efficiency technologies that will be needed to make significant cuts in emissions. Policies to remove the barriers to behavioural change are stated as the third critical element. Also, 'research and development, demonstration and market support policies can all help to drive innovation and motivate a response by the private sector’ [2].

All stakeholders need to be committed to this process and provide as much flexibility as possible to achieve these targets. Many professional expertise and skills are needed. Planners, Designers, Surveyors, Architects, Civil, Mechanical and other specialist Engineers and consultants, specialist builders, workers, need to collaborate and participate in this process establishing a knowledge and skills base from which organisations can benefit and stimulate innovative procurement processes in delivering the quality standards that are expected. Alongside companies that are already taking action to cut their emissions, and those that are developing innovative low-carbon products and services, professional and educational institutions need to be aware of the challenges that are facing them in enhancing the knowledge and skills. Long-term investments are needed in terms of research, training, continuing professional development programmes, incentives, etc. Many new professions and specialities are emerging as a response to the increased corporate property and asset management programmes. Environmental management and planning is now considered as a new field of professional expertise [3]. Energy consultants are in high demand. These aspects raise the questions of formal training in higher education, for new type of professionals.

Innovation in the current context has to incorporate issues of social, environmental and economic sustainability, where quality of life issues are given a high priority. Developing a culture of innovation in organisations and industry appears to be vital in triggering innovation. The main driving forces are the ideas of stakeholders; customers, management, marketing personnel and production personnel, as they focus on problem fixing and developing new ideas. The lack of proper qualifications, training, access to cutting edge knowledge and technology, fear of taking risks, the culture and mind sets of the particular organisation could all be contributing factors. For an organisation to be competitive specialist skills, consultancy services and professional expertise are needed. The thinking has to move away from the traditional box and consider whole life values rather than short term demands, profits and balancing books. This new way of thinking can be stimulated by research and development within the organisation or externally, exposure to innovative technology and projects, promoting best practice and specialist training. While some European countries and countries like Japan move forward by bringing their sustainability agenda to the public sector, up until recently the UK seems to have been slow in embracing these ideas. A number of reviews of the construction industry provided waves of re-structuring and re-inventing, but long-term sustainability in improved products and processes for better performance, efficiency and innovative application of renewable and low carbon technology serving the built environment is yet to come. While funding remains a major constraint there are many other issues that directly or indirectly influence this process [4].

Research related to the construction industry tend to be multi-disciplinary, long term and challenging. In most cases they are disseminated through refereed journals and ‘these may not be the most appropriate forms of output either for improving knowledge through academic discourse or for dissemination to industry’ [5]. Traditionally universities provided education and skills to students as well as carry out research within particular disciplines. A well defined peer review process established quality and clarity and a clear demarcation of public and private was established. Private consultants and other organizations provided knowledge to private commercial organizations and the government. In the current context, the distinctions between public and private boundaries are distorted. Universities are involved in consultancy, and industry has become a significant participant in scientific research and training. Thus, education & professional institutions and research organisations need to allow for diversity, new ideas, disciplines and forms of knowledge. The need and the rise of new fields of study put pressure on the education and professional system to be flexible and innovative to respond to new opportunities and developments. The intention of this paper is to examine some key issues that are important in accelerating innovation in the built environment and how research and education can stimulate this process. It briefly looks at the process of innovation, explores drivers and barriers for innovation and how research and education in construction, design, engineering and project management can enhance this process. The paper summarises lessons learnt from two Engineering and Physical Sciences Research Council (EPSRC) funded research projects to illustrate factors that promote or hinder innovation. The discussion examines the accelerators of innovation in relation to education and research, including the importance of educating all stake holders, the role of the professional and research organisations and the crucial role played by the correct mode of dissemination of the research. The role played by the government in focusing attention on new opportunities for innovation, and an organisations capability in absorbing research into practice are also discussed.

2. The Innovation process

Innovation process is defined by experts as ‘the successful exploitation of new ideas’ [6] which results in ‘enhanced performance and delivers objectively new or improved services to the user’ [7]. Recent authors have stated that ‘innovation is not a discreet or entity, but a socially mediated process that results from, and contributes to, a range of systemic relationships and interdependencies’ and ‘from organizational, managerial and individual practices and decisions’ [6]. Their view of innovation is as a socially constructed and not technologically determined process, noting by way of introduction that ‘innovation is, and will remain, a socially determined and hence unpredictable process’ and concluding that ‘technological change requires associated social, organizational and managerial changes’. There is also a consensus that innovation is risky, requires significant investment and is often resisted within firms [8]. Innovation is often categorised according to whether it involves the development of a new product- by a new or established technique- or the introduction of new processes for producing an established product [9]. While many people associate innovation with major technological or organisational advances, the vast majority of successful innovations result from a stream of small incremental changes which may individually have only limited effects on consumer behaviour [10].

2.1 Innovation in the built environment

Innovations in the built environment are often a complex blend of government, business, and market and consumer decisions. The main rationale for innovation in the built environment is economic benefits related to cost reduction and quality improvements. Other rationales include tackling environmental and structural problems and achieving public policy objectives. The rationale for government support of innovation in the housing industry focuses on the social and economic importance of housing. It acknowledges the value of innovation and the social benefits to be obtained from improved industry performance and the need for government funding in order to offset the industry's characteristic under-investment in innovation activities. As evident from the results in Case Study One, government support can be crucial for innovative projects to sustain their investment in a competitive housing market. Consumers also rely on the government for protection against failures in the system. Given the problems facing building innovations (risk, invisibility, uncertainty, cost of failure and correction, 'trialability', and difficulty in establishing relative advantage in the short term) consumers probably expect government and building officials to be conservative in their acceptance of innovations. Reducing risk may be as important to homebuyers as cost savings. If so, time-honoured technologies and processes will not be abandoned without ample evidence that their replacements will perform as expected. This socio-cultural fear of change and risk is deep rooted, difficult to change and forms a major barrier in bringing innovation to the housing sector. Information sharing and responsive communications can contribute in combating these fears.

Innovative processes can be easily adopted in new construction and the complex problem lies with the existing built environment. The UK has a fairly mature building stock which must be taken into account if a significant change in environmental performance is to be achieved. New buildings only add between 1-5 % of the total building stock each year [11]. Intelligent application of advanced 'smart' facade technology in conjunction with innovative environmental systems can result in significant energy savings and – at the same time – improvement of indoor comfort. Case Study examples from Research Project 2 illustrate that very little innovative environment technologies are implemented in the refurbishment of the existing housing stock. While initiatives such as 'Decent Homes Programme' [12] is intended to improve the environmental performance of dwellings, they sometimes achieve the opposite results, as housing authorities treat these schemes as vehicles for obtaining more funding rather than achieving sustainable dwellings. Research shows that when there are opportunities to employ new and innovative technologies in refurbishment, housing authorities implement basic or out-of-date technology to update their stock due to tight budgets and fear of risk [13].

There is a need for more government investment and research, alongside commitment from industry to provide a driving force for a future renewable technology markets. This would lead to augmented markets which in turn increase the demand and the supply in mass production, bringing the costs down. In Photovoltaic technology, 'Britain is losing out to countries that have created a large market, by introducing market stimulation measures and low manufacture costs' [14]. The lack of market demand is one of the major factors preventing the growth of PV, and subsequent employment, in the UK on a larger scale [15]. Many countries including Germany, Japan, the Netherlands, Norway and the USA have initiated programmes of government investment, in collaboration with industry, which have lead to thousands of solar electric homes being built around the world. These increased markets offset the high costs, which has led to employment opportunities in the PV field, as well as associated professions. Germany has established themselves as world leaders through extensive research, development and technological developments [16]. UK does not currently have a suitably large market to display its expertise in PV technology or the financial incentives to develop this market further.

3. Lessons from two research projects

3.1 Monitoring an innovation programme to examine Egan compliance in social housing in UK- (2001-2004)

Project one monitored a consortium of Register Social Landlords (RSLs) established to provide innovative high quality housing designed and procured in line with the principles set out in the Egan Agenda (1998). A strategic partnering arrangement was set up with a single contractor who developed an award winning modern pre-fabricated timber frame housing system. It was an opportunity to monitor and record the performance of 28 housing development projects and the roles played by a complex team network. As the RSLs agreed to procure 2000 new house units over a four year period (2001-2005), the research project exploited the opportunity to study a major innovation programme and identify what key lessons could be learnt. The main aim of the research was to set, monitor and compare the Key Performance Indicators (KPIs) and map the cause and effect relationships within the change programme. The selected contractor was the subject of several takeover bids by rivals and experienced a number of problems with both, the supply of the timber frame housing system and site personnel, which compromised the quality of construction and resulted in a high turnover of site-based operatives. This, together with other problems (outlined below) meant that the volume of demand initially forecasted never materialised. The details of the research methodology, data and analysis are beyond the realm of this paper and are published [20]. A brief summary is presented here.

The research methodology was based on case study monitoring and action research and a range of questionnaire surveys, detailed interviews with key project personnel, examination of site meeting notes and general feedback reviews were undertaken to identify good and bad practices associated with each project.

Key Lessons learnt from the initiative:

- All parties needed to be fully committed to the innovation programme;
- The level of demand required to sustain the contractor's performance should be ensured and risk management processes needed to be in place prior to commencing the project;
- Innovative procurement processes require a change in mindset at all levels within the organisations. Effective mechanisms should be put in place to ensure that everyone understands the joint goals and know their part in the overall process;

- Training was identified as an essential ingredient in this process. The lack of familiarity with the innovative approach illustrated the need for formal training for all project managers, prior to commencement of new projects. There was also the need for support systems in terms of knowledge and information to be in place for frontline staff;
- Communication and co-ordination, which lead to continuous improvement of services and products, emerged as some of the key drivers of the process; and
- Even though the government encourages initiatives, such as that monitored in the research study, there is little flexibility in support systems to assist in sustaining them.

A major drawback of the project was that, a continuous improvement process which would feed information from the site and different stakeholders who were involved with the project, was never implemented. The innovative timber frame system needed more research and development input to reduce the defects and the associated costs.

3.2 Stakeholder consultation for Sustainable Urban Environments Project (SUE_IDCOP, 2004-2007)

The SUE-IDCOP programme is responsible for providing the fundamental knowledge to underpin the improved sustainability of existing buildings. The overarching aim is to find ways to improve the performance of existing building envelopes which reduce the consumption of non-renewable resources over the whole building life-cycle in a way that is economically viable and socially acceptable. There are many innovative environment technologies that are readily available in the market. Case study examples here in UK and extensively throughout Europe show that these technologies can be used effectively and economically in new build housing. In UK, there is very little evidence of their use in routine maintenance and refurbishment. The current data on refurbishment illustrate that very basic building technology, sometimes unsustainable, is used to upgrade the dwellings. As part of the ongoing research, a number of stakeholder consultations were undertaken. Here, results from a pilot study done with 6 major housing associations to identify barriers in promoting innovative environment technologies in refurbishment are presented.

The aim was to identify and review the barriers that stakeholders face in promoting innovative environment technologies in social housing refurbishment. The consultation was carried out in relation to three sectors in the procurement of social housing; management, development and the maintenance sectors. It was considered under the following criteria: Energy peformance, Water performance, Waste management, Durability and Flexibility (Whole life performance), Health and well-being of tenants (Quality of life issues).

The results illustrated that:

- Value for money is a major governing factor and the benefits should outweigh the costs incurred. The RSLs work on a tight budget and unless it is proven that the benefits outweigh the capital cost, none of the new technologies are considered for implementation. The capital costs of most of these technologies are significantly higher than the available budgets and the potential cost savings in utility bills. The tangible benefits of employing renewable technologies are usually long-term and do not result in quick savings.

- The technology should be proven and fully demonstrated.
- There are quite a lot of products and systems in the market but very little information about their long-term performance, durability and ways in which they can directly reduce cost. More information about whole life performance and cost savings is needed and should be made available to the RSLs.
- Confidence levels in the new products are low due to high costs in demonstration projects and occupants and organisations are reluctant to take the risks.

All the above factors illustrate that there is a demand for more information, effective communication and research and development. Informing and educating tenants and organisations about the long term benefits and whole life cost value seem crucial in implementing innovative technologies. Research and development is essential to bring the cost down and increase market potential.

4. Factors that affect innovation

Factors that affect the implementation of innovative technologies define the context in which the industry operates. 'Three sets of factors that affect innovation and are controllable constitute elements to develop strategies to foster more innovation in housing. They are referred to as innovation accelerators, innovation barriers and contingent factors (factors which can foster or impede innovation, depending on how they are managed or implemented)' [19)]. The first major reason for innovation is economic benefit which can be reflected in increased profit, increased market share and business growth. Another reason for innovation is remedying problems which results in better performance and related economic benefits. A third reason is to achieve public policy objectives, such as energy conservation. The public policy rationale for energy conservation may well be environmental preservation; the private sector rationale may be reducing operating costs of homes or businesses and making profits by marketing improved products. The housing consortium monitored in research project 1, was set up to achieve a 'better performance at an affordable cost using factory production techniques' as was advocated in the Egan agenda (20)

Organisations and their structure have a major influence in the innovation process. Visionaries who have corporate influence can drive innovation and influence the market growth, but will need support from other organisations in stabilising the process and creating the demand that is needed to establish the market. Project 1 was set up solely by a visionary who wanted to achieve real change in the social housing sector. But as the lessons from this experience show, the organisational structure and the support which was needed to facilitate such an initiative was not present. The commitment of all parties, a changed mindset at all levels and better communications between all levels were crucial requirements to make the initiative a success.

The construction industry has a serious shortage of skilled labour and a skilled workforce is critical to an organisation's ability to innovate. Training and education are essential in the development of a skilled workforce. In Project 1, the contractor experienced many problems due to his inability to retain skilled workers. The lack of demand for the houses (mainly due to rival takeovers) slowed down the factory production and affected the retention of staff, which in turn affected the quality of the product. Poor quality products resulted in losing the trust and confidence of the consortium members and reduced the demand that was originally envisaged [4].

Risk is one of the main barriers to innovation. Innovators face many types of risk, including performance failure, market rejection, delayed or non-approval by regulatory authorities, rejection by trades/labour and liability. All of these risks have an associated potential financial loss, and the trend is towards increasing risk, particularly risk of liability. Results from the stakeholder consultations showed that many housing organisations are reluctant to implement innovative technologies due to fear of taking risks, and consider implementing only basic technology in their refurbishment programmes.

Financing innovation has always been a key problem. Small and medium companies find it hard to invest in research and development and hence break into new markets due to financial constraints. Research Project 1 shows that, in some instances, there are considerable upfront capital costs, but increased consumer demand and a greater market share will contribute to recover these costs. In Project 2, the housing associations were reluctant to spend the initial capital cost required, without having guarantees that they will be recovered within a limited time. Developers are also wary of implementing new technologies because of fears about consumer preferences. Consumer demand affects the supply and market investors and stock market analysts become concerned about investment in new techniques or products which may be regarded as risky. Project 1 showed that without sufficient demand, a new initiative cannot sustain itself. Lack of consumer demand, coupled with the inflexibility of building regulations and regulation administrators, are commonly regarded as detrimental factors for innovation.

The construction industry is heavily regulated by national and local regulations governing land use and planning, infrastructure and buildings. Literature reviews, experiences from the industry and research, indicate that regulations are a major barrier for innovation. In particular, factors such as lack of mandate to accommodate or foster innovation at the local level, and lack of empathy by local building officials to accommodate innovations, are detrimental to the process. It is the availability of incentives that promote innovation. These incentives could be of various forms, such as tax or VAT refunds, and targeted funding and support. Some incentives, such as compensation to offset costs of training trades on how to incorporate innovations may also be useful [4].

5. Accelerating innovation

5.1 Educating all stakeholders

Professional expertise and skills play a crucial role in supporting the Governments agenda to combat climate change and promote sustainable development. The requirements of the EU Energy Performance of Buildings Directive (EUPD) creates a large demand for; professionals who had specialist training in energy performances and sustainable construction techniques including the installation and maintenance of renewable energy alternatives, professionals who are aware and trained in new legislative practices and higher standards. With the establishment of the ‘The Higher Education Partnership for Sustainability’ [21] the government explores some of the key elements of good practice in integrating sustainability issues into the provision of all courses in the higher education sector. Based on existing good practice, it provides useful tools to help course designers identify and prioritise sustainability elements in any existing or new courses. The South East England Development Agency (SEEDA) is also working collaboratively with the region's businesses and universities to promote knowledge transfer, innovation and training. The lessons learnt from project one emphasized the need for training and information sharing in facilitating innovation process. New communication technologies can assist in co-ordinating this information.

The social systems surrounding construction, especially housing production, resist change. This could be due to inflexible mindsets, socio-cultural values, or simply fear of change or taking risks. In order to achieve the full benefit of innovative technology, the user has to be familiar with its use. Educating the occupier is crucial to overcome these setbacks. Research carried out by Sustainable Homes (2003) showed that, given the right information and control, tenants are happy to implement new environment technologies in their dwellings. Savings in utility bills can be a major incentive in this process.

5.2 The role of professional institutions

Employment patterns and the role of professional institutions play an important part both in retarding the development and uptake of new ideas. They often see themselves as guardians of ‘the discipline’, and resist radical change [5]. In the construction sector, many employees, especially engineers, architects and planners etc. are members of professional associations, who usually have their own publications which inform the members about new debates, methods of practice, new technologies, regulations and government policies. They also can play a key role in developing Continuing Professional Development (CPD) courses and activities which keep their members up to date with new developments of technology, research and knowledge. The traditional role of construction professionals as ‘knowledgeable experts’ may require augmenting with additional interdisciplinary skills to enable participation in teams of specialists [22]. The practice of ‘Expert advisers’ providing discipline-based knowledge at certain times is being challenged by new ways of organizing processes in which systems integrators and ‘knowledgeable team players’ are required.

5.3 The role of research funding organizations

The main funders of academic research aim to create new knowledge; educate and train people; and promote public trust, confidence and understanding of science and technology. But little is done about how this research could be put into practice and stimulate industry to maximise the benefits. The objective of the UK’s EPSRC, which is the main funder of construction related academic research, is to generate new knowledge that helps to improve and underpin industrial competitiveness and the quality of life, in collaboration with research users of all types which include design, engineering and construction organizations, client and user organizations, professional and trade associations, and government and nongovernmental agencies.

5.4 Dissemination of research

Dissemination is a key factor in benefiting from any research and development activity. Construction academics may not have the skills or resources to carry out the dissemination, technology transfer and delivery of results once research has been completed. This in turn influences the expectations of funders and industrialists and the capability to absorb and implement new ideas within the industry. In order to obtain the maximum benefit of research a complex feedback and learning processes has to take place through development and implementation. According to Gann 'the steps taken between research and impact are not usually sequential in nature, particularly in construction. Moreover, the experience of collaborative research projects indicates that interactive and iterative processes involving researchers and practitioners can produce valuable and implementable results before research is completed. Nevertheless, some research projects may not result in benefit for many years, whereas others may never result in measurable success – such is the nature of research' [5]. Publications can play an important role in knowledge formation and diffusion but may not be the best mode in certain types of construction research. CPD courses, workshops, conferences and seminars also facilitate the dissemination process. Currently there are many construction industry related forums that promote the sharing of knowledge and information with the patronage of the government or as independent bodies.

5.5 The government's role

Governments can enhance or slow innovation processes. Despite governments advocating innovation, there is little support to sustain the growth of innovation. Advocates for adoption of building innovations have to change building codes to enable builders and consumers to adopt any favored innovation. Government incentives in terms of tax benefits and funding can facilitate the innovation process. Clear government targets and patronage can make the construction sector embrace innovative strategies into practice. New innovative procurement methods and contractual reforms have to be introduced to achieve the targets set. Initiatives such as Partnering (PPC 2000), Private Public Partnerships (PPP) and Private Finance Initiatives (PFI) contractual agreements were introduced as a result of Latham [23] and Egan [17] reviews.

Current policy in the UK identifies the experienced client as the main institutional leader in stimulating construction innovation, yet doubts remain regarding a clients' ability to play this role. Nam and Tatum [24] show that a client needs to be technically competent in order to understand innovative proposals from systems integrators, and hence take the risk of innovating. The analysis of complex systems industries also suggests that more attention needs to be given to the two other elements of the innovation superstructure: the regulatory environment on the one hand, and the professional bodies, research establishments and universities on the other. 'It is the way in which the professional institutions carried out their brokering role that sometimes slowed the innovation process, and it was this brokering that provided the basis for the new regulations' [25].

The UK Government is committed to expanding its supporting programme for renewable energy technologies including research, development, demonstration and dissemination. The main hurdle preventing large-scale manufactures of photovoltaic panels in the UK is the current market, or lack of it. The understanding and potential of photovoltaic technology is improving, but further research and development is required to achieve cost reductions. It is important that strong partnerships are established between industry and government. Increasing environmental concerns and the need to achieve emission reduction targets should help the technology to become further established as a marketable and economically viable product [15].

5.6 Organisational capability to innovate

Cohen and Levinthal [26] argue that industrial research and development (R&D) not only generate new information but also improve the ability of firms to absorb knowledge developed outside the firm. The type of staff employed provides an indication of a firm's capability to develop, manage and utilize new technical knowledge. Other issues are equally important such as; organizational structure and culture, the nature of internal and external communications, coordination and feedback mechanisms, the ability to codify knowledge and the type and use of information and communications technologies [27].

Companies associated with fast-moving science and technology sectors usually invest more intensively in R&D than most construction organizations. By other industries' standards investment by government and construction firms in R&D is very low, particularly in the UK; this is not the case in some other countries such as France, Japan or Scandinavia [5]. It follows, from Cohen and Levinthal's argument, that lack of internal R&D capability in construction indicates that many firms are unlikely to have the capability to absorb the results of academic research, or work published in journal articles. Technological progress across the sector is therefore likely to be slow. When faced with the prospects of technological change, the majority of construction firms are recipients of innovation first exploited in other sectors, or by a few construction market leaders. Even when a firm has the technical competence to absorb new ideas, it may not have the internal structure, systems and cultural attributes necessary to capitalize on research results.

6. Conclusions

Awareness of climate change and adaptations of buildings form a key role in the current environmental agenda. Promotion of renewable energy and innovative environment technologies are essential to meet the targets set by the government. Government support mechanisms in terms of resources, incentives, providing opportunities and access for local and international markets, training and information sharing mechanisms all can foster innovation. The drivers of innovation are economic benefits, performance improvements, environmental upgrading, research, development and information and knowledge transfer techniques and access to markets. While the implementation of innovative technologies can be accelerated with the right government-lead incentives like subsidies, tax benefits, availability of resources and information; the removal of barriers will be equally if not more effective: less strict regulations or reduced financial risk. Risk is one of the main barriers to innovation. Organisations can control risk by researching innovative technologies to reduce the number of unknowns about them, establishing quality control measures to reduce product deficiencies and training staff to increase their competencies.

The accelerators of innovation are education, research, development and information and knowledge transfer techniques. Educating all stakeholders, including the occupants of the built environments, are essential in this process. There is a significant role for the universities and professional institutions to play, acting as repositories of knowledge and as an essential part of the knowledge production system. Together with research organisations they need to allow for diversity and allow for sources of new ideas, disciplines and forms of knowledge.

Government has a key part to play as a sponsor of higher education, academic research and as a facilitator in bringing academic research and industrial practitioner communities together in collaborative research projects. In the current context, interactions between academic researchers and industrial practitioners appear to be increasing. New models of collaborative research have emerged partly sponsored by the public sector and promoted by professional institutions. Management of research, correct mode of dissemination and implementation are important components in the process of absorbing research results into practice. Continuous improvement processes are important in feeding back knowledge from one project to the next. Technology transfer could take place through closer interactions between researchers and practitioners using new technology. Firms need professionally qualified personnel who work in technically challenging and specialist areas to absorb and act upon the results of academic research in the UK. They also need the internal technical support infrastructure which assists in learning between projects and which can improve their internal business processes by developing feedback and learning mechanisms. Current development in technology provide new opportunities in providing virtual environments in which mistakes can be made and rectified before implementation takes place on real projects. They could also provide new environments for learning and training. Communications in terms of intranets, internet, hotlines, and knowledge sharing databases all facilitate this process and support the dissemination of good practices and feedback on implementation of new ideas.

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Performance measurement in construction research & development: The use of case study research approach

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Abstract

The process of finding solutions to the research problem does not follow a clear sequential approach, but often takes unexpected turns due to the uncertainties of the research process and its outcomes. However, appropriate research design would be able to identify any problems and pitfalls that the researcher may come across during the process. In this regard, consideration of the research philosophy pertaining to the study helps a researcher in choosing the appropriate approach for a study. Not only the philosophical stance, but also the research problem under investigation and its underling circumstances influence the selection of a research approach. Accordingly, this paper discusses the factors that drive the selection of a case study as the research approach with particular reference to the use of single case study to undertake an in-depth inquiry regarding the impact of performance measurement towards construction research and development. Further, this paper discusses the incorporation of multi-phase, multi-perspective and multi-method approaches within the single case study to build valid theory.

Keywords: Interpretivism, Single case study, Performance measurement**,** Research approach, Research and development

1. Background

Research and development (R&D) activities play an important role within the construction industry by developing advanced and new construction materials, processes and management methodologies to successfully address its stakeholder needs. Further, R&D activities help to enhance the effectiveness and efficiency of construction processes and address resource constraints and sustainable goals [1, 2]. Moreover, R&D activities facilitate the exploration and creation of new knowledge and capabilities within organisations to help them compete successfully in the marketplace [3]. Hence, prioritising R&D activities, creating longer term R&D

programmes and increasing investment on R&D activities have been identified as vital factors for the growth of the construction industry ([4, 5]).

Due to rising costs, time and other resource constraints, much attention is paid on identifying the actual contributions from construction R&D activities, justifying and showing the accountability of resources spent, and ensuring outputs are aligned with expected goals. The inadequacy of mechanisms to evaluate the successfulness of R&D activities and the effective usage of funds has negatively affected these activities in construction (see [6, 7]). R&D has also become more complex, as it involves many stakeholders and has a wide range of interrelated activities [8]. Lack of communication and coordination between stakeholders and lack of clear objectives to address their requirements are evident within construction R&D. Consequently, these issues have lowered the investments for construction R&D and resulted in producing research results with low applicability.

It was revealed that, to address the issues within construction R&D, effective control and monitoring mechanisms are needed [7]. Thus, this study suggests the implementation of Performance Measurement (PM) within the construction R&D function to enhance its success (see [7]). The utilisation of PM systems within the construction R&D function would generate benefits including: evaluating the success of R&D activities; identifying the future improvement areas and required support for such activities; the proper allocation of resources, and improved communication, coordination and direction of employees towards common goals [7, 9]. Through the literature, it was identified that the concept of PM within construction R&D is not adequately exploited. Therefore, this study intends to address this gap with particular reference to its PM application. Accordingly, the aim of the study is to explore the influence and impact of performance measurement on the construction R&D function. To achieve this aim, following research questions are formulated:

- what is the importance of R&D to the construction industry?
- what is the current position of construction R&D function?
- what are the critical success factors of construction R&D function?
- how is the performance of construction R&D function measured?
- how can PM influence the performance improvement of construction R&D function?

This paper discusses the research methodology adopted for this study with particular reference to the use of single case study as the research approach. The paper first presents the philosophical stance pertaining to the study. Secondly, the selection of case studies as the research approach and rationale behind the use of single case study is presented. Next, the paper examines the phases and methods used during the single case study to build theory.

2. The research methodological design

The main intention of any research is to add value to the accumulated knowledge through the means of identifying, investigating and producing solutions to an unsolved problem [10]. The process of finding solutions to the research problem is “not a clear cut sequence of procedures followed by a neat pattern, but a messy interaction between the conceptual and empirical world" (Bechhofer, [11] cited in [12]). Booth et al [13] also agree with this view stating that "research follows a crooked path, taking unexpected turns, even looping back itself". Even though the research process is uncertain and risky, the appropriate research design would minimise the possibilities of any failure by identifying and forecasting problems and pitfalls that the researcher may come across. In addition, research design looks into the philosophical aspects of the research which in turn helps to identify the overall research strategy (collection, analysis and interpretation of data to draw up conclusions); evaluate various research methods and identify their limitations; increase the compatibility of research approaches and research techniques.

To design the research methodology logically and systematically, the researcher used Kagioglu et al's [14] hierarchical model. This model nests the research philosophy, approach and techniques (Figure 1) where the outer ring "guides and energises the inner research approaches and research techniques" [14]. Adherence to the nested model ensured the chosen research philosophy, approach, and techniques are compatible with each other and as a whole cater for the requirements of this study.

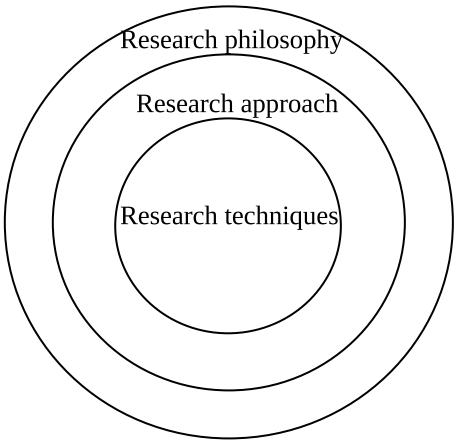

Figure 1: Nested approach [14]

Following sections further describe the research philosophy and research approach pertaining to this study in detail.

2.1 Research philosophy

Gill and Johnson [12] stipulate that there is no one best approach to research but rather a compromise between the options based on the philosophical understanding or basic beliefs about the world. Agreeing with this view, Easterby-Smith et al [15] also recognises research philosophies as the base for effective research design and argues that failure to adhere to philosophical issues can affect the quality of the research negatively. There are two main research philosophies - Positivism and Interpretivism - which can be placed at the two extreme ends of a research continuum [15]. Three assumptions can be identified within these philosophical stances i.e. Ontology, Epistemology and Axiology. Ontology seeks to identify the nature of the reality; Epistemology shows how we acquire and accept knowledge about the world; and Axiology indicates the nature of the values the researcher placed on the study [15, 16]. The following section evaluates how positivism and interpretivism is characterised with the ontological, epistemological and axiological assumptions.

2.1.1 Positivism

Positivism takes the ontological assumption of reality as having a pre determined nature and structure. This is known as “realism” [17] or “objectivism” [18]. Further, the positivist lies on the epistemological assumption that the properties of reality needs to be measured through objective measures rather than interfering subjectively through sensation, reflection or intuition [15]. Moreover, the positivist believes that the process of research is value free in terms of the axiological assumption [16, 18]. Thus, the researcher would detach from the research environment and takes the role of an independent observer without interfering with the research environment and would not allow the values and bias to distort the research results. In addition, the positivist uses deductive method i.e. abstracting a concept prior to testing it through empirical evidence [12, 15, 16].

2.1.2 Interpretivism

The Positivistic approach which was originally used to study the natural science was criticised when applied within the social science as the latter deals with human behaviours. It is argued that humans cannot be treated as objects and theories that lead into definite laws due to the fact that humans are influenced by feelings and perceptions. Thus, conversely to positivistic studies, interpretivism is based on the ontological assumption that the external world does not have a pre determined nature or structure but is created by the perceptions and consequences of humans. This is known as “idealism” [19] or “subjectivism” [18]. Further, interpretivist lies with the epistemological assumption that the properties of reality can be measured through subjective measures by examining the perceptions of people [15, 16]. Thus, rather than searching for casual explanations or for external factors, interpretivist admire the different views that people place on their experiences. This makes the researcher more closely interactive with the research environment unlike in the positivist studies. Due to this close interaction, the interpretivist believes that the research is value laden, thus choice of what to study and how to study is determined by human beliefs and interests [15, 16]. Further, the interpretivist generates ideas and theories inductively by getting rich data from the study itself.

Interpretivism can be identified as the most appropriate research philosophy for this study due to a number of reasons. To achieve the aim the study the reseacher was required to identify different views of the people regarding the importance, success factors and suitable performance measures related to R&D within the construction sector. Hence, the study valued and encouraged the free flow of ideas, opinions and perceptions of the people, and based on their experience within the research environment thus, considers the human interaction as the main driver of the study. Hence, the study takes the ontological assumption of ‘reality is not pre determined, but socially constructed’ and the epistemological assumption of ‘the knowledge is gathered by examining the views of the people’. In terms of the axiology, the study takes the value laden stance as it is believed that the researcher would add value to the study. The characteristics of positivism and interpretivism based on ontology, epistemology and axiology and the philosophical stance pertaining to this study (shown with a red circle) are illustrated in Figure 2.

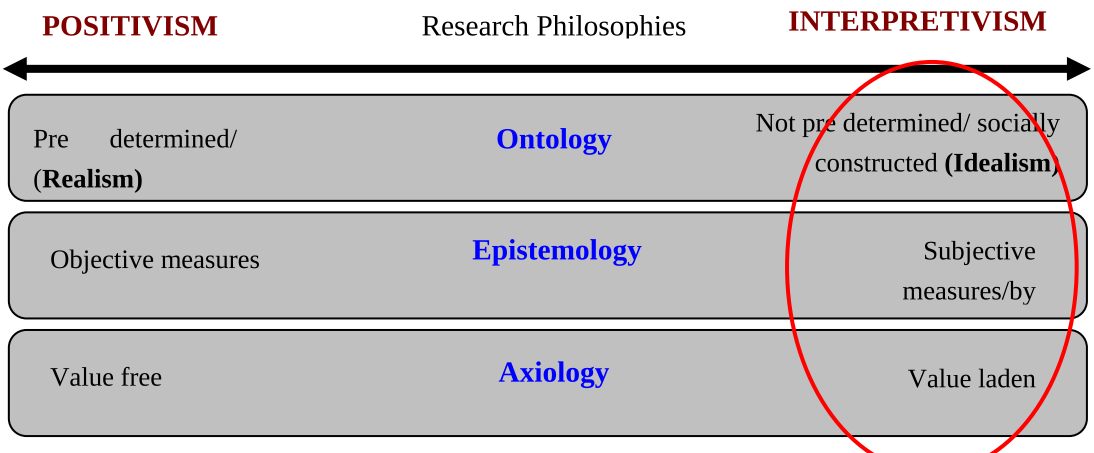

Figure 2: The philosophical stance pertaining to the study against the research philosophical continuum

Having identified the philosophical stance, the next section looks into the research approach governing to this study.

2.2 The research approach

There are number of research approaches where ones research can be based upon, such as experiments, surveys, case studies, action research, and ethnographical studies. Since the parameters are controlled and simplified with hypothesis, experiments are mostly associated with the deductive approach. Similar to experiments, surveys are also related to deductive approach [18]. Collins and Hussey [16] describe case studies as "an extensive examination of a single phenomenon". Unlike the experiments which separate the phenomena from their context, case studies are carried out within the rich, real-world context which the phenomena occurs [20-22]. As oppose to experiments and surveys, ethnographical studies are rooted within the inductive method. In the ethnographical research, the researcher uses the socially acquired and shared knowledge to understand and interpret the human activities [16]. Thus, this approach is suitable to investigate the characteristics of people, their societies and customs. Action research is based on the assumption that the social world is changing constantly and the researcher and the research are also part of the change [16]. Therefore, the researcher will become a part of the environment under study whilst trying to solve practical problems [23-25] and influence the attitudes and behaviours of the participants [26].

From the above discussion, it is evident that research approaches tend to favour deductive or inductive method based on the way they build theory. From the discussions in Section 2.1.1 and 2.1.2 it was revealed that the interpretivist prefers inductive method whilst positivist prefers deductive method. Therefore, by considering these views it can be claimed that the research approaches are likely to be harmonised well with a particular research philosophy than the *other, thus the selection of the research approach needs to reflect the philosophical stance of the study. Accordingly, the researcher plots the research approaches against the philosophical continuum (see Figure 3).*

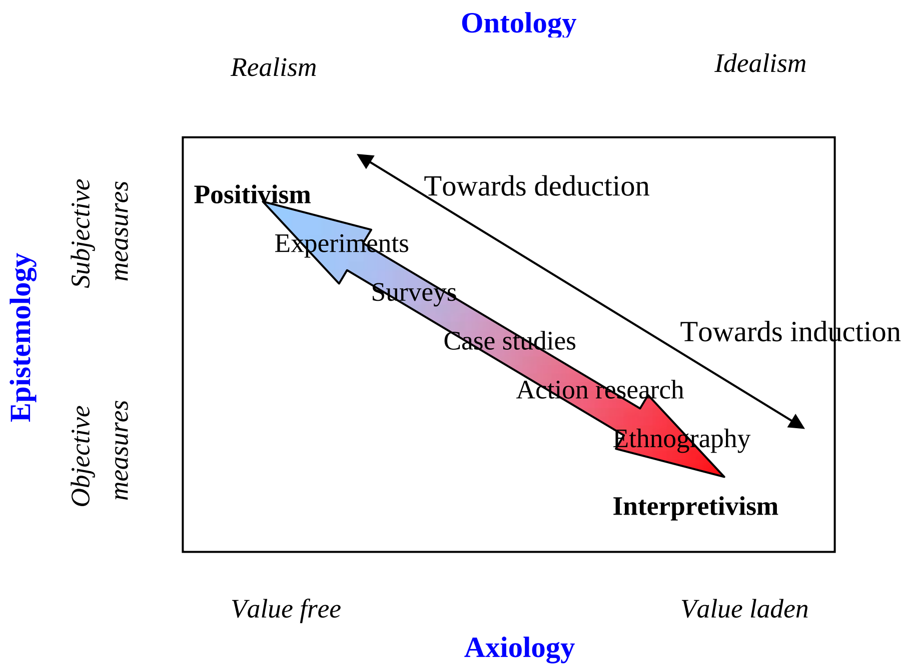

Figure 3: Research approaches within the philosophical continuum

Having developed the relationship between the research approach and philosophy, the following section justifies the use of case study for this study.

2.2.1 Case studies as the research approach

According to figure 3, experiments and surveys are more towards positivism while case studies, action research and ethnography are more towards interpretivism. Since this study takes the interpretivism stance with regard to the philosophy, the use of experiments and surveys are unjustifiable. Accordingly the researcher has to make a choice between ethnography, action research, and case studies. The research under consideration does not intend to influence or change the attitudes or procedures of the participants or the environment as in action research. Further, it does not intend to study behavioural patterns or psychology of the participants as in ethnographical studies. Hence, the case study approach is preferred for this study to explore the PM applications within construction R&D over action research and ethnography.

In addition to the philosophical stance, the research questions posed in a study influence the selection of a research approach. Yin [21] stipulates that "how" and "why" type of explanatory questions favour the use of case studies whilst "what" type of questions support exploratory research. This study consisted of "what" and "how" type of questions (see Section 1) thus, by using the case study research approach, much insight can be obtained firstly by exploring and secondly by explaining the phenomenon under investigation.

Moreover, based on the degree of focus on the contemporary events as opposed to historical events, a researcher can decide a suitable research approach. As Yin [21] states, case studies are more suitable to study contemporary events. Since this study considers a contemporary phenomenon, i.e. the impact of PM towards construction R&D, the selection of case studies can be further justified.

The above section provided three rationales for the selection of case studies; firstly considering the philosophical stance coupled with the requirements of the study, secondly based on the research questions posed and thirdly due to the contemporary nature of the study. The section below further justifies the selection of case study research approach by providing the added benefits of case studies and elaborates on the design aspects of the case study for this study.

2.3 Case study design

The unit of analysis and scope of this study (see Section 2.3.2) requires the consideration of multiple perspectives from different categories of people involved in the construction R&D function. Furthermore, to find solutions to the research questions given in Section 1, and the exploratory and explanatory nature of the study, multiple data collection techniques were needed to cater for the varying purposes of the study. Thus, it became an advantage for this study to choose a research approach that assists an in-depth analysis by incorporating multiple methods. As Zonabend [27] asserts case studies are carried out in a way that incorporates the views of the "actors" of the case under consideration. Further, Gerring [28] stipulates that "one of the primary virtues of the case study method is the depth of analysis it offers" and the use of multiple sources of evidence for data collection [18, 21]. Thus, by using the case study research approach, the study gains the depth of inquiry as well as the utilisation of multi-methods as required.

Despite the advantages discussed above, case studies are criticised for biasness, use of incomplete evidence and for being time consuming and expensive [10]. Yet it can be argued that, if not properly designed the biasness can be included in surveys and experiments. Although case studies are considered as time consuming and expensive, careful design can minimise time and budget. In addition, case studies have a number of advantages which can offset their inherent drawbacks. As mentioned above, case study research approach embraces variety of evidence such as document reviews, interviews, and observations [10, 18] which is considered as a strength that increases the richness of the collected data whilst creating the prospects for data triangulation.

Having chosen case studies as the research approach based on the philosophical stance, research requirements, research questions, contemporary nature, and by considering the added benefits, the next section explains the compromise made between the use of single and multiple case studies.

2.3.1 Single vs. multiple case studies

As stipulated by Yin [21], case studies can be broadly divided into multiple and single and then depending on the number of unit of analysis, embedded (more than one unit of analysis) and holistic (one unit of analysis). A single case study approach is suitable when it investigates critical, unique, representative, revelatory or a longitudinal study [21]. A critical case can be used to challenge, confirm or extend a theory whilst the unique case represents a rare situation. As opposed to a unique case, a representative case captures a common situation or a "typical" project, thus, studying one case is sufficient to get an understanding about other situations. A revelatory case can be used to study a phenomenon that was inaccessible earlier. From a longitudinal case, the phenomenon will be studied over a time period observing how certain conditions have been changed with time. The study under consideration falls under the critical case as it sought to develop and refine a theory on the impact of PM towards construction R&D. The researcher argues that to develop a valid theory, it is critical or important to apply it to the existing situation and refine it. Thus, by taking the critical view, the abstracted concepts will be applied to the existing situation (i.e. the R&D function) and refine it.

Furthermore, this study takes a longitudinal approach as the phenomenon under consideration i.e. PM within construction R&D function is a dynamic process. One of the objectives of the study is to develop a Performance Measurement System (PMS) that could be used to identify the impact and influence of PM on the construction R&D function. To identify the actual impact of PM on the function, the PMS developed through the study needs to be tested on a R&D project, over a time period. Nevertheless, when considering the scope of a PhD, testing the PMS on a R&D project is not practical due to their life span. This is considered as a limitation of this study. As an alternative, it is expected to present the developed PMS to a group of experts through a workshop during the theory refinement stage of the case study, and thereby to assess the impact and influence the PMS could provide to R&D function. With such practical limitations a similar refinement and identification of the impact of key performance indicator's (KPI) on a Knowledge Management environment was done by Pathirage et al [29]. In his study, a structured survey was used during the refinement stage to get the views regarding the impact of KPIs. Accordingly, by taking the longitudinal view, this study explored the current situation within construction R&D function, designed and proposed solutions to enhance the effectiveness of R&D activities and finally obtain the views of expertise on the anticipated benefits of the use of PMS.

The third rationale for the selection of single case study is based on the depth of coverage from this study. Generally speaking, by using multiple case studies, a researcher can increase the breadth of a study. However, the single case study provides the opportunity to explore the phenomenon in detail. Though single case studies are often criticised for not generalising conclusions, many authors argue that the number does not matter as long as the case study addresses its stipulated objectives [21, 30, 31]. Consequently, if it is designed and conducted appropriately, even a single case study would be able to contribute to the knowledge rather than a poorly designed multiple cases. By taking forward this argument, the researcher also believes that what matters is not the quantity of case studies (because the quantity cannot substantiate the quality of the research work), but designing the case study to suit its scenario governed by the aim of the study. Since this study expects the continuous development and refinement of theory the researcher needs to carry out an in depth study by making a compromise between the breadth and depth. The depth of coverage using multiple data collection methods, multiple perspectives and at three different instances is further discussed in Section 2.4.

In brief, the study chose the single case study approach due to the criticality of the theory development and refinement of the phenomenon, the longitudinal view of the study and the depth of inquiry. The next section looks in to the unit of analysis pertaining to this study.

2.3.2 The unit of analysis

As asserted by Miles and Huberman [32], the unit of analysis of a study is a "phenomenon of some sort of occurring in a bounded context". According to Collins and Hussey [16] it is the focal point where the variables, phenomena and the research problem referred to and about which the data is collected and analysed. Because of its importance, Miles and Huberman [32] identify the unit of analysis as the "heart" of the study. Remenyi et al [10] states that the decision of the unit of analysis is governed by the research questions of the study. The unit of analysis of a case study can range from an individual, group of people, to a process or relationship (see [10, 21]). It is advisable to establish the unit of analysis similar to a previous study by considering the literature in the subject area rather than establishing it arbitrarily [10, 21]. Accordingly, by considering the research questions posed for the study (see Section 1) and by considering the previous literature (see [33]) *R&D function* was selected as the unit of analysis of the study. R&D function was defined as the "set of activities necessary to effectively and efficiently initiate, co-ordinate and accomplish the product and process development activities of a company" [34]. Therefore, by fixing the unit of analysis at the R&D function, this study takes the single-holistic case study nature.

Having identified the unit of analysis, the researcher fixed the boundary of the study. Definition of the boundary helps the researcher to identify the scope of the study, for example to determine the limits of the data collection [21]. Construction R&D activities can take the form of academic research, industrial research and collaborative research between academia and industry. It was identified from the literature and expert interviews that collaborative research yields number of benefits [35, 36]. Thus, the unit of analysis was extended outwards to represent multiple organisations namely the universities and construction organisations which fall under the scope of the study. Accordingly the data was gathered from the individuals (academics and industrial partners) employed in those multiple organisations regarding the R&D function.

2.4 The case study process

As discussed in Section 2.3.1, the single case study approach was selected for this study. Accordingly, the researcher explored and understood the PM concept within the construction R&D function, without controlling the variables but rather taking into account the variables applicable and studying the inter relationships between R&D and PM. As noted by Strauss and

Glaser [37], theory building requires the on going comparison of data and theory. Adding to that, Lynham [38] asserts continuous refinement between theory and practice is also needed for the effective theory building. This section describes the case study process used for the theory building and refinement with particular reference to the stages and objectives of the case study.

As mentioned in Section 2.2, the deductive method starts by conceptualising the phenomenon followed by empirical observation to test it whilst inductive method starts with empirical observation to develop theory. Further, it was noted that the positivism research takes a deductive method whereas the interpretivism takes the inductive method. However, it was justified that the research under question take the interpretivist stance in terms of the philosophy (see Section 2.1). Therefore, should this study use a purely inductive method and generate the theory from the data itself? Eisenhardt and Graebner [20] provide much insight to answer this question by stating that case study research starts with a deductive approach and moves on to an inductive approach to build theory. The importance of having an initial definition of the research question prior to starting theory building was highlighted, otherwise the researcher can become overwhelmed by the amount of data gathered. Similarly Yin [21] asserts the need of pre establishing a theory or conceptualising the phenomenon prior to data collection and analysis process. Accordingly, before starting the case study approach, the researcher conceptualised the PM in construction R&D function by deriving research questions through a comprehensive literature review and expert opinion. Thereafter, during the case study design and preparatory stage (refer Figure 4), a suitable case study was selected and the data collection protocols were prepared and piloted. With this background, the researcher started the actual data collection within the case study. The case study took multi-phase approach that consisted of three stages of data collection (refer Figure 4).

The first stage took on an exploratory nature by investigating the current status of construction R&D, application and need of PM within R&D, and exploring the success factors of construction R&D in general. For this semi structured interviews were carried out. The second and third stages also took an explanatory nature. Accordingly, during the second stage, the critical success factors of construction R&D function was established by administering a questionnaire survey. The data from the first and second stage lead to the development of the PMS to identify the impact of PM towards construction R&D. During the third stage, it is expected to refine the theory developed through the case study and to suggest solutions for effective PM within the construction R&D function.

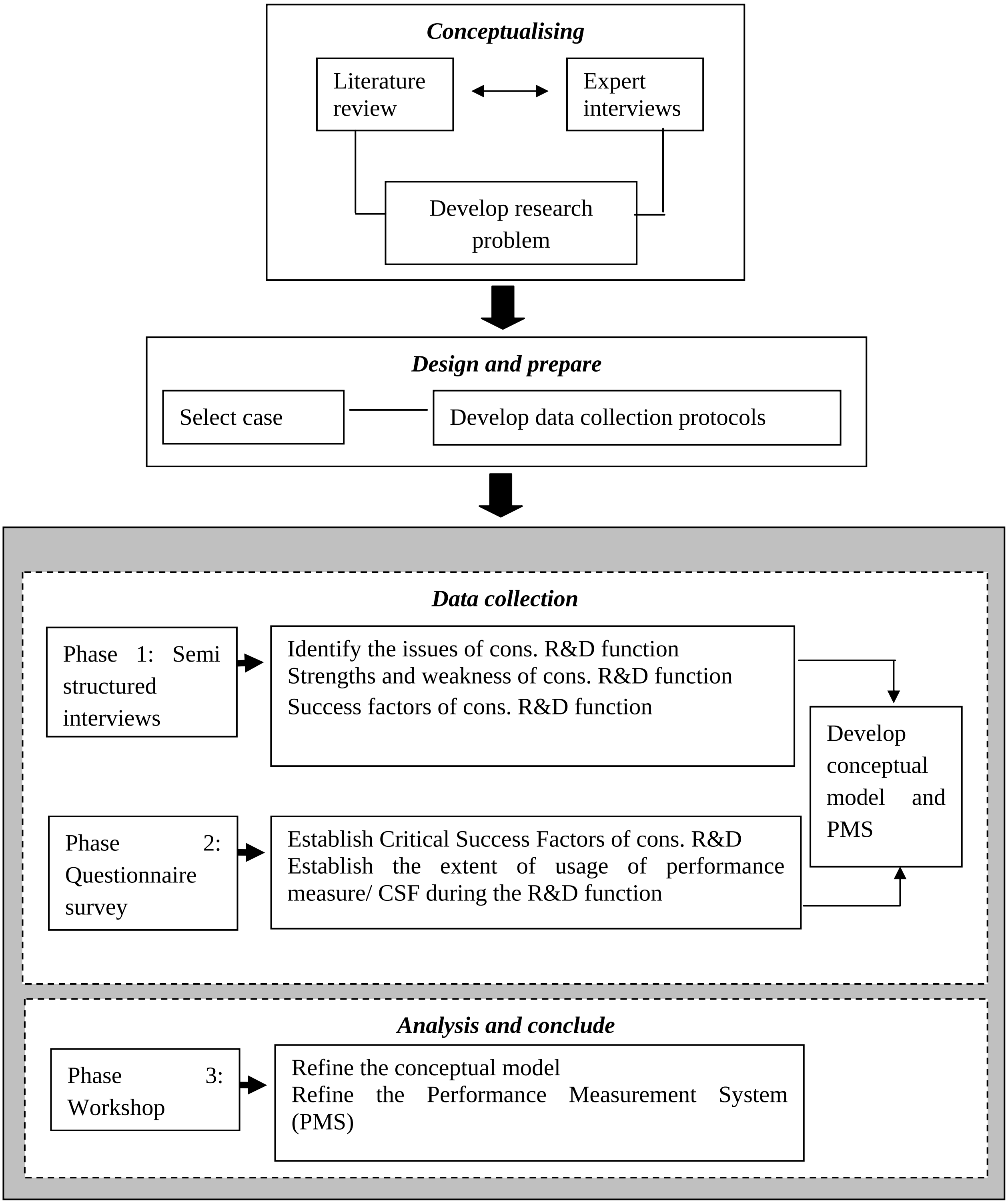

Figure 4: The single case study research approach

During the case process, the researcher adheres to a number of characteristics to enhance the completeness, validity and reliability of the study (refer table 1)

Table 1: Characteristics of an exemplary case (adopted from [10])

Character	Description	How it is addressed
Significant	Case study is of interest to the relevant stakeholders	Through the literature and expert opinion, the need for PM within R&D function was established. Further, paucity of research in this area created the need of further research.
Complete	Clear definition of research problem, identification of boundaries of the case study	Establish the research problem through a comprehensive literature review and refinement of the same through expert opinion. Through the research questions the study gained the focus and identified the areas to be explored. Identification of unit of analysis and scope of the case study ensured the proper establishment of a boundary.
Consider alternative perspectives	Collecting the relevant evidence from different perspective and triangulation of evidence	The evidence was gathered from principle investigators, researchers and industrial partners to corroborate the same issues. Triangulation of evidence in terms of source, methodology.
Display sufficient evidence	Present compelling and convincing evidence	Through the data analysis, the initial research questions and thereby the aim and objectives of the study was addressed. Creating links between the literature and empirical evidence, consideration of the different perspectives to corroborate the evidence.
Composed in an engaged manner	Ensuring the validity and reliability of the study	Number of good practices was adopted to ensure the reliability and validity of the study (member checking, preparation of interview guidelines, tape recording the interviews, piloting the survey etc.).

In brief, it can be summarised that the initial concepts abstracted through the literature review and expert opinions were empirically observed, validated and will be refined by employing a multi-phase single case study approach, by considering multiple perspectives and by using multiple methods for data collection.

3. Conclusions

The paper explored the use of single case study research approach to evaluate the impact of PM towards construction R&D function. It was revealed that the proper understanding of the philosophical issues followed by a clear definition and design of research strategy are essential elements in developing successful research. Through the use of single case study, the paper emphasised that what matters is not the number of cases, but the appropriate design and selection of methods to investigate the research in question. Therefore, it can be concluded that the application of single case study to investigate the impact of PM in construction R&D function by incorporating multi-phase, multi-perspective and multi-method approaches will enable us to build up a *valid theory* due to the continuous comparison of empirical data with the study's initial concepts (propositions) and the refinement of the developed theory within the same case study.

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The Effect of Language of Instruction on Course Results for Civil Engineering Students in Estonia

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Abstract

Education globalisation is a reality today. Students from different countries can participate in exchange programmes in universities worldwide. However, this makes sense only if students understand the language of instruction. For large and industrialised nations there is no problem, they teach in their native language and there are always foreign students who can understand the course content. Developing countries and small nations face a more complicated situation: they can choose to teach in an internationally recognised language or in their native language. Both solutions have their advantages and disadvantages and in both cases a large number of students pursue their university education in a foreign language. The research is intended to examine whether language proficiency represents a significant disadvantage for engineering students who do not learn in their mother-tongue. This paper describes research into the performance of Russian-speaking civil engineering students relative to their Estonian-speaking counterparts at the Tallinn University of Technology. Results over eight years for a course taught in the Estonian language are compared to determine whether any trends in the relative performance of students from the two main language-cultural groups and also genders are perceptible. In addition, comparison is made with students' results for a course taught in English in the 2006/7 academic year to provide an indication of the effect of Estonian language knowledge on course results.

Keywords: Engineering education; education globalisation, influence of language; influence of gender

1. Introduction

1.1 The Wider Research Context

In today's globalised market for higher education, students have the possibility of studying at universities in almost any country worldwide. However, this makes sense only if they understand the language of instruction. For large and industrialised nations the choice of language of instruction at universities is obvious - they teach in their official state languages (English, Russian, French, German, Chinese, etc.) and there are always foreign students who can understand the course content. Developing countries and small nations, on the other hand, face a more complicated situation: they can choose to teach in an internationally recognised language (as universities in Sri Lanka do), in their native language (as in Estonia) or some combination of the two. In all cases, issues relating to language proficiency amongst students and institutional capacities to provide suitably qualified staff and course material in all requisite subject areas to teach in the elected language (or languages) arise.

While a considerable body of literature examines the role of language-cultural groups in education in Estonia generally, to the authors' knowledge this is the first time that an attempt has been made to compare the advantages and disadvantages deriving from language-cultural group membership in the education of engineers in Estonia. As such it represents original research.

1.2 Historical Background to the Linguistic Environment in Estonia's Universities

Largely as a consequence of Soviet era settlement of ethnic Russians, Ukrainians and Belorussians in Estonia, a Russian-speaking minority comprises approximately 30% of Estonia's population. Throughout the Soviet era, education was provided separately in both Estonian and Russian languages, the majority of schools being either monolingual Russian or monolingual Estonian schools. At university-level, students were taught separately in Estonian and Russian groups with both groups following the same programme but each in their native language.

Since the restoration of independence in 1991, one of the most significant government policy changes in Estonia has been the adoption of Estonian as the only official state language. In order to integrate the Russian-speaking minority, the Estonian Government has elaborated a State Programme for Integration [10]. Among the comprehensive measures planned are different methods for the teaching of Estonian language. However, most schools remain as either Estonian schools or Russian schools and a considerable proportion of Russian-speaking children complete secondary school with limited Estonian-language proficiency. As the language of instruction at state-funded universities is mainly Estonian, this constitutes a potential disadvantage in pursuing further academic studies (Leino et al [9]; Brown [4]).

With an Estonian-speaking population in the order of only 1 million people, it is debatable whether it is possible to provide universities with high quality professors in all the necessary fields. Consequently, universities are faced with a choice between two working language directions for the future:

- to maintain the requirement that academic staff be able to teach in Estonian and thereby effectively preclude foreign staff with the risk that quality might be compromised; or,
- to drop the demand for teaching in Estonian and thus increase the pool of eligible academics. However, this involves risks associated with the quality of engineering knowledge transfer if students are not fluent in the language of instruction and the negative effects that this will have on Estonian engineering and scientific language.

> Having avoided it during 50 years of Soviet occupation, voluntarily accepting the demise of Estonian language through changing the language of instruction in universities at a time of national independence would be unthinkable.

There is a need to find a reasonable compromise to this problem by deciding which disciplines, at what levels, etc. might be taught in other languages in such a way so as to complement the core, Estonian language, university courses. The current study's investigation into the influence of language of instruction on course results offers empirical input to this debate by providing insight into the effectiveness of knowledge transfer where issues of language proficiency exist.

1.3 Languages of Instruction in the Faculty of Civil Engineering at Tallinn University of Technology

Tallinn University of Technology (TUT) was founded in 1918 as an engineering college and it was granted university status in 1936. Today TUT is one of the largest public universities in Estonia and has over 10,000 students. In the Faculty of Civil Engineering there are approximately 800 students. The faculty currently offers Master of Science in Engineering and PhD study programmes with nominal study durations of 5 years and 4 years respectively. At TUT civil engineering students are taught separately in Estonian and Russian for the first two years during which time non-Estonian-speaking students can take the Estonian language course offered by the university. Starting from the third year the language of instruction is primarily Estonian. From this point, Russian-speaking students are taught in a combined group with their Estonian-speaking counterparts in the Estonian language.

Since Estonia's accession to the European Union in 2004, the effects of education globalisation have begun to be felt. With increasing international mobility of both students and staff, the university hosts more foreign professors, lecturers and students and, as a consequence, the use of English at TUT is growing. As more courses taught in foreign languages (particularly English) are developed, Estonian-speaking and Russian-speaking students are increasingly being called upon to undertake some of their studies in a foreign language (refer to Altbach [2] on the predominance of English as an international academic language).

2. Problem Definition

In this way, language issues are central to TUT's ability to successfully maintain the quality of technical education and thus fulfil its national obligations to develop and transfer knowledge as well as to compete in the global market for education and research. Two specific language-related questions arise from recent developments and anticipated future trends:

- How has the change to Estonian language tuition affected students whose home-language is not Estonian – particularly the large minority of Russian-speakers?
- How might the increasing tendency to provide modules in English or other foreign languages impact on the performance of students?

3. Basis of Research Approach

The importance of proficiency in the language of tuition and testing has been investigated by many researchers covering a variety of taught subjects, e.g. Cuevas [5], and, unsurprisingly, an inadequate understanding of the language of instruction is found to be a major source of underachievement. Similarly, a considerable collection of factors have been variously found to be correlated with academic performance including:

- Alfan, E. and Othman, M.N. [1]: secondary school academic performance, admission qualifications, gender, attendance (full-time / part-time), linguistic capacity, ethnicity, culture, age;
- Eskew, R.K. and Faley, R.H. [6]: academic aptitude, past performance; effort / motivation, previous experience of subject matter, exposure to more generally related subject matter areas;

Some have considered these in the context of ethnic groups, e.g. Hofman, A. and van den Berg, M. [7], – ethnic specific differences: prior education, financial considerations (minorities need to earn more to afford university), effort.

The influence of language of instruction has been widely investigated at the level of primary and secondary schools in Estonia. Leino *et al* [9], based on empirical studies, stated that young non-Estonians put greater emphasis on their acquiring education and obtained better results than the local Estonian majority. The same authors also found that differences exist in students' performance at schools in Estonia between both the Estonian and Russian language-cultural groups as well as on the basis of gender so that the subgroups may be ranked by school results achieved as follows (from best to worst): (1) Girls whose language of instruction is Russian; (2) Girls whose language of instruction is Estonian; (3) Boys whose language of instruction is Russian; (4) Boys whose language of instruction is Estonian.

R. Kallas [8] has observed the performance of students of non-Estonian origin learning in Estonian secondary schools and indicated that there is no significant difference in their results by nationality.

In this paper an attempt has been made to compare the advantages / disadvantages deriving from language-cultural group membership in civil engineering education at university level.

4. Methodology

The research described here is essentially a comparative before and after study. It compares the performance of two populations of undergraduate students one of which is Estonian-speaking and the other Russian-speaking. The results obtained by these students in a Building Technology course are compared:

- for the years when the two groups received separate instruction in Estonian and Russian languages, i.e. before the change to all students receiving the course in Estonian; and,

- for some years after the change to all students being taught the course in Estonian.

Since it is a comparison, the influence of factors such as prior education, past performance, age, previous experience, culture and financial considerations are assumed to be insignificant in that they are considered to remain relatively constant. The effect of gender, however, must be taken into account as the changing proportions of males and females within the language-cultural groups may affect differences in course results between the groups given that gender differences in academic performance have already been observed at school level (Leino *et al* [9]).

For the years 1999 to 2006 inclusive, the results for all students participating in the Building Technology course were collated. The student group for each year was disaggregated by language-cultural group membership and by gender into four sub-groups: (1) Estonian-speaking females; (2) Estonian-speaking males; (3) Russian-speaking females and (4) Russian-speaking males. The course results obtained by students in each sub-group were compared in order to determine:

- whether the course results achieved by Estonian-speaking students in each year are significantly better than those achieved by Russian-speaking students; and,
- whether the course results obtained by Estonian-speaking males differ significantly from those obtained by Estonian-speaking females and whether the results obtained by Russian-speaking males differ from those obtained by Russian-speaking females.

In addition, comparison was made between students' results in the Building Technology course (taught in Estonian) and those in the Project Management in Construction course (taught in English).

5. Description of the Study Group and Results

5.1 The Building Technology Course 1999-2006

The course of Building Technology is taught during 2 semesters in the third year of engineering studies. It involves 120 academic hours of lectures and a course project. Students must pass 8 tests, 2 written exams and defend their course project, which involves considerable independent work. In return, they receive 6.5 credit points (3 for the first exam, 2.5 for the second and 1.0 for the course project).

In the years 1999 and 2000, Estonian and Russian students were taught in separate groups in their respective languages. Since 2001, the separate groups have been united and the language of instruction is Estonian. For the 8 years from 1999 to 2006, total student participation in the course varied from 44 to 130 with the proportions of Estonian-speaking and Russian-speaking students varying from 55% - 72% and 28% - 45% respectively. Between 16% and 27% of participating students were female.

5.2 The Project Management in Construction Course 2006

In 2006, for the first time, a course previously offered in Estonian language was delivered in English. The course, Project Management in Construction (60 academic hours and 2.5 credit points), was taught to fourth year civil engineering students. Students' performance was assessed by means of a coursework project and a written exam. A total of 74 students participated in the course of whom 55% were Estonian-speaking and 45% Russian-speaking. 38% of participating students were female.

5.3 Results

For the Building Technology and the Project Management in Construction courses, the student participation rates and average results achieved for the years under consideration are tabulated in Table 1 and Table 2 respectively.

Table 1: Student Participation in the Building Technology and Project Management Courses

Student Subgroup	Number of participating students							
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
a) Building Technology Course								
Estonian-speaking Females	16	4	11	8	6	14	9	11
Estonian-speaking Males	71	60	30	26	18	48	57	49
Russian-speaking Females	15	12	5	4	4	12	13	17
Russian-speaking Males	28	25	14	9	16	21	29	32
Total	**130**	**101**	**60**	**47**	**44**	**95**	**108**	**109**
b) Project Management in Construction Course								
Estonian-speaking Females	-	-	-	-	-	-	-	**15**
Estonian-speaking Males	-	-	-	-	-	-	-	**26**
Russian-speaking Females	-	-	-	-	-	-	-	**13**
Russian-speaking Males	-	-	-	-	-	-	-	**20**
Total								**74**

Table 2: Average Results obtained for the Courses

Student Subgroup	Average results, %							
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
a) Building Technology Course								
Estonian-speaking Females	78.6	81.3	88.7	59.1	69.3	84.9	71.8	76.6
Estonian-speaking Males	71.3	83.4	83.3	79.3	77.0	78.0	78.2	74.8
Russian-speaking Females	77.2	86.8	82.8	72.8	66.0	58.6	68.8	57.5
Russian-speaking Males	72.5	79.5	69.6	60.1	66.8	58.3	64.5	61.6
b) Project Management in Construction Course								
Estonian-speaking Females	-	-	-	-	-	-	-	74.2
Estonian-speaking Males	-	-	-	-	-	-	-	76.1
Russian-speaking Females	-	-	-	-	-	-	-	65.4
Russian-speaking Males	-	-	-	-	-	-	-	57.8

6. Analysis and Interpretation of Results

By analysing the results obtained by individual students comprising each language-cultural and gender subgroup, the statistical significance of the relationships under investigation were tested.

6.1 Do Russian-speaking Students Perform Worse than their Estonian-speaking Counterparts?

The research hypothesis may be framed as follows: The change from instruction in separate languages to instruction in Estonian negatively affected the performance of Russian-speaking students. A corresponding null hypothesis enables the testing of our hypothesis:

- Null Hypothesis 1: (For each year) Estonian-speaking students did not perform significantly better than Russian-speaking students,

An unpaired, one-tailed Student's $t-$test was applied. The values of p calculated show the probability of these results assuming the null hypothesis. The results of this analysis are shown in Table 3 below.

Table **3***: Probability of the Observed Results assuming Null Hypothesis 1*

Student's $t-$test (unpaired, 1-tailed)	**Test results**							
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
a) Building Technology Course								
Degrees of freedom	128	99	58	45	42	93	106	107
Probability, p (assuming null hypothesis)	0.356	0.357	0.015	0.056	0.051	1E-06	8E-05	2E-06
b) Project Management in Construction Course								
Degrees of freedom	-	-	-	-	-	-	-	72
Probability, p (assuming null hypothesis)	-	-	-	-	-	-	-	1E-05

Assuming an alpha level of p =0.05, we may reject the null hypothesis at values of p <0.05. In the years 1999 and 2000, prior to the change from separate tuition in Russian and Estonian to all students being taught in Estonian, Estonian-speaking students did not perform significantly better than Russian-speaking students. Whereas, in the years 2001, 2004, 2005 and 2006 the null hypothesis may certainly be rejected, the values of p yielded for the years 2002 and 2003 (0.056 and 0.051 respectively) are marginal. However, it should be noted that these results are influenced by the lower number of students participating in the Building Technology course in these two years and, in consideration of this, the better performance of Estonian-speaking students in these years may be interpreted as being significant.

Thus, Estonian-speaking students performed significantly better in all years after the change to Estonian language tuition only (2001-2006) and we may accept our research hypothesis that the change from instruction in separate languages to instruction in Estonian negatively affected the performance of Russian-speaking students. This is clearly visible from a plot of the average course results achieved by the two language cultural groups as shown below in Figure 1.

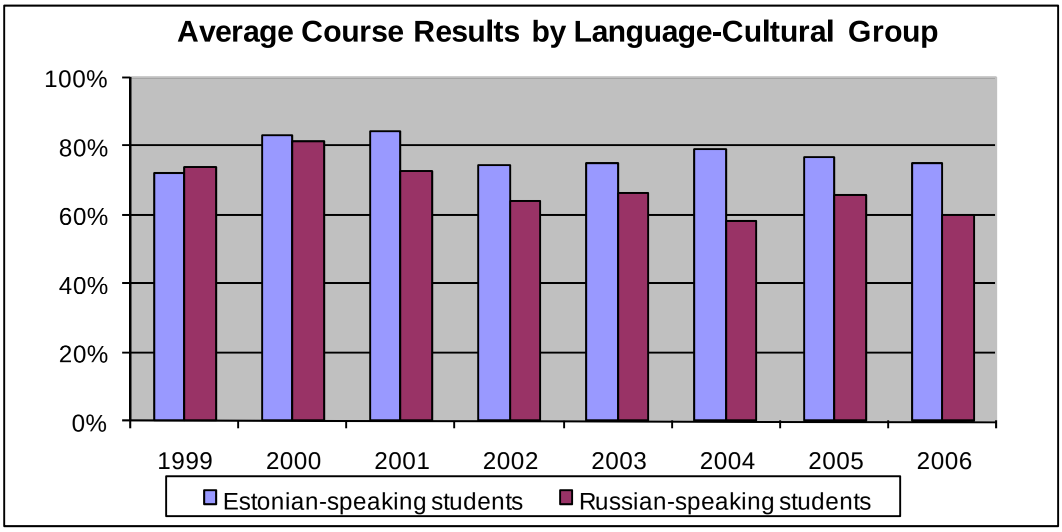

*Figure **1**: Average Course Results by Language-Cultural Group*

In the years 1999 and 2000, when the Building Technology course was taught in two separate languages, the average results obtained by the Russian-speaking students were similar to those of the Estonian-speaking students. In the years 2001 through 2006, when all students were taught in Estonian, a noticeable gap is apparent between the average results of the two groups.

A further illustration of the effect of the change on Russian-speaking students may be seen from a plot comparing the proportion of students in each of the two language-cultural groups who achieved ’good’ grades (i.e. grades of 4 and 5 in the TUT grading system, corresponding to results of > 80%) as shown in Figure 2 below.

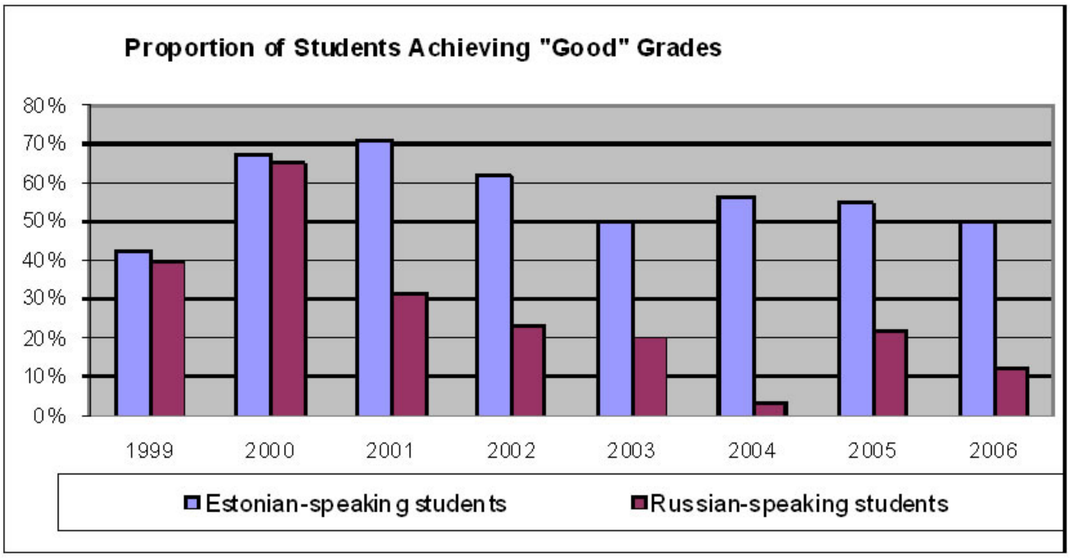

Figure **2**: *Proportion of Students Achieving "Good" Grades*

The same analysis of results achieved by the two language-cultural groups in the Project Management in Construction course (which was conducted in English) reveals that Estonian-speaking students performed significantly better than their Russian-speaking counterparts. This may indicate a similar gap between the groups in both Estonian language and English language proficiency but could as well be influenced by other factors. In contrast to the results for the Building Technology course which allow for comparison before and after the change in the language of tuition, the Project Management in Construction course results are available for only 2006 when instruction in English started. Beyond serving to confirm that a performance gap between Russian-speaking and Estonian-speaking students exists in other courses besides the Building Technology course, they do not provide additional insight into the nature of this gap.

6.2 Is there Evidence of a Gender Difference in Student Outcomes?

Since a difference in the performance of Estonian-speaking and Russian-speaking students (following the change to Estonian language tuition) has already been established, the existence or otherwise of significant gender differences in performance must be investigated within the language-cultural groups rather than considering the entire student group.

Research Hypothesis: Within the Russian-speaking and Estonian-speaking groups, differences between course results obtained by males and females exist.

- Null Hypothesis 2: (For each year) Estonian-speaking males did not perform significantly differently to Estonian-speaking females.
- Null Hypothesis 3: (For each year) Russian-speaking males did not perform significantly differently to Russian-speaking females.

An unpaired, two-tailed Student's $t-$test was applied. The values of p calculated show the probability of these results assuming the null hypothesis. The results of this analysis are shown in Table 4 below.

Table **4***: Probability of the Observed Results assuming Null Hypotheses 2 & 3*

Student's $t-$test (unpaired, 2-tailed)	**Test results**							
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
a) Building Technology Course								
Degrees of freedom	85	62	39	32	22	60	65	58
Probability, p (null hypothesis 2)	0.218	0.737	0.082	0.067	0.600	0.062	0.101	0.695
Degrees of freedom	41	35	17	11	18	31	40	47
Probability, p (null hypothesis 3)	0.486	0.264	0.159	0.253	0.913	0.968	0.463	0.487
b) Project Management in Construction Course								
Degrees of freedom	-	-	-	-	-	-	-	39
Probability, p (null hypothesis 2)	-	-	-	-	-	-	-	0.450
Degrees of freedom	-	-	-	-	-	-	-	31
Probability, p (null hypothesis 3)	-	-	-	-	-	-	-	0.165

Assuming an alpha level of p =0.05 again, in no year within the study may either null hypothesis 2 or 3 be rejected as all calculated p values exceed this threshold. Thus, there is no evidence of statistically significant differences between the course results obtained by males and females in either language-cultural group. This may well be influenced by the small sample sizes.

6.3 Has the Performance Difference between Estonian-speaking and Russian-speaking students Increased over Time (since 2001)?

Having established that there is a significant gap in performance since 2001 between the Russian-speaking and Estonian-speaking students and that this appears to be independent of gender differences, it is important to determine whether this gap is stable, narrowing or widening. Figure 3, below, plots the difference in results (how much better Estonian-speaking students have performed, expressed as a percentage of the Russian-speaking students' average results) for the Building Technology course against time.

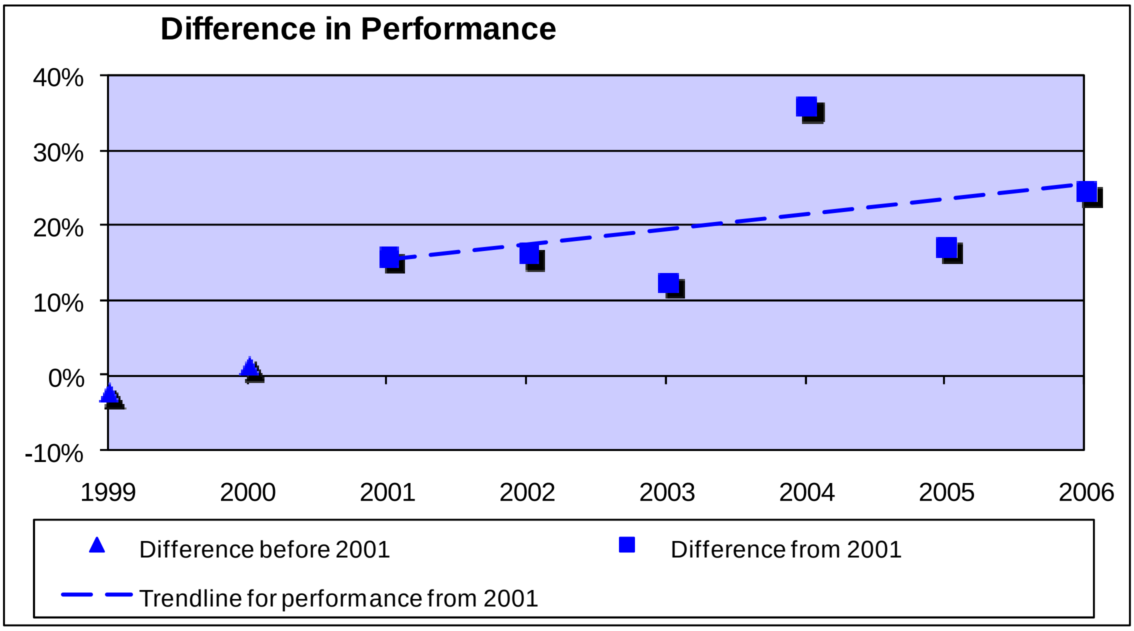

*Figure **3**: Difference in Performance*

A linear trendline superimposed on the performance differences calculated for the years 2001 to 2006 would indicate that the performance difference has tended to increase over time. It is also evident that the performance differences between the groups which were negligible in 1999 (-2%) and 2000 (1.6%) are considerable from 2001 (the average results of the Estonian-speaking group having ranged between 12.7% and 36.2% better than the average results of Russian-speaking students). Interestingly, the performance difference calculated for the Project Management course results in 2006 is 24.1%, very similar to that shown below for the Building Technology course in the same year.

7. Conclusions

This research represents an initial and very limited investigation, but it does highlight the sensitivity of the language problem by showing that students' performances are dependant on their proficiency in the language of instruction:

- The difference in the results achieved by Russian-speaking students and those achieved by Estonian-speaking students since separate language tuition was stopped and the Building Technology course was taught in only the Estonian language indicates that the Russian-speaking students' Estonian language skills are insufficient and considerably compromise their course results. A direct relationship between language proficiency and course outcomes is apparent.
- As observed with the Project Management in Construction course, opting to teach in a foreign, international language may yield similarly large gaps between language-cultural groups' performances. In contrast to the case of the Building Technology course where at least the Estonian-speaking group's results were not adversely affected by the language proficiency factor, all students' results in the Project Management in Construction course may have been adversely affected by the choice of English as the language of instruction.

It follows that decisions concerning the language of tuition at universities have a profound effect on knowledge transfer to students and, ultimately, on national development.

8. Recommendations

The considerable magnitude of the performance gap observed and the possibility that it may be increasing is concerning not just from a narrow, effectiveness of university tuition point of view, but potentially for its wider socio-economic and political implications. It is therefore recommended that a further, wider investigation establish whether or not these performance differences are apparent in other courses taught within the Faculty of Civil Engineering and to define more precisely the factors influencing the differences with a view to proposing practical measures to close the gap. Additional factors affecting performance may include the extent of students' employment, lecture attendance rates, etc which need further investigation.

In the wider, international context, where both students and professors are increasingly mobile, questions are raised in terms of the effectiveness of learning in foreign languages – to what extent are engineering students throughout the world having their learning experience compromised by inadequate language skills? The influence of language of instruction must be given thorough consideration.

- It is important to ensure that students obtain solid fundamental knowledge and, therefore, that instruction in basic and core modules of the civil engineering curriculum should preferably be maintained in students' native languages. Where this is not possible, targeted language support should be provided. Similar was suggested also by Briguglio [3] in strategies for overcoming linguistic difficulties.
- At a higher level of education (Master, PhD) the need for knowledge of foreign languages is obvious and engaging international professors is highly recommended. The same applies to elective courses within the civil engineering curriculum. However, lecturers instructing in foreign language must give consideration to students' knowledge of the language of instruction.

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A Change in Perspective For Construction Management Education

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Abstract

Competency-based training has become synonymous with training per se. It has had a particular and major impact on vocational education and training, and it is unsurprising that professional associations have moved to adopt competency-based accreditation of study programs in construction management. However, this paper will argue that the nature of university education, the constraints on course structure, the traditions of teaching, etc. collectively militate against effective competency-based educational models. At the same time, there are significant questions being raised against the promotion of competencies as an effective measure of professional education. Educational providers, legislators, and professional associations each tend to disagree about what competence means and what the nature of expertise actually is.

This paper will draw on the emerging concepts of transformative learning, to propose perhaps a more radical response to what appears to be an ongoing (and ultimately losing) battle to condense construction management programs further and further. The conceptual framework it presents will range across reflective and deliberate practice, situated learning, disciplined awareness, and the ontological structure of disclosure. In essence it calls for a displacement of competency and knowledge as the primary drivers of vocational degree programs in construction management. Instead it argues for a more psychosocial approach to learning, where content is replaced with process as the driver of learning. The psychosocial approach privileges a case-in-point approach to learning. It moves the focus of education away from the individual learner gaining a discrete body of abstract knowledge, acquired and subsequently applied in practice. It treats learning as an interpretive process in which understanding is related to action contexts, and not to prescribed conceptual structures.

Keywords: Education, Transformative Learning, Competency-Based Training, Case-in-Point

1. The growing domination of competency-based training

1.1 What is competency-based training?

There remains a significant difference of opinion, within the literature, on a range of issues relating to competency-based training: how best to define and distinguish competency itself; what might constitute a competency-based training model; and how competency-based assessment and accreditation might most effectively be implemented [1]. According to the U.S. Department of Education, a competency is defined as the "combination of skills, abilities, and knowledge needed to perform a specific task" [2]. There is clearly an emphasis on the combination of theoretical knowledge with practical experience. This emphasis is one of the most consistent elements found in how competency is defined more generally. It is an important common emphasis, however. It makes it explicitly clear that competency is fundamentally about the assessment of the capacity for a person to perform certain professional tasks, in given situations, in a particular way [3].

In this sense, the relevance of competency-based training to professional practice (and vocational training more generally) is undeniable: professional competence is inevitably benchmarked against a particular set of specific competencies. The concern of this paper is not, therefore, in regard to the nature of professional competence and how it may or may not be constituted. Rather, this paper takes issue with the use of those professional competencies, so identified, as the basis for the accreditation of professional, higher-educational degree programs in construction management. In other words, the issue here is about the relevance of a competency-based training model for vocational higher education degrees in construction management.

1.2 The background to competency-based training

The emergence of competency-based training (CBT) has been driven largely by industry, specifically by the response of industry to broader-level skill shortages. It has long been realised that the operation of any business or undertaking (existing or proposed) can be broken down into particular resource requirements. The human resource component of those requirements can be identified quite directly in terms of particular competencies. It matters little if it is the strategic plan for an entire business, the performance of a particular department, project, team or even an individual. Given a particular set of performance targets, a comprehensive list of the competencies required to satisfy such targets can also be made explicit. These requirements can then be compared with a survey of the scope and depth of existing competencies within the organisation, department, project, team or individual. It is then possible for a mapping of the capacity/capability gaps, between what is required and what is available, to be generated. Almost surgically, some might argue, training interventions can be identified and targeted to provide all of those, and only those, competencies required of particular individuals: no unnecessary training, no wasted resources, and everything driven directly by business objectives. Of course that places a lot of emphasis, and responsibility, on identifying the required competencies correctly. But as a driver of human resource recruitment and training, CBT has been a major growth area in recent years.

CBT has been a revolution for workplace training – but it has been an industrial revolution. In seeking to divide professional practice into discrete, specialised and contained tasks, where no resources are to be wasted on learning anything other than those particular discrete, specialised and contained tasks, CBT has become reductionist and prescriptive [4]. Any such reductionist approach fails fundamentally to address the needs of professional practice, which is something entirely more holistic in nature [5]. Thus CBT, initially at least, tended to hit a wall with professional practice. In response, the concept of CBT has undergone a series of significant evolutions and improvements. These improvements have included a better alignment of training tasks with the development from novice to expert: different levels of competency have been introduced to stage the learning of particular competencies. CBT has also been improved by including a broader mix of competency types, to more explicitly include attitudes and values as learning outcomes. This expansion of CBT began to introduce new problems of how to measure the different levels and more subjective considerations with reasonable fidelity. Questions relating to the effective and consistent assessment of such an extended and more complex CBT framework are beginning to emerge, making CBT assessment of increasing concern [6].

1.3 The assessment of competency-based training

Assessment within a more complex competency framework is not a simple problem. Notwithstanding that such competencies have first to be identified correctly, effective assessment demands that common, clear and explicit standards have to be agreed and established. Along with such standards must be specified the valid and reliable evidence required to demonstrate when and how each competency has/is to be satisfied. All of this information then constitutes the common assessment framework that each teacher and assessor must understand and interpret in an agreed manner. Throw into this already complex mix the fact that learning situations vary, assessment can involve a range of different methods (from observation through to personal reflection) and the fact that assessment is inevitably judgement-based, and the potential for inequity is clear. Of course such frameworks have been developed successfully, even at a national level, in particular contexts. The question and issue remains, however, whether effective frameworks can be developed for a higher education context where the significance of implicit cognitive processes is more acute [7, 8].

The difficulties exposed in assessment of competencies, are then reflected in the difficulties faced by the teachers of those competencies. To be properly prepared to teach professional practice competencies it can be argued that the educators need, to a substantial degree, to be an expert practitioner themselves [9, 10]. It is an increasingly rare case that an effective academic researcher will also have the breadth of professional expertise needed to teach or assess the complex of professional competencies. This is perhaps more particularly the case in construction than other market sectors, where the separation of research and practice has always been apparent. It is certainly the case where the competencies required are those relevant to anticipating and responding to unexpected events and the disruptive challenges of natural and man-made disasters.

According to Sullivan[11], the following characteristics are essential elements for an effective assessment framework to operate:

- Competencies are carefully selected
- Supporting theory is integrated with skill practice. Essential knowledge is learned to support the performance of skills

- Detailed training materials are keyed to the competencies to be achieved and are designed to support the acquisition of knowledge and skills
- Methods of instruction involve mastery learning, the premise that all participants can master the required knowledge or skill, provided sufficient time and appropriate training methods are used
- Participants' knowledge and skills are assessed as they enter the program and those with satisfactory knowledge and skills may bypass training or competencies already attained
- Learning should be self-paced
- Flexible training approaches including large group methods, small group activities and individual study are essential components
- A variety of support materials including print, audiovisual and simulations (models) keyed to the skills being mastered are used
- Satisfactory completion of training is based on achievement of all specified competencies

These characteristics describe a process for the development of effective competency-based accreditation. It is not clear whether it is possible to take only a selection of these characteristics and still constitute a competency-based approach. In fact examples where a complete implementation of this list has been achieved are rare across the spectrum of educational settings. In professional degree education and accreditation settings, the full list would appear increasingly unattainable.

1.4 The accreditation of competency-based training

In Australia, the Australian Institute of Quantity Surveyors (AIQS), the Australian Institute of Building Surveyors (AIBS) and the Australian Institute of Building (AIB) collectively publish their joint system for the assessment of courses and accreditation qualifications – The Cooperative Accreditation Agreement for Education Providers: Handbook for Users [12]. The Cooperative Accreditation Agreement (CAA) is thus a joint initiative for the professional accreditation of higher education programs in construction management and related professional disciplines. It is specific to Australia, but mirrors the accreditation processes applied in other countries and in professional disciplines more generally. The following is a summary of the CAA, as presented in the handbook.

The CAA system constitutes a broad-ranging process through which a particular higher educational provider can seek to have a program of study accredited as meeting the academic requirements for membership of a participating professional body. There is a difference between an initial accreditation and an ongoing accreditation process, but this difference is insignificant in the context of this paper. Essentially, the accreditation process involves two (2) phases.

In Phase 1, the education provider submits program documentation detailing the nature and scope of the program of study, and how the program meets the requirements of the professional body. This documentation would include: general information on the academic institution and school; broad descriptors of the title, length of study and industry experience requirements of the program; data on number of students in the program, graduating and entering; comments on the facilities and funding available to the program; a listing of all full-time and part-time staff, their roles, staff/student ratios, teaching quality calculations, etc.; and a matrix that describes how graduate competencies and benchmarks as required by the professional associations are met by the program. The documentation is then reviewed by two external examiners, one a practitioner nominated by the professional body and one academic nominated by the educational provider. The documentation, the external examiners review and the educational providers' response to the external examiners review are then considered at an initial CAA meeting. If satisfactory then accreditation is awarded for a period of time (typically 5 years) and the CAA moves to Phase 2.

In Phase 2, there is an annual review by the external examiners that is to include compliance data on the threshold standards set by the professional body. This report is then considered at an annual CAA meeting, along with the educational providers' annual response, comments from representatives of the accrediting professional body and any other relevant items.

There is a range of assessment criteria listed in each CAA that is common to all professional bodies. The substantive, and only, difference between the assessment criteria specified by each professional body is in the compliance threshold of specific competencies/benchmarks set by each professional body. For example, the AIBS lists in excess of 100 discrete competencies that all graduates of an accredited program are required to satisfy.

A number of concerns have been raised with regard to the overall CAA approach and requirements, but this paper takes particular issue with the use of competency-based benchmarks as the basis of a professional accreditation process for graduate education.

1.5 The implications of a competency-based training approach

Competency-based training (CBT) has revolutionised vocational training, and now features prominently in workplace training and across the school and TAFE education sectors [13]. The adoption of a competency-based accreditation process by various professional bodies might be assumed to be a simple extension of that revolution in training and education. However, the vocational degree context is very different to workplace and diploma-level studies.

One of the most apparent consequences of a CBT accreditation process in construction management higher education has been the relentless increase in the range and scope of competencies being identified. Program amalgamations have combined what were traditionally separate disciplines into the same program of study. In Australia almost all quantity surveying and building degrees have now been amalgamated in this way. The combined competencies for both quantity surveying and building professional accreditations then have to be contained within a single program. More and more content is being included in/imposed upon the same program structures.

At the same time, teaching traditions have tended to focus on lecture-based presentation and delivery of the content. Changing pressures of larger class-sizes, reduced contact time, lower staff-student ratios, etc. each make it more and more difficult to support competency-based training and assessment. Anecdotal evidence suggests that the construction industry is tending to favour more generic graduate attributes over specialist competencies, especially as graduates increasingly fail to satisfy the traditional expectations for specialist competencies. This trend is likely only to be accentuated by generation X and Y graduates, who tend to avoid the longer duration required for effective CBT.

A crisis appears to be developing around CBT in the higher education context. In very broad terms, industry is not satisfied with the levels of competency that Universities currently produce, academic staff do not have the same depth of industry experience as their predecessors, degree programs are already packed with content and do not have the space to accommodate a full suite of professional competencies, and today's students are tending to be motivated to learn only that particular mix of competencies tailored to their individual career aspirations. The strong growth in demand for education is in terms of the graduate attributes associated with dealing professionally with disruptive challenges: problem solving, team work, ethics, creativity, resilience, leadership, etc. These have a very different focus to the bulk of competencies listed by professional associations, and are exceptionally difficult to contain in a competency-based approach to learning. Another approach is called for.

2. The emergence of transformative learning

2.1 What is transformative learning?

The notion of transformative learning, originally proposed by Mezirow [14], seeks to address the process of change involved when students move from a schooling context to a working context. It is particularly focussed on the more fundamental, personal aspects of this change: moving beyond the learning of facts and information; to learning/identifying the framework of personal values and attitudes within which facts and information are interpreted; to challenging and changing the personal worldviews, value frameworks and 'habits of mind' that drive and constitute our (learning) behaviour [15]. Under the traditional rubric of transformative learning there are two schools of thought: (i) the rationalists who focus on an explicit process of critical reflection and discourse, deconstructing experiences in a prescriptive process of self-examination, adjustment and reintegration [16]; (ii) the psycho-socialists who focus on extrarational sources or prompts that are more intuitively/emotionally based, and involve the development of sensitivities and presencing over critical reflection [17]. Since the initial dichotomy, various versions and hybrids of the two schools have emerged.

This paper focuses on an interpretation and application of transformative learning that offers a different orientation to teaching and learning again, from the more generic personal transformation of the approach in general. The particular interpretation adopted here is intended to address the learning requirements of construction management, specifically in terms of how students engage (directly) with (and in) the socio-cultural aspects of construction management practice. These socio-cultural practices are the shared routines, sensibilities, vocabulary, styles, artefacts, procedures, etc. that the people who constitute a particular professional group have developed over time [18]: what Schön [9] refers to as the 'language, media and repertoire' of a particular professional practice. These learning requirements are often considered in terms of 'communities of practice' (CoP) or 'situated learning' responses [19]. For CoP and situated learning responses, the operational context is the actual working environment itself. The focus on transformative learning provides for an effective teaching responses to occur within a classroom setting, and is therefore likely to be more practicable than the CoP or situated learning approaches in many instances.

2.2 What does transformative learning offer?

In contrast to a CBT approach, where the emphasis is on particular competency outcomes, transformative learning puts the emphasis on changing the framework that drives and interprets our learning. Students often enter higher education with a view of learning based on authority and achievement. Authority is deemed to include the teaching staff who determine what and how the content will be taught and learned. The authority offers such qualities as knowledge, predictability, safety, answers and power. Students tend to expect and welcome the authority as this mirrors the context in which they successfully learned at school. Authority provides a robust comfort zone for the new learning context. Achievement in learning is gauged by the grades and equivalent performance measures applied to the study program. Grades provide a hugely important driver for an increasingly achievement-focussed generation of students. Authority and achievement complement each other, because each reinforces the others need: to maximise achievement, students expect an authority to deliver 'comfortable' learning.

Transformative learning in this context moves to break the dependency on authority and achievement. It does this in order to transition students into a learning context more like the working environment they will face on graduation. It would appear that the working environment today is far less structured, less dependent on contained specialist knowledge and more complex than previously. Transformative learning offers the possibility of challenging an existing mindset/expectation around authority and achievement, to better enable a student to understand and deal with the working environment they will face. This personal reorientation is particularly important for a rapidly changing working context. It equips students with the concepts and understanding to appreciate the need for transformational change, what is required to achieve transformational change, and how to promote transformational change in others and in organisations. Thus, transformational change provides the essential tools for students to become effective change agents.

In addition to these broad outcomes, transformational learning also offers a more direct alternative to competency-based training. There is no argument here against the need for a range of competencies to be taught and learned within a higher educational context. It is the unilateral emphasis and focus on CBT, promoted by the professional accreditation bodies, that is being called into question. Rather than a comprehensive (and therefore large) set of required competencies, this paper calls for more focus on what are typically referred to as 'graduate attributes'. Mezirow [20] argues that transformative learning leads to students having improved self-knowledge, who are more mindful, autonomous, reflective, able to deal with change, creative, socially responsible, ethical, etc. These are commonly cited as the graduate attributes higher education programs typically seek to develop in their graduates. With the force and imperative imposed by professional accreditation, such graduate attributes are increasingly given only lip-service. Transformational learning puts the focus directly back onto such graduate attributes as explicit outcomes from the learning experience.

2.3 How is transformative learning taught?

It is notoriously difficult to teach personal transformation, particularly in the context of an undergraduate degree program at University. It is certainly so when operating within the paradigm of teaching that presumes learning to involve knowledge transfer, and to revolve around a process of reading, lecture, expert presentation, formal discussion, note-taking, exams, etc. Teaching based on knowledge transfer is very different to teaching based on the preparation of students to exercise the judgement and skill needed to bring that knowledge to application in practice. It is different again to teaching based on the promotion of self-awareness and the capacity to operate effectively in the face of an adaptive challenge. The role considered for transformative learning in this paper is with regard to this latter teaching ambition.

How might teaching based on the promotion of self-awareness and the capacity to operate effectively in the face of an adaptive challenge be taught to a reasonable large, undergraduate class? A particular approach currently being applied and explored by the author is a technique that uses the classroom as a case-in-point. Case-in-point teaching is an approach to teaching developed by Ronald Heifetz and his colleagues at the Kennedy School, Harvard University [21]. It essentially draws from the expectations, situations, feelings, dynamics, behaviour and discussions that occur within the classroom setting, as an immediate experiential reference point for discussions and reflections on transformative learning [22]. The author has recently taught a project management course to 160 first year construction management undergraduate students using this case-in-point approach, to surprising good effect.

Case-in-point essentially follows the U-Process developed by Senge and Kahane, where three phases are required for transformation: a sensing phase, where the emphasis is on acknowledging and recognising the impact of our mindsets on what we do; a letting-go phase, where habits, blind-spots and historical presumptions are identified so as to be suspended; and a presencing phase, where an expanded sense of self (through reflection) is realised [23]. It involves a process of naming, where particular terms/metaphors are introduced as a shorthand vocabulary to refer to elements of the sensing, letting-go and presencing phases of transformation. For example, the notion of a balcony and the dance floor is used to discuss the different perspectives provided on a situation when a person is (on the dance floor) actively involved in the moment, actions and discussions. Contrast that to the more reflective (balcony) perspective where relationships and dynamics are more apparent. Naming and discussing such issues not only builds an effective lexicon for conversations, but acts to sensitise the student to particular roles, characteristics and possibilities.

Case-in-point articulates a rich assortment of terms, each introduced in response to some immediate experience. It has generally been applied to the teaching of leadership, precisely the adaptive leadership needed when responding to complex and uncertain situations, such as those following a catastrophic event. However, the nature of the transformation required to learn how to practice adaptive leadership, is fundamentally no different to that required to improve self-knowledge, become more mindful, autonomous, reflective, able to deal with change, creative, socially responsible, ethical, etc. In other words, here is a teaching process that does emphasise graduate attributes. Less dependence on professional competencies would free space in the programs to include more explicit case-in-point teaching, and thereby more effectively promote graduate attributes.

3. In conclusion

Competency-based training has become synonymous with training per se. It has had a particular and major impact on vocational education and training, and it is unsurprising that professional associations have moved to adopt competency-based accreditation of study programs in construction management. However, the nature of university education, the constraints on course structure, the traditions of teaching, etc. collectively militate against effective competency-based educational models. At the same time, there are significant questions being raised against the promotion of competencies as an effective measure of professional education. Educational providers, legislators, and professional associations each tend to disagree about what competence means and what the nature of expertise actually is.

This paper has proposed an alternative emphasis away from competency-based training, towards a more transformative learning. Transformative learning is presented as a psychosocial approach to learning, where content is replaced with process as the driver of learning. The psychosocial moves the focus of education away from the individual learner gaining a discrete body of abstract knowledge, acquired and subsequently applied in practice. It treats learning as an interpretive process in which understanding is related to action contexts, and not to prescribed conceptual structures.

A particular method of teaching transformative learning has been described. The case-in-point method mixes a naming and framing of particular situational features with a sensing, letting-go and presencing approach. Where this is generally applied to teaching adaptive leadership, it is beginning to be applied also to more direct teaching of particular graduate attributes. It is the broad contention of this paper that teaching a full spectrum of professional competencies (in construction management, for example) is untenable in the current University context. A substantially scaled-down set of such competencies, complemented by more explicit teaching of graduate attributes, would appear a more attractive proposition in the current market context.

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Acceptability of Lean Concepts to Functions of Quantity Surveyor in Sri Lanka

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Abstract

'Lean' is a newly addressed concept for construction industry, the core of this concept is segregating construction activities into Conversion Activities and Flow Activities, arguing that making conversion activities more efficient whilst improvement of non value-adding activities - i.e. reducing or eliminating them – should primarily be focused.. In addition to processes, Lean concepts can be adopted to professionals' activities in construction industry- i.e.Quantity Surveyor. Effectiveness and efficiency of their functions are essential for a profitable process with overcoming all inconveniences and difficulties that may arise. 'Lean' can be considered as a method of overcoming aforementioned situations. This study explores the acceptability of Lean Concept in functions of Quantity Surveyor in the Sri Lankan context, through an expert opinion survey using Delphi Method. The research finds that Sri Lankan Quantity Surveyors accept the core principles of 'Lean' and concludes that 'Lean' is an acceptable concept within the Sri Lankan Quantity Surveyors and recommended as a methodology to be adopted for the Sri Lankan context. The needing of examining the Feasibility and the Suitability of the Lean concepts is suggested before implementing, while providing base for 'Suitability Test'. Several requirements and organisation related procedures are also proposed for successful implementation of Lean Concepts for the Sri Lankan Quantity Surveyors.

Keywords: Contracting Quantity Surveyor, Flow Activities, Lean Concepts, Sri Lankan construction industry

1. Background

Construction sector encompasses a wide spectrum of activities including provision of professional and technical. While providing them, construction industry is still renowned for its chronic problems such as low productivity, insufficient quality, time over-runs, and poor safety, which hinder customer delivered value.

Among the professionals who are involved in the construction process, to perform, to avoid above issues and provide a good quality service, Quantity Surveyor plays a major role. The Quantity Surveyors is one of the major characters of the construction team, a financial consultant [1] who is keeping accounts and controlling of all costs. The Royal Institute of Charted Surveyors (1991) defines the role of the Quantity Surveyor as "ensuring that the resources of the construction industry are utilised to the best advantage of society by providing financial management for projects and a cost consultancy services to the client and designer during whole construction process." Duties of a Quantity Surveyor depend on factors such as nature of the project; organization context; and, procurement system adopted. However, the traditional role of the Quantity Surveyor was typically organised around the production of Bill of Quantities and final accounts [2]. In addition, [3] describes QS in a different way; as an amalgam of several other disciplines such as economics, law, accountancy, management, information technology and construction technology. In sum, the traditional services of the quantity surveyor were considered to be largely reactive, but necessary important which was mainly a technical back office operation has expanded his services to various paths [4] such as Real Estate Management, Contract Management, Project Management, Facilities Management, Risk Management, Value Management, Claims Management.

Through QS work, various problematic circumstances such as low productivity, insufficient quality, poor coordination and high expenses [5] can associated with the Quantity Surveyor, same as for any other construction professional. Thus, there is a need to apply some methodology to increase their productivity and efficiency in functions.

In the beginning of the 1990's, the new production philosophy, which is known by several names(world class manufacturing, lean productivity, new production system) evolved in the European Construction Industry and in United States, adapting from Japanese manufacturing principles of Lean thinking; Lean Concepts, to provide solutions for such chronic problems arise in construction industry. The core of it is in the observation that there are two aspects in all production systems: Conversions and Flows. Conversion activities produce tangible outputs whilst flow activities bind such conversion activities together during the delivery process of the outputs. Although all activities expend cost and consume time, only conversion activities add value to the material or piece of information being transformed into an output, thus, the aim is to reduce or eliminate non value-adding flow activities and to make conversion activities more efficient [6].

In addition to processes, Lean concepts can be adopted to professionals' activities in construction industry. According to traditional thinking consideration is paid only for the conversion activities and ignores flows. Many tools and techniques have been devised for implementation of Lean thinking in amplifying the performance of the professionals such as quality assurance, computerized integration of design and procurement and electronic data interchange and they can be implemented for the profession of Quantity Surveying also. According to [5], application of the Lean principles can be done several stages. Through such an application, cost and time reductions can be achieved; and hence productivity improvements can be achieved in number of circumstances which incorporates the benefits of competitive advantage.

Considering the current status of Construction Industry in Sri Lanka, this concept seems productive and effective, timely and appropriate at the outset. Still, since any type of an application may need to be customised to better suit the local setting, the acceptability of Lean Concepts to role of the Quantity Surveyors in Sri Lankan context, too, is indecisive. Therefore, the essentials of this new philosophy should be explored in the domestic environment in order to test its acceptability to Sri Lanka, before the application. Thus, it seems necessary first to be clear on a main area of focus in Lean Concepts - such as the prevalence of non value-adding activities in the profession of Quantity Surveying in Sri Lankan construction processes and the awareness of such concepts amongst both consultant's and contractor's Quantity Surveyors in order to examine its relevance to the Sri Lankan context.

2. Acceptability of Lean Concepts to QS

For any process or activity, proper systematic implementation is essential to achieve maximum usage of the implementing concept. In adopting the Lean principles for the Quantity Surveying profession, proper consideration should be given, to gain the benefits and evaluation of the concept because it is important to check the adoptability to a particular organization, environment or a role. "Strategic Option Evaluation Tests" presented by Johnson and Scholes (1997) can be used to check the application of Lean for the profession of Quantity Surveying since it consist of three tests which are helpful in evaluating a strategic option. These are Suitability Test, Acceptability Test and Feasibility Test. Both Suitability and Feasibility Tests have been intentionally omitted from this study since they are more related to process and organisation context and results is hard to generalise for the whole Quantity Surveying population they cannot be accomplished through the scope of this study.

2.1 Acceptability

According to the Strategic Option Evaluation Tests, the Test of Acceptability considers whether the strategic option will gain crucial support from the people who involve in it or whether it will lead to opposition or criticism. According to general management theorists to check the acceptability of a philosophy, acceptability of its principles must be checked among involving people. Therefore, principles of 'Lean' and methodologies to attain the concept will be explored in the remaining part of this section.

2.1.1 Principles of 'Lean'

As stated above the core principles of 'Lean' should be analysed to check the acceptability and the core principles of Lean Concepts are elimination or minimising of non value-adding flow activities and making conversion activities more efficient. In addition to those core principles, According to [5] and [7], there are few other principles in 'Lean' related to construction professionals. They become the benefits gained by the involving professionals, as mentioned below.

- Increase output value through systematic consideration of customer requirements
- Reduce variability
- Reduce cycle times
- Build continuous improvement into the process
- Simplify by minimizing the number of steps, parts and linkages
- Increase output flexibility

- Increase process transparency
- Focus control on the complete process
- Balance flow improvement with conversion improvement
- Benchmark

Thus, if the construction professionals are to accept Lean philosophies, they also should believe in these principles, as mentioned above. For example, if a Quantity Surveyor is to accept major principles of 'Lean', he also should accept that only conversion activities add value and thus non value-adding flow activities should be eliminated whilst making conversion activities more efficient in all his activities and it gains benefits. Only if they are convinced and open to believe its benefits in implementation, they support in establishing Lean principles for their duties. If the Quantity Surveyors feel that application of Lean concepts may cause inconvenience to them, with the prevailing workload, they may hesitate to accept this philosophy. Since this application creates changes for the prevailing workflow or process, an extra attention and effort are needed for the procedure, this may creates less-responsive among Quantity Surveyors about them.

3. Selection of research approach for testing the acceptability

In this research process such opinion survey will be conducted for few functions of a Quantity Surviving role, which are mostly used in Sri Lankan Construction industry. According to [4], functions of a contracting Quantity Surveyor, can be identified according to their relative importance; pricing of Bill of Quantities, Interim valuations, Variation accounts, Cash Flow preparation and Final accounts are the five functions which are most common in Sri Lankan context. Above mentioned decomposition of activities can be done for them and then the acceptability of Lean principles can be tested by identifying flows and conversions included in them.

Since, this is an initial study on acceptability of Lean Concepts in Sri Lankan Quantity Surveying; it is needed to pay attention to a broader perspective rather than to in-depth analysis. Thus, considering all these facts it was decided to undertake an Opinion Survey based on the Delphi Method to check the acceptability of Lean Concepts for the Quantity Surveying, in the Sri Lankan context.

Since the M1 and M2 are considered as main contractors who carry out the major construction work in Sri Lanka while adopting profession of Quantity Surveying, expert panel from the Quantity Surveyors of M1 and M2 contractors was selected. Among all Quantity Surveyors involving in post contracting activities in the industry, managerial level Quantity Surveyors of the organizations were selected because since this 'Lean' is a managerial concept which can be successfully achievable with the level of experience through the industry. With the idea that, there may be many types of flow wastes in the functions of Quantity Surveying, but due to the fact that there may be flows either hidden or not given much attention, only well experienced personnel will observe and identify the most amount of them, it was decided to choose twenty five (25) Quantity Surveyors who are currently involving in managing post contract activities, with high level of experience.

4. Delphi Method

As required by the Delphi Method , the mode of data collection was through questionnaires, and, were distributed in three rounds. Data collection steps were as follows.

STEP 1: The Delphi Round One Questionnaires will be distributed amongst the panel members, with the aim of identifying flows and conversions of the selected functions of Quantity Surveying.

STEP 2: As the second step, the Delphi Round Two Questionnaires were distributed to the survey sample, presenting the identified flows and conversions from the First Round. The participants were asked to provide their opinion on these identified flow activities, whether they can be eliminated or minimized, or not while make opinions on the given statements about the lean principles.

5. Data Analysis and Discussion

5.1.1 Identification of Conversion and Flow activities

In the First Round, the participants were asked to identify the Conversion and Flow activities separately, they had experienced in the Sri Lankan construction industry, out of given sets of sub activities, decomposed from the selected major five activities (see Figure 1) and to mention the additional types of activities they had experienced. After analysing the collected data from the First Round of the survey, the results were taken to the second round to check the opinions regarding the elimination and minimisation of flow activities. Out of the total results obtained from the Delphi Round One, the flow activities, which obtained less than fifty percent (50%) opinion, have been excluded as per the analysis criteria. When analysing the second round results, flow activities, which scored more than fifty percent (50%), as ‘can be minimised or eliminated’ were only selected in modifying the models of the selected functions of a Quantity Surveyor. The results obtained through the analysis can be presented according to the selected activities as follows.

(A) Pricing Bills of Quantities

All other sub activities relate to both flow and conversion activities, according to the opinions of the panel. Flow activities hold 86.96% of total activities, while emphasising that most of the sub activities were flows which consume time and cost, without adding value to the total process. Only ‘get site visit investigation report’ and ‘use pre-bid meeting records’ scored more than 75% of flow wastes which cannot be minimised, according to the results of the second round. Out of all fourteen (14) flow activities mentioned in the round two, eight are more than 50% saying that they can be minimised or eliminated. It emphasises that although they believe there is a huge set of flow activities, they may have the problematic mentality on whether they can be minimised or eliminated in the real practice as illustrated in theories. Pricing Bills of Quantities is a critical activity of a contracting organisation, which decides the profit and the survival of the organisation in the industry. Quantity Surveyor is the responsible person in this task to perform it accurately, holding a great risk. Therefore, it is amply palpable that above mentioned flows- ‘get site visit investigation report’ ‘use pre-bid meeting records’ and also ‘Getting prices from suppliers’ hold a high percentage as ‘cannot be minimised or eliminate’, when considering the importance of information receiving from that steps.

All five functions were checked and analysed using decompositions of sub activities (see Figure 1) and activities, which can be minimised or eliminated, are presented in shaded boxes (see Figure 1). All the activities can be presented as this and figures of other activities are not been presented due to space limitations.

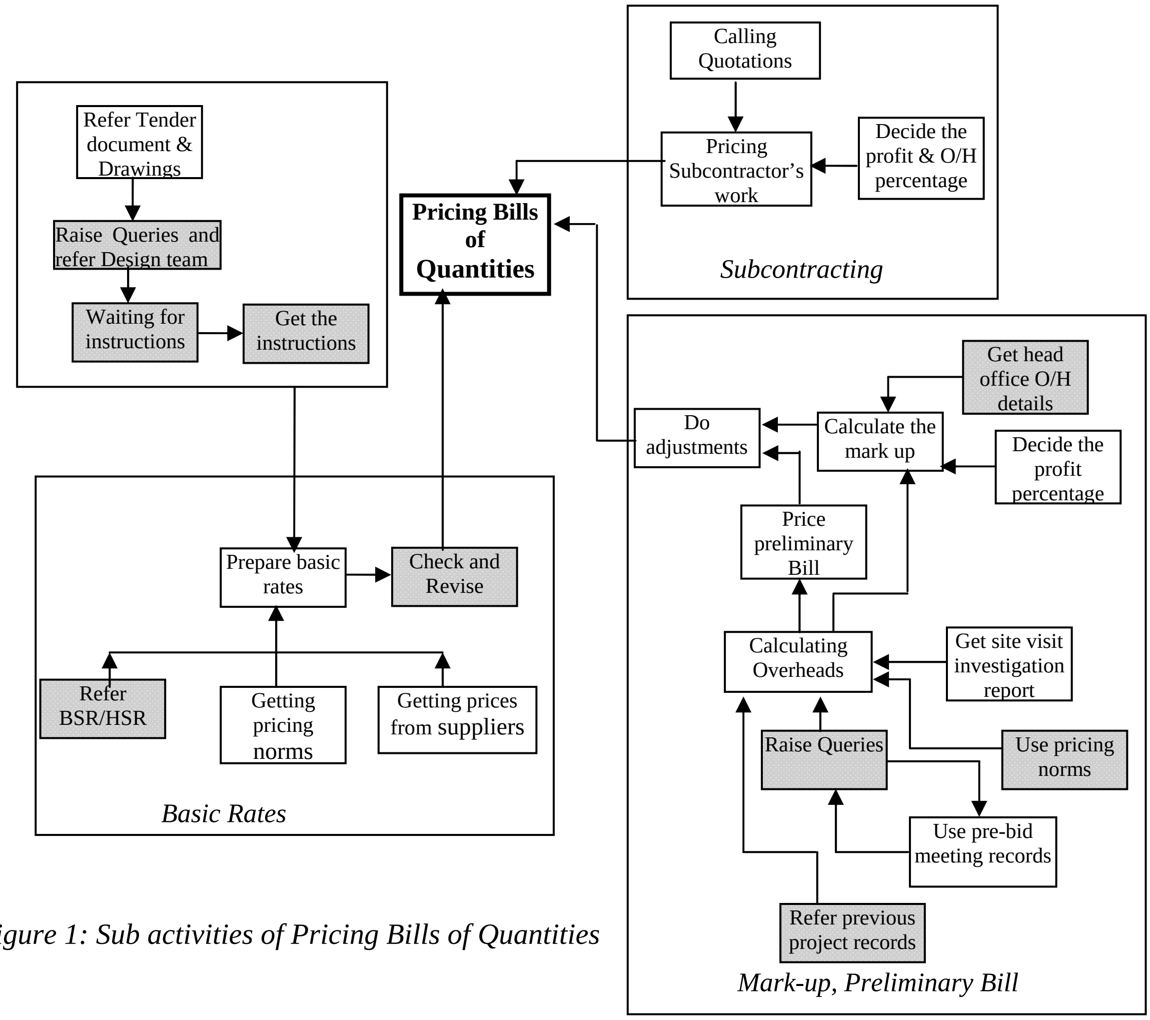

Figure 1: Sub activities of Pricing Bills of Quantities

(B) Interim valuation

In the function of Interim Valuation, only the ‘preparation of interim application’ acts as a pure conversion activity, as selected by the experts, resulting of 91.67% of activities as flows. Only ‘Joint measurements’, ‘Obtain items and rates from BOQ’ and ‘refer previous valuations’ obtained more than 50% out of all responses of the panel, which emphasizes that the most of the sub activities of the function act as conversions throughout the interim valuation process. Joint measurement is the only flow activity which gained higher percentage as ‘cannot be minimized or eliminated’ type, according to the second round results of the opinion survey. Other two activities can be eliminated or minimised according to the responses of the panel.

(C)Preparation of cash flow

Preparation of cash flow bears the highest percentage of 92.86% as flow activities, which leads to conclude that it, is the least significant out of given five functions, among the contracting Quantity Surveyors. There are five (5) flow activities which scored more than 75% in the first round while only ‘Raise Queries gained more than 80% while others hold between 50%-65%. The results mentioned above, provides evidence to confirm the thought that most Sri Lankan contractors are not practicing standardize or proper cash-flow forecasting or controlling method.

(D)Pricing Variations

Pricing Variations, twelve (12) sub activities were presented and three (3) were selected as fully conversion activities with 100% of total while six (6) sub activities obtained 80% as flow activities which can be considered as high amount. In pricing variations, ‘Submit the Quotation for Engineer’s approval’ is only activity which depict less tendency to be minimised or eliminated, while all others scored more than 50% as flows that can be minimised. As this holds the least percentage of flow activities; the panel has considered that most of the sub activities of the function are significant. There is a propensity to arise variations in any project and pricing is important from the view of both client and contractor.

(E)Final Accounts

When considering Preparation of Final Accounts, out of seven activities, only two activities scored more than 50%. It allows concluding that most of the sub activities in the final accounts are conversion activities, according to the opinions of the panel members. When considering second round results, both flow activities can be minimised or eliminated with a percentage ranged from 65%-70%. It is also a significant function of a Quantity Surveyor since it is the point that both client and the contractor view the total financial involvement of the product- leads to Quantity Surveyor to feel more on his responsibility than adopting new concepts.

Even though the Quantity Surveyors participated in the study were quite experienced and in managerial level of contracting organisations, they also had mentioned a considerable percentage of flow activities as ‘cannot be minimised or eliminated’. The main reason for this might probably be the fact that a concept such as Lean Concepts, which pays attention to flow wastes, has not been applied in the Sri Lankan construction industry so far. If there had been such a concept, the whole workforce including Quantity Surveyors throughout the organisation, would have had knowledge and practice to some extent, regarding minimising of flow activities. Since these different professionals and other parties such as clients, statutory authorities and suppliers have different roles to play in the construction setting, Quantity Surveyor needs to deal with them in fulfilling his/her tasks. Thus minimising or eliminating identified flow activities would cause changes to the procedure and influence other involving parties, which would lead to explicit problems. Also this procedure may incur additional resources such as time and other physical resources and new implementation may interrupt the existing process of the Quantity Surveyor including other organisational activities. If there would not be such barriers, there seems to be a demand for such a concept to be applied in the Sri Lankan construction industry in order to eliminate the earlier mentioned non value-adding flow activities.

Thus, it is very logical to argue that these non value-adding flow wastes should be a critical factor causing such cost and time overruns. Therefore, these flow activities seem to be a major weakness in contracting Quantity Surveying, also with the overall Quantity Surveying profession in the Sri Lankan construction industry.

From the above analysis of results from Delphi Round One and Two Questionnaires, it seems apparent that these non value-adding flow activities are a major weakness in contracting Quantity Surveying profession in Sri Lankan construction industry.

Thus, there needs to be a necessity for some methodology which can eliminate or minimise these non value-adding activities from the functional processes of the Quantity Surveying. Since Lean Concepts is a concept, that aims to eliminate or minimise non value-adding flow activities, it can be argued that Lean Concepts is appropriate in applying to renovate the processes of contracting Quantity surveyors in Sri Lankan context.

From the above discussion, it is quite evident that Lean Concepts is suitable to apply in the Sri Lankan context. Thus, it is then necessary to test how 'acceptable' this concept is, in the Sri Lankan context.

Before understand the 'applicability' of the Lean principles, it is needed to understand that there is a need of such theory, for the functions of Quantity Surveyors. With above opinion survey, panel members clearly understood about the flows and conversions in their functions and 'need of Lean concept' for their functions, to gain a more effective and efficient work procedure.

5.1.2 Acceptability of Lean Principles

In order to test the acceptability of Lean Concepts, through the Part 'B' of Delphi Round Two Questionnaire, the participants were asked to mark their opinion regarding twenty (20) statements which were compiled based on core principles of Lean Concepts.

Table 1: Results of checking the acceptability of principles of 'Lean'

No.	Statement	Mean	St.Dev
Principle 1	**'Conversions add value for the process'**		

01	All of earlier mentioned main functions of a Quantity Surveyor add value to the final output for the client	4.80	0.50
02	A majority of functions of a contacting Quantity Surveyor in the concepts industry are add value to the final output for the	4.64	0.64
03	Any Quantity Surveying function consist both value adding and non value adding activities	4.48	0.77
08	Conversion activities should be improved to gain an efficient and effective process	3.28	0.74
<u>Principle 2</u>	**<u>'Flow activities, which are non value-adding, should be eliminated'</u>**		
04	Most of the sub activities of main functions add no value to the final product of the client	3.48	0.87
05	Non value adding activities consumes both time and cost but adds no value to the process	4.24	0.60
06	The amount of value adding activities is less when considering the sub activities of single function of Quantity Surveying	3.88	0.73
07	The amount of conversion activities (value adding activities) are less inside all contracting Quantity Surveying functions	4.52	0.77
09	Flow (non value adding) activities should be minimised or eliminated to gain an efficient and effective process.	4.64	0.64
<u>Principle 3</u>	**<u>'To increase output value, systematic consideration of customer requirements is essential'</u>**		
10	The prime intention should be adding value to the client in every activity in the process	4.72	0.61
11	Systematic consideration of customer requirements should be given to increase output value of the functions	4.52	0.71
20	With these improvements, Quantity Surveyor can gain benefits through his/her functional processes which assist in achieving	4.68	0.56
<u>Principle 4</u>	**<u>'Reduce variability'</u>**		
12	These improvements reduce the variations which can be arise through the process	3.80	0.96
<u>Principle 5</u>	**<u>'Reduce cycle time'</u>**		
13	These improvements reduce the time of a particular process	3.80	0.87
14	Improvements should be continuous through whole process of the functions	4.64	0.57
<u>Principle 6</u>	**<u>'Minimise the number of steps'</u>**		
15	These improvements help to minimise the number of steps in a function of a Quantity Surveyor	4.04	0.79

Principle 7	**‘Increase process transparency’**		
16	These improvements help to create error free functions for the contracting Quantity Surveyor	3.76	0.97
17	These improvements increase the sharing and communicating information in functions for the contracting Quantity Surveyor	4.36	0.57
Principle 8	**‘Control and balance of the process’**		
18	When improving the functions, total procedure of the work should be considered well.	4.65	0.63
19	Both conversions and flows should be improved simultaneously	3.68	0.99

The results showed that the Mean values for the eight principles are approximately around 4.00 with Standard Deviation values lesser than 1, which can be considered as a less deviation. Inline with the earlier interpretations of Mean and Standard Deviation, the above results show that all the eight factors gain values over the centre limit of 3.00, even after the deviations are considered. This implies that there is consensus amongst the participants that they ‘Agree’ to these principles. Therefore, it is reasonable to argue that the experts accept that ‘Conversions add value for the process’, ‘Flow activities, which are non value-adding, should be eliminated’– which are the statements two core principles of Lean Concepts. Among all the statements, Principle 3 statements gained the highest mean value, depicting that most of the members believe in positive side of the statement. It is true that there should be a systematic procedure to adopt any concept successfully, for a particular process and this general truth apply for the Lean Principles as well. Further it can be argued from the results of lowest mean value of the Principle 4 above, ‘Reduce Variability’-that the experts believe that there would be a level of accomplishment on it, but only up to a marginal extent. Panel members may have the mentality that the adopting new methods of Continuous Improvement would occur some deviations to their normal procedure of the functions. Although, Lean Principles emphasises that Continuous Improvements will reduce the propensity of varying the work throughout the procedure, above stated mentality of the practitioners may had lead to comparatively low response on it. Therefore it seems that whilst the experts themselves accept the Lean principles, they believe that the other practitioners too would accept the ideology of Lean Concepts. This emphasises the importance of teamwork and coordination between the Quantity Surveyor and other involving professionals, for a successful completion of tasks. So this improvement should not be focused only to Quantity Surveying profession and should relate to involving other professionals in an organisation.

Since reliability and validity of the results must be checked, ‘Reliability Analysis’ in the SPSS 10.0 software is used to measure the reliability of the data obtained through the research while the Rotated Component Matrix of the Factor Analysis in the SPSS 10.0 software was used to

check the validity. Thus, according to the above discussed results of the Factor Analysis, the twenty (20) statements in the Part ‘B’ of Delphi Round Two Questionnaire seem to be valid. This implies that the intended idea of testing the acceptability of Lean Concepts in the Sri

Lankan context is conveyed through these twenty statements. According to the Reliability Analysis, since the Cronchbach's Alpha value of the data exceeds 0.70, it is clearly evident that the data obtained for Factors are reliable.

6. Conclusions

'Lean' is a new philosophy for the construction industry which was adapted from the manufacturing industry which depicts the concept that there are two activities in any process- Conversions and Flows. This concept argues that whilst making conversion activities more efficient, improvement of non value-adding activities - i.e. reducing or eliminating them – should primarily be focused [6].

From the obtained results of the first part, it can be clearly identified that all selected activities of Quantity Surveying are considered as conversion activities, when taking them as a whole. But each of them is a combination of sub activities-identified as conversions and flows. In accordance with the data analysis, major portion of the main activities are flow activities which obtained more than eighty five percent (75%) of total sub activities (see Figure 2), means that major share of Quantity Surveying activities consume time and other expenses without adding a worth for the process.

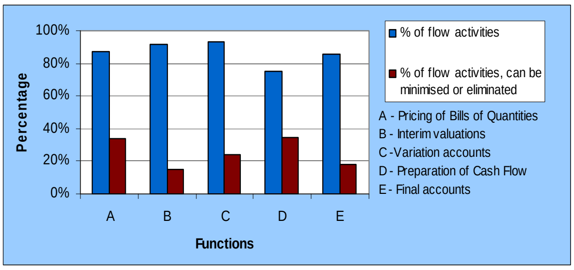

Figure 2: Proportion of Flow Activities of selected functions of a Quantity Surveyor

These results suggest that almost all participants in the panel have a common understanding that there are frequent flow activities throughout the provided functions of a contracting Quantity Surveyor in the Sri Lankan construction industry. This leads to conclude that all Quantity Surveying functions consist both flow and conversion activities.

Also it was disclosed that most of the flow activities can be minimised or eliminated and the awareness amongst the Quantity Surveyors regarding these non value-adding flow activities is considerable. This fact also support that 'Lean' is a suitable concept for the Quantity Surveyors since it becomes easy to adopt it with the awareness of component in it.

This research discovered that Lean Concepts are acceptable for implementing in functions of contracting Quantity Surveyors in Sri Lanka. To accomplish this in Sri Lanka, individual quantity Surveyor and the involving organisation should check its feasibility and suitability for the working procedure within the particular firm. In order to check whether it is feasible to implement the concept of Lean Concepts within the particular organisation, the company should ensure that, there is top management commitment to the implementation; there should be resources provided to the Quantity Surveyors and also company policies and regulations should facilitate this concept.

Also it is recommended that the Quantity Surveyor as the cost expert in the industry should try to quantify these wastes and should try to cost them. As a result he/she would be able to draw the attention of all the management and other employees of the company to take necessary actions to prevent these flow wastes. A cultural change to Quantity Surveyor and other involving parties is essential to minimise the problematic effects arising through the application of the 'Lean Concepts'.

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A knowledge transfer perspective on research and teaching in higher education

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Abstract

Transferring new knowledge created through research into teaching is a primary task in any higher education institution. Recently in UK, this area has gained a wider attention with the growing emphasis on student learning approaches, quality assurance procedures and research funding mechanisms. The link between research and teaching is not automatic. Thus, it needs to be formally created in higher education departments in order to achieve a productive relationship and to manage research activities of university staff with their teaching duties. The research study on which this paper is based on, aims to develop a framework to enable transfer of research knowledge into teaching. This study is different from previous approaches in that it looks into the research and teaching link as a two-way knowledge transfer process in the light of growing knowledge management viewpoints. The framework which is developed through an exploratory case study is validated through five further case studies in different disciplines. Thus, the final framework that is described in this paper can be considered by a higher education institution in creating a formal research to teaching transfer process.

Keywords: Higher Education, Knowledge Transfer, Learning, Research, Teaching

1. Background

Research studies that have explored the relationship between research and teaching had revealed different outcomes. The quantitative studies, which have considered different outcomes to measure research and teaching, have generally concluded that there is no relationship between university staff research and teaching [1]. The qualitative studies, which have considered actor perspectives, for example, staff, student and researchers' views, have concluded that a symbiosis relationship exists between university staff research and teaching [2, 3]. Badley [4] synthesises different interpretations of R&T relationship into five types, 'an impending divorce'; 'a martial relationship'; 'a holy alliance; 'a scholarly relationship'; and, 'a really useful link'. In an impending divorce, separate institutions exist for research and teaching. In a martial relationship, research is viewed as the male partner and teaching as the female partner. In a holy alliance view, research is seen as a generator of uncertainty; and, teaching need to address this uncertainty. In a scholarly relationship, research and teaching are separate but overlapping scholarly activities. Badley [4] further adds a ‘really useful link’ by seeing R&T in an interactive relationship.

According to Jenkins [2], an effective way to link research and teaching is managing staff research to benefit student learning, which will benefit both students and staff; and, also, will improve knowledge development and learning within universities. However, as most studies confirm, research and teaching are loosely coupled activities, which may not have a necessary or an automatic link; and, therefore, it is necessary to create this link to achieve a productive relationship [5]. Recent studies address this issue and introduce different strategies to create a beneficial relationship rather than the problematic one that naturally exists.

As Jenkin and Zetter [5] argue, it is the academic departments who should develop this effective link depending on whether the department is teaching-biased or research-biased. Research-biased departments can create the link to benefit teaching from their research activities. Previous work shows that in research-biased departments, students are unaware of the high quality research discovered within these departments due to poor transfer mechanisms [6]. Thus, these departments can help students to appreciate the value of research within the department by creating a flow from research into teaching. Transferring research into teaching in research-biased departments is, therefore, seen as an important task that needs prompt attention.

Research has also found that the R&T link is dependent on different disciplines [7]. ‘Linking Research & Teaching’ [8] is a national project that has broadly studied the R&T link in a variety of disciplines such as geography, biosciences, law, health science and hospitality disciplines. An associated project, namely LINK: Good Practice Resources Database [9] explores the R&T link specifically in the built environment sector. In addition, the work of Fawcett et al [10] on nursing; and, the work of Cech [11] and Sears and Wood [12] on bioscience provide useful insights into this link. Planet [13] is a special issue that focuses on R&T link in geography, earth and environmental fields. However, these research studies fail to appreciate useful insights from the extant knowledge transfer and learning literature. By identifying this gap, an attempt is made to bring in knowledge management perspectives to this transfer process and develop a better understanding on the phenomenon.

2. Knowledge Transfer Perspective

Some pedagogical researchers have identified the importance of knowledge management perspectives on university research and teaching. For example, Jenkins [2] states that knowledge economy demands academics to be creative and gain ability to create; find; and, synthesise new knowledge. Scott [14] state, “in a ‘knowledge society’ all students –certainly all graduates – have to be researchers. Not only are they engaged in production of knowledge; they must also be educated to cope with risks and uncertainties generated by the advance of science.” Scott [15], further, laments that in the knowledge society research and teaching are no more separable activities; and, the impact of the knowledge society has been to make research and teaching even more transgressive. Brew [16] puts across knowledge-based views with respect to research and teaching link. Accordingly, research and teaching are seen as activities where individuals and groups negotiate meanings and build knowledge within a social context. Brew [16] brings in the concept of academic community of practice where academic departments, disciplines, sub-specialisms, a university as a whole, or networks of professionals interact through face-to-face settings to disseminate research knowledge.

More insights can be gained by viewing research into teaching as a knowledge transfer process. According to Sexton and Barrett [17], knowledge transfer is viewed as the movement of knowledge via some channel from one individual or firm to another. In this context, this means movement of research knowledge (be it research findings, skills or processes) from researchers (be they academics, researchers or practitioners) to students (be they undergraduates or postgraduates) through teaching and other mediums such as seminars, workshops, conferences and project-based work.

Szulanski [18] identifies the difficulty of a knowledge transfer process in six ways. First, strength of relationship between the staff (staff research) and students influences the effectiveness of the transfer. Such relationships can be strengthened by creating positive attitudes among students toward staff research though awareness. Second, direct transfer of research findings to students is inappropriate as this can create ambiguity. In order to overcome this difficulty, research output of projects can be re-constructed to suit the student audience. Rowland [19] describes this as 'talk down to students'; that is devising a simple structure to deliver complex research knowledge to students. Third, absorptive capacity of students differs depending on their prior knowledge [20]. In fact, as Elton [21] argues, a positive R&T link depends on the nature of student' learning experience and the abilities of students (absorptive capacity). Thus, strategies need to take this into account. For example, at level one, students can be given an introduction to the basic research process and at a higher level they can access direct research experience. Fourth, reliability of research results is an important factor in transferring research knowledge into teaching. Lindsay et al [22] explains that research needs to be of interest, relevance and utility to students. This suggests that research results should be tested for their suitability and accuracy before transferring to students. Fifth, Szulanski [18] points out motivation as an influencing factor during knowledge transfer. Not only staff motivation but also student motivation is required in creating this R&T link. This can be created by a cultural change within a department as described in Section 3. Finally, since the transfer does not occur in a vacuum, contextual factors such as organisational context can also have an influence [23]. In sum, to transfer research into teaching effectively, these factors and their impacts need to be considered.

According to Davenport and Prusak [24], effective knowledge transfer does not involve mere transmission but also absorption and use following such a transmission. As such, initiating the R&T link in a department and feeding research knowledge into teaching is insufficient; the transfer needs to ensure that such knowledge is absorbed and used by students after a transmission. Huberman [25] confirms this when he claims that research data penetrates very slowly into the consciousness of the potential user, helped along by discussions and observations. According to him, the dissemination of research knowledge depends on its usefulness to the user and the absorptive capacity of the users. Accordingly, when students are considered as the potential users of such a transfer process, their learning process followed by such a transfer is an essential consideration. As Griffiths [26] emphasises, for an effective transfer and learning, providing students with learning opportunities is insufficient; therefore, it is equally important to evaluate student learning. In fact, learning is the key driving force that links research and teaching [27, 28]. As such, in transferring research knowledge into teaching, different student learning styles need to be addressed.

The literature on learning styles can be grouped into four theories [29, 30, 31]. First, the 'field dependency' theory illustrates that learning can be influenced by the context that the students learn. Second, 'holistic versus sequential' learning theory describes that some students prefer visual approaches whereas some prefer verbal approaches to learning. Third, experiential learning theory (Kolb, 1984 cited in [29]) explains an individual's learning cycle in four aspects: activist, reflector, theorist and pragmatist. This role of experience in learning calls for activities such as project-based work that provide students with first-hand experience. Finally, based on 'surface versus deep' learning theory, it is the deep learning styles that should be encouraged in higher education institutions compared to surface learning. Griffiths [26] describes that inquiry-based learning as a powerful active learning tool, especially in the form of problem-based learning. Schon [32] describes that 'reflection on action' is also needed when students engage in active learning processes. On the whole, these theories on learning, suggest that not everyone can be taught in the same way and the teaching approach need to take these differences into account in evaluating student learning followed by such a knowledge transfer process.

In summary, the educational research has established that R&T link is not automatic and need to be created in each academic department based on the discipline. The knowledge transfer and learning literature values the importance of student perspectives and maintenance of R&T link following an immediate transmission process. With these key findings from the literature, the next sections move to the empirical stage. Accordingly, the research methodology is explained next.

3. Research Methodology

This research selected case study methodology due to the context-specific nature of the phenomenon under study. The case study methodology allows to carryout an in-depth investigation of a complex phenomenon within its real life context. According to Yin [33], "*a case study is an empirical inquiry that investigates a contemporary phenomenon with its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.*" As such, the case study method was considered most suitable for this research. This study was based on multiple case studies, which were of exploratory and explanatory nature.

The case studies were designed by identifying the unit of analysis and a sampling strategy. The unit of analysis considered was academic departments within a university while the study expanded to individual and university levels where appropriate. The sampling strategy was to identify departments that focus on vocational or social science disciplines. Accordingly, study first selected a department on built environment with a high research assessment rating as an exploratory case study. Aim of this exploratory phase was primarily to develop a framework to transfer research into teaching. Subsequently, departments that focus on disciplines such as information technology; sociology; nursing; geography; and, management were selected for detailed case studies. Aim of these case studies was to validate the already developed framework in the identified disciplines. The next section describes the development of the framework.

4. Framework Development

This section explains the development of a framework (see Figure 1) to create research to teaching transfer. The initial framework that was developed through the exploratory study was validated in detailed case study phase. This section describes the final generic framework that is validated by case study participants.

As case study findings identified, many academics favoured introducing formal strategies to facilitate RtoT transfer process. In formalising these strategies within a department, the questions as to 'who should lead?' and 'who should be allocated to maintain the link?' arise. These questions led to recommend assigning a new staff position called 'R&T co-ordinator' with 'R&T team'. By allocating human resources in this way, not only the link can be initiated but also it can be maintained. Therefore, the start-up activity of the framework is assignment of ownership and resources.

To enable RtoT transfer, three activities based on case study findings are identified as necessary. First activity is to review current research and teaching policies in creating the R&T link. The second activity is review of staff recruitment and development strategies at regular intervals; for example, research staff job descriptions can be changed to include teaching duties. Thirdly, to improve the learning environment and to make effective use of advanced technologies, creating and maintaining interactive forums, both physical and virtual, are proposed. The purpose here is to link students, researchers and the academic staff in the department in order to strengthen relationships and provide opportunities to disseminate good practices and research.

The specific RtoT transfer strategies are then considered by integrating various RtoT strategies; some of these were already in practice and some were suggested through case studies. Firstly, a cultural change within departments is proposed in terms of research and teaching practices. At the heart of this change, a week of activities (an 'innovation week') is introduced to offer research awareness and knowledge. This 'innovation week' is introduced at each year of study. For example, in the first year of study, 'innovation week' can be assigned for research awareness activities such as awareness of the research institute and staff research. Similarly, in the second year, this week can be used to give students knowledge on research such as research process, methods and findings. In the third year within this week, research skills can be cultivated in students by offering them research training and experience. This progressive introduction of research activities from lower levels to upper levels enable to feed-forward learning gained at each year. Thus, this innovation week will provide a research environment among students. Furthermore, this week can be effectively utilised to provide opportunities to interact and share knowledge with different groups such as academics, researchers, postgraduate students and, also, relevant industry practitioners.

Most staff believed in project-based learning and problem solving as a path to transfer research to teaching. Thus, an integrated project task is introduced as another RtoT transfer strategy. This is a group exercise that enables students to work collaboratively and gain active research experience. Further, to provide not only new findings within the discipline, but also to give students with first hand research knowledge, separate module called 'research module' is proposed. For undergraduates this module can be introduced at the final level along with their dissertation project whereas for postgraduates this module can be introduced along with their research project. This module is aimed to specifically select current research themes and make students knowledgeable on these. Further the coursework tasks related to this module can specifically focus on giving students some research experience. Finally, based on suggestions offered by interviewees, another RtoT strategy introduced is implementing 'short courses' around staff research activities. Finally, as an outcome activity of this RtoT transfer process, recognising and rewarding RtoT good practices are proposed.

The above-discussed nine activities are integrated into an overall framework that represents 'RtoT transfer process'. These activities are divided into four elements: start-up, process-specific, on-going and outcome (See Figure 01). The start-up and outcome elements act as input and output activities in the RtoT transfer process. The most significant activities related to RtoT transfer process are grouped under the process-specific element, where the real transformation takes place. The four activities under this are shown in a loop to represent the learning cycles within and in between the activities. Three activities, which should take place on a regular basis to enable the RtoT transfer process, are identified under on-going element. This framework is aimed at providing a step-by-step guide for academic departments to transfer its research into teaching.

In validating the framework within case study departments, significant comments were received which were incorporated into this final framework. Most departments agreed that this is a comprehensive framework that covers most of RtoT aspects. However, one case study department, which had strong informal research-based teaching practices, stated that it is important to evaluate the value of such a formal transfer mechanism where natural transfers exist. With respect to separate ownership, academics raised mixed views. Some stated that it will create bureaucracy while some pointed that people will start thinking that it is someone else job. Thus, it is important to emphasise that a separate ownership is assigned purely to facilitate the process and all academics need to effectively take part in RtoT transfer. Anyhow, many saw the importance of assigning an ownership, in particular, to manage administrative work in connection. The 'innovation week' received many positive comments; for example, in healthcare courses its academics expressed that this week would work well with their large student batches. Some mentioned that this week would nicely align with their induction programme in level one. Some academics pointed that this kind of activity needs to be assessed to get good student participation. In recognising and valuing good practices, academics emphasised on valuing innovative teaching methods and staff personal development.

5. Conclusions

The importance of research knowledge transfer into teaching has been identified and debated by many authors with differing viewpoints ranging from the type of the discipline to types of departments. Key areas such as knowledge management and learning have been largely ignored in the search for effective strategies of research knowledge into teaching. This research had developed an understanding on research knowledge transfer into teaching through case studies across several disciplines.

Even though, research-informed teaching is the key to transfer research into teaching, many academics agreed that there should be formal processes to aid natural mechanisms. Such formal mechanisms should not only be implemented in a department but also be properly maintained and evaluated for the success. Further, formal mechanisms should not mislead its members to feel that it is a separate process. Both literature and case studies emphasised that departments should have a research to teaching culture where everyone is actively and effectively involved. Finally, considering knowledge management concepts and views of academics, the transfer should go beyond academic departmental level to a wider community where everyone effectively share and disseminate research knowledge and good teaching practices.

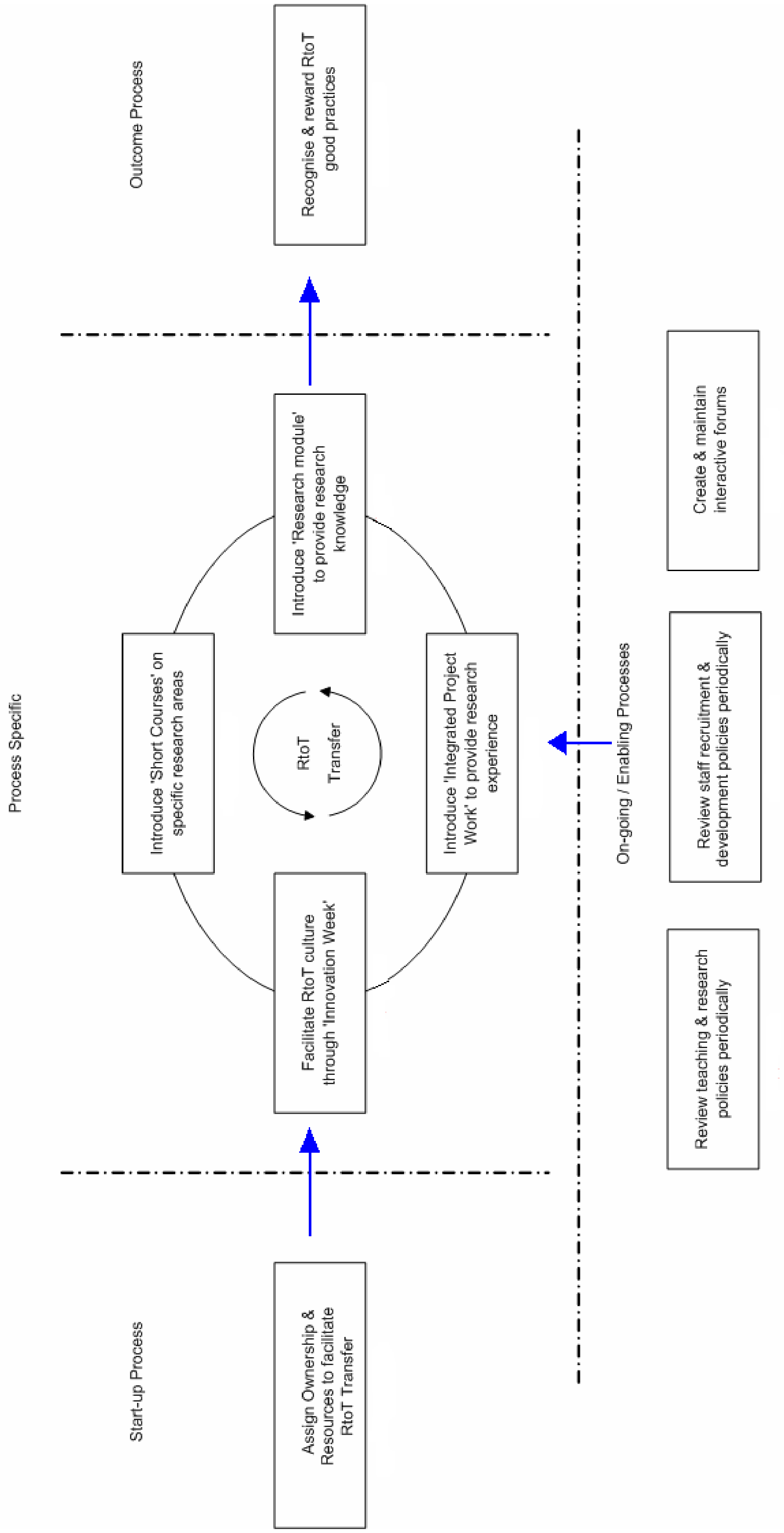

Figure 1: Framework to Transfer Research into Teaching in Higher Education Institutions

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Simplistic model for employee selection and evaluation in the UK construction industry

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Abstract

Several researchers perceive construction industry as a knowledge based, value creating sector of an economy. There is an emerging importance placed on the Human Resource Management in the construction industry, as one of labour intensive sectors of the economy. The issue of the critical role played by employees in fostering an effective construction business has often been overlooked over the years. Capacity of wealth creation of a company is based on the knowledge and capabilities of its people. Therefore the value addition is done to the organisations by installing such personnel knowledge into knowledge management systems that organisations create and use. This focus of the human resource as a strategic resource central will help organisations to achieve competitive advantage in business environment. It also represents an alternative way in which to understand employee selection and evaluation. Employee selection and evaluation practices can contribute significantly to the organisation gaining a competitive advantage. Hence it is very important to analyse and formulate a suitable set of competencies in a knowledge-centric industry such as construction. This research attempts to construct a simplistic model to help the industry practitioners to rank the suitability of a person for an assigned job based on their competencies. From a literature synthesis and informal discussions with experts, qualification and work experience are selected to form a simplistic model. This paper discusses scaling of selected competencies while highlighting the appropriate methodology for the undertaken research.

Keywords: Employee selection, Human intellectual capital, Qualification, Work experience, Research methodology

1. Background

The UK construction industry is one of the strongest in the world, with output ranked top amongst top global construction industries[1]. The industry contributes to roughly 8% of the national GDP and employs in excess of 1.8 million people[2]. Thus construction in the UK is considered as one of the pillars of the domestic economy, with its capability to deliver the most difficult and innovative projects, matches that of any other construction industry in the world [3]. Nonetheless there is a deep concern that the industry as a whole is underachieving. A considerable amount of attention and effort has been directed in number of disciplines to address the industry's poor performance level. In light of this, it is increasingly being acknowledged that knowledge management can bring about the much needed innovation and improved performance in the UK construction industry [4, 5]. Furthermore several researchers perceive the construction industry as a knowledge based, value creating sectors of the economy [6, 7]. This affirms the transition of the construction industry from an asset-centric to a knowledge-centric business environment.

There is an emerging importance placed on the Human Resource Management in the construction industry, as one of labour intensive sectors of the economy, which is still considered to be an uncharted territory [8] within construction organisations. Nesan & Holt [9] argue that the issue of the critical role that employees play in fostering an effective construction business has often been overlooked over the years. According to Cooke-Davies [10], "it is people who deliver the projects and not processes and systems", which gains increased validity in the context of labour intensive construction industry. Hence it is prerequisite to define more appropriate and realistic employee selection and evaluation for the creation of knowledge-centric construction industry.

2. Importance of Intellectual Capital

Even though commentators tend to use different terminologies to explicate two types of organisational assets, commonly they can be divided into tangible and intangible assets. While tangible assets are referred as traditional or physical assets [11, 12], intangible assets are mostly referred as intellectual capital [13-17]. Despite the differences in the usage of terminology, many researchers believe in the importance of intellectual capital over the traditional tangible assets of an organisation.

According to Petty and Guthrie [17], the commonly held definition of intellectual capital is that offered by Organisation for Economic Co-operation and Development(OECD) which describes intellectual capital as the economic value of two categories of intangible assets of a company, organisational capital and human capital. Organisational capital refers to organisational infrastructure such as software systems, distribution networks, and supply chains. The term human capital corresponds to human resources, consists of education, competencies, values, attitudes and experience components [18]. Various other authors consider intellectual capital as the combination of human capital, structural capital and relationship capital. Interestingly, of these various categorisations of intellectual capital, human capital is regarded as the most valuable asset [19].

The advocates of the human capital approach emphasise that many of the assets that individuals bring to the organisation are intangible, premised in individual, tacit knowledge rather than the more explicit, explicated, formal, routine and standardised knowledge [18, 20, 21]. Capacity of wealth creation of a company is based on the knowledge and capabilities of its people [22]. Therefore the value addition is done to the organisations by installing such personnel knowledge into knowledge management systems that organisations create and use. This focus of the human resource as a strategic resource central will help organisations to achieve competitive advantage in business environment. It also represents an alternative way in which to understand employee selection and evaluation.

The contemporary employee selection and evaluation is a complex decision-making process that has a means that places the right employees in the right jobs at the right time [23]. These are key human resource practices in any organisation which can contribute significantly to the organisation gaining a competitive advantage. Several researchers from the field of knowledge management consider that success of an organisation is formed by the interaction between individuals and several types of knowledge [24, 25]. Organisations frequently spend considerable resources making an effort to engage employees who are well suited to the positions that should be filled. Engaging employees may be subjected to the trial time, but in case of poor or disappointing employees, there are often substantial costs associated with the engaging, training, and firing before realising that an employee is inadequate. Therefore these painstaking decisions can be very significant at the beginning about whom to engage [26].

Individual competency is anything that an employee brings to a job or acquires along the way throughout a carrier that ultimately contributes to the success of entire organisation [27]. This includes relevant skills, knowledge, abilities, formal education and experience gained on the job. As a distinctive concept, a competency goes further to include any other demonstrable personal attribute that improves performance [27]. According to Cardy and Selverajan [28] competency model is considered as the set of competencies associated with a job or role in an organisation. Core of these competency models are built by determining the factors which are used as the basis for assessing the relative value of employee suitability. Criteria of competency models are influenced by strategic vision and mission goals which are again interrelated to organisational culture and leadership. Furthermore external environment and requirements derived from its dynamic nature also influence the selection criteria of a competency model.

Perhaps the dominant model to date is the development on generic competencies. The fundamental assumption behind generic competencies is that a set of characteristics necessary for success across organisational settings can be identified [28]. Hence it is very important to analyse and formulate a suitable set of generic competencies in a knowledge-centric industry such as construction. Perhaps, one way of looking at this is by understanding various ‘human intellectual capital measures’, which represents the areas where personnel knowledge can add value to an organisation to achieve competitive advantage in business environment. Hence, by analysing these ‘human intellectual capital measures’ a generic criteria for employee selection and evaluation can be formulated.

3. Human intellectual capital measures

The research and published literature on measuring and reporting intellectual capital has grown rapidly over the years. The current focus of intellectual capital research work is primarily concerned with the process of creating and managing intellectual capital and understanding of better measurement of intellectual capital. Measurement of intellectual capital is mainly concerned with finding the best metrics to use for the purpose of measuring human intellectual capital. Skandia navigator/ value scheme developed by Edvinsson and Malone [20], the balanced scorecard by Kaplan and Norton [29], Sveiby's intangible assets monitor [30]; intellectual capital rating approach are few of them, currently being used under the intellectual capital measurement domain.

Leif Edvinsson, the chief architect behind Skandia's initiatives developed a dynamic and holistic intellectual capital reporting model, the *Navigator* with five areas of focus: financial, customer, process, renewal and development, and human capital. This new accounting taxonomy identifies the roots of a company's value by measuring hidden dynamic factors that underlie "the visible company of buildings and products" [20]. Here, human capital is considered as the combined knowledge, skill, innovativeness, and ability of the company's individual employees to meet the task at hand, which also includes the company's values, culture, and philosophy. The other important intellectual capital measurement system was proposed by Sveiby [30], which is based on three families of intangible assets: external structure (brands, customer and supplier relations), Internal structure (the organisation: management, legal structure, manual systems, attitudes, R&D and software) and individual competence (education and experience).

Another Intellectual capital measurement model is intellectual capital rating approach, which was developed by Intellectual Capital Sweden to enable firms to manage their intangible assets better and to give companies a practical tool to use when discussing, analysing and measuring intellectual capital [31]. It is originally based on ideas put forth by Sveiby [30] indicating a division in internal, external and market assets. The intellectual capital rating model contains three main areas of intellectual capital; organisational structural capital, human capital and relational structural capital. Once again the core of this intellectual capital model is the human capital. Based on these models various authors looked into different types intellectual capital measures to help organisations to strengthen and improve their competitive advantage by measuring and recuperating intellectual capital. Table 1 provides the list of measures used by various commentators to evaluate employee competence/human capital. This list only provides the concerned factors mentioned the researchers in their research article.

From this analysis is it evident that qualification and work experience are perceived as the most important factors in determining employee competence/human capital. Most of the authors on this area agree with the importance of these two factors and suggested other factors which would also help the organisation in improving its culture and competitive advantage. Few informal communications conducted with academics and industry practitioners suggest the same. Especially the employee selection and evaluation based on qualification and work experience is found to be very common in the practice. However, there is a concern over the class of qualification, decay of 'knowledge from qualification' over the years, relevance of the qualification, relevance of the work experience and relative importance of work experience to qualification. Having these in mind, this research proposes a simplistic model for competency based employee selection and evaluation in the UK construction industry.

Table 1: Sources of reference for various Human Intellectual Capital measures

	Armstrong and Baron [32]	Caddy [14]	Edvinsson and Malone [20]	Golec and Kahya [23]	Guthrie [33]	Kennedy and Dresser [27]	Petty and Guthrie [17]	Sveiby [30]	Turner and Cox [34]
Qualification	√		√	√	√		√	√	
Work experience		√	√		√		√	√	
Training and education	√	√	√	√				√	
Rewards and recognition		√							
Communication skills	√			√		√			
Innovative capabilities			√	√			√		√
Leadership qualities	√		√	√					√
Salaries and benefits		√						√	
Involvement in projects								√	
Value and attitude	√			√				√	
Loyalty			√						

4. Development of simplistic model for competency based employee selection and evaluation

Focus of this research is to propose a simplistic model to help the industry practitioners to rank the suitability of a person for an assigned job. As such, research intends to develop a simplistic model based only on easily observable major human intellectual capital measures, qualification and work experience. Furthermore, an additive model is found to be appropriate than a multiplicative model. Multiplicative model will result to zero 'human intellectual capital' without either qualification or work experience. To avoid this, an additive, simplistic model is proposed for this study. However, concerns such as class of qualification, decay of 'knowledge from qualification' over the years, relevance of the qualification, relevance of the work experience and relative importance of work experience to qualification are also incorporated into this model.

$$Y = r_1 dQ + r_2 cE$$

Where, Y = Human intellectual capital

r_1 = Relevance of the qualification

d = Decay of ‘knowledge from qualification’ over the years

Q = Qualification

r_2 = Relevance of the work experience

c = Relative importance/weighting of work experience to qualification

E = Work experience

Here, Y is proposed to be measures in human intellectual capital units, only to assist the ranking of suitable personals. As shown in figure 1, human capital measures are dependent on several organisational characters and decision maker. Especially relevance of the qualification (r_1) and work experience (r_2) are very subjective and they are left for the management/decision maker for a suitable employee selection and evaluation. This research attempts to determine ‘decay of knowledge from qualification over the years’ (d) and ‘relative importance/weighting of work experience to qualification’(c) to help the practitioners with easy and general decision making process. However, it is prerequisite to quantify qualification (Q) and work experience (E) to measure human intellectual capital. Other than the coefficients of work experience, it is easily quantifiable.

4.1 Qualification

Quantifying qualification is very important since qualification is considered as an independent variable in this model. The National Qualifications Framework (NQF) sets out the levels against which a qualification can be recognised in England, Wales and Northern Ireland. This is a widely accepted framework which illustrates the level and category of those qualifications, which have been accredited by the Qualifications and Curriculum Authority (QCA), which enable recognition of candidates' achievements and which facilitate career progression. Here, higher education qualifications are categorised into 5 levels in terms of their minimum amount of required credit at the point at which the qualification is awarded (QCA, 2007). The amount of credit attributed is based upon an estimation of the learning time, which it would take the average learner to achieve the specified learning outcomes. The tariff used to determine the relationship between learning time and credit is averaged at 10 hours (QCA, 2004). Hence, ‘credit requirements for each qualification’ can be considered as directly proportional to the ‘amount of required knowledge acquisition’ which enables scaling of qualifications against credit requirements. Following Table defines the credit requirements for major higher education qualifications of NQF. Details of other qualifications and incorporation of class of qualification are still to be explored in the first phase of the study to quantify qualifications and to scale them against credit definitions.

Table 2: Framework for higher education (FHEQ) qualifications and their credit definitions

Qualifications	FHEQ qualification levels	Credit definitions	Accumulative credit definitions
Doctorate	D	540	900
Masters Degree	M	180	540
Bachelors Degree	H	360	360
Diploma of Higher Education	I	240	240
Certificates of Higher Education	C	120	120

5. Research Methodology

This research is aimed to develop a simplistic model to measure human intellectual capital for employee selection and evaluation. This is largely a model development/theory building attempt by quantitative research methods using primary data gathered from employers' opinion. As discussed above, firstly it is important to quantify qualification (Q) and work experience (E) before estimating decay of knowledge from qualification over the years' (d) and 'relative importance/weighting of work experience to qualification'(c). As such this research is divided into three phases of data collection and analysis to develop this competency based model for employee selection and evaluation.

As shown in Table 3, the exploratory, first phase of the research focuses on quantifying qualification (Q) and work experience (E). Above mentioned guidelines will be assessed with expert opinion gathered from unstructured interviews to form an accepted scale of measurement. This qualitative, rich data is expected to provide guidance to understand the influence of different methods of scaling. The main, second phase of the research will concentrate on estimating d and c which are more quantitative. The details and scaling of qualification (Q) and work experience (E) will also be confirmed in this phase. For this a survey method would be more appropriate to collect quantitative data which would be analysed with regression analysis. In the third phase of the study, case study employer will be asked to rank a list of employees and the ranks will be compared to the ranks achieved from the list created from the usage of the constructed model. Significance of this ranking will be evaluated against 'degrees of freedom' to determine the level of significance, which would help the hypothesis testing in this phase. Since it is a model testing/theory testing phase, case study approach is more appropriate to improve the validity of this model in the UK construction industry.

Table 3: Research Methodology

Phase	Research type	Research method	Research techniques
1	Exploratory research	Expert opinion	Interviews and content analysis
2	Model development	Survey	Questionnaire survey and regression analysis
3	Model testing	Case study	Questionnaire and hypothesis testing

6. Conclusion and further research

Employee selection and evaluation practices can contribute significantly to the organisation gaining a competitive advantage. This research attempts to construct a simplistic model to help the industry practitioners to rank the suitability of a person for an assigned job based on their competencies. Person's qualification and work experience are selected as competencies by literature synthesis and informal interviews to construct this model. With the usage of an additive model and scaling of qualification based on accumulative credits, a simplistic competency based employee selection and evaluation model is formed. However, concerns such as class of qualification, decay of 'knowledge from qualification' over the years, relevance of the qualification, relevance of the work experience and relative importance of work experience to qualification are also incorporated into this model. Appropriate research methods and techniques are selected to build and test this model and to improve its validity for the use of the UK construction industry.

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Performance of Mature Entry and Matriculation Entry Students focusing on the National Diploma in Building at the University of Johannesburg, South Africa

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Abstract

Developments in the teaching of the National Diploma in Building students should be geared towards meeting the needs of the construction industry in South Africa. These needs are usually in the form of skills and knowledge required to resolve thorny issues encountered in practice. The lack of capacity in the construction industry needs to be addressed from the basis of ensuring that the education system caters for both mature entry and matriculation entry students. The paper looks at a comparison in performance between mature entry and matriculation (just finish High School) entry students focusing on the National Diploma in Building students at the University of Johannesburg. The paper will make a comparison between those students who work first before enrolling for their first year National Diploma in Building and those who are directly from high school. Cooperative education involves training and systematically developing students through the acquisition of the requisite skills, attitudes, values and knowledge required to adequately perform in their chosen careers. The paper describes the problems and experiences that have been encountered by both mature and matriculation entry students in their three years of study which affects their performance. The paper will then look at the value of prior experience in enabling students to finish their National Diploma in Building within a three year period. The paper closes with some recommendations for the future.

Keywords: Building, Construction, Education, Mature, Matriculation, Skills, South Africa.

1. Introduction

The University of Johannesburg was founded on the proud academic traditions of the former Rand Afrikaans University, Technikon Witwatersrand and two campuses of Vista University. The UJ has approximately 46 000 students, who attends classes on its five campuses, spread over the industrial landscape of Johannesburg. The UJ is focussed on maintaining high academic standards, while boldly embracing change and empowering its students to contribute knowledge and skills to this city and our beautiful country. In South Africa the levels of unemployment and poverty are extremely high and unemployment is one of South Africa's most pressing problems. Acceptable levels of social development, economic growth and a decrease in high crime levels will only be achieved if the 28 per cent unemployment is decreased dramatically. The high unemployment rate can undermine the democracy if it is not reduced. At the same time there is a great need for physical infrastructure in both urban and rural areas. According to the World Bank [1] infrastructure can deliver major benefits in economic growth, poverty alleviation, and environmental sustainability - but only when it provides services that respond to effective demand and does so efficiently. In addition there is a lack of capacity and skills at institutional, community and individual levels.

From a theoretical perspective supported by experience elsewhere in Africa and the world at large, there is a huge role to be played by tertiary institutions in addressing skills development in South Africa. One of the main thrusts of the RDP White Paper remained "to link reconstruction and development: to reduce poverty and create employment through programmes of infrastructure construction and maintenance." The Reconstruction and Development Programme is a programme that seeks to redress the inequities and deprivation caused by the former government's apartheid policies. The programme is founded on six basic principles, linked together which make up the political and economic philosophy that underlies the whole RDP: the use of all available resources in a coherent and purposeful effort that can be sustained into the future; a people driven process; peace and security for all; nation building; reconstruction and development; and democratisation of South Africa [2]. These principles are indicative of a strong emphasis the RDP places on community participation methods.

There is an urgent need to address the skills and unemployment challenges in South Africa. The levels of unemployment have been rising steadily over the years. The unemployment rate is an extremely important indicator of economic and social health. The level of unemployment was 7% in 1980; 18% in 1991 McCutcheon [3]; 15.7% in 1995 Statistics South Africa [4]; 30.2% in 2002; 27.4% in 2003; 25.6% in 2004; and 26.5% in 2005 Labour Force Surveys (LFS) [5]. The unemployment rate rose rapidly over the 1990s, then fell in 2003 and 2004 and rose again in 2005. This is due to the drastic fall of the demand for unskilled labour in the formal sector caused by structural changes in the economy as a result of a decline in the importance of the primary sector.

2. Aim and Objectives of the Study

The study aims to gather and share information on the performance between mature entry and matriculation (just finish High School) entry students focusing on the National Diploma in Building students at the University of Johannesburg. The paper will make a comparison between those students who work first before enrolling for their first year National Diploma in Building and those who are directly from high school. Cooperative education involves training and systematically developing students through the acquisition of the requisite skills, attitudes, values and knowledge required to adequately perform in their chosen careers. The paper describes the problems and experiences that have been encountered by both mature and matriculation entry students in their three years of study which affects their performance. The paper will then look at the value of prior experience in enabling students to finish their National Diploma in Building within a three year period. The paper closes with some recommendations for the future.

3. Methodology

A questionnaire was designed and distributed to 30 students who are currently on the 4th year of study who had worked before embarking on their first year of study. All the 30 students who were given the questionnaire responded to the survey.

4. Skill Development in South Africa

The important note was to recognise the improvement of the work skills of all South Africans, which is critical to grow the national economy. The Skills Development Act (SDA) was promulgated to create the structures and framework for the national development strategy. In terms of the SDA employers are obliged to provide formal structured education to their workers. Furthermore, the act encourages partnership in this effect between government, employers, workers, education and training providers, and beneficiary communities. The trained people are the beneficiaries from the community. According to SDA, the needs of employers, the economy and the communities must dictate which skills development should be developed.

The SDA covers structured, targeted and generic training implying that all training interventions should be planned and managed as projects that is the reason why Group Five has “people at the gate” which is Corporate Social Investment Project. In SDA, employers together with their workers formulate workplace skills plans (WSP) to enable them to realize their employment training targets. All designated employers pay a monthly skills development levy of 1% of their budgeted payrolls to the National Skills Fund (NFS), via South African Revenue services (SARS). Of this amount, the employer can claim back 70% in the form of discretionary grant, provided that they submit WSP and Implementation Report (IR) annually and conduct special training projects.

These levies finance the implementation of the National Skills Development Strategy (NSDS). Construction Education and training Authorities (CETA) receives 10% of the skills levies paid by construction employers for administration costs, NSF receives 20%, and 70% is available to be claimed back by these contributing employers. However, international trends shows that companies need to spend between 4% and 7% in order to be successful in addressing the current shortages and gaps (National Advisory Council on Innovation (NACI) [6]. Furthermore, there appears to be over-reliance of a number of levels in the micro and provincial economy on the SETA’s as being responsible bodies for coordinating the identification of scare skills in South Africa.

5. Education of “Thinkers”: Theory

Preparing young people for the world of work is a current focus for discussion and debate in South Africa and in many other countries. Current questions on the subject ask whether or not young people should be prepared for the working environment and if so how ands why? The education of young people is a central political and economic issue in South Africa. In recent years there has been much debate on the form and content education policy should have. One aspect of the debate has been on whether the education system should specifically prepare young people for the world of work. In order to achieve this there must be a close scrutiny of the curricula and there must be a shift in the balance of subjects with the emphasis being towards the sciences and technologies with less emphasis on art-related subjects. It is believed that in a technologically orientated society such as South Africa, the educational bias should reflect this. Whilst this philosophy might be regarded as sensible, there are those who believe that young people should have a more pluralist education. Such an approach exposes young people to a wider range of options, thus enabling knowledge and expertise to be nurtured equally.

The present word “university” comes from the Latin “universitas litterarum” which means “the whole of sciences” (taught at the university). The important aspect of generality of the university education or the need to educate the students in a broad sense (i.e. not only technical), simultaneously underlining the must for some sort of universal knowledge, based on “thinking”. Creativity depends on the information base and the capacity of unrestricted thinking. The question to ask ourselves does the present method of teaching encourage critical thinking? Teaching theory is the best and most efficient way to teach. There is nothing more practical than a good theory. “A good education system should be based on theory and practice, whereby practice may be viewed as a long-time experiment on full-size scale. The opinion prevails that “theory is one eye, practice the other. Only with both of them together can one truly have three-dimensional construction vision.

There are complaints that students need better understanding and appreciation of how theory applies to situations encountered in practice, and graduates are not prepared for the jobs they face in the present world, being weak in concept and problem-solving tools. Employers must recognise the graduate as an entry level without experience and without definable capabilities latter will emerge during their experiential learning, since “real-world” problems are often complex and “unstructured” and do not lend themselves well to classroom analysis and synthesis of solutions. Some people believe that “work experience has a more role to play than ever before and some believe theory is more important. What is the solution? I believe it should be a combination of both?

6. Examples of Work-Based Tasks

There are numerous ways that universities have endeavoured to prepare their students for the world of work. Many of the suggestions are not new or will they be suited to every course or group of students. Examples will need to be carefully evaluated, adjusted, piloted and honed to reflect the particular ethos of a course, the staff, employers and student needs and abilities. Only when such a process is undertaken can a judgement be made on their validity.

7. Industrial Training Practice

In this model, students are employed for about one year. Training can be undertaken in a single period or be divided into blocks of 3 to 6 months duration. Being exposed to real industrial practices, students se and feel the stresses and pressures of that particular industry. Further, in many instances, students work long hours and are given considerable responsibilities. Whether or not companies should make heavy demands on inexperienced students is a separate debate, but as a preparation for a future career many industries would argue that such experience has unsurpassed benefits. Some companies with international links can also provide excellent training. Such exposes students to a wealth of experiences, both technical and social, and has benefits in developing communication skills in different societies and cultures.

8. Lecturers into Industry

Lecturers must be seconded to industry. Whether for a few days or several weeks, the net effect is that lecturers refamiliarise themselves with industry practices and procedures and gain knowledge. This educational/ industrial experience then comes full circle in that lecturers, having updated their skills, are thus able to impart this to students. The three-way arrangement between industrialists, lecturers and students where there is collaborative integration has mutual advantages. Industrialists must be given chance to teach certain modules. Industry/Education partnership must be encouraged. Visit to industries must be encouraged.

9. Non-Formal Education

Non-formal education became part of the international discourse on education policy in the late 1960s and early 1970s. It can be seen as related to the concepts of recurrent and lifelong learning. Tight [7] suggests that whereas the latter concepts have to do with the extension of education and learning throughout life, non-formal education is about 'acknowledging the importance of education, learning and training which takes place outside recognized educational institutions'. Fordham [8] suggests that in the 1970s, four characteristics came be associated with non-formal education: relevance to the needs of disadvantaged groups; concern with specific categories of person; a focus on clearly defined purposes; and flexibility in organization and methods.

Table 1: Models of normal and non – formal education- Adapted by Fordham 1993 from Simkins 1977: pp12-15

	formal	**non-formal**
purposes	Long-term & general Credential-based	Short-term & specific Non-credential-based
timing	long cycle / preparatory / full-time	short cycle / recurrent / part-time
content	standardized / input centred academic entry requirements determine clientele	individualized / output centred practical clientele determine entry requirements
delivery system	Institution-based, isolated from environment. rigidly structured, teacher-centred and resource intensive	Environment-based, community related. flexible, learner-centred and resource saving
control	external / hierarchical	self-governing / democratic

The purpose of RPL is to relate informal training, life experiences and work experience to a set of clearly defined vocational (workplace) outcomes to open up the candidate's access to wider career and vocational training options, especially to those candidates who have previously been denied access to formal training opportunities.

Table 2: The Benefits and challenges of Recognition of Prior Learning

Role-player:	Benefits of RPL:	Challenges of RPL
EMPLOYER	Existing worker competence can be easily measured against required standards (employable skill standards) Cost-effective identification of further training needs Better qualified workforce increases competitiveness Aid to effective recruitment	The workshops as they are conducted by external assessors are going to be costly for the company. The company will loose a number of production days as the employees will be attending the workshops on different days.
LEARNER	Improves self-esteem and self worth Improves visibility and accessibility of qualifications Provides for recognition of existing skills and knowledge Identifies individual paths to relevant qualifications Improves work motivation and performance Candidate-centred-focuses on individual skills and training needs.	Most of the employees from the previously disadvantaged may have problem with the language as only English and Afrikaans will be used. This may lead to other people not benefiting from the workshops. RPL is self-paced and self-managed so many employees may end up not completing if they are not self discipline.

10. Results of the Survey

Thirty students were selected and each student was given a questionnaire to complete. All the thirty questionnaires were completed and returned. There were twenty seven male and three female students. The age of the students ranges between 22 years and 44 years. Out of the 30 students only 4 were from outside South Africa. 40% of the students came from the Gauteng Province; 20% Limpopo Province; 15% Eastern Cape Province; 7% from Lesotho; 7% from Botswana; and 11% from KwaZulu Natal. The average years of experience in the construction industry before doing the first year in Building is 6 years. More than 80% of the students had worked for the private sector and 20% for the public sector. 50% of the respondents alluded that they work first before going to the University to further their studies after completing High School because they wanted to learn more about the construction industry before choosing the right course; 20% of respondents had no money to further their studies and they had to work first to raise money to pay for the studies. 20% of the respondents were offered a job opportunity immediately after High School completion. 10% of the respondents were encouraged by their parents to enter the construction industry as they were employed by the industry themselves.

90% of the students were employed as Trainee Site Agents and 10% as Trainee Technical Officers. 80% of the students alluded that they were adequately prepared and 20% were very well prepared for their first year. They were exposed to a variety of construction projects; project management skills, site management skills, human resources management; construction skills; communication skills; report writing; team work. The students were also able to make a right choice between construction management and quantity surveying course. All the 30 students alluded that it was easy to complete their studies on record time. The 30 students had not repeated any subjects in their Diploma in Building Programme. 80% of the students believe that all students must work before doing their first year. 20% of the students believe that students should be exposed to the construction industry in their first of study.

80% of the students received good support from their supervisors and 20% of the students received poor support. 80% of the students attributed their support to good communication channels between themselves and their supervisors. The 20% of the students were neglected most of the times and left alone. The supervisors were to busy to give guidance to the students. As a result team members were the one who assisted them in addressing the challenges they faced while undertaking their work. All the students were very positive about the future of the construction industry and the construction profession in South Africa. They believed that more people must be trained in order to improve the construction industry. 90% of the students alluded that their industry exposure made them to understand the construction industry better and they were able to choose construction as their career.

The students who come direct from high school encounter the following that makes them to repeat some subjects: lack of communication skills; lack of computer skills; unable to work in a team; no practical knowledge of the construction industry; lack of skills to write and present report properly; lack of problem solving skills; and unable to relate theory to practice. From the research it can be concluded that prior work experience among Diploma in Building students reduces the failure rate. This also improves the through put rate.

11. Recommendations

- Students who are admitted straight from Matric (High School) must be encouraged to work during university vacation in their first year.
- Potential students who undertake work based learning first must be encouraged to keep a daily log book which will contain details of the work they have performed during their stay in that company. A major benefit of this approach will be the positive development of the potential student’s attitudes towards responsibility and accountability in relation to the project in which he or she is engaged.
- Encouraged more female students to engage in the construction industry
- Each potential student must be assigned a supervisor from the first day they are employed. The supervisor must check and certify the correctness of the record for each task performed.
- The supervisor must have appropriate qualifications and experience and should ideally hold the position of either a registered quantity surveyor, construction or construction

project manager, or a site agent or a construction surveyor. Any other person provided that he or she holds a responsible position in the company being represented, and is actively pursuing continuing professional development in a built environment field of study.

- The learning outcomes must be clearly defined from the beginning when the person is offered an employment opportunity.

12. Conclusion

The paper looked at a comparison in performance between mature entry and matriculation (just finish High School) entry students focusing on the National Diploma in Building students at the University of Johannesburg. The paper made a comparison between those students who work first before enrolling for their first year National Diploma in Building and those who are directly from high school. The research revealed that those who worked first before doing their first year of study all of them completed the Diploma in Building in record time (three years). The high failure rate is caused by lack of knowledge about the construction industry. The foregoing examples provide a range of options available to assist in providing world of work experiences for students in the different disciplines. Academic institutions must be relevant as the industry requirements changes industries must also play a major role in affording graduates an opportunity to learn, as you cannot buy experience.

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The relevance of professional institutions to students and early career practitioners in the property and construction industries within Australia

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Abstract

The role of professional institutions and the transition from student membership to full professional membership among real estate and construction students in Australia is examined. Students' perceptions of professional qualifications and institution membership is explored to show that graduates seek networking and career advancement opportunities over professional training and development opportunities. The expectation of many young practitioners is that they will work outside Australia during their career and this has significant implications for the future policy development of professional bodies. The paper provides a valuable insight into the aspirations of young professionals and goes some way to identifying the reasons for the low level of transition from student membership to full membership of the national and international professional bodies.

Keywords: professional institutions, student membership, real estate and construction education Australia.

1. Background

The property and construction industry has relied heavily on its professional bodies to maintain educational and professional standards among its members and to regulate the profession for the benefit of its members and the public. It is widely recognised that professions fulfil an important role in society and much has been published on these benefits over the years. Grimshaw [1], writing on the facilities management profession, identified a number of underlying characteristics of a profession. He posited the hallmark of a profession to be; 'specific and have a definable knowledge and skills base that has to be acquired and tested; a high degree of self-control of behaviour via codes of ethics; and a recognised social responsibility that gives a primary and selfless orientation to the community interest.' [1;55].

The regulation of ethical standards by professional bodies is recognised as a cornerstone of professional practice and, in many jurisdictions around the world, it is the professional bodies, with their well established codes of ethical practice, that provide a regulatory buffer between the professional in practice and the role of the state in protecting the public. The role of professional codes; ‘is to prevent professionals from exploiting the asymmetrical information that is a part of the professional-client relationship.’(Jamal & Bowie 1995). It is for these reasons that professional bodies have grown in national and international contexts and the import of the quality of membership and the ethical standards which they maintain is essential to their continued success [1, 2].

While the importance of professional body membership has not changed, there is an apparent change in the attitude of young members towards membership. The value for money and the need to belong have been questioned. Wilson [3] examined the role of the accounting professions, highlighting the need for value for money in professional institutions stating: ‘At a more tangible level of services, when the value of their annual subscriptions is questioned members of both bodies are scratching their heads.’ This reluctance to join is echoed in many professions where the benefits of membership are weighed against the financial costs to the individual or the organisation [4]. Yet other research in the USA points to an increasing membership of trade associations by ‘generation x’, with a focus on what they can get out of the membership in terms of career advancement and the benefits of networking that can be achieved [5, 6;11].

There is little research in the property and construction professions with respect to the value of membership to young graduates. As the professional bodies seek to become global organisations the need to attract new members is a quintessential element of the growth strategy. This rapid growth expectation, while being realised among established practitioners, is not being so readily translated into student and early career professionals.

The Royal Institution of Chartered Surveyors (RICS), the largest international professional institution in the property and construction industry, established an office in Australia in 2000 with a stated objective of attracting new members and growing its professional influence within the Asia-Pacific region. It was envisaged that young practitioners would be attracted to the global brand as interest from Universities to accredit courses in both property and construction, was strong. One early strategy to attract young members was to offer free student membership. Not surprisingly this strategy paid off with student membership rising from virtually nil in 1999 to over 3000 by 2007 [7]. While free student membership has grown, the level of conversion to full membership has not been as strong. The reasons for this lower than expected conversion is not clear, although it might be as a result of changing attitudes to professional body membership and perceptions of value for money as has been demonstrated in some other professions.

2. A survey of student attitudes to professional institution membership in Australia

This paper reports on research supported by the RICS Oceania into the perceptions of students and young property and construction practitioners to the professional bodies within Australia. The research, although supported by the RICS, sought to address the full range of professional bodies serving the property and construction sector and was not influenced by any individual professional body.

2.1 Methodology

The research methodology was based on a paper based questionnaire which could be distributed easily among students studying property and construction courses in Australia. A questionnaire survey was compiled by the Universities of Melbourne and Queensland in the early part of 2007. The survey was piloted to industry prior to distribution to selected participants. In order to gain as wide a spectrum of students as possible, the survey was administered to a range of student cohorts in three separate universities. The universities selected to participate were leading course providers in Sydney, Melbourne and Brisbane. The students were drawn from all year groups within the undergraduate program and from postgraduate students undertaking master level study. The survey was administered in the early part of semester one 2007. A total of six hundred and sixty one completed surveys were returned.

The survey comprised three sections: Section one asked the respondent about their age, gender, the course they were studying, the level of the course (undergraduate or postgraduate), the year of study and their intentions to work within Australia and or overseas during their career. This data enabled the researchers to ascertain whether these respondents were aware of, or were likely to join, professional bodies based on their age, gender and year of study. It might be anticipated that professional body awareness and perceived importance would increase with years of study.

The second part of the questionnaire posed questions about the professional bodies. Respondents were asked whether professional body membership was important to them and of which bodies they were currently student members. They were also asked which bodies they intended to join in the future. Also in this section respondents were asked to rank the importance of reasons for joining professional bodies, and were asked about their expectations from professional bodies. This data helps to identify the drivers and expectations potential members and current student members have of professional bodies.

The third section asked more detailed questions identifying a number of built environment professional bodies which operate in Australia. For those in employment, respondents were asked whether employers paid fees. Respondents were also asked to respond to questions about the length and duration of professional training prior to attaining full membership of professional bodies and their views on current fee levels. Finally respondents were able to give any additional comments if they wished.

3. Data analysis and results

3.1 Survey demographic

The respondents to the survey were predominantly aged 21 and under, with 23.4% in the 22-25 year age group, 8% in the 26-34 year age group and only 5.8% being aged over 35. The postgraduate respondents, representing 7% of the sample, were, as would be expected, older than the undergraduate respondents with 43.5% in the 26-34 year age group and 21.7% being over 35.

The gender balance of respondents was 60.5% male to 39.5% female. These figures are deemed to be representative of the gender balance in the built environment courses at the three universities.

The break-up of courses studied at the three universities were; 56.2% of the respondents studying property and 14.9% studying combined courses such as ‘property and construction’ or ‘construction and architecture’. Of the remaining students, 10.4% were studying planning and 8.5% construction courses.

Overwhelmingly the respondents were enrolled on full time courses (91.4%) with only 8.6% studying part time. Similarly 87.6% or 571 respondents were enrolled on undergraduate courses, with 12.3% studying at post graduate level. The largest proportion of the total, 40.8%, were in the first year of study, leaving 59.2% to be in the second or subsequent years of study. The courses attended were three or four year undergraduate ordinary and honours courses or 1.5 year postgraduate masters courses.

3.2 Career Intentions

The respondents were asked to give some indication of their career intentions, particularly if they intended to work outside of Australia as this might have some bearing on the type of professional body the students may orientate towards. The survey revealed that 45.3% intended working solely in Australia for the first two years after graduation. This is a period during which they could, if motivated, complete training for professional body membership. A significant number, 34.5%, did not know whether they would remain in Australia to work in the two years following graduation. The remaining 20% intended working elsewhere within the two years after graduation. Just over a third of these respondents were seeking to work in Europe, closely followed by those seeking to work in Asia. Ten students were looking to work in the Americas with the remaining respondents considering the Middle East and New Zealand. Of those intending to work overseas, 17% did not identify the countries in which they intended to work upon graduation.

In the longer term 74.8% of respondents believed it was probable or certain that they will work overseas during their career. Of the remaining respondents 14.6% did not know whether they would work overseas and only 0.8% of respondents stated that they did not intend to work overseas with 9.8% stating it was not likely that they would. These figures clearly show that many of the graduates from property and construction courses in Australia are contemplating working internationally at some point in their careers with 20% of them intending to go oversees shortly after completing their degrees.

3.3 The importance of professional qualifications

The students' perceptions as to the importance of professional bodies could provide a clear indication of their understanding of the role of professional institutions and the likelihood that they would seek to join one of these organisations. The responses from the surveys were very positive and show clearly that respondents view professional qualifications as being very important to them. 93.8% viewed professional qualifications as being either very important (64%) or of some importance (29.8%). Only 3.3% viewed professional qualifications as being of either no or limited importance and 2.3% did not know.

Student membership of professional institutions was found to be relatively low. Only 35% of students belonged to a professional body with the most, 12.9%, belonging to the Australian Property Institute (API) and 8.3% being members of the RICS. A large proportion, 21.6%, were members of more than one professional body. A total of 429, or 64.9%, of the respondents were not members of any built environment professional body.

Respondents were asked which professional bodies they intended to join when they graduated. The number of responses left blank was relatively high at 31%. This contradicts a previous response in respect of the importance attached to the professional qualifications. Most students intended to join the API, 41%, and 9.2% intended to join the RICS. When duel API / RICS membership was considered the response rate was 34.2%. This result shows that, while there is a clear perception that professional organisation membership is important, a large number of students had not considered which institution they would join. Those that had made a decision tended to favour the local organisation over the international one, a figure which did not reflect the proportion of respondents intending to practice overseas.

The respondents were asked how important it was to them personally to join a professional body. The responses showed that there is less importance attached to gaining professional membership than gaining professional qualifications. It is apparent that there is a gap in knowledge of these respondents in that professional qualification and professional membership are not seen as co-related and mutually beneficial. Joining a professional body was seen as very important by 28.2% and 45.3% saw it as being of some importance. This compares to 93.8% who saw professional qualifications as being very important or of some importance. Only 73.5% saw professional body membership as important.

3.4 Reasons for joining professional institutions

The next section of the questionnaire asked respondents a series of questions about what they perceived as reasons to join, and the benefits of, professional body membership. Respondents were asked to rank each the reasons given on a Likert Scale between one and five, with five being the highest option. The results, shown in Table 1 below, clearly show that the top reason or motivation for joining a professional body was that it is perceived to enhance career prospects. This reason was followed by the apparent access to professional networks and the increasing of career progression (promotion). The next reason for joining a professional body ranked by the respondents was employability, followed by the need to keep abreast of current issues, remuneration, the apparent increase in employability overseas and the improvement of benefits paid by employers. It is a major concern that professional body membership is not perceived as being a benchmark of professional skills and knowledge - this reason being ranked nine out of the ten reasons given. Access to Continuing Professional Development (CPD) was ranked at ten, and last as a reason to join a professional body. These results indicate that students' expectations of the role of professional institutes is not fully aligned with those of the institutes in terms of a professional body membership being a benchmark of a member's professional skills and knowledge and, as such, a means of enhancing work opportunities both within and outside Australia.

Table 1 Reasons for joining a professional body

Reason	**Number of responses**	**Mean**	**Rank**
Enhances my career prospects	632	4.26	1
Provides access to professional networks	629	4.11	2
Increases promotion	626	4.05	3
Increases employability in Australia	626	4.00	4
Will keep me up to date	632	3.98	5
Improves my salary	627	3.91	6
Increases employability outside Australia	622	3.86	7
Improves benefits paid by employers	628	3.74	8
Is a benchmark of professional skills and knowledge	628	3.65	9
Provides access to CPD	624	3.63	10

Respondents were then asked to rank their expectations of professional bodies (again on the Likert Scale between a score of 1 and 5, with five being the highest score). The results are shown in Table 2 below. Networking was the biggest expectation that students had of professional bodies. The clear implication from this is that networking opportunities such as social events, training seminars and CPD activities, present an opportunity to raise the profile of institutions and attract young members. The second expectation ranked was in career development and mentoring opportunities, with students expecting that professional membership will enhance their career progression. These results show a disconnect between career development expectations (ranked 2) and structured training (ranked 5), in that students are perhaps not considering the need to take-up further education and training in order to enhance and develop their careers. It is interesting to note that access to state of the art knowledge was ranked equal second, demonstrating that students have some expectation that the professional bodies will serve them as a source of future knowledge. The enhancement of salary was ranked fourth by the respondents showing that there is not a clear expectation that professional body membership would equate to greater earning capacity, even though career development was ranked second which might be expected to be associated with increased earning capacity.

There is an expectation evident among students that mentoring schemes are provided by the professional institutions to assist their progression to full membership. There is a need for institutions which do not already do so to meet this expectation and develop effective mentoring programs to guide the transition from student membership into full membership.

Table 2 Expectations of professional institutions

Expectations of professional bodies	**Number of responses**	**Mean**	**Rank**
Networking opportunities	632	4.32	1
Career development and mentoring opportunities	631	4.08	2
Access to state of the art knowledge	631	4.08	2
Enhanced salary	629	3.90	4
Structured training	630	3.80	5

3.5 Perceptions of employers' expectations

Respondents were asked whether they thought their employers expected them to join a professional body. The answers to this question revealed a substantial gap in knowledge and understanding about professional bodies among Australian based students. A large number failed to answer the question and this could be attributed to the high number of first year students who are unlikely to work in professional offices at this stage in their studies. Of the 485 who answered, 127, or 26.2%, did not know whether their employer would expect them to join a professional body. The largest percentage, 63.7% (309), stated they thought their employer would not expect them to join a professional body and only 10.1% thought employers would expect them to join. Clearly only a small minority of students see that employers would expect them to become professionally qualified. This data provides an interesting student perspective that can be compared with the actual expectations of employers of graduate property professionals. Further research is required in this area to map industry employer expectations.

A similar picture emerges when students were asked whether they thought employers would pay employees professional body membership fees. A large number failed to respond, 190 or (28.7%), and an even larger number, 201, did not know the answer. 46.7% thought their employers would not pay professional fees, with 7.4% considering that their employers would pay their fees. A similarly cloudy view of whether an employer would pay fees for an employee to be a member of more than one professional body was apparent in the sample. Only 5.6% thought their employer would pay for more than one professional membership and 35.3% thought that their employer would not pay more than one fee. These results show that students entering professional practice do not have an understanding of what might be expected of them in terms of membership of professional bodies, and very few expect that their membership fees would be paid by their employer.

The entry requirements of professional bodies vary but, in general, most currently require a period of structured, ‘on the job’ experience before being granted full membership. The RICS Assessment of Professional Competence (APC) takes a minimum of two years and applicants are required to submit a diary, a critical analysis of a project, a summary of experience and undertake an interview with three RICS members before they are able to join as a full member. When asked about the current RICS APC, 65.5% of respondents (379) felt that it was either too long a time period or too much work. However, 33.7%, (195) thought that it was ‘about right’.

A similar response was achieved when asked about the level of professional bodies’ membership fees. Using examples of several professional bodies current fees, students were asked if the fees were, in their opinion, too high, too low or about right. The results varied from organisation to organisation but broadly fell into categories of one third not knowing and one third each thinking they were too high or about right. Very few students, not surprisingly, thought they were too low. This result could be considered to reflect the lack of detailed knowledge of the professional bodies, as demonstrated above, with a large number of students not in a position to be able to evaluate the appropriateness of the fee level.

4. Conclusions

The results of this survey of student perceptions of professional organisation membership within the built environment profession have provided some valuable insight into student knowledge and attitudes. They will provide a useful resource both for those educating and preparing students for entry to the profession and for those administering the professional institutions. What has emerged form the research is that students do value professional qualifications but that there is a distinct lack of understanding about the role of the professional bodies in their careers.

The level of international outlook for students in their careers, with many expecting to work overseas early in their careers, is encouraging for globalisation of built environment professional practice. This result has implications for the recruitment of students into professional bodies and clearly shows the need for international links between professional bodies and the establishment of global professional recognition. It demonstrates that professional institutions will increasingly need to work on their ability to service members in a global context.

The move by some professional institutions to establish themselves as global profession bodies may go some way to addressing this challenge, although the results of the survey clearly show that, in the Australian context, local institutes are a preferred option over international options. This local preference becomes even more significant when taken within the context of membership fees. If student perceptions are correct, and employers are reluctant to pay more than one professional membership fee, if any, then the growth of international professional bodies is likely to be restricted. There are lessons to be learned in terms of international versus local that should influence institutional policy moving forward.

The area of most significance in terms of why students are not progressing to full membership of professional bodies is demonstrated at a number of levels. While professional qualifications are seen as important by young practitioners, membership of a professional organisation is seen as less important. Membership is perceived as taking too long to achieve, with a complex joining process over two years. It is apparent from the results that student perceptions of the importance of the APC is not in tune with the importance that professional bodies place on this period of practical experience. If student conversion to full membership is to be achieved then some considerable education of the need for, and importance of, this training needs to be undertaken by the institutions. The period of training required by professional bodies needs to be seen to add value both to employers and to young members seeking advancement of their careers. It is also clear that in order to assist potential members to successfully navigate their way to full professional institute membership, the expectation among students that mentoring programs exist needs to become a reality.

The expectations of what membership offers in terms of career advancement and networking opportunities are not necessarily the same priorities that employers might perceive of the membership organisations. The next phase of this research will seek to evaluate major employer groups' perceptions of professional institutions. It will seek to establish perceptions of professional institutions importance in the work environment. It will allow conclusions to be drawn as to the importance of structured training before becoming a full member of an institution and will gauge the willingness of employers to pay professional membership fees and reward employees for seeking to become members of local and international professional institutions.

The message that can be taken from this research is that young professionals entering professional practice are focused on career development and will only seek to link themselves with professional bodies where that membership delivers clear value for money in delivering career goals and opportunities for advancement. This finding echoes those cited at the beginning of this paper pertaining to other professions and the challenges that member professional institutions will face in the future. These results will be useful in guiding the development of professional institutions as they seek to service their membership and increasingly meet the demands of a global membership base.

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The relationship between research and teaching in built environment undergraduate education

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Abstract

The research-teaching nexus debate is a complex and often contentious one which has received a good deal of attention in the UK in recent years. Based on an international survey of built environment academics and practitioners this study explores the importance and relevance of research to Surveying undergraduate education. A key finding is that although the research process and outcomes can nourish undergraduate studies, they have a much greater impact upon postgraduate provision. There is a consensus amongst those surveyed that (UK) Research Assessment Exercise type research may have only marginal relevance when compared to case study, market-based or professional development type activity. Many respondents believe 'blue sky' research to be of limited use to undergraduate studies.

Keywords: Research teaching nexus, undergraduate education.

1. Background

1.1 Research and research funding

The UK Government currently funds Higher Education Institutions' (HEI) research through a dual support system, providing distinct but related sources of income. Firstly, the four UK Higher Education (HE) funding bodies (the Higher Education Funding Council for England, the Scottish Higher Education Funding Council, the Higher Education Funding Council for Wales and the Department for Employment and Learning Northern Ireland) allocate 'quality-related' (QR) funding on the basis of performance in a periodic Research Assessment Exercise (RAE) in the form of block grants to universities. The most recent RAE was in 2001 and the next in 2008. Secondly, the Research Councils, for example ESRC and EPSRC funded through The Office of Science and Technology (OST), award grants for specific projects or programmes on a competitive basis. The Government is committed to this system and to rewarding excellent research, and the correlation between an HEI's QR and OST income streams is very strong: between 2000 and 2005 the average correlation was 0.98, with no variation across years [1].

Other sources of research funding available to universities include charities (e.g. the The Joseph Rowntree Foundation), industry, the European Union and Government departments. Success in securing significantly sized awards from these sources often relies upon extensive networks and research reputations. According to HM Treasury [1], once again the correlation between institutions' QR income and their total research income is very strong, between 0.97 and 0.99 over the same five year period. Hence, success in the RAE is of crucial importance: not only does it provide the major source of research monies, but the associated profile it affords a university is highly likely to be a key factor in securing other research grants and awards.

Whilst acknowledging that the RAE has led to an increase in the quality of research, the UK Government's White Paper *The future of higher education* [2] clearly argues for a change in strategy. One of the stated aims is to reward research intensive institutions by funding research in larger, more concentrated units – notably through the RAE in 2008. It also confirms that research council grant funding, will follow a similar pattern.

Analysis of Royal Institution of Chartered Surveyors (RICS) statistics indicates that in 2005 approximately 9000 students were registered on accredited UK courses. The distribution of these students across the various RAE research-rated universities is shown in Table 1.

Table 1: Percentage of students on RICS accredited courses

Rating	%
5*	3
5	14
4	9
3a	21
3b	26
2	3
1	0
DNS	24
Total	100

%	percentage of national total (9020) of students on RICS accredited courses
– – – (red)	optimistic equivalent minimum threshold to receive funding RAE 2008
– – – (green)	minimum threshold to receive funding RAE 2001
DNS	did not submit to RAE 2001

The cumulative totals show that 47% of students are currently studying at research funded institutions (i.e. those rated 3a and above). If the threshold is raised to 4 (or the equivalent score under RAE 2008) following RAE 2008 then, all other things being equal, this would drop to 26%. If, as some experts are suggesting, the bar is raised to 5, then only 17% of students would be studying at universities funded by research grants through their relevant HE body. Such a funding regime could create a polarisation of Surveying Schools/Departments which could in turn be reflected in recruitment policies i.e. some (relatively few) universities will seek to develop and recruit research-focussed career academics, whilst others (the majority) require experienced practitioner/teacher staff. So, how important is departmental research activity to undergraduate students and what balance of expertise is actually required for an effective Surveying academic?

1.2 Research and teaching

Dearing's report *Higher Education in the Learning Society* [3] concluded from the evidence received by the National Committee of Inquiry that a total separation of research from teaching in HEIs had little support, stating:

> *There is near-universal rejection of the idea that some institutions of higher education should be 'teaching only' institutions. For the majority of respondents, such an institution would simply not be a 'university' in any legitimate sense of that term.*

In contrast, the Government's White Paper [2] outlines a policy that encourages such a separation. The White Paper cites research by Hattie and Marsh [4] which, it claims, found no relationship between the ratings of both research and teaching. The White Paper goes on to suggest that institutions should play to their diverse strengths. The summary confirms the intention to channel research funding towards the highest achievers, stating that the Government will:

- *encourage and reward research in larger units* . . . [and]
- *invest more in our leading research departments and universities.*

In fact Hattie and Marsh [5] are of the view that the UK White Paper misinterprets and misrepresents their findings. Whilst they do conclude in their 1996 study:

> *. . . that the common belief that teaching and research were inextricably intertwined is an enduring myth. At best teaching and research are loosely coupled;*

their report also adds:

> *The strongest policy claim that derives from this* [study] *is that universities need to set as a mission goal the improvement of the nexus between research and teaching . . . we beseech you to publish and teach effectively.*

Many authors, such as Brown [6], argue strongly that the research-teaching relationship in universities is crucial because it is that which sustains the HE sector's claim for distinctly better resourcing, when compared to Secondary and Further Education (FE). If there are no benefits to teaching, he argues, there is no case for doing research in universities at all. Indeed, the research-teaching nexus debate is a complex and often contentious one, but the notion that links should be developed has received a good deal of attention in recent years. The Higher Education Academy has published substantial and comprehensive reports on teaching-research relations [7] and on institutional strategies to achieve such links [8]. These excellent publications are recommended to readers seeking an in depth consideration.

1.3 Aims of the paper

As part of a much more broadly based research project funded by the RICS Education Trust and the Construction Knowledge Exchange into the future of Surveying education, this paper aims to explore the following questions:

What are the essential criteria for an effective academic in the Surveying field?

What is, or ought to be, the relationship between research and teaching in a Surveying context?

2. Methodology

Phase I comprised a detailed literature review of publications related to the research-teaching nexus. **Phase II** included ten semi-structured interviews with selected Research Directors or Heads of Schools, following which eight regional forums were convened to gather a broader view from academics and practitioners related to the themes of research and teaching in the context of Surveying education. The research study interviewees were drawn from some of the UK's leading Surveying education providers. Student numbers, geographic location and RAE 2001 scores were used to identify the sample. Focus groups were convened throughout the UK. The forums in England were closely aligned with the Construction Knowledge Exchange (CKE) national network and took place in Bristol, Leeds, London, Newcastle, Salford and Wolverhampton. In addition, forums were held in Belfast and Edinburgh. Manifest items, i.e. those which are physically present in the recorded content of interviews and focus groups, are identified to avoid any reliance on latent content, which is according to Robson [9] a matter for inference or interpretation. Hence, direct quotations are used extensively in the presentation of findings, and are indented and italicised in the script for clarity. Attitude statements extracted from interview transcripts, focus group notes and the literature were used to create an item pool from which an on-line questionnaire was devised. The questionnaire was widely promulgated during **Phase III** of the research and over a three-week period 433 respondents, working principally in academia and practice, took part in the survey from all World Regions.

3. Findings and discussion

3.1 Essential criteria for academic staff

The interviews revealed that whether or not an institution is actively pursuing RAE funding does have a significant impact upon their recruitment policy. But from the broader spectrum of participants in the study, there are very different views as to the relative merits of professional experience, teaching expertise and research capability. Whilst many interviewees refer to an 'ideal' profile for a Surveying academic, they all realize that it is largely unattainable.

> *The ideal person is someone with professional qualifications, industrial experience, teaching experience and research experience . . . we very rarely get people who meet those ideals.*
>
> *Ideally I want somebody who has 10 years experience in practice, has a PhD, has a long string of outputs, has experience of teaching, has a good personality and is well organised. You tell me who I can recruit with that for £35K.*

Amongst the whole sample though, the greatest contrast in opinion relates to the importance of professional experience in comparison to research capability. Interestingly, teaching experience is mentioned relatively infrequently. The following quotations are a representative sample of opinions held by staff within post-1992 universities (old polytechnics):

Experience of practice is essential but this is a personal view, not an institutional one.

. . . by and large we want somebody who will show relevant experience in the particular field.

The research record and capabilities of the staff would feature in the desirable rather than the essential list.

I have to say to you, that in the recruitment of staff to those areas, the issue of the research capabilities . . . is but a marginal consideration. The more important thing short term, is the experience and expertise that they can offer . . .

I've just turned down 3 people who have got PhDs – they may have been very clever, they may have lovely PhDs – our students would eat them alive.

Professional experience is essential for undergraduate education.

However, examples of a diametrically opposed view are not uncommon, but not nearly so prevalent. The following quotations illustrate the views of staff within pre-1992 universities:

I'd plump for the research capabilities . . . [they] *are about the long term capabilities of the individuals. The experience* [is about] *the short term and frankly, given the pace of change in the real world, quickly becomes redundant.*

I think the value of a practitioner in a university actually diminishes quite quickly.

We would expect someone who's got a PhD . . . to pick teaching up - whereas somebody with a professional background, they would be difficult to transform into researchers.

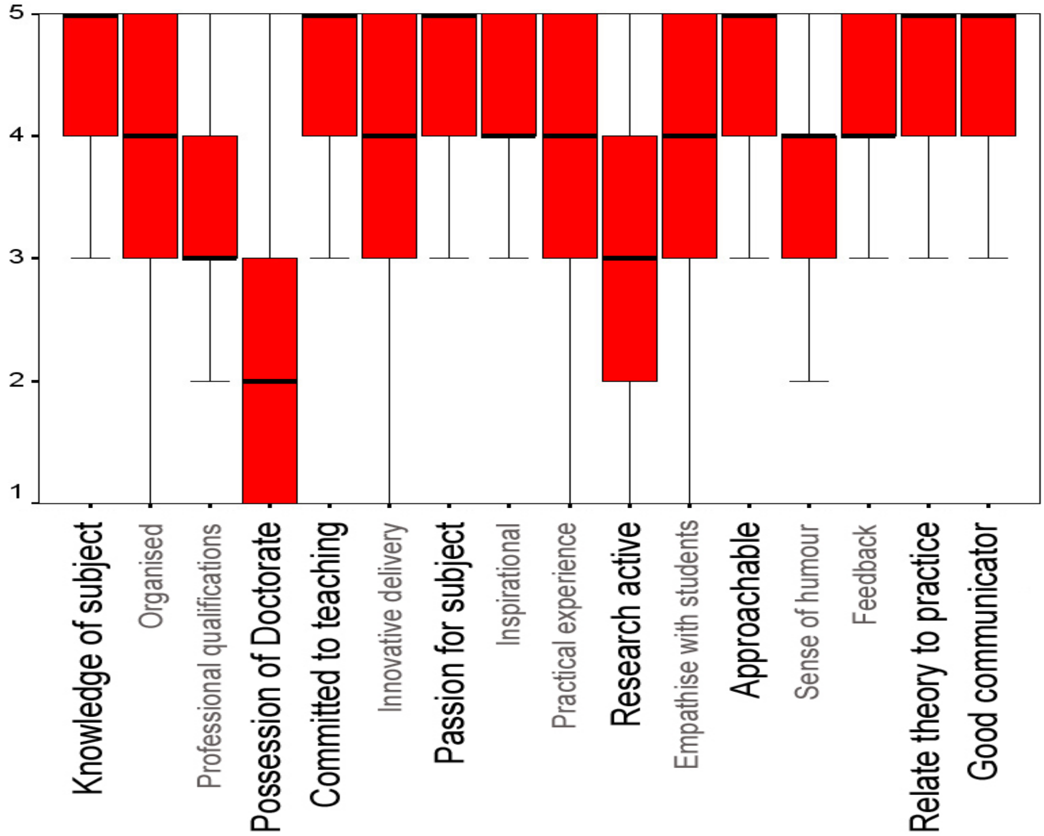
Their background is mainly research; we were quite happy to make that appointment, even though the person had limited professional experience, limited teaching experience.

The University is not interested in professional qualification, that's a bonus . . . it's 99% research profile – doesn't matter how good a teacher you are – doesn't matter what you know professionally in the Chartered Surveying sense.

Professional practice is not relevant.

Your ability to teach any Surveying topic is not a consideration.

The questionnaire results indicate that the majority of the attributes extracted from the literature are rated as either very important or of great importance, although possession of relevant professional qualifications and commitment to research are considered as quite important and the award of a doctorate degree of little importance.



5 = great importance

4 = very important

3 = quite important

2 = little importance

1 = not important

Figure 1: Attributes of an effective lecturer

Notwithstanding the preferences and ratings expressed above, there is a consensus from interviews and forums that, to date at least, performance in research has been the key to achieving promotion as a Surveying academic.

> *There's not necessarily a connection between good quality teaching and individual promotion prospects.*
>
> *It is increasingly difficult for people to progress up unless they have research credentials. Not impossible, but increasingly difficult.*
>
> *If you look back, at who's received promotions over the last 10 years here, you would find it's heavily weighted in favour of research . . . there has been a bias in favour of research, I can't deny it.*

The questionnaire results concur with the qualitative data in this respect: 45% of academic respondents believe that their department ranks research more highly than teaching or management duties when promoting staff.

3.2 Research and teaching

Views expressed at the interviews and forums indicate a broad agreement that there are important links between research and teaching.

> *Research is about knowledge generation, teaching is about knowledge dissemination – they have to be linked.*
>
> *It's an integral process. I think it's invidious to try and separate the two.*

A number of interviewees have a firm belief that research can nourish the curriculum, but that it must be relevant.

> *We've taken a very strong view that the vast majority of our research should be linked to teaching.*
>
> *The expectation is that every member of staff will continuously think of ways by which they can pass their scholarship / research knowledge on in to teaching.*
>
> *Research is important in terms of the way in which we communicate the ethos of research itself to our students, so that's the first reason it's important. The second reason it's important is of course in terms of subject content and choice of subject content.*

Others are more equivocal.

> *Research culture does feed its way through to the undergraduate programmes but it's difficult to show.*

There are clearly very different practices at different universities. Two respondents who have recently completed terms as External Examiners make the following observations.

> *As an External Examiner I see a kind of dislocation between research capability and their teaching material and teaching load.*
>
> *I've just finished – I will not say where – as an External Examiner, where the people who are research active, you just never saw them. They were not involved in the teaching of the students.*

There is also considerable disagreement about the type of research or scholarly activity which might benefit Surveying courses. Many feel that professional development activity is important; others that market based or case study research is most useful. The issue of 'blue sky' or 'discovery' type research is one that seems to generate some of the most fervent opinions. Many participants question its applicability and usefulness, particularly to undergraduate programmes.

> *Professional development for keeping up to date is more important than research that makes discoveries.*
>
> *Pure research that is published in journals* [is not useful], *as opposed to research that informs, embellishes and brings to life good teaching and knowledge transfer.*
>
> *To be honest, a building surveyor couldn't care less about the esoterics of electrical power engineering research, for example, but they are interested in how you put a transformer inside a building.*
>
> *Research that is market information based, that is what we crave. And it can be incorporated* [into the curriculum] *much quicker.*
>
> *RAE type research is always about 'blue sky' and may not be too relevant to practice.*

Some go further.

> *It* [research] *is not that important, not crucial at undergraduate level. Surveyors get educated on the BSc to get the knowledge base.*

Nevertheless, many participants do feel that students benefit from being taught by researchers, that it is of great help particularly when supervising student research projects and dissertations, and cite reputable postgraduate programmes which are largely based around research strengths.

However, the view that research potentially diverts valuable time and attention away from teaching is very commonly held and is repeated many times during both interviews and forums alike.

> *Research diverts attention from teaching, as the saying goes, "teaching ruins a good day".*
>
> *You could argue it takes resources away from teaching and learning and researchers are not fully committed to teaching.*
>
> *The big negative is that some good academics expend by far the majority of their energy on research work and they see teaching as not even a by-product.*
>
> *I think if we are not careful teaching is devalued.*
>
> *Our success in research does mean we've got to face certain tensions, particularly in terms of the teaching / research balance.*

The questionnaire attempts to distil a number of these issues. Respondents generally agree that courses should be delivered in a research-active department and likewise research of direct relevance to the needs of industry, the invention and generation of new ideas and the application of existing knowledge in experimental development should underpin course delivery. Common themes to emerge from an analysis of the positive contributions that research can make to teaching are:

- Enriches the curriculum: currency, context, breadth and relevance
- Promotes staff development: pedagogic, intellectual and vocational
- Provides funding: capital and revenue
- Develops key skills: problem solving, creativity and communication
- Creates a progressive learning environment and school culture
- Promotes innovation: new knowledge and ideas
- Stimulates staff and increases retention
- Encourages collaboration, team-working and internationalisation
- Enhances staff credibility and role model for life long learning

Whilst several questionnaire respondents recorded the view that research has no negative contributions aside from the time taken to pursue such activity, the majority used this opportunity to identify tensions associated with the research-teaching nexus as follows.

- Limits time available for student education and welfare
- Lacks relevance and is overly theoretical
- Distorts course content
- Leads to isolation and preoccupation with personal research
- Devalues teaching
- Takes funding and experienced staff away from teaching
- Polarises teaching and research activity
- Adversely affects (“dulls”) the student experience
- Overloads academic staff

In addition, respondents suggest that an undergraduate curriculum is less likely to reflect staff research interests than a postgraduate programme, and is generally perceived to be of less value to undergraduates than postgraduates. The majority of academics either agree or strongly agree that the pressure to be research active is draining the value placed on teaching and that the synergy between teaching and research is undermined by the fact that they are managed, assessed and funded separately.

4. Conclusions

4.1 Research and research funding

It is evident that some providers of Surveying education are research-led, take pride in this fact and place high value on RAE-type activity when recruiting staff. Others are teaching-led, although it would be erroneous to suggest that no research takes place in these departments - much depends upon the chosen definition of research. Hence the idea of polarisation is perhaps rather simplistic. The evidence here is that there is a research-teaching continuum along which institutions are variously placed and that the pluralism of purpose which this demonstrates is thought to be healthy. As such it should be recognised and applauded. However, it is also widely acknowledged that funding systems over a period of years, and particularly following RAE 2001, have not helped those aspiring to move along the continuum from teaching only, towards research.

In this context, the evidence confirms that there are very different opinions regarding the essential and desirable qualities for a Surveying academic. Unsurprisingly research-led universities favour candidates with research expertise, whereas teaching-led universities are normally more interested in professional experience. What is clear from the open discussions and the questionnaire is that professional experience is considered to be of greater importance for an effective Surveying lecturer. Despite this view, the evidence also suggests that research expertise is the most important criteria in the *promotion* of academic staff confirming Brown's [6] assertion that universities (even the post-1992 institutions) give far greater esteem to research over teaching.

4.2 Research and teaching

The findings of this study suggest that research outcomes and the research process can nourish undergraduate studies, but that they have a much greater impact upon postgraduate provision. Whilst most people accept the value of research in enabling academic staff to keep abreast of the latest developments in industry, the real issue centres on the nature and scope of the research being undertaken. Many people consider RAE type research to have marginal relevance when compared to case study, market-based or professional development type activity. Indeed many participants rail against the notion of 'blue sky' research, believing it to have limited interest or use to undergraduate studies. There is a clear link here to Elzinga's [10] notion of 'epistemic drift' which Chynoweth [11] suggests can occur when the availability of research funding encourages research in some areas to the detriment of that in others. Indeed, Brandon [12] observes that this has already occurred in the Built Environment field with the growth of research in Management at the expense of Technology. At its extreme, this phenomenon can lead to a School/Department which has a top research rating, but where the research subject matter has, at best, only tenuous links to the Surveying knowledge domain. Furthermore, a strong message from the evidence gathered here is that research diverts resources (time, funding, commitment etc.) away from teaching, and that teaching is devalued as a result. This perhaps suggests a need to adopt a broader appreciation of the concept of scholarship, as recommended by Boyer [13], to include the scholarship of discovery research; the scholarship of integration including the writing of textbooks; the scholarship of application and the scholarship of teaching. As he speculates, this may help to break out of the tired old teaching versus research debate.

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A QUT Experience in Combining Sustainability Research with Educational Activities and Professional Practice

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Abstract

The paper discusses the development and delivery of a university subject on sustainable construction, using related research projects as case studies and learning materials. It exposed students from a variety of disciplines to real life scenarios, to group around project cases, and learn to work with one another in solving sustainable development problems. The problem based learning approach directly responds to the new trends of learning by practising which, in the area of sustainability education, is particularly appropriate because of the need for multi-disciplinary approach to complex issues, and the impetus for research and development to provide timely input for education in this growing discipline with a relatively short history. Collaboration of students from cross-disciplines, the engagement of industry and practitioners, the concept of using project cases and student design competition, and the tangible improvement of students' comprehension of the sustainability phenomenon as a whole, have been the highlights of this Australian experience.

Keywords: sustainability, education, problem based learning, construction research, practice

1. Introduction

Climate change, rising oil prices, increasing energy and resource demands have become issues of priority around the globe and major impacts on everyone's life. Naturally this further raises the high level of concerns over sustainable development and living among our societies. Such awareness is not only reflected through intensified media reports and evolving policies and strategies from governments, but also shown in the level of sustainability coverage in all levels of education as a whole.

In Australia, the educational focus on sustainability coincides with the UNESCO's initiative for a wide-spread global implementation of sustainable education. Nowadays school children of all ages tend to get early lessons on sustainable living through a variety of exercises and projects, ranging from tips of reserving water, to the use of alternative energy to designing model cars. At the university level, many academic disciplines have developed subjects and courses that cover relevant sustainability issues. For planning, design, engineering, and construction education, the need to respond to this global challenge is particularly strong, as graduates from these disciplines work on the front end of the issue, directly on projects with sustainability deliverables.

Despite of the flurry of activities on sustainability curriculum development by many disciplines from Business schools to Science departments, existing trends of these subjects tend to tends to be restricted to the elaboration of sustainability principles, environmental management concepts, and methods and systems of assessing performances, while professional disciplines home in on the specific technological innovations. Few had the opportunity to allow students to "put the ideas altogether" as they will undoubtedly be accustomed to do in the real world of professional practice after they graduate [1]. This requires that we not only teach students 'what" as the technical know-now, but also the 'why' to encourage them think and act in the appropriate way for the rest of their life.

The need to introduce real-life experiences to classrooms in order to promote "deep learning", was also emphasized by a number of earlier research [2][3][4]. It will be much easier for students to relate to and leave with better impressions when their course work study is integrated with the learning of practice under supervision.

This paper discusses the importance of the shifting sustainability foci and how they will impose on sustainability curriculum development in higher education. An example of an integrated approach to combining research, learning, and practical experiences at an Australian university was introduced as a better way for students to learn to practice sustainable design, engineering and construction.

2. The Impetus of Enriching Sustainability Curriculum

There are many interests in the introduction and enrichment of the sustainability agenda into university education. Resource depletion and climate changes are driving the society towards unprecedented awareness of the sustainable issues. Under the pressure of clients and other stakeholders, our industries and businesses are changing the game and are responding to the sustainability challenge with new strategies, processes and products. To do so, they will require a new breed of young professionals to have not only the technical knowledge but also the passion about developing green solutions to design, engineering and construction works, through the promotion of their own belief and self discipline [1] [4] [5]. In June 2006, the Queensland University of Technology conducted an industry survey on graduate capabilities in the fields of engineering and the built environments. The results show that sustainability knowledge has consistently ranked very high by all involved disciplines, as considered by a wide range of practitioners.

Universities will therefore have the obligation to ensure that the students, our future professionals, understand not only the specific technological advancement but also the holistic sustainability practices that occur on a much more complex scale. This application aspect will need to be taught in an integrated manner so that students will become confident in working with peers from other areas as a team, listen and responds to other professional views as they would have to after graduation, and become active practitioners of sustainability. It has been argued that the challenge of sustainability education is essentially to 'learn by practising what is preached' and to shift intensions from impact mitigation to regeneration [6].

Linking research with teaching has been promoted as the way of fast tracking from education to practice [7]. While it is easier said than done, the area of sustainability in the built environments presents three main advantages, compared with many traditional and long established disciplines. First, there are many aspects in sustainability, in terms of social, economical, environmental and institutional dimensions, to explore and associate with through various disciplines. For example, investigating the attitudes towards and the social impacts of sustainable housing is as valid as the design of systems to improve indoor air quality and workplace health of office buildings. And these can be covered from science to engineering, health to law, and management to education perspectives, all current ingredients of high education. Secondly the relatively short history of sustainability education means that lecturers and students are all striving to access appropriate teaching and learning materials. There are virtually few “set routines” to follow but perhaps the associated “reluctance” to change. Thirdly, in parallel to the evolution of sustainability bottom lines and the philosophies of environmental evaluation, there are continuing technological advances being made to deal with specific areas, using individual products and practices. There are enormous information and knowledge out there to be tapped into, to supplement general sustainability courses and subjects through topical coverage of “hot spots” and teaching foci. These arguments highlight the need for multi-disciplinary approach to the subject matters with consistent knowledge update and course materials management. An integrated and multidisciplinary teaching and learning environment linking with research and opportunities of practice will be the new paradigm (Figure 1).

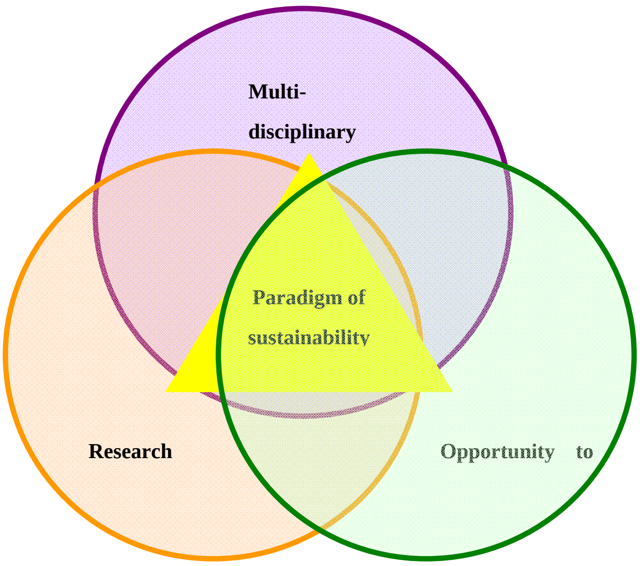

Figure 1 Integrated approaches to sustainability education

3. QUT's Living Laboratory Approach

3.1 Background

The Faculty of Built Environment and Engineering at the Queensland University of Technology, Australia, has a unique organisational structure. It contains almost all of the disciplines involved in developing buildings, infrastructure and other built assets and engineering facilities. For example, there are courses in architecture, interior design, urban planning, property, surveying, construction management, as well as structural, mechanical and electrical engineering. The Faculty also hosts two Corporative Research Centres (CRC) that conduct a large number of industry sponsored real life research projects. Researchers in these projects are also lecturing staff of the university. This presents added opportunities to experiment the integral approaches discussed above in a *living laboratory* setting for teaching, research and showcasing technological advances. The following sections detail one example of applying this philosophy in developing and delivering a subject on sustainable construction.

3.2 Curriculum development

The subject of *Smart and Sustainable Construction* was developed as a final year elective, open to students from a range of related disciplines. The first two years of running this subject saw over 60 students enrolled and completed successfully. They represented eights disciplinary areas of construction, civil engineering, electronic engineering, property, quantity surveying, interior design, landscape architecture, and architecture design.

The subject is based on the study of sustainable development of commercial and residential projects and concentrates on problem solving at a multi-disciplinary level. Case study materials and students' project cases were supplied from relevant CRC and other research projects. The syllabus is project-based and student-centred, with students from different disciplines forming groups to undertake project work according to the chronological order and lifecycles of realistic project development cases. The specific areas of study covered in this unit included:

- Sustainability and its impact to construction and engineering development
- Flexible design considerations
- Innovative building techniques and processes
- Smart engineering services
- Environmental, legislative and social context of sustainable development
- Appropriate techniques for project performance evaluation

This subject utilised real life research project as source for study materials to aid teaching and integrated assessment works. Students formed groups made up of various disciplines to undertake assessments. For example as part of the assessment during one semester, they delivered three major technical reports, and made a presentation based on the evaluation of the project development, should it follow their recommendations and plans. On a continuing basis, project cases were developed and updated with examples such as Sustainable housing development utilizing specific site characteristics; Multi-storey office building refitting project in CBD areas, Urban village development with mixed uses and facilities, Resort and marina development with environmental impact assessment, innovative construction methods, and economic justifications.

3.3 Student competition and research projects

Findings from major research projects that deal with housing and office building refit were used as lecturing materials extensively in this subject. Ways of bridging the gap between research work and scenarios of teaching and assessment were explored. For example, research on integrated sustainable housing development with end result of a demonstration home was used in 2005 offering of this unit as a case study for student assignments as well as the scenario and theme for a student design competition.

With the support of the research industry partners, a student competition on the architectural, engineering and construction aspects of a sustainable demonstration home was held. Research team members of this research project, who were also lecturing staff of different disciplines, provided instruction to nine groups of students who made entries in the competition. Students were able to see the current industry foci on matters related to their disciplines and be part of the problem solving process. Other stakeholders had the opportunity to contribute to education and promote their trades and businesses to potential employees and partners.

At the start of the semester, students were given specific briefings about the challenges faced by housing developers involved, and had the opportunity to investigate matters further by speaking to planning and construction authorities in the local governments. Field observations were organised for students to gain first information about site characteristics (Figure 2).

Figure 2 Field trip and site investigation

After two rounds of judging which involved university lecturers, developers, and practising architects and engineering consultants, three winning designs were selected. They covered architectural design of the home, building methods, and lighting systems:

(a) Interior lighting using solar powered LED **-** to integrate high efficiency LEDs powered by photovoltaic (PV) cells with intelligent control for interior home lighting.

(b) Alternative building system for sloping site – to improve architectural designs from a sustainable construction point of view, using most economical building systems including modular framing for specific site conditions encountered.

(c) Sustainable housing design with local characteristics – to achieve utopian harmony with the natural environment, new sustainable materials and technologies, and high level of comfort and ambience with the modern lifestyles suited for the local topography and subtropical conditions. With focuses on passive design, energy efficiency and social issues, the design dealt with water and aspect; wind, privacy and land formation; soil, vegetation and access; and subdivision context and neighbourhood (Figure 3).

Figure 3 Student design (architectural) with professional enhancement

There winning designs were then enhanced through student involved consultancy practice between the consultants and the developers. Students were also invited to participate in the design practice of the consultants as part of work experience. This produced final documentation for building approval. Students were very pleased to see their own input in the final products.

3.4 Stakeholder engagement

Students were informed of the subject and competition through “promotional” efforts such as posters and staff recommendation. They responded well to the new subject and came from a wide range of disciplines with a high degree of specialised expertise in the field. As all students were senior and have a degree of maturity towards their fields of study, their willingness to contribute and to share responsibilities has been the driver for the successful learning process. A number of opportunities were created throughout the semesters to allow students “mingle” with each other. This included discussion groups, assignment teams, debating challenge, allocated tasks for presentation, etc. But according to students who took this subject, it was the problem based learning and the student competition that motivated all.

With a motto of "university for the real world", QUT is particularly active in bringing back the practitioners to the classrooms. This subject has 13 weeks of lecture programmes which enlisted teaching and learning support of two architects, two civil engineers, one electrical and one mechanical engineer for the development and delivery. It also involved a builder and the developer who discussed with students and presented real life experiences on specific site problems, demographics of clients, and local regulations or applicable building codes.

The practitioners were able to observe how students learn and develop skills. Through this process and following the completion of the subjects, the builder and one of the architects offered employment opportunities to students. Students learned from life experiences of the practitioners and the practitioners had the opportunity to hand-pick promising young professionals of tomorrow.

Higher degree research students (PhD and Master by research) were also involved. As part of the research team, they not only participated in research development that had bearings on case study materials for the classroom, but also provided tutorials during the subject delivery as most of them have industry experiences. Through classroom questions and feedback, these research students pick up practical issues that may warrant further exploration in the research projects.

4. Evaluating the Educational Approach

Through theories and practical components, students gained real life experiences of "how and where" to start dealing with sustainability issues on hand. The intangible benefits included the development of competence, working with multi-disciplinary teams and for some students, employment opportunities. But how have students improved their overall understanding, and more importantly, the philosophical approach, to the challenges ahead of their lives? To partly answer these questions, and to provide feedback for the curriculum development, a student survey was conducted through reflective learning exercises during tutorial sessions.

The survey consists of a total of 16 questions in four categories of Awareness, Lifestyles, Professional engagement, and Technical knowledge, which were drawn together through references to media exposure, course contents coverage, and general lifestyles in the local environment. Examples of these questions include:

(a) *Compared to agricultural and industrial use of water, our daily lifestyle does not cause problems to water resources because the level of consumption is minimal;*
(b) *Design is the specific phase in project development where the triple bottom lines (economical, environmental and social) of sustainability should be incorporated.*

The survey was conducted twice over the semester: in Week 2, when students first started this unit; and in Week 13, after subject completion. To ensure validity and reliability, the same question was asked in a different way or in a different context, and the order and grouping have been changed for the second survey. Each question needs to be rated from *Strongly disagree*, to *Strongly agree* according to a scale of 1 to 5. Depending on the nature of the question, and the most appropriate answers may be at either end of the scale. Where applicable, students are also invited to elaborate on and justify their ranking.

Table 1- Table 1 Students' ranking of survey questions

	Week 2 ratings					Week 2	Deviation from		Week 13 ratings					Week 13	Deviation from	Improvement	%
	1	2	3	4	5	average	best score		1	2	3	4	5	average	best score	or regression	
Q1		4	2	8	10	4.00	1.00				2	6	14	4.55	0.45	0.55	54.55%
Q2	1	4	14	4	1	3.00	2.00		1	3	5	10	3	3.50	1.50	0.50	25.00%
Q3	3	7	12	2		2.54	1.54		8	8	2	4		2.09	1.09	0.45	29.24%
Q4	3	5	13	3		2.67	1.67		3	7	5	7	0	2.73	1.73	-0.06	-3.64%
Q5	11	12		1		1.63	0.63		10	12	0	0		1.55	0.55	0.08	12.73%
Q6	2	6	4	10	2	3.17	1.83			5	10	7		3.09	1.91	-0.08	-4.13%
Q7	3	12	1	7	1	2.63	1.63		8	11	1	2		1.86	0.86	0.76	46.85%
Q8	3	8	1	10	2	3.00	2.00			5	5	11	1	3.36	1.64	0.36	18.18%
Q9				13	11	4.46	0.54				2	12	8	4.27	0.73	-0.19	-34.27%
Q10		1	3	14	6	4.04	0.96		1	1	5	6	9	3.95	1.05	-0.09	-9.09%
Q11		5	2	12	5	3.71	1.29				2	6	14	4.55	0.45	0.84	64.81%
Q12	2	7	11	4		2.71	1.71		5	6	7	4		2.45	1.45	0.25	14.86%
Q13			2	13	9	4.29	0.71				2	13	7	4.23	0.77	-0.06	-9.09%
Q14	1	3	8	12		3.29	1.71			1	1	7	13	4.45	0.55	1.16	68.07%
Q15		6	7	9	2	3.29	1.71				2	7	13	4.50	0.50	1.21	70.73%
Q16	5	12	3	4		2.25	1.25		8	9	5			1.86	0.86	0.39	30.91%
			Note: 24 students provided valid responces in Week2 and 22 did so in Week 13. Total enrolment is 28.														

Table 1 shows students rating of the questions over one semester of study. The improvement or regression on the first round of rating was indicated. It is evident that students have shown improved understanding and consciousness of sustainability, reflected by improved rating on the responses to the majority of questions. Detailed analysis shows that the improvement has been far more significant than the regression, which only occurred in four of the questions in smaller percentages.While not intended for scientific measurement of learning outcome, the survey served the purpose of gauging the attitudinal change of students over the course of the subject, particularly by exposing and involving them in sustainability subject with real life examples, team work and opportunities for "hand on" experiences. A separate exercise, which asked students to complete the ecological footprint quiz by the Earth Day Network (EDN) (http://www.earthday.net) also showed improved the level of awareness and general attitudes towards sustainability.

5. Conclusion

The rising level of sustainability awareness and concerns in our society demands changes in the way industries and businesses operate. This in turn requires universities to prepare our students with the knowledge and skills to take on the sustainability challenge technically and mentally. Traditional classroom teaching has the danger of turning students to be technical experts in a topical area, while still not believing in the general philosophy. We will need to promoting students own belief and self-discipline, and the ability of taking on complex problems of sustainability by teaming up with other professionals. New curriculum development needs to introduce the theory of sustainability in a more tangible and practical way by combining disciplinary specialties together, as required in real life practices. The learning by practising approach, as demonstrated in a case of subject design and delivery in this paper, will present such potential. The engagement of stakeholders in high education, from the industries to researchers, and from professionals to academics and students, will provide more opportunities for a win-win situation for the "sustainable" education of sustainability.

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SECTION V

CAPACITY BUILDING

An assessment of municipal development and program management

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Abstract

Palestinian local government has been amongst the most committed bodies responsible for the provision of services that have a direct impact on the quality of life of Palestinians. Palestinian local government has been resilient, thus for at least, in responding to increasing demands for municipal services, such as water provision and distribution, wastewater collection and treatment, solid waste collection, transportation and disposal, and construction and maintenance, among other. However, service levels have been, and remain, to a large extent, to be unacceptable, three municipalities in the Gaza Middle Area enjoyed high profile funding from Danish International Development Assistance (DANIDA) in order to improve the level of environmental infrastructure and services, and through this, to build the managerial and administrative capacity of the municipal councils. The objective of this paper is to evaluate some of large scale infrastructure projects and small scale projects that are implemented in Gaza Middle Area. The general finding of this paper indicates that infrastructure services and capacity building have improved. Some recommendations are suggested.

Keywords: Local government, development, infrastructure services, management.

1. Introduction

As result of almost 30 years of administration neglect and under investment, the physical infrastructure in the Gaza and West Bank is severely deteriorated. Thus, since 1994 priority for investment has been given to the renovation and extension of physical infrastructure (Water. sewerage, roads). The major part of international development assistance has been invested in trunk infrastructure with emphasis on the principal urban centers. But attention must now be turned to upgrading the infrastructure and service delivery of smaller municipalities and strengthening their capacity to plan and manage the improvement of infrastructure and services in a sustainable manner. The new municipalities of the Gaza middle Area in particular need for support. Eighty percent of their populations are refugees and major part of their development has been refugee camps since 1948.

Palestinian municipalities bear the greatest responsibilities concerning the delivery of services that affect citizens' lives, services which include water, wastewater, solid waste management, building licensing, local roads, public health and environmental protection among others. The newly appointed municipal councils have a very limited income and virtually no funds for development. They are faced with some of the worst standards of infrastructure and services delivery in Gaza, and the populations, particularly the lowest-income groups, women's, children and the elderly are exposed to immediate health hazards in their living environment. Municipalities in the Palestinian context lacked of well-established service delivery functions. Such municipal performance has an impact on how the public views the effectiveness and efficiency of government in general, in addition to municipal performance's direct and more visible impact on the quality of life of the residents.

In pursuing municipal functions, and given the absence of large national government and regulatory bodies for extensive periods of time, Palestinian municipalities have grown more organically than systematically and structurally in an attempt to fulfill the requirements of a very demanding public. This is especially true for the municipalities of Gaza Middle Areas, municipalities that are also relatively newly-established and whose residents are even more demanding. This is because three of the four municipalities (Breij, Maghazi and Nusseirat) embrace refugee camps, and because of the associated municipal services deficit backlog and other related socio-economic and political difficulties. The upside of this organic organizational growth has been well demonstrated municipal resilience in service delivery modes in response to intensive changes in the political environment. The downside has been however, a lower consistency, hence a lower quality of service, and municipal management's inability to exercise effective and systematic control over service delivery, control being the undisputed prerequisite to municipal service improvement.

2. Background

According to the current administrative divisions, the Palestinian territory was divided into two geographic regions. These are the West Bank and Gaza Strip. The West Bank was divided into nine governorates and two districts (Jenin, Tulkarm, Qalqiliya, Nablus, Ramallah & AL-Bereh, Jerusalem, Jericho, Betlehem, Hebron, Tubas, and Salfit districts), while Gaza Strip was divided into 5 governorates (North Gaza, Gaza, Middle area, Khan Yunis, and Rafah). The Gaza Strip is bounded by the Mediterranean Sea from the northwest, by AL-Naqab Desert from east and south and by Egypt from the southwest. The Gaza Strip has an area of only 365 km^2 with a total population of 1.1 million. Its length about 45 km, the width is 6 km in the north with maximum 12 km at south [1, 2].

Gaza middle area consists of 4 municipalities: Breij, Maghazi, Nusseirat and Zawayda. The four municipalities serve 125,887 people, distributed over 26,325 donums under municipal jurisdiction. Population density ranges between 1.5 persons/donums, the lowest in Zawayda municipality, to 7 persons/donum in Maghazi Municipality. In the four municipalities combined, there are 186 municipal employees, of whom there are roughly 32% contracted and daily laborers. Details of the general employment situation in the four municipalities as well as other general data are provided in table 1.

Table 1- General information on four Gaza Middle Area Municipalities

Item \ Municipality		Breij	Maghazi	Nusseirat	Zawayda
General	Date of establishment of municipality	1997	1996	1996	1997
Demographic Variables	Year 2002 projected population (capita)	37609	21278	55000	12000
	Area (Donums)	5570	3055	9800	7900
	Population density (Persons/Donums)	6.8	7.0	5.6	1.5
	Population density (persons/km^2)	6752	6965	5612	1519
Municipal Manpower	Total number of municipal executive staff, including Mayor	36	27	94	29
	Number of municipal staff/1000 residents	1.0	1.3	1.7	2.4

3. Socio-economic context

The most notable feature of the Palestinian economy, and that the Gaza Strip in particular, is its almost complete dependence on Israel. Most goods produced in the occupied Palestinian territories are sold to or through Israel and around 90% of all import come from or through Israel. In 1993, more than 25% of the Palestinian labour force was employed in Israel, primarily as day labour. In the Gaza Strip, where a proportionately higher percentage of the labour force works in Israel, income from the Israeli labour market constituted 43% of GNP. In this context, repeated Israel border closures, trade restrictions, and policy of replacing Palestinian with foreign workers during the past five years have had a visibly disruptive effect. Per capita GNP in the Gaza Strip, for example, has (measured in 1995 USD) average of USD 1,911 in 1992, to USD 1,127 in 1997, and has been accompanied by a significant increase in unemployment and poverty.

Refugees living in camps, constituting the poorest segment of the population and the most dependent upon the Israeli labour market, have been the hardest hit by theses restrictions. In spite of the on-going international aid programmes and the opening of new investment opportunities as a result of the peace Agreement, the Palestinian economy continues to experience severe strains. Unemployment continues to rise and the living conditions continue to decline. Unemployment in Palestinian areas estimated by the World Bank to be 25% in 1996 was more recently estimated by Palestinian sources to be than 40% as a result of repeated recent border closures [3]. While both the West Bank and Gaza Strip suffered the same obstacles to economic and urban development during the occupation, the overcrowding and high rate of population growth in Gaza Strip in addition to the high percentage of refugees (c. 80% of the population) makes the economic conditions in Gaza far more severe than those of the West Bank [4].

4. Prior and on-going assistance to the municipal sector

Broadly, international aid to the municipal sector falls into three categories: capital projects for upgrading physical infrastructure, assistance to institutional capacity building, short-term income generating activities. More than 90% of aid funds to municipal development have been invested in the first category, though most aid programmes embrace two of these categories, and some include all three [5, 6].

4.1 Capital projects for upgrading physical infrastructure

Capital projects have been dominated by the water and drainage sector. The World Bank through the various components of the Municipal Infrastructure and Development Programme (MIDP), has disbursed/committed some US $35.6 million. A further $25 million is earmarked for Gaza Water supply and sanitation management project to which the European Investment Bank is lending $40 million. The European Union Municipal Infrastructure Project has committed Ecu 25 million to water and sewerage in Gaza, and Japan $50 million as part of a $200 million grant to Khan Yunis water and sewage treatment. Germany has contributed some DM 600 million p.a. to upgrading sewerage systems, mainly in the West Bank and has committed $75 million to a central sewage treatment plant for Gaza City and the Gaza Middle Area. Sweden has committed $25 million to water sewerage and drainage in Jabalya and USAID is funding a $7.2 million storm water drainage project in Gaza City. The Danish contribution to infrastructure development has been a DKK120 million input to the IBRD Emergency Rehabilitation Project for water supply and drainage in Gaza and inter-urban roads in the West Bank.

4.2 Assistance to institutional capacity building

Institutional capacity building in the municipal sector has received less attention. The World Bank local Government Reform and Capacity Building Programme ($7.1 million) is operating in Gaza and Rafah as well as three municipalities in the West Bank and has earmarked funds for institutional reform in the Ministries of local Government, Planning and International co-operation, and finance. Norway has provided substantial support to upgrading the physical planning capacity of the Ministry of Planning and International co-operation. The Netherlands has assisted the establishment of the Association of Palestinian Local Authorities (APLA) and is likely to assist with the establishment of an Institute of Public Administration for training local government officers. And the German Infrastructure upgrading programme includes a significant technical and management training component.

Table 2 - Project details

Project Name	Location	Project Period in Days	Project Start Date	Contract Value US$	Additional Value US$	Actual Contract Value US$	Contract Completion Date	Actual Completion Date	Added Project Period Days	Actual Project Period Days	Status
Wadi El Qshaash	Nuseirat	90	21Aug 99	399,380.00	50,677.26	450,057.26	23-Dec -99	29-Feb-00	68	192	Finished
Block G & H area	Nuseirat	150	13Sep 00	481,579.00	0.00	393,542.18	19-Feb-01	13-Feb-01	0	145	Finished
Block F& M area	Nuseirat	300	28Aug 00	898,256.00	42,550.85	940,806.85	20-Sep-01	28-Dec-01	70	370	Finished
El Kansaa Road	Bureij	120	21Aug 99	448,944.40	48,272.49	497,216.89	23-Dec-99	26-Mar-00	94	218	Finished
Al Quds & Alamal St.	Bureij	180	19Aug 00	529,138.00	39,000.00	568.138.00	19-Feb-01	28-Apr-01	67	247	Finished
Safad & Hoda St.	Bureij	180	2 Aug 00	399,395.14	33,070.00	432,465.14	2-Feb-01	28-Apr-01	67	247	Finished
Al Shaheed Area	Bureij	120	3 Mar 02	134,296.50	0.00	134,296.50	11-Jul-02	12-Aug-02	31	151	Finished
ElHusini St.	Maghazi	120	21 Aug 99	309,827.70	44,014.58	353,842.28	23-Dec-99	31-May-00	160	280	Finished
Abubaker St.	Maghazi	240	5 Jun 00	1,106,956.00	97,665.00	1,204,621.00	8-Feb-01	30-Jul-01	166	406	Finished
Municipality Building reconstruct	Nuseirat	90	20 Aug 00	77,220.00	13,087.55	92,307.55	11-Sep-00	21-Jan-00	72	165	Finished
Sewage line at Salah Al Den Road	Nuseirat	90	01 Jul 01	95,670.90	0.00	92,431.40	27-Jun-01	1-Oct-01	0	84	Finished
El Hertany St. No. 9	Nuseirat	90	1 Sep 02	71,034.52	0.00	71,034.52	1-Dec-02	1-Dec-02	0	90	Finished
El Hertany St. No. 7	Nuseirat	90	1 Sep 02	48,900.00	0.00	48,900.00	1-Dec-02	24-Dec-02	23	113	Finished
Cemetery road	Nuseirat	60	1 Oct 02	38,612.81	0.00	38,612.81	1-Dec-02	26-Dec-02	25	115	Finished
Municipality Garage Construct	Bureij	90	2 Oct 00	36,960.00	0.00	31,692.48	2-Jan-01	25-Feb-01	54	146	Finished
Block 4 road	Maghazi	90	1 Oct 02	63,000	0.00	63,000	30-Dec-02	30-Dec-02	0	90	Finished

4.3 Short-term income generation activities

Income generation through insistence on labour-intensive methods of implementing infrastructure projects is becoming common amongst donors. However, these only provide short-term job opportunities. There have not been any significant suitable employment generation programmes in the municipal sector. The IBRD Holst Fund Employment Generation Programme (EPG) was an emergency income generating programme that of provided direct grant aid to small projects with an 80% labours content. The IDA Community Development Project provides short-term employment through labour intensive infrastructure projects in some 250 small municipalities and villages. The Swedish Jabalya water and waste project has an explicit employment component to its objectives with the intention of creating more sustainable jobs in public works programs.

5. Municipal projects assessment

The Support to Municipal Development and Management in the Gaza Middle Area (SMDM) project started in 1999 funding from Danish government covering three municipalities in Gaza Middle Area. Implementation of the projects in Gaza is constrained by conflict between Palestinians and Israelis which has led to severe economic decline both in terms of living standards and in terms of the solvency of the municipal administration. The project will support the municipalities in provide improved infrastructure services through labour intensive construction methods and at the same time increase their technical and management capacity to do so.

A project Steering Committee (PSC) which composed of representative of all the municipalities Mayors, Ministry of local Government, Ministry of Financial, Danish Representative Office and Project Manager will be responsible to guide the overall work of the project and will approved all project activities. All individual project activities particularly the infrastructure and services improvement sub projects will be implemented by the three municipalities individually. In day to day activities the Project Manager (PM) with coordination with the Danida Chief Technical Advisor (CTA) will work very closely regarding both the forward planning and the progress monitoring of the project detailed activity and disbursements.

Sixteen projects were studied by means of reviewing project documentation and meeting with key personnel like program manager, mayors and technical staff responsible for implementing the projects (see Table 2). The population of covered area is approximately 96,000. Nearly all residents are refugees or related to refugees of the 1948 war. It has been found that little evidence of program-wide planning of infrastructure in Gaza Middle area. However, program-wide planning was not viewed as being critical to the success of the program by the donor. Project selection is well organized but not as obvious as it might be.

The project selection process consists of the individual municipalities creating lists of projects to be carried out and then prioritized them in order of perceived need. The mayor then prepares a written proposal for presentation to the higher Project Steering Committee (PSC) for funding approval. Once the project is approved oversight and funds are transferred to the local agency for implementation. There is an active financial audit function exercised by the cognizant Palestinian Authority agencies. In particular the Ministry of Local Government and the Ministry of Finance conduct joint financial audits. An interesting point is that the funds are transferred directly to the local municipalities by DANIDA rather than through the national ministries. This ensures that the money actually gets spent on the intended projects.

Concerning supervisory consultant selection procedure, it was noticed that this process consists of advertising in the official newspapers giving the project information, a statement of necessary qualifications, the method of tendering for the work and the date for tender. The proposals are evaluated based on experience, the staff proposed, financial proposal and the technical proposal. Following this evaluation the winner is announced and a contract signed. The management by consultants of the individual projects is limited to using inspection forms, daily reports, site instructions and weekly reports. The procedure for defining projects was as follows: the individual municipalities developed a list of urgent projects to improve the refugee camps' situation. The lists were raised to the steering committee for approval. Each project was also presented to the steering committee for approval prior to implementation.

With regard to projects designed by the technical department of the Municipalities, it has been observed that neither the design calculations nor the design criteria were documented in the projects’ file. Drawings aren’t fully detailed, some existing facilities aren’t presented on the drawings and structural details are sometimes omitted. Missing technical specifications, missing pages in the technical specification and discrepancies between the table of contents and the document content were found. Some specifications referred contractors to international specifications, which the contractor has no access to. These issues push SMDM project management technical team to assist the technical department of the Municipalities through providing local consultant service to assist them in the projects design.

The contractor selection procedure is clear, organized and follows the local regulations for all projects. In most situations the lowest bidder was the successful bidder. Some contractors were not selected because they didn’t satisfy the general specification requirements. It has been observed that the price for supervisory consultant services within the time frame of the contract is fair provided that a professional representative of the consultant’s office is assigned to the job. However, delays occurred on all projects due to a number of factors that resulted in a cost increase. One of these factors was the experience level of the supervisory consultant representative and Gaza main borders closure which affecting lacking of construction materials and unstable prices cost.

Concerning project’s health and safety requirements and the implementation of these requirements, a complete section about health and safety was included in the general specification. The contractor was ordered to follow the health and safety regulations on all the projects. It is noticed that there are many letters from the municipality engineer and the consultant to contractors to follow the health and safety regulations. These are particularly related to the wearing of shoes and safety helmets. Given the number of letters sent to some contractors it is evident that compliance with health and safety regulations needs to be strengthened. In one case, there is a letter from a laborer to the municipality when he described an accident that occurred to him. The contractor didn’t provide compensation. This accident wasn’t registered in the daily or monthly reports or in the accident log. While direct evidence is lacking, it is apparent that there may be a problem with adherence to health and safety regulations despite attempts by the municipalities and consultants to enforce safe building practices.

The quality of the finished work is appropriate for the invested cost when compared to other projects in the Gaza Strip. The overall functional quality appears to be adequate for the purpose intended. For the projects there is submitted document from the contractor requesting approval for project activities and invoices payment. For some daily reports the consultant requested the contractor to take approval for using the projects materials and to be tested in independent laboratory before using in the site.

Normally the consultant requests the independent laboratory to collect the samples for testing. Results from the laboratory were discussed by the lab technician or the consultant although some results are less or approximately equal to the required strength or quality which in most cases was rejected by the consultant.

Some problems were occurred which led to disputes, change orders or claims. The early large projects all had relatively large sums of money paid for change orders and claims. In addition to that a time extension was granted to one of the contractors which relieved him from penalties. The reasons for change orders and claims were traced and found to be as following:

- Substandard design had resulted in introducing major changes which should have been taken into consideration at the design stage. The rush to get projects ready for construction may have led to substandard design.
- The quantity of work listed in the bill of quantities in the contract documents was not surveyed properly at the early stages of the projects. Accordingly, some items exceeded anticipated contract quantities by 25% and resulted in unit rates being revised upward.
- On some occasions the consultant evaluation for claims was unjustified. Examples of that are increasing the unit rate of some items by 100%. Instead of, per contract specifications, a reduction in the unit rate to be agreed in case of the quantity of work exceeds 25% of contract quantity.
- A time extension was granted to a contractor in the absence of entitlement demonstrated on an up-dated time schedule. The consultant's evaluation for some claims was not supportable. For example, holidays and rain days were considered to be an approved delay when they should not have been.
- Time extensions were granted to the contractor for shortage of materials in absence of a material supply schedule and without assessing whether the shortage was a result of the contractor's planning or to border closures.

6. Conclusion

The living conditions in the neighborhoods affected by the projects have been improved substantially. There is considerable evidence that the people living in the project areas have received a substantial benefit in the form of improved quality of life. Therefore, the selections have merit. However, program-wide planning could be improved. There is a need for a master plan treating the entire service area as one entity to assist the municipal leaders in developing projects.

SMDM project is the only one which explicitly target the Gaza middle area municipalities. It is also the only project in this region which activities implemented directly by the municipality administration. Its emphasis is on civic participation through highlight on local committee's needs and participations. DANIDA through providing the Technical Assistance Team consisting of national and international advisers and consultants which assist and support the municipalities in their implementation of the project activities and play a strong role in advising and increasing the capacity building of the municipalities staff during SMDM project period reflected positively in their performance. The procedure used for selecting supervisory consultant is to some extend sound.

More training of the municipal staff is required to strengthen their ability to provide oversight of the consultants and, indirectly, to the contractors. Guidance should be provided to the top management and councils members of the municipalities encouraging them to support their professional staff in dealing with the consultants and contractors. Guidelines should be established specifying documents that should be made available in Arabic and English. More attention needs to be directed toward maintaining complete construction records, log books, letter files and written directions among the municipal engineers, consultants, and contractors.

The health and safety written requirements are realistic and reasonable. However, compliance with health and safety statutes and regulations could be improved. There is considerable evidence of violations witnessed by the municipal engineers and consultants that were not corrected by the contractors involved. This indicates a pattern of violations. The site quality control needs improvement. Documentation of proper quality control procedures and standards is acceptable. Evidence of follow through on correction orders is sufficient.

There were design flaws, some outside the ability of the individual municipality and consultant to avoid. As experience was gained, design issues became less of a problem indicating that as experience is gained, better designs can result. Although not of a magnitude to cause severe difficulties, bills of quantities were improved and properly surveyed, time extensions granted with ordinarily acceptable reasonable cause but in some cases cost analysis was missing. There is evidence of claims being approved with sufficient documentation to justify the claims. There are also indications of positive changes in managing construction problems and claims on later projects.

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Living laboratories to support collaboration

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Abstract

Through a case study analysis, this paper discusses the essential elements of successful university-industry partnerships in the context of the integration of the scholarships of teaching, research and application. This scholarly integration is advocated as the modern paradigm of real-world laboratory activity termed the “living laboratory”. The paper further examines the application of the concepts of experimentation, engagement and regeneration as critical measures for evaluating successful university-industry partnerships. University-industry partnerships play an increasingly important role in the current climate of universities being held increasingly accountable for the benefits of their scholarship to be transferred to the wider community and to demonstrate measurable impacts.

Keywords: Industry collaboration, Industry-University partnerships, Living laboratory

1. Background

1.1 An overview of industry-university partnerships

Universities are increasingly accountable for the benefits of their scholarship to be transferred to the wider community and to demonstrate measurable impacts. A recent call in the UK higher education environment for “business-facing” Universities has been followed by a debate on the prospect of UK research council funding being more fully determined by innovation potential rather than simply based on research quality. In Australia, the forthcoming Research Quality Framework is scheduled, at the time of writing of this paper, to be the first such exercise to have a separate “impact” rating alongside one for “quality”. It is in this context that collaborative university-industry partnerships play an increasingly crucial role.

The benefits of industry-university partnerships are illustrated in the data given in Table 1 below. It is based on a sample size of 8,172 ranging from small to large scale businesses.

Table 1- Data from the Community Innovation Survey for UK 2003 [1]

Businesses undertaking innovation	Increased goods & services	Increased market share	Improved quality	Reduced costs
No university partner	42%	40%	46%	33%
University partner	82%	81%	85%	65%

It is important to differentiate types of university-industry partnerships that can be established. At one end of the spectrum is a consultancy where a single academic provides a service. Other than being a revenue generator, this type of activity has limited flow-on benefits to the individual/s or the academic institution. Publicly-funded academic research in partnership with an industry sponsor, which entails the creation of new knowledge falls at the other end of the spectrum. Such a partnership may involve only a single, or a limited number of individuals. A recently emerging form of partnership entails a more collaborative and deep-seated involvement where both organisations work as one to gain benefits to meet their respective organisational goals. Such partnerships evolve and mature over time and are primarily influenced by the level of trust and commitment held by both parties and the outcomes they generate.

1.2 The essential elements for Industry-University partnerships

The role of the modern professoriate has been the subject of study by Boyer [2]. He makes the strong argument for the work of the academic community to extend beyond scholarship involved in pure research (the scholarship of discovery) or in student learning (the scholarship of teaching). He elaborates on the scholarship of application, linking knowledge to applied problem solving, and the scholarship of integration where research, teaching and applied work is brought together in common scholarly environments. It is this integration that we advocate as the modern paradigm of a real-world laboratory which we have labelled as a “living laboratory”. The following are proposed as the essential elements or critical success factors, of a living laboratory for the sustainability of a university-industry partnership.

1. A common fit between the two organisations, at a strategic level. For example, the corporate vision and strategic goals should enable the formation of a shared and common bond clearly demonstrating the feasibility of working together to enhance its achievement. This would also mean the accommodation of organisation specific characteristics such as understanding the nature of academic research and in the case of the industry partner, the need to safeguard shareholder value.

2. The two organisations subscribe to the common shared goal of ensuring mutual benefits to each other within a “win-win” framework. The primary challenge is to identify and clearly articulate the specific beneficial role for each organisation in the context of the partnership. This in essence would form the vision for the partnership and has to be endorsed and supported at the highest levels of the two organisations.

3. Though the engagement is at a whole of organisation level, it needs “champions” or “partnership guardians”, essentially a small group sharing the common passion of

"making the partnership work" and understanding its strategic goals. It is not realistic to expect every key member of both organisations to understand the nature of the partnership or to have the patience to abide by its stipulated protocols.

One could argue that there are a set of KPIs that evolve and mature for a living laboratory, which might equate to the partnership moving through phases of experimentation, engagement and regeneration. In the experimentation phase, the KPIs might equate to the number, value and spread of projects. Engagement might be measured by the number of repeat projects, the diversity of source of participants from within partner organisations, and the extent to which the link goes more than one person deep. Regeneration implies structural or organisational adjustment around the partnership and can be measured by shared employment of staff, opening up the networks of the two organisations, and the establishment of shared business ventures and facilities. These concepts of experimentation, engagement and regeneration lie at the heart of the QUT Blueprint for its future [3]. This paper examines these critical success factors and measures of a successful university-industry partnership, through a case study analysis.

2. Case study of an exemplar partnership

2.1 The partners

The case study involves the collaborative research partnership between Queensland University of Technology (QUT) and Brisbane Airport Corporation (BAC). QUT is one of Australia's largest universities, with a student population of over 40,000. QUT prides itself as being a university for the "real world" with a focus on applied research and a commitment to transferring the benefits of its scholarship to the wider community. The University seeks to develop strategic partnerships with research, industry and community organisations. QUT's vision for the future, as encapsulated in its Blueprint [3], is to:

- provide outstanding learning environments and programs that lead to excellent outcomes for its graduates;
- undertake high-impact research and development in selected areas, to the highest international standards, reinforcing the University's applied emphasis; and
- strengthen and extend the University's strategic partnerships with professional and broader communities to reflect both its academic ambitions and civic responsibility.

BAC is a privatised airport operator responsible for the development and management of the Brisbane Airport. It is Australia's fastest growing airport and now receives the second largest number of overseas visitors into Australia. To meet the growing demand, BAC is undertaking an ambitious infrastructure development program worth A$2.2 billion over the next seven years including a new runway, major terminal expansions and road upgrades in addition to significant commercial developments. Already more than 130 businesses and nearly 16,000 people work on the Airport. This is forecast to exceed 40,000 people by 2025. BAC's vision for the future, as documented in its strategic plan [4] is:

- to transform Brisbane Airport from a city airport to an “Airport City”;
- to develop as a premier gateway airport and a major inter-modal transport hub;
- to promote and develop Brisbane Airport’s role as a major economic engine for the South East Queensland region;
- to grow and develop by balancing economic benefit and environmental impact.

Evaluating the profiles of the two organisations, the following are clearly evident:

- overlap in the perceived social and community responsibilities;
- the desire to achieve excellence in core activities with clear long-term goals;
- BAC has a wider agenda than merely aviation which in turn provides the platform for developing linkages across a broad cross-section of QUT’s areas of academic expertise.

2.2 The underlying concepts

The BAC-QUT Partnership was formalised through a Memorandum of Cooperation in 2000. However, such agreements are only a statement of intent and are often not legally binding. Consequently, the delivery of the envisaged benefits rests solely on those directly responsible for the day-to-day management of the Partnership. They have the responsibility for developing the vision, long-term strategy, management structure and the maintenance of goodwill which are the key defining factors for any partnership.

Since the signing of the Memorandum, the relationship has grown significantly. This is demonstrated by both organisations being increasingly integral to each other’s business. QUT plays a key part in the development and planning processes of BAC with the Airport entering a critical period of growth and development. BAC provides a living, breathing research environment for QUT to enhance its research and development expertise.

The growth and consolidation of the Partnership is underpinned by the innovative concept where QUT has become the “R & D arm” of BAC, and BAC the “living laboratory” for QUT. This concept was developed on a shared vision of mutual benefits to ensure a whole of organisation involvement. For BAC to achieve its vision of the best Airport City in the world and a model for other international airports, it needs to develop best practice management based on extensive research. For BAC, it is not feasible to undertake research encompassing the diversity of disciplines relevant to the operation of an international airport and building of an Airport City. BAC has “outsourced” this responsibility to QUT.

QUT has a primary focus on real world research relevant to society. However, the problems of society cannot be neatly packaged and are not mono-disciplinary. They require the expertise of a diversity of disciplines to work together. Hence, QUT requires a supportive environment where multidisciplinary research, solving real problems will help to push the boundaries of knowledge. Consequently, QUT considers the Brisbane Airport as its living laboratory where it can strengthen its leadership position in the delivery of real world research outcomes, through the integration of the scholarships of teaching, discovery and application [2]. In this supportive environment, academic researchers have the opportunity to create knowledge and witness its translation into application. Together BAC and QUT aim to create an environment with resulting outcomes extending beyond the confines of the Brisbane Airport.

2.3 Partnership management

The management framework for the Partnership is illustrated in Figure 1 below. It encompasses a Steering Committee for the day-to-day management of the Partnership, with overview and guidance provided by a Strategic Advisory Committee. In order to further strengthen the engagement between the two organisations, BAC has appointed Prof. Ashantha Goonetilleke as the Chair in Airport Innovation. He is based at the BAC to further develop research activities and to provide counsel to BAC on appropriate research and technical support.

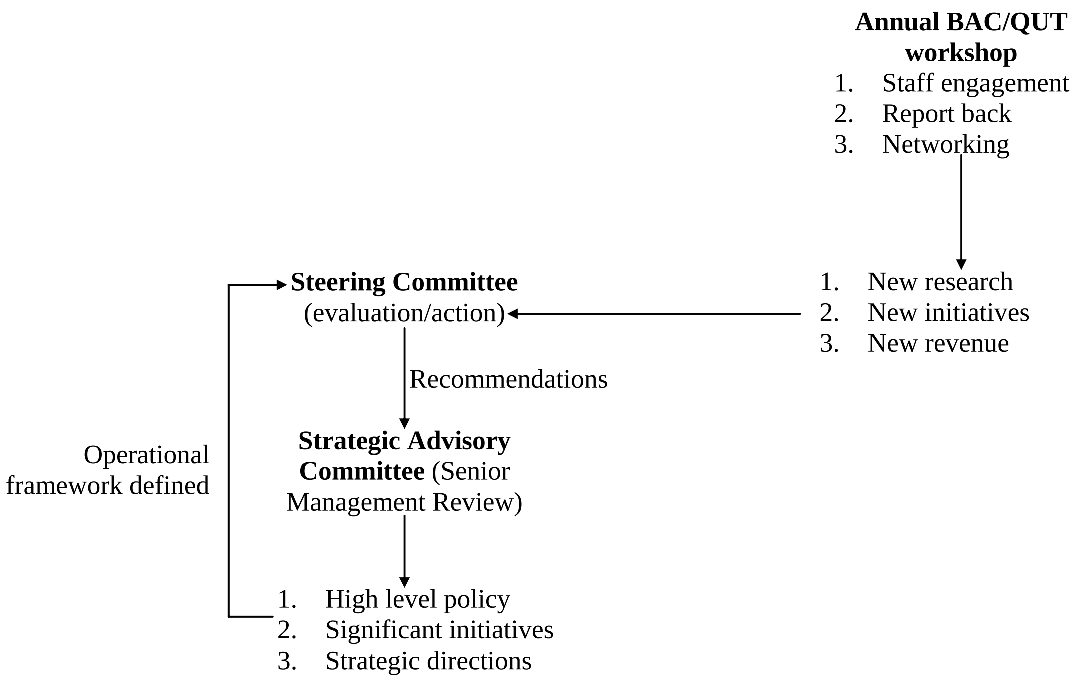

Figure 1- Management framework for the Partnership

For all practical purposes, functioning as a BAC employee, Prof. Goonetilleke performs a varied role. Firstly, he provides technical advice in his own area of expertise, which is water engineering. Secondly, he functions as a technical advisor, providing independent counsel on a range of issues, review of technical documentation and assisting in the drafting of consultancy briefs. Thirdly, he acts as the “relationship manager” for the Partnership liaising between the two organisations, assisting in the development of research projects and facilitating the formation of research teams within QUT and, progress monitoring.

The Steering Committee consists of two senior BAC Executives and Prof. Goonetilleke plus a QUT senior staff member. As shown in Figure 2 below, the Steering Committee is the single point of contact between BAC and QUT. It acts as the bridge between the two organisations to facilitate the delivery of applied research and training to meet BAC needs and the formation of collaborative partnerships between QUT and BAC staff for undertaking research projects. The projects undertaken satisfy the criteria that QUT has strong interest and expertise, and the projects are of strategic value and advance best practice at the Brisbane Airport. BAC engages in these projects either through direct funding or through leveraged funding through QUT.

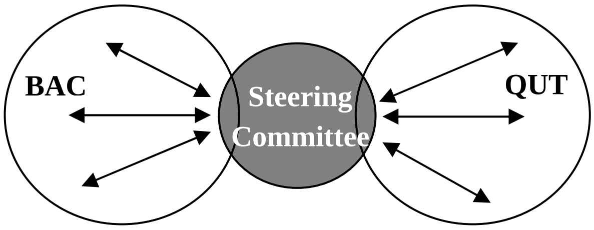

Figure 2 - Role of the Steering Committee

To fulfil its mission, the Steering Committee operates in three different ways defined as:

1. Bringing people together – acting as the intermediary
2. Building the relationship – providing the forum
3. Maintaining the relationship – being the minder

The Steering Committee reports to the Strategic Advisory Committee which consists of the Steering Committee members, two QUT Executive Deans and the Director of Finance and Resource Planning and three additional BAC Executives. The purpose of this committee is to oversee and to provide guidance to the Steering Committee. Its key responsibilities include:

- developing a strategic approach to resources and develop a framework that ensures effective collaboration and targeted successful outcomes for the partners;
- undertaking a twice-yearly senior management review, providing the opportunity for the Steering Committee to discuss their activities and to seek strategic guidance and support;
- providing opportunities for selected research, teaching and learning and other engagement teams to present the outcomes of their programs;
- developing a coordinated approach for promotion of partnership activities, to audiences within the two organisations, and other key influencers and wider communities;
- consider recommendations on appropriate policy and directions for the Partnership to be taken forward to the Chief Executives of the two organisations;

Partnership management as outlined above encompasses a number of layers of responsibility. Additionally, a crucial factor in the success has been the strong support extended by the senior management. At QUT, the Vice Chancellor and other senior staff have been regularly engaged in activities. At BAC, the CEO and the General Manger Operations have been strong champions. This top-down approach has led to the incorporation of innovation into BAC performance plans and in turn has driven them to seek further opportunities for collaboration.

2.4 Achievements to-date and cultural impact

Primary objectives of the Partnership as articulated in the Memorandum of Cooperation are:

Objective 1 Undertaking collaborative research projects

The Partnership has been successful in undertaking collaborative research projects amounting to $4.0M. Since commencement, the number and value of projects has grown exponentially as illustrated in Figure 3 below. In 2006, the Partnership received national recognition with the award for Outstanding Achievement in Collaboration in Research and Development presented by the Business Higher Education Round Table of Australia [5].

Considering the gradient of the graph in Figure 3, it is evident that there was a notable increase in the engagement commencing 2002. This coincides with the formation of the Steering Committee. The next significant change was in 2005 with a further increase in engagement. The embedding of a QUT academic at BAC commenced in 2004. It could well be that the presence of an academic helped in the stimulation of research. The average value of projects being undertaken has increased appreciably. Additionally, the Partnership has generated the following large multilateral projects involving a number of additional industry partners:

- “The Airport Metropolis: Managing the Interfaces” study, brings together fourteen organisations including five national and international universities, three airports, three government departments, a port corporation, a city council, and a rail operator. This four year project valued at over $1.5M investigates the conflicts at the interface between a modern airport city and the surrounding urban area.

- “Airports of the Future: Secure, Efficient and User Friendly Smart Space” is a large $6M research project currently under development seeking Federal Government funding. It has twenty three stakeholders including capital city and regional airports and regulatory and border security agencies. The project proposes the creation of “smart spaces” within airports integrating information as a complex integrated system.

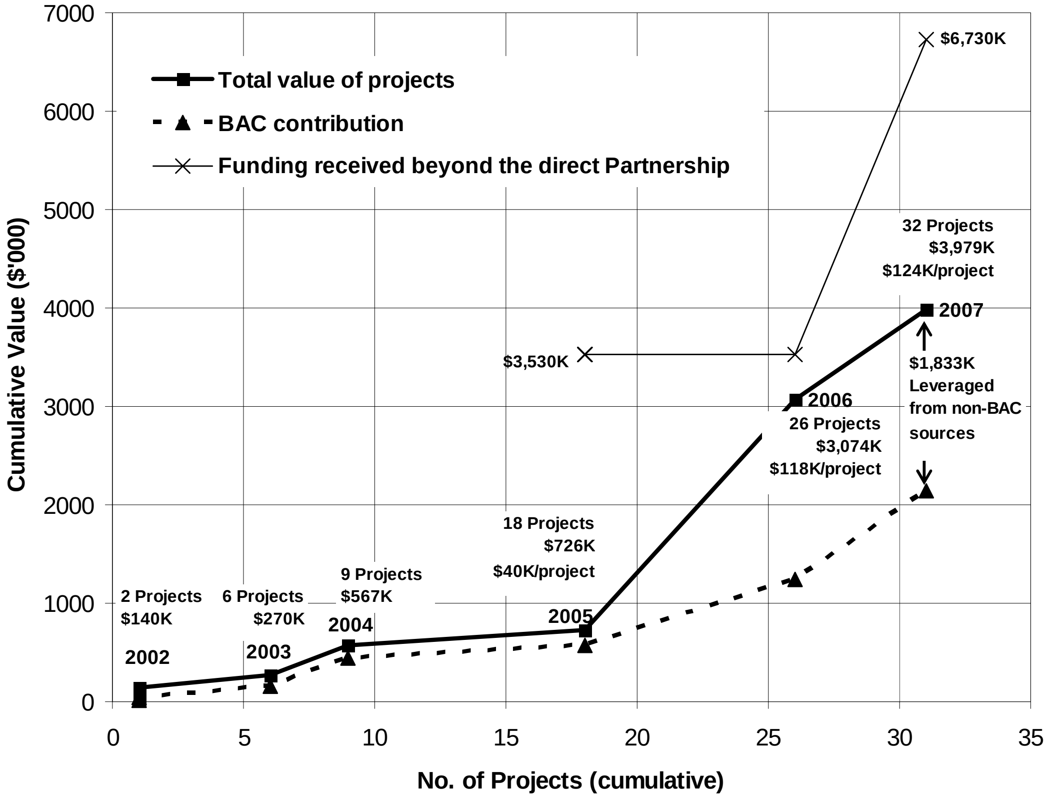

Figure 3- Progression of the Partnership

Objective 2 Wide engagement leading to whole organisation involvement

All the different divisions in BAC have been involved in the commissioning and collaboration in research projects as illustrated in Figure 4 below. In the case of QUT, researchers from seven of the nine faculties have been engaged in conducting research as shown in Figure 5 below. The total number of researchers engaged is over fifty including nine early career researchers.

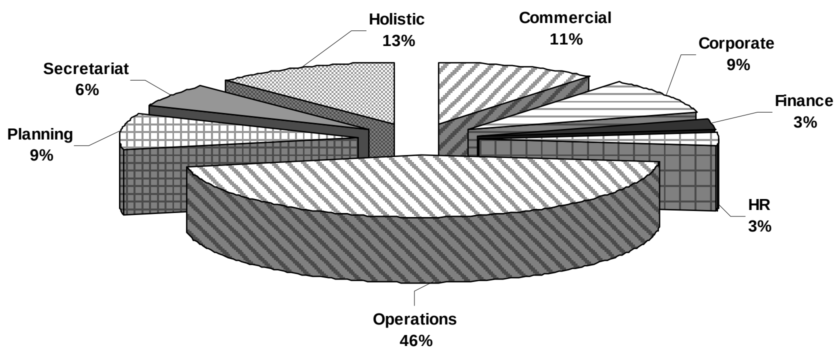

Figure 4 - Share of projects (by # only) commissioned by the various BAC divisions

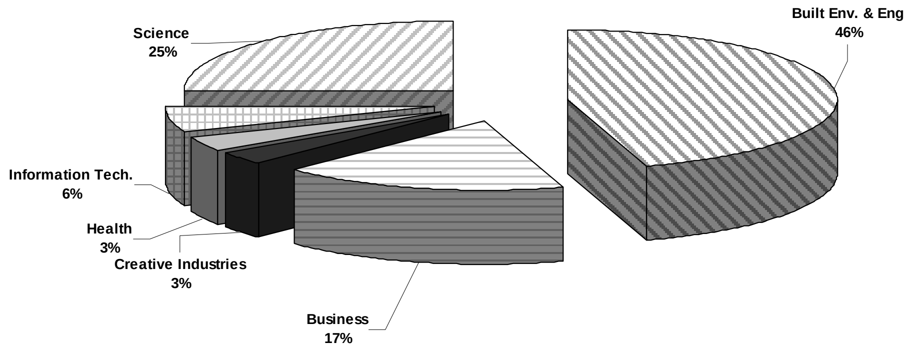

Figure 5 - Share of projects(by # only) undertaken by the different QUT Faculties

Objective 3 Undergraduate and postgraduate student engagement

The Partnership has created significant potential for postgraduate study in the form of data access, opportunities for case study analysis and funding for scholarships. To-date this has benefited four doctoral and three masters students. Undergraduate students too have benefited from the Partnership including:

- Opportunities for work experience for engineering undergraduates to meet the stipulations imposed by the Engineers Australia for graduate engineers.
- Sponsorship of the Faculty of Built Environment and Engineering Dean's Scholars Program. The Program offers high achieving students the opportunity to complete a Bachelor and Master of Engineering degree with financial support.
- Sponsorship of QUT Motorsport Program. As part of the annual Formula SAE Competition, undergraduate students undertake the design, construction and racing of a 610cc Formula race car.

Objective 4 Leveraging research funding from other sources

As illustrated in Figure 3 above, a significant part of the research funding has been leveraged from sources other than BAC. This highlights the fact that the funding received from BAC has played the key role in providing the platform for leverage additional resources from other industry partners and research funding agencies. The partnership has also become a platform for other collaborative research in the aviation sector space with award of funding from the State Government's Smart State Research Facilities Fund of a $3.53M grant for Unmanned Aerial Vehicles (UAV) research and the more recent $3.2M award of a Smart Skies research grant in collaboration with the Commonwealth Scientific and Industrial Research Organisation and Boeing for testing the commercial development of UAV technology for civil infrastructure related applications in Australia.

Objective 5 Collaborations across the industry and internationally

The Partnership has provided the platform for developing a collaborative network with a diverse range of stakeholders in the aviation sector (see also Objective 1). This has resulted in:

- Collaborations with other airports and regulatory and border security agencies across Australia who have joined the various research projects initiated by the Partnership thus enabling QUT to establish a leadership position in aviation related research.
- Collaborations with national and international universities for undertaking aviation related research, thus ensuring that a project's scope is not constrained by the limitations of in-house expertise.

Objective 6 Direct impact on the operational management

The scientific and technical support provided by QUT will lead to changes in the operational management of the Brisbane Airport in key targeted areas. As examples:

- The study on grassland management developed an ecological strategy to reduce bird visitations to the Brisbane Airport. Large scale trials undertaken have shown an 80% reduction in birds which in turn will lead to a corresponding reduction in bird strikes. Furthermore, by keeping the grass to the specified height, it reduces mowing costs by around $60,000/year.
- Assisting in the implementation of strategies on water efficiencies and the introduction of water reuse has enabled BAC to effect a saving of 40% on potable water consumption amounting to a saving of over $0.6M per year.

As discussed above, over the past six years the quantity and scope of research projects undertaken has increased significantly, highlighting both organisations' co-dependence on each other. As the relationship evolved, each organisation has had to become familiar with each other's business, corporate culture, commercial drivers and future goals, whilst developing mutual trust and understanding. A true marker of the strength of the relationship between QUT and BAC is the freedom with which they share highly confidential information. For example, BAC allowing QUT to explore sensitive airport issues such as safety and security is a testament to the trust they have in QUT.

The partnership represents a significant change in the culture of both organisations. BAC has opened up its development, planning and operational process to the rigours of academic assessment and advice, which has led to an organisational culture that is more technically rigorous and conscious of ecological sustainability. QUT has adopted a far more sophisticated approach to collaboration across its faculties to bring a "whole of university" approach to the Partnership. The traditional silos of expertise that generally exist in academia have given way to a more transdisciplinary approach to research, with collaborative involvement from many areas of science, technology, business and humanities.

2.5 Plans for the future

QUT and BAC view the Partnership as a best practice model for universities and industry working together. The Partnership has moved beyond a mere collaboration between two organisations and provides leadership to other airports for developing solutions to critical issues. QUT strives to emulate it as an exemplar for all of its other collaborative relationships.

It has been recognised that the intellectual property originating from the various research projects undertaken is unique and can make a significant contribution to the aviation sector in general. Consequently, the potential for the commercialisation of this intellectual property is being actively investigated. Furthermore, this unique approach to collaboration goes beyond mere R & D. QUT hopes to establish education as an "industry" at the Airport. An initiative currently being investigated is to deliver executive education programmes and niche courses to the Airport Community, later to be expanded to encompass the northern suburbs.

3. Conclusions

In terms of critical success factors for an effective academic partnership, the case of the BAC/QUT Partnership demonstrates a clear strategic alignment and a focus on shared goals between the two organisations. The partnership is based on a model of organised partnership management that embraces a number of champions from the two organisations. The partnership has received recognition and gained national awards for the success of the collaboration. The measures of performance demonstrated in the collaboration are evidence that the framework for measurement of experimentation, engagement and regeneration does offer a maturity model for an evolving partnership and its benefits as summarised in Table 2 below.

This case study does illustrate and demonstrate emerging principles of how to develop and evaluate collaborative partnerships between Industry and Universities. The framework that emerges would be applicable to other partnerships and would potentially offer a more robust way of designing and evaluating such collaboration if applied to partnerships in a wider set of contexts. The analysis in the case study offers a number of implications for individual academics, university support environments, and public policy.

There is an increasing likelihood of involvement in such partnerships becoming a focus for academics with its implications for their training, recruitment and promotion. The way that departmental/school, faculty and university-wide support is best organised for such partnerships to be encouraged, supported and migrated to higher levels of maturity poses many challenges and questions. As described in the introduction to this paper, the growth and success of such collaborative partnerships is both encouraged by and further stimulates the policy changes in research council funding, research selectivity, and third stream funding that is such a focus of policy development in the sector at present.

Table 2 - Evaluation of Collaborative Partnership Maturity Development

Performance Measure	Presence in Case Study
Experimentation	
• Number of projects	Increasing in early stage and then stable
• Scale of projects	Significant recent increases
• Range and diversity of projects	Initial broadening and subsequent focus
Engagement	
• Repeat project involvement	Repeat of partners, investigators, and external funders
• Multiple engagement of the two partner organisations	Initial increase and then stability in partner breadth of involvement
• Multiple engagement of many partner representatives	Expanded and then formalised expansion
Regeneration	
• Shared engagement of staff	Formalised 3-year funded chair agreement
• Shared business unit and facility development	Co-investment in third party business and facility development
• Opening of relationship to respective business networks of each partner organisation	Significant recent expansion of research to competitor airports and universities

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Changing Training Needs arising from the Introduction of Off-site Construction Techniques

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Abstract

The objective of this paper is to examine the changes in training needs arising from the increase of off-site construction in the Republic of Ireland. The methodology employed was a case study using a participant observation research technique. For a period of three weeks, the researcher observed the construction of residential housing, constructed using off-site techniques. From the practices observed and from interviews with the operatives on-site, an account of the differences in skills required between those employed in traditional construction and off-site construction was compiled. Each of the different trades involved in traditional construction was addressed and a comprehensive list of the skills training gaps was compiled. The paper examines the implications of the existence of these gaps in training and makes recommendations for corrective action to be taken by the relevant education and training policy makers.

Keywords: Off-Site Construction, Traditional Construction, Training

1. Background

In the relatively short period of time between the early 1990s and the present day, Ireland has changed from having an economic situation which obliged many of its people to emigrate and seek employment abroad (often to the construction sites of Britain and elsewhere) to its current state of full employment (Central Statistics Office, 2006a). This unprecedented (and largely unexpected) increase in prosperity has brought about dramatic changes. Whereas in the past emigration was a necessary safety valve now it is the reverse with thousands of returned Irish emigrants and new immigrants finding jobs here each year. Most sectors of the economy have benefited but perhaps the most visible and dramatic growth can be seen in the construction sector. This is not surprising since the higher levels of employment, increase in population, lower interest rates etc. would inevitably give rise to an unprecedented demand for housing.

Housing output in Ireland has grown at a phenomenal pace, increasing by 400% between 2002 and 2006. By the end of 2006, Ireland’s per-capita housing construction output was higher than anywhere else in Europe. In 2005, for example, Ireland’s output was 19 units per 1000 of the population compared to 4 units per 1000 in the UK. This figure increased to 20 units per 1000 in 2006 (Department of Environment Heritage and Local Government, 2006). The Irish house building sector in 2005 with an output of 81,000 units accounted for 16% of GDP and employed

12.2% of the total workforce (Davy, 2005). In turn, this accounted for approximately for 50% of the output of the Irish construction industry. By the end of 2005 it was estimated that total housing stock in the Republic of Ireland amounted to 1.69 million dwelling units in the State in 2005 with 30% of these units having been built in the past 10 years (Central Statistics Office, 2006b). This equates to 400 houses per 1000 persons, which is approaching the EU average of 450 units per 1000 of the population (DKM, 2005). This level of construction output would not have been possible without the assistance of many thousands of recent immigrants. One in every ten workers employed in the industry in 2005 was a foreign national (DKM, 2005).

2. Off-site versus On-site construction

Until relatively recent times the vast majority of Irish homes were built in the traditional masonry way using the traditional skills of bricklayers, block layers etc. With the traditional method, all load-bearing inner skin walls and load-bearing partition walls are constructed in concrete blockwork. Non load-bearing walls are constructed either in blockwork or timber studwork. Services such as wiring and plumbing are fixed to or chased into the blockwork and covered by the plasterers. The block laying, brick laying and plastering work is usually referred to as the “wet trades” and the electrical and plumbing work as the “follow-on trades” (Allen and Thallon, 2006).

A two storey masonry house for example, is constructed by bricklayers building up both the load-bearing outer and inner walls, one course at a time. The builders fix the insulation inside the cavity between the two leafs of the external walls and they may also fix the window and door frames as they progress upwards. Carpenters are called in to place the floor joists, though sometimes the floor consists of pre-cast concrete floor panels crane lifted into the site. The bricklayers then build the walls up to roof level at which point they hand over again to the carpenters who build the framework for the roof, making way for subsequent felting and tiling.

About two thirds of the work on a traditionally built house involves skilled craftwork, making it very labour intensive and this was one of the external drivers pushing the industry towards greater use of off-site. In Ireland up to recently most residential buildings were built in the traditional way.

In its broadest sense, off-site construction embraces most contemporary construction techniques. Even the traditional bricks and blocks can be regarded as prefabricated components in simplest form (Gibb, 1999). At the other end of the spectrum, whole buildings can now be prefabricated and pre-assembled remote from their final destination and installed in place ready for use with only the minimum of on-site work needed. In all cases, off-site construction invariably involves three stages - factory prefabrication, transportation to site and site assembly. This means that part of the construction that would previously have been done on-site is now moved to a facility away from the site. The percentage of the work done off-site can vary between two extremes reflecting situations where most of the work can be done off-site by factory personnel and situations where most of the work is still done on-site by the traditional craftspeople.

A further part of this research established that approximately 50% of all housing completions in Ireland currently employ off-site construction methods – a large portion of which use timber framed construction as its primary construction method. This makes timber frame construction the off-site market leader in the low-rise residential sector and therefore the primary target of this research.

3. The aim of the research

The aim of the research was to establish the type of off-site systems being used, the extent of that use, the pace at which they are growing and the problems which arise especially at the (on-site) point of assembly and the human resource implications where skilled labour is concerned. This paper is produced as part of that research. The specific objective of this paper is to examine the changes in training needs arising from the increase of off-site construction in the Republic of Ireland.

4. Research Strategy

Following a significant amount of exploratory research using secondary sources, on-site participant observation was established as the most appropriate method of studying the precise issues that were arising in the increasing use of off-site construction methods. Using this approach, the tradespeople would be observed to establish:

- Their input to the process and stage of construction;
- The nature of the work being completed;
- How the work being done compared to what traditionally had been done;
- Any specific technical or organisational problems that may arise.

5. Refining and Testing the Research Method

The research method was initially tested by through conducting a number of interviews and carrying out a series of site visits to off-site facilities (factory pre-fabrication and pre-assembly) and on-site (assembly and erection) operations. This established the issues to be investigated and these were further through an initial week of participation observation on a small site where a single timber framed house was being erected. This process highlighted the issues that would be confronted in the gathering of information and the level to which the researcher could realistically expect to get involved in the project. It also highlighted the following construction related issues that might be expected to occur during the primary research:

1. Systems delivered with inaccurate dimensions (an off-site problem) which resulted in panels not fitting together;
2. Poor system erection (an on-site problem) which resulted in the system not being assembled properly;
3. Poor system servicing (an on-site problem) which resulted in the system being damaged by follow-on trades.

These issues would then be investigated to establish the changes in training needs that were emerging in the move to off-site construction methods.

The preliminary findings had certain implications for the principal research method chosen and lead to the following conclusions:

- All three problem areas identified would manifest themselves at the on-site stage and therefore could best be investigated at an on-site location. (Problem no.1 is an off-site issue but it is on-site that its effects will be seen and experienced);
- A timber-frame construction project was chosen as the most appropriate on-site location as this system has the biggest market share in the off-site low-rise residential sector in Ireland;
- Participant observation was confirmed as the most appropriate research method because it would enable the researcher to work side-by-side with and observe the craftsmen involved in the erection and assembly of the systems. It would also allow for checking of the dimensional accuracy of the systems components being delivered to the site.

6. Site Selection Process

A participant observation study naturally imposes some constraints with regard to location and duration. In order to make the optimum use of the time available (four working weeks) a timber framed housing project consisting of 104 houses was chosen. Phase 1 of this project was already completed and occupied before the observation commenced. However, Phase 2 had several houses at different stages of construction and thereby provided an ideal opportunity for observation, both of the phases of construction and of the role of all of the different trades in the construction process.

The study was conducted over a four week period from 14th Nov to 12th December 2005 and, with the approval of the contractor’s site management team, the researcher engaged in all of the construction tasks associated with timber frame delivery, erection, roofing, servicing and cladding. In this way an opportunity was provided to work closely with all of the craftspeople involved, thereby enabling the recording first hand of observations by means of photographs and diary.

7. Data Collection

The following data collection methods were employed:

- Note-taking - notes were made on a regular basis on the construction site or later in the day. These notes were based on observations and conversations with other workers and often consisted of short phrases or simple keywords to act as subsequent reminders or reference points;
- Visual records - Over one hundred photographs mostly for purposes of record as an aide memoire but some of which could also be used in the presentation of results;

- Data-gathering interviews - informal interviews with site foremen and other construction personnel on specific issues.

During the course of the intensive four-week observation study the researcher participated fully in all of the on-site construction activities of a timber-frame construction project based on off-site methods. This provided a first hand opportunity to see and experience many of the practical day-to-day issues that arise on-site.

The on-site erection of a timber frame house includes the following steps:

1. Site preparation;
2. Scaffolding;
3. Crane/ lifting equipment;
4. Arrival and unloading of the trailer;
5. Erection of ground floor walls (external panels);
6. Erection of ground floor walls (internal panels);
7. Positioning of first floor panels;
8. Erection of first floor walls (external panels);
9. Erection of first floor walls (internal panels);
10. Erection of the roof.

At the outset of the study period the researcher was assigned to work with the erection crew consisting of four carpenters - two fully qualified and two apprentices. This provided the opportunity to develop an insight of the perspectives of an experienced crew member from those of an apprentice.

The entire timber frame kit took ten working days to construct. Although the structure of the house up to roofing stage was completed in the first two days it took a further eight days to complete. In the period of the participant observation all of the craft areas involved in the building and servicing of a timber frame house were observed.

8. Data Analysis

The trades involved in the building process observed during the four week on-site research period. This was then compared to the standard tasks undertaken by these trades in traditional brick and block building to establish the changes in tasks undertaken when the timber frame construction process is used. Table 1 lists these changes.

Table 1 - Tradespeople involved in constructing a traditionally built house compared to a timber frame house

Tasks performed	Traditionally Built House	Timber-Framed House
Foundation	*Masonry*	*Masonry*
Ground floor load-bearing walls	*Masonry*	*Carpenters*
Ground floor non load-bearing walls	*Carpenters*	*Carpenters*
First floor construction	*Carpenters*	*Carpenters*
First floor load-bearing walls	*Masonry*	*Carpenters*
First floor non load-bearing walls	*Carpenters*	*Carpenters*
Roof rafters	*Carpenters*	*Carpenters*
Felt and battening	*Carpenters*	*Carpenters*
Roof tiling	*Roofers*	*Roofers*
External door and window installation	*Installation crew*	*Installation crew*
Cladding	*Masonry*	*Masonry*
Electrical work	*Electrician*	*Electrician*
Plumbing work	*Plumber*	*Plumber*
Insulation installation	*Insulation crew*	*Insulation crew*
Plasterboard attachment	*Plasterboard crew*	*Plasterboard crew*
Internal plastering	*Plasterers*	*Plasterers*
Painting and decorating	*Decorators*	*Decorators*

The extent of changes observed allows each of the trades to be categorised as follows:

- Significantly affected, where trades are being asked to take on additional tasks;
- Moderately affected, where trades are being asked to work in a different manner;
- Not affected.

The traditional trades which most significantly affected are carpenters and masonry workers. Table 2 shows how the tasks are divided up between these two crafts depending on whether the dwelling is being traditionally built or timber-frame built. This illustrates that the tasks required in constructing a traditionally built house the tasks are more or less divided equally between masonry workers and carpenters. A timber-framed house on the other hand relies more heavily on the work of the carpenters. This additional work being undertaken by the carpenters on timber frame raises the need for specific system erection training. Carpenters are expected to assemble the new timber frame systems. Ideally this should require special training to ensure the system is properly assembled. Since the timber frame components are the main structural elements of the building it is essential that they be assembled correctly. Improper assembly can obviously impact negatively not only on the structural stability of the building but also on its thermal performance ability. If for example the panels are not tightly fitted together this will leave air gaps affecting the heat retention capability of the building. These problems can be avoided if the building is properly erected by a trained timber frame erection crew.

The impact on masonry workers is more a question of workload reduction rather than any significant change in the type of work they are required to do.

Table 2- Significantly affected trades

Tasks Performed	Traditionally Built House	Timber Framed House
Foundation	*Masonry*	*Masonry*
Ground floor load-bearing walls	*Masonry*	*Carpenters*
Ground floor non load-bearing walls	*Carpenters*	*Carpenters*
First floor construction	*Carpenters*	*Carpenters*
First floor load-bearing walls	*Masonry work*	*Carpenters*
First floor non load-bearing walls	*Carpenters*	*Carpenters*
Roof rafters	*Carpenters*	*Carpenters*
Felt and battening	*Carpenters*	*Carpenters*
Cladding	*Masonry*	*Masonry*

The training of timber frame erection crews for proper system assembly is being addressed by the Irish Timber Frame Manufacturers Association in conjunction with FÁS (the national training agency). At the moment however there is no government recognised training programme operating in Ireland. The majority of timber frame manufacturers provide a list of certified erection crews but these crews are not endorsed by government certification standards.

It became clear from the direct and participant observation studies at various sites that the majority of the carpenters were trained in all the traditional carpentry skills and for the most part were coping adequately with new demands of timber frame construction. The fact remains however that they were not formally trained to recognised standards in timber frame erection and assembly techniques and the need for such training should not be underestimated. The additional skills needed could be acquired in a relatively short time but they are essential if the quality and structural integrity of the building is to be guaranteed. Additional health and safety training is also needed to ensure the crafts involved recognise the particular hazards of the system of construction, an issue that is now even more relevant with the recent change in building regulations that allows timber frame construction for buildings up to four storeys high.

The tradespeople who are moderately affected are listed in table 3 below. Crafts people in this category are the same for both systems. In this case they do essentially the same jobs but under different conditions.

Table 3- Moderately affected trades

Tasks Performed	Traditionally Built House	Timber-Framed House
Electrical work	*Electrician*	*Electrician*
Plumbing work	*Plumber*	*Plumber*
Insulation insertion	*Insulation crew*	*Insulation crew*
Plasterboard attachment	*Plasterboard crew*	*Plasterboard crew*
External door and window installation	*Installation crew*	*Installation crew*

For example, electricians and plumbers are required to service the building in a similar way for both systems but chasing through concrete is more difficult and time consuming while timber, though easier to penetrate, requires greater care. Similar considerations apply to the installation of doors and windows, the placement of insulation and attachment of plasterboard. The difference in the nature of the tasks here derives from the difference between fixing to concrete and fixing to timber.

The electricians and plumbers have to chase their service lines through the walls of both types of buildings. Chasing through a concrete building is a slower and dirtier job. Timber on the other hand is easier to chase, not only because of the open spaces between the vertical studs, but also because timber is easier to drill through. However, as timber frame is a structural skeleton, only certain parts of the beams can be drilled. The position of the drilled hole, its diameter size and the number of holes in one area are crucial if the structural performance of the timber beam is not to be compromised. Since the majority of electricians and plumbers are accustomed to working on traditionally built dwellings some additional training is required if they are to install services in timber frame houses.

During informal interviews with the senior electricians and plumbers on-site it became clear that best practice guidelines were both known and understood. It was clear from observation however that proper procedures for drilling were not always adhered to as the drilling or chasing was almost invariably carried out by an apprentice rather than a fully qualified tradesperson. A number of examples were found of multiple holes have been drilled for piping and/or electrical cables in a single beam, many so close to the edge of the beam that the structural integrity of the beam was compromised. In all cases observed, further investigation established that the drilling and chasing work had been done by the apprentices who could not yet be expected to be fully familiar with best practise procedures.

The other tasks that are moderately affected by the shift towards timber frame involve insulation insertion, plasterboard attachment and external door and window installation. The trades affected are merely required to attach the various add-ons to a different material i.e. to timber instead of to concrete. From observation and informal interviews it became clear that these trades found it easier to install in a timber frame compared to a concrete building. It became apparent that sometimes window and door openings from the timber frame kit were delivered either in the wrong size or in the wrong place. This is an off-site problem where the system is delivered with inaccurate dimensions or, as sometimes happens, with openings that were not supposed to be there.

The tradespeople who are not affected are listed in table 4 below. The tasks for these trades are the same for both systems because the working environment in which the jobs are done is essentially the same. These tradespeople confirmed that their jobs were not affected to any significant degree by the shift from traditional to timber frame.

Table 4 - Non affected trades

Tasks Performed	**Traditionally Built House**	**Timber-Framed House**
Roof tiling	*Roofers*	*Roofers*
Internal plastering	*Plasterers*	*Plasterers*
Painting and decorating	*Decorators*	*Decorators*

Having identified the trades involved in constructing and servicing both systems (traditional brick and block and timber-framed) and the skills which they are bringing to the different tasks it is appropriate at this point to look again at the potential problem areas identified for investigation in the exploratory research in section 5 above.

1. Systems delivered with inaccurate dimensions (an off-site problem), which resulted in panels not fitting together.

No delivery of systems elements with inaccurate dimensions was recorded during the participant observation period. However, the fact that this sometimes did occur was raised by those who participated in the informal interviews on site and confirmation was given that such panels were generally sent back to the factory to be altered prior to redelivery to site.

2. Poor system erection (an on-site problem), which resulted in the system not being assembled properly.

Again the observation study did not identify any major problems affecting the quality of the work carried out by the erection crews. The carpenters were the group most significantly affected by the shift from traditional to timber-framed construction in that they were engaged in many phases of the work (timber-frame erection and assembly) - phases which traditionally would have been mostly carried out by masonry workers. The tasks however were essentially those requiring woodworking skills and in the circumstances the carpenters were coping reasonably well. There is still however a significant issue in relation to additional carpenter training and the need for some form of certification to ensure that proper procedures are followed.

It is therefore important, that the regulatory authorities and the relevant training organisations become more proactive in this area. Apart from the new skills required by the timber frame system, the add-on training must also embrace health and safety procedures not only for the erection crews but for other site workers as well.

3. Poor system servicing (an on-site problem) which resulted in the system being damaged by follow-on trades.

This is a serious issue in that it can potentially affect the structural stability of the building. Plumbers and electricians, though themselves only moderately affected by the shift from traditional to timber-frame, are sometimes responsible for poor system servicing. This mostly arises when untrained personnel (i.e. apprentices) are allowed to undertake the drilling work for the service lines. The holes if not drilled in the proper locations can seriously impact on structural stability. Poor workmanship in this area can go undetected until the consequences become apparent perhaps years later. A similar training to that envisaged for the erection crews is recommended whereby the follow-on tradespeople can also be certified thus ensuring the maintenance of proper servicing standards.

9. Conclusion and Recommendations

In analysing the findings of the study the crafts or trades involved were divided into three categories depending on the degree to which they were being impacted upon by the new system of construction in which they were engaged. The categories were formed on the basis of whether the trades were significantly affected, moderately affected or nor affected at all.

The trades most affected were the carpenters and the masonry workers. The impact on the masonry workers was more a question of a reduction of workload rather than any significant change in the tasks they were required to do. Not surprisingly the carpenters were involved in many phases of the timber frame construction whereas in a traditionally constructed house the load-bearing walls of the building would have been the responsibility of the masonry workers. Though the carpenters were trained in traditional woodworking techniques they were not necessarily accustomed to erecting and assembling vital load-bearing parts of the building. Ideally this requires special training to ensure that the timber frame system is correctly assembled. The additional skills needed could be acquired in a relatively short time and there is evidence that the regulatory authorities and the responsible training organisations need to be more proactive in this area.

Most of the follow-on trades such as electricians, plumbers, insulation and plasterboard crews were in the moderately affected category. These were doing essentially the same jobs as they would have done in traditionally built houses but under different conditions. The difference in the nature of the tasks derived from the difference between fixing to concrete and fixing to timber. Where plumbers and electricians are concerned, drilling through timber-frame components requires appropriate training if the quality of the finished building is not to be impaired. Follow-on trades such as roof tiling, internal plastering, painting and decorating were not affected because the working environment in which these jobs were done was essentially the same for both systems.

Because the off-site systems used in residential construction in Ireland are at the less advanced end of the market, approximately half of the work still remains to be done on-site. Heavy reliance on the traditional on-site skills to complete this half of the work can give rise to poor system erection, assembly and servicing. These are all issues that could be addressed by further training.

It is estimated that off-site systems as currently practised in Ireland will continue to grow in the future and that there will also be a gradual move from open panel systems to more advanced forms such as closed panel systems and to a lesser extent pods. Such a move would have further implications for the various building trades changing the very nature and location of some of these jobs. A further shift of construction work away from building site to factory could lead to a breakdown of some of the traditional crafts, such as plumbing and electrics, into simpler tasks which would be done by specially trained factory personnel. These factory-trained technicians would in effect be replacing some of the traditional tasks as we know them. These and other issues arising from this study will hopefully provide useful points of departure for further investigation.

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Antecedents to Training and Training Practices: Key Findings from the South African Construction Industry

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Abstract

The paper aims to report the findings of research into factors contributing to or impeding the training and recruitment of personnel within the South African construction industry. The research uses a postal survey questionnaire technique for primary data collection from a sample of consultants and contractors within the Western Cape region of South Africa. Literature review is used to identify relevant practices, which are then incorporated into the design of the survey instrument. Survey response data is subjected to descriptive statistical analysis and subsequently discriminant analysis based on organisational size. Lack of training was reported by both the consultants and contractors as impacting skills shortage. Lack of financial incentives to train construction workers and quality of training ranked as the most next impacting influences on skills shortages according to the contractors. On the other hand, skills leakage and lack of training were the most influential factors on skills shortages according to the consultants. Interesting, both contractors and consultants ranked the effects of higher education as the least influencing factor. This paper argues that development and introduction of aggressive campaigns to positively promote careers in the construction industry including the provision of more attractive bursaries at high school and higher education levels are necessary. This will lead to a development and introduction of more meaningful financial incentives and funding arrangements to train and retrain construction human capital at all levels. This paper contributes to the contingency theory by investigating the impacts of organisation size on recruitment and training aspects.

Keywords: Antecedents, Analysis of Variance, Training, Construction Industry, South Africa

1. Background

This section provides a general overview of the legislative framework and government policy that inherently affect the shortage of construction skills within the two sub-sectors. In particular it addresses the following questions: What impact would the current legislation and/ or policies have on skills development in the two sub sectors (specifically, management, consulting professions, skilled, and unskilled?). To what extent, if at all, could problems and/ or possible gaps in current legislation and / or policies impact on skills development in this specific context?.

1.1 Legislation and government policy

Construction in South Africa occurs in and is impacted by a legislative framework that includes the need to comply with, for example:

- The Constitution of the Republic of South Africa
- The Skills Development Act, No 97 of 1998

The objective of the project was to produce a status report on the skills base within the construction industry, benchmarked internationally against future skills needs and priorities. The National Skills Development Strategy's vision is underpinned by the following guiding principles:

- Developing a culture of high quality lifelong learning
- Fostering skills development in the formal economy for productivity and employment growth
- Stimulating and supporting skills development in small business
- Promoting skills development for employability and sustainable livelihoods through social development initiatives
- Assisting new entrants into employment

In addition, the Implementation Strategy of the NSDS, the Sector Skills Plan of the CETA and Companies' Workplace Skills Plans collectively aims to:

- Increase the level of investment in training and education
- Improve the impact of the training and education that is undertaken
- Ensure that training, education and qualifications are properly structured and quality assured

This section takes a general overview of the legislation and government policy that inherently affect the shortage of construction skills within the three sub sectors. In particular it addresses the following questions: What impact would current legislation and/or policies have on skills development in the three sub sectors (specifically, management, consulting professions, skilled, semi-skilled, and unskilled)? To what extent, if at all, could problems/possible gaps in current legislation and /or policies impact on skills development in this specific context? The approach adopted is similar to that of NACI [1].

1.2 Skills Development Act (Act No 97 of 1998)

Recognizing that the importance of the working skills of all South African is critical to grow the economy, the Skills Development Act (SDA) was promulgated to create structures and framework for national skills development strategy. In terms of the SDA employers are obliged to provide formal structured education and training to their workers. Furthermore, it encourages partnerships in the effort between government, employers, workers, education and training providers, and beneficiary communities. According to the SDA, the needs of employers, the economy and communities must dictate which skills should be developed. It covers structured, targeted and generic training - implying that all training interventions should be planned and managed as projects. Employers together with their workers formulate workplace skills plans (WSPs) to enable them realize their employment and training targets.

2. International Review

Although The SA Construction Industry Status Report of 2004 acknowledge that Skills enhancement in the construction industry faces a very particular challenge since the construction sector employs the fourth highest number of persons having no formal education. To this effect, the second phase report reviewed international literature to examine international experiences relative to skills development. To this end several countries were investigated; *inter alia,* the United Kingdom, Scotland, China (Hong Kong), Ireland, Israel and Australia. However it's beyond the scope of this paper to present the majority of the literature review, however similar trends and challenges confronted the construction industries in each of the countries reviewed. For example within the UK context, Agapiou, Price and McCaffer [2] examined the construction industry in the UK. They recognized the increasing failure of the industry to attract new recruits for several reasons. Further, while offering competitive attractive remuneration packages, the industry was renowned for its poor image and failure to offer a sustainable career structure. Considering the loss over time especially during times and economic downturn when high numbers of skilled workers leave the industry and fail to return when work becomes available again, it is unlikely that these skills will be replaced from the ranks of the unemployed only (Holt et al, [3]). Within the Hong Kong context, Chan and Chiang [4] argue that factors such as technological advances and increased specialization have changed construction methods and consequently the need for new construction skills. In order to establish the equilibrium between supply and demand for construction skills the Works Bureau of Hong Kong needed the development of a manpower-planning tool that would assist the development of the construction industry and assist in maintaining the balance of labour and supply. Elsewhere, studies have been done to forecast construction labour requirements, for example in Israel for the period of 1991 through 2000 as a basis for planning decisions involving recruitment of new workers, initiation of training programs and investment in labour saving technologies (Rosenfield and Warszawski, [5]). The study sought to estimate the demand for workers in major construction skills for the period 1991 through 2000, assessing the existing supply of such workers, and compare demand and supply for skill, derive conclusions and offer recommendations. Training issues have been addressed within the African context with a number of Least Developed Countries (LCDs) showing diligence in mounting training programmes tailored to their needs

(Zeffane and Rugimbana, [6]). According to Visagie [7], there are also some challenges facing small, medium, and micro enterprises (SMMEs) in South Africa such as access to training. Other authors argue that organisations which fail to have a coherent training strategy finds itself "dependent on the external labour market, and hence in a position where it is unable to regard labour as anything than a cost" (Ashton and Felstead [8]). Within the Sub Saharan countries such as Mozambique, there is agreement that training and development, and recruitment and retention are part of the key practice areas of people management. According to Storey [9], despite this acknowledgment, however few firms make use of no training whatsoever. More, whilst unstructured, informal ad hoc and ongoing training probably represents the most feasible option given adverse external circumstances. Webster and Wood [10] also conducted a study which aimed to explore the nature of contemporary HRM practice in Mozambique and found that the failure of HRM techniques to diffuse across the economy, despite heightened external pressures, highlighted organizational inertia, including the continued reliance of many firms on low-paid and low skilled workers, and on autocratic paternalism. Robertson [11] explored the role of training and skilled labour in the success of SMEs in developing economies and found that the effects of increased trade and international dispersion of manufacturing activities on the demand for skills to be widely known. More so, the study concluded education and skills occurred in many types and on many levels, as such emphasis could be put on improving access to primary, secondary, or tertiary education; on training workers for semi-skilled or highly skilled jobs (or no providing very little training at all). A study conducted within the West Yorkshire (UK) construction sector by ECOTEC Research and Consulting Limited [12] for the CITB-Construction Skills

Identified a lack of staff time for training, or a lack of time to supervise training and significant barriers in additional to time related issues. It is evident from the literature review that no matter the country or the models used, the experiences are generally similar. The following trends were observed:

- A general lack of training and the quality thereof; the large number of self-employed; the perception that the construction industry is not a sustainable career choice; there is a grater emphasis on multi-skills in terms in terms of technical skills as well as the need for soft skills; as there is a large number of self-employment and small subcontractors, the amount of time available for training is significantly reduced; the forecasting models used are data sensitive; and the forecasting of future demands and supply can be a indicative tool for planning purposes

Therefore, in order to achieve these objectives of investigating and determining the antecedents to training and training practices within the South African Construction industry, the views of 40 Contractors and 24 Consultants were surveyed within the Western Cape Province. The findings of the survey are reported using descriptive statistics. The following section reports on the research methodology that the researchers then conducted which forms the basis of this paper.

3. Research Methodology

To investigate the factors contributing to or impeding (thus termed antecedents) the training and recruitment of personnel within the South African Construction Industry, the following research methodology was employed in the study.

3.1 Research Aims and Objectives

The main objectives of this research was to determine the skills base of CETA's two sub sectors; identify the skills gap within the sector with special reference to its SMME segment and benchmarking the research internationally against future skills needs and priorities. Finally to aligning findings with the National Skills Development Strategy (NSDS) objectives. The project specifically targeted the following sectors within the construction industry:

- Construction (Building and Civil Engineering Contractors)
- Built Environment professionals (Architects, Quantity Surveys, Civil Engineers, etc.)

3.2 Sample

A mixture of regional and local contractors in the Western Cape Province was interviewed. The original plan was to conduct a qualitative approach based on interviews. The original sample data planned is shown in Table 1.This study issued 90 questionnaires to randomly selected organisations. As evidenced from Table 1, there were difficulties encountered in engaging the contracting sector relative to participation in the study. This is despite allowing for the several measures. The respondents were informed that it would be on an "Interview Basis", those unable to make time to the interview were called and faxed the questionnaire. Another option explored was that of "Telephone Interview" with the last resort being the self completion of the questionnaire. Despite all the measures undertaken, only the Contracting Sector didn't achieve the desired sample as shown in Table 1. The final responses as a percentage of the total number (66) received

Table 1.0: Original Sample versus Response Rate

Sub Sector	Original Sample Planned	Total Responses Received	Response Rate
Contractors	66	40	61%
Consulting Professions	24	24	100%
Total	90	64	71%

A mixture of national, regional and local contractors and consultants were interviewed. Table 2.0 shows the frequency of the respondents by the number of employees

Table 2.0: Frequency of Respondents by Number of Employees

Number of Employees	Contractors (N=40)		Consultants (N=24)	
	No	**Frequency (%)**	**No**	**Frequency (%)**
< 10	5	12.5	5	20.8
> 10 < 50	13	32.5	10	41.7
> 50 < 100	11	27.5	7	29.2
> 100 < 250	7	17.5	2	8.4
> 250	4	10	-	-
Total	40	100	24	100

Table 2 shows that 41.7(%) of the consultants interviewed employed between 11 and 50 workers and 29.2% between 50 and 100 workers. On average the respondents had been in business for 34 years. The majority responded "yes" when asked if they were registered. Registration was however interpreted differently and a variety of organisations were mentioned.

3.3 Measurement Instrument

The Survey instrument used in this study comprised of 6 sections and dealt with the following; The first part (demographics) sought information pertaining to primary participation, geographical location, years of establishment, type of work, profile of labour, turnover, distribution of labour (by gender, disability and age), and distribution of skills profile by number. Section two dealt with skills shortage and development and the output and issues sought were criticality of shortages and impact of skills shortage. The third section was designed to measure the levels of importance and agreement of 21 recruitment and recruitment practices. Each item or practice was measured from a range of (1) representing very low importance or agreement to (5) very high importance or agreement. Thus (3) represented indifference, i.e. neither low nor high importance. Training practices were examined in section four and the issues sought were the constraints and barriers measured on a 5 likert scale with (1) representing totally disagree to (5) totally agree, thus (3) represented indifference, i.e. neither agree nor disagree. This comprised 23 items.

3.4 Reliability and Validity of the Measurement Instrument(s)

According to Sureshchandar et al. [13], a critical aspect in the evolution of a fundamental theory in any management concept is the development of good measures to obtain valid and reliable estimates of the constructs of interest. The instrument designed for recruitment and recruitment practices, and who results are reported in Table 3 had Cronbach coefficient of 0.657, whereas the instrument for factors affecting skills shortages (see Table 4.0) and a higher Cronbach alpha value of 0.844. Measures to counteract recruitment problems instrument (Table 5.0) had Cronbach alpha value of 0.751.

3.5 Statistical Methods

The primary focus of the study presented in this paper was to investigate the antecedents to training and training practices and determine whether differences existed in the perceptions of the antecedents between contractors and consultants and whether organisation size influenced the perception of such. The *Statistical Packages for the Social Sciences (SPSS)* was used for the analysis. Two levels of data analysis are conducted: a macro-level analysis of aggregate, surface characteristics of the respondents and a micro-level analysis of deeper, fined data methods. In order to compare the antecedents to training practices of different groups of organisations by size, statistical tests were conducted to compare the mean scores of the training and recruitment practices (variables) between groups of employees classified by organization size. Analysis of Variance (ANOVA) and independent *t*-tests were used to test for significant differences (Chileshe et al [14])

3.6 Definition of terminology

Contractors and Consultants were asked what factors they considered important when recruiting and employing new workers. A short explanation (see Table 3.0) of the factors follows to provide clarity:

Table 3.0: Definition and explanation of terminology

Terminology	**Definition or explanation**
Adaptability to changing working environments	Whether the employer felt it important that prospective employees were able to be flexible and adapt to changing environment
Ability to work in teams (crews)	Whether it was important that employees were "team players" and able to work successfully with others.
Multi-skilled	Whether it was important that employers had more than one skill such as, for example being able to lay bricks, plaster and tile.
Project duration	Whether the duration of the project had any bearing on the recruitment / employment practices of the company
Labour-only contractors	Whether the existence of these contractors had any effects on the recruitment practices of employers
Equity	Whether companies considered employing female, disabled and other previously disadvantaged persons as a deliberate strategy

4. Results and Discussion

Contractors were asked what factors they considered important when recruiting and employing new workers. Table 4 presents the findings by the means of responses relative to those factors. One of the objectives of the study was to investigate the impact of organisation size on the recruitment and recruitment practices. Analysis of Variance was conducted for the Contractor sample and the findings indicate that there were some significant differences in a minority (12%) of the recruitment practices among the Contractors differentiated by the size of the Labour force. The practices were as follows: "Possession of craft (trades specific skills" (*F* (4,

35) = 3.426, p = 0.018 < 0.05); "Profit margins (F (4, 35) = 4.406, p = 0.005 < 0.05)"; "continuity of work" (F (4, 35) = 4.649, p = 0.004 < 0.05); and "citizenship, non South African or South African" (F (4, 35) = 2.900, p = 0.036 < 0.05). The inference to be drawn is that although some significant differences exist due to organisational size differential, overall, the majority of recruitment and recruitment practices are not affected by size. This is of particular importance given that the Construction Industry's structure is comprised of Small and Medium sized organisation. As argued by Robertson [11], SMEs often lack the knowledge and resources to engage in training programs; however their success in upgrading themselves technologically may depend crucially on subsidised educational and training infrastructure provided by their governments

4.1 Recruitment and recruitment practices

Table 4: Mean Score Comparison of Importance of Factors to Recruitment and Recruitment Practices: Consultants and Contractors

	Contractors (N=60)		Consultants (N=24)	
Aspects of Recruitment and Recruitment Practices	**Rank**	**Mean[1]**	**Rank**	**Mean[1]**
Adaptability to Changing Work Environments	1	4.325	4	4.583
Ability to Work in Teams (Crews)	2	4.325	1	4.299
Multi-Skilled	3	4.225	7	4.000
Project Duration	4	4.025	14	3.565
Profit Margins	5	4.000	9	3.958
Possession of Craft (Trade) Specific Skills	6	4.000	8	3.958
Continuity of Work	7	3.921	2	4.417
Rates of Pay	8	3.948	5	4.217
Possession of Generic Skills	9	3.900	11	3.696
Consideration of Retraining Existing Workers	10	3.900	10	3.875
Previous Work Experience (Occupational History)	11	3.875	3	4.333
Citizenship (non-SA or SA)	12	3.825	16	3.417
Training of Inferior Labor (Poorly Skilled at Employment)	13	3.736	12	3.625
Learner ships	14	3.700	5	4.083
Gender Equity	15	3.675	18	3.208
Medical History	16	3.650	17	3.375
Secondary/High Schools	17	3.615	13	3.609
Equity (e.g. Disabled Persons)	18	3.625	15	3.542
Labour-Only Contractors	19	3.526	20	2.957
Language Issues	20	3.307	-	-
Age	21	3.282	19	3.000

Note[1]: Where 1= extremely unimportant; 2 = slightly unimportant; 3 = neutral; 4 = slightly important and 5 = extremely important.

The results in table 4 indicate that contractors ranked the following as the most important aspects that influence recruitment decisions and employment practices (ranked by the means of their responses): Adaptability to changing work environments (mean = 4.325, rank =1st); Ability to work in teams or crews (mean = 4.325, rank = 2nd); Multi-skilled (mean 4.225, rank = 3rd); Project duration (mean = 4.025, rank = 4th); and Profit margins (mean = 4.000, rank = 5th). On the other hand, the following factors were considered to be least important: Age (mean = 3.282, rank =21st); Language issues (mean = 3.307, rank =20th); Labour-only contracts (mean = 3.526, rank =19th); Equity e.g. disabled persons (mean = 3.625; rank = 18th) ; and Secondary / high schools (mean = 3.615; rank = 17th)

Respondents were asked to give reasons for the recruitment practices that they follow. Several citied training as being important in the recruitment of staff. Comments relating to training include:

- We recruit people that are willing to work and learn the trade with a view of growing with the company.
- Workers can also be employed in construction if they are trained. Then you need the construction, but they must also be trained.
- Training schemes have collapsed. Sub-contractor approaches not contracted. All of this resulted in unskilled labour (that will never receive training) being placed in skilled labour positions.
- Lack of quality training as well as knowledge and not forgetting education and that training happens mainly at the work face
- As the demand increase for all employees within the construction industry so does the bargaining power of the employees and the opportunities out there in the market. The increase in the number of projects means that "young" employees are thrown out in the "deep end" and have to learn the hard way other than formal training over the years.
- People must be taken to school to learn the building trades as they used to do in the past, not only come back with the certificate. We all need money to work so women must also get opportunities same as men.

4.2 Training and training practices

Factors affecting skills shortage Constraints and barriers to training were assessed in this study via twenty three items scored on a 5-point Likert style scale. Contractors and Consultants were asked to rate several factors that may have had an impact on skills shortages in the South African construction industry, where 1 = extremely negative impact; 2 = moderate negative impact; 3 = no impact; 4 = moderate positive impact; and 5 = extremely positive impact. These responses provided a basis to establish to what extent the factors had a negative influence on skills shortages in organisations. Table 5.0 presents the comparisons of the rankings by the means of responses relative to those factors. A one-way ANOVA was conducted to compare scores on the factors affecting skills shortage by organisation size (number of labour turnover). The findings indicate that there were some significant differences in only a minority (2) of the factors affecting skills shortages among the Contractors differentiated by the size of the Labour force. The factors were as follows: "Skills gained experientially without formal training" (*F* (4, 31) = 3.164, *p* = 0.027 < 0.05) and "Recruitment Policies" (*F* (4, 32) = 3.977, *p* = 0.010 < 0.05). Consultants only reported significant differences on one of the factors namely "Skills gained experientially without formal training" (*F* (3, 18) = 4.133, *p* = 0.022 < 0.05)

Table 5: Mean Score Comparison Impact of Skills Shortages on the Construction Industry: Contractors and Consultants Views

Cont Rank	Cons Rank	Factors affecting skills shortages	Contractors Mean Score (N=40)	Consultants Mean Score (N=24)
1	1	**Lack of Training**	1.816	1.391
2	4	**Lack of Financial (Monetary) incentives (to train)**	2.027	1.783
3	=13	**Quality of Available Training**	2.132	2.304
4	12	**Profit Margins**	2.333	2.174*
5	10	**Qualifications that are broken into narrow task-related units**	2.361	2.174*
6	9	**Lack of Multi- skills**	2.368	2.087
7	3	**Cyclical Nature of Industry**	2.417	1.636
8	2	**Skills Leakage**	2.432	1.435
9	11	**Image of Construction Industry**	2.528	2.174*
10	20	**Technological Changes (New Methods, Techniques, Materials)**	2.688	2.545
11	-	**Labour intensive construction (labour based)**	2.684	2.435
12	6	**Continuity of Work (Supply)**	2.729	1.957
13	19	**Legislative Framework**	2.765	2.435
14	7	**Basis of Remuneration**	2.806	2.046
15	17	**Procurement Approaches (e.g. Preferential Procurement)**	2.821	2.435
16	5	**Casualization (Itinerant/Temporary Workers)**	2.842	1.955
17	16	**Arrangement of Work**	2.848	2.619
18	18	**Labour-only subcontractors**	2.892	2.435
19	22	**Self Employment**	2.917	3.087
20	8	**Labour Saving (Technological/Mechanical Methods)**	3.053	2.136
21	=13	**Skills Gained Experientially Without Formal Training**	3.056	2.305
22	15	**Recruitment Policies**	3.108	2.348
23	21	**Effects of Higher Education**	3.278	2.826

The inference of Table 5 is that, the higher the mean, the more positive the impact of Construction Skills shortages, whereas, the lower the mean, the greater the negative impact of Construction Skills shortages. It is evident from Table 5 that Self Employment (mean = 3.087) had the highest positive impact on Skills Shortages followed by the effects of higher education (mean = 2.826). On the other end of the spectrum, lack of Training (Mean = 1.391) had the highest negative impact on Construction Skills shortages according to the Contractors. These were followed by: Quality of available training (mean =1.816; rank = 1st); Lack of financial (monetary) incentives to train, (mean = 2.027; rank = 2nd); Quality of available training (mean = 2.132, rank = 3rd) and Profit margins (mean = 2.333; rank = 4th). The findings are consistent with the literature review, for example the study [12] conducted in the West Yorkshire Construction Sector regarding the barriers to training drew similar conclusions as common barriers being related to costs associated with training. Webster and Wood [10] also found that the Construction industry in comparison to other sectors such as tourism was highly unlikely to make use of even informal methods of workplace training. Visagie [7] further opines that lack of training / development as a generalist which inhibits the ability to deal with the SMMEs as a composite whole.

4.3 Measures to Alleviate the Recruitment Crisis

Measures to counteract recruitment problems were assessed in this study via six items scored on a 5-point Likert style. Contractors and Consultants were also asked to what extent they agreed with the statements pertaining to measures to counteract recruitment problems. Table 6.0 presents the comparisons of the rankings by the means of responses relative to those measures.

Table 6: Rank Comparison of Measures undertaken to alleviate the recruitment crisis

Contr Rank	Cons Rank	Measures to counteract recruitment problems	Contractors Mean[1] Score	Consultants Mean[1] Score
1	2	**Skills shortage results in inflationary wage rate increases**	1.391	3.792
2	1	**Skills shortage leads to poaching of staff from competitors**	1.783	4.130
3	5	**To avoid skills shortage companies should build relationships with schools**	2.304	3.625
4	4	**In times of shortage, we pay above average industry rates to attract workers**	2.174	3.696
5	3	**We consider employing women as an alternative source of workers.**	2.174	3.739
6	6	**Companies should provide incentives that include financial rewards to attract school leavers to work for them in construction**	2.087	3.478

Note[1]: Where 1= totally disagree; 2 = slightly disagree; 3 = neutral; 4 = slightly agree; and 5 = totally agree. **Contr** = Contractor and **Cons** = Consultant.

4.4 Constraints and Barriers to Training

Contractors and Consultants were asked to rate to what extent by indicating the levels of agreement (where 1 = totally disagree, 2 =   and 5 = totally agreed) the following statements tabulated in Table 7 acted as constraints and barriers. Table 7 highlights the view of the Contractors and Consultants on a number of constraints and barriers to training. Both Contractors and Consultants reported the sensitivity or lack thereof to the needs of the industry of training service providers and unsuitability and / or lack of existing training courses as the greatest constraints and barriers to training. As reported by the CITB study [12], the majority of small organizations did not even have written training plans. Interestingly, unlike the cost of training that ranked second lowest, restrictive funding arrangements were ranked the third highest barrier to training. This finding suggests that contractors may have greater problems accessing funds for training. On the other hand the cost of training itself was perceived as being less problematic.

Table 7: Rank Comparison of Constraints and Barriers to Training

Cont Rank (N=24)	**Cons Rank (N=40)**	**Constraints and barriers to training**	**Cont Mean Score (N=24)**	**Cons Mean Score (N=40)**
1	**1**	$C\&B_1$=Sensitivity or lack therefore to the needs of the industry of service providers	4.000	3.917
2	**2**	$C\&B_2$=Unsuitability and / or lack of existing training courses	3.913	3.892
6	**3**	$C\&B_3$=Restrictive funding arrangements	3.500	3.889
4	**5**	$C\&B_4$=Duration of training courses	3.696	3.834
8	**4**	$C\&B_5$=Unsuitable and / or inappropriate unit standards	3.261	3.874
5	**7**	$C\&B_6$=Structure of training courses	3.571	3.714
10	**8**	$C\&B_7$=Procedure to claim back training expenses	2.727	3.655
9	**9**	$C\&B_8$=Legislative requirements	3.143	3.600
3	**10**	$C\&B_9$=Cost of training	3.783	3.541
7	**6**	$C\&B_{10}$=Multiplicity of new initiatives	3.286	3.806

Analysis of Variance was also conducted to ascertain the organisational size differentiation on constraints and barriers for the Contractors. There were significant differences in 30% (3) of the extent to which following issues acted as constraints and barriers: "Unsuitable and or inappropriate unit standards" (F (4, 32) = 3.344, p = 0.021 < 0.05); "duration of training courses" (F (4, 29) = 3.297, p = 0.024 < 0.05); and "Sensitivity or lack therefore to the needs of the industry or service providers" (F (4, 31) = 3.841, p = 0.012 < 0.05). On the other hand, no significant differences among the scores of the contractors were reported; therefore organisation size does not impede the perceptions of these barriers for the Consultants. However these findings contradict those of CITB [12] who found that small firms with 1- 10 employees making up more than 89% of all construction companies in West Yorkshire, the nature of organisation size in fact had a significant impact on the amount, type and level of training that construction companies provided for their staff.

5. Conclusions

This research paper has presented an overview of the perceived skills base and shortage of the construction industry in the Western Cape province of South Africa. In order to achieve a global perspective of the current position relative to skills shortage and development, recruitment and recruitment practices, training and training practices, retrenchments and retirements, project management and participation in construction, the study was contextualised against international experiences as extracted from a review of international literature and study visits. This section summarises the key findings and the various issues associated with the construction industry in the Western Cape. It draws conclusions from the research discussed in various sections of this paper and gives recommendations on how to address challenges. In terms of ranking, contractors rated the collapse of the apprenticeship scheme, company operations or ambitions to grow and diversify and project costs and over-runs as being the main causes of a shortage of skilled workers. Their reasons for the basis of skills were given as a lack of artisans, operators and skilled labour. Contractors ranked the lack of training, the lack of financial incentives to train, the quality of available training, profit margins and qualifications that are broken down in narrow-task related units as the factors that had the most negative impact on skills shortage. The factors that had the least impact on skills shortage were the effects of higher education, recruitment policies, skills gained experientially without formal training, labour saving methods and self-employment. The views of the contractors and consultants confirm the findings are supported by literature conducted by Dainty et al [15] who argued that tight labour market conditions a shortage of high quality skills have forced construction employers to discard training and workforce development activities in favour of aggressive recruitment practices. Holt et al [3]) citied poor labour retention, the failure to develop and train workers, inability of workforce to keep up with change and the introduction of new technology as the primary causes of skills shortages.

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Up-skilling the New Zealand construction industry: a critique of the learning options

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Abstract

Education for the building and construction industry in New Zealand is facing a considerable shift in scale because of the requirement for builder licensing by 2010. The Department of Building and Housing has authorised five educational options for the industry up-skilling programme: self-directed learning, reading materials provided by the Registrar, receiving formal instruction, attending an information session, or any other activity considered by the Registrar to be relevant. This paper questions the efficacy of two of these options based on research that was undertaken in 2005 to identify the preferred learning styles of those in the construction industry. We conclude that the options 'self-directed learning' and 'reading materials provided by the Registrar' will not provide pathways to educational qualifications, but may be barriers to the success of the up-skilling project.

Keywords: Learning styles, Builder licensing requirements, New Zealand

1. Introduction

Education for the building and construction industry in New Zealand is facing a considerable shift in scale. A significant number of professionals must be licensed by 2010. This new licensing system has been introduced to address a number of recent building failures in New Zealand. Problems with building quality appear to have arisen from a number of causes, such as: a move away from prescriptive standards to a performance-based building code, the growth of more complex residential buildings and the rapid development of new technologies, materials and systems [1].

However, from an educational perspective, the most glaring cause of complaint in the industry during the last 15 years has been the removal of formal educational requirements for builders. Therefore, the need to up-skill the construction industry is perceived as a primary solution to an endemic problem. Consequently, the Department of Building and Housing (DBH) has introduced a new licensing system, based upon nationally recognised standards of competence [1].

It is reported that in 2006 less than 50% of employees or owners in the construction industry had formal qualifications. These numbers are more staggering for the builders and carpenters. Only 35% had a formal education, which means that 65% of builders will require some educational support to meet the new industry requirements by 2010.

The DBH [1] has determined a programme for up-skilling the building and construction sector which includes a number of learning options:

1. self-directed learning,
2. reading materials provided by the Registrar,
3. receiving formal instruction,
4. attending an information session, or
5. any other activity considered by the Registrar to be relevant.

The balance of this paper attempts assess the efficacy of the proposed learning options in light of available data concerning the preferred learning styles of the building sector. Section 2 describes research undertaken in 2005 concerning the preferred learning styles of a sample of the building sector in New Zealand. The section provides a brief overview of the learning styles literature that underpins the objectives and methodology of the study. Sections 3 and 4 discuss the findings of the study in relation to two of the proposed learning options; self-directed learning and reading materials. Section 5 speculates on the outcome of the industry up-skilling project.

2. New Zealand building sector learning-styles study

In 2005 a team of researchers from the Centre for Property and Construction Research, Unitec New Zealand explored the learning preferences of the building industry in order to design a teaching model specifically for the building and construction industry [2]. The study included representatives of four stakeholder groups within the sector:

apprentices
experienced trades people
building company principals
building control officers.

If the extent of the literature is an indicator, educationalists believe that student learning styles are important (see Coffield et al, 2005 for an extensive review). Popular examples of learning-styles profiles are based on the process of learning suggested by Kolb [3]. In these models learners are attracted or repelled by individual preferences and expectations. For example, the ‘reflector’ needs time to think through the implications of any new material and is thus repelled by the necessity of having to provide evidence of instant learning. The ‘activist’ is repelled by excess detail when learning new material and prefers to focus on uncluttered tasks.

The social dimension of learning was identified in the 1970s. Witkin, Moore, Goodenough, and Cox [4] suggest that children learn through a variety of social factors: learning alone, learning with peers, or learning with teachers. They developed a dichotomy model based on dependency. Field-dependent children prefer learning in groups and with teachers setting the agenda and structure of the learning outcomes. On the other hand, field-independent learners prefer independent activity, self-defined goals, and structuring their own learning.

Another stream of learning-styles research focuses on learning preferences which are a series of ‘information processing habits’. Bandler & Grinder [5] suggested that information is accessed through specific senses including through the eyes, ears or hands. Therefore attention needs to be given to learning locations and the kind teaching materials available. For example, learners have preferences for how new information is presented; graphically, verbally, as text or by learning through personal experience.

A wide variety of questionnaires are available to identify learner preferences based on the specific models, usually from a single perspective. An exception is the model developed by Dunn and Dunn which is predicated on a view of learning that integrates the influence of social preferences and preferred information processing modalities [6]. These two types of preferences may be measured using the Productivity Environmental Preference Survey (PEPS) [7].

In the New Zealand construction industry study, representatives of all groups self-administered the 100 question PEPS. About 250 questionnaires were completed. However information concerning individual education qualifications was not requested, so we do not know how many people in this sample would be involved in up-skilling. Therefore, in this paper, we will use the data obtained from 153 building and construction students as a proxy for people who would undertake additional education as part of the industry up-skilling programme.

PEPS is designed to capture social as well as information accessing preferences. The PEPS contains 20 factors. Responses are analyzed to produce a score for each factor, rendering a mean of 50 and a standard deviation of 10. For each of the factors, a score of one standard deviation above or below the mean indicates an element that is significant for the respondent. Factors which fall in the ‘low’ 20 to 40 and ‘high’ 60 to 80 ranges are the factors significant for individual learning-style profiles [7]. Scores between 40 and 60 indicate some other mediating element [8]. Due to limited space only five of the 20 PEPS factors will be discussed in this paper because these factors relate specifically to the proposed DBH up-skilling programme.

3. DBH option 1: self-directed learning and PEPS factors

Self-directed learning is the first education option proposed by the DBH [1]. A cluster of four PEPS factors, **responsible, structure alone/peers and authority figures** provides insights into learning preferences related to self-directed learning.

As noted above one stream of the learning-styles literature suggests that there are two commonly identified types of learner: field-dependent and field-independent [4]. The difference between the two types of learner is the level of ‘other’ support required for learning. Thus, the preferred elements in the environment within which learning takes place are significantly different between the two types (Coffield et al 2005).

Table 1- PEPS factors indicating self-directed learning preferences

PEPS factor	>40 Low score indicative of independent learning	<60 High score indicative of dependent learning
Alone/Peers	A low score indicates that a learner prefers to work alone and may find the company of others distracting.	A high score indicates a strong preference for learning with peers because talking aids learning and understanding.
Authority Figures	A low score indicates a learner prefers to ‘get on with it’ and does not want continuous guidance.	A high score indicates that a learner prefers to work with an instructor or expert present.
Responsible	A low score means that a learner is less willing to follow instructions and prefers to carry out tasks they have initiated themselves.	A high score means that a learner requires detailed instructions and will normally attempt to complete the required tasks.
Structure	A low score indicates that a learner prefers to work out the details of a task and prefers to interpret the necessary requirements.	A high score implies that a learner wants the instructor to provide a large amount of detail so that no interpretation is required; timelines, itemised resource lists, and criteria for successful completion of tasks.

Table 1, based on what the PEPS factors, shows that low scores indicate field-independent learners and high scores indicate field-dependent learners. Field-independent learners prefer to initiate and design their own tasks while working alone and only having input from teachers once they have completed a task. Field-dependent learners prefer working with their peers on assigned tasks that have detailed instructions while having constant interaction with an instructor [4].

3.1 PEPS factors: Alone/Peers and Authority Figures

As noted the New Zealand study did not collect data on qualifications of the participants in each of the four stakeholder categories. However, we know that students are in the process of 'up-skilling' and thus, an analysis of their learning preferences may provide some insights into the possible success of the DBH up-skilling project [1]. The 153 building and construction students all had some connection with a tertiary educational institution in one of three New Zealand cities. The range in age was 16 to 45 and students were enrolled in courses ranging from pre-carpentry to Bachelor of Construction. Only one student was female. However, analysis of the data from this pragmatic sample indicates that little difference was noted in any sub-set [10].

The PEPS factor *Alone/Peers* has highest level of preference in this study. 80 individuals or just over half of all students (52.3%), the largest single group in this study, prefer learning with their peers. Only five students in this study indicate a preference for *learning alone*. The next highest number of students indicating a high level of preferences is for the PEPS factor *Authority Figures*. 76 (49.7%) of the 153 students have a strong preference for learning with authority figures close at hand to constantly provide feedback on student progress.

These findings concur with a study of construction students in the USA. Choudhury [11] introduced Reciprocal Peer Tutoring (RPT) to construction students in classes over three semesters at Texas A&M. Small groups followed a set protocol of devising questions and quizzing one another and handing in correct answers to the teacher during class time. The Choudhury experiment models the preferences of the New Zealand construction students to work with peers in close proximity of an instructor.

3.2 PEPS factors: Responsibility and Structure

There appears to be little tendency within the sample towards taking individual responsibility for learning. In relation to the PEPS factor *Responsibility*, only about 12 % of respondents, 24, have a score below 40 indicating a preference for personal decision-making in relation to learning. On the other hand 64 students (41%) have a marked preference for following detailed instructions to completion of learning tasks. The PEPS factor *Structure* has a similarly high level of preference in this study. 74 individuals (48.4%) of all students prefer learning materials to be structured. In addition, the trend line is 60. Taking these two factors together implies that the majority of students in this study want well-defined learning outcomes, task completion timetables and assignments with an absence of ambiguity. As well they want instructors close at hand to check the progress of learning tasks that have a single learning outcome.

These learning preferences for New Zealand building students are not unusual. For example, accommodation of high levels of structure with low levels of personal responsibility is evident in a Toolkit designed for construction instructors in the UK [12]. An eighteen slide presentation provides students with a virtual tour of dry rot in a building. In addition, each slide poses a question to direct student attention to important points and to maximise their observation capabilities. The limited number of slides provides a high degree of structure, while the questions indicate that the responsibility for knowing what is important remains with the instructor.

How do educationalists account for the need for a high degree of structure, plus a desire for sharing the responsibility for learning with peers and instructors? One explanation is that the majority of construction students in this study are surface, not deep learners [13]. Deep learners seek an understanding of what they are learning and need to be able to fit it into their cognitive structure. Surface learners focus on completing a task. The results of this study are indicative of the learning preferences of surface learners. While surface learning may not be the expectation of educators, it seems to be a common preference for construction students in Hong Kong [14] as well as New Zealand.

Whether or not the students in this study are surface learners, the preferences indicated by a majority of students in this study do not meet the criteria of independent learners. Thus, the ideal of an independent learner who works alone and takes responsibility for designing and completing learning tasks as suggested in the DBH [1] option for ‘self-directed learning’ is problematic. Based on the findings of this study, DBH option 1 will not be chosen by a majority of the industry to move forward the up-skilling project.

4. DBH option 2: reading materials provided by the Registrar in relation to PEPS and VARK factors

The second suggested education option to up-skill the construction industry in New Zealand is ‘reading materials provided by the Registrar’ [1]. As this option is very specific in what kind of learning is being offered, it would be prudent to gain a more accurate definition of the meaning of this information accessing modality [6].

The principle assumption of learning styles theory is that learning is a transformative process [13]. Information is presented, then internalised and transformed by individual cognitive processes to become individualised knowledge which can in turn be presented as information [8]. Bandler & Grinder [5] suggest that if information is not presented in a format that the learner prefers, then the information is probably ignored. However, the four information accessing modalities - auditory, visual, tactile and kinaesthetic - are the least used factors in the numerous learning-styles models according to Coffield et al. [9]. The difficulty in defining and then measuring a modality may be the reason.

In the PEPS model the distinctions between each modality are simplistic. However, a more accurate description of information accessing modalities is currently to be found on the VARK internet website [15]. Table 2 illustrates the difficulty of comparing different models, but it does seem important to do because of the additional insights that may become apparent concerning construction student preferred learning styles.

This paper will focus on two factors that appear to be significant to the New Zealand construction industry; visual and tactile modalities. Visual learning seems self-explanatory--

learning by seeing. In the PEPS model *Visual* has the specific meaning of learning through the process of reading. The Fleming model shifts the focus from the process of reading to the packaging of the reading material suggesting that it should include drawings and images [15].

Table 2 - Comparison between PEPS and VARK factors for information accessing modalities

PEPS	**Visual**	**Auditory**	**Tactile**	**Kinesthetic**
	The learner transforms information into knowledge by reading.	The learner transforms information into knowledge by listening.	The learner transforms information into knowledge by handling and manipulating instructional resources.	The learner transforms information into knowledge by active involvement and experience.
VARK	**Visual**	**Aural**	**Read/Write**	**Kinesthetic**
	The learner prefers the emphasis to be on the packaging of information: attractive shapes, colours and contrasting spacing composition. The learner transforms information into knowledge by making drawings or images.	The learner prefers information to be heard. The learner transforms the information into knowledge by telling somebody else.	The learner prefers information to be in the form of dense text. The learner will probably verify the information heard or seen by finding it in written form. The learner transforms information into knowledge by creating a written text.	The learner does not accept ideas presented as abstractions which the learner can not experience. The learner transforms information into knowledge by observing then doing.

In the PEPS model *Tactile* learners are advised to write as a way of satisfying the need to learn by handling instructional resources, one example might be to write what has been read [7]. Fleming creates a new category by combining the *Visual* and *Tactile* factors of PEPS to a Read/Write modality to describe the process [15]. Thus, even though both models use common words to indicate information accessing modalities, the models appear to provide significantly different process explanations. The PEPS model implies a single sense transformation process whereas the VARK model describes linkages between a number of modalities in the transformation process. For example, people who prefer to learn by reading will also need to

write what they have heard thus transforming information accessed through the ears into knowledge using both eyes and hands [15].
These definitional shifts between the two models may relate to the currency of the model. The Dunn and Dunn model was initially developed over 30 years ago [6]. Much research into learning-styles has been undertaken since then [9] and if the constructs are valid, then it would be expected that newer and clearer definitions of the learning process would be expected as suggested in the VARK model [13, 15].

4.1 PEPS and VARK information accessing modalities

As noted in Figure 1 a significant number of students in this study appear to have rejected *Visual* as a preferred mode of accessing information. Fewer than 5% of students preferred the *Visual* mode, but almost 15% rejected it outright and the majority of student scores were below the mean [10].

It may be that the obvious lack of preference for the PEPS *Visual* modality is an indication that construction students prefer the VARK definition of how information should be presented. Abdelhamid [16] found that construction students showed a marked preference for visual information defined as 'pictures, diagrams, graphs, demonstrations' in his study of Michigan State University construction management students. The US students appear to have the same preferences as the NZ students, if reading must be done, then the material should be visually ideographic.

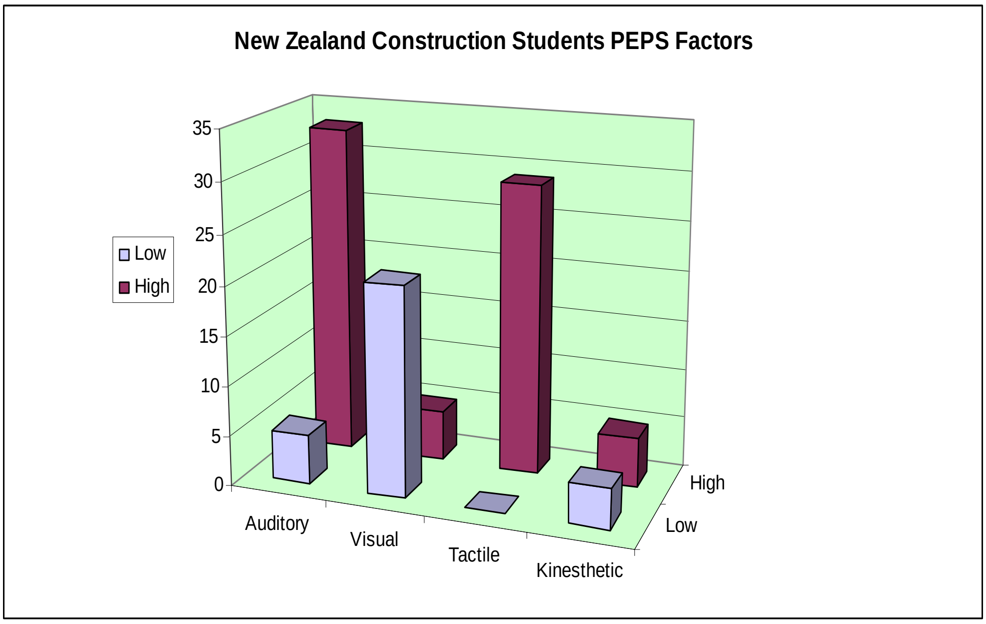

Figure 1 - Information accessing modality preferences of New Zealand building students

Figure 1 shows that the students in this study did not indicate an obviously negative response to *Auditory, Tactile or Kinaesthetic* modalities. Although the number of students with decided preference for *Auditory* and *Tactile* are not great, only about 20% each, the mean for both was toward 60 rather than towards 40. And indeed not one student rejected *Tactile* as way of accessing information.

In a 'hands-on' industry such as construction, it comes as no surprise that students prefer to learn in ways that allow them to observe and try. Murray et al. [12] describe the SLICE Lecturers' Toolkit. This initiative appears to be based on the perception that students learn in a variety of ways and construction students prefer visual as defined in VARK and tactile information accessing as defined in PEPS. Their course content is in the form of workbooks, so students can use their tactile preference. The workbook is highly visual 'containing 22 colour photographs and 12 professional-level drawings. And learners are able to write in their workbook, either to satisfy a need for *Tactile* experience (PEPS) or a *Read/Write* information transformation process (VARK).

On the other hand, Dunn claims that 'many adult males are neither auditory nor visual learners and some remain essentially tactile or kinesthetic all their lives' [6]. If this is the case, it may account for the rejection of *Visual* as a modality of learning with this group. However, it is difficult to interpret the meaning of the low levels of preference for *Kinesthetic* information accessing found in this study of 152 male building students if the Dunn contention is true. At the same time the results may only be a reflection of the criticisms by some scholars that the PEPS lacks clarity as a survey instrument [9].

Another explanation for these difficult to interpret results may be the lack of compatibility between student preferred learning styles and the data collection process. Completing an unfamiliar questionnaire is a learning task. For example, the questionnaire required students to read text but not to write, and peer consultation was not encouraged. Maybe the learning environment that the building students prefer was absent while they completed the questionnaire, thus making learning difficult for some students. We can only speculate, but it does seem possible that if students had been able to talk with their peers and ask questions of instructors; if students could have written, drawn and found ways to tell others about the meaning of "I can sit in one place for a long time.", then their scores for preferred information accessing factors may have been different.

Which returns us to the question of the appropriateness of the DBH [1] providing 'reading materials' as an educational option to ensure a competent building and construction industry. Even with the flawed PEPS instrument and difficulty of interpretation, construction students in this study clearly do not prefer to access information through text. Many of the students in this study appear to outright reject reading as a way of learning. But the extent of the problem appears to be more wide-spread because all groups in the exploration of construction industry learning styles indicated an aversion to visual information accessing [2]. Thus, educational options available for up-skilling the New Zealand industry must use other information accessing modalities.

5. Conclusion

We began this paper by asking the questioning the efficacy of the educational options proposed by the DBH in their attempt to expedite up-skilling of the New Zealand building industry. By focusing on two options in relation to the preferred learning styles of a sample of building students, we have concluded that these two options may prove to be a barrier rather than a pathway to a competent and formally educated workforce.

The first DBH educational option is ‘self-directed study’. All stakeholders in this research preferred learning with peers in the presence of an instructor. The students in the study did not overwhelming prefer to design and carry out independent study. They wanted highly structured learning materials that detailed both inputs and outcomes.

The second DBH educational option is ‘reading materials provided by the Registrar’. Participants in this research rejected text or reading as a preferred option of paying attention to information or transforming the information into personal knowledge.

It appears that DBH option one and option two are exactly the opposite of the educational alternatives that would provide successful pathways to up-skilling the building sector. Although this discussion focused on building students, data were also collected from a variety of other occupations such as fitters and plumbers, electricians, engineers, architects and building inspectors. We found a similarity between the builders and the other occupations but the number of responses was too small to make definite comparisons. However, if even a small number of other occupations have similar preferences, it could be argued that success of the construction industry up-skilling programme is more likely if an education opportunity takes into account the preferred learning-styles of the sector [9].

In addition the findings of this study have implications for a wider audience. Students in all subject areas that are encompassed in the field of the Built Environment may have learning preferences similar to the students in this study. If this is the case, then traditional classroom practice [12], as well as the push for use of distance learning, needs to be re-examined for effectiveness.

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Diffusion and implementation of innovation in construction industry: Case studies for an institutional framework

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Abstract

Emerging countries have to develop their own specialised institutional frameworks in order to diffuse and foster innovation in their construction industries. In establishing new institutions, developing countries can take the industrialized countries as a model. However, the differences should be analysed in detail, and the model developed should be adapted to the environment in which the new institution will work. Examining the UK construction industry within this perspective, in this study, universities are taken into consideration as one of the major elements of innovation diffusion and two of the enterprise centres of University of Salford, CCI and SCRI are analysed with the case study method in order to reveal its success factors with an institution building conceptual model. As a result, the important role of these centres in fostering innovation in the construction industry is explored and lessons are driven for emerging countries on how to develop appropriate institutional frameworks.

Keywords: construction, innovation, institution building

1. Introduction

Higher education institutions play a significant role in the production of knowledge and stimulation of innovation within the industry. From the perspective of the construction industry, however, the literature indicates the poor relationship between the universities and the industry. The Fairclough Report [1] describes the construction industry as wary of academia. In order to overcome this barrier for innovation, engagement mechanisms play a crucial role in bringing together the knowledge of the higher education and the construction industry. Four types of engagement mechanisms are identified by Lambert [2] in the UK context: Personal contacts and staff exchanges (such as visiting professors, guest lecturers, or industry secondments); business support and consultancy; collaborative and contract research; establishment of joint ventures and spinout companies. Building specialised institutions is a more holistic approach which comprises a variety of mechanisms designed for bringing together the universities and the industry. Therefore, good practices of the developed countries can be successful models for developing ones.

In this context, the success factors for an institution in diffusing and implementing innovation will be explored according to an institution building model and the applicability of this model for developing countries will be set up for further discussion.

2. Innovation and the Construction Industry

Competitive environment of the world economies is getting more severe as globalization changes the world. Developing countries are challenging developed countries for the value added products and high-tech industries. In this severe environment of competitiveness, even successful companies of the past are trembling against the rapid change we face.

Porter [3] states that, during the past 20 years, western companies have responded the competition with continuous improvement. Companies are remaining competitive by information technology (IT) investments, re-engineering, Total Quality Management (TQM), lean production and other similar techniques for optimizing their productivity. He also suggests that companies have to offer value creating and differentiated new products for creating unique competitive positions by integrating all their competencies.

In addition to these competitive needs, spectacular achievements of the high-technology sectors of the economy have driven interest in the generation of new ideas and its implementation, i.e. what is now being considered innovation [4]. Differentiation of products, processes and services in an innovative way is a major key to sustainability and competitiveness for the market share. This differentiation may be achieved through a completely new product/process or an adaptation, whereas it can be achieved by developing an existing product/process or service.

In this context, there are several different definitions of innovation reflecting its principal characteristics. Rogers [5] defines innovation as "… an idea, a practice or object that is perceived as new by an individual or other unit of adoption". He argues that the idea should be to new to the observer rather than being newly discovered in that period of time. Freeman [6] defines innovation as "... the actual use of non-trivial change and improvement process, product or system that is novel to the institution developing change" in his popular definition which is also used by Koskela and Vrijhoef [7] and Slaughter [8]. EU and OECD legislations define innovation as "...the implementation of a new service or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations.".

The definition of innovation in the construction industry is not far away from these above. Tatum [9] highlights the subjectivity of being new, and defines innovation as the first use of technology for construction firms. Toole [10] used the definition of "Application of technology that is new to an organization and that significantly improves the design and construction of a living space by decreasing installed cost, increasing installed performance, and/or improving the business process". Construction Research and Innovation Strategy Panel (CRISP) defined innovation as "The successful exploitation of new ideas, where ideas are new to a particular enterprise, and are more than just technology related – new ideas can relate to process, market or management". "The successful exploitation of new ideas", which is also used by the Department of Trade and Industry (DTI), is widely used and accepted in the construction industry and academia in the UK.

Academicians seem to share an increased understanding of the differences between construction and traditional manufacturing sectors. Traditionally, product suppliers perform similar to other industries to improve the performance of their products or the process creating them [11]. However, construction activities are project based which have a discrete nature and many different types like roads, bridges, houses, airports. One of the major differences between the overall construction process and most of the other industries is that in the construction sector, design and production are often separated. In most of the industries, design and application are integrated or performed in the same company. In construction industry, design and construction are sub-divided and fragmented. Contractors usually build projects designed by design professionals. Diverse and discrete nature of these projects makes long term development and improvement very difficult. Contractors are reluctant to spend money on anything rather than the immediate needs of individual projects. Even most of the employees are hired for specific projects and firms are being reluctant even for training their work force, because of the possibility of loosing their staff to another company for the next project. In these circumstances research and development are usually being neglected. This market structure seems to be the main barrier for the long term improvement and innovation in construction.

In literature, Construction industry has been examined with some concerns about its innovativeness but these concerns have motivated some researchers to pay attention on the issues and solutions for the construction industry [11]. Although the level of innovation is considered as low compared to other industries and poorly innovative, potential of the industry to innovate is also acknowledged [8,12]. Winch [13] argues that the evidence for this perception is usually based on comparative industrial performance data which is not suitable for construction, as argued above. Hence, like any industry, construction needs to increase the rate of innovation [8].

Most of the literature on technical change and innovation focuses on creation and development, but the real gain will be achieved when they are widely spread and widely diffused [14]. Moreover, innovation theories and diffusion is extensively discussed in the literature but most of these discussions treat diffusion as a non-integral part of the innovation process. Innovation theory and particularly diffusion theory has a gap for project-based sectors such as construction [15].

3. Institutional Development for Innovation in Construction

Without diffusion, innovation would have little social or economic impact [14]. Hall [14] and Widen [15] also state that diffusion is not the means by which innovations become useful by being spread throughout the population but it is also an intrinsic part of the innovation process : Understanding the diffusion process is the key to understanding how conscious innovative activities conducted by firms and governmental institutions (activities such as funding research and development, transferring technology, launching new products or creating a new process) produce the improvements in economic and social welfare that are usually the goal of the activities. For entities which are "catching up", such as developing economies, backward regions, or technologically laggard firms, diffusion can be the most important part of the innovative process [14].

Existing institutional structures in developed countries have strong influences on the process of construction like "invisible hands", but this influence can be benignly as well as malignly [16]. Industrialised countries have an evolved construction industry with specialised institutional frameworks where it relies on the interaction of a variety of institutions, each with its own specialist priorities like training and development of professional skills, organisational management, regulating the industry through contractual procedures, standard setting and implementation. Developing countries have to create their own frameworks by establishing dedicated institutions [17]. On the other hand, besides the strong need for institution building in developing countries, there is a possible danger of creating unwieldy bureaucracies.

In order to find the success parameters in construction industry development and answer questions like how successful institutions fulfil their client's needs, the institutional factors that carry them to success and their dynamic linkages in their operational environment should be analysed well. Operational environment of organisations are much more complicated than what it seems because they contain both man-made and physical elements. In contrast with the physical environment, man-made-elements tend to be more"...irregular, nonrecurring, irrational and unpredictable" [18].

Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints and the framework that shape human interaction. World Bank's Building Institutions for Markets Report [19] defines institutions as the rules, enforcement mechanisms and organizations supporting market transactions. Policies affect which institutions evolve – but institutions too affect which policies are adopted. The major role of institutions in a society is to reduce uncertainty by establishing a stable structure to human interaction.

In institution building one size does not fit all and guidance is always needed on how to develop appropriate institutions by building on the successes of the countries and the good practices, and learning from the failures. But not withstanding the uniqueness of countries, analysis of country experience does hold important lessons for institutional development. There are roles for private and public, and national, local, and international actors. The World Bank's Report [19] distils lessons on building effective institutions. Importance of the supporting institutions, human capabilities and available technology that exist are underlined. Countries are invited to innovate to identify institutions that work and that do not as they would gain from expanding successful public innovations. Connecting communities through open information flows will help create the demand for the institutions and the forces for change within the countries and promoting competition will modify the effectiveness of existing institutions and create demand for new ones.

In establishing new institutions, developing countries can take the industrialized countries as a model. However, the differences should be analysed in detail, and the model developed should be adapted to the environment in which the new institution will work. Complementary institutions, such as those promoting transparency and the enforcement of laws, existing levels and perceptions of corruption, costs relative to per capita income, of establishing and maintaining institutions, administrative capacity including human capabilities and the technology available should be considered as the main differences that would produce dissimilar results.

Both existing and newly transplanted institutions can be more effective in developing countries if they are systematically modified to take these differences into account. Institution building is generally a cumulative process, with several changes in different areas building up to complement and support each other. Even small changes can build momentum for future changes, the whole is greater than the parts and even moderate progress in parts can contribute to a better system. Institution builders can be diverse such as policy makers, business people, or community members. Institutional reform is not just the preserve of national governments. Individuals and communities, entrepreneurs, companies, organizations can build institutions, often in partnership with each other. National governments may initiate reform or may simply respond to pressures from the private sector or from external actors.

Developing countries have to find ways to accelerate this evolutionary process, and this usually implies the establishment or development of dedicated institutions. Evidence has been accumulating that such institutions can yield significant benefits in terms of improved national construction capacity and performance, provided they focus realistically on the ambitions and needs of their clients rather than engage in fruitless empire-building (or academic status-building) for its own sake. The qualification is important, since there are other examples of institutions which have failed to understand and meet the needs of their clients, and later foundered through a combination of inertia and the weight of self-imposed bureaucratic procedures. The question to be asked here is if these institutions are accepted as successful in terms of their clients' needs and priorities, how they managed it and whether the seeds of the success be identified and planted elsewhere. In order to answer this question, it is necessary to analyse the institutional factors which lead to success in this specialist area of institutional development and in particular examine the dynamic linkages that must exist between such an institution and its operational environment [17].

4. Research Methodology

This study is structured as a multiple case design with embedded units of analysis.

Case study approach is considered to be week and dubious [20] by some researchers. However other researchers have regarded this method as effective for appropriate conditions. Cook et al [21] defines this strategy as a fundamentally different research strategy with its own design. This approach allows investigators to gather the holistic and meaningful characteristics of real life events Yin [22].

Evidence for case studies may come from six sources: documents, archival records, interviews, direct observation, participant-observation and physical artefacts [22]. As the various sources are highly complementary, a good case study should use as many sources as possible. Yin [22] explains extremely important characteristics of high-quality case studies as: using multiple, not single source of evidence, creating a case study database and maintaining a chain of evidence where possible.

Institutions can be placed in three broad categories: learned societies, trade associations and training, research and development institutions. This third type, training, research and development institutions are more at the centre of interest of this paper as an institutional category, and the case studies are chosen accordingly.

These case studies rely on multiple sources of evidence. These sources are: documentation, archival records, interviews and direct observations. Agendas, announcements and reports online from the web page of Centre for Construction Innovation CCI (www.ccinw.com) and Salford Centre for Research and Innovation SCRI (www.scri.salford.ac.uk) are used as present documentations. Director of CCI, Mr Andrew Thomas is interviewed. He explained the Centre's past, targets set, activities and services given, their relationship with public and private bodies and the future predictions for CCI in a two hours open-ended interview. Most of the documents which are not accessible on the internet are provided by him. Director of SCRI, Mr. Carl Abbott answered open ended questions in a meeting and provided SCRI's last annual report of 2006 for further information. Academicians from the University of Salford like Dr Peter McDermott and Prof Mike Kagioglu filled some gaps by their valuable contribution. Participation to a Twilight Seminar-Innovating in the built environment, held on the 25th of April by CCI, added direct observations to this framework. Finally, a previous case study on CCI "Facilitating Innovation-The Role of CCI" by Carl Abbott and Stephen Allen [23], was both informative and testimonial partially for this study.

Case studies are explored by Esman's [24] institution building conceptual framework. The same model is used by Miles and Neale [17] for structuring case studies on a construction programme of ILO, and McDermott [16] for criticising Latham Report on its proposed institutional framework for implementation.

4.1 Esman's Model

Milton J Esman [24] captures the essential elements of the institutional process in his conceptual framework "The institution building universe". These essential elements are characteristics of the institution itself, institutions linkages with its environment and purposeful exchanges in between: "transactions" (Figure 1).

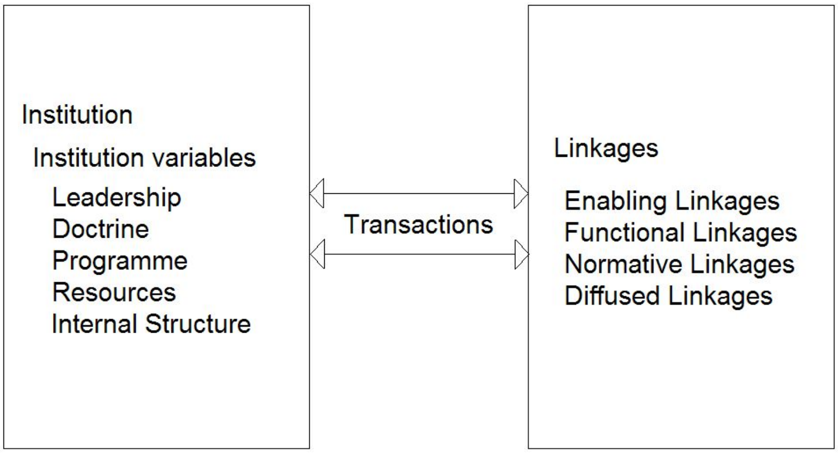

Figure 1 - The institution building universe

Five major variables of the institution are listed as follows:

- Leadership: An innovative organisation needs strong leaderships to reach their aims; especially when they are new. Every single organisational procedure should be set from the beginning, from a draft of ideas. This appears to be the most important factor an organisation should have.
- Doctrine: Defines the institution's aim to achieve, what the institution stands for and in relation with the leadership, its values and style.
- Programme: What the institution does to achieve its goals, services and functions defining the resource needs.
- Resources: The main expenditure of the institution-building is usually the staff they recruit.
- Internal Structure: Institution's management framework. As it has strong cultural dimensions, it should be devised to suit the needs of its local environment.

As the existence of an institution strongly depends on its relations with its environment, these links are considered in four categories:

- Enabling linkages: Vital relationships which give the institution its legality, purpose, resources and form.
- Functional linkages: linkages with complementary or competing organisations that support or help in general to achieve objectives.
- Normative linkages: These are relationships with institutions which have similar interests and purposes. Such relations can be either friendly or on the icy side.
- Diffused linkages: Individuals or groups who are not directly related with the Institution but may have big impact for reaching the desired objectives with their influence and create acceptability. Project champions can be an example for this kind of relationship.

5. Case Study 1 : Centre for Construction Innovation (CCI)

CCI was formed in 2000 for the promotion of the Rethinking Construction agenda in the North West region of UK. North West Development Agency NWDA and CCI was partnering in the first years of the establishment. CCI is a 'not for profit' enterprise and one of the three enterprise centres of University of Salford's School of Built Environment.

- **Leadership:** Centre is being managed by an operations director, an associate director and a general manager. CCI has a strong leadership, directed by a professional from the industry who has a successful past and an extensive knowledge background. He is the one who provides leadership and directs the team strategically. He is the second director of the centre after Dennis Lenard but he has been within the centre from the first day of its foundation. Co-director of the Centre is an academic who has publications on supply chain management, decision support systems, trust, and implementing innovation in construction. Dealing with the centre's projects and supporting the project managers is the duty of the general manager and he is also responsible for the future work.
- **Doctrine:** CCI is formed to promote the Rethinking Construction agenda derived from the Egan Report, in the NW region. Whilst this started with the 'Rethinking Construction' agenda it has now been expanded to wider issues of the built environment such as sustainability, design, procurement, skills and process. The main aim is to provide industry and its clients act collectively to improve performance in the means of productivity, profits, defects and reduced accidents, through the application of best practices and create a 'movement for change'. The Centre was also positioned as an organisation for the diffusion of innovation created by the research in its academic sister SCRI.
- **Programme:** CCI has a wide range of activities like training, coaching, consultancy, mentoring, procurement and event management services. Training programmes include Respect for People, Better Public Buildings, Sustainability and Environment, Lean Construction, KPI & Benchmarking, Supply Chain Management, Procurement Value Based, Contractual Agreements, Whole Life Costing, Integrating Teams and Post Project Review. Other main service modules are: Procurement Coaching, Partnering and Team Integration, Bid Coaching and Debriefing, SME Capacity Building and KPI. The Centre also has some 'products' like 3D visualisation / VR suite aiming to present practical uses of visualisation in various industries from construction to retailing, showing ideas on how 3D visualisation can implemented for different economical and consultation issues; on-line KPI management tool to allow companies to store and analyse their own data supported through consultancy and advice. The Centre hosts 6 of the region's Best Practice Clubs, manages the CUBE – regional ABEC Gallery and Seminar space and participates in many AE / Industry Link for University Research.
- **Resources:** CCI is not a large organisation. Total number of employees is currently about 20, including management team, project managers and administrative staff. 9 of them are Project Managers, 3 of them are administrative staff. They also have gallery assistants for the ABEC gallery and seminar space. The ratio of the professionals to the academics is %70 to %30. Academics and postgraduate students also participate in process and services. There is a 'ring-fenced' structure between the centre and the University of Salford. This structure enables them to invest surpluses for future research and development. Annual turnover is between 1.5 to 2 million Pounds. Main amount of this turnover comes from ERDF, NWRDA, Construction Industry Training Board (CITB), Manchester City Council (MCC) and Constructing Excellence. Apart from these, sales of the products and services developed by CCI have an important share in the total turnover. 3D visualisation / VR suite and on-line KPI engine are two of the most money-earning 'products' of the Centre. Apart from the listed above, at least half of the income is from the other small projects and consultancy services. The centre is trying to secure itself by bidding for new opportunities continuously. The main expenditure of the Centre is its staff, which is common for similar institutions all over the world [17]. Termination of the ERDF funding in 2008 will be challenging for

the near future. A replacement should be found in the near future, to secure the Centre's human resources and activities.

- **Internal Structure:** Being a small organisation, CCI does not have a complex organisational structure. The Centre is guided and advised by a non executive Board. The Board consists of representatives of University of Salford and other academics, representatives of other organisation's (like Northwest Development Agency, Constructing Excellence, CITB and so on), contractors and even clients who all have an influence on the Centre's activities. They come together bi-annually and focus on the sectoral activity and interaction of the CCI. Under the management level, there are two functional divisions: Project Management and Project Support. The centre has nine Project Managers (PM), each of them experts of their field. Every PM runs projects and service modules of his/her own interest. However, the team work approach adopted by CCI is also leading them towards supporting other projects of expertise, running under the initiative of other colleagues and work together as equal parties in the workshops. Administrative staff including an events manager and exhibition assistants are in the Project Support section.
- **Linkages:** In many ways, CCI case study is a study of linkages. The Centre has strong relationships with every stakeholder in the NW construction industry with a contact database of 14.000 individuals and 2300 companies of varying sizes. The number of people the centre engages through its many activities in a year is over 2000. The fact that it was founded, and is governed in partnership by academia, members of industry and public bodies gives CCI strong enabling and functional linkages. Its educational programmes involve significant number of members of academic institutions and professionals from the main sectors of the industry, thus enhancing the functional linkages and promoting normative ones. Through the development of the 'Rethinking Construction' agenda CCI has become a key provider of advisory and grant aided services to the construction sector. The Centre is now promoting influence of a powerful agenda-rethinking construction and is promoting these agendas for the UK construction industry. CCI keeps its good relations with all the participants of the Industry and is part of a wide industry network including research centres, governmental and regional policy bodies, training organisations, professional organisations like CIC, RICS and RIBA as well as private sector companies and clients. The Centre is now at a stage of establishing both national and international franchises.

6. Case Study 2 : Salford Centre for Research and Innovation (SCRI)

The Centre has been established since January 2002, and it brings together a diverse group of leading international academics from the schools of Construction and Property Management, Information Systems Institute and Art and Design. SCRI is positioned within the most highly rated Built and Human Environment (BuHu) research institute in Britain. SCRI is collaborating closely with more than 60 national and international companies and institutions, representing all elements of the supply chain. The Centre develops industry relevant and appropriate research-based processes, management and operational frameworks, and Information Technology solutions in a holistic, multi-disciplinary, integrating and inclusive manner.

- **Leadership:** SCRI is managed by the integration of four committees. The Executive Committee is responsible for the overall management of the Centre and it comprises the Chairman, Director and the Centre Manager. The Centre Manager has changed recently as the previous manager is appointed as professor in University and now co-directing SCRI, with responsibility for Health and Care Infrastructure Research and Innovation Centre (HaCIRIC). The Executive Committee meets as and when need arises.

- **Doctrine:** SCRI is a major influencer of the international research agenda. According to the Centre's vision and strategy statement, they are targeting an institution that will reveal the long term needs of the industry and society to challenge current thinking and develop integrated solutions as well as exploiting research outputs. They are helping create a built environment for society that will facilitate future aspirations and compares well with world-class standards in the provision of built environments. Centre's industrial perspective is a construction industry that is socially responsible, sustainable, innovative, diverse and flexible. They are actively engaging with the agendas of national and international academic and industrial communities. These engagements create sustainable strategic alignments. In this context, they are addressing selected research areas in which SCRI has international intellectual leadership. In order to achieve these goals, they are operational to be recognised as one of the leading multidisciplinary centres in the built and human environment globally, trying to increase the value set on the construction by society. They are regularly revising the vision and strategy of the Centre are being revised regularly with workshops, scenario planning and vision development activities.

- **Programme:** Consistent with the doctrine of the Centre, research is conducted with four themes : process, people, IT and integration and five programmes that are : revealing long term needs, challenging current thinking, developing integrated solutions, building research capability, exploiting research outputs. Under the IT theme SCRI develops its integrated IT platform. They work on tools for measurement of work in progress on site and technology foresight. In the process theme, they are focused on research into a better understanding of design process, health outcomes of the built environment, agile project management, production control in construction and the incentive flow down in complex product service projects. People theme involves research such as conflicting policy objectives, and future policies. In the integration theme, the Centre has successfully applied the development of a new centre dealing with health and care infrastructures. Health and Care Infrastructures Research and Innovation Centre (HaCIRIC) has a high potential as it is addressing an important field of research in which recent work is far from convincing the rising requirements. In this context, SCRI has a number of collaborative research with other leading research centres and industry partners. Researchers of the Centre are also involved in the teaching within the University. This is a policy of the Centre both for their careers and dissemination of the work undertaken in SCRI. The Centre organizes many seminars and conferences like SCRI forum and the Annual International Research Week. SCRI forum brings together a wide range of industrialists and key academics enabling them to discuss range of issues. Annual International Research Week brings together researchers from all over the world and they find the opportunity to represent their work to other researchers and also people from academia. This event makes valuable contribution to the researchers work as well as providing a fertile ground for new projects.

- **Resources:** Under the steering Committee, SCRI has 2 different "teams" which are management team and research team. Management team comprises centre chairman, centre director, centre co-director, centre manager, lead investigator, EPSRC star recruit coordinator, centre administrator, assistant administrator, academic enterprise-industry engagement coordinator. Research team involves 15 Investigators, 18 researchers, 10 associates and 15 academic associates. The Centre also has 3 support personnel. SCRI is funded by the Engineering and Physical Sciences Research Council (EPSRC). They have been funded 2.950.000 GBP for the 2002-2006 period as Salford Innovative Manufacturing Research Centre (IMRC). Renewal of this funding was a total of 4.950.000 GBP for another 5 year period (2007-2011). This amount is expected to be the last full funding. There are also various contributions to the Centre from project partners and collaborating companies. Contributions both in kind and cash have a total amount of around 2.150.000 GBP since the date of its establishment.

- **Internal Structure:** SCRI is managed by a group of integrated committees. Steering, Executive, Management and Research committees are acting to enable a constant dialogue between the members of research and administration and to certify a transparent management and effective decision making system. Steering Committee embraces key individuals of academia and industrial sectors, both from the UK and abroad. It is responsible to improve the Centre's activities and portfolio as well as developing its strategy and vision. This committee includes the Centre manager, Director, Co-director and consultants with a total number of about 20 people. SCRI Executive Committee involves the Chairman, Director and Centre Manager. It is the board that is responsible from the overall management of the Centre and reports to ESPRC on progress, finance and human resources. Structure of this committee is recently changed, altering the previously existing Management and Extended Management Committees that existed before in order to accelerate the routine decisions. The Extended Management Committee is changed and titled as the Management Committee which is responsible for the academic leadership and strategy of the Centre. It is established to ensure transparency and for greater engagement with academicians. Co-director of CCI is also a member of SCRI Management Committee. And finally the Research Committee provides a forum for all members of SCRI to discuss research issues as well as workshops where issues like research methodology, theory development etc. are debated.

- **Linkages:** The SCRI chairman is a member of European and National Technology Platforms (ECTP and NTP). That ensures the Centres international influence but also SCRI's research agenda to be strongly influenced by international issues. Their research under the Revaluing Construction theme has influence on construction strategies of both UK and EU and they lead in many CIB workgroups internationally. SCRI is the highest rated Built and Human Environment Research Centre in the UK. Multi-disciplinary research landscape of the Centre includes many activities within the University of Salford. Research Institutes like IRIS and Adelphi and other IMRC centres and institutions as well as some project groups they are involved are closely linked to each other in the SCRI's research area. They have strong relations with industry intermediaries that diffuse knowledge from academia. Centre for Facilities Management (CFM), Construct IT (CIT) with many others are examples of such intermediaries. The other case study of this paper, Centre for Construction Innovation (CCI), is one of these centres as positioned to diffuse and implement the research of SCRI. Teaching activities within the University forms the Centre's linkages for teaching. They are in masters training, courses and they work with Education in the Built Environment (CEBE) as well as their research into teaching. Relations with government and policies, such as Regional Development Agency (RDA), ERDF regionally, DTI nationally, EU and CIB internationally complete the picture of linkages.

7. Conclusion

Centre for Construction Innovation is an institution established and formed with the influence of the reports commissioned by both the Government and industry, towards enabling the construction change agenda in the Northwest region of UK. Affiliated to the University of Salford, the Centre transfers knowledge and acts as a hub for the industry. They bring together research and industry and help working in close partnership with other agencies to deliver knowledge, skills and services to all members of the construction supply chain; from clients through to construction delivery teams and product suppliers. CCI is a sound example for diffusing and fostering innovation in the construction industry. The Centre has a flexible structure that can easily adopt the market conditions of the construction industry.

SCRI, on the other hand, have a strong vision to reveal and build research competencies and capabilities. They are trying to challenge the current way of thinking, exploit research outputs and develop integrated solutions for the long term needs of the industry. They are funded by ESPRC as one of the 16 Innovative Manufacturing Research Centres in the UK. Their research based environment is managed by committees consisting key people in their scientific field of interest. Researchers of SCRI produce a vast number of scientific journal and conference papers, reports, articles, book chapters and books. In accordance with its research based structure, SCRI is managed by a hierarchy of committees.

These two case studies show the importance of the efficient governmental policies and support of public and private bodies for their common interest. University/research link provides prestige and gravity to the institution. Strong leadership, close relations with public and private bodies as well as the industry, wide range of activities, not for profit structure of the centres are all important issues for being leading institution examples. However the governmental policies and the movement for change agenda shapes the UK construction industry and requires a good understanding to form similar institutions in developing countries for the diffusion and implementation of innovation in construction. Further examples should be studied and number of case studies should be increased for further decisions.

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Skilled Workforce in Sri Lankan Construction Industry: Production Vs. Acceptance

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Abstract

The quality of workforce is one of the major determinants of the organisational success which ultimately lead to competitive advantage. Being predominantly a labour intensive industry, construction gets high benefits from the skilled workers. In this regard, effective training programs to enhance the skill levels of the workers are of paramount importance in the construction industry. This research was undertaken to unearth the answer to the research question of "how the skilled labour production is catered for the acceptance in Sri Lankan construction industry". A desk study was carried out to find training courses which are available for construction trades. Accordingly various training programs for different trades were identified which are conducted by five key training institutes, viz. ICTAD, NAITA, DTET, VTA and CCI. A questionnaire survey was conducted among 77 recruitment officers in medium to large size contracting firms and 34 subcontractors in six distinct trades. The findings suggested that when recruiting workers who belong to trades such as plumbing and electrical, the contractors gave extra concern to their training qualifications. However, when it comes to trades such as masonry, carpentry, bar bending and painting the contractors' consideration on training qualification was at a lower level. The study further revealed that HR managers were more knowledgeable about training institutes than the Site Engineers or the PMs.

Keywords: Contractors, Recruitment, Skilled workforce, Sri Lanka, Training

1. Background

1.1 Skilled Workforce

In contracting organisations it is evident that there are number of groups of people who have special skills that are essentially needed for the construction processes. One of the groups that were less discussed than others is skilled workforce or tradesmen. They are crucial, because without them Architect's concepts and Engineer's designs would not be a reality. According to

Tradesmen [1] "A tradesman is a skill manual worker in a particular trade or craft. Economically and socially, a tradesman's status is considered between labourer and a professional with a high degree of both practical and theoretical knowledge of their trade". Skilled trades' workers have always been a benefit to a local economy. They are instrumental in turning materials into useful items. Their training, expertise and experience have helped craft products and build industries [2]. When it comes to construction phase, the performance of skilled workforce is one of critical factors to the success of any construction project. For the year 2003, it is estimated that the direct labour engaged in the construction industry is around 330,000 while the total labour force of all industries is 6.9 million and, the contribution to the Gross Domestic Product by the construction industry sector was 6.97% in Sri Lanka [2].

According to Gunawardane and Jayawardena [4] Sri Lankan construction industry is dominated by unskilled workers and has only six traditional skills as shown in the figure-1. In addition they further stated that Sri Lankan workers are "all rounder" within their broad field. For example masons very often do all work related their trade such as brick laying, concreting, plumbing, plastering, tiling, scaffolding and even bar bending. When it comes to carpenters often erect formwork and false work, fabricate door and window frames, fit glazing and so forth. These practices are common in building projects.

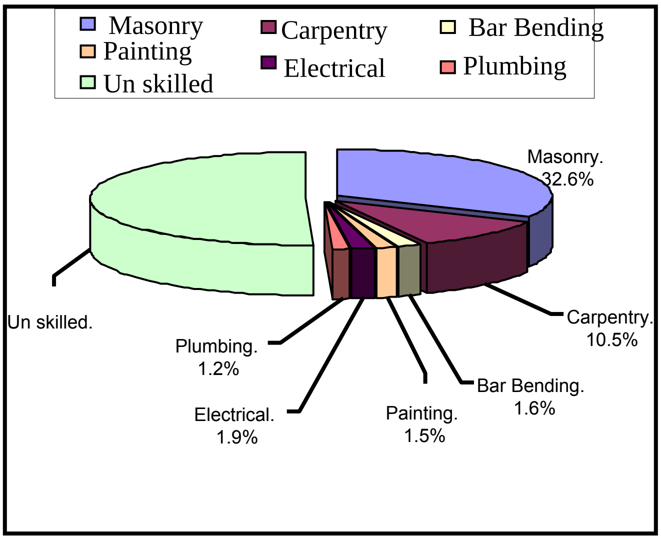

Figure 1- Occupational Structure of Sri Lankan construction trades

Construction is a labour intensive industry that places heavy reliance upon the skills of its workforce [3]. Paucity of skilled workforce results poor quality, high wastage and long-term productivity decline in the industry [4]. According to Dainty et al. [5] insufficiency of skilled workforce in the industry can generate poor work quality and delays in completion times of the projects and it leads general contracting firms to restrict their ambitions for growth, despite the buoyant nature of the construction industry. Therefore it is evident that the recruitment of skilled construction workers emerged as one of the key concern of the contractors. Although skilled workforce offers several benefits there is no standard method for determining the skill level in construction at the recruitment. Agapiou et al. [3] highlighted the contractor's recruitment criteria vary from one to another and it depends on local labour supply factor in construction.

1.2 Training of Workers

Since, training provides an indication of the skill level of the workforce [6] some employers tend to consider qualification acquired from undergoing formal training course as the basis of recruitment of workers. Therefore training is vital important for any sort of employment. In literature, it is defined “employee training” in a variety of ways. Amongst these, following Wickramasinghe [7] is one of the most commonly cited definitions related to human resource management. According to them, “Training is a process of updating the knowledge, developing skills, bringing about attitudinal and behavioural changes and improving the ability of the trainee to perform his or her tasks efficiently and effectively.” It demonstrates that training can enhance the worker’s skills and ability for the better performance of the career. In addition training can change attitudes and behaviour of the trainee. Therefore it is evident that, “Employee Training” has been and is being widely used to denote updating of skills, knowledge, attitudes or behavioural patterns of the employee. It means changing what employees know, how they work, their attitudes towards their work or their interaction with the co-workers or supervisor. To the extent that the construction industry is concerned the above scenario can be similarly applied for workforce in contracting organisations. In recent years there are number of training institutes have been established for skilled workers in Sri Lanka which provide training of varying quality at different levels and awarding standard qualifications certificates such as National Trade Test (NTT) equivalent to National Vocational Qualification system (NVQ) in United Kingdom.

1.3 Recruitment of workforce

Vacancies in organisations generally come up because of the departure of existing workforce which is called as labour turnover. Additionally it may arise because of a new position has been created. In such occasions organisation has to make a strategic decision regarding how it will build its workforce. Accordingly effective recruitment is essential for the successful functioning of an organisation. Recruitment is a process to discover the sources of man power to meet the requirements of the staffing schedule and to employ effective measures for attracting that manpower in adequate numbers to facilitate effective selection of an efficient workforce” [8]. Successful recruitment depends upon finding people with the necessary skills, expertise and qualifications to deliver organisational objectives and the ability to make a positive contribution to the values and aims of the organisation. This scenario can be similarly applicable for recruitment of skilled workforce for contracting firms too. According to literature there are criterions such as experience, work history, formal qualifications, attitude, task flexibility which are normally adopted by the employers at the recruitment of skilled workforce in construction industry.

Dainty et al. [5] stated that in United Kingdom most of construction organisations recruit workers who had not completed their qualifications. Few firms recruit workers who had progressed on to advanced apprenticeships and higher-level National Vocational Qualifications. They further revealed that, contractors think modern apprenticeships and the qualifications systems underpinned them did not produce the quality of skilled worker's experienced. According to Gunawardena and Jayawardena [4] most of the contractors and clients in Sri Lanka do not demand workers have trade test qualifications or National Vocational Qualifications for employment. As well as, most of skilled workers do not possess formal qualifications and having gained their skills experientially. CCI Bulletin stated that the majority of Sri Lankan contractors adopt their own criteria for the recruitment of the skilled workforce such as year of experience. It was further stated that the contractors who follows careful conceived recruitment practice are in difficult stage to consider which certificate to accept and which one is complying with industry requirements. Therefore by looking at above, it is evident that the skills gained through undergoing training programs is not the major concern when determining the skill level of the workers in both foreign and Sri Lankan context. If the skills gained from the training programs are not treated on its merits by the contractors then the huge amount of money and time which spends on these will be wasted. This put the workers to an ambiguous state as they do not have a proper idea on what is more important to carter the demand in construction labour market [9].

Even though various researches have been carried out on training, only a limited number of these have focused on construction. Out of those limited number of researches, only a few have been conducted in the Sri Lankan context. But none of these have addressed the issue of "How the skilled labour production is catered for the acceptance." Thus, this research intended to fill the research gap by studying skilled workforce production and acceptance in the Sri Lankan construction industry.

2. Method of Study

Desk study was carried out to collect secondary data regarding training programs existing for construction workers in Sri Lanka. Survey approach was adopted for the primary data collection. Sample of contractors was selected based on probability stratified sampling technique. Questionnaires were presented among 77 recruitment officers (Project Managers or Site Engineers and Human Resource managers) and 34 Sub contractors in six distinct trades (Masonry, Carpentry, Bar Bending, Painting, Electrical and Plumbing). Descriptive statistical methods were used for the analysis of data collected from questionnaires. To find out the most typical values for the group of data obtained by questionnaire survey, statistics called minimum, first quartile, median or second quartile, and third quartile or maximum were used.

3. Research Findings

3.1 Skilled workforce Production

In Sri Lanka the training of construction industry craftsmen is mainly carried out by a series of training institutions, which belongs to public and private sector [10]. The public sector training institutions are the Vocational Training Authority (VTA), National Apprentice and Industrial

Training Authority (NAITA), Department of Technical Education and Training (DTET), Institute of Construction Training and Development (ICTAD). In addition, there are few private sectors training institutions as Chamber of Construction Industry Sri Lanka (CCI), Jayalath construction and so on. They have larger number of trainers who involved in specific training. Those institutions have their own curricula which were prepared for six to eighteen months training courses. Following table illustrates the training programs which are conducted by key training institutes in Sri Lanka at present for different trade workers.

Table 1- Training programs for construction workers in different trades

Key Training institutes	Courses Conducted					
	Masonry	Carpentry	Bar Bending	Painting	Electrical	Plumbing
ICTAD	√		√	√	√	√
NAITA	√	√		√	√	√
DTET	√	√		√	√	√
VTA	√	√	√	√	√	√
CCI	√	√				

In addition it was revealed that there are two schemes of establishing skill levels of construction workers by training institutes in Sri Lanka.

National Trade Test (NTT)

This is a program to trade test and issue “certificate of proficiency” to those who possess relevant skills. Informally trained practicing craftsmen mostly use this scheme to obtain a recognised certificate for upliftment of their local and foreign employment opportunities. At present there are three levels of certificates namely grade III, grade II and grade I which means semi - skilled, skilled and highly skilled levels respectively. In Sri Lanka, NTT is carrying out by National Apprentice and Industrial Training Authority (NAITA).

National Vocational Qualifications System (NVQ)

National Vocational Qualifications are designed to measure the competency of different vocational skills. The intention of having NVQ is to produce Sri Lankan workforce globally competitive, through a standardised technical and vocational education system. The main objectives of setting up of NVQ are to recognise vocational skills locally and internationally, match and cater vocational training or skills with market demand, recognise the certificates those possessed through the NVQ system and to create an internationally competitive workforce in Sri Lanka.

The National Vocational Qualification Framework of Sri Lanka (NVQSL) has been established to support the efforts of fulfilling above objectives of NVQ.

National Vocational Qualifications Frame Work of Sri Lanka (NVQSL)

National Vocational Qualification (NVQ) framework makes provision for a nationally consistent skills development relevant to economic and social development and is of an international standard. The National Vocational Qualifications (NVQ) of Sri Lanka is based on national skills standard identified by the industry stakeholders. The skill standards include relevant core and generic skills. Recognition of skills of Sri Lankan is important to fulfil the requirements of National policy for Human Resources Development. The Skill Development Project (SDP) has initiated with the Government (TVEC) to resolve problems of mismatching training programs with current market demand, duplication of training provided by institutions and non-availability of a unified standards.

The NVQSL is therefore supporting the sustainable and strategic solutions to national training needs. As such NVQSL is now able to achieve international recognition for qualifications of skills those set up by the system and certificates offered by the institutes. Competency Based Training (CBT) curricula and appropriate training, learning and assessment materials are included in the framework. The system awards qualifications at seven levels as given below. The each level describes the process, learning demand and the responsibility applicable to each level of performance.

Table 2 - National Vocational Qualifications Levels

Level No.	Qualification	Description
Level 1	National certificate	This level 1 recognises the acquisitions of a core or entry level skills.
Level 2 **Level 3** **Level 4**	National certificate	These level 2, 3, 4 recognise increasing levels of competencies. Level 4 qualification provides for full national craftsmanship.
Level 5 **Level 6**	Diploma	These level 5 and 6 recognise the increasing levels of competencies ranging from technician level to management level.
Level 7	Bachelors degree or equivalent	This level includes planning, making resources, management processes.

3.2 Skilled workforce Acceptance

Contractors' Awareness on Training Institutes in Sri Lanka

Results of the questionnaire survey revealed that the majority of medium size (M4 and M5) contractors' Site Engineers/ PMs have substantial awareness regarding training institutes rather than large size (M1, M2 and M3) contractors'. Thus it is obvious medium contractors recruit more workers with formal training qualifications on project basis rather than large contractors. It was revealed that most of large size contractors tend to sub contract the almost all of their work rather by adopting their own labours. As a result, Site Engineers or PMs who are recruiting workers on project basis may not be bothered about recruitment of skilled workers and they may not have much of awareness regarding training institutes. Since medium size contractors have a higher tendency to perform in the industry by means of their own labours especially on project basis, they were vigilant about recruitment of workers. As a result the largest part of Site Engineers/ PMs of medium size contractors have considerable awareness on training institutes for construction skill trades in Sri Lanka. When evaluating HR managers' awareness large size contractors were advanced to medium size contractors. Hence, it is clear that large contractors much consider about permanent workforce than medium contractors do. However, comparatively HR managers have superior awareness rather than Site Engineers/ PMs in both medium and contracting firms. It explicates HR managers who recruit permanent workforce give much concern about awareness about training institutes with the intention of recruiting high quality workforce with formal qualifications than Site Engineers/ PMs who are recruiting project basis temporary workers. In the case of subcontractors, it was revealed that electrical and plumbing trade subcontractors held supreme awareness on training places while bar bending and painting subcontractors were having a lesser amount of awareness about training institutes. Carpentry and masonry sub contractors have had considerable awareness regarding all five key training institutes in Sri Lanka.

Contractors' Correct Awareness on Key Training Institutes

Eventhough contractors have awareness on training institutes, it is imperative to test out whether their awareness is correct or not. It was determined through testing the marked courses for particular trades by contractors are really conducted in those training institutes. Large size contractors' correct and incorrect awareness was compared with the medium size contractors'. Sub contractors awareness was compared trade wise. Accordingly even though the majority of medium size contractors' Site Engineers/ PMs have substantial awareness regarding training institutes rather than large size contractors, large size contractors have correct awareness than medium size contractors. Results of the survey demonstrated that HR managers who are working in both large and medium size contracting firms have equal correct awareness regarding training institutes. Taking into consideration sub contractors situation it is evident that exclusive of bar bending and painting sub contractors all of remaining sub contractors were well known about training organisations.

Popularity of Training Institutes for Different Trades

According to responses, it was identified NAITA as the most popular institutes among recruitment officers for trades like carpentry, electrical and plumbing while ICTAD and DTET were popular institutes for masonry, bar bending and painting respectively. Although some contractors recognised VTA and CCI as training institutes for skilled trades in construction industry, they were not well popular among all.

Results of questionnaires presented for sub contractors revealed that NAITA was the most popular training institute for masonry trade among masonry sub contractors while ICTAD, NAITA, DTET, VTA and CCI were popular equally among carpentry sub contractors. VTA was identified by most of bar bending subcontractors as a training institute for their trade. Although there was no most popular training institute identified for painting trade ICTAD, DTET and VTA were evenly identified by painting sub contractors. In electrical trade, some other training institute/s was well liked among particular sub contractors. However ICTAD, NAITA and DTET were similarly popular among electrical sub contractors. In the case of plumbing trade, most of plumbers were familiar with some other institute/s and they have had similar awareness about ICTAD, NAITA, DTET and VTA.

Level of Consideration of Skilled Worker's Formal Training Qualifications at the Recruitment Stage

By doing the research it was able to assess to what extent contractors consider training qualification as a citric at the recruitment stage of a construction worker. The results were categorised trade wise such as masonry, carpentry, bar bending, painting, electrical and plumbing for the easy of comparison.

Most of the recruitment officers of medium and large size contractors and sub contractors suggested that they sometimes consider training qualifications at the recruitment of masons. It implies they do not give much weightage for training at the recruitment. As the reasons for that, the majority of recruitment officers revealed that for masonry trade formal training is not much essential and there is a deficiency of trained fresh workers for masonry trade due to it is a hard working and less reputable trade within the society.

Considering the circumstances of three types of recruitment officers, it is evident that exclusive of carpentry sub contractors, the majority of Site Engineers/ PMs and HR managers of both medium and large size contractors sometime consider training qualifications at the recruitment of carpenter.

It was apparent that according to recruitment officers' judgment, during bar benders' recruitment they give less weightage toward formal training qualifications and rarely consider for not only permanent workers but also project basis workers as well. As the reason for that, they said although appropriate training is important for bar benders' employment due to the nature of works, there is a lack of qualified bar benders. They further revealed that bar benders should have ability to interpret drawings and undergoing a formal training course is necessary for that.

In the case of painting trade, the largest part of recruitment officers of large and medium contractors and sub contractors give slight weightage for formal training requirements during both permanent and project basis painting workers selection. Majority of recruitment officers declared that painting is a trade, which is not needed as much of awareness and formal training for the workers and it is sufficient to have experience to carry out the task successfully.

Electrical trade results demonstrated that most of HR managers of large size contractors consider always formal training for permanent electricians than Site Engineers/ PMs while contrary situation exists in medium size contracting firms. Taking into consideration the overall circumstances it can be concluded that most of recruitment officers state training is crucial for trade like an electrical. Because workers have to deal with technical works and necessary technical awareness should acquire through undergoing a formal training courses rather trial and error.

According to the recruitment officers' of large and medium size contractors' viewpoint, they often consider training requirements for plumbing trade while subcontractors consider sometimes. Their opinion was formal training is needed for plumbing trade because skills required to perform tasks in the trade cannot obtain through trial and error.

4. Conclusions

The prime aim of this research was to find "how the skilled labour production is catered for the acceptance in Sri Lankan construction industry."

The desk study revealed that, there are number of training programs available for the construction workers in Sri Lanka, which were structured in various trades. Some organisations have widened their spectrum up to island wide training programs which focused both rural and urban youth; while others are limited only for urban trainees. Furthermore it was discovered that all selected five key organisations of ICTAD, NAITA, DTET, VTA and CCI are not providing training programs for every trades. The study unearthed two schemes of establishing skill levels of construction skilled workforce namely, NTT and NVQ. NTT can be identified as a program set to trade test and issue "certificate of proficiency" at three levels to those who possess relevant skills. Informally trained practising craftsmen mostly use this scheme to obtain a recognised certificate. National Vocational Qualifications systems are designed to measure the competency of different vocational skills with the intention of producing globally competitive workforce in order to suit industry specific, through a standardised technical and vocational education system.

The data analysis revealed that Site Engineers from medium size contractor organisations were more knowledgeable regarding training institutes than the large size contractors. However, it was found that HR managers in large contracting firms possessed higher awareness regarding training institutes than those who were in medium size contracting firms. The empirical findings further disclosed that HR managers have ascendancy over Site Engineers/ PMs in terms of awareness regarding training institutions both in medium and large contracting firms. In the case of sub contractors, electrical and plumbing trade contractors held the upper hand in terms of awareness on training institutes whereas, bar bending and painting sub contractors were having a lesser amount of awareness about training institutes. With respect to the correct awareness, it was disclosed that Site Engineers of large contracting firms have correct awareness regarding training organisations while HR managers' correct awareness was alike in both large and medium contracting firms. Nevertheless, Site Engineers possessed highest correct awareness than HR managers of above two types of contracting firms. Considering sub contractors' correct awareness, the study found that masonry, carpentry, plumbing and electrical sub contractors have 100 percent correct awareness regarding training institutes for construction skilled workers in Sri Lanka while bar bending and painting counterparts have not so. NAITA was found out as the most popular training organisation among carpentry, electrical and plumbing trades. Results Masonry and bar bending sub contractors' revealed that ICTAD is the most popular training institute among them and DTET was most popular amongst painting sub contractors. The study further discovered that the recruitment officers often consider formal training qualifications for electrical and plumbing trades while some times they think about it for masonry and carpentry trades. The empirical findings further disclosed that the recruitment officers rarely gave consideration for formal training qualifications when recruiting workers the trades such as painting and bar bending.

Therefore, it can be concluded that most of Sri Lankan contractors and sub contractors are aware of available training institutes and courses for construction skilled trades. Another important finding of this study is, although contractors were asked to list down formal qualification of skilled workers which they recognised at the recruitment, even no body have come up at least with one training qualification. Therefore, it is obvious that contractors are familiar with training courses rather than training qualifications. According to literature, the general presumption was contractors' acceptance of formal training courses is not in a significant level. However, this study revealed that contractors consider training qualifications at the recruitment stage as significant basis for trades like electrical and plumbing. The higher intensity for technical knowledge for the trades such as plumbing and electrical were identified the as the reason behind this regard. However, the results proved that, contractors did not give much attention for trades like masonry and carpentry; since, these trades are still enclosed within its traditional boundaries and has undergone a lesser improvements in terms of technology. Therefore, the workers were still capable of earning skills through trial and error.

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Managing Knowledge to Produce Innovation in Sri Lankan Consultancy Firms

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Abstract

Innovation is one of the major issues identified as being important to improve the performance of the construction industry. Construction firms are increasingly being challenged for successful innovation. The knowledge resources such as human, structure and relationship of the firms are taken a significant part in the process of innovation. Managing these capitals to achieve innovation is a challenging task to firm's management. Thus, the aim of this study is to explore how consultancy firms in Sri Lanka, manage this knowledge capital towards innovation. Multiple case studies were conducted by direct observation and interviews with top and middle level managers of the firms. During interviews documents and archival records were examined. Nvivo software was used to codify and content analyse the transcripts. The findings explore the nature of innovation in Sri Lankan consultancy firms. The results indicate that in the process of innovation, client's requirements are a key factor. The firms mostly focus to satisfy their clients and survive in the market. The innovation is pushed by client's requirements and internal professional's skills. At the same time inadequate resources and clients' inadequate attention obstruct the process. Firms have enough knowledge capitals such as communication networks, efficient management, professional's skills, energetic young peoples and standard documentation to produce innovation. However, due to the less intention of clients and the management on innovation, the innovation process is slow in Sri Lanka. Through established guidelines, training and development programs employees can be given opportunity to manage knowledge capitals effectively.

Key words: Construction Innovation, Knowledge Capitals, Consultancy firms, Sri Lanka

1. Introduction

This research focuses on managing knowledge to produce innovation in Sri Lankan consultancy firms. The paper contains several sections: introduction, research methodology, development of conceptual model, case study findings, and conclusion. Innovation is one of the major issues in many industries around the world. It is essential for the success in industry performance and for development. Innovation is one of key activities identified as being important to improve the performance of the construction industry [1]. Construction industry faces major challenges, including that of improving its environmental performance and every new construction project has its specific new requirements depending on the demands, existing knowledge, technical and other developments which are combined to form something new.

There are several definitions for innovation introduced by authors from time to time with different viewpoints. For example, Urabe (1998 cited [2]) revealed that innovation includes the generation of a new idea and its implementation into a new product, process, or services that lead to the dynamic growth of the national economy and the increase of employment, as well as the creation of pure profit for the innovative business enterprise. The similarity between those definitions is that something new is created, a product or a process, and put to use. Innovation really means change [2] and the change can be one of the two types; firstly, change in the product or service being provided, or secondly, change in the process by which the product or service is created.

In the current thinking, innovation is not treated as a purely technological change; it can be classified according to its process; as *radical* and *incremental* innovations [3]. Radical is a very new product or service for the community whereas, Incremental innovation is a significant improvement of the existing product or service that happens gradually. Each case of innovation is affected by factors such cultural, human and management factors [4]. Cultural factors are the factors, which related with the organisational environment. Individual's personal characteristics are included in human factors and the management factors are especially connected to the support from top management.

The generic innovation model (see Figure 1) show, that successful innovation *outcomes* are achieved through an appropriate innovation *focus* that is responsive to *contextual factors*, realised by appropriate *organisational capabilities* and channelled through effective and efficient innovation *processes* [2]. There are two principal clusters of thought in the general innovation literature concerning the process of innovation in firms: multi-stage process, which comprise of recognition, invention, development, implementation and diffusion stages [2] and non-linear cycle process of different and convergent activities [5]. The contextual factors and organisation capabilities in the generic model shows that innovation process in the firms depend on the internal and external driving factors as well as barriers.

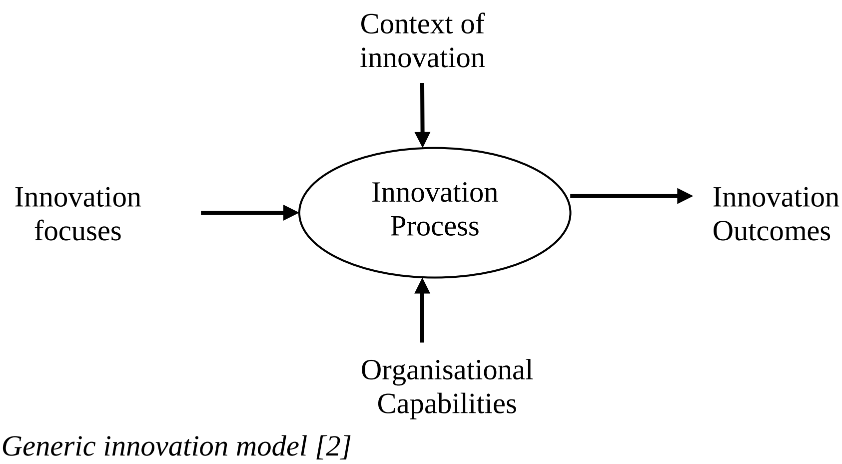

Figure 1 - Generic innovation model [2]

Egbu [6] revealed that knowledge is a vital organisational and project resource that contributes organisational innovations and project success. Knowledge management takes an essential part in the process of innovation. One starting point for the study of the role of knowledge in innovation at firm level is to focus on the various forms where knowledge can be taken and the modalities in which it plays a role in innovation.

Managing knowledge is a critical challenge for knowledge-intensive firms in bringing innovation. As Lu and Sexton [7] suggests, appropriate human capability within construction firms is vital for successful innovation and performance improvement in the construction firms. Furthermore, they argue that innovation in service firms are significantly different to manufacturing firms, and; also, project-based firm to non-project-based firms. This has implications to construction industry, which is project-based and more service-oriented. Consultancy firms are more service-oriented and identifying their innovation behaviours is noteworthy in nature.

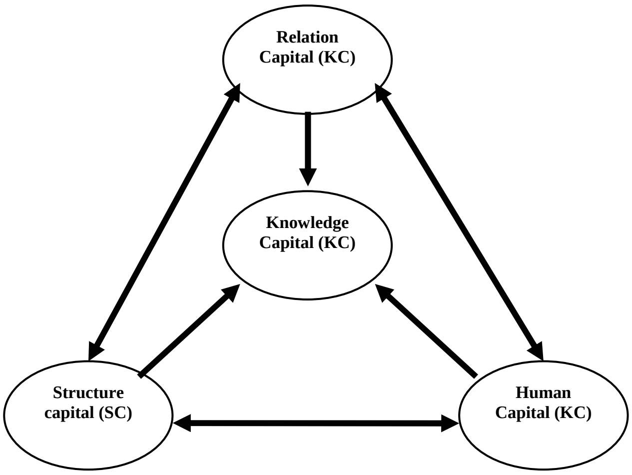

Figure 2 - Knowledge-Based innovation model [7]

Egbu [6] mentioned knowledge is the vital organisational resource, at the heart of innovation. Coombs and Hull (1997 cited [8]) have stated path–dependency is a very important concept to the understanding of mechanisms which link knowledge to innovation. Path-dependency means that firms acquire specific capabilities over time and these capabilities create a strong shaping force over what the firm will do in the future.

Lu and Sexton [7] recognised knowledge capital (KC) (see Figure2), which is a combination of human capital (HC), relationship capital (RC) and structure capital (SC), is the driver for innovation in knowledge-intensive firms. By effectively managing these HC, RC and SC, firms can achieve successful innovations. Innovation in consultancy firms can be a new idea or new process put to use. Managing the human knowledge (HK), structural knowledge (SK) and relationship knowledge (RK) is a major challenge for the firms to produce innovation. Next section describes the research methodology adopted for the study.

2. Research Methodology

Based on the background study, the aim of this research is to explore the overall approach of managing knowledge to produce innovation by consultancy firms in Sri Lanka. The aim was achieved through several objectives; identify key drivers and barriers, understand the innovation with its focuses and outcomes, explore how to manage knowledge capitals to produce innovation and develop an appropriate framework for successful innovation.

The literature search was made more specific and more focused by restricting the analysis to the fundamentals of innovation. Whilst carrying out the literature review much care was given to inculcate appropriate breadth and depth; consistency; clarity and brevity and effective analysis and synthesis. The collected literature was used to develop a conceptual framework denoting the research problem.

The research focused on consultancy firms in Sri Lanka and studied three cases (see Table 1), as it provides multiple sources of evidence and probable replication of findings. The case study method was chosen as it allows an in-depth investigation into a phenomenon in its real-life context [9]. The data were collected from the key participants of organisations such as Architects, Engineers and Quantity Surveyors (QSs) through semi-structured interviews. The interview questions were open-ended to allow the discovery of new issues. While conducting the interviews, follow-up questions were used to receive more details. At each interview, a brief introduction about research was given to help the respondent understand the context. Interviews were tape- recorded with the permission of the interviewees. Interviews were followed based on the guidelines prepared prior to interviews. At the same time documents were accessed to strengthen data collection. The organisational culture, communication system and flexibility of the organisational structure were observed. The interview data was analysed using content analysis with Nvivo software. The following section illustrates the development of conceptual model.

Table 1 - Case study details

Organisation	Name of the interviewee	Designation	Duration	Description of the organisation
Case A	Engineer Architect QS	Senior Engineer & Director Senior Architect Senior QS	One hour 40 minutes 30 minutes	Case A is the leading consulting organisation and is in the good books in the local construction industry. The company was founded in 1977 to include a consortium of main professional skills required for construction projects of any type of works.
Case B	Engineer Architect QS	Engineer and Post contract manager Senior Architect Senior QS	50 minutes 30 minutes 40 minutes	Case B is a multi-disciplinary independent consulting organisation established in 1968 as a partnership firm. After 30 years it was incorporated in 1997 as a private limited liability company. The organisation structure includes the major functions of engineering consultancy and architecture.
Case C	Architect Engineer QS	Chief Architect & Director Senior structural engineer Chief QS	35 minutes 30 minutes 40 minutes	Case C is one of the leading consultancy organisations in Sri Lanka. It was established in 1976 and, it is a limited liability company consisting of charted Architects, Engineers, Quantity Surveyors and Urban planners. The firm offers comprehensive architectural and engineering services for all types of projects.

3. Development of Conceptual Model

The literature findings were synthesised, in particular, Sexton & Barrett and Lu & Sexton work, in developing the framework. In this, organisational capabilities and context components were represented by drivers and barriers. Knowledge capital was added to explore knowledge-based innovation.

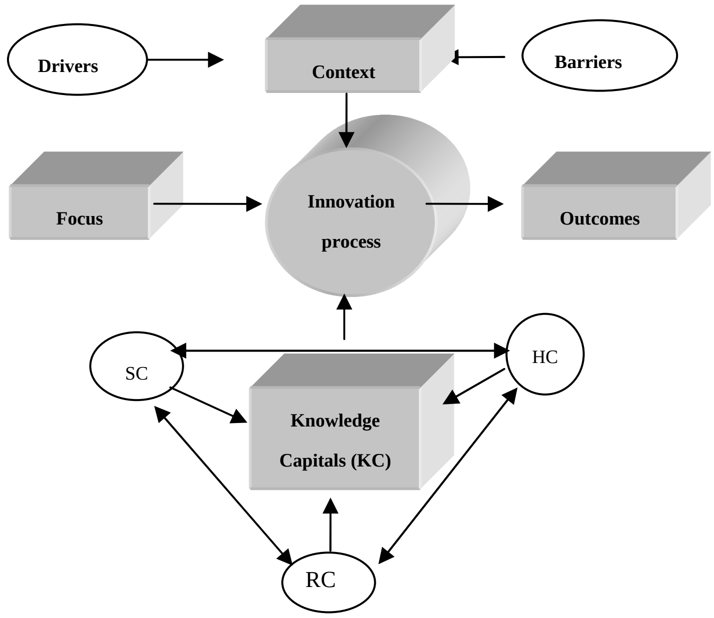

Figure 3 - The Conceptual framework for SL construction consultancy firms.

In this model, innovation is initiated by Focus and influenced by contextual factors in terms of drivers and barriers (see Figure 3). These factors are acting internal as well as external. Knowledge is highly associated with innovation and as an essential element for innovation. Thus, Knowledge capitals are incorporated in to the model to balance these drivers and barriers and achieve successful innovation outcomes.

The overall approach and nature of innovation in consultancy firms was explored, in the case study firms through focus, outcomes, contextual factors in terms of drivers and barriers and knowledge capital includes human capital, structural capital and relationship capital. These findings are discussed in the next section. Case study findings are analysed in the following section, which includes innovation focuses, innovation outcomes, innovation drivers, innovation barriers, knowledge capitals, and managing knowledge capital.

4. Case Study Findings

Through the field study, the conceptual framework was reviewed with the identified factors under each elements of innovation. In this model (see Figure 4), key innovation focuses, outcomes, drivers, barriers, and knowledge capitals were identified and managing knowledge capital to successful innovation was explored in selected consultancy firms in Sri Lanka. This section discusses factors under each element in detail to understand the overall approach of innovation.

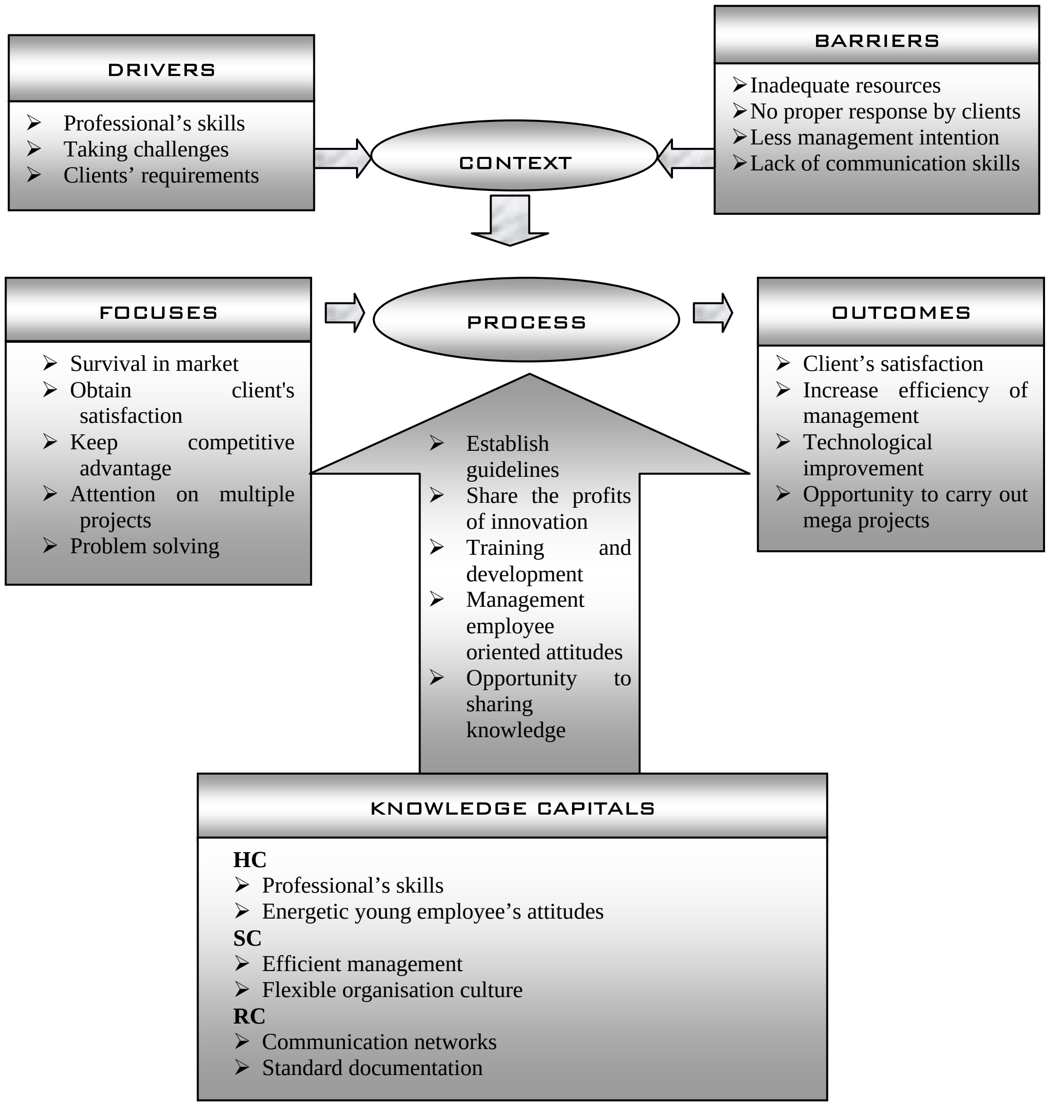

Figure 4 - Framework for Successful Innovation in SL Consultancy Firms

4.1 Innovation Focuses

Survival in the market and **intention on multiple projects** were the most dominating focuses in each case. In all three professionals view, **survival in the market** was the most significant focus. Engineer, in Case B mentioned, "*as a private company, nobody thinks about innovation. To make profit, organisation is carrying some new idea. As was as by doing this we could survive in the market with the good name*". **Problem solving** was identified as a focus by the engineer as well as a director in Case A. He said, "*basically, every day we are doing innovation.*

Every site has problems. Even a house project we have to do some work for the first time. There is an innovation".

Architect, Engineer and Quantity Surveyor's of the three cases indicated that **intention on multiple projects** as a focus of the firms. Through this, they supposed to increase the efficiency of firms as well as give value for organisation rather than give value to a particular project. The QS in Case A said, "w*e are considered to give a value to organisation rather than make success in a particular project*". Respondents from Case A and C and one from Case B indicated that **get competitive advantage** is also one of the key focuses for innovation. Offer a sustainable product with client and end-user satisfaction and linearly increase the profit was a point highlighted by them. Pay attention on getting **Client's satisfaction** was explained as a focus by the engineer and QS in Case B. Engineer of Case A also supported to this factor. The QS of Case C stated, "*we have to satisfy the client. Otherwise they won't come to this organisation for their future projects*".

As per the innovation focuses, factors identified through the research, the key factors that the consultancy firm's focuses could be summarised as **survival in market, keep competitive advantage, intention on multiple projects, client's satisfaction** and **problem solving.**

4.2 Innovation Outcomes

The **client's satisfaction or client relationship development** was identified as a most dominant outcome. Respondents from all three cases supported this. Focus on survival in the market; get competitive advantage and client's satisfaction encourage the firms to produce the outcome of **client's relationship development**. Architect of Case A said, "*most of our client have trust on us, and keep them with us, our inputs are more flexible. Not like other consultants, some times we are trying more options for them to feel comfortable and, they require us to do the feasibility study as well*".

Both architect and QS from Case A and B, declared that **increased management efficiency** is an outcome of innovation. In Case A, all three respondents stated that **opportunity to carry out mega projects** of the country is their successful outcome due to their reputation. The architect of Case A expressed, "*if you take tallest project in the country, nobody knows what to do at the beginning. Even the client is also confused with local consultants, so we took the challenge and were able to produce drawings*". As well, in Case C, carrying out unique **hotel project** was identified as an outcome. For example, two respondents from Case C proudly expressed, "*we are specialist for hotel projects in the country*". **Technological improvement,** which could be computer-aided drawings and communication were stated by respondent in each Case A and C.

4.3 Innovation Drivers

Client's requirement was identified as a key driver from outside of the organisation. In Case B, all three respondents and two respondents from other cases mentioned that the **client's requirement** of the project is the most important driver towards innovation. For example, Architects of Case A's statement was as follows; "*nowadays clients are very sophisticated. They need product within a short period. We are capable to do that, and our philosophy is to satisfy the client is the main thing*". Architect of Case B confirmed the views of the former stating, "*client's tight time schedule, meet client's cost targets are externally and our professional skills, knowledge are internally forced for the innovation. External factors take important place in the innovation approach. We mainly concern about the external factors*".

Among internal drivers, the capabilities of the professionals who are working in the organisation drive the innovation process. The capabilities are articulated in different forms as **professional's skills,** and **knowledge from education**. Professional's skills on individual fields as well as individual skill force towards innovations. This fact was supported by architect and QS from Case B and C.

Other important pushing factor was identified that the attitudes of the individuals which is **taking challenges and professional's intention** were drivers for innovation in Case A and C. Professional's intention towards innovation was recognised as power to innovation in Case A and C. Director as well as architect of Case C mentioned that "*the intention of a professional or a person will affect the innovation of the project. It will vary according the project. The person is earning for living. If the person will get more salary, he will spend enough time on project success*". The respondents indicated that employees may motivate to take challenges due to their knowledge and their experience. In particular, young professionals generally like to take challenges. One of the directors of Case A confirmed; "*we have given maximum freedom to young professionals. That's why we are better. There is a reason, that is young people can take challenges. Some people don't like to take challenge. If you motivate to take challenge, it will be an innovation*". The discussion identified that from the architects, engineers and QSs view; **client's requirement, professional's skills and attitude of take challenges** are the key internal and external drivers to innovation.

4.4 Innovation Barriers

Inadequate resources for projects were indicated as a leading barrier by QSs of Cases A and B. In addition to this point, Engineer of Case C said; "*not allocating enough human resources; resources with less experience; not supplying the drawings on time and inadequate technology are responsible for unsuccessful innovations*". In Case B, architect and QS declared that not receiving the **proper response from the clients** contribute for unsuccessful innovation**.** In addition, most of the clients are concerned only on their time and cost limits but not on innovation. That makes professionals to think and work on cost and time dealing not even on quality of final product or service.

Some other barriers were identified in Case A and C, such as less management intention towards innovation**;** high employee turnover; not updated knowledge; and lack of communication. Even though, these factors were mentioned mainly by one respondent; the effect of these factors on innovation process is significant. Team members not having the attitude to share knowledge on problem-solving and other important matters, was referred as lack of communication. Director from Case C indicated that **non updated knowledge** as a significant barrier to innovation. In addition, he explained as follows, "*here our professionals are not updated most of their knowledge. We have to be always updated, when the new technology comes. That is the main problem we have. Other one is communication problem (not a language problem) there is a lack of discussion between individuals. Due to that the knowledge is not transferred among the individuals*". Engineer from Case A mentioned, "*top management has less intention towards the new ideas rather they are interested in making a good profit"*. Barriers to innovation in consultancy firms can be summarised as follows; **inadequate resources, no proper response by clients, less management intention** and **lack of communication.**

4.5 Knowledge Capitals

The case studied organisations have **professionals' skills, knowledge from education and young energetic people attitudes,** which are recognised as human capital. In both Cases A and B, **professional's skills** were the most dominant factor. The professionals posses a good technological knowledge with experience and they were graduated from leading universities. Their skills lead them to come out with new ideas based on their knowledge. In Case A, one respondent stated that **attitudes of employees and energetic young people** are their secret for success. In addition, they declared, "*as a Sri Lankan we have a remarkable history, we can make good buildings if we are willing to take challenge*". This thinking was motivated towards innovation as well the young people adapted to this thinking and they think in new ways rather than going with what is existing. They feel that enough responsibility and authority to be given to young professionals to carry out the tasks entrusted. Engineer of Case A said, "*we are thinking about foreign knowledge and people. But we could do innovations with local knowledge, local people when taking challenges*".

Structural capitals such as **standard documentation**, **established system** and **the efficient organisation structure** were identified through the interviews as well as observation. **Standard documentation** by using new computer technology was identified in Case B. The computer technology gives good opportunity to share information quickly and firm maintains a small library within the organisation too. In Case C, there is a recently established system, which gives opportunity for its employees to carry on tasks of each division without delays and errors. Director of Case C declared; "*being professionals we should perform well in the project whether the project is small or big. Starting from the design, our capable architects are producing good design. We have good documentation system for each and every project and well established process towards innovation"*. Respondents indicated that the flexible hierarchy of **organisation structure** with adequate communication channels also support to carry out the work efficiently. **Efficient management system** was identified as a good structural capital and relationship capital. For example, give opportunity to employees to come up with new **ideas (decentralization); informal parties; and, site meetings** can be seen as efficient management activities.

The **communication network** is helpful to increase the relationship internally as well as externally, which was mentioned in Cases A and C. In Case A, **deal with foreign consultants** was identified as power to relationship capital. Other than these, **flexible friendship culture** and **informal get-togethers** were recognised as good relationship capital. The relationship capital is used to integrate the human and structural capitals.

4.6 Managing Knowledge Capital

Most of the respondents indicated that managing human knowledge towards innovation was a critical task for management. The research findings on managing knowledge capitals (KC) identified that the most of the activities are related to human capitals. Arrangement of **training and development program** is a key way to increase innovation. This was declared by engineers, architect and QSs in three cases. The organisations send out or abroad their employees for trainings and arranging workshops within the firms as well. Case C allocates funds to pursue higher studies to their professionals. The senior people shared their knowledge and experiences with juniors, which helped juniors to think creatively. This indicated knowledge sharing takes important place in managing KC. Make opportunities to share the knowledge is one of the efficient ways to produce innovation.

The management is sharing their success of innovation ideas in monetary terms with employees by giving them monitory incentives. This makes employees to feel happy and remain in the firm. In all three cases, respondents declared that giving additional compensation encourages the humans. The next important management activity is **established standard guidelines** to carry out the tasks as a way of managing relationship capital. In all three cases respondents identified that the working procedures, practicing formal relationships, and coding knowledge were built good base towards innovation. Not only formal relationship but also improving informal relationship by arranging get-togethers, trips and celebrations make sprit between employees. In Case B, top management has been arranging celebration every month called 'Happy hour'. Statement of director in Case C was as follows; "*really we have not a very systematic programme .but, when any problem occurs; informally we are solving that with the involvement of top level management by using the relationships with other individuals or other parties*".

Other than these, some of the other management activities were identified from the cases; g**ive adequate responsibility; develop database; and, cost planning**. In the middle of these, allocate and give adequate responsibility to suit their skills, increase the productivity of employees are on the way to innovation. In Case A, respondent said that allocating proper tasks to young professionals facilitated innovative ideas on the way of innovation. Next section concludes all the findings of this section.

5. Conclusions

The results indicated that in every project, there is an innovation to satisfy client. To get **competitive advantages**, firm introduced new ideas and process from time to time. Mostly, firms are concerned with **multiple project success** and they are not in favour of getting success from a single project. Outcomes of innovation depend on focus. Findings indicated that there is a relationship between focuses and outcomes. Case study firms achieved satisfaction from the client and they are contented with that. In addition, innovation approach helped to increase the efficiency of management in organisational level as well as project level.

The findings indicated that external drivers were considered as the most affecting factors. Client's requirements represent tight time schedule, budget and special requirements, which are related to the project. Though they had resources, not delivering or allocating resource to project on time was observed as an obstacle to innovation process. Most of the clients require projects adhere to time and cost but less concerns on new ideas or processes. The results indicated that the **management intention** was mainly on profit making. They do not realise the advantages, which can be achieved from innovation**. Lack of communication** between team members also obstructs the process of innovation. The members do not have the attitude to share the ideas and other important matters with other team members. These circumstances discouraged innovation. Knowledge capital plays an important role in the process of innovation. Improvement in knowledge capitals increases the efficiency of top management. In addition to this, results show that three capitals cannot be treated separately. However, case study firms mainly concern on managing human and relationship capitals.

In Sri Lankan consultancy firms, innovations have been taking place through their operations. However, they could not be recognised as innovations. Since they could not identify the performance lying on that, the process was not successful all the time. In this context barriers have more power than drivers. To balance this, top management needs to manage knowledge capital. This research explored a framework for successful innovation in the Sri Lankan context (see Figure 4). This framework may be used as a decision making tool by the top management in the direction of innovation.

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Researching “Construction Client and Innovation”: pilot study and analysis

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Abstract

Clients or users of products, processes or services are being identified as the potential sources of innovation in research conducted in various sectors (e.g. IT, aviation, and laboratory equipment). At present there is concern about the construction client’s potential to be an innovation promoter within the construction industry. Several researchers have recommended proactive client involvement in construction. Within this background, the authors have designed a research with the aim of ‘improving the role of the client in promoting innovation’. In this context, this paper is an attempt to elaborate on the initial findings that emerged from the initial pilot case study

Keywords: Construction industry, Construction client, Innovation, Case study design.

1. Introduction to background of the research

Literature shows that there have been concerns regarding the level of innovation in the construction industry for some time despite having a considerable potential to be innovative [1, 2]. These concerns have motivated a number of researchers to conduct research on the innovation related issues in construction to identify solutions [3]. It was also identified that the lack of innovation is not caused by lack of capability but due to the lack of coordinated effort. Therefore there is a need for key personnel in the innovation process who can coordinate the team towards innovation using resources already available [4].

In the recent era, the construction client is looked upon as a person who can coordinate and direct the construction process towards innovation [5],[6]. Egemen & Mohamed [7] state that the “traditional assumption that clients only need projects which are completed within budget, on schedule and with a reasonable quality should start to change” implying a more proactive contribution is needed from the client for the development of the construction industry and its innovative outcomes.

Within this background authors have formulated a research with the aim of "improving the role of the client in promoting innovation" (see [8]). It is expected to derive answers to three main research questions that are 'what are the roles and characteristics of client that favour innovation?', 'how do the identified characteristics effect innovation?' and 'what are the best practices that can be derived to promote innovations in projects?'. To cater for these research questions in line with epistemological, ontological and axiological assumptions, the authors have argued that the case study method is the best fit research strategy for this research. (see [9]).

After the philosophical stance and the research strategy the authors have moved on with the case study design, case study selection and execution of a pilot case study. The objective of this research paper is to highlight the criteria behind the case study process (section 2) and discussion of the main themes that emerged from the pilot case study (section 3). Finally the paper will be concluded with a summary and an introduction to the future direction of the research (section 4).

2. Case study design

"A research design is the logic that links the data to be collected to the initial question" [10]. Saunders et al [11] agree and further adds that the research design is required to satisfy the identified aim and objectives within the practical constraints where the constraints can be time and money etc. In the above section the authors have briefly introduced the background to the research design and how the 'link' between initial question and the data to be collected is established up to the research strategy selection. In this section the discussion on 'link' development is extended up to case study design. In the sub sections below the process is discussed briefly in logical sequence.

2.1 Definitions

As a first stage of the case study design the authors have developed working definitions for key elements of the case study design, which are discussed in following sub sections.

2.1.1 Case, unit of analysis and boundary

Construction is a loosely-coupled system with subsystems which are independent to a certain degree [12]. Further, the discontinuous and temporary project-based nature of construction presents a problem for the accumulation of knowledge [13]. Under this scenario, there is a risk that the knowledge and experience gained in one subsystem will not efficiently diffuse to other subsystems or to the whole system. Further, the temporary project-based nature hinders knowledge transfer beyond the project concerned. Under these circumstances the authors believe it is more effective to analyse the core of the knowledge. Therefore, the core; 'the client's role in innovation' is being selected as the unit of analysis within the case of innovation of the project.

2.1.2 Innovation defined

Innovation; it can be a result of formal research and development or day to day problem solving [14]. A number of researchers have developed definitions for innovation. However in essence all the definitions refer to implementation of new products or processes that are new to the given context which yield an enhanced economic value [15-20]. In line with these established definitions the authors have adopted the 'application of knowledge to a given context in order to implement significantly new processes, products or management approaches that will lead to increase efficiency and enhance rate of return' as the definition of innovation for this particular research on innovation.

2.1.3 The 'Client' defined

Kometa et al [21] simply define the client as the one who pays the bills. The client can be an individual or an organisation responsible for financing the project. The authors agree with Kometa et al [21] and take the view of the client as the one who funds the project. However authors narrow the definition of client to member(s) of the funding body who directly interact with the project whereas the funding body can be an organisation or an individual.

In this research it is envisaged to study how the client interacted with the project in order to identify the client's role in the innovation. If the whole organisation is to be taken as the client (in a case of client organisation) the focus on this core issue would have been diluted. Further it would not facilitate the study of personal value of individuals as the focus would have been on organisational culture. On the other hand by narrowing down the definition of client to the individual level could enable the discussion on personnel traits and values. In addition, as a member of a larger organisation the "individual" will represent the overall organisational culture. Therefore, the authors argue that the focus on individuals rather than on the organisation is more suited and takes up the definition stated above for this research.

In this section the authors have highlighted the relevant definitions developed for the study. In the section below the discussion will be focused on the case selection aspect of the research design.

2.2 Case selection

The authors have selected the holistic multiple case study method as the suitable approach to case study design. Yin [10] identifies 4 types of case study - they are single embedded, single holistic, multiple embedded or multiple holistic in a 2 x 2 matrix. For a single case study to be justified the case should be critical, unique (or extreme), typical, revelatory or longitudinal case (see [10]). The authors do not intend to prove a well formulated theory thus this research does not fall in to the critical case criteria. Further, innovation is a common phenomenon thus cannot be argued to be unique or revelatory. Even though innovation is not unique, the context specific nature of construction leaves little ground to consider the typical case option. Furthermore, study the same case at different points of time is also not required as it will not add any value to the achievement of aims and objectives. Thus this particular research cannot be justified as a longitudinal study.

The possibility of having multiple units of analysis within a case ceased with the selection of 'innovation' as the case, and 'client's role in innovation' as the unit of analysis; because of the none existence of two clients within a one case. Therefore, the authors argue the holistic multiple case study approach as the best fit method for this research.

In multiple case design, case selection had to be selected deliberately as one which predicts similar results or contrasting results for predictable reasons [10]. This approach in case selection enables the researchers to select cases that demonstrate characteristics which they are interested in [22].

To fulfil the aim of this particular research on 'client's role in innovation' it is required to select a case from a context where innovation is present or from a context where innovation is not present due to predictable reasons. However, authors have selected the option of 'context with innovation' because it provides comparable scenarios without the need of isolating other variables to achieve the objectives of the research. Further, it is also required to select a case with a high possibility of finding a well committed well interacted client.

In pursuit of the above requirements, authors have selected cases from the partnering or collaborative construction contracts. The partnering contracts provide opportunity for better communication, learning and innovation across supply chain [23]. The fact that 'innovation gets benefited from partnering environment' is well established in the literature [24]. Therefore, it can be argued that such an environment provides the client with better opportunity to participate in the innovation process more actively; thus there is a greater scope to study and reveal hidden knowledge regarding clients' roles in innovation within such environment. Further, the knowledge revealed from this study could also benefit the clients of projects where partnering is not the most suitable procurement method of delivery. In line with this argument authors have selected a project code named Project Y as the pilot case study. The background of the Project Y is discussed in the section 3.

In this subsection authors have described the process and arguments behind case selection. In the following subsection discussion is extended to data collection and analysis

2.3 Data collection and analysis

The researchers have devised the semi structured interviews as the main data collection method for this study due to its ability to facilitate in depth inquiry into the issues [10]. The interviews were conducted in two stages. In stage one, identified participants to the innovation (except clients' side participants) were interviewed to gather information related to the client's role in innovation and to identify 'what are the issues?'. The interviews were kept open ended to the maximum possible extent to make the interviewees feel free to express their views. The data gathered was transcribed and analysed to identify main themes or issues highlighted by the interviewees. At stage two the clients were interviewed. Those stage two interviews were also semi structured open ended but took more focus on the themes identified with emphasis on 'why those happened'. This process enabled the researcher to gather an understanding of the issues in at least two distinctive perspectives as well as to triangulate findings to derive firm conclusions.

In this pilot study the data analysis was conducted using computer aided qualitative analysis software packages. The speed and rigour provided by these software as emphasised by Seale [25] is considered to be an advantage. Two types of software have been used in this study – namely *nVivo 2.0* and *Decision explorer 3.1.2*. The combination of software enabled the researcher to exploit the advantages of both for the successful data analysis. *nVivo 2.0* shows strengths in document or transcript management, coding and retrieval functions required for data management and analysis. It is, however, weak as a modeller which was then complemented by using *Decision explorer 3.1.2.*

The data collected from the pilot case was categorised or coded as initial step of data analysis (see [11]). General themes were identified from the set of data collected as well as from literature. These themes identified are discussed in the following section which includes a description of the background of the pilot case study; Project Y

3. Initial findings of the pilot study; Project Y

3.1 Project background

Case study Y is about the client's role in development and execution of an innovative repair solution to a condemned central pier of a bridge in North West of the UK. At the time the project team concerned in the case study took over the project, the bridge pier was expected to be completely demolished and a new pier to be reconstructed in its place as per the recommendations made by a third party. The recommendation was accepted and budget allocated for the reconstruction was also made available by the client organisation at that time. However, due to the possible disruption to traffic that would be caused by the reconstruction, the project team sought other ways of finding a solution to the problem. Through extensive value management and value engineering processes, a repair solution to the existing bridge pier using advanced concrete repair and cathodic protection systems was developed. Even though concrete repair and cathodic protection techniques have been in used for some time within the construction industry, using these techniques in a context where traditional reconstruction is expected had been considered to be an innovation. By challenging the established expectation of the bridge pier reconstruction the project delivery team managed to complete the project at a cost of £2.3 million saving approximately £2 million compared to original budget allocation.

Within this pilot case study three interviews were conducted. The Project Manager, the Designer and the Client were interviewed to gather data from diverse perspectives.

In the following sections findings and major themes revealed are discussed in a logical sequence.

3.2 Client as a manager of the innovation

This particular research on the client's role in innovation confirmed that the client is performing the basic functions of management which are planning, organisation, direction, and control [26, 27]. The client mobilised not only the innovation but the whole process of construction by planning and setting the scene for the project team to perform. The current literature identifies the client of a construction project as the initiator of most of the construction projects by identifying novel requirements to be delivered by the construction sector [28]. One of the interviewees in the study from the clients side stated "*What I used to do was to design the project in year 1 (one year before the construction). I also got innovation there because I got time to go up to other people in client organisation to get approval*" The planning and organisation for the innovation culture was done well ahead of the project to derive successful innovative outcomes. The importance of planning was further stressed "*What I need to do, research wise, is to bring that (innovation) forward and include it in my project. (if not) Lot of that is lost on ... sorted too late in the process*". The findings coincide with coordination role of the client that was stressed by Nam & Tatum [4], "they (clients) establish the mechanism by which the involved parties communicate and collaborate, make decisions on important technical matters throughout the project execution and sometimes share a high proportion of the risk".

The client takes an active part in the direction and control of the innovation process. "*I like to hear some good ideas and then say yes you can do that or no you can't do that depending on other criterion of the client*". The client's involvement in direct and control went beyond the initial planning of the innovation to the completion of construction. One of the other participants attests to the client's innovation director role "*Without doubt the client was behind encouraging the innovation*".

These initial findings enable the authors to confirm the managerial role played by the client in the process of innovation, by proving that the client inevitably performs the basic managerial functions of planning, coordination, direction and control in promoting innovation.

With this understanding of client as a manger the findings are further discussed below.

3.3 Roles of the client

The authors have thus argued that the client functions as a manager within the context of innovation. Within this section the emphasis is on the identification of specific roles played by the client within the context of innovation. As a structure for the analysis and the discussion, the authors have taken up the roles of manger identified by Mintzberg [26, 29, 30]. Mintzberg [26] identifies ten major roles of a manager within three broad categories which are interpersonal, informational and decision roles. In the following sub sections the role of the client will be discussed within these main categories.

3.3.1 Interpersonal role of the client

The activities or roles of the client that arise from formal authority and status are discussed within this subsection. The client's ability and willingness to be a team player was identified as one of the most important contributory factors to the innovation by the interviewees in the case study. Relationships built between client and the rest of the project team, strengthened by mutual trust and understanding and respect for people and clients' proactive approach resulted in highly satisfactory achievements. Participants to the project appreciated the team sprit of the client by stating "*it was precisely because of this interaction, trust and team work and I might say friendship that it worked so well*". The client admitted the team sprit that went beyond the professional members of the delivery team. "*I was invariably rubbing shoulders with the guy that did the painting. It was not a question.*" The mutual trust developed gave courage to other team members to make bold and inevitably risky decisions that formed the backbone of the innovation. "*Without doubt I can say that the client would have stood beside the team even if the project had failed*", stated the project manager.

Coordination is another important interpersonal role performed by the client. The client interviewed, overviewed the work involved "*it's not just me and the project team delivering Project Y. It is me working with various offline divisions delivering services to me so that I can deliver that product.*" The bringing in other offline divisions (divisions of the client organisation that are not directly linked to the project but essential, such as technical approval divisions) expedited the innovative solution. In the client's eye the innovation is essentially a "*departure to standard method of working*" which required an approval from the relevant division within the client organisation. The effective coordination mechanism set up by the client enabled the designers to directly liaise with relevant personnel in the technical division without going through the lengthy bureaucratic route. One designer recalled his experience regarding the dealings with offline divisions. "*It was just like talking to your colleague on next desk. OK, this is the idea, what do you think about this; and that's the way more or less we battered it from one side to another and knocked it into shape*".

The effective coordination mechanism established by the client helped to raise the innovation culture among the team members. Early contractor involvement was a key instrument behind the innovation outcome. One designer appreciated the client's effort by stating "*we are very lucky as the client actually funded these early consultations with specialist contractors who were able to convince the designers that new methods of working could actually solve this problem*".

During the interviews it was asked whether client can be seen as the driver of the innovation as it is a well debated topic among scholars. However, most of the participants were doubtful of considering the client or any one person as the driver but instead a collective team effort was emphasised. Even though the client half-heartedly admitted after some thought "y*es I like to think so (as a driver)...yes*" he went on to acknowledge the designers and specialist contractors as the main source of innovation.

3.3.2 Informational role of the client

It became evident that the client is engaged with a large amount of information processing and monitoring activities that have a bearing on the innovative outcomes.

The client's willingness to be kept updated with the scheme's development rendered positive outcomes. "*The client was so well up to speed about what we were doing. So they are able to sign things off very quickly for us*". However, it should be noted that the other members also played an important role in keeping the client updated. The project manager stated "*we kept the client informed from the day one*". The client also expressed gratitude for being allowed to be part of the scheme's development. "*I am also with them on site monitoring costs and everything else as it goes through the actual execution of the project*".

"*The client brought in … the knowledge about procedures and process (of client organisation) that we need to get through to get the project approved*" said the project manger. The client emphasised the importance of disseminating the knowledge of those procedures. "*I am well versed with the loops that we need to jump through to get the job from conception to completion. And I know which famous projects may be gone through which haven't quite worked*". The correct information leads the design team towards the correct goals that determined the project success.

3.3.3 Decisional role of the client

Within the context of the project the client was required to make decisions based on authority vested and the information received.

Any decision made regarding an innovation involves a proportion of the risk. Other participants were impressed with the client's ability to face that risk. The project manager complemented the client "*what we did at Project Y, was a quite bold piece of work to do*". The client also admitted that there was considerable risk involved but attributed the strength to face that risk on his experience and competence. "*As a professional engineer I keep up with the profession and I see what's going on out there in the wide world.*"

The client's ability to look forward at different angles was identified by the project participants as a major advantage. "*This particular project sponsor was a quite forward thinking man who was open to ideas and innovations*", stated the project manager. The client attested the statement of the project manager and further added "*the obligation is not just to take the obvious but to challenge (the present way of working) with a … risk and safety on board*". The vision of the client led the designers towards the innovative solution and the saving of considerable time and money.

Another one of the most valued aspects by the project participants was the timely decisions made by the client. However, project participants attribute it to the successful informational role of the client. The project manger stated "w*hat he didn't need to do is go away and then try and* *understand what we were asking*“ (because the client was well versed with the present development of the scheme). The designer stated “*they were quicker than what their procedure said*” appreciating the decision making efficiency of the client.

In this section the authors discussed the positive characteristics of the client and how they effected the innovation and the morale of other team members. In the next section effort is taken to identify areas where further improvement can still be made.

3.4 How can client improve in the role of innovation promoter

One of the designers of the project admitted that he is absolutely satisfied with the performance of the client, stating “*it would be very pragmatic or very picky (if you started to find fault with the client)*”. Another participant identified inter-department relationships of the client organisation as a possible area of improvement. The client identified that they could have taken some action to prevent knowledge loss with the disbandment of the project team. “*I am not sure … lessons learnedt from that project, whether they are disseminated where they need to be within the client organisation*”.

In the above sections the authors have discussed initial findings from the case study Y. In the following section the initial findings are summarised with an indication of the planned way forward.

4. Summary of findings and way forward

The study revealed that the client is performing a role of manager within the innovation setting. The ability of the client to be part of the project delivery team was highly treasured by other professionals. The development of mutual trust, coordination among various stakeholders, including in-house offline divisions of the client organisation, are valued contributions from the client. Even though the participants failed to identify the client as a source of innovation everybody acknowledged the client’s contribution to setting the scene for the innovation. The knowledge brought in by the client regarding his organisation’s internal processes and procedures together with his ability to ‘ask the right questions’ helped the design team to steer their design towards the correct direction. The study confirmed a correlation of the client’s commitment and technical competency with the level of innovation which was identified by Nam and Tatum [4]. The commitment coupled with the technical background enabled the client in prompt decision making which was looked upon as a major advantage by the rest of the project team in developing the innovative solution. Even though the client managed the coordination between the project team and the in house divisions of the organisation, other participants identified it as a possible area of further improvement. The client identified that action should have been taken to preserve lessons learned for future use which is another burning issue within the construction industry.

The authors identified the collection of data from a further case study as an essential next step in the research. The data collected from a further case study will enable the researcher to carry out in depth case data analysis as well as cross case data analysis which will improve the reliability and the generalisability of the findings.

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Capacity building for sustainable enterprise development

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Abstract

The importance of 'Capacity Building' across industries was realised in the last decade and it brought number of repercussions in most of the industries including the construction. The construction industry has been criticised for its underperformance, which results of several problems and the insufficient capacity of contracting organisations. The capacity building concept and its applications are rarely concerned in contracting organisations due to the nature and features of the industry. The paper focused to develop a framework that highlights the capacity building in contracting organisations towards the sustainable enterprise development. The framework is developed by obtaining the information through the comprehensive literature review and the questionnaire survey and it was tested its adoptability and the acceptability in contracting organisations through the interviews. The research found that most of the leading contracting organisations are willing to adopt the developed model because it focused the organisation's vision and mission which ultimately drives towards the enterprise sustainability.

Keywords: Capacity Building, Sustainable Development, Contracting Organization, Sri Lanka.

1. Background

1.1 Capacity building

The term 'Capacity Building' often implies, the activities, which are carefully planned and executed, in order to build the capacity. It is the heart of many development agencies' current strategies [1]. It encompasses the country's human, scientific, technological and resource capabilities [2] and the fundamental aim is to enhance the ability to evaluate and address the critical questions related to policy choices and modes of implementation among development options. With reference to the International Development Research Centre [2] capacity building provides organisations to access the current knowledge sources and skills, innovative and proven methodologies; networking and funding opportunities, replicable models for addressing community needs and managing resources, options for organizational management and governance and strategies for advocacy, government relations and public outreach. Therefore it was recognised the capacity building is one of the most decisive issues that need to be addressed in world wide scale in construction organisations.

It's hard to find a concrete framework for organisation capacity development. Because the capacities are differ from one organisation to another and it will vary with organisation's vision and the mission. But it is significant to introduce the capacity building activities for construction organisations in developing countries, since most of them are compelling on lack of resources and inefficient use of the available resources.

1.2 Contracting Organisations' capacities

In simple terms, an organization's capacity is its potential to perform its ability to successfully apply its skills and resources to accomplish its goals and satisfy its stakeholders' expectations [3]. It can be expressed in terms of effectiveness, efficiency, relevance, and sustainability [4]. It further refers to the staff and resources, as well as its structure, management systems, and linkages with other organizations. The capacity building in organisations was emphasized as transferring the physical and financial resources and modern technologies to weak organizations, coupled with specialized technical education and training during the last decade. But this effort failed, because of the local capacities were not developed to manage the activities and maintain the facilities that they were depend upon the outside aid. At present, the technological enhancement, institutional change and declining budgets for improve the capabilities of individuals and organizations were supported for sustainable enterprise development. Organizational capacity development is an ongoing process by which an organization increases its ability to formulate and achieve relevant objectives [2]. It involves strengthening both its operational and adaptive capacities.

When it comes to the construction, the contracting organisations are needed to be sharpening with their existing capacities as well as drive for the new capacities. They are the key party who is going to physically build the structure for their client and waiting the profit. The organizational capacity development is undertaken by the contracting organization through its own decisions with relates to the several elements of it. Because they are highly dealing with large number of transactions, that is need to create an efficient and effective system in the organisation. Therefore the concept of capacity building becomes critical in contracting organizations. Institute for Construction Training and Development (ICTAD) grade is a yardstick to measure the capacities of construction organizations in Sri Lanka. To determine the capacity of a firm, ICTAD has a point system for grading the each resource. Basically, organization capacity falls under the factors such as finance resources, human resources, plant & equipment, work experience and the organization management.

1.3 Sustainable enterprise development

The concept of sustainability in building and construction has evolved over many years. The initial focus was on how to deal with the issue of limited resources, especially energy, and on how to reduce impacts on the natural environment. Emphasis was placed on technical issues such as materials, building components, construction technologies and energy related design concepts. More recently, an appreciation of the significance of non-technical issues has grown. It is now recognised the well balance between economic, social and environment sustainability. Sustainability is a systematic concept, relating to the continuity of economic, social, institutional and environmental aspects of human society [5]. It can be further defined as the 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' [6]. Sustainability seek to create conditions where social and environmental benefits which can simultaneously help to drive the business forwards. Sustainability is innovating and thinks beyond the current paradigm. However the lack of respect for sustainability within the construction industry would also appear to be a problem across developing countries. With reference to Danny [7], there are ten key factors that influence any organization towards the sustainability. Those are valid to apply the contracting organizations too.

- Participation and ownership
- **Capacity building** and training
- Government policies
- Financial
- Management and organization
- Social, gender and culture
- Technology
- Environment
- External political and economic factors
- Realistic duration

Therefore it is recognized that the sustainable enterprise can be created through the capacity building.

1.4 Capacity building for sustainable enterprise development

According to Hortan, [8], Capacity-development efforts generally include one or more of the five approaches in any organisation. Such are Information distribution, Training, Facilitation and monitoring, Networking, and Feedback, to promote learning from experience. Practically all capacity-development efforts distribute information in one form or another. Capacity development for an organization is one of the most fundamental management activities that realise the vision where the organization wants to be in the short and long term future. Therefore any performance management system will need to have strategy as the main input to build the organizational capacity, so that any result coming out of the system could be used to evaluate the extent to which the organization has met its capacity in terms of management, people, resources, partnership, financial, marketing, risk, knowledge, facilities etc. Since the sustainability is the most significant concept which greatly influence on the quality of human life, the organization should always decide on behalf of the sustainable values and establish their vision and mission. However by developing the organizational capacity it will automatically drive the organization towards the sustainability.

2. Research Methodology

This research was focused to introduce a framework for capacity building in contracting organizations towards its sustainable goals. It basically explores the current organizational capacity, key areas to be improved, existing development programmes, and future avenues of new capacities. The survey was limited to M1 and M2 grade contracting organizations that are operating in Colombo metropolitan region. Data was gathered from twenty five contracting organizations (25) to develop the framework.

Through the literature review, a questionnaire guideline and capacities relates to the contracting organisations were identified. The questionnaire was consisted of two parts. General information of the organisation was obtained at the very first stage and the factors which significant to the organizational capacity building towards sustainable goals in the last. In order to identify the importance of those factors the Likert scale and the Important Index (II) was used. By analysing the data derived through the literature review and the questionnaire survey a framework for the organizational capacity building was developed. The semi-structured interviews were conducted among six senior management personals of the selected organisations to check the adoptability and the acceptability of the developed model.

The framework analyses how the organization can performs successfully to achieve the sustainable goals through capacity building. It comprises of two main processes. The identical driving factors and the way they are able to achieve the organisation’s sustainability will be discussed. IDEF (Integrated DEFinition) methods were used to create graphical representations of various systems, analyze the model, create a model of a desired version of the system, and to aid in the transition from one to the other. It’s a group of modelling methods that can be used to describe operations in an organization. Among them IDEF0 method was used to model the functions of the contracting organizations, which creates a graphical model of what controls the function, which performs it, what resources are used in carrying it out, what it produces, and what relationships it has with other functions and at the last to visualize and present the framework, which express the relationships as a sequential in a process manner.

3. Data Analysis

It was identified the under mentioned capacities derived from the respondents of the contracting organisations that they believe the organisation can drive towards the sustainable goals through incorporating those to the system. The ranks were assigned on a five point numerical rating scale, where 1 represented 'low important' and 5 stood for 'significant'. Same value of the each number has been assigned as the weights of particular number. The mean rating of the variable was obtained using the sum total of point obtained and the number of responses for that particular variable. The equation is as follows.

$$m = \sum_{a=1}^{5} \frac{Y_a Z}{R}$$

Where,

Y - Number of respondents

Z - Weights

R - Number of responses to that particular variable [9]

By calculating the mean rate, the capacities were ranked and the framework was developed.

Table 1: Contracting organisation capacities and their importance level

Capacity	Percentage of all companies
Management	
Leadership	92.20 %
Strategic planning and management	92.20 %
Decision making	87.80 %
Project management skills	85.37 %
Financial	
Payment procedures	81.46 %
External financial support	74.63 %
Resources	
Material and Plant and machinery management	89.76 %
Human Resource	
Skill development of personals	88.29 %
Workforce retaining strategy (Restricting the migration)	85.37 %
Technical and in-house expertise	85.37 %
Personal attitudes (Positive attitudes to create better relationship)	79.51 %
Marketing	
Customer satisfaction	84.88 %
People and other stakeholder focus	78.54 %
Information systems	
Knowledge development	85.37 %
Research and development	
Innovation, learning and knowledge management	89.76 %
Documentation	
Knowledge of contract documentation and procedures	83.90 %
Contract conditions	82.93 %
Other management systems	
Quality assurance system	86.34 %
Process management	82.44 %
Risk management	72.20 %

External Factors Industrial regulations, laws, policies	70.24 %
Others Environmental sustainability Project joint venture	84.39 % 80.00 %

Through the respondents it was identified the following capacity development activities to direct the contracting organisation towards sustainability.

- Take action to deal with financing problems
- Improve practical education
- Institute arrangement for leadership succession in firms
- Improve the corporate knowledge by train participants to work as team and stick them on the organizational success
- Improve the knowledge on law, regulations, policies and administrative systems
- Improve and modify the existing networks of strategic allies, suppliers and sub contractors
- Access to inexpensive, highly skilled labour and capital
- Access to most efficient means of production, affordable and eco friendly building materials and engineering knowledge.
- Proper maintenance of firm's track records
- Establish proper communication structure and enhance the communication skills of the participants
- Increase the resource capacity in terms of assets, equity, materials and plant and machinery
- Improve the risk management capability of the organization
- Apply innovative and cost effective technologies those facilitate efficiency and productivity in all aspects of the organization
- Managerial expertise is important because of the peculiarities and problems of the organization
- Recruit technical expertise and experienced professionals and achieve reputation
- Improve corporate infrastructure
- Introduce Research and Development unit for the organization

In order to realise sustainable development, through building the organizational capacity, all the above activities should be highly conform to the sustainable values. Merely consideration on the profit making may leads to achieve development in one aspect over the other aspects.

The survey result found the potential areas of capacity building in contracting organisations.

Table 2: Potential areas of capacity building in contracting organisations

Element	**Potential Areas**
Materials	Procurement , Delivery, Storage, Prefabrication, Standardization, Product availability, New products, Waste
Management	Estimating, Cost control, Negotiations, Scheduling, Field inspection, Marketing, Communication
Engineering	Design standards, Design practices, System engineering, Drafting, Specification, Value engineering
Construction techniques	Pre-cast elements, Pre-assembled modular, Foreign development
Labour (Human resources)	Turnover, Availability, Labour relations, Contract agreement, Training, Quality control
Regulations	Contract conditions, Government economic policies, Taxes and levies, Financial policies, Sales policies
Equipment	Capacity , Simplicity , Maintainability , Utilization
Information system	Forecasting (labour, plant, cash requirement, estimation, etc), Communication, Network with suppliers and sub contractors, Information technology

4. The framework for capacity building in contracting organisations

The construction industry has been shifted from its traditional processes towards a more client oriented business approach, which recognizes the importance of innovation, training and research. It is encouraged to modernize and adopt collaborative and sustainable approach. By means of developing the contracting organizational capacity, through the financial, managerial, human resource, marketing and information system, it can be achieved the organisational sustainability.

The developed framework for the capacity building in contracting organisations was based on the proper identification of inputs, outputs, processes and the controlling factors of the organisation. The identical activities under each process are as follows;

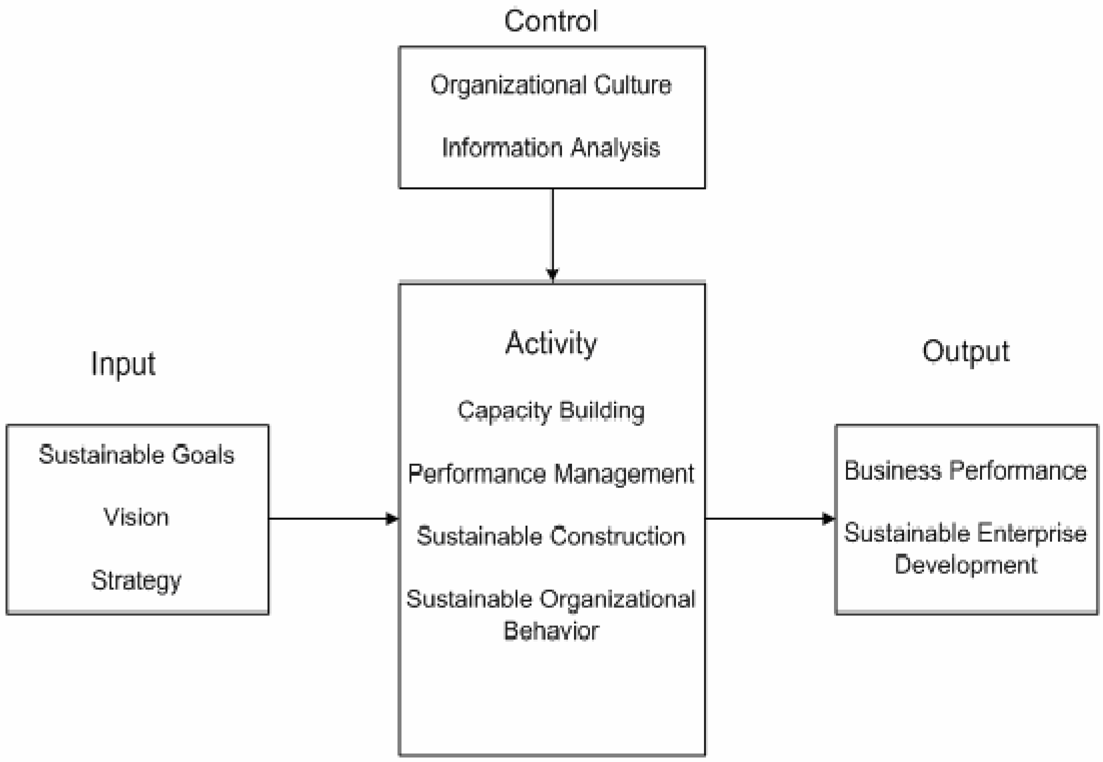

Figure 1 - Structure of the Framework

The framework is focused on the organisations' vision and missions. To make sustainable enterprise it was outlined the critical capacities that should be incorporated to the framework.

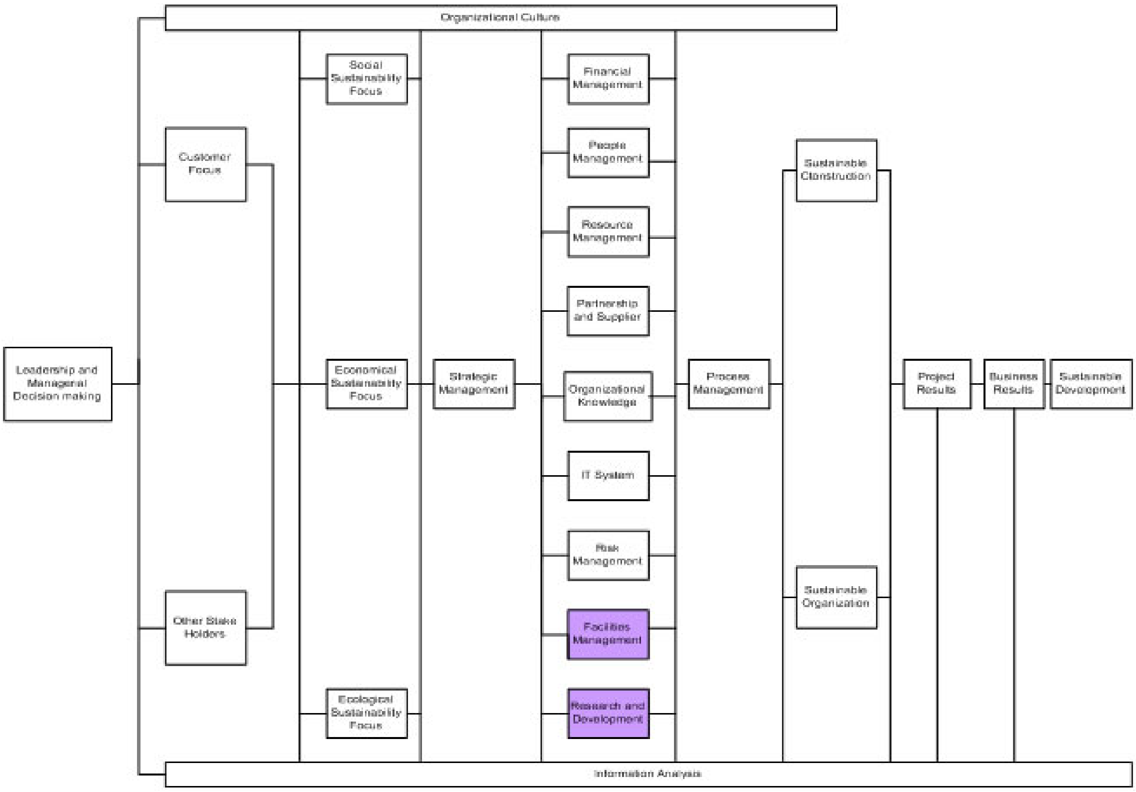

Figure 2 - Framework for capacity building in sustainable enterprise

The framework starts with leadership as the main driving factor for change and the improvement of the organisation. Leadership should focus on customer, people and other stakeholders while focusing on sustainability in terms of social, economical and environmental, which in turn should guide the development of strategic plans. The strategic plans are further detailed into functional and programmatic capacity building plans such as financial management, human resource management, resource management, facilities management, partnership and supplier management, organizational knowledge management, information system management, risk management and research and development. Those are incorporated to the process for establish the sustainable construction and the sustainable organisation. Once when it is implemented the project plans and the organizational processes, improved project results. Improved project results will affect customer, people and other stakeholders' satisfaction on the organizational level, which would finally reap organizational business results and carry the organization towards sustainable development. Organizational culture and information analysis were identified as the controlling factors of contracting organisation towards its journey to sustainability. The coloured cells of the framework have identified as the new capacities that proposed to incorporate to the existing capacity building plans of the contracting organisations. The framework facilitates the capacity development through joint venturing, handle a proper network of contracts, producing a qualitative products as well as the customer satisfaction in contracting organisations.

Contracting organisation can share resources, expertise, risks and rewards with other firms and parties. This concept facilitates some advantages such as reduce risks, improve knowledge and access to advance technology, which help to expand the organizational capacity. The initiating of this theme is needed for construction industry to change its traditional fragmented process towards more sustainable approach, which recognize the importance of innovation, training and research to achieve sustainability within the construction process and organization as well as it enable to acquire almost all the expertise knowledge, resources,

Further the build up a network of contacts is very much important when the organisation towards its sustainable goals. The network with correct people is essential, since inappropriate choices parties' leads to loss the business. This provides access to people for information of potential value and enhance reputation power and influence for effective business relationships. This collaboration and inter relationship is encouraged the sustainable approach, since it making more market responsive, create better integration of supply chain, engage with all stakeholders and create far more ethical and enhanced sustainability profile.

The production of high quality product to an affordable price through process of disruptive innovations brings the competitive advantage. Superior quality may attract higher cost, but it can be control by merge other innovative strategies to the production process. In effect the importance of the construction industry in contributing to everyone's quality of life has taken on a greater significance. It depends on the quality, specialty and cost competitiveness of the products and services. Sustainable capacity building is determines the nature, function and appearance of our communities at last.

Further the link between Contractor and the client brings the continuous job opportunities. Through the capacity building it is important to train the contractor's staff to have a good attitude to build a strong relationship with clients through the exposure, mutual respect and sincere. The construction team and operations team in the contracting organization are both important for achieving the design objectives, and ideally these teams should be represented in the design process to assure that there is continuity of thought and understanding of the sustainable concept that affects the implementation. The correct balance between time, cost and quality can be achieved through the client-project management agreement by making decisions in a sustainable manner and then customer satisfaction can be obtained.

5. Conclusions

The developed framework is tested in its adoptability and the acceptability among the selected contracting organisations. Out of six, five organisations (83%) are accepted the framework and they were commented it is par with their organisational vision and the mission. Therefore it can be concluded the developed framework on capacity building direct the contracting organisation towards its sustainable goals.

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Lifelong learning as a tool for updating technical knowledge

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Abstract

Skills and competencies acquired in university are rarely sufficient for a lifetime's work. While careers can last more than thirty years, skills often become obsolete within five. This is particularly true for technical professionals. Others, particularly those lacking higher education, have many barriers set in the way of obtaining further schooling; age limits are often set on support for these potential students.

At the same time, adults living in modern Europe do not have much time to devote to learning. Family and other personal obligations start to take priority, and balancing these with professional obligations can be overwhelming already, even before we consider possible academic pursuits.

Employers are looking for proficient and skilful workers. They cannot ignore the health and happiness of their workers, for without these attributes, workers cannot be fully proficient. The personal demands of the workers have to be balanced with the economic demands for training and education. Many employers have chosen to adopt a policy of emphasizing education and training that lasts throughout workers lives. We agree that lifelong learning is important given the context of today's rapidly developing technology and business practices in a global economy.

Our goal is to determine how we can organize workforce education, and make knowledge more approachable to women and people who live far from universities. We will also consider ways to help those who need to improve their technical knowledge late in their careers, and also to help those who have entered the workforce without higher education.

Keywords: Education, research, lifelong learning, training, adults, women, family

1. Background

1.1 Adult learner and life – long learning

"Adult learner" defined by the European Parliament, means a learner participating in adult education [1]. Life-long learning refers to persons aged 25 to 64 who stated that they received education or training. [2].

EU Commission to the Council – Adult learning published on October 2006 paper with the title,” It is never late to learn". They wrote about lifelong learning and how important lifelong study is for economic competitiveness, demographic change, poverty and social exclusion. Also they showed types of actions needed. By the end of 2007, the Commission intends to draw up an action plan based on the experience gained from the Socrates and Grundtvig programs [3].

1.2 New countries in EU – position and work condition

The EU numbers 27 countries [4]. In 2004 the European Union accepted ten countries (Cyprus, Malta, Slovakia, Slovenia, Poland, Hungary, the Czech Republic, Latvia, Lithuania, and Estonia), Romania and Bulgaria joined in 2007. All new EU countries had been in a new position. Ten countries, excluding Cyprus and Malta, come from a socialist system. From 1998 to 2004 the EU economy was in a new transition and they accommodated to new market in EU. This period registered big progress and good impulsion to start in the EU.

Now is 2007. Many companies have had extensive experience in marketing, lots of new knowledge and have good experts. They have worked and made contact with many experts everywhere in the EU. For further progress they need a good education and the possibility to acquire new knowledge. Technical knowledge and high technical profession experts are wanted because this kind of people are lacking. Why? In fact, technical knowledge is not as popular as other knowledge like law or economy. All around the world the situation is similar and in the last few years many governments strive to make these fields of knowledge more popular. Other reasons are work conditions. It is not just indoor work, mostly outdoor work under bad or good weather conditions (civil and mechanical engineers) and under extreme workplace conditions (mining engineers). People in technical fields mostly work ten and more hours per day and if they don't have degree education, they very hard to take it, especially if live on part of Europe from 12 new countries after 2004.

1.3 Courses in University

Most universities in the EU offer fixed programs, which proofed by government before they are implemented. Universities do not have options to prepare something interesting every year, because it takes too much time and too many people to develop new programs.

Undergraduate program last 180 ECTS (1 ECTS is to Bologna Declaration about 25-30 hours which included lectures, personal work [5]). Most of programs are designated for a population that does not have work obligations, family obligations and so on. Undergraduate programs consisting of 180 ECTS is about 5400 hours. If one spends 3 hours per day for study, one can study 90 hours per month. In this situation study is last 6 years.

1.4 Why are high degrees not good for adult learner

Across the EU the work week averages 35 to 42 hours. We work Monday to Friday. Saturday and Sunday we have free. In this days family take priority.

In Slovenia, we work from 8 a.m. to 5 p.m. A lot of people spend more then one hour per day commuting. If we add that together it amounts to 11 hours per day. Average required time to sleep is six to nine hours per day [6]. For family, hobbies and personal activities this theoretically leaves six hours per day free (Figure 1).

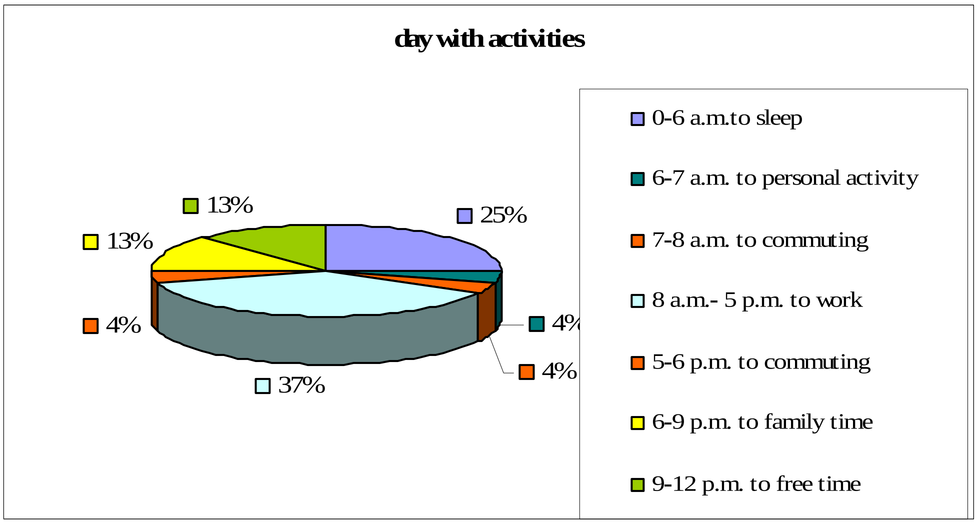

Figure 1: activities in on day

Technological development and technical knowledge requires continual education for people who work. The progress of computer tools advanced much in the last 15 years. The knowledge of new standards and legislations are required to be competitive. This is very difficult also for people with higher education, who in average are 40 years old.

What are the differences between men and women in the workplace? They do not exist as far as employers are concerned. But as a matter of fact differences exist and are large. Women bare children, they become pregnant (including all complications) and children need maternal care, especially in the first 3 years. Women get paid less for the same education and have a worse workplace environment than men. Women often have difficulty juggling their professional and family lives.

2. New solutions

If we look around universities in EU we can see universities in England and some universities in other parts of Europe offering short and summer courses in technical fields. They are designed for people, who want education and new knowledge during their life time careers. They also offer distance learning or e-learning programs.

For all of these activities special programs at universities are designated with titles "Centre for education and professional skills" or "Life-long learning education" or "Learning through work" amongst other titles. There are employees who maintain all of it education and professional development specialists.

2.1 Distance and e-learning is a good solution for adult learners

Some universities offer distance learning with e-learning tutorial hours and in the past more popular e-learning. Both of them are suitable for use in work place, because they don't need to go to a university. Through distance learning one can study at any time, but in a fixed time with e-learning. In addition, Klinc (2007) warned of problems during the e-learning course ITC Euromaster (9 universities over the World). On a survey question "Did you experience any problems during the course?" 86 % students answered Yes [7]. In fact e-learning is not completely developed, but the distance approach to education offers numerous benefits:

1. Accommodates different learning styles and schedules
2. Uses various educational resources or media (paper, video, audio, online) as instructional tools
3. Allows use of multiple communication methods (e-mail, teleconference, video conference, instant messaging)
4. Supports self-directed and self-paced learning style and methods

Many students choose this type of education because full-time jobs, physical limitations, or other commitments prevent their participation in the more traditional approaches to instruction.

The other form of distance education, often called hybrid, supplements traditional classroom instruction with online resources. The instructors deliver classroom lectures, but homework, assignments, and supplemental material may be retrieved online.

New computer technology made virtual worlds that are beginning to change higher education. Companies are developing tools to help universities better manage students and courses delivered in cyberspace, the trendy three-dimensional online world called »Second Life« [8]. Second Life has recently become one of the cutting-edge virtual classrooms for major colleges and universities, including 22 partners from USA, UK, Australia and Israel. Second Life fosters a welcoming atmosphere for administrators to host lectures and projects online, selling more than 100 islands for educational purposes, according to a New York Times article. Rebecca Nesson, an instructor at Harvard who brought her Legal Studies class to Second Life in the second half of 2006 said: "Normally, no matter how good a distance-learning class is, an inherent distance does still exist between you and your students. Second Life has really bridged that gap. There is just more unofficial time that we spend together outside of the typical class session." [9].

The more important information is how students overcome the technical and interface difficulties with Second Life? How is this way of education suitable for adult learners? We know that the group “Adult learner” is not a “Net Generation” (a group that has never known a world without computers and the Internet). Is the Second Life a suitable educational way in all professionals?

Learning through the media is important, especially for workforce people, but nothing can substitute for the experience of hearing, talking to and building a relationship with a real person from another culture. The purpose of using the latest communications technology is to expand student's communications skills, enhance fundamental goals of education, including critical thinking and problem solving.

With all the technical progress, faculties and instructors will find the learning styles oriented towards teamwork, experiential activities, and the use of technology such a online discussions or simulations.

But in spite of this, in the next 5-10 years, distance learning and e-learning will be a good option for adult learners.

2.2 Fees and financial situation in Europe

Some universities will be providing online professional development courses at varying prices, depending on the provider and the nature of the course. As with credit, this is an important question to ask prior to enrolling in an online professional development course. Credits for online courses are often charged at the same rate as credits for traditional courses.

For a good education you often need a lot of money. The fees are not low. On university web sites, we can find this data:

- 1100 £per 60 credits at Level M at the University of Cambridge (UK),
- 180 £ per one online course at the University of Oxford (UK)
- 674 £ per Day and Weekend Day or Evening Classes for Professional Development in University of Oxford (UK)
- 895 £ for 3-4 days short course, 18.500 £ per undergraduate degree and 4.240 per postgraduate degree at the Imperial College in London (UK)
- 8.380 £-10.920 £ per undergraduate degree and 7.500 £+ per postgraduate degree at Herriot Watt University (UK)

And some universities across Europe:

- 2660 CHF for two years of part time or one year full time study in MAS ETH in Zurich (CH),
- 2800 CHF for a block course (200 hour split 2 year) in MAS ETH in Zurich (CH),
- 895 Euro for 3 days short course in Tehnishe University in Graz (A),
- 1000 Euro per year for a undergraduate degree at TU in Munich (D),
- 1500 Euro per year per undergraduate study and 1800 per year per postgraduate study at the University of Maribor – Faculty of Civil Engineering (SLO).

In the 27 European countries there are 268 regions [10]. We have big differences between the highest and lowest regions ranged. If the average GDP expressed in terms of purchasing power standards (PPS) European data is 100 %. In table 1 show how high is PPS in 10 regions in Europe Union.

Table 1: GDP data expressed in terms of PPS in % - the five higher and five lowest regions over Europe

Region (Country)	PPS in %	Region (Country)	PPS in %
Inner London (UK)	**303**	**Sud - Muntenia (RO)**	28
Luxembourg (LU)	251	**Severen tsentralen (BG)**	26
Bruxelles-Cap. (BE)	248	**Yuzhen tsentralen (BG)**	26
Hamburg (DE)	195	**Severozapaden (BG)**	26
Wien (AT)	180	**Nord - Est (RO)**	**24**

In fact, for many people from countries with low PPS (purchasing power standards) areas in Europe, studies in other countries, with good faculty and good programs are too expensive and unattainable.

2.3 Degree education inaccessible to adult learner

More and more adult learners are finding the convenience and flexibility of online learning to be a good match for their learning goals and busy lifestyles.

Right now there is a strong demand for online studies. Most degree programs in technical fields at the universities or faculties are not suitable for adult learning working people between 25 and 64 years of age. In a degree program, it is not possible to choose individual subprograms and work on them at ones own pace and time.

2.4 What are the reasons for insufficient offering of programs

Why don't the universities or the faculties in technical fields offer more degree programs for adult learners? What are the reasons? Is basic knowledge like math and physics a great difficulty for adult learners? What about the popularity of technical knowledge? Do industries not require formal education? Are they satisfied with workers who learn in the workplace from other degree educated colleagues? What is the relation between universities and employers? Are they integrated?

We live in a time of revolutionary change. Not only is the world relying increasingly on technology for economic growth and job development, but the countries are making the difficult transition of refocusing a significant amount of its technology investment from national security to international economic competitiveness. Engineers play an ever more significant role. They develop new manufacturing processes and products; create and manage energy, transportation and communications systems; prevent new and readdress old environmental problems; in general, make technology work. For all of this, they need specific technical skills, economy, law, management, medicine, etc. These professions require analytical and problem solving abilities, all of which are part of an engineering education.

Engineering colleges who working in companies must not only provide their graduates with intellectual development and superb technical capabilities, but following industry's lead, those colleges must educate their »no formal education colleagues« or students to work as part of teams, communicate well, and understand the economic, social, environmental and international context of their professional activities. Engineering education programs must attract an ethnic and social diversity of students. Not only does the engineering profession require a spectrum of skills and backgrounds, but it should preserve its historical role as a profession of upward mobility.

Engineering education will be most effective if implemented with the aid of all sectors of the community; and programs must not only teach the fundamentals of engineering theory, experimentation and practice, but be relevant, attractive and connected:

- relevant to the lives and careers of students, preparing them for a broad range of careers, as well as for lifelong learning involving both formal programs and hands-on experience;
- attractive so that the excitement and intellectual content of engineering will attract highly talented students with a wider variety of backgrounds and career interests, particularly women, underrepresented minorities and the disabled, and will empower them to succeed; and
- connected to the needs and issues of the broader community through integrated activities with other parts of the educational system, industry and government [11].

Engineering deans are principally responsible for leading engineering education, they work in partnership with their faculties, secondary schools, the broader university, government and chambers, other engineering colleges, and build even closer ties to industry. These sectors make up the broad constituency of engineering education.

Many universities and their engineering colleges aspired to the model of the "research-intensive" university. This model focused on developing research excellence in scientific and engineering fields, and on creating research-oriented doctoral degrees. Are we in need of this model in all levels and all professinal programs, as well as programs for adult learners?

The world now demands new models. Progress communications technologies are enabling engineering schools to expand their reach and accessibility, and to experiment with alternate modes of teaching and learning.

A variety of models in engineering education will result from the process of schools reexamining their individual missions.For example, some colleges may opt to combine elements of traditional technology-based engineering education with a strong emphasis on broader skills such as written and oral communication, management, economics and international relations. This type of program would aim to prepare individuals for technological decision-making and policy-setting as well as for non-engineering professions. Other engineering colleges may choose to become more like "professional" schools, preparing students for professional engineering practice through the master's level. Engineering education needs own models. No one model suits every engineer or every organization that engineers serve.

Universities must put together an effective study system. A new training and certification program will base on the company's application delivery curriculum. [12]. In that way, the students will have a first hand view of how related concepts are being used in workplace. Thus, engineering education must take into account the social, economic, and political contexts of engineering practice; help students develop teamwork and communication skills; and motivate them to acquire new knowledge and capabilities on their own. Because many modern engineering projects require a combination of several disciplines, students also need exposure to the integrative field of systems engineering. The aims of engineering education will prepare an engineer to be successful in the changing workplace. It aims to equip students with technical knowledge and capabilities, flexibility and an understanding of the societal context of engineering.

Included among the often-mentioned barriers to successful use of online professional development are:

- creating quality courses that meet instructional needs;
- training instructors to successfully provide effective courses;
- ensuring there is proper support to meet student academic and online learning needs;
- and attending to the technical requirements needed to successfully develop, provide and access online courses.

That online teaching will take as much or more time than teaching traditional face-to-face classes (courses). This is because the level of interactivity with each individual student is increased [12].

3. Creating the condition for successful education for an adult learner

In October 27, 2006 in statistical indicator Eurostat shows the relation between female [2] and male [13] live-long learning students in the EU (Figure 2):

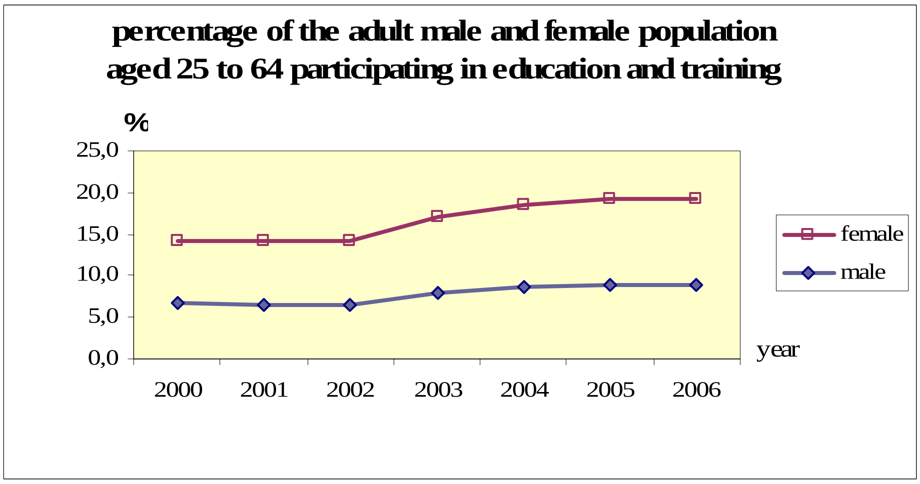

Figure 2 - Live-long learning students in EU

The percentage of adult students, who want to study, is increasing.

One education model, suitable for adult learners in EU, Learning Through Work, is found on University of Derby web site [14]. Learning Through Work is a way of getting a university qualification without having to leave the workplace. It's a form of work based learning. It's based on the simple premise that people don't always need to attend college or university to learn, because learning is part and parcel of everyday working life, and promotes continuing professional development.

In Learning Through Work, they offer opportunities for people to engage in individual and group programmes of study leading to credit and awards ranging from Certificates of Achievements to full Master's awards. They offer support through a learning contract and a simple but sophisticated online managed learning environment. Learning Through Work comparing distance learning, with recorded lectures for self-study and e-learning tutorial hours, such programs are more suitable to women; for them it is very difficult to leave their families and go elsewhere to further their education.

Responsibility for life-long learning and good technical knowledge is not just that of an individual. It is also the responsibility of the EU Commission, government, universities and employers.

In further, we can see some solutions which are connecting learning, work and family, especially in fields of technical education. This way is much more suitable for women with children and families in the EU.

The EU Commission could prepare financial support for adult learners if they want to study in other countries. They should consider PPS for regions, because it is not the same if you come from Romania or Belgium and go to England or Portugal.

Government should reduce taxes for employers who have study workers and have tax exemptions for workers who are studying.

University can prepare quality and actuality short courses to wide specters and flexible learning opportunities, like distance learning and e-learning. Each of the courses should be part of a wider certificate, diploma, undergraduate or post graduate study. All universities in the EU should prepare recorded lectures in their own as well as English language.

Employers should support their own adult learners. For example: a shorter work week (40 and more hours reduced to 30 hours) or part time work. They should offer technical support and places for studying. Many people can study after they finish their workday. They can study at their workplace because they have peace and quiet, as well as all technological support necessary in the learning process.

Finally, this way you can find individuals, who have higher personal motivation for learning in the technical field and get opportunity for their own development.

4. Conclusions

Everyone wants a good job, a lot of free time and money. But for most of us this is impossible. Modern life is like patchwork. Five days a week are for work, family, free time and personal activities. We must balance between many tasks. Study and education in technical fields (especially engineering) are not easy. One must work very hard in the new transition EU countries, because we have to accommodate to a new situation and a new position in the world. Employers want individuals who work hard, are responsible and are constantly learning new skills and widening their knowledge. How can this be done?

Life-long learning is an opportunity for workers who were not able to finish a university degree program. They want to continue their education so they can better themselves and get better jobs, as well as for personal growth. Such students are the best, because they have the personal motivation and energy to get ahead. Nevertheless, adults with good education and the opportunity to get ahead are more inquisitive and innovative.

Learning through work, like open learning and long distance education featuring pre-recorded lectures, e-learning (tutorial hours and practical modules that can be performed over a block week, with flexible schedules, or an individual program) are much better for the adult student then standard and fixed programs that the government proofed ten years ago.

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The Importance of the Construction Sector: Measuring its Value

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Abstract

An essential issue in consideration of the state of the construction sector and its relationship with the macroeconomy is measurement of the activity of the sector. To fully appreciate the economic value of the construction sector, a distinction needs to be made between the value of the sector *in* the economy and the value *to* the economy. A narrowly-defined construction industry contributes around 5-6% of Gross Domestic Product (GDP) in many developed countries, whereas, on a wider definition, the contribution may be roughly twice this size [1],[2]. On the basis that the entire built environment falls into the field of activity of construction, however, the value to the economy may even be considered to be as high as 20% of GDP. The latter figure is based on the 'framework system approach' to analysing the built environment sector. The rationale behind this approach and its use in understanding the construction sector's role are developed and explained. Data on Sri Lanka are presented to consider the validity of the approach in the context of a developing economy.

Keywords: Construction sector, Macroeconomy, Evaluation.

1. Introduction

Construction is an industry of major strategic importance and it is essential that the statistics produced for the industry are valid, reliable and comprehensive in their coverage. In 2003, nCRISP (the UK Construction Industry Research and Innovation Strategy Panel) established a Socio-Economic Task Group with the aim of producing a report, which would paint a picture of the UK construction industry and the role it plays in contributing to the over-arching goal of sustainable development. In the Preface to the resultant 'Pearce Report' (*The Social and Economic Value of Construction: The Construction Industry's Contribution to Sustainable Development),* the Chairman of nCRISP stated that: 'The industry and its contribution to the UK economy and the health and well-being of UK society was neither fully understood nor adequately valued' [1], p.ii).

The United Nations defines construction as comprising 'economic activity directed to the creation, renovation, repair or extension of fixed assets in the form of buildings, land improvements of an engineering nature, and other such engineering constructions as roads, bridges, dams and so forth' [3]. Construction activity represents a significant share of the economies of most countries in terms of its contribution to GDP and total employment and it is also an important market for materials and products produced by other sectors of the economy. Pearce considered construction both in its narrow sense (on-site construction activity) with its contribution to GDP at around 5% and in a broader definition (including quarrying of construction raw materials, manufacture of building materials, sales of construction products and various associated professional services) making a contribution of about 10% of GDP. The nCRISP Task Group considered that it could be taken even wider than that – to include land, property and facilities management but stopped due to data availability and the fact that they 'had to stop somewhere' [1], (p iii).

1.1 The aim of construction activity

To consider construction activity to be merely the act of building is to take too narrow an interest. The productive issue to be solved by construction is more wide-ranging and represents a considerable economic and social challenge. It is a question of producing and managing the living and working environment of the whole population. The entire built environment, as distinct from the natural environment, falls into the field of activity of construction.

On this basis, the principal aim is not merely to produce and manage structures for people's living and working environment, but rather *to produce and manage the services rendered to end users by these structures throughout their physical life-cycle (production, use, improvement through to demolition)* [4]. Valuing the construction industry, and assessing the importance of the industry to the economy as a whole is a difficult yet important task. Highlighting the importance of construction to the economy is a key point to ensuring it is a high priority for government agendas.

There is a distinction between the value *to* the economy and the value *in* the economy, both of which will vary vastly dependent upon the definition of the sector used. The value to the economy considers the construction industries use as a driver for growth, and as a catalyst for other industries to do well. A good construction sector will usually ensure a healthy level of business across the board, as the necessary infrastructure for such actions to occur will be in place. The implicit value in the economy is more easily defined and assessed, and is measured as the contribution to GDP. However, both assessments still rely on a consistent definition of the sector so that reliable and comparable estimates can be made.

The construction industry has an important role to play within the overall economy of any given country but how that role manifests itself will vary greatly from one nation to another. In developing countries it is likely that the extraction of raw materials and on-site construction activity is most important, as the country seeks to set up a significant infrastructure, in the form of roads, railways and buildings. In developed countries, the onus is on professional services and the sale of the end products. It is also possible that a large repair and maintenance sector will emerge, the longer the main infrastructure has been in place, as potential customers seek to maintain and update current dwellings or work places rather than looking to new building altogether.

Broadly speaking, the construction industry is part of the process of creating and sustaining the built environment. In a narrow view, the construction industry is placed solely in the secondary sector, as this accounts for the transformation from manufactured materials into a final product. However the reality is that the construction industry spans across the primary, secondary and tertiary sectors, as the process sees raw materials transformed into manufactured materials and then on into a final product, with professional services and sale of products at the end of the line. The weightings of each part of the chain will vary from one country to another, skewed according to their level of development, with a higher concentration of primary and secondary sector firms in developing countries and more tertiary sector firms in developed countries, such as the UK or USA.

The traditional perception of the contribution of the construction industry to the economy is based on the methodologies employed for the definition and measurement of construction activity according to international standards. Within this context, the limitations of the concepts used in this definition are considered, and an analysis is undertaken of the usefulness of the measures. Construction activity has changed in response to new demands over recent decades and an evaluation is made of a new approach, to focus on construction activity to meet the changing needs of the economy and society. The role of built assets in the development of a nation needs to be considered and it may be that broader measures of the economic value of the built environment are needed in order to allow an assessment of the contribution of the built environment to quality of life and to enable the value of the construction industry to be properly understood. This basic definition of the construction industry does not include other value-adding construction activities such as:

Upstream - manufacturing, mining and quarrying, architectural and technical consultancy, business services.

Parallel **-** architectural and technical consultancy.

Downstream **-** real estate activities.

2. A new approach

In addition to the Pearce Report, the case for a new approach to the valuation of construction activity has come from two other areas. Firstly, the 'International Council for Research and Innovation in Building and Construction' (CIB) *Revaluing Construction* agenda focuses on improving the value of the final construction output and requires that the totality of activities involved in the production of the built environment is reviewed. (See [5] for a holistic assessment of construction). Secondly, Carassus [4] proposes a framework system approach for understanding the construction sector. The rationale for this approach is based on the view that the role of the construction sector should be viewed in a wider context than that of the narrowly-defined 'International Standard Industrial Classification' (ISIC) definition of the industry. Figure 1 illustrates this approach and indicates the extent of the construction sector system.

2.1 The construction sector framework

In recent years the construction industry has come to play a new role within the economy of many developed countries and it has been moving away from a production-based focus, to one where it acts as a provider of services for the built environment. Carassus argues that large-scale production by the construction sector on housing and civil engineering projects formed a necessary part of economic growth policies in post-World War Two industrially developed countries. Since the 1990s, however, there has been a notable change in terms of the demands placed upon the construction sector. Emphasis has moved away from building stock creation and is now placed on the repair and maintenance of the building stock created during the growth years. In order to appraise Carassus' proposed framework, a research project was set up under the auspices of the CIB, to test its application in nine developed countries[1]. One result of the study was to show that repair and maintenance accounted for (on average) about 50% of construction output. Beyond repair and maintenance, managing the existing stock has become a strategic issue for companies and government. The impacts of facilities management and public-private partnerships are strong signs of this trend.

Quality and maintenance cost aspects of the service rendered by the built capital have become important, as too has flexibility of use. This means that the operations and function of the construction sector need to be considered in a different manner. The industry has become much more involved in dealing with whole life cycle issues, which have become the dominant feature of sustainable development.

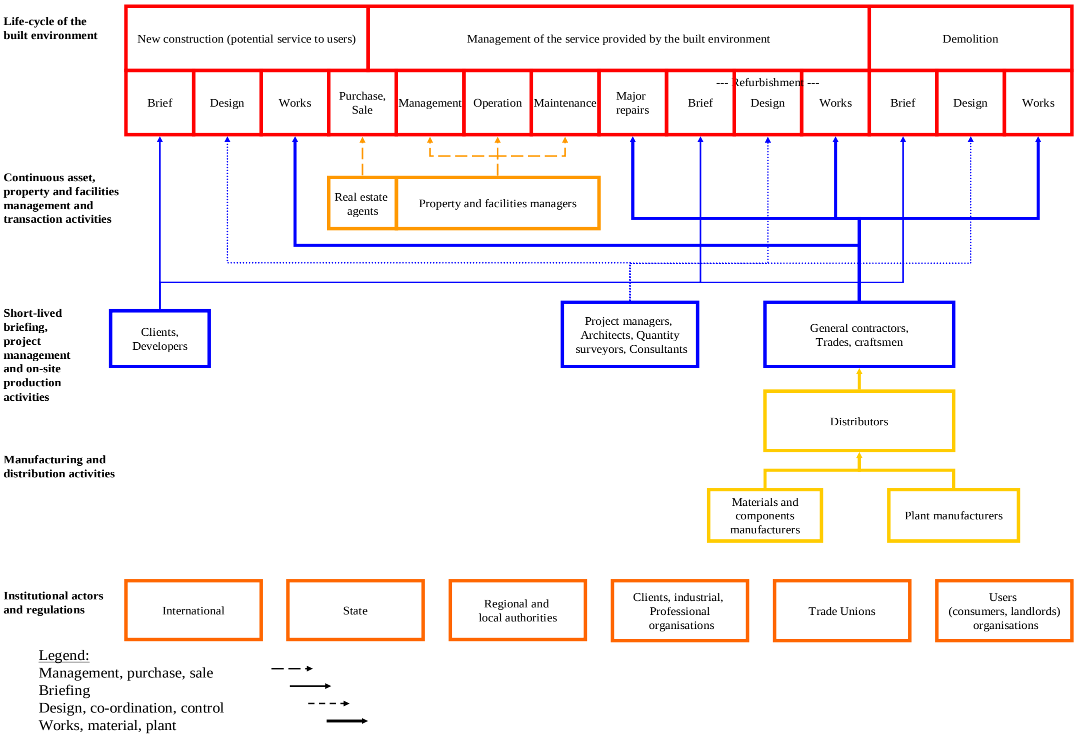

Figure 1 - The construction sector framework (Source: Carassus [4])

[1] The nine countries in the CIB 'Construction Industry: Comparative Analysis' study were: Australia, Canada, Denmark, France, Germany, Lithuania, Portugal, Sweden and the UK.

2.2 Defining the sector

The narrow sector consists solely of on-site assembly including repair work, which encompasses site preparation, construction of buildings and infrastructure, building installation and building completion. The broader definition consists of much more, including the supply chain for construction related products, including the mining of construction materials and the manufacture of construction products. The broad definition also includes professional services such as management, architecture, design and facilities management. These two definitions are illustrated by Figure 2, which depicts the structure of the construction industry, and how the different components feed into the built environment.

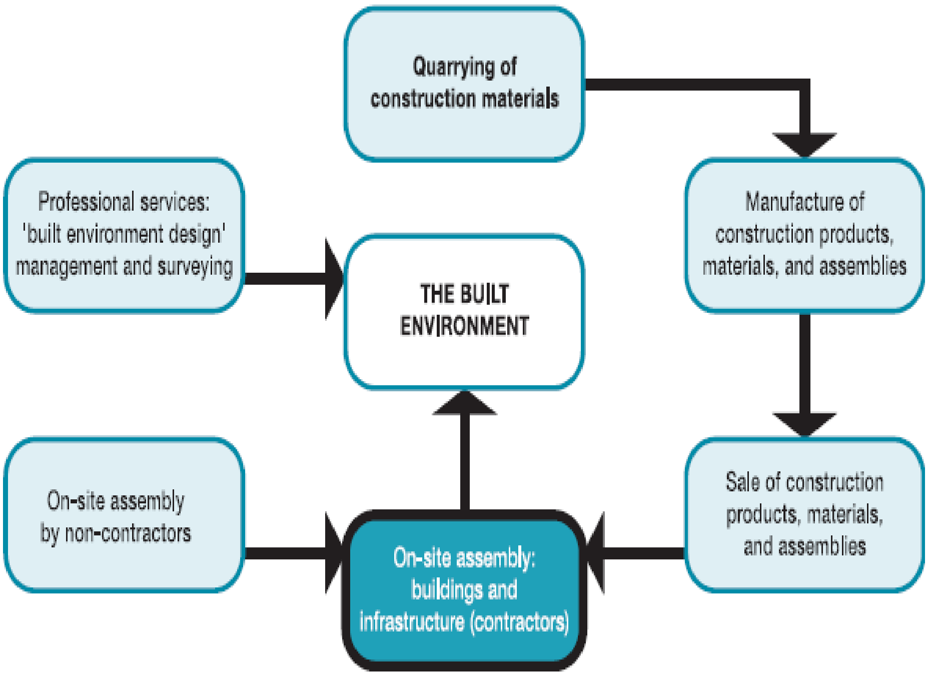

Figure 2 - Broad and narrow industry definitions

(Source: The Pearce Report [1])

There is obviously a significant difference between the narrow and broad definitions and the resulting impact the construction industry has on the economy. However both of these definitions are quite high level, including ‘sectors’ of the construction chain rather than individual tasks. In order to truly ascertain the full value of the construction industry and create a better defined description, a more detailed look at economic relationships between the construction industry and the rest of the economy must be made.

2.3 The economic contribution of the construction sector

Research undertaken at the University of Salford, as part of the CIB Revaluing Construction agenda has produced an assessment of the contribution of the construction sector to GDP, based on the wider linkages of the sector using analysis of UK Input-Output tables. (See Foulkes and Ruddock [2], for a detailed explanation of the procedures).

Table 1 - UK Construction Sector GVA contribution by SIC code

SIC Classification	**GVA as a % of total GVA**
14 Other Mining and Quarrying	0.08
25.2 Plastic Products	0.12
26.1 Glass and glass products	0.02
26.2/26.3 Ceramic goods	0.03
26.4 Bricks, tiles and construction products in baked clay	0.04
26.5 Cement, lime and plaster	0.01
26.6-8 Articles of concrete, plaster and cement etc	0.21
45 Construction Work	6.2
70.1/part 70.2 Real estate activity with own property	1.89
70.2 (part) Letting of dwellings, including impudent rent	7.9
70.3 Real estate activities on a fee or contract basis	0.5
71.32 Renting of construction and civil engineering machinery and equipment	0.42
74.2 Architectural and engineering activities	1.95
Total % of GVA contributed by 'Construction Sector'	**19.37**

Table 1 includes values calculated from Input-Output tables, and only includes the proportion of each category that is actually directly attributable to the construction industry.

The table above makes it clear that, although the broad definition in the Pearce Report is a useful one, it still does not give the full picture. By only using high level descriptions of 'sectors' within the construction industry, it is difficult to measure the total impact caused, as in some cases too much value will be attributed to the construction sector, but more critically many aspects are missed altogether. This more detailed break down of how the construction industry contributes to the economy also has the advantage of showing which areas have most importance (value added importance rather than actual importance within the chain) to the economy.

A similar analysis can be applied to other economies. Based on ISIC rev.3, Figure 3 shows an estimated measurement of value-added by the construction sector, in twenty European countries.

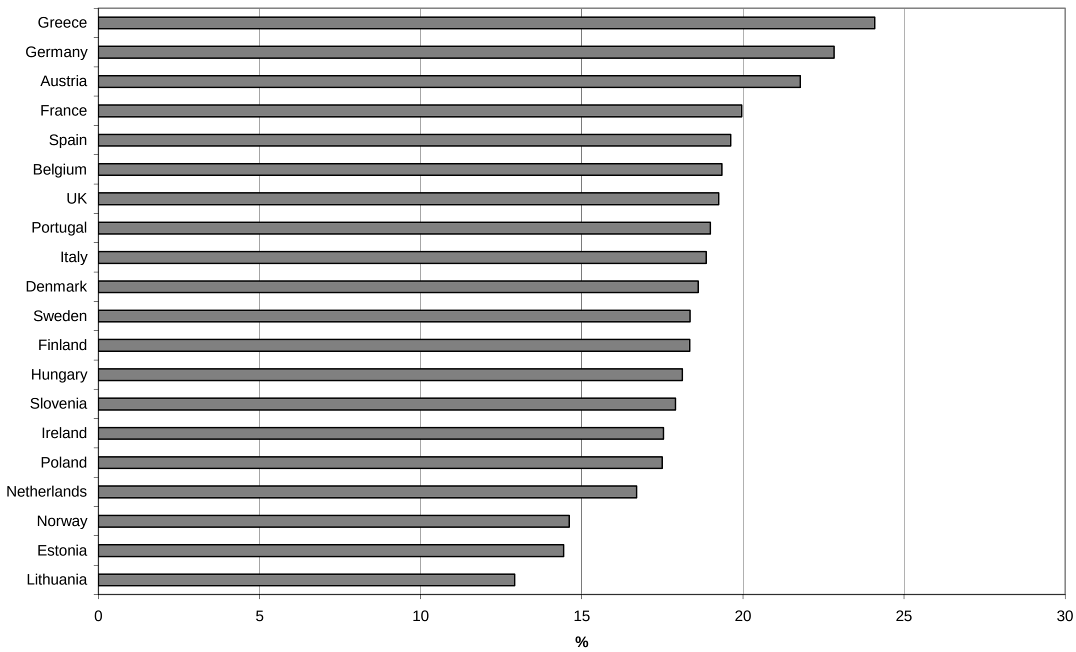

Figure 3 - Size of the construction sector in twenty European countries (as % of Gross Value Added) based on homogenised ISIC classifications. (All years 2000 except Slovenia 2001; Norway 2002)

(Data sources: National Statistics databases)

2.4 A contextual application to Sri Lanka

Consideration can be made, of the application of the construction sector approach in the context of a developing country. In Sri Lanka, in terms of the importance of the construction sector, it is not surprising that, post-tsunami, the 'official' construction sector growth rate has outstripped the growth in GDP (see Figure 4). In the supporting sectors growth has been particularly strong.

For instance, the value of imports of total building materials increased by 21.8% in the third quarter of 2005 from a value of 49.7% for the corresponding period of 2004.

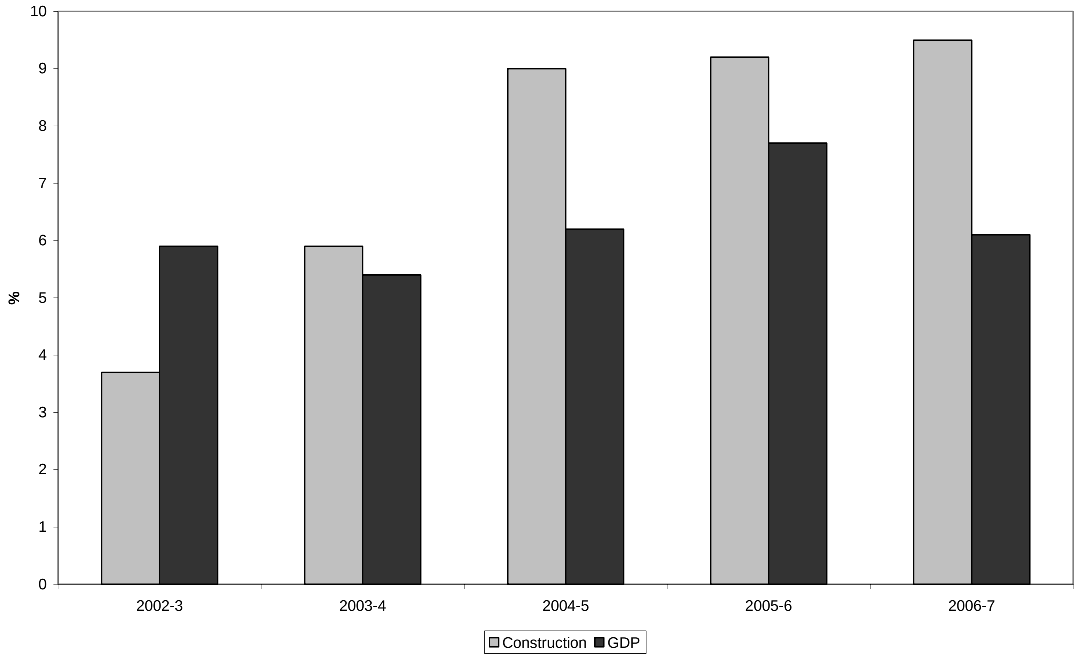

Figure 4 - Growth rates: Construction sector compared to the macroeconomy

Source: Derived from: National Income and Industry Statistics, Department of Census and Statistics, Sri Lanka. (Various years)

The notion of attempting to measure the value of the 'ancillary' parts of the construction sector in a developing country can be much more difficult due to a lack of comprehensive information, particularly inter-industry (input-output) data. Using a methodology, in which the inter-sectoral relationships derived from the aforementioned study of developed countries are used to determine coefficients, Table 2 represents an attempt to evaluate the overall value of the construction sector, calculated by mapping these coefficients on the Sri Lankan data.

Table 2 - Percentage share of GDP by origin at constant (2002) prices of major economic activities. (First quarter, 2007)

Divisions	**%**
Construction [Division 6]	6.4
Parts of: Mining [Division 3.2] Manufacturing: (Rubber and plastics) [Division 4.2.3] (Fabricated metal products, machinery and equipment) [Division 4.2.5] Banking, insurance and real estate [Division 10] Ownership of dwellings [Division 11]	10.4
Total	**16.8**

Note: The Divisions refer to the designation of economic activities by the Sri Lankan DCS

Source: Derived from: National Income and Industry Statistics, Department of Census and Statistics, Sri Lanka.

This measurement is based upon a snapshot, single-year assessment and a consistent set of time-series data would, of course, be needed to give the representation more validity. However, it is interesting to note that this value of 16.8% fits within the range of values observed in the developed countries shown in Figure 3.

2.5 The contribution of the construction industry to economic development

One aspect of the important contribution made by the construction sector to a country's economy concerns the relationship between a country's state of development and the level of activity in the construction sector. At the macroeconomic level, studies have tended to concentrate on developing countries (See Turin [6]; World Bank [7]; Wells [8]; Bon [9]). The idea of an inverted 'U' relationship between construction activity and the level of income per capita (i.e. in the early stages of development, the share of construction increases but ultimately declines, in relative terms, in industrially advanced countries) was put forward by Bon [10] and has been empirically tested by Ruddock [11] and Ruddock and Lopes [12]. As noted by Tan [13]: 'In low income countries, construction output is low. As industrialisation proceeds, factories, offices, infrastructure and houses are required, and construction as a percentage of gross domestic product reaches a peak in middle income countries. It then tapers off as the infrastructure becomes more developed and housing shortages are less severe or are eliminated.' According to the study undertaken by the CIB project group, after allowing for cyclical fluctuations, the general trend in construction activity in very developed countries is for construction activity to be in relative decline [4].

3. Conclusion

This paper has attempted to put forward a case for a re-evaluation of the construction sector in order to discern the true value of the construction sector to the economy and thus consider its role in the development of a sustainable built environment. At the core of the discussion is the issue of the nature of a sustainable built environment – balance of new and old; conversion versus demolition. It is beyond the scope of this paper to plan the journey required to transform the built environment from its actual state to sustainable state but the perceived economic value of the built environment must be appreciated in order to properly evaluate the sector's full contribution to the quality of life.

It is worth reiterating the limitations of existing data sources, which prevent a true assessment of the value of construction activity. As suggested in a CIB Task Group survey report on sources of macro-and market data in construction [11], in many countries, improvements to existing national statistical reporting systems are needed, to ensure that all construction activity is measured. A fundamental principle of sources of data on construction activity produced by national statistical offices is that official statistics are essential for obtaining a transparent picture of the true value of construction. In spite of the UN's attempts to impose standardisation on national statistical bodies, there are still many differences in underlying concepts and definitions for different countries and the problem of coverage to incorporate the 'grey' construction sector is, in many countries, a significant issue.

The importance of relevant data for assessing such effects is of paramount importance and the government cannot be relied upon as the only source of useful information. Official government statistics are not, of course, the only source of data and, in the industrially developed world, there is a plethora of private organisations producing data on the national construction sector. These tend to be forecasting institutions, contractors' organisations or information service providers. In those countries, where a comprehensive information system does not exist, the CIB Task Group survey has shown that options such as, government financing through a public/private agency, a subscription applicable to users or a levy system on members of the industry, could be considered. Improved statistical information would lead to improved awareness of the true value of construction activity. The target audience for this output would, of course, include government agencies for policy and planning activities.

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Capacity Building:
A Framework for the Built Environment Education

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Abstract

Capacity building is a continuous process which delivers better services by developing and strengthening the skills, instincts, abilities, processes and resources that organisations and communities need to survive, adapt, and thrive in the fast-changing world. The improvement of existing capacities and the building of new capacities provide multiple avenues to thrive the organisation in its visions. It was recognised the demand for the built environment education with the rapid growth of population and their pattern of thinking. Therefore the built environment education is one of the important arenas that requires the capacity development at present. To meet the challenges, it is essential to enhance the existing capacities or introducing new capacities to the built environment education. The study focuses to develop a framework to explore the capacity building in built environment education and test the validity of proposed framework in Sri Lankan context. A comprehensive literature survey and a structured questionnaire survey were carried out to identify the capacities in built environment education in local and international contexts. Further the framework was tested in its acceptance through interviews among the professionals who were proven in the built environment education. The acceptance level of the proposed framework is very high but it needs to check its practical validity by adapting the framework to a built environment educational institute.

Key words: Capacity building, Built environment education, Institutional Framework

1. Background

The term “Capacity building” has multiple meanings and an interpretation depends on a person who uses and the environment which implement. The concept is generally addressed in the areas of education, training, and human resource development events. Capacity building is a continuous process which delivers services has a direct bearing on the performance capacity of the organisation [1] by developing and strengthening the skills, instincts, abilities, processes and resources that organisations and communities need to survive, adapt, and thrive in the fast-changing world [2]. Specifically, capacity building encompasses the country's human, scientific, technological, organisational, institutional and resource capabilities. A fundamental goal of capacity building is to enhance the ability to evaluate and address the crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environment potentials and limits and of needs perceived by the people of the country concerned.

A fundamental objective of capacity building is to enable society to optimize the use of its resources to meet its immediate and future needs and which can be characterized by three main activities: skills upgrading, both general and specific; procedural improvement; and organisational strengthening [1].

It is increasingly understood that "Higher education is the modern world's basic education, but many countries are falling further and further behind" and it is understood that "Higher education is no longer a luxury, it is essential for survival" [3]. There is growing concern for the safety and security of the civil infrastructure in relation to natural and manmade disasters. Safeguarding the future requires the expertise of professionals involved in the design, planning and construction of the built environment. This is particularly important to ensure that safeguards have the long-term vision to not only protect this generation, but future generations also [4]. Capacity development in built environment education is a two-way activity, which is in developing countries is a complex area which is an on-going process that must be based on a national priority and a holistic historical analysis of the national system of higher education and its contribution to social, economic and political development [5]. A number of disciplines dominate the term 'built environment' but there is no agreed definition of built environment as to the remit of the term. Centre for Education in the Built Environment [6] includes Architecture, Construction, Housing, Landscape, Planning, Surveying and Real Estate as the built environment professions. Safeguarding the future, requires the expertise of professionals involved in the design, planning and construction of the built environment.

There is growing concern for the safety and security of the civil infrastructure in relation to natural and manmade disasters. Due to the high demand for Built environment it is important to enhance the capacities of the built environment education. But improving the existing capacities, introducing new capacities are significant in both built environment and higher education system.

2. Capacity building

Capacity building is not a new concept and has been used in a number of fields to improve human resources and organizational structures. Researchers, policy makers and other leaders in different industries have used the concept of capacity building to evaluate and assess the potential, ability or capability of a group of people, team, company or even society to attain self-proposed goals [7]. Capacity building approaches vary and change depending on the organization and its vision and missions. The concept has evolved from a standard approach to a systematic and individualized method of analyzing a system's needs [7].

The meaning of capacity building varies depending on the context where it is being used. Harris [7] defines capacity building as, “creating the conditions, opportunities and experiences for collaboration and mutual learning.” The Center for Disease Control and Prevention (CDC) cited in [7] defines capacity building as, “technical assistance, training, information sharing, technology transfer, materials development or funding that develops, enhances, or sustains and organization to better serve customers or operate in a more comprehensive responsive and effective manner. Subramaniam [8] suggests that capacsity building is similar to “development” or “strengthening.” Further it’s a term which create reform or support activities that facilitate sharing of experiences, strategies and knowledge.

By analysing most of the definitions illustrated by various gurus in the field it was identified the most related capacities for the built environment education. It was hoped that the proper integration of those capacities direct the sustainable built environment education at the end.

2.1 Need for Capacity Evaluation

A serious obstacle to progress is the absence of data on educational efforts and outcomes [9]. It is critical to conduct an evaluation of a system before implementing and setting goals that may turn out to be unrealistic with the current capacity of that system. Porter [9] suggest that capacity building activities should happen prior to implementing a new law or a new service so that an organization can be prepared to independently implement the new requirements and achieve the intended goals. The evaluation of a systems capacity to perform certain skills or reach specific goals is also important to determine what is working and what changes are needed [10] The following figure shows the process of capacity building and at the end how it could be achieve the sustainable built environment education.

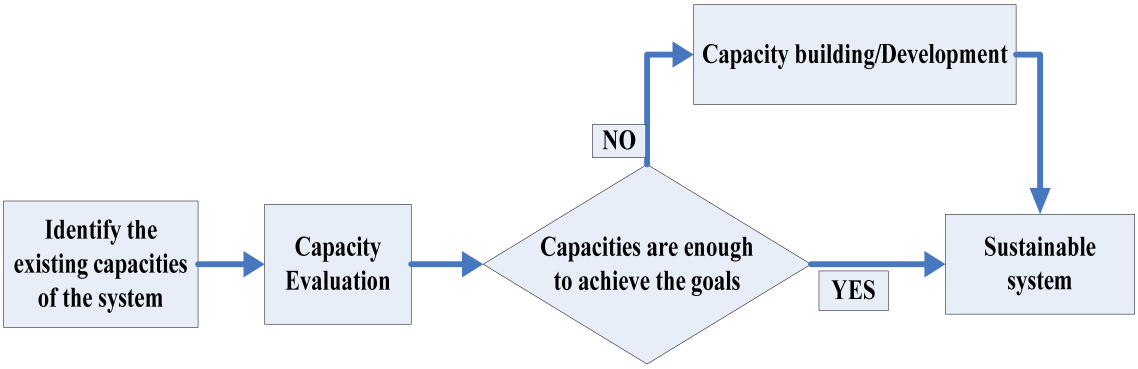

Figure 1- Capacity building process

3. Higher education and its capacities

The definition of higher education differs according to the context in which it is used. There is no overall consensus on the exact objectives of higher education, although some objectives like production of a qualified workforce, training people for careers in research, and enhancing life prospects are more commonly cited [11]. Almost all definitions agree that higher education refers to post-secondary education, where a degree, diploma, or certificate is awarded at the end of the study. Higher education builds on the level of competence, knowledge, and skills normally acquired in secondary education. The exact definition of this level, and consequently of higher education and of a higher education institution or programme, varies from one country to another. Consequently, the concept of 'higher education institution' may also vary. For example, in some countries, teaching is considered to be a field of higher education, while, in others, teaching is considered to be part of post-secondary education without falling into higher education.

Carter [12] mentioned the role of higher education sector related to built environmental as Promote built environment degrees, develop the skills industry needs, develop a long term aspiration for a career in the construction industry, Foster "enthusiasm" in the built environment.

4. Built environment education

There is a great link between built environment education and the construction industry. The built environment is based on the man-made surroundings that provide the setting for human activity, ranging from the large-scale civic surroundings to the personal places.The following diagram illustrates the link between the education system and construction industry in Sri Lanka.

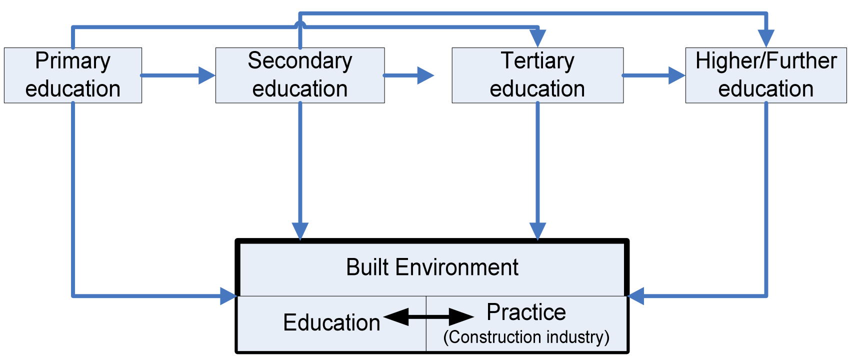

Figure 4 Education system and construction industry

4.1 Built environment education and capacities

Ginny cited in [13] has defined built environment education as, architecture and other facets of the material culture are the focal points of built environment education. For instance, it includes teaching and learning about city planning, architectural and landscape design, preservation of historic sites, and the issues and challenges raised by these activities. In general, the means and ends and the conditions and consequences of human interventions in the natural environment comprise the subject matter of built environment education. This includes teaching students to care for the built environment as it fits into the natural environment. Built environment education pertains to a great variety of places, objects and processes. So are recycling of resources and developing of model communities. And it refers to decision making about public issues, such as saving historically significant sites and balancing the sometimes conflicting goals of environmental protection and economic development. Built environment education prides itself in its design of ladders, nets and bridges to allow students to progress from one qualification to another, to provide some safe guards for students where they do not perform to an adequate level and to allow its qualifications to be recognised by other subject disciplines [14].

Through the literature survey the capacities were identified in two major types. The Institutional level capacities includes teaching, learning, research and innovation, governance, management, and finance. The Programme level capacities are assesment procedures, governance and management, community engagement, programme results and curriculum development.

There is growing concern for the safety and security of the civil infrastructure in relation to natural and manmade disasters. Safeguarding the future requires the expertise of professionals involved in the design, planning and construction of the built environment. Therefore it was recognized the necessity of enhancing the built environment education in local context as well as in the international context.

5. Research Method

A comprehensive literature survey and review was carried out on capacity building in the Built environment education systems. A Questionnaire Survey which was aimed on close ended questions by asking the significant level of capacities from the built environment professionals. The derived level of significance through the Questionnaire Survey was confirmed through structured Interview Surveys among the professionals who are practicing in construction industry and academic institutions.. Then a framework was developed by mapping the Higher education capacities and Built environment capacities together and finally the framework was tested on its acceptance through the expert opinions.

6. A Framework

At present there is multiple capacity development programs undergo in various sectors including the higher education. But the proper integration of capacities in built environment education is lacking. Therefore the research is focused on developing a framework for Capacity Building in built environmental education. The framework encompasses three domains. Those are the Capacities of higher education, the process and the capacities relates to the built environment education. Each domain involves different issues and mechanisms. The domain includes the concepts of built environment as an educational object; capacities in both institutional and programme level; capacity building process in concise way. Capacities of an educational institute can be categorized as Institutional level capacities and course content can be identified as the programme level capacities.According to the literature review; teaching, learning and research are identified as core capacities. So In the proposed framework institutional level capacities can be divided into two categories such as core capacities and supportive capacities. Further a Questionnaire survey which contains close ended question asking the significant level of capacities was carried out among the built environment professionals.This will help a built enviornment institute to identify the significant capacity and to make the capacity development on that capacity.

It is noteworthy that the new framework has been equipped with several user-friendly features than the results obtain through the application of one concept without knowing the other. Introducing this framework will create a path to identify the capacity building in built environment education institutions. Implementation of the capacity building in regular intervals will provide a sustainable output at last. This framework is based on the built environment education and focused only the undergraduate courses. So this framework gives a clear picture of built environment education capacities. Achieving the sustainable built environment through optimum use of resources can be obtained through the capacity building process.The proposed Framework is validated through the expert opinions from expert panel which comprises of four professionally trained experts and whom are presently working in the built environment educational institutions in Sri Lanka. The expert opinions critically analyzed with the literature and some changes have been done to the proposed framework such as addition of benchmarks and stakeholder involvement.

A FRAMEWORK FOR CAPACITY BUILDING IN BUILT ENVIRONMENT EDUCATION

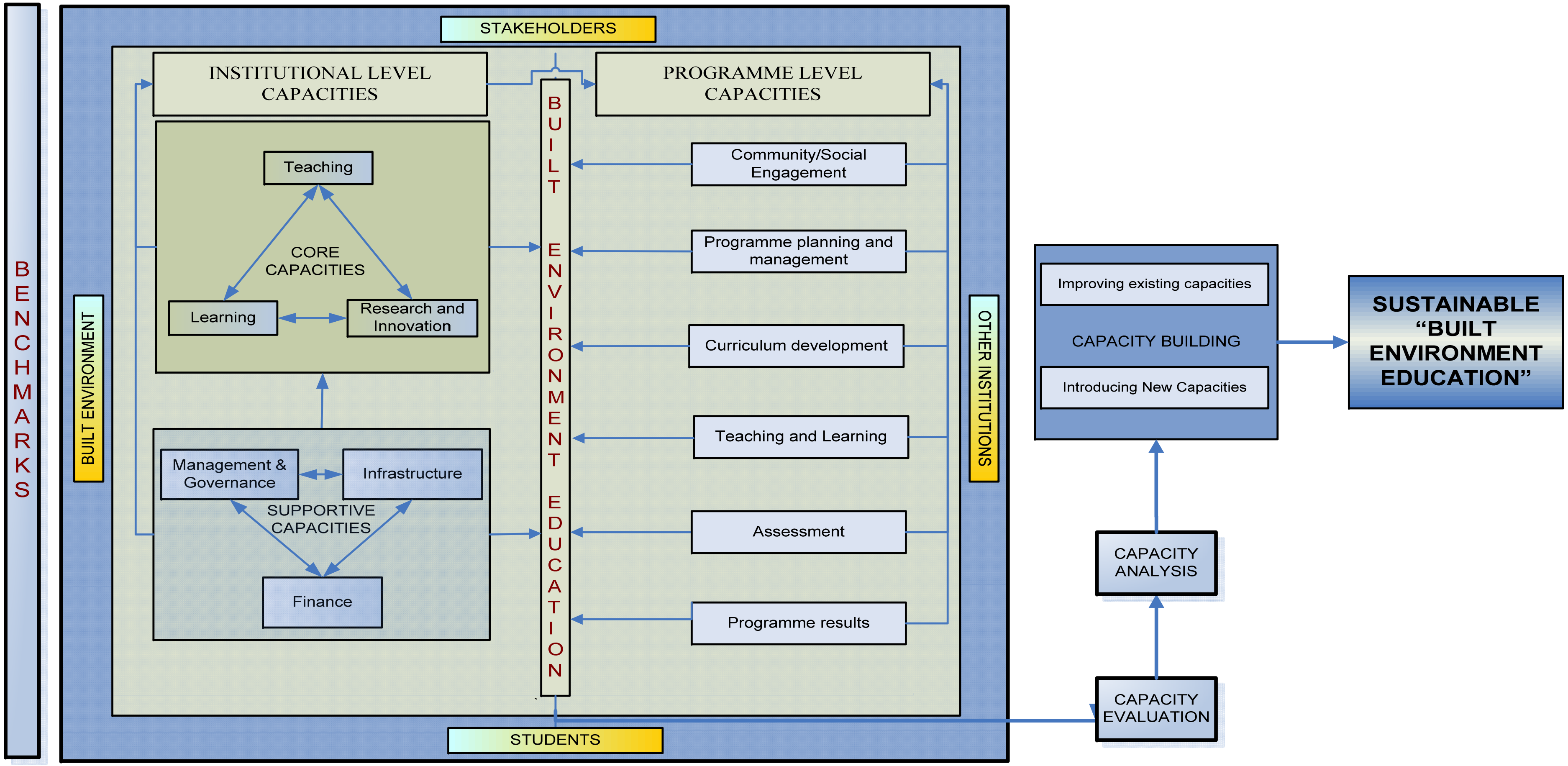

Figure 3 Framework for capacity Building in Built environment education

7. Conclusions

Higher education institutions have been confronted with far-reaching demands and challenges. Safeguarding the future requires the expertise of professionals involved in the design, planning and construction of the built environment. But improving the existing capacities, introducing new capacities are significant in both built environment and higher education system. To deploy the capacity building in built environment education it is significant to develop a framework for the built environment education. So this research aimed to develop a framework for built environment education to explore the capacities. The study aimed, by means of a literature survey, at exploring the perceptions, challenges, capacities of the built environment education, and then this research focused to identify the link between capacities involved in built environment education and finally concludes with a framework development and its validation.

The framework identified the capacities in terms if institutional level and programme level. The framework further sharpens with identification of benchmarks and the environment both internal and external. The developed framework is tested in its validity through expert opinions. Through the opinions it was caused to further modifications in certain intervals. The completed framework needs to check its practical validity by adopting in a built environment education institute. But it already accepted by the experts who were proven in the built environment academia. Therefore it can be concluded that the proposed framework could be sharpen through its practical application.

When an institute is practically implementing the proposed framework it is advisable to identify its capacities. Also mission, objectives, benchmarks may vary to institute to institute. So the institute whom is applying this framework should clearly define there organizational goals, objectives, missions and bench marks for activities. The framework can be recommended for the built environment educational institutes up to the undergraduate levels. But it needs to further develop for the postgraduate levels by incorporating the remaining capacities. . This framework will give a clear path for the capacity developments in built environment education institutes, thus it will lead to the sustainable built environment education.

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Small and Medium Size Contractors in Swaziland: Current Challenges

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Abstract

In Swaziland the construction sector is not only a significant source of direct employment but also a sector which contributes, through its wide range of projects and operations. The Swazi economy is unable to deliver employment for a growing number of would-be workers. Structural unemployment and poverty are persistent and growing problems in contemporary Swaziland. Small businesses have been advocated as an important means of generating employment in which Swaziland is not an exception. The paper will first outline the arguments that have been put forward for the development of small contractors in the construction industry in sub-Saharan Africa. The paper will then describe the problems and successes that have been experienced in Swaziland in relation to small contractor development programme. The paper will conclude with recommendations for the future which will enhance the success of small contractors in Swaziland

Keywords: Contractor, Construction, Development, Employment, Programme, Small Businesses, Swaziland.

1. Introduction

In Swaziland and other countries there seem a general consensus that small enterprises are the mainstay of economic growth and prosperity. Small contractors can be powerful instruments of generating job opportunities; small contractors can perform small projects at different and remote geographical locations that might be unattractive to big firms or too costly using the big firms; low overheads enable small contractors to work at more competitive prices; large number of functional small and medium scale black contractors can help to decentralise the construction industry dominated by established large contractors; the relatively low skills and resources required at this scale can easily lower the entry point for the small and medium size owners to begin to participate in the industry; and a large number of functional Swazi owned contractors can develop a platform for growth and redistribution of wealth in Swaziland.

At a time when the public sector and big business are shedding jobs, small businesses are maintaining real employment growth. The small contractor development programme falls under the Ministry of Public Works and Transport. The main mandate of the ministry is to ensure the provision and maintenance of a sustainable public infrastructure, an efficient and effective seamless transport system and network, regulation for a vibrant construction and transport industry, management of public service accommodation and the provision of meteorological services. In carrying out its mission, the Ministry is committed to upholding safety and environmental standards for socio-economic development by making the best use of the country's available resources. The following are the responsibilities of the ministry: construction and maintenance of Government buildings; construction and maintenance of public roads; administration of the Road and Outspan Act; planning and Regulation of Road Transport Services; Government Transport Administration; administration of the Road Traffic Act; administration of the Road Safety Act; Road Transportation Act; Government Housing; Royal Swazi National Airways Corporation; Civil Aviation; Meteorological Services; Regulation of Air Transport Services; and Regulation of Rail Transportation Services

2. Emerging Contractors in South Africa

In South Africa, the contractors enter the market at the lower end and in the general building contracting category, making the sector extremely competitive and unsustainable[1] and the emerging contractor policies intended for black economic empowerment (BEE) are being used as job creation opportunities, which contributes to the over crowding of the emerging market. It is common for black businesses to be based on technical skills which are based on technical skills, which are used to satisfy needs of the community. However, technical competence is no guarantee of business success. Operational (e.g. scheduling and ordering) and business (e.g. planning, financial control and budgeting) skills are vital to the success of any enterprise. It is precisely these skills which are often lacking in the black business and it is thus imperative that these are developed if the industry is to expand to accommodate the meaningful black presence that is necessary for economic growth.

Small enterprises contribute positively to the economics of the country and to the survival of large numbers of people. However, the success of small enterprise is impaired by the common weakness from which many enterprises suffer. South Africa is faced with a large challenge of developing infrastructure in the communities which were previously disadvantaged, and also upgrading the existing infrastructure to cope with the high demand. This category of contractors is the preferred vehicle of delivery of infrastructure to communities [2].

3. Financial Constraints

The high competition among emerging contractors has contributed to increase financial failures of the emerging market, making the market unsustainable. The (CIDB: 2005) states that the large numbers of emerging contractors have moved into higher value public tendering in the 0.5m to 2m market, which is also becoming overly competitive. In a study which looks at the construction industry in South Africa [1]. Emerging contractors should not tender for higher contract values until they have gained enough experience and have financial capacity to handle the larger contracts.

The CIDB [3] states that from 1995 to 2005, about 5907 construction companies were formally liquidated. The CIDB [4] states that much more than 90% of the emerging black contractors survive the first five years. The CIDB further highlight that 1,400 construction companies were liquidated over the past three years. Emerging contractors feel that the banks are reluctant to deal with them unless exorbitant interest rates and through compulsory business management services. Complexity, risks involved in the construction industry have led to enormous failures especially in small contractors and those small emerging contractors harboring the wrong impression that there is quick money to be made are the mostly affected [2]. Lack of access to finance both during pre-construction which disqualifies emerging contractors from meeting guarantee and performance bond requirements and during construction which leads to cash-flow problems, incomplete work and even liquidation are financial constraints facing emerging contractors.

4. Relationships between Emerging Contractors and Suppliers

Emerging contractors do not have good relationships with their suppliers. In a functioning relationship, the material supplier provides credit to the contractor (30-90 day term), contractor pays on time and the cycle gets repeated. In an emerging supplier relationship, the supplier requires cash upfront and will not deliver the material until payment is made in full. The reason for this is if the supplier provides credit to the emerging contractor, the contractor is often unable to pay on time due to capacity or performance constraints. The reluctance by suppliers in the relationship with emerging contractors is caused by the following risk factors:

- History of emerging contractor’s failure to complete projects which is very high
- Systematic contractor payment processing delays, especially for construction works commissioned by the public sector.
- The potential for material losses due to theft, lack of appropriate storage and mismanagement by emerging contractor

5. Late Payment by Clients

Emerging contractors run into problems due to late payments by the clients. A problem arises when the local council run into budget difficulties and be unable to pay. The emerging contractor does everything right, his work is of good quality but the local council doesn’t pay on time and the contractor ends up owing the bank and defaulting. In one case, the contractor built 400 houses, but the town councilor had used the money for other pressing needs. On a different project, the same contractor built 150 of 300 houses; only to discover that the town council had forgotten to register the houses and this caused a delay in the payment for over a year. The unlucky contractor, failing to repay loans in a timely fashion had his business put into liquidation.

6. Difficulties when Running a Business

The Construction Industry Development Board (CIDB) [1] has presently concluded a reform measure whereby it used certain criteria to grade/ categorizes / register the contractors, which are to a certain extent being contested at some quarters. All these reform measures tend to concentrate on how to make projects accessible to the black contractors. They do not change the complex conditions of the contract performance procedure; they do not equip the contractors with the required capacity/ competency that can achieve success.

In South Africa, problems facing small emerging contractors in the contractor development programs (CIDB, DPW, CETA (2005) are as follows: [4] usually open adverts are placed in the media calling on people to come out and participate; it is very difficult for a selection process to capture those with the proper drive, passion and ability to work as contractors; this brings wrong people in the programs and drives them easily on the way; the required academic qualification is usually matric or less; no prior technical and managerial skills/experience in construction related fields as prerequisites; few matric holders make rare success; most successful contractors have degree or diploma in construction related field, with 5-10 years technical and managerial work experience; inadequate training done at short period's in-between projects; unsuitable for the contractor's time and project need; inappropriate trainers; clear-cut grading criteria had been elusive; recently CIDB graded/categorized the contractors using some contested criteria; core tech and management staff not stated, this may still lead to contractors getting projects they do not have capacity for; the contractors do not seem to understand the nature of complexity and risk in contracting; do not seem to be adequately informed of how to deal with them properly; the contractors lack skill, experience and tools to win profitable contract; they either win a grossly under-priced bid, or lose a grossly over-priced one; they lack own ready finance and access to affordable loan.

Due to lack of collateral, any one that gets credit from banks is subjected to high interest and financial risk management charges that make contracts unprofitable; in the ambition to grow big and make big profit, most of them take projects they do not have the necessary skills and financial resources to execute; the contractors tend not to employ qualified worker; they consider them expensive, but they fail while doing things all by themselves or with cheap, incompetent workers; they lack skills to properly program projects resources in monthly segments for healthy cash flow; they are not allowed front load due to lack of trust; they do not know how to prepare documents for timely payment; delayed payment; they do not seem to understand terms of contract conditions; do not know how to use applicable contract performance procedure to deal with client; they do not get properly trained in this. they are usually considered incapable of doing competent work, which imperils their relationship with the client's agent; they do not seem to know how to use applicable contractual instruments regarding instruction, demand for specific performance, and payment; they are not properly taught; where they know these rules they fail to use them due to fear of being 'red listed'; in attempt to make huge profit they cut specified quality, do bad work that falls short of the design standards/specification. Rejection of such works usually leads to none payment, conflict and most times failure of the contractors; and those that manage to win profitable contracts get only 2% profit if they are able to successfully complete the project; it seems discouraging.

7. International Experience with regard to Small and Medium Enterprise

In order to get an overall perspective of the environment and conditions within which we operate, it is imperative that we look at similar situations of small enterprise development in other countries. Bangladesh, Singapore and Malaysia have grappled with similar situations as far back as the post Second World War reconstruction period. These countries in different ways have a longer history and applied experience with regard to the development of a small business strategy. We do however recognise that different circumstances supported their initiatives, despite common experiences of the war devastation. In spite of positive circumstances in the above economies for Small Medium Micro Enterprises (SMMEs) to prosper, the strategies took at least ten years to unfold. This provides us with the opportunity to learn from other countries experiences, both useful and harmful, for Swaziland’s unfolding small business strategy.

All three countries add a different perspective about 'international best practice'. International best practice in these countries suggests that a strong institutional framework displays the following characteristics: a combination of financial and non financial services delivered by separate institutions in close co-operation as part of a national strategy; targeted finance programmes i.e. broad based, industry based and sector based schemes with focused assistance e.g. machinery, factory premises, raw materials, training programmes and technology; a detailed and comprehensive 'economic umbrella plan' with targets i.e. an overall vision and the inputs to be invested with clear detailed outputs within particular time frames; avoidance of ad hoc and disconnected programmes. Programmes are part of the larger strategy or plan [5]. A rapid delivery of programmes and an ability to rapidly shift programme focus and resources; ease of access to user; demand driven support; and a platform for interaction between public and private sectors with a strong emphasis on the planning role of the state.

8. Contractor Accreditation Process in Swaziland

A registration of accredited construction enterprises in Swaziland constitutes an essential tool for the industry transformation, for monitoring the performance of enabling environment programmes, and for ensuring compliance with the performance of public-sector projects. All construction enterprises engaged in public sector work, or in receipt of State funding training or support functions, will be required to be registered in a manner that will reflect their capacity and performance. The registration process must address the following: the operation of a preference scheme, or approved public tender list, which would reduce industry and public sector cost associated with an all out open tender process at the same time supporting risk management; performance monitoring to enable the promotion of improved contractors and to ensure compliance where standards are violated; and; the targeting of resources to the emerging contractors which are demonstrating progress and the withdrawal of support from those which have graduated or have failed to progress [6].

8.1 Category 1

Project Category 1 is eligible to tender for:

1. Locally and internationally funded construction projects above R20 million.
2. Specialist Projects of any value in areas where there is little or no expertise in the other categories to generate interest and competition.
3. Will Have 5% disadvantage on the tendered price on all locally funded projects when compared to the prices tendered by category two contractors.
4. Will have 10% disadvantage on the tendered price on all locally funded projects when compared to the prices tendered by category three contractors.
5. Will have to manage 25% of relevant portions subcontracted to category 3, 4, 5&6 contractors.
   (These will be sub-contracts, tendered for by registered local sub-contractors as part of the main contractor's bid in line with the percentage sub-contracts specified as shown below).
   - 15% to category 3 and 4 contractors.
   - 10% to category 5AND 6 contractors.

8.2 Category 2

Project Category 2 is eligible to tender for:

1. Local and internationally funded construction projects above E10 million.

2. Specialists' projects of any value in areas where there is little or no expertise in the lower categories to generate interest and competition.

3. Will have 10% disadvantage on the tendered price on all locally and internationally funded projects, when compared to the prices tendered by category 3 contractors.

4. Will have to manage the 25% of relevant portions sub-contracted to category 3, 4 5, and 6.
(These will be sub-contracts, tendered for by registered local sub-contractors as part of the main contractor's bid with the percentage sub-contracts specified as shown below.)

- 15% to category 3 and 4 contractors.
- 10% to category 5 and 6 contractors.

8.3 Category 3

Project Category 3 is eligible to tender for:

1. Local and internationally funded construction projects above E5 million.

2. Specialists' projects of any value in areas where there is little or no expertise in the lower categories to generate interest and competition.

3. Maintenance projects above E1million

4. Entitled to a portion of the 15% sub-contract works to category 1 and 2 contractors.

6. Will not be eligible to tender for routine maintenance works such as vegetable control, porthole patching, fencing etc.

7. Will have 10% advantage on the tendered price on all locally funded projects when compared to prices tendered by category 2 contractors.

8. Will have 5% disadvantage on the tendered price for sub-contract work, when compared to the prices tendered by category 4 contractors.

9. Will have to manage 25% of relevant portions sub-contracted to category 4, 5, and 6.
(These will be sub-contracts, tendered for by registered local sub-contractors as part of the main contractor's bid with the percentage sub-contracts specified as shown below.)

- 10% to category 4 contractors.
- 15% to category 5 and 6 contractors.

8.4 Category 4

Project Category 4 is eligible to tender for:

1. Local and internationally funded construction projects above E1million.

2. Specialists' projects of any value in areas where he has sufficient expertise and experience.

3. Maintenance projects above E1million.

4. Will not be eligible to tender for routine maintenance works such as vegetable control, porthole patching, fencing etc.

5. Will have 5% advantage on the tendered price on projects when compared to the prices tendered by category 3 contractors.

6. Will have to manage the 25% of relevant portions sub-contracted to category 5, and 6 contractors.
(These will be sub-contracts, tendered for by registered local sub-contractors as part of the main contractor's bid with the percentage sub-contracts specified as shown below.)

- 15% to category 5 contractors.
- 10% to category 6 contractors.

8.5 Category 5

Project Category 5 is eligible to tender for:

1. Local and internationally funded construction projects above E500, 000.00 but below E3million.

2. Specialists' projects between E500, 000.00 and E1million in areas where he has sufficient expertise and experience.

3. Maintenance projects between E500, 000.00 and E3million.

4. Will be eligible to tender for all road reserve maintenance contracts.

5. Will have a 2% disadvantage on the tendered price on all sub-contract works when compared to the prices tendered by category 6 contractors.

6. No sub-contract works.

8.6 Category 6

Project Category 6 is eligible to tender for:

1. Local and internationally funded construction projects below E500, 000.00.

2. Specialists' projects between E500, 000.00 in areas where he has sufficient expertise and experience.

3. Maintenance projects below E500, 000.00.

4. Will have a 2% disadvantage on the tendered price on all sub-contract works when compared to the prices tendered by category 5 contractors.

9. Problems Facing Small and Medium Size Contractors in Swaziland

The problems facing small contractors are not unique to Swaziland. The vast majority of construction firms are small enterprises that rely on outsourcing personnel as required. This has severely affected skills training and the retention of expertise in the industry as construction workers become highly mobile, walking in and out of the industry, depending on performance in other sectors of the economy. The impact can be seen in the rigid adherence to management techniques and construction practices handed down from colonial times which, as a result of inadequate skills and capacity. Delays with interim and final payments, as well as onerous contract conditions faced by construction firms, can also impose huge constraints on the industry. Many construction firms have suffered financial ruin and bankruptcy because of delays in payment, which are common with government contracts. Contemporary research that was conducted in 2007 by the authors revealed the current reasons for the failure of small and medium size contractors in Swaziland. 87 owners of the small and medium size contractors were interviewed. 68% of the contractors are less than four years; 20% are between 5 and 9 years; and 12 % had operated for more than 10 years. There was no contractor that had operated more than 15 years. 63% of the respondents believe that the four major banks in Swaziland have proper systems in place to support small and medium size contractors once they have secured work. On the other hand 37% of the respondents do not believe that the four major banks in Swaziland have proper systems in place to support small and medium size contractors. 33.4% of the respondents think that the current environment within the construction industry in Swaziland is favourable for small and medium size contractors to be successful. On the other hand 66.6% of the respondents believe that the construction industry environment is not favourable for the success of the small and medium size contractors.

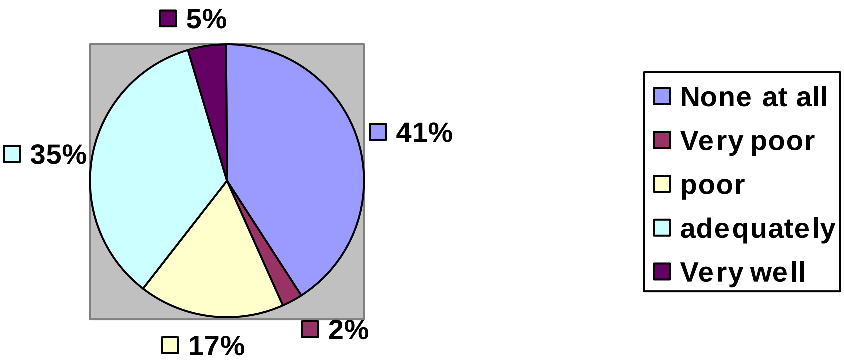

Figure 1 - Develop Business Skills

From the above figure 40% of the respondents are satisfied with business skill development and 60% of the respondents were not satisfied. The figure above shows that the respondents are not satisfied with regard to the development of business skills.

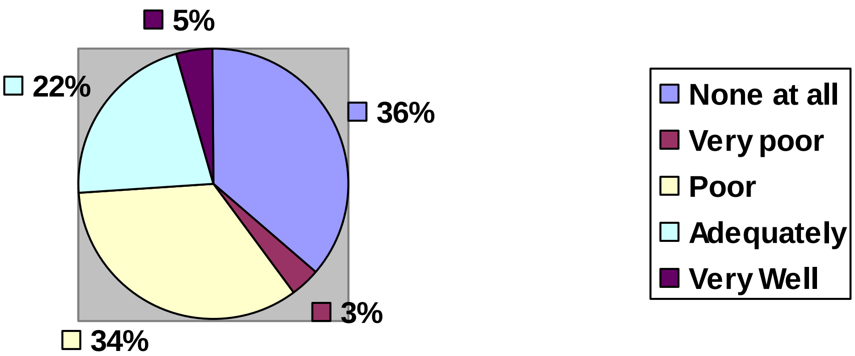

Figure 2 - Develop Management Skills

From the above figure 27% of the respondents are satisfied with the development of managerial skills. 73% of the respondents are not satisfied with the development of managerial skills. It is clear from the above figure that respondents had not been trained.

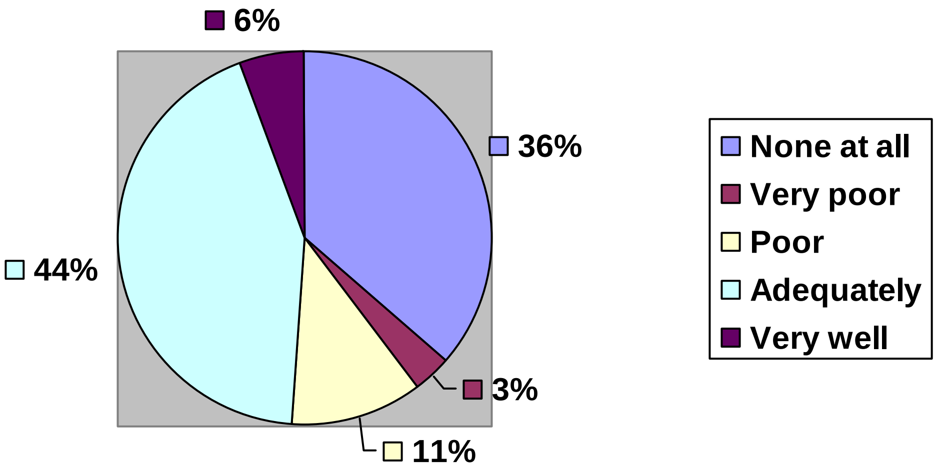

Figure 3 - Develop Technical Skills

From the above figure 47% of the respondents are satisfied with the development of technical skills. 53% of the respondents are not satisfied with the development of technical skills.

From the research conducted it can be concluded that the relative lack of success among the small and medium size contractors in Swaziland is a results of the following problems which must be addressed in order for the contractors to be successful:

- A lack of resources for either large or complex construction work.
- An inability to provide securities, raise insurance and obtain professional indemnity.
- The contracts were inevitably packaged in such a way as to exclude small contractors.
- Inadequacy in technical and managerial skills required in project implementation.
- Lack of continuity in relation to type, scale and location of work
- An inadequate approach and insufficient knowledge, time and experience required for the whole process of finding work, once found, insufficient understanding of the contract documentation and the preparation and submission of tenders.
- Slow and non-payment by government after completing a government project

10. Lessons and Recommendations

The planning processes in Singapore and Malaysia are comprehensive, detailed and act as a guide for different Ministries to set quantitative and qualitative targets for delivery institutions. The planning process involves extensive consultations and input by a broad range of stakeholders, which is then co-ordinated and submitted to cabinet and finally parliament as the Industrial Master Plan. These plans tend to unite society around a common purpose and vision.

Integral to economic planning in Singapore and Malaysia is targeted financial assistance for broad based, industry based and sector based schemes with focused assistance programmes e.g. machinery, factory premises, raw materials, training programmes, industrial linkages, technology and research and development. The interest rates for the contractor programmes are generally lower than bank loans. The overall plan identifies certain industries and sectors as crucial to the economic development of the country. Holistic support programmes including financial incentives are introduced for identified sectors and industries. The growth of these industries and sectors act as a catalyst in the development of other sectors. It is seen as an investment by government with spill off effects. The government financial assistance is not ad hoc but part of a broader strategy.

None financial support programmes cover a focused and wide range of issues including targeted training, quality circles, research, mentoring, design and product development, skills development, Local Enterprise Upgrading Centre, infrastructure development, export development, technology development and technical assistance. These support programmes are closely linked to the financial packages e.g. the buying of machinery requires, optimal training in the use of such equipment. Support programmes are not seen in isolation to the broader strategy and guides entrepreneurs in fulfilling the targets set. The programmes are able to rapidly shift focus and resources. The Singapore Local Enterprise Upgrading Centre acts as a first stop for SMMEs giving assistance in technical consultancy and financing. It co-ordinates government programmes administered by a range of institutions. The first stop centre avoids bureaucracy for the entrepreneur and increases delivery efficiency. Government procurement is clearly an important mechanism in redistributing resources and opportunities in society. In Malaysia the government has actively used procurement as a means to empower, skill and redirect resources to the Bumiputeras.

11. Conclusion

The small and medium size contractors in Swaziland is relatively underdeveloped, mainly constrained by limited access and high cost of capital and weak support programmes from government. There is also lack of skills. The most important deciding factors in the development of small contractors in Swaziland are to address the issue of access to finance, shortage of skills and adequate support from government must be a priority. Survival, growth and expansion of the small business sector are essential for economic growth and job creation in Swaziland. Small businesses represent over 95% of the total number of business organizations in the United States of America [7]. Thompson [8] points out that small businesses employ six out of every ten people and have been responsible for more than half of all the innovations developed during the 20th century. Haswell & Holmes [9] they attribute small business failures to the following: managerial inadequacy, incompetence, inefficiency and inexperience in running a business venture.

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SECTION VI

DISASTER MITIGATION

Gender mainstreaming in disaster reduction: why and how?

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Abstract

The significant losses in human life and livelihoods, the destruction of economic and social infrastructure and damage to the environment caused by disasters in the past decade has increased the necessity for proper disaster reduction and risk management strategies. A disaster is shown as a combination of a trigger agent and vulnerabilities. Since vulnerabilities are the dependant component of a disaster, they should be managed and minimised in order to reduce disasters. Disaster reduction policies and measures, which ensure a decrease in vulnerabilities, need to be formed and implemented to achieve a sustainable and consistent plan of disaster management. Since women are more vulnerable in a disaster, their needs and concerns should be widely integrated into risk reduction plans and procedures from both perspectives of women as beneficiaries and decision makers. Gender mainstreaming is considered an important element in disaster reduction policy making to integrate a gender equality perspective in all policies at all levels. Gender mainstreaming in disaster reduction refers to promoting awareness about gender equity and equality, to help reduce the impact of disasters and to incorporate gender analysis in disaster management, risk reduction and sustainable development to decrease vulnerability. This paper reviews literature on disaster reduction and gender mainstreaming to emphasise why gender mainstreaming has become a necessity in disaster reduction attempts and to highlight the ways in which it can be achieved.

Keywords: Disaster reduction, Gender mainstreaming, Women.

1. Background

1.1 Introduction

"Disasters, one of man's oldest concerns, reach back to periods of pre-history and myth, yet strangely enough, are hardly an area of critical scrutiny" [14] (p. 66). Disasters are known as sudden events, which bring serious disruption to society with massive human, material and environmental losses and these losses always go beyond the capacity of the affected society to cope with its own resources [15],[27]. According to McEntire [17], any disaster is a combination of a triggering agent and a set of vulnerabilities – and it is these vulnerabilities, the conditions, which affect the capacity of a society to respond to the triggering agent which is the controllable component of a disaster. Since disasters cause large-scale damage to human life, their livelihoods, economic and social infrastructure and environment [11],[28] and these damages have shown a significant increase in the last one and a half decades [28], the world is in serious need of a sustained and comprehensive disaster reduction strategy. In achieving this, the needs and concerns of all social groups such as poor, rich, men, women, young, old, indigenous or non-indigenous must be necessarily integrated into the disaster reduction policies and measures because the level of vulnerability depends on these social aspects [11]. The Secretariat of the United Nations International Strategy for Disaster Reduction [8] emphasises that the vulnerability of women to disasters is greater mainly because of the social values.

The main aims of this paper are to highlight the importance of gender mainstreaming in disaster reduction policymaking and to discuss ways of mainstreaming gender. In order to make the path of achieving this aim clearer, this paper gives an account of the nature and types of disasters and the world's movement towards disaster reduction in its early sections. The next section characterises and classifies disasters as a preface to the disaster reduction trend and practices, which are described later. The third section focuses on gender mainstreaming, its importance and proposed means of integrating it into disaster reduction policies and measures. This paper is based on a review of academic literature, papers and reports produced by the United Nations International Strategy for Disaster Reduction (UN/ISDR) and various other institutions.

1.2 The way disasters are seen

1.2.1 Defining disasters

Historically, disasters were known as acts of god, or events outside human control, which brought massive disruption to society [17]. However, subsequently, with the expansion of scientific knowledge, disasters became synonymous with disaster agents or more specifically, they were seen as natural hazards [17]. UN/ISDR defines a disaster as a serious disruption of the functioning of a community or society causing widespread human, material, economic or environmental losses, which exceed the ability of the affected community or society to cope using its own resources [15]. However, disasters are interpreted in different ways by scholars and institutions. Weichselgartner [33] argues that natural disasters are a social phenomena because the overall damage due to natural hazards is the result both of natural events that act as a "trigger" and a series of societal factors. According to Jaya Kumar [14], the term is used to indicate a whole range of distress situations both individual and communal and that disasters are events in time, which have distinct phases of onset, climax and withdrawal. Ariyabandu and Wickramasinghe [1] view disasters as sudden events, which require immediate, emergency relief. McEntire [17] puts forward a different perspective by indicating that disasters as the disruptive outcome or human-induced triggering agents when they interact with and are exacerbated by vulnerabilities from diverse but overlapping environments. Apropos, as Shaluf et al. [28] indicates none of these definitions of disasters are universally accepted yet. The way that the disasters are explained varies according to the discipline in which they have been defined. Generally, there are four main bases for defining disasters as technical, sociological, political and medicinal [29]. However, almost all the definitions describe a disaster as an event, which disturbs the social structure or the environment, causes a significant loss and needs external assistance in recovery.

1.2.2 Types of disasters

Disasters are often divided into two main categories - as natural or man-made according to their cause [28],[15],[23],[27]. Figure 1 illustrates this. In addition to the two main categories of disaster, Shaluf [28] and Shaluf and Ahmadun [27] indicate that there can be a third category of disasters as hybrid disasters, which occur as a combination of natural and man-made disasters. Further, Shaluf and Ahmadun [27] show that natural and/or man-made disasters can trigger subsequent disasters as well.

Disasters are classified into three groups by Jaya Kumar [14] referring to the spatial dimensions of disasters as small, localised or large and regional disasters. On the other hand, disasters can be categorized into two, based on their spatial and socio economic characteristics as exogenous disasters and endogenous disasters [14] (p.75).

- Exogenous disasters- which relates to an energy that is external to society and which injure, destroy and affect everyone trapped within the spatial or temporal dimension. This can be defined as an event concentrated in time and space in which a community or a society experiences and shares severe danger, injury and destruction or disruption of the social structure and essential function of the society.
- Endogenous disasters- which emerge from forces within society and which injure one group while enrich other or which distress is suffered by one section of the community while material gains and social satisfaction accrue to another.

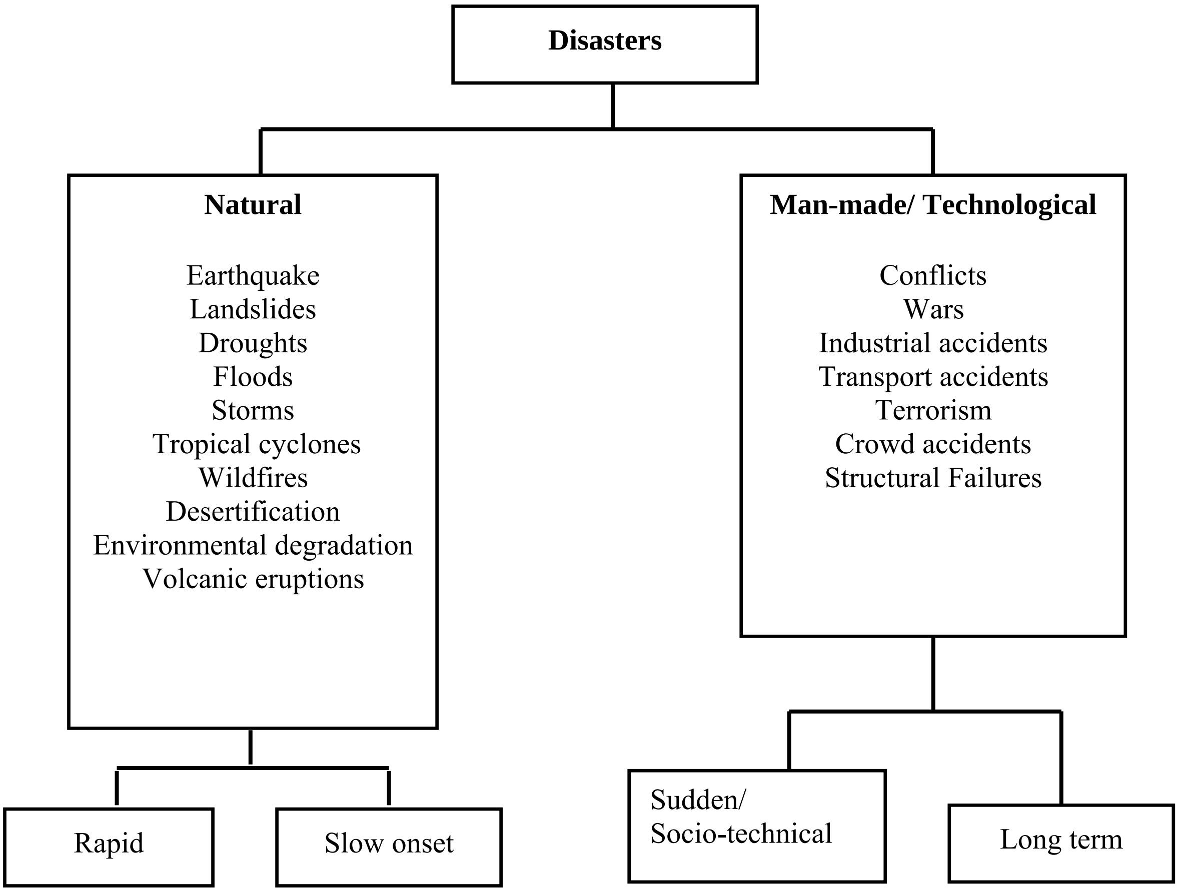

Figure 1: Categorization of disasters according to their cause

1.2.3 Occurrence of disasters

Initially, scholars and policy makers gave attention to disasters concentrating mainly on hazards giving an implication that the hazard agent was the disaster [19]. UN/ISDR [12] describes hazard as a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Furthermore, hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydro-meteorological and biological) or induced by human processes (environmental degradation and technological hazards) [12]. However, this initial perspective on disasters was problematic because natural occurrences such as tornados in uninhabited plains may not be seen as a disaster and some hazards such as floods and fires can even be beneficial for the environment (e.g. providing rich, fertile soils for farming and forest rejuvenation) [19]. Therefore, the subsequent viewpoint that all disasters irrespective of whether they are natural or man made emerge as a combination of a triggering agent/hazard and vulnerabilities [17],[24] is more rational. With the establishment of the latter view, the emphasis on vulnerabilities in the context of disasters was raised gradually.

1.2.4 Vulnerabilities

Vulnerability is known as a set of conditions that affect the ability of countries, communities and individuals to prevent, mitigate, prepare for and respond to hazards [1]. It is seen that all individuals and communities are to varying degrees vulnerable to hazards and all have intrinsic capacities to reduce their vulnerability [34]. Apropos, vulnerability is given various definitions in disaster research since 1980 [33]. Similarly the disaster definitions vary according to the discipline they are based on and the way in which vulnerability is seen depends on the respective discipline [19]. UN/ISDR [12] defines vulnerability as the conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of a community to the impact of hazards. Based on the above explanation, the Working Group on climate change and disaster risk reduction of the Inter Agency Task Force on Disaster Reduction [34] illustrates the different dimensions of vulnerabilities as follows.

- Physical vulnerability refers to susceptibilities of the built environment and may be described as "exposure".
- Social factors of vulnerability include levels of literacy and education, health infrastructure, the existence of peace and security, access to basic human rights, systems of good governance, social equity, traditional values, customs and ideological beliefs and overall collective organisational systems.
- Economic vulnerability characterises people less privileged in class or caste, ethnic minorities, the very young and old, the disadvantaged, and often women who are primarily responsible for providing essential shelter and basic needs.
- Environmental vulnerability refers to the extent of natural resource degradation.

On the other hand, McEntire [17] categorizes the variables, which interact to produce a future of increased vulnerabilities under physical, social, cultural, political, economic, and technological headings as given in the following list. This classification splits the social vulnerability in the earlier categorization into three separate groups as social, cultural and political dimensions of vulnerabilities. In addition, the environmental dimensions are brought under the physical variables here in contrast to the earlier division.

- Physical
    - the proximity of people and property to triggering agents
    - improper construction of buildings
    - inadequate foresight relating to the infrastructure
    - degradation of the environment.
- Social
    - limited education (including insufficient knowledge about disasters)
    - inadequate routine and emergency health care
    - massive and unplanned migration to urban areas
    - marginalisation of specific groups and individuals
- Cultural
    - public apathy towards disaster
    - defiance of safety precautions and regulations
    - loss of traditional coping measures

    - dependency and an absence of personal responsibility.
- Political
    - minimal support for disaster programmes amongst elected officials
    - inability to enforce or encourage steps for mitigation
    - over-centralisation of decision making
    - isolated or weak disaster related institutions
- Economic
    - growing divergence in the distribution of wealth
    - the pursuit of profit with little regard for consequences
    - failure to purchase insurance
    - sparse resources for disaster prevention, planning and management
- Technological
    - lack of structural mitigation devices
    - over-reliance upon or ineffective warning systems
    - carelessness in industrial production
    - lack of foresight regarding computer equipment/programmes

McEntire [17] explains that vulnerability acts as the dependant component while the triggering agent stands as the independent component of a disaster. This dependant component is determined by the degree of risk, susceptibility, resistance and resilience [17]. Therefore, vulnerabilities should be managed in order to mitigate disasters. McEntire [17] shows invulnerable development or vulnerability management as a process whereby decisions and activities are intentionally designed and implemented to take into account and eliminate disaster to the fullest extent possible.

2. An overview of disaster reduction

Disaster preparedness through minimising vulnerabilities has been identified as a better approach to face disasters than post-disaster responsiveness [9],[24]. According to Goodyear [6], creating a culture of prevention is essential to address everyday hazards and the consequences of a disaster. Disaster risk reduction is defined as the conceptual framework of elements considered with the possibilities to minimise vulnerabilities and disaster risks throughout society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development [12]. Therefore, disaster risk reduction must be more decisively incorporated as an essential component of all development strategies, policies, programmes and investments for national and local governments [26]. In other words, disaster reduction incorporates taking measures in advance, addressing risk reduction, involving environmental protection, social equity and economic growth, the three cornerstones of sustainable development, to ensure that development efforts do not increase the vulnerability to hazards [11].

The United Nations International Strategy for Disaster Reduction (UN/ISDR) is a pioneer in disaster reduction movement in the international context. ISDR aims at building disaster resilient communities by promoting increased awareness of the importance of disaster reduction as an integral component of sustainable development and it promotes following four objectives for disaster reduction.

- Increase public awareness to understand risk, vulnerability and disaster reduction globally.
- Obtain commitment from public authorities to implement disaster reduction policies and actions.
- Stimulate interdisciplinary and intersectoral partnerships, including the risk reduction networks.
- Improve scientific knowledge about disaster reduction.

A close inter-relationship is shown between disaster reduction and sustainable development in disaster management research. Stenchion [31] determines that a number of development activities have a great responsibility and inter-relationship with disaster risk reduction because both development and disaster management are aimed at vulnerability reduction. Further, it is indicated that development can increase and/or decrease disaster vulnerability [18]. It is essential, therefore, to take measures of disaster risk reduction into consideration in all development activities. The framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters states, "there is now international acknowledgement that efforts to reduce disaster risks must be systematically integrated into policies, plans and programmes for sustainable development and poverty reduction, and supported through bilateral, regional and international cooperation, including partnerships. Sustainable development, poverty reduction, good governance and disaster risk reduction are mutually supportive objectives. In order to meet the challenges ahead, accelerated efforts must be made to build the necessary capacities at the community and national levels to manage and reduce risk" [13].

3. Gender mainstreaming and disaster reduction

3.1 Gender and disasters

"Disasters affect women and men differently because of the distinct roles they occupy and the different responsibilities given to them in life and because of the differences in their capacities, needs and vulnerabilities" [1] (p.51). UN/ISDR [8] indicates that women are more vulnerable in disasters and they are the most affected. The poor and predominantly female and elderly populations are characterised by higher economic vulnerability as they suffer proportionally larger losses in disasters and have limited capacity to recover [34]. Enarson [4] identifies the following points as the reasons for women's higher vulnerability in disasters.

- Women have less access to resources.
- Women are victims of the gendered division of labour.

- Women are primarily responsible for domestic duties such as childcare and care for the elderly or disabled and they do not have the liberty of migrating to look for work following a disaster.
- As housing is often destroyed in the disaster, many families are forced to relocate to shelters.
- When women's economic resources are taken away, their bargaining position in the household is adversely affected.

In addition to the above factors, Enarson [4] points out that disasters themselves can increase women's vulnerability not only because they increase female headed households but sexual and domestic violence are also increased following a disaster.

According to, Enarson [4] and Khatun [16], although women are at greater risk than men in disasters, it is the women who make it possible for the community to cope with disasters because their social role is central to the management of a disaster coping strategy. However, women's abilities to mitigate hazards and prevent disasters and to cope with and recover from the effects of disasters have not sufficiently been taken into account or developed [1]. As Ariyabandu and Wickramasinghe [1] indicate, in current practice of disaster reduction women are seen as helpless victims and their capacities, knowledge and skills in each stage of the disaster cycle are not recognised. The gender differences in the disaster mitigation have been discussed primarily in the context of vulnerability or community involvement. The absence of women in decision making positions in emergency and recovery planning is not effectively addressed. Therefore, a gender perspective should be integrated into all disaster reduction policies and measures in order to decrease women's susceptibility in disasters. However, gender equality in disaster reduction requires empowering women to have an increasing role in leadership, management and decision making positions because women are not only victims of disasters but they can act as agents of change in disaster reduction planning [8],[11].

3.2 Gender mainstreaming

The Platform for Action (PfA) at the Fourth World Conference on Women in Beijing in 1995 brought up the concept of gender mainstreaming, the commitment to integrate gender perspective in all forms of development and political processes of governments [22]. UN/ISDR [11] elaborates gender mainstreaming as the process of bringing a gendered perspective into the mainstream activities of governments at all levels, as a means of promoting the role of women in the field of development and integrating women's values into development work. Although, the ultimate aim of gender mainstreaming is to achieve gender equality, it is not for promoting equality to the implementation of specific measures to help women; it is to achieve equality in all general policies and measures by actively and openly taking the possible effects on the respective situation of men and women into account at the planning stage [5].

According to the Employment and European Social Fund [3], gender mainstreaming means a partnership between women and men to ensure both participate fully in society's development and benefit equally from society's resources. Gender mainstreaming covers the following aspects.

- Policy design
- Decision-making
- Access to resources
- Procedures and practices
- Methodology
- Implementation
- Monitoring and evaluation

Therefore, gender mainstreaming is necessary to incorporate in the policies and programmes related to disaster reduction mainly because “gender shapes capacity and vulnerability to disasters” [2] as discussed earlier. As the United Nations Office of the Special Adviser on Gender Issues and Advancement of Women [22] explains, gender mainstreaming can promote gender equality and women's empowerment, particularly where there are glaring instances of persistent discrimination of women and inequality between women and men. Gender mainstreaming can be used as an effective tool to reduce the vulnerability of women, which arise due to various factors including less access to resources and to bring more women in to disaster reduction policy making process.

However, promoting gender mainstreaming is a long, slow process requiring inputs on many fronts over a long period of time, including advocacy, advice and support, competence development, development of methods and tools and vigilance in following up and evaluating progress [22].

3.3 Gender mainstreaming in disaster reduction

According to the definition given by the International Labour Organisation [7] for gender mainstreaming, it is bringing the experience, knowledge, and interests of women and men to bear on the development agenda and identifying the need for changes in that agenda in a way which both women and men can influence, participate in, and benefit from development processes. Accordingly, mainstreaming gender perspectives into disaster risk reduction should concern women in development processes as equal partners to men as both decision makers and beneficiaries [1].

According to Carolyn Hannan, Director of the UN Division for the Advancement of Women [7], the following basic principles should be set up for mainstreaming gender.

- Adequate accountability mechanisms for monitoring progress need to be established.
- The initial identification of issues and problems across all area(s) of activity should be such that gender differences and disparities can be diagnosed.
- Assumptions that issues or problems are neutral from a gender-equality perspective should never be made.
- Gender analysis should always be carried out.

- Clear political will and allocation of adequate resources for mainstreaming, including additional financial and human resources if necessary, are important for translation of the concept into practice.
- Efforts to broaden women's equitable participation at all levels of decision-making should be taken.

Therefore, mainstreaming gender in to disaster reduction policies and measures translates into identifying the ways in which women and men are positioned in society [11]. In other words, in the context of disaster risk reduction, gender mainstreaming refers to fostering awareness about gender equity and equality, etc, to help reduce the impact of disasters, and to incorporate gender analysis in disaster management, risk reduction and sustainable development to decrease vulnerability [11]. Gender mainstreaming can be used to bring equality into disaster management through considering the specific needs and interests of vulnerable women before, during and after disasters.

The United Nations International Strategy for Disaster Reduction [11] shows gender mainstreaming in disaster reduction as a parallel but inter-linked process to the mainstreaming of disaster reduction into sustainable development policies and activities while recommending to integrate gender, development and environmental management and disaster risk reduction both in research and practice. It further recommends that efforts should be made to increase a gender balance in decision-making positions to deal with disaster risk management. There is a need for a focus on the disaster and sustainable development planning processes and ensure a participatory approach and involvement of non-traditional/non-conventional ideas and partners.

4. Conclusions

Disasters, which disrupt society with enormous damage to the human life, environment and economic resources treat women and men differently. Women are more vulnerable to the consequences of disasters because of their social role. This emphasises the need to achieve gender equality in disaster reduction and integrate a gendered perspective to all policies and measures implemented in disaster management context.

Gender mainstreaming in disaster reduction allows women to decrease their vulnerability through identifying their specific needs at the disaster management planning stage. Women are empowered by gender mainstreaming to reach equality in decision making roles in disaster reduction and to utilise their skills in planning and implementation of policies and measures. After identifying the existing roles of men and women through gender analysis, gender mainstreaming helps to achieve equality in disaster reduction by giving a comprehensive understanding of the possible effects of policies and measures developed for disaster reduction on gender roles. However, since disaster reduction and development have a close inter relationship, gender mainstreaming in disaster reduction is a parallel and inter-linked process to mainstreaming disaster reduction into sustainable development policies.

5. The way forward

This paper focused to give an account for the importance of gender mainstreaming in disaster reduction through a discussion of literature findings on disasters, the types of disasters, different categories of disaster vulnerabilities and gender mainstreaming and its role in disaster reduction process. Apropos, gender mainstreaming in disaster reduction facilitates non-traditional ideas and parties to participate in disaster reduction and sustainable development planning while empowering women to develop their leadership qualities and other special skills in the decision making process.

Therefore, the study which was the basis for this paper aims to continue researching in the future on:

- establishing a relationship among disaster reduction, construction and gender,
- demonstrating the importance of gender in the context of disaster reduction construction,
- understanding the need for mainstreaming women in construction in disaster reduction,
- identifying the ways of mainstreaming women in construction in the disaster reduction decision making process.

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A Bayesian-based Decision Support Tool for assessing and managing rock fall disasters

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Abstract

Recent catastrophic events demonstrate the importance of the post-disaster interventions, where the management of rescue operations and recovery assistance to citizens, the coordination of several organizations and the allocation of proper resources are truly critical issues. Many Civil Defence Systems have developed the knowledge and the experience to understand in “real time” the actual situation of the disaster context (e.g. through GPS tools for continuous monitoring or using ICT infrastructures to communicate with field forces); nevertheless, due to the complexity of the situation and the amount of information to process, specific decision support tools are needed that allow the decision maker to provide prompt responses and effective coordination of all the actors of the Civil Defence System. The paper describes a decision support tool, based on Bayesian Belief Network (BBN), for rescue and recovery operations during a rock fall disaster; the variables in the model allows both the representation of the causal chain of physical phenomenon and the assessment of other context factors affecting the emergency planning and management. The quantification of this advanced Decision Support System (DSS) is based on data gathered from available monitoring system and on experts’ judgements. The paper starts describing the Bayesian-based approach, showing the ability of the model to integrate different data-sets in different steps of the analysis (from the preliminary definition of the hydro-geological phenomenon to the integration of expert’s observation into the model). Finally, a brief case study is presented, referring to a rock fall event in an urban area, where the capability of the BBN to incorporate direct observations and describe a real case of rock fall is shown.

Keywords: Disaster management, Rock fall, Bayesian Network, Decision Support System, Civil Defence

1. Background

Landslides are one of the greatest natural hazards, causing considerable damage and claiming a large number of victims in several areas of the world. The consequences of landslide phenomena in Italy are so significant that they represent a genuine socio-economic problem, of an extent which is unique on a European scale and in the Mediterranean basin, and second only to Japan amongst the technologically advanced nations [1]. Managing natural risks therefore constitutes a fundamental problem for society [2] and is likely to play an increasingly important role in the future. It must be said that this type of event shows no sign of decreasing, despite the heavy investments being borne by public and private bodies. All this must be related to the fact that the large part of interventions have been directed towards remedying damage already caused by landslides and flooding rather than preventing such phenomena with systematic planning, based primarily on in-depth geological, morphological and climatic studies. The analysis and assessment of landslide risk is a complex task, due to: 1) the specific characteristics and hydrogeological properties of the area under assessment (landslide susceptibility), 2) the interactions between the natural environment, the built environment and the social environment, 3) the organization and management of rescue operations. What is clear, however, is the importance of an accurate knowledge of hydrological phenomena to be able to prepare efficient forecasting and planning intervention. There are various strategies a community can adopt in order to manage the risk of landslides, that can be grouped into three main categories: the first type of intervention consists of planning checks, to reduce high risk elements; the second category comprises engineering solutions, to reduce the probability of occurrence and the probability of a landslide having an impact on targets to be protected; the third category entails monitoring and warning systems, to reduce the number or vulnerability of elements at high risk. In order to manage risk correctly (Figure 1) it is therefore necessary to move to an initial phase of risk analysis, in the traditional terms of danger, vulnerability and value of the elements at risk, followed by a phase of risk assessment. Risk assessment consists of determining whether or not the calculated risk is acceptable to the community, and to what extent [3].

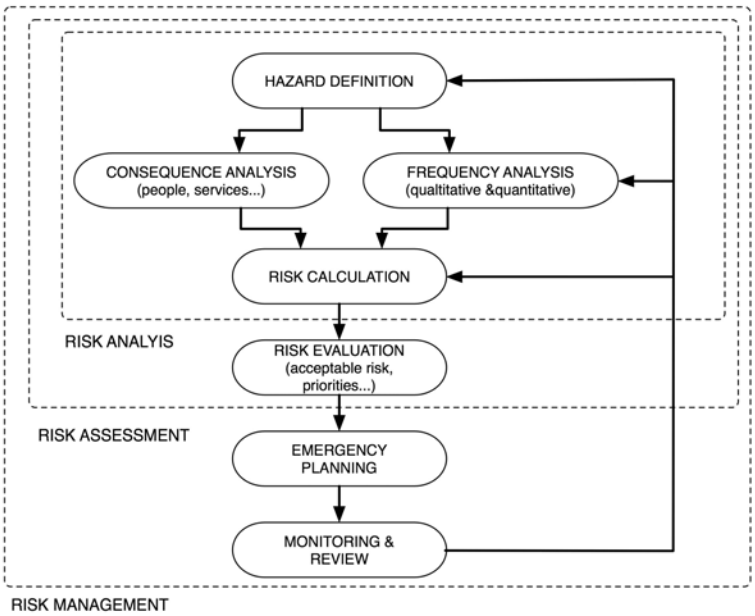

Figure 1: A model of landslide Risk Management

1.1 Rock fall: description of the phenomenon

Rock fall represents one of the highest risks in mountain area. A recent bibliographical study [4] outlines that rock fall is one of the most dangerous phenomenon for people safety. A rock fall consists in blocks fall due to slope traction or shear joints and the phenomenon can be divided in different steps, that are detachment, free falling, impact, bouncing, and sliding. Number of events that may cause a fall is wide and almost unpredictable. Historical data shows that such events are really common in Lombardy [5][6], mainly due to hydrogeological characteristics, geological local circumstances (essentially lithological-structural), pluviometric phenomenology and climate (characterized by frequent froze-unfroze cycles). According to the latest researches the highest risk areas are Sondrio and Lecco province and Garda lake area (INTERREG II C) [7]. In Lecco Province rock falls are 28.4% of overall censed landslides in Lombardy, while in Sondrio province this percentage rises to 30%. One must notice that risk of infrastructure and built up areas damaging is really high, and local public administrations have to evaluate large areas of dangerousness. As previously mentioned, detachment is due to a critical combination of intrinsic factors [8], described in the proposed model by means of a Bayesian Network (BBN) that represents the complex causal chain of the phenomenon [9] [10].

2. The Hydrogeological Network

2.1 Definition of the structure

The construction of a Bayesian Network [11] is made up of two fundamental steps: 1) the definition of the variables and of the links between variables, 2) the quantification of the links in terms of conditional probabilities. In both steps the contribution of experts is required to define the knowledge space, both in qualitative terms (topology of the network) and quantitative terms (estimation of the conditional probabilities). The logic of procedure is comparable to the construction of a cognitive map [12], since it is possible to proceed by identifying which causes may lead to some effects or, vice versa, given certain effects, which causes they may be attributable to. The adoption of a coherent inductive or deductive reasoning has the advantage of making the expert more confident in formalising the knowledge space. In this first step three fundamental basic structures (Figure 2) may be identified to which it is possible to relate every other subset of a graph [13]. Recognizing such structures is very important for studying the dependence of the variables and in general the capacity of the network to transmit the so-called causal flows generated by inserting the observations and experts' judgments. Indeed, in the case studied the typical phenomenology of a rock fall was translated, thanks to the contribution of some experts who identified the main hydrogeological variables and the dependent relationships between the phenomena. The use of BBN in the hydrogeological field is in any case well-known in the study of similar phenomena [14] [15]. The inductive process, followed in the topological definition of the network, uses the logic of identifying the phenomena capable of influencing the chosen target variable "rock fall": a set of relevant factors and observable phenomena exists whose correlation with the rock fall is proven by literature. Following on from these considerations in the first step of the procedure the experts defined the variables as well as the links, obtaining the hydrogeological BBN shown in Figure 2.

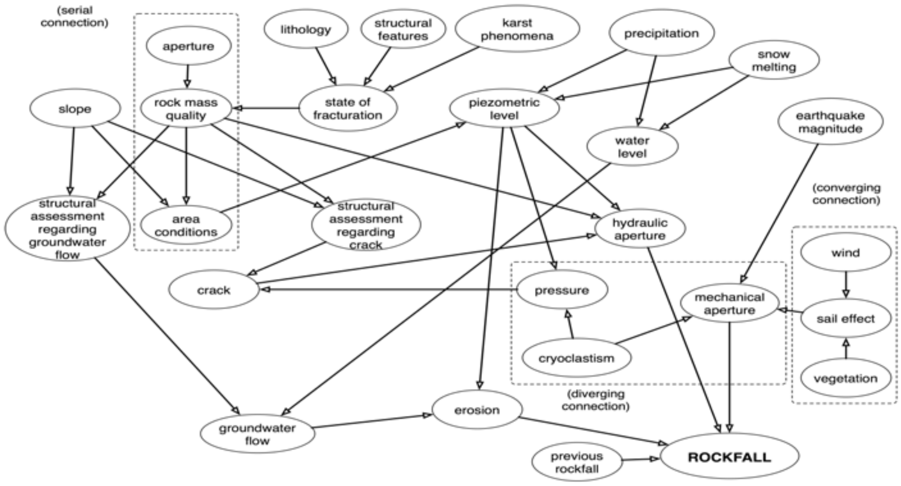

Figure 2: The hydrogeological BBN for forecasting rock fall (and basic cognitive structures: serial, diverging and converging connections)

In the second step all the links between variables were quantified: the method adopted for the quantification of the Conditional Probability Tables (CPT; Table 1), is largely based on the elicitation of experts' judgments, due to the lack of direct observations or consistent data from literature. The chosen approach required a strict validation process in order to assure the consistency of the knowledge incorporated into the network.

Table 1: Example of a Conditional Probability Table (CPT) for computing $P(X_3|X_1,X_2)$

X_3	X_1			
	y		n	
	X_2		X_2	
	y	n	y	n
y	p1	p2	p3	p4
n	1-p1	1-p2	1-p3	1-p4

2.2 Quantification of the variables: elicitation of experts' judgments and observations

The qualitative topology of the network is translated into a quantitative model of relationships between variables by the CPTs, which are generated for each variable in the network that has input nodes. To do this an elicitation process of expert's judgments is required which leads to the links between the variables being expressed in terms of conditional probability and finally the definition of the conditions surrounding the problem, i.e the definition of the states of the prior variables. Getting the analysis underway therefore requires the experts to fill in a questionnaire; such an instrument is capable of translating qualitative (verbal) estimations on the nature of the links, into probabilities of a conditional nature (Figure 3) [16] [17]. The expert is asked to quantify all the links in the network answering to questions like: "What is the probability that the state of fracturation is absent, knowing that there is a good lithology and an absence of Karsist phenomena?” where the answer should be: “Is expected with a very high probability (0,85-0,9) that the state of fracturation is absent”.

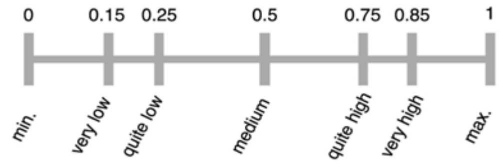

Figure 3: Example of comparative judgments scale for quantifying BBN variables

3. Using the Hydrogeological Network as a DSS for Emergency Management

The BBN is now capable of returning the probability of a generic rock fall in the reference geographical area, via the conditional probability of the target variable “Rockfall”, and based on the conditions defined by the prior variables. In addition we can improve the knowledge space of the hydrogeological phenomenon each time it is possible to gather direct observations of the variables [18] to partially replace experts’ estimations. Indeed the opportunity for updating the knowledge about the phenomenon may come from inspections by geologists at the rock fall front: through direct observations or the use of instruments on the ground (e.g. distometers) they are able to gather more data and return information back to the control room. New data can be translated into the BBN updating the values into the CPTs (i.e. filling in the fields represented in Table 2 and Table 3). The joint exploitation of on-site inspections or monitoring and the proposed BBN allows to organize appropriate countermeasures (evacuation, structural reinforcement etc.) [19]. The present version of the BBN does not incorporate any decision model for selecting suitable measures for risk mitigation or emergency management, nevertheless and updated estimate of rock fall probability is an important factor for the decision makers.

4. Case study: The Varenna rock fall

4.1 Rock fall event

On the 13th of November 2004, at around 17:30, 15.000 m^3 of rock broke loose from the slopes of the Foppe mountain at an altitude of 600 m above sea level, and tumbled down the slope below, reaching the village of Fiumelatte, in the commune of Varenna, completely destroying two residential properties and damaging a further 5. The masses of rock also hit the Milan-Lecco-Sondrio-Tirano railway line causing it to be disrupted and damaged two medium and high-voltage power lines. The mass, which was of immense dimensions (110 m^3, 300 tonn.), claimed two victims and left one injured before coming to rest against a large building some 10-15 meters away from the provincial road [20].

4.1.1 Observations on the hydrogeological characteristics predisposing the rock fall

What follows (Table 2) is a summary of the geological characteristics, taken from geological studies of the area, which must be considered in the model (prior variables) and their corresponding values which have been included in order to calculate the probability of rock fall: these values have been quantified with a probability equal to 1, since they are assumed as deterministic observations: the incline, for example, is very steep (in certain stretches the slope exceeds a 70° gradient with respect to the reference plane) and is formed of cemented debris often covered with arboreal and shrub vegetation (vegetation). A further cause can be identified in the morphology and in the several discontinuities observable in the rock, due to erosion, cryoclastism and pressure induced by run-off water.

Table 2: Synthesis of the variables, and the relative states, predisposing rock fall in the area of Varenna

Variable	**Description**	**State and assigned value**
Lithology	Densely stratified black limestone, occasionally bituminous, with isolated flint nodules and pyrite smearing produced by a process of sedimentation occurring in the past	sedimentary = 1
Karst phenomena	The mountain is affected by Karst phenomenology of the dissolving type	deep = 1
Structural features	From a structural point of view they often exhibit folds and faults and the strata predominantly lie horizontally deposited in opposite direction to the sloping soil	fault = 1
Slope (°)	The slope is sheer	> 70 = 1
State of fracturation	Dolomite light pink-grey limestone rocks, massive, locally stratified and intensely fractured along the joints in direction E-W, NNW-SSE & NW-SE and with open vertical fractures, and one higher up, even more massive in appearance, of almost entirely dolomitic composition	very fractured with Karst phenomena = 1
Aperture	The discontinuities are predominantly lacking filling material	open, empty = 1
Vegetation	The mountain side is characterized by tall, leafy trees	tall & leafy = 1

4.1.2 Observations on triggering factors

The event that has just been described and examined appeared unpredictable, even with the observed conditions: there was none of the typical predisposing and triggering factors of rock fall in the days leading up to the event itself and therefore no warning signal allowed the rock fall to be forecast. On the other hand, further environmental observations allow the conditions of the rocky mass to be defined better: the rock fall phenomenon, predominant in the area in question, is linked to triggering factors such as freeze-thaw cycles, thermal cycles, and seismic stresses for example. On the day the rock fall occurred wind speeds exceeding 60 km/h were recorded: given the presence of tall, leafy vegetation, it is possible to state that one cause triggering the event may be the sail effect created by the combination of the two factors. All these causes that are intrinsic to the area, coupled with the freeze-thaw cycles and the steep incline of the mountainside, facilitate the manifestation of the phenomenon. The BBN is capable of incorporating the above-mentioned observations thanks to the definition of the states of the corresponding variables listed in Table 3.

Table 3: Synthesis of the variables, and relative states, corresponding to the environmental observations in the area of Varenna

Variable	**Description**	**State and assigned value**
Cryoclastism	Along the rock faces there is cemented colluvium forming carbonatic breccias with blocks of considerable dimensions, interspersed with incoherent sandy horizons, with thicknesses of a few decimeters up to about ten meters (crumbling effect due to the freeze-thaw cycle, known as cryoclastism)	yes = 1
Precipitation (mm/gg)	Scarce during the period prior to the rock fall and irrelevant to the rock fall phenomenon	< 40 = 1
Snow melting	Winter month so harsh temperatures wich do not cause snow melting	no = 1
Previous rock fall	The area affected by the rock fall event had already been classified for some time as an unstable area of the Province of Lecco. The area is frequently affected by rock fall phenomena	yes = 1
Wind (km/h)	On the day of the rock fall the recorded wind speed exceeded 60 km/h	> 60 = 1
Earthquake magnitude (Richter)	Although it is an earthquake zone, no relevant phenomena showed up prior to the rock fall	< 2 = 1

4.2 Results

With the predisposing conditions quantified above and with the addition of the values corresponding to the environmental conditions (triggering factors), the BBN returns a very high value for the probability of rock fall (P (Rock fall) = 95,15%). In particular the contribution of the environmental conditions observed is about 30%. Similarly to what has been described previously, the observations on the predisposing factors alone are not sufficient to determine a high probability of collapse. The observations carried out do indeed have a great impact on the variables “mechanical aperture of discontinuities” and “hydraulic aperture of discontinuities”. For example, a fissure increase in the order of centimetres per day (or week), measured by a fissure gauge (Figure 4), is an extremely important warning signal, so much so that it would prompt the evacuation of the surrounding urban areas in case of imminent rock fall.

Figure 4: Aperture monitoring using a fissure gauge

The case study brings out the fact that the combination of the strong wind recorded on the 13th of November, and the presence of tall, leafy trees (conifers), generated a strong sail effect destabilizing the mountainside and producing the rock fall. In addition to the external mechanical stress due to the sail effect, the case under analysis reveals the presence of an area which is intrinsically predisposed to landslide and rock fall. The sedimentary lithology, the presence of numerous discontinuities and the steep gradient are characteristics which can strongly predispose the detachment of material. In short, when the observations carried out in the simulation lead to a value in the order of millimeters being associated to the daily variation of the apertures, the network returns P(Rock fall) = 68%, whereas if (for example with monitoring instruments) an evolution of the phenomenon in the order of centimeters is observed, the BBN returns an extremely high probability value, that is to say an almost certain occurrence of the rock fall. The simulation run using the BBN therefore proves to be consistent with the true evolution of the phenomenon as described on the basis of the data available for the Varenna rock fall.

5. Conclusions

The results obtained following the simulations, although still in the preliminary stages, have allowed the following objectives to be met: 1) to obtain an initial validation of the model and 2) to provide the first set of information which can be used to support the decision making process in the early stages of emergency. The preliminary results provided by case study do quantitatively confirm the validity of the knowledge space of the BBN: marginal probabilities, returned by the model are consistent with the qualitative description of the real event. Finally, what is more interesting from an operational point of view, the BBN model of a rock fall demonstrated a good sensitivity with respect to the type and amount of available information. Indeed, the analysis pointed out that the simple observation of the predisposing environmental conditions leads to a limited variation of the probability of occurrence of the rock fall – information that is marginal in decision making terms –, but also demonstrated that the improvement of the BBN knowledge about rock fall phenomenology (e.g. aperture discontinuity), either direct or via network computation, returns clear and unambiguous assessments (in the case study the rock fall probability increased over 95%). This leads to the conclusion that the BBN is able to exploit all the knowledge made available by the experts on the ground and by monitoring devices. In the case of environmental conditions favouring rock fall (persistent rain, seismic phenomena, steep slope of mountainside etc.) the proposed model can be jointly used with predefined threshold values to identify critical situations or areas and to release early warnings and alerts. Thanks to early warnings, anticipated inspections can be scheduled, obtaining more precise information and observations on the actual site conditions, which can be used to update the corresponding variables in the BBN, as shown. The process can be managed directly by the analyst on-site or by operators at the control room, which receives verbal communications from the site. Further steps of the research project will be focused on the development of a fully integrated system for monitoring, improved situational awareness and decision making, during emergency management [21][22].

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Raising Preparedness by Risk Analysis of Post-disaster Homelessness and Improvement of Emergency Shelters

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Abstract

A central element of disaster response is the provision of adequate emergency shelters for those who have been made homeless by a disaster. In order to raise the preparedness for the disaster case and thereby improve the disaster response it is necessary to first of all analyse the risk of post-disaster homelessness and secondly to develop adequate shelters. Therefore, a risk analysis has been undertaken investigating the distribution and the reasons for post-disaster homelessness. Furthermore, in order to improve the available emergency shelters different options of an insulated floor for tents in cold climate regions were developed.

Keywords: Preparedness, Risk analysis, Emergency shelter, Reconstruction, Disaster management

1. Background

Due to natural disasters every year hundreds of thousands of residential buildings are destroyed leaving their inhabitants for a certain period of time homeless and in need of both intermediate shelters (such as emergency and temporary shelters) and long term housing reconstruction. Especially in cold climate regions it is important to provide adequate emergency shelters quickly, in order to prevent post-disaster illnesses or even death from the cold. However, the Pakistan earthquake in 2005 with its 3.1 million (mio.) homeless showed once more that appropriate tents for cold climate regions are not available. With no other emergency shelter option than tents feasible this earthquake underlined again the necessity to develop winterised tents.

2. Risk Analysis of Post-disaster Homelessness

For the undertaken risk analysis the data on post-disaster homelessness of the database EM-DAT was used [1]. It was shown that the distribution of homelessness over disaster types varies with the largest number of homeless generated by floods (672 homeless per year per mio. inhabitants), followed by windstorms (266) and earthquakes (71). Analysing the reasons for the observed homelessness it was found out that for earthquakes the number of homeless increases with higher Richter scale magnitude while, considering the human development index (HDI), the highest homelessness is registered for medium human development (Figure 1). This can be explained by an increase in vulnerability in the transition from low to medium human development e.g. by rural exodus and the formation of large urban slums while for high human development the vulnerability decreases e.g. due to larger financial means for preventive measures. Finally, assigning to each country a risk class depending on its Mercalli scale zoning and combining this with the human development status a risk index for earthquakes was formulated [2].

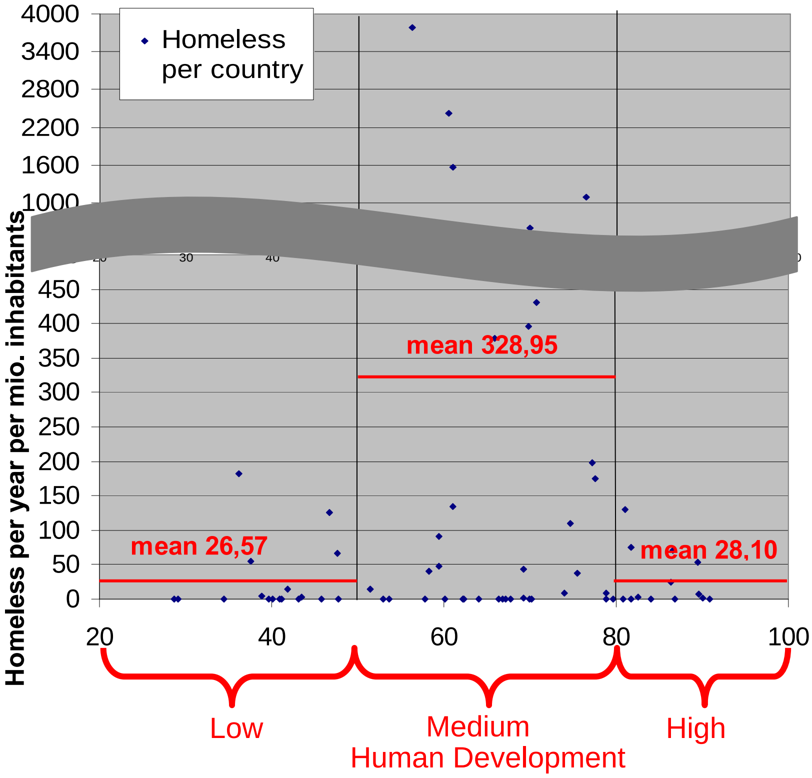

Figure 1: Homelessness by earthquakes depending on Human Development Index

Analysing the post-disaster shelter situation the dependency between socio-economic boundary conditions, vulnerability and shelter need could be identified (Figure 2). In each of the 3 parts of the diagram the different options which exist depending on the socio-economic boundary conditions are depicted with an increase in vulnerability from the left to the right. Initially the socio-economic conditions such as building quality and site location influence the structural vulnerability of the individual's home e.g. poor people settling on endangered land (part I of Figure 2). In this way the socio-economic conditions affect the total number of homeless which corresponds with the above demonstrated relation between human development status and the number of homeless due to earthquakes.

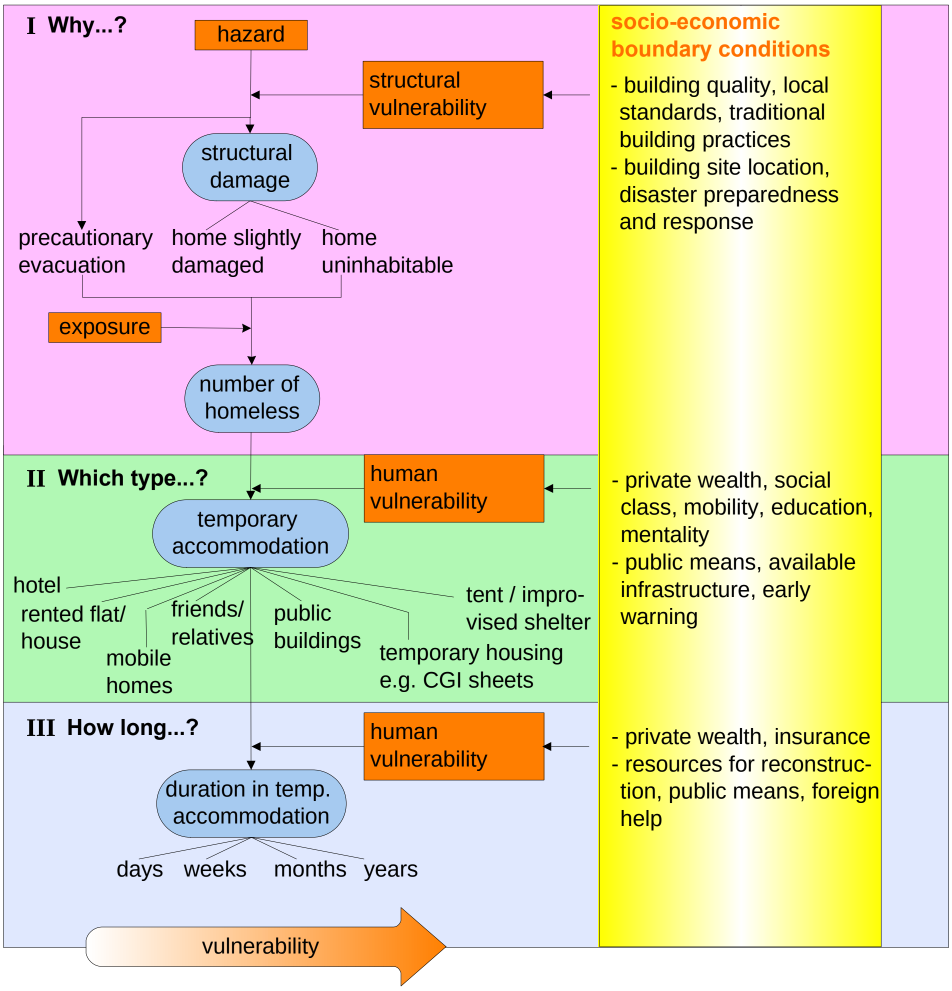

Figure 2: Influence of vulnerability on post-disaster shelter situation

Furthermore, the socio-economic conditions contribute to human vulnerability which influences the availability of emergency shelter options (part II of Figure 2) as well as the duration in temporary housing until reconstruction is finished (part III of Figure 2). For example a wealthy person in a highly developed country can rent a hotel room and quickly return to a reconstructed home paid for by insurance whereas a poor person in a developing country will be compelled to wait for the delivery of tents and external help for reconstruction. From past disasters it can be shown how with increasing human vulnerability the emergency shelter options change from renting a hotel room over mass accommodation in schools towards tents. This signifies that the availability of emergency shelter options is not arbitrary but depends on the socio-economic context. At the same time this means that adequate shelter can only be provided if it is designed in correspondence with the given socio-economic situation.

3. Winterisation of Emergency Shelter Tents

Due to the observed lack of sufficient winterisation of emergency shelter tents the UNHCR (United Nations High Commissioner for Refugees) defined the development of cold climate tents as a pressing task. Within this task the provision of an insulated tent floor is of major importance as it not only restricts the overall heat loss from the tent but reduces the heat loss of the occupants while they are sitting or sleeping on the ground [3]. Especially during the night the heat loss from the body is critical as less heat is produced and hence freezing is more likely. Therefore, different options for the floor insulation have been investigated using insulation materials from the building industry like Expanded Polystyrene (EPS) as well as locally available materials such as straw. Beside the conformity with the specific requirements from the use as emergency shelter material e.g. low cost, ease of transport the thermal properties of the solutions were evaluated using calculation methods from the building codes.

Table 1: Thermal properties of different options for tent floor

Type	**Basic win-terisation**	**Solid system**	**Air layer system**
Standard	2 tarpaulins, 3 blankets p.p.		
Additions		2cm EPS / XPS, stove	2cm air layer, stove
R_{tot}	0.21 m^2K/W	0.78 m^2K/W	0.80 m^2K/W
$Q_{sleeping}$	157 W	59 W	59 W
Q_{floor}	2273 W (heated)	613 W	603 W
T_{si}	-4.1 °C (heated)	13.5 °C	13.6 °C

In Table 1 the heat loss of an uninsulated tent floor consisting of two layers of plastic sheeting is compared with two insulated options. The solid system is formed by 2 cm of rigid Styropor or Styrodur lying between two plastic sheetings. For the second option a 2 cm air layer is constructed by a rectangular grid of supporting beams and a top tile both of High Density Polypropylene (HDPP). The thermal properties of the air layer are additionally improved by an infrared reflecting coating on the underside of the top tiles. Table 1 shows for a ground temperature of -10 °C how the heat loss during sleeping can be reduced from 157 W to 59 W by the installation of a stove and the provision of an insulated floor. The achieved value is well below the heat produced by the body during sleeping (85 W) so that the occupants do not chill. Similarly the overall heat loss for an internal tent temperature of 20 °C can be reduced drastically. This is important for the heating up of the tent as the heat produced by a standard stove is restricted to 5–7 kW. Furthermore, the thermal comfort which depends largely on the radiation of the surrounding surfaces is raised by a significant increase in the inner surface temperature of the floor (T_{si}).

Summarising the results of the research on insulated tent floors, an easy to apply tool for the shelter aid sector has been developed indicating adequate floor insulations options depending on the local climate (Table 2). All depicted options beside the air layer system are designed with two plastic sheetings: one on top of the insulating layer to protect from daily wear and tear and one underneath to protect against water etc. Beside the two options discussed above the specifications of the options are as follows:

- **Acoustic floor mat:** Quiet Zone Acoustic Floor Mat of 9.5 mm closed cell, extruded polyethylene foam

- **Pallet with/without IR-reflec.:** Standard wooden pallet with min. height of 134 mm; area between top boards of pallets filled with additional boards to form a closed wooden cover of min. 18 mm wood; with IR-reflection: aluminium foil fixed to underside of wooden cover

- **Straw:** ~10 cm thick layers from bales of dried straw

Table 2: Options for insulated tent floor depending on local climate

Min temperature	10 °C	5 °C	0 °C	-5 °C	-10 °C
EPS / XPS	✓	✓	✓	(✓)	(✓)
Air layer	✓	✓	✓	(✓)	(✓)
Acoustic floor mat	✓	(✓)			
Pallet without IR-reflec.	✓	✓	(✓)		
Pallet with IR-reflec.	✓	✓	✓	✓	✓
Straw	✓	✓	✓	✓	✓

The applicability of the different options depends on the inner surface temperature as this is the most critical requirement for thermal comfort. The minimum acceptable inner surface temperature was set to 15 °C (case ✓) or providing less thermal comfort to 13.5 °C (case (✓)). With these temperatures as boundary conditions the following other thermal properties are fulfilled:

- Q_{floor} < 485 W resp. 631 W (i.e. overall heat loss through floor)

- $Q_{sleep,down}$ < 34.1 W resp. 33.2 W (i.e. heat loss from body downwards during sleeping for bed clothing + 1 layer of medium thermal resistance blankets resp. 2 layers of medium thermal resistance blankets)

It can be summarised that an insulation of the tent floor is possible both with imported or locally available materials and that thermal comfort can be achieved even under severely cold conditions.

4. Conclusions

Much work has been undertaken to identify the risk of death or monetary damage due to natural disasters. However, the significance of shelter for a fast recovery of the affected population and the large financial expense for both temporary shelter and reconstruction necessitate as well an analysis of the risk of post-disaster homelessness. The undertaken risk analysis shows how a risk index can be developed using the endangerment and the human development status as indicators.

With respect to an improvement of the disaster response the presented options for an insulated tent floor demonstrate that an enhancement of the thermal properties of emergency shelter tents is possible. This will not only raise the immediate post-disaster living conditions of the affected but as well enhance the overall sheltering process. With adequate emergency shelters to hand and a thereby raised preparedness for the disaster case, more time for good reconstruction becomes available and potentially temporary shelters become abundant leaving additional money for a better reconstruction. However, much effort is still required to ensure the completion of fully winterised tents.

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Investigating SME resilience and their adaptive capacities to extreme weather events: A literature review and synthesis

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Abstract

In the UK, extreme weather events (EWEs) such as floods, heat waves and storms are increasing in frequency and severity. The ability of local communities to cope with the immediate impact and recover from the aftermath is critical to the continued well-being of the community that is affected. As part of Engineering and Physical Sciences Research Council (EPSRC) funded projects we investigate how Small and medium-scale Enterprises (SMEs), prepare themselves for the effects of EWEs. SMEs constitute a substantial proportion of the community that is affected as a result of these events. They need to prepare themselves for the effects of EWEs in a way that minimises disruption to them and allows them to return to near normal working conditions as soon as possible after an event. Very few studies have examined how SMEs respond to EWEs. Policy makers and theorists in this field have proposed various models and frameworks to improve the adaptive capacities of SMEs by concentrating on identification of risks and opportunities coupled with strategy development and implementation. Their individual and collective attitudes influence the activities that SMEs perform towards preparation of disaster preparedness plans and post disaster recovery measures. The paper argues that this continuous process of engaging SMEs will develop their adaptive capacities and enhance their coping measures in facing up to the risk of extreme weather events. The paper provides a literature review and a synthesis and a methodological vehicle to guide this research.

Keywords: SME, extreme weather events, coping skills, adaptive capacity, built environment

1. Introduction and main focus

The World Bank estimates that, in 1998, various natural disasters killed over 50,000 people and destroyed $65 billion worth of property and infrastructure [1]. This number significantly increased in 2004 due to the tsunami. South Asia Disaster Report [2] states that 2004 – 05 period was the ‘most appalling’ period in the history of South Asia. In the UK, extreme weather events (EWEs) such as floods, heat waves and storms are increasing in frequency and severity. For instance, according to UKCIP [3] climate change is likely to impact on winter peak river flows to rise up to 20% by 2050. Further, insurance industry reports specify that this will double the likelihood of flooding in certain areas [4]. The ability of local communities to cope with the immediate impact and recover from the aftermath of a disaster is critical to the continued well-being of the community that is affected. Small and medium-scale Enterprises (SMEs) constitute a substantial proportion of the community that is affected as a result of these events. They need to prepare themselves for the effects of EWEs in a way that minimises disruption to them and allows them to return to near normal working conditions as soon as possible after an event. Most of the natural disasters affect many organisations and are difficult to predict or prevent. SMEs in particular are often affected directly and indirectly from the very same disasters faced by large companies. However, the former tend to have fewer resources than their larger counterparts with which to plan, respond and recover. As part of UK’s Engineering and Physical Science Research Council (EPSRC) ideas factory project titled “community resilience to extreme weather events through improved local decision making”, we investigate the role of SME’s within a community in response to extreme weather events in the UK. The three year research project commences in February 2008.

The objective of the paper is to conduct a literature review on unique characteristics of SMEs, their general behaviours and decision making. These will inform the investigation of the various coping mechanisms and the importance of SME resilience and disaster risk management (DRM) plans. The literature review and synthesis of the paper will serve as the foundation for research. This paper will also inform policy making in the area of building resilience and coping strategies for SMEs when facing up to EWEs.

The paper is organised as follows. First, it provides insights into the unique behaviour of SMEs and how this behaviour is aligned with improving their coping strategies against extreme weather events. Then, the paper focuses on disaster risk management and discuss cases from various countries on the importance of disaster risk management planning to SMEs. The third section of the paper provides insights into participatory approaches as a potential tool to engage SMEs into generate solutions for them to effectively and efficiently face up to challenges of extreme weather events. The paper then sets out the research problem and the methodology. Finally the conclusions are drawn.

2. Literature review and synthesis

2.1 SMEs and their unique behaviour

Burk [5] presents the European Union based definition for an SME by considering its number of employees and annual turnover. Accordingly an SME could have 1 – 250 employees and a turnover of up to Euro 50 million. This size is relevant to the particular sector in which the SME operates. For example an SME in the oil sector, where there are a number of extremely large corporations, may be classified as small as a comparative measure. A similar size firm in the fashion design industry may be classified as large as the fashion design industry consists of many large firms [5]. SMEs are socially and economically important to society, "since they typically represent 99% of all enterprises in Europe and America" [5: 14]. According to Robbins et al [6] SMEs are important to the economic vitality of cities, states and the countries due to their significant number and employees. However, they tend to display vulnerability in facing up to various conditions prevailing in a country's economy resulting in business failure. Ability of SMEs to turnaround their companies is constrained due to their limited access to financial resources and capital [7]. It is therefore pertinent to investigate unique SME behaviour, their coping skills, resilience in facing up to both direct effects of extreme weather events as well as the various indirect economic effects of extreme weather.

Historically, it has been recognised that the SME sector poses various challenges for implementing policies, transfer of good practice and various Government agendas. For instance, studies conducted by researchers at University of Salford [see 8, 9, 10] identified that strategic horizons and organisational capabilities of SMEs did not allow sufficient 'organisational slack' to conduct activities outside their main business activities. Therefore for an appropriate SME resilience agenda to emerge it is of strategic importance that mitigating measures against EWE's are conceptualised as closely associated with the mainstream business activities of these companies. This notion will further strengthen the processes followed for effective engagement, identification of SME coping strategies, role of intermediaries and preparation of interface toolkits and other support material.

SMEs' ability to effectively react to various EWEs are often affected due to lack of planning, vulnerability to cash flow interruptions, lack of capital for recovery, ineffectual interactions with national agencies, infra-structure problems [11], individual attitudes and organisational culture [12], access to expertise, business sector and perceived exposure to risk [13]. Collectively these factors determine the adaptive capacities and the overall behaviour of SMEs. For SMEs one also needs to consider the general attitudes towards disaster recovery and business continuity planning (BCP). Even though guidance exists for BCP [14], most SMEs do not consider it, or are under-insured against the potential risks [15].

2.2 Disaster risk management (DRM) and SMEs

The severity of extreme weather events has impacted many businesses and individuals and the effect has spread over to various regions in the world. The main risks to any business of EWEs are increased costs and loss of revenue. According to Canadian Chamber of Commerce [16] the risks (within the context of Canada) could include risks of blackouts and damage to property and inventory from floods and high winds as a result of extreme weather events. In addition crop failures from drought will affect farmers, and lack of snow in winter will affect ski resorts. In the UK, Bosher et al [4] identified that most significant threats to the built environment in the UK were considered to be floods, climate change, ageing/inadequate infrastructure, and inadequate urban planning. Figure 1 identifies the perceived threat to the built environment through the multi-sectorial study conducted by Bosher et al [4].

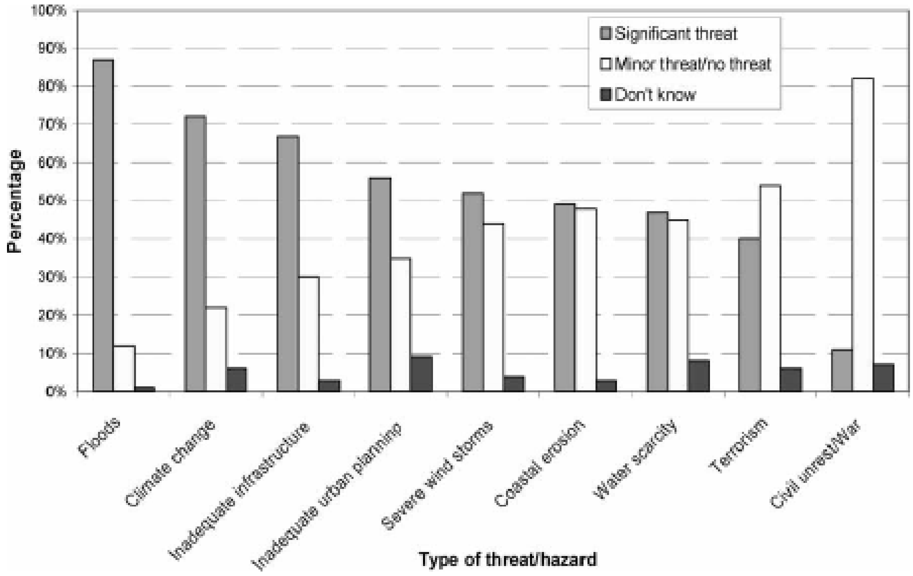

Figure 1: Perceived threats to the built environment through a Multi-sectorial study (Source: [4])

The ability of companies and individuals to insure these losses vary to a large extent. SMEs in particular find it very difficult to insure against EWEs due to the funding restrictions that they have. According to Dunn and Flavin [17], who studied results from the insurance industry, found that losses caused by various extreme weather events have multiplied several times as indicated in Figure 2.

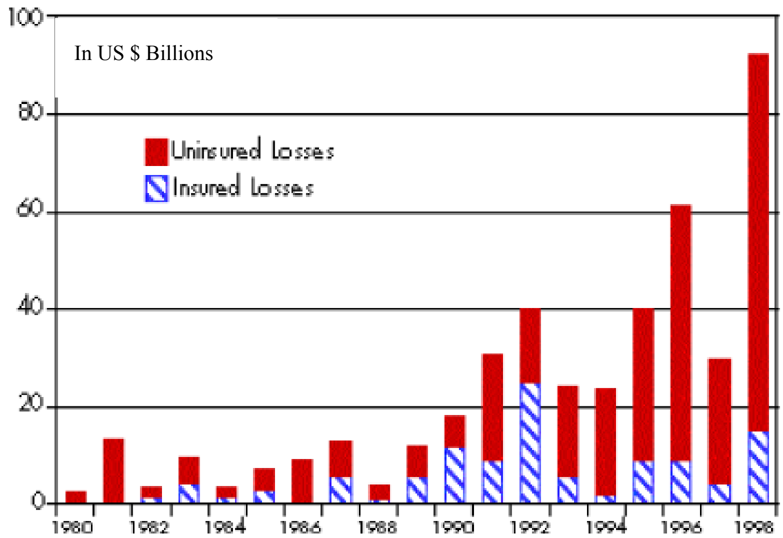

Figure 2: Losses from weather related disasters in the world (Source: [18])

As stated by Raksakulthai [18] insurance companies paid US $91.8 billion in losses from weather-related natural disasters around the world in the 1990s. This was a significant increase from the previous decade. This report further states that, "as developing nations attempt to build infrastructure and a tourism industry, some may find insurance rates prohibitive because of their vulnerability to extreme weather events" [18: 25]. Many insurers have already raised the premium rates for islands like Jamaica following the destructive hurricane Hugo of the late 1980s, while others have completely withdrawn property insurance". To a large extent, this phenomenon also applies to SMEs in developed countries. For instance, in the UK, Overall buildings insurance increased by 3% to cover estimated £3 billion flood damage in June and July 2007 and the Association of British Insurers (ABI) in the UK have stressed that £800 million per year additional funding pledged by the UK Government is insufficient and they may conduct a review of providing buildings insurance in the light of these heavy losses [19]. This might result in either significant increases in insurance premium or complete withdrawal of buildings insurance cover for areas subjected to extreme flooding. This was proven within the context of the Caribbean Islands in the 1980's when they suffered from the effect of hurricanes. This effect will further constrain SMEs in pursuing the insurance route and strengthen calls by policy makers of various other risk management planning, resilience measures and strengthening their coping mechanisms. Due to possible non-availability of insurance schemes in the future to cover business premises in areas of severe flood risk, several opportunities may arise where we can apply case studies and good practices from developing countries in the area of disaster risk management (in developing countries some of the insurance schemes found in developed countries are not available). In contrast to non-availability of insurance schemes, in the recent past, certain countries have witnessed the introduction of new insurance schemes in areas which are prone to various extreme weather events. For instance, according to Raksakulthai [18], the skiing industry is so vulnerable to climatic changes that some resorts protect themselves from decreased snow cover by purchasing 'snow insurance'. This indicates that some companies are developing or expanding coverage for loss of business due to various weather-related events, which are likely to increase around the world. For the insurance industry, therefore, new opportunities might arise for new products to be introduced.

According to Schneider [20] DRM has often been viewed as a reactive measure because activities such as risk reduction and hazard mitigation are rarely seen as urgent. To reduce risks, Bosher et al [4] suggests various forms of mitigation measures. Some of the non-structural measures address the development of coping mechanisms and consist of various behavioural changes that the companies can make in either avoiding or reducing the impact of risk in facing up to extreme weather events. Within the hotel sector, Raksakulthai [18] lists out various indigenous strategies that large resort hotels adopt such as when the meteorological department predicts high winds making swimming for children dangerous, alternative activities are planned at the man-made lakes located within their resorts. However, small businesses (small hoteliers) do not have adequate resources to adopt the requisite behavioural changes due to unfavourable weather conditions. They face financial, manpower and other resource constraints. For instance, guides working for small hotels who takes tourists on diving excursions or trips to nearby islands such as 'Phi Phi' also receives the weather report each day (like large hotels). When rain is forecasted (or when it starts raining), the guides have no choice but to cancel the trip as they are unable to organize any alternative trips due to constraints in funding.

Jackson [21] studied various stakeholders in the tourism sector, in Caribbean Islands and found that their level of concern about the vulnerability of building in coastal areas despite the damages and economic setbacks caused by hurricanes in recent years was very low. Part of the challenge therefore was to convince the various stakeholder groups who believed that there are no viable alternatives to beach tourism of the risks involved in pursuing existing land use polices without adjustments. Large hotel owners (resorts) on the other hand who construct their premises using multi storied buildings, have a number of advantages such as small building foot prints to guestroom floor space ratio that reduced the number of guest units that are vulnerable to storm surge related flooding. But it was found that the SME hotel owners built their hotels with a larger footprint within the coastal areas, thus increasing their vulnerability to the effects of extreme weather. The degree both SMEs and large companies are affected due to extreme weather and the emphasis on risk management can be assessed through various impact assessment tools. As part of disaster risk management, UKCIP [3] proposes a holistic impacts assessment tool for organizations to assess the potential impacts of various EWEs on their business. This tool emphasizes that the scope of risk assessment should not be limited to one particular company and it should be broadened to cover other SMEs that are involved in the supply chain. For instance, it recommends several focus areas for risk assessment such as understanding the vulnerability of the supply chain companies to EWEs, which is important as any delays on scheduled deliveries, power outages and the effect to the transport infrastructure can cause severe problems to another company's operations although it is not directly affected by an EWE.

Aside from some of the above risk assessment tools recommended for businesses, DRM strategies are usually prepared for communities at large and are often conducted by International Non-Governmental Organisations and various agencies in developing countries (Shook, [22]) and local councils and Government policy makers in developed countries. In addition, large multinational companies which have access to financial and other resources conduct their own DRM plans. Sometimes, DRM becomes a mandatory process that large companies have to undertake due to the potential hazard that could be created to the society at large. For example, severe flooding in the area of Surrey in the UK could have caused the recent spread of the "foot and mouth disease" in the area. Investigations into the cause of the epidemic revealed that appropriate measures were not put in place within an animal health laboratory in the area [23]. This is indicative of the inadequate DRM conducted by the private laboratory, mainly against the effect of severe flooding due to the perceived remoteness of such an effect. DRM, therefore is relatively common at the level of the communities and large companies, but SMEs usually do not consider DRM activities as a priority area within their businesses due to the perceived misalignment between the opportunity costs of DRM and potential future profitability of their businesses. As pointed out earlier, SMEs are not usually receptive to Government policy making. Governments, SME associations, supply chain companies should therefore work with the SMEs to facilitate behavioural changes so that SMEs could develop their coping measures and decision making skills. One approach that might benefit is known as adopting of participatory approaches. Adopting participatory approaches could ensure continuous SME engagement in DRM by understanding of existing SME coping strategies and their adaptive capacities and changing their behaviours by building up their resilience in facing up to EWEs.

The objective of adopting participatory approaches is to facilitate a process of knowledge transfer between the Government policy makers, SME associations, supply chain associates and the targeted SMEs. The key challenge of good practice knowledge transfer is how easily it is absorbed by the transferee. This depends on the absorptive capacity (Cohen and Leventhal, [24]) of the recipient and the appropriateness of the new context to receive the new knowledge. According to Lillrank [25] the transfer process involves three variables. They are; the level of abstraction used in the process, the approach of actors involved in the process and the type of managerial content transferred. Further, Goh [26] citing Zulzanski [27] focuses on transferee characteristics and points out that a recipient's lack of motivation, absorptive capacity and retentive capacity can result in poor transfer of knowledge. Therefore a participatory approach should aim at achieving the above outcomes for SMEs to successfully develop their adaptive capacities.

2.3 Participatory approaches for effective engagement of SMEs and synthesis

The objective of participatory approaches is to gain some of the subtle dynamics of the SME community that is affected due to the EWEs and gaining a thorough knowledge on how their coping skills, BCP measures and their decision making aspects are influenced. This knowledge is gained through a continuous process of engagement between the various elements of the SME network. The continuous process of engagement through adopting of participatory approaches ensures the fulfilment of the three variables cited by [25]. Any disconnection between these elements would result in possible failure of the SME engagement process. A significant part of this knowledge is not available in explicit fashion (as documents). This knowledge exists mainly as tacit knowledge and is embedded and grounded within the SMEs and their actions. (both individual as well as within networks). For example Empson [28] refers to explicit knowledge as the 'tip of the iceberg', because a substantial part of the knowledge is tacit and hidden below the surface. Practical action [29] suggests various tools for participatory assessments as good practice information. Some of the participatory tools are observation, semi-structured interviews, drama, role play, diagrams and visual tools, mapping, modelling of various scenarios. (for a full list of participatory tools – see [29]). The Practical action infopack is tailor-made for individual households and has a community emphasis. We attempt to customise some of these tools to cater for SME engagement. Moving from community to encapsulate companies, is a major step forward considering the change in the unit of analysis.

Several other participatory tools exist in practice. One of the techniques that can be combined with SME engagement in coping with EWEs is to visually model various EWE scenarios to understand SME behaviour, their adaptive capacity, coping skills and the overall resilience. First, this technique can be utilised to present SMEs with different scenarios utilising a very user friendly interface and then it can also be used to capture the different perspectives of the SMEs.

According to Doduras and James [30] fuzzy modelling techniques can also encourage participation and improve communication between different SME groups. Soft systems modeling technique can be used to build up these EWE scenarios. Soft systems modelling utilises the rich picture diagram technique. Sutrisna and Barrett [31] adopted the rich picture diagram (RPD) technique to map a construction process. The rationale for the RPD here was to "acknowledge the complexity and specific characteristics of each construction project in trying to congregate evidences to tell the storyline of the construction project being studied" [31]. Within the context of SME engagement in facing up to EWEs, RPD can be utilised both to transfer the knowledge relating to various EWEs to the SMEs as well as to understand SME coping mechanisms and their decision making processes. Therefore RPD can be used both as a data gathering as well as a data analysis tool.

Further, Brown-Gaddis et al, [32] adopted computer based participatory modeling technique to engage various stakeholders. This has become an important means by which stakeholders are engaged in the scientific process. There are many stages in the modeling process in which stakeholders can engage including model development, data collection, model assumptions, scenario development, interpretation of results, and development of policy alternatives based on model results [32].

The above discussion indicates that simply raising awareness of the problems with the SMEs will not result in behavioural changes. Although large companies will be to a certain extent be receptive to various Government policy making and regulations towards DRMs and improving their adaptive capacities, SMEs perceive such strategies as too remotely connected and misaligned with their business objectives. Therefore, a possible way of making effective changes to SME work practices and behaviour, might be to effectively engage them through a formalized way that is sympathetic to their specific working conditions and needs. Through the literature review and synthesis the paper then sets out the broad research problem so that SMEs are informed of ways and means of improving their adaptive capacity and coping strategies in facing up to extreme weather events.

3. Problem identification and research focus

SMEs as a group constitute an important element in a country's economy. Due to the lack of access to financial resources and capital, they are unable to survive against volatility of markets and adverse economic conditions. Therefore as EWEs can create devastating effects on the economy of a country, they can exert undesirable consequences against the survival of SMEs. Although this effect is well documented in literature (Canadian Chamber of Commerce, [16]; UKCIP, [3]), very few studies have examined the existing coping strategies, adaptive capacities and the SMEs' overall resilience in response to the effect of EWEs. Also it is important to further extend the study to include sector based comparison of how SMEs cope with EWEs. For example, how different would a SME type firm of solicitors and a SME type construction company react to an EWE? The non existence of such studies pertaining to SMEs has also been pointed out by Runyan [11] who studied the area of crisis management.

Policy makers and theorists in the field have proposed various models and frameworks to improve the adaptive capacities of SMEs by concentrating on identification of risks and opportunities coupled with strategy development and implementation. However, the effectiveness of these models and frameworks in practice and how the SMEs' individual and collective attitudes influence their activities have not received adequate attention. This research focuses on this broad area of understanding the SME decision making processes, their coping strategies and their adaptive capacities in facing up to various extreme weather events. The research also tests and validates various solutions that will enhance the overall resilience of SMEs against EWEs.

4. Methodology

The research considers a broad array of approaches to investigate, the current scoping mechanisms and adaptive capacities of SMEs and finding solutions. Engaging SMEs via participatory approaches is the overall guiding methodology for this research. As a first step, a UK wide cross-sectoral survey will be conducted to identify the current coping mechanisms and adaptive capacities of SMEs. The preparation of the survey instruments will be informed by a an extended review of literature, gathering existing weather generator data and assembling of documented cases of SMEs and policymaking related to EWEs from other countries. The initial survey sample will include SMEs (in excess of 500) from areas having a very high risk and a low risk of various extreme weather events such as flooding. Then participatory action research is conducted with a target sample of fewer SMEs (about 50) focusing on the coping measures and solutions. The solutions will also be disseminated towards a wider body of SMEs through various networks and supply chain partners. A re-survey is then undertaken of the same initial sample of SMEs to identify any improvements achieved during the course of the research. This methodology integrates with other methodologies of this research and runs parallel with other workpackages of the programme investigating into how various stakeholder groups such as SMEs, individual households and Government policy makers cope with extreme weather events.

5. Conclusions

SME sector is renowned for suffering the most in times of crises such as extreme weather events and prepared the least for such events. The paper provides a literature review and a synthesis on generating various methodologies, frameworks and models for improving adaptive capacities and enhancing coping measures of SMEs. The paper draws upon experiences of other countries in dealing with SME engagement and argues that this continuous process of engaging SMEs will develop their adaptive capacities and enhance their coping measures in facing up to the risk of extreme weather events. It proposes a high level abstraction of the core principles of SME engagement through various participatory techniques associated with appropriate capacity and capability building techniques that will enable the various stakeholders such as SME networks, supply chain partners and policy makers to create a new application to suit the appropriate context of the transferee SMEs.

This research is currently at a very early stage in the developmental life cycle. The key emphasis at this stage is to gather information pertaining to similar initiatives from other countries. The paper through a literature review and synthesis sets out some of the guiding principles and the overall methodology to conduct the research programme. The problem identification and the methodology will enable the various stakeholders of this project to delve into some of the finer details of the research agenda, which will further inform the development of key milestones and tasks.

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Children as Actors in Disaster Management: Insights from a South Asia Regional Research Study

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Abstract

Disasters around the world disrupted the lives of millions of people, especially children pushing many of them in to prostitution, armed conflict, drug trafficking and other dangerous occupations leading to violation of their rights. At the same time, approaches to disaster management continue to be largely technology centered, top down and isolated from human development processes. This paper is focused on disasters that took place during 2004-2005 in South Asia region. The paper is divided in to four sections. First section discusses various approaches to disaster management. The second section discusses whether and how Children's needs and rights have been addressed by the duty bearers during various disasters in the selected countries. Section three briefly discusses various policies and legal frameworks related to disaster management. The paper concluded in the fourth section. The paper is based on a larger regional study conducted during 2005-2006 supported by Save the Children Sweden Regional office situated in Nepal.

Key words: Child Rights, Disaster Management, Legislation, Policy, South Asia

1. Background

1.1 Approaches to Disaster Management

Historically, approaches to disaster management were *technology-centred, top-down* and isolated from the development process. They relied heavily on outside 'experts'. However, over the past two decades, increasing emphasis has been placed on, on the one hand, *community-based approaches,* and on the other, pre-emptive approaches that focus on the root causes of vulnerability rather than isolated disaster events (Blaikie et al., 1994). Particular stress has been put on local capacity-building (Alexander, 1997; Benson et al, 2001; Christie and Hanlon, 2000; Rocha and Christoplos, 2001) as a means of increasing resilience to natural hazard events, preventing disaster and adapting to environmental and climatic change (Allen 2005:83 cited in Asian Disaster Management News 1997).

The growing evidence that the top down approaches to disaster management resulted in inequitable, unsustainable and inappropriate results. There is a paradigm shift – humanitarian agencies moving away the traditional relief and response focus disaster preparedness to a developmental approach incorporating hazard mitigation and vulnerability reduction in their strategies [[1]] . However, in the recent decades new approaches to disaster management have been evolved.

Many development practitioners now support *Community Based Disaster Management* (CBDM) approach. This approach has been discussed, debated and adopted in the World Conference on Natural Disaster Reduction held in 1994 at Yokohama, Japan.

Community Managed Disaster Risk Reduction (CMDRR) is another approach that seeks to bridge the gap between disaster and development. It refers to a process of reducing disaster risks in which communities actively engage in identifying, analysing, addressing, monitoring and evaluating their disaster risks to reduce their vulnerabilities and to enhance their capacities to overcome a disaster situation [2]. Community Managed Disaster Risk Reduction paradigm warrants facilitation from the development practitioners. However, currently there is a significant capacity gap that constrains the application of CMDRR in practice.[3]

Right based humanitarian approaches to Disaster Management are based on the belief that the humanitarian imperative comes first and that people affected by conflict and calamity have right to protection and assistance[4]. They seek to alleviate human suffering without offending the affected people's dignity or undermining the local capacities. Generally, they apply a *rescue-relief-rehabilitation* model of interventions. In practice, excepting in few cases, they fail to pay attention to children's particular needs, women's personal hygiene and care of people with special needs[5]. The findings of several studies suggest 'disaster interventions rarely consider children holistically as the UNCRC indicates they should'[6].

Furthermore, every new disaster brings renewed demands for a swifter response. However, the danger is that such requests strengthen and centralise the power and authority of the technical and sectoral agencies, which in turn strengthen fast-moving, non-participatory practices that undermine the ability of communities to respond. Studies on children, women and minorities in disaster shed light on the role of class, race, gender and age in different societies. There is a serious need to find a place for children and youths on the disaster research agenda.

1.2 Children Rights and Natural Disasters

The history of Children Rights movement dates back to 17th century in countries like USA, contrary to a number of writings. For example 'The Bodies of Liberties (1640)' established first code in the world to offer legal protection to the children. On the one hand, the children under this law could be 'putt to death' for insubordination against their parents [7] .n the other hand, under this law, children could voice to the state authorities whether or not they were subjected to abuse by their parents (cited from Jones 1992). Against this back of legal histories, the Children's

Rights movement comes of age when the United Nations Convention on the Rights of the Child (UNCRC) ratified by as many as 192 state parties in 1989[8]. The declaration of UNCRC is truly a milestone in the history of evolution of Children Rights movement across the globe. The convention[9] draws attention to four sets of rights namely: the right to survival; the right to protection; the right to participation; and the right to development.

The (UNCRC) sets principal standards for the well-being and development of children. It is based on the premise of the child as a subject and bearer of his/her own rights. The Convention provides a comprehensive framework for action on and by children. It is the first human rights treaty combining civil, cultural, economic, political and social rights of children, overcoming ideological debates on "who goes first". A child rights-based approach challenges the existing societal role models and perceptions of the child detrimental to its well-being and development and promotes a new culture of respect towards young people.

> *"A century that began with children having virtually no rights is ending with children having the most powerful legal instrument that not only recognizes but protects their human rights."*
>
> – **Carol Bellamy**, UNICEF Executive Director

In addition to the conventions and laws, various academic disciplines like Psychology and Social Work have been influencing the Children Right's movement in different countries. Today we can conclude that children are better off as a result of years of child advocacy, yet there are areas like disasters in which children are largely treated as passive beneficiaries. An estimated 77 million children under 15, on average, had their lives severely disrupted by a natural disaster or an armed conflict, each year, between 1991 and 2000. Millions of children were made homeless, lost loved ones, received injuries, witnessed or experienced violence and suffered scarring psychological traumas.

Anderson (2005) argues that 'significant progress has been made in the social science disaster research held since its inception several decades ago. Despite the advances in knowledge, important areas of research have been seriously understudied, including the impact of hazards and disasters on children and youths' (p.159). Anderson highlights that the knowledge base on children and disasters is so thin that studies related to children in this context are needed across the entire mitigation, preparedness, and response and recovery spectrum[10].

Drabek's systematic survey of disaster research findings mainly refers to children in a mental health context reflecting a dearth of information on the topic of children and disaster[11]. Thus there is a serious need to find a place for children and youths on the disaster research agenda and to advance knowledge about this segment of the population. Such knowledge would provide a more complete understanding of the impact of hazards and disasters on society across the board and result in a firmer basis for policy and practice[12].

In the following section, I present the field evidence on whether and how children's rights have been addressed by the duty bearers during disaster relief and rehabilitation? How have child rights concepts been incorporated in the program designs? Are systems and polices inclusive of children rights in disaster management?

2. Insights from Country Case Studies

2.1 Research coverage and Method

The research focused on and was restricted to earthquakes in Pakistan and India in 2005 and Kuchch (India) in 2001, Tsunami 2004 (India and Sri Lanka), and floods of 2004 in *Tarai* Nepal. A desk research was conducted to collect the secondary information on the subject matter. A large amount of web based literature was collected and analysed. A brief policy literature was conducted in order to strengthen the analysis. Further, to supplement the secondary information using an exploratory and descriptive research design, primary data was collected by administering a questionnaire. Key Informant interviews were conducted with policy makers, bureaucrats and NGO and media representatives. Focus Group Discussions were carried out with children and members of Child Clubs involved and affected by disasters. Some case studies were collected to provide the evidence of the situation and interventions as best practices and learning for the future.

2.2 Child Rights and Floods: Nepal Tarai

Nepal Terai region is prone to flood, due to accelerated deforestation and the construction of dams on the rivers on the Indian side. As such, today a large number of people are exposed to seasonal floods.[13]

The floods and landslides in 2004 have affected the lives of approximately 360,243 persons of 62,357 families in 25 districts of the Nepal.[14] The most affected districts were concentrated in Terai region and few in mid hills.[15]

The government approach/activities were focused only on disaster relief and often directed by the Chief District Officer (CDO), who heads District Administration Office. The District administration follow the *Natural Disaster (Relief) Act (NDRA), 1982* to implement the disaster related activities.[16] The Act has provisions for formation of the disaster relief committees at the central, district and local levels. At the district level, a District Natural Disaster Relief Committee functions under the Chairmanship of the CDO and the Local Development Officer as its member secretary. The committee is responsible for policymaking and implementation of disaster activities. It was evident from the field material and from the discussions with the district level bureaucrats that the Act does not mention about children and their rights and hence there was no special focus on children while delivering the government relief activities.

We conclude that the central approach of the government related to flood/disaster management remained or restricted to using the army and police for emergency operations and sending packages of relief material along with the rescue teams. After the situation has been normalized, there were no clear follow-up actions. There at least six government departments that are involved in disaster related activities. None of them have a child centric plans and coordination among them is often missing.[17]

From the field evidence, it has become evident that due to the lack of co-operation and coordination among the government departments and other agencies involved in Tarai flood disaster management in 2004, most of the disaster victims/families did not received the necessary help in time. In cases of delayed relief assistance and co ordination, the children and elder citizens were the most affected.

In contrast to the government approach, some Non-Governmental and Relief organizations like Nepal Red Cross Society, Dhanusha Branch mentioned that their Junior Red Cross Circle members not only received relief benefits but also participated in data collection, distribution of food and other materials. The organization staff consulted children to decide the actual victims (and to avoid political influences) from flood affected villages. Partner NGOs of Save the Children (like ASMAN Nepal) have implemented child related projects with a focus on Child Rights of varying degrees and understanding.

Some NGO leaders (for example Dr. Ajaya Kant from RCDSC, Mahottari district) claimed that though they did not implement their relief activities from a child point of view but family as a unit. The NGO staff claimed that helping a family means reaching not only adult men, women but also children and old age members.

We came across few other NGOs that implemented the relief activities as designed by their donors. In this case, the NGOs rather acted as delivery agents by signing contracts with their respective donors. However, the NGO leaders expressed that though they did not want to function like a contractors, ultimately they want to help communities in some ways.

In addition to the above observations, we found that the NGOs activities were mainly focused on school going children, leaving a large section of non-school going children in the villages. In many cases the NGO activities were also time bound and funding based. Few local NGOs did implemented some activities during the floods that were child focused, but overall understanding or implementing the activities from a child rights perspectives was missing. There was no evidence that the implementing NGOs have had a long term plan and understanding on children rights.

Focus Group Discussion with *Bal Committee* (Child Committee) members at Shree Rashtriys Prayhamik Vidhyalaya Dholbaja, Kiratpur and other students[18] suggest that children were involved in the process of finding out other children and families who were severely affected and needed a support. According to the students the flood level was above their neck levels. Some of them were protected by Nepal Army. Some of them lost their house and stayed for about a month in the relief camp located in the same school. Some of them mentioned that they received cloths and school bag with books and other materials.

From the evidence, I conclude that the children affected by the floods were neither consulted nor represented in the program plans of implementing agencies. The survival needs of children only received some attention. Disaster management policies in Nepal are still based on the emergency-relief- rescue approach.

2.3 Child Rights and Earth Quakes Disasters: Pakistan and India

On January 26, 2001 a massive earthquake with 6.9 on the Ritchter Scale struck western state of Gujarat, India at 08:46 a.m local time. The tremors were felt in Delhi, Bombay and neighboring Pakistan. The epicenter of the quake was 20 km north-east of the town of Bhuj, the district headquarters of Gujarat's Kuchchh district[19] while, at the same time, seriously affecting all the area within the range 100 km from the epicenter.[20] The result was catastrophic total 7906 villages from 182 blocks from 21 districts were affected taking death toll of 20,005. About 166,000 people were reportedly injured out of which 20,000 were seriously injured[21]-[22].

On 8th October 2005 another powerful earthquake (also known as South Asia earthquake) occurred at 08:50:38 Pakistan Standard Time (09:20:38 Indian Standard Time) stuck (7.6 on the Richter scale) causing widespread damage in Pakistan, India and Afghanistan. Over 70,000 were killed (about 17,000 students were killed when their schools collapsed) with as many injured and approximately 3 million were rendered homeless. More than 50 percent of the homeless were children[23]-[24].

In both the country cases response came from various sources. In addition to governmental efforts many international organisations especially focusing on children and local NGOs were involved in rescue, relief and rehabilitation activities. Presence of International Save the Children Alliance, Red Cross and other organisations were visible in both the cases.

In the case of Gujarat Earth Quake (2001) *Child based emergency response* programs were implemented. Save the Children and *Kutch Nav Nirman Abhiyan* (Abhiyan), a network of NGOs jointly implemented Semi Permanent Shelter (SPS) programme. The objective of the programme was to help substantial number of families through selected group of NGOs, to build interim shelters while they continue to rebuild their lives and homes and thus enable them to protect themselves and their children against severe weather conditions before the onset of monsoon in the Western part of India. The SPS programme was conceived as an alternative to both, temporary and permanent shelter programmes.[25]

Child to Child (CtC) groups have been formed by NGOs. Each child group has a support of teacher and is comprised of boys and girls in about the same proportion as their school enrolment rates. With support from Save the Children and the NGOs, these groups have developed an identity, momentum and an agenda of their own and have been able to undertake several difficult tasks such as the cancellation of a transfer order of their school teacher (Fathegarh village). Exposure visits to Ahmedabad and other NGOs working with children have had a significant impact on CtC members as many of them had never travelled outside their Taluka in their lives. Socially relevant activities such as abolition of chewing tobacco (*gutka)* – a known cause of cancer in India, improved solid waste management in the villages etc. have been initiated by the children.

A Child Help Line was established and the telephone based service was supplemented by a set of trained volunteers from partner agencies who established contact with vulnerable children – orphans, children of single parent, physically and mentally disabled children and established their linkage with other agencies that could provide the necessary support.

Like the Bhuj Earthquake, the Earthquake disaster of 2005 in Pakistan, also focused on bringing normalcy back into children's lives affected by the earthquake and to mobilize families and e community support to help children.

The other focus areas have been reconstruction and restarting of government schools, reconstruction of integrated child development service (ICDS) centres, establishing Adolescent Girls Drop-in Centres, creating Safe Play Areas, formation of Cricket Clubs, capacitating the teachers and ICDS workers on Child Rights and child protection issues. The evidence suggests that children can play an active role in disaster management. It was clear that the local communities if mobilised are the best judges of protection needs of children and vulnerable families.

2.4 Child Rights and Tsunami : India and Sri Lanka

A massive underwater earthquake with M 9 struck Indian Ocean near Sumatra at 06:28:53 a.m. IST on December 26, 2004, and triggered a series of lethal tsunamis that spread throughout the Indian Ocean, killing large number of people and devastating coastal communities in Indonesia, Sri Lanka, India, Thailand, and Maldives. The result was catastrophic with 186,983 people dead and 42,883 missing, 125,000 injured and almost 1.68 million displaced. More than 500,000 houses were totally or partially damaged. Road and railway networks were torn apart in large parts of Indonesia, Sri Lanka, Maldives, and in some parts of India (Andaman Islands). The direct damage caused by this earthquake was more than $7 billion.

In India, the State government provided immediate relief support very quickly. The government's supports were mainly focusing to food and non-food items, clearing of debris, setting up temporary shelters and providing assistance to the families who lost their family members. International Non Governmental Organisations (INGOs) also did provide support to meet the gap. The focus of the INGOs relief support (for example of Save the Children) was to meet the survival, development and protection needs and requirements of children along with their family members. It supported with foods including high energy foods for infant, pregnant and lactating mothers, cooking utensils, clothes for women, men and children, sleeping mats, medical and hygiene kits, notebooks and pencils, toys and other play materials and play areas.

In Sri Lanka, the government and NGOs have been involved in relief, rehabilitation and preparedness program for the Tsunami affected population. Since some of the regions have been severely affected by the Government-LTTE war, many organizations have also been involved in relief and rehabilitation programs. Further, few organizations have already integrated the issues related to child rights and child protection in their long term development plans. The field material suggests that, rescue, relief and rehabilitation are the major approaches taken to respond to the Tsunami affected communities in the country. But in the later period, many of the organizations have also paid attention to the disaster preparedness and disaster risk reduction. Organizations (such as SCiSL, World Vision Sri Lanka) have also integrated a long term plan on disaster preparedness and disaster risk reduction (DRR) especially focusing to community based awareness raising and preparedness as well as influencing at policy level.

Sri Lanka banned adoption of child orphaned by Tsunami, which is a firm step to protect children from sexual exploitation and trafficking. There is a separate department of rehabilitation, relief and disaster management formed recently. The staffs in the department are yet to be equipped well with knowledge and skills on child rights and child participation.

3. Disaster Policies and Legislation

In Nepal before 1981, there were no organized relief and rehabilitation activities for victims of natural disasters. The relief activities were based on social welfare activities of local institution and individuals. It was in 1982 that Natural Disaster Relief Act of 1982 has been enforced and amended in 1992. According to this Act, Home Ministry and Department for Disaster Management are responsible for relief activities, where as Ministry for Physical Planning and Housing is responsible to implement a long term solution for the displaced. Central, regional, district and local relief committees are formed to channelise the implementation of relief activities. National Disaster Relief Regulations (NDRR) could not yet be formulated which is very essential, due to which the Act could not be fully effective. Ironically the Local Governance Act is silent on natural disaster management and relief. It has created vacuum on effective implementation of relief activities at local level.

In Sri Lanka *the National Disaster Management Act No.13 of 2005 is* formulated and passed by the Parliament of Sri Lanka in May 2005. *The* Disaster Management Council is a statutory institution responsible for policy formulation and the Disaster Management Centre (DMC) is responsible for implementation. The Ministry of Rehabilitation, Reconstruction and Refugees is the nodal ministry to address issues relating to the conflict in North and East regions in the country.

Under the Indian Constitution, disaster management is the responsibility of state governments. For example, the Gujarat Disaster Management Act 2003 provides scope for capacity building of groups in local communities to cope with any disaster. At the national level, there is a National Crisis Management group headed by the cabinet secretary to assess the impact of major disasters. The group consists of various nodal ministries. In India, the new approach adopted by the government translated in to a National Disaster Framework covering institutional mechanisms, disaster prevention strategy, early warning system, disaster mitigation, preparedness and response and human resource development. For example, disaster management as a subject in social sciences has been introduced in the school curriculum for class 8th and 9th in schools run under CBSE system. The state governments have been advised to take similar steps vis-à-vis their school boards.

A brief analysis of legal frameworks and policies in the South Asian countries suggest that there are policy gaps in the implementation. The disaster policies are mostly relief centered. As more then one government agency is responsible for disaster management, evolution of better co ordination strategies is essential. None of the legal frame works recognized children as the actors and provided scope for their participation and consultation in decision-making.

4. Conclusions

Research on Children in disasters is relatively young and needs much more attention from all the quarters. Researchers and Social Workers should give the subject the attention it deserves, so that much can be learned about the outcomes of these disasters for children and how children can be actors in the management of the disasters rather as passive beneficiaries.

Children are the most photographed but least consulted, while making disaster management polices and programs. The rescue- relief-rehabilitation model of interventions resulted in treating children as passive beneficiaries and not as actors. These models fail to pay attention to the special needs and rights of the children.

Policies related to natural disaster preparedness, relief and response are adult focus and there is much less consideration of children's needs and rights. Hence, children who are most vulnerable in disasters are always left behind and suffer a lot. Hence, such polices and guidelines need to be child focus and sensitive. The specific survival, development and protection needs of children need to be addressed in emergency response, rehabilitation and preparedness.

Children rights perspectives were often talked about but seldom implemented. However, in some cases (the Save the Children work in Pakistan Earthquake for example) there is evidence of children participation ensuring their right to participate in decision making.

There is acute need of consideration of children's participation in rescue, relief and rehabilitation and preparedness phases of disaster including situation assessment and decision making. Evidence from the field has shown that children's participation is possible in all stages and has enriched the quality of response and support and enhanced the ownership and sustainability of the program.

The paper concludes that there is an urgent need for increased focus on the child centred preparedness and risk reduction policies and co ordination between the governments, donors and NGO in the region.

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[14] According to the annual report of Department of Water-Induced Disaster Prevention (DWIDP), since 1983 an average of 300 people lost their life in flood and landslide each year.

[15] Source: NRCS District Chapters & Ministry of Home Affaires (MOHA), and different media reports. Affected Districts are : Jhapa, Morang, Sunsari, Saptari, Siraha, Dhanusha, Mahottari, Sindhuli, Sarlahi, Rauthat, Bara, Parsa of east Terai in Nepal and similarly, Arghakhanchi, Palpa, Dhading, Makawanpur, Ramechhap, Kabhre, Udayapur, Khotang, Okhaldhunga, Terhathum, Kabhre in East Hills and Pyuthan, Achham west hills.

[16] Before the enactment of Natural Disaster Relief Act (NDRA), 1982 there was no well structured disaster policy. The Act has already been amended twice in 1989 and 1992. However, National Disaster Relief Regulations (NDRR) could not yet be formulated due to which the Act could not be fully effective.

[17] The Natural Disaster and Floods Division of the Ministry of Home Affairs is the central unit responsible for managing/coordinating emergency response. 1. The DWIDP is designated as the lead coordinating agency. 2. The Department of Narcotics and Drugs Control and Natural Disaster Management is the sole agency involved in post-disaster operations. However it does not have physical infrastructures under its command. It has to rely on the district administration to carry out relief and rescue operations. 3. The Department of Hydrology and Meteorology is supposed to provide flood warning system. As the equipment available with the department is antiquated and insufficient, it has to rely on old system of meteorological forecasting. 4. The Department of Mines and Geology, which is supposed to provide specific resources for landslide and environmental hazard mapping, seemed to be equally unaware.5. The Department of Soil Conservation and Watershed Management, responsible for providing specific resources commensurate with river training works to manage the upper watershed of the rivers, was also silent. 6. The Department of Health Services is responsible for mobilizing medical teams and medicines to flood-affected areas (source : www.nepalnews.com. Cover story dated **VOL. 22, NO. 06, AUG 02 - AUG 08, 2002)**

[18] All together 16 students representing class 3,4 and 5 were there in the meeting. Ten of them came from Kiratpur, three from Parsahi and two from Dolbhaja, and one from Nayatol. Among them three students belong to class five are the members in the Balcommittee formed in the school.

[19] Kachchh district alone reported 18,416 deaths, which was almost 92% of total human loss. This district sustained 90 percent of the deaths and 78 percent of the injuries reported overall, and contained 257,000 of the houses damaged or destroyed (source: Gujarat earthquake- Fact sheet at www.un.org.in/UNDMT /states /gujarat/updates.html).

[20] The Indian Meteorological Department (IMD) has recorded a Richter magnitude of 6.9 with location being north-east of Bhuj, while the United States Geological Survey (USGS) maintains that the magnitude was 7.9, and the epicenter lay north of Bachau in a location 50 kilometers from the IMD site (Source : Preliminary Observations and Aftermath of Gujarat Earthquake, India by Rajib Shaw and Ravi Sinha, 2001).

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[24] 1,400 people died in Indian-administered Kashmir and 6,622 were injured while 150,000 lost their homes. source: http://www.unisdr.org/disaster-statistics/impact-killed.htm accessed on 02/08/06.

[25]The programme initially targeted to provide earthquake safe technology and material assistance to about 22,000 families, which eventually grew to about 24,000 families living in 253 villages of eight out of ten talukas of Kutch district. The programme was implemented by a group of 13 NGOs.

Tsunami Disaster Risk Reduction- Practical Guidelines for the Indonesian Context

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Abstract

Much of the practical advice and certainly the theoretical position of those trained in disaster management fall short of what is encountered in Indonesia. Based on the development of tsunami guidelines for Aceh this paper outlines the particular differences that make Indonesia a special case. The proximity of tsunami generation and consequent lack of warning time, a large coastal population, large areas of flat coastal land and the lack of escape options particularly for those returning to previously tsunami hit areas puts Indonesia unfortunately outside much of the experience of neighbouring countries such as Sri Lanka and India. And consequently, there is the need for specific guidance for the Indonesian context.

This paper documents the basis for the tsunami disaster risk reduction measures that were developed to provide some rational grounding on which to plan an evacuation from village rebuilding projects located back in tsunami affected areas of Aceh.

The paper addresses issues of escape times, safe havens, widths of escape paths and most importantly the decision between a horizontal or vertical evacuation. The development of the guidelines utilized video footage from the tsunami disaster, fire evacuation data, surveys from survivors, risk theory and "common sense" to arrive at its final recommendations. Unfortunately, those recommendations, given that people were opting to return to at risk areas, expose the harsh reality of the decisions that the community would need to make.

Keywords: Disaster risk reduction, tsunami, guidelines, planning

1. Background

1.1 Methodology

There is a lack of design guidance on exactly how one physically builds disaster risk reduction into communities. And this was the situation that faced many NGO's in terms of developing meaning village plans as required by BRR in Aceh , Indonesia as part of their post disaster reconstruction work following the Asian Tsunami of 2004 [1]. In response, engineers, architects and planners on the ground developed their own rational approaches for this design one of which is now outlined in this paper. The standard approach consisted of marking exit routes on to a masterplan of the village under study that would have been sufficient given adequate warning. However, the Indonesian reality of between 10-20 minutes of warning time meant that exit (or evacuation) distances were in reality severely limited and consequently design teams had to determine a suitable design approach. And hence the topic of this paper.

This approach was developed based on the following 4 pieces of research:

1. A tsunami report by Wilkinson [2]
2. Interviews of survivors of the tsunami
3. A desktop review of past lessons learnt based around work by the US Geographical Service [3]
4. The development of practical guidelines based on speeds of people observed in fire situations and video footage of the actual disaster.

And in particular, the work by Wilkinson.

1.2 The Wilkinson Report

Wilkinson studied the tsunami context in Aceh and confirmed that for "..for areas close to the fault zone such as west Aceh, it is unlikely that the planned Indian Ocean tsunami warning system can respond quickly enough to save lives. From the end of the earthquake, it was only 5 minutes before the first indication (the withdrawal of the water from the shore) of the tsunami was observed at Calang. This time was insufficient and 90% of the population died. This highlights how little time is available for warnings to be given to areas that are closest to the epicentre."[4]. He goes on to recommend that "…The planning….must assume virtually no warning of any future tsunami and plans should be based on reacting immediately to large earthquakes. Access to safe refuges should take no longer than 10 minutes to reach safely. Many survivors stated that it was not possible to move far during the earthquake and that they could only run after the earthquake finished. In Calang there was only 10 minutes between the earthquake stopping and the first wave arriving. It should be noted that what happened at Calang could happen to any point along the West Sumatran coast that is close to an earthquake epicentre." And straight away it is evident that the tsunami context in Indonesia is different from that observed elsewhere. Unfortunately, this difference was not readily appreciated by Agencies on the ground.

Figure 1: Map of Aceh and its West Coast Area Studied by Wilkinson(locations of interest are underlined)

Moreover, Wilkinson went on and suggested that rather then being a rare event the Asian Tsunami was more common than appreciated "…In effect, major tsunami causing earthquakes that occur about every 200 years at different sections of the fault zone [and they] are out of phase by about 40 years. Hence, the average return period of a disastrous tsunami is of the order of 100 years but the present probability of a it occurring now is 3% per annum based on it occurring in the next 20 to 50 years. In addition, the average occurrence of smaller tsunamis (less than 5 or 6 metres) over the last 170 years is 30 years and these events will continue to occur." And more specifically "…these frequencies [are] well within the time frame for determining design forces for important buildings and should be of major importance for the design of future planning and construction. However and more importantly these frequencies are of major concern because it is within the lifetime of the people living in the area and moving back into their devastated housing sites. It must be recognised by Government that there will be a massive loss of life again if action is not taken to have people living in safe areas." He concludes that "…despite the information above it is considered at this stage that there is insufficient data to undertake a numerical analyse of these previous tsunamis to determine the wave tsunami height distribution along the Sumatra west coast. However based on the frequency of tsunamis over the last 170 years and on geotechnical advice provided to the author in Australia the best estimate of reoccurrence of a 10-metre tsunami, is of the order of a 100-years and it is not a rare one off event. This height is less that the maximum height of 13-metre at Lhoknga and along much of the coast between Banda Aceh and Calang." (Underlining added)

Thus, in summary he was stating the following:

- Early warning tsunami systems are not an option for much/most of the West coast of Sumatra with 10 minutes being the probable evacuation time after an earthquake before the arrival of a tsunami.

- The Asian Tsunami was not a rare event and that a 10 metre wave height should be the standard design tsunami with a return period of 100 years (meaning that there could be expected to be one such event every 100 years). But with a 3% chance (3 times that of the 100 year event at 1%) of it occurring in the next 20-50 years.
- Other smaller tsunami of less than 5 to 6 metres would have a return period of 30 years.

His work immediately puts the tsunami risk into context.

1.3 Interviews of Survivors

Given such a background, how did anyone survive? Earlier research work by Potangaroa had created a database of 404 eye witness accounts of survivors of the Asian Tsunami in Aceh using a questionnaire developed at the Cambridge University Centre for Risk in the Built Environment [5]. These interviews were later analysed in collaboration with Cambridge University [6] and given that there were (at least they were perceived to be at the start of this process) critical villages in the city of Banda Aceh (the Provincial capital) those respondents from Banda Aceh (91 in all) were analysed separately to find the following:

1) What was their sense of the earthquake?
2) What was their immediate response to the earthquake?
3) When were they first aware of the tsunami and what warning did they have?
4) Where did they go in response to the tsunami? And how did they go?
5) Was their first choice exit route available?

The results from this are summarised next.

1.3.1 Sense of the Earthquake?

The majority of those surveyed experienced a violent or strong earthquake. (80% of respondents indicated that it was a violent while 19% indicated that they felt a strong earthquake with the remaining 1% being a fisherman at sea at the time). This is significant as it indicates that despite experiencing a violent seismic event the possibility of a resulting tsunami did not occur. Moreover, Wilkinson reports that he found one person from the last tsunami in 1941 during his review of the tsunami affected areas along the west coast of Aceh and that despite there being songs (that formed part of the local culture) about a large wave no one understood what the song meant or the potential for a tsunami. Thus, despite a history and culture associated with tsunami, the potential risk and warnings of a tsunami are unfortunately not recognised within the community.

1.3.2 Immediate Response?

Most people ran outside (74%) with only a small percentage electing to stay inside their houses or the buildings they were in (6%). The remainder of people were already outside and moved to where others were congregating (20%). Such a response (running outside) is not surprising but does underline the need to ensure exit ways out of the house are protected or structurally secured.

1.3.3 What Warning?

Most of these survivors were warned by others of the pending tsunami (51%). However, 44% had no warning and were only aware of the tsunami when it arrived. Thus, there is a need for a fundamental warning system possibly based around ground shaking intensity and community socialisation of such a system possibly through schools.

1.3.4 Where And How Did They Go?

Perhaps the most interesting information is where did people go in response to the tsunami? Most people moved on to the road (24%). The next popular choice was to be with other family members (16%), the neighbour's house (15%), a shop or café (14%) and then the mosque (11%). Interestingly, these were all horizontal evacuations and relatively smaller numbers elected for a vertical evacuation with only 7% climbing trees and 5% climbing on to roofs. Fortuitously, 5% of people managed to survive being in the water.

In terms of mode of travel 46%of people walked while only 11% were able to evacuate by private vehicle and 18% (strangely) by bus. 2% were carried out because of injuries.

1.3.5 Blocked Route?

Finally, it is also interesting that 66% of the survivors reported that their usual route was blocked. Clearly, they were able to go around or take an alternative route but plainly there is a need for substitute routes through communities and villages. Nonetheless, such routes would be under pressure given the essentially horizontal evacuation options taken earlier

Thus, in summary significant numbers had no warning of the pending tsunami, had there preferred exit routes blocked and elected to walk out once they were aware of the danger.

1.4. Lessons for Surviving a Tsunami: Desktop review.

Other countries are (like Indonesia) subjected to tsunami. And the aim of the desk review was to ascertain what survival strategies worked in other countries and what should/ could be used in Indonesia. Much of this work in other countries had been gathered by the US Geological Service. The lessons are tabulated below with the lesson learnt in italics and its relevance to Aceh reviewed.

Thus, while many of the lessons learnt in other tsunami affected countries did apply in Aceh there were several that did not. Significant among these were the ineffectiveness of any early warning system for Indonesia (raised earlier by Wilkinson) and the consequent need to evacuate vertically rather than horizontally. This need requires the identification and tsunami design of designated buildings within the immediate community as safe havens. Obvious buildings would be mosques, schools, health clinics and most public buildings.

Table 1: Lessons Learnt from Other Countries

Many Will Survive the Earthquake	*Lesson: In coastal areas, the largest subduction zone earthquake may kill fewer people than the tsunami that follows.* This was also true for Aceh with many surviving a 8.9 Richter scale earthquake but dying in the resulting tsunami.
Heed Natural Warnings	*Lesson: An earthquake may serve as a warning that a tsunami is coming, and so may a rapid fall or rise in coastal waters.* There are various natural warnings from the environment and nature of an impending tsunami. Some are well recorded while others are more folklore. The most known is the sudden recession of coastal water below usually tidal levels. But others such as falling water levels in wells and unusual animal behaviour were apparently seen in Aceh.
Heed Official Warnings	*Lesson: Play it safe, even if warnings seem ambiguous or you think the danger has passed.* No warnings were able to be issued.
Expect Many Waves	*Lesson: The next wave may be bigger, and the tsunami may last for hours.* Most people in Aceh that did see the tsunami wave saw a wave train consisting of 3 wave fronts. The first was a small wave with a larger 2nd wave not far behind. The big wave was the third wave and many observed that it was also a breaking wave. However, countries distant from the source of the tsunami usually experience more than one such wave train with the perhaps hours between the different water level peaks. This did not appear to be the case in Aceh.
Head for High Ground and Stay There	*Lesson: Move uphill or at least inland, away from the coast.* This is universal but the big difference for Aceh was the lack of time to get any warning sent out. This shortage of time means that people in the tsunami affected area could only move within a 600-900 metre radius once the earthquake shaking stopped.
Abandon Belongings	*Lesson: Save your life, not your possessions.* There are several instances where people returned to pick up possessions.
Don't Count on the Roads	*Lesson: When fleeing a tsunami caused by a nearby earthquake, you may find roads broken or blocked.* This was also experienced in Aceh as indicated earlier (66% had their exit route blocked). And video footage immediately after the earthquake but before the tsunami clearly show the extent of traffic jams even when the roads were not apparently broken or damaged.
Go to an Upper Floor or Roof of a Building	*Lesson: Only if trapped and unable to reach high ground, go to an upper story of a sturdy building or get on its roof.* This did not or could not occur in Aceh. The decision to change from a horizontal evacuation to a vertical evacuation was one of the major issues of the evacuation in Aceh, and Banda Aceh in particular..
Climb a Tree	*Lesson: As a last resort, climb up a strong tree if trapped on low ground.* This did not occur as noted earlier. This may have been due to there being predominantly coconut palms that can be only climbed by the fit.
Climb onto Something that Floats	*Lesson: If swept up by a tsunami, look for something to use as a raft.* Seemed to be anecdotal evidence of this amongst those that survived being in the tsunami water.
Expect the Waves to Leave Debris	*Lesson: A tsunami will leave behind sand, the remains of houses, and bodies.* This was certainly the case in Aceh.
Expect Earth quakes to Lower Coastal Land	*Lesson: A large earthquake can leave nearby coastal areas lowered, allowing tidal water to flood them.* This was generally true for Aceh. The port area of Banda Aceh sunk but parts of Simeulue Island were lifted.
Expect Company	*Lesson: Shelter your neighbours.* This occurred in Aceh as shown in earlier statistics.

2. The Design Details

The work so far set the basis of the design process in Aceh but the process had to assume the following:

- People individually knew where to go (the horizon and vertical evacuation plan)
- Families collectively knew where to go (if they were not at home at the time of the tsunami)
- And safe havens (either hill tops or designated buildings) besides being identified were open and accessible.

Consequently, there was also a significant community and socialisation component required to make such a plan effective.

2.1 Safe Havens

For a hill top to be suitable as a safe haven required additional height above the design height of the tsunami (the so called run up height). This will vary depending on the distance from the shoreline and Wilkinson [7] below suggests the follows design clearance heights (modelled using a flat ground profile). And it is only that area of the hill beyond and the building area above the heights given in table 2 below that can be counted as a safe haven.

Table 2: Estimated Safe Heights for Hills and Clearance Heights for Buildings

	500m inland (metres)	**1000m inland (metres)**	**2000m inland (metres)**	**3000m inland (metres)**
Safe Height for Hills	22	17	10	6
Minimum Building Height Required on Level Ground	10	9	6.5	4

2.2 Tsunami Design Loads

In addition, where a building is designated as a safe have it must be designed for the appropriate tsunami loads Again, Wilkinson [8] in table 3 below suggests water speeds from which the dynamic pressure could be calculated and added to the static water pressure for the design loading on the building. Wilkinson notes that " … In many cases, the impact wave will cause the more severe design loading condition for housing, buildings, and structures. The maximum wave, which arrives shortly after the impact wave, has lower velocities, but it is the design condition for larger buildings and structures…" An alternative design approach to that suggested by Wilkinson is given by the proposed Japanese Code [9] which suggests simply tripling the height of the inundation level and applying the resultant pressure to the building. Whichever approach is adopted, it should be noted that any debri generated by the tsunami will typically double the density of the water (and hence double the tsunami loading) but debri will also block any localised panel collapse subjecting the building to even further loading. Timber debri in particularly, should be controlled.

Table 3: Estimated Wave Heights, above Ground Level, and Velocities for a 10 metre Tsunami

Distance from Shoreline (Metres)	**Impact or Front Wave**		**Maximum Wave**	
	Wave Height (metres)	**Water Velocity (m/sec)**	**Wave Height (metres)**	**Water Velocity (m/sec)**
At shoreline	4.5	5.5	10.0	5.5
500	5.0	6.0	8.0	5.5
1000	4.5	5.5	7.0	5.0
1500	4.0	5.0	6.0	4.5
2000	3.5	4.5	5.0	4.0
2500	2.5	4.0	4.0	3.0
3000	2.0	3.0	3.0	2.5
3500	1.0	2.0	2.5	2.0

As a rough comparison, Indonesian seismic load levels are equivalent to 1.7 to 2.5 metres of static water pressure and therefore tsunami loading will be significantly larger than any seismic requirement

Therefore, based on the distance to the shore line the wave height at a particular site can be calculated from table 1 above. And the design tsunami height can then be approximated by taking off the site elevation above sea level from that wave height. This will be used later to ascertain the evacuation line for natural havens and the suitability of built safe havens.

2.3 Evacuation Distances

How fast do people evacuate following a tsunami warning disaster? There are no guidelines in the literature for tsunami and the closest comparison is with fire evacuations of buildings. Typical figures are given in table 4 below for such evacuation walking speeds [10].

These figures were verified against video footage from the tsunami and an example of that is shown in figure 2 below. It is of a dependent elderly person being assisted to a nearby roof. In 4.5 seconds they are able to move 10 to 12 metres, an average walking/running speed of 2.7 metres (compared to 0.948 for an independent elderly person).Thus, the observed evacuation speeds can be significantly higher than those suggested for fire evacuation albeit on a tar sealed road in good weather during the day. Given that such an evacuation could be in bad weather, could be at night and in the dark and/or over broken or blocked roads suggests that lower evacuation speeds should be used and the figures on the right of table 4 were selected by the shelter team as being reasonable. Therefore, the evacuation line or limit based on 1 to 1.5

metres/sec for 10 minutes is a radius of between 600 to 900 metres. Thus, any safe haven would need to be within that radius.

Table 4: Evacuation Speeds used for Fire Safety Design

Walking Condition	Design Fire Evacuation Speeds* (metres/sec)	Suggested Tsunami Evacuation Speeds** (metres/sec)
A person with a child	1.02	1.5+
An independent elder person	0.948	1.0-1.5
A dependent elderly person	-	1.0
A group of elderly people	0.751	-

*based on Fire Safety & Disaster Preparedness 1987. ** based on video during the tsunami

2.4 Bottle Necks

These evacuation distances can only be achieved where there is sufficient space for people to walk. And many in Banda Aceh and in particular Calang reported being caught in traffic jams such as the one shown in figure 3 below taken from video footage in Banda Aceh. It shows both motor bikes and vehicles locked up and unable to move.

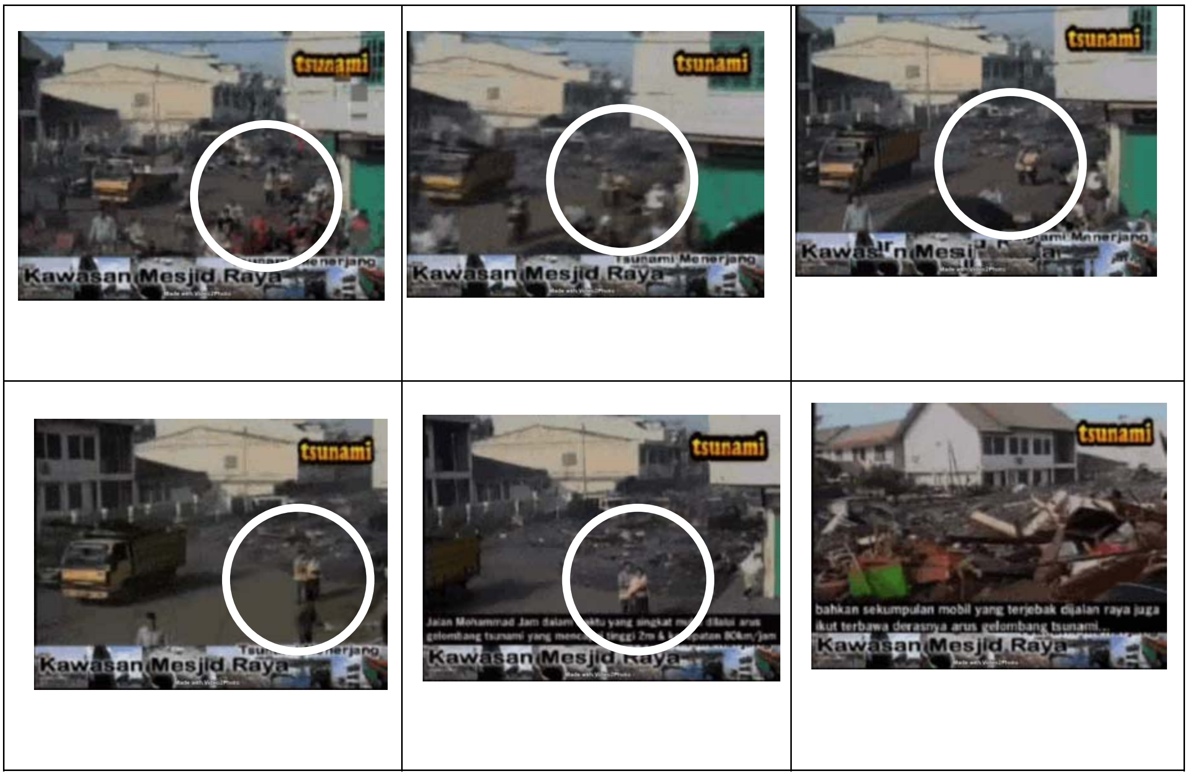

Figure 2: A dependent elderly person evacuating in the face of the tsunami

People should evacuate on foot (as the outlined in the earlier research) and not by car or motor bike. And to check that there will be sufficient walking space an arbitrary road lane of 2.5

metres was assumed with any remainder being potentially a walking lane of 800mm width. And based on the evacuation speeds each lane would have a minimal capacity of 1.5 persons/sec. For example, if the road width (drain to drain) was 6 metres then there would 2 traffic lanes of 2.5 metres = 5.0 metres and 1 metre leftover which would sufficient for one lane of foot traffic; 7 metres would be 2 traffic lanes and two walking lanes while 8 metres would be 3 traffic lanes and no walking lanes. And consequently would require alternative walking options potentially outside the side drains of the road.

2.5 The Design Process: Step by Step

Thus, the design process consisted of the following procedure:

1. Calculate the distance from the shore line and ascertain the site elevation.
2. Read off table 2 for the tsunami height and from table 3 for the safe haven height criteria.
3. Identify potential natural and building safe havens on a topographical map of the village/ community.
4. Mark on the map the area of the village/ community those areas within the evacuation limits of 600-900 metres of these safe havens.
5. Based there being 5 people per household calculate the evacuation network numbers
6. Based on say 3 people per m^2 calculate the people capacity of the haven.
7. Starting from the safe haven and working out wards check the capacity of the people lanes. Assume people can “short cut” across house sections.
8. Check the capacity of the haven to take these expected numbers of people.
9. Identify those areas of the village that do not have an evacuation option and engage community facilitators to ensure that these people are aware of the risk.
10. Concurrently, present findings and discuss overall situation with village/community.

Figure 3:Traffic Grid Lock Prior to the Tsunami.

3. Conclusion

The development of the above design process was welcomed by the design team and applied to the 17 village master plans that were being developed. While the results of all 17 could not be confirmed there were responses reported for the two villages in Banda Aceh where the above procedure was applied. These two villages had been badly destroyed by the Asian Tsunami but despite that people had elected to move back to their original sites. The process identified that they were too distant from any natural features and consequently people would have to seek refuge in buildings and adopt a vertical evacuation quickly. Suitable buildings were then located within the evacuation radius (and assuming that the buildings were able to with stand the tsunami loads) were treated as safe havens. The network analysis was completed and access ways checked. And thus, the approach seemed to be working. However, when the floor area of the safe haven was checked it became clear that there would be insufficient room and that one half of the village would potentially witness the other half being swept away by the tsunami. And quite suddenly, the realisation that someone was going to have the terrible job of shutting the door (as it were) on the other half of the village that the full gravity of the situation of the villagers was realised. The sense was that despite having developed a well grounded design procedure we had some how failed, badly, and unfortunately there was no conclusion.

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Integrated Monitoring and Assessment of Rockfall

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Abstract

This paper will present a new methodology for the assessment and monitoring of rockfalls through an integrated multi-disciplinary approach. Current solutions include classical surveying instruments (e.g. total stations, GPS) integrated to sensors for monitoring local deformations (e.g. strain-gauges, deformometers), which are used to achieve information about a limited number of critical points of a rock slope, complemented by geological inspection and qualitative analysis. The innovation of this approach is firstly based on the use of some new sensors which allow to increase the achievable information: terrestrial remote sensors – laser scanner and ground-based interferometric SAR – would allow the measurement of deformations of whole surfaces instead of single points, ground penetrating radar the exploration of rock sub-surface, digital photogrammetry the automatic measurement of crack deformations, seismic and acoustic sensors the detection of vibrations and sounds which could be pre-signal of a rockfall. The second stage of the research involves the integration of different techniques to exploit the full achievable data. This means either the integrated use of sensors and the development of expert systems to integrate different measurements and to make decisions. All activities will be carried out through the setup of some test fields in the Alpine area, where all investigation techniques will be tested.

Keywords: Engineering Geology, Natural Hazards, Rockfall, Georadar, Ground-Based InSAR, Seismic Sensors, Terrestrial Laser Scanning

1. Introduction

1.1 Relevance and impact of rockfall disasters

The investigation of potentially unstable mountain slopes is today a primary need to increase natural and anthropic risk prevention and forecasting. The continuous expansion of human habitats, the presence of transport routes in valleys, melting of alpine permafrost as a consequence of global warming, and exceptional climatic events are amplifying the risk of catastrophic mountain-slope failures, landslides and, more in general, hydro-geological instability. Among the many natural hazards in mountainous regions, *rockfalls* are frequently occurring processes that are characterized by their suddenness and difficulty of prediction [5].

The most part of worldwide countries are interested by this concern, that involves areas with major and minor relieves, with a manifold impact at social level, on national and regional economy, and on the environment. These grounds show somehow this research topic is nowadays relevant, and operational solutions to cope with it might have a great direct and indirect fall-down on the whole society.

Figure 1: A case of rockfall happened at Fiumelatte di Varenna (Northern Italy); on the left is shown the rock face where in november 2004 several big masses fell and hit a railway station and a house

1.2 State-of-the-art of rockfall prevention

The problem of preventing or reducing damages consequent to rockfalls is complex, due to the very large number of feasible scenarios, with the local morphology of the site providing an additional degree of freedom. Due to this complexity, several competences are needed to address at the best methods and investigation techniques.

The state-of-the-art on analysis, prevention, and monitoring of rockfalls accounts for several studies which mostly concern only a limited aspect of the whole problem. Solutions applied for deep-seated landslides, based on either terrestrial and aerial observations [4], cannot be easily extended to rock face investigations, due to the presence of vertical and sub-vertical faces. Here the main role is currently played by classical surveying and monitoring instruments (e.g. robotic total stations, deformation and displacement sensors) with results complemented by geological inspection and qualitative analysis, as well as the weather observation and forecasting. On the other hand, measurements are registered at predefined times, according to the magnitude of the rock displacements and to the acquisition rate of the adopted instrument. In case of permanent monitoring systems, some measurements per hour could be taken, while in case the instrument needs to be periodically repositioned, the frequency might become weekly or monthly. Moreover, traditional monitoring techniques are based on the definition of a safety threshold for every measurement. When this is not respected, an alarm will be activated and emergency procedures will be called for. By this approach the data integration is seldom exploited.

The complexity of rockfall assessment and monitoring requires not only to focus on specific issues, but to establish a close cooperation between experts skilled in several research fields. Indeed, only a multi-disciplinary environment would allow a real integration between different technologies and methods. Unfortunately, until now the cooperation has been generally limited to geologists and geotechnical engineers, with very few openings to expertises in measurement and data acquisition systems. Thus it’s possible to state that a multi-disciplinary approach represents the real new frontier of this research field.

1.3 The GPE-PROMETEO project at Polimi

In 2005 the Politecnico di Milano (Italy) university launched an internal project (PROMETEO) focusing on 6 different frontier research fields on the theme of hazard management and public protection (see the website of PROMETEO for information about all involved topics – [16]). The basic aim was to establish some multi-disciplinary investigation teams collecting different resources (instruments, knowledge and people) working inside the university. Here we limit ourselves to deal with one of the sub-projects (GPE), where the problem of rockfall is concerned, among others. The acronym GPE means "first emergency management" ("Gestione della Prima Emergenza", in Italian), and is focused on establishing criteria for optimizing aid actions just after disasters due to the hidro-geological desease (or to other reasons, e.g. earthquakes) resulting in the destruction of buldings and human artifacts, and involving buried people. One of the specific tasks of this project is to establish the safety conditions for intervention of the emergency teams, based on the evaluation of the so-called *residual risk*. In case of a landslide or a rockfall, this means the capability of understanding in a quick time and possibly with limited resources, if the happened phaenomenum is not completely ended and might occur again. This issue becomes even more complex when dealing with rockfalls, subject that has only been partially investigated till now, as reported in subsection 1.2. This goal generated the need for a wider investigation about rockfall in GPE, which is focused to open new frontiers in this research field based on a multi-disciplinary approach, called IMARF ("Integrated Monitoring and Assessment of RockFall").

On-going research activities under GPE are organized in two main sections. The first one concerns testing and development of new technologies, sensors, and data processing techniques for rock face monitoring. This aspect will be the specific subject of the paper and it will be dealt with in section 2. The second one is based on establishing a methodology to apply different investigation and monitoring instruments and method by an integrated approach, which can be summarized by the following items:

1) Considering in a given region all sites possibly interested by rockfalls, in each of them different investigation tools are applied to locate *sensible areas* where rocks might fall down.

2) Relationships should be found between observed processes (cracks, deformations, vibrations, sounds,…), morphology and rockfall triggering. This goal can be reached by the analysis of several cases, either from literature and past experiences, and from new testing activities.

3) Criteria to define which sites should be monitored and which techniques should be applied have to be set up.

4) Different sensing techniques need to be tested in on-the-field labs (see next section 4 for more detail).

5) Some risk-based operational guidelines for setting an effective monitoring strategy and for emergency management and rescue related to a given rock face have to be written.

As it can be seen by the listed items, the IMARF research program requires several activities and specializations to be continuously applied for a period of at least 5 years. In the following pages of this paper we would like to deal with the problem of monitoring the rock face stability, being this task already on-going at our university.

2. Overview of adopted monitoring techniques

In recent years new instruments and techniques for deformation monitoring based on ground remote sensors have appeared (Terrestrial Laser Scanning and Ground-Based Interferometric SAR), whose application to rockfall monitoring represent a current challenge. On the other hand, the development of Ground Penetrating Radar and related data analysis methods offers powerful tools to investigate about sub-surfaces. This could be successfully exploited to detect discontinuities under a rock face, and then to locate areas of possible mass detachments. Similarly, digital photogrammetry is expected to allow monitoring of deformations on the surface of the rock (e.g. in case of cracks). Eventually, distributed sensors (microseismic or acoustic) could allow to sense small sounds or vibrations which might be a signal of an upcoming rockfall.

New techniques need to be widely tested on sites really interested by rockfalls, in order to evaluate their potential and operational effectiveness. On the other hand, these are expected to be integrated both mutually among them as well as to traditional monitoring systems.

2.1 Terrestrial Laser Scanning

Terrestrial Laser Scanning (TLS) is a quite recent technique (first instruments appeared about 10 years ago) able to directly acquire in a quick time 3-D unspecific points describing the surface of a given object, with an accuracy lower than ±1 cm [15]. The availability of Long-Range sensors, capable to realistically operate up to a range of 500 m, and the possibility of integrating data acquired from different points of view, allow the geometric survey of geological sites of big dimensions [1]. For this reason, this tool is ideal for the determination of the local morphology of a slope (see item 1, sub-sec. 1.4), considering the possibility to integrate also LiDAR data as well as terrestrial and aerial imagery, extending the achievable information.

However, the most challenging task concerning the use of TLS for rock face analysis is monitoring. Indeed, this technique allows to measure a huge number of points with a very high spatial resolution (also 1 point every few square cm) which is not comparable to that of any other instruments (also Ground-Based Interferometric SAR), as presented in the following sub-sec. 2.2). On the other hand, considering the intrinsic precision of range measurements by laser scanners, summed up to the accuracy of georeferencing (task needed to transform all data acquired from different positions and epochs into the same reference system), the accuracy of the acquired 3-D points of a rock face is not enough to forecast rockfalls. Indeed, these might occur also after displacements of a few mm, which cannot be observed by directly comparing TLS measurements. In recent years, several papers were published dealing with the monitoring of buildings by TLS (see e.g. [12]), the most of these overcoming the problem of low accuracy by exploiting the regularity that surfaces of structures generally present. Thus they interpolate the georeferenced point-cloud captured by TLS by geometric shape (planes, cylinders, polynomial surfaces,…) so that the acquisition noise can be strongly filtered and deformations detected from the comparison of interpolating surfaces taken at different epochs.

Unfortunately, the application of the same strategy to rock face monitoring is not trivial, first because regular surfaces seldom exist here, secondly because the complexity of sites and the long-ranges involved make very critical the georeferencing. In the activities of IMARF, some results achieved during a parallel research on dam monitoring will be translated to the case of rock faces [2]. These are based on 2 main solutions, whose effectiveness is to be tried during on-going tests:

1. to improve the georeferencing, the laser scanner is accurately repositioned over a fixed removeable pillar, locked to a stable permanent foundation on the ground (see Figure 2);

2. to reduce the measurement noise, small (the size depending on the rock face regularity) portions of the rock face are interpolated by simple surfaces (flat or parabolic).

Moreover, the application of *change-detection* [20] based on TLS data will be adopted for measurement of the total mass of rock which has detached from a given face between two different epochs.

During this project, further investigations are carried out in order to evaluate parameters influencing the accuracy of TLS measurement, and in particular: roughness and colour of the surface, angle of incidence laser beam, intensity of sun lighting. Similarly to somewhat was carried out by other researchers on the sensor calibration of some TLS models, the scanner adopted in our testing is under experimental calibration [11].

*Figure 2: On the left a GB-In SAR system IBIS-L by IDS (Pisa, Italy); on the right a long-range terrestrial laser scanner Riegl LMS-Z429*i *mounted over a steel pillar for precise repositioning.*

2.2 Ground-Based SAR Interferometry (GB-InSAR)

Synthetic Aperture Radar (SAR) interferometry is a methodology that has been used for a wide range of applications among which the measurement of ground displacements. The combination of the SAR technique, exploiting the movement of the physical radar antenna along a straight trajectory, and differential interferometric analysis, comparing phase information of reflected waves collected in different time periods, provides high resolution radar images allowing displacements evaluation with a sub-millimetre accuracy.

In recent years, satellite, airborne, and Ground-Based Interferometric SAR (GB-InSAR) techniques have been successfully employed for terrain monitoring (landslides, glaciers, subsidences, and volcanic slopes deformations [19]) and for civil engineering concerns (bridges, dams, towers and buildings monitoring). Both systems can be used in all weather conditions, and they allow to obtain information from all the region covered by the antenna beam, to perform measurements during night and without the need to access the area undergoing examination. Nevertheless, ground-based investigation offers some benefits when compared to satellite-borne platforms: a remarkable flexibility in the acquisition design can be achieved (i.e. suitable to almost any application) and the system can usually be deployed in a straightforward and time-effective way.

The possibility to analyse nearly vertical instable rock faces (very steep slopes are not visible in satellite images) and the capability to perform fast and frequent measurements (satellites pass over the same ground area after a time period related to their orbits) make GB-InSAR a very promising technique for addressing rockfall monitoring and management of the first emergency. In Figure 2 an example of a GB-InSAR system is shown.

Moreover, the acquisition of TLS scans concerning the same rock face monitored by GB-InSAR is expected to improve the results which can be obtained from both techniques separately. Indeed, precise deformation measurements carried out by GB-InSAR will be used to refine TLS data. On the other hand, laser scanning measurements will allow to solve for phase ambiguities of the radar system or to explain the consequent loss of coherence. Eventually, integration of these remote sensors would improve the localization of controlled points on the rock face and should make possible the repositioning of GB-InSAR instrument to carry out periodic measurement at different epochs, without the need of its permanent installation.

2.3 Image-based techniques for monitoring of crack deformations

Enlargement of cracks in rock faces is one of the more evident signal of failure, thus their monitoring is a useful tool of prevention. Different methods are currently available to perform this task, all of them capable of a precision better than that needed to detect mass detachment. This could be evaluated in the order of ±0.1 mm, even though it depends on local conditions. An important classification can be made according the automation degree of the adopted method: (i) several sensors (e.g. *deformometers*, *comparators*) require to be handled in correspondence of a pair of reference point across the crack, then they are able to measure the variation with respect to a previous epoch; (ii) *automatic systems* (e.g. *strain-gauges* or *fiber-optic deformometers* – see [14]) based on sensors which are permanently positioned over each crack and linked to an acquisition/energy supply unit via a serial or parallel cable connection. The use of (i) or (ii) approach presents evident advantages and drawbacks, and the selection is mainly based on the possibility to access the slope in safe conditions. In IMARF a solution has been already developed which is based on the analysis of a sequence of images captured by a digital camera at different epochs (see [3] for details). Either deformations across and along the crack direction can be measured, thank to a pair of targeted plastic labels which are permanently fixed on both sides of the existing (or foreseen) fissure. Images can be acquired periodically by a digital camera, but also a continuous monitoring by a videocamera is feasible, according to the local geometry of the site.

2.4 Ground Penetrating Radar

Dip, shape, filling, orientation and penetration depth of fractures in a rock-mass are important parameters in geomechanical modelling as well as for slope-stability analysis. Ground Penetrating Radar (GPR) is indeed a powerful non-destructive tool to image the presence of discontinuities in the sub-surface. Many studies involving GPR investigations have already been carried out on rock faces and very steep slopes ([8], [10], [17]). Multi-frequency and multi-polarization surveys were performed to assess sub-surface rock conditions in order to delineate and locate internal fractures.

To overcome the fact that surface-based georadar method is not appropriate for the reflection imaging of steep-dipping features (this is primarily due to the unfavourable radiation patterns of most georadar antennas), borehole data were also collected but final results showed little significance because of azimuthal invariance of borehole antennas.

Rather complex processing algorithms have been developed to deal with data collected in presence of rugged terrain, undulating topography and big boulders [6].

Data collection in such difficult contexts (rough terrain, steep and uneven slopes) is definitely demanding, thus improvements and customizations (e.g. wireless technology to move the instruments efficiently on the slope) to the acquisition system are essential. For instance, data from GPR could be coupled with TLS techniques to position the GPR traces on a numerical model of the rock face and to define the 3-D geometry of potentially unstable blocks.

Previous experiences of our research group with GPR applied to the investigations on limestone rock quarries have been very encouraging [13]. Preliminary experiments in different test-sites with high frequency antennas were performed to evaluate the propagation of the radar signal inside a limestone rock mass and its ability to resolve thin discontinuities. The achieved results were positive.

Finally a new acquisition configuration with a low frequency antenna has been tested to explore the possibility of collecting data with an air gap between the antenna and the investigated rock mass. However, this solution still requires further study.

2.5 Seismic/Acoustic techniques

Seismic investigation of an unstable slope may involve passive short-to-long term monitoring of microseismic events and refraction seismic experiments [18].

There is usually a good correlation between fracture propagation inside the rock mass as well as slope displacement and the rate of the microseismic activity. The monitoring strategy basically foresees the installation of a permanent seismic network (surface and borehole sensors) to develop a site history and to provide a predictive capability based on temporal changes in the rate of the microseismic activity and/or on temporal changes in the recorded waveform characteristics.

On the other hand, the purpose of 3-D tomographic seismic surveys is to determine the broad scale distribution of highly fractured rocks (dry cracks, fracture zones, and faults on a wide variety of scales), which is expected to be represented by low P-wave velocities [7]. The 3-D velocity model has a great importance when incorporated in the microseismic events localization procedure. It has been shown that the quality of the velocity model dramatically affects localization errors [9].

At present our researches are addressing lab and on site tests for the evaluation of different data acquisition and inspection solutions, e.g. seismic sensors able to detect microseismic events (geophones, piezoelectric and MEMS - Micro Electric Mechanical System - accelerometers), and devices tailored to the detection of acoustic emissions generated inside the rock mass.

The final goal would be developing a wireless seismic network able to operate autonomously in a challenging environment (harsh weather conditions, difficult access and constraints for power supply), allowing an efficient, low-cost gathering and transfer of acquired information that will be handled with brand new dedicated and power-aware software for a fast and efficient data processing (e.g. filtering, detection, pattern recognition and localization algorithms).

3. Analysis and integration of multi-source data

The integration of different data is the core of IMARF project and concerns two different levels. The first one is related to the use of multisource data during the data processing stage, in order to improve the quality of achievable information. Example of this have been already reported at sub-sections 2.2 (TLS and GB-InSAR) and 2.4 (TLS and GPR).

The second one concerns the integration of different final results that are obtained from every monitoring system, in order to recognize and to predict cases when the risk of rockfall is too high and decisions must be taken (e.g. evacuation of population which could be hit). Typically, monitoring sensors work through the definition of thresholds: when a signal or a measurement goes out the safety field, an alarm is activated. This concept still holds for integrated monitoring as well, even though the setup of suitable values for every threshold is an open problem (see sub-sec. 1.4). However, the added-value derived from the IMARF approach is not only limited to the availability of several systems sensible to processes which might address to possible rockfalls (deformations, sounds, etc.), because this also accounts for correlations between different signals. This extension would allow to detect high risk situations which might occur also in case every of the single sensors' alarm thresholds is still satisfied. Strategy will involve pre-alarm thresholds which could be activated by different monitoring systems, each of them triggering a specific emergency procedure. These might consists in analysing data acquired by other systems to look for correlations, or to start new investigations by adopting techniques for remote deformation measurement (GB-InSAR and/or TLS) or GPR measurement. The integrated analysis of all collected data after a pre-alarm status will give a final risk evaluation based on the estimation of the possible total volume of detached rock mass. At this stage an external alarm procedure involving Civil Protection forces will be called for.

4. On-the-field testing

The IMARF's approach requires to experiment different innovative technologies to the aim of assessing and monitoring the stability of a rock face. Moreover, also already known monitoring and investigation instruments need to be tested in this context, in order to optimize, improve and possibly standardize their use. The testing stage will involve test-sites of different size and complexity, which will be dedicated to experiments concerning specific sensors only, or to the whole integrated monitoring system. In this case, tests will be not limited to assess performances and capabilities of each technique, but will extend to the full IMARF procedure.

Currently some initial test fields have been selected in the Lecco mountain area, in the nearby of a county road which is continuously affected by rock falls in different areas. In a second stage, three different rock faces which have been recently affected by rockfalls (see Figure 1) or which are likely to be (see Figure 3) will be equipped by an integrated monitoring system.

Figure 3 - Two test-sites for on-the-field experimentation of integrated monitoring, located in the nearby of Lecco town (Northern Italy): on the left the Navegno rock face, on the right the Rialba Tower.

5. Conclusions and future activities

As a first follow-up of the research, we expect the assessment of innovative technologies requiring both a metrological analysis and further investigation and improvement to grant effectiveness in the envisaged application. The second main objective of the research is to develop risk-based operational guidelines for emergency management and rescue under specific site conditions. This activity will be based on innovative modeling and analysis approaches, such as: definition of a quantitative method for the evaluation of the contribution of the new monitoring systems to the effectiveness of emergency management plans and, in general, to improve the safety of population; development of a decision support system for real-time emergency management, specifically to assess the stability of a given site, integrating experts' judgements and observed data.

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SECTION VII

LEGAL SCHOLARSHIP AND RESEARCH WITHIN THE BUILT ENVIRONMENT DISCIPLINE

The rule in Hadley v Baxendale (1854) and its place in the standard form of contract[1]

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Abstract

The English Standard forms of Building and Engineering Contracts make complex provisions for dealing with delay and the management of its financial consequences. Similar provisions are found in many countries where the general structure of these contracts has been adopted. Analyses of these indicate that by approaching their application from the common law rules concerning damages for breach of contract provide a clearer rationale for explaining what these clauses set out to do. This enables users in countries outside the common law jurisdictions to gain a clearer means of adapting or using them.

Research into the earlier versions of the standard forms indicates that the relationship between the common law and the standard forms appear to be drafting accidents. Later judicial analyses of the common law identified the relationship between primary and secondary obligations. Clauses in the standard forms allocate these expressly. Only by examining the scope of the rule in *Hadley v Baxendale* (1854) in a construction setting, is it possible to identify the practical solutions the standard forms provide.

By analysing a variety of clauses in different standard forms of contract, it is possible to identify a common thread running through these clauses. These indicate that in order to understand the drafting, a clear appreciation of the rules about the right to damages at common law is essential. Only then is it possible to understand why these clauses were drafted and how they may be adapted and used in other jurisdictions.

Keywords: Risks, damages, secondary obligations, delay, liquidated damages, direct and indirect loss.

1. Introduction

There is wide range of contractual provisions dealing with delay and its consequence in the English Standard form of construction contracts. The paper analyses the legal interpretation of a number of such contractual provisions. The wording of earlier forms reflect their history, and in

[1] My thanks to Andre De Wet (Quantity Surveyor and Project Manager for Transnet South Africa) for the idea of this paper

the older forms, by the manner in which the courts have interpreted them. Newer forms contain different wording but their aims are the same; to allocate the risk arising in these contracts in a clear and efficient manner. Contractors can as a result, price their tenders clearly knowing what their risks are. As a consequence price comparisons between tenders can be managed in a straight-forward manner. These principles were emphasised by the Privy Council in *Phillips HK Ltd v AG of HK* [1] that 'parties…should be able to know with a reasonable degree of certainty the extent of their liability and the risks which they run as a result of entering into contracts. This was 'particularly true in the case of building contracts and engineering contracts'. Quantifying delay in completion and its consequences is particularly important in situations where it is difficult for the employer to prove its actual losses. It then makes commercial sense for parties to agree the actual losses recoverable beforehand so as to reduce this uncertainty. This paper analyses these provisions in the context of JCT05 [2], the NEC3 [3] and the PFI4 [4] standard form contracts. Their relationship with the case law on damages for breach of contract is evaluated in the context of these.

2. The common law

2.1 The significance of Hadley v Baxendale in English Law

In *Photo Production Ltd v Securicor Transport Ltd* [5] Lord Diplock giving the opinion of the House of Lords, observed that it was a characteristic feature of commercial contracts that parties promise each other that things will be done. Two examples he gave are (a) that a building would be constructed in accordance to plans agreed and (b) that services of a particular kind would be provided. So where one party fails to deliver what has been promised, the 'promisor has failed to fulfil [its] own primary obligation'. This failure amounts to a breach of the contract. The main remedy under English law is damages i.e. monetary compensation which aims 'to put innocent party in the place they would have been had the contract been completed'. This is called its reliance loss. *Hadley v Baxendale* (1854) [6] established the rules for deciding whether the defaulting party was liable for <u>all</u> the damage caused by their breach. This is commonly described under the rules of 'remoteness of damage'. English law this rule to decide whether a particular loss in the circumstances of the case is too remote to be recovered. There are two limbs to the Rule (Anderson B):

'Where two parties have made a contract, which one of them has broken, the damages the other ought to receive in respect of such breach of such a contract should be such as may:

(a) fairly and reasonably be considered as either arising naturally, i.e., from the usual course of things, from the breach of contract itself, or

(b) such as may reasonably be supposed to have been in contemplation of both parties, at the time they made the contract, as the probable result of breach of it.'

Such is the importance of this case to Anglo-American Law that 26 academics contributed papers to the 150th anniversary of *Hadley v Baxendale* [7]. Now whether there are two rules or simply two different aspects of the same rule has caused much academic and judicial debate. Lord Hope in *Jackson v Royal Bank of Scotland* (2005) [8] observed that what was in the contemplation of the parties was in fact, the principle underlying both. Lord Walker of Gestingthor too, stressed the importance of that underlying principle of what the contract breaker knew or was taken to know, 'so as to bring the loss within the reasonable contemplation of the parties' (at para 48). From a strictly legal perspective therefore, there may well be only one rule but from the practical point of the clauses in contracts dealing with these, the courts treat it as of consisting of two different rules. In *Hotel Services Ltd v Hilton Int Hotels (UK) Ltd* [9], the Court of Appeal, in relation to the need for special knowledge [the what was in the contemplation of the parties] found that 'authority dictates that the line between direct and indirect and consequential losses is drawn along the boundary between the first and second limbs of *Hadley v Baxendale'* (at para. 18).

2.2 Remoteness of damage

The rules established *Hadley v Baxendale*, were explained by Lord Hope at para 26 in *Jackson* (2005), a case concerning the sale of dog chews. In the process he explained that the court of appeal misunderstood the effect of the case. In fact the crucial date for determining what 'may reasonably be supposed to have been in the contemplation of both parties' was the date of the contract, not the date of the breach. Why this matters is because it is then that the parties could limit their liability under the contract. So while the rules are 150 years old, three eminent Lord Justices misapplied them, which illustrates that applying them are in practice not at all easy. If the rules are so easily misunderstood, allocating damages through the contract itself is from any perspective, the better way to manage commercial relationships.

2.3 Application in construction contracts

Before the decision in *Balfour Beatty Construction (Scotland) Ltd v Scottish Power plc* [10], it was quite difficult to imagine a scenario where the rule would be applied in a construction context. Or that the point would be of such importance that it would reach the House of Lords. During construction of an aqueduct, the batching plant broke down due to the rupturing of the fuses provided by the supplier. Since watertight construction required a continuous pour of concrete, this came to at end with the power failure. Once it was restored, attempts were made to continue the work by cutting back the old concrete and adding fresh concrete. The contractor was unable to meet the specification for a watertight aqueduct and the engineer instructed the demolition and rebuilding of the structure. In an action against the supplier the contractor won damages for breach of contract. On appeal by the supplier against damages of £229,102.53 plus interest, the Lords confirmed that: damages should either arise naturally from the breach or have been in the contemplation of the parties at the time they made the contract. What one party knew about the other's business was a question of fact. The demolition and reconstruction of the aqueduct was not in the contemplation of the supplier [since they did not know, and were unlikely to know, that a continuous pour was required make the structure water-tight].

The answer is of course to ensure that the supplier is aware of the consequences of a breach. Note though that damages were awarded under the first limb of *Hadley v Baxendale* for the damages that arose naturally when the fuses failed. An example of this was the costs of cutting back unsuccessfully the concrete in an abortive attempt to restart the work. In *Stuart Pty Ltd v Condor Commercial Insulation Pty* Ltd [11] too, the court of appeal found that the event giving rise to the loss (a fire due to faulty workmanship of the sub-contractor) was not within reasonable contemplation of parties under the second limb. The relevance of the second limb is that the parties can limit their liability at the time of contracting for what would otherwise be a breach of contract. For instance, had the supplier known what damage might result, it could have stipulated that they were not liable for any damage resulting from a failure of their fuses. Would they not then also have raised the matter of a back-up generator if a continuous supply was so vital to the operation? After all, in *Hadley v Baxendale* itself, the claim for loss of profits caused by delay in the delivering of the broken mill shaft to the repairers, failed under the second limb precisely for that reason. How were the couriers to know that the mill would have no back-up shaft (which was after all central to their business)?

It should be borne in mind that even if the tests in *Hadley v Baxendale* are satisfied, the quantification of the loss has to be made. In this respect English law takes a reasonable approach. In *Electronics and Construction Ltd v Forsyth* [12] the House of Lords was held that where the costs of repair were disproportionate to the benefit to be gained, the winning party was only entitled to nominal damages. To demonstrate the difficulty of deciding damages at common law, it should be pointed out that 9 judges at three different judicial levels were eventually split 5:4 in the same case. Thus demonstrating that deciding whether a swimming pool had to be constructed to its specified depth, where there was no benefit to be gained by doing so, was no easy matter. The case was not a commercial one as it involved a builder and a home owner. The principle has however, been applied in commercial contracts. For an example see *Birse Construction Ltd v Eastern Telegraph Co Ltd* [13]. Damages of £2 were awarded to the winning party, because it was selling the defective premises without repairing it. A further illustration of the principle at work is *Shepherd Homes Ltd v Encia Remedation Ltd* [14]. It took a 5-week trial for the claimant to prove that a failure to carry out the work with reasonable care and skill had resulted in the damage. Even then though the claimant succeeded on all points of claim, for 40 of the 94 of the houses damaged by subsidence only nominal damages was awarded of £2 per house.

3. Contractual provisions

What these cases show is the difficulty, uncertainty and costs of successfully proving damages at common law. For this reason, avoiding the application of rule is a much the wiser option. Construction contracts therefore, make specific provisions for the payment of damages, to achieve the ‘certainty’ referred to in *Phillips*. These were emphasised in *Photo Production Ltd v Securicor Transport Ltd* [15] where the House of Lords distinguished between the primary and secondary obligations of the parties. Where there is a failure to perform those primary obligations (i.e., the performance obligations in the contract), there is a breach of contract. Lord Diplock observed that: ‘The secondary obligation on the part of the contract breaker…is to pay monetary compensation to the other party for the loss sustained by him as a consequence of the breach.’ Parties are free to decide for themselves how to allocate those secondary obligations. The approach of the courts to such allocation of risk was described by Chadwick LJ in *Watford*

Electronics Ltd v Sanderson [16] (with whom LJ Gibson and Mr Justice Buckley agreed) at 55 as accepting that:

> 'Where experienced businessmen [and women] representing substantial companies of equal bargaining power negotiate an agreement, they may be taken to have regard to matters known by them…They should be taken to be the best judge on the question whether the terms of the agreement are reasonable.'

Gibson LJ too went on to say that a court should not assume that either party is likely to commit their company to unfair or unreasonable terms. So where they have agreed the allocation of risk, the price must be taken as reflect that allocation and that therefore there would be little scope for a court to unmake the bargain of commercial people. He adopted the observation of Forbes J in the *Salvage Association v CAP Financial Services* [17] at p. 656 to the effect that: 'where a party well able to look after itself enters into a commercial contract and, with full knowledge of all relevant circumstances, willingly accepts the terms of the contract which provides for the apportionment of financial risks of that transaction, I think the court should be slow to interfere'.

The apportionment of financial risks include the provision of LD for delay, inserting exclusion or limiting clauses, and making provision for loss and/or expense to be paid in certain defined circumstances. Consequential losses are also excluded or limited to the value of the contract. Termination clauses too, fall in this category for they contain provisions that are in fact much wider than the position at common law. Again, what has to be borne in mind is that by so doing, the parties are in effect allocating risk between themselves.

The primary obligation of the contractor is to carry out the work required to prescribed standards in a specified time. That of the employer is to pay for the work. Provision is then made for a starting and a completion date. Any construction contract will contain other obligations, but the primary purpose of this paper is analyse the provision of secondary obligations only.

4. Secondary obligations

The early versions of the JCT standard form of contract had limited provisions for the payment of extra money (now called 'loss and/or expense'). It appears that before JCT 63, there was no provision for the payment of extra money arising out of a delay caused by the employer [18]. However, the contractor had at common law, a claim for damages arising out of the delay. Such a clause was introduced in JCT 63 contract but was limited scope. These were substantially expanded in subsequent editions in 1980 and in 1998. The latest version, the JCT 05 has simplified these clauses. This contract too introduces provisions dealing with consequential loss [19] as does the NEC3.

4.1 Liquidated Damages

The object of LD is to fix the compensation resulting from delay in completing the contract. The advantage of doing so is to escape the uncertainty and costs of suing at common law. The sum so fixed is a pre-estimate of damages. The figure consists of the estimated costs arising out of any delay. This will usually be direct costs only and falls into the first limb of *Hadley v Baxendale*. For commercial reasons, the resulting sum may not always amount to the true value of the loss. *Bath and Somerset* [20] provides an example of the kind of losses (or costs) that can be incurred. The employer successfully proved that the LD's was not the only damages it was likely to suffer if the project was delayed and that it was likely to incur other heads of damage too.

The actual sum need not be accurate as it is only an estimate at the time of the invitation to tender. In what circumstances if it was not 'correct' would it amount to a penalty? This question arose in *McAlpine Capital Projects Ltd v Tile Box Ltd* [21] where the law was extensively reviewed. Mr Justice Jackson proposed a test for discriminating between a LD clause and a penalty. It was his view was that: 'a pre-estimate of damages does not have to be right in order to be reasonable. There must be a substantial discrepancy between the level of damages stipulated in the contract and the level of damages which is likely to be suffered before it can be said that the agreed pre-estimate is unreasonable' (at para 20). Note that LD was £45,000 per week and at trial it was claimed that the work 2.5 years late (at para 25), however the employer was able to prove that its actual losses exceeded the sum allowed. The effect of this judgment is that is difficult to conceive of a situation where a sum expressed as LD will be held to be a penalty in a construction contract.

As always, the parties are free to choose whether or not their contract should make provision for fixed payments to be paid in the event of delay. Under NEC 3, Liquidated Damages are provided for in the optional clauses rather than in its core clauses. Option X7 requires the contractor to pay damages for delay from the completion date until the date the employer takes over the works. Should the option not be adopted, the employer is left to recover damage for delay at common law. In the light of the difficulties of proving loss at common law, this is not a particularly wise choice, especially since in a construction contract, the effect of delay is often difficult to quantify afterwards.

4.2 The relation between Liquidated Damages and extensions of time

Where the employer is wholly or partially responsible for an act of prevention that for prevents the contractor from completing on time, the employer cannot recover LD unless the contract provides otherwise. As Phillomere LJ observed in *Peak Construction (Liverpool) Ltd v McKinney Foundation Ltd* [22], 'a clause providing for LD are closely linked to one providing for an extension of time.' The parties agree that were delay is due to the employer; such a provision cures the default. Note though that where the employer issues a notice of intention to deduct LD, the sum crystallises at that date and the employer can deduct LD despite an extension of time being granted [23].

The JCT 05 calls these provisions ‘relevant events’: clause 2.29. In practice, these are risk allocating measures. As the contractor does not have to include a price in its tender for these possibilities, the tender price should reflect this. In addition the contract contains provisions for loss and expense: clause 4.29 (discussed below). There is not necessarily a connection between the two in JCT contracts: *H. Fairweather & Co Ltd v LB of Wandsworth* [24]. This is emphasised in the JCT 05 contract which widely separates a claim for an extension of time from a claim for loss and expense. The NEC3 by contrast, treats these together in clause 60 where they are called ‘compensation events’. Clause 61 requires the contractor to give notice of compensation events. Where the project manager accepts that’s such an event has occurred, the project manager may instruct the contractor under clause 62 to provide a quotation for extra time and compensation. Note that the NEC also uses a system of early warnings in clause 16.1. This requires the contractor and project manager to notify each other of matters that could increase prices, delay the works or the meeting of key dates.

The PFI 4 allows for Supervening events in clause 5. These are three kinds: 5.2.1: (a) Compensation events which are at the Authority’s risk and for which the contractor receives compensation (b) Relief events which the contractor is best able to manage, but receives no compensation and (c) Force Majeure events. These arise through neither party’s fault, but provide ground for the contractor to terminate its employment under the contract. Clause 5.1.3 provides that Compensation events entitle the contractor to more money and extra time and relief events only extra time to complete.

It is clear from precedent how the court will approach the meaning of the clauses in JCT 05. In *Beaufort Developments (NI) Ltd v Gilbert-Ash*, Lord Hoffman said of the process at p. 784 that legal documents often contain superfluous words. He gave two reasons for this: (i) clumsy draftsmanship and (ii) the lawyer’s desire to cover every conceivable point. Of the JCT standard form of contract he said that it is periodically renegotiated, amended, and added to over many years. It would be unreasonable to expect there to be no redundancies or loose ends. It was therefore important that that earlier judicial authority and practice on the construction of similar contracts be examined to discover the true meanings of the words used. He added that standard forms of contract evolve and reflect the interaction between the draftsmen and the court. These could not be understood without referring to the meanings the judges gave to previous versions of the contract.

The guidance notes to the NEC 3 make clear that this contract is radically different from other existing standard form contracts, and that in should be used in a different manner. Admirable as this view is, common law judges do not make decisions in isolation. In *Costain Ltd & Ors v Bechtel Ltd & Anor* (2005) [25], the court had to interpret the duty of the project manager in certifying payment where the contract required the exercise of good faith. The clause was similar to that contained in NEC 3 where clause 10.1 requires the employer, the contractor, the project manager and the supervisor to ‘act…in a spirit of mutual trust and co-operation’. To decide what the words meant the court looked at previous precedents dealing with the duties of a certifier. It concluded that in those cases involving other forms of contract, the certifying role required the exercise of fairness and impartiality. Having decided that, there was no need to decide what the clause actually meant in the context of the contract. It is therefore suggested that in interpreting expressions such as compensating events or relief events, the courts are likely to look at the interpretation of similar provisions in other contracts. It is therefore important when using new forms of contract to be aware of the way in which the courts have interpreted other contracts dealing with the same matters.

4.3 Direct loss and/or expense

Clause 4.23 of JCT 05 allows the contractor to claim 'loss and/or expense' caused by matters materially affecting the regular progress of the works. It requires the contractor to make written application to the Architect/Contract Administrator stating that it has incurred or is likely to incur direct loss and/or expense in the execution of this contract for which it would not be re-imbursed by payment under any other provision of this contract. This is an important proviso because the granting of an extension of time does not automatically trigger a claim for loss and expense. Only when 'the Architect is of the opinion that the direct loss and/or expense has been incurred…by matters referred to in clause 4.23…then the Architect shall ascertain or shall instruct the Quantity Surveyor to ascertain, the amount of such loss and/or expense.' Such claims for delay and disruption may include (apart from additional project specific costs: (a) loss of profit (b) finance charges such as interest on borrowed capital (c) head office overheads (d) loss of productivity or uneconomic working (e) idle plant or machinery and (f) increased costs resulting from inflation.

4.4 The meaning of direct loss and/or expense

The words direct loss and/or expense were considered in *Wraight Ltd v PH &T (Holdings) Ltd* [26]. It was held to mean that the sums recoverable are equivalent to damages at common law. Megaw J said at p 34 that there was no other meaning to be given to the phrase other than what it would have in relation to a breach of contract: see *Hadley v Baxendale*, thought it must be stressed that at no point does he refer to that case itself. The Court of Appeal in *FC Minter v WHTSO* [27] considered the phrase in relation to the JCT 1963 contract. It held that direct loss and/or expense is loss that arises naturally, and in the ordinary course of things, as stated in the first limb of *Hadley v Baxendale*. It defined 'direct damage' as 'that which flows naturally from the breach without any other intervening cause and independently of any special circumstances whereas indirect damage does not so flow.' Any claim put by a contractor is therefore subject to the question of whether it falls within the first limb of *Hadley v Baxendale*. Keating [28] considers that the use of other formulae by contractors does not displace or detract from this principle. These formulae are based on the theory that where the period of delay is uncertain and hence the contractor cannot take steps to reduce its head office expenditure or other overheads by obtaining additional work, an approximation of the damages supposedly incurred by the contractor can be made [29].

In *FC Minter* finance charges were claimed as direct loss and/or expense. In holding that the JCT terms contained an implied term to pay interest as a constituent part of direct loss and/or expense, Stephenson LJ added that in the context of the building contract involved and 'the accepted "cash flow" procedure and practice', he had no doubt that the sums claimed was direct loss and/ or expense. See also *Tate & Lyle Food & Distribution Ltd v GLC* [30] where it was decided that an interest claim for direct loss and /or expense should be calculated at a rate equivalent to the rate of borrowing.

A further detailed analyses of the phrase was carried out in *Robertson Group (Construction) Ltd v Amey-Miller (Edinburgh) JV* [31]. Lord Drummond Young had to construe the meaning of the phrase 'all direct costs and directly incurred losses' in a letter of intent. The employer argued that the expression limited the contractor to the cost of labour, plant and materials used on the contract. It excluded head office overheads and any profit element. The contractor claimed that it was entitled to recover not only the cost of labour and materials plus the cost of plant and sums paid to subcontractors but also an appropriate sum to cover their head office overheads plus an appropriate element of profit. The judge considered to the case law on the expression loss and/or expense in the JCT forms. These could 'be summarised in two propositions. First, the word "direct" in the expression "direct loss and/or expense" is concerned with remoteness of loss…Second, the word denotes that the loss or expense in question must flow naturally from the contractual event relied on by the claimant, in the sense of the first [limb] in *Hadley v Baxendale'*. It is worth remembering that in the JCT contract, the costs of disruption of the regular progress of the work is not a breach of contract but a specific contractual entitlement to compensation for loss and/expense. Hence it is an example of a secondary obligation fixing the likely damages and circumstances where it will arise. Lord Drummond Young concluded that the phrase included profit and overheads.

4.5 Provisions excluding indirect and consequential losses

Making provision in traditional contracts for contractor design elements has led to standard form contracts containing provisions dealing with consequential losses. JCT 05 now has such a provision in clause 2.19.3. This is due to the inclusion of a 'Contractor's Design Portion'. The clause limits the liability of the contractor for loss of use, loss of profit or other consequential loss arising from a design failure. This is limited to the amount stated in the appendix. The NEC 3 too in Option X18 'Limitation of liability' in Clause X18.1 states that 'the Contractor's liability to the Employer for the Employer's indirect and consequential loss is limited to the amount stated in the Contract Data.

Clauses of this type are commonly found in contracts for the supply and installation of goods and materials. In *British Sugar plc v NEI Power Projects Ltd* [32] for example the clause provided that: 'The Seller will be liable for any loss, damage, cost or expense incurred by the Purchaser arising from the supply by the Seller of any such faulty goods or materials …save that the Seller's liability for any consequential loss is limited to the value of the contract.'

The importance of the clause for the parties is shown in sharp relief when the facts of the case are considered. The contract between the parties was for the design, supply, delivery, testing and commissioning of electrical equipment at a final price of £106,585. The buyer claimed that the equipment was poorly designed and badly installed and caused the power supply to break down. Damages of over £5 million were claimed for the increase in production cost and the losses of profits resulting from the breakdown.

The recent case of *Shepherd Homes Ltd v Enica Remediation Ltd* (2007) [33] demonstrates principle in operation in a construction setting. The preliminary issue for the court was whether a limiting term had been incorporated into a piling sub-contract. The value of a contract for the design and installation of ground beams on a site where the underlying soil was peat was £100K. Within a year of completion properties on the site showed signs of cracking due to settlement with a potential liability of £10m. The sub-contractor had included a term clause with their offer stating that 'our maximum liability is limited to the Contract price; whether in contract or in tort, for any damage or loss whatsoever, including all direct, indirect or consequential loss' Clarke J decided that the clause was a fair and reasonable one in the circumstances.

The meaning of the phrase is much clearer by a series of cases. In *British Sugar* and also *Deepak Fertilisers & Petroleum Corp v. Davy McKee* (London) (1999) [34] the Court of Appeal had once again to consider the formulation adopted in pervious cases. This was that the phrase 'consequential loss' did not exclude losses arising naturally from the breach of contract. In each case the Court of Appeal concluded that 'consequential loss' and 'indirect and consequential loss' refer to damages falling into the second limb of *Hadley v Baxendale*. In *British Sugar* it also did two other things: (a) It adopted the view that once a court has in a similar context, authoritatively construed the phrase, the 'reasonable businessman' must intend the phase to bear that meaning and (b) it confirmed that the phrase is concerned with damages that are too remote unless they are within the actual contemplation of the parties at the time they made the contract. The result of this approach is that a party intending to exclude categories of foreseeable loss, would be better off specifying what is included rather than specifying what is excluded. Examples are loss of profit, overheads, additional costs required to bring the project back to the level contracted for and loss of revenue.

5. Termination clauses

Lubenham Fidelities & Investments Co Ltd v. South Pembrokeshire DC [35] illustrates clearly the difference and risks between termination clauses and the right to repudiate at common law. Termination clauses terminate the employment of the contractor and not the contract. In *Lubenham* the contractor abandoned the contract because of what it considered an under-valuation of an interim certificate of payment. The employer determined the employment of the contractor under an express provision. In leaving the site, the contractor was in breach of the obligation to proceed with work regularly and diligently. It was held that no right to suspend the work for underpayment existed at common law. The contractor had repudiated the contract and was liable in damages to the employer. The employer in following the procedures laid down by the contract had lawfully determined the contractor's employment.

Repudiating (and effectively terminating the contract) is therefore fraught with risk. This is because having done so, the party who has chosen to do this, will only later find out whether it was lawfully entitled to do so. In *Alkok v Grymek* [36] for example, the contractor having repudiated the contract was found by the Court of Appeal to have had no grounds for repudiating their contract. So too did the contractor in *Lubenham Fidelities*. The result was that in both cases the contractors were held liable for all the damage resulting from their breach of contract. Similarly in *Rheidwood* (2007) [23], the contractor thinking it had the right to determine its employment was found to have repudiated the contract instead.

The JCT 05 contains two types of termination clauses. One deals with the effect of insolvency (clause 8.1) and the other with defaults under the contract. Clause 8.4.1 deals with defaults by the contractor and clause 8.9.1 with those by the employer. These rights are wider than those at common law and in addition, the contract has accounting provisions dealing with the consequences. The NEC 3 deals with the right to terminate in clause 90. Clause 91.1 entitles either party to terminate on insolvency. Clause 91.2 deals with defaults by the contractor, clause 91.4 allows the contractor to terminate for non-payment and clause 91.5 allows either party to terminate. Clause 92 contains the procedures to be followed upon termination. The PF1 Contract in clause 21.1 allows the contractor to terminate on authority default and clause 21.2 allows for termination due to contractor defaults.

6. Conclusion

The primary interpretation of contractual clauses dealing with delay and its consequences have been made in the earlier cases on the JCT form of contract. It can therefore be concluded that in interpreting expressions such as compensating events or relief events, the courts are likely to look at the interpretation of similar provisions in other contracts.

By adopting the analyses made by the House of Lords in *Photo Production* it is possible to demonstrate the close relationship between the standard forms of contract and the common law. Construction contracts expressly allocate secondary obligations which arise as a consequence of a failure to carry out primary obligations. By doing so, contractual parties avoid the difficulty, costs and uncertainty of proving damages at common law. Where the courts have to decide what these clauses which allocate secondary obligations mean, they in fact, return to the common law principles to decide this. The question of how the parties have allocated risk then depends on whether the loss falls into the two limbs of *Hadley v Baxendale*. This is the very thing that secondary obligations are meant to avoid. The result is that contractual provisions such as liquidated damages fall into the first limb because it is a direct loss. The same applies to provisions for loss and/or expense (and probably for compensating events or relief events) as well. Consequential losses fall into the second limb unless they are in fact direct loss and for this reason the wording of the clause is crucial. Termination clauses, while not strictly within the rule, avoid the application of the rule, since they too eliminate the uncertainty of damages at common law and the further risks of unlawfully terminating a contract. What all these express secondary obligations do is to allocate risks between the parties, which ultimately is the purpose of a construction contract.

Therefore, in dealing with the English standard forms of contract and their meaning, it is vital to understand the relationship between the contractual provisions and the common law. Only then is it possible to decide how risk is allocated and how the clauses may in turn be modified to reflect the legal position in other jurisdictions.

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Judicial Mediation Statements in the Technology and Construction Court: Appropriate Cases for Mediation

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Abstract

Many common law countries, which operate an adversarial system, promote the use of mediation to help reduce costs for the parties and minimize the pressure on courts. In the United Kingdom (UK), this has taken the form of the Civil Procedures Rules (CPR) and court protocols which encourage the parties and their lawyers to consider Alternative Dispute Resolution (ADR) or facilitate mediation use in appropriate cases. Under CPR, judges have the power to penalise unreasonable behaviour in litigation through costs sanctions and rejecting an offer to mediate has been found by the court to be unreasonable behaviour. [1] Case law provides that a successful party will not be deprived of their costs unless it is shown that they acted unreasonably in refusing to agree to mediation. Although the Court of Appeal in Halsey (2004) dispensed guidelines on when a case will be deemed 'appropriate' for mediation, it was emphasised that the list was not conclusive, thus disputing parties and their legal advisors cannot determine, with certainty, when a refusal will attract a cost sanction. [2] P4 Limited v. Unite Integrated Solutions PLC (2006) exemplifies the likely approach the Technology and Construction Court (TCC) will take to an unreasonable rejection of mediation and is a significant 'steer' on when construction cases are deemed appropriate for the process. [3] This paper examines the Halsey (2004) guidelines and reviews cases in the TCC to elicit how the specialist court is applying and developing mediation appropriateness criteria.

Keywords: Mediation, ADR, judges, Technology and Construction Court (TCC), Civil Procedure Rules (CPR), court protocols.

1. Background

1.1 Court encouragement of mediation: Civil Procedure Rules (CPR)

The CPR were introduced to reduce the costs of litigation, increase the efficacy of the courts and control increasing "combative" behaviour in the adversarial system. [4] [5] CPR implemented a new litigation 'landscape' where judges are under a duty to further the overriding objective of the court to deal justly with the cases by using case management. [4 Forward] Judges control litigation through case management meetings (CMC) by setting timetables and allocating trial dates. [5 para. 3] Court protocols set down detailed requirements for pre-action meetings, document disclosure and timing for responses and imparts a duty on the parties to consider alternative ways of settling their dispute. ADR is given a significant role within case management, as judges have a duty to encourage and facilitate settlement which might be through the use of alternative procedures in appropriate cases. [6] For example, at the request of one party, ADR may be endorsed by permitting a stay in the proceedings [6 at 26.4(1)] but stronger encouragement has been the inclusion of a cost sanction for unreasonable behaviour in litigation, which can take account of a party's rejection of an offer to mediate or use ADR. [6 at 26.4] An unsuccessful litigant generally has to pay the costs of the successful party but judges have discretion to take account of any circumstances', which may include consideration of the parties' efforts 'if any, before and during the proceedings in order to try to resolve the dispute'. [6 at 4.5(3)(a)(ii)] Cost sanctions have been made not only for non-compliance with court protocols [7] but also for unreasonable refusals to participate in ADR. [2][3] Additionally, judges have discretion to award costs at a higher indemnity basis rather than the standard rate. [6]

1.2 Definitions

Earlier explanations of ADR suggest the term involves the 'help of an independent third party' [8] but the TCC provides a broader definition in its guide by including 'any process that the parties enter into voluntarily'. TCC pre-action protocols also count 'formal inter-party negotiations' as an acceptable alternative [9 at 7.1.1] and contend that the protocol is a *'type of ADR, because it requires there to be at least one face-to-face meeting between the parties before the commencement of proceedings. At this meeting, there should be sufficient time to discuss and resolve the dispute"*. [9 at 7.2.2] The courts have accepted 'round table meetings', [10] and 'negotiation or attempts to use an honest broker' [11] when considering whether the parties' conduct in litigation has been reasonable, which is indicative of the importance placed on settlement by the CPR. [8]

The TCC pre-action protocol and the Court of Appeal in Halsey note that ADR is usually a 'form of mediation' with a neutral. [9] [2 at 5] Different 'variants' of mediation are described as 'facilitative' or 'interest based' where the mediator assists the parties to create their own settlement. A more recent phenomenon is the recognition of mediators taking an 'evaluative' role by providing a view on the merits of a case or by making suggestions for settlement outcomes. Some UK construction literature identifies this as 'evaluative mediation' but it is also referred to as 'conciliation' where the conciliator makes a recommendation at the end of the mediation phase if settlement has not been reached. [12]

Statutory adjudication is regulated by the Housing Grants, Construction and Regeneration Act 1996 (HGCRA), which provides a statutory right for parties to construction contracts to elect an adjudicator to give a decision which is binding on the parties until practical completion. The UK construction industry has a long history of using Arbitration, which is a confidential private tribunal where an arbitrator, selected by the parties, makes a legally enforceable binding decision as governed by the Arbitration Act 1996.

The UK construction industry also utilises Early Neutral Evaluation (ENE) where the parties jointly choose a neutral with specific expertise to give a non-binding decision. Judges offer a form of ENE [13] and recently the TCC piloted a Court Settlement Process (CSP) where judges offer to assist the parties reach settlement, 'in such manner as the Judge considers appropriate'. The Court Settlement Order prescribes a process resembling mediation where the mediator adopts 'evaluative' techniques rather 'than 'facilitative' techniques, where the parties are encouraged, rather than directed, to explore alternatives and create their own solutions. [15]

1.2 CPR in the TCC

The TCC is governed by the Construction and Engineering Court Protocol. [14] The parties are required to meet 28 days after the claimant has received a letter of response from the defendant and at this meeting consideration should be given to whether some form of ADR is 'more suitable than litigation' and if so try to agree the 'form to adopt'. [14] The TCC will in appropriate cases indicate what type of ADR this should take but emphasis this will be mediation in most cases.

At the first CMC meeting the parties are required to address the court on '*the likely efficacy of ADR, the appropriate timing of ADR, and the advantages and disadvantages of a short stay of proceedings to allow ADR to take place'*. [9] There are two important considerations lawyers and their clients need to evaluate. First, what criteria of a construction dispute make mediation a suitable alternative, and second, what conditions do the courts regard as appropriate for rejecting an offer to mediate in order to avoid a cost penalty. This paper is essentially concerned with the second consideration. It analyses evidence from cases to elicit court opinion on 'appropriate mediation criteria' and the existence, if any, of specific conditions where a refusal may be deemed acceptable or unacceptable. This paper considers the judgments from the civil appeal court, which are binding on the TCC.

The CPR rules are underpinned by the principle of directing 'appropriate' or 'suitable' cases to alternative procedures. Before considering the leading cases in the Court of Appeal, this paper will explore, briefly, the key findings from construction mediation studies on the effectiveness of mediating.

2. Appropriate criteria for mediation use

2.1 Empirical findings in the construction industry

There still exists a shortage of empirical data which identifies the suitability and effectiveness of mediation for construction disputes. One problem is that studies use different measures for establishing mediation effectiveness, for example determining mediation success in relation to party satisfaction or non-compliance with mediation agreements. [16][17] This paper is concerned with judges encouraging the parties to 'settle' cases through mediation and will therefore analyse survey findings relating to settlement outcome as the criteria for mediation effectiveness.

A leading study in the US found disputes involving delays, changes, job site administration, property damage, defective work, personnel injury or site conditions had little affect on mediation reaching full or partial settlement but a significant variable on outcome was the financial size of the dispute. The higher amount involved in the case the less often full settlement was achieved.` [16 at 107] The extent of discovery also influenced outcome, as mediations were twice as likely not to settle when this activity had not taken place. The duration of mediation was also significant because the longer the parties mediated the more likely the process settled. The quality of mediators also influences outcome as the more varied techniques used, such as caucusing, site visits or consulting experts, the more likely settlement was achieved. [16 at 144] The parties' perception of mediator quality was influential: Mediation was less likely to settle when the parties believed the mediator was weak. [16 at 145] However, the US research discovered that the most important factor was the rules adopted in mediation. When the parties created their own rules they were more likely to settle their dispute than when the mediator adopted regulations designed by the court or professional institutions. [16 at 144-145]

A study of construction mediation in the UK similarly found settlement outcomes were not affected by the type of dispute or the identity of the parties (contractor, sub-contractor, employer, or client). [18] However, analogous with US findings, the most critical factor for non-settlement was found to be the attitude of the parties. [16] [17] Mediation was often ineffective when one or more of the parties had unrealistic expectations, were intransigent or unwilling to compromise or when both parties were too far apart at the beginning of the process. Mediation outcomes in UK court schemes in the UK also indicate that *'case type, case value, party configuration, representation, case complexity*' are not determinative on settlement. Settlement is more likely to be a combination of factors including '*individual characteristics of the cases, attitude and motivation of the parties, skills and knowledge of the mediator.* [19]

A review undertaken by the TCC to determine when mediation provides a 'real alternative' to litigation, at what stage the TCC should encourage mediation and which mediation techniques are particularly successful reports that most disputes are still settling through 'conventional negotiation'. [20] The report suggests that statutory adjudication is dealing with cases involving payment, variation, delay and site conditions, leaving the court, and mediation if the parties are directed or encouraged to use it, with more difficult complex cases, which are often multiparty, involving defects, design and negligence. It has been suggested there is a trend for more difficult cases being taken to mediation, with the result that settlement is harder to achieve because of increasing familiarity and tactical use of the process by lawyers. [21][22] The TCC report advises mediation may fail if engaged in too early because of a lack of information about the case and if used too late substantial expenses may be incurred or the parties may be 'too entrenched' but, perhaps significant is the finding that mediation was most often undertaken voluntarily by the parties rather than through a court order or court pressure and that most mediations were conducted by a small cohort of experienced mediators, which confirms findings from other studies. [23]

The construction studies suggests the type of case and the relationship of the parties are unlikely to create barriers to settlement but that there are a number of significant determinants that may lead to failure, which centre on the skills and quality of mediators; the mediation rules; the uncompromising attitudes of the parties and the financial size in dispute.

2.1 Jurisprudence Case Review: Appropriate criteria

The Court of Appeal first sanctioned a party for unreasonably refusing an invitation to mediation in Dunnett. [1] The decision did not give guidelines on the appropriateness criteria but led the way to a number of cases eulogising on the ability of mediation and the skills of mediators to transform the dispute resolution environment. [1] [24] Lord Judge Brooke observed that many cases can be successfully settled by a 'skilled mediator', even those which appear unpromising because of the intransigent attitudes of the parties. Further, experienced mediators are able to achieve outcomes 'beyond' the scope of the court and lawyers. [1 at 14] This view was reiterated in Hurst v Leeming (2003) by Mr Justice Lightman, who affirmed that *'the mediation process itself can and does often bring about a more sensible and more conciliatory attitude on the parts of the parties than might otherwise be expected to prevail before the mediation'.* [25] Although the power of mediation to transform party relationships is well documented, [26] the empirical data reported above suggest that the parties' attitudes are one of the key factors contributing to non-settlement. None of the reasons given for not mediating in Hurst v Leeming, a 'watertight case', excessive costs already involved in litigation, defence of serious allegations or the lack of substance in the case, were found to 'necessarily' lead to a reasonable rejection. The test to apply was whether 'objectively viewed' there was an 'unrealistic prospect' that the process would achieve settlement. [25 at 12-19] The decision was criticised for failing to provide certainty on when it is safe to reject mediation in any given circumstances because a judge could decide there was a good prospect for mediation to achieve a settlement. [21][22]

The test in Hurst v Leeming was considered by the Court of Appeal in Halsey (2004). Lord Justice Dyson's judgement exhibited a change in emphasis on the virtues of mediation by acknowledging the merits of the process still need to be empirically demonstrated. [2] Nevertheless, the decision is founded on the belief mediation is 'suitable for many disputes'. Parties are encouraged to use mediation, not only because the court believes it is a less expensive option than litigation, but because it provides a wider range of outcomes 'including apologies, explanations, continuance of relationship and agreements without legal obligations'. [2 at 14] However, research in the UK castes doubt on the perception that creative outcomes or continuing relationships feature often in construction mediation. [18] [21] [22]

Following Halsey, the unsuccessful party has the burden of proving a party has acted unreasonably in refusing mediation. Six circumstances were identified that should be taken into consideration when determining this question but these are not limited:

(1) Nature of the Case: Halsey takes the view that most cases by their nature are suitable, but accepts the subject matter of some will be 'intrinsically unsuitable for ADR'. The court accepted there were a restricted number of situations where rejecting mediation might be considered safe. The recommendations given by a Commercial Court Working Party in 1999 were accepted: where a party requires a court determination on a point of law, where the issues have importance for future trade or commerce or where a case involves fraud or disreputable commercial conduct but two further examples were provided: when a party wants a resolution of law or injunctive relief.

(2) Merits of Case: The merits of a case are a more problematic and Halsey identifies only one 'clear cut criteria' where a party is likely to be exonerated for refusing mediation: When a party would have succeeded at summary judgement but had not made an application. A more difficult judgment relates to the belief a party has regarding the merits of their case. If a party believes that s/he has a strong case the court might find this relevant but warned future courts to take account of the susceptibility of large organisations and public bodies to cynical invitations to mediate from parties with unmeritorious claims, which force them to make 'nuisance-value' offers to avoid the cost of mediation. However, as Brooker and Lavers observe, smaller organisations, perhaps sub-contractors, with 'limited budgets and a good claim' are equally susceptible to tactical mediation strategies by large corporations, resulting in settlement on unfavourable terms in order to avoid what is an increasingly expensive ADR option. [22]

Border-line cases involve an even more difficult assessment, because courts are likely to view them as 'suitable' for mediation. Halsey advises that 'little weight' should be given to a rejection in these circumstance unless there are 'compelling countervailing factors', which the court does not specify but which are likely to derive from the other five circumstances. Making judgments on the balance of success at court is usually in the hands of legal advisors and it is recommended that the best line of action must be to accept an offer to mediate in borderline cases. However, where parties believe that they have a 'watertight case', in contrast to the decision in Hurst v Leeming, Halsey held that a refusal may be justified but only if it is reasonable: An unreasonable belief that a case is watertight will warrant a penalty for unreasonable behaviour.

(3) Other settlement methods: Another relevant factor is whether other 'settlement methods' have been attempted, which is translated in the judgment to mean 'settlement offers'. Refusing such offers may be evidence of a party's 'unrealistic understanding of the merits of their case'. Halsey highlights that mediation is often successful when other attempts have been made to settle but identifies involvement in settlement methods as 'no more than an aspect of factor'. Nevertheless it does indicate the importance of the dispute resolution strategy that litigants adopt. Parties should be advised to seriously consider any offer and to make counter offers in order to justify continuing litigation. It is also indicative of the importance settlement is given in CPR and the broad concept given to ADR to include negotiation. [8]

(4) Costs: The TCC protocols state ADR can lead to 'significant savings in costs and may result in a settlement which is satisfactory to all parties'. [9 at 7.1.2] However, the cost of mediation may justify rejecting the process where it is disproportionately high to the sums at stake. Halsey notes mediation can cost as much as a day in court and that significant costs can accrue when settlement is only achieved just before the court date. Studies suggest mediation is becoming expensive, particularly if the parties are well advanced in litigation and intend to employ legal representation and a leading mediator. [21] [22] if judges direct or facilitate the process in unsuitable cases then these costs become a direct cost of litigation although; the courts have shown willingness to award aborted mediation costs to the unsuccessful party. [27]

(5) Delay: Weight is given to the timing of mediation: If the offer is late and has the effect of delaying trial that may justify rejecting mediation. The TCC protocols do not enlighten the parties merely noting that ADR or mediation may be appropriate at any time. [9 at 7.2.1.] There may be a diminishing return on engaging in mediation close to trial, however there may be other benefits such as testing witnesses or evidence or narrowing issues which may make late mediation an attractive option. [21] [22]

(6) Prospect of success: The factor that is most difficult to assess with certainty is whether mediation has a reasonable prospect of success. Hurst v Leeming established this to be the critical factor [25 at 381] but Halsey (2004) views it as relevant but not determinative. The court illustrated a party's response to an invitation to mediate with two cases. First, when the opponent takes an intransigent position a party may 'reasonably decide mediation has no reasonable prospect of success because of the unlikelihood of reaching a reasonable compromise'. Second, if a party has been 'unreasonably obdurate' the court may decide that mediation has no reasonable prospect of success but a party is not allowed to rely on their own uncompromising approach, which would be unreasonable behaviour and could be penalised through costs. [2 at 25-26]

Halsey observed that some disputes are inherently more intractable than others (although crucially the decision does not specify which ones or, why) and that some mediators are more skilful that others, which may affect the outcome and the ability of the court to decide how reasonable a prospect there was for success. [2 at 27] Shipman argues that a party should not be allowed to cite mediator skills or competence as a relevant factor as it creates uncertainty in case management. [8 at 206] However, mediator skills have been found be a key factor to settlement. [17][18][23] Specialist courts and judges hearing complex construction cases have long been a feature of litigation and the parties in the building environment are now seeking subject-expert mediators. This is leading to construction mediation being in the hands of a few specialist well qualified, expensive mediators. [20] As mediation grows so too will the pool of experienced mediators but in the current climate a reasonable belief that there is a shortage of mediators with relevant experience might suffice when claiming it was not unreasonable to reject mediation. However, the likely success of such a claim in the TCC is weakened for a number of reasons. First, the TCC provides for judges to offer their services to help resolve the dispute through appropriate methods. Second, the court protocol directs the parties to where information can be found about mediation. [9 at 7.3.4] Finally, the TCC indicate that if the parties fail to agree a mediator when involved in an ADR order, the court may facilitate selection from lists provided by the parties. [9 at 7.3.3]

The Halsey guidelines indicate broad circumstances where the court may find that mediation was a suitable option. Although a party may wish to rely on their right to seek redress from a court they may find they have little support from judges who use their discretion when awarding a cost penalty. Shipman believes judges' discretion is influenced by their 'ideological attitudes' to the function of the court by either maintaining a pre-CPR approach of finding the correct legal outcome or adopting a post-CPR approach of allocating limited court resources to appropriate cases which increases the uncertainty of predicting how the court will view a rejection to use mediation. [8 at 194] The following section will evaluate how the TCC has interpreted the Halsey guidelines.

3. Appropriate Criteria in TCC

The court protocols require the parties to consider ADR but it is only when a party claims there has been an unreasonable rejection of mediation that the court uses its discretion as to whether costs should be awarded against the successful party on this basis which can be at the indemnity basis. [6 at Part 44] A search of the databases reporting TCC cases (BAILII, WESTLAW and LEXUSNEXUS) using the terms mediation, mediate, mediator and ADR since the decision in Halsey, returned twenty-nine cases. The data indicates three cases were determined involving costs which are relevant to an identification of mediation appropriateness criteria for construction disputes. Reference is made to other cases as the decisions indicate categories or circumstances of construction disputes where judges view mediation to be appropriate or inappropriate. It is also noted that in twelve cases mediation had been attempted but had not settled, which indicates a relatively high level of settlement failure.

Prior to Reid Minty v Taylor [2002], it was understood indemnity costs were awarded for behaviour 'lacking in moral probity' or 'deserving of moral condemnation', however it was found not to be necessary to reach this standard [28] but behaviour that is 'unreasonable to a high degree' will be penalised. [29] The TCC considered whether the conduct of the successful party had sufficiently reached this level when refusing to mediate in International Ltd & Orr v Styrene Packaging and Insulation & Ors [2005] [30] The court was unaware of any case where a rejection to mediate was the 'sole justification' for awarding indemnity costs but accepted that in 'exceptional circumstances' it may be 'wholly unjustified to reject an offer to mediate. [30 at 9] Having examined the facts, the judge declined the claim for indemnity costs because the successful party had not 'wholly refused' mediation and had agreed to mediate when the offer was first made but the parties were unable to agree the form to take. Further, the court determined that it was not unreasonable to refuse mediation because the parties were already preparing for trial on the directions of the judge.

There is little evidence available to help parties evaluate the optimum timing for mediation. Although the TCC protocols suggest ADR may be appropriate at any time, Halsey held that it is unlikely to be unreasonable to refuse a late offer to mediate, particularly when this would delay trial and add to litigation costs. [2] Following Dunnett, there were reports that some lawyers were using mediation offers as a 'cost terrorism' devise. [21] [22] The TCC condemned the tactics of 'belated offers' from solicitors who had got themselves into 'costs difficulties' in

Wates Construction Ltd v HGP [2005] because it is 'not a practice in accordance with the CPR' and because mediation in these circumstances is unlikely to settle. [31] In contrast, mediation was commended as an option for 'overall settlement' on costs after trial in Multiplex Construction (UK) Ltd v Cleveland Bridge UK [2006]. [32] The TCC had determined the preliminary issues of a complex construction case involving an interpretation of the Heads of Agreement, an interpretation of the Supplementary Agreement, a decision on the value of work completed and a resolution of who had repudiated the subcontract, which resulted in both parties winning some issues but no 'overall winner'. Mediation at this stage was deemed to offer the potential of saving costs and management time. [32 at 666]

Indemnity costs were considered in relation to the parties' conduct in litigation and an unreasonableness of refusal to use ADR in Tonkin & Anor. v UK Insurance Ltd (2) [2006]. [33] The TCC concurred that an award at the higher rate 'simply' because of a failure to mediate is not sufficient. The claimants' house had been destroyed by fire and they asserted that the defendant's scheme for reinstatement was undervalued. They failed to better the defendant's payment into court under a Part 36 offer and the judgement also found they had refused 'two sensible offers of mediation'; their scheme for reinstatement was 'wholly inadequate'; their case was 'weak' as they were found to be wrong on 'almost every issue' and further their conduct was 'unreasonable and at times reprehensible', particularly their unjustifiable attack on the bone fides of the defendant's expert witness. [33 at 42]

His Honour Judge Coulson, observed that indemnity costs need not always be awarded because a party maintained a weak case or because the losing party refused ADR [33 at 30] and had the claimants been reasonable 'in just one way' they would have avoided the higher rate. [33 at 40] On the issue of rejecting ADR, the court stated this was a 'grave mistake' because it was deemed to particularly appropriate 'in this <u>case</u>, for <u>these</u> disputes' of architectural detail'. [33 at 31(b)] Emphasis given in judgment]

The Halsey guidelines were considered in P4 Ltd v. Unite Integrated Solutions PLC [2006] in a case that Mr Justice Ramsey regarded as a 'classic example' of suitability for ADR. [3] P4 alleged that the defendant (Unite) had converted £70,000 of goods supplied by them to Unite's subcontractor, who became subsequently insolvent. P4 claimed Unite had notice of a Retention of Title clause in the goods but had gone on to install a significant number. P4 made several Part 36 offers but failed to better the amount awarded by the court, therefore under Rule 36.20(2), the court, unless unjust to do so, had to order the claimant to pay the costs up the date of the Part 36 offer. P4 claimed it was unjust and Unite were claiming their costs for the whole period of the litigation at the indemnity rate. In response, P4 submitted that no costs should be paid, first, because Unite had failed to provide requested information about the payment order made to the subcontractor and, second, because Unite had unreasonably refused mediation. Mr Justice Ramsey, in giving the judgement, reiterated that the Halsey guidelines are not limited to the six factors but Unite were found to have unreasonably refused P4's invitation to mediate for the following reasons:

Nature: The dispute was found to be suitable because, although not of significant value, it did cover a number of factual issues including; the number of unfixed goods on site at the time P4 gave notice of the Retention of Title clause and whether the subcontractor had been paid for the goods. The court refuted Unite's claim of an on-going relationship where a point of law needed to be determined and the assertion they needed to defend allegations of bona fides on the grounds that both issues emerge after P4 offered mediation.

Merits: Unite's claim of a 'watertight case' at the time of the first proposal to mediate was rejected because it only became stronger later during the proceedings. In the judgment of the court, they did not have a strong case when the first two offers of mediation were made. Further, the court contended mediation would have helped Unite's weak oral evidence on the number of fitting made, which with other evidence may have narrowed the dispute.

Other methods: Exchange of offers and information were not held to be evidence of other settlement methods but the court noted P4, during this phase, increased the Part 36 offers indicating an 'increasingly unrealistic view of the merits of its case'. [3 at 37] The court observed offers to settle might be relevant but only an 'aspect' of whether there is a reasonable prospect of success for mediation. Particular note was made that letters exchanging offers are not a 'proper substitute' for a process of ADR with a third party neutral, such as a mediator, which allows the parties to gain a more realistic understanding of their position and avoid 'increasingly unrealistic offers' being made.

Costs: The court disagreed with Unite's argument that the cost of mediation outweighed the amount in dispute because their analysis had failed to take into account the cost of proceeding to a hearing and the time spent on litigating, which should have been factored into the evaluation leading to a conclusion mediation would have been less expensive than going to trial.

Delay: Unite accepted that there was no delay in offering mediation, which the court confirmed but they were found to be unreasonable when they stated in correspondence at the beginning of the claim that P4 had not considered mediation when they had done so. This indicated Unite were not seriously considering ADR.

Prospect of success: Mr Justice Ramsey, took as the starting point 'the majority of cases are capable of settlement and are in fact settled in this way'. [3 at 41] Unite, had used Halsey's example that a party's intransigency might suggest little prospect for mediation success and submitted P4's obduracy was an indication that settlement was unlikely. However, the court stated Halsey had suggested success 'may not only depend on the willingness of the parties to compromise', implying mediation can be successful even under these conditions. The court was of the opinion not only would mediation have had a 'reasonable prospect' of success but a 'good prospect' and there was a good possibility P4 would have compromised if they had the opportunity to meet face to face or with a mediator.

P4 was suitable for mediation because it involved small sums compared to the cost of litigation and there were a number of 'uncertain factual and legal issues'. [3 at 45] The court were ‘persuaded’ that it was of ‘great importance’ that both parties had a long commercial relationship, albeit through the subcontractor, which P4 had been seeking to develop because this would have given mediation a good prospect of success. [3 at 45] Unite were found to have unreasonably refused mediation which prevented the parties from an early resolution of their dispute but only for the period up to the Part 36 in July 2005 when P4’s case became weaker, after that date Unite were awarded their costs but not at the indemnity rate because P4’s conduct was not found to be ‘out of the norm’. [3 at 51]

Construction cases are likely to be deemed appropriate when they involve disputed facts or legal issues because mediation might allow the parties to gain a better understanding of the dispute and bring about settlement, or allow the parties to narrow the issues. Certainly had the parties meet face to face at an earlier stage in P4, it may have shed light on the missing evidence of payment to the sub-contractor, which was crucial to the dispute. Settlement is undoubtedly the optimum outcome from mediation but an understanding by the TCC that other advantages can be gained is a factor parties are advised to take into consideration when reviewing dispute resolution strategy, particularly when the court make their judgments with the assistance of hindsight. [29] Research indicates other benefits can accrue with mediation such as clarifying or narrowing issues, assessing strengths and weaknesses or reality checking, all of which might stimulate a later settlement or help prepare for trial with the added bonus of reducing litigation costs. [21][22] Tactical benefits such as ‘feeling the financial muscle’ of the other side or ‘testing’ the evidence have been identified as incentives for mediating but some lawyers adopt a more cynical use by employing 'tactical games' and being ‘less open and more manipulative with the mediator’. [21 at 213] The parties are entitled to adopt any position they like in mediation and the court will not look behind the reasons settlement was not achieved as this compromises the confidentiality of the process. [2 at 14] It would be unfortunate if the TCC, in its efforts to encourage mediation, play into the hands of less scrupulous parties.

4. Conclusions

Mediation has been shown to offer benefits to disputing parties and it is irrefutable that many TCC judges, with personal experience and expertise in construction disputes believe it should be ‘routinely’ discussed and used by the parties. [2] A failure to do so may be sanctioned, although it is unlikely to be at the indemnity level unless there is other evidence of unreasonable behaviour in litigation. Construction parties should take into account that the court continues to emphasis the ability of mediation to deal with intractable parties and the importance of continuing commercial relationships despite evidence suggesting uncompromising attitudes are often a key factor for non-settlement and mediations rarely achieves creative outcomes enabling parties to continue their ongoing relationship. Although Halsey witnessed a retreat from the contention that nearly every case will acquiesce to mediation or the skills of experienced mediators, the personal experiences and perceptions of judges continue to drive appropriateness criteria in the TCC, which could in the long term work negatively against its true potential. The more construction parties experience mediation, or less experienced mediators, failing to work its ‘magic’ with intractable parties or not producing creative outcomes, the less confidence there is likely to be in the process. [22]

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Developing a Conceptual Framework of Catastrophic Withdrawal Behaviour in Construction Dispute

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Abstract

The voluminous reported studies on dispute management have engendered a need for sustainable improvement in negotiating skills because of its decisive effect on the success or otherwise of construction dispute negotiation (CDN). Earlier studies identified that performance of negotiators dictate and influence the outcomes of negotiation. Negotiators should also be responsive to their opponent's negotiating style and strategy as these would undoubtedly affect their own negotiating attitudes. The prospect of negotiation is doomed if negotiators lose the interest to continue. This phenomenon is described as withdrawal in this study. Withdrawal has been found to be influenced by a vast array of cognitive factors. Ignoring or undermining these cognitive obstacles to negotiation can be fatal as these can be the major hurdles against successful outcomes. This study aims to contribute to the study of CDN by analysing withdrawal phenomenon under a 3-variable catastrophe framework. Future research directions for the development of conceptual model of CDN withdrawal are also proposed.

Keywords: construction dispute negotiation, withdrawal management

1. Introduction

It has widely been accepted that conflict is inherent in all construction projects. If conflicts are not handled properly, they will escalate and turn into disputes. When this happens, the disputes need to be resolved. There is a range of resolution methods available for this purpose. Among these, negotiation is the most informal, thus, allows the disputants to take control of the resolution process. Furthermore, it offers high degree of confidentiality and is well recognised as a time- and cost-effective method. An effective negotiation involves heavy information exchange as well as meticulous trade off of values and interests. Negotiators are responsible in charting for successful outcomes. As such, it is imperative to keep the negotiators at the negotiation table. In other words, once negotiators withdraw, the disputes would likely have to be dealt with by other means like arbitration and litigation. This is an undesirable outcome as the possibility of future dealings and relationship among the contracting parties would very likely be tarnished. Moreover, several reviews of the construction industry reported that contracting environment remains adversarial and disputes are often not resolved promptly. It is further stated that practitioners often deal with small and uncomplicated construction disputes with reasonable efforts. Unfortunately, complicated disputes are intentionally ignored. In actual facts, construction professionals should instead be able to recognize and diagnose problems as they evolve and apply appropriate means to resolve them. Despite the complexity involved, negotiators should display their perseverance and patience to engineer a successful negotiation. In this connection, *"…an increasingly lean world which is saturated with uncertainty is that the future will be punctuated with unexpected, potent and cryptic events which will require a rapid response…"* [1]. To mitigate this impact, it is important that the construction industry can react accordingly. In this study, withdrawal is defined as situations when negotiators decide not to continue with the negotiation [2]. Withdrawal behaviours (WB) are therefore those happenings that would lead to withdrawal if not controlled. Withdrawal behaviours will foster the growth of an uncooperative working environment. As such, productivity erosion, and profitability reduction as well as an adversarial and mistrust environment among contracting parties will surface. In view of the importance of withdrawal in construction dispute negotiation (CDN), a conceptual framework on withdrawal is developed by examining (i) what phenomena characterize withdrawal behaviours in CDN?; (ii) how can a model of withdrawal in CDN be formulated?; and (iii) which factors trigger withdrawal?

2. Characterizing withdrawal behaviour by catastrophe theory

Negotiation breakdown occurs when one of the negotiating parties withdraws. It is resulted from psychological struggles experienced during the course of negotiation [3]. Resolution becomes impossible once withdrawal happens [4]. Furthermore, it will also lead to destructive outcomes that have damaging effects on later interactions. When withdrawal tendency is high, the associated feeling of uneasiness and insecurity would ultimately cause collapse. Withdrawal does not sit comfortably with the rational models that predict negotiators would pursue their goals and maximize joint profit. Retreating and leaving the dispute unresolved is thus simply a suboptimal outcome. Neale and Bazerman [5] stated that "… *a great deal of sub-optimality in negotiated outcomes is attributable to deviations from rationality in negotiators' cognitive processes…* ". Negotiation often involves mixed-motive interactions in which disputants face particular cognitive problems. In those circumstances, these disputants continue to experience high degree of cognitive dissonance, losing face, negative self-image, disrespectfulness and unfairness, and misunderstanding that lead to withdraw. Indeed, research has revealed that once withdrawal happens, it can affect the way people think and act, as well as repetitive withdrawal behaviours. Bluedorn [6] described withdrawal as a reduction in the socio-psychological attraction to or interest in organization. Herzberg *et al*. [7] suggested that ultimate withdrawal is predisposed by a series of dysfunctional behaviours progressing from declining performance, frequent lateness, and absenteeism to withdrawal.

Withdrawal may also be a sensible tactic when negotiator feels being excessively exploited by an opportunistic opponent. It can be triggered by the number of counterparts' non-compliance to negotiated agreements. In addition, Surra and Longstreth [8] demonstrated that people, who felt tension with others, were more likely to withdraw from negotiation than those who didn't. These interpersonal problems often drive anxiety and fear. Negotiators may also experience frustration, strain, and uneasiness when they dislike each other. The likely responses in these circumstances will be psychological or physical withdrawals from the negotiation processes [4], [9]. Rise in withdrawal tendency will fester in an organization, grow in proportions and ultimately cause collapse [10].

In most negotiation models, negotiators are regarded as rational utility maximizers. As such, these models typically suggest that negotiations would end in resolution at the point that utilities of each party are enhanced [11]. This proposition suggests that continuing the negotiation process is more beneficial than withdrawing [12], [13]. However, negotiators often fail to reach an agreement even when there are mutually acceptable solutions within the positive contract zones described by Walton and McKersie [14]. This proposition suggests that there exists a threshold of level beyond which withdrawal will suddenly occur. Some of the social science studies [14] reported similar findings in that human behaviours exhibit a continuous change of behaviour often display a discontinuous lapse; a classical phenomena described by Catastrophe Theory (CT) [15]. In this study, withdrawal in construction dispute negotiation (CDN) is taken as the behaviour whereby a negotiator loses the interest to continue with the negotiation. It is further suggested that such change is dynamically associated with the underlying factors of disputes and can be characterized by a catastrophic discontinuous lapse.

CT has widely been used in a number of science based research fields such as physics, chemistry and biology. More recently, it has been used in social science and finance. The simplest catastrophe model, cusp, is a 3-variable framework that includes one dependent behavioural variable (represented by Z-axis) and two independent control variables (represented by X- and Y-axes). The dependent variable shall have polarized discrete forms, whereas the two control variables are known as normal and splitting factors respectively [16]. The horizontal plane formed by axes X and Y is called the control surface, while the respective value of Z forms the behaviour surface. Negotiation is an argument across value and interest. It involves multi-emotional mood of various status. In a professional negotiation context, the withdrawal behaviour axis may run as shown in Figure 1 as described by Zeeman [17]. At one end, negotiation can be brought to a successful conclusion only when the disputants remain at the negotiation table with hopeful manner or either party's impending proposal is more desirable than the previous one [2]. On the other hand, once negotiators lose their interest to continue, the negotiation probably would collapse – withdrawal occurs. Figure 2 illustrates the hypothesized catastrophe model of negotiator's withdrawal tendency. The withdrawal tendency as shown in the figure is a result of the interaction between the normal and splitting factors. The behaviours of withdrawal ranging from continue to withdraw as depicted in the behaviour surface (B) are governed by the withdrawal tendency as shown in the vertical axis.

Emotional mood		Withdrawal behaviours
	Withdraw	Withdraw
		Abuse
		Irrational argument
		Rational discussion
	Continue	Concessions
		Apologies

Figure 1 The behaviour axis model describing the emotional mood of a negotiator in an negotiation (Modified from Zeeman [17])

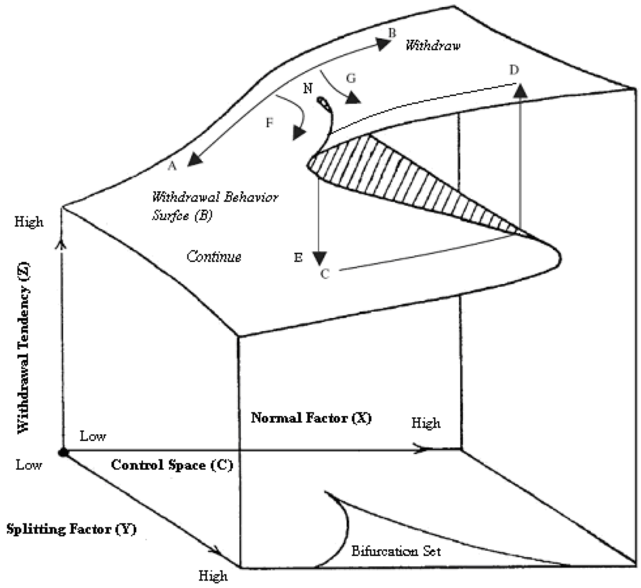

Figure 2 A 3-variable cusp CDN withdrawal framework (Modified from Zeeman [17])

3. Models development

Figure 2 shows a typical 3-variable cusp catastrophe CDN withdrawal model. In this, a set of respective values of X and Y defining the edges of the pleat represents the singularity set. Once the intensities of the normal and splitting factors reach the critical value of the singularity set, the behavioural variable undergoes a catastrophic change. It is visualized as the arrows D and E in Figure 2. There is one likely form of behaviour in any given combination of the two control factors except within the bifurcation set. In other words, there are two stable equilibriums for some combinations of values of control variables inside the bifurcation set [18]. The pleat of the behaviour surface runs smoothly without crease and there is a middle fold that completes the pleat of the cusp behavioural surface giving the representative feature of the "S" shape of cusp model. This shadow region in Figure 2 represents an area having an unstable equilibrium and of least potential. At the point N, marginal change in path causing major change in behaviour and it is represented as the neutral point. The pleat in the behaviour surface diverges from the neutral point and enlarges along the splitting factor. It is represented by the path F and G in Figure 2. Once a transition from the upper surface to the lower surface is made or vice versa, a return of its original behaviour value will not occur even if the same magnitude differential in the control variables values are reached as shown by the path CD and DE. They are called the hysteresis paths.

4. Model descriptions – Control variables

Several researchers have admitted that there are cognitive frames that individuals use to understand negotiation situations and react correspondingly [19]. Pinkley and Northcraft [20] further described the three orthogonal dimensions of frames: (1) relationship level versus task level, (2) emotional level versus intellectual level, and (3) cooperate level versus win level. As these forces in CDN co-exist and are in dichotomy, these forces fit nicely with the requirements of the 3-variable cusp catastrophe framework. Therefore, the application of CT to analyze the relationship between withdrawal behaviour and its drives in dichotomy is considered probable. These three dimensions are identified as pragmatism, intelligence and interdependence in the study.

4.1 Pragmatism (Task level versus Relationship level)

The first dimension, pragmatism, refers to the variation in the extent to which a disputant focuses on ongoing relationships and the conflict itself with the other party. Disputant with a high relationship orientation focuses on interpersonal concern; disputant with a high task orientation instead concentrates on the substantive aspects of a dispute, such as money or property settlements. Harold [21] stated a model focusing on the tension between relationships and goals in conflict handling. When a negotiator is engaged in a conflict there are two major concerns to deal with: (a) achieving goals of the task and (b) preserving the relationship. The importance of goals and relationships affect how negotiator acts in a conflict situation. Framed with these two concerns, the arrangement of the five styles of managing conflict is as shown in Figure 3.

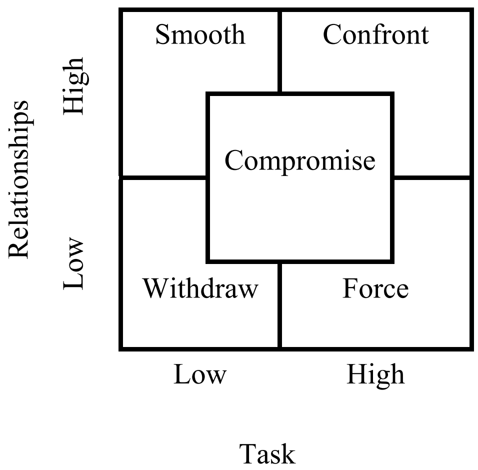

Figure 3 Task versus Relationship model (Adopted from Harold [21])

4.2 Intelligence (Emotional level versus Intellectual level)

The second dimension, intelligence, reflects the degree of attention a disputant pays to the affective components and substances of a dispute. A disputant in one way focuses on feelings involved, such as jealousy, hatred, anger, and frustration, and in other way on actions and behaviours. Bazerman *et al*. [22] stated that positive moods tend to increase negotiators' tendencies to select cooperative strategies and enhance their ability to communicate for integrative gains. An angry negotiator who is less accurate in judging the interests of his opponent would achieve lower joint gains. Thus, it advocates move such as deception in negotiation. Simultaneously, Radford [23] characterized that a negotiator can be accommodating or coercive from an intellectual perspective. An accommodating move is one that strives for an agreement. A coercive move, on the other hand, is to seek a favourable outcome for one's own. In Figure 4, the four styles model in the emotion/intellectual perspective is proposed.

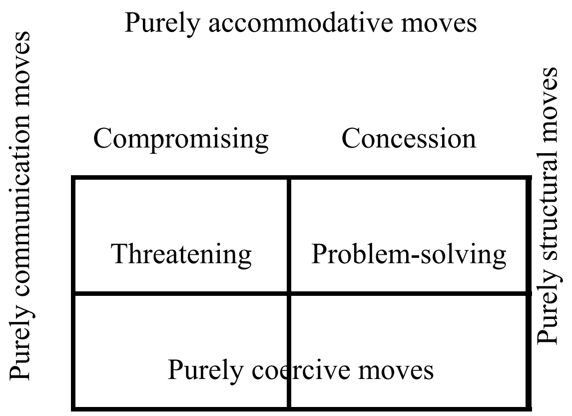

Figure 4 Emotional versus intellectual model (Adopted from Fraser and Hipel [24])

4.3 Interdependence (Cooperative level versus Win level)

The final dimension, interdependence, suggests that negotiation involves a fundamental tension between whether parties feel they need to cooperate or compete in order to achieve their goals. Deutsch *et al*. [25] distinguishes between two key dimensions, i.e. assertiveness in the pursuit of one's own goals, and cooperativeness in pursuit of mutual goals. Thomas and Kilmann [15] elaborated this conception by using two orthogonal dimensions that include cooperativeness and assertiveness. Carnevale *et al*. [26] stated that "…*Bargainers will make pressure statements only if they can accompany them with efforts to stare the other side down.…* ". In other words, parties who perceive the other parties as dominant lead the arousal of dominant behavioural responses among parties. Actions involving either attack or retreat are viewed as their walk-away option as a source of power. As such, the intention to cooperate or to win may be related to individual's withdrawal tendency. For the purpose of this study, Thomas-Kilmann model [27] on conflict handling style is used (Figure 5).

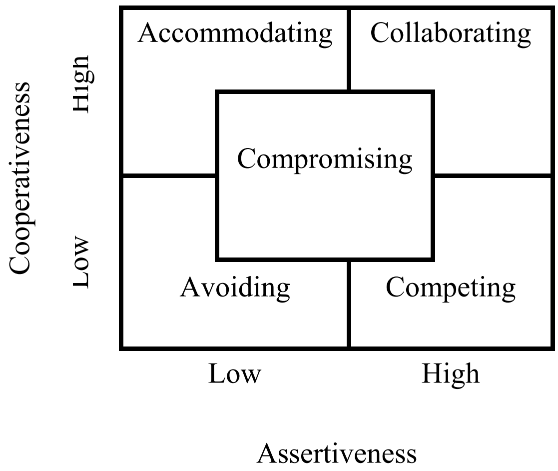

Figure 5 Cooperative versus win model (Adopted from Thomas and Kilmann [27])

To sum up, the measurement frameworks of the three conflict frames are adopted into the control factor models as represented in Figure 6.

Level		Control factor model		
		Pragmatism	Intelligence	Interdependence
High	↕	Force	Problem-solving	Collaborating
		Withdraw	Compromising	Avoiding
		Compromising	Concession	Compromising
		Confront	Threatening	Accommodating
Low		Smooth		Competing

Figure 6 Control factor models for the three negotiation dimensions

5. Catastrophe CDN Withdrawal Model

Having introduced the model components, this section gives the implications suggested by the CT. According to the model in Figure 2, the changes in the withdrawal tendency as a result of the moderating effect of the splitting factor on control factor influence the withdrawal behaviour. To illustrate the working by way of an example, hypothesized cases with low, moderate and high degree of pragmatism (as splitting variable) level are elaborated (Figure 7). When the level of pragmatism is low, the parties emphasize the areas of agreement to preserve their relationship. At this position, the situation can be described as either smoothing or confront, i.e. change from continue to withdraw is relatively unlikely. The parties are more accommodating and willing to adjust their responses to situational demands. This situation is reflected in Figure 7 as the path movement between A and B. It is noted that the changes in intelligence are approximately proportion to that of withdrawal tendency. Thus, if an abrupt change in the withdrawal behaviour under a low pragmatism, a fairly large increase in intelligence is necessary. On the other hand, when the degree of pragmatism becomes moderate, the parties become less adaptive as they concentrate on the materials. The capability of matching the intelligence demands becomes weaker across intelligence level from high to low. A small change in the intelligence level can result in substantial change in withdrawal tendency as indicated by the path movements of CD and DE (Figure 8). With reference to the study of Blau [28], it is suggested that current behaviour is a response to the previous behaviour of the others. If pragmatism and intelligence levels are moderate, it is possible for the party to withdraw or continue as indicated by the point H and J in Figure 8, where point I is the least possible form of behaviour.

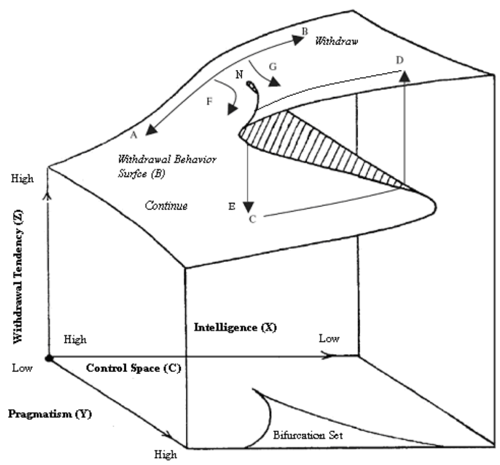

Figure 7 A hypothesized cusp catastrophe CDN withdrawal model with pragmatism as splitting factor (Y) and as intelligence normal factor (X)

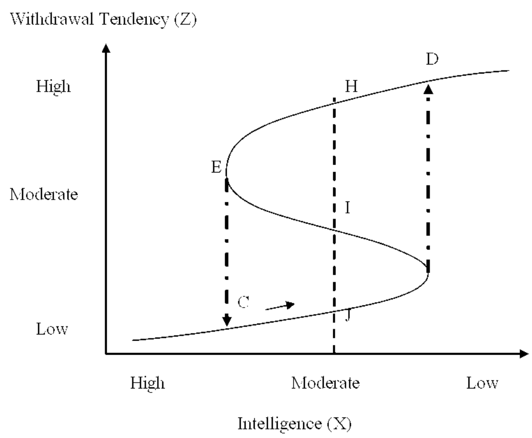

Figure 8 Withdrawal tendency movements at middle level of Pragmatism (Y)

6. Concluding Remarks

Most construction disputes are firstly negotiated for a resolution. A negotiation can be considered doomed if a negotiator withdraws from the process. Once negotiation fails, conflict may escalate. It may have to resort to lengthy and costly legal actions. In this study, withdrawal is defined as situations where negotiators lose the interest to continue with the negotiation. This study suggests the use of cusp model to describe the dynamics of withdrawal behaviour. This conceptual framework is subject to empirical testing currently being conducted by the authors to confirm the appropriateness of employing the three dimensions of negotiation frames – pragmatism, intelligence and interdependence as control and splitting factors of a 3-variable cusp catastrophe CDN withdrawal framework. Six such frameworks are proposed through different combinations of these frames. Testing of these models shall provide invaluable insight to enhance the understanding of CDN.

7. Acknowledgement

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Legal research in the built environment: a methodological framework

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Abstract

The methodological basis of legal research has traditionally not been explained by its practitioners and this has led to misunderstandings between researchers in interdisciplinary fields, including the built environment. The paper therefore develops a methodological framework as a mechanism for communicating the implicit, often subconscious, methodologies employed by legal scholars to other researchers within the built environment. It distinguishes legal research from scientific research and defines it as a normative process which is undertaken within the humanities research tradition. The approaches adopted by researchers are explained primarily in terms of deductive, analogical and inductive reasoning although it is noted that the term "methodology" is more suited to research in the sciences than in the humanities.

Keywords: Disciplines, Epistemology, Jurisprudence, Knowledge, Law, Methodology, Research, Theory.

1. Introduction

Legal research is a comparatively recent phenomenon within the built environment research community. Its academic methods have traditionally been regarded with suspicion by other built environment researchers who have struggled to recognise its outputs as credible research contributions [1]. In particular, legal researchers have arguably been insufficiently reflective as to the methodologies employed in their work and, as a consequence, have found difficulty in explaining these to researchers from other disciplines.

The underlying reasons for this phenomenon are to be found in the traditional approach to legal education which conditions students to "think like a lawyer" [2] without providing any theoretical grounding in the methods actually being employed. As a consequence legal researchers have always struggled to define their work in terms that their academic peers in other disciplines can understand [3].

The present paper therefore reflects on the techniques actually employed by legal researchers at a subconscious level and attempts to make these explicit. It presents these in the form of a methodological framework for possible adoption by the built environment legal community as a mechanism for more effectively describing its work to researchers in other disciplines within the field

2. Epistemological considerations

2.1 The nature of legal scholarship

Before considering the methodologies employed by legal researchers (or legal scholars, as they are more usually described) it is first necessary to understand the epistemological nature of the process being undertaken by them, and to appreciate how this differs from other research in the built environment.

There is a dearth of theoretical literature on the nature of legal scholarship and a consequent lack of awareness about what legal scholars actually do. Nevertheless, Arthurs proposed a useful taxonomy of legal research styles in his report on legal education and research in Canada [4]. This has informed the analysis in this paper and is represented as a matrix in Figure 1.

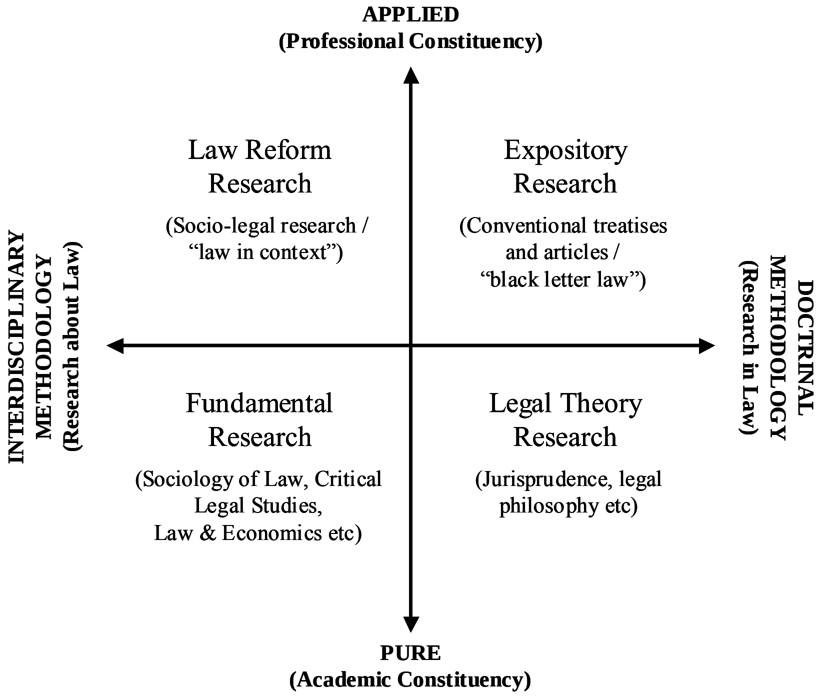

Figure 1: Legal Research Styles (after Arthurs 1983)

It will be seen that the vertical axis of the matrix represents the familiar distinction between pure research which is undertaken for a predominantly academic constituency, and applied work which generally serves the professional needs of practitioners and policy makers. This has been explored in some detail elsewhere [5]. In the present context, the more interesting distinction is that between doctrinal and interdisciplinary research which is represented by the horizontal axis and the present paper considers only this aspect of Arthurs' model.

2.2 The meaning of 'doctrinal' research

Doctrinal research (on the right in Figure 1) is concerned with the formulation of legal "doctrines" through the analysis of legal rules. Within the common law jurisdictions legal rules are to be found within statutes and cases (the sources of law) but it is important to appreciate that they cannot, in themselves, provide a complete statement of the law in any given situation. This can only be ascertained by applying the relevant legal rules to the particular facts of the situation under consideration.

As will be discussed below, deciding on which rules to apply in a particular situation is made easier by the existence of legal doctrines (for example, the doctrine of consideration within the law of contract). These are systematic formulations of the law in particular contexts. They clarify ambiguities within rules, place them in a logical and coherent structure and describe their relationship to other rules. The methods of doctrinal research are characterised by the study of legal texts and, for this reason, it is often described colloquially as "black-letter law".

2.3 Contrast with scientific research

Doctrinal research is therefore concerned with the discovery and development of legal doctrines for publication in textbooks or journal articles and its research questions take the form of asking "what is the law?" in particular contexts. This form of scholarship has always been the dominant form of academic legal research [6].

At an epistemological level it differs from the questions asked by empirical investigators in most other areas of built environment research. Scientific research, in both the natural and social sciences, relies on the collection of empirical data, either as a basis for its theories, or as a means of testing them. In either case, therefore, the validity of the research findings is determined by a process of empirical investigation. In contrast, the validity of doctrinal research findings is unaffected by the empirical world.

Legal rules are *normative* in character as they dictate how individuals *ought* to behave [7]. They make no attempt either to explain, predict, or even to understand human behaviour. Their sole function is to prescribe it. In short, doctrinal research is not therefore research *about* law at all. In asking "what is the law?" it takes an internal, participant-orientated epistemological approach to its object of study [8] and, for this reason, is sometimes described as research *in* law [4].

As will be described below, the actual process of analysis by which doctrines are formulated owes more to the subjective, argument-based methodologies of the humanities than to the more detached data-based analysis of the natural and social sciences. The normative character of the law also means that the validity of doctrinal research must inevitably rest upon developing a consensus within the scholastic community, rather than on an appeal to any external reality.

2.4 External factors and interdisciplinary research

In practice, even doctrinal analysis usually makes at least some reference to other, external, factors as well as seeking answers that are consistent with the existing body of rules. For example, an uncertain or ambiguous legal ruling can often be more easily interpreted when viewed in its proper historical or social context, or when the interpreter has an adequate understanding of the industry or technology to which it relates. As the researcher begins to take these extraneous matters into account the enquiry begins to move leftwards along the horizontal axis in Figure 1, in the direction of interdisciplinary research.

There comes a point, towards the left hand side of the matrix, when the epistemological nature of the research changes from that of internal enquiry into the meaning of the law, to that of external enquiry into the law as a social entity. This might involve, for example, an evaluation of the effectiveness of a particular piece of legislation in achieving particular social goals, or an examination of the extent to which it is being complied with.

3. Methodological framework

3.1 Dominance of the doctrinal tradition

The dominance of the doctrinal tradition in legal scholarship has already been noted [6]. However, it is important to understand that this is not simply a single, isolated category of scholarship. Some element of doctrinal analysis will be found in all but the most radical forms of legal research and it was once suggested within a socio-legal studies context, that social scientists should be regarded as "intellectual sub-contractors" who should be kept "on tap, not on top" [9]. Doctrinal analysis therefore remains the defining characteristics of academic legal research and the account which follows represents an attempt to describe the nature of the methodologies employed within it.

3.2 Role of deductive reasoning

The starting point is to recognise that there is no fundamental distinction between the process of academic doctrinal analysis and the legal analysis undertaken by practising lawyers or judges. As already described, the aim, in each case, is to answer the question "what is the law?" in a particular situation. In the case of practising lawyers or judges this will be a real and well-defined situation requiring an immediate answer to the question. For the legal scholar, the situation, or more likely the class of situations being considered, will be hypothetical and the purpose is to undertake a more in depth analysis which is capable of informing the deliberations of practitioners and judges in future cases.

In either case, the initial process of applying a rule of law to a factual situation can be understood as an exercise in deductive logic. Most readers will need no explanation of this form of reasoning which, of course, also forms the basis of the scientific method. However, in a legal context, the familiar syllogism, comprising major premise, minor premise and conclusion, takes the following form:

- Major premise – identifies a general rule of law which requires a specified legal outcome when particular facts are present in a situation.
- Minor premise – describes a particular factual situation.
- Conclusion – states whether the rule in the major premise therefore applies to the facts in the minor premise, and whether the specified legal outcome therefore takes effect.

By way of example, in English law, section 108 of the Housing Grants, Construction and Regeneration Act 1996 contains a general rule of law (the major premise) that a party to a construction contract is entitled to refer a dispute under the contract to adjudication. Therefore, where a particular dispute arises in a particular construction contract between a particular employer and a particular contractor (the minor premise) we can conclude, as a matter of deductive logic, that either party is entitled to refer that dispute to adjudication (conclusion).

3.3 Dealing with the hard cases

This, of course, is an idealised account of the process of legal reasoning. If the process were as simple, and as mechanistic as this, society would have no need for lawyers, and still less for legal scholarship. In reality, in almost all cases, the deductive model will fail, without further analysis, to produce a definitive answer to the question of what the law is in a given situation.

Legal rules, of necessity, have to be expressed in general terms and were famously described by Hart [8] as having an "open texture", and therefore capable of interpretation in more then one sense. In the context of the above example, there has, for instance, been considerable judicial and academic discussion over the meaning of "dispute" in relation to construction adjudication. There will, therefore, often be an element of doubt as to whether a rule applies to a particular factual situation and this characteristic will, of course, be manipulated by the opposing parties and their lawyers in an attempt to achieve the outcome that is most favourable to their interests.

Although Hart [8] concluded that judges exercise discretion in these so-called "hard cases", their decisions are actually based on recognised patterns of reasoning employed within the legal community which are used to supplement the deductive model described above. Lawyers and legal scholars are therefore often able to predict the outcomes of future cases by employing, however subconsciously, the same patterns of reasoning that will eventually be used by the judiciary.

3.4 Role of analogical reasoning

The most widely used technique is undoubtedly the process of analogical reasoning. In contrast to deductive reasoning, which entails reasoning from a general rule to a specific case, analogy involves a process of reasoning from one specific case to another specific case. In those many situations where it is unclear whether a particular factual situation falls within the ambit of a rule, it can often be helpful to examine apparently similar cases which have previously come before the courts. If, upon examination, the facts of these cases are found to be sufficiently similar to the facts of the subject case then it can be concluded that the facts of the subject case should be treated by the courts in the same way. Most readers will be familiar with this process in the context of the operation of the common law doctrine of precedent.

The decision as to whether a case is sufficiently similar to another is ultimately a subjective one as no two cases are ever completely identical. Judges therefore have considerable scope to distinguish the facts of a subject case from those in an established precedent if they choose not to follow it. Nevertheless, this scope is not unlimited and Bell [10] has highlighted how judicial decision making in these circumstances is constrained by social conventions within the legal community which he describes as the "rules of legal discourse". He describes how these "provide a framework lying outside the power of the reasoner within which he has to operate if his arguments are to count as legal justifications". Judges are subject to these rules but so, of course, are lawyers and legal scholars who all participate in the same legal discourse, and who all desire their arguments to be taken seriously.

3.5 Role of inductive reasoning

A third technique involves the use of inductive reasoning which can be described as the reasoning from specific cases to a general rule. This can be of particular assistance when a particular factual situation does not appear to be addressed directly by a legal rule at all and it therefore becomes necessary to "fill the gap" in the law. As with inductive reasoning in the sciences a general proposition can sometimes be derived from a number of specific instances.

In the case of legal reasoning this involves the recognition of a new general rule which emerges from a number of earlier authorities which are then regarded simply as particular instances of the new rule. *Donoghue v Stevenson* [1932] AC 562 is the best known example of this technique. Particular instances of negligence had been recognised by the courts for years before the famous snail in the ginger beer case came before the courts. However, it was not until Lord Atkin proposed his now well-known neighbour principle in this case that the tort of negligence was recognised as a more general rule, capable of being applied to novel fact situations which were not already described in the individual authorities then available. Once again, the capacity for developing new rules in this way will be regulated and limited by the recognised rules of legal discourse described above.

A variety of other techniques is available which, like those already described, also allow the available body of legal rules to be marshalled into coherent patterns (or "doctrines") and applied to new factual situations in an apparently logical and consistent manner. Indeed most legal discourse revolves around the verbal manipulation of the available sources of law in the belief that the answer to most legal problems can be found in the underlying logic and structure of the rules if only this can be discovered [11]. This approach is usually described as legal formalism [2] and, despite numerous academic criticisms of its assumptions (for example, Fitzpatrick &

Hunt [12]), continues to represent the dominant paradigm within legal practice and within legal scholarship, at least in terms of external appearances.

3.6 Role of policy judgments

Nevertheless, there is now a widespread recognition that, in some cases, the law cannot be determined with certainty from an analysis of the rules alone. Although judges will justify their decisions by reference to the existing rules [13] there is a growing realisation that the rules (in the so-called "hard cases") can sometimes be used to justify a number of possible, and opposing, legal outcomes. This is, once again, a function of the open texture of legal rules and, where this occurs, the law is said to be indeterminate [14].

If law is indeterminate, and some cases are decided according to a value judgment made by the judge on the day, there are of course implications for democracy, and for the rule of law. This has unsurprisingly generated criticisms of the political role of the judiciary (for example, Griffith [15]) which remains beyond the scope of this chapter. However, the judges' political role is usually described more charitably in terms of making decisions according to "policy considerations" and this is now widely accepted as a legitimate part of the judicial function.

The challenge for the legal scholar (or practising lawyer) trying to predict the likely outcome of future cases is to understand the nature of the policy considerations that are likely to influence the judiciary. Dworkin's [16] influential writings provide a wealth of guidance in this respect and remind us that policy decisions are far from the arbitrary and unpredictable exercise of judicial power that some would suggest. Rather, he argues that legal systems consist of underlying principles, as well as rules, and that judges are bound to follow these when deciding the outcomes of hard cases. As with Bell's [10] rules of legal discourse described above, these can be seen to provide a constraint on judicial action, and at least some assistance in attempting to anticipate the likely outcome of cases. Bell's [17] empirical work on policy matters also identifies the particular forms of policy argument used by the courts and this can also assist the scholar in trying to anticipate judicial decision making in this context.

3.7 Summary

In summary, therefore, it is probably incorrect to describe the process of legal analysis as being dictated by a "methodology", at least in the sense in which that term is used in the sciences. The process involves an exercise in reasoning and a variety of techniques are used, often at a subconscious level, with the aim of constructing an argument which is convincing according to accepted, and instinctive, conventions of discourse within the discipline.

Although the discourse is apparently conducted according to formalistic conventions it is also influenced by shared value (or policy) judgments which often remain unspoken. The "methods" employed in legal scholarship are therefore neither consciously learned, nor consciously employed as is the case with scientific methods. The skills and conventions of legal analysis are instead learned at an instinctive level through exposure to the process, and they are then employed on the same basis in the development of legal argument. In much the same way that the use of an explicit methodology confers legitimacy in scientific research, credibility within legal scholarship is therefore dependent on the researcher's work demonstrating an understanding and adherence to the accepted conventions and norms of its discourse.

4. Relationship of law to other disciplines

This lack of a formal research methodology, and the reliance on analysis and the development of argument within a prevailing academic discourse, is of course a particular feature of the arts and humanities family of disciplines to which law belongs. This places law at the "soft" end of the familiar disciplinary spectrum and (in common with design), law therefore differs from the dominant built environment research specialisms in this respect. Unlike law and design, the other built environment disciplines of technology, economics and management all belong either to the natural, or to the social sciences.

The science / arts & humanities distinction reflects genuine epistemological and methodological differences between the families of disciplines about the nature of knowledge, and about the manner of its production. Becher [18] has described knowledge production in the sciences in terms of the cumulative and piecemeal accumulation of individual segments of knowledge which, over time, contribute to a comprehensive explanation of particular phenomena. He contrasts this with humanities disciplines like law. These, he describes, as being concerned with the organic development of knowledge through an ongoing process of reiterative enquiry. They address multifaceted, rather than discrete, problems and attempt, not to explain the individual components of phenomena, but to develop a holistic understanding of their overall complexity.

The dominance of the scientific disciplines within the built environment inevitably influences prevailing views about knowledge and knowledge production within the field. Indeed, the language of built environment research is often dominated by the rhetoric of the social sciences in particular. This is characterised by a concern with the traditional social science methodologies (see, for example, Fellows & Liu [19]) and with an emphasis on empirical investigations rather than the development of theoretical perspectives (Betts & Lansley [20]; Brandon [21]).

5. Conclusion

The paper has shown that the normative process of doctrinal analysis is the defining characteristic of most legal scholarship. It has demonstrated how this places it within the humanities tradition with corresponding methodologies and cultural norms. As the built environment research community operates overwhelmingly within a scientific paradigm it embraces different methodologies and cultural norms from those traditionally associated with legal scholarship with consequent difficulties for communication.

In common with other humanities disciplines most legal scholarship is not concerned with empirical investigation, but with the analysis and manipulation of theoretical concepts. The methodologies employed therefore differ from those of the sciences and are probably more accurately categorised, in social science terms, as techniques of qualitative analysis. As has been seen, deductive and inductive logic, the use of analogical reasoning and policy analysis all feature strongly within this process.

Crucially however, as the process is one of analysis rather than data collection, no purpose would be served by including a methodology section within a doctrinal research publication and one is never likely to find one. This is perhaps the most striking difference between the appearance of research outputs in the two traditions, and the one which has historically caused most difficulty for legal scholars when subject to peer review by other built environment researchers.

This paper began by highlighting the failure of the legal research community to adequately explain itself to its peers in other disciplines and in this sense it can hardly complain if those peers then judge it by standards other than its own. Communication between disciplines is one of the great challenges to achieving genuine interdisciplinary and that challenge is never greater then when trying to bridge the gulf between the humanities and the sciences.

Nevertheless, it is surely incumbent on all of us within the built environment research community to do precisely that. This involves developing at least an awareness of practices within the field's various disciplines. But it also involves a willingness to reflect upon our own previously unquestioned assumptions about the practices in our own discipline, and to articulate these for the benefit of others within the field. It is hoped that the methodological framework presented in this paper might provide a vehicle for communicating the nature of legal research to other built environment researchers, and thereby assist the process of communication within the wider discipline.

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An analysis of dispute resolution literature in construction management journals

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Abstract

Dispute resolution has become an established part of construction management discipline, both with respect to the academic research undertaken and to its wide application in practice. This paper analyses the recent literature on construction dispute resolution as published in the mainstream construction management journals, aiming to identify those aspects of dispute resolution that have been studied by the researchers and chosen for publication. Peer reviewed articles published in the selected mainstream construction management journals are analysed and classified in terms of research stream, level of analysis, sector, definitions of dispute, sources of information, contribution of the articles and backgrounds of the authors within a meta-classification framework proposed. Based on the findings, the paper presents research trends, neglected areas and future research suggestions for the discipline.

Keywords: Dispute resolution, Construction management, Meta-Analysis, Research Trends

1. Introduction

Academic journals are platforms where communication of research findings and scholarly debate take place. In the academic world, communication is central to the promotion of knowledge and while there are many forms of communication channels, the most permanent and durable are the published literature, especially refereed academic journals. An established refereed journal is a repository of good and novel insights gained from data-based research, scholarly enquiry, rigorous analysis of experience and careful logical debate about an issue or phenomenon [1].

The analysis of mainstream journals is well established [2] and occurs not just in the core scientific and social scientific disciplines. The analysis of a single journal as a case study provide a historical record, describe the information characteristics of a journal and give an opportunity to assess the editorial policies or develop recommendations for future policies and publication gaps to be filled [1]. On the other hand, analysing a broader sample can provide a map of a discipline reflecting important patterns and is seen as vital for research policy making at national and institutional levels. Jacobs [3] also suggests that the studies of publication patterns are useful indicators of scientific productivity, trends, emphasis of research in various disciplines, and of researchers' preferences for publication outputs. Results of such studies may be very useful in decision making in research administration and planning, in collection development and use in libraries. These results further enable policy makers in different organisations and funding agencies to evaluate their decisions on the awarding of grants to individuals and institutions. Within all fields of study, it is needed to know the ways in which an academic discipline develops, the main dimensions of the subject matter and the ways relevant research methods and tools are used. These studies are called meta-analyses and concern, in general, the characteristics of the papers and the nature of the authors in various aspects.

This paper sets out to reflect upon the most recent research in the field of dispute resolution in construction and gives an overview of what aspects of it have been studied in the papers published in five main stream refereed construction management journals; Construction Management and Economics, Journal of Professional Issues In Engineering Education and Practice, Journal of Management in Engineering, Journal of Construction Engineering and Management and International Journal of Project Management in the last decade. With this study on the recent research in the field, a more holistic view of the subject area can be obtained to identify trends and knowledge gaps. This integration of the recent research is expected to contribute to generating new agendas for future research and to the debate on the development of the field.

The objectives of the analysis are:

- Identify the content in the recent studies of dispute resolution in construction, including research stream, level of analysis, sector and definitions of dispute.
- Identify the style including sources of information and contribution of the article.
- Identify the author background.

Dispute resolution in construction has been subject to considerable scrutiny in recent years. Although there have been some studies of the previous research undertaken in this field, these reviews have not considered patterns of published output from academic research. This review is deemed timely since the international community of researchers in the field of dispute resolution in construction, represented by CIB Working Commission W113 on Law & Dispute Resolution introduced new Task Groups, TG-67 Statutory Adjudication in Construction and TG-68 Construction Mediation with a mission of fostering the development of legal scholarship across a broad range of legal subject areas within the field of construction. With the constitution of these task groups, the Commission also encourages the formation of groupings of specialists in particular areas that are able to address individual topics in greater depth [4]. Both task groups aim to produce bibliographies and international reviews as their first outputs, showing the importance of the studies of previous research in navigating future research.

2. Method

A wide variety of sources are available on dispute resolution in construction including journal articles, conference papers, reports, presentations and thesis. To ensure the academic standard of the literature analysed in this study, only peer reviewed articles were decided to be included. For this purpose a core of international refereed journals that had a construction and project management perspective were designated and the keyword "dispute" was searched for amongst the title and the keywords sections of the articles in the selected journals. In order to obtain the most recent research in the field, the study was limited to a ten year period (1997-2006) of publication.

2.1 Journals Analysed

The articles that are analysed in the study were obtained from a group of international refereed journals selected in tune with the aims of the paper. These journals are Construction Management and Economics, Journal of Professional Issues in Engineering Education and Practice, Journal of Management in Engineering, Journal of Construction Engineering and Management and International Journal of Project Management. These journals aim to provide a home for serious articles which recognize and reflect the fundamental changes in construction and project management and its sub-disciplines. Although there are several journals more specialized in dispute resolution in construction, the journals above were chosen to understand how the subject acquires a niche in the mainstream construction management journals. All articles published between 1997 and 2006 in the journals listed were included in this study but book reviews and editorials were excluded.

2.2 The framework

Betts and Lansley [1] suggest that the meta-models are important for the analysis and classification of a discipline, inter-relating different areas of study and identifying emerging or neglected themes. The rationale for the use of meta-models arises out of a theoretical understanding that the main determinants of the nature of construction management research come from the multi-disciplinary background of its knowledge bases, the many organisational levels within the industry, the multiple stages through which construction projects move in their life-cycle, the professional differentiation that exists between parts of the sector and the distinctions within different types of research process.

The design of a meta-classification framework for the articles analysed has been the core issue of the study. Many classifications including the ones proposed by Betts and Lansley [1], Dickinson et al. [5] and Wolfe [6] were studied. The meta-classification framework adopted in this paper is based on independent classifications of the content, style and author background of the papers in many factors. The framework, the factors and their attributes examined are given in Table 1. The journal articles were analysed against this framework and categorized by one of the attributes of each factor.

Table 1 The meta-classification framework that the articles were analysed against

	Factors	**Attributes**
Content	**Research Stream**	Analysis of a Dispute Resolution (DR) Method Method Selection Models Factors Affecting DR Causes of Disputes DR Approaches Alternative Dispute Resolution (ADR) Policy Making
	Level of Analysis*	Global / Industry (Glo/Ind) National / Industry (Nat/Ind) Profession Group (Prof's Group) Firm/Organisation (Firm/Org) Project Professionals/Individuals (Prof's/Indiv's)
	Sector	Public (Pub) Private (Priv) General (Gen)
	Definition Dispute**	Yes (Y) or No (N)
Style	**Sources of Information***	Reviews Case Studies Empirical Data (Emp Data)
	Contribution of Article*	General Insights Statistical Results (Statistical Res) Model Building System Building
Author	**Author(s) Background****	Academic, Practitioner or Government (A, P or G) & Construction Related, Law Related (C or L)
	Author(s) Country	

** Adapted from Betts and Lansley [1]*

*** Adapted from Dickinson et al [2]*

The framework adopted in this study has three groups of dimensions, one concerned with content and the second style, following the proposal of Betts and Lansley [1] who imply these are the two principal means of characterizing research. The final dimension analysed is the author background to understand the contribution of researcher groups in the field.

In content dimension, the first factor examined is the research stream which defines the main subject of the article. This is an important means of gathering the body of knowledge in a discipline and determining the frequently published or neglected themes. The attributes for this content are analysis of a dispute resolution method, method selection models, factors affecting dispute resolution, causes of disputes, dispute resolution approaches, Alternative Dispute Resolution (ADR) and policy making. The second factor examined is level of analysis which determines the organisational level at which the research was done. Within the construction proper there are organisations that operate at different levels. The construction project is a dominant level for many but enterprises and national bodies are examples of other potential levels of application. The attributes are therefore determined as global/industry, national/industry, profession group, firm/organisation, project and professionals/individuals. The third factor examined is the sector at which the research was done. Although there are common attributes like building, housing, civil engineering etc in the literature for this factor, the attributes are determined as government, private and general in this study due to the characteristics of the discipline studied. The final factor of the content dimension is whether the article contains a definition for dispute or not, since defining the subjects and issues investigated by research provides precision and clarity in the discipline [5].

In style dimension of the meta-classification framework, the first factor is the sources of information of the articles which are the inputs of the research. The attributes for this factor are reviews, case studies and empirical data. The second is related to contribution of the article as the outputs of the research where the attributes are general insights, statistical results, model building and system building.

The final dimension is the author background where the articles are analysed against the attributes academician, practitioner, government, construction related and law related. The country where the research was undertaken was also noted to gain insight into levels of contribution from different countries. Beside analysing the articles against these eight factors that constitute the meta-classification framework, the relations between the factors were also examined in quest for providing a map of the discipline of dispute resolution in construction.

3. Analysis and Results

The results show the analysis of forty-two journal articles published on the subject of dispute resolution in construction in the chosen mainstream construction management journals between 1997 and 2006. Table 2 shows the number of articles from each journal according to their publication years analysed in the study.

Table 2 Publication years of the journal articles

Journals	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Construction Management and Economics	4		2	2		1			1	1	11
Journal of Professional Issues In Engineering Education and Practice							3	3	2	5	13
Journal of Management in Engineering				2			2	1			5
Journal of Construction Engineering and Management				1	1	1	2	1		4	10
International Journal of Project Management		1	1	1							3
Total	4	1	3	6	1	2	7	5	3	10	42

The distribution of the number of articles show that there is a continuous interest in the subject of dispute resolution in the mainstream construction management journals. The results do not show a general decrease or increase in the number of articles but rather a wave of rise and falls indicating that dispute resolution is a well-established sub-discipline in construction management.

The forty-two papers analysed involved 61 different authors from only 8 different countries. This analysis generates one of the most remarkable results showing that the research on dispute resolution in the construction industry is still undertaken by the authors from a very limited number of countries. The majority of the research in the field is done in the USA, the UK and Hong Kong.

Of the 42 papers, 12 were authored by single authors, 15 by two authors, 12 by three authors and 3 by four authors. Only 2 papers involved the collaboration of authors from different countries namely the UK and Hong Kong. This is another remarkable result showing that international collaboration is limited although benchmarking the practices and lessons learnt from cases prove very useful in advancing the discipline. Strengthening the relations between the researchers from different countries and backgrounds is needed to bring in new perspectives. The formation of the new task groups TG-67 Statutory Adjudication in Construction and TG-68 Construction Mediation by CIB Working Commission W113 on Law & Dispute Resolution is important in this regard as well, providing a platform for more vigorous international collaboration and a forum to facilitate exchange and synthesis of research internationally.

Results from the analysis of the journal articles against the meta-classification framework proposed are presented in Table 3. A discussion of the findings for each factor in content, style and author dimensions follows.

Table 3 Results from the analysis of the journal articles against the meta-classification framework proposed

	Content				Style		Author	
Author(s)	Research stream	Level of analysis	Sector	Definition of dispute	Sources of information	Contribution of the article	Author(s) background	Author(s) country
Aibinu (2006)	DR Approaches	Project	Gen	N	Case Study	General Insights	A & C	Singap.
Brooker & Lavers (1997)	ADR	Prof's Group	Gen	N	Emp Data	Statistical Res	A & C/L	UK
Brooker & Lavers (1999)	ADR	Prof's Group	Gen	N	Emp Data	Statistical Res	A & L	UK
Chan & Suen (2005)	DR Approaches	Nat/Ind	Gen	N	Emp Data	Statistical Res	A & C	HK
Chan & Tse (2003)	Causes of Disputes	Glo/Ind	Gen	N	Emp Data	Statistical Res	A & C	HK
Chan (1997)	Analysis of a DR Met	Nat/Ind	Gen	N	Reviews	General Insights	A & C	HK
Chan et al. (2006)	Meth Selection Mod	Glo/Ind	Gen	N	Emp Data	Model Building	A & C	HK
Cheeks (2003)	Analysis of a DR Met	Nat/Ind	Gen	N	Reviews	General Insights	A & L	USA
Cheung & Suen (2002)	Meth Selection Mod	Project	Gen	Y	Emp Data	Model Building	A & C	HK
Cheung & Yeung (1998)	Analysis of a DR Met	Nat/Ind	Pub	N	Emp Data	Statistical Res	A/P & C	HK
Cheung (1999)	ADR	Nat/Ind	Pub	N	Emp Data	Statistical Res	A & C	HK
Cheung et al. (2000)	Factors Affecting DR	Project	Gen	N	Emp Data	Model Building	A & C	HK & UK
Cheung et al. (2000)	Factors Affecting DR	Nat/Ind	Gen	N	Emp Data	Model Building	A & C	HK & UK
Cheung et al. (2002)	ADR	Nat/Ind	Gen	N	Emp Data	General Insights	A & C	HK
Cheung et al. (2004)	ADR	Nat/Ind	Gen	N	Emp Data	General Insights	A & C	HK
Cheung et al. (2004)	Analysis of a DR Met	Prof's Group	Gen	N	Emp Data	System Building	A & C	HK
Cheung et al. (2004)	Analysis of a DR Met	Glo/Ind	Gen	N	Reviews	System Building	A & C	HK
Cheung et al. (2006)	Analysis of a DR Met	Nat/Ind	Gen	N	Emp Data	Statistical Res	A & C	HK
Fenn et al. (1997)	Causes of Disputes	Nat/Ind	Gen	Y	Emp Data	Statistical Res	A/P & C/L	UK
Gebken & Gibson (2006)	Meth Selection Mod	Project	Gen	N	Emp Data	Statistical Res	A & C	USA
Harmon (2003)	Analysis of a DR Met	Nat/Ind	Gen	N	Reviews	General Insights	A & C	USA
Harmon (2003)	Analysis of a DR Met	Nat/Ind	Gen	N	Emp Data	Statistical Res	A & C	USA
Harmon (2004)	Analysis of a DR Met	Prof's Group	Gen	N	Reviews	General Insights	A & C	USA
Harmon (2006)	Analysis of a DR Met	Prof's Group	Gen	N	Reviews	General Insights	A & C	USA
Jannadia et al. (2000)	DR Approaches	Project	Priv	N	Emp Data	Statistical Res	A & C	S. Arabia
Kassab et al. (2006)	Meth Selection Mod	Glo/Ind	Gen	N	Case Study	Model Building	A & C	Canada
Kennedy (2006)	ADR	Nat/Ind	Gen	N	Emp Data	Statistical Res	A & C	UK
Loosemore (1999)	Analysis of a DR Met	Prof's/Indiv's	Gen	N	Case Study	General Insights	A & C	Australia
Loosemore et al. (2000)	DR Approaches	Firm/Org	Gen	N	Reviews	General Insights	A & C	Australia
Molenaar et al. (2000)	Causes of Disputes	Glo/Ind	Gen	N	Emp Data	Model Building	A & C	USA
Mitropoulo & Howell (2001)	Causes of Disputes	Project	Gen	N	Emp Data	Model Building	P & C	USA
Ndekugri & Russell (2005)	Analysis of a DR Met	Nat/Ind	Gen	N	Reviews	General Insights	A/P & C/L	UK
Ock & Han (2004)	DR Approaches	Firm/Org	Pub	N	Case Study	General Insights	A/G & C	Korea
Rubin & Quintas (2003)	Policy Making	Nat/Ind	Pub	N	Reviews	General Insights	P/G & C/L	USA
Seifert (2005)	Analysis of a DR Met	Glo/Ind	Gen	N	Reviews	General Insights	P & C	USA
Stein & Hiss (2003)	Analysis of a DR Met	Nat/Ind	Gen	N	Reviews	General Insights	P & L	USA
Stipanowich (1997)	DR Approaches	Nat/Ind	Gen	N	Reviews	General Insights	A & L	USA
Thompson et al. (2000)	Analysis of a DR Met	Nat/Ind	Gen	N	Reviews	General Insights	A/P & C/L	USA
Vallero & Vesilind (2006)	Analysis of a DR Met	Project	Gen	N	Case Study	General Insights	A & C	USA
Yates & Duran (2006)	Analysis of a DR Met	Project	Pub	N	Case Study	General Insights	A & C	USA

Yates & Epstein (2006)	Causes of Disputes	Nat/Ind	Gen	N	Reviews	General Insights	A/P & C	USA
Yiu et al. (2006)	Factors Affecting DR	Nat/Ind	Gen	N	Emp Data	Statistical Res	A & C	HK

3.1 Content

The first factor analysed in content section is research stream, which is the most diversified factor analysed in this study. In the meta-classification framework proposed, the attributes for this factor are defined as analysis of a dispute resolution method, method selection models, factors affecting dispute resolution, causes of disputes, dispute resolution approaches, Alternative Dispute Resolution (ADR) and policy making. As the results in Figure 1 reveal, a remarkable portion of construction dispute resolution research is most closely related to analysis of a dispute resolution method. The seventeen articles in this research stream involve the analysis of different ADR methods as well as the combination of various dispute resolution methods with organisational dispute prevention methods and tools developed with the aid of new technologies. It is remarkable that only two papers are about e-applications of these methods. The dispute resolution methods adopted by the statutory adjudication acts and standard forms of contracts such as FIDIC or NEC and their consequences are largely discussed as well. The contribution of the vast majority of research in this stream is general insights with the main source of information being the reviews and case studies. ADR and DR Approaches, each in six of the articles, are the following most frequent research streams. In ADR stream, the studies of the identification of key features of ADR (for ADR process design) and the studies on the current use of ADR constitute the main areas. The source of information is generally empirical data (mostly surveys) and the contribution of the articles are statistical results or general insights. Articles in the DR Approaches research stream generally deal with the behavioural aspects at the organizational level and trends at the national level. The rest of the attributes of research stream attracted less attention.

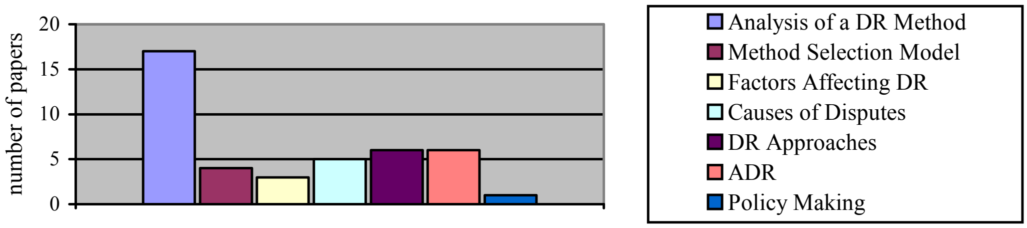

Figure 1: Articles by research stream

The attributes of the second factor, levels of analysis, were determined following the classification of Betts and Lansley [1]. At least one journal article was identified at each level of analysis in this review and national / industry level has received the most attention. This is possibly due to the unity of acts and regulations at a national level. The firm / organisation and professionals / individuals attributes received the least attention in which the research undertaken was about the dispute resolution approaches of organisations and individuals respectively.

In terms of sector, there is a lack of specific focus on public and private sectors. With the exception of a few authors, most do not make reference to their research concerning the sectors although the contexts are markedly different for dispute resolution in public and private construction sectors.

As for the last factor in the content dimension, articles were analysed for definitions of dispute. Although all journals analysed contained the word dispute in the title of the article or as an article keyword, only two of the articles actually define dispute. The failure of journal articles to clarify the content and dimensions of a subject does not assist comparing and generalising between studies [5]. More definitions are necessary especially for the resolution of the debate and frequent confusion concerning the definitions of conflict and dispute and moreover the debate concerning the scope of Alternative Dispute Resolution (ADR) methods.

3.2 Style

In the style dimension of the meta-classification framework, the articles were firstly analysed for their sources of information. The attributes were designated as empirical data, reviews and case studies for this factor. More than half of the articles used empirical data as their source of information. A variety of research techniques were used to collect data that include surveys, interviews and historical analysis. Case studies were classified as a separate attribute and six of the articles were determined as case studies. Fourteen articles, on the other hand, were classified as review-based articles. These review contributions demonstrate that non-empirical articles can offer value and indispensable insight to this research field.

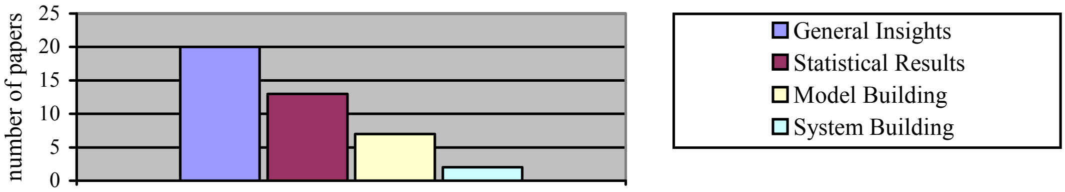

Figure 2: Articles by contribution

A further research aspect of the articles analysed was the contribution of the articles to the field (Figure 2). There were twenty articles offering general insights most of which were reviews, whereas thirteen articles offered statistical results arising from the empirical data used. One remarkable result is that there were only seven model building contributions and only two system building contributions among the articles analysed. The research stream in model building articles were diversified. The lack of model building articles might be explained by the difficulties associated with making generalisations in the field, however the existing examples show they prove valuable with the right techniques in advancing the knowledge base in the field. This way, the insight and results that have been collected in the field can be tested and organised to become more useful for the development of the theoretical base of the research field.

3.3 Author

The last dimension of the meta-classification model proposed is the author background. One of the most striking results reached in the analysis of the dispute resolution in construction literature is the publication dominance of academic authors. There are only four articles without any academic authorship. In addition, of forty-two articles, there are only six articles that include collaboration in authorship between academic and non-academic authors. Only two of these include authors from government which is consistent with the small number of public sector articles. However, dispute resolution is largely under the influence of government regulations and there is a need for more studies on pubic sector dispute resolution including collaboration of the authors from the government to derive benefits from the accumulated data and actually advance the public practices.

Another aspect of the author factor is the distinction between construction related and law related backgrounds. Out of forty-two articles, four involve authors with a law background and five with construction and law backgrounds in collaboration. This does not imply that authors with construction background do more research, but it is rather due to the peculiar design of this study that attempts to look at dispute resolution field from the perspective of construction management mainstream journals. However, it is clear that more collaboration between authors from different backgrounds would bring in different perspectives and contribute to the improvement of the research in the field.

4. Conclusion

The recent dispute resolution literature in construction management journals was analysed against a meta-classification framework proposed in this study. The articles in selected mainstream construction management journals published between 1997 and 2006 were searched with a keyword “dispute” in title and keywords section. In total, forty-two articles were analysed against several factors including research stream, level of analysis, sector, definition of dispute, sources of information, contribution of the article and author background. Due to the limitations of the paper, academic books, reports, conference papers and journal articles published prior to the specified ten year period were not included in the analysis.

Remarkable findings have been reached regarding some of the factors. First of all, nearly half of the construction dispute resolution research is most closely related to the analysis of a dispute resolution method as a research stream. The seventeen articles in this research stream involve the analysis of different ADR methods as well as the combination of various dispute resolution methods with organisational dispute prevention methods and tools developed with the aid of new technologies. In terms of level of analysis, national/industry has received the most attention in the literature analysed possibly due to the unity of acts and regulations at a national level. The identified shortcomings include the lack of specific focus on public and private sectors, the failure of most of the articles to define dispute, the lack of articles contributing to model building in the discipline, the limited practitioner and government employee authorship and the limited collaboration between academic and non-academic authors resulting in the publication dominance of academic authors. Future research directions are suggested in the study in order to address the identified shortcomings and improve the knowledge base in dispute resolution in construction field.

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Critical Factors for Insurance Premium Computation in Construction

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Abstract

Workers' compensation insurance is imperative for construction projects to safeguard the interests of workers and contractors. The commitment of insurers under this insurance is extremely broad. They must therefore accomplish rigorous risk and market assessments to decide optimal premiums. General insurers in Singapore have been experiencing detrimental loss-ratios in this business due to the lack of a proper framework that encompasses all the critical variables. The purpose of this study is to identify and explore the critical variables for premium-rating of construction workers' compensation insurance. An extensive literature review helped identify 17 variables that may influence premium rates. An interview questionnaire survey and subsequently a statistical analysis of the survey data were carried out to identify the critical variables. Eight variables were found significant for insurers for premium-rating including: wage roll, project hazards, project safety, contractor's claims history, insurer's overhead costs, insurer's corporate objectives, competition, and investment income from underwritten premiums. The findings of this study can be used by insurance companies in their risk assessment and premium-rating exercises.

Keywords: *Occupational injuries, Construction safety, Workers' compensation insurance, Premium, Singapore*

1. Introduction

Construction is one of the most dangerous and risky occupations. Insurance is a keystone to eliminate most of the financial threats in construction business [7]. Bunni [3] identified five types of insurance that are available for contractors for different risk nature: contractors' all risk insurance, general liability insurance, worker's compensation insurance, motor insurance , and marine transport insurance. Contractors' all risk insurance covers physical losses or damages to works, plant, equipment and materials during the course of construction that are resulted by crises such as natural disasters, fire/explosion or collapse. General liability insurance indemnifies the contractor in respect of legal liability for damages arising from death or injury to non-contracting entity or damage to non-contracting entity's property due to a project. For example, damage to adjacent property, injury to any third party due to an excavation work or damage to underground utilities may be indemnified under this insurance. According to the Workers' Compensation Act, cost of all the injuries/fatalities to workers resulting from construction activities should be borne by the contractor, irrespective of fault. Worker's compensation insurance (WCI) is purchased to transfer this financial risk to a professional insurer. Motor insurance provides liability coverage for over-the-road hazards for self-propelled motor vehicles used for the sole purpose of providing mobility to construction equipment such as pumps, cranes, air compressors, generators, etc. In international construction, marine transport insurance is required to protect from any losses resulting from ship crises when travelling by the sea.

Out of these five classes of insurance, the significance of the WCI in construction is overwhelming because the construction industry is well-known for poor safety performance globally. In Singapore, the construction industry accounted for 29% of the total number of industrial workers but accounted for 40% of worksite accidents [5]. Moreover, the latest analysis as of year 2006 on worksite accidents by the Ministry of Manpower, Singapore revealed that the construction industry recorded the highest accident frequency and injury severity rates among all the industries in Singapore [18]. Providing adequate WCI covers is therefore mandatory by the law of Singapore for employers to engage workers under a contract of service. It is enforced to safeguard the interests of occupational injury victims and to ease their employers' financial burden of compensating. On the other hand, insurance companies who issue the WCI for construction projects are forced to assume abundant financial risks. This implies that the construction WCI is a critical class of insurance in the whole portfolio of any insurer's business. Hence, the utilisation of an effective premium-rating technique is essential for insurers to perform rigorous risk assessments for construction WCI.

In the Singapore insurance industry, WCI premiums are traditionally computed by applying a rate on the wage roll of construction projects. There has been a collective agreement among general insurers that the preferable WCI premium rate for construction projects is 1% of the wage roll. This rate is merely a benchmark. Individual insurers set competitive rates around the benchmark considering other important variables. However, no strong theory supports this benchmark norm and therefore lacking of an effective framework for insurers to perform structured analyses on project risk and market factors. In the face of keen competition in Singapore's insurance market, underwriters tend to compromise the technical factors such as the risk profile of a project and the contractor's safety management system, due to the lack of a well-balanced framework. This brings about riskier projects that are being covered by insurers at lower premiums, which ultimately result in adverse loss ratios. Most of the general insurance companies in Singapore have been encountering undesirable loss-ratios in the construction WCI due to inadequate premiums; some have given up issuing the WCI altogether and a few other companies have bankrupted [13]. The industry statistics for year 2006 of the General Insurance Association of Singapore reinforced that the WCI is the third largest class of insurance in Singapore. It continued to struggle in 2005 with an underwriting loss of S$7 million in the first half of 2005 compared to the same period in 2004, when it lost S$1 million. The incurred loss-ratio has climbed from 72% to 80%. The WCI business has sustained poor underwriting results over the years. This is mainly due to unrealistic pricing, under declaration of wages by some companies as well as aggravated and fraudulent injury claims by some foreign workers [10]. Hence, there is an intense need for developing a new methodology for WCI premium-rating of construction projects. The prime task towards developing a new model is to identify the critical variables that influence WCI premiums for construction projects. Hence, the aim of this paper is to explore and critically analyse the variables pertinent to WCI premium-rating.

The paper is presented in various parts. Firstly, a general view of workers' compensation insurance is given followed by an account on the literature review findings on variables pertinent to WCI premium-rating. Then, the research method and the findings are described followed by a conclusion.

2. Background of WCI

During the industrial revolution, injured workers had to prove employers' negligence to recover medical expenses, lost wages and other damages caused by accidents. Employers had three primary defences for them to avoid liabilities for injuries. The first was the concept of *contributory negligence,* which prevented the employee from recovering any damage if he/she contributed to even in a small way to the cause of the accident. Another defence was the *fellow-servant doctrine.* If the injury resulted from contributory actions of fellow employees, the employer was not considered liable. The third defence was the *assumption of risk doctrine.* It could limit a worker's recovery of damages if he/she knew of the workplace hazard and assumed those risks by going to work [6].

Besides overcoming common law defences, injured workers faced other problems in filing lawsuits against the employer: (1) filing lawsuits often resulted in injured workers losing their jobs, (2) the lawsuits were expensive and time-consuming thus workers had difficulty finding lawyers to represent them, and (3) there was no guarantee that the employee would win the suit and collect damages [17]. Thus, injured workers received no compensation, lost the current job or faced difficulty finding other jobs due to disability. To overcome this unfair situation, the workers' compensation system was designed as a trade-off between employers and employees. The underlying principle behind the system is that the cost of on-the-job injuries, regardless of fault, should be borne by employers. In exchange, the injured workers forfeit the right to sue employers. The basic objectives of the workers' compensation are to: (1) provide sure, prompt and reasonable benefits to work accident victims or their dependents, (2) provide a single remedy and eliminate time-consuming and costly trials, (3) encourage maximum employer interest in safety and rehabilitation, and (4) promote frank study of accidents' causes and reducing preventable accidents [9].

According to Singapore's Workers' Compensation Act, the compensation to a victim can be as high as S$147, 000. Thus, all contractors are required by law to procure the WCI for all their projects to eliminate such financial burden in the event of any worksite injuries/fatalities. Failure to do so is an offence punishable with a fine of up to S$10,000, a jail term of up to 1 year or both [16]. Hence, the WCI is an integral part of the insurance business.

3. Premium-rating variables for construction WCI

In insurance, unlike other industries, the cost of the production is unknown when the contract is sold, and it will be unknown until the policy expires. Therefore, the pricing for insurance must be based on predictions of losses, expenses and incomes in future. Under the WCI, the commitment of an insurer is extremely broad; there are no exclusions, and there is no maximum limit on the insurer's liability [20]. Setting an appropriate cost for some future contingency of unpredictable timing, frequency and size requires the estimates of future claims, investment income, administrative expenses, profit and tax. In addition, the price can profoundly influence the volume of the business attracted [2]. Hence, WCI premium-rating is a critical management function for any insurer, which should decide premiums that are high enough to cover all the future costs, yet low enough to meet the market competition. The premium-rating is regarded as a two-stage process [2]:

1. The costing exercise – this is a scientific method that calculates the cost of future claims from the insured risks and all associated expenses.

2. The pricing exercise – this is a commercial adjustment to technical costs that considers broader corporate and market factors.

4. Predicting future claims in construction WCI

The scientific approach to determine the cost of future claims of a WCI policy entails an assessment of project and contractor related variables. Under the project-related variables, the following were identified by various authors:

- Worrall & Buttler [21] noted that the wage roll, project duration and the expected workers' compensation liability per wage roll unit need to be accounted for predicting claims.
- The Canadian Wood Council [4] reported that base rates are influenced by the: (1) location of the project, (2) type of construction, and (3) general industry experience on loss history for projects of similar type and location.
- Lott [15] added that an assessment of the workers' risk management programme will lead to an effective prediction of the costs to be incurred. This assessment should scrutinise the following aspects:
    1. Management commitment and employees participation in workers' risk control;
    2. Workplace hazards, population demographics and previous incident rates;
    3. Implementation of a pertinent risk/safety programmes; and
    4. Training of supervisors and workers.

As for the contractor-related variables, Groth [12] commented that WCI premium-rating must consider contractors' past claim history. Coble [8] noticed that the contractor's size has a bearing on premium rates. The Canadian Wood Council [4] suggested that insurers must consider the following variables:

1. Contractors' knowledge, experience and safety-consciousness;
2. Compliance with loss control and underwriting recommendations by the insurer;
3. Acceptance of deductible, that is, a retention of part of the claims cost by the contractor;
4. Potential future business; and
5. Placement of multiple policies with the same insurer.

5. Determining the mark-up for construction WCI

The adjustment of the technical costs of risks for commercial interests necessitates the consideration of insurers' corporate factors and market factors. The variables, pertinent to insurers, were recognised by many authors in the literature, viz:

- Vaughan [20] identified three variables that influence the mark-up:
    1. The expenses of acquiring and administering the business (overhead costs);
    2. The profit required by the insurer; and
    3. The return from the investment of premiums by the insurer.

- Young [22] quoted that premium-rates are adjusted on account of the profit/loss experience of the insurer in the past, and the outstanding claims to the insurer from all projects. The competition and the volume of business in the market also influence the mark-up.
- Booth [2] reported that corporate objectives of insurers will have a significant bearing on mark-ups.
- Phifer [19] observed that the reinsurance premium, which insurance companies pay for risk sharing with re-insurers do influence the pricing.

6. Research method

From the literature review above, 17 variables pertinent to WCI premium-rating of construction projects were identified and classified into four categories as shown in Table 1. Subsequently, a questionnaire was designed with the objective of determining the most significant variables. The questions in the questionnaire assessed the significance of the 17 variables for deriving the optimal premium rate on a 10-point Likert scale, whereby 1= “Low important” and 10= “High important”. The field survey was conducted during November and December 2005 in the Singapore insurance industry, which encompasses a population of 23 general insurers. An interview questionnaire survey was conducted to collect data because having a questionnaire administered face-to-face by an interviewer can attain higher response rates than mail surveys [1].

All the 23 companies were covered in the survey. At every interview session, the questionnaire was presented to the interviewee for his/her response. Additional explanations were rendered when needed. Moreover, interviewees were invited to elaborate on the rationale for their answers.

Table 1: Premium-rating variables

Variable category	Pertinent variable
1. Project factor	• Wage roll • Project duration • Project hazard level • Effectiveness of the safety management system on site
2. Contractor factor	• Contractor’s claims history • Placement of multiple policies by the contractor • Expectation of potential business from the contractor • Co-operation by the contractor • Contractor’s size
3. Insurer factor	• Corporate objectives of the insurer • Investment income from underwritten premiums • Overhead costs of insurance • Amount of outstanding claims to the insurer • Profit/loss experience in WCI business • Reinsurance cost
4. Market factor	• Competition • Volume of business in the market

7. Profile of the respondents

As shown in Figure 1, the designations of the interviewees were top management (48%) and middle management (52%). The top management interviewees comprised of managing directors, general managers, senior managers and managers. The middle management interviewees were assistant general managers, deputy managers and assistant managers. The mean working experience of the interviewees was 21 years. The minimum and maximum working experiences were 8 and 35 years, respectively. Also, more than 75% of the interviewees had experience of above 10 years. From the interviewees' profile, it is understood that all of them are well-qualified and well-experienced in the subject matter. Hence, the data collection is perceived to be reliable.

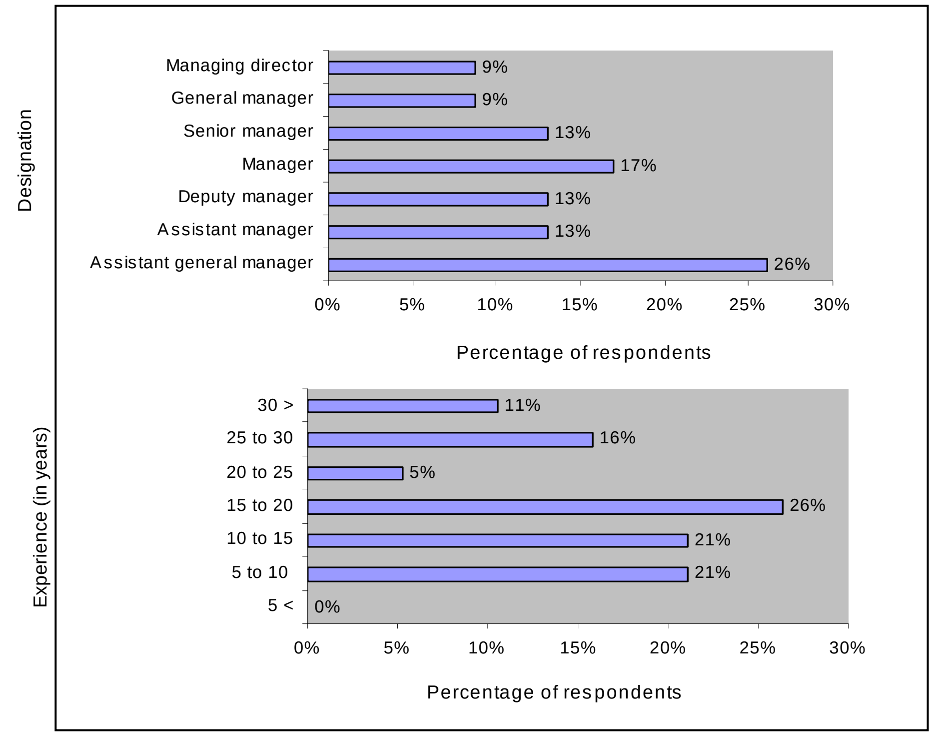

Figure 1. Profile of the respondents

8. Data analysis and discussion

A statistical analysis was accomplished to identify the most important variables according to the Pareto's 80/20 rule for WCI premium-rating. Descriptive statistics were computed for each category of variables as shown in Table 2. The 17 variables were re-organised, as illustrated in Table 3, into 3 groups namely, important variables, less important variables and unimportant variables, based on their mean importance ratings. Unimportant variables have mean importance ratings < 4.00, important variables possess mean importance ratings > 7.00, and the rest are less important variables. The above grouping notion was adapted from the medical industry of Singapore where Goh [11] proposed a pain scale, as shown in Figure 2a, to measure cancer pain intensity in patients. Based on that scale, the 9 equal intervals in the 10-point Likert scale were re-arranged into 3 equal intervals as illustrated in Figure 2b.

Table 2: Descriptive statistics of industry survey findings

Variables	Descriptive statistics							
	Mean	Standard deviation	Median	Mode	Kurtosis	Skewness	$X_{Min.}$	X_{Max}
Project factor								
• Wage roll	8.33	1.32	9	9	0.41	-0.81	5	10
• Project duration	5.10	3.10	6	3	-1.30	-0.12	0	10
• Project hazard level	9.33	0.71	9	10	-0.76	-0.63	8	10
• Effectiveness of the safety management system on site	7.67	2.17	8	8	3.67	-1.74	1	10
Contractor factor								
• Contractor's claims history	8.33	1.21	9	9	-1.18	-0.19	6	10
• Placement of multiple policies by the contractor	5.00	2.56	5	8	-0.66	-0.66	0	8
• Expectation of potential business from the contractor	3.76	2.60	4	0	-1.09	0.00	0	8
• Co-operation by the contractor	4.90	3.15	5	2	-1.34	0.01	0	10
• Contractor's size	3.38	2.92	3	0	-1.26	0.37	0	9
Insurer factor								
• Corporate objectives of the insurer	8.05	1.13	8	7	-0.80	0.32	6	10
• Investment income from underwritten premiums	7.24	1.23	7	8	-0.34	0.33	5	10
• Overhead costs of insurance	7.10	1.34	7	8	-1.22	-0.06	5	9
• Amount of outstanding claims to the insurer	6.62	2.15	7	7	0.14	-0.92	2	9
• Profit/loss experience in WCI business	6.76	2.51	7	10	-1.10	-0.34	2	10
• Reinsurance cost	6.71	1.91	7	9	0.05	-0.67	2	9
Market factor								
• Competition	7.38	1.68	7	7	-1.23	-0.14	5	10
• Volume of business in the market	4.52	2.52	5	6	-0.72	0.09	0	9

Table 3: Re-organisation of variables

Variables group	Pertinent variable
1. Important variables	• Wage roll • Project hazard level • Effectiveness of the safety management system on site

	• Contractor's claims history • Competition • Corporate objectives of the insurer • Overhead costs of insurance • Investment income from underwritten premiums
2. Less important variables	• Profit/loss experience in WCI business • Reinsurance cost • Amount of outstanding claims to the insurer • Project duration • Placement of multiple policies by the contractor • Co-operation by the contractor • Volume of business in the market
3. Unimportant variables	• Expectation of potential business from the contractor • Contractor's size

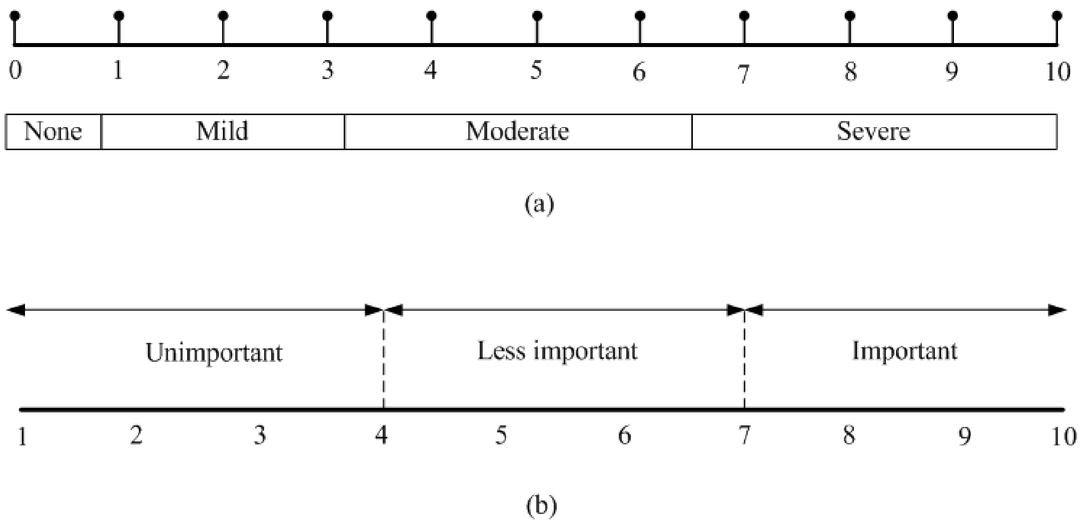

Figure 2: (a) Pain scale (Goh, 2004); (b) Intervals of rating

9. Important variables for premium-rating

Eight important variables for premium-rating were identified out of the 17 variables (See Table 3). A brief discussion on each variable is provided below, based on the qualitative explanation rendered by the interviewees.

1. Wage roll:

In the Singapore insurance industry, WCI premiums are traditionally computed by applying a rate on wage rolls of construction projects. There has been a collective agreement among the insurers that the preferable WCI premium rate for construction projects is 1% of the wage roll. This rate, however, is merely a benchmark. Individual insurers set competitive rates around the benchmark heuristically considering other important variables. The wage roll is also considered as a representation of the project duration since both are positively correlated.

On another perspective, when the wage roll is high, the premium amount is high though the premium rate is low. But, claims and administrative costs will be proportionately less, making it possible for insurers to earn more money by insuring bigger projects. Thus, large projects drive keen competition.

2. *Project hazard level:*

The project hazard is directly correlated with the frequency and severity accidents and thereby the amount of compensation to be paid by the insurer. Therefore, the higher the project hazard, the higher the premium rate. The project hazard has to be assessed in line with project's scope. The assessment should peruse if the project involves demolition works, explosive works, excavation works, works at heights, works involving lifting and cranes and/or confined space works. The hazard in each type of work has to be assessed via a rigorous analysis of relevant attributes. For example, the hazard in works at heights can be deduced by the total height of the building. Moreover, the characteristics of the project location/vicinity should also be assessed. Among the attributes to be scrutinized for project locality are: soil condition, site congestion level, and/or presence of any chemical/manufacturing factory or combustible source.

3. *Effectiveness of the safety management system on site:*

Presence of an effective safety management system on site is significant in reducing claims; thus, the better the safety management system, the lower the premium rate. All the insurers recognised that inspecting the safety management system of the project is essential in inferring potential claims. However, they encountered two constraints, viz:

- Lack of guidelines to assess the effectiveness of the safety management system; and
- Although a contractor can produce a well-documented safety plan for a project, its implementation on site is still uncertain as it is inherent to the attitude of the site management team.

4. *Contractor's claims history:*

Insurers examine a contractor's claims records for the past five years to deduce the contractor's safety performance as an alternative to assessing the safety management system. From the survey, it would appear that records with low severity and high frequency infuse higher premiums than records with high severity and low frequency.

5. *Competition:*

Triumphing competition is crucial in any business. A well-thought out strategy is necessary to assess the competition level by considering the number of competitors, regional economic condition, prestige in the project and the project size. This can subsequently be used to adjust the mark-up that the higher the competition the lower the mark-up.

6. *Corporate objectives of the insurer:*

The mark-up in a premium coheres with an insurer's corporate objective(s). The corporate objective of a Singapore's insurer at any given time can be one or more of the following:

i) Ensuring the survival of the company;

ii) To write a given premium volume;

iii) Achieving an overall operating ratio across the whole portfolio;

iv) Achieving an adequate level of profitability or return on equity; and

v) Achieving a target premium growth rate.

For objectives i to iii, an insurer may intentionally quote a low premium while for objectives iv and v, the same insurer may wish to quote an average premium.

7. Overhead costs of insurance:

Overhead costs are key components of a mark-up; the higher the overhead costs, the higher the mark-up. Overhead costs for the WCI includes brokerage fees and administrative costs for underwriting and claims management. The brokerage fee is a fixed percentage in the Singapore's market; 10% of the premium. Administrative costs vary from company to company, which are estimated to be in the range of 15% to 35 % of the underwritten premium. In total, overhead costs amount to 25% to 45% of the premium in Singapore.

8. Investment income from underwritten premiums:

The underwritten premium can be invested by the insurer on shares, subsidiary companies, real estate, etc. The returns on these investments influence the premium significantly. If the investment returns are high, the insurer can quote attractive premiums as the insurer's reserve is stable.

10. Less important variables for premium-rating

Seven variables seem less important for WCI premium-rating of construction projects.

1. Profit/loss experience in WCI business:

When an insurer experiences a remarkable profit/loss over a period of time, it is acceptable to adjust the premium rate for new undertakings. If there is a profit growth, the insurer may wish to reduce the premium so as to win more projects, as there is a buffer to assume the risk and to develop the business. In contrast, if the experience is bad, premiums for new projects could be increased with consideration of market trends because losing business is preferred to suffering from loss. However, such adjustments in the WCI's context are not encouraged by most of the Singapore insurers because profitable years will have to be balanced with less profitable years.

2. Reinsurance cost:

Reinsurance is the principal mechanism that insurance companies use to transfer part or all of the risks assumed through their own underwriting activities. The reasons for reinsuring are as follows:

- For balance sheet protection – reinsurance is purchased to protect the solvency of the insurance company.
- To increase the capacity – the risk exposure that an insurer can reasonably accept is restricted by the size of its capital base. Reinsurance allows taking larger risks, which makes the company more attractive to insurance brokers and their clients.

Risk of an insurer can be ceded to a re-insurer via facultative reinsurance and treaty reinsurance. Under the facultative arrangement, each risk is underwritten by the re-insurer on its own merits with a separate reinsurance contract. Under the treaty system, reinsurance is underwritten for a class of insurance, annually. The treaty reinsurance is further categorised into proportionate treaty and non-proportionate treaty. The subsets of the proportionate treaty are quota share reinsurance and surplus reinsurance while the subsets of the non-proportionate reinsurance are excess-of-loss (XOL) reinsurance and stop-loss reinsurance. The WCI in Singapore adopts the XOL treaty reinsurance.

A re-insurer decides the XOL treaty premium for an insurer based on the estimated premium income, loss-ratio, risk profile of the business covered and the excess point of the treaty. Insurers can decide upon attractive premiums for their policies, depending on their treaty premiums. However, reinsurance cost is usually less than 10% of the premium. Hence, it is not a major concern for premium-rating. Most of the companies incorporate the reinsurance cost into the overhead costs.

3. Amount of outstanding claims to the insurer:

When a particular class of insurance, like the WCI, experiences too many claims, the insurer prefers to increase the premium for new projects so as to recover losses. Nevertheless, market competition restrains such adjustments. On the other hand, decreasing the premium rate to attract more business for cash flow purposes is also unfeasible because the WCI is the riskiest insurance class in Singapore.

4. Project duration:

When the project duration is longer, the risk exposure of an insurer is longer and the earned premium, along with the net profit for the year, is reduced. Project duration is therefore a moderate consideration for some insurers in Singapore. However, the other insurers perceive that the duration is built into the wage roll; thus, it can be negligible for premium-rating.

5. Placement of multiple policies by the contractor:

When contractors take multiple policies for projects, discounts may be considered as the risks can be spread among policies. Contractor's all risk (CAR) insurance and the WCI are the main construction insurances. The WCI is ranked as the worse policy by insurers, which earns small premiums but large claims. Meanwhile, the CAR insurance has been contrary in this aspect. Mostly, the loss in the WCI is covered by the total premium from both policies. Most of the insurers prefer selling insurance packages rather than individual policies. Hence, the placement of multiple policies is more of a prerequisite than a discounting factor in Singapore.

6. Co-operation by the contractor:

The Singapore's construction industry is heavily reliant on foreign workers from neighbouring developing nations such as India, China, Bangladesh, Thailand and the Philippines. The objective of these workers is to earn money as fast as possible to return to their home countries for a comfortable life. There were incidents in Singapore whereby: (1) some of the injured workers chose to claim by common law to reap greater compensation and (2) some workers injured themselves or acted recklessly in order to claim compensation [14]. It is therefore important for insurers to scrutinise the root cause(s) of accident(s) and any fraudulent action(s) of workers to diminish their risks. Contractors' support is paramount in such situations, which could be a consideration in premium-rating. Nonetheless, it is a weak factor because there could still be claims although the contractor is supportive.

7. Volume of business in the market:

It is acceptable to increase premium rates when the construction industry undergoes an economic boom. Nonetheless, more insurers enter the market when the demand is high. This makes the Singapore's market constantly competitive.

11. Unimportant variables for premium-rating

Two insignificant variables for premium-rating are identified below.

1. Expectation of potential business from the contractor:

The expectation of potential business from contractors are irrelevant for premium-rating because construction projects are secured through competitive-bidding, thus the prediction of potential projects for contractors is difficult

2. Contractor's size:

Large contractors with good safety records demonstrate their capacity to use sophisticated and less hazardous construction methods. It is therefore beneficial for insurers to favour large contractors. However, all main contractors employ subcontractors. Thus, subcontractors' experience, operation methods and records become key factors. As per insurers' experience, reported accidents mostly involved subcontractors' workers whereby the main contractor provided the WCI.

12. Conclusion

Providing an adequate WCI is mandatory for a Singapore contractor to employ workers in construction projects. It is enforced to safeguard the interests of occupational injury victims and to ease contractors' financial burden of compensating. Under the WCI, the commitment of an insurer is extremely broad unlike other classes of insurance; there are no exclusions and there is no maximum limit on the insurer's liability. Hence, WCI premium-rating is a critical management function for any insurer who should decide premiums that are high enough to cover all the future costs, yet low enough to meet the market competition. Nevertheless, general insurers in Singapore seem to be reluctant to issue the WCI for construction projects as they have been experiencing undesirable loss-ratios. These losses occurred mainly due to underestimating of potential risks in construction projects. This is, in turn, the result of the ineffectiveness of the premium-rating framework as used by the general insurance industry in Singapore. Hence, an effective WCI premium-rating framework is imperative for Singapore insurers to address this dilemma. Identification of the critical variables for such a framework is crucial and fundamental.

Seventeen variables pertinent to WCI premium-rating for construction projects were identified in a literature review. An interview questionnaire survey was conducted in the Singapore general insurance industry to identify the most significant variables that fit in the Pareto's 80/20 rule. Statistical analyses results of the survey data indicate that eight variables are important for WCI premium-rating: (1) wage roll, (2) project hazard level, (3) effectiveness of the safety management system on site, (4) contractor's claims history, (5) overhead costs of insurance, (6) competition, (7) corporate objectives of the insurer, and (8) investment income from underwritten premiums. The finding may be utilised by insurance companies in Singapore to re-engineer their premium-rating approach. The study may be extended to develop a premium-rating model for workers' compensation insurance incorporating these significant variables.

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Contracting in Good Faith – Giving the Parties What They Want

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Abstract

Examines the duty of good faith as an express obligation contained in the newer standard forms of construction contracts. Describes good faith provisions in other jurisdictions and the seeming hostility of the English judiciary. Discusses the benefits that might arise from "concretising" the duty of good faith in English law and encourages developments in this area.

Keywords: Good faith, Construction contracts, Standard form contracts, contractual innovation.

1. Introduction

Partnering promotes a co-operative approach to contract management with a view to improving performance and reducing disputes. The relationship between a contractor and a client in a partnering contract contains firm elements of trust and reliance. In so far as partnering is delivered through the medium of contracts, those contracts more often than not contain an obligation that the parties act in good faith to facilitate delivery of those aims.

Partnering contracts pose a problem for contract advisors containing as they do "hard" and "soft" obligations. Whilst all conditions of contract are equal, some, to misquote George Orwell, are more equal than others. Clients can be advised and terms drafted stipulating hard obligations such as payment and quality standards. But what of the soft obligations – and in particular the duty of good faith – what are we to make of them? As one leading commentator put it:

We in England find it difficult to adopt a general concept of good faith…we do not know quite what it means." [1]

The resulting situation is that "soft" obligations are often overlooked and not given any particular importance. This sentiment was picked up by a report expressing the consensus of construction lawyers as being that duties of good faith are not likely to be newly recognised in law by reason of their introduction into partnering contracts.[2]

This consensus of opinion invites the question whether this is what the users of construction contracts want. Parties having taken the trouble of entering into a partnering contract may feel disappointed to learn that their voluntarily assumed mutual obligations are not enforceable. This paper seeks to open a discussion around this point and recommends the "concretising" of the duty of good faith by judiciary and/or parliament to deliver what the parties have chosen for themselves.

2. The Newer Contract Forms

By far and away the most popular forms of contract are those which make no mention of partnering obligations.3 The dominance of the JCT lump sum and design and build forms remains intact. However, the growing trend is to use contracts which move away from formal legal "black letter" contracts to contracts fulfilling a different role which includes seeing the contract as a management tool and a stimulus for collaboration. The challenge for these newer contract forms is to capture this new role whilst providing sufficient contractual certainty in the event that disputes arise.

The link between contracts, partnering and good faith was initially made by organisations such as Associated General Contractors of America making statements such as:

"Partnering is recognition that every contract includes an implied covenant of good faith." [4]

These connections are relatively straightforward in the United States, a legal system that recognises the duty of good faith in contracting. The principles of partnering are congruent with the doctrine; trust, open communication, shared objectives and keeping disputes to a minimum. Making the connections in the English context is more challenging given the absence of the general duty of good faith. In its absence it is the partnering contracts themselves which fill the gap.

In the thirteen years since the Latham Report partnering contracts have become significantly more sophisticated in terms of the wording of partnering obligations and the conduct expected. The duty to act in good faith is a common thread.

There are variations on the exact imposition of the duty to act in good faith in partnering contracts. A distinction can be drawn between those which are intended to regulate the parties' behaviour through the contractual terms and conditions (binding) and those which place a non-contractual partnering framework over the top of another contract (non-binding). The latter have been described as seeking to influence rather than mandate certain behaviour [5].

The parties to the JCT Non-Binding Partnering Charter agree to "act in good faith; in an open and trusting manner, in a co-operative way in a way to avoid disputes by adopting a no blame culture". The binding multi-party PPC 2000 requires that the parties "agree to work together and individually in the spirit of trust, fairness and mutual co-operation". The NEC x12 Partnering Option calls the parties "partners", and requires that partnering team members shall "work together to achieve each other's objectives."

The latest contract to enter the fray is the JCT Be Collaborative Constructing Excellence Form. The contract goes further than the other partnering contracts in introducing an over-riding principle which includes a duty of good faith and stipulates that this principle takes precedence over all other terms.

This contract completes the transition of good faith-type provisions from being somewhere on the under-card of contractual terms to being the main event. A significant proportion of the standard forms of contracts now available to the construction industry expressly impose an increasingly onerous duty on the parties to act in good faith. This paper will briefly review the history of the duty of good faith before examining the reasons why the consensus of rejection of the legal significance of this development exists.

3. The Duty of Good Faith

The attraction for contract draftsmen to use the phrase "the parties owe each other a duty of good faith" is understandable. The phrase resonates with the reader who has an instinctive grasp of what it is the contract is trying to do. This resonance is, due in part, to the long history and high esteem in which the duty is steeped.

The concept of good faith has great normative appeal. It is the aspiration of every mature legal system to be able to do justice and do it according to law[6]. The duty of good faith is a means of delivery.

Good faith has an ancient philosophical lineage and is referred to in the writings of Aristotle and Aquinas[7] . They were concerned with the problems of buying/selling and faced the dilemma of how to achieve fairness while not stifling enterprise in commerce. This dilemma is still an issue today and its successful resolution is a major challenge for those seeking to (re-) establish a duty of good faith.

The ancient concept of good faith in a revived form went around Europe, England and United States like wildfire at the end of the 18th century. Lord Mansfield described the principle of good faith in 1766 as the governing principle applicable to all contracts and dealings[8].

The duty of good faith subsequently fell into disuse in England in favour of encroaching statute law and the emphasis on the promotion of trade. Emphasis shifted onto contractual certainty in contracting instead [9]. Contractual certainty has remained the cornerstone of standard form construction contracts since their inception at the start of the 20^{th} century. Procurement and contracting in the 21^{st} century however is different. The role of the contract is changing and the re-emergence of the duty of good faith is an important element in this development. The advantages of recognising the legal enforceability of the duty have been presented as [10]:

- Safeguarding the expectations of contracting parties by respecting and promoting the spirit of their agreement instead of insisting upon the observance of the literal wording of the contract
- Regulating self-interested dealings
- Reducing costs and promoting economic efficiency
- Filling unforeseen contractual gaps
- Providing a sound theoretical basis to unite what would otherwise appear to be merely a series of disparate rights and obligations

The support for introducing the duty of good faith amongst industry commentators has not to date been overwhelming. Academic studies in this area tend towards mild encouragement for the judiciary or parliament to take action and introduce a general duty [11]:

Making the case for the imposition of a general duty of good faith is as challenging as attempting a definition. Despite its beguiling simplicity it has proved to be an elusive term. The attempts to define good faith at best replace it with equally vague and nebulous terms. The danger, as one commentator put it, is that any definition would "either spiral into the charybdis of vacuous generality or collide with the scylla of restrictive specificity" [12].

The difficulty of defining "good faith" is not necessarily a problem for partnering contracts which tend to evoke the spirit rather than the letter of the law. However, progress has been made in defining the term, particularly by the Australian judiciary. The parallels here are striking – a common law jurisdiction grappling with the issue of how best to "concretise" the duty of good faith.

The Australian Judge Paul Finn made the following useful contribution towards definition in the common law tradition:

"good faith occupies the middle ground between the principle of unconscionability and fiduciary obligations. Good faith, while permitting a party to act self-interestedly nonetheless qualifies this by positively requiring that party, in his decision and action, to have regard to the legitimate interests therein of the other." [13]

Thus far the English Courts have denied themselves the opportunity to engage in this shaping of the meaning of good faith in the modern construction context despite its historical relevance, its resonance with the public and even in light of other recent stimuli to its introduction.

4. Other Stimuli towards Introduction of a Duty of Good Faith

As mentioned above, English law made a choice to promote trade through contractual certainty rather than through widely drawn concepts. In Europe the duty of good faith has flourished to the extent that its existence of otherwise in contract law is one of the major divisions between the Civilian and Common Law systems[14]. The great continental civil codes all contain some explicit provision to the effect that contracts must be performed and interpreted in accordance with the requirements of good faith. For example, article 1134 of the French Code Civil and Section 242 of the German Code.

In France, the rather vague concept of good faith or “bonne foi” has been given clarity and definition by judicial decisions, which cumulatively have produced a number of “rules” relating to the performance of contractual obligations and, possibly more importantly, to the obligations of parties before a formal contractual relationship is entered into. For example, good faith is the legal basis for the rules relating to the French doctrine of abuse of rights (l’abus de droit). This is where the court adds a further qualification to the specific express contractual obligations to prevent the purpose of the contract being thwarted by a manifestly unfair attempt to rely on a contractual right.

The development of the doctrine in France has also been determined by the nature of the contract being considered. The courts have developed different types of duties based on the general obligation of good faith that are specific to certain categories of contract. In the context of engineering and construction contracts, there is authority that the developer must provide all relevant data that are necessary to the proper completion of the project by the engineer.

German law has adopted a even more positive approach to the doctrine of good faith than the French. Good faith creates positive extra-contractual obligations and is used as a justification to facilitate performance of the contract. The doctrine is contained in sections 157 and 242 of the German civil code, the Burgerliches Gesetsbuch, which provides that:

S157 – Contracts shall be interpreted according to the requirements of good faith

S242 - The debtor is bound to perform according to the requirements of good faith

The wider statutory basis extending the application of the doctrine from performance to the definition of contractual obligations which explains the different approach of the German Courts, which has been used to create a positive duty of co-operation from one party to the other. For example, in one case where German long-term contracts were adversely affected by inflation after the First World War, it was held that the principle of good faith allowed the judge to re-allocate contractually agreed risk pursuant to section 157.

In summary of this point, the experience in France and Germany has been that that through the duty of good faith the German and Court have had the freedom to develop its doctrines without incurring the reproach of pure judicial decision law making. This has enabled the identification and solution of problems which the existing rules do not or seem unable to reach. Whether or not either of these models could be successfully adopted in England and Wales is not a question that can be easily answered. A “bolting on” by domestic law makers of a French or German type duty is extremely unlikely step in any event. The move contemplated by this paper is much more modest in scope: where the parties have expressly contracted in good faith there ought to be a detectable legal meaning to give some weight to their undertaking.

It is unsurprising, given the establishment of the good faith doctrine into continental legal systems, to discover the duty is enshrined within European law. For example, the Unfair Terms in Consumer Contracts Directive 1993 may strike down consumer contract if they are contrary to the requirements of good faith. The Commercial Agents Directive 1986 also makes reference to good faith.

Moves towards the harmonisation of European Contract law by the European Contract Commission stopped short of outright commitment to the duty of good faith but did state that regard is to be had to the observance of good faith in international trade.

Neither is good faith a concept unknown to English Law. The obvious example is in insurance contracts which are subject to a duty of utmost good faith owed by the assured to disclose material facts and refrain from making untrue statements while negotiating the contract.[15]

The duty of good faith is also apparent in areas of law where there is a special relationship such as family arrangements and partnerships.

A pattern is discernible towards the re-emergence of the duty of good faith in English law. Despite this encroachment (or possibly because of it) suspicion and hostility abound, in the words of one commentator *“(the duty of good faith) is a vague concept of fairness which makes judicial decisions unpredictable.”[16]*

Another argument against the imposition of a general duty of good faith is the preference given to ad hoc solutions in response to demonstrated problems of unfairness. In other words, good faith outcomes are already being achieved through other means. Examples of these outcomes have been given [17] as the contractor’s duty to progress the works regularly and diligently and the Employer’s duty not to obstruct and to co-operate. However, ad hoc solutions can lead to unsatisfactory results. Contract draftsmen have given the judiciary a unique opportunity to create new law based around the key concept of good faith. This paper now examines judicial attitudes in this area.

5. Judicial Hostility?

The grounds for the seeming hostility (with one notable of exception) of the judiciary to the concept of good faith has already been stated – suspicion of broad concepts. The approach is, to paraphrase Lord Bingham in Interfoto Picture Library v Stilleto Visual Programme Ltd [18] to avoid any commitment to over-riding principle in favour of piecemeal solutions in response to demonstrated problems of unfairness.

The judgment of Lord Ackner in the case of Walford v Miles [19] sums up the prevailing sentiment: "the duty to carry on negotiations in good faith is inherently repugnant to the adversarial position of the parties involved….how is the court to police such an "agreement?"

From time to time the courts have, at least, entertained submissions about the more general application for the duty of good faith [20]. A trilogy of cases [21]in the Court of Appeal suggested a move towards a more general principle. Lord Bingham was at the time dropping heavy hints such as: "we would, were it material, imply a term that [x] should act in good faith in the performance of this contract. But it is not material." In the second case "the court would then have wished to consider whether it was not subject to a duty of good faith substantially more demanding than that customarily recognised in English Contract Law". In the third "I am for my part by no means sure that the classical approach to the implication of terms is appropriate here".

The impact of these judgments on the Technology and Construction Court appears to have been minimal. The initiative towards the introduction of a general duty of good faith has not found support here. His Honour Judge Lloyd Q.C. in the case of Francois Abballe (t/a GFA) v Alstom UK Limited [22] "the proposition that "good faith" may be used as a fall back device tellingly shows why it is wrong but tempting to consider with the advantage of hindsight whether a term should be implied. I do not consider I should be a hero and permit the Claimant to advance this term."

The door seemed to be more firmly closed on the introduction of a general duty of good faith by His Honour Judge Seymour "the development of the law in the direction anticipated by Sir Thomas Bingham would, it seems to me, be fraught with difficulty….. I should not be prepared to venture into these treacherous waters…" [23]

There has only been one case where a specific duty to act collaboratively has been considered by the judiciary. The case of Birse Construction Limited v St David Limited [24] has been poured over in great detail in other articles. For the purposes of this paper the relevant considerations of the case are that a) it features a non-binding partnering charter and b) the Judge specifically highlighted that the parties had entered into a partnering arrangement.

His Honour Judge Humphrey Lloyd recognised that the terms of the partnering charter were important in providing the standards of conduct of the parties. Although such terms may not have been otherwise legally binding, the charter was taken seriously as a declaration of assurance. In short, the parties were not allowed to interpret their relationship in a manner which would have been inconsistent with their stated intention to deal with each other collaboratively.

It is possible to discern support from this judgment for the parties' expressed desire to operate in good faith in their dealings with one another. This support fulfils the role of meeting the expectations of the contract users. Increasing numbers of contract draftsmen have been bold enough to include good faith provisions in their contracts. The contracts have been welcomed by their users. If they find themselves into difficulties then the users have a reasonable expectation to be bound by their promises to one another. The challenge for the judiciary is to decide on the appropriate level of support to be given to the more prescriptive and onerous terms of contract now employed in the latest construction contracts.

6. How best to deliver what the parties want?

It is beyond the aims of this paper to provide a blue-print for how a general duty of good faith might operate. One commentator has pointed out that if good faith is to be of any practical utility it needs to provide a few clearly understandable action-guiding principles of conduct [25]. The small print solution of listing every possible potential misconduct on the part of any party is not suitable given the complexity of construction contracts and the move away from voluminous forms. One approach would be to allow the judge/arbitrator/adjudicator a wide discretion so that they might "concretise" the duty in line with the principles of conduct as they see fit or in line with experiences in other jurisdictions.

Good faith in negotiations could mean an inquiry into the reasons for breaking off negotiations. Examples of bad faith might include negotiating without serious intention to contract, non-disclosure of known defects, abusing superior bargaining position, arbitrarily disputing facts and adopting weaselling interpretations of contracts and willingly failing to mitigate your own and other parties' losses and abusing a privilege to terminate contractual arrangements.

The effect of the court recognising the duty of good faith as a hard obligation has been likened to recognising the general duty of care in negligence or the principle of undue enrichment [26]. As a result the principle may remain relatively latent or continue to be stated in extremely general terms without doing too much damage to the important virtues of certainty and predictability in the law. The principle could also provide a basis on which existing rules can be criticised and reformed.

The alternative way of introducing a duty of good faith is to set down guidelines in a statute. A statutory obligation to act in good faith was recommended by Latham as a measure which would lead to the improvement of the performance of the construction industry. The government of the time chose not to move in this direction. The time may have come to revisit this decision.

7. Conclusion

Good faith has been described as "repugnant to the adversarial position of the parties". The duty is surely not so repugnant to an industry currently characterised and actively pursuing an agenda not of adversarial relations but of collaboration.

The industry would benefit from some clear messages from the judiciary as to the enforceability of their collaborative arrangements. The positive stance taken in the Birse v St David case is encouraging in terms of direction but further concretising of the exact meaning of such obligations on the particular facts of any case would be helpful. Re-ordering the structure of construction contracts by introducing the sound theoretical basis presented by the duty of good faith is an achievable and laudable aim. The expression of this underlying principle with its uncluttered simplicity may serve to bring clarity to the dense contractual conditions for which the industry is renowned.

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10 See n.6,supra

11 "awaiting developments through the common law is likely to be slow; the time for appropriate legislation may now have come" M. Miner, (2004) Construction Law 15(2), 20-22

"future explicit recognition of the concept (of good faith) is not inconceivable and would appear to demand only a re-definition rather than a sea change in judicial analysis." B. Colledge, (1999) 15(3) Const L.J. 288-299

12 See n.5, supra

13 P D Finn, "The fiduciary principle", in T G Youdan (ed), *Equity, Fiduciaries and Trusts* (Toronto, Calgary, Vancover, 1989) 1, at p.4

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21 Philips Electronic Grand Public SA v BSB [1995] EMLR 472; Balfour Beatty v DLR [1996] 78 BLR 42; Timeload Limited v British Telecom [1995] EMLR 459.

22 LTL 7.8.00 [TCC]

23 Hadley Design Associates v Lord Mayor and Citizens of the City of Westminster [2003] EWHC 1617 [TCC]

24 [1999] BLR 194

25 See n.7, supra

26 See n.14, supra

The optimization of regulations that guarantee housing quality

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Abstract

All countries have sets of public building regulations to guarantee a minimum technical quality of buildings. Major goals are safety, health, energy saving, practicability and environmental aspects. To assure that the regulations are met enforcement regulations like permit procedures are laid down in laws. Tasks and responsibilities for building control bodies and other actors in the building process are defined. The reasons to set up national regulations vary per subject and change in the course of time because of societal changes and a changing view of the role of government. The goals and approaches in most countries are similar on the headlines. A closer look at the way things are worked out shows a broad spectrum of differences. There is some influence of the European union, e.g. the European Construction Products Directive, the Euro Codes and the European Performance of Buildings Directive. In the Netherlands there is an ongoing debate about the minimization of the administrative burden caused by regulations at one hand, and the improvement of the enforcement at the other hand. Also in other countries like England and Germany discussions are going on about the building regulations. Environmental aspects like energy conservation are dominating the policy agenda; this might request an innovation of the role of building regulations. Part of the discussion is the form the regulations take. This paper presents some societal developments and examples that influence the way one can look to the role of the government in safeguarding a minimum quality of houses. This is illustrated with examples of the systems of building regulations and building control of various European countries based on the outcome of ongoing international comparative research.

Keywords: Building regulations, Europe, Technical requirements Deregulation, Privatization.

1. Introduction

The protection of safety and health was the primary reason for governments to draw up technical regulations for the built environment. In the course of time other goals, such as utility, accessibility and energy saving have come to play a part. Although the necessity of some set of public building regulations is undisputable, in the Netherlands, as well as in other countries, the scope, level and system are a constant subject of discussion since there is a permanent urge for deregulation. The administrative burden for all parties in the building sector caused by building regulations is the reason for a constant process of minimization and optimization of the building regulations in a way that they facilitate an effective and efficient building process. A reference to the scope, level and organisation of the building regulations in other countries is considered to provide a good basis for this process.

The OTB Research Institute for Housing, Urban and Mobility Studies undertakes comparative studies of systems of building regulations since the mid nineteen-nineteen's. A few years ago we finished a study commissioned by the Dutch Ministry of Housing, Physical Planning and Environment. It was a comparative study of the building regulations in eight European countries focussed on technical requirements for dwellings and the systems of building control. The project resulted in two publications Meijer et all [1] and Sheridan et all [2]. Recently we have started a new initiative to collect information of the systems of building regulations in all European countries. In another project the systems of enforcement of building regulations in Australia and Canada are investigated. The projects generate much insight that contributes to the ongoing policy debate about the urge for deregulation on the one hand and on the other hand a rising sense of necessity of a proper functioning system of building regulations and building control. Recently the Dutch government has launched a project in which it wants to fundamentally reconsider the system of regulations. It fact it is considered to be a "green field study". There is a strong feeling in Dutch politics that the whole system is too complex, too detailed and goes far beyond what should be the core of government responsibility. One thinks that the optimization of the current system would only lead to minor improvements. Therefore it is considered that one should start from scratch again: first develop a vision on the way the government should interfere in the building process. When that is clear a new system can be build. It seems that the vision on the role of the government is clear yet. The government sets up the framework of the regulations and wants to hand over responsibilities and tasks for the implementation and control to the private parties. The government is responsible for the system and the private parties are responsible for the quality of building. It is unknown yet what this means for the further transformation of the system. In this paper we take this dilemma as a starting point. We use the characteristics of the current system with its pro's and con's in combination with examples of other countries and some societal developments to create some basic elements for a terms of reference for a future system of building regulations. In section 2 we go into the societal circumstances that define the need of building regulations. Section 3 deals with the systems of formulations of the technical regulations. In section 4 the organization of building control and the ways tasks and responsibilities are divided over parties in the building process is worked out. In section 5 we discuss the basic elements of a system of building regulations.

2. Reasons and goals for building regulations and building control

The Dutch Building Decree has the following mayor goals: safety, health, practicability, energy saving and environmental protection. This last goal however has not yet resulted in concrete regulations (it is still an empty chapter), although it has already been introduced in the Housing Law several years ago. In Sheridan et all [2] we compared the starting points (goals) and the subjects that were covered by the building regulations in eight European countries. The conclusion was that there are many similarities in de European countries in the mayor goals and subjects that are covered. However the formulations and the level of detail vary quite a lot. This makes it also difficult to be quite sure about the exact scope of the regulations in the various countries. Structural safety and fire safety are the most basic requirements and are well covered in regulations in all countries. For these regulations it is also most likely that there might be some convergence of the regulations within Europe. The development of the Euro Codes, containing calculation methods will contribute to this development.

1. DEFINITIONS 2. SAFETY - Structure - Moving in and around the building (Floor guarding, Staircase, Ramp) - Power supply (Electricity, Gas, Lighting) - Fire safety (Fire and Smoke development, Escape) - Burglary safety 3. HEALTH - Sound (From outside, installations, between rooms) - Moisture - Discharge of water - Ventilation - Harmful materials, substances and radiation - Harmful small animals - Water supply - Daylight	4. PRACTICABILITY - Dimensions of corridors and rooms (Accessibility for wheelchairs to the building, Minimum dimensions Door openings, length and width of living room and sleeping rooms, Minimum ceiling height) - Dimensions of toilet and bathroom - Kitchen (Sink unit and cooking appliance installation place, Dimensions of cooking place) - Other rooms and spaces (storage room for bicycles, Garden or balcony, places for services) 5. ENERGY SAVING - Thermal insulation - Reduction of air permeability - Energy performance 6. ENVIRONMENT (sustainability) (empty)

Fig 1 Main subjects of the Dutch Building Decree 2003

The public debate in the Netherlands about the burden caused by building regulations always starts with the proposal to eliminate regulations from the Building Decree. In fact the existences of more or fewer of these technical requirements have little influence on the whole of administrative procedures, processing time and costs. The planning regulations are much more dominating the process. It must be said that the politicians that are responsible for this, seem not always be informed well enough. Within the scope of regulations the subjects regulated under ‘practicability’ are more and more considered not to belong to the core of government responsibility. Developers would be smart enough to have dwellings designed and build that meet the preferences of buyers or tenants. In fact the housing market is far from perfect yet. The shortages in the stock and the big distance between the user (the occupant) and the developer of a house frustrate this. In 2003 the requirement for a balcony (for apartments) and a storage room for bicycles were removed from the Building Decree. It was thought that developers would realise these elements anyway. It turned out to be quite different. In 2007 the mayors of the four largest Dutch cities wrote a letter to the minister to ask for a reintroduction of these regulations.

In their cities quite large shares of the new developed housing stock do not have balconies nor storage rooms for bikes. These flats are not really wanted (even on a tight market).

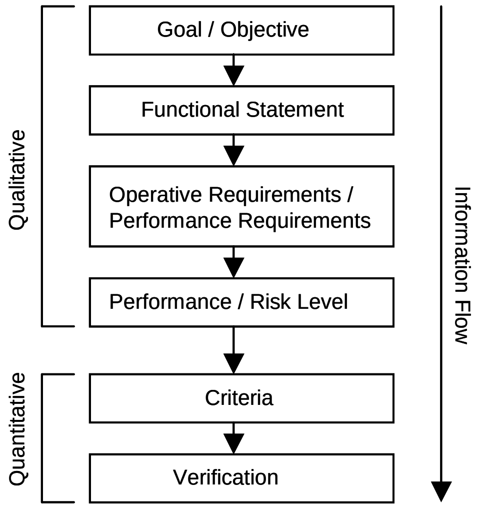
In 2007 the Building Decree existed 15 years. During a conference many representatives of Building Decree discussed about the pro's and con's of the current regulations. One quite clear conclusion could be drawn from the debate: no one wants to eliminate more requirements from the Building Decree. Even developers, builders and home owners are in favour of a good functioning national system of building regulations. When elements are removed from the regulations at national level there is a 'danger' that pseudo regulations are going to be developed at local levels or that some quality topics have to be defined at project basis. Public building regulations in fact serve a series of goals of which the guarantee basic qualities for its users is only one. Also the rights of third parties (e.g. fire safety for neighbours) and the contribution to societal goals at a much higher level (e.g. the reduction of CO2 emissions) have to be covered by the regulations. Houses have a much longer life span than its first users. It is a responsibility of a government that for economical and environmental (use of materials) reasons, new build houses have basic qualities that are contribute to the possibilities of a long life span (future value). Furthermore the national regulations provide equal legal rights to developers. Common used definitions and calculation methods facilitate communication in the building process. A growing concern of the contribution of the building stock to environmental pollution (energy use, CO2 emission, use of scare materials and many more environmental parameters) will lead to more regulations in next years. So if it is not likely or desirable to narrow the scope of the regulations, then what is the key to deregulation? In section 3 we look to the system of formulation of the regulations and in section 4 to the organisation of building control.

3. Systems of formulation of technical building regulations

The formulation of technical requirements has been discussed for many years. For instance, the Building Research Station of the Department of the Environment in England conducted comparative analyses of building control from 1969-74 [3] [4] [5] [6]. The move away from prescriptive specifications towards functional requirements started over 40 years ago, offering a clear explanation of specifications, functional requirements, and performance standards, together with the use of deemed-to-satisfy clauses, codes of practice, the system of agréements, and information for guidance. In 1978 the Nordic Committee on Building Regulations developed a five-level model of technical requirements [7]. Almost 20 years later, Bowen compared this with the structure of the first version of the Dutch Building Decree [8].

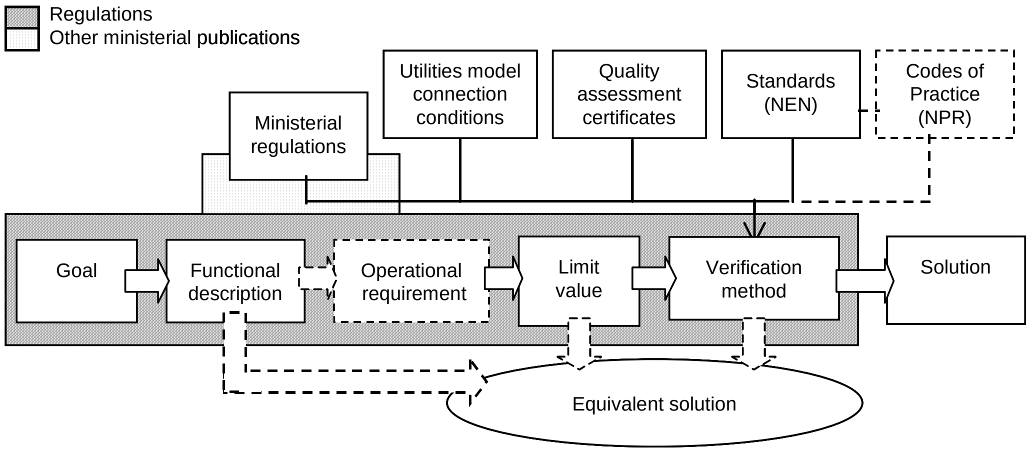
The CIB Taskgroup 37 'Performance based building regulatory systems' developed a model to analyse and describe the various systems of performance based requirements. In 2004 the Taskgroup held their final meeting at the CIB-world conference in Toronto and the final report was presented [9]. The concept of the 'Performance System Model (PSM)' was formalized.

Fig 2 Performance system model CIB-TG 37



The PSM moves on from the Nordic five level system, introducing a 'Performance risk level', which determines the application of requirements, and a further level of 'criteria' which can be worked out into of objectives like health and safety, fire safety, structure, and sustainability. It also combines levels four and five into a single verification level, which includes design guides as well as testing or modelling techniques and can also refer to acceptable solutions.

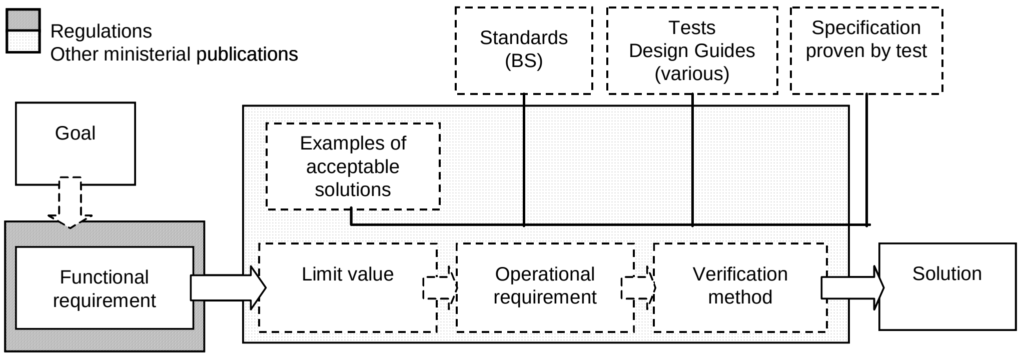
Fig 3 The Dutch Building Decree



We have used this model to analyse the formulation of requirements in different countries. Some countries, including the Netherlands, have consciously attempted to follow such a model.

Others have devised their own performance-based systems. The analysis is difficult, even for those countries that have adopted some form of performance-based system, firstly because commentators vary in their understanding of these terms and secondly because there is inconsistency within the specific systems of regulations in the countries used for different subjects. As other commentators have pointed out [10] [11] the term ‘performance requirement’ is interpreted in different ways. Although it is understood by CIB to mean the qualitative formulation of requirements or goals, as opposed to prescriptive regulations with mandatory design solutions, some countries understand it to constitute a description of desired levels of performance. In The Netherlands the formulation of regulations in the Building Decree was the result of a deregulation program in the nineteen-eighties which used the following criteria: a regulation must be legally explicit and equitable, unambiguous and thereby measurable and verifiable, and a regulation should present only a minimal restriction on freedom and innovation in design. These criteria have been interpreted very strictly and led to a system of performance requirements that conforms to the CIB-TG 37 model. In 2003 a revision of the Decree was introduced [12].

Fig 4 The Building Regulations of England and Wales



In England and Wales, the structure of the Building Act, the Building Regulations, and the associated advisory Approved Documents is relatively clear, in terms of a hierarchy of components. However, there are some inconsistencies between different subjects, which are partly the result of a rolling programme of review and amendment, but also reflect the nature of the subjects. The Building Act 1984 is the enabling legislation for the Building Regulations 2000. Schedule 1 to the Building Regulations sets out functional requirements, grouped in themes, termed ‘Parts’. Each functional requirement is brief. Approved Documents (ADs) are issued for each of the themes, which elaborate the requirements, discuss the underlying issues, and describe strategies that can be used to comply with the functional requirements. The ADs include: guidance on operative strategies and tactics (advisory equivalent to operative requirements); and various forms of verification: description of methods of measurement and verification, often by reference to British Standards; direct examples of acceptable solutions. Building control bodies can also accept alternative strategies and tactics, provided the developer demonstrates that they comply with the functional standards.

The Dutch Building Decree is quite abstract and difficult to read. Only the higher educated in the construction industry can work with it on a proper way. During the years more and more documents have been developed that should serve laymen. Most professionals are quite satisfied with the system. They can work with it and are used to it. The biggest advantage of the system is considered to be its clearness. For most topics, in most cases the required performance can exactly be defined. It seems that for reasons of deregulation a system like the English Building Regulations might be somewhat better, although the advantages are not really obvious. A transformation of the system will be very expensive and lead to a long time of transformation in the building industry. The further development of interpretive documents and software seems to be a better choice.

4. The organization of building control

Another element of the system of building regulations is the whole organization of building control, including the definition of permit procedures, and the division of tasks and responsibilities over public and private parties in the building sector. In most European countries (local or regional), authorities have traditionally been responsible for controlling and checking building plans and for granting permits. Figure 5 classifies the systems of eight countries according to the allocation of responsibility for exercising building control. Three categories are distinguished: public responsibility for building control, private responsibility for building control and private responsibility for granting permits. A fourth possible category – public responsibility for granting permits – has been omitted, as this remains the archetype in all European countries.

Fig. 5 Responsibility for control.

Public responsibility for control	**Private responsibility for control**	**Private responsibility for granting permits**
A. Local authority carries out control (Netherlands, Denmark, England & Wales)	C. Local authority contracts out, private organisation is responsible (Germany)	G. Private organisations are qualified to issue building permits (England & Wales)
B. Local authority contracts out but remains responsible (Netherlands, Denmark)	D. Legal liability for private control based on building regulations (France)	
	E. Private inspection because of liability and insurance requirements (Belgium, France)	
	F. Full private responsibility (Norway, Sweden, Germany)	

Our studies show that administrative procedures in Europe vary widely. Although building permit procedures are determined at the national level, developments indicate a trend towards convergence across the Europe member states. This trend is best described as ‘procedural (or administrative) deregulation'. Within these countries, the category of construction works that require building permits is diminishing. Authorities are trying to improve both the effectiveness and the efficiency of their procedures through such initiatives as making a procedural distinction between simple and regular procedures. Actions being taken to streamline regular procedures even further include introducing online facilities for acquiring information and applying for permits, allowing exceptions for certain frequent construction works (i.e., Type Approval) and dividing the regular procedure into phases [13].

The future of building control (and especially the way it is best organized and executed) are high on the agenda in many European countries. In almost all cases deregulation and privatisation are important themes. The way one can look at solutions however differs. Below we give a short impression of the actual situation (and discussions that take place) in the Netherlands, England & Wales and Germany.

Netherlands

In the Netherlands municipalities are required to check permit applications for new developments against the Building Decree, issue building permits, and supervise the construction work. However the current enforcement system does not function as well as it should [14]. Local authorities often lack the manpower to check all building plans and to conduct site inspections in a satisfactory manner. The smaller authorities in particular are unable to cope with fluctuations in the number of applications received. The quality of the building inspection departments, particularly among smaller authorities, leaves something to be desired. The small departments have difficulty in achieving the required level of specialization and to provide the necessary ongoing training. The local authorities do not apply uniform assessment protocols. Accordingly, not all building applications are subject to the same evaluation methods. Local authorities have limited liability for injury, loss or damage due to negligence in the control and inspection procedures. This is to the detriment of the quality and completeness of those procedures. Finally there is a risk that local political interests will stand in the way of objective enforcement of the regulations.

To improve the situation various ideas and instruments have been developed. A first step was taken in the direction towards more privatisation. In the early 2000's the idea was worked out to certify engineering companies and architect firms to check the integral (or one or more parts of the) Building Decree. In the past years this new system has been tested. Although the results are positive, the possibility for a private control is not yet incorporate in the Housing Act. However many stakeholders within the construction have recently (October 2007) signed a declaration of intent with the Dutch ministry of housing to develop the private building decree further. The organizations involved want to stimulate local authorities and market parties in the building industry to use the private building decree control possibility in practice. Other instruments that have recently been developed are aimed at the harmonization of plan check and site inspection procedures. A uniform assessment protocol has been developed to establish priorities for the checks and inspections. As stated in the introduction paragraph the Dutch government has recently started a study to fundamentally reconsider the building regulatory system. It remains to be seen what effects this project will have on the deregulation and privatization of building control in the Netherlands.

England & Wales

Since the 1980s, private bodies in England and Wales can be certified as Approved Inspectors, who determine whether the design and construction of projects meet the demands, and they are authorised to issue building permits. The approved inspectors operate side by side with local authority building control. Most of the construction works in England and Wales are still controlled by local authorities. In time, the English regulations may change some more. In addition to the self-certification schemes for the installation of specified equipment and for the replacement of windows, England is considering the development of self-certification for entire buildings by enterprises or individuals who have been deemed 'competent' by accrediting bodies.

The Department for Communities and Local Government recently made a start to review the English building control system. Not because there is something serious wrong with the system but there are some weaknesses that needs to be addressed. The department has bundled the first ideas and suggestions that involved stakeholders have came up with [15]. Six key areas have been identified for which attention and action is needed:

- What should be the vision and strategy for future building control? The public in particular has little sense of the purpose of building control or who is responsible for what.
- The levels of inspection and compliance are sometimes lower than they should be. Potential future ways are to develop an effective risk-based approach to inspection and enforcement and a wider range of sanctions and greater powers of enforcement.
- Building control processes are generally paper based and need updating and e-enabling. Alternative routes to compliance should be encouraged and developed further, particularly where self-certification is possible, so that cost and delay can be taken out of the system.
- Approved Documents are too technical and complex for most small building contractors to follow. The distinction between Approved Documents and Building Regulations needs clarification. Guidance needs to be simplified and targeted to take account of the different needs of different types of projects and different types of users.
- All parties involved with construction works are subjected to frequent change and have difficulty keeping up. Regulations are sometimes updated before previous changes have been fully applied. This makes it difficult for the industry to plan and therefore harder to prepare or innovate. This could be prevented by the introduction of fixed cycles of building regulation review and stakeholder engagement procedures to make better regulations.
- Building control is being considered as an ageing profession in which it is increasingly hard to recruit and retain staff. Resources which are intended to support training and development tend to be used for other purposes.

These proposals will be further developed. The results will be incorporated in a full consultation paper that should be published before the end of 2007.

Germany

In Germany privatization always has been an important feature of building control. Since the 1920s, local building control authorities in Germany have contracted out much of the control work to specialised engineering firms. These inspection *engineers*, who are certified, must meet strict requirements, and they are liable for their work. During the 1990's and early 2000's the German system has been severely deregulated. Most German states have enlarged the category of exemptions substantially Also a distinction has been introduced between an elementary and a regular permit procedure. The elementary procedure (e.g. dwellings with limit and moderate heights) consist of a check of the stability, durability and fire safety of the constructions. During the last decade the German system has made a sizable further step towards further privatisation. Construction works that are subject to the elementary procedure must be checked by certified inspection experts. The levels of education, experience and similar qualifications that are demanded of these experts are lower than those that are demanded of inspection engineers.

The main driver behind these developments seems to be to bring back the administrative costs for principals and applicants of building permits. These effects have indeed been realized. We give an example from one of the German states. In Bayern for instance the regulatory system was changed in 1994. Between 1994 en 2003 about one third of all house construction has been built without a permit. Roughly eighty percent of the construction works that needed a permit in that period have passed the elementary procedure, which took on average five weeks. The average duration of the regular period took around eleven weeks. All in all it is estimated that Bayern building owners have saved themselves some 132 million euro's on fees in the period 1994-2003 [16]. There is however a serious downside to this. The deregulation of building control also has caused negative effects. Especially the organisation of inspection engineers and the chambers of architects in various German states have warned about the effect before the deregulation took place and are now still criticizing it. The states and local authorities hardly check building plans and carry out site inspections. Research after the collapse of an ice skating hall (in 2006) learned that more than half of the similar construction works that were inspected had shortcomings. Also in the residential sector the financial loss of damage because of defects has grown with 30 percent in the past five years. It is expected that in the next five years many owners of one family and two family houses in Germany will be confronted with damages caused by building defects. The savings of administrative costs (through deregulation) and the transfer of the responsibility to the proprietor/owner has had serious consequences. The organization of inspection engineers states that: "who wants to deregulate should ascertain that the few regulations that are left are being met" [17] [18].

It is not known in which direction the German building regulatory system will develop in the near future. What is evident is that privatization and deregulation per se can have serious negative side effects. The situation after the deregulation and privatization operation seems to be very clear. The owner/applicant is responsible for control and the quality of their construction works. What happens when the owner/principal (for lots of reasons) does not effectuate this responsibility?

5. Discussion

Building regulations are an essential tool in planning and building processes. The government takes responsibility in defining a bottom quality for buildings. The complexity of design, construction and the organisation on the development procedures bring along many risks of failures. One may not expect that the primary processes of design and construction will lead to buildings that meet the defined requirements without strict quality assurance procedures. Therefore building permit procedures based on procedures of plan checking and site inspections are essential elements of the building regulatory systems. Time and again initiatives are started in the European countries to reduce the administrative burden and to improve the actual enforcement of the regulations. This can be worked out at several levels: the scope of the regulations, the system of formulation of the regulations and the system of enforcement. The expectation is that the scope of public regulations will not become narrower. The growing importance of environmental issues and reduction of energy use in buildings will lead to more regulations. Also, we believe that the existence of technical requirements is not the main reason of administrative burden. More can be gained by an easy use of the regulations in the building practice and an effective and efficient quality control process. The move towards more privatisation seems to be a sensible move. But do not consider it as a panacea for (serious) failures and weaknesses of current building control systems. Look at the German experiences. We think the Dutch and (especially) English are good 'process examples' to try to develop a sound future building control system. Current problems and barriers are addressed without the exclusion of possible solutions beforehand. Developments and solutions found in one country can inspire other countries in their strife for a better building regulatory system. However solutions for one country can not be automatically implemented in another country. Tailor-made solutions for certain problems/barriers still are needed.

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Minimizing construction disputes: the relationship between risk allocation and behavioural attitudes

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Abstract

The continuing incidence of costly disputes in the construction industry has led to a common interest of researchers in different countries to identify the generic aspects of conflicts, claims, disputes and their resolution. This paper undertakes a comprehensive review of literature in the field of construction disputes and identifies the relationship between procurement selection (with the inherent risk allocation) and the behavioural attitudes of key stakeholders as critical factors in the incidence of disputes. It conceptualises the research area and identifies a proposal for further research based on case studies of construction projects in Lebanon which have encountered disputes and claims.

Keywords: Disputes, conflict, claims, risk, behavioural attitudes.

1. Introduction

1.1 Disputes and conflict

Unlike other types of industries where the development and manufacture of product can be standardised and tested before being purchased, the nature of projects in the construction industry is extremely diverse. Every project is unique. Even where identical buildings are under construction, the site conditions in each will differ and introduce new challenges. Moreover, it is a multi-party process where numerous specialist parties are involved due to the diversity of skills required and thus maintaining teamwork atmosphere and controlling potential conflicts is important. Also, the construction projects normally span for a long period between the decision to invest and the completion of works. This leads to instability of supply and demand and high sensitivity to economic fluctuation [1].

Maintaining a cooperative environment becomes a difficult task because conflicts are inherent in construction projects [2,3]. Where conflicts result in adversarial stances and mistrust, they have a detrimental effect on project performance [4]. Eliminating conflicts appears to be a daunting objective[5,6] and so efforts have been directed towards reducing their magnitude and/or keeping them under control [7].

The definition of dispute is itself a matter 'in dispute'. Some authors refer to disputes as simple disagreements, whilst others refer to disputes as the consequence of rejecting a claim [8, 9, 10]. Put in simple terms, and where it is referred to in what follows, a dispute is considered to be in existence where one party does not accept the rejection of the claim by the other party. Accordingly there has to be a claim, a rejection and a non-acceptance of the rejection. It is not considered to exist on the basis of a claim alone [11].

There appears to be a consensus in the literature that conflicts can be constructive or destructive. Accordingly, constructive conflicts should be encouraged whereas destructive conflicts that lead to disputes should be avoided [12, 5, 8, 4, 13]. Moreover, the sooner the destructive conflict is resolved the higher the percentage of resolution success and the lower the cost [4].

1.2 Causes of disputes

An extensive list of 56 causes of disputes over delay identified by Assaf *et al.* [14] includes: shortage of construction material, changes in types and specifications during construction, slow delivery of material, damage of material in storage, delay in the special manufacture of the building material, shortage of labour, labour skills, nationality of labourers, equipment failure, equipment shortage, unskilled operators, slow delivery of equipment, equipment productivity, financing by Contractor during construction, delays in Contractor's progress payment by Owner, cash problems during construction, design changes by Owner or his agent during construction, design errors made by designers, foundation conditions encountered in the field, mistake in soil investigation, water table conditions on site, geological problems on site, obtaining permits from municipality, obtaining permits for labourers, excessive bureaucracy in project Owner operation, building code used in the design of the project, preparation and approval of shop drawings, waiting for sample material approval, preparation of scheduling networks and revisions, lack of training personnel and management support, lack of database in estimating activity duration and resources, judgement of experience in estimating time and resources, project delivery systems used, hot weather effect on construction activities, insufficient available utilities on site, the relationship between different subcontractor's schedule, the conflict between the consultant and the Contractor, uncooperative Owners, slowness of the Owner decision making process, the joint ownership of the project, poor organization, insufficient communication between Owner and designer at the design phase, unavailability of professional construction management, inadequate early planning of the project, inspection and testing procedures used in the projects, errors committed during field, application of quality control based on foreign specification, controlling subcontractors by general Contractors in the execution of the works, the unavailability of financial incentives for Contractor to finish ahead of schedule, negotiations and obtaining of contracts, legal disputes between various parties, social and cultural factors, accidents during construction [14].

Through a questionnaire survey conducted on 61 contemporary construction projects in Hong Kong Kumaraswamy [8] attempts to better understand disputes; he identifies common root causes, proximate causes and confirms the need of further studies to isolate the real root causes of avoidable claims and disputes. A list of the root causes and the proximate causes is shown in Figure 1.

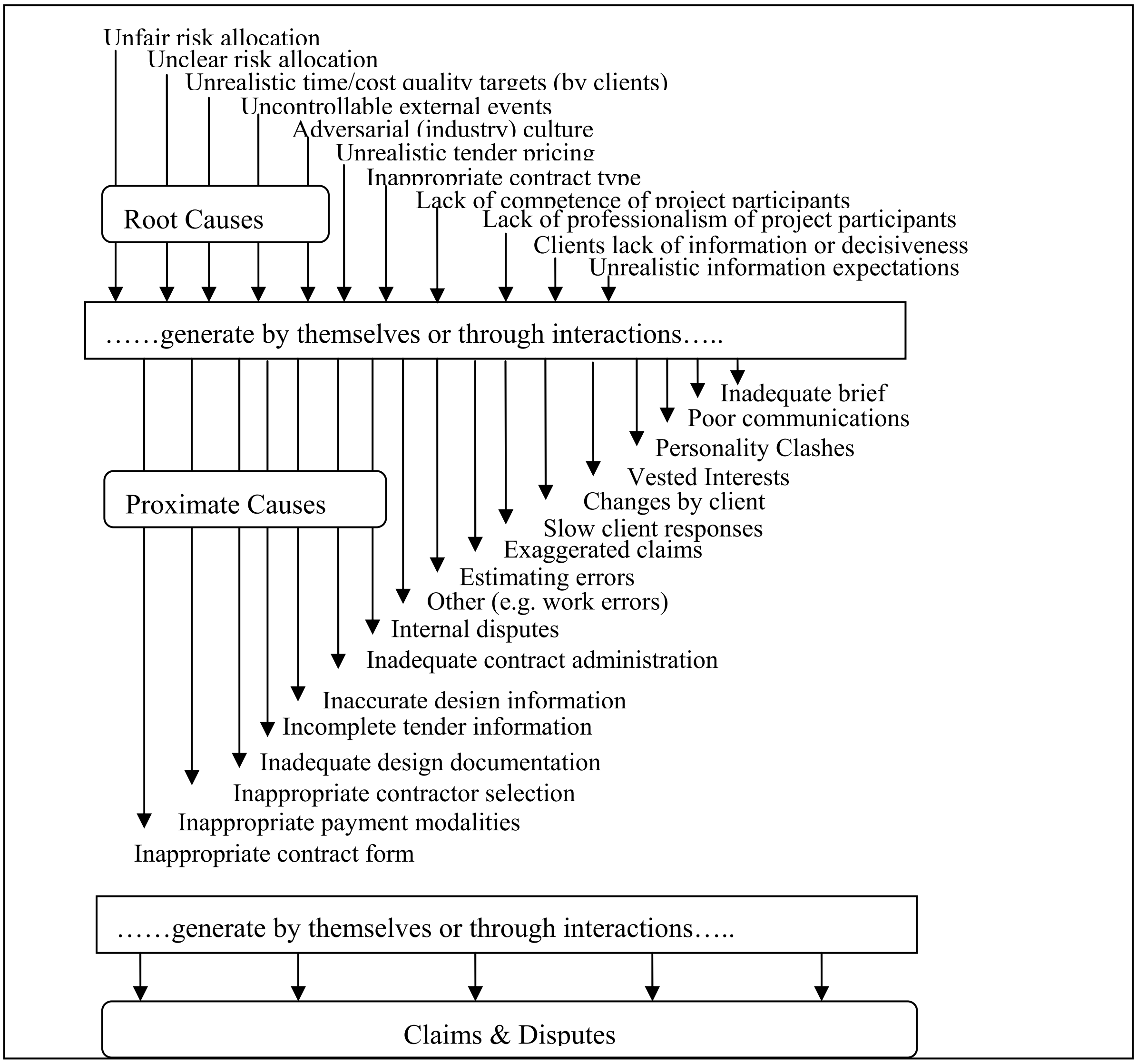

Figure 1- Root Causes and Proximate Causes (Kumaraswamy [8])

Other attempts to categorise the causes of disputes are shown in Table 1.

Table 1- Categorising Causes of Dispute (adapted from Fenn, [3] and Fenn, [60])

Al Momani [15]	Causes of delay: poor design, change orders, weather, site conditions, late delivery, economic conditions, and increase in quantity.
Alkass *et al.* [16]	Strikes, rework, poor organization, material shortage, equipment failure, change orders, act of God.
Bristow and Vasilopoulous [17]	Five areas unrealistic expectations: contract documents, communication lack of team spirit and change.
Colin *et al.*[18]	Six areas: payment, performance, delay, negligence, quality and administration.
Diekmann *et al.* [19]	Three areas: people, process and product.
Heath *et al.* [20]	Seven areas: contract terms, payment, variation, time nomination, re-nomination and information.
Hewit [21]	Six areas: change of scope change conditions, delay, disruption, acceleration and termination.
Kululanga *et al.* [22]	Four sources of dispute: (1) errors, defects and omissions in the contract documents, (2) underestimating the real cost of the project in the beginning, (3) changed conditions and (4) stakeholders involved in the project.
Madden [23]	Three categories: legal, technical and quantum.
Molenaar *et al.* [24]	Three categories: people issue, process issue and project issues.
Rhys Jones [25]	Ten areas: management, culture, communications, design, economics, tendering pressures, lay, unrealistic expectations, contracts and workmanship.
Semple *et al.* [26]	Four areas: acceleration, access, weather, and changes.
Sykes [27]	Two areas: misunderstandings and unpredictability.

Fenn [3, 60] conducted exhaustive studies of previous research into causes of disputes and the above table shows a sample from his studies of attempts to identify causes of disputes. However, it is evident from the sample that direct comparison of the results is, as expressed by Kumaraswamy [5], “neither possible nor useful, because of the diverse industry cultures and differing methodologies and terminologies used in data collection, analysis and outcome presentations.” However, all these factors as pointed out by Kumaraswamy [8] fall in the broader sense in three categories of external factors, contract and project teams. The same has been confirmed by the Dispute Prevention and Resolution Task Force of the Construction Industry Institute (CII) where the factors were described as project uncertainty, process problems including imperfect contracts and people issues [28, 29].

Mitropoulos and Howell [29] move beyond individual factors and study the effect of interaction of technical, contractual and behavioural factors on the development of disputes as proposed in a dispute development model. These authors again identify three basic factors that directly affect disputes: project uncertainty, contractual problems and opportunistic behaviour.

Fenn *et al.*'s [12] research proves that studies conducted to determine dispute causes do not identify the causes that produce the most expensive delays. He concludes that there is a need for research that would investigate the causes of general disputes. Kumaraswamy[5] again emphasizes the need for a deeper analysis of the causal linkage between conflicts, claims and disputes. Identifying common causes and consequences of unresolved conflicts and claims would allow for more effective dispute avoidance as well as more efficient resolution of 'unavoided and unavoidable disputes' [5]. In spite of abundant research in the area, the continuing emergence of costly disputes verifies that further studies are needed to identify the causes of these disputes.

2. Uncertainty, contracts and behaviour

2.1 Project uncertainty

Construction projects are sensitive to an extremely large matrix of hazards and risks due to some of the inherent characteristics of construction projects [1]. As with disputes, many attempts have been made in the literature to identify and categorise risks. Zack [30] presents an exhaustive list of risk allocated in standard construction contracts that includes: physical risks, acts of God, impractical/impossibility, latent site conditions, quantity variations, site access, weather, capability-related risks, defective works, labour forces, subcontractor, supplier failure, economic risks, bonding, contract termination, cost escalation, economic disasters, failure to pay, insurance, project funding, taxes, time-related risks, acceleration, delays and disruptions, early use of facility, suspension of works, untimely responses, union strike, engineering and construction risk, changes, Contractor furnished equipment/material, continuation of work, coordination, defective contract documents, interpretation of requirements, means and methods of construction, owner-furnished equipment materials, permits and licenses, productivity, site safety, and work quality. Comparing these risks factors with the causes of disputes mentioned above by Assaf *et al.* [14] it is noticed that these risks are included as causes of disputes. This suggests that where risks surface in a project and are not treated correctly a dispute will result. Previous literature has ascertained that the risk should be transferred to the party that has the competence and expertise for best assessing, managing, controlling and minimizing it [31, 32, 33]. Risk allocation may be achieved through any one or a combination of risk retention, risk transfer, risk reduction and risk avoidance [33]. Given the significance of risks on project success, construction practitioners have raised awareness to the importance of risk management.

2.2 Contractual issues

Choosing the appropriate procurement method is a vital preventive method which if not carried out effectively might increase the probability of dispute occurrence. For this reason many models have been devised for procurement selection including discriminate analysis approach, multivariate analysis, decision support system, knowledge-based systems, procurement rating systems, procurement path decision charts, the multi-attribute approach, the analytical hierarchical process, the project procurement system selection, the objective-subjective procurement method and the multicriteria / multiscreening model [34, 35, 36].

Some authors focus on the importance of proper contract documentation in avoiding and resolving disputes. Carnell [37] proposes that 'getting it right' requires successful negotiation of the contracting parties throughout the procurement and apportionment of risk, complying with contract requirements and monitoring delays. Jannadia *et al.* [38] conclude that, based on previous studies, waiting until the end of the project to resolve disputes makes the procedure more time and cost consuming. The authors investigate techniques that can be incorporated in preparing construction contracts for dispute avoidance and resolutions including: allocating fair contract risk, drafting dispute clauses, team building, and provision of a neutral arbitrator and binding arbitration. The authors conducted a survey in Saudi Arabia where results show that there was a common desire among the parties to draft dispute resolution clauses but they need to be better educated about the importance of 'fair risk allocation'. Other attempts in dispute prevention through contract procurement propose using alternative non-traditional procurement methods such as the design-build, EPC, PFI/PPP, Partnering, Concurrent Engineering, Incentive/Disincentive Contracts [39, 40, 41, 42, 43, 44, 45, 46].

Lowe and Leiringer [13] describe disputes as being the source of possible time and cost overrun and possible adversarial relationships between the different parties. This is not welcome to either the Owner or the Contractor. Cost overrun might lead to the project being unsuccessful, unfeasible or nullifying any benefits. Although avoiding disputes has been recommended, this is not usually possible and where disputes cannot be avoided efforts should be made to manage and contain the consequences. It is to the advantage of both the Employer and the Contractor to manage disputes towards a resolution as this will safeguard the success of the project.

2.3 Behaviour

The main causes of inter-organizational conflicts are identified as: conflict due to task interdependency, conflict due to differentiation, conflict due to differing values, interests and objectives, conflict due to communication obstacle, conflict due to tension, and conflict due to personality traits [47].

The resulting conflict leads to stereotyping and attitudes of low friendliness, low trust, and low respect which in turn has an adverse impact on performance [47]. In studying the dispute predictors: people, project and process criteria as likely sources of emanating disputes, the results showed that the people criteria had the most effect followed by the process criteria [10]. The team working approach on a project helps avoid opportunistic behaviour through promoting cooperation and establishing good relations [48, 49]. It is also important for the project team to establish effective problem solving mechanisms [29]. Jergeas and Hartman [50] propose approaches such as reference to facts and better understanding of contractual terms that could help the Contractor and the Owner to avoid protracted disputes as effective project management might be more successful than resorting to claim experts.

Zaccaro *et al.* [61] examined the theoretical framework for leadership where the two necessary qualities are identified to be social perceptiveness and behavioural flexibility. Self-monitoring includes three characteristics: a concern for social appropriateness, a sensitivity to social cues, and an ability to control one's behaviour in response to those cues [51, 52, 53].

Rahim [54] based his study on the conceptual scheme first presented by Blake and Mouton [55] to classify the modes for handling interpersonal conflicts into five types: problem-solving, smoothing, forcing, withdrawal, and sharing. He differentiated styles of handling interpersonal conflict on two basic dimensions, concern for self and concern for others as shown in Figure 2.

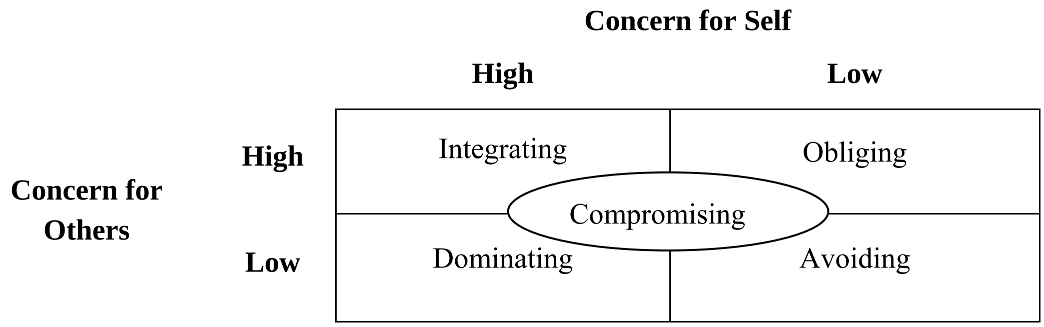

Figure 2- Styles of Handling Interpersonal Conflict (Rahim, [54])

In an attempt at studying the importance of behavioural attitudes of each party in dispute resolution, Loosemore *et al.* [56] highlights Latham’s recommendation to increase levels of trust as a means of reducing conflict. Based on previous surveys conducted by Rahim [54] and Likert and Likert [57], results show that there is a need for less reliance on prescribed rules and procedures, greater attention to lateral communication and a willingness to decentralize decision making authority. Conflict can also be minimized through enhancing the understanding of the other party’s perception, stimulating openness, reducing relational uncertainty, and analyzing problematic issues before escalating the tension [7]. The degree of open confrontation of differences, rather than smoothing them over or forcing decisions, will also encourage better cooperation and overall performance [58]. If qualified people are assigned by both parties of a contract, they will begin to know, understand, respect and trust each other. The work experience will build solid relationship and thus the effectiveness in negotiating settlements will increase and the time spent negotiating settlements will decrease [2, 7].

3. Research area conceptualisation and proposal

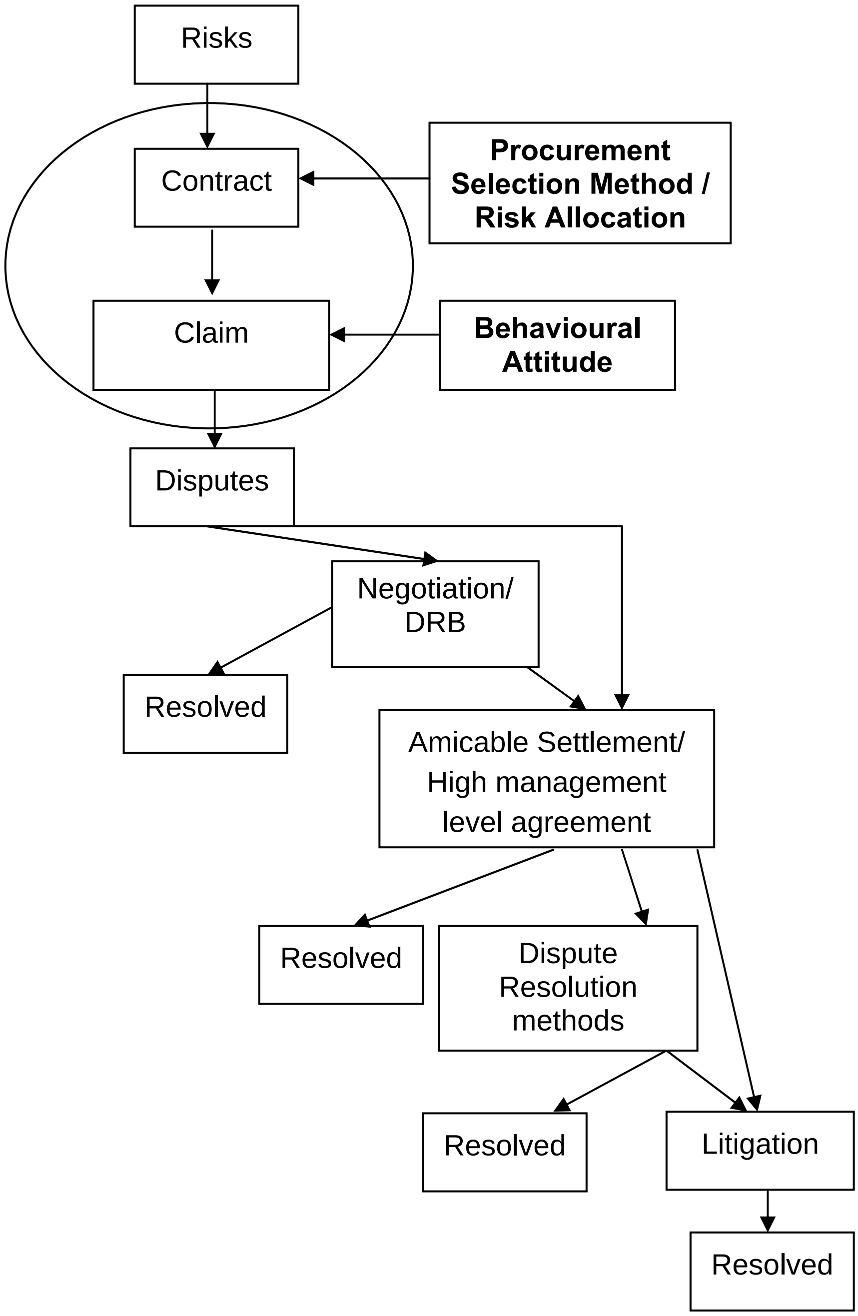

Figure 3 - Conceptual Flowchart of Dispute Evolution and Resolution

The literature clearly reflects the interrelationship between different factors. A study of disputes has led to the study of risks, conflicts, claims, procurement methods, and dispute resolution methods. Figure 3 shows a conceptual flowchart that describes the trajectory of disputes from inception to resolution based on the detailed literature review.

In addition, the literature reveals abundant research studying different aspects of the problem and proposing preventive and remedial measures at the different stages of the construction project. However, the construction industry continues to suffer from cost overruns due to disputes and there remains a need, recognized by many authors, to identify the generic causes of disputes. By reference to the conceptual flowchart in Figure 3 the proposed research questions can be stated as:

1. What is the impact of risk allocation in contributing to the incidence of disputes on construction projects?

2. Can effective project management / contract administration help mitigate claims and minimize construction disputes?

3. How does the behavioural attitude of the parties involved in projects affect dispute avoidance, management and/or escalation?

The long term aims of this research are therefore to examine the frequency and causes of common disputes in the Lebanese construction industry and to identify possible relationships within and between the risk allocation strategies adopted during the procurement of the construction works and the behavioural attitude of the parties. Once the relationships are understood, a theoretical framework will be developed to help prepare advisory risk and behaviour recommendations for construction projects.

The unit of analysis studied in the cases studies are the claims themselves. The research design consists of multiple case studies where the case studies are the contracts in construction projects that have embedded units of analysis i.e. the claims. At the first stage, documentation related to 25 different projects is studied to identify the scale of claim, the causes / reasons and the dispute resolution methods employed. The events and observations from these case studies will be further supported by 25 interviews conducted with practitioners involved in the above mentioned projects at the second research stage. The findings from stages one and two will be analysed and processed to formulate a framework of factors which contribute to the incidence of construction disputes. The third research stage will then test this framework through the development of a questionnaire to be distributed to practitioners throughout the Lebanese construction industry. The framework will then be modified accordingly and a set of conclusions and recommendations drawn.

The first two stages comprise two sources of evidence used in the data collection procedure: documentation and interviews. The 25 cases to be examined have been chosen based on the combination purposeful sampling method described by Patton [59] where two different sampling methods are applied by way of triangulation. These two methods are the:

- Maximum variation sampling where the cases are heterogeneous representing different parties to the contract and different procurement practices.

- Criterion sampling where all the cases examined are construction projects in Lebanon.

Accessibility to these projects is provided by a leading practice in the region. However, it is conditional on a confidentiality agreement regarding the names of the projects and the parties involved. The practice is a chartered quantity surveying and project management firm. Accordingly, their role in these projects varies between project manager, quantity surveyor, contract administrator, claim expert, and mediator. The parties involved in these contracts represent a significant portion of contractors and consultants taking a lead in the Lebanese construction market along with different owners, both public and private.

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SECTION VIII

SUSTAINABILITY

Adapting NSW Health Facilities to Climate Change– A Risk Management Approach

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Abstract

With incontrovertible evidence that anthropogenic climate change is occurring worldwide, the need to safeguard critical community infrastructure in the face of increasing incidences of extreme weather events must be addressed. This paper reports the results of a risk management workshop conducted early in 2007 for the NSW Health Environmental Health Branch that considered possible risks to human health and impacts on healthcare infrastructure likely to be associated with these types of events in NSW, Australia. The findings from this study are generalisable to other communities and indicate a range of available controls to address and manage the identified risks and opportunities generated by climate change for critical healthcare infrastructure.

Keywords: Climate change, healthcare infrastructure, risk management, asset management

1. Background

This study was undertaken at the request of the NSW Health Environmental Health Branch as part of the *Human Health Impacts of Climate Change Adaptation Project* funded by the NSW Greenhouse Office, NSW, Australia. The NSW Greenhouse Office project was designed to provide research evidence and develop policies and programs that will enable NSW government service providers to adapt to the potential impacts of climate change.

The intent of the study was to undertake a preliminary investigation of the adaptive capacity of NSW Health infrastructure to increasing incidences of extreme weather events likely to be generated by climate change. For the purposes of the study, the IPCC definition was adopted, whereby ‘adaptive capacity’ is ‘the ability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences’ [1].

Climate change research indicates that both mitigation and adaptation strategies are required to cope with the effects of climate change which now appear inevitable no matter the degree to which mitigation either becomes a higher priority or is in fact pursued. For example, the 2006 UNFCCC Adaptation Framework notes that ‘Until recently, policy makers concentrated on mitigation, partly because of worries that highlighting adaptation options might reduce the urgency for mitigation…mitigation and adaptation are not alternatives; both need to be pursued actively and in parallel. Mitigation is essential and adaptation is inevitable.’ [2]. This study has necessarily considered both of these approaches in the background research and in conduct of the risk management workshop. However the primary focus is on adaptation strategies required to safeguard essential healthcare infrastructure so as to protect the current and future health status of the NSW population.

The risk management approach towards adaptation strategies adopted by this study was developed in accordance with recommendations made by the UNFCCC [2], the Australian Greenhouse Office [3], CSIRO [4], UK CIP [5] and other authorities. For example a Norwegian study noted that: ‘Reducing the potential for defects or damage through the development of technical and organizational preventive measures (a risk management strategy) while at the same time applying the precautionary principle and discursive strategies in the design, construction and geographical localization of buildings, is likely to increase the robustness of the built environment in the light of the unknown risks of future climate change’ [6].

2. Introduction

As a developed country, Australia is well placed to protect its healthcare and other community infrastructure from the anticipated additional demands likely to be placed on it by increasing incidences of extreme weather events likely to be associated with climate change. However, although these demands may place only incremental additional loads on systems already designed to cope with disasters and other emergency situations, they require recognition, anticipation and responses to be identified within existing health asset management frameworks. This will ensure that should the predicted demands arise, appropriate responses will have been determined well in advance and incorporated into health asset management practices so that healthcare infrastructure will be able to cope with the increased load and stresses likely to be imposed. If not considered in advance, such responses will become reactionary without guarantee of success or adequacy, and possibly of much greater cost to the community in terms of damage to infrastructure and potential reduction in health status of the population.

It must also be recognized that climate change will affect the built environment in many and diverse ways. However, it is a problem that can be addressed with proper identification and planning, as supported by the comment made by the IPCC Report that: ‘Climate change will affect human settlements against a very dynamic background of other environmental and socioeconomic factors. Human settlements are expected to be among the sectors that could be most easily adapted to climate change, given appropriate planning and foresight and appropriate technical, institutional, and political capacity.’ [7].

3. Methodology

3.1 Aims and Objectives

The *parameters* of the study were deliberately restricted to focus on the facility-related impacts of climate-related extreme weather events such as heat waves (and bushfires), floods, storm surges, and tsunamis. It is anticipated that appropriate planning for health facility infrastructure will help reduce the potential adverse impacts of extreme weather events on the health of the community. The overall *objective* of the study was to identify a range of potential adaptation strategies for NSW healthcare facilities in coping with extreme weather events. More specifically it aimed to:

1. Explore the impacts that extreme weather events may have on healthcare buildings specifically in the context of the NSW climate (but with reference to the wider Australian context), focusing on the differing requirements by location.
2. Investigate the suitability and applicability of the suggested responses (gleaned from the existing literature) from a healthcare infrastructure perspective
3. Assess the "adaptive capacity" of health infrastructure in the light of healthcare, social, financial, technological, and political impacts in Australia resulting from climate change
4. Where possible, align potential strategies with existing disaster planning strategies

Finally it aimed at developing an Action Plan that summarises identified key risks and opportunities, and a strategy in dealing with each of these. In doing so, it also determined where further research and investigation are required in order to develop a cohesive NSW strategy for dealing with the impact of extreme weather events on healthcare infrastructure. [8]

3.2 Method

The study commenced with the identification of key stakeholders who were subsequently invited to a Risk and Opportunity Management (ROMS)[1] Workshop held over two days that was facilitated by Professor Martin Loosemore of UNSW. Key stakeholders were determined through a process undertaken by the authors of the study in conjunction with representatives of the NSW Health Environmental Health Branch. A total of ten people were selected initially on the basis of their professional backgrounds and current occupations in roles of influence in the healthcare and community sectors (Figure 1). Other criteria for selection then became their likely concern with the effects of climate change related extreme weather events on healthcare infrastructure (their objectives affected by project outcomes) coupled with their perceived abilities in determining effective adaptive responses and possible subsequent involvement in the implementation of these (their ability to implement the project objectives).

[1] The ROMS Methodology was originally developed for Multiplex Facilities Management and subsequently developed and used by many major public and private sector organisations throughout Australia and Asia. ROMS complies with AS/NZS 4360:2004 and other international risk management standards; The principles underlying ROMS have been published in [34] and can be explored further at http://cell-media.com/ROMS/

Ability to implement project objectives

Minor Stakeholders Clinicians Green Building Council of Australia	*Important Stakeholders* Experts/scientists Aust Building Codes Board Peak Industry Bodies (FMA, IHEA, etc) Private Hospital Associations
Major Stakeholders Rural services sector Aged care sector Community services sector Nursing care Mental health sector Local Government Planning Authorities EMA	**KEY STAKEHOLDERS** NSW Health Asset and Contract Services Ambulance/emergency Services Private - designers and/or contractors/ Government – NSW Dept of Commerce (Govt architect) NSW Health Statewide Services Branch NSW Health Environmental Health Branch NSW Area Health Services (clinicians/public health officers)– NSCCAHS NSW Greenhouse Office Aged Care Services Assoc (ACSA)

Objectives affected by project outcomes

Figure 1: Selection matrix for workshop participants

The identified key stakeholders were invited to participate in the ROMS workshop which following a background briefing for participants, was conducted in accordance with the structured process set out as follows.

Workshop 1
Step 1 : Stakeholder analysis and common objectives
Step 2 : Identify risks and opportunities to those objectives
Step 3 : Assess their magnitude and prioritise them
Workshop 2
Step 4 : Develop an action plan to minimise risks and maximise opportunities

Workshop proceedings and outcomes were documented in the ROMS format, and an accompanying report written to highlight the analysis of the findings and the key themes that emerged. In the first step of the first workshop, participants identified the following common objectives for the study:

1. *Quantifying impacts***:** To develop a research program to identify, analyse and assess impacts of extreme weather events on health infrastructure.
2. *Evidence-based practice:* To identify a range of potential facility-related responses to the health-care challenges posed by climate change, that may assist in influencing potential funders of climate change research. To ensure practitioner/researcher engagement to facilitate evidence-based practice by operationalising research, ensuring research is relevant, practical and disseminated in a usable format.
3. *Asset management planning:* To ensure procurement, design, FM, urban planning and asset management planning strategies enable effective health-care responses to climate change and do not exacerbate problems in event of a crisis.
4. *Ensuring behavioural change*: To raise awareness of climate change including changing public expectations and behaviours, securing buy-in from industry stakeholders by means of communication and education.
5. *Integrated planning:* To ensure a coordinated cross jurisdictional response to climate change at internal, local and society level involving: disaster planning; emergency services, private health care sector, and other non-health care community services.

These common objectives were then aligned with the initial project objectives identified by the NSW Health Environmental Health Branch for the study, and are discussed further in the results below.

4. Results

The outcomes of both workshops are summarised in the final report for the project. In the report itself, they are summarised in terms of their relationship to the objectives of the project sponsor, NSW Health and a draft Action Plan is then proposed for review and discussion by project stakeholders.

4.1 Risks to the Healthcare System due to Climate Change Extreme Weather events – Impacts on Human Health and Health Facilities

It was beyond the scope of the study (and not included in the objectives of the risk management workshops) to undertake specific or detailed investigations into the predicted effects of climate change generated extreme weather events on human health or the associated changing demands for healthcare services. This work is either being undertaken by others or more properly demands the skills of public health specialists and epidemiologists [eg 9-12]. However, the background briefing for the workshop and introductory remarks by NSW Health noted outline findings documented by other parties from journals and government reports.

The change in weather patterns, including increased variability and extremes, suggest that patterns of disease will alter both within NSW and Australia generally [1, 4, 13, 14]. Healthcare infrastructure may come under pressure as a result of those seeking refuge from extreme events (heat, storms, etc) and it may also be subject to increased demands by those suffering injury or ill health as a result of such events (e.g. elderly or vulnerable populations suffering from heat stress related to extended periods of higher than normal temperatures). While much of NSW will be drier, heavy rainstorms may be more frequent in central and south-east NSW, and in the far north-east, particularly in summer. In autumn and winter, heavy rainstorms are likely to increase in the centre and north-west of the State, and decrease on the coast. Increased average wind speed and extreme winds are expected in spring (greatest across central NSW). Along with these climate projections, it is also noted that the "loss of life, and the impact on hospital and emergency services, through extreme weather events is likely although not predictable" [3]. Consequently, "a major challenge in Australia is how to protect and improve public health systems…" [15]. The following table lists a range of extreme weather events that may be experienced more frequently or more severely as a result of climate change and, based on actual examples, indicates possible health impacts and associated facility impacts that have resulted and that may potentially occur again in the future.

Table 1- Health and Facility Impacts associated with Extreme Weather Events [Adapted from 30]

Events	**Health impacts**	**Facility impacts**
Heatwaves (and Bushfires)	In Australia and other countries, heatwaves are responsible for more deaths than any other natural hazard but are mostly underrated because they are viewed as a 'passive' hazard in contrast to the more catastrophic hazards such as tropical cyclones or bushfires [16, 17]. Heatwaves are likely to affect the elderly and other vulnerable populations (very young, dependent on alcohol or other drugs, chronically ill, etc) causing them to	Sydney heatwaves in 2005 "one hospital has been swamped by people not needing medical treatment - simply looking to take advantage of its spacious air conditioned reception area" [18]. The 7-day heatwave in Adelaide in February 1997 caused hospital computers to overheat and fail [16]. Water shortages and water supply failures may also become a problem as demand for water may increase dramatically. Transport systems suffer from problems and interruption due to possible

	seek admission to health facilities due to increased incidence of CVD and other ailments.	heat-related expansion of railway lines and steel bridges, and other associated damage to roadways [16].
Floods	The flooding of the river Elbe in 2002 in Saxony/ Germany required immediate public health action in order to ensure a proper public hygiene response [19]. Floods are significantly likely to result in degradation of human health and loss of life, high financial cost, trauma and associated human misery [19-21]	Where healthcare facilities are flooded, electrical power outages may be unavoidable. In the UK in June 2005, Warwick Hospital evacuated emergency patients by ambulance and helicopters [22]. Flooding creates access problems for physicians and other staff travelling to and from the hospital [23].
Storm surges	93 hospitals were adversely impacted Hurricane Katrina in the Southern USA in 2005, with 19 hospitals evacuated and 18 closed [24]. Numerous deaths were attributed to transportation shortages, although evacuation measures were aided by helicopters, buses, and ambulances. In March 2006, Tropical Cyclone Larry crossed the tropical north Queensland coast near Innisfail, giving pressure to medical services [16, 25], although at a much smaller scale than Katrina.	Water pushing several kilometres inland where land is low lying may potentially knock down healthcare facilities and wash away roads [19, 26, 27]. In March 2006, Cyclone Larry in north Queensland, the Innisfail Hospital was forced to close, thus requiring medical support from Townsville and Cairns Base Hospitals. Herberton hospital was without power until a generator was provided and leaking roofs resulted in emergency evacuation [16, 25].
Tsunamis	The South Asian tsunami in 2004 was one of the largest flooding disasters in recent history, causing about 280,000 fatalities in eight countries from Asia to Africa [28]. Post-traumatic stress disorders and problems of hygiene and infectious diseases were also noted, which caused many fatalities including a large number of suicides [28].	During the 2004 tsunami in Indonesia, 1 main referral hospital, 4 district hospitals, and 41 out of 240 clinics were destroyed [29]. In the Maldives, where most healthcare facilities escaped major structural damage, some facilities such as Mulee hospital lost all their medical records and equipment. Access difficulties further hindered the provision of health services following the disaster.

4.2 Possible Infrastructure Responses

While calls for responses to extreme weather events are evident within the literature, the workshop identified that a key barrier to moving forward with adapting to extreme weather events was the lack of understanding of the likely quantum and nature of the impacts of such events on health infrastructure. In particular, prior to any attempts at adaptation, the quantification of the impacts of climate change and the resulting extreme weather events was considered key to reinforcing understanding of the immediacy and severity of problem. Table 2 lists some potential adaptation responses by health and other authorities that may assist health services and infrastructure to cope with extreme weather events - these have been identified from existing research. They include immediate responses such as evacuations, as well as long-term facility responses to help mitigate the risk of facility failures. However the ability to translate these responses into facility planning policies and design are yet to be assessed in terms of the current adaptive capacity of existing health services and infrastructure.

Table 2- Summary of possible infrastructure responses for managing the risks associated with extreme weather events impacting on healthcare facilities [30]

POSSIBLE INFRASTRUCTURAL RESPONSES TO EXTREME WEATHER EVENTS	
Immediate	• Increased public awareness • Warning procedures for the community especially those at highest risk • Thermal control – airconditioning, close blinds, windows, etc (heatwaves) • Environmental control (to filter out smoke and dust, etc) • Emergency fire fighting response • Evacuation of those in immediate danger to safer facilities, surge hospitals, etc.
Long-term	<u>Urban planning</u> • Regulations – such as the Australian Standards, Building Codes, Health Facility Guidelines, Engineering Services guidelines – to ensure appropriate ventilation, air quality, thermal condition • Urban Design (e.g. land use, green spaces, water bodies) • Environmental management of high risk areas adjacent to urban areas or health facilities • Improved communication networks among urban planners • Redundancy built into road and transport networks to avoid isolation of facilities and emergency services • Availability of safe and environmentally controlled gathering spaces for the community to seek relief e.g. shopping centres, public libraries, etc, and to avoid unnecessary burdens being placed on health care facilities by those not in need of healthcare interventions. <u>Health System Responses</u> • Coordinated disaster responses – emergency services – ambulance, fire, police, etc that work with facilities to ensure healthcare delivery is uninterrupted • Relief plan: surge hospitals, counselling, etc <u>Facility Management</u> • Site selection and utilisation • Facility design, detailing, and construction • Maintenance of equipment, e.g. airconditioning and facility fabric such as roofs and downpipes, so that structural failure is avoided in a disaster situation • Backup and spare capacity for building services e.g. electricity, water, ensuring uninterrupted supply

The ROMS workshops indicated that an evidence-based approach must underpin adaptation strategies that are intended to respond to the threats posed by climate-related extreme weather events. However, the need to include adaptive strategies in the current health infrastructural processes has not yet been considered (i.e. design documentation and tender processes do not yet incorporate this requirement). Other difficulties in adopting this approach included the lack of evidence regarding the translation of adaptation strategies into facility requirements and designs, and the likely costs associated with these.

It should also be recognised that the current health infrastructural processes are predicated on the commercial realities associated with competitive tendering processes, and exist in a political climate faced with increasing expenditure needs for healthcare service delivery and infrastructure. Thus the need for greater apparent ‘efficiency’ in the expending of public monies often becomes the highest priority, and this usually involves reductions in capital costs. Should the need to incorporate adaptation strategies into healthcare design and facility maintenance become required, this may increase initial capital costs for health projects. This may conflict with current project delivery and funding processes which do not always recognise the link between capital and operational costs, and result in a backlash of resistance in those funding health capital projects to the incorporation of specific adaptation requirements.

4.3 Adaptive Capacity – existing and required

Research efforts to understand the impacts of extreme weather events on health services and health infrastructure are few and to date have not provided a comprehensive understanding of effective response strategies. Table 1 showed potential facility impacts already demonstrated to be associated with the health impacts generated by the identified list of extreme weather events. The workshop identified the lack of certainty around how climate change will impact the Australian community, and that a sense of urgency was beginning to become apparent but was yet to be translated into policy and adaptation strategies. Changing attitudes towards adaptation and then “ensuring behavioural change” is an important factor in enhancing the “adaptive capacity” of health infrastructure to cope with extreme weather events. Comprehensive identifications of the impacts on the social, financial, technology and the political climate are still at a relatively early stage.

Furthermore, the attitude of those managing and funding health infrastructure projects was identified as one impediment to the implementation of adaptation responses for health services and infrastructure. It was suggested that this might be partly be a result of the lack of understanding and certainty surrounding the likely additional impacts of extreme weather events on health services and infrastructure. It was suggested that research is needed to provide more evidence (including practical examples and case studies) to improve community and health system understanding regarding the likely effect of increasing incidences of extreme weather events on health services and infrastructure, and the adaptation of these to cope with the predicted impacts. A “bottom-up” approach is an alternative strategy and could be pursued simultaneously. Those working in and using facilities could promote an adaptation strategy at facility level and seek endorsement from those at higher levels of the organisation. Such efforts ultimately require great levels of stakeholder perseverance and commitment to participation in the process, as this may involve an incremental additional work load to those assessing facilities would result in ongoing assessment of the adaptive capacity of all health infrastructure. For example, specific building related data is gathered from such an assessment in addition to site-related data, plus the condition of building services such as electrical and mechanical systems, integrity of the building fabric, etc, could be assessed as required at an appropriate level of detail.

4.4 Integration with current disaster management strategies and other community responses

Currently, adaptation strategies to cope with extreme weather events are considered under the banner of disaster management and emergency planning in countries such as the US, UK, and Australia, in regard to the need to cope with terrorist attacks or outbreaks of infectious diseases within the Australasian community. However, it does not yet consider additional burdens likely to be placed on health services by increased incidence of extreme weather events. Consequenty, such efforts do not embrace clear adaptation strategies nor do they often address practical implications for infrastructure in order to safeguard critical service functions such as healthcare delivery. It is necessary to identify the need for “spare” or “surge” capacity [31] in new and existing healthcare infrastructure in order to cope with the increasing demands associated with extreme weather events.

The quantum of additional facility requirements or indeed the location of these facility resources is not yet identified, partly because the science surrounding the additional burdens on human health that may be associated with climate change has not yet been robustly investigated for the Australian situation, as noted previously. Moreover, one of the key impediments to understanding this issue that emerged from the ROMS workshop was the current lack of focus on the issue of climate change adaptation strategies within NSW Health itself. These require a heightened sense of urgency from those in NSW Health responsible for planning and funding the development of health facilities.

Another barrier to the development of suitable responses, as previously noted, is the lack of integration (or recognition of the essential interrelationship) of Capital Expenditure and Operational Expenditure budgets. This interrelationship is not always apparent during the planning phases of healthcare projects, with short term decisions sometimes made that cut capital costs in the shorter term, but often significantly increase operational costs over the longer term. Difficulties resolving planning issues are not uncommon due to the myriad different government authorities currently involved in planning the NSW urban environment. This problem also tends to be exacerbated by the inconsistencies in process and efforts between the different responsible authorities, plus the lack of continuity in the government bodies representing the different sectors due to their frequent changes in personnel, shifting areas of responsibility and thus their effective realms of influence.

4.5 Research Required

Impacts of Climate Change extreme weather events on Health and Facilities: Although awareness of climate change has permeated through the Australian government system and other funding bodies, many were still uncertain about its impact on Australia and the health of its community, its health services and infrastructure. It was also noted that there was uncertainty (and confusion) surrounding the government's commitment to pursuing the adaptation route for health infrastructure as opposed to mitigation strategies. Current research is now focusing on climate change related impacts on human health on a regional basis, for example, Campbell-Lendrum and Woodruff [32]. However, this study also notes that 'The attempt to carry out a full accounting of the health impacts of climate change rapidly clarifies significant knowledge gaps', which require further research to obtain more useful predictions of these impacts. [33]. The use of GIS[2] mapping, LIDAR[3] and other technologies to examine the impact on real locations of the predicted increasing incidence and variability of extreme weather events are feasible techniques already being used. These could be used to assist in modelling the impact of the impacts of climate change on existing health care infrastructure and to assess the suitability of proposed locations (or necessary re-locations) of future facilities.

Infrastructure Responses and Adaptive Capacity: Several strategies were identified by the workshop to encourage a better understanding of the suitability and applicability of adaptive responses through evidence-based practice. These included the development of innovative strategies through multi disciplinary research that should include accurate forecasting of implementation costs. To maximise the likelihood of implementation of these strategies, they should where possible align with current government policies and practices. Where possible, they should become an extension of existing processes and procedures and require minimal additional staff or equipment for implementation.

Integration with Current Disaster Management Strategies and other Community Responses: Suggestions made at the workshop to address this requirement included the need for applied research to be more prescriptive in its outcomes specifications and to include the prioritisation of efforts to respond to disaster planning strategies within agreed adaptation frameworks. As part of an expanded disaster response strategy, healthcare infrastructure becomes even more critically important to the community, and this fact should assist those asserting the importance of adapting health infrastructure to cope more effectively with extreme weather events. In practical terms, this provides an extremely robust argument for influencing the Asset Management Planning policies and processes of NSW Health. The role of health care infrastructure should be to support health system responses in disaster situations at least by not failing when placed under such additional pressure.

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[2] ***G**eographic **I**nformation **S**ystems*, tools used to gather, transform, manipulate, analyze, and produce information related to the surface of the Earth. This data may exist as maps, 3D virtual models, tables, and/or lists (webopedia.com, accessed 05 June 2007)

[3] 'Lidar' or laser radar is a method for detecting distant objects and determining their position, velocity, or other characteristics by analysis of pulsed laser light reflected from their surfaces. (Answers.com, accessed 05 June 2007)

To assist in the implementation of adaptation measures, it is suggested that costs and operational benefits must be identified by those advocating climate change adaptation strategies. These benefits should be identified and tested against performance measures specifically developed for health services and health infrastructure, requiring engagement with building industry experts (contractors and facility managers) in the arena. These may include business continuity issues in disaster situations, with health services required to maintain current and increased levels of health service delivery in disaster situations.

4.6 Communication of Research Findings

Developing a greater understanding of the impact of extreme weather events on health infrastructure requires a range of strategies, particularly those emphasising clear and effective communication with stakeholders.

- Providing scientific information and evidence on the immediacy and severity of the likely impacts of extreme weather events on human health and health infrastructure in NSW
- Releasing research publications reporting findings from influential forums and respected research bodies
- Maintaining the relationship of project objectives to a wider national research agenda
- Continuing to engage with leading and/or credible researchers in the area (particularly in terms of applied research)
- Clarifying the extent of problems and costs that may be associated with neglecting the necessary adaptation efforts
- Identifying a range of possible adaptation strategies for health facilities in terms of suggested future projects, costs, programmes, actions and demonstrable outcomes.

Influencing clinical and asset management practices could be achieved by means of demonstration projects showing the implementation of health infrastructural adaptation strategies and ongoing evaluation of these. In addition, practices could also be influenced directly through development and implementation of government policy. This may be aided by keeping the dialogue simple, establishing mechanisms to facilitate cross sectional communications, and encouraging health services to be proactive in accelerating change and being brokers in determination of action agendas.

5. Discussion and Recommendations

This study has found that the current lack of understanding of the problems (nature, frequency, severity, and relevance) associated with extreme weather events in Australia (including NSW) has led to perceived uncertainty surrounding the need for adaptive strategies for health services and infrastructure in response to the increasing incidence of extreme weather events likely to be associated with climate change. Consequently, further research is needed to increase the understanding of the impacts of extreme weather events on both healthcare service needs and health infrastructure to ensure uninterrupted delivery of these services. This involves the quantification of such impacts, including the risks associated with ignoring them and not acting, as well as the benefits associated with a prompt response. The information should be made available and communicated in a form that may be clearly understood by the community.

Results from this undertaking should then be distributed in seminars and forums and through other influential bodies that endorse climate change adaptation agendas. Finally, as further research is undertaken and adaptation strategies implemented, an education and communication strategy should be developed to inform key stakeholders regarding:

- The likely impacts of climate change on the demands for health services in NSW health facilities
- The adequacy of current NSW health infrastructure capacity to cope with the additional demands likely to be imposed
- Implementation strategies for reconfiguring or augmenting capacity to cope with the identified demands
- The costs associated with this reconfiguration or augmentation, and assurances given that these will be met in order to ensure business continuity within the health sector in the event of natural disasters now and into the future
- Confidence that an integrated disaster planning and management strategy is in place that will ensure the continuity of operation of health facilities in the event of natural disasters associated with the increasing incidence of extreme weather events likely to be generated by climate change.

6. Conclusion

Although this study focused on a specific geographic region and health system (NSW Health) many of the findings are clearly generalisable to other settings and locations. The study demonstrates the need for a systems approach to developing adaptive capacity in healthcare infrastructure to cope with climate change. This includes the requirement to determine not only the impact of increasing incidences of extreme weather events on the health of the community that may increase the demands of the customers for healthcare services, but also to consider how to prevent health facilities failing under the demands placed on the building fabric due to these same events. Working with existing systems appears to offer the greatest chance of success in achieving both these aims. For example, where possible, tapping into existing disaster management frameworks will ensure more effective community responses and greater pressure for the development of adaptive capacity for healthcare infrastructure. This approach will thus also be more responsive to the existing political, social, technological and institutional capacity, wherever the healthcare system may be located.

Authors Note: This paper draws substantially on (and reproduces some parts of) the Report into the Potential Impacts of Climate Change Related Extreme Weather Events on NSW Healthcare Infrastructure, unpublished draft dated 31 May 2007, (Carthey et al., 2007). Therefore, acknowledgments must be made to Glenis Lloyd of the NSW Health Environmental Health Branch, the project sponsor.

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Sustainability index for roof covering materials

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Abstract

Construction is the largest user of materials of any industry. Hence selecting environmentally preferable building materials is one way to reduce the negative environmental impacts. The insufficiency of scientific data available in Sri Lanka for roof covering material selection is seen as a problem. The purpose of this study is to derive sustainability index for alternative roof covering materials which will assist the design team members to take informed decision. It was intended to take into consideration the environmental, economic and technical performance of the roof covering materials. Life Cycle Assessment (LCA) is adopted to assess the alternatives including the economic and technical performance. The attributes, Embodied energy, Reusability and Hazardous emissions to air measured in terms of Global warming potential (GWP), Acidification Potential (AP) and Criteria air pollutant (CP) are representing the Biophysical aspect of sustainability. The attribute, Life Cycle Cost represents the Economic aspect of sustainability and Functionality measured in terms of thermal performance represents the Technical aspect. According to the overall sustainability index derived, Asbestos takes the highest index while Zn/Al takes the second highest and Calicut tiles take the least index.

Keywords: Embodied energy, Roof covering materials, Life cycle assessment

1. Background

1.1 Sustainable construction

All economic sectors, including the construction industry, now face an inescapable challenge posed by the term “sustainability”. The construction industry is commonly considered as one of the largest industries in both developed and developing countries in terms f investment, employment and contribution to GDP. Consequently, the impact of the construction industry on the environment is also significant [7].

In 1987, the World Commission on Environment and Development (WCED) produced a publication entitled Our Common Future (WCED, 1987), which is referred to as the `Brundtland Report'. The publication described the concept of sustainable development as meeting the basic needs of all people and extending to all the opportunity to satisfy their aspirations for a better life without compromising the ability of future generations to meet their own needs [4].

The term `sustainable construction', was originally proposed to describe the responsibility of the construction industry in attaining 'sustainability'. First International Conference on Sustainable Construction was held in November 1994 in Tampa, Florida, United States of America. A major objective of the conference was `to assess progress in the new discipline that might be called "sustainable construction" or "green construction" [4].

Green design leads to sustainable development. Green design principles are adopted at design phases of construction. These principals are meant to affect the design so that the construction becomes sustainable." Green design" is intended to develop more environmentally benign products and processes [3].

Hill and Bowen ended up in figuring out a framework for the attainment of sustainable construction. They outlined two multi-stage frameworks which would lead to sustainable construction. They are as follows,

- Application of Environmental Assessment (EA)
- Implementation of Environmental Management system (EMS),

In the planning and design stages of projects, sustainable construction can be achieved by applying the principles, procedures and methods of Environmental Assessment (or Environmental Impact Assessment). A comprehensive traditional EA would evaluate alternatives for the sourcing of certain materials, such as the siting of quarries for stone aggregate, but would be unlikely to consider the life cycle environmental costs of most materials and products used in the construction process [4].

The traditional EA should be expanded to consider life cycle assessment of alternative materials and products which could be used in the construction process. In addition, the EA should ensure that efficiency is a key criterion in the use of water, energy and land. The results of such a life cycle assessment should influence the purchasing specifications for materials and products to be used. These examples illustrate how application of the principles of sustainable construction would expand the practice of EA towards the goal of attaining sustainability [4].

As Environmental assessment methods deal with assessing the whole building in terms of sustainability, they are inherent of the drawbacks that they do not consider the relative importance of criteria and they lack in considering whole life cycle of the product which is necessary as far as sustainable construction is concerned. Current methods for environmental assessment of buildings such as BREAM and BEPAC only focus directly two principles-

‘environment’ and ‘futurity’. They do not include criteria which explicitly assess buildings against either ‘equity’ or public participation [2].

1.2 Construction materials

‘If the construction industry is considered globally, it is by far the largest consumer of materials on planet Earth. The fact that construction materials are low-value should not surprise us; neither should it blind us to the importance of these materials. The sheer scale of consumption means that their use has a major impact on the environment, and economists, engineers and environmentalists have all devoted much thought to ways of measuring this impact. A number of criteria or indices of impact have been devised, with the objective of furnishing numerical data, which can help decision making. Qualitative assessments are useful up to a point, but if real progress is to be made it are necessary to quantify the impacts of materials consumption [6].

The concept of sustainable building incorporates and integrates a variety of strategies during the design, construction and operation of building projects. The use of green building materials and products represents one important strategy in the design of a building [5].

1.3 Building materials and sustainability

The overall performance of the building is the most important consideration in achieving more sustainable construction. Building materials play an essential role in increasing the energy efficiency of buildings and contributing to economic prosperity. Traditionally, materials selection for the design and construction of facilities has been based on economic and technological considerations, given the desired life span of a facility and the program of requirements and codes it must meet. In design environments where ecological, health, and ethical impacts are increasingly important, often the only way to choose from many different material alternatives is by relying upon on quantified professional judgment or past experience. The method should allow comparison of not only the technical performance and costs of materials, but also the immediate and long-term impacts their use has on the finite supply of natural resources and the ongoing needs for those resources by society. Together, these impacts comprise a measure of the sustainability of materials and should be given consideration during materials specification [1].

1.4 Aim of the study

Based on the background study, the necessity for scientific data which could assist the process of material selection was identified. And also it was found that such data do not exist in Sri Lanka for roof covering material which has a significant contribution to the sustainability of the whole building. Hence this study aims at developing a sustainability index for roof covering materials which could be used to assist selection.

The objectives for this study were as follows,

- To calculate the embodied energy of the roof covering material
- To establish the level of reusability of the roof covering material
- To calculate the emissions to air during the life of the roof covering material
- To determine the life cycle cost of the roof covering material
- To determine the functionality of the roof covering materials in terms of thermal comfort

2. Research Methodology

Life Cycle Assessment was adopted as the methodology for this study. Life Cycle Assessment is a “cradle-to-grave,” systems approach for measuring environmental performance. The approach is based on the belief that all stages in the life of a product generate environmental impacts and must therefore be analyzed, including raw materials acquisition, product manufacture, transportation, installation, operation and maintenance, and ultimately recycling and waste management.

This study was limited to the following roof covering materials,

Asbestos corrugated sheets.

Zn/ Al sheets

Calicut tiles

According to the release ‘Census of Population and housing, 2001’by Census and Statistics department of SriLanka, the above mentioned roof covering materials has the highest usage in housing units in SriLanka. (Simple pitched roof with 30x100 ft plan area was considered for this study).

Selection of the manufacturing organizations

Manufacturing organizations were selected based on their level of maintenance of documentations. Organizations which had obtained SLS standards or the ones which were owned by government were assumed to have proper documentations maintained. Where the organization did not meet the above mentioned requirements, more than one organization was investigated to cross check the figures and the average figures are taken as final figures.

Data Collection Procedure

Semi structured interviews with the professionals or technicians who are familiar with the production processes were done and observations of the processes involved were also adopted as other means of data collection. In addition, documents were referred where ever necessary.

3. Methodology and limitation for each objectives

To calculate the embodied energy of the roof covering material

Process analysis has been adopted in calculating the embodied energy for this study because the simple reason that it produces accurate results. Process analysis was carried out only at the final factories at least one for each alternative. Embodied energy figures already available for intermediate products were directly used.

To establish the level of reusability of the roof covering material

Reusability was measured in terms of the importance to be reused. It was calculated by the fraction of prices of old roof covering material and the new roof covering material.

To calculate the emissions to air during the life of the roof covering material

Major portion of the emissions during the life time of the roof covering materials is by transportation and during manufacturing, since the roof covering materials alone do not emit any gasses through its life time. Transportation at the final manufacturing factory was the only transportation considered for this study. Transportations at intermediate productions are not considered due to time constraint. The emissions were related to environmental impacts which could be grouped under LOCAL EFFECTS and GLOBAL EFFECTS. For the transportation by sea, the same emission factors of vehicles were considered because of the non availability of emission factors and of the fact that the emissions by sea transportation are obviously more than that of the land transport.

LOCAL EFFECTS

Acidification Potential; Acidifying compounds may be in a gaseous state either dissolved in water or fix in solid particles.

Criteria air pollutants; are solid and liquid particles commonly found in the air.

GLOBAL EFFECTS

Global warming potential; was considered as Global effect. Global warming potential is represented in grams of CO2 emitted.

In order to express these three impacts in CO2 equivalent values, following normalisation values were used (Table 1). However each impact was given equal importance.

Table 1Normalization values for environmental impacts

Impact	Normalization Values
Global warming	25 582 640.09 CO2 equivalents/year/capita
Acidification	7 800 200 000.00 millimoles H+ equivalents/ year/capita
Criteria air pollutants	19 200.00 microDALYs / year/capita

To determine the life cycle cost of the roof covering material

Life cycle cost was considered. Initial cost involved the cost of roof covering materials with the costs of roof frame and roof plumbing. Discount rate is arrived at considering the commercial bank lending rates. The interest rate was taken to be 15 percent for this study which is the average of the period, 1977 – 2001.

To determine the functionality of the roof covering materials in terms of thermal comfort

Because a research had already been done comparing the values for thermal comfort of roof covering materials, it was decided to use those as secondary data for this study in order to meet this objective.

4. Data analysis

4.1 Embodied energy

Embodied energy of calicut tiles

Four cases were examined in order to determine the Embodied Energy (EE) of calicut tiles. Table 2 contains the energy consumption at different stages of life cycle based on the findings of case 1. This table displays the energy consumption for 11, 200 numbers of tiles considered. Findings on other three cases had slight differences because of the difference in technology and transportation distances. Average Embodied energy of the four cases investigated amounted to 26,170.29 MJ.

Table 2Energy at different stages of life cycle of calicut tiles

Stages of Life cycle	Energy in (GJ)
Extraction	0.396
Transportation	3.079
Drying	123.696
Firing	125.047
Pugging and extruding	6.104
Embodied energy	258.322

Embodied energy of asbestos sheets

Table 3 displays the energy consumption at different stages of life cycle and the total embodied energy of asbestos sheets based on the findings at the factory investigated for 800 Asbestos sheets of the size 10’x3’. Only one factory was investigated for asbestos sheets.

Table 3Energy at different stages of life cycle of Asbestos sheet

Stages of Life cycle	Energy in GJ
Production of asbestos ore	64.602
Production of cement	129.616
Transportation	7.279
Manufacturing	3.330
Embodied energy	204.827

Embodied energy of Zn/Al sheets

Table 4 contains the energy consumption at different stages of life cycle and the total embodied energy of Zn/Al sheets based on the findings at the factory investigated for 12 Tons of Zn/Al sheets of 0.35 mm thickness. Only one factory was investigated for Zn/Al sheets.

Table 4Energy at different stages of life cycle of Zn/Al

Stages of Life cycle	Energy in GJ
Production of high tensile steel	417.600
Transportation	7.256
Manufacturing	0.046
Embodied energy	424.902

4.2 Environmental impacts

Environmental impacts of calicut tiles

The following table displays the average impacts of the four cases investigated for calicut tiles.

Table 5Environmental impacts of calicut tiles

Effects	g CO2 Equivalents
Global warming	2,894,797.89
Acidification	17.28
Criteria air pollutants	1,176.89

Environmental impacts of asbestos sheets

Table 6 Environmental impacts of asbestos sheets

Effects	g CO2 Equivalents
Global warming	484,183.00
Acidification	6.51
Criteria air pollutants	443.47

Environmental impacts of zn/al sheets

Table 7 Magnitudes of the Environmental impacts of Zn/Al sheets

Effects	g CO2 Equivalents
Global warming	482,710.20
Acidification	7.79
Criteria air pollutants	529.73

4.3 Reusability

Table 8 Reusability of the alternatives

Roof Covering materials	Average market price of old material (Rs)	Market price of new material	Reusability
Asbestos sheets	56.25	110.00	0.51
Zinc alum sheets	398.50	907.00	0.44
Calicut Tiles	6.50	24.00	0.27

Value indexes for each variables considered

Table 9 Value index for Embodied energy

Roof covering material	EE per 1 square meter of roof plan area	Value index
Asbestos sheets	134.90	100.00
Zinc alum sheets	1,448.43	9.31
Calicut Tiles	549.57	24.38

$$\text{Value index} = \frac{\text{Minimum value of EE}}{\text{Embodied energy value}} \times 100$$

Table 10Value index for Global Environmental impacts

Roof covering material	Global environmental impact in terms of CO2	Value index
Asbestos sheets	318.88	44.78
Zinc alum sheets	142.81	100.00
Calicut Tiles	49,211.56	0.29

$$\text{Value index} = \frac{\text{Minimum value of Global impact}}{\text{Global impact}} \times 100$$

Table 11Value index for Local Environmental impacts

Roof covering material	Local environmental impact	Value index
Asbestos sheets	0.30	50.00
Zinc alum sheets	0.15	100.00
Calicut Tiles	25.08	0.59

$$\text{Value index} = \frac{\text{Minimum value of Local impact}}{\text{Local impact}} \times 100$$

Table 12Value index for Life cycle cost

Roof covering material	Life cycle cost	Value index
Asbestos sheets	654,440.00	100.00
Zinc alum sheets	2,803,186.00	23.34
Calicut Tiles	1,040,520.00	62.89

$$\text{Value index} = \frac{\text{Minimum value of Life Cycle Costing}}{\text{Life Cycle Cost}} \times 100$$

Table 13Value index for Reusability

Roof covering material	Reusability	Value index
Asbestos sheets	0.51	100.00
Zinc alum sheets	0.44	86.27
Calicut Tiles	0.27	52.94

$$\text{Value index} = \frac{\text{Reusability}}{\text{Amount of best case}} \times 100$$

Table 14Value index for Functionality

Roof covering material	Functionality ranking	Index
Asbestos sheets	2	50.00
Zinc alum sheets	3	33.33
Calicut Tiles	1	100.00

$$\text{Value index} = \frac{\text{Minimum rank value}}{\text{Functionality rank}} \times 100$$

The following table contains the sustainability indexes for each alternatives considered. This sustainability index was arrived at by summing the value indexes derived for each variable for each roof covering alternative considered.

Table 15 Sustainability index

Roof covering material	Sustainability index
Asbestos sheets	444.78
Zinc alum sheets	352.25
Calicut Tiles	241.09

The following radar chart, graphically illustrates the level of sustainability of the each roof covering material considered. More the area a material is dispersed from the centre of the graph, the more its sustainability.

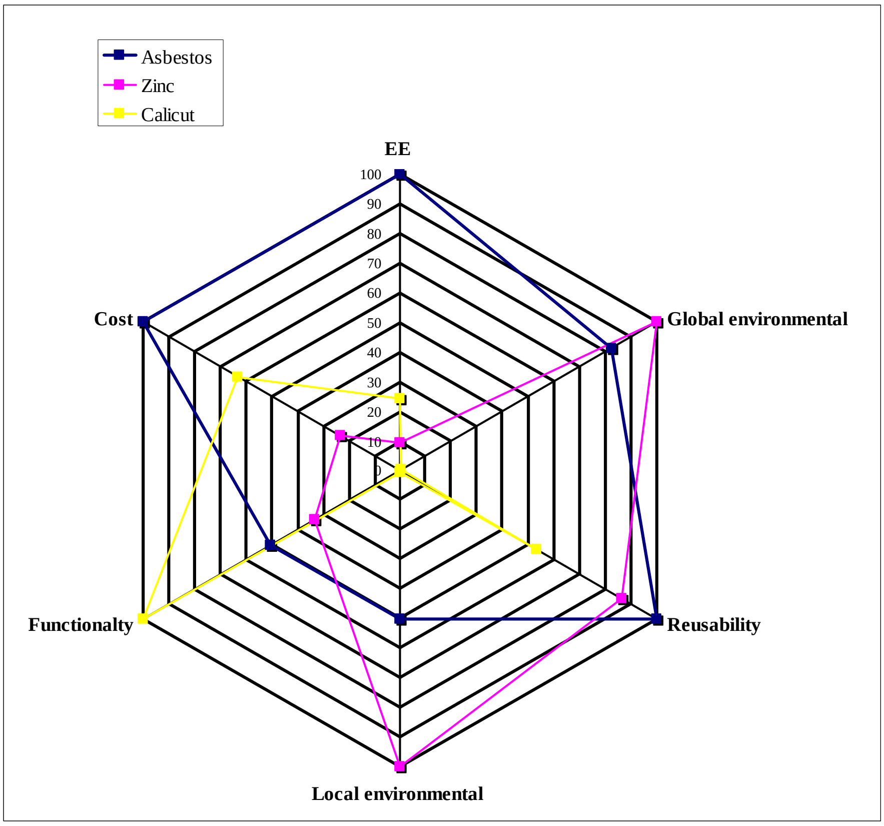

Figure 1 Graphical representation of sustainability of roof covering materials

5. Conclusion

Based on the findings of this research, Asbestos sheets have the lowest embodied energy coefficient where as calicut tiles have the highest. It is because of the reason calicut tiles uses fire wood extensively for production. Asbestos sheets are less energy consuming. However this increased energy consumption could be off set against the calicut tiles' longest life time.

As far as Global impacts are concerned, Zn/Al sheets have the lowest Global impact where as Asbestos and calicut tiles have higher Global impacts. The reason for the calicut tiles to have higher values for Global impacts (E.g. Global warming) is that it uses fire wood extensively which results in increased emission of CO2. Calicut tiles have the highest effect on the local environment too, due to its long transportation with large quantities and the immense use of fire wood. Asbestos sheets have high reusability index whereas the Zn/Al sheets have the second highest and calicut tiles takes the least. When comparing asbestos sheets and calicut tiles based on life cycle costing, asbestos sheets takes the lower NPV value, because of the reason that its frame cost is significantly less than that of calicut tiles', even though it has one replacement during the life of the building. For Zn/Al sheets the cost of roof frame and roof plumbing are comparatively high and it has three replacements during the life time of the building. Hence Zn/Al takes the highest NPV among other two roof covering materials. calicut tiles have the highest thermal performance reducing the cost of roof insulation and Asbestos and Zn/Al sheets have their thermal performance ranked second and third respectively.

The findings of this research are based on two limitations. Each attributes of sustainability was given equal importance; embodied energy and life cycle cost may not be of equal importance. No normalisation values were used in order to add the value indexes together to arrive at the sustainability index; reusability and environmental impacts are in two different units.

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Towards process mapping the development of sustainable housing projects in the UK

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Abstract

In the UK the focus on design and planning processes has been strongly influenced by the need for decision-makers to respond to government policy regarding community involvement, the development of sustainable communities and transparency. The Consideration of sustainability alongside the financial impacts of the construction projects calls for the focus during the pre-construction stage of a life cycle of the project to shift towards the life cycle of the project. The major benefit of sustainable building projects is their low environmental impact within and after the construction stage and even after their deconstruction. Using good quality materials from sustainable sources will increase the lifecycles of sustainable construction projects and reduce their negative impact on the climate.

This research aims at developing an initial framework of the processes involved with sustainable socially owned housing projects which when further refined could help deliver better social housing projects. Interviews were conducted with construction professionals in the operating within the development processes of sustainable social housing projects. The emergent framework highlights the actual processes used on the ground to consider sustainable factors as well as the pre-construction cost evaluation of social housing projects. It examines the actual consideration of the project whole life cycle during the feasibility stage for this type of projects. This early consideration of sustainable issues in general and sustainable materials in particular helps to reduce the negative effects of the construction projects on the environment and prepare by the using of recyclable materials to avoid the awful impacts of unexpected disasters on the environment.

Keywords: Process mapping, Climate, Social housing projects, Sustainability, Cost

1. Background

Building materials are commonly selected through functional, technical and financial requirements. However, with sustainability as a key issue in the last decades, especially in western countries, the environmental load of building materials has also become a more important criterion. Causing the minimum possible harm to the environment and users through the design, construction, use upkeep and eventual end of life recycle, avoiding the need to destroy, and replace or abandon as unsuitable without proper consideration, should all be amongst the aims of the sustainable materials [1].

The building industry, directly or indirectly causing a considerable part of the annual environmental damage, can take up the responsibility to contribute to sustainable development by finding more environmentally benign ways of construction and building. The polluted air, land and water, climate change, loos of biodiversity are some of the negative consequences of unsustainable construction upon the environment [2]. Overall energy use, carbon dioxide emissions, number of threatened species, and water pollution levels all continue to increase; extreme weather events and other environmental disasters clearly indicate our increasing pressure on the planet [3]. The rising consumption of resources is more than the planet can bear [4]. The sustainability of a certain material based product is mainly dependent on the materials used for the product itself or during its lifetime. The selection of sustainable materials for a construction projects, recycling and reuse these materials and using renewable resources are of vital importance to respond to the environmental problem and prepare to avoid the awful impacts of the unexpected disasters. These sustainable materials determine the use of our natural resources as well as the amount of energy used for the production and the use of the product [5], [6] and [7]. However, it is also very important to select materials and equipment from sustainable sources, with the lowest in-use environmental impacts, with the lowest embodied environmental impacts, and with high-recycled content.

This paper reviews key elements of choosing sustainable materials approach as a background for understanding the environmental impacts of construction materials upon the environment. After this introduction, a discussion about sustainable material and recycling is developed for consideration of how to minimise the negative environmental impacts of the construction materials. Thus, the initial steps involved in the development of a process mapping of sustainable social housing projects examined as an example of the real considerations of sustainable issues in the construction projects. Finally, the paper concludes with some general recommendations regarding the importance of choosing sustainable construction materials.

1.1 Measuring environmental impacts of materials

The environmental impact of construction, sustainable buildings, designing for recycling and eco-labelling of building materials have captured the attention of building professionals across the world [8] and [9]. The greenhouse gas emissions, toxic emissions, habitat destruction and resource depletion caused during the extracting, processing and transporting of construction materials and then dealing with their waste have major environmental impacts. Corgolewski [10] explained that taking into account the environmental impacts of selecting durable and well performing materials chosen for sustainable construction projects should be done over their full life cycle including manufacturing, construction, operation, maintenance, demolition and disposal. In each phase, consideration of the energy used, resources consumed, waste generated, potential for recycling and emission generation should be given. Looking more specifically at the housing industry, the environmental impacts of the long-life materials in a house are significant in ways that create quality, long lasting environments with minimum damage to the planet [1]. It then goes further by minimising the embodied impacts of the construction materials used to achieve the design of the sustainable housing projects. Barton [11] explained that the UK government has become interested in sustainable housing during the 1990s, along with other mainstream actors, such as private sector house builders. Low carbon sustainable housing projects are one of the attempts to solve the climate change problem. Climate change has been judged by the UK government to be an important domestic and international environmental issue [12]. The UK government wishes to see all housing associations integrate sustainability into their procurement and development approaches in terms of a triple bottom line approach to project evaluation to create more sustainable housing projects. This will have important implications for all those organisations involved in social housing, it will place sustainability, and its assessments at the heart of housing procurement practice [13].

BREEAM incorporates a profiling system to assess the environmental impacts of commonly used building materials and components called *The Green Guide to Specification*, first developed in 1996. The *Green Guide* enables practitioners to tell if the materials and components they specify have a low environmental impact. Rather than using full life cycle assessments which are complex, time consuming and expensive processes, the environmental ratings summarised in the *Green Guide* provide a quick and easy way for designers and specifiers to assess their options [14]. The UK government has pledged to reduce energy consumption and CO_2 emissions to a level of 20% less than the 1990 figures by 2010. The manufacturing of building materials and components still accounts for over 10% of national UK energy use representing some 29% of national industrial energy use [15]; the environmental harm arising from the production of some materials also continues to be of concern. CIBSE [16] guide L explained that materials production and construction accounts for 30% of the total waste in the UK. Some production processes can result in volatile organic compounds VOC emissions, which can be irritants or toxins. Nitrous oxide NO_x, released in energy production and manufacturing combustion processes, is both a contributor to acid rain and reacts with VOCs in sunlight to produce photochemical smog that in turn is implicated in increased incidence of asthma and respiratory illness. SO_2, also released from the combustion of oil and coal products primarily, is the main contributor to acid rain [14].

It is evident that construction materials have a major impact on the environment. It is therefore very important to specify recyclable sustainable materials as one of the main processes during the pre construction stage to minimise the damage caused by the construction projects on the environment.

1.2 Recycling

Thormark [17] explained that recycling and reused building materials are very important issues in order to reduce the environmental impacts within the building sector. The main benefits of recycling are saving of natural materials, saving of energy, decrease of harmful emissions and reduction in space needed for landfill. In the early stages of product development, recycling or deposition must be taken into account to achieve sustainable products with a minimum of environmental impact. Appropriate design and construction practices can help components be easily extracted at the end of their useful life in such a way that they can be reused or recycled [10]. The selection of sustainable materials must strongly be directed to the future recycle-ability of a product in order to meet the demands of the future. Choosing sustainable materials for construction means that recycling these materials after deconstruction or during the reconstruction activities following disasters can be done in a number of ways:

• *Energy recycling*. The material is burnt and the energy is used for heating.

• *Material recycling*. The material is typically re-processed in order to make new products.

• *Re-use (or recycling)*. The product or parts of it can be used again, sometimes after reconditioning. Reconditioned products or spare parts are sold at a lower price than a new part which is typical for second hand markets (used car parts, etc.).

• *Breakdown*. Natural organic materials, many synthetic polymers and some metals can be broken down naturally in the nature or by chemical methods to environmentally friendly products or chemicals.

All processes mentioned above are generally restricted by environmental legislation, which is a way to minimise toxic products and/or emissions to be formed, which can lead to air or water impacts as well as affect human beings, animals and plants. Recycling can have different meanings as can be understood from the examples above. A clear definition of the word is recommended to avoid misunderstanding in specific cases [18]. However, typical recycling processes could be chosen after disasters depending on the type of the project and the materials used for the construction. It is very important to know the key sustainable factors which are taken into account during the whole life of the project and insure that choosing sustainable materials is one of the main processes to develop sustainable projects during the pre-construction stage of these projects.

2. Materials and process mapping in construction projects

Although the government is still striving towards the improvement in the construction industry since 1994, the success to achieve that is still apparently little. The recent highly instructive reports of Harty *et al*. [19] provided a comprehensive range of factors, some of which will affect the future of the construction sector. It was unsurprising, that sustainability, as one of the current trends which is considered of primary importance in the construction industry, is still short of getting to grips with the complexities and uncertainties of both the present and the future of the construction industry. These reports confirmed that there are still significant weaknesses in the construction project delivery processes. Project delivery processes are the processes used to get owners needs converted into a constructed facility, and include programming, procurement, design, construction, and operation. Lapinski *et al.* [20] supposed that part of the reason for high process waste is that owners and project teams have a limited understanding of which processes are the most important ones for sustainable project delivery. Further, the intermediate deliverables, activities, and outcomes of current delivery processes are best suited for conventional building types and are often unresponsive to the needs of sustainable building projects [21]. In addition, it is posited that process mapping can be used to improve the customer focus of the process by assisting in the elimination of the non-value added activities and reduce therefore the process complexity [22].

Having recognised that social housing is a major point for the development of a sustainable community, the UK government seeks to develop more sustainable policies in this type of publicly financed building project. As sustainable housing projects offer numerous benefits including energy efficiency, improved indoor environment quality, increased health and occupant productivity, and the minimization of resource usage during the construction and operation of the building. However, to achieve their performance benefits, additional requirements are often needed in the delivery processes for sustainable housing projects. The focus on design and planning processes has been strongly influenced by the need for decision-makers to respond to government policy regarding community involvement, alongside the development of sustainable communities and transparency. Riley *et al.* [23] explained that sustainable building projects require intense interdisciplinary collaboration, highly complex design analysis, and careful material and system selection, particularly in the early stages of the project delivery process. Lapinski *et al.* [20] claimed that a first cost premium is commonly associated with sustainable buildings because of their additional requirements to purchase better quality building components and super insulated building envelopes. However, the current project processes which are used to deliver sustainable buildings are often laden with wasteful rework, delays, changes, and overproduction [24]. Social housing projects are a good example of the building projects in UK, but it is asserted that they suffer the same critical weaknesses in their delivery. There is a great need to investigate the current processes of developing sustainable social housing projects, identify the various phases of social housing projects with particular emphases on sustainable issues to capture the actual stages during setting their budgets.

2.1 Generic process protocol

Research conducted by Shashar *et al.* [25] developed a generic process protocol for use in the construction industry. The process protocol is a mechanism that facilitates the arrangement and classification of all the processes that are involved in the design and construction of a project. It can be thought of as an information route-map of how the processes related to construction projects ought to work so as to produce a more efficient, effective and economical way of undertaking the design and construction of projects. It has been claimed that tangible benefits can be realised in this process through waste reduction, shortening the duration of projects and improving communication methods and channels [26]. The process protocol identified the main phases of activity that need to be addressed in the delivery of a client's project but as yet its many sub-phases remain to be fully detailed. The generic process protocol considers the whole lifecycle of the construction project whilst integrating its participants under a common framework. The process protocol is divided into a series of sub phases defined as: pre project, preconstruction, construction and post construction. Within each of these major phases there are sub phases that can be operated at the same time to make the process more efficient in smaller scale projects. One such sub-phase of the pre-project phase of the project is the pre-design phase. At this initial stage of the project the process is unpredictable because it has not yet been specified in detail and adopted in practice; such processes can change as the brief or clients needs progress. It has been claimed that performance at this sub-phase level depends on the capabilities of the individuals, rather than that of the organisation [25].

2.2 OGC procurement guide:

OGC guides [27] and [28] were provided in 2007 by the UK Government who underlined its commitment to sustainable development to achieve a better quality of life through the efficient use of resources. The first guide took the project procurement life cycle as its base and focused to deliver a sustainable solution which satisfies the social, economic and environmental aspects of sustainable development that should be addressed during the lifecycle. The project procurement lifecycle considers the whole life of a project from inception through to design and construction, operation and finally re-use or disposal. It is a process which identifies where and when key decisions are to be made and determines the critical outputs that should be delivered at each stage of the project.

The project procurement lifecycle according to this guide encompasses the following critical phases:

- Business justification
- Project brief and procurement Process
- Design brief
- Construction process
- Operation and management
- Disposal and re- use.

This guide was taken as a base which illustrates the processes by which the public sector client can procure and deliver construction projects that best promote sustainable development while still achieving optimum whole life value for money. Examining sustainability in the second guide helps the project team to identify the range of options and deliver the best value whole life solution. However, this guide highlighted the key areas of sustainability together with a series of questions and steps for action to help to choose the best solution for the project.

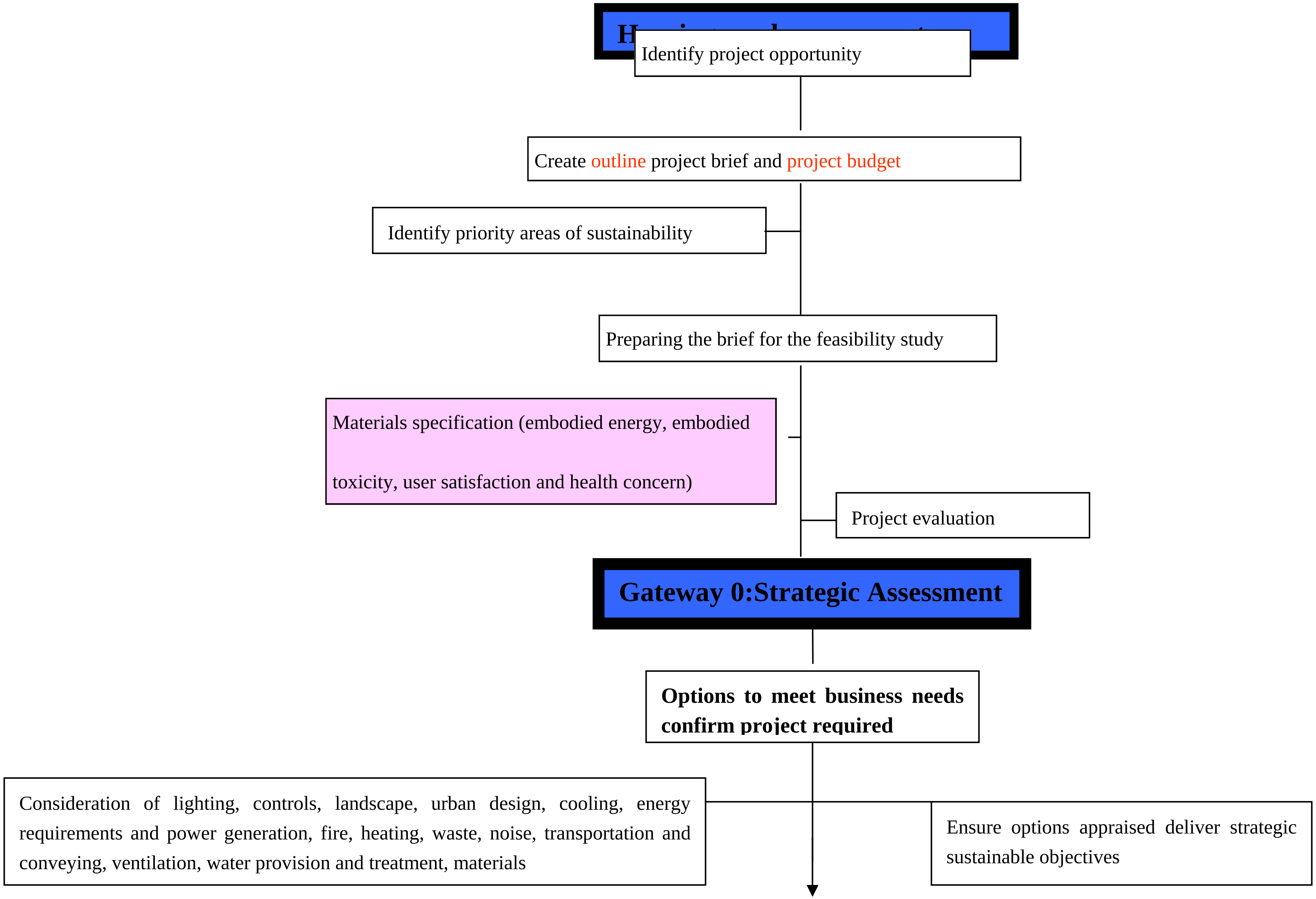
The consideration of sustainability is placed alongside the consideration of all the procurement processes in this guide. It starts with clearly highlighting of the importance of sustainability considerations with all the risks associated in the brief stage to the client to ensure that all parties involved in the project are considered in the project are conscious of the client’s needs and requirements. The tender appraisal process should be made clear so tenderers should be asked to provide full details of how the required sustainability objectives will be achieved. So in the pre construction stage the client must be satisfied that the proposals meet or exceed the original project and design brief. While the client and the integrated supply team should make provisions to minimize pollution and disruption during the construction period and ensure the health and safety of local residents as well as construction site staff. At the end the construction period and as a part of the commissioning and handover of the project, the client should be provided with training, facility operations and maintenance information, health and safety files and procedures for reporting defects.

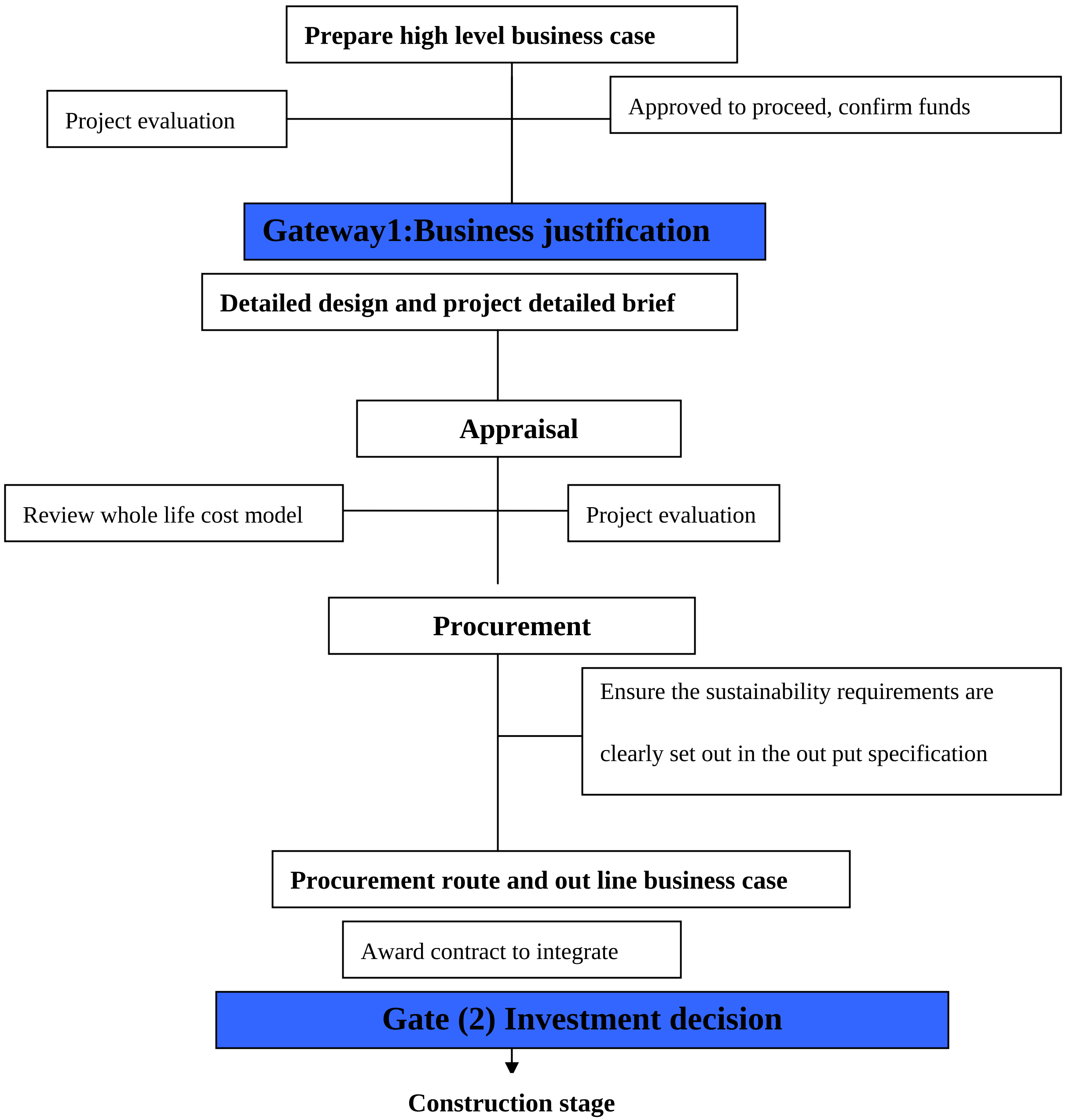
2.3 The research contribution:

The aim of this part of the research is to develop a process map as an essential tool for construction processes of sustainable social housing projects. Its aim is to check the reality of considering sustainable issues in general and sustainable materials in particular during the initial steps of developing the project budget. It aims also to evaluate the existing process maps and to identify when and how sustainable factors are taken into account in this type of projects. To achieve that, the research developed an integrated framework between the generic process protocol as an academic point of view of the process of developing the project and both of the OGC 2007 procurement and sustainable frameworks from the public funding projects point of view. Then this integrated framework was tested in the social housing projects of housing associations to check its validity.

Comparing of the Generic Process Model and the OGC model and pointed out some of their inconsistencies. It was not possible to find enough integrating points between these two frameworks as they have different critical phases and different hard gates. In addition; there is no clear mention for sustainability in the generic process protocol. For that and as publicly funded social housing projects in the UK are supported by the government, in addition to the great emphasis on sustainable issues within the whole life cycle of the building from design to construction and operation in this guide, this research aimed to check the validation of the integration of both the OGC 2007 procurement and sustainable guides for social housing projects of Housing Associations in the UK. Interviews were made with develop mangers in a number of the key Housing Associations concerned with developing sustainable housing projects in the UK. The aim of the interviews was to adjust the integrated OGC framework to suit the actual planning and construction steps experienced by practitioners on the ground who were involved in sustainable housing projects in the UK. It aimed also to show where, when and how sustainable materials are chosen. As a result of this analysis the work is able to highlight the exact stages and their timing involved in the consideration of sustainable materials in addition to other aspects of sustainability associated with the development of sustainable socially owned housing projects. The result of this research was a new grounded framework which can be used to set out a map of the processes involved in the development of sustainable housing projects in the UK. Table 1 showed the high level features of the framework and highlighted the stages of choosing sustainable materials for housing projects.

Table 1: Main features of the framework of the pre-construction processes of the actual sustainable housing projects in the UK




Prepare high level business case
Project evaluation
Approved to proceed, confirm funds
Gateway1:Business justification
Detailed design and project detailed brief
Appraisal
Review whole life cost model
Project evaluation
Procurement
Ensure the sustainability requirements are clearly set out in the out put specification
Procurement route and out line business case
Award contract to integrate
Gate (2) Investment decision
Construction stage

3. Conclusions

Sustainable materials and equipment have the lowest in-use environmental impacts, low embodied environmental impacts, and high recycled content. Producing sustainable building projects requires intense interdisciplinary collaboration, highly complex design analysis, and careful material and system selection, particularly early in the project delivery process. In addition, the process of developing the project cost is an integral part of the construction project management. Reusing materials or selecting those with high recycled content will reduce the depletion of natural resources and protect the environment. This research tried to make sure that sustainable housing projects consider choosing sustainable materials by highlighting the developing processes of this type of projects to encourage all new built housing projects to consider sustainable issues and use sustainable materials in their projects. The process map which was developed from the interviews which were conducted with housing associations in the UK showed that choosing sustainable materials is one of the main development processes. These sustainable construction materials are good to protect the environment during the lifecycle of the project and even for the recycling issues after its deconstruction.

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Practising energy efficient design for commercial buildings in Sri Lankan industry

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Abstract

The building industry is constantly expanding with consequences on energy expenditure. As similar to the most countries, in Sri Lanka too building industry is the most Energy consuming Industry. In recent years there were much discussions regarding Energy conservation techniques to mitigate the demand side of the energy sector. Building design directly affects the energy performance of the building. The emphasis on energy Conservation has therefore, to begin at the design stage & control throughout the life cycle (Design, Construction, Operate and Maintenance) of the building project.

Buildings, energy and the environment are the issues that the building professionals have to address in current day projects. This is partly due to the increasement of public awareness on environmental issues related to building developments. Therefore, to achieve the energy efficiency goal, architects and building designers need to perform energy conscious designs in their relevant discipline. The expanded design team collaborates in early design stages to generate many alternative concepts for building forms, envelope and landscaping, focusing on minimizing peak energy loads, demand and consumption.

Purpose of this study is to find to what extent energy conscious design has been considered by designers in the Sri Lankan context, and to recognize the areas to be developed to achieve energy efficient building in the industry. The research methodology adopted was quantitative, within that questionnaires were used for detailed survey. A pilot study was conducted by through telephone interview prior to the detailed survey.

Through this research it is found that there should be mandatory energy guidelines enforced for the designers. In addition, designers' lack of knowledge on life cycle benefit; available technology; available energy efficient techniques; and non- usage of energy analysis tools are major hindrance to proceed to the energy efficient design.

Keywords: Energy Analysis Tools, Building Energy Code, Design Team, Energy Efficient design.

1. Background

In most of the countries, the building industry is the most energy consuming industry and it is constantly expanding with consequences on energy expenditure. Past twenty years of research effort had produced a consensus understanding of the impacts of energy consumption and the approaches to reduce this impact by using energy efficiency and the deployment of renewable energy technologies. Especially the Building Energy Efficiency codes have been developed in many countries, and almost all developed countries have enforced them [1]. Further the building energy simulation tools are in rapid development and now been increasingly used in building designs [2]. Therefore, to achieve the energy efficiency goal, architects and building designers need to design energy conscious designs in their relevant discipline. Hence this research is aimed to find what extent energy conscious design has been applied by the designers in the today's buildings in Sri Lanka.

In Sri Lanka, the demand for electricity is rapidly increasing. In the year 2004, electricity demand growth rate varies between 7% - 8%. Average Electricity consumption per capita is 348Kwh/person at the same period and it has grown by 8% from previous year [3]. It was forecasted that electricity demand will quadruple in the next 15 years. However the last few years have seen the power generation of the country gradually shifting more towards thermal power generation. In 2004, Gross power Generation increased by 5.68% but gross generation of hydropower plants were reduced by 13.63% at the same period [4]. It is estimated that by 2014, 82% of the total electricity demand will be met by thermal power generation [5]. At the same time, Authorities are finding very difficult to construct thermal power plants in the face of rising opposition from the local people on economic and ecological grounds.

In Sri Lanka main sectors of energy consumption are Industrial, Transport, household and Commercial and others (religious organizations, etc.). According to the Energy Conservation Fund (ECF) [6] for year 2003, percentage of consumption of Household and Commercial sector was 51.10 % when compare with the other two sectors at Industry and Transport which are respectively 24.41% and 24.80%. Among these, the rate of increase in energy demand in the commercial sector is the highest due to the rapid development of the sector, changes in life styles, contemporary architectural practices and lack of suitable energy saving technologies and building management/automation systems. Due to these reasons, the present annual electricity consumption in commercial buildings, which is approximately 1000GWh, is expected to increase by 28% of the total electricity demand [5].

According to the demand side Management, the energy demand in this sector can be reduced by applying various energy conservation techniques throughout the life cycle of the building. Passive cooling, shading and sun control, efficient daylighting and Heating, Ventilation and Air Conditioning (HVAC) systems, active solar and photovoltaic system are some of the main energy conservation technique. As per the ECF, domestic and commercial sector have 12% of conservation potential from the total annual consumption that potentially saves Rs 2.4 billion annually [6]. According to the UK Department of Energy Estimates that, the better design of new buildings could produce energy consumption reductions of 50% and that appropriate design intervention in the existing stock of buildings could result in a 25% reduction in energy consumption ([7]). The electricity cost in most of the high rise buildings in Sri Lanka are generally are 50% of the monthly operating budget [8]. Any reduction in energy cost will have greater impact on per square feet cost of the building. This will enable the building owners to reduce their office rentals. That will provide them a competitive advantage, especially when competing with smaller office buildings this overhead are comparatively low.

Therefore, to achieve resource conservation and efficient energy management in this area requires effective retrofit and innovatory design measures. By effective implementation of such measures, the commonly agreed and achievable target reduction is around 30%, with more optimistic expectations - up to 70% - for buildings incorporating advanced technology features [9]. However, such strategies and technologies have not yet been widely adopted by the construction industry. The majority of buildings are still been designed without energy-related considerations beyond those enforced by energy codes. One reason for this is that practitioners do not have the means to assess the impact of new strategies and technologies during the design stage.

The sustainable development has become a Global focus in present day industry. Buildings, energy and the environment are issues that the building professionals have to address in current day projects. This is partly due to the increased public awareness of environmental issues related to building developments. Therefore, to achieve the energy efficiency goal, architects and building designers need to design energy conscious designs in their relevant discipline.

2. Sustainable Design

Sustainable design is the thoughtful integration of architecture with electrical, mechanical, and structural engineering. In addition to concern of the traditional aesthetics of massing, proportion, scale, texture, shadow, and light, the facility design team needs to be concerned with long term costs: environmental, economic, and human.

The Rocky Mountain Institute [10] outlines five elements for sustainable design:

- Planning and design should be thorough. Sustainable design is "front loaded" compared with traditional design. Early decisions have the greatest impact on energy efficiency, passive solar design, daylighting, and natural cooling.
- Sustainable design is more of a philosophy of building than a prescriptive building style. Sustainable buildings do not have any particular look or style.
- Sustainable buildings do not have to cost more, nor are they more complicated than traditional construction.
- Integrated design, that is design where each component is considered part of a greater whole, is critical to successful sustainable design.
- Minimizing energy consumption and promoting human health should be the organizing principles of sustainable design. Other than the above elements for sustainable designs are energy saving architectural features, energy conserving building envelope, and energy-efficient and health-promoting mechanical, electrical, and plumbing systems.

The main objectives of sustainable design are to avoid resource depletion of energy, water, and raw materials; preventing environmental degradation caused by facilities and infrastructure throughout their life cycle; and to create built environments that are livable, comfortable, safe, and productive.

3. Energy conscious design in Sri Lankan context

To achieve sustainable development, one of the major contributions has given through designing energy efficient buildings. Therefore practicing and developing the energy conscious design enhance to produce more energy efficient buildings. This research is aimed to find the practice in the energy efficient design in building industry in Sri Lanka. Due to the broad scope of energy efficient design, this initial research is focuses on identifying energy conscious design discipline of architectural and services designers from the building sector and considering mainly commercial building in the Sri Lankan industry. The aim of this research will be addressed:

- To identifying the energy conservation techniques and design tools and other measures to achieve energy conscious design.
- To identifying the measures taken to achieve the energy conscious design and their impediments factors.
- To investigate the level of consideration on the energy efficient design by the designers.
- To recognize what areas should be developed in the industry towards crafting energy efficient buildings.

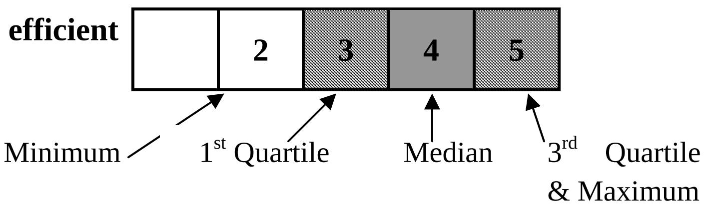
4. Research Methodology

The research methodology for this study adopted was quantitative. Initially the pilot study was conducted by telephone interview to find out the designer's consideration to the energy efficient design and the usage of energy analysis design tools. Then detailed survey was conducted within that closed questionnaires used. It includes fixed responses option as Likert scales. This was used to identify what extent that energy conscious design has been practised and what level it has considered in current context. Unstructured interview was not suitable since the scope of study is limited to find the level of practised and not in detail in depth as case studies. Structured questionnaire survey is conducted with selected thirty samples which included in the pilot study sample. Fifteen number of professionals related to Architectural designs had been interviewed, and the rest of the fifteen professionals were interviewed in Services Design such as Electrical and Air Conditioning discipline.

Descriptive statistical method was used for the analysis of data which were collected from structured interview. The levels of responses incorporated with the statements were given weightages to convert this ordinal set of data to numerical figures. Further for descriptive statistical measures, viz. the minimum, maximum, median and the quartiles were used in analysis. A graphical box diagram as given in following example is used to present this parameters for easy comprehension (Figure 1):

What do you think about energy efficient design?

Figure 1: Box Diagram



Explanation: This box diagram can be interpret as, 50 percent of the responses have considerable knowledge in energy efficiency design. Less than 25 percent of the designers have some idea on that and at least one of the designers would have heard about the energy efficient design. Further there were some designers who have thorough knowledge in the energy efficient design.

Further Mann-Whitney U test have been used to identify the significant differences between two independent groups of sample as Architects and Services Engineers.

5. Research Findings

5.1 Results from the designers

The analysis of the responses of the designer reviled the following results.

Q1	What do you think about energy efficient design?		2	3	4	5
Q2	Do you think that is practical to achieve?			3	4	5
Q3	To what extent client consider through out the design phase?	1		3	4	5
Q4	Does the client allocate sufficient funds for energy efficient designing?	1	2	3	4	
Q5	Do you think that clients are not sufficiently aware of issues such as renewable energy and energy efficient buildings?	1		3	4	

According to the diagram Q1, it can be seen that at least 50 percent of the designers have some idea regarding energy efficient design. The 25 percent of the designers have considerable more knowledge on that. And every designer has at least heard about energy efficiency design. And there are designers who have thorough knowledge in energy efficiency design.

According to above diagram Q2 shows that all the designers somehow believe that it can be practically achieved and 50 percent of designers have confident that energy efficiency can be achieved frequently at operational stage which would be anticipated in the design stage.

According to above diagram Q3 shows, 50 percent of the designers believe that some how client consider energy efficiency measures throughout the design phase without concerning only at the initial stage.

The above diagram Q4 shows that, more than 50 percent of the designers reflect that the client rarely allocates sufficient funds for the energy efficient design at the design stage and at least 25 percent of the designers state that client never allocate sufficient funds for energy designing.

From above diagram Q5 it represents that, more than 50 percent of the designers responds that only some of the clients does not have average awareness on issues such as relevant to energy efficient designing and renewable energy. Its specially need to consider that none of the designers said that all the clients do not have sufficient knowledge on energy related issues. So which can be interpreted as most of the clients have considerable awareness related to the energy efficient issues.

From above diagram Q6, it explains that 50 percent of designers believe that some clients are voluntarily adopting the energy efficiency measures without any financial incentives and nearly 25 percent of the designers express that client are less likely to adopt energy efficient measures without financial incentives and education on the costs and benefits.

Q7. Do you think that the followings will be required to insist clients and designers to consider the energy efficient designing?

a.	New building regulations or legal enforcement are required.			3	4	5
b.	New mechanisms and incentives are		2	3	4	5

required to encourage clients to invest in

		1	2	3	4	5
c.	Provide sufficient information and knowledge to client and designer regarding the energy efficiency.			3	4	5
d.	Provide enough access to the resources, products, information and skilled assistance regarding energy.			3	4	5
e.	Provide training and education to state and local officials, private industry, and consumers.			3	4	5

According to this diagram Q7 represents, that 75 percent of the designers considerably agree that new building regulations or legal enforcement; provide sufficient information and knowledge; increase the availability of the energy efficient products; provide training and education will be required often to insist to consider energy efficient designing. Further 50 percent of the designers expressed that new mechanism and new incentives often insist the client and designer to go for energy efficient design.

Every designers express that these above factors are much more needed to insisted to clients as well as designers to proceed with the energy efficient designing. Most of the designers expressed that statutory requirements will help level of playing field for developers and builders as energy-conscious designers and building professionals will not have to compete with others who achieve construction cost savings by eliminating or ignoring energy-efficient features in their design. Some architects believe that mandatory standards limiting the design freedom and innovations if the Building Energy Standards are not comprehensive and flexible enough.

Q8	Do you think that time taken for design is high for achieve clients energy efficient requirement?	1	2	3		
Q9	Do you think that design cost is high for achieve clients energy efficient requirement?	1	2			

According to the diagram Q8 and Q9 it shows that, only 25 percent of the designer’s states that design time is never long for energy efficient designs and when compare with design cost more than 50 percent of the designers stated that design cost was never high. And none of them states that design cost and time duration of the energy efficient design were always high.

Q10	Do you think that time taken is long for constructing energy efficient buildings?	1	2	3		
Q11	Do you think that integration design process by using in-house professionals will enhance the energy efficient design?	1		3	4	5

According to the diagram Q10, it shows that 25 percent of the designers states that construction time is never long as well as 50 percent of the designers expressed rarely time increased for construction of the energy efficient buildings.

As per the diagram Q11, it shows that the 50 percent of the designer's states that the integration design process by using in-house professionals will sometimes enhance the energy efficient design. Only 25 percent of the designers states that it often enhance the energy efficient design. Further it is found that, some of the designers described that it depends on the availability of communication modes in the organization. Even though the professionals are separated the design process will be enhanced by proper communication system between these professionals.

Q12	Do you set energy performance goal?	**1**	**2**			
Q13	Do you follow any checklist to achieve this goal?	**1**	**2**			
Q14	Do you use any technique to evaluate energy efficient design?	**1**	**2**			
Q15	How often the proposed alternative designs has been agreed by the client?	**1**		**3**	**4**	**5**
Q16	How often the proposed alternative designs has been agreed by the other design professionals?	**1**			**4**	**5**

From the box diagram Q12, Q13 and Q14 represents, that the similar responses obtained for to above three facts. Where more than 75 percent of the designers are do not use any check list to achieve energy efficient design goal; do not set energy performance goal and do not use any technique to evaluate their design.

From the box diagram Q15 and Q16 represents, 75 percent of the designers states that the alternative designs proposed by them has been agreed by other professionals but it is 50 percent in case of client. In case of energy efficient designs the clients is the most influence on decision making process in case of alternating the proposed designs.

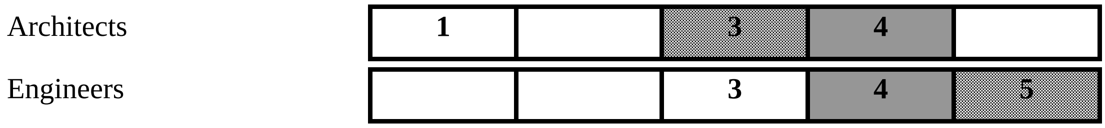
5.2 Results from the Engineers and Architects

1. Do you think that there is sufficient energy saving technologies available in the current market?

Architects	**1**	**2**	**3**	**4**	
Engineers	**1**		**3**	**4**	**5**

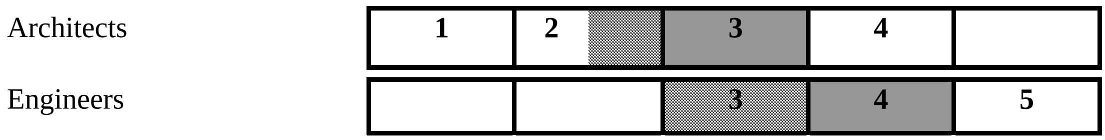
According to this diagram, more than 50 percent of the Architects state that the energy saving technologies are rarely available in the current market. However, 50 percent of the Engineer states that energy saving technology available often in the market. Some of the Engineer states that there are always sufficient energy saving technologies available in the market but in the other case of none of the Architects mentioned as it is.

2. To what extend energy efficient requirement of the client succeeded?



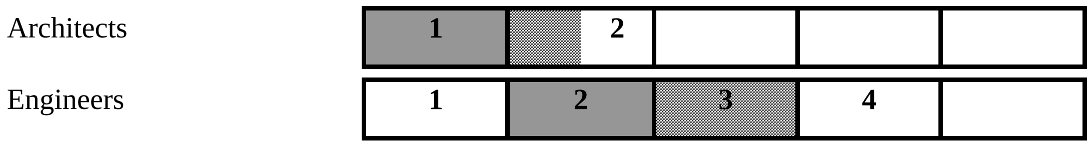
According to the Box diagram, the more than 75 percent of the Architects states that client succeeded with his requirement very often. But there were no Architects who response as always it is succeeded. But in the case of Engineer it was found that more than 25 percent of respondents state always the client succeeds with his initial requirement. At least every Engineer has a confident that energy efficient design was considerably succeeded with the client initial requirement.

3. Do you think that construction cost is high for energy efficient buildings?



From the above diagram it represents as, 50 percent of the Architects states that sometimes the construction cost is high for the energy efficient building. In meantime, within the Engineer states at least for somehow construction cost is high.

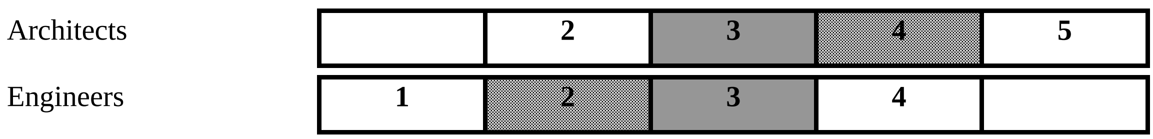
4. Does designer follow any guidelines to achieve energy efficient designing?



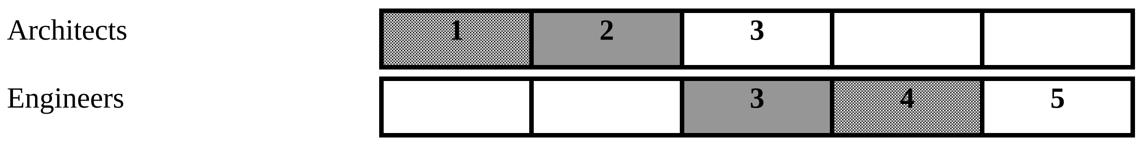
From the diagram it can be found that more than 50 percent of the architects have never follow any guidelines related to energy efficient design. At the same time, 50 percent of the Engineer has somehow follow guidelines such as Energy Efficient Building Code (EEBC) in their design. While their questioning it was found that EEBC was not popularize among the design professionals especially Architects.

5. What extent the designers use following techniques to achieve energy efficient building?

a. Incorporate solar passive techniques in a building design to minimize load on conventional systems

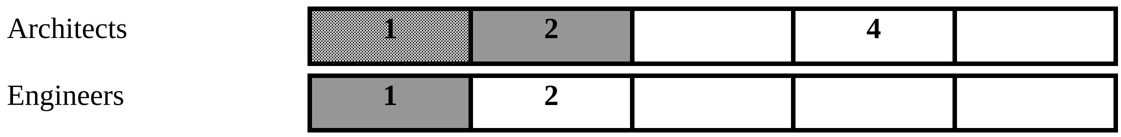


b. Design energy efficient lighting and HVAC systems



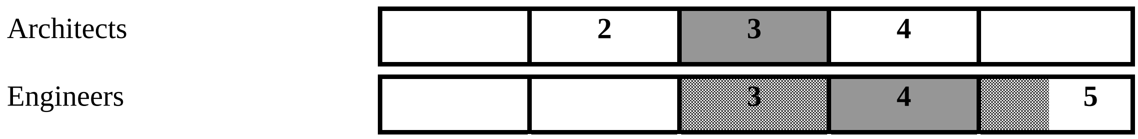
From above two diagrams that it clearly shows that Architects and Engineers have different level of knowledge on techniques used to achieve energy efficient building. Its clear that more than 50 percent of the Architects have some idea on that solar passive techniques in a building design to minimize load on conventional system when compare with the Engineers, who have less than 25 percent. It is vice versa in the case of designing of energy efficient lighting and HVAC system. From this its obvious that the Engineers have considerably high knowledge on HVAC system.

c. Use low energy materials and methods of construction & reduce transportation energy (reducing embodied energy)



When we consider the technique of using low embodied energy materials to achieve energy efficient in the building, none of the professionals have through knowledge on that. Especially 50 percent of the Architects have less knowledge on that but in the case of Engineers have no idea about it.

d. Use renewable energy systems (Solar photovoltaic systems/ solar water treating systems) to meet a part of building load.



The above diagram indicates that more than 50 percent of the Engineers have considerable knowledge on the use of renewable energy systems to achieve energy efficient in the buildings. But more than 75 percent of the Architects have some idea on that.

6. Conclusions

This study was conducted to identifying the designers concern towards the energy responsive design in building industry. Nowadays the world focuses on sustainable development. Hence the designers focusing more on the sustainable design with respect to the construction industry. The awareness regarding the energy efficient design is very important in the present day design scenario. Most of the designers should consider it not only by considering the benefit of the clients but should need to consider the society’s benefit as well.

As an initial measure to reduce the demand side energy was taken by introducing EEBC as voluntary guidelines to the Sri Lankan Building industry in the year 2000. However till now it has not developed and the implementation of that code is very rare in present day industry. Most of the designers expressed that the mandatory guidelines must needed to construct more energy efficient buildings in the future. They further expressed that the present EEBC should need to be updated and revised before it is practiced as a mandatory guideline. This should be implemented as soon as possible. This will encourage more designers and engineers to craft their design as energy conscious design in future.

Furthermore clients have been very reluctant to go for energy conscious design. Because most of the clients have misconception that construction cost was high for energy efficient construction by only considering the initial cost. However it is not real in the present scenario. When considering the long run of the building it is found that energy efficient building is more economical than the traditional energy non-conscious buildings. Some of the designers have considerable knowledge on life time benefits of the energy efficient design and they have a high responsibility to convince client to go for energy conscious design.

In the Sri Lankan building industry, certain energy efficient design concepts are in practice such as solar gain control, efficient lighting, power factor correction etc. but technique like passive design techniques were not much familiar among the designers. Moreover it is found that technique to achieve energy efficient building, by using low embodied energy material, is not well-known among the designers. Most of the designers' state that due to non-availability of material and technologies in the market are also one of the main obstacles to go for energy conscious design.

However, in general most of the designers are not considerably concern in related to the energy efficient designs in their design discipline. In addition to that the knowledge regarding energy analysis tools also lack within the designers. And most of the designers believe that it is not practicable to use in Sri Lankan context. Hence providing education and training and other measures to familiarize the energy conscious design will be much more needed in the present day industry. In addition to the designers, the parties of the stakeholders such as local officials, private and public clients and consumers also necessary to be aware on the energy efficient aspects to save energy and provide vital economic and ecological benefit to the country like Sri Lanka.

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Management Plans And State of Environment Reports Prepared And Implemented By Local Councils In Nsw: Problems And Potential for Biodiversity Conservation

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Abstract

The *Local Government Act 1993* (NSW) demands every local council in NSW to prepare, inter alia, a 'management plan' and a 'state of the environment report'. This paper critically examines both mechanisms and the relationship between them. Discussion is underpinned by the context of biodiversity conservation at the local level. Whilst good intentions lie behind the legislative requirements, their environmental benefits are questionable. They are often recognised as little more than bothersome bureaucratic hurdles. Although overdue legislative and policy change is forthcoming, concern is raised about loss of focus on the conserving biodiversity.

Keywords: local government, environmental law, management plans, state of environment reports, biodiversity conservation, policy change.

1. Introduction

There are almost 700 local councils across Australia, including 252 'general councils' in the most highly populated state, New South Wales (NSW). They differ widely on various scales. But one common feature is that the Federal Constitution fails to recognise local government, which is therefore a creature of State Parliaments. An issue of greater concern is local government's lack of financial resources in meeting functional expansion and community expectations. Dealing with the natural environment provides a ready example. This article considers two legislative requirements of councils in NSW. The first is preparation of the 'management plan', which extends far beyond the traditional 'corporate plan'. The second is the local 'state of the environment report' (SoER), which is exclusive to NSW [1]. The commentary illustrates the nature, benefits and problems of both mechanisms, including their statutory linkages. It then briefly moves on to current State Government policy change. The broader notion underpinning the paper is that statutory mechanisms designed for environmental monitoring do not always play the conservation tune.

2. The Management Plan

Councils in NSW that embark on major new projects, including conservation works, must engage in the *management plan* process. As described by the NSW Department of Local Government (DLG), this is the 'central mechanism … by which councils allocate their resources and prioritise their activities' [2]. The legislation – namely the *Local Government Act 1993* (NSW) (LGA 1993) - requires every council to endorse a management plan every year. Similar plans under different names are required in all six Australian States. In theory, the plan is the vehicle through which a council determines how it will exercise its broad service powers. Mandatory consultation provisions illustrate how the management plan is a potential instrument for community participation and accountability [3].

The legislation directs that the management plan contain details about a council's proposed 'principal activities' for, at least, the following three years. It must identify such actions that the council intends to carry out, as well as 'statements' on (at LGA 1993, s 403):

- the objectives and performance targets for each such activity;
- the means by which a council proposes to achieve those targets;
- the manner in which a council proposes to assess its performance in respect of each specified activity; and
- any matters prescribed by regulation (i.e. the *Local Government (General) Regulation 2005* (NSW) (LGGR)).

The extent to which the above matters are addressed is variable. Of the 25 plans studied by Marshall and Sproats in 1997/98, six included 'no performance indicators at all' [4].

'Principal activity' is not defined. Instead, the legislation lays down a non-exhaustive list of matters that, if carried out, the management plan must address. It refers to traditional municipal functions in wide terms such as 'capital works projects' and 'services'. Whilst some conservation projects, such as street tree planting, may fall into one or more of these categories, the list also makes specific reference to 'activities to properly manage, develop, protect, restore, enhance and conserve the environment in a manner that is consistent with and promotes the principles' of Ecologically Sustainable Development (ESD). In accordance with the LGGR, these are known as 'environmental protection activities' (EPAs) (cl 199(2)). It would appear that the formula is broad enough to extend well beyond physical conservation works, such as providing financial and technical assistance to voluntary conservation groups. But it is clear that the legislation does not *compel* councils to undertake EPAs. It only requires councils to detail such activities in the prescribed manner should any be undertaken. Whilst it may be argued that the focus is on procedure rather than outcome, the statutory openness nevertheless reflects the subsidiarity principle. The State Government plays no role in approving the management plan.

In addition to the general consultation requirements as discussed later, a council must, under the LGGR, 'consult' and 'involve' the community, including 'environmental groups', in developing ‘environmental management strategies’ for EPAs (cl 199). The legislation is silent on how a council should meet these obligations. Even the term ‘environmental strategy’ is undefined. Of course, the extent to which councils engage their local communities will vary. In its guidelines on preparing management plans, the DLG provides a brief list of possible approaches, such as ‘community workshops’ and ‘issue based research & reporting’. Yet it presents scant detail [5]. Furthermore, the LGGR requires a council, when preparing that part of the draft management plan relating to EPAs, to ‘apply’ the principles of ESD. An explanatory statutory note simply states that councils are to ‘take into consideration’ the principles of ESD. This is scarcely onerous. In the case of resource-poor or uninterested councils, ESD is likely to receive nothing more than lip service. Such councils are unlikely to engage in any EPAs in the first place.

The weakness of the regime becomes even more apparent in the case of principal activities falling *outside* the EPA umbrella. Apart from the provisions relating to EPAs, the LGA 1993 does not expressly demand the factoring of any environmental concerns into the decision-making equation. For instance, a council might decide to construct a new road through native woodland. As the activity comprises a ‘capital works project’, various statements must be provided in the plan. The concern, however, is that the information may relate to engineering issues alone. There is no express requirement that environmental issues be confronted. The situation is not helped by the LGGR in which the provisions relating to ESD apply to EPAs alone. This is ludicrous. It suggests that ESD has been saved only for those activities already intended to conserve or improve the environment. It is also inconsistent with the DLG’s own guidelines, which state that ‘ESD principles apply to *all* of the activities of the council’ [6]. This aspect of the LGGR is likely to be invalid in view of the statutory object relating to ESD in the primary Act at section 7(e) which, on its face, is not restricted to a particular subset of a council’s activities. Whilst the courts may rely on this and other introductory provisions to ensure that ESD is at least *considered* by councils in relation to *all* their activities, it is still unfortunate that section 7(e) suffers from lack of supportive, substantive provisions throughout the remainder of the Act. This provides an example of the weakness of the legislature to provide clean and workable frameworks for achieving ESD [7].

There is one qualification to the apparent limitations of the management plan provisions. Local citizens may use the public consultation process to demand that appropriate environmental objectives are injected into the management plan [8]. Public involvement in local conservation policy depends on community awareness of the process, neighbourhood dedication to indigenous biodiversity and the extent to which a council seeks feedback beyond formal public procedures. The DLG urges councils to pursue a more ‘proactive and targeted approach’ beyond the bare requirements, noting that mere exhibition at the end of the plan-making process ‘does not, in itself, provide for adequate community and stakeholder input’ [9]. Whilst Brown et al assert that whilst council/citizenry partnerships is obligatory, they lament that ‘the baseline of real partnership’ identified by their empirical research is ‘low’ [10].

If there is sufficient commitment to biodiversity conservation, the management plan has enormous potential. It provides opportunity for councils to integrate conservation principles across the entire spectrum of their actions by incorporating them into their adopted ‘objectives’ and ‘performance targets’ for every principal activity. In terms of biodiversity conservation, this will be more effective than the occasional one-off project to help protect a special place. It should also help minimise inconsistent actions between different departments of a council. A commitment to desired environmental objectives must *permeate* council activities in order to achieve an integrated approach [11]. The problem is that many celebrated local environmental projects tended to work in isolation away from other spheres of council activity [12].

Whilst the management plan process may promote strategic co-ordination *within* a council, co-ordination *between* councils is another matter altogether. A particular council might actively pursue biodiversity conservation through its management plan whilst its neighbour may follow different priorities. The regional dimensions of environmental management mean that without effective cross-boundary cooperation, the good work of one council can be undermined by another. The system provides little encouragement for councils to work towards common regional goals through their individual management plans. A small exception is found in the required ‘particulars’ for matters prescribed by the LGGR to be addressed in management plans. The scheme demands that management plans include certain information on ‘any proposed council activity relating to the management’ of ‘stormwater’, ‘coasts and estuaries’, ‘sewage’ and ‘waste’ (cl 198(1)). Details are also required on ‘the relevant characteristics of the area, catchment or region’ as well as council membership on relevant bodies and ‘any action to be taken jointly with other councils or bodies’ (cl 198(2)(d)). These provisions may encourage councils to turn their minds to opportunities for cooperative action, not only with their neighbours but also with other authorities, especially at the State level. It is a rare statutory example of pushing councils, as described by Smith, into ‘creat[ing] networks … with other agencies’ and attempting to ‘persuad[e] other agencies to achieve prescribed ends’ [13].

The reference to ‘coasts and estuaries’ in particular may prompt councils to develop biodiversity policy for these aspects of the environment, preferably at a regional scale. Such places are special to the community and are creating pressure for growing populations. But the statutory nudge relates only to a discrete component of the environment. It does not extend to non-coastal environments unless affected by stormwater discharge and the like. Even within their narrow ambit, these clauses hardly enjoy a high profile, tucked away in subordinate legislation.

Drawing the material together, despite wide opportunity presented by the management plan mechanism, there is a danger that for some councils, a combination of limited outlooks, conflicting priorities, resource shortcomings, pre-occupation with procedural management and perhaps uninterested neighbours will ensure that effective biodiversity conservation remains in the realm of empty talk, if addressed at all in the management plan. SoERs, however, may assist to drive innovative environmental directions.

3. SoERs and Linkages to Management Plans

The LGA 1993 requires each council to prepare an annual report. In terms of general bureaucratic culture, this is no surprise. The legislation is very specific as to what it must address. For instance, it must contain information 'as to [a council's] achievements with respect to the objectives and performance targets set out in its management plan'. It thereby provides a layer of environmental accountability with respect to a council's 'principal activities' depending on the extent to which environmental concerns have been infused into the 'objectives and performance targets' in the management plan. By enabling the outcomes of all proposals to be evaluated and reported upon, the management plan goes beyond being a merely descriptive document. Moreover, the annual report *must* include the SoER.

The SoER concept is scarcely restricted to local government. Measures were adopted on a global basis in the mid-1990s by the Organisation for Economic Co-operation and Development (OECD) to address environmental concerns on a 'pressure-state-response' model [14]. A series of national SoERs for Australia commenced in 1996, now demanded by Commonwealth legislation. Adoption of SoER obligations by individual State/Territorial jurisdictions has also arisen, pushed by four out of six states in addition to the Australian Capital Territory. As noted earlier, NSW is the only state where every council must prepare its own SoER. This places any council that is struggling financially in an invidious position.

Introduction of the SoER requirement created a bombshell. It was inserted in the Local Government Bill 1993 by the then Opposition, with the support of independent members, but opposed by the then Government. Mr J Turner, who had chaired a special Parliamentary committee to oversee development of the bill, warned that the costs would be 'crippling' [15]. The NSW Local Government Association, interestingly, despite initial chagrin, later decided to support the SoER concept subject to State Government assistance. But no monetary help has ever arisen [16]. In other words, the SoER requirement was simply dumped upon a largely unprepared local government. The only substantial support councils have received is written guidelines. The resource-intensive nature of SoER preparation has been softened slightly, however, by provisions introduced in 1997 allowing for four-yearly 'comprehensive' SoERs updated by annual 'supplementary' SoERs.

The original 1993 list of themes to be addressed in council SoERs included, *inter alia*, 'areas of environmental sensitivity', 'important wildlife and habitat corridors' and 'any unique landscape and vegetation'. Such vague descriptions must have promoted subjectivity, inconsistency and potentially unsympathetic environmental management. For instance, when might a corridor have been sufficiently 'important' or a landscape 'unique' to warrant attention in the SoER? Following a Ministerial discussion paper [17], in 1997 the NSW Parliament rewrote section 428(2)(c) LGA 1993 by adopting the following 'sectors' that a SoER must address (including 'biodiversity') [18]:

I. land,
II. air,
III. water,
IV. biodiversity,
V. waste,
VI. noise,
VII. Aboriginal heritage
VIII. non-Aboriginal heritage,
IX. with particular reference, with regard to each such environmental sector, to:
X. management plans relating to the environment,
XI. special council projects relating to the environment,
XII. the environmental impact of council activities.

In 1997, the then Minister for Local Government noted unsurprisingly that the quality of reports varied widely [19]. There is still evidence of resistance to SoERs. Whilst councils at least recognise the statutory obligation to prepare SoERs, this does not necessarily translate into utilising them as effective environmental management tools. An invaluable contribution SoERs may provide is to alert councils to the need for appropriate responses to existing or foreseeable environmental problems. For example, a SoER might reveal a particular area to be more ecologically significant than previously believed. The council might then, for instance, choose to use the information to support an amendment to an instrument under the land use planning legislation to protect it. Or it might decide to negotiate with landholders to encourage on-ground environmental management. Alternatively, it may choose to carry out environmental protection works itself. Clearly, SoERs can do far more than prsent interesting data and gather dust.

The legislation provides strong linkages between SoERs and the management plan. First, one of the items listed under s 403(2) LGA 1993 (in relation to the required 'particulars' for proposed 'principal activities' to be addressed in management plans) refers to 'activities in response to, and to address priorities identified in, the council's current comprehensive report as to the state of the environment and any other relevant reports'. This is crucial. Second, the LGA 1993 requires each council, when compiling its SoER, to address each of the eight specified 'environmental sectors' in the context of 'management plans relating to the environment' (see s 428(2)(c)(ix) above). This widens the net for all identified principal activities to be assessed against a variety of environmental criteria, including biodiversity. It makes good sense [20], and was recognised in some quarters well before 1997 [21]. The notion is championed by the DLG which recommends an optional 'environmental management plan' (EMP) as a 'sub-plan linked to the management plan' [22]. By bringing local environmental problems to the attention of elected representatives, a SoER may therefore influence the types of 'principal activities' that a council may decide to engage in. In turn, a later SoER may be utilised to evaluate the environmental outcomes of such actions. In other words, the SoER may be seen as an *extension* to the management plan process by addressing essential follow-up action. The DLG commends a 'management planning/annual reporting cycle' [23]. The concept is attractive but empirical research is needed to help check the extent to which such potential falls into the realm of rhetoric.

Literature suggests that the potential of SoERs is not being reached. Senior municipal personnel interviewed by Brown et al in 1998 cited the SoER as ineffective and merely something to complete under the legislation [24]. Whittaker similarly refers to managers complaining of difficulties in interpreting SoERs, with some asserting that they 'have not seen, let alone read [the SoER] for their council' [25]. Brown et al's findings are especially disturbing as they involve councils at Sydney's periphery with relatively large budgets and, presumably, far more environmental expertise than remote resource-poor authoritives. Such comments reflect, arguably, managerialist trends that emphasise cost-cutting rather than long-term environmental improvement. But the SoER is a very different mechanism to the traditional budgetary reports with which council executives are familiar. As Brown et al note, the SoER 'has as its central reference point the whole environment … rather than council's activities in that area' [26]. It deals with broad issues such as biodiversity decline, which are difficult to reduce to financial statements. A narrow perception of SoERs means a minor role in shaping municipal agendas.

The LGGR demands that comprehensive SoERs apply the 'pressure-state-response' model in analysing data, identifying appropriate indicators for each sector and presenting results. It therefore corresponds with the OECD model. The 'response' component is especially noteworthy by identifying 'the response of councils, government agencies, industry and communities to the pressures on, and state of the environment' (LGGR cll 14-15). Not only do the provisions require a council to canvas its own approaches, if any, but those of other bodies. They arguably encourage a council to adopt the role of environmental steward by considering a full range of issues affecting its area, including matters beyond its conventional jurisdiction. A SoER may, for example, address the impact of other authorities' policies on biodiversity. For instance, it might contain information on reserves, such as national parks managed by State government located within one or more local government areas. In theory, consideration of such matters may lead to lobbying by councils and/or development of inter-agency partnerships.

The architecture of the legislation illustrates that councils are expected to *respond* to issues raised in their SoERs. In addition, the LGGR requires a council, when preparing that part of its management plan dealing with EPAs, if any, to 'consider' its most recent comprehensive SoER (cl 219). This further encourages the management plan/SoER 'cycle', providing a third link between the two mandatory mechanisms. The *National Local Government Biodiversity Survey* reports that a 'high proportion' – more specifically, 45% – of surveyed councils in NSW had 'incorporate[d] biodiversity objectives into their corporate/operational plan [27]. In view of the statutory linkages with their specific references to the environment, the figure is disappointing, suggesting that more than half of the councils had paid minimal, if any, attention to the requirements relating to biodiversity accountability and ongoing management. More recent survey analysis would reveal if the problems have declined further.

Public involvement may influence the direction of SoERs. In preparing their SoERs, councils must consult with their communities, including 'environmental groups', and also involve people in 'monitoring changes to the environment' (LGGR cl 220). But again, there are no details on how this is to occur. Terms such as 'environmental group' are undefined. Brown et al found the desired council/community partnership to be 'almost non-existent' amongst the authorities surveyed, with three managers viewing the community as ‘irrelevant and/or disinterested’ [28]. Such analysis is troubling, especially in view of increasing pressure on local communities in view of limited municipal finances. A Commonwealth Parliamentary report issued in 2003 has warned councils against entering costly functional territory [29].

No public comprehensive review of SoERs has been undertaken to test the extent to which they influence council on-ground policy. Whilst there is widespread recognition of the fragile and limited extent of vegetation remnants, the emphasis appears to be on the need to gather more information rather than setting down concrete responses. Yet many SoERs do not reflect the opportunities, let alone obligations, imposed by the LGA 1993 and LGGR. In many cases, the detailed statutory rules appear to have been disregarded. Of course, there is scope for SoERs to *evolve*. But biodiversity will continue to diminish whilst we wait. Importantly, such comment is not intended to overlook those councils that are head and shoulders above others. Sutherland Shire and Randwick City provide immediate examples. Both are located in the Sydney metropolitan area rather than remote NSW.

There is also the issue that environmental sectors that SoERs must address, including biodiversity information, can clearly transcend municipal borders. They may be ill-suited to be dealt with on a piecemeal, council-by-council basis. This raises the idea of *regional* SoERs. In their review of early SoERs, Brown and Greene observed that ‘[m]any issues were … more appropriate for regional or catchment treatment’ [30]. In an effort to minimise costs for individual member councils, but also in recognition of the sheer common sense in adopting a regional perspective, some voluntary ‘regional organisations of councils’ (ROCs), or other strategic alliances, have promoted regional approaches. In 2000, the Western Sydney Regional Organisation of Councils (WSROC) published its Regional SoER, described by Parissi as ‘the first regional [SoER] in Australia … based on sustainability principles’ [31]. But such an example does not remove the statutory requirement that each council must prepare its own individual SoER. In the 1997 discussion paper on SoERs, Minister Page acknowledged wide support for regional SoERs but remained steadfast in his commitment to individual SoERs [32]. This was unfortunate. From an ecological management viewpoint, SoERs prepared on a bioregional basis would make far more sense than many unconnected SoERs of varying quality.

The law-makers do not dismiss regional dimensions of SoERs altogether. In introducing the 1997 amendments, Minister Page promised that regional reporting would ‘be encouraged where environmental issues are best addressed at that level’ [33]. Clause 39(1) LGGR requires a council to include in its SoER ‘information relating to the general region’ if analysis of any of the factors listed under LGA 1993 section 428(2)(c) ‘cannot be met’ solely by reference to the local municipal area. A council must then observe all the statutory requirements for SoER reporting, such as adopting the ‘pressure-state-response’ model, in the ‘regional’ part of its SoER. Information on biodiversity would be a willing contender for regional attention. Yet the LGGR fails to define ‘region’. There is no statutory requirement, nor even a suggestion in the DLG’s guidelines, for a uniform approach to regional information. As for WSROC’s regional SoER, Parissi raises many concerns raised by council staff but concludes ‘that a strengthened foundation is needed’ [34].

The picture is again one of unfulfilled opportunity. Any success of the SoER as a conservation tool relies on a combination of political commitment, sufficient resources and regional willingness. As far as politics are concerned, many councils will already have other priorities cemented by tradition. Cowra Shire Council's 1998/99 SoER provides an example. Under the 'biodiversity' heading, it suggests that conservation be restricted to 'rocky outcrops of land which can not be cultivated' because the floor of the Lachlan Valley 'is too valuable ... to *not be* cleared and put into intensive agricultural production' [35]. This Council's priority was clearly on boosting the local economy grounded in agriculture. It would be interesting to check if a wider commitment to biodiversity has since emerged.

4. Current Policy Change and Conclusion

At the time of writing, it is likely that the two major mechanisms discussed above will be substantially changed, if not deleted. In late 2006, the DLG issued an 'Options Paper' regarding the future of, inter alia, management plans and SoERs [36]. Of the three options put forward, it appears from that the third alternative is supported by the DLG. Significantly, it does not embrace continuation of either the management plan or SoER. Instead, at the top of the hierarchy is a 'Community Strategic Plan' (CSP), which is designed to serve the community rather than the council itself. It will address four themes: social, environmental, economic and governance. The CSP will last for ten years, after which time scales will depend on individual council decisions. Below the CSP there is to be a 'delivery plan' for every four year electoral term, an annual operational plan and the annual report, which will influence the CSP. The failure to include an improved, well articulated and community-based structure for the SoER demands reconsideration. Further investigation into regional cooperation is crucial. Although SoERs will be optional, and most likely not mentioned at all in the revised scheme, those councils devoted to maintaining the concept can apply their own emphases. This would not only match the subsidiarity principle but encourage regional scales where warranted. But retention of SoERs, or structurally different devices dealing with the environment, will not be universal. Whilst the legislative and policy review by the DLG was well overdue, we do want to see the biodiversity baby being thrown out with the administrative bathwater.

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The built environment in Southern Africa: The influence of diversity, culture and tourism on conservation

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Abstract

South Africa has a diverse and cultural society with a tradition of colonialism, cultural interaction, separatism and democracy. To conserve buildings influenced by South African history, a sympathetic approach to all its cultures is needed to ensure conservation, showing merit in diversity.

To this end tourism in Southern Africa plays a major role in respect of sustainability of cultural and historic buildings.

This paper will demonstrate how this was done in the past and how future conservation will play a major role in showing the cultural history of the Southern African heritage. The paper will be strongly supported by visual images of the South African built environment.

Keywords: Diversity, tourism, cultural heritage, conservation, built environment

1. Background

South Africa has a tradition of colonialism, cultural interaction, separatism and democracy within a diverse and cultural society. To conserve buildings influenced by South African history, a sympathetic approach to all the cultures is needed, one that will ensure conservation showing merit in diversity.

Tourism in Southern Africa plays an important role in respect of sustainability of cultural and historic buildings.

Southern African conservation in the past and how future conservation will play a role in its cultural heritage is demonstrated in this paper.

2. Early architecture: expression of culture and art

Ancient trading patterns are indications of social and cultural interaction between the people of Southern Africa, Europe and the countries on the Indian Ocean rim and from even further east. Commerce between the people of the Horn of Africa, the Arabian Kingdoms, and the ancient cultures of India and China influenced the Iron Age people of Africa (Bizzell, 2002: 3).

Many examples of South Africa's early building heritage exist and can be visited to appreciate the history and diversity. Some examples are:

- Buildings of the late Iron age. Corbelled dome-houses were very small with tiny entrances built from local stone without any cement or painting (Hartdegen, 1988: 3).

- The Vlakfontein Tswana Iron Age settlement: This settlement in the Transvaal is sometimes called the lost city, it shows remnants of a wonderful early culture. Unfortunately, very few examples of complete structures remain (Hartdegen, 1988: 4).

- Thulamela town, inhabited about five centuries ago, shows the building material of the area and the circular walls, a reminder of the Zimbabwe ruins (Nussey, 1997: 17).

- Masorini is an accurate reconstruction of an African iron-smelter's village that existed in the Kruger Park area during the 18^{th} Century (Nussey, 1997: 17). The traditional Xhosa hut, grouped together to form kraals, have their own style built with stone, mud-bricks and mud-plaster with white washed walls. The white walls and black thatched roofs stand visually pleasing amongst the green hills of the Transkei (Hurford, 1997: 74-75).

- The Sotho hut with it's brilliant and subtle decoration and style, usually done by the women of the tribe, is part of South Africa's beautiful architectural heritage (Hurford, 1997: 46), and is now being protected in a cultural village where people find enjoyment and proudly share their tradition, style and culture with visitors, in a manner that conserves some of the Sotho culture tradition. One example of such a village is found in the Golden Gate National Park.

3. The beginning of the Western influence

In 1488 the Cape of Good Hope was said to be discovered by Bartholomeu Dias when he was sailing around the southern most tip of Africa. For the people of Europe the history of South Africa had begun. Since then the view of South African history has broadened to include the evidence of science, archaeology and palaeontology and, in fact, the history of this region stretches back to the dawn of man. Three ships belonging to the mighty Dutch East India Company sailed into the bay of the Cape of Good Hope on 6 April 1652. On board was the first group of white settlers willing to occupy and establish a trade outpost. Previously, survivors from wrecked ships had ascertained that the Cape soil was fertile and that the inhabitants were not cannibals as many Europeans feared (Hartdegen, 1988: 5).

The Portuguese, English, French and Dutch voyagers called at the Cape purely to take on fresh water, fish and game which would sustain them for the remainder of their arduous voyage to Asia (Hartdegen, 1988:5).

4. The Cape Dutch influence on the built environment

The arrival of the Dutch settlers in 1652 brought another architectural influence to South Africa and today many Cape-Dutch buildings still exist especially on farms. Some of these are amongst the Cape's best attractions, open to tourists where the wine and fruit produce can be enjoyed. Some good examples of Cape-Dutch architecture can be seen at the following places:

- Groot Constantia: The original manor house was developed for Simon van der Stel in 1692 (Hartdegen, 1988:26) (See photograph 1 in addendum).

- Meerlust: The estate belongs to the Myburgh family since 1757. The typical Cape-Dutch style homestead was built in 1776 with material imported from Holland and Batavia, while indigenous timber like yellowwood and stinkwood were used for doors and floors (Hartdegen, 1988: 26).

- Boschendal: A white-washed H-shaped Cape-Dutch homestead, built against the backdrop of the Groot Drakenstein Mountains. Tourists may enjoy and experience the style and culture of an earlier century (Hurford, 1997: 138).

The legal practices of the Dutch in the 17th and 18th centuries led to the development of racial order, which in turn led to migration to find some Promised Land where people might follow their own cultural practices. This led to inland development. There were a few cultural changes especially regarding language (Thompson, 1990: 68).

5. Architecture and the British influence

The British occupation of South Africa brought further change to South African architecture and roofing styles. Among the 1820 settlers were trained potters who started producing pan-tiles, which were extensively used as roofing material in the Eastern Cape (Hartdegen, 1988: 48). Amongst buildings built in the British architectural style in South Africa are:

- The Tulbagh town house now known as Mount Bijou: Built between 1812 and 1822 follows the Cape style but with a new English aesthetics of classical symmetry and proportion (Hartdegen, 1988:54) (See photograph 2 in addendum).

- Other examples that still exist are the Union buildings designed by Englishman Sir Herbert Baker in 1910 (incorporating Cape-Dutch, English and Italian renaissance influences), Pretoria station (1908), and St Andrews College in Grahamstown (1913) (Hartdegen, 1988: 99, 114, 120, 121, 129).

6. European tradition in the 19th Century

One should be careful not to judge European architecture as foreign to Africa. European architecture has influenced Africa's culture and expression of life to a great degree. The question that needs to be asked is whether European style is sympathetic to Africa or does it, in it's contrast, make a mockery of Africa's own heritage.

Most developments in respect of services, railways, infrastructure and development of towns in the colonial times, especially after the British Settlers arrived in 1820, took place. Great Britain dominated activities in the Cape of Good Hope for many years (Thompson, 1990: 66).

Examples of architecture that find their place in sympathy with the South African environment are found mainly in church buildings and are based on European styles. These punctuate towns and environments in recognition of our temporary habitation and dependence. Among these are:

- Holy Trinity Anglican Church in Port Elizabeth (1866). A free-standing Gothic revival construction, with pointed stonework and plastered dressing. A building with lovely flowing lines (Herholdt, 1994: 109) (See photograph 3 in addendum).

- The Graaff-Reinet Dutch Reformed Church (1887) is a focal point of this historical town with more than 200 national monuments. The church was modelled (like many others in South Africa) on its English counterpart, the Salisbury Cathedral, but adjusted to the South African culture, environment and needs, and stands as an example of faith and tradition (Hurford, 1997: 100 - 101).

Port Elizabeth shows examples of imported styles brought to the area by settlers during the 19th century. Today these buildings add to the character of the city. Styles were adjusted to suit the conditions of the new country, examples of these are:

Late Georgian style: Simplicity, chimneyed gables and symmetrical façade (See photograph 4 in addendum).

Early Victorian with classical decorations, decorated barge board and convex veranda sheeting.

High Victorian: A style with strong colours and vertically stressed in the building form.

Regency. A style showing full pane windows grouped in pairs (Theron, 1983: 4-5, 10, 11).

Dramatic changes occurred in many parts of South Africa under the impact of both external and internal influences. Most of the capital investment in the mining industries came from overseas. Kimberley, city of diamonds, and Johannesburg, city of gold, developed and grew.

Johannesburg grew to contain the largest concentration of people in the entire region (Thompson, 1990: 110).

7. Independent republics

During the period of independence of the two inland republics (Orange Free State and the Transvaal) some interesting buildings were built. Examples of these are:

- The Presidency in Bloemfontein (1886) (See photograph 5 in addendum).
- The Fourth Raadsaal (Government building) in Bloemfontein (1893).
- The "Twin Tower Church" in Bloemfontein (1880). A building in the Romanesque Gothic style.
- Church Square Buildings: Pretoria (1890 – 1910). (Hartdegen, 1988: 282-285)

8. 20th century architecture

This century may be divided into various phases in the political life of South Africa and its influence on architecture, the Union of 1910, the world wars, the Republic of South Africa in l961, the apartheid era, and the democracy in 1994. Some examples of these eras are:

- Grootte Schuur hospital in Cape Town (1937).
- Tudor style theatre in Natal (1935).
- Libertas, official residence of the State President.
- Black housing with its box type units to establish the apartheid cities.
- The building boom of the sixties: The University of the North as an example of architecture for black universities; the Civic Centre in Kimberley.
- The Diamond House in Johannesburg is an example of classic architecture of the late twentieth century.
- The Bloemfontein Civic Centre (Hartdegen, 1988: 282, 214, 226, 260, 264, 284, 286) (See photograph 6 in addendum).

9. Rural areas – the built environment and sustainability

Sustainability in the Southern African context is also linked to the wealth of communities in both rural and urban environments. Sustainability relates closely to environment and the built-environment that establishes the physical environment and a sense of place where people live and have to make a living.

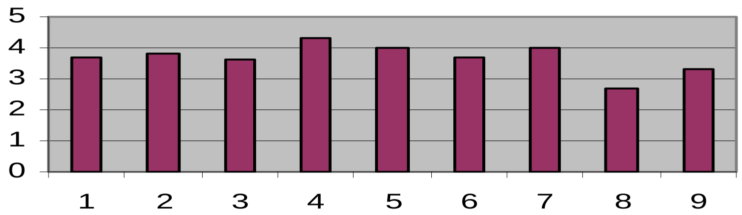
9.1 Rural areas

Sustainability in rural regions is seen as part of the building blocks for environmental protection, upliftment and economy.

To establish the stability of these building blocks, a study relating to the rural areas of the Free State region was done by the University of the Free State (UFS). Professionals working in rural areas were contacted to test their opinions on the sustainability of their areas. The study showed that tourism will and has already played an important role in sustainability.

Physical projects aimed at manufacturing, tourism, infrastructure development and state spending should contribute to 'economical and financial sustainability' (Graph 1).

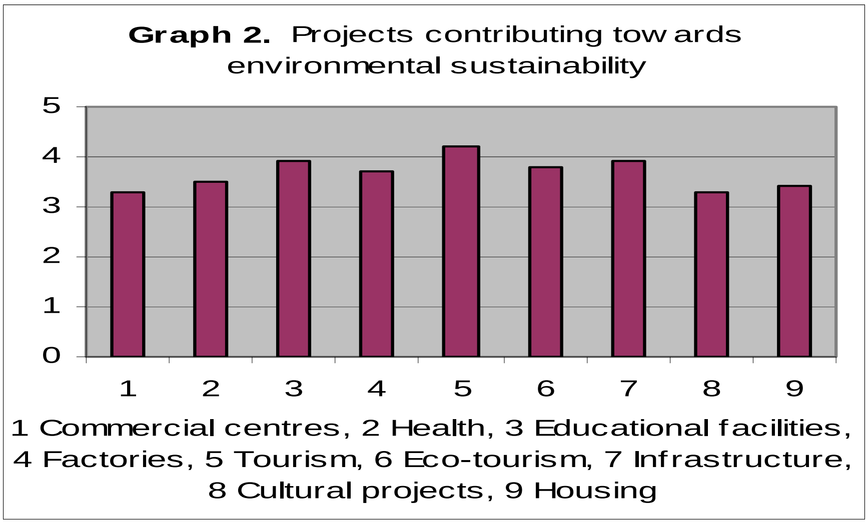
Graph 1. Physical developments which positively contribute towards economy and financial sustainability



1 Commercial centres, 2 Health, 3 Education facilities, 4 Factories, 5 Tourism, 6 Eco-tourism, 7 Infrastructure, 8 Cultural projects, 9 Housing

(Source: Department of Quantity surveying and Construction Management, University of the Free State (UFS))

As far as the 'environment' is concerned, tourism, eco-tourism, infrastructure, development and state spending will have a substantial positive influence on 'financial sustainability' (Graph 2).



(Source: Department of Quantity surveying and Construction Management, University of the Free State (UFS))

The most pressing problems of rural areas were pointed out as being, the economic situation, urbanisation, limited physical projects and state spending (Verster and Berry, 2004).

The question that should also be answered, in the context of this paper is: what influence does architectural heritage play in the establishment and growth of the tourism industry?

The proposition is that architectural history and heritage help to tell the story of a country, of its pain and achievement, and establishes a sense of culture, art and society, and that tourism helps to relay the country's story and heritage.

If the proposition holds true it establishes the theory that the protection and heritage of architecture will positively influence the economic position of urban as well as rural communities. The sustainability of rural communities is specifically important in the South African context.

9.2 Rural needs and the professions

Designers and planners should also have a keen sense of cultural diversity and steps should be taken to make a community interesting and wonderful to experience:

- Open spaces, bars and cafés to foster and develop the night-life economy.
- Council-owned properties to assess their feasibility as arts or cultural venues.
- A youth cultural policy and a circuit for popular activities.
- Conversation and arts initiatives, linking the greening of local areas to culture.

- Attention to street design, furniture and sculptures (Montgomery, 1990: 23).

A further proposition in respect of architecture and the conservation thereof may follow from Montgomery’s opinion that examples of architectural heritage punctuate an environment, telling the story of a culture and it’s sympathy towards history and the present.

By conserving, rebuilding, and actively promoting South Africa’s architectural heritage, this may further enhance the country as a tourist destination.

10. Present buildings focusing on the South African architectural heritage

10.1 New approaches

The Peoples Parliament in Kimberley is an example of how Africa’s organic architectural heritage and the concept of the people’s square or “Patello” finds its way into the present built environment as interpretation of traditional response to shelter, open space, ceremony and celebration. The language of Africa’s architecture is further developed in this manner while maintaining consciousness of location.

10.2 New trends

Another reason why South Africa’s architectural heritage should be protected, is due to the negative influence of foreign style or rather ‘fake’ style that has found it’s way into the South African architectural production system. As Lipman in (Le Roux, 2005: 6) calls it “fake foreign fads” (Le Roux, 2005: 16). This refers to Tuscan, Italian and Georgian styles that have found their way into commercial and residential architecture. In defence of South Africa’s European architectural style such as Cape-Dutch, Georgian- or Transvaal-regionalism, Van der Vyver (in Le Roux, 2005: 17) holds that these styles were adapted to local climate, availability of material and craftsmanship.

Joubert (in Le Roux, 2005), argues that Africa has produced some notable Afropean buildings that “...celebrate our socio-economic and environmental peculiarities, while respecting the integrity of Eurocentric design premises.” The Mpumulanga government buildings in Nelspruit and the new Constitutional court building in Johannesburg are some notable examples (Le Roux, 2005: 17).

11. Socio-cultural impact of tourism

Any meeting of people has a rub-off effect on those involved in the encounter. In some cases, when two people have a similar cultural background and knowledge of each other's language, the communication is verbal. In most cases it is a silent dialogue. Communication, by a look, a gesture and a general manner of behaviour. This most universal kind of communication is particularly related to tourists and the natives of the region they visit, for the impact of their meeting is usually brief and superficial. In spite of this, however, tourists carry away powerful images of the places they visit and the native resident receives a strong impression of the tourist and his ethos (Theobald, 1994: 92).

11.1 Mass tourism

Culture and building heritage in this sense, is of course, one of the main motives for travel from the time of the Grand Tour until the time of mass travel. Classical history, Bible history, Egyptian history and the Renaissance were motivations for most tours and the claim to consider oneself a cultured person. The arrival of mass travel made the pursuit of pleasure the main motivation for a holiday (Theobald, 1994: 99 – 100).

Desirable types of tourism that have some or all of the following characteristics are:

- Tourists behave differently to mass tourists.
- They have different attitudes towards the resources they use compared to mass tourists.
- Tourism is usually small scale (low numbers of tourists).
- The local community (hosts) has more control over tourism (Burton, 1998: 138).

The cultural heritage in South Africa needs constant attention and the conservation of buildings to ensure continuous growth of awareness of this heritage attracts the above types of tourism.

11.2 Community based tourism

Community-based tourism is a form of tourist development characterised by the participation of the local community in the decision-making process at an early stage. It has been advocated in Western democracies and widely debated and experimented with, for example, in the United Kingdom in the 1970's in the context of education, housing and leisure planning. It re-emerged to become a fashionable concept in tourism planning in the 1980's, both in the Western democracies and as advocated for third world countries. This was due to the recognition that the costs and benefits of tourism development were distributed unequally between the local host populations and 'outside' interests (e.g. national governments, multi-national development companies), where the local community often suffered more of the costs and experienced less than their fair share of the benefits (Burton, 1998: 139).

Community tourism, where local people participate in the decision-making, is seen as a remedy to these perceived disadvantages. The common assumptions behind the community approach are usually:

- That a unified view of what is locally acceptable can be found.

- Local communities will put a high preference on environmental quality when tourism development decisions are made (Burton, 1998: 139).

12. Conclusion and recommendations

This paper aims to show examples of the wonderful architectural heritage of South Africa as well as the variety of styles, history, materials used, culture and time periods. It also proposes that the protection of this heritage will enhance South Africa’s image as a tourist destination.

Historical architecture is important for sustainability and should focus on value at these entities to attract tourism, especially the up-market industry. Research clearly shows the importance of tourism towards sustainability (refer to Graph 1). A country and its citizens must protect architecture to ensure the attraction of tourism for sustainability.

Figure 1 proposes a model of the main elements and links that should influence conservation of the built environment in the South African context, to ensure sympathy for the country's building heritage.

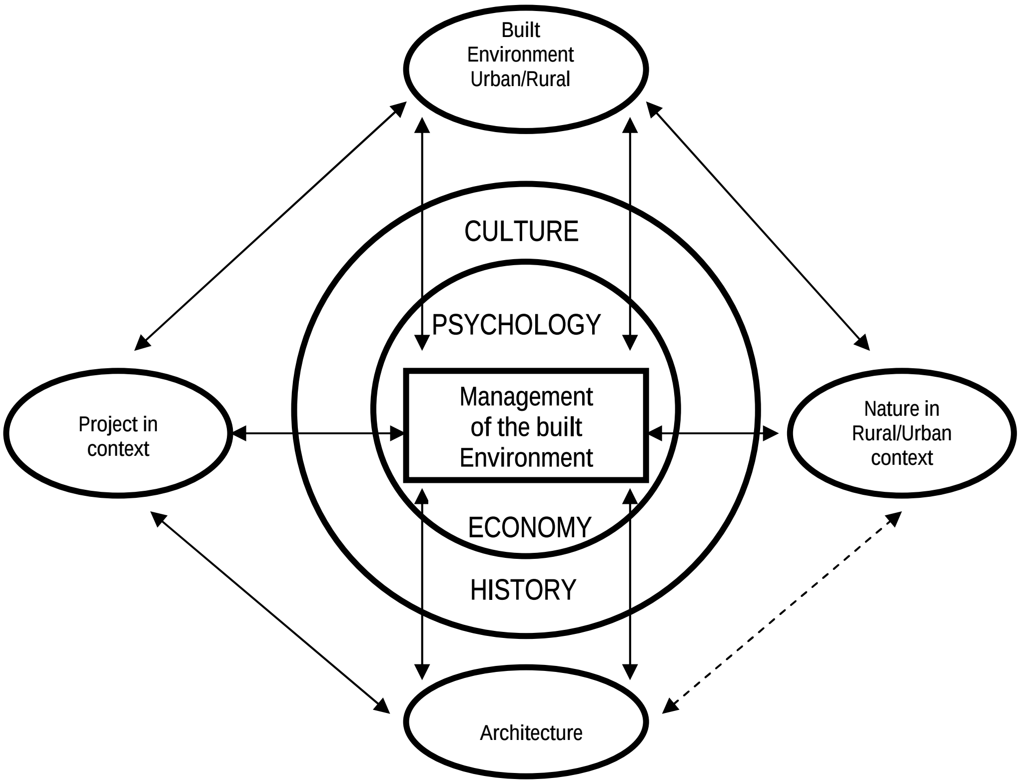


Figure 1- Main elements of conservation of the built environment (Source: Adapted from Verster, 2004)

South Africa has an interesting heritage of building architecture, objects and structures that inherently depicts the people of the country, their culture, politics and inter-relationships. New, Africa-centred architecture that may delight visitors to the country has now begun to evolve.

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A New Village in Sri Lanka:

Learning Lessons There, Sharing Lessons Here

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Abstract

When the Indian Ocean tsunami hit Sri Lanka, it destroyed the 190-person village of Kalametiya. Eleven people were killed and every building was ruined.

In March 2005, the first two authors helped to "catalyze" the reconstruction of the town under the direction of Sri Lankan architect Madhura Prematilleke and with Ball State University faculty colleague Nihal Perera and 21 students from the U.S. These efforts, along with those of many local citizens and relief workers, built one of the country's first post-tsunami permanent villages, known today as Minsiripura.

Responding to such extreme local circumstances can challenge existing knowledge, if one is prepared and open. For example, when building with no electricity on-site, participating in auspicious moments, sharing tea with adults, and playing with children, the need to respond to local conditions becomes magnified, especially to an outsider. When working with limited resources under an unyielding sun, it is immediately obvious that buildings, builders, and architects must be "smart" regarding the climate, available materials, and culture. And when heeding the plans and advice of others, one comes to understand that letting go—believing that a good way to change the world is to be open to changing yourself—can reveal something wonderful that was previously unimaginable. Such circumstances provide a test, of sorts, regarding what is known and what needs to be known, and represent a classic epistemologic reordering, what Maxine Greene refers to as 'wide-awakeness' in contrast to sheer attentiveness, in which a person is fully present in the contextualized moment before him or her.

This paper reflects on our shared experiences in Kalametiya and discusses how lessons learned there have influenced recent works completed by the authors and their students, including a construction in Halifax, Nova Scotia, Canada and deconstructions in Flint, Michigan, USA. Both projects question conventional 1-2-3 sensibilities (which assume that knowledge flows

primarily if not exclusively from the First World to the Third World) and instead promote a 3-2-1 awareness--that there is much to be learned in the developing world.

Keywords: Kalametiya, CapAsia, Autoethnography, Local Knowledge, Bottom-up

> *There is great need here . . . and . . . I should say, the locals are well on their way to making their own futures, to finding their own way in their new worlds, lives, houses and occupations.*
>
> *It is an amazing opportunity for us, the fullest of moments to be alive, to be contributing and to be understanding the decency and compassion that exists in the world, and in our students.*
>
> Wes Janz email sent from Tangalle, Sri Lanka to the Ball State University community on March 7, 2005 [1]

1. Background

When the Indian Ocean tsunami hit Sri Lanka on December 26, 2004, more than 40,000 lives were lost and another 2.5 million were displaced. Among these large numbers of people directly impacted by this natural disaster was the 190-person village of Kalametiya. Eleven people were killed and every building was ruined.

Four months later, in March 2005, under the direction of Sri Lankan architect Madhura Prematilleke and with our Ball State University faculty colleague Nihal Perera and 21 students from the U.S., the first two authors helped “catalyze” reconstruction of a new village. [2] These efforts, along with those of relief agencies, relief workers, many local citizens, and the Kalametiyans themselves, built one of the country’s first post-tsunami permanent villages, known today as Minsiripura.

With this paper the co-authors Wes and Tim reflect upon the lessons we learned in Sri Lanka and suggest how our experiences there effected and continue to effect the lessons we share with students and colleagues here in the U.S. and North America. The involvement of Thalia, a Ball State University faculty colleague in our university’s Department of Education Studies, is an effort to add depth to this consideration of our immersive and/or active learning experiences as part of a postcolonial pedagogy.

Reflexivity is a process in which a researcher continuously reflects on how the action research process changes his or her perspectives. Autoethnography adds a critical dimension to the process. There are two different understandings of autoethnography. In the first and most common approach, “autoethnography is understood as ‘the process by which the researcher chooses to make explicit use of [their] own positionality, involvements and experiences as an integral part of ethnographic research.’” In the second approach, autoethnography “is not something researchers do that they may want to study. . . The intent is to strategically alter the way an audience of dominant outsiders understands the subordinate group, and beyond that, to push back to some extent, against the shove of domination." [3]

What follows are some examples of how we have approached the process of reflexivity and our current efforts at reconsidering a specific Sri Lankan experience in early 2005 now, nearly three years later. While we will rely on self-reflection which, by definition, places us at the center of the stories that we are constructing, we will also offer instances in which the locals "pushed back" against the outsiders, even as the Kalametiyans welcomed us into their village, lives, and futures. By displacing ourselves, we seek to complicate conventional 1-2-3 sensibilities (which assume that knowledge flows primarily if not exclusively from the First World to the Third World) and instead offer our early insights into a 3-2-1 view that argues that there is much for the developed world to learn from the developing world.

2. Prior Knowledge

Sri Lanka was not an unfamiliar place to us. Our faculty colleague, Nihal Perera, is a native Sri Lankan. He is also the originator and director of CapAsia, a unique field study program that brings U.S. students to south Asia every other spring semester for eleven weeks of study. [4] Wes is the co-director of CapAsia and had visited Sri Lanka in 2001, 2002, and 2003. In 2003, on CapAsia III, Nihal and Wes collaborated with Madhura, Vijitha Basnayake, and Varuna de Silva and led sixty Sri Lankan and CapAsia students in the design and construction of two pavilions on the Moratuwa campus. With the successful completion of this project and the growth of our friendships, trust grew in each other. [5] Nihal and Wes had some, admittedly limited, experience with a natural disaster in south Asia. Both were in Delhi with students in 2001 when the Bhuj earthquake hit. And in 2005, before bringing the CapAsians to Sri Lanka, Nihal took the students to Bhuj, where they visited some of the areas devastated in 2001, in order to see what developments had occurred since the earthquake.

The tsunami struck as CapAsia IV was about to depart for south Asia. We anticipated a planned construction program with the architect Laurie Baker in Thiruvananthapuram. The day after the tsunami, Nihal and Wes spoke of the need to change the field study's itinerary, based on the belief that with our active knowledge of Sri Lanka we might be among the best positioned U.S.-based university programs to offer our services to those effected by the great wave. Using our local connections in Sri Lanka, we diverted our students away from the pre-arranged building project in India and towards the fishing village of Kalametiya.

3. CapAsia IV, 2005, Kalametiya

Pre-tsunami, Madhura was planning a resort near the village of Kalametiya, approximately twenty kilometers east of Tangalle and just south of Hungama. Not wanting to overwhelm the lives of the villagers with the new facility, he took the time to get to know the people believing this could help mediate the resort's impact on the lives and livelihoods.

Post-tsunami, Madhura volunteered his services and time to the village's reconstruction. The original village had been situated along the coast in a beautiful palm grove. The site for the new village, as ordered by the national government, was moved four kilometers inland on a sun-baked site to the north of the Kalametiya Bird Sanctuary.

Madhura encouraged us to help in any of four areas: 1) permanent house construction, 2) restoration of livelihoods, i.e., repairing fishing boats, 3) cleaning up house debris, and 4) social engagement. In particular, he wrote, "The frustration among [the villagers] is growing under these very difficult circumstances and social engagement with groups at different levels will be very useful to ease some of this frustration. Opportunities include play activities with the young kids, sport with the young men – volleyball or cricket, or even board games; cook-outs with the women, camp-fires etc."

Once we arrived, our plans to begin constructing immediately were derailed: in keeping with charts that were done of the stars, the village's auspicious moment would occur two days after our arrival. We had to wait. We had to set aside our schedule and, for the moment, our ambitions and take time to get to known the people and place.

As a result, our group spent part of one day assisting locals in cleaning up the remnants of the village swept into a lagoon by the tsunami, making neat piles of the torn remains: coconut wood framing members and tree branch posts, corrugated tin sheets tumbled into misshapen globes by the water wall, and aluminum cabling. Household items too--lamp bases, plastic chairs, insulated coolers, curtains, and tablecloths--the stuff of people's lives. Fishing nets, floats, and a boat hull tossed by the vengeful water. Pile after pile. And Wes found a passport in the sand, number K0538847, and imagined its owner before, during, and after the tsunami.

We then visited the temporary village, a U-shaped arrangement of approximately thirty 3-meter by 3-meter shelters constructed by Oxfam. The fishing families, who lived their entire lives under palm trees on a beach washed by ocean water and breezes, found themselves living in wood boxes sealed with corrugated tin roofs, all baking in the hot equatorial sun. A local woman named Rasika said to Nihal and Wes: "Now we are the dried fish."

At the auspicious moment--shortly after 8:00 AM on March 6, 2005--three young monks chanted as milk was boiled and a foundation stone set. As work began on the foundation trench for the first house, the leaders of CapAsia intended to complete one "demonstration" house that the villagers and builders could use as a model in completing the other twenty-nine houses. We came to a somewhat painful realization that this would be impossible. The hard-packed earth and hand tools slowed our progress.

In keeping with something Madhura said in an earlier conversation, we began to rethink our role as one that could provide great energy to begin the entire rebuilding of the village—to "catalyze" the construction of houses for everyone. We could get the big work going. And as we had come in "under the radar"—not associated with any large funding or supervisory agencies—we might be able to push forward even is some official permissions were missing or on the way.

We decided to spread the student group across the site, staking out foundations for the entire village, and beginning their trenches too. When we departed one week later, all the house foundations were dug, the majority of the trenches had a concrete pad poured in them on which the granite foundation would be built, and the first house had its granite foundation completed.

While on-site in Sri Lanka, flying back to the United States together, and teaching at Ball State University, Wes and Tim spoke of their shared experiences in Kalametiya, sometimes in direct reference to the project--“Could you figure out who was managing the construction site?”--sometimes more abstractly--“I’m more and more interested in simple tools” and “Maybe it’s time to do a project in which you’re not afraid to fail.” These questions, found or addressed while in Sri Lanka, provided us with a number of lessons that came and continue to influence our teaching.

4. Lessons

4.1 Lesson 1: Waking up

The CapAsia participants were time travelers, moving through air, space, and countryside at different speeds and in different orbits, to a place destroyed in an instant, where the survivors lived disjointed lives even as they waited patiently for a new beginning and a new rhythm for their days.

Our experiences on the ground brought a rawness, an immediacy, and a heightened awareness of how long a simple task might take to begin or complete, a feeling that one’s strong young body was being underutilized, a sense of wonder at the different rituals and beliefs that framed our efforts, and a desire to do something immediately for people whose lives had been completely upended, if not nearly ended.

Among the most notable comments on this aspect of the project was one by Tim, who arrived in Sri Lanka several days after the other CapAsians. Wes met Tim at the Negombo airport (after a long series of pan-Pacific flights) and escorted him to Kalametiya through a long night’s drive along the Coastal Highway, arriving at the construction site just as the auspicious moment rituals began. In a state of both exhaustion and euphoria--tired from the long trip and ready to help in whatever way he could--days later Tim said he “woke up in Sri Lanka with a pick in his hands.” For the students, this “waking up” was an especially difficult negotiation between their desire to make a difference and the anxiety they felt as they were awakened from their long middle class sleep by new challenges, insights, and pains they did not know and could not anticipate.

Locals “pushed back” at our plans. We had to wait for the auspicious moment. Many of the village men and some of the local villagers paid by relief organizations to work did no work.

Instead, they sat in the shade, watching. Persons who had lost a family or family member in the tsunami remained in a state of shock. In a sense, our "waking up" was tied to their "waking up." A local European provided alcohol to the village's men and kept them occupied, for reasons we could not determine. In this, there was a multi-layered local "sleep" as well, one we could not shake. [6]

4.2 Lesson 2: Not knowing

We adopted a way of working that not only took cues from the locals, but looked to them to provide leadership. While the plans gave us some sense that we knew where the project was headed, still, there was a great deal we did not know. From another vantage point, it can be said that we had no choice in the roles we assumed. Wes and Tim did not speak one word of Sinhalese (the local language), had never swung mamotties (the local hand tools used for digging), and were not expected to be in-charge of the building site. We came to understand the need to trust the others to know what to do and what was best. We followed the lead of men working on the construction site often in sandals and sarongs, and of women on the site as well whose intimate understanding of the local tools and conditions allowed them, at times, to outwork even our strongest CapAsian men.

While we had some knowledge, still, we did not know. For example, once the granite foundation wall was completed, we knew from the drawings that a concrete bond beam would be built to rest on top of it. We did not know, exactly, how it would be constructed on site. We didn't know how they planned to build the frame to hold the wet concrete of the bond beam until it was built. What wood was to be used? How was it to be assembled? How would it to be connected to the granite? There were many such moments when our existing knowledge gave us some notions, but provided limited insight.

At the same time, on a site where agents of various international, national, and local agencies and funding sources had their own interests, one could see that our inability to find logic within the system of construction was caused not only because we were foreigners. We got the sense that the Sri Lankans themselves did not understand how to organize the site—truckloads of granite blocks were being dumped with no on-site direction, masons were working without any direct supervision by the architect, water tanks were being placed without any consultation.

We could not direct, only respond. Letting go provided the chance to see the limits and relevance of our cultural and architectural knowledge. Was what we knew or learned about construction in North America even relevant on this piece of land in southern Sri Lanka, and if not, WHY? What did it feel like to let go, to work for others, and in not knowing, find even greater success? We could help, but it was, in the end, their job site and in a very positive sense, their village.

4.3 Lesson 3: Living now

We had no choice but to connect to the place and people. The ground in and on which the village was to be built was stubborn and did us no favors. We came to know its color, texture, and taste. The sun was hot and relentless. We sweated profusely, drank great amounts of water, and longed for the coolness of the ocean breezes. Our bodies were fully engaged--hands blistered immediately, we had grit in our teeth, and our backs ached. Still, with bandaged hands and smiling faces, we continued to work.

Even as we were caught in the immediacy of the moment, some of the Kalametiyans sought to extend friendship and connections into the future. They kept us in the "now" even as their engagements with us—working and playing with us, inviting into their homes, for example—suggest their efforts to break the immediacy of our involvement. Months later, one family sent Tim a Christmas card, and some of our students also remained in communication with the villagers. In the "now," they joined us in attempting to extend our bonds into the future. They "pushed back" at us by offering their friendship and thanks.

4.4 Defining success

Our week in Kalametiya was just that--seven days. Maybe the villagers saw us as an ephemeral presence--we were there for a short time, they enjoyed and appreciated our efforts, and then we were gone, too soon.

We had come to Kalametiya expecting to complete a "model" for others to follow, to impart our knowledge and expertise. In short time, we had to shift our expectations and follow the fluid course of events. There was little coordination on site. There was not any obvious animosity or anger, but no shared understanding of the project either. The masons kept to themselves and to their own pace.   We never worked in the cool of the evening. In this, there was little urgency and not much big energy, except among some of the villagers themselves.

We came to a different understanding of the successes of the project. Our building site was among the first to begin reconstruction, four months after the disaster. Visitors told us that this was the only reconstruction site in the area that had Sri Lankan locals working alongside westerners. By the time of our departure all thirty houses had been started. We came to appreciate this accomplishment as a greater success than completing just one. As we departed among hugs, tears and glasses of thick, sweet tea, we saw our role as that of a catalyst for both healing and reconstruction, and with that altered perspective understood our involvement as a great success.

We departed, of course, with much work left to do, from a construction site where we contributed little knowledge, had almost no input, and did not understand even the most basic of tasks, intervening in lives that had been through tragedies we couldn't imagine. We didn't get to start the project when we wanted to, didn't accomplish our objective, and stopped with just a small percentage of the work completed. And we left behind friends and a place we had grown close to and had been a part of, a place with which future contact would be difficult (it was out of the range of mobile phone service and the mailing address was a city several kilometers away).

It was, we came to understand, enough to help begin, enough to complete one house foundation, and more than enough to be very sad when we departed.

4.5 Lesson 5: Shifting innovation

The architect Sheila Kennedy speaks of the "shifting geography of innovation." In this, she challenges the widespread belief that we, in the developed West, innovate and give to or share our technology with those in developing economies and settings.   She argues that a 1-2-3 (first world to third world) exchange fails because the innovation often cannot adapt to the local culture. [7]

Working alongside the masons, the local citizenry, and the Kalametiyans shifted our perspectives. We learned by participating in their means and methods, which grew directly out of the place. We watched a mason lay out a foundation plan in twenty minutes with one piece of string--an assignment that two of our graduate students took two hours and numerous pieces of string to complete. We checked to make sure the top of the foundation was of a uniform height not with a laser or even a level, but with a simple garden hose filled with water. And our young, strong students did their best to match the digging skills of local men and women, but could not.



In this, we learned practical and technical lessons related to technique and local intelligence. Maybe more importantly, we learned humility, that "our" way is just one way, and might not always be the best way. In this, we found that a 3-2-1 flow of knowledge, from third world to first world, has much to offer. We learned, again, the need to listen. [8]

In one of our small architectural contributions, Tim suggested that a construction detail of the foundation needed further attention. Specifically, a metal "tie" was needed to mechanically join the granite blocks to the beam that rested on top of them. This was a detail not shown in the architect's drawing and not being constructed by the masons. We telephoned the architect who said his office had forgotten to show the "tie." Then, Wes instructed the masons on-site, without a word of shared language, to include such a "tie" in the future. In a sense, our "push back" improved the constructed quality of the houses. More importantly, it established the relevance of shared knowledge, of both following and questioning within the project.

5. Case Studies

Two recent projects suggest the ways in which our experiences in Kalametiya inform both our practices with students and our attempts to alter the ways in which we, the dominant group, understand the subordinate group.

5.1 Project 1: Halifax, Nova Scotia, Canada

Each summer the Department of Architecture at Dalhousie University in Halifax, Nova Scotia (Canada) runs a series of FreeLAB studios that must result in a full scale built construction of some type. As the name implies, the projects are largely determined by individual instructors who are invited from around the country and the world. Tim was invited to lead a FreeLAB in the summer of 2006, two years after participating in the reconstruction of Kalametiya.

The Light Sail Installation was intended to reveal the unique qualities of its site, located adjacent to the historic grain silos at the Halifax waterfront. The piece is composed of a grid of light reflectors salvaged from the site. In this, the work invests both the reflectors and the silos with a new life and reveals the beauty of the site itself. The reflectors are suspended from a custom fabricated steel frame and when activated by the breeze they pivot independently, creating a brilliant dance of light. The work is interactive--participants are able to both rotate the assembly and affect the projection of light through the screens and onto the massive wall of the grain silos.

Tim considers the result of the short (15-day) FreeLAB among the most successful of his design-build efforts with students, of which there are many. He found himself reflecting on how his experiences in Kalametiya might have influenced his approach to the project in Halifax:

On the long drive out to Halifax I "woke up" to the fact that I had no idea what I was going to build or where I was going to build it. I had a familiar tool—a 120-volt welder--in the back of the truck and a fair assortment of my own tools, something I could count on. I had never gone into a project feeling quite this exposed. I needed to lead but I also needed to be open to the flow of events. I needed to let go and follow. Had my experience in Kalametiya prepared me for this?

Prior to leaving for Canada I had discussed my work with Wes in a friendly conversation and he suggested I needed to have a "grand failure," a comment I took in jest at the time but found myself thinking about often on the long drive to Nova Scotia. A grand failure? Letting go of control? Pushing boundaries? What exactly was he getting at?

Upon my arrival in Halifax (after a three-day drive) I found myself having dinner at the home of my hosts and meeting some of the other FreeLAB instructors (six labs run concurrently) for the first time. This dinner was my first stop in Halifax and the FreeLAB was to begin the following morning, lasting for just over two weeks. This is an ambitious schedule for a construction project of any kind. I intended to do a site-specific installation but had no idea what to build or where to build it. I had very little money for the construction. And I wanted to do something derivative of a place that I was visiting for the first time.

Over dinner I discovered that the other instructors did have specific ideas of what they would build. Most had external funding and some were familiar with the place. A grand failure? I thought to myself that Wes would be very pleased as I felt I had set myself up for just that.

To "not know" Halifax and FreeLAB was to see both the workshop and my work with the clarity of fresh eyes, new people, and a new place experienced for the first time. The short deadline, very limited funding, and negotiating within the bureaucracy of a new university created their own anxious pressure. Complementing these concerns were the luxury of complete focus and no distractions. There was just the project, the students, and the place. The temporary nature of the work intensified the experience and focus of the moment. In this sense, to speak of "living now" is to understand that the completed project had a life of exactly one day. There was an opening, an event, and a bright short life full of magic, energy and pride. I left town the next day on a journey toward home over 1500 miles away. The Light Sail was dismantled and put into storage.

Had placing myself in that uncomfortable situation of not knowing, not planning, contributed to the project's success? Does organizing a project to guarantee a good result in some ways constrain the potential for a great one? Could I have taken this chance prior to "letting go" in Kalametiya?

Finally, to write of the shifting geography of innovation, the Light Sail took its cues from the leftover, the derelict, the industrial backyard of the city, and in that ragged mix found beauty and elegance. The project began with an inventory of the discarded contents of an old warehouse, finding inspiration in the unlikely, in the "rubbish" of the place itself. We approached the project with a willingness to quietly listen and to learn from this unlikely place as well as a willingness to let the investigation and the process define the response. Shop technicians were consulted and became participants in the design of the project, even as they worked as enthusiastic facilitators from separate (competing) departments.

In retrospect, listening, including, and enabling were central to the success of the project. Were these lessons I had learned while sweating alongside the local masons in the dusty red earth under the hot sun of Kalametiya? One is never sure where prior knowledge ends and new knowledge begins, or where one may find beauty in the unexpected. The temporary nature of the project and the abstraction of distance and time allow one to be open in ways he or she might normally be closed. It's hard to define what one takes from such events, but in the end I've discovered perhaps that the true magic lies in letting go.

5.2 Project 2: Flint, Michigan, USA

General Motors was founded in Flint one hundred years ago. The city and its worker-citizens rode the company's rise to a position of global primacy. At its peak in the 1960s, Flint was home to 190,000 persons and 80,000 General Motors' jobs, and prepared for a population of 250,000. Today, with the U.S. auto industry in free-fall, Flint's population is at 120,000 and 17,000 GM jobs remain. No one is sure if the bottom has been reached or is even in sight.

As Flint shrinks, houses are abandoned. Comprehensive numbers are difficult to establish, but a demolition crew chief told Wes that 4,000 houses need to be torn down "today" and another 10,000 will need to be torn down in the future. Crews tear down two to seven houses every working day. The quantity of demolition waste produced in Flint is significant: 200 cubic yards of waste/house x 5 houses/day (+/-) x 5 work days/week x 52 weeks = 260,000 cubic yards/year. That's equivalent to a 15-story building the size of a soccer field. Every year.

  

In 2006 Wes was commissioned to determine if it is possible to deconstruct houses in Flint so as to reduce, even slightly, the amount of waste produced when a house is torn down. Ultimately, in this radically extreme setting, three recommendations were made. The first, "soft strip," suggested the need to pull elements off and out of the houses that were most easily removed—gutters, downspouts, handrails, aluminum siding, and more. [9]

Waking up in Flint is to be in a place with almost no hope--you're a time traveler with no sense of time as there is no movement forward. To work in Flint, you have to let go of much of what was and is known. Living now, in Flint, is to acknowledge that the bottom has not been reached, that there are problems that can't be solved, that one needs to be humble in order to understand the depth and breadth of the distress. Living now in Flint is also to engage house teardown processes that are well-practiced--thousands of houses have been torn down using essentially the same backhoes, fire hoses, large dump trucks, bulldozers, landfill, and people. Living in Flint today is also to run into untold numbers of liquor stores, squatters, unemployed persons, and others in distress. This is the "now" of a shrinking city. To work in Flint, today, as an architect is to have to redefine one's sense of success. How does one "succeed" in such a setting? Can you find a place for your architectural knowledge? And Flint is not alone. Cities are shrinking throughout the Rust Belt in the United States, in the former Soviet Union, and in the older societies in Europe. In shifting to these places of innovation, issues arise that challenge our sense of responsibility and knowledge.

There was tremendous "push back" by the various actors. Too many abandoned houses, a well practiced and rough teardown process, limited funding to support teardown efforts, a desire to reduce landfill deliveries, scavengers and squatters, a lack of support from the State of Michigan, thousands of lost jobs, and more. Each, essentially, is part of a setting in which their combined "shove" overwhelms the efforts of any others.

6. Conclusions: New Modes of Practice and Design

To address the title of her own article "Can Architects be Socially Responsible?" Margaret Crawford replied: "[A]s the profession is presently constituted, no. Both the restricted practices and discourse of the profession have reduced the scope of architecture to two equally unpromising polarities: compromised practice or esoteric philosophies of inaction." However, Crawford offered two avenues for further exploration: "existing material conditions rather than . . . idealistic projections of future technical capabilities" and "compelling stories about social needs" (such as the homeless, communities threatened by decay; elderly, poor, minority groups, and more). [10]

The projects profiled herein evidence significant overlap among Crawford's proposals and the authors' interests. "Existing material conditions" were central aspects of the works. "Compelling stories" were engaged both in the ways in which Wes and Tim, as Maxine Greene might say, were "wide-awake" and fully present themselves, and in the ways that local people assumed, expected, and demanded participation and presence. [11]

In this version of immersive learning, constructional projects are grounded in local building cultures, immediate settings, and real lives; these moments are conceived as learning venues for all.

That said, basic questions arise. Who is the building educator? Who is the building student? Who is the building community? Absent "answers," even as old and new concerns for power and position swirl around us, our search for new modes of practice and design will continue.

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Development of low-cost fly ash bricks

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Abstract

Fly ash is produced in vast quantities as a by-product of the burning of fossil fuels for the thermal generation of electricity. At present 10-15% of the fly ash produced in Australia is utilised in cement manufacturing and concrete industry, with the remaining majority requiring costly disposal processes. Due to growing environmental concerns and the need for cleaner production, the management of fly ash has become an important issue facing the power generation industry. For that reason, many researchers are actively working to find new and improved methods of combating the fly ash waste disposal problem, particularly by establishing its useful and economic utilisation. One such example that is gaining considerable interest in many parts of the world is the utilisation of fly ash in brick manufacturing.

This paper examines the potential for using Class F fly ashes from Queensland as major constituents in the manufacture of common residential building bricks. Scaled-down pressed bricks were made by varying proportions of fly ash, sand, hydrated lime, sodium silicate and water. Both fired, oven-dried and air-cured bricks were tested for their properties including compressive strength, tensile strength, water absorption, and durability. In the paper, the test results are analysed and effects of variables discussed. Recommendations and conclusions as to whether or not the fly ash bricks can perform adequately alongside the clay bricks are included.

Keywords: Construction material, Brick, Fly ash, Sodium silicate, Masonry

1. Background

Housing shortages in many developing countries have stimulated efforts to develop construction methods that use cheap and durable local materials. It is essential to develop technologies that use minimal resources because of the increasing shortage of energy and raw materials. In this regard, the International Development Research Centre (IDRC) in Canada [1] noted that one of the most promising building materials for many countries is the fired clay brick. Traditionally produced in a cottage industry setting, fired clay brick production plays a major role in the informal economy of such countries. However, it is hampered by a number of problems:

Brick makers have little training;

The quality of bricks produced is low, and supply is irregular;

Great quantities of firewood are needed for production while energy loss (in the form of heat) is high at 40-50%; and

The process is damaging to the environment.

On the other hand, in many countries, electricity is often supplied by coal-powered generators. In the power stations, approximately 80-90% of the ash formed from burnt coal is carried out of the furnace, then extracted from the flue gas and is known as fly ash. Large quantities of fly ash produced as a by-product of coal-based power stations have been viewed as a serious environmental problem. It is not surprising that with growing environmental awareness, there has been considerable interest in the use of fly ash in the brick manufacturing industries. At present, India has been leading the way in fly ash brick manufacturing.

The use of fly ash in brick manufacturing is not new. Sloanaker [2] studied class F fly ashes from the USA to produce fired bricks for construction. It was indicated that fired bricks made from feeds of 72% fly ash, 25% bottom ash, and 3% sodium silicate met commercial specifications. In India, Rai [3] was able to produce calcium silicate type bricks using fly ash, sand and lime mixtures, while in Australia, Kayali [4] patented a new process to produce bricks from 100% fly ash which has a compressive strength of more than 40 MPa using a kiln with a firing temperature of 1000°C - 1300°C. In addition, it is worth noting that the possibility of developing non-fired (air-cured) fly ash bricks was studied in Israel [5].

This paper describes an experimental investigation into the use of fly ash in making pressed fly ash bricks by firing, oven-drying and air-curing. Tests were carried out to determine the strength characteristics and water absorption properties of the bricks.

2. Materials

In the current investigation, pressed bricks were made using fly ash and other materials such as sand, lime and sodium silicate of various proportions, wherein the amount of fly ash was at least 50% by mass.

A dry processed “fine-grained” ash from Queensland, namely the Tarong fly ash, was chosen as the main constituent in this investigation. The ash is classified as a low iron mix with more than 75% of constituents as oxides of Silica and Alumina (see Table 1).

Table 1: Main Constituents and Properties of Tarong Fly ash

CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	Na_2O	K_2O	TiO_2	Mn_2O_3
0.1%	70%	25%	1%	0.1%	0.01%	0.1%	0.5%	1.6%	0.03%
Note: pH = 4 Particle density = 2.14 Loss on ignition = 1.5									

Fly ashes are pozzolanic materials, i.e. they react with water with the addition of lime (CaO) to form cement materials. Some fly ashes have a sufficient amount of "free lime" such that they have self-cementing characteristics. However, Queensland fly ash contains low (< 4%) CaO contents (i.e. class F fly ash) and hence, it does not show appreciable self-cementation behaviour.

To improve the mix gradation and workability, two types of sand were used in this study, namely:

- Silica sand: this sand is normally used for the manufacture of domestic glass and has a silica content of about 98%.
- River sand: common sand normally used in concrete manufacture.

Liquid Sodium Silicate (LSS) Grade 42 (SiO_2 : Na_2O = 3.22, total solids = 39.3%, pH = 11.2) was used as an additive in this investigation. This material, also known as water-glass, is generally considered to be non-hazardous although skin contact should be minimised to avoid irritation. It is expected that by adding water-glass, silicon-oxygen anions found in fly ash go into solution and form polymers which begin to coagulate in the liquid during curing [5]. The alkali of the sodium silicate then reacts with silica present in fly ash in the glass phase, strengthening this process of polymerisation and coagulation, ending with the generation of a water-stable silica gel. Dehydration of the silica gel and consolidation of the structure subsequently produces an increase in the strength of the bonds, resulting in the creation of a hard, solid material.

Commercial building lime (hydrated lime) was used to trigger the pozzolanic reaction of the class F fly ash (and hence improve the strength and durability of the bricks). Care was taken to avoid "scumming" and after trial and error testing, each fly ash brick was prepared with a constant amount of lime (5% of total mass). This additional lime did not seem to cause any "scumming" after firing.

3. Specimen preparation

There were four major steps involved in producing the test specimens. These included, proportioning of constituents, mixing, moulding/pressing of green bricks and followed by firing, oven-drying or air-curing.

Initially, three different combinations of fly ash and sand (i.e. primary raw materials) were used, namely, 50/50, 70/30 and 90/10. Liquid Sodium Silicate (5, 10, 15 and 20%) and hydrated lime (5%) contents were added to the mix with proportions calculated by multiplying the percentages in parenthesis by the total mass of primary raw materials.

The mixing of constituent materials was performed in two stages. First, the dry materials (ash, sand, lime) were mixed thoroughly using a 15 litre mechanical mixer. The second stage

involved the addition of LSS and water (as required). This was done gradually until the mixture was of a uniform and mouldable consistency.
A steel mould with moveable top and bottom platens was used to produce the green bricks. With the bottom platen supported by four springs, the mould assembly was placed on a hydraulic press machine (Figure 1). It was found by trial and error that 150 grams of mix, moulded using pressure of around 10 MPa would produce a test brick of approximately 78 mm x 38 mm x 27 mm; the ratio of these dimensions are similar to those of a common house building brick (225mm x 105mm x 75mm).

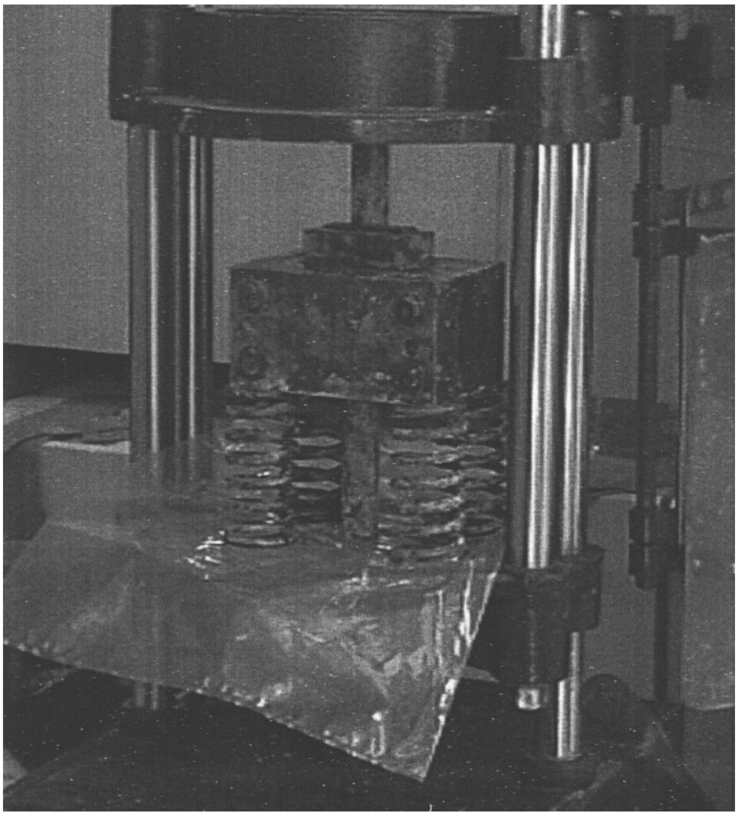

Figure 1: Brick Casting Using a Hydraulic Press Machine

To produce fired bricks, a high temperature oven was used. An initial study carried out to find the effect of firing temperature indicated that a firing temperature of 555°C was adequate. The green bricks were placed in the oven with an initial temperature of 25°C. This was increased gradually to 555°C in 120 minutes and subsequently kept at 555°C for 100 minutes. Thereafter, the oven temperature was dropped back to 35°C over 100 minutes and the bricks were then cooled to ambient temperature with the oven door ajar. The brick specimens were subsequently removed, weighed, measured and visually inspected.

In addition to the above, a number of non-fired bricks were studied in the present investigation. The first was air-cured bricks, which were placed in airtight plastic bags for 28 days before testing. The use of airtight bags was intended to reduce the effects of carbonation, which is a problem known to affect concretes high in fly ash and lime content. Other bricks were cured in a standard oven at 105°C for 24 hours, and a limited number of bricks were cured in open air prior to testing.

4. Testing and results

4.1 Fired bricks

It was observed that bricks with high moisture content values usually developed hairline surface cracks after firing. Excessive moisture contents were associated with gross shrinkage, leading to the development of severe cracks and loss of strength, and hence moisture contents were kept below 30%. Test results generally indicated that to achieve optimum performance, the moisture contents of both fly ash/silica sand and fly ash/common sand mixes had to be within the range of 25±2%.

The dry density of the green bricks is proportional to the densities of the brick constituents and primarily the moulding pressure used to form the bricks. The moulding pressure used was 10 MPa, a value commonly used in clay brick production. This produced brick specimens having dry densities ranging from approximately 1.15 t/m^3 to 1.65 t/m^3. For optimum performance, however, bricks made from fly ash/silica sand and fly ash/common sand would need dry densities of approximately 1.40 t/m^3 and 1.60 t/m^3, respectively. Compared to dry densities of 2.25 t/m^3 to 2.8 t/m^3 for clay bricks, the proposed fly ash brick was remarkably lighter.

Compressive strength is the only mechanical property used in normal brick specification; it is the failure stress measured normal to the bed face (as the majority of brickwork only experiences vertical compressive loads due to the self-weight of the brickwork and bearing loads). Three specimens were tested for each batch of bricks in accordance with AS/NZS4456.4.

For each tested specimen, the failure load was noted and recorded to estimate the uniaxial compressive strength; given by Equation 1 below.

$$\sigma_c = K_a(1000P/A) \qquad (1)$$

Where σ_c = uniaxial compressive strength (MPa),

P = failure load (kN),

A = net cross-sectional area (mm^2), and

K_a = aspect ratio factor (to allow for height-to-thickness ratio), in this case 0.61.

The results, as shown in Table 2, indicate that the compressive strength of the fired bricks under investigation increased rapidly with the amount of LSS up to approximately 15% by mass. It can also be seen that for bricks containing silica sand, higher proportions of fly ash to sand tend to exhibit greater strengths.

Additions of LSS in excess of 15% by mass lead to high moisture content values in the green bricks made with 50/50 and 70/30 fly ash/silica sand. Consequently, these bricks experienced more shrinkage/cracking, which caused a weakening of microstructural bonds and ultimately a decrease in compressive strength. Bricks made with 90/10 fly ash/silica sand, however, continued to increase in compressive strength with additions of LSS up to twenty percent. It can be seen from the results that compressive strengths greater than 20 MPa were easily achieved by all mixes containing silica sand and 15% LSS, and strengths >25 MPa could be achieved with the 90/10 fly ash/silica sand mixture incorporating 20% LSS.

Table 2: Uniaxial Compressive Strength (Average Values)

	COMPRESSIVE STRENGTH, σ_c (MPa)	
% LSS by mass	WITH SILICA SAND	WITH COMMON SAND
50/50 FLY ASH/SAND		
5%	8.57	9.37
10%	7.55	15.41
15%	23.49	30.82
20%	12.29	-
70/30 FLY ASH/SAND		
5%	8.25	8.11
10%	11.40	11.72
15%	26.98	25.91
20%	24.31	-
90/10 FLY ASH/SAND		

5%	10.01	7.56
10%	16.66	12.72
15%	24.29	24.10
20%	27.81	-

For bricks containing common sand, it was also found that the compressive strength increased rapidly with the amount of LSS up to approximately 15% by mass. As with the bricks made using silica sand, the bricks containing common sand also became saturated when amounts of LSS were increased to 20% by mass to an extent that the raw mixture was non-workable; rendering moulding, extraction and handling impossible. Hence, mixtures containing 20% by mass of LSS were discarded as being unviable.

At 15% LSS, the 50/50 fly ash/common sand mixture performed differently than bricks made with silica sand; the former clearly exhibited the highest average strength (>30MPa). However, with the objective being to maximise fly ash utilisation and the fact that the 70/30 mixture of fly ash/common sand produced the most consistent results averaging around 25MPa with 15% LSS, it could be selected as the most viable mixture alternative.

For the indirect tensile strength, the testing method was in accordance with AS/NZS4456.14. The test simply involves applying a line load to a brick, supported by a linear reaction in the plane of linear loading to cause the brick to fail/split.

The failure load is indirectly related to the tensile strength of the brick (Equation 2).

$$f_s = 2F_s/(3.142bh) \qquad (2)$$

Where f_s = tensile strength (MPa),

F_s = maximum splitting load (N),

b = width of chosen cross-section (mm), and

h = height of chosen cross-section (mm).

The average results, as shown Tables 3, indicate that the indirect tensile strength of the bricks tends to increase with increased additions of LSS. Increasing the amount of LSS from 5% to

15% by mass brought about an increase in tensile strength from less than 1 MPa to something close to 2 MPa.

The mixture of 70/30 fly ash/silica sand with 15% LSS produced consistent results averaging around 2.3 MPa. In general, compared to the tensile strength of common clay bricks, the tensile strength of the fly ash bricks was lower (2 to 3 MPa less).

The water absorption of a brick is the percentage increase in mass of a dry brick when it has been saturated. The test for water absorption properties was performed in accordance with AS/NZS4456.14. Two types of water absorption tests were performed, i.e. cold water 24-hour immersion test and 5-hour boiling water test. The results are shown in Table 4.

It can be seen from Table 4 that the experimental bricks exhibited distinct water absorption characteristics with respect to their constituent proportions of fly ash, sand and LSS content.

The water absorption of all brick mixes decreased with increasing LSS content. This was expected as increasing the LSS content, produces more impermeable bricks and hence, the potential for capillary action reduces, subsequently decreasing the water absorption capacity of the product.

The percentage water absorption of all bricks increased with increased fly ash content. The 90/10 fly ash/sand brick exhibited the greatest water absorption characteristics, whereas the 50/50 fly/sand brick exhibited the lowest and most promising water absorption characteristics, and the 70/30 fly ash/sand brick exhibited water characteristics between the two mentioned extremes.

In comparing cold and boiling water absorption results, it is evident that little difference exists between these properties. This is due to the fact that the testing method period was lengthy enough for the test bricks to become saturated during both testing procedures.

The results achieved for the bricks made with silica sand are slightly irregular when compared to those of the bricks made with common sand. The tendencies described above still apply but are not as distinct to the eye as those derived for bricks with common sand.

The optimum blends of 70/30 fly ash/sand showed distinct differences in water absorption properties for the different sand types used. The bricks made with silica sand exhibited unacceptable water absorption as compared with those of the bricks made with common sand. The latter averaged approximately 13% water absorption, when 15% LSS was used, which can still be considered comparable to that of typical clay bricks.

Table 3: Indirect Tensile Strength (Average Values)

FLYASH/SAND RATIO	% LSS BY MASS	TENSILE STRENGTH, f_S (MPa) WITH SILICA SAND	WITH COMMON SAND
50/50`	5	0.66	1.01
	10	0.75	1.86
	15	1.66	2.69
	20	1.57	0
70/30	5	0.73	1.64
	10	1.63	1.15
	15	2.30	1.95
	20	2.76	-
90/10	5	0.94	1.17
	10	2.71	0.99
	15	1.68	1.93
	20	2.69	-

4.2 Non-fired bricks

As mentioned earlier, Freidin & Erell [5] reported the results of an experiment whereby air-cured bricks were made from fly ash, slag and water-glass. If air-cured bricks could perform adequately, it would certainly be the most economical option. In the present investigation, it was decided to prepare non-fired bricks with 70/30 fly ash/sand ratio. Only common sand was used with either 0 or 5% lime and with either 12% or 15% sodium silicate. Table 5 shows the results from air-cured and oven-cured bricks (tested in moist, dry and wet conditions), along with those shown in [5].

It is seen that, in general, the results from the present investigation agree with those from [5]. Curing in a sealed bag produced the worst performing bricks, especially when tested in moist conditions. Curing in open air for 28 days produced much better performance when testing was carried out after oven drying the bricks (at 105°C) to a constant mass. The best performance was achieved when green bricks were placed in an oven (105°C) for 24 hours before testing; the results were comparable to, if not better than, those of the fired bricks. In general, the addition of lime improved the brick's performance. It should be noted that whilst bricks cured in open-air have reasonably high dry compressive strength, the strength completely disappeared after 48-hours soaking.

Table 4: Water Absorption Results

		COLD WATER ABSORPTION (%)		BOILING WATER ABSORPTION (%)	
FLY ASH/SAND RATIO	% LSS BY MASS	With Silica Sand	With Common Sand	With Silica Sand	With Common Sand
50/50	5	25.00	22.73	20.37	22.73
	10	24.07	20.91	21.30	20.91
	15	18.97	-	15.52	-
	20	17.69	-	15.04	-
70/30	5	33.66	31.37	29.70	31.37
	10	25.00	28.85	21.00	27.88
	15	22.93	13.16	19.27	14.04
	20	19.64	-	17.86	-

90/10	5	34.38	36.73	30.21	35.71
	10	20.00	31.96	17.89	30.93
	15	26.73	20.56	22.77	20.56
	20	25.25	-	21.21	-

5. Conclusions

The results of this investigation suggest that it is possible to produce lightweight bricks from fly ash at a firing temperature of around 550°C. In particular, with proper proportioning, these bricks can produce compressive strengths comparable to those of common clay bricks. Although their tensile strength is somewhat below the typical values of clay bricks, the absorption characteristics may be comparable to those of clay bricks.

There appears to be an optimum composition for the fly ash bricks studied. A combination of 70/30 for fly ash/common sand with 15% liquid sodium silicate and 5% lime would produce the best performing brick in terms of strength, mouldability and water absorption.

As compared with fly ash bricks containing silica sand, it was found that fly ash bricks containing common sand performed better in terms of water absorption while their strength characteristics were not significantly different. It is obvious that common sand would be a much better choice in terms of cost.

Table 5: Results from Non-Fired Bricks (Average Values)

	LIME (%)	LSS (%)	CURING METHOD	TEST COND.	σ_c (MPa)	f_S (MPa)	COLD WATER ABSORP. (%)	BOILING WATER ABSORP. (%)
Current Study	0	15	Sealed bag	Moist	0.5	0.06	18.2	18.1
	5	15	Sealed bag	Moist	2.8	0.36	17.1	18.3
	5	15	Sealed bag	Dry^^	6.4	-	-	-

	5	15	Open air	Dry^^	21.0	-	-	-
	5	15	Oven dry#	Dry	30.0	4.21	-	-
	5	15	Open air	Wet^	Fail	-	-	-
	5	15	Oven dry#	Wet^	22.4	-	-	-
	0	12	Oven air	Dry^^	20.5	2.50	18.2	21.2
	0	12	Oven dry#	Dry	35.0	-	17.6	20.7
	0	12	Oven air	Wet^	Fail	-	-	-
	0	12	Oven dry#	Wet^	16.4	-	-	-
Freidin & Erell [5]	0**	20	Open air	Moist	1.6	-	36.5	-
	0*	15	Open air	Moist	4.0	-	22.5	-
	0**	20	Open air	Dry^^	3.2	-	-	-
	0*	15	Open air	Dry^^	8.0	-	-	-

* With slag ** Without slag # Oven dry at 105°C for 24 hrs

^^ Tested after oven-drying to a constant mass

^ Tested after soaking in water for 48 hrs

The possibility of developing oven-dried fly ash bricks has also been explored and the results show that it is possible to simply dry green bricks at 105°C to obtain performance similar to that of the fired fly ash bricks. Translated into the conditions found in many developing countries, this could mean an affordable small/home industry with low energy requirements and minimal energy losses. More than that, the process is making use of waste material (fly ash) in large quantities and hence, is more environmentally acceptable.

It is difficult to provide a cost estimate for the manufacture of fly ash bricks since it depends on the availability and cost of the raw materials (fly ash, sand, sodium silicate). However, the above results suggest that aside from material and transportation costs, it is possible to manufacture the bricks using a much cheaper and simpler technique and hence, compete directly with clay bricks.

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Sustaining Cultural Heritage in South And Southeast Asia: integrating Buddhist philosophy systems theory and resilience thinking to support sustainable conservation approaches.

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Abstract

The World Heritage Convention, based on euro-centric principles espoused in the Venice Charter, provides a mechanism for listing and protecting tangible and intangible heritage in many countries. The World Heritage List is wide-ranging but not all-encompassing representing selected examples of indigenous heritages. However, there is an extensive collection of heritage that falls outside this safety net of recognition and protection, particularly in developing countries of Asia.

Many cultural heritages of Asia have their roots in the cultural traditions of the sub-continent developing independently to those of Europe. As a result the traditional view is that the cultural systems of the sub-continent are based on spiritual values, norms and beliefs, communalism, and holism. However western culture has evolved towards the development of values founded on the reality of the material world or materialism, and rationalism. Tangible and intangible heritages values have had a distinctive role in presenting the differences between the western mode of thinking and that of Asia.

This paper proposes that any sustainable approach to the conservation in South and Southeast Asia must be based on the cultural and philosophical traditions that have underpinned the formation of the cultural heritage. Through a review of literature synergies between systems theory, resilience thinking, based on holism, and the philosophical traditions of the region, particularly Buddhism are established. Focusing on a case study of non-secular built heritage in Sri Lanka it is argued that systems theory provides the foundation for an alternative paradigm supporting an original approach to sustainable conservation and protection of cultural built heritage in South and Southeast Asia. Outcomes presented in this paper indicate such an approach highlights the uniqueness of cultural traditions, notions of spirituality, place-making and spatial relationships particularly of non-secular monuments. Sound preconditions for sustainable cultural heritage conservation outside the institutional protection provided by the World Heritage Convention and euro-centric approaches.

Keywords: Sustainability, cultural heritage, Buddhist philosophy, systems theory, conservation theory, resilience thinking.

1. Introduction

1.1 Background

This paper explores the interconnections between Buddhism, resilience thinking and systems theory in the context of developing a sustainable approach for the conservation of non-secular built heritage in the South and Southeast Asian region. The non-secular built heritage is conceptualised as a complex system within the larger system of the culture in which it resides; thus providing the development of a theoretical basis for then constructing a conceptual framework (MacKee 2007). The functions and elements of systems theory are discussed to evaluate its usefulness as an approach to the conservation of non-secular built heritage. The paper reinforces and explores the links made between systems theory and Buddhist philosophy as developed by Chao and Midgley (2007a, 2007b), Midgley and Chao (2007), Macy (1991a, 1991b, 1976), Khisty (2006a, 2006b), Churchman (1968) and Ellis and Ludwig (1962). A discussion of these two overlapping worldviews is crucial to be able to propose systems theory as a credible framework for an Asian approach to conservation of non-secular monuments.

The essential proposition of this paper is that the current theories and representative wealth of charters and guidelines that govern conservation practice are the “tip of the iceberg”. Beneath lie an immense body of cultural philosophical and religious thought and traditions that underpin the whole sphere of Western approaches to conservation (MacKee 2007). This research poses a fundamental question: How would the rich and unique cultural built heritage of the Asian region be interpreted and conserved if the theories and guidelines that were to underpin it were based on the cultural and philosophical traditions of the region?

For the reasons discussed here, this research postulates a new paradigm supported by a conceptual framework for conservation of non-secular monuments in South and Southeast Asia, based on the cultural and philosophical traditions of the region. This is represented by the philosophical foundations of Buddhism that has widespread acceptance throughout Asia and a number of key similarities with other philosophies in the region, predominately Hinduism. Buddhism forms the basis of the study for this reason; however it doesn’t provide a coherent foundation for the development of a conceptual conservation framework. For this purpose a search for an appropriate sound methodology was undertaken. From the literature review, the work of Joanna Macy (1991a, 1991b, 1976), a Buddhist and systems theorist, provided the initial links between Buddhism and systems theory which has since been supported by a number of others (Chao and Midgley 2007a, 2007b, Midgley and Chao 2007, Khisty 2006a, 2006b, Checkland 1999, Schmithausen 1997, Capra 1996, Churchman 1968, Ellis and Ludwig 1962).

Macy (1991a, 1991b, 1976), establishes links between Buddhist philosophy and systems theory based on the synergies and similarities between the Buddhist universal law of causality and the cyclical process of cause and effect and can be related to the notion of feedback loops in cybernetics and systems theory (Macy 1991a, 1991b, Schmithausen 1997). In Buddhism the concept of the universal law of causality is central to the notion of *karma*. *Karma* is an important notion in the context of a cyclical view to life processes, that is birth-death-rebirth, as

opposed to a linear view and is a common theme amongst the religions/philosophies of the sub-continent (Harvey 2003, Kalupahana 1976). Macy's (1976) other key links relate to holism, as she perceives Buddhism as providing a holistic view to life and empiricism. In Macy's view, the Buddha is essentially an empiricist as he developed a philosophy based on his experiences and observation of life and has avoided all metaphysical arguments. She supports these further similarities by detailing the empirical basis of systems theory and how systems theory relies primarily on empirical data as a means of dealing with problems (Macy 1991a, 1991b, 1976).
The established synergies between the philosophy of Buddhism and those of philosophical traditions of the region as proposed primarily by Macy in her work has been reinforced in the recent work of Khisty (2006a, 2006b) writing on systems theory; Kumar and Sankaran (2006) writing on management and systems theory; Capra (1996, 1982) writing on systems theory and changes in Western thought, and one of the early proponents of systems theory in management, Churchman (1968). Churchman's links are implicit in a much broader discussion on spirituality. For Khisty (2006a, 2006b), while his connections broadly reinforce those of Macy, he further elaborates on the idea of Interbeing as proposed by the Venerable Thinh Nacht, a contemporary Buddhist priest, which is along similar lines to Macy's proposal. Interbeing is a term that covers the Buddhist concepts of interdependence, interconnectedness and interrelatedness. Khisty (2006a) equates this with the idea of holism in systems theory and that all systems are interrelated, avoiding separation and reductionism in traditional management and problem solving. Kumar and Sankaran (2006) provide strong links with Hinduism and Checkland's (1999) Soft Systems Methodology. Their starting point is the notion of context sensitivity and the concept of the flexibility of truth in the Indian context and how within this Indians react to their own context, and then act rather than accept the general abstract formulation of law applicable to all (Kumar and Sankaran 2006). This relates to the idea of a lack of a hard reality and how this is conceptually similar with Checkland's Soft Systems Methodology. Checkland's Soft Systems Methodology is situation driven and always iterative wherein a person internalises what they see, understands and then act according to their understanding of the situation (Hutchings and Cassar 2006, Checkland 1999 1990).

In the context of this research these issues are relevant predominately because they offer an organic, holistic, pluralistic ontology of aspects that may guide the conservation and preservation of non-secular built heritage in the South and Southeast Asian region. This would ensure that all aspects of the uniqueness of the monuments and indigenous beliefs are taken into account in a sustainable context.

2. Systems Theory

The history of scientific investigation in the context of western enquiry has been based on a rationalist empiricist approach to problem solving (Capra 1996, Laszlo 1972, Van Bertalanffy 1968). Descartes' methodology for solving scientific problems has proved influential (Dicker 2003, Arrington 2003). His idea of reducing or "pulling apart" the problem into its parts, solving the parts and then reassembling them has been used to solve a range of issues (Du Plessis 2000, Capra 1996, Flood and Jackson 1991). Such reductionism has been predicated on the belief that any whole or problem can be described or defined by the sum of its parts. In science there has been the tendency to adopt this approach, and in fact, many of the theories that we apply today are based on this foundation thinking. By way of an example of reductionist thinking, we can explore the issues and 'solutions' of the problems of public transport, these solutions are often then proposed as the panacea for a range of urban problems (Checkland 1999, Flood and Jackson 1991). Local authorities or public utilities that manage these systems may look at timetables, routes or quantities without looking at the complex issues of the total system that include all modes of public and private transport and their interrelationships to obtain a successful public transport system. Instead there has been a tendency to focus on the issues of the parts in isolation, rather than the connections that link the parts (Checkland 1999, Laszlo 1972, Churchman 1968).

This paper argues that the non-secular monuments of South and Southeast Asia, inclusive of all tangible and intangible heritages, need to be considered as part of a larger whole of the Asian region, society and culture in which they exist. This is particularly true in the situation of South and Southeast Asia where global Euro-centric conservation theories have been applied to complex and unique systems of heritage-cultural-societal interrelationships, quite different in conceptual foundations to those from where the conservation theories were developed in the first place (MacKee and Hartig 2007, MacKee and Hartig 2006, MacKee and Briffett 2000).

2.1 The application of systems theory in sustainable development

Historically, there has been a search for a better way to understand the complex relationships that make up the human-nature interface. Many authors (Khisty 2006a, 2006b, Eckersley 2004, 1992, Capra 1996) argue that is has been the commitment to a mechanistic worldview and reductionism that has resulted in significant environmental problems. The prevailing worldview for our (western) understanding of the environment has also been one of anthropocentrism, whereby humans are the centre of moral concern. The anthropocentric view has in part been reinforced by Judaeo-Christian teachings that humans are made in the image of God and have dominion over nature, which has been the orthodox interpretation of the Biblical account of creation (Passmore 1980). The work of many philosophers both pre and post-renaissance support this, for example Descartes is identified (Dicker 2003) with providing the philosophical basis for setting humans apart from the natural world (Khisty 2006a, 2006b, Dicker 2003, Rockmore 2003). 'Dualism' is the term given to this worldview and it also supported anthropocentrism and provided a theological cornerstone for philosophical dualism (Dicker 2003). The environmental degradation that has resulted from the Cartesian view is well documented and requires no detailed investigation (Cooper 2003). However, the contemporary claim that human domination of nature has been destructive has been accompanied by new scientific and theological paradigms that rethink the validity of strong anthropocentrism (Cooper 2003).

Rachel Carson's Silent Spring (1962) is considered to be the beginning of the ecological revolution and a counter to strong anthropocentrism. Ecocentrism (Eckersley 2004, 1992) is a position that argues that the whole of nature should be given moral consideration. It has similarities with deep ecology (Naess 1989, 1986, Sessions 1995, Devall and Sessions 1985) where "biocentric egalitarianism" is forwarded as a counter to the idea that humans are at the top of the hierarchy of creation or evolution. The roots of the deep ecology movement can be found in the early writings of Thoreau Roszak and Mumford (Devall and Sessions 1985). Deep Ecology also has its origins and influences stemming in part from the writings of Spinoza and Zen Buddhism (Khisty 2006b, Devall and Sessions 1985). Khisty's insights into deep ecology are useful here because of the links to Buddhism in the form of Zen Buddhism. Among many other things, what has arisen from the debate between the advocates of anthropocentrism and ecocentrism is the contested notion of stewardship. Stewardship is the view that through divine intervention or evolution, humans are endowed with particular skills and talents that provide them with a level of consciousness and comprehension that allows them the responsibility to make moral decisions about the rest of creation/life, (Khisty 2006b, Passmore 1980). Where the anthropocentric movement put humans above nature, value was seen as residing in humans with nature only given instrumental value (Capra 1996). In contrast, deep ecology, which could be considered as a truly holistic environmental philosophy, considered human beings as an intrinsic part of nature, a unique strand in the fabric of life (Khisty 2006b, Capra 1996). Khisty (2006a, 2006b) sees deep ecology as an extension of spiritual systems, particularly that of Buddhism.

The discussions on spirituality and natural systems can be applied to the way in which we deal with environmental protection and our relationship with the environment to systems theory. This direction is supported by the notions of holistic thinking, that is the basis of systems theory, by looking at the idea that the natural-social-economic divide is actually one complete system of which each subsystem with very subtle relationships and links, communication loops, is related to the whole. The work of Du Plessis (2005, 2001, 2000, 1999) has focused on the application of systems theory to sustainable development for this reason, especially in the context of African cultures. Khisty's (2006a, 2006b) work, while providing strong links to Buddhist philosophy, has linked the environmental movement with systems theory through the tenets of deep ecology. The idea of systems in the context of the environment relates to a notion of natural systems that places humans within the emergent complexity along with all other aspects of the larger ecosystem. Once we understand the relationships between the various subsystems of which humans are only one of many, it is hoped that we can move towards a more environmentally sustainable future.

2.2 The concepts of Complex Systems and Resilience Theory

Earlier discussion has shown how, in general, systems are holistic, strongly connected, operate cyclically and to support the cyclical processes that rely on feedback loops (Macy 1991a, Laszlo 1972, Bertalanffy 1968). In studying the changes that occur in natural eco-systems research has led to the notion that these systems are invariably very complex (Walker and Salt 2006). The highest level of complexity is evident in social-ecological systems, that is the relationship between human systems and ecological systems (Walker and Salt 2006, Berkes, Colding and Folke 2003, Berkes and Folke 1998). Understanding the complexity of these co-evolving systems; their interrelationships, change dynamics and transformation has provided the rich foundation for looking at the 'resilience' of these systems (Walker and Salt 2006, Berkes, Colding and Folke 2003, Berkes and Folke 1998). At the heart of resilience thinking is the very simple notion of coherence despite change and the idea that to ignore change is to increase our vulnerability and forego emerging opportunities (Walker and Salt 2006, pp 9-10). In resilience thinking humans and nature are considered as elements of the one system, as they are interdependent. To think of one in isolation of the other is to come up with only a partial solution (Walker and Salt 2006). In essence, Resilience, defined by Walker and Salt (2006) is a systems capacity to absorb disturbances without a regime shift and they see it as the key to sustainability (Walker and Salt 2006, p38).

One link between resilience theory and this research is Redman's (2005) discussion of the notion of resilience thinking in archaeology. He postulates that "...resilience thinking looks at change transformation and adaptive cycles and archaeology provides the opportunity to study not only one completed cycle but multiple completed cycles " (Redman 2005, p70). Redman's contention is that the study of persistence and change in systems is at the heart of resilience thinking and can be verified by archaeology in the study of many systems historically over time. In so doing archaeology confirms the notions of adaptive cycles of change and transformation and the dynamic changes that occur over time in social-ecological systems (Redman 2005). Redman's study has implications for the current research in that, as with archaeology, the conservation of monuments and specifically non-secular monuments is about dealing with persistence despite change and transformation. This changes the temporal, utilisation and management contexts. The research argues that culture; heritage and built heritage can be considered as systems that are interconnected and interdependent. The application of resilience thinking to the conservation of built heritage provides the opportunity to understand and deal with the persistence and survival of heritage against the ongoing forces physical, social and natural change. That is, resilience thinking engages in a trans-disciplinary way the dynamic interconnections and interdependencies amongst the key systems.

Another link between resilience and the current research is the notion of interdependence mentioned earlier in the context of considering human and natural systems as one, the social-ecological system. Buddhism also has a holistic view of the human and natural systems in that they are seen as one system, yet interdependent and interconnected to one another (Khisty 2006b, Macy 1991a).

Resilience thinking provides the opportunity to extend the ideas presented in this paper to the next level of exploring the concept of resilience in the context of a broader range of heritage issues. Systems theory provides a foundation from where to establish parameters as no other research has attempted this alternative interpretation of non-secular built heritage.

3. Eveloping an Asian Approach To Conservation: Integrating Systems Theory And Buddhist Philosophy

The discussion to this point has attempted to coalesce the disparate links between the cultural and philosophical traditions of the region under study and develop a viable theory. With its links to Buddhism specifically, Hinduism and Asian culture more broadly, it is proposed that systems theory provides a foundation to develop a viable theoretical framework. The literature reveals the notion of two worldviews existing, that of the West and East and classified the differences in terms of mechanistic and systemic worldviews (du Plessis 2005, 2001, 2000, 1999). This mechanistic worldview is goal-orientated, the systems worldview is process orientated (Du Plessis 2000, 1999). As briefly discussed earlier in the introduction, the conservation theories, practices, guidelines and policies of the West arise from a mechanistic worldview drawing on the philosophical heritage of the West/Europe. Based on doctrines of rationalism and empiricism, the tools of conservation are observation, measurement and rational analysis lying within a linear causal framework. Determining the authenticity, significance and the values within the monument, it is argued here, are the "goals" of Euro-centric based conservation. To achieve one, a number, or all of the goals is the aim of conservation. It is the processes mentioned here that are used to protect heritage on the World Heritage list and other heritage outside the scope of the list, by default, as no other formal mechanism exists.

3.1 The development of a systemic conceptual framework

The essential principles of current global conservation practice are based on the test of authenticity, the significance of the monument, and the values that are contained within the monument. These principles have been formulated within the mechanistic worldview sustained by the rationalist and empiricist philosophical supported by a reductionist model. For example, the essence of these principles has sought to assess the monument by the "reduction" to a set of nine criteria3 (Jokilehto 2006). These criteria seek to analyse the monument in a rationalist framework, concerned with components seen in isolation rather than in a holistic sense. Concepts that define the monument or cultural built heritage (CBH) within very rationalist boundaries (Munjeri 2004) are in contradiction to Asian values and philosophies. Different values require very different conservation approaches. As the systemic approach has been linked to the cultural traditions and values of the east, any approach to conservation developed within this milieu would recognise the uniqueness of South and Southeast Asia. In this context the protection and conservation of the cultural built heritage would be seen as a system within the larger complex system of the cultural and philosophical systems of South and Southeast Asia. In this way it is necessary to view the whole larger system in which the CBH is a subsystem, and not reduce the system to its smaller components such as authenticity, significance or its various values and look at these in isolation. The subsystems encompass questions of spirituality, naturalistic sensibilities (Seung-Jin 2005, 1998) the cultural landscapes (Taylor and Altenburg 2006, Taylor 2004) along with values, norms and societies (Munjeri 2004) that may form part of the larger system. These proposed subsystems are those that demonstrate the differences between Asian and Euro-centric conservations approaches.

This paper has briefly discussed the philosophical and cultural traditions in an attempt to synthesise the foundation for an Asian approach to the conservation and protection to the cultural built heritage in Asia. It has been argued that systems theory has strong associations with Asian cultural and philosophical thought, particularly Buddhism, and could be appropriate as the foundation from which to build a framework for the conservation of monuments in Asia.

3.2 The components of a framework based on systems theory

There are a number of key principles of Buddhism; including impermanence, karma, dukkha, the eightfold path and the four noble truths (Macy 1991a, 1991b, 1976, Kalupahana 1976). As argued above, three principles of Buddhism that provide strong links with systems theory are universal interconnectedness, radical interdependence and mutual conditioning (Khisty 2006a, 2006b, Macy 1991a, 1991b, 1976). It has been argued that these principles provide the methodology for describing intra- and inter-systems relationships that would be the basis for determining what is important about the heritage, how is it important, and how it could be conserved. These are then three key relational qualities of heritage, chosen because they explain the complex multiple reciprocal relationships (Munjeri 2004) between heritage, communities, societies, tangible and intangible values that provide a basis for developing a theoretical framework for conservation in South and Southeast Asia. Table 1 provides the description of the elements of the framework while Figure 3 summarises the process of the framework.

Table 1: The three key relational qualities of heritage systems within South and Southeast Asia (Source: The Author).

Key Relational Quality	**Description**
Interconnectedness	The quality where interconnections exist between one system and another.
Interdependence	The quality where one system is dependent upon another.
Mutual conditioning	The quality where one system conditions another, one system must have existed for the other to come to exist.

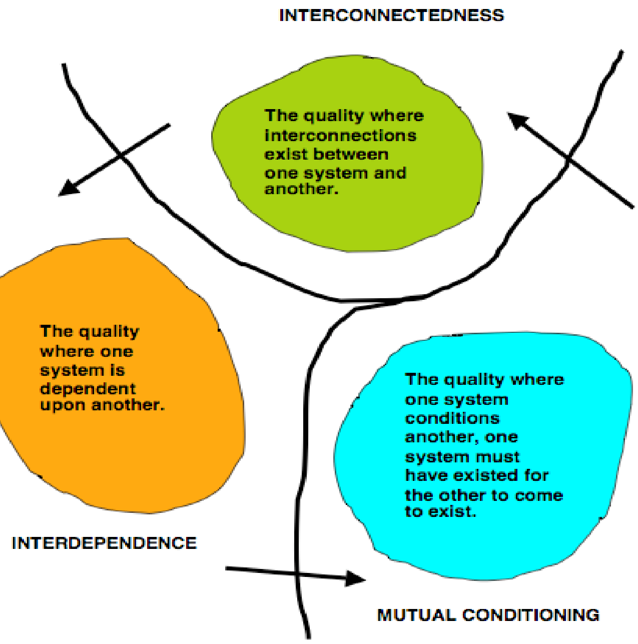

Figure 3: This figure summarises the process of the framework and how this would be operationalised (Source: The Author).

The concept of universal interconnectedness relates to fact that everything is a part of everything else, not only spatially but also temporally. Society is situated in an intricate order, and thus everything is interconnected with other aspects of a larger society or culture (Khisty 2006a, 2006b). Society along with all other things, is embedded in a context, within the universal system (Khisty 2006b). For non-secular heritage the implications are that since its creation there has been a continuum that ties the non-secular heritage to each period in time as much as the previous and the future, implying that there is a relevance to all people at various points in time. This suggests that heritage is interconnected to each period and relevant to each period in equal proportions. At another level it implies that there is interconnectedness between the heritage and those that initially created the heritage. However, there is also interconnectedness with those who consume the heritage through time. Within the heritage object there is interconnectedness between the various elements that in sum are the total of the heritage. This encompasses material elements, spiritual, values, norms, and other intangible values that can be identified. In Sri Lanka, for example, Ruwanweliseya Stupa encompasses these elements because of its place in peoples spiritual. The interconnectedness described demonstrates that heritage is dynamic with relevance continuing through time. In relation to the systems that have been developed in this research, interconnectedness can be traced between the various systems, from the primary system of culture to the subsystems of heritage and non-secular heritage. Within subsystems there is interconnectedness as according to Buddhist philosophy everything is connected to everything else. This relationship of systems is significant in describing the reciprocal relationships that exist between the heritage and other systems that tie these to tangible and intangible values, and the culture at the higher level.

In Buddhism the notion that everything is dependent and reliant on mutual assistance, support, cooperation, or interaction between everything is termed radical interdependence, for the purpose of the framework it is sufficient to simply refer to interdependence. Buddhist cosmology considers the entire cosmos as a cooperative, where everything lives together as a cooperative (Harvey 2003, Macy 1991a, Kalupahana 1976). A noble environment can only be built, or protected, when we realise that the world is a mutual, interdependent, cooperative enterprise. Thus we have the belief that everything in life is interdependent, there are interconnections, and there is interdependence. These qualities explore how one system or subsystem may be dependent on another. For example the Buddhist stupa or pagoda is dependent upon people worshipping around it for its very being for all time, it is this action that provides the meaning. If people did not worship around it or had not developed a belief in its sanctity then what would it represent or would it ever have existed. Clearly one is dependent upon the other for its significance or meaning. As discussed earlier, it is the next level of the relationship, the interdependence, of one system with another that a specific heritage system develops significance.

The mutual conditioning principle means that all conditioned things and events in the universe come into being only as a result of the interaction of various causes and conditions. This is significant because it precludes two possibilities; first that things can arise from nowhere, with no cause and conditions, and second, that things can arise on account of a transcendent designer or creator (Dalai Lama 2002 cited in Khisty 2006b). The all-encompassing range of mutual conditioning is best caught in the short, though deceptively simple formulation: "When this is, that is; this arising, that arises. When this is not, that is not; this ceasing, that ceases." (Smith and Novak 2003 cited in Khisty 2006b p 301). Initially, what was the context for the creation of the heritage? For some, cultural built heritage in the Asian region the circumstances that lay behind the origination underpin the character and qualities of the particular heritage. In Cambodia, Angkor Thom was erected as the heavenly palace of the ruler Jajavarman VII. This original conditioning led to the condition of the environmental system that led to the conditioning of the landscape system and the relationship between this and the building. In Agra, India, The Taj Mahal, the white marble monument created as an act to bury a much-loved Queen and then the Emperor who worshipped her, conditioned the monument as a mausoleum. The construction of this monument and its formal gardens conditioned the landscape on the banks of the Yammanu River, thus conditioning the greater environment with its form and silhouette against the horizon The conditioning analysis can be extended further and further. The conditioning dealing with the origination impacts with the other systems in which the heritage has relationships. While defining mutual conditioning, this discussion highlights the notions of holism and cyclical relationships implicit in systems theory.

Table 2: A framework for heritage conservation in south and Southeast Asia (Source: The Author).

Key relational qualities of heritage.	**Clarifying questions.**
Interconnectedness	• What are the interconnections with the cultural system? • What are the interconnections with the communal subsystem? • What are the interconnections with the tangible values subsystem? • What are the interconnections with the intangible values subsystem?
Interdependence	• Is the subsystem dependent upon other heritage subsystems? • Is the subsystem dependent upon tangible value subsystems? • Is the subsystem dependent upon intangible value subsystems? • Is the subsystem dependent on other cultural systems?
Mutual conditioning	• In what context was the heritage created? • In what context has the heritage existed? • In what context is the heritage perceived? • In what context is the heritage to be conserved/restored/rebuilt?

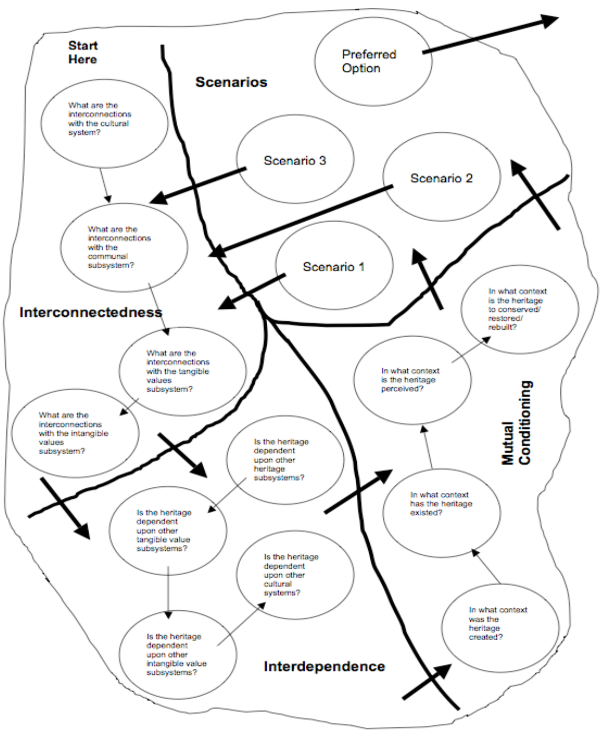

Figure 4: This diagram shows all the cycles in the complete process of applying the framework to the conservation of non-secular heritage in South and Southeast Asia (Source: The Author).

3.3 Discussion of the framework

The conceptual framework and supporting ideas presented here provide an alternative to the Western/Euro-centric approach for conservation strategies for the cultural built heritage in South and Southeast Asia. It is argued that systems theory provides a means of operationalising the alternative paradigm that, while based on describing the heritage and the culture with in which it exists as a series of systems and subsystems, has its theoretical argument very much founded within the philosophical and cultural experiences of the region. It is proposed that the systems theory framework is a means of exploring a heritage system whether it is tangible or intangible and determining how the heritage system exists within the larger cultural system in the context of developing a strategy for protection. The adoption of systems theory moves beyond the existing system of looking at the heritage in the terms of conditions of authenticity that are essentially a series of material terms with token gestures to traditions, feelings and spirit (Jokilehto 2006). The acceptance of the notions of intangible or immaterial values as described in the Nara Document on Authenticity (Larsen and Marstein 1995, ICOMOS 1994) or the Hoi An Protocols (UNESCO 2005) are the only presentations of possible exceptions to the accepted procedures and interpretations that are given in international charters and guidelines. They do not offer a viable alternative method for conserving heritage in South and Southeast Asia. In the same way as the current systems; they are only a product of the cultural and philosophical traditions of the west. It is argued that the framework presented here has substantially strengthened the premises of those documents by employing the essence of the cultural and philosophical experiences of the region.

In the tradition of systems theory the proposed conceptual framework would be made operational by the use of empirical research and data (Checkland 1999, 1994). The answers for the clarifying questions (refer Table 2 and Figure 4) would be provided by careful research into the heritage and its history, the values that underpin its existence, and all other data that provides a complete story about the heritage. This information would come from oral traditions and more tangible sources. The crucial issue is to understand the heritage subsystems and all its interconnections and relationships with the larger systems and other subsystems. This process is in marked contrast with Western heritage that is assessed to have authenticity resulting only from a number of supposedly universal material values (Taylor and Altenburg 2006, Seung-Jin 2005, 1998, Taylor 2004, Menon, 2003). The purpose of these clarifying questions, while exploring material values, is to underpin authenticity in the Asian context with those values that are significant to the heritage based on relational qualities of subsystems and systems.

As discussed above the proposed conceptual framework is supported by the process of generating scenarios that are then examined against the outcomes of providing answers to the clarifying questions. While scenarios have not been commonly used in the conservation decision-making process, these are common in planning decision-making (Lombardi & Brandon 2003, Lombardi 1999, Lichfield 1998, 1988, 1976). Scenarios are seen as simulating real world situations that can be tested under "laboratory" conditions to explore possible outcomes and use the result to make choices for courses or action. In this sense, the scenarios generated for the framework would be based on real-life solutions creating probable courses of action.

The reiterative process of testing these scenarios would then result in an appropriate course of action that accounts for the intangible values and sense of place that are critical to understanding the significance of Asian heritage. The scenarios can all be tested for their resilience in the face of known destructive forces, technological change, development pressures, and tourism.

4. Summary and Conclusions

This paper has presented an alternative paradigm and a structured framework for interpreting the cultural heritage of South and Southeast Asia for the purposes of developing conservation approaches. Based on established synergies between systems theory and Buddhism specifically (Chao and Midgley 2007a, 2007b, Midgley and Chao 2007, Khisty 2006a, 2006b, Macy 1991a, 1991b, 1976, Ellis and Ludwig 1962) and Asian cultures more broadly (du Plessis 2005, 2001, 2000, 1999, Churchman 1968), the framework has been constructed that takes into account, for example, the intangible values, sense of place, cultural traditions and philosophies that are elements of the specific cultural heritage of the region under study.

The philosophy of Buddhism is founded on three principles; interconnectedness, mutual conditioning and radical interdependence (Khisty 2006b, Macy 1991a, Kalupahana 1976). The notion that everything is related or connected to everything else, that an action cannot occur without a previous action is the key to these three principles. For these reasons Buddhism is seen as a holistic approach to the questions of life and matter. Providing the basis of a Buddhist hermeneutic and is seen to explain most of what occurs in Buddhism. As discussed in this paper, Buddhist ideologies and principles have been adopted as the key relational qualities of the framework that has been developed to provide an alternative approach to conserving cultural built heritage in South and Southeast Asia. Traditionally, problem solving in the scientific context has been reductionist in nature, breaking down the larger problem into smaller components. Conversely, systems theory focuses on looking at the problem and its context in terms of systems and looking at relationships between these systems. The other aspect of systems theory deals with the communication between systems and the feedback loops that exist that make the process cyclical and informative. The synergies that have been identified between Buddhism and systems theory are based on the nature of holism and the cyclical nature of communication and feedback loops. The cyclical qualities of the communication channels between systems allows for reiterative evaluation of the relationships while assessing the basis for protecting the cultural heritage.

Finally, from this discussion a conceptual framework was formulated that incorporated the philosophy of systems theory and principles of Buddhism. The framework has the key relational qualities, interconnectedness, interdependence and mutual conditioning that form the basis of the relationship between the heritage and the people who consume it. The interpretation of these key relational qualities is done with clarifying questions, which provide the opportunity to describe the key relationships that give the heritage its values and meanings, significant qualities in the context of how people view the heritage.

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Educated trade-offs for sustainable resource development through stakeholder participation

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Abstract

The paper describes an on-going case study at Ma Oya river basin in Sri Lanka where the conflicting uses/issues of the natural resources in the river and its valley are identified through the consultation of key stakeholders. The study conducted in the entire down stream and immediate upstream of a proposed multi-purpose balancing reservoir at Yatimahana, included 145 Grama Niladhari divisions in 16 Divisional secretariats along both banks of the river. It assesses the natural resource uses; the present issues and future probable issues with regard to resource uses, stakeholder views and then discusses the probable social and environmental impacts of the proposed reservoir. The results obtained in the study are direct inputs for a five-step framework developed for educated trade-offs. The term 'educated trade-off' means that stakeholders are able to engage in technically, economically and environmentally (including socially) informed (educated) decision-making between the critical resource uses (trade-offs) in a river valley.

Keywords: educated trade-offs, stakeholder consultation, river basin development, natural resources

1. Introduction

Development activities in river valleys are usually planned and implemented independently by different user sectors. In most instances these decisions are based on purely sectoral interests (e.g. water for irrigation, mining of clay on riverbanks) and are planned primarily for economic or political benefits. The environmental and social impacts of such activities are generally not known and are often neglected at the design and planning stages [1]. Most of the negative long-term impacts of such activities/projects are realized only long after the projects have been implemented.

It is imperative to study the physical, biological, economical, socio-political and administrative impacts of a project, in order to find a viable solution for sustainable development of natural resources within a river basin, which are intricately woven with each other [2]. In addition, past research demonstrates that such resources planning without consultation of all the stakeholders in decision-making is highly ineffective [3]. In the recent times there is widespread recognition of the need for greater stakeholder consultation in water and other natural resources development projects. It is the premise of this study that in such involvements stakeholders should be able to engage in educated trade-offs between the values of the different resource uses/issues in a river valley or otherwise the consultations will be emotional. However, the main hindrance for educated decision-making by the stakeholders is lack of methods of educating the stakeholders on the technical, economical and environmental (including social) impacts of the decisions taken by one group of stakeholders on the choices of another group.

Thoradeniya and Ranasighe [4] proposed a framework on 'Educated Trade-offs' as a tool, which facilitates trade-offs between different resource uses by educating the stakeholders on the combined (economic and environmental) economic value of each resource use. The framework consists of five steps. The first step identifies the stakeholders and the conflicting uses/issues of the natural resources in the river and its valley, through the consultation of key stakeholders. The critical bounds of the technical requirements of the conflicting resource uses and issues identified (minimum required volume when the use is by extraction of water and maximum volume not to exceed the assimilative capacity of the river or river valley for other issues) are then estimated in step two. The economic value and the environmental value of the respective critical bound of the technical requirements are estimated in the third and the fourth steps. Combining the economic and the environmental value of critical bounds, 'educated tradeoffs' for stakeholder consultations are finally estimated [5]. The results of the analysis will be useful information for stakeholders to make rational decisions between different resource uses/issues in a river valley.

With regard to the resources uses of a river and its valley, the issues and stakeholders show a significant variation spatially and temporally. Therefore, it is expected that a more accurate scenario of the situation is possible through the bottom level (grass-root) stakeholder consultations. Further the literature survey did not reveal studies focused on basin wide grass-root stakeholder identification in planning and implementing development projects, which could have its impacts on a larger area beyond the project area itself.

The objective of this paper is to present as a case the results from an on-going study at Ma Oya river basin of Sri Lanka, where the proposed framework is being applied. A key stakeholder of the river basin, the National Water Supply and Drainage Board (NWSDB) has proposed a multi-purpose, balancing reservoir as a solution for the temporal water scarcities experienced at present. The economic justification of the project is through hydropower generation. However, the negative social and environmental impacts that could occur basin wide have not been adequately considered in the feasibility report. Therefore, the present study identifies the resource uses and stakeholders, assesses the stakeholder views, and then discusses the probable social and environmental impacts of the proposed reservoir and valuing such impacts. Thereby facilitating the stakeholders of Ma Oya river to engage in rational discussions leading to less-emotional decision-making between the different resource uses at times of resource scarcity.

The approach used in the study for consulting stakeholders, for identifying the resource use sectors and pertaining critical issues, proved to be efficient for a rapid assessment of spatial variation of a river basin situation. Estimates for prioritising the use sectors were possible with the data collected at the survey. Drinking water (dug wells), washing and bathing, and environment were the user sectors estimated as top priority in most of the locations.

2. Ma Oya river basin: uses and issues

2.1 Resource uses

Ma Oya river commences in the central hilly regions and flows to the Indian Ocean through north western Sri Lanka. The river drains a catchment area of 1528 km^2 along its total length of 130 km [6]. It flows through Kegalle district at upper reaches and acts as the boundary between Kurunegala and Kegalle Districts in its mid reach, thereafter as the boundary between Kurunegala and Gampaha Districts. The right bank of the final reach of the river forms the Southern Boundary of the Puttalam District and flows into sea at Kochchikade. (See Figure 1).

Annual average rainfall of the Ma Oya basin is 2219 mm [6]. The low rainfall values occur in the months of January, February, June, July and August. The basin covers five agro-ecological regions and the land use of the river basin is mainly characterized with paddy, rubber and coconut cultivations.

Figure 1: Ma Oya river basin and river network

The river flows are mainly used for supplying drinking water to 17 major population centers, two major industrial zones and also some private water supply schemes. The next major use of the river flow is as a pollutant carrier (absorber) from a number of cities as well as private poor dwellings located on the riverbanks and from a number of industries located in the river valley.

2.2 Issues of resource uses

Ma Oya river basin has been identified for its critical resource use issues. Highly stressed surface water resource situations are experienced during the 6-8 weeks of the dry season in spite of the fact that it is located within the wet zone of the country [6]. Thus during the low flow periods the two major uses (water supply and pollutant carrier) are conflicting with each other and results in critical water stressed situation both due to inadequate quantity and poor quality [7].

The other use sectors such as hydropower, tourism, sand and clay mining have also created localised adverse impacts to the environment and the local populations. The already documented environmental and social impacts due to the different use sectors, range from drying up of springs used for drinking and household needs of the villagers at upstream locations to dried up wells, abandoned paddy lands, pools of stagnant water creating breeding grounds for malaria and other types of mosquitoes in down stream locations [8]. The different use sectors are uncoordinated and the uses are uncontrolled.

The NWSDB, a key stakeholder of the river basin has proposed a multi-purpose balancing reservoir in the upper catchment at Yatimahana as the best option in an attempt to mitigate the expected severe water shortages in the near future due to the increasing demands, [9].

The objective of this reservoir project is to store the excess flows of the river during rainy seasons and then to release the required flows, under control, during the dry weather periods. The proposal acknowledges the importance of Integrated Water Resources Management (IWRM) and has considered irrigation, industry and hydropower sectors in addition to the water supply and sanitation sector. The irrigation sector water demand has been taken at present level with zero future growth while the demand by the industry sector is allowed a future growth. Hydropower is proposed mainly as a strategy for achieving the economic viability of the reservoir project [9].

3. Application of Educated trade-off framework

It is speculated that the implementation of the balancing reservoir may have adverse impacts on the other water use sectors. For example, the ground water table of the river valley could remain low for a longer period due to regulation of flow, leading to production losses in the agriculture sector. Also water quality could deteriorate with increased pollutant concentrations in the river again due to regulated low flows for longer periods. This situation could lead to limiting the growth of industries (requiring water as a raw material for production or seeking river as a pollutant dispenser) in the Ma Oya river valley.

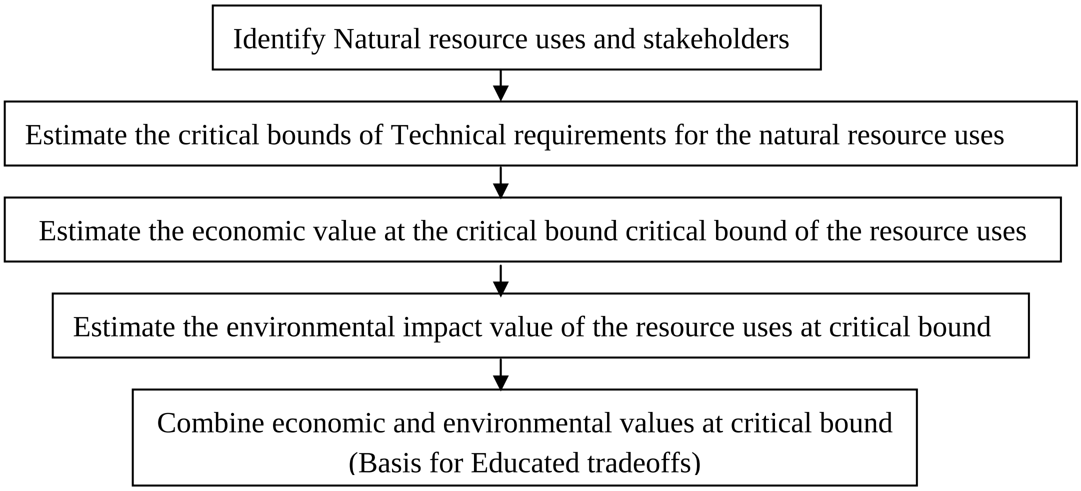

Figure 2: Five-step framework for Educated Trade-offs

Therefore, in resource scares situations the stakeholders require to make decisions on prioritizing the resource use sectors. The ‘Educated Trade-off Framework’ (See Figure 2) suggested in Ranasinghe [5] is applied for the proposed development work in the Ma Oya river basin.

4. Identification of the multiple stakeholders and the Natural Resource Uses/ Issues

4.1 Stakeholder involvement level and techniques

Identifying stakeholders and uses/issues (a situation analysis) is the first step of the ‘educated trade-off’ framework. The methodology used for this identification is to conduct sample surveys in the areas considered. Samples represented all sectors having a stake in the river including public administration, public and private institutions in the river resource use sectors, and representatives of social, political, religious, and ethnic groups of public at grass-root level.

Since the objective is to collect data for a situation analysis the stakeholder involvement level is low; ‘consultation’ as opposed to ‘participation’ [10]. The techniques used are a questionnaire survey and a structured interview. The feed back of the survey facilitates identification of the resource use patterns, critical issues, the environmental impacts already experienced and further possible social and environmental impacts in future.

4.2 Approach for grass-root stakeholder consultations

A six-step approach was designed to obtain necessary data from the grass-root stakeholders [11]. The first step is a desktop study where the Divisional Secretariat Division (DSD) was identified as the administrative unit to conduct the field studies, as the number of DSDs was small enough to handle within the scope of the study; rapid assessment of resource uses.

The second step is a combination of a reconnaissance survey and a visit to the selected administration units (DS office). The objectives of the reconnaissance survey are three-fold; to obtain the data required for planning the stakeholder meetings, such as maps showing Grama Niladhari Divisions (GND), stream network etc.; to create an awareness about the research at the DS level and to create an initial awareness among the concerned Grama Niladhari (GN); to obtain the necessary support of the government administration units for the study.

The data collected (DSD maps etc.) at the reconnaissance field visit are the base for the desktop study II at the third step. This step identifies the GNDs along both banks of the river. At the fourth step the GN's of the selected divisions are educated on the background, objective and the expected results of the research. This is achieved through written communication followed by telephone conversations where possible.

With the above insight, at step 5, the GN's are entrusted to select the appropriate sample representing the different resource use sectors. The final step involves a visit to each GND to administer the questionnaire survey and to interview each respondent.

4.3 Resource uses and Stakeholders

The representative sample constituted of 427 stakeholders from river estuary to Aranayake (a location upstream of the proposed reservoir). Table 1 gives the sample distribution according to the riverbank location and DSD. The number of GNDs in each DSD is also indicated.

The resource use sectors at each GN division could be identified through the stakeholder survey. The user sectors, which are critical at present, as well as sectors, which are expected to become critical in the future, were also identified. Table 2 gives the resource use sectors for six sample GNDs (1L – Kammalthara, 12 R –Thambakanda, 26 L – Nalla, 38 R – Koholana 51 L – Diyagama 75 R- Arama) selected at random. The use sectors, which are critical at present are marked '⊗' while those which are expected to become critical in future are marked '+'. The non-critical use sectors are marked 'X'.

The major use sectors of the natural resources of the river and its valley according to the number of GND are bathing/washing, sand mining, drinking water through dug-wells, agriculture through ground water, rearing animals and waste disposal sectors. The other use sectors, which are more localised in nature, are the water supply schemes, industries, clay mining, dinking water (direct), inland fishing and tourism.

Table 1: Stakeholder sample distribution

Left Bank			**Right Bank**		
DSD	**No. of GND**	**Sample size**	**DSD**	**No.of GND**	**Sample size**
Negambo	03	09	Wennappuwa	04	17
Katana	05	17	Dankotuwa	07	27
Divulapitiya	17	64	Pannala	14	42

Mirigama	09	26	Narammala	02	08
Warakapola	08	24	Alawwa	13	42
Galigamuwa	02	05	Polgahawela	06	20
Rambukkana	06	12	Rambukkana	11	17
Kegalle	01	03	Mawanella	10	10
Mawanella	07	13	Aranayake	08	31
Aranayake	12	40			
Total	**70**	**213**		**75**	**214**

Table 2: Resource Use Sectors in sample GN divisions

GN division		**1 LB**	**12 RB**	**26 LB**	**39 RB**	**51 LB**	**75 RB**
Distance from estuary (km)		0	22	50	77	97	124
Natural Resources User Sectors	Drinking water (direct)						X
	Bathing washing	⊗ +	⊗ +	⊗ +	⊗ +	⊗ +	⊗
	Pipe water source					X	X +
	Industries			X			X
	Hydropower						X
	Sand mining	⊗	⊗ +	X	X	X	X
	Mining clay	⊗	X	X			
	Pollutant discharge						
	Fishery	⊗ +	X	X			
	Recreation			X			
	Animal bathing		⊗ +	X	⊗ +	X	X
	Agriculture/other land	X	⊗ +	⊗ +	⊗ +	⊗ +	X
	Dug - Wells		⊗ +	⊗ +	⊗ +	⊗ +	X
	Environment	⊗	⊗ +	⊗ +	X		⊗ +

⊗ - uses critical at present + - uses critical in future X - uses not critical at present /future

5. Technical requirements and economic value of project

Estimating the critical bounds of technical requirements of natural resource uses/issues is the second step of the framework. The engineering knowledge is utilized to develop the methodologies to estimate upper/lower bounds of the technical requirements for utilization of the different resource uses. Usually, when a project is proposed these bounds are already estimated. The estimates for lower bounds of the technical requirement of the river flow for four use sectors thus identified by the project report [9] on the proposed balancing reservoir are;

a) Water Supply and Sanitation Sector - Flow requirement at eight present extraction points down stream of the proposed reservoir is estimated as 170,000 m^3/day in 2015 and 237,500 m^3/day in 2025.

b) Industry sector - Flow requirement at the three present extraction points down stream of the proposed reservoir is estimated as 18,000 m^3/day in 2015 and 37,000 m^3/day in 2025.

c) Irrigation Sector - Flow requirement at the three existing schemes, which are non-functional at present, is 36 million m^3 per annum. This is considered a fixed value.

d) Environment Sector - The proposal has considered different flows varying from 3 m^3/s to zero for this sector.

Estimating the economic value of the technical requirements of the natural resource uses/issues at above stated critical bound is the third step of the 'educated trade-off' framework. This is again estimated in the feasibility report for the proposed balancing reservoir [9]. The report clearly indicates aspects considered for the calculation of economic parameters of the project.

The economic benefits of the project are due to power generation, water sales, crop production, land value increases, generations of new business activities. The economic costs of the project are due to capital costs, which includes construction costs of the dam and the powerhouse, refurbishment cost of electrical and mechanical components which has a life time less than the project life time and land acquisition costs (inclusive of resettlement, compensation costs) and recurrent costs, which include operation and maintenance costs, personnel and material costs.

The estimated economic internal rate of return (EIRR) for the base case is 15.2%. A sensitivity analysis has been carried out for five scenarios. 1) capital cost 10% higher 2) benefits 10% lower 3) benefits delayed by one year 4) combination of scenario one and two 5) combination of scenario one, two and three. The report [9] recommends the project as the EIRR stands over and above the cost of capital even under the worst economic scenario.

6. Environmental value at the critical bound of the technical requirements of natural resource uses

6.1 Estimates of social and environmental impacts

Estimating the environmental value of the critical bound of the technical requirements of natural resource uses is the fourth step of the framework. The net environmental value of the reservoir project will be the difference between the environmental (including social) benefits due to the reservoir and the social and environmental costs of the other uses due to the reservoir project. It must be noted that net social and environmental costs referred to here are those, which are either not quantified or underestimated, in the economic analysis. Then all of the environmental benefits and costs of impacts valued in constant value terms become line items in the economic analysis.

‘With project’ and ‘Without project’ scenarios are considered. ‘With project’ scenario prioritize reservoir releases to meet the minimum demand by the water supply and sanitation sector by acting as a regulating reservoir for water supply schemes of the NWSDB. In addition, depending on the flow availability, the reservoir will release a flow of 4 m^3/sec for hydropower generation. It is also proposed to release a flow of 1 - 3 m^3/sec as minimum environment flow requirement in the event that there is insufficient flow to meet the hydropower generation requirement [9].

The major factor that has been overlooked in this proposal is the livelihood and the resource use patterns of the grass-root stakeholders. As the present study shows 121(83%) of the GN divisions reported sand mining as a means of livelihood. The prevailing political system and the corruption of the regulatory and law enforcing officials encourage large scale sand mining resulting in a deeper riverbed. The regulated reservoir releases coupled with the lowered riverbed will result in longer periods of low water levels and could lead to a number of negative impacts as described by the stakeholder responses in the next section. A major positive impact that has been overlooked is the further reduction of flood damages, which has already diminished to a considerable extent with the widening, and deepening of the riverbed due to sand and clay mining.

6.2 Stakeholder Views

Views were elicited on conflict situations the stakeholders have faced with regard to present resource uses and also on such situations, which could arise in the future. 372 (87%) respondents agreed that their resource uses have faced conflict situation at present and 378 (88%) agreed that there could be such a situation in the future. 371 (87%) respondents believed that they know the reasons for such threats and conflict situation and 346 (81%) respondents of the total sample attributed the cause as the resource exploitation by other sectors.

Drinking water obtained through dug wells by the people living on the riverbanks is identified as the one of the two major user sectors at 129 (89%) GNDs, which is at a very critical situation at present at 114 (79%) GNDs. This is also the user sector expected to be in the most critical situation in future 116 (80%) as it is a basic requirement of human, which cannot be denied. Stakeholders responding to the survey claimed that the dry weather water level of the river has dropped up to 12 meters due to indiscriminate sand mining activities carried on the riverbed. As a result the water table in the vicinity of the river has also dropped resulting in deeper water levels in the dug wells. In most villages along the river the dug wells run dry within a short time after the rain has ceased.

Similarly bathing and washing is found to be the other major use sector, which is in a critical situation at present at 89 (61%) GND. Large numbers of people not only along the river but also from nearby GNDs depend on the river waters during dry spells, as this is their only source for bathing and washing. This sector is identified as threatened or critical due to a number of reasons; sudden deep pits created under water (*Wakkalam*) due to severe sand mining, at most of the earlier bathing spots (*Mankada*), which are very risky as the slightest error in a step could lead even to drowning. A number of deaths have been reported of whom most were outsiders coming for recreation. Deep sand mining has also resulted in surfacing the bedrock. Once the rock is surfaced it becomes slippery and could lead to accidents. Also, discharge of waste by different sectors such as factories, hotels, slaughterhouses etc. into the river specially during the dry spells has resulted in poor quality water unsuitable for bathing.

Another sector that is impacted presently, at 102 (70%) GN divisions out of the reported use at 125 (86%) GNDs, is agricultural lands on the riverbanks. On one hand, excessive land erosion is reported specially during floods incurring severe damages to the property. On the other hand during the dry spells these lands become very dry due to lowered ground water table resulting in reduced or no harvest.

Environment though is an indirect resource use sector, also receives priority attention due to the large number of people living in the riverbank areas, vegetation and the eco systems. The situation analysis also showed that out of 64 GN divisions who showed an interest on the environment, 49 (76%) declared that the sector is already threatened.

6.3 Gaps identified and next steps

The grass-root stakeholder consultations revealed that in most locations sand mining is continued at least as an illegal activity resulting in increasing depths of riverbed. Thus the three indirect water user sectors (dug-wells, non-irrigated agriculture and environment), which depend on ground water, are severely impacted. These impacts are directly related to the river water level but not to the flow. Therefore a gap is identified in the feasibility report as it focuses only on the river flow. The feasibility report had attempted to analyse all the water requirements by different user sectors either as a volume or as discharge.

Therefore, the next step would estimate the river water levels according to the proposed reservoir operations and to quantify the social and environmental impacts in space and time. Then the primary and secondary environmental valuation methods [12] will be utilized to estimate the economic values of the above environmental impacts, at the critical bound of the resource uses (reservoir operation) at resource scares situation.

Once the identified social and environmental impacts due to project is estimated, the final step of the framework ‘the net value of the critical bound of the technical requirements of natural resource uses/issues’ can be estimated by combining the economic and environmental values. The combined value of the critical bound of a technical use/issue would be in economic terms. The stakeholders of the river valley need to be educated with this newfound knowledge in order for them to be able to engage effectively in decision-making process. Knowing the technical requirements and the combined value of the critical bound of the technical requirement would help stakeholders to be educated with which uses need to be prioritized in a year that has less water.

7. Conclusions

This case study focused on identifying the different natural resource user sectors and the stakeholders, which varies spatially. The six-step approach adopted for this purpose proved to be efficient in achieving the set objectives. Particularly the approach to elicit views and information on the resource uses of the stakeholders through the respective GN's, was successful mainly due to two reasons. Firstly, the involvement of GNs as stakeholders were easy due to their educational level and secondly, in most of the occasions the participants chosen by the GNs proved to be from different user sectors with divergent views.

The research results clearly indicated the spatial variation of resource user sectors and the pertaining issues. Five resource use sectors, which were identified as threatened or as facing conflict situation at most number of GND locations are a) drinking water due to the drying up of dug wells, b) lands on the river banks due to severe erosion c) sand mining due to inefficient regulatory framework d) bathing and washing sector due to the high risk posed by deep pits beneath water level and pollution and e) environment.

The proposed 'educated trade-off framework' would be very useful in identifying the spatially varied stakeholders and the resource uses, the probable social and economic impacts and values of them and finally to obtain the combined value of the proposed reservoir development project.

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SECTION IX

FACILITIES MANAGEMENT

Briefing as a process of cultural knowledge exchange in a hospital partnering project from a Facilities Management perspective

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Abstract

Outsourced Facilities Management (FM) has been noted to be problematic in terms of understanding clients' needs, especially in the hospital sector. This paper argues that an understanding of hospital's needs inevitably requires an understanding of the hospital's organisational culture, where the 'value' for FM rests. Using a hospital partnering project as a case study, it investigates the *process* of learning about culture, an approach which has traditionally been treated as a black box. Nonaka's [1] theory on knowledge creation provides a framework for the study, with an emphasis on the socialisation process whereby individuals exchange their cultural knowledge through face-to-face experiences during briefing. Sackmann's [2] categorisation of knowledge proves useful in detecting such exchange. It was found that a lengthy, deep, and thorough discussion on specific topics triggered the sharing of cultural knowledge. "Creative chaos" in the form of problems, disagreements, and conflicts should be encouraged and managed as it facilitates the sharing of cultural knowledge. Finally, cultural knowledge exchange was found to be an extremely subjective process, whereby the briefing participants competed against one another to impose their version of knowledge.

Keywords: Cultural learning, Facilities Management, hospitals briefing, partnering, knowledge exchange.

1. Background: the need for cultural learning

Outsourced Facilities Management has been noted to be problematic in terms of understanding clients' needs [3, 4]. Cultural, systems, and operational differences between Facilities Management and hospital teams can mean that clients' needs are not effectively and accurately captured, causing a mismatch between the design and the intended use of the building [5]. In hospitals, the impacts of such mismatches can be enormous, including higher maintenance and operational costs, poor value for money, and even higher death rates [6, 7]. The challenge involved in understanding the hospital's needs and in designing appropriate facility strategies ultimately points to the importance of understanding the hospital's organisational culture. Organisational culture is often referred to as a social construct which is shared among members and represents the collection of agreed values, norms, beliefs, feelings and ideologies that makes up an organisation [2, 8]. Although organisational culture researchers have varied in their focus on either perspective, it is generally accepted that, in essence, organisational culture is represented by its members' mindsets, basic assumptions, or beliefs [8, 9]. Although culture is also recognised as being tacit, highly personal, hard to define, formalise and not easily observable but it is *learned* rather than derived from one's social environment rather than one's genes [10, 11]. It is a form of *learned knowledge* which is sustained by social processes and which defines the different kind of behaviours that are considered appropriate and acceptable. At a project level, the importance of understanding a client's organisational culture during the briefing process has been noted by various authors [12, 13].

However, previous research into the briefing process has almost exclusively ignored the need to *learn* the culture. Indeed, many still see the process of *cultural learning* as a separate variable rather than as necessarily embedded in the efforts to understand client's needs. This has meant that the processes needed to effectively capture cultural knowledge have remained undeveloped, as have the conceptual theoretical frameworks to understand it. This new perspective demands that the process of briefing is treated as an organic and cyclical process of *cultural learning*, where Facilities Managers and client representatives gradually converge upon a shared meaning of each other's cultures over time. It is one which is supportive of the strategic development in Facilities Management, but it is also one which challenges recent arguments on developing "value" for the profession [3]. The cultural learning perspective argues that 'value' for Facilities Management rests on developing capabilities to capture cultural knowledge through better cultural learning practices. It also advocates a higher level of awareness, receptivity and sensitivity towards cultural issues as a measure for higher competitive advantage.

This study also points to briefing as a context in which cultural learning can take place. As briefing process often occurs early in the building procurement process and is where clients' needs are captured, refined and balanced and then translated into a design brief [14], it can consequently be argued that the briefing process is a suitable context for cultural learning where learning about clients' requirements is most influential to the project outcomes. Green [15], and Barrett and Stanley [14] argue that 'briefing must be seen as a process not an event', where clients' requirements are progressively captured and translated into effect throughout the construction project in a process of social construction of the meaning of client requirements, rather than a one-way flow of information. In the hospital context, the New South Wales (NSW) Process of Facility Planning Guidelines refers to such a process as being part of the Project Implementation (PI) stage, which is when the outsourcing of Facilities Management occurs, and as such defines the briefing process for this study.

2. Framework: knowledge exchange through socialisation

The *process* of learning has largely been explored from a social constructivist perspective, which suggests that organisations continually strive to make sense of the world through conversations and the interactions between people as they negotiate meanings within their community [16]. It represents an important point of departure from the traditional view of learning as occurring only in individuals' heads, by shifting the focus of learning to the *social* arena in which it takes place. The rationale of adopting this perspective is that organisations now have the opportunity to purposefully manage their sociological environments in order to deliberately enable and support the learning processes. Such establishment of learning theories has also enabled the scrutiny of the *process* of learning to take place, rather than treating it as a black box, as has traditionally been the case [17], active and dynamic rather than passive and static. This view is valuable for understanding cultural learning in the hospital briefing context because it recognises the high level of complexity of hospital organisations and it also emphasises the importance for the Facilities Management team of managing the social environment during the briefing process. This is achieved by recognising that the interactions during the process can themselves be seen as contexts which present opportunities for both groups to learn about each other.

The knowledge creation theory developed by Nonaka [1] is best suited for conceptualising cultural learning because it is the *only* theory that acknowledges and emphasises the learning of tacit knowledge, which is particularly relevant to learning about culture as proposed in this study. A thorough review of this theory was presented in Chandra [18]. This knowledge creation process involves four stages of knowledge conversion, namely: socialisation, externalisation, combination, and internalisation. In particular, socialisation process which represents the first stage out of four stages is important in conceptualising learning though a social context. This socialisation stage will be explored in detail in this paper.

Socialisation is the process of the *sharing* of the tacit knowledge of organisational members, whereby they learn the norms and values of the organisation, share feelings, emotions and experiences in order to remove the barriers between self and others, so that they become part of that organisation [1, 19]. It is particularly relevant to, and useful for, studying cultural learning in the hospital briefing process, especially in the context of partnering projects, because socialisation allows briefing participants to get to know one another. It is not only that this is an opportunity for the Facilities Management group to understand the client's needs, but it is also an opportunity to align such needs with its facilities strategies and project constraints, and to prioritise them accordingly. In briefing, socialisation takes place when the Facilities Management group and the client group meet and share their cultural knowledge to better understand the hospital's facility requirements.

Socialisation takes place within "originating ba", which often takes the form of physical face-to-face experiences, in which language is central to the process [19]. Although Nonaka *et al.* [19] argue that non-verbal language can play an important role, it is also important to note that a non-verbal context for socialisation largely exists in an intra-organisational setting where members are familiar with one another. In hospital briefing such non-verbal context for socialisation may be difficult to attain because, in an inter-organisational, temporary and contract-bounded relationship between the Facilities Management and hospital groups there is often no common language in the first place. To this end, it is established that verbal language used during the briefing process signifies socialisation that occur between the Facilities Management group and the Hospital group whereby they exchange cultural knowledge.

3. Method: measuring cultural knowledge exchange

In measuring cultural knowledge exchange, it is first necessary to understand the range of briefing meetings involved. This study uses an Australian partnering project, where it involved a major redevelopment within an existing hospital precinct, and whereby the managing contractor was engaged prior to the design stage rather than later in the process as in the traditional method of contracting. The briefing meetings referred to in this study were called "user group" meetings and it was in such meetings that the Facilities Management group gained cultural knowledge that was important to the effectiveness of the design outcomes. During these user group meetings, the Facilities Management group and the various users of the planned facility had the opportunity to socialise and exchange tacit cultural knowledge, which became the basis for the data collection process.

Determining the sharing of tacit cultural knowledge – Culture is previously defined as a shared way of thinking, or a shared knowledge structure that people use to make sense of perceived situations. People in social settings exchange many different kinds of knowledge to define their own and others' culture [20]. The literature of organisational knowledge and knowledge management present various categorisations of knowledge (Table 1). It can be seen that the various categorisations of knowledge essentially refer to similar ways of differentiating knowledge. Sackmann's [2] categorisation of knowledge has been chosen to be the basis for discussion that provides a framework in which the transfer of cultural knowledge through briefing meetings can be detected. It was established that such knowledge is embedded in the contexts, which, in this study, took the form of explicit discussions on facility-related issues between the hospital and Facilities Management groups during briefing meetings.

Table 1: Summary of different levels of knowledge (Adapted from [18]: 28)

Authors	**Level of knowledge**			
Sackmann (1992)	Dictionary	Directory	Recipe	Axiomatic
Spek and Spikjervet (1997)	Data	Information	<u>Knowledge</u> Knowing what Knowing how Knowing why Knowing where Knowing when	
Pawlowsky (2001)	"What"	"How"	"What should be"	"Why-things-are-done-the-way-they-are

Dictionary knowledge refers to the labels used to describe or name things or events [2]. Other researchers refer to this type of knowledge as 'symbols', 'data', and in the context of communication, the 'what' questions. In the hospital briefing process such knowledge may refer to the exchange of information about facility requirements, such as the size of rooms the hospital needs and their preferred locations. **Directory** knowledge refers to commonly held practices, for example, knowledge about chains of events and about their cause-and-effect relationships [2]. This is also referred to by others as 'data which has been assigned a meaning', 'clustered data that is meaningful within a given context, or the 'how' question. In the hospital briefing process such knowledge may refer to the description of facility requirements, which may include "how" members of hospital groups arrive at the facility requirements, as stated within the brief documents. **Recipe** knowledge refers to knowledge in the form of prescription, repair, and improvement strategies, which includes recommendations of certain actions on how a particular problem should be solved [2]. van der Spek and Spijkervet [21] also suggest that knowledge at this level contains individuals' values and awareness. In the hospital briefing process, such knowledge can take the form of discussions on what the facility needs and what its requirements should be. **Axiomatic** knowledge refers to reasons for causation, and explanations of the final causes perceived as underlying a particular event, which is about the 'why things happen', why a particular problem has emerged [2] or 'why-things-are-done-the-way-they-are', and involving personal values. In the hospital briefing process this knowledge may take the form of reasons that explain facility requirements, such as explaining needs in the light of the hospital's facility problems, and their proposed culturally-bound practical uses. Bood [22] further observes that organisational culture is most equated with axiomatic knowledge, a type of knowledge involving fundamental beliefs or final causes that cannot be further reduced. More importantly, Sackmann [2] argues that these four types of knowledge do not exist in isolation, but that they form an integrative and interconnected *gestalt*, labelled the *cognitive culture map*.

Measuring the "focus" of interaction – The recorded briefing meetings needed to be transcribed so as to allow the researcher to reread and analyse repeatedly [23]. In measuring the focus of interaction, thematic content analysis was undertaken as it allows the analysis of the texts using categories, such as those of Sackmann's [2], and which was assisted by the qualitative research software NVivo. To achieve higher validity against the criteria and construct variables as well as inter-rater reliability, Krippendorff [23] suggests firstly the need for a coding procedure: A label (name), a definition of what the theme concerns (characteristic or issue constituting a theme), a description of how to know when the theme occurs (indicators) and any qualifications or exclusions to the identification of the theme, and finally providing examples to eliminate possible confusion when looking for the theme. Secondly, it must be ensured that themes be a repetition from various units, rather than a single occurrence.

4. Result and findings

It was necessary to separate the case study into two sub-cases, as they involved different sets of briefing meetings. There were a total of *nine* meetings for Case Study 1 and *six* meetings for Case Study 2. This difference was due to the differing nature of the facility planning process for each sub-case. In both case studies all meetings were attended by representatives of the following subgroups: clinicians, planners, contractors, and consultants.

4.1 Contexts of cultural knowledge sharing

Table 2 shows that in Case Study 1 the topic of space fit-outs seemed to dominate the briefing discussions, with the highest total number of occurrences (N=252), followed by discussions on space allocation (N=156) and layout (N=128). This was due to the nature of the department involved, as their operation relied on the equipment and technological advancement of the facility. In Case Study 2 the topic on space layout seemed to dominate the briefing meetings (N=300), perhaps also because of the nature of the department involved, for whom room relationships and placements were important for the effectiveness of their operations. Space allocation (N=67) and fit-out (N=36) seemed to be a secondary focus during the briefing process in this case because of the consultative rather than clinical (surgical) nature of the work of the clinical department involved in Case Study 2. In both cases, knowledge sharing occurred within the contexts of discussion on facilities requirements in terms of space allocation, space layouts and space fit-outs.

Table 2: Topics of cultural knowledge sharing [18]: 116

Case studies	Level of knowledge	Space Allocation	Space Layout	Space Fitout
Case study 1	Dictionary	49	30	54
	Directory	53	39	89
	Recipe	34	38	71
	Axiomatic	20	21	38
	Total	**156**	**128**	**252**
Case study 2	Dictionary	23	93	12
	Directory	22	128	17
	Recipe	13	60	4
	Axiomatic	9	19	3
	Total	**67**	**300**	**36**

4.2 Types of cultural knowledge shared

Figure 1 shows the different types of knowledge shared in the briefing meetings in both of the case studies. Directory knowledge, representing the "how" question, was most frequently shared during the entire series of briefing meetings, followed by dictionary knowledge, recipe, and axiomatic knowledge. An example of **directory knowledge** was "how" facility requirements were formulated, which triggered the sharing of background information regarding the project requirements. More specifically, much of the directory knowledge was shared in the context of explaining the communication process during the project and space fit-outs, such as regarding equipment fittings, doors, and windows and space layouts such as room details and relationships. For example, as the clinicians disagreed with the amount of space allocated for their offices, one planner explained "how" office spaces were to be allocated: *"{The CEO} is quite keen on more of a cheap way of looking at and managing office space, and if people can share, they will, and it is directly his will and within the space planning principles, and if your role is not a manager, then you share it"* (Planner 06, Case Study 1). This indicates that directory knowledge sharing occurred through a process of problem solving and was triggered by disagreements on facility-related issues.

Dictionary knowledge was less frequently shared than directory knowledge. Observations during meetings indicated that such knowledge was communicated with much reference to the briefs (eg Room Data Sheets / RDS) and hence was not fully verbalised. This meant that verbal interactions during briefing meetings did not focus much on the sharing of such knowledge, since such sharing could use texts as a medium for communication rather than verbal speech. For example, a contractor clarified the scope of the project by referring to the RDS: *"page 11, just to confirm, items not part of stage 1... Conferencing area is shared… office areas are not included in this part of stage 1 works"* (Contractor 07, Case 2). While this type of knowledge seemed to be basic and could be communicated through texts, it formed the basis for the sharing of other types of knowledge through uncertainties, disagreements, or conflicts.

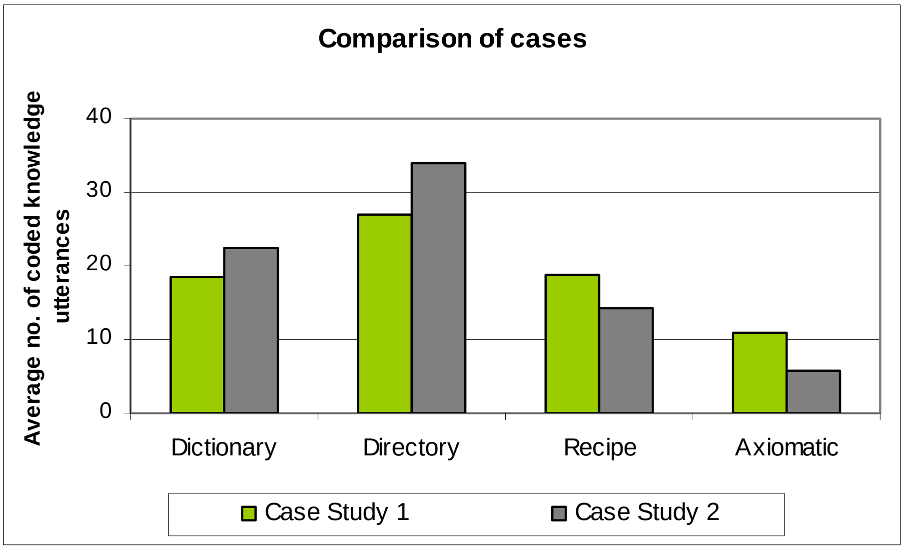

Figure 1: The types of knowledge shared on average during briefing meetings [18]: 117

Recipe knowledge was the next most frequently shared type of knowledge to directory, reflecting that the groups were learning about the project requirements and its problems, thus making recommendations in terms of recipe knowledge when problems remained unresolved and disagreements persisted. For example a consultant presented a recommendation on the door fit-out in Case Study 1, in which the clinicians insisted on have sliding doors in order to avoid encroachment into the rooms: *"If we are looking at a pair of door options, in terms of the impact on the room, we can have one leaf swinging 180 degree, so that it falls flat against the glass wall"* (Consultant 06, Case 1). The contexts in which these types of knowledge were shared were discussions about space allocation, layouts and fit-outs.

Axiomatic knowledge was the least shared among the subgroups, and seemed to emerge mostly during a lengthy and deep discussion on certain topics. For example the contractors asked the clinicians in Case Study 1 for justification of the size of glass windows, the placement of the glass windows, the types of glazing required for the glass windows, etc. A clinician responded by explaining the "why" of their requirement: *"The side window is meant so that a staff member from one room can see to the other one if there is nobody in there. The front window is so that people outside the room, at the nursing station, can see what is going on in the room"* (Clinician 03, Meeting 9) and another clinician added *"Because otherwise you have got to have a staff member looking after patients all the time, which means a long term recurrent cost, you must have twice the {number of} staff"* (Clinician 06, Case 1). The sharing of "why" knowledge is interconnected with the sharing of other types of knowledge (ie "what", "how", and "what should be"), which is consistent with Sackmann's [2] assertion that the different types of knowledge form an interconnected *gestalt*.

Still referring to Figure 1, it is important to note that the average sharing of recipe and axiomatic knowledge was consistently higher in Case Study 1 than in Case Study 2, which seemed to be influenced by the enthusiasm of the briefing participants in Case Study 1, which added to the dynamics of interactions during their briefing meetings. For example, one clinician in Case Study 1 acknowledged that they were *"most enthusiastic when it comes to this planning process"* (Clinician 03, Case 1). Another clinician explained their enthusiasm for aiming to alter the government's design guidelines by travelling extensively around the world to obtain supporting data: *"…we are so adamant on some of the design features we want to put in… we went around to look at the other {unit} on how the {space} allocation should be"*, and further explained that *"we have travelled extensively throughout the US, Canada, UK, Scandinavia, Europe, France, Germany, Adelaide, Melbourne and all the big cities looking at the design structure of the {unit}"* (Clinician 01, Case 1). The enthusiasm of the clinicians in Case Study 1 was acknowledged by clinicians in Case Study 2 who pointed out: *"what's ideal and best is what they {Clinicians in Case Study 1} want… Most of the time they will always want to stand for the best, because it is quite an ego-driven area within the hospital"* (Clinician 06, Case 2). This finding is consistent with Nonaka's [1] assertion that a group's enthusiasm, and thus cooperation and commitment, supports the sharing of knowledge.

4.3 Holders of knowledge

'Holders' in this section refers to individuals who participated in the briefing meetings and who uttered either knowledge about, *or* concern with, a topic. Knowledge, in this instance, refers to all categories of knowledge namely, dictionary, directory, recipe, and axiomatic. Figure 2 reveals a stark difference in knowledge held by the clinician subgroups between Case Study 1 and 2 (higher in Case Study 1 than Case Study 2). The clinician subgroup in Case Study 1 reflected the highest knowledge held among all subgroups, affirming an earlier finding that the level of cultural knowledge held was influenced by the enthusiasm and assertiveness shown by the group and that, at the same time, passiveness seemed to result in lower cultural knowledge being held. Furthermore, it is also interesting to note that the level of knowledge held by the contractors and the consultants was also higher in Case Study 1. As mentioned earlier, the dynamics of interaction initiated by the clinicians seems to have influenced not only the knowledge held by themselves, but also triggered the utterance of knowledge held by the contractors and the consultants. Figure 2 also shows that, during the briefing meetings, the clinicians held the most amount of knowledge compared to other subgroups. It is interesting to note that the contractors seemed to utter the least amount of cultural knowledge. The following section discusses the details of the holders of the different types of knowledge based on each case study.

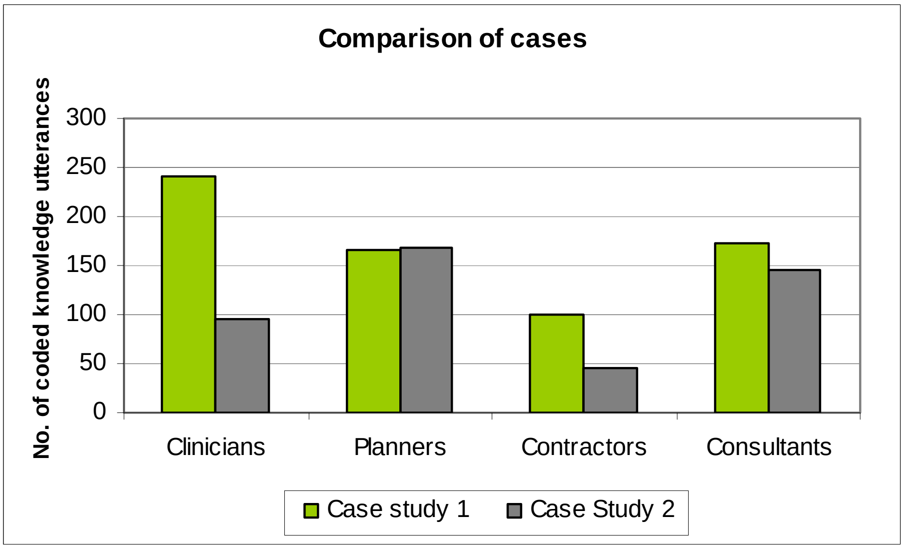

Figure 2: Holders of knowledge uttered during briefing meetings in Case Study 1 and 2 [18]: 120

4.3.1 In Case Study 1

Figure 3 shows that, except for dictionary knowledge, the clinicians uttered the highest amount of knowledge, compared to other subgroups. In particular, the difference seemed to be highest in terms of recipe and axiomatic knowledge, where clinicians made recommendations for developing facility strategies by stating their reasons for making such suggestions. This further reflects the enthusiasm and assertiveness of the clinicians during the briefing process. The planners mostly held directory and dictionary knowledge because they possessed much of the background knowledge of the project from the early feasibility studies undertaken prior to the briefing stage. The active involvement of the consultants was also shown, in that directory knowledge seemed to be mainly held by the consultants, perhaps due to their facility design experience relating to hospitals, detailed practical knowledge about the specific facility requirements of the project, and most importantly, as noted by Kelly *et al.* [24], their responsibility for translating the project requirements into design outcomes. This was also evident in the holders of recipe and axiomatic knowledge, where the consultants represent the second highest scoring group.

Analysis of Case Study 1 also suggests that knowledge exchange was enhanced through conflicts and disagreements among the clinicians themselves. For example, the clinicians had arguments about the room fit-out, in which the nurses were concerned about the complexity of operating of such fit-outs (ie operational issue), while the doctors focused on the medical outcomes (ie strategic issue). This is similar to the "creative chaos" referred to by Nonaka *et al.* [19] as being a factor that encourages knowledge exchange. From the cultural learning perspective used in this research, creative chaos is therefore desirable during briefing. This seems to contrast with the current briefing literature, which emphasises the importance of gaining consensus [25]. While consensus is eventually required, the findings of this study indicate that some chaos is first needed to encourage cultural learning. It also indicates that the briefing process was not a simple learning process between the Hospital and the FM group but, rather, reflected an unclear boundary between the learning participants (between the existence of subcultures and the existence of subjective/individual opinions) and between different levels of learning (individual learning to subgroup learning to group learning). For example the clinicians could come to disagreement among themselves, indicating the clients' inability to articulate their needs as pointed out by Barrett and Stanley [14], and Shen and Chung [25]. Nevertheless, this resulted in the exchange of cultural knowledge among the clinicians, as well as with the FM group, which presents as opportunities for clients to discuss, discover, and learn about their own requirements.

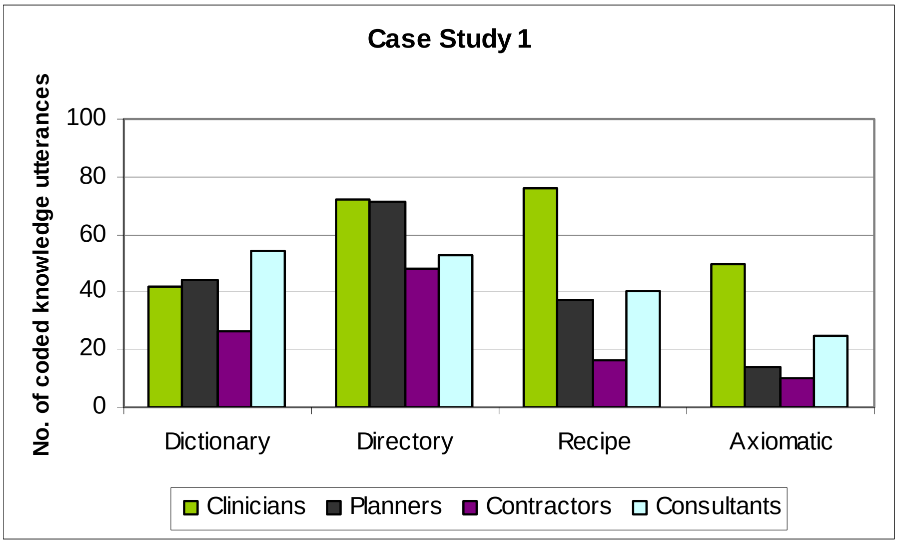

Figure 3: Holders of knowledge in Case Study 1 [18]: 121

4.3.2 In Case Study 2

As shown in Figure 4, the planners dominated the process of knowledge sharing throughout the briefing meetings, especially in relation to directory and recipe knowledge. Observations of the meetings indicated that this was because the planners initiated the majority of the conversations by providing background information about the progress of the design process. The consultants also actively provided responses by presenting draft drawings, explaining and aligning them with facility requirements, and prompting questions for further modifications. The clinicians, however, showed passivity in the process compared to the planners and consultants; for example, only a few of the members voiced their opinion when asked by the planners and/or consultants. This passivity was also reflected in the lower number of attendees in the meetings from this department, compared to those in Case Study 1.

It is interesting to note that, although the clinicians did not hold much knowledge overall, they uttered more axiomatic knowledge than the other subgroups. This indicates the negotiating nature of the briefing process, where clinicians, although relatively passive, persuaded others of their requirements by providing examples of evidence-based practices. For example, when given the total amount of storeroom area by the planners, the clinicians argued, by sharing knowledge about their daily routines, that *"if you look at our current storeroom, staff have to line up to get things because there is not enough space"* (Clinicians 11, Meeting 3). The basis for such negotiation tended to be disagreements on facility requirements, which surfaced as the groups addressed the "what", "how", and "what should be" questions of the facility requirements (ie dictionary, directory, and recipe knowledge). This confirms an earlier finding (in Case Study 1) that the exchange of axiomatic knowledge is encouraged by disagreements between and within the groups. Furthermore, such exchange was facilitated through discussions on other types of knowledge, rather than independently of them.

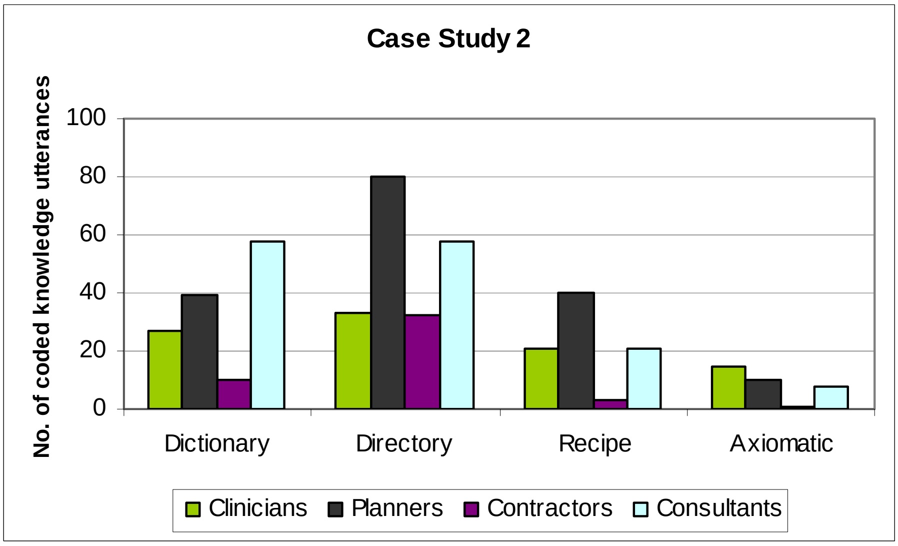

Figure 4: Holders of knowledge in Case Study 2 [18]: 123

5. Discussion and Conclusion

This paper has discussed the contexts for knowledge sharing, the types of knowledge shared during briefing meetings and the holders of knowledge within a hospital partnering project. The above analysis indicates that when the FM group and the Hospital group met the focus of their interactions was not on the sharing of axiomatic knowledge, as this type of knowledge seemed to emerge only during a lengthy and deep and thorough discussion on specific topics. Consistent with Nonaka's [1] assertion, axiomatic knowledge did not exist independently, but was embedded in discussions about facility requirements such as space allocation, layouts, and fit-outs. Furthermore, there appeared to be an unclear boundary between the groups and among members of the same group in the sharing of knowledge, when members learned about their own facility requirements. It was also found that in both case studies the sharing of axiomatic knowledge was largely initiated by the clinicians as they participated in the negotiation and bargaining process of facility requirements during the briefing meetings. This supports Green's [15] assertion that the briefing process involves a social construction of meaning, as facility requirements are defined during the briefing process. However, as opposed to Green's [15] view, the cultural learning perspective appeared to highlight that this process can be purposeful and extremely subjective, as briefing participants competed against one another to impose their version of knowledge through such sharing of axiomatic knowledge. For example, Case Study 1 participants shared much of their recipe and axiomatic knowledge in attempts to convince others of their viewpoints. With their enthusiasm and assertiveness the clinicians seemed to have influenced not only the knowledge exchange among themselves, but also among the contractors and the consultants in the negotiation process. Finally, the sharing of all types of knowledge also seems to be facilitated through problems, disagreements, and conflicts in facility-related issues (or "creative chaos" [19]).

Conversely, agreements seem to prevent the sharing of knowledge, for example, recipe knowledge. The implication for briefings is that "creative chaos" in the form of problems, disagreements, and conflicts should be encouraged and managed, so as to facilitate the sharing of axiomatic as well as other types of knowledge.

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Grading maintainability parameters for sanitary-plumbing system for high-rise residential buildings

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Abstract

Sanitary-plumbing system can waste energy and even become a source of fatal contamination unless designed, constructed or maintained properly. Human health and convenience are the two critical issues and it is important to identify, analyse and quantify the maintainability parameters of complex sanitary-plumbing systems to meet requirements of today's bigger and better buildings. This research was undertaken to investigate the common defects in sanitary plumbing system in high rise residential buildings and their causing factors which may be the critical maintainability parameters of sanitary-plumbing systems. From the detailed case studies of five residential buildings in Singapore, a total of 113 defects were identified for ten major components of sanitary-plumbing system. Out of them 56 were graded as significant by 33 experienced facility managers based on frequency of occurrence and their adverse effect on: economy, system performance, environment and health. Poor maintainability consideration in design stage was apparent from the comprehensive defect analysis. The defect commonly found in almost all the components was the "inaccessibility" for regular inspection and maintenance.

Keywords: Contamination, Defect analysis, Maintainability, Sanitary-plumbing, System performance.

1. Introduction

Apart from wasting precious energy and water, sanitary-plumbing system can become a source of fatal contamination unless it was designed, constructed and maintained properly. With time the concept of maintenance has changed from the action of "breakdown repair" to "preventive maintenance". Only clean water with quality hygienic standard is considered satisfactory.

Hence this system deserves a keen attention particularly in Singapore as abundant rainfall, high temperature and humidity, coupled with high population density can cause waterborne diseases to spread easily and quickly unless a high standard of public health is maintained [1]. In a recent survey conducted by Hassanain [2], design professionals of nine countries have proposed 41 design guidelines with an emphasis on occupant's health to a great extent.

Codes of practise, standards of design and operation handbooks have clear and well-defined guidelines for design and construction of sanitary–plumbing systems in general [1,3-5], along with detailed consideration for certain major issues such as piping [6], valves [7], pumps [8] and life cycle costing [9] etc. Yet major problems are reported frequently, all round the world such as leakage resulting in water scarcity [10], sewage contamination of potable water causing sickness [11] or recurrent cases of Legionella [12]. The root cause of many of these problems is derived from corrosion and wearing off of metallic parts which are common in pipelines, particularly in the consumer's plumbing fittings. Corrosion favours bacterial growth, developing high concentration of lead and copper components within the system and leading to dirty and contaminated water [13]. Researchers have drawn attention to various problems related to sanitary-plumbing system, such as lead contamination [14], biofilm formation [15] etc.

In most cases the solutions for a particular issue were seldom well communicated as a design, construction or maintenance guideline. Health and convenience are the two major critical issues, and it is not only important to identify and solve various defects, but it is equally essential to quantify and grade the maintainability parameters especially when qualitative decision making process is inadequate for complex sanitary-plumbing systems to meet the requirements of today's bigger and better buildings. To address the absence of such grading system, this research was undertaken to investigate the types of defects that are commonly occurring in sanitary plumbing system in high rise residential buildings and to identify the significant ones.

2. Research methodology

2.1 Data collection

In order to obtain a preliminary idea of common maintenance problems in sanitary–plumbing system, major components were examined in a systematic site investigation process. In the first phase of data collection, an in-depth field survey was conducted in five residential towers to identify the common defects occurring in each major component. Discussion with facility managers (FM) and maintenance personnel was followed by expert on-site inspection. Comprehensive photo of each component parts were taken to investigate elements such as the fixture and fittings in individual toilet units, water storage tanks and pumps etc. The defects were diagnosed with the help of information provided by FMs, maintenance records of the buildings and the knowledge gained through the literature review [16-23] were elicited.

From the defect analysis, it was observed that a defect can cause adverse effects on (1) economy, (2) system performance; (3) indoor environmental quality (IEQ); and (4) occupants' health and well-being. These factors contribute to the level of seriousness of a defect A frequent defect might not have significant effect, whereas a very serious defect may happen once in a lifetime. For example, a slow discharge rate of supply water is common but it may not have as much impact on the user when compared with the contamination of potable water from sewage which may cause serious illness. Therefore apart from the frequency of occurrence, the following four major impacts were also considered to be the significant factors caused by the sanitary-plumbing system defects. :

- Economic loss: accumulated financial loss in long term due to the result of the defect. For example, high consumption of electricity due to wrong design resulting in excessive pipe length and bending leading to energy loss of hot water before discharging through the taps.
- System performance loss: such loss occurs when the system performs significantly below normal operating efficiency. For example, slow or disrupted sewage pumping system choked by solid waste discharge.
- IEQ loss: This loss originated from the defect that causes deterioration of the built environment. For example, due to trap seal loss, foul air from the discharge pipes or stacks enters into the building.
- Human health loss: affects the health of the building occupants and maintenance personnel as a result of the defect. For example, illness caused by Legionella contaminations in water supply system.

The defect data related to major components and sub-components of sanitary-plumbing system was collated in a detailed survey questionnaire. In a face to face interview, 33 experienced FMs were asked to indicate the frequency of the defect in a five point Likert scale, where, 1 = ‘rare’, 2 = ‘sometimes’, 3 = ‘quite often’, 4 = ‘very often’ and 5 = ‘always’. In order to estimate the impact of each defect, the respondents were asked to indicate the significance of the defects in terms of four consequences also in a five point Likert scale, where, 1 = ‘negligible’, 2= ‘slight’, 3 = ‘moderate’, 4 = ‘serious’ and 5= ‘very serious / fatal’. Among ten major components, the questionnaire for sanitary piping is shown in Appendix A as an example.

2.2 Data analysis

Mean ratings for the level of seriousness of the defects were calculated from the feedback received. Mean rating for frequency was defined as $\overline{X}_{FR}$, while the same for four impacts, namely, economic loss, system performance loss, IEQ loss and health loss were denoted by $\overline{X}_{EC}$, $\overline{X}_{SP}$, $\overline{X}_{EN}$ and $\overline{X}_{HW}$ respectively. For each defect, the vales were calculated by a general formula (Equation 1). Using statistical tool SPSS 12, T-test was carried out to identify the significance of each mean. The midpoint test value of 3 (by definition) was assigned to measure whether the defects have a significantly large enough mean with p<0.005.

$$\text{Mean frequency of occurrence } \overline{X} = \sum_{l=1}^{5} i \times n_i \Big/ \sum_{l=1}^{5} n_i \qquad (1)$$

Where, i = frequency rating.

n_i = number of responses for i-th rating

3. Results and discussion

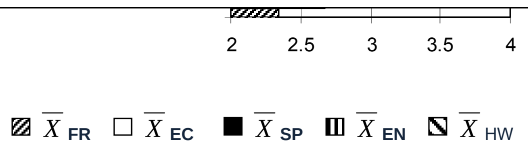
3.1 General observation

For water supply, in most of the condominiums or public housing in Singapore, a gravity supply system was observed whereas hot water is supplied mainly from heater of individual residential units. Tankless type instantaneous heater is commonly installed for shower unit where no hot water is provided for lavatory and kitchen sink. For sanitary works, ventilated stack is used for all buildings with a height more than six stories. The wastewater is collected and conveyed by combined sewers to sewage treatment works before final discharge into the sea. In general it was found that many defects occurred due to poor design consideration for maintenance. The access to various components or provision of work space for maintenance is inadequate. In concealed pipe work, it is difficult to determine the exact location and root cause of any fault. It was also observed that one defect may give rise to a chain of defects. For example, corrosion of piping may cause leakage, which in turn results in water ponding, backflow of dirty water from surrounding soil, as well as wastage of water.

3.2 Survey results

The summary of survey results is presented in Tables 1 - 6 for water supply, while Tables 7 -10 illustrate the prevalent defects in sanitary system. A total of 113 defects related to ten major components of sanitary-plumbing system were identified, out of which 56 were found serious and among those 13 were referred by FMs as frequent and 17 occurs in two or more categories. Economy, system performance, IEQ and health & well-being were affected by 40, 34, 9 and 20 defects respectively. All the significant defects for ten major components are graphically illustrated in the defect list (Tables 1-10). As an example, defects in sanitary piping are discussed in details in Section 3.3.

Table 1: A summary of the defects in supply main

Sub component	**Common defects (11 nos.)**	**Seriousness of significant defects (3 nos.)**
Piping	Overflow, contamination, slow discharge / backflow, hydraulic thrust, dirt accumulation at dead end, less supply, leakage, damage	
Stop Valve	Unable to cut supply for repair	

Air valve	Air lock at high point (low pressure flow), Air gap at summit (normal flow)	

Table 2: A summary of the defects in service pipe

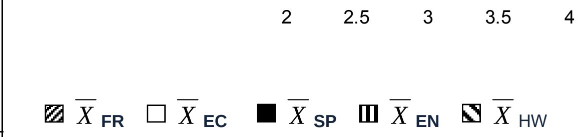
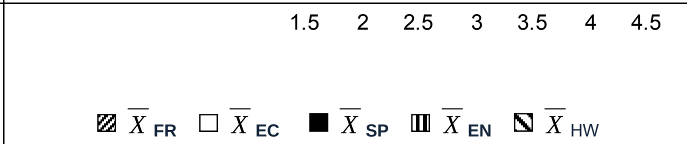
Sub component	Common defects (18 nos.)	Seriousness of significant defects (11 nos.)
Underground pipe	Settlement, damage due to settlement	
Exposed pipe	Corrosion, other degradation	
Internal pipes	Leakage, contamination, air locks, slow discharge, noisy flow, dirt accumulation, supply-discharge interference, damage (thermal stress), poor accessibility, difficult to locate, difficult cleaning	
Valves	In-accessibility, supply suffers during repair	
Fittings	Corrosion	

Table 3: A summary of the defects in over-head / under-ground storage

Sub component	Common defects (14 nos.)	Seriousness of significant defects (11 nos.)
Tank body	Corrosion, leakage, poor / no ventilation, flooding around tank, clogged wash out pipe	

	hinders cleaning	
Intake	Overflow, interruption, back siphonage, stagnation / short circuiting	
Discharge	Contamination, level goes below pipe invert	
Controls	Faulty valve, alarm indicator etc	
Accessory	Corroded net or strainer etc, entry of dirt or insect	

Table 4: A summary of the defects in distribution pipe

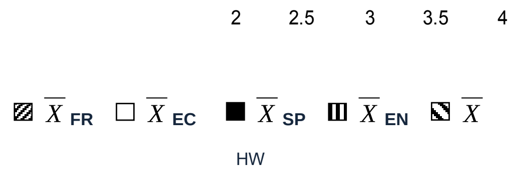
Sub component	**Common defects (14 nos.)**	**Seriousness of significant defects (7 nos.)**
Underground piping	Settlement, damage due to settlement, mechanical damage, leakage	
General	Contamination, degradation, low discharge rate, air locks, frictional loss, head loss at bend / joint, noisy flow, ugly arrangement	
Valves	In-accessibility, supply suffers during repair, corrosion of components	

Table 5: A summary of the defects in hot water supply

Sub component	**Common defects (8 nos.)**	**Seriousness of significant defects (5 nos.)**
Piping	Wastage of water, heat loss, short circuiting in the piping of the primary and secondary circuit, scaling, Legionella growth, corrosion	2 2.5 3 3.5 4 $\overline{X}_{FR}$ $\overline{X}_{EC}$ $\overline{X}_{SP}$ $\overline{X}_{EN}$ $\overline{X}_{HW}$
Tank	Corrosion, bursting	

Table 6: A summary of the defects in pumps

Sub component	**Common defects (9 nos.)**	**Seriousness of significant defects (3 nos.)**
body	Corrosion	2 2.5 3 3.5 4 FR EC SP EN HW
Impellers	Corrosion, out of balance	
Valves	Damaged reflux and isolating valves	
Controls	Faulty control can't auto interchange duty and standby pumps after each cycle of operation.	
In general	Damaged pumps, choking, over heating, excessive vibration	

Table 7: A summary of the defects in sewage ejector or solid diverter tank

Sub component	**Common defects (8 nos.)**	**Seriousness of significant defect (4 nos.)**
Tank / pit	Poor accessibility for maintenance, poor working condition, inadequate ventilation,	2 2.5 3 3.5 4

	vandalism / break in, water penetration / ponding, corrosion	$\overline{X}_{FR}$ $\overline{X}_{EC}$ $\overline{X}_{SP}$ $\overline{X}_{EN}$ $\overline{X}_{HW}$
Air compressor	Incomplete sewage discharge	
Sump pump	Unable to dewater	

Table 8: A summary of the defects in sewage pumps

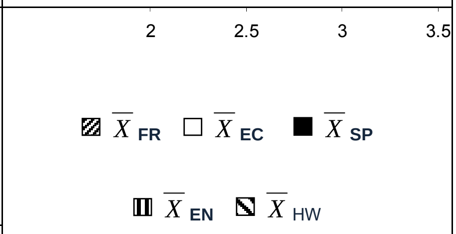
Sub component	Common defects (5 nos.)	Seriousness of significant defects (2 nos.)
Body	Corrosion	2 2.5 3 3.5 4 $\overline{X}_{FR}$ $\overline{X}_{EC}$ $\overline{X}_{SP}$ $\overline{X}_{EN}$ $\overline{X}_{HW}$
Impeller	Corrosion, out of balance	
Controls	Unable to auto interchange of duty and standby pumps after each cycle of operation.	
General	Long fibrous materials of raw sewage cannot be pumped (clogging), solids of diameter ≥ 64mm diameter cannot be pumped (choking)	

Table 9: A summary of the defects in sanitary piping

Sub component	Common defects (10 nos.)	Seriousness of significant defects (7 nos.)
General	Corrosion, leakages, slow discharge , no discharge, discharge of foul air into the building, poor accessibility for maintenance and repair, contamination , trap seal loss,	2 2.5 3 3.5 4 4.5 $\overline{X}_{FR}$ $\overline{X}_{EC}$ $\overline{X}_{SP}$ $\overline{X}_{EN}$ $\overline{X}_{HW}$

	mosquito breeding in open trap, noisy flow	

Table 10: A summary of the defects in sanitary fixture and fittings

Sub component	**Common defects (13 nos.)**	**Seriousness of significant defects (3 nos.)**
WC pan	Water ponding around pan, discharge pipe disconnected from pedestal type pan, collapsed / dislodged of support brackets of wall-hung WC	
Flushing Cistern	Leakage of water and air at the connection of flush pipe and WC pan, damaged device no longer automatic	
Urinal	Clogged trap	
Bidet	Backflow or back siphonage	
Bath and shower unit	Leakages at the joints at the edge of wall and tray, poor maintenance of the waste pipe / trap under the bath	
Floor trap	Slow drainage	
Grating / cover for floor trap / waste	Corrosion, damaged gratings causes undesirable opening and penetration of garbage or other solid waste	
Accessory	Corrosion of installation screws	

3.3 Discussion

For three sub-components of sanitary piping, a total of ten common defects were identified from the first phase of data collection, among which none was frequent but seven were found to be significant for their impacts. Such piping seldom suffers from leakage, but it causes considerable amount of economic loss. This may be due to the corrosion of structural members initiated by water leaking through the joints of concealed pipes. Slow discharge is an example of system performance loss, but no discharge incurs huge cost as the trap or pipe that may require replacement. Though discharge of foul air into the building due to trap seal loss is a well discussed topic but it is considered insignificant from FMs' point of view. On the contrary, poor accessibility for inspection, cleaning and repair was reported as a major hurdle for maintaining proper IEQ. Contamination as caused by backflow and back-siphonage i.e. major defect of design or construction was considered expensive as replacement is the only remedy. Similarly mosquito breeding in open traps was found to have the highest emphasis for health and well being among all 113 defects as this may cause fatal Dengue fever to spread. For the same reason, this defect was considered to be a great expense on FM as failing to rectify this defect may incur huge penalty. Noisy flow as caused by interrupted discharge is an unpleasing example of system performance loss, often demanding costly cleaning or replacement.

From the present study, it was established that among many defects in sanitary-plumbing system, most of the defects can be prevented by considering four major maintainability criteria, namely, design, appropriate material selection, construction practices, and operation & maintenance (O&M) practices and few defects have more than one cause.. It is important to know at which stage what are the defects arise so that the appropriate preventive measures can be taken to improve the maintainability. It was found that among 56 significant defects, 38 are design related, 14 occurred due to poor material selection, 16 were due to bad construction quality and inadequate O&M practises were responsible for 19 defects. Especially poor accessibility for regular inspection, cleaning and routine maintenance was found to be one of the major and prevalent defects which can be addressed during the design stage.

4. Conclusions

The study had identified 56 persistent defects out of total 113 defects commonly occurring in ten major components of sanitary-plumbing system. The inaccessibility for regular inspection and maintenance was detected as the common defect for almost all the components. From the analysis based on feedback provided by 33 experienced FMs regarding: (1) frequency of occurrence of various defects and (2) seriousness of the defects in terms of their adverse effect on economy, system performance, indoor environmental quality and occupants' health & well-being, it was established that the most important contributing factors for maintainability is good design, next comes by O&M practices, followed by construction quality, and material selection. This comprehensive defect analysis was aimed to help the designers, contractors and facility managers to realize the long term effect of their decisions made and form the basis of an enhanced maintainability to promote good practices for efficient and safe functioning of highly maintainable sanitary-plumbing system. Further, this may provide a simple guideline for FMs to achieve and as well as owner to enjoy lower life cycle maintenance cost of building services. This generic research method can be applicable for any other building services.

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APPENDIX A: Sample questionnaire for sanitary piping

<table>
<tr><th colspan="3">Defects for sanitary piping</th><th>Grading for Frequency</th><th colspan="4">Grading for Impacts</th></tr>
<tr><th rowspan="2">Sub-compo-nent</th><th rowspan="2">Description of Defect</th><th rowspan="2">Probable Causes of the Defect</th><th rowspan="2">1= Rare
2= Sometimes
3= quite often
4= very often
5= Always</th><th colspan="4">1 = Negligible 2= Slight
3 = Moderate 4 = Serious
5= Very serious / fatal</th></tr>
<tr><th>Econo my</th><th>Sys. Perf.</th><th>IEQ</th><th>Health</th></tr>
<tr><td rowspan="4">Piping</td><td>Corrosion</td><td>Deterioration over time, piping material is not corrosion resistant or unsuitable for pumped media</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Leakages</td><td>Corrosion, joining pipes of different material, absence of elastomeric seal at joints or sleeve at slab / wall penetrations</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Clogging (slow /no discharge)</td><td>Dirt entering through damaged / removed floor trap or solid construction waste causes clogging in pipes</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Noisy flow</td><td>Interrupted flow (bad design of pipe-trap connection)</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

	Discharge of foul air into the building	Non provision / wrong design of ventilating pipe, trap seal loss of fixtures					
	Poor accessibility for maintenance	Mismatched position of access cover / cleaning eyes and pipe joints, pipes covered by building elements					
Fixture	Contamination	Backflow and back siphonage					
Trap	Trap seal loss	Waving out (pressure fluctuation) for short / straight vent, induced siphonage due to absence of trap ventilating pipes; self siphonage of undersized discharge stacks.					
	Mosquito breeding	Irregular cleaning and poor housekeeping					

Performance management approaches used by facilities management services in hospitals

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Abstract

The idea of this paper is to understand the methods of managing performance in healthcare facilities management in the UK. Most of what is put forward in this paper is based on an already completed research study on 'the role of Facilities Management in the control of Healthcare Associated Infections (HAI)'. Therefore the findings presented in the paper are discussed with a specific focus on the control of Healthcare Associated Infections (HAI). The paper first reviews different definitions and concepts of performance management (PM). It then discusses some of the common performance management approaches used by facilities management (FM) services in hospitals in the UK. These discussions of the paper are based on the findings of a mixed methodology approach. The data sets obtained were subjected to rigorous qualitative and quantitative analyses. Based on the findings of the data analysis, the paper finally concludes that there is a need for a robust performance management approach in order to improve the quality of the National Health Service (NHS), UK.

Keywords: Domestic services, Healthcare Associated infections (HAI), Facilities management, Performance management

1. Introduction

This paper is based on research titled 'the role of Facilities Management services in the control of Healthcare Associated Infections' (Liyanage, 2006). Healthcare Associated Infection (HAI) by definition means "infection which was neither present nor incubating at the time of admission but has developed during the course of a stay in hospital or other healthcare facility" (Scottish Executive Health Department, 2002). Studies throughout the world document that Healthcare Associated Infections are major causes of morbidity and mortality. According to Ayliffe et al (1999) the acquired infection rate is approximately 5-10% in the UK and other developed countries. A review of literature suggests that errors in clinical practices dramatically contribute to the emergence of HAI (Bennet and Brachman, 1998). Nevertheless, some suggest that, if HAI is to be controlled effectively, it is also essential to focus on non-clinical areas such as Facilities Management (FM) as well (Meers et al, 1992; Horton and Parker, 2002).

FM in healthcare usually includes a myriad of services. These are mainly in two categories; hard FM and soft FM. Hard FM relates to management and maintenance of property and other physical assets, while soft FM includes the management of support services. The built environment, including infrastructure facilities such as estate and property, indoor air, structure and fabric, water supply, electricity and telecommunication systems come under the first category (hard FM); and catering, cleaning, waste management, security, and laundry describes the latter (soft FM).

The main aim of this paper is to present and discuss the methods of managing performance in FM services in hospitals from a control of HAI point of view. In doing so, specific attention is drawn only to the cleaning service, which for the purposes of this paper is classified as 'domestic services'.

2. Performance management

The concept of Performance Management (PM) has no generally agreed definition in or across the literature reviewed for this study. According to Martinez (2001), performance management is a term borrowed from the management literature that has only recently been adopted in the healthcare field. The term 'Performance Management (PM)' was first used in the 1970s, but it did not become a recognised process until the latter half of the 1980s (Armstrong and Baron, 1998). As Armstrong and Baron (1998) state, PM is mostly identified as a system which enhances individual performances to support or achieve organisational goals. Adair et al (2003) stress that the term PM cannot be defined in the absolute and that its meaning is contextual in terms of both individuals and activities. Many authors or researchers have different views on PM; some have taken a human resource focus to define performance management (Armstrong and Baron, 1998; Storey and Sisson, 1993), while others provide an organisational view of PM (Fletcher and Williams, 1992; Watkins, 2005). However, according to Donabedian (1980) it is not totally appropriate to consider PM in view of individual performance alone.

Performance Management (PM) can be seen as a significant area in the control of HAI in domestic services. However, it has seldom been recognised as a main component in the said area. As Bartely (2000) has recommended, PM is essential to assess the level of adoption of control of HAI standards in FM services. The Auditor General for Scotland (2000), also provides some of the benefits of PM as follows:

- Measure progress towards achieving corporate objectives and targets.
- Promote the accountability of service providers to the public and other stakeholders.
- Compare performance to identify opportunities for improvement. Performance indicators may be used to identify opportunities for improvement through comparison both within the organisation over time or between different units or organisations.
- Promote service improvement by publicising performance level.

PM can be used as an effective tool to detect pros and cons of the domestic service and it can also support strategic decision-making. It could be used as a point of reference to compare past performance levels with the present. Further, it could also be utilised to identify mistakes and assist with appropriate remedies to be taken.

3. Existing performance management approaches in FM services – case study findings

3.1 Details of the case studies

The existing performance management approaches used in FM services (specifically domestic services) for the control of HAI was identified using the findings of qualitative and quantitative methodologies. The qualitative methodology employed a case study approach involving 26 semi-structured interviews with key parties in the control of HAI in domestic services. For the purpose of this study, domestic services in hospitals were categorised as shown in figure 1.

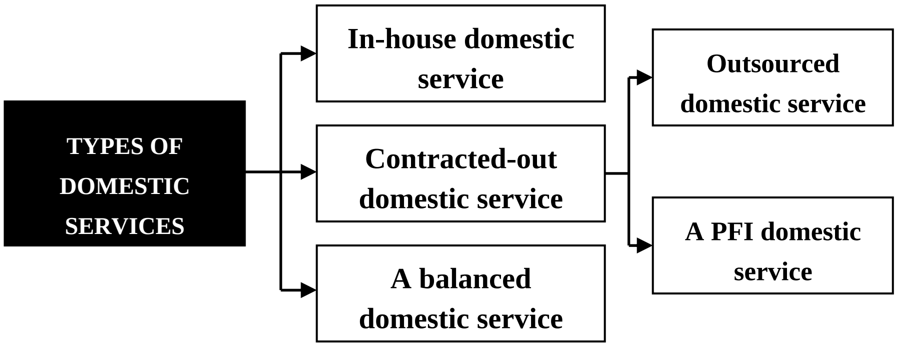

Figure 1: types of domestic services (Adapted from NHS Estates, 1998)

Using the above classifications two different types of domestic services were chosen for the case study approach.

The selected cases were: an in-house domestic service and a Private Finance Initiative (PFI) domestic service. Choosing an in-house and a PFI domestic service was strengthened by the increasing concern by the NHS for such types of services as well as their current level of use. For ease of reference the two case studies were coded as '*In-house case*' and '*PFI case*' in the study reported here. Both *In-house* case and *PFI case* are main hospitals in two of the largest Acute Trusts in the NHS in Scotland. In the In-house case, the domestic service was provided by an internal team that was under the control of the hospital management. The PFI scheme of this hospital was large; hence the private sector partner was a consortium (the special purpose vehicle, i.e. SPV) whose members included a construction company and a principal service provider. The client was the particular NHS trust. The construction company and the principal service provider were the main contractors. The principal service provider had sub-contractors to manage both clinical and support services (FM). The support service provider (i.e. the FM provider) managed all FM services including the domestic service.

3.2 Case study findings

Table 1 presents the PM approaches in-use for the control of HAI in the two case studies. Discussions related to all the above are presented in detail in subsequent paragraphs.

Table 1: PM approaches in-use in FM services

PM approaches	*In-house case*		*PFI case*	
	Yes	**No**	**Yes**	**No**
Audits by Audit Scotland	✓	-	✓	-
Audits by Infection Control Teams (ICT)	✓	-	-	✓
Audits by the domestic service	✓	-	✓	-
Audits for reviewing standards ISO 9001:2000	✓	-	-	✓
Environmental audits	✓	-	-	-
Performance appraisal	✓	-	✓	-
Personal Development Plans	-	✓	✓	-
Patient Satisfaction Survey Techniques	✓	-	-	✓
Programme Evaluation Techniques	-	✓	✓	-
Benchmarking techniques	-	✓	✓	-

Both the *In-house case* and the *PFI case*, in the main, had two types of PM approaches, i.e. external audits and internal audits. The audits carried out by Audit Scotland were the main types of external audits in both cases. The Audit Scotland is responsible for investigating whether the domestic services achieve the best possible value for money and adhere to the highest standards of financial management. It provides a baseline review of hospital cleaning services and makes several recommendations. The recommendations are aimed at improving the quality and effectiveness of hospital cleaning. The review also incorporates a baseline assessment of compliance with standards for cleaning services issued by the Clinical Standards Board for Scotland - CSBS (2002). The Audit Scotland reviews are carried out together with the domestic managers in hospitals. Its reviews are conducted against a number of criteria relating to floors, fixtures and fittings, sanitary ware, walls, curtains and screens and waste bins. Each area is rated using a Likert scale of four, i.e. very good, acceptable, need for improvement or concern (i.e.

unsatisfactory). This basically provides a ‘snapshot’ of the levels of cleanliness in hospitals in Scotland. As one of the domestic managers from the *PFI case* noted:

“The Audit Scotland gives us an action plan to comply with for anything that they felt was unsatisfactory. We have to then respond within a given time frame.”

Audit Scotland completed its last audit in May 2002. However, it is supposed to carry out its audits in hospitals throughout Scotland, at least once every three years.

The *In-house case* had two other external audits, the environmental audits and the audits carried out for ISO 9001:2000 quality accreditation. The environmental audits are carried out quarterly, by the Health and Safety Executive (HSE) and Environmental Health. It is an independent review, which specifically audits the cleanliness of kitchen areas, ward areas and the conditions of hospitals. The ISO 9001:2000 audit, on the other hand, is a process level quality accreditation. It is carried out by an external organisation called SGS Yardsley. SGS Yardley conducts its audits twice a year across the NHS Trust of the *In-house case*. The audits not only include the domestic service but also areas such as maintenance, catering and portering. As the General Manager (Facilities) noted, this audit is similar to a rolling programme:

“Their (ISO 9001:2000) performance tool is a check list. They (the auditors) come with a list of areas to check. Each time they come, they check different areas, so, they make sure that they cover the whole service every year”

The ISO 9001:2000 audits provide a report on the performance of the *In-house case* at the end of each audit. It identifies any areas of shortfalls and provides a sufficient time period to rectify the problems. As the hotel services manager of the *In-house case* explained:

“It is a fairly robust system. They provide us with a corrective action form. If we have a number of corrective actions then they (the auditors) tell us that we have a poor performance level. Usually they benchmark our system against the number of corrective actions we have.”

The main types of internal audits carried out by both cases are known as self-audits. As the name implies, they are carried out by the domestic service itself. The domestic supervisors in the *In-house case* are mainly responsible for these self-audits. The supervisors go round the wards and physically check surfaces, walls, beds, and sanitary areas to ensure that the wards are free from dust. It is carried out weekly or at times, daily. If there are any under-performing areas then the supervisors have to bring this to the attention of the responsible domestics and the latter have to take necessary actions in order to rectify the problem. In the *PFI case*, the NHS Trust (client) and the PFI consortium carry out individual audits, simultaneously, to ensure performance of the contractor. The PFI contractor also carries out an audit similar to the *In-house case*. The PFI consortium and the NHS Trust adopt a point system when carrying out their audits. They allocate points to each and every area of the wards (depending on the level of risk involved in terms of control of HAI, e.g. very high, high, low, very low) and finally sum up the points to determine the total (out of 100 points). If the total is more than 90%, then the contractor's performance is very good.

The other types of internal audit in the *In-house case* are the ICT (Infection Control Team) audits. Some of the senior members of the infection control teams carry out these audits in order to check compliance of the domestic service with the requirements of the control of HAI. They check cleanliness in wards, cleanliness in sanitary areas, different waste segregations, staff compliance and hand washing procedures. The audits are carried out at least monthly.

Apart from the aforementioned audits, both the *In-house case* and *PFI case* have another PM approach in-use, i.e. the performance appraisal (PA). According to one of the domestic managers in the *In-house case,* performance appraisals and reviews have become a necessary part of the domestic service. However, due to time constraints, in both cases, it is limited to only appraisal and review of performance of domestic managers (including supervisors) not domestics. The domestic manager meets with their subordinates once a year and has a personal interview, approximately for one hour. The latter is asked about their job role, job satisfaction and any problems regarding their work. Apart from the performance appraisals, in the *PFI case*, personal development plans are also used as part of an on-going PM programme. This is also for domestic managers. As one of the domestic managers from the PFI contractor's side highlighted, it is a meaningful part of their career-planning process. It recognises domestic managers' contributions toward achieving organisational goals and identifies training and education needs. The *PFI case* also extends their use of PM by adopting programme evaluation techniques and benchmarking techniques in their service. The latter is mainly used to identify their current performance levels compared to previous performance levels whilst the former is used to review the performance of their programmes (e.g. effectiveness of training and education programmes for domestics).

4. Common approaches in managing performance in FM services - Questionnaire survey findings

4.1 Questionnaire survey details

Findings gleaned from the 26 interviews prompted the need to further investigate the most common PM approaches in-use in the control of HAI in facilities management services (specifically domestic services). A questionnaire survey was therefore carried out as the next step of the research study. All four different types of domestic services (refer to figure 1) were chosen for the questionnaire survey, i.e. in-house, outsourced, PFI and the balanced approach (a mix of in-house and contracted-out domestic service). The target population of the questionnaire survey was limited to only domestic managers and infection control team members across England and Scotland. A total of 412 completed questionnaires were received out of the 1304 sent out, giving an overall response rate of 31.60%. Frankfort-Nachmias and Nachmias (1996) state low response rate as one of the serious problems of a postal questionnaire survey. As they noted, the typical response rate for a personal interview is about 95%, whereas the response rate for a mail survey is between 20 – 40%. The response rate of this survey is therefore satisfactory.

The data collected from the survey was analysed using Statistical Package for Social Sciences (SPSS) version 12.0.

4.2 Questionnaire survey findings

As identified from the case study findings, much of the focus of performance management in the *In-house case* and the *PFI case* is on performance audits. However, it is understood from a thorough review of literature that number of other PM approaches which exist in organisations.

Undoubtedly, one of the most widely recognised PM approaches is the Balanced Scorecard (BSC). Developed by Kaplan and Norton, and popularised by the marketing efforts of major consulting companies, the phrase ‘balanced scorecard’ appears to have entered the management vernacular (Neely, 1999). Kaplan and Norton (1992) created the balanced scorecard to assist businesses in moving from ideas to action, to achieve long-term goals, and obtain feedback about strategy. The Balanced Scorecard identifies four fundamental perspectives: financial perspective; customer perspective; internal-business-process perspective; and learning and growth perspective. It expresses an organisation’s strategy as a set of measurable goals from the perspectives of owners/investors, other external stakeholders and the organisation itself.

The European Foundation Quality Management (EFQM) model is another popular model widely used in organisations. In the EFQM, the two main important criteria are the ‘enablers’ and the ‘people results’. The model consists of nine components, namely: leadership, people management, policy and strategy, resources, processes, people satisfaction, customer satisfaction, impact on society and business results. The assumption behind the model is that, excellent results with respect to performance, customers, people and society are achieved through leadership driving policy and strategy, people, partnership and resources, and processes (EFQM, 1999; as cited in Samuelsson and Nilsson, 2002). The model assists organisations to achieve business excellence through continuous improvement in the management and deployment of processes to engender wider use of best practice activities.

Likewise, there are several other approaches used by organisations in measuring and managing performance. Some of them are as follows:

- PQASSO (Practical Quality Assurance System for Small Organisations)
- the Big Picture (an organisational improvement framework and diagnostic tool for identifying strengths and weaknesses within an organisation or programmes of work)
- Investors in People (a national standard for improving organisational performance by training and developing people to achieve organisational goals).

All the above performance management approaches are a range of models and improvement tools that either provide a performance management framework for the whole organisation or support a particular aspect or area of performance.

A careful observation would suggest that some of these common approaches are used in healthcare organisations as well, e.g. BSC and EFQM. Besides, in the NHS, there is also a national Performance Assessment Framework (PAF) to assess performance in the NHS as a whole (NHS Estates, 1999), which is based on the BSC approach. The PAF highlights six areas of performance which, taken together, give a balanced view of the performance of the NHS: health improvement; fair access; effective delivery of appropriate healthcare; efficiency; patient/carer experience; and health outcomes of NHS care. The PAF is supported by a set of national headline NHS Performance Indicators (e.g. access, mental health, diabetes, cancer and coronary heart disease). Even so, currently, the PAF does not give much attention to infection control as part of their overall assessment in hospitals. In addition, it has also not given any particular attention to domestic services (and FM services as a whole).

Given the above discussions, a list of PM approaches (14) were put together, drawing on the literature and discussions with the participants of the case studies. These are given in Table 2 together with the overall mean scores and the rankings of the frequency of use of the PM approaches in the control of HAI in domestic services.

As table 2 results reveal, of the fourteen performance management approaches only the audits carried out by the domestic service is 'very frequently used' in domestic services (overall mean score is 1.62). It is further affirmed by its mode value being in the scale of 1. Four other approaches are also significant and fall in the category of 'frequently used' with mean scores in the range of 2.57 (audits by the Infection Control Teams) to 2.95 (patient satisfaction survey). Out of the nine remaining approaches, only three approaches are 'not frequently used', as they have mean values greater than 4. These approaches are the audits for ISO 9001:2000 quality accreditation, Balanced Scorecard and the EFQM Business Excellence model. Even though it was identified at the beginning of this section that the latter two are the most used approaches in organisations in-general (Neely, 1999), from a domestic service point of view, they can be identified as the least used approaches of PM as their mode values are 5 (i.e. not at all used).

Table 2: PM approaches in-use in the control of HAI in domestic services

Frequency	**PM approaches**	**Mode**	**Overall mean score**	**Rank**
Very Frequent	Audits by domestic service	1	1.62	1
Frequent	Audits by infection control teams (ICT)	2	2.57	2
Frequent	Environmental audits	3	2.58	3
Frequent	Audits by the National Audit Office	3	2.86	4
Frequent	Patient satisfaction survey	2	2.95	5

Frequently used PM

Fairly Frequent	PA for domestic managers	3	3.31	6
Fairly Frequent	Benchmarking techniques	3	3.37	7
Fairly Frequent	PA for domestics	3	3.44	8
Fairly Frequent	Personal Development Plans	3	3.48	9
Fairly Frequent	PAF by the NHS	3	3.74	10
Fairly Frequent	Programme evaluation techniques	5	3.87	11
Not Frequent	ISO 9001:2000	5	4.25	12
Not Frequent	BSC	5	4.41	13
Not Frequent	EFQM	5	4.72	14

Meaning of scale (frequency of use of the performance management approaches):

1 (Very frequent), **2** (Frequent), **3** (Fairly frequent), **4** (Not frequent), **5** (Not Applicable/not at all used)

5. Performance management in FM services – data synthesis

It is necessary for organisations to measure and manage their performance in order to know where they stand in terms of performance levels, to compare results with past performance levels or with others and to set goals for future improvements.

As mentioned in the earlier sections of the paper, the importance of domestic services (and facilities management as a whole) within the NHS should not be underestimated. Standards of cleanliness can vary enormously and have a direct influence on the quality of care received by the patients (NHS Estates, 2001). Therefore, PM should be an integral part of domestic service provision and best carried out with the full involvement of service providers. Robust approaches of PM should exist in domestic services across the NHS covering all aspects of cleaning and the control of HAI – from the activities of staff carrying out day-to-day cleaning tasks to the strategic responsibilities of managers engaged in the longer term planning of the service (Auditor General for Scotland, 2003).

From the case study findings, it was identified that several PM approaches, most of which are related to performance audits, are in place in the two cases (i.e. *In-house case* and *PFI case*). This may be due to the fact that audits have been the prime methodology for the assessment of service costs across departments and functions within Facilities for some years with national compulsory audit systems (Heavisides and Price, 2001). Even though, in this study, audits are taken as PM approaches, in reality it is only part of the PM cycle. The latter not only includes performance audits, but also performance measurement and performance control. According to Wikipedia (2006) 'audits' are independent review and examination of records and activities to assess the adequacy of system controls, to ensure compliance with established policies and operational procedures, and to recommend necessary changes in controls, policies, or procedures. It can be done internally (by employees of the organisation) or externally (by an outside firm). In the study reported in this paper, internal audits (carried out by the domestic services and infection control teams) appear to dominate the PM approaches. External audits such as environmental audits and audits by the National Audit Office also seem to be relatively common. These approaches, although essential for domestic services to ascertain snapshot reviews of the service and, at times, cost and output positions, are not geared towards measuring efficiency, efficacy and economy with respect to service provision. Further, it does not assist in continuous improvement. Thus, there is a need for domestic services to use rather more robust PM approaches that cover most aspects of PM. Balanced Scorecard (BSC) and EFQM are leading examples of robust approaches of PM. Although different, they share many common characteristics such as:

- They encourage whole-organisation thinking and management (Adair et al, 2003)
- They highlight the importance of effective stakeholder management, stakeholder integration, staff involvement and continuous improvement (Atkinson et al , 1997)
- They clarify the links between strategy, processes, and outcomes (Amaratunga et al , 2000); and, most importantly,
- They focus strongly on measuring and managing performance results

The Facilities Management 'Good Practice Guide' published by NHS Estates (2001), which has been designed to enable domestic services to assess their current performance in comparison with others, is integrated with the principles of EFQM. This is based on the premise that excellent results are achieved through the enablers of commitment, effective leadership, clear and realistic policies, good management of people and finance and the understanding and management of well-defined processes. Also the performance assessment framework developed by the NHS follows the principles of BSC. According to NHS Estates (1999), the use of the balanced scorecard allows organisations to get a more rounded view of performance by identifying different key elements of performance and understanding how changes in them may have implications for others. However, even though BSC and EFQM are thought to be the most used approaches in organisations in general, surprisingly, they are the two least used approaches in domestic services (refer to table 3).

The overall research findings suggest that the use of performance indicators and measures is very limited in domestic services. Financial performance is considered the prime performance indicator especially in the *PFI case*. This is mainly driven by the budget constraints occur in FM services in hospitals. Resources (including staff) are the other main indicator used by the domestic services in the control of HAI. An example of a performance measure used by the *In-house case* is also given as follows (see Table 3):

Table 3: An example of a performance measure

Description	Performance measure	Target	Signed by	Action plan
Beds are effectively cleaned and prepared for use with fresh clean linen	yes/no/not applicable	95%	ward sister/ auditor	(target and time scale)

The absence of a robust PM approach could be the main reason for the lack a comprehensive set of performance indicators and measures in domestic services. It was understood from the above discussions that most of the domestic services have only performance audits to gauge their performance. Even if they have other performance management approaches, most of them do not use its results to ‘manage performance’. For example, the domestic services do not feed back their performance results to the staff and managers, which can help to prevent repetition of mistakes. The domestic managers should not collect performance data simply because it is available, or because having large amount of data proves that they work. Instead, they should choose performance measures that can help describe the overall performance of their service, and directions towards the required goals and accomplishments. A robust performance management approach is therefore needed to enable the domestic managers to measure the effectiveness of all aspects of their working practices (both financial and non-financial). If these are not properly identified and measured, the domestic service, without a doubt, could be faced many challenges.

6. Summary and conclusions

Despite its importance, little has been researched or published in the areas of performance management in healthcare organisations, and even less so in the context of domestic services. There is evidence of a lack of common understanding of what is meant by performance, or how performance could be measured in practice, especially with regard to the control of HAI in domestic services. The main approach to performance management in domestic services is performance audit. The performance audits are either carried out by internal teams of the hospital (e.g. the domestic services or infection control teams) or external teams (e.g. the National Audit Office or environmental agencies). While the domestic managers, nationally, would agree that they are striving to improve their services in hospitals; the standards of performance remain extremely variable, mostly due to resource limitations such as budget constraints and staff shortages (because of high staff turnover and sickness absence) and tight time schedules. Besides, the lack of an overall yardstick (i.e. benchmark) to compare the variations in performance standards has exacerbated the problems in domestic services. A new mindset is, therefore, needed that moves away from the traditional one-sided ‘cost’ or ‘snapshot’ audits to a new multi-faceted approach of performance management.

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A Reliability Based Approach for Management of Council Owned Buildings in Australia

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Abstract

With an aging stock of public buildings, development of innovative methods for management of risk of failure and optimizing of maintenance expenditure has become extremely important to Australian public work engineers. A major challenge in many sophisticated asset management systems is identifying the type and quantity of data required to establish a reliable predictive model for maintenance and renewal expenditure forecasts. With the high variability of condition data, a reliability based approach is more appropriate for predictive modeling. Another important observation made of traditional asset management systems is that the deterioration models are mainly a function of age. This has been observed to be unrealistic on many occasions.

The paper presents an innovative approach based on Markov process for deterioration modeling of buildings owned by local councils in Australia. The concept for the complete asset management model is presented with input data clearly identified. Using some preliminary data established from council records and consultation of experts, transition matrices for Markov process modelling have been established for major elements of council buildings. The complete process for deterioration prediction is demonstrated with a typical example.

Keywords: Markov process, Service life modeling, Infrastructure management, Risk management

1. Introduction

Management and sustainability of built infrastructure is an extremely important issue being addressed by many research organizations in the world. The research work funded by European communities lead the world in these areas as reported by Flourentzou et al [5], which are still continuing. There are several approaches reported in recent literature to address the issue.

These can be summarized as:

- Approximate methods where condition of different elements were rated A, B, C and D or 1, 2, 3, 4, 5 through condition inspections. Deterministic life cycle analysis is conducted assuming the time period of progression of deterioration to be fixed in one state (Hovde, [6]).

- Same as above with modifications for different exposure conditions and usage through fixed factors calibrated with data (ISO factorial approach Bamforth, [2], Tepley [13]).
- Reliability based methods using the discrete Markov chain for deterioration modelling.
- Reliability based methods using continuous Markov process (Maheswaran et al , [12]).
- Predicting life cycle of assets considering an integration of three drivers such as Market drivers, physical deterioration and functional obsolescence.

Out of the above, the most common approach used by the industry is a deterministic method based on condition data and fixed deterioration curves. However, these approximate methods lack the ability to account for uncertainties, which is essential to manage risk of maintaining assets to provide the required level of service delivery. Preliminary research at RMIT have indicated that to consider majority of the issues affecting management decision making for effective service delivery of councils a reliability-based approach incorporating some attributes of the ISO factorial approach and consideration of other drivers such as market and functional issues (Allehaux and Tessier, [1]) is essential. Use of Markov chain for deterioration modeling and decision-making is being explored at RMIT University in Australia to address this need.

Previous work on application of Markov process for deterioration modeling of structures have covered deterioration prediction of bridges due to chloride induced corrosion (Maheswaran et al, [11]), concrete structures (Lifecon, [11]) and separate elements of buildings (ISO1586, [9]). In no reported work, the application of Markov process has been attempted on a complex infrastructure systems comprising of a large number of elements. There have been some issues raised about the application of Markov process for predicting deterioration. The Markov curve has a shape which indicates flattening of the curve toward the end of the period whereas in real structures, opposite is observed. This is normally handled by predicting the last stage using a separate probability distribution (Lifecon, [10]).

2. Proposed methodology

2.1 Conceptual framework

In deterioration modelling the attributes of a model randomly change over time. A Markov chain is a probability model, which has a finite-state, for describing a certain type of stochastic process that moves in a sequence of phases through discrete points in time according to fixed probabilities. The process is stochastic because it changes over time in an uncertain manner. In this chain the future states are dependent only on the present state and independent from the any state before the present states. Markov chain consists of transition matrix and initial distribution. Transition matrix consist of a set of finite set of states S (1,1,3….n) and a propriety pi j to pass from state i to state j in one time step t. Time can be treated as either discrete (called Discrete-Time Markov Chain) or continuous (called Continuous-Time Markov Chain). In Markov chain the states are continuous and similarly the time could be either discrete (called Discrete-Time Markov Process) or continuous (called Continuous-Time Markov Process).

The first step for using Markov Chain modeling is evaluating the condition of building elements. This is to assess their physical, operational and maintenance conditions. For any building element a condition rating scheme constitutes of four ratings A, B, C and D where A represents new or nearly new element and do not required any maintenance action. D represents a condition which indicates that the element has to be replaced.

A	Excellent	The element is as new
B	Satisfactory	The element is sound, minor damage, minor maintenance required
C	Unsatisfactory	Major damage. Major maintenance required.
D	Failing	Serious damage. Element should be replaced

Although the deterioration processes evolve over continuous time, for simplicity, discrete time steps could represent these processes (such as the time of the building inspection). Hence in this paper Discrete Time Markov Chain will be considered as a model for predicting the life cycle for building element.

3.2 Discrete Time Markov Chain

Discrete Time Markov Chain is a finite-state stochastic process in which the defining random variables are observed at discrete points in time. This chain satisfies Markov property, which mean that given that the present state is known, the future probabilistic behaviour of the process depends only on the present state regardless of the past. If an element is in state "i", there is a fixed probability, Pij of it going into state j after the next time step. Pij is called a "transition probability". The matrix P whose ijth entry is Pij is called the transition matrix . Transition matrix consist of a set of finite set of state S (1,1,3….n) and a propriety pi j to pass from state i to state j in one time step t. In Markov chain pi j should satisfy two conditions

pij $\geq$ 0, and $\sum_{j} P_{ij} \leq 1$

This mean if an element is in state i, there is a (P_{ii}) probability that this element will stay in state i, and (1- P_{ii}) will move to next state j.

Present state at time t is i: $X_{t=i}$

Next state at time t + 1 is j: Xt+1 = j

Conditional Probability Statement of Markovian Property:

$$Pr\{Xt+1 = j \mid X0 = k0, X1 = k1,\ldots,Xt = i\} = Pr\{Xt+1 = j \mid Xt = i\} \text{ ---------(1)}$$

Discrete time means $t \in T = \{0, 1, 2, \ldots\}$

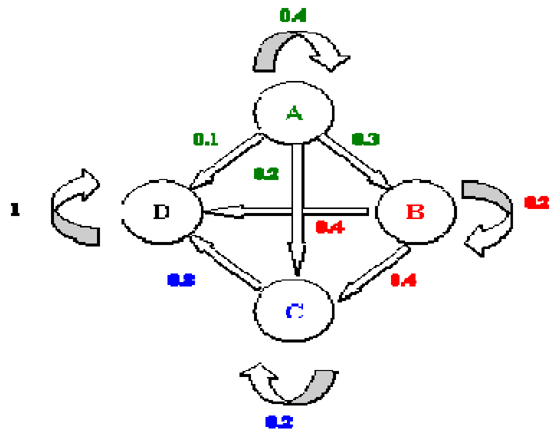

Figure 1: Transition from A to D

	State A	State B	State C	State D
State A	0.4	0.3	0.2	0.1
State B	0	0.2	0.4	0.4
State C	0	0	0.2	0.8
State D	0	0	0	1

Figure 2: Transition Matrix

Figures 1 and 2 show a typical transition matrix. The probability of an element being in a given state at a given point in time can then be depicted by the set of curves shown in figure 4.

An initial distribution 'v' is a single row matrix representing the number of elements in each state. In Markov chain after one time step the new distribution will be the result of multiplying initial distribution v by the transition matrix P

Distribution After 1 Step: vP

The distribution one step later, obtained by again multiplying by P, is given by $(vP)P = vP^{2}$.

Therefore distribution After 2 Steps = vP^2

Similarly, the distribution after n steps can be obtained by

vP^n

P2 is the two-step transition matrix for the system. Similarly, P3 is the three-step transition matrix, and Pn is the n-step transition matrix. This means that the ijth entry in Pn is the probability that the system will pass from state i to state j in n steps.

3.3 Prediction of the future cost

To predict the future cost for any element there are two kinds of costs: inspection cost, and element replacement cost or element repair cost, when the element makes a transition from one state to another.

Inspection cost is represented by the m-dimensional column vector

$$\mathbf{C}^{\mathrm{S}} = \left(c_1^{\mathrm{S}}, c_2^{\mathrm{S}}, \ldots, c_m^{\mathrm{S}}\right)^{\mathrm{T}} \qquad \text{---(2)}$$

Where each component is the cost associated with state i.

The cost of a transition is embodied in the m × m matrix

$$\mathbf{C}^{\mathrm{R}} = \left(c_{ij}^{\mathrm{R}}\right) \qquad \text{---(3)}$$

Where each component specifies the cost of going from state i to state j in a single step.

Expected cost of being in state i, (Jensen and Bard(2003)) is given by:

$$c_i = c_i^{\mathrm{S}} + \sum_{j=1}^{m} c_{ij}^{\mathrm{R}}\, p_{a\,ij} \qquad \text{---(4)}$$

Where, $p_{a\,ij}$ is the probability of maintenance action.

3.4 Absorbing states

An absorbing state is a state from which there is a zero probability of exiting. An absorbing state is a state j with pjj = 1. In other words, without any maintenance action, element which reached condition D will stay in that condition forever. Calculating the expected number of steps to absorption (elements pass from different states to end up in state D) can help to obtain an overall view about the estimated life cycle for that element.

To calculate the absorbing states

Let 0, 1, . . . , k be transient states and

k + 1, . . . , m – 1 be absorbing states.

Let qij = probability of being absorbed in state j given that we start in transient state i.

Then for each j we have the following relationship

$$qij = pij + \sum pirqrj , \ i = 0, 1, . . . , k$$

For fixed j (absorbing state) we have k + 1 linear equations in k + 1 unknowns, qrj , i = 0, 1, , k.

3.5 Long term behaviour of the Markov Chain

If there are recurrent actions taken to repair or replace the element in any state it leads to a steady state probability, which help to set a stable maintenance plan and expenditure.

Calculation of steady state probability can be given by,

Let $\pi = (\pi1, \pi2, . . . , \pi m)$ is the m-dimensional row vector of steady-state probabilities for the state space S = {1,…,m}. To find steady-state probabilities, solve linear system:

$$\pi = \pi P , \ Sj=1,m \ \pi j = 1, \ \pi j \geq 0, \ j = 1,\dots,m$$

3.5 Building Weights

In linking the Markov model to a decision making process, the building weighting method suggested by Zhang [14] is appropriate. He has divided building network(N) into each individual building (b) then divided the building into its constituting system (s) which is dependent on its components(c). Finally he divided the component to elements (e). He suggested that the overall performance of a building network is eventually dependent on the performance of all the buildings elements. For each element there is a composite measure (w) of key factors (distress, structural capacity, safety……… (Hudson et al [8]) Then he multiplied these weights by assigning value for these factors (v). The result will provide conditions index for this element.

$$CI_t^{bsce} = \sum W * V \text{ -(5)}$$

According to Zhang (14) there are four allowable management actions that could be taken for each element in any estate (a1=replacement, a2=major repairing, a3= minor repairing, a4 no action). These can be incorporated by substitution in to the same expression.

3.6 Application

A major challenge in application of the proposed concepts is the quality and quantity of the data needed. A probability distribution is needed for all major data categories for elements of an infrastructure system. With the support of the Brimbank City Council in Victoria, data are currently being collected for this purpose.

3. Demonstration of the method

Process is demonstrated with a division of a building into five key components:

- Building Structure (30% of building weight)
- Building Exterior (15% of building weight)
- Building Interior (25% of building weight)
- Building Services (20% of building weight)
- Building Site (10% of building weight)

(The weighting system has been developed in consultation with Brimbank City Council).

Figure 5 shows probability curves for the building external finishes with time. The time step considered is 1 year with external walls finishes reaching the condition ‘D” in 5 years. Transition matrix derived for the given probability curves are shown in figure 5.

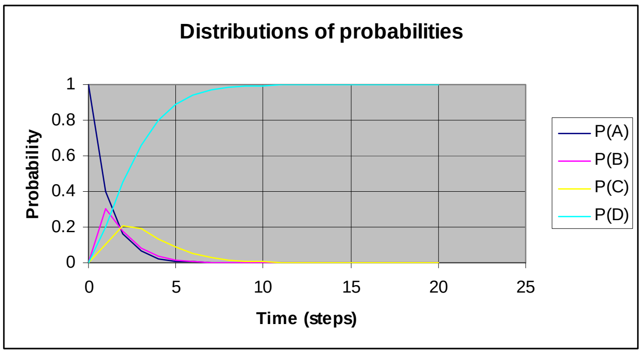

Figure 4: Cumulative Space

	State A	State B	State C	State D
State A	0.4	0.3	0.1	0.2
State B	0	0.2	0.4	0.4
State C	0	0	0.5	0.5
State D	0	0	0	1

Figure 5: Corresponding transition matrix

Once the transition matrix is developed for a given element type, the cost of maintenance can be calculated as a function of the deterioration curves.

The first step towards this is determining maintenance action matrix. Depending on the council asset management policy, different scenarios could be decided. In this paper a maintenance action has been assumed as per the following matrix

	State A	State B	State C	State D
State A	1	0	0	0
State B	0.7	0.3	0	0
State C	0.4	0.4	0.2	0
State D	0.5	0.3	0.2	0

Figure 6: Maintenance action Matrix

For example for elements in State C, 40% will be replaced to reach (State A), 40% will be repaired to State B, 20% will stay in State C

According to Zhang (14)

$sn=r*(M*P)^n$

Where

- sn – System performance
- M – maintenance policy matrix
- P – Transition matrix,
- r – Initial state vector.
- n – Time Step
- In external finish example (M*P):

	State A	State B	State C	State D
State A	0.4	0.3	0.1	0.2
State B	0.28	0.27	0.19	0.26
State C	0.16	0.2	0.3	0.34
State D	0.2	0.21	0.27	0.32

*Figure 7: (M*P)Matrix*

From this matrix future cost and status can be predicted as shown in figure 10 for ten time steps. Figure 8 shows the transient probability of the four conditions A, B, C, D against time step. In developing the figures, the cost is assumed to be in units with inspection cost assumed to be equal to one unit. Figure 9 shows the cost matrix for repair/maintenance.

Figure 8 also demonstrates reaching of steady state with a fixed maintenance regime. The asset manager can then identify the percentage of elements in each condition after reaching a steady state for a given maintenance regime. In this example, at the steady state, there will be 26.4% elements in condition A, 24.6% elements in condition B, 21.2% elements in condition C and , 27.8% of the elements in condition D. If this is not acceptable by the organisation, maintenance regime can be changed to reflect the strategic objectives of the asset manager.

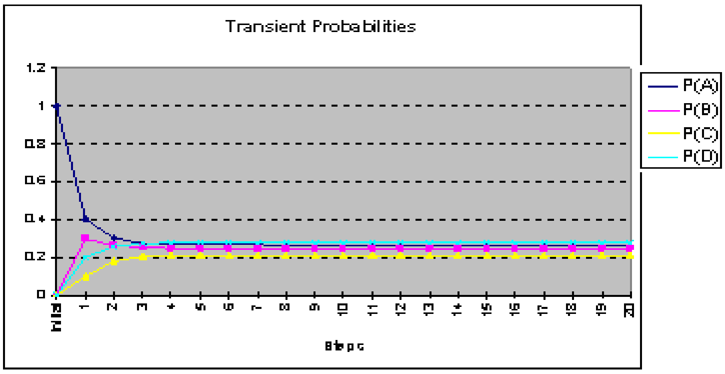

Figure 8: Future Prediction

	State A	State B	State C	State D
State A	1	0	0	0
State B	5	1	0	0
State C	7	4	1	0
State D	10	8	6	1

Figure 9: Repair/replace maintenance cost matrix

Time Step	State A	State B	State C	State D	Step Cost	Cum. Cost	NPW
Initial	1.000	0.000	0.000	0.000	2.400	2.400	2.400
1	0.400	0.300	0.100	0.200	5.507	7.907	7.406
2	0.300	0.263	0.181	0.256	5.783	13.690	12.185
3	0.274	0.251	0.203	0.272	5.852	19.542	16.582
4	0.267	0.248	0.209	0.276	5.871	25.413	20.592
5	0.265	0.247	0.211	0.277	5.876	31.289	24.241
6	0.264	0.247	0.212	0.278	5.877	37.166	27.558
7	0.264	0.246	0.212	0.278	5.878	43.043	30.574
8	0.264	0.246	0.212	0.278	5.878	48.921	33.316
9	0.264	0.246	0.212	0.278	5.878	54.799	35.809
10	0.264	0.246	0.212	0.278	5.878	60.677	38.075

Figure 10: Future prediction cost

To calculate the buildings weight all building elements should be inspected then overall building network weight formula could be applied. In this paper the effect of current physical condition of external wall finishes on the building weight will be calculated. Tables 1 and 2 present the assumed building element weighting for this example of external finishes.

Table 1: Weightings for Elements of Building Exterior

Building Exterior of the whole building weight	15.0%
External Walls	20.0%
Windows	13.0%
Doors	16.0%
Fire Escapes	16.0%
Roofs	16.0%
Steps/Ramps/Walkways	5.0%
Roofs	14.0%
Total Exterior weight	100.0%

Table 2: Weight factors for a given condition

State	Weight Factors
A	1
B	0.8
C	0.3
D	0.0

From the above tables, the discount weight for external walls finishes in state C can be calculated as = 0.3 * 20% * 15%= 0.9 %. However, according to figure 10, only 21.2% of elements will be in condition C. Therefore with the proposed maintenance action plan, we can say that the reduction of the building condition from 100%, due to deterioration of external finishes in condition C will only be 21.2% x 0.9% = 0.19%. The asset manager then can perform a similar evaluation for all the major components of the building to evaluate the reduction in building condition from 100%. This will allow him/her to establish a benchmark for the building condition.

4. Conclusions

The paper presented the concept of using Markov chain for deterioration modelling of buildings. Application of the methodology considering a fixed maintenance regime and an associated cost was presented. The methodology is quite powerful in establishing the relationship between an established maintenance regime and the future cost. This is then incorporated into the decision making through a building weighting method which can be used to enhance the outcomes of the Markov analysis process. Whilst the method requires a significant initial investment to establish :

- The deterioration matrix
- Maintenance regimes and associated costs
- Building weighting,

once the method is established, self calibration can be incorporated into the information system making the functioning of the system quite smooth. The concept is currently being implemented with a project funded by the CRC for Construction Innovation at RMIT University.

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Procurers, Providers and Users (PPU): towards a meta-role model for conceptualising product-service in the built environment

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Abstract

The product-service paradigm requires a shift in focus for many engineering disciplines, forcing them to change from providing products to providing products and associated services. Such a shift is likely to present several challenges to the built environment due to its inherent organisational fragmentations and through-life discontinuities. This paper presents a preliminary conceptualisation of the product-service paradigm as seen from a built environment perspective. The proposed PPU model represents the meta-roles and the information flows, considered as key to sustaining the product-service concept within the built environment.

Keywords: product-service, PPU, knowledge management, through-life management, built environment, incentive flow-down, requirements flowdown, learning from use

1. Introduction

Engineering companies are perceived to be going through a paradigm shift, from providing products to total service business models. This paradigm shift, often referred to as product–service, requires the shift in focus from designing and selling physical products, to sell a system of products and services, which are jointly capable of fulfilling specific client demands. Complex engineering projects include large scale defence infrastructure (e.g. aircraft carriers), aircrafts, large scale construction infrastructure projects, software development etc. This does not, however, preclude the idea that product service paradigm is equally significant for engineering endeavours of a lesser scale (e.g. customised housing). Leiringer and Green [1] note that although in the construction sector, the development of the PFI (Private Finance Initiative) market has had a significant impact on how many companies win work, the extent to which construction operating companies have become more service-oriented is debatable.

This paper is an interim outcome of the ongoing EPSRC / ESRC funded 'Grand Challenge' project, Immortal Information and Through-Life Knowledge Management [(KIM) - http://www.kimproject.org]. KIM involves twelve UK universities, including eight EPSRC funded Innovative Manufacturing Research Centres and spans a number of industries including aerospace and construction. Its aim is to address a perceived shift among engineering and construction companies from product to a product-service paradigm, and to explore the implications of this for knowledge management.

This paper is aimed at presenting a preliminary conceptualisation of the product-service paradigm as seen from a built environment perspective. Firstly this paper will briefly introduce the concept of product-service paradigm. Secondly the specific research focus of the paper is presented. The procurer, provider and user (PPU) model is presented next as a preliminary conceptualisation of the product-service paradigm for the built environment. The conclusion and the way forward are presented as the final part of this paper.

2. Product-Service paradigm

Product service paradigm presents a different approach to the way engineering systems are considered. It puts the user at the heart of the system. This means that the satisfactory servicing of user requirements is a key priority, and in most cases dictates performance measurement. For example Maloney [2] states that there is no natural demand for the construction product; the demand for the constructed product is derived from the intended use of the facility. This entails that design, production, operation / use, maintenance / refurbishment, are no longer separate activities, but are part of a seamlessly integrated, multi-agent, multi-cyclical, long term supra system. Therefore the focus on whole life cycle of the product's ability to provide sustained services is an essential requisite. It requires new business, operational and information system models that extend many years into the future.

A shift from product to product service presents many challenges from several perspectives, as outlined in the following sub- topics.

2.1 Product development

Designing for product-service is extremely challenging. One of the main issues that needs addressing is 'how do we know what users of the facility need in several decades?'. As the user needs are strongly influenced by what happens in the broader external environment, predicting such future requirements become further challenging. Designing systems to co-evolve with the changing circumstances may be an avenue worth exploring in this regard. Need to support globally distributed design, production and use are also key considerations.

2.2 Information management

The through-life aspect of product service paradigm means that information will be continuously generated. McMahon [3] observes two issues that requires attention. Firstly, how to ensure that the information created and the knowledge gained during the design and subsequent operation of the product are recorded and organised in such a way that they are accessible through the whole life of the product, and of most value in product support and in further design work. This could mean that approaches to avoid information overload, and continued harnessing of the power of information technology developments, needs to be considered. Secondly, how to ensure that the organisations involved adopt the most appropriate strategies to maximise their performance in the new business approach.

2.3 Procurement

The success of through-life support depends heavily on the integration of a network of organisations such as specialised component suppliers, subcontractors and service providers. This network of organisations, the context and the environment within which it operate will change with time (e.g. staff turnover, technology changes such as hardware and software, user needs, market & social changes etc.). It is vital that procurement and contractual arrangements move towards providing integrated solutions rather than pursuing bounded interests.

Leiringer and Green [2] observe that the move from product delivery to also providing additional services can hardly be considered a paradigm shift. They contend that firms in a whole host of sectors would claim to have been operating in this way for a long time. However, they note that the trend for product manufacturers to add various forms of services to their offerings is clear. There are many reasons why a firm would want to undertake a transition towards this end. Such a change could be mobilised as a means of securing future business, or it could be initiated by a change in public procurement strategy.

3. Product-Service in the built environment

Blyth [4] notes that the relationship between organisations and buildings is dynamic and continuously changing. The predominant approach to building procurement has tended to assume that a building project is a self-contained event. The CRISP consultancy commission study [4] shows how buildings are part of a far bigger 'organisational project' and subject to rapid change;

- Adaptability and flexibility are not necessarily 'explicit' priorities during the briefing, design and construction of buildings, they often seem to be implicit;

- The definition of a 'flexible' building depends on the organisation using it, therefore it is difficult to brand buildings as flexible or inflexible;

- It is more important to test whether a building can respond to a variety of different demands rather than worry about trying to predict what those demands might be;

Blyth [4] states that the CRISP study did not reveal a particular pattern of change in the one building considered, but it did reveal how operational constraints can undermine flexibility strategies built into buildings;

- The operational constraints of an organisation need to be clearly articulated in the brief since they can easily conflict with physical building systems, therefore compromising the ‘flexible’ elements of a building;

- The study revealed that different stakeholders had different interests in adaptability and flexibility. It seems to matter most to those who manage buildings because they have to grapple with everyday management problems. Users probably notice it when things go wrong and designers only when they are asked to investigate a failure;

- Decisions affecting adaptability and flexibility are taken by different people during the briefing, design and construction process. Unless these are coordinated, the result may be a less adaptable and flexible building than anticipated;

- Maintenance of key client and design team personnel from when a building is designed and built to its adaptation several years later provides valuable continuity. For example, the cost of controlling infection in the environment may not be an explicit operational cost;

- Hidden building operating costs may distort perceived costs of running buildings;

- The procurement process is a vital link in achieving a coordinated strategy for matching user needs and building responses. Anecdotally, clients of PFI projects perceive that they are expected to pay a ‘high price’ or a ‘penalty’ to PFI contractors if they want to make changes. This suggests that clients are finding it difficult to transfer a major area of risk.

The CRISP study also reveals the importance of adaptability and flexibility, and noted that there is more work to be done to gain an understanding about how it impacts on organisations and buildings. It offered four specific further research directions;

- Longitudinal studies of buildings to reveal how the politics of decision-making in an organization affect decisions about buildings, and consequently how the building responds to changing organisational needs;

- Research into the cost and benefits of adaptability and flexibility by tracking how a range of buildings has responded over time and how the occupiers have changed;

- Comparative studies of a number of buildings into how they have responded to organizational change to identify common themes;

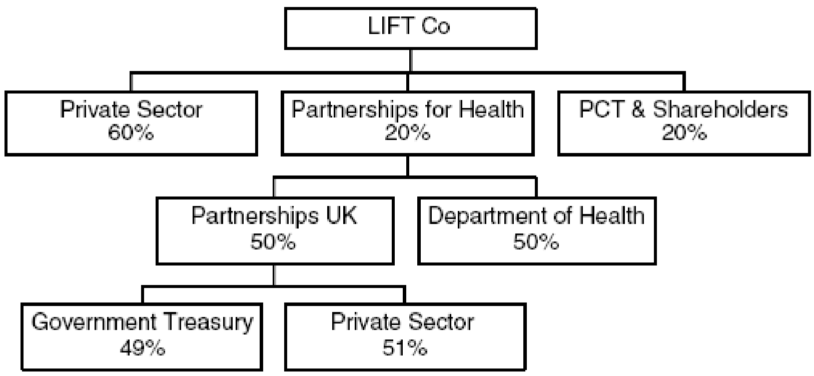
- A study of the speed of organisational change during the development of a building project from early briefing to handover to identify the effects on decision-making about the new building.

4. Stakeholders and through-life issues

Product – Service approach to the built environment (i.e. buildings, public and private infrastructure and other associated services) requires significant attention being paid to the involvement of stakeholders and their roles, over time. Since built products are expected to last for a comparatively longer life span, through-life issues related to how the buildings and the intended services evolve, bears a significant impact on the successful leverage of the product-service business models.

4.1 Stakeholders of the built environment

The presence of many stakeholders in the planning, design, construction and operation of the built environment is well documented. They range from national to local government agencies, designers, builders and facility managers to end users. Increasing focus on partnering and private financed initiatives for procuring public infrastructure such as healthcare, education and transport, has to a certain extent resulted in increased upfront mapping of the stakeholder engagement. Figure 1 below is such an abstract attempt to indicate one such high level stakeholder involvement in UK healthcare sector.



LIFT – Local Improvement Finance Trust

Figure 1: Ownership arrangement of LIFT companies [5]

Siriwardena [6] through a literature review demonstrated that although PPP/PFI context provides a case for product-service in the built environment, the origins and the diffusion has not followed with the same intention. Governments avoiding the use of public money to provide public services, and privatisation seems have been the driving forces for these schemes. The lack of emphasis on life cycle considerations, especially the maintenance / refurbishment aspects, and adaptability and flexibility within the PFI literature indicates the need for further research on the readiness of PPP/PFI schemes to act as the built environment's response to the product-service challenge.

4.2 Life cycle issues

Most buildings and infrastructure are built to last for a considerable period of time. Brand [7] quoting architect Chris Alexander notes "A building's foundation and frame should be capable of living 300 years. That's beyond the economic lifetime of any of the players." [7, p 194]. Koskela [8] highlighted several approaches namely life cycle assessment, product-service systems, product-life cycle management, systems engineering, integrated solutions, public-private partnerships, design studies and concurrent engineering, which claim to indicate life cycle considerations in engineering contexts. In a systematic comparison of the mentioned approaches, it was concluded that major focus tends to be directed towards the front-end of the life cycle, especially to redesign and design decisions, which conventionally are considered of crucial importance, especially from a life cycle view point, with relative less attention on the subsequent use, maintaining, refurbishment and disposal.

Multiple life cycles can be observed within built products over time. They include component life cycles, space and functional life cycles, physical life cycles and legacy life cycles. Table below provides an explanation these terms.

Table 1: Multiple life cycles of the built environment

Type of life cycle	**Description**	**Examples**
Component life cycle	Refers to the life span of various components in buildings	Lifts, electrical equipment, doors, windows
Space / functional life cycle	Refers to the life span of a particular space in a building. When the intended use of the buildings changes, these spaces will attain different names	Warehouse / storage spaces in buildings changing to office space over time
Physical life cycle	Refers to the safe technical life of the building	Buildings above this period are considered not safe and are generally demolished
Legacy life cycle	New buildings are built with many in existing sites, but carries the same names, and	Demolition and re-building of primary schools in UK Demolition and re-building of

	are its associated history	sports stadiums such as Wembley stadium in London

It could therefore be contented that conceptualising product-service for the built environment requires the consideration of changing roles of its stakeholders over time and the whole life cycle issues, tied together by information and incentive flows that facilitate continuous product and service delivery improvements.

5. Procurers, Providers and Users (PPU): towards a meta-role model

The main aim of the PPU model is to encapsulate the changing roles of the stakeholders over time, and the resulting shifts of the flows between them. It is important to note that over time, the roles (the type of vested interest) that stakeholders have is likely to change. Therefore, the terms procurers, providers and users are time dependent (meta) roles. The arrows in the diagram indicate the various types of flows that are considered as important for the sustaining effective product –service delivery in the built environment.

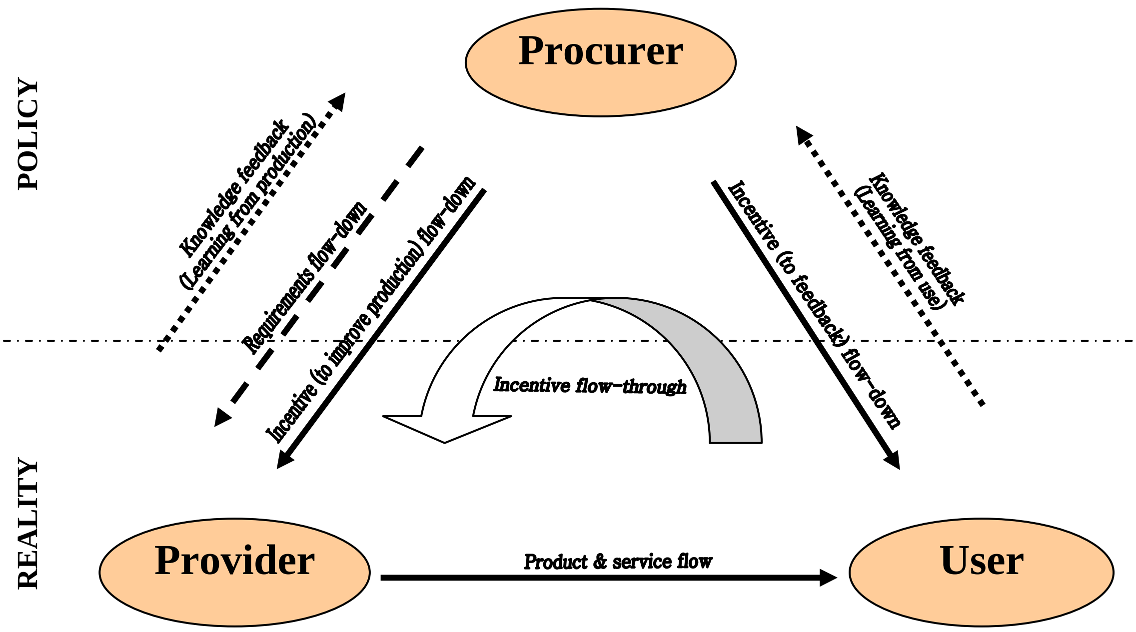


Figure 2: PPU model

The following table provides a brief explanation of the meta-roles indicated in the above diagram.

Table 2: Meta Roles of the PPU model

Meta Role	**Description**	**Examples**
Procurer	Procures the products and services needed to provide main public services	Central Govt., Local Govt. National Health Service
Provider	Provides design, production, maintenance and refurbishment services	Designers, Builders, Facility Managers, sub contractors
Users	Uses the built facility as part of its resource base to deliver the business objectives	

The following table illustrates one possible way in which the meta-roles are likely to change over time, in the primary education sector in UK.

Table 3: Changing stakeholder roles over time

	New build	Periodic service maintenance (5 years after)	Refurbishment (20 years after)	Demolition (60 years after)
Procurer	Central Govt & Local Govt.	Primary school	Local Govt.	Central Govt. & Local Govt.
Provider	Framework contractors	FM company	Contractors	Demolition contractors
User	Primary school	Staff and pupils of the school	Primary school	

6. Conclusions and way forward

The perceived shift from product to product-service is likely to present several challenges to the firms and stakeholders of the built environment. Aspects such as product development, information management and procurement need to take into account the changing roles of the stakeholders over time. Consideration of through-life issues also adds further complexity. The Procurer, Provider and User (PPU) model is suggested as a possible way to encapsulate the complex relationships and meta-roles, paving the way to guide future research of this project. The research team is currently engaged in field work studies in healthcare and education sectors, and hope to report the findings in forthcoming publications.

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Asset Management Planning for Developing Countries

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Abstract

The built environment consists not only of buildings but also of the essential support infrastructure such as highways and utility services. These assets frequently fail because of inadequate maintenance and investment as they reach the end of their useful lives. Only with a system for the replacement of assets, when they become obsolete or beyond reasonable repair, can those responsible ensure the effectiveness and efficiency of their businesses. The methods employed in asset management have much in common with the accountants' approach to depreciation but differ significantly in that condition and performance are the prime drivers rather than age and fixed asset lives. The setting up of an asset management system is well within the capabilities of any organization and much time and effort can be saved if the tasks are dealt with in a structured manner. Thus the primary tasks can be organized into a sequence involving: inventory compilation, grading and costing. The resulting information can then be used to provide a valuation of tangible assets and forms the basis to drive the rehabilitation and replacement aspects of a capital investment program.

Keywords: asset management, inventory, grading, valuation, investment

1. The Context of Asset Management

1.1 The Meaning and Objective of Asset Management

Whilst the term 'asset management' may have different meanings to many people, its meaning in the context of the constructed environment is simple: "to ensure, through refurbishment or replacement, the continued delivery of intended outputs to the beneficiaries of those outputs". The receivers of the benefits are often referred to as 'customers' though in the case of a building they may be occupiers or tenants.

Asset management is not about the short term maintenance of assets which is a regular process concerned with keeping the asset in functioning condition for the operators. Nor is it concerned with the day-to-day management of the assets i.e. facilities management.

1.2 The External Context

Funding agencies, who bankroll much construction in developing countries, have recognized that, with finite resources, they cannot continue to pour unlimited funds into the premature replacement of neglected assets. This view is well founded and along with the concept of 'appropriate technology' coincides with the new morality of only providing that which can be sustainably managed thus avoiding problems for the next generation. There are many others who have a part to play in ensuring that constructions are sustainable. **Fig 1** shows the players in relationship to each other and the investment programme. It also introduces the asset inventory which forms the basis of asset management planning.

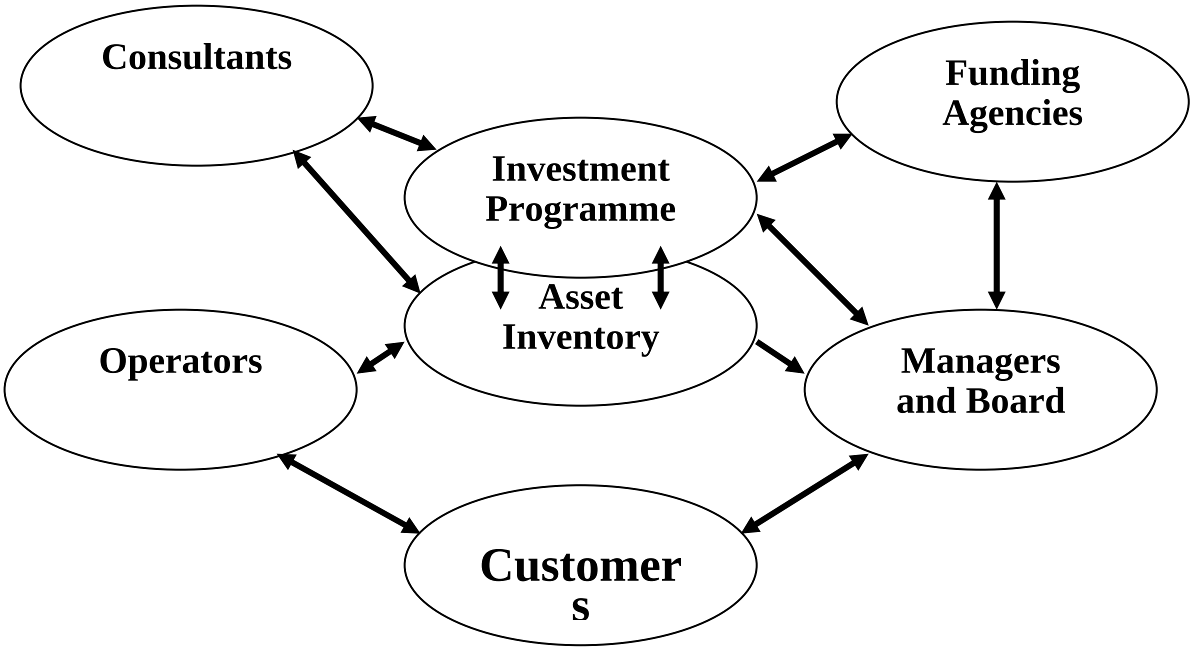

Figure 1- Stakeholders in the Built Environment

The term 'customers' is used to denote those who benefit from the output of, or use of, the constructed asset(s).

1.3 The Internal Context

An asset management plan needs to be administered and placed within a structure which is organized to deliver the planned benefits to the intended 'customers'. These 'capital' functions, which relate to the spending of funds, include:

- Strategic planning
- Asset management planning

- Project appraisal

- Investment programme management

Whilst some of the detailed tasks may be contracted out (e.g. to consultants), all of them must be present and effective for the outputs of a construction programme to be sustainable. The more advanced processes (especially design, tendering and construction) are normally outsourced.

The need for an asset management plan (AMP) is most evident in those areas where maintenance and rehabilitation have been neglected resulting in a lower level of service to customers. Where the care of buildings and operational plant is not properly managed, early renewal becomes the only option to abandonment. Thus heavy (re)investment is undertaken by funding agencies often on a (roughly) ten year cycle and little is done locally between interventions.

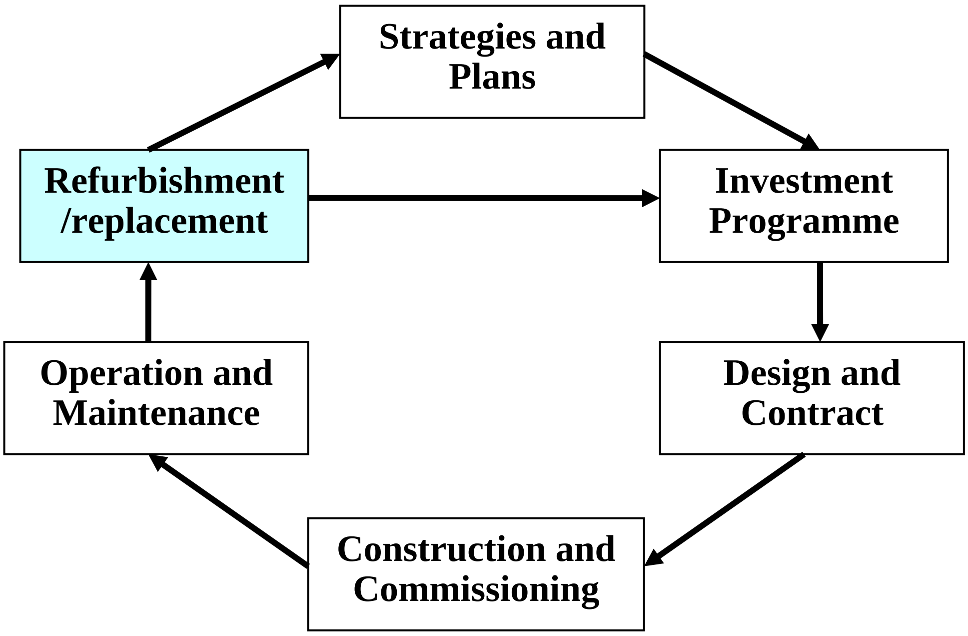

Figure 2- asset management covers replacement / refurbishment within the construction cycle
.

Asset management looks after the replacement and refurbishment of the assets by planning to keep them in operation before they wear out. Thus it can easily be seen to be an essential part of any sustainable system in the life of infrastructure - build only that which you can look after - and then look after it! [3].

1.4 Benefits

The benefits of an AMP can be listed:

- Provides a central inventory with unique references
- Provides consistent information on capacity, throughput, condition etc.
- Links investment with service levels through performance grades
- Provides a valuation of tangible assets
- Plans and prioritizes investment
- Can be used to measure and record improvement

Whilst these are not detailed here one can see immediate benefits such as the ability to feed consultants and project planners with up-to-date asset information.

2. Outline of the Methodology

An AMP consists mainly of an inventory of assets - usually contained in a database - and a computerized system that aids valuation and compiles output in such a way that the priorities for investment can easily be recognized and acted upon. **Fig 3** shows the typical layout of an AMP and the interaction of the components.

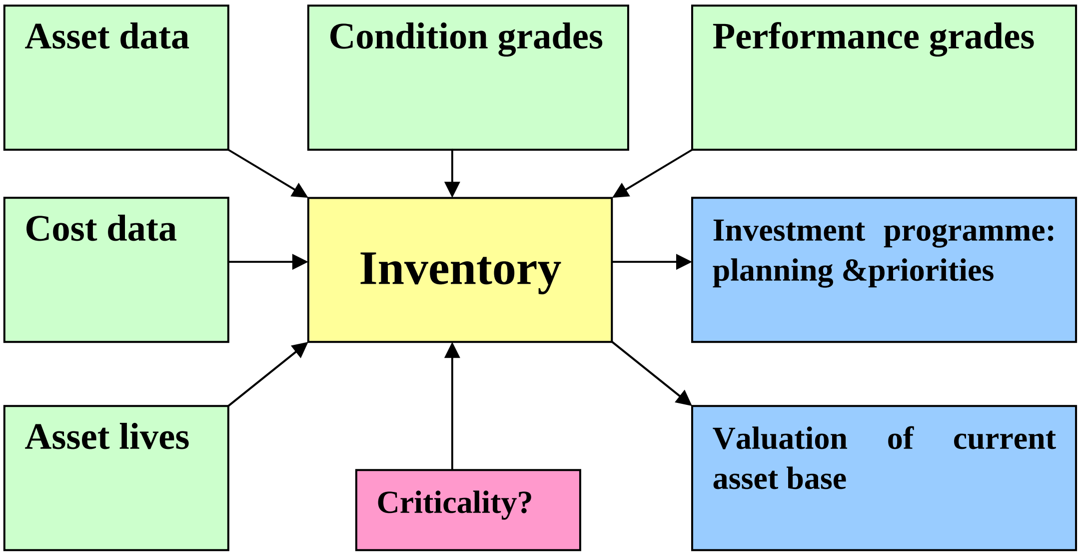

Figure 3- Typical AMP structure

The methodology involves firstly compiling a set of databases and spreadsheets - the inventory of all tangible assets. The most important assets will vary according to the nature of the business of the organization, thus for a water utility they would include dams, boreholes, treatment plants pump stations and pipelines but for a power company it would be generating plants, sub stations and power lines. A rail operator would wish to list lines, stations, goods yards and rolling stock etc.

After setting up a basic inventory the next stage involves assessing the condition of the assets, following this performance is assessed, and thirdly replacement costs are estimated. When these data are complete the condition and performance grades are compared with a look-up table and a percentage remaining asset life (RAL) is assigned. This, multiplied by the replacement cost gives the current asset value (CAV). The condition and performance grades, with the nominal asset life, can then be used to assign priority to the assets for replacement or refurbishment.

The remaining part of this paper is concerned with more detailed advice on setting up an asset management plan based on the author's TRAMP system developed for use by a water utility in the Caribbean [1].

2.1 Inventories

The organisation of the asset inventory is crucial to the success and efficiency of the planning process. Trying to put all of the data for an organisation (large or small) into a single inventory is fraught with difficulties. The data to be stored are so varied that a single table or set of related tables may soon become over complex and littered with empty fields. Whilst the data can be collected into a series of spreadsheets, there are considerable benefits in using a database which allows sorting and filtering to be done much more easily.

Data can be collected at three levels:

- plant or location level (one entry per site)
- process level (typically 10 entries per site)
- unit level (typically 100 entries per site)

Using a water utility as an example, the plant level would consist of a water treatment plant being considered as a single entry. The process level would take each part of the plant which performs a different process separately. At the unit level each pump, screen, channel etc. is included individually. The choice of the level to be used is crucial to data efficiency. The upper level is too crude and the lower level too detailed thus the middle level is normally recommended. Each component process is included in the inventory and separately graded.

As will be seen later in Section 3, it is also necessary to differentiate between structures and mechanical/electrical components as they have very different asset lives and often exhibit very different condition grades.

2.2 Organization

The development of a relational database may be beyond the means of many small organisations. There are therefore two approaches that can be taken:

- build up a single set of related tables in one inventory
- organize the data into separate types so that a series of 'flat file' tables are created

In the initial stages of development the latter option is by far the simplest to adopt and this is recommended. If, at a later stage, a relational database is required then it can be compiled relatively quickly as the problems concerned with the data collection and storage will, by then, have been resolved.

Any organisation will tend to have different types of asset. The typical division of data types, this time using an airport as an example, is given below:

- Land
- Runway
- Taxiways
- Terminals
- Traffic control
- Other buildings
- Fuelling facilities
- Mobile plant
- Miscellaneous e.g. vehicles, furniture, computers etc.
- Safety and security assets

2.3 Data collection

Data collection is a classic 'chicken and egg' conundrum. How do you know what to collect until you've tried? The resolution of this problem involves the development of the methodology first, then the use of test data to debug it. This will give a practical solution quickly but not the final structure; a database should be seen as a living entity and subject to further refinement.

The preferred process is to define an objective methodology and then collect data, at first subjectively and then objectively. In practice data collection tends to be undertaken before the methodology has been defined as this is the easiest thing to do and progress will be apparent even if the whole exercise has to be repeated. The use of a small sample of test data results in a robust system being reached quickly.

The primary entries can be set up from existing tables of assets, where they are available, and the principle exercises of correlation will be based on getting information from previous reports, system maps and from field operators.

Each of the organisation's functional areas will have existing data to be compiled as the basis of the inventory and there will be gaps, duplications and errors. The key to correcting these errors involves firstly cross-checking the data of the master sets against each other. Secondly a system of 'partial publication', to interested parties, is undertaken with selected areas highlighted for them to check. As each stage of data collection is completed the draft table is circulated to field operatives and corrections are requested. During this process most duplications and omissions are quickly picked up and the use of multiple names can be rationalised.

The procedure for compiling an AMP is listed below:

1. collect all existing data on systems and assets
2. structure database tables and headings
3. collect sample condition grade data
4. test database with sample data and design input formats (forms)
5. undertake condition grade assessments (site surveys) and compile database
6. develop levels of service (LoS) standards
7. undertake performance grading with operational staff and enter data
8. input asset lives
9. input cost data
10. design queries and output reports
11. run valuation and prioritization reports

2.4 Data Fields

A database requires that data fields be defined before storage can take place. The simplest guide to the likely field requirements is to look at the existing data sets or examples that have been produced elsewhere. It is simple to spot the recurring data requirements involving references, names, location, size, material, type, etc. These form the basic set up for the data tables and are revised once the initial system is compiled. At this stage the best way to debug the tables is to use a set of test data involving at least ten records.

2.5 Hardware and Software

The issue of hardware is now fairly simple as the preferred solution will always be to use the simplest system capable of doing the job. A single PC with printer is normally quite sufficient.

The wide availability of M/S Windows makes it a suitable platform and both XL and Access may be used in compiling the asset inventory.

There also exists, at this point, an obvious opportunity for a commercial or academic organization to build an on-line system which can be remotely accessed from anywhere in the world. Whilst the major benefit would ensue from providing clients with a ready made system, the greatest advantages could ensue from the parent organisation's ability to use the data for research.

Such a development could also be of great benefit to the funding agencies in being able to collect data in a standardised format.

3. Condition Grading

Condition Grades (CG's) are simply a consideration and recording of the soundness of an asset in terms of wear and tear. 'Condition' describes its structural integrity and safety, and is therefore that which can be seen. CG's do not take into account the performance of the item as performance grades are assigned separately. A sample grading structure is appended.

3.1 Survey

Condition grading is normally best undertaken by a team of two persons - one who is responsible for data collection and one who operates and maintains the assets on a daily basis. This ensures both local input and consistency. Simple forms are used to gather the information.

Condition grades for buried assets (e.g. cables and pipelines) are more difficult to assess initially and the first set of grades may be have to be subjectively applied. These are gradually improved as failure data, and survey information, linked to assets or areas, becomes available.

3.2 Grades

Each asset identified in the inventory must be given a condition grade. In the case of assets which consist of structural and mechanical/electrical (M&E) parts two grades are required. The basic grading system is simple and must be used consistently to aid comparisons with others:

Table 1- Basic grading system

Grade	Description
1	Excellent
2	Good
3	Adequate
4	Poor
5	Awful

Grades of 1 to 5 ranging from excellent (1) to awful (5) are assigned. To get a meaningful profile the grades must reflect the full range of assets. The appendix shows a more detailed description of typical generic condition grades.

4. Performance Grading

Performance grades (PGs) are a measure of how well an asset performs its allotted task and will reflect its reliability; it is not a measure of how new it is. Nor is it a measure against the specification but a grading against the required output **as perceived by the customer**. Assets can be in excellent condition but are not achieving the required output and vice versa. This is particularly true in the case of inappropriate technology (i.e. the wrong tool for the job).

In order to perform this task properly it is necessary, first, to define the 'levels of service' (LoS) that the customers receive or expect to receive. Thus grade 1 (excellent) represents the aspiration of the organization and grade 5 (awful) the lowest level of service that is supplied to a significant population.

A single PG will suffice for each asset/process, there being no need to differentiate between a structure and M&E components.

4.1 Levels of Service

The 'performance' must be assessed or graded against a set of defined criteria or 'levels of service'. These are set in relation to customer perceived performance rather than against abstract design criteria - in simple terms - i.e. does it do the job?

Thus, performance will reflect the loading, configuration and type of unit being employed and not its condition. A LoS scheme for a railway company could include:

- Punctuality
- Availability capacity
- Frequency of service
- Safety in transit

To allow a reasonable spread of occurrences within the grades the performance definitions should take account of the local situation.

4.2 Grades

Grades 1 to 5 are assigned within the same general approach - ranging from excellent (1) to awful (5) - as for condition. Again performance is assessed at the process level though a whole plant may be given a single grade at first and then refined as the information improves. Thus passenger delays at an airport could be graded 4 but on subsequent examination it is determined that the baggage handling system is to blame for the problem and the grade is then assigned to that process to reflect this.

Performance grading is undertaken between asset management staff and the managers responsible for the assets' operation. This ensures that consistency is maintained. An example of LoS for power supply is given below in Table 2:

Table 2- Sample level of service criteria

CS1	Continuous Supply
CS2	Supply for 100 hours per week
CS3	Supply for 50 hours per week
CS4	Supply for 25 hours per week
CS5	Supply less than 25 hours per week

5. Valuation

The valuation process is based on the replacement cost or ‘modern equivalent asset value’ (MEAV). This is reduced to a percentage of its full value according to the condition and performance of the asset to give the current asset value (CAV).

5.1 Asset Lives

The first step in the valuation process is to add the asset lives to the inventory. Typically structures will last 50-60 years and M&E plant about fifteen. A list of asset values, based on those used by the accountants, is developed for use in calculations within the database [2].

5.2 Modern Equivalent Asset Value (MEAV)

The inventory itself will not yet provide the valuation of the assets necessary for business purposes. In order to achieve this it will be necessary to add cost data for each type of asset. The replacement cost is used and it this can be based on size bands for the type of asset. The MEAV represents the cost of replacing the asset with an equivalent one that is capable of performing the required task and is thus based on throughput rather than capacity.

This same cost data can be used both in the valuation and, later in an investment programme as the first estimate for budget purposes. It is also useful in strategy development as the basis for appraisal of options. The values are based on cost curves or matrices as is most appropriate for each type of asset and are updated annually in a stable currency.

5.3 Remaining Asset Life

The remaining asset life (RAL) is calculated as a percentage from a look-up table contained within the database. A typical example is shown below:

Condition Grade

Table 3- % Remaining Asset Life (RAL)

Perf. Grade	**1**	**2**	**3**	**4**	**5**
1	**100**	**75**	**50**	**25**	**10**
2	**85**	**65**	**40**	**20**	**7**
3	**70**	**50**	**30**	**15**	**4**

4	**60**	**40**	**20**	**10**	**2**
5	**50**	**30**	**10**	**5**	**1**

5.4 Current Asset Value (CAV)

Calculating the current asset value is now simply a matter of multiplying the MEAV by the %RAL, e.g:

Say MEAV = $100,   Condition grade 4,   Performance grade 3

Refer to Condition / performance matrix for %RAL

Remaining Asset Life = 15%

Therefore CAV = 100 x 0.15 = $15

The database is configured to provide a report which summarises the replacement and current values thus giving a statement of the organisation's assets in operational terms for comparison with the book values contained in the accounts.

6. Rehabilitation and Renewal

The next step is to use the information gathered in order to be able to give priorities for renewal and refurbishment to all projects. Similar assets may be grouped into action plans for improvement or areas may be chosen for levels of service improvements. These should all be part of documented strategies - but that is another subject.

6.1 Priorities and Investment Program drivers

The prioritization of rehabilitation schemes can be set up, initially using the remaining asset lives:

- Calculate Remaining Asset Life (RAL) in years

  RAL(yrs) = AL(yrs) * %RAL /100

- Produce provisional priority listing based on RAL (in ascending order)

This can be further refined if assets have been assigned a 'criticality index', which represents the importance of the asset within the overall system, however, in most cases, it is valid to assume that the assets with the greatest throughput will be the most critical.

All that remains is to cross check which assets are already contained within projects, action plans or other initiatives:

- Annotate projects with project or strategy names

- Allocate remaining projects to the investment programme or to new action plans as part of overall strategy

7. Planning for the future

Long term planning may now be undertaken using the information from the database and associated strategies. Using the remaining asset lives, crude estimates of renewal rates can be produced as a basis (no more) for predicting annual expenditure on renewal and refurbishment. This, with prioritization of the investment programme, represents the next phase of development.

8. Conclusions

An asset management plan is essential for the long term sustainability of any group of constructed assets.

Whilst there is expensive proprietary software available, a simple system can be set up using a PC and a simple database. The methodology described can be adapted by any organisation or business for its own use.

It is not necessary to specify all of the requirements before commencing work; a gradual development involving the users of the data is preferred. Subjective judgements of grades may be made initially and later replaced with objective data based on measurement and observation.

To be effective, both condition and the performance of assets (based on levels of service) should be recorded.

The generic grades (1=excellent to 5=awful) are fundamental and must not be altered, however, the detailed grade descriptions should be amended to reflect the local environment and levels of service.

Research into the reasons for asset failure would be useful to determine the reasons why asset management is not universally understood and employed. With this understanding the sustainability of the constructed environment may, hopefully, be improved.

The time may now be opportune to create an easy-to-use, on-line asset management system within an academic or commercial organization concerned with the sustainability of the built environment.

9. Appendix

Sample condition grades for mechanical & electrical plant

CG	**Grade**	**Asset Description**
1	Excellent	• in 'as new' condition • electrically safe • requires only routine maintenance
2	Good	• shows only superficial signs of wear and tear, protective coatings still intact, no corrosion • electrically safe • infrequent minor failures
3	Adequate	• all components functioning well • significant signs of wear and tear, minor corrosion • electrically safe • regular minor failures but no major failures
4	Poor	• still functioning but requires substantial maintenance to be kept going • electrically safe but marginal • regular minor failures and occasional major failures
5	Awful	• frequent (monthly) breakdowns, not working or abandoned • electrically unsafe

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Infrastructure Asset Management (IAM): Evolution and Evaluation

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Abstract

Despite its rapid development in the last decade, infrastructure asset management today suffers from an identity crisis as the definition and scope of infrastructure asset management remains a contentious issue. The purpose of this paper is to trace the evolution of infrastructure asset management and evaluate the current practices. In the process, a framework defining the scope of infrastructure asset management is proposed. Notwithstanding the systematic approach that many organisations adopt to manage their infrastructure assets, this paper argues for the need to adopt a more integrated and strategic perspective in the light of the dynamic contemporary operating environment.

Keywords: Infrastructure, asset management, strategic, performance

1. Introduction

Infrastructure asset management (IAM) has emerged as a discipline to provide a more systematic approach to the management of infrastructure assets. The benefits of an improved asset management process envisaged by IPWEA [1] are enhanced customer satisfaction, governance and accountability, risk management, financial efficiency and sustainability. The purpose of this paper is to propose the need for an integrated and strategic approach to infrastructure asset management through examining the current practice of infrastructure asset management in the industry. The paper opens by discussing the development of IAM. The next section evaluates the current practices of IAM and puts forward a framework that encapsulates the scope of IAM. Finally, the paper reviews the current challenges to the management of infrastructure and concludes by arguing for the need of a more integrated and strategic approach to the effective management of infrastructure asset.

2. The development of Infrastructure Asset Management

The concept of IAM is not a new but an evolving idea that has been attracting the attention of many agencies operating and/or owning some kind of infrastructure assets. One of the first comprehensive adoptions of the term “asset management” was during the privatisation of water utilities in Great Britain in the 1980s [2]. In Australia, “asset management” made its way into the public works in 1993 when the Australian Accounting Standard Board issued the Australian Accounting Standard 27 – AAS27. Standard AAS27 required government agencies to capitalise and depreciate assets rather than expense them against earnings. This development has indirectly forced organisation managing infrastructure assets to consider the useful life and cost effectiveness of asset investments. The Australian State Treasuries and the Australian National Audit Office was the first organisation to formalise the concepts and principles of Asset Management in Australia in which they defined asset management as “ a systematic, structured process covering the whole life of an asset” [3]. This initiative led other Government bodies and industry sectors to develop, refine and apply the concept of asset management in the management of their respective infrastructure assets. Hence, it can be argued that the concept of IAM has emerged as a separate and recognised field of management during the late 1990s.

However, IAM is more than a new management buzz word. There are still many questions about what asset management really means today. In comparison to the other disciplines such as construction, facilities, maintenance, economics, finance, to name a few, infrastructure asset management is a relatively new discipline and is clearly a contemporary topic. The primary contributors to the literature in IAM are largely government organisations and industry practitioners [1, 3-8]. These contributions take the form of guidelines and reports on the best practice of asset management. Hence, the literature tends to lack well-grounded theories. To-date, while receiving relatively more interest and attention from empirical researchers [2, 9, 10], the advancement of this field, particularly in terms of the volume of academic and theoretical development is at best moderate. A plausible reason for the lack of advancement is that many researchers and practitioners are still unaware of, or unimpressed by, the contribution of IAM towards the overall performance of the asset. A more compelling argument against the progression of the concept of asset management is the general lack of an integrated framework that defines what IAM. This is expected as the discipline of infrastructure asset management continues to evolve.

Infrastructure investment and maintenance decisions in the past were made in accordance to tradition, intuition, personal experience, resource availability, and political considerations. There was no systematic application of objective analytical techniques in such decisions. To address this deficiency, many asset management systems with inherent investment analysis capabilities have been developed, in practice, and have been used for years. These asset management systems focus on databases, asset inventories, technical models and other analytical tools. Most of these systems are used to monitor conditions through which the organisations then plan and program their projects on a ‘worst off’ basis. Success was often measured in terms of controlling backlogs in the short term, not in optimising system performance or minimising user impacts [10]. In addition, many such asset management approach ignore a systematic wide focus that involves bringing a variety of assets under one single entity [11] [2]. The focus is more on individual assets rather than the long-term asset management needs of an organisation.

Due to the relatively long life-cycle of infrastructure asset, the consideration of a whole life cycle approach is becoming increasingly important in infrastructure investment decisions. This shift has forced the design, procurement and decision-making on infrastructure asset to be based on whole life value [12]. Life cycle cost is the total costs throughout its life including planning, design, acquisition, installation, operation, maintenance, refurbishment, and disposal costs attributable to owning or using the asset [13]. Thus, life cycle approach is becoming central to asset management by taking account of the total cost of an asset throughout its life [6, 7]. This strategic view is important as it takes a long term view of infrastructure performance and cost. Furthermore, IAM is driven by policy goals and objectives based on performance and sustainability. These strategies are analysed in terms of objective assessment of costs, benefits and level of service provided to ensure that the present needs are met without compromising the ability of future generations to meet their needs [7].

3. Current Practice and Scope of Infrastructure Asset Management

The preceding discussion suggests that the management of infrastructure assets has traditionally been approached from a *functional* perspective i.e., to ensure the optimum performance of the asset. However, there is evidence to suggest a broadening of this perspective to include infrastructure asset as an important business *resource* that is capable of contributing to the organisation's goals. In this context, the main goals of infrastructure asset management are to achieve maximum return on assets, optimise total cost of ownership and fulfil safety and environmental requirements. In other words, asset management can and should contribute to the broader corporate goals. Clash & Delaney [14] found that the organisational and business foundations as well as disciplined decision making are far more crucial to achieving the capabilities of effective asset management than that of a full-blown asset management system alone; thus alluding to the extended role of IAM. For asset management to become a true value-adding pursuit within a corporate framework, it must be primarily concerned with filling a strategic role, i.e. asset manager must be proactive not reactive in their approach [15]. They must be able to forecast the needs of their organisations and make forward plans that will support the aims of the organisation in the future.

In the age of competition, especially with more involvement of the private sector in the provision of infrastructure, there is an increased emphasis on the management of valuable assets. In the private sector, a performance-based asset management strategy is needed at the heart of all asset management approaches. Practitioners in private IAM want and need a better understanding of its meaning, impact, and value to their organisations. The goals of IAM must reflect business goals i.e. infrastructure asset must generate revenue and ensure that business needs are met without compromising the competitiveness of the business in future. As a result, innovative ways of managing assets are being practiced. The scope of IAM activities extends from the establishment of an asset management policy and the identification of service level targets which match stakeholder expectations and legal requirements, to the daily operation of facilities required to meet the defined level of service [1].

In this regard, it can be said that infrastructure asset management responsibilities are today numerous and complex. Consequently, many individual asset management processes and practices have evolved, each with its own focus. Due to the diverse guides issued by different organisations, infrastructure asset management as it stands currently can mean different things to different organisations. As a result, different organisations have adopted different aspects and principles of asset management in accordance to what asset management means to them, in practice. To this end, a framework that synthesises the current practice of infrastructure asset management is useful for forging a common platform upon which future discussion on infrastructure asset management can be based.

The scope of infrastructure asset management can be depicted through four quadrants (see Fig.1). The north and south axes represent a strategic vs operational perspective. The operational aspect of asset management involves the practical business of keeping the infrastructure in working conditions. The strategic perspective of infrastructure asset management considers the integration of the user needs, the environment and the business functions of the organisation in the longer term. The east and west axes are anchored on each end by distinguishing asset as a function versus asset as a resource to business. Asset as a function concentrates on what can be done to improve the performance of the asset, i.e., asset optimisation. Asset as a resource on the other hand, considers how asset can best used to enhance business goals.

	Strategic		
	• Strategic planning • Stakeholders relationships • Organisation structures **4**	• Risk Analysis • Asset Strategies • Market Analysis • LCC **2**	
Resource			**Function**
	3 • Return on Asset • Financial, Human • Asset quality • Performance Measure • IT Systems	**1** • Asset Database • Decision system • Condition monitoring • Life prediction	
	Operational		

Figure 1- Infrastructure Asset Management (IAM) Framework

Quadrant 1: Asset as a Function (Operational)

This group of IAM practices concentrate on improving the maintenance of infrastructure asset to prevent failure. They are concerned with providing an asset that is reliable and in optimum condition. The activities include the development of infrastructure asset databases, decision systems, condition monitoring, and life prediction system within an asset management decision support framework.

Quadrant 2: Asset as a Function (Strategic)

The asset management activities in this quadrant aim at improving the performance of infrastructure assets over a longer term. They are concerned with not only the provision of infrastructure assets for operation, but also how the asset can perform and provide value for money over a longer period of time. This includes issues concerning the individual asset procurement and management, overall asset portfolio and the maintenance of an asset strategy. The typical activities include life cycle costing, demand analysis, risk analysis (financial, technical and environmental), etc.

Quadrant 3: Asset as a Business Resource (Operational)

This quadrant considers asset management processes related to achieving organisational productivity and quality enhancements. This includes cost minimisation initiatives, compliance with local environmental goals, asset profitability and quality, internal organisation efficiency (e.g. IT, operations, human resources, finance etc.).

Quadrant 4: Asset as a Business Resource (Strategic)

This quadrant focuses on asset management responsibilities that supports and creates value to all stakeholders. It typically involves the development of an IAM strategy by undertaking market trend analysis, asset demand analysis and stakeholder consultation. Various infrastructure asset options are then weighed and considered for their ability to contribute towards the organisation's business goals.

4. The future of Infrastructure Asset Management

The discussion thus far has illustrated the development of IAM from a narrow functional perspective to a broadening role in enhancing business goals. The expansive scope of IAM was summarised through a proposed IAM model. It is cogent and timely to end this paper by considering the future challenges to IAM.

In recent years, the challenges that most industrialised economies face relates to those of building and managing infrastructure assets. On the one hand, infrastructure is vital for supporting economic growth, meeting basic needs, facilitating mobility and social interaction, on the other, environmental pressures in the form of changing climatic conditions, congestion and so on are likely to increase, turning the spotlight firmly on the inherent tensions between the imperative for further infrastructure development and the quest for sustainability [16].

Accountability has emerged as a requirement for any organisational structure, public or private. Those in charge of economic resources, such as infrastructure must give account of their stewardship, irrespective of whether the transactions and resources in question are those of a government or a private sector entity [17]. Van der Mandele et al [18] suggests that there are four main groups of stakeholders involved in the provision of infrastructure: users, service providers, government, and the general public. Each of this group has conflicting demands from one another. Users are constantly looking for better service level in terms of speed, capacity, security and reliability. Their main objective remains one of identifying the most cost efficient way of securing a high quality service [19]. Service providers are constantly looking at how they can cater to the demand of these users efficiently so as to maximise the return to their shareholders. They will always look at how operation cost can be minimised, and how to increase capacity and reliability of the infrastructure assets. Government is concerned with how to regulate the infrastructure asset so that it can support the economic development and yet is accessible to all population. [20, 21]. Accountability on the use of public fund to build, maintain and regulate the infrastructure assets is also a top priority. The nexus between use of infrastructure assets and the physical environment is the area of concern for the general public. This relates to noise, air pollution and a host of other environmental issues. With so many stakeholders involved, infrastructure asset provision becomes a matter of prioritising these demands, and deciding how these demands can best be met with the least compromise on organisational goals.

The existing literature has also provided other challenges of infrastructure management currently faced in the industry. These challenges are: The need to accommodate continuing growth to support the economic and social developments of the nation [16, 20]; Significant parts of infrastructure are ageing and nearing the end of their economically useful lives [22]; Current funding commitments are either inadequate or yet to be identified, to support the substantial costs of renewal and replacement [22]; Current planning and political processes do not provide the necessary long term focus [22]; Only limited infrastructure information is available in some key areas [22]; The increasing sense of vulnerability of society and its economic structure because of perceived rise of terrorism [16]; The continuing integration of economies and systems, for example through the increase globalisation and trade in goods, services and information [16].

Moreover, globalisation is intensifying economic and other linkages among countries making it increasingly necessary to plan, develop and finance infrastructures across national borders. The key players too change over time, as the roles and responsibilities of the public and private sectors shift and evolve. In this challenging environment, infrastructure owners/providers need to focus on stewardship to meet the expectations for quality including safety characteristics, operational efficiency and durability and accountability as guardian of infrastructure assets. Asset manager must be responsible, accountable, open, consistent and ethical in the management of asset concerning the level of investments in assets, the benefits and costs that arise from the investment and how well the assets are maintained and managed. Asset management decisions need to be based on a proper evaluation of options which take into account all costs and benefits over the life of asset, and incorporate an explicit analysis and determination of an acceptable level of risk [23]. This allows for more transparency in decision making and improves the process and accountability for capital and recurrent works. Hence asset managers must adopt a more holistic, integrated and structured process of maintaining, upgrading, and operating physical assets in a cost effective way [24, 25].

For this to happen, infrastructure asset management should be an interdisciplinary and comprehensive business strategy integrating finance, planning, engineering, construction, personnel, economics and information management. It should include all the dimensions proposed in this paper. In other words, IAM must not be approached only from a functional perspective but to also incorporate infrastructure asset as a important business resources from a more strategic perspective. It is a process for ensuring the requirements of organisations, users and other stakeholders are clearly understood and integrated into an asset management framework that optimises the outcomes achieved from policy and investment decisions [4].

5. Conclusion

The practice of infrastructure asset management has broadened in scope and complexity. Due to the lack of an integrated framework, it has led to an unsatisfactory state of confusion in practice and research. The contentious issue of defining IAM is a stumbling block to the advancement and accumulation of the IAM knowledge base. This paper has reviewed the development of IAM practices and formulated an IAM framework that categorised the practices into 4 quadrants. Most organisations have concentrated their IAM practice in one or two of these quadrants. However, with the increasingly challenging operating environment, such disparate practice of infrastructure asset management may not be sufficient to create maximum value and contribute to business success. Consequently, there is a need to adopt a more integrated approach to IAM through the incorporation of all the dimensions proposed in this paper. Only then, can infrastructure asset management be satisfactorily accountable to the different stakeholders.

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Opinion Study on Garbage Disposal System for Condominiums Using Quality Function Deployment

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Abstract

Management of solid waste has become as a major problem in Sri Lanka due to lack of proper separation, collection and disposal systems and insufficient legal framework. Among the sources of generating solid waste, residential developments are paramount importance. Over the past few years, considerable growth has taken place in the real estate sector particularly in terms of condominium developments due to high growth of population, urbanization and scarcity of lands in urban areas. The amount of waste that is being collected within these entities is higher than the individual residential houses and manner in which it is disposed and collected is different and complicated. Therefore it is important to manage and dispose solid waste in an effective way to reduce the environment burden as well as better hygiene living environment within condominiums.

The main purpose of this research was to review the existing garbage disposal systems, and improving functionality while enhancing the occupants' satisfaction. The survey was conducted by taking 130 occupants in private sector middle income apartments with response rate of 69%. The results revealed that certain drawbacks and inconveniences associated with the existing mode of garbage disposal. Further it was recognized the importance of design and operation guidelines which relates to the garbage disposal.

Key words: Customer Satisfaction**,** Garbage Disposal System, Condominiums, Demanded Quality, Quality Function Deployment

1. Background

1.1 Introduction

Solid waste management has emerged as one of the important areas of urban policy planning and management in all over the world with the population and urban migration. The United Nations conference on the environment and development held in Rio, in 1992, affirmed that environmentally sound waste management is one of the major issues that need to be tackled for maintaining the quality of the earth's environment and to achieve sustainable development. At present, the disposal of solid waste is becoming as severe logistic and cost consuming issue in many countries including Sri Lanka.

Due to high generation of solid waste in past two decades with the industrialization and urbanization, Sri Lanka is experiencing many environmental and health problems that aggravated by absence of proper management system and lack of forward anticipation and planning. And also no actions were taken to cater future demands [1],[2]. Further they have highlighted that the infrastructure and resources for waste collection are lacking in most part of the country, so uncontrolled scattering and dumping of garbage is wide spread.

Over the past few years, considerable growth has taken place in the real estate sector particularly in terms of condominium developments due to high population growth, urbanization and scarcity of lands in urban areas. Disposal of waste from these entities is arguably more complicated [3]. De Alwis [4] points out ,the per capita generation of solid waste has increased an average of 0.75 kg per person per day in 1986 to about 1kg person per day and the expected value in the year 2010 is 1.25 kg per person per day. Since there are hundreds of families have been living Colombo, sources of generating waste in high-rise apartments will become as a critical issue. Present situation is the most government formed condominiums and some of the private ones handled garbage inefficient and ineffective manner. According to Samarajeewa [5], there is a higher level of dissatisfaction with the method of garbage disposal in both public and private sector in Colombo Metropolitan Area (CMA).

1.2 Manipulating and Waste Handling in Condominiums

The domestic solid can be classified as garbage, rubbish/trash, ashes and bulky wastes [6]. Major difference between waste from high-rise buildings and single family units is the manner in which it is disposed and collected. In Hong Kong, conventional and automated refuse collection systems are commonly used in residential developments [7]. Though several modes of waste disposals are incorporated still operating improper systems and standards in place with regard to solid waste in most of the countries. There is no single approach has been accepted as the best method for waste management due to community and waste diversity. Most of solid waste professionals realise that ideal way to minimise the stress on disposal systems is to reduce the amount of waste that is produced. Thus reduction, reuse and recovery before disposal are vital to enhance the above concept. Reduction is using of fewer disposable goods. Reuse is using items again after initial consumption. Recovery is recapturing the material or energy value of the items at its highest point.

Handling, separation, storage and processing are critical steps of solid waste at the source before they are collected. This is applicable to condominiums as well. In high- rise buildings handling methods depend on the storage location and collection method. Basement storage, Outdoor storage/mechanized collection and specially designed vertical chutes are common garbage modes that can be identified in those entities. Both positive and negative impacts exist with the aforementioned systems.

1.3 Legal aspects behind Solid Waste Management

In order to execute and maintain any system in a disciplinary manner, there should be a well structured legal frame work. Under the Apartment Ownership Act (Amendment), no.39 [8], there are no strict provisions pertaining to the solid waste management within the apartment itself. But when applying for the registration of condominium plan, the common amenities should be in the satisfactory level. According to the guidelines provided by city planning division at Colombo Municipal Council, in order to get the building approval, applicant should submit the following documents with the design.

- In house collection methodology
- Waste minimization techniques
- Temporary storage methods
- Waste transfer system to the final transfer location
- Storage methodology

However to evaluate the aforesaid factors there are no certain parameters, procedures or standards than used merely as guidelines. The ‘Waste Management Zonal Concept’ is one of the strategies which was identified by the authority. Under this required rules, by-laws and guidelines have been formulated for waste segregation, collection, cleaning, transportation, and transferring, processing and final disposal of waste. However, theses rules, by-laws and guidelines are not being currently implemented and are only drafted rules for public comments.

Therefore, existing waste disposal methods which are being used in high-rise buildings, governing legal framework behind the solid waste management and its impact to the environment are key areas that need to pay more attention to design proper modes of garbage disposal.

1.4 Research Objective

The developers’ lack of understanding of user requirements and paying too much attention on profit maximization, usually results in a low quality product [9]. While developing the design, more consideration should go on basic amenities and maintenance to optimize the end user requirements. The research paper is planned to do opinion study on effective design and operational guidelines for the solid waste management system in the middle income apartments while satisfying the end user requirements.

2. Research Methodology

2.1 Data Collection

The survey was conducted by taking 130 occupants in private sector middle income apartments in CMA with response rate of 69%. The questionnaire consisted of nine (9) attributes of a garbage disposal system related to the functional and quality aspects, which were included based on the findings of pilot survey and literature. Same attributes were used to assess importance among the designers with response rate of 72%. Further interviews and participatory approached were used to support the questionnaire surveys.

2.2. Data Analysis

Based on a Likert scale of 5 to 1 [where 5= very important; 4=important; 3=somewhat important; 2=less important; 1=not important at all] the average degree of importance given by the respondents was calculated using Formula (1) [10];

$$\text{Degree of Importance} = \frac{\text{Sum of all the scales given by respondents}}{\text{No. of respondents}} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

Similar formula was used to calculate the average level of satisfaction. [where 5=extremely satisfied; 4=satisfied; 3=neutral; 2=dissatisfied; 1=extremely dissatisfied]

The standard deviation was determined to measure the dispersion of the data about the mean. Using the mean values and standard deviations computed from the data, a hypothesis test (t-test) was carried out to identify the factors which were significantly greater than 3. For this test, the null hypothesis was taken as H_0: $\mu \leq 3.00$, and the alternative hypothesis, as H_a: $\mu > 3.00$, where μ was the population mean of the corresponding factor. The t-test was performed at 5% significance level (alpha = 0.05) and the critical t – values for the sample were taken as 1.96 and 1.74 for occupants and designers respectively [11]. The results of the hypothesis test are given in Table 1.

Quality Function Deployment (QFD) methodology was evaluated in this research as a strategy to realize the importance of the customer in order to identify the demanded quality of solid waste management. House of Quality (HOQ) is the heart of the QFD (See Figure 1) and the name is obviously due to its shape [12]. Once the attributes of customers (voice of customers-VOC) matched with technical/design requirements (voice of designers-VOD), the design targets could be determined from the HOQ.

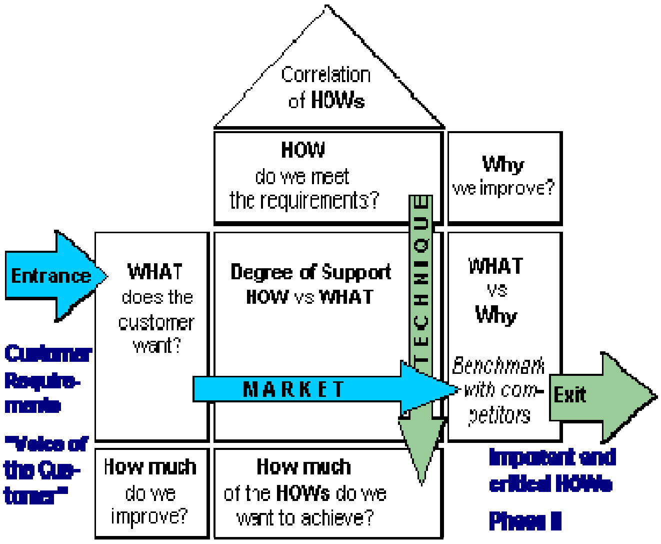

Figure 1: Basics of House of QualitySource: www.noweco.com

3. Results and Discussion

3.1 Degree of Importance and Level of Satisfaction

Basically, from occupants' point of view, satisfaction occurs when outcome meets or exceeds the users' expectations. Dissatisfaction occurs when a negative discrepancy is present between the users' anticipated outcome and the actual outcome. Data presented in Table 1 revealed that all the attributes are identified as critically important by both occupants and designers.

Table 1 – Attributes of garbage disposal system which are significantly not satisfied

Item	Attributes	Satisfaction (Occupants')		Importance (occupants')		Importance (Designers')	
		Mean	t-score	Mean	t-score	Mean	t-score
A	Sufficient space for service area	0.28	-27.80	4.27	16.88	4.61	24.04
B	Convenience of collection points at each floor	2.62	-4.35	4.43	24.34	4.44	18.92
C	Eliminate bad odours	2.41	-6.64	4.76	38.75	4.67	30.00
D	Effective collection and temporary storages at each floor level	0.28	-27.80	4.04	8.97	4.56	20.37
E	Ease of transfer to final storage within premises	1.92	-13.66	4.82	45.22	4.56	20.37
F	Effective final storage method	2.17	-10.16	4.59	29.32	4.61	24.04
G	Regular collecting and transferring solid waste to final storage	0.32	-23.29	4.51	28.68	3.94	12.05
H	Regularly collect by statutory authority	2.87	-1.76	4.62	31.74	3.89	9.49
I	Precautions to deal with accumulated solid waste due to failure of statutory authority	1.89	-11.40	4.62	28.02	4.50	22.05

There is no significance difference between the data derived from the occupants and the designers. However, occupants are highly dissatisfied with all the factors. It was revealed through unstructured interviews, the importance of indoor environment to users. This aspect is further justified by above statistics. Among the attributes given higher importance, C, F, H and I are closely related to the quality of the internal environment.

3.2 Expected Quality Vs Perceived Quality

Simply, the quality gap is determined the mean difference between degree of importance (expectation of service) and level of satisfaction (perception of service performance) of each attribute. The gap measure is managerially useful and provides a direct, clear sign of how to make the proper decision. The reaction of respondents in terms of their satisfaction regarding existing garbage disposal have been presented in Table 2.

Table 2- Attributes with Quality gap between expectation & satisfaction of occupants

Item	Attributes	Mean	Mean	Quality Gap
		Level of Satisfaction	Degree of Importance	
A	Sufficient space for service area	0.28	4.27	3.39
B	Convenience of collection points at each floor	2.62	4.43	1.81
C	Eliminate bad odours	2.41	4.76	2.35
D	Effective collection and temporary storages at each floor level	0.28	4.04	3.76
E	Ease of transfer to final storage within premises	1.92	4.82	2.90
F	Effective final storage method	2.17	4.59	2.42
G	Regular collecting and transferring solid waste to final storage	0.32	4.51	4.19
H	Regularly collect by statutory authority	2.87	4.62	1.75
I	Precautions to deal with accumulated solid waste due to failure of statutory authority	1.89	4.62	2.73

The larger gaps provide the attributes where designer/ developer needs to pay more attention as these indicate their failure to satisfy the attributes that are most important to the customers (occupants). The tabulate data illustrated the significant quality gaps in, regular collecting and transferring solid waste to final storage, effective collection and temporary storages at each floor level and sufficient space for service area. To improve the expected quality of the occupants these areas need to be prioritised. Interviews conducted with designers revealed that developers are not bothered about the quality aspects they are hurrying in completing the design and construction and prime intention is to maximize the profit. And also developers are come up with fixed budget and their goal is to increase the rentable area as much as possible.

However, in order to developers to survive in a competitive environment, it is important that firm should have standard data base that includes factors that influence customers' choice of housing and how people decide what will best satisfy their needs.

3.3 Integrating QFD and Survey results

The House of Quality (HOQ) matrix is the heart of the QFD. Demanded quality elements reflected the highly dissatisfying areas reported by occupants in apartments. Quality elements reflected design guidelines or activities rather than product attributes in this study. The application of HOQ matrix required input from two sources namely, the survey on residential apartments and expert opinion survey among construction specialists, such as architects, engineers and quantity surveyors specially involved in the design of high-rise buildings. Basic steps for development of HOQ matrix are presented in Table 3.

Table 3: Basic steps for development of HOQ matrix

Steps	Brief Description
1st Step	Identify the most important customer group – Occupants of apartment
2nd Step	Determine the customer demand (this is also known as 'demanded quality' and it represents the 'what' room in HOQ, Refer Figure 1)– Through Questioner Survey
3rd Step	Customer importance rating – degree of importance were taken using a scale from 1 to 5.where 5 for 'extremely important' and 1 for 'not important at all'
4th Step	Customer competitive evaluation (Illustrates customer perception observed in market survey)- this was not considered
5th Step	Determine the technical requirements (this is also known as 'quality element' and it represents the 'how' room in HOQ, Refer Figure 1)–Through Expert Opinion Survey
6th Step	Determine the relationship matrix between 'whats' and 'hows' – 1-3-9 scale was used where 9- strong, 3- moderate and 1-week relationship. Through Expert Opinion Survey
7th Step	The Correlation matrix (Inter relationships between technical requirements – 'hows vs hows') – this step was not considered
8th Step	Determine the target values : Absolute Importance (AI) and Relative Importance (RI) AI = ∑ (Degree of Information x Relationship Factor) $\text{RI (\%)} = \frac{\text{Absolute Importance}}{\sum(\text{Absolute Importance})} \times 100$ ***Eg: Effective Ventilation system*** *AI = [(4.76x9) + (4.26x9) + (4.04x9) + (4.59x3)] = 172.87* *RI = 172.87 / 1512.77 x 100 = 11.43 %*

After the relationship has been determined, the scoring was done. This shows target value or relative importance for each quality element. The larger target values have the great impact on the most important customer requirements and cater the great number of customer requirements.

Data presented in Figure 2 picturised the developed HOQ matrix. Based on the results of matrix, "sorting out of garbage", "effective building management", "selection of effective vertical transport mechanism", "effective design layout, well ventilated storage area", "efficiency of collecting by statutory authority and effective air locks/ ventilation system" were found to be most important quality elements in order to meet customer requirements. Therefore it was identified these quality elements have greater influence towards optimizing of quality of existing facility and end user requirements. Apart from above, the other elements like , "effective structural accessibility to disposal truck", "cleaning of garbage rooms after removing" are also have greater impact on satisfying the occupants' requirements.

Quality Element Strong - 9 Medium - 3 Weak - 1 Demanded Quality	Degree of Importance	A						B		
		Effective design layout	Effective air locks/ ventilation system	Well ventilated storage area	Sorting out of Garbage	Selection of effective vertical transport mechanism	Effective structural accessibility to disposal truck	Cleaning of garbage rooms after removing	Efficiency of collection by the statuary authority	Effective building management
Sufficient space for service area	4.27	9								
Convenience of collection points at each floor	4.43	9			3					
Eliminate bad odours	4.76	3	9	9	3	3	3	9	9	3
Effective collection and temporary storages at each floor level	4.04	9	3	3	9	9		9		9
Ease of transfer to final storage within the premises	4.82	1			3	9				
Effective final storage method	4.59	3	3	9	3	3				
Regular collecting and transferring collecting solid waste to final storage	4.51				3	9				9
Regularly collect by statutory authority	4.62				3		3		9	3
Precautions to deal with accumulated solid waste due to failure of statuary authority	4.62		9	9	9				9	9
Absolute Importance	**1089.82**	147.56	110.30	137.83	161.20	148.43	28.13	79.20	126.00	151.17
Relative Importance (%)	**100%**	13.54	10.12	12.65	14.79	13.62	2.58	7.27	11.56	13.87
Total average.	241	122.24						118.79		
	%	50.72						49.28		

Note : **A** : Design Aspects **B** : Operational Aspects

Figure 2: House of Quality Matrix

Further, based on the results obtained from the HOQ matrix, 50.72 % and 49.28% of relative importance are respectively covered the activities that are relevant to design and operational aspects. This shows both phase have same influence towards the successful of the project as a whole. Therefore, the appropriate way of exercising design activities can lead to better and quality product, to address this goal the QFD technique ought to be usable and useful.

4. Conclusion

It may be concluded from the above results that the attributes are considered as significantly important by both designers and occupants though all the attributes are dissatisfied by the occupants. Therefore comparatively higher quality gaps can be identified in all attributes. The difference is significant in the areas are, regular collecting and transferring solid waste to final storage, effective collection and temporary storages at each floor level, sufficient space for service area, ease of transfer to final storage within premises and precautions to deal with accumulated solid waste due to failure of statutory authority. Lack of recognition for user needs, absence of voice of the customer during the design phase, limited budget, greater profit margin and scarcity of lands on highly demanded areas can be identified as indirect reasons for this.

The areas having comparatively higher quality gaps are need to be given more priority when designing a garbage disposal system for high-rise buildings. And also in order to execute and maintain any system in a disciplinary manner there should be a well structured legal framework. Finally, the identified design and operational guidelines would be useful for both designers and developers in their future developments.

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SECTION X

POST DISASTER RECONSTRUCTION

The Tragedy of Errors: Lessons for Local Government Reform in Pakistan's Earthquake Reconstruction Programme

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Abstract

This paper reviews the rural housing reconstruction implemented by the government of Pakistan in the aftermath of the devastating earthquake that struck northern Pakistan on October 8, 2005. This government reconstruction programme, in the form of cash grants distributed in several tranches conditional upon the meeting of earthquake-resistant construction parameters, makes for an interesting case study on post-disaster reconstruction policy formation and implementation. Further, lessons learnt from the successes and failures of this programme may inform effective development and service delivery in developing economies of the region, such as Pakistan.

Keywords: Reconstruction, earthquake, local government, law, cash grants, grievances

1. Background

On October 8, 2005, an earthquake measuring 7.6 on the Richter scale hit the North West Frontier Province of Pakistan and the state of Azad Jammu and Kashmir, causing more than 70,000 deaths, incalculable injuries and wide-scale destruction of private houses and public infrastructure. Immediately after the earthquake, the government and non-governmental organizations (NGO) focused on relief to help victims survive the impending winter. As part of its relief scheme, the Government of Pakistan (GOP) provided a financial assistance grant to those who had suffered a death within their family, those injured in the earthquake and those who had suffered damage to their homes. Whereas the death and injury 'compensation' were a one-time payment, the housing grant was envisaged as the first tranche of a broader long-term private housing reconstruction scheme designed to help victims reconstruct earthquake-resistant homes. The financial assistance grant, including the first tranche of housing assistance, was initially administered by the Federal Relief Commission, a newly-created federal agency tasked with coordinating relief efforts undertaken by the Army, NGOs, international agencies and citizen volunteers. However, the task of designing and implementing the private housing reconstruction programme fell to another new centralized federal-level agency called the Earthquake Rehabilitation and Reconstruction Authority (ERRA).

Given its goals, the private housing reconstruction program can be viewed as a revolutionary government-sponsored service delivery and development program, *albeit* in this specific post-disaster environment. In the context of the Musharraf government's 2001 local government reforms and their heavy focus on local development and service delivery, the housing reconstruction performance offers interesting lessons for the reform of local governance in Pakistan. This case study is especially instructive because the historical causes of lag in development and service delivery failure – manipulation by the central government, absence of the political will, inadequate resources and lack of trained personnel, and apathy, indifference or a lack of demand by the citizens – are absent in this case.[1] In fact, not only has Pakistan received substantial international aid and technical assistance for reconstruction activities, there is also immense international and domestic political pressure to achieve the ends of the reconstruction plan. In that context, this paper evaluates the performance of the rural housing reconstruction process and identifies policy and administrative failures to highlight requirements for effective development and service delivery in Pakistan.

This paper will review the housing reconstruction process in some detail. It will also evaluate the policy and administrative failures in the implementation of the reconstruction plan and suggest avenues for the reform of local governance in Pakistan.

2. The Earthquake Reconstruction and Rehabilitation Program

The October 2005 devastated parts of the North West Frontier Province (NWFP) of Pakistan and the Pakistan-administered state of Azad Jammu and Kashmir (AJK). The district governments in NWFP are organized on the post-devolution model while AJK continues to retain the pre-devolution administrative structure.

One of the GOP's first priorities following the earthquake was to provide victims with temporary shelter to survive the impending winter. The central government created the Federal Relief Commission (FRC) to coordinate relief efforts and implement a 'National Action Plan.' Having struggled with its efforts to first distribute tents and later corrugated iron sheets, the government decided to facilitate the relief and rehabilitation process through a financial assistance scheme.[2] Initially, the government quickly distributed a cash grant to those whose houses had been damaged through the Federal Relief Commission (FRC). Once the relief phase was over, the Government of Pakistan began devising an ambitious plan to ensure the reconstruction of earthquake proof private housing and public infrastructure. Instead of leaving longer-term reconstruction to local or provincial/state governments, the GOP assigned the newly-created Earthquake Reconstruction and Rehabilitation Authority (ERRA) the task of designing and overseeing the process from the federal level. The rationale for centralization of reconstruction policy-making was stated to be the achievement of uniformity across the entire earthquake-affected area. This centralization also appears to reflect a belief on the part of the central government that the local and provincial governments lacked the capacity to design and implement such a program. Lastly, the donor organizations, most notably the World Bank, also demanded a significant supervisory role for themselves which could only be accommodated readily at the federal level. In addition to this centralization of policy-making, a range of new institutions and offices were created under ERRA to supervise the process at various tiers. Existing local government institutions, as well as the army, INGOs, national NGOs, and international institutions were involved in various aspects of the reconstruction program. We shall evaluate the institutional arrangement and implementation of reconstruction and derive lessons from it.

2.1 Phase I of the Housing Reconstruction Plan

In the first phase of the housing assistance program, FRC offered Rupees 25,000 (approximately USD $420) to anyone whose home had been damaged by the earthquake. Although this payment was envisaged as the first instalment of a multi-tier financial assistance program, there were no reconstruction-related conditions attached to this tranche, which actually served as a relief grant for most people. Neither were there any ownership requirements to determine eligibility for the grant; as a result, urban tenants, rural sharecroppers, illegal occupiers of government property, and landowners alike were held eligible for the grant. Indeed, the only restriction on disbursement of this tranche was the disbursement of one grant per roof, no matter how many families were residing under that roof. However, many families in these areas, particularly in AJK, occupy adjacent structures that serve as separate housing units but that are covered by one roof. Failure to recognize this living arrangement resulted in a policy that forced the government to choose one of several nuclear families living under one roof to receive the assistance funds, leading to resentment and bitterness.

Eligibility was determined by three member teams in AJK and NWFP, comprising of civil servants (mostly from the revenue department), army and local political representatives, who conducted surveys to verify damage. However, the process was cursory and the teams did not record the state of damage or other detailed information. Due in some measure to the scale of the disaster, the harshness of terrain, destruction of roads and transportation infrastructure and the urgency in completing this process, no effort was made to develop and announce a schedule for the inspections conducted by the assessment teams. This resulted, in a twofold problem. Many people, who had temporarily relocated out of the affected areas, had moved to relief camps or were away for work or some other reason, missed out on receiving the first tranche.[3] On the other hand, many sat waiting in their villages and towns for the assessment teams to appear, and became heavily dependent on relief goods. The failure to inform the public about the inspection schedules was telling of the inadequacy of the information management and distribution capacities of local, provincial/state and federal governments.

2.2 Phase II of the Housing Reconstruction Plan

Starting in January 2005, ERRA sprang into action and started formulating its housing reconstruction policy at the central level through input from donor agencies, international

NGOs, and consultants. On April 7, 2005, ERRA unveiled an elaborate cash assistance program for private housing reconstruction. The policy identified three categories of housing assistance recipients. Owners of completely destroyed houses (Category A) qualified for a total package of Rupees 175,000 (approximately USD $ 2,920), including the first tranche. Per this policy, an additional three tranches of Rupees 75,000 (approximately USD $ 1,250), 50,000 (approximately USD $ 830) and 25,000 (approximately USD $ 420) would be disbursed and qualification for each subsequent instalment would be subject to fulfilment of reconstruction conditions. The second tranche of Rupees 75,000 was primarily to enable people to clear the debris and build foundations according to approved earthquake-resistant design parameters. The third tranche of Rupees 50,000 was meant to be used on reconstructing walls according to the specified designs. A final tranche of Rupees 25,000 would be disbursed to construct a roof. This payment schedule was created in order to incentivize recipients to adhere to the designs for earthquake resistant housing and to facilitate inspections to ensure compliance. Ideally, this entire process was meant to be completed prior to November, 2006 so that victims did not have to spend another harsh winter without adequate shelter or in camps. The second category of housing assistance (Category B) recipients included those whose houses were damaged but reparable. These individuals were entitled only to a second and final tranche of Rs. 50,000 (approximately USD $ 830), for a total package of Rs. 75,000 (approximately USD $ 2,920) including the first tranche already disbursed. Finally, those who suffered minor damage (Category C) would not to receive any further assistance.

To accomplish its goal of distributing earthquake-resistant designs and training artisans and homeowners to construct in accordance with them, ERRA created a vertical structure. In recognition of the army's limited social mobilization capacity as indicated during the administration of the relief phase and the long-term nature of the process, ERRA sought willing local and international NGOs as partner organizations (POs) to help in this endeavour. However, since there weren't sufficient NGOs to cover the entire area, army personnel, particularly from the corps of engineers, were also recruited for this task. PO mobile teams, consisting of technical staff and social mobilizers, were tasked with distributing designs and informing and training locals. To train the mobile teams, ERRA created six Housing reconstruction Centers (HRCs) in NWFP and five in AJK, each headed by a Housing Reconstruction Coordinator. Although the HRCs are managed by an international NGO or UN agency, all HRCs within a particular district report to a district-level representative of ERRA called the District Housing Coordinator. The office of the District Housing Coordinator is situated in the District Reconstruction Unit (DRU) which oversees private housing and public infrastructure reconstruction. Another body, the District Reconstruction Advisory Committee (DRAC) has been set up, consisting of the District *Nazim* (in NWFP) or AJK government representative in (AJK), the DC (AJK) or the DCO (NWFP), Army representative, the District Housing Coordinator responsible for housing reconstruction and DRU Program Manager responsible for public infrastructure reconstruction to coordinate between the various civil, military and civil society organizations working at the district level. DRU in turn reports to the State Earthquake Rehabilitation and Reconstruction Authority (SERRA) in the state of AJK and the Provincial Earthquake Reconstruction and Rehabilitation Authority (PERRA) in NWFP.

SERRA and PERRA coordinate between the central office at ERRA, the DRUs, and the provincial and state governments in NWFP and AJK.

The following diagram shows the relationship between various institutions created or seconded by ERRA to undertake different aspects of the housing reconstruction process. As the figure indicates, this unduly complex multi-tier arrangement includes institutions with divergent command and reporting mechanisms, making coordination between them virtually impossible.

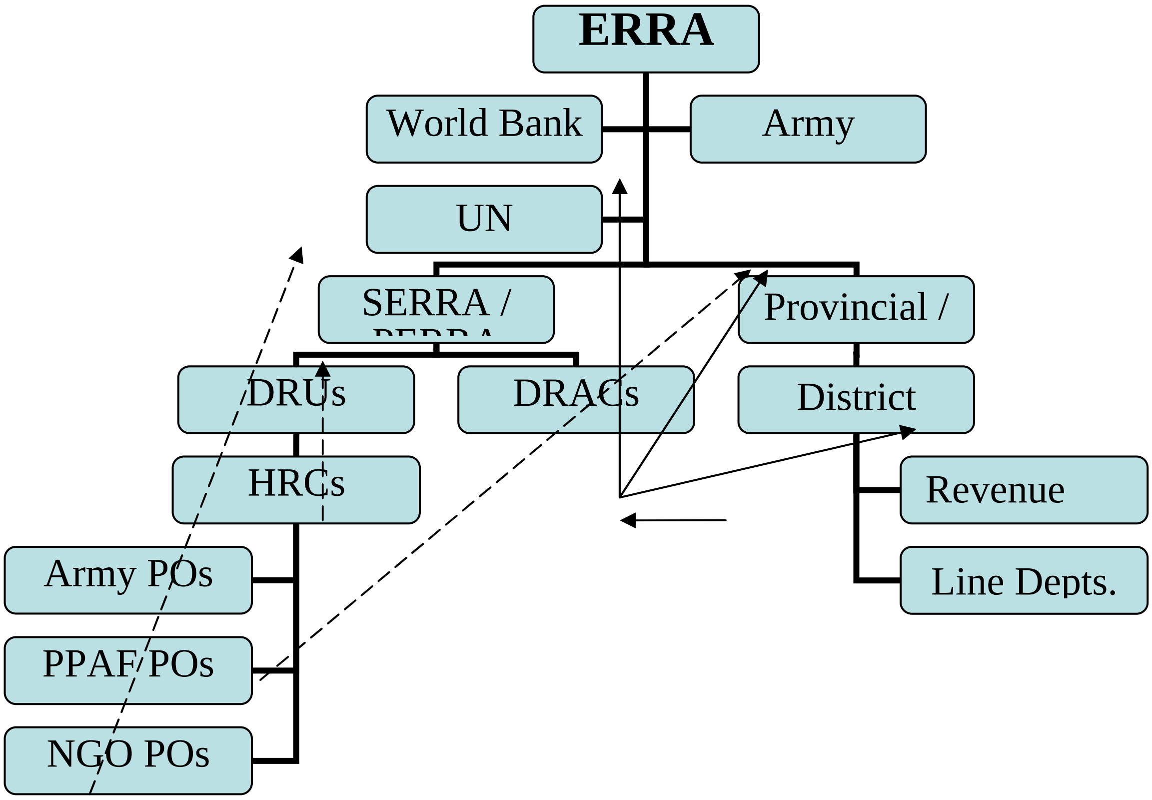

Figure 1- the relationship between various institutions created or seconded by ERRA to undertake different aspects of the housing reconstruction process

Given the time needed to establish this structure, ERRA began administering eligibility surveys for the second tranche even before the structure was completely set up. Eligibility determinations for this instalment were done by Assistance and Inspection (AI) teams in some areas and POs, particularly NGOs associated with the Pakistan Poverty Alleviation Fund (PPAF), in others. Per ERRA policy, the second tranche, in contrast to the first, was available only to legal owners of the property on which the damage or destroyed house stood. The rationale behind this policy was that while the first tranche was intended to provide people with a means to secure temporary shelter, the second payment is intended for reconstruction by the legal owner of the destroyed property. In theory, this is a reasonable policy. However, given local realities in many of the earthquake-affected areas, particularly in the NWFP where a significant percentage of the population live as tenants and sharecroppers, the legal ownership requirement was at odds with the purpose of enabling victims to rebuild their homes since it would leave so many sharecroppers without financial assistance.[4] Further, this created the possibility of hostility between landlords and sharecroppers resulting in widespread social unrest in some areas.

2.3 Grievances with the First and Second Tranches

Although the majority of victims appear to have received the first tranche, many rightful claimants did not receive assistance as pointed out earlier. While some have claimed corruption, political victimization or incorrect application of the policy (ie. asked for ownership status or NIC), most complainants missed out simply because they were away from their homes at the time of the survey.

Given the volume of complaints (estimated at more than 82,000 by June) and the lack of capacity to verify these complaints, neither ERRA nor the district administration took any effective action to address them. Further, there was an overwhelming sense that the majority (90 to 95 percent) of these grievances were not genuine. In fact, it was hoped that the second tranche survey would automatically resolve any genuine complaints arising from the first tranche. However, an analysis of the second tranche survey methodology suggests that this is unlikely to be the case. There are likely to be quite a few people in this category since once again inspection schedules were not announced.

In addition, the second survey itself has created a number of grievances. First, some have claimed that the AI teams or POs have classified them in a lower category of damage. Thus, individuals who believe they should be in category A or B might complain that they have been placed in B or C respectively. This is especially applicable to those who have cleared the debris or repaired their homes and thus cannot prove the level of damage they had suffered. A particularly explosive grievance, primarily in the NWFP, has been the second survey’s requirement for legal ownership. Since this requirement excluded several tenants and sharecroppers in NWFP’s overwhelmingly agrarian economy, it has created a great deal of resentment. Although ERRA has declared that any sharecropper that can provide a No Objection Certificate (NOC) from his landlord will receive compensation, the policy has created a number of problems and has been discussed in detail below. For now, it is sufficient to note that this policy has excluded a number of recipients who have missed out on the second instalment because they cannot establish ownership and has generated a new kind of grievance.

3. Other Issues with the Reconstruction Process: Designs, Timing, Inspections and Subsequent Tranches

3.1 Design Issues

In addition to grievances with the administration of the first and second tranches, there appear to be a number of problems with the remainder of the housing reconstruction policy. First, there have been several problems with preparing and distributing earthquake-resistant designs. ERRA took a lot of time in finalizing the designs, and the design parameters were changed on more than one occasion. The delay may be attributed partly to lack of capacity within ERRA to undertake the task itself as a result of which it had to involve other agencies such as NESPAK, ANCETT, etc. and had to reconcile the differences of opinions between these agencies' experts. As explained above, PO mobile teams were supposed to distribute the designs and educate people about meeting the parameters. However, delays in finalizing MoUs between ERRA and POs further hampered the process. Other means of distributing designs through mail, newspapers, or radio programs were not initially employed. While some of these avenues were employed later, inexcusable delay had already occurred. A lot of people began receiving cheques for the second tranche by mid July of 2006 but had neither received designs nor training. With no construction possible during the heavy Monsoon rains, the reconstruction of homes was barely begun prior to the onset of winter in November 2006. Further, in an effort to rebuild their houses prior to winter, many refused to wait for designs, which is a major failure of this program. This will result in either the construction of non-earthquake-resistant housing or changes will have to be made in order to receive further compensation causing hardships and additional expenses.

The content of the designs have also proved problematic. The designs contemplate a small steel concrete rural house consisting of two rooms and a kitchen. Locals oppose these designs for several reasons. First, steel and concrete are more expensive than mud, mortar, wood and other locally available materials. While the housing payments were never intended to cover the cost of an entire home, the money is proving even less useful given the expensive specified materials. Second, the transportation of these materials to remote areas, particularly where there are no metalled roads, is both costly and problematic.

3.2 Pre-Earthquake Landlessness

An issue that has arisen in some parts of NWFP is the landlord-sharecropper issue. As mentioned above, only legal owners were allowed to receive the second tranche of housing compensation. Following complaints by sharecroppers in the NWFP, ERRA announced that a sharecropper could receive the second tranche if he submitted a No Objection Certificate (NOC) from his landlord. The policy also prohibits landlords from evicting the sharecroppers for three years. In return, the sharecropper is obliged to spend the entire amount on reconstructing the house. Understandably, the legal ownership requirement was problematic for sharecroppers who constitute up to 20% of the potential claimants in some areas.[5] A landlord's refusal to sign an NOC may amount to de facto eviction if the sharecropper does not have other resources to build a new home. If the sharecropper makes a home without reconstruction assistance, it will likely not be earthquake proof leading to a failure of the reconstruction policy.

3.3 Post-Earthquake Landlessness

The earthquake has caused landslides in many areas, with the result that people in these high risk areas have been rendered landless. Therefore, even if these people are held eligible for cash assistance, they have no land to reconstruct on. Those affected have been residing in official or makeshift camp sites. The relief camps have caused numerous problems and social tensions related to lack of privacy (*purdah)*, sanitary facilities, insecurity and violence against women.

3.4 Delays in Urban Planning

While much of the earthquake destruction took place in the rural areas, two urban areas, Muzaffarabad in AJK and Balakot in NWFP, were severely affected. Since both towns are on a fault-line, there were discussions regarding whether these areas would be entirely relocated. While it has been decided that Balakot will be moved to a new site, Muzaffarabad is being re-planned but will remain at its original site. Unfortunately, however, both processes have been subject to much delay. Although the decision to relocate Balakot has been taken at higher levels, no formal policy has reached the locals. Consequently, people have started building on their other locations, which is sure to complicate any relocation plan ERRA eventually devises. In contrast, Muzaffarabad has a rehabilitation plan was created by JICA and ERRA. Given the complexity of relocating a city the size of Muzaffarabad, it was decided to keep Muzaffarabad at its original location to minimize conflicts and problems. The survey for the 2^{nd} tranche only began in urban areas in August 2006. Many people have complained at the delay and point out that the funds are not enough to construct a house in urban areas.

3.5 Ownership Disputes

ERRA's decision to predicate disbursement of the second tranche on proof of legal ownership has also subjected victims to several problems. Many legal owners died during the earthquake and their families did not immediately focus on changing ownership records and finalizing inheritance matters. When talks of the second tranche surveys began, ERRA announced that only legal owners would receive the second instalment. However, this information was not circulated to the earthquake victims in a widespread manner. As a result, many legal heirs did not have the appropriate documentation proving ownership when AI teams came to survey their homes for the second tranche and in fact only learned of the requirement during the assessments. The legal ownership requirement is having a number of repercussions for the financial assistance scheme. First, failure to inform people about the requirement has led to several victims missing out on the payment. Moreover, given the state of public infrastructure and revenue records, the decision to announce a policy based on finalization of ownership records has been difficult for both earthquake victims as well as an overburdened revenue office. As word spread, many people tried to finalize their records. Many, however, were unable to and those who missed out will likely take this issue to court. Indeed, this policy has significantly impeded the progress of the second phase of the financial assistance scheme and will contribute to the delay in reconstruction prior to this winter.

A study of property-related suits filed after the earthquake conducted by the authors may alert one to multifarious property disputes that may have arisen in the aftermath of the earthquake. A number of cases filed after the earthquake involve direct challenges to the denial of housing assistance or death compensation. Other cases hinge on other issues but betray access to housing assistance or death compensation as a primary motivation for litigation. Some cases involve challenges to the ownership rights of possessors. A few of the disputes relate to the urgent need to divide joint property (*mushtarka khata*). Since there has been a tendency not to formalize mutations of property for years, sometimes over generations, as a result the property becomes the joint property of all the heirs. After the earthquake, as many people are seeking alternate plots to build new homes, the division of joint property appears to have become a serious issue. Further, there are clear indications that disputes over boundary, water rights and passage rights are likely to increase due to the change in terrain, diversion or extinction of water resources and need for alternate land for reconstruction.

These findings have grave implications for the court systems in earthquake affected areas and access to justice. The courts in AJK are much better placed to deal with an increased case load due to recent reforms introduced by the Chief Justice of the AJK High Court. Further, since the revenue system has not been devolved, the district administrations possess the powers to dispose of such cases administratively. Nonetheless, the infrastructure and records of the civil court system and revenue administration have been badly affected and one may anticipate that any increase in the case loads will lead to delays and hardships. In NWFP, the backlog of cases in civil and revenue courts is much higher and even a small increase in caseload is likely to inundate the judicial system.

3.6 Vulnerable Groups

Vulnerable groups, including widows, orphans, and the disabled, have suffered disproportionately from many of the glitches associated with the financial assistance scheme. The lack of information regarding processes and procedures, the need to stand in line to receive cheques, open bank accounts, and register grievances, for example, has been especially difficult. Women, in particular, have suffered a great deal: given the social restrictions they face, travelling, standing in lines, having to go to male-dominated office environments, and their general lack of awareness about how government offices operate have resulted in many problems. Consequently, it may be expected that when faced with abuse, either from relatives or strangers, such as in cases of usurpation of their compensation, inheritance rights or property rights, they are likely to find it much harder to gain access to justice.

4. Analysis of the Causes of Policy and Administrative Failures

The above discussion of the problems afflicting the compensation process indicates that the rural housing reconstruction plan suffered from a number of policy and administrative failures. Many of these policy issues appear to be rooted in ERRA's failure to anticipate problems and appreciate local variations. The absence of local input resulted in a lack of ownership in the reconstruction process on the part of local government institutions and political representatives. The process suffered further from a failure to provide information regarding policies and their rationales. Other administrative failures stem from some of the structural problems that have plagued the reconstruction process. An analysis of these problems and their causes can offer important lessons for local government reform to achieve effective service delivery and development in Pakistan.

4.1 Centralization of Policymaking

As is evident from the above discussion, several of the housing reconstruction policies suffered from a failure to take into account local considerations. The process seems to have faltered on two levels. First, the policymaking was done at the federal level, mostly by ERRA, with very little input from local government and elected representatives. There was a deliberate attempt at achieving uniformity across the earthquake affected areas without realizing that one size may not necessarily fit all. This centralization was also premised on the belief that leaving the matter in the hands of provincial, state or district government institutions would lead to politicization, corruption, and maladministration of the program. Second, as and when the problems arose, ERRA took unnecessarily long to recognize the problems and identify solutions due to its faulty institutional structure plagued by mismanagement of information and ill-defined chain of command and control.

4.2 Absence of Institutional Memory and Feedback

The decision to create a new structure to administer the earthquake reconstruction process has brought with it a variety of problems. At the outset, the process has been challenging since ERRA has obviously not been involved in any such programs before and therefore has no institutional memory or experience to contribute to the current process. More significantly, the composition of ERRA leaves much to be desired in this regard. Despite the demands to appoint civil officers from the bureaucracy with significant local and provincial/state government experience that emanated from certain quarters in the early days of the relief and rehabilitation phases the military government chose to appoint serving army officers at the helm of FRC and ERRA central offices as well as ERRA field offices. Army officers typically have very limited understanding of the structure, rules of procedure and institutional ethos of civil institutions and scarce knowledge of local socio-political milieu that local government officials may be expected to possess. Other staff members of ERRA's central office, including those with non-military backgrounds, also appear to lack both disaster management experience and special knowledge of the local environments. Other institutions which were involved in the design of the reconstruction policy, namely the World Bank, UN and other international agencies, also lacked the ability to anticipate local issues and ramifications of the policy decisions framed in Islamabad. The views of district administrations, local politicians and the provincial/state governments were ignored to the notable ire of these institutional players. At a later stage, there was hope that ERRA would become more informed of the particular problems associated with the implementation of its policy choices. However, it appears that the communication has been one-way with ERRA issuing orders and expecting only good news in return. The communication failure may be attributed to the weak chain of command between ERRA institutions and the failure to clearly define their roles.

4.3 Delay in Establishing the Administrative Structures

The creation of ERRA and its subordinate institutions in the form of SERRA, PERRA, DRUs, HRCs, and others led to a need to create and staff a new organization and train new personnel. As a result, although ERRA was created in late October 2005, discussions related to housing reconstruction policies did not begin until January 2006, largely because ERRA was still establishing itself. Even after ERRA became functional at the central level, it took a long time to establish the vertical structure in the districts and below. In addition to delays in formalizing and creating ERRA’s structure, it took a great deal of time to provide resources to key personnel to do their jobs. Confusion in terms of roles and responsibilities has also hindered the process.

4.4 Weak Chain of Command

ERRA’s relationship with the district administration has been further complicated by the general dynamic between local governments and ERRA. Since ERRA has been created, there has been a distinct sense in the local governments that existing institutions were bypassed and resentment arose regarding the need to assign such a grave local matter to a centralized, parallel structure. The process of creating and staffing ERRA, training its personnel, and providing it with resources has raised questions about why the capacity of the existing local government institutions was not strengthened instead. District officials maintain that while ERRA will likely overstay its three-year limit, it will not be a permanent institution. Therefore, the expenditure on strengthening this temporary structure will dissipate vital resources in the long-run; resources which could instead have bolstered local government capacity and geared them towards an effective service delivery and development outlook. This criticism raises the obvious question about whether district administrations, particularly the devolved governments seemingly geared toward service delivery and development in the NWFP, would have been able to efficiently implement the reconstruction process. Judging from research trips watching the district administration handle the tasks assigned to it, there is an overwhelming sense that the district administrations would not have been able to handle the process on their own. District governments in both the NWFP and AJK suffered from a lack of capacity, technology, organization, and competent personnel even before the earthquake and these gaps were significantly widened due to the losses suffered in the earthquake. However, an approach that integrated the district administration in a way that would utilize their strengths and given them some responsibility and ownership would have gone a long way toward dispelling some of the current resentment that is being expressed.

The criticism that ERRA bypassed existing institutions is not confined to its approach toward the district administration. There were several institutions that ERRA could have used to facilitate the process: using the post office to mail cheques rather than requiring people to travel to central locations and wait in line; disbursing cash instead of cheques through the district government (as was initially done in AJK); printing lists of those held eligible in gazettes and distributing designs through post offices, banks or even local mosques; and publicizing information over the electronic and print media.

4.5 Information Management Failures

At a minimum, even if local input would not have made a difference on certain issues, ERRA's failure to publicize its policies, articulate the rationale behind them, and outline detailed procedures have left many people feeling victimized. For example, the majority of grievances in the first as well as second tranche resulted from a failure to publicize the schedule of inspection visits. Even people directly involved in the reconstruction process did not appear to have complete and up to date knowledge of various ERRA policies, especially since some of the policies kept changing, what to say of ordinary people. Most notably, the delay in finalizing and distributing designs is inexcusable, especially since easily available means were ignored. As a result, the general public remained generally ignorant of ERRA policies, the nature and roles assigned to various ERRA institutions and officials. The failure to consult and/or inform the public has led to the feeling that ERRA is insensitive or unconcerned about local problems.

5. Conclusions

The design of and the problems that have plagued the implementation of the housing reconstruction program of ERRA can teach us a lot about how to reform local government institutions in order to enable them to efficiently undertake service delivery and development functions. Many of the issues identified in this paper relate back to the debate over the efficacy of the devolution plan and the reform of local government in Pakistan. That the GOP did not entrust the reconstruction program wholesale to the local government may be attributed partly to the disorientation and capacity gaps caused by the earthquake in local government institutions. Nonetheless, the fact that when the local government was co-opted for aspects of the program even these were not fully entrusted to it, indicates the central government's lack of confidence in the competence and integrity of these institutions. For example, composition of the survey teams for both tranches was designed by ERRA in order to minimize politicization and corruption. Further, the scheme to involve POs for distributing design information and to undertake social mobilization, rather than the various local government departments, indicates an assessment on the part of ERRA and the central government that local government lacked the capacity for social mobilization and awareness creation. This is a stark admission of the continuing communication gap between local government institutions and the general public.

The analysis of the reconstruction program also indicates that it is important that policy-making should be done at, or at least informed by local level considerations. This can only be achieved if there is genuine public participation in policy-making. This shall be achieved not by nominally including politically elected representatives into the fray, but rather through giving elected local governments real voice and decision-making powers. In addition, there should be political accountability to the public in order to ensure that elected LG officials are swayed by local requirements rather than extraneous considerations. Therefore, it is not enough to make bureaucrats nominally responsible to elected officials; rather elected officials should be responsible for, and held responsible by the public for, the performance of local government. Finally, there should be means through which those especially aggrieved by LG decisions should be able to seek redress and hold LG officials legally accountable. Existing means, such as petition for judicial review (writ jurisdiction of High Courts) are not proving to be effective in establishing legal accountability of elected officials or bureaucrats. An effective system of administrative law at the local level is a pressing necessity.

The design of the housing reconstruction program and its failings has highlighted the acute need for developing additional capacity at the LG level. This capacity includes an appropriate administrative structure, the necessary infrastructure, adequate financial resources, and the development of social mobilization and information management capacities. Until this is done, and LG is provided the necessary tools to perform the tasks, it is unreasonable to expect any far reaching results.

References

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An exploration of current planning, design and building issues in post-disaster housing reconstruction

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Abstract

A number of housing projects funded by charities and NGO's in response to disasters, in developing countries are deemed to be inappropriate due to poor project management and limited resources which may comprise one or more of the following: limited knowledge of local climatic conditions; local materials; and the way people live and work within their communities; and often simply lack of experience. Habitually it is believed that there is neither the time nor resources to undertake detailed analysis to ensure what is being constructed is 'fit for purpose'. Large amounts of funding, often from charitable giving, are used to plan, design and build housing projects, projects unlikely to be sustainable due to ineffective and inefficient use of resources. Hasty decisions made without appropriate local consultation inevitably create inappropriate and unwanted results, such as housing which cannot be used by local communities; and housing that does not even meet local standards for safe building. The introduction of structured decision making to allow for the audit of the cognitive processes adopted, alongside access to appropriate tools and techniques to engender the adoption of local knowledge, will reduce the risk of unsustainable building projects. Research is currently being undertaken to capture tacit, implicit and explicit knowledge and map the project management practices of leading aid agencies (NGOs and charities working in disaster relief) to understand decision making practices that result in best practice amongst these organisations. This information will subsequently be used to develop best practice guidance to be disseminated widely amongst organisations providing housing during reconstruction following both man-made and natural disasters.

Keywords: disaster relief, decision making, housing, knowledge management, sustainability

1. Background

Housing recovery passes through four stages in the aftermath of a disaster: emergency shelter; temporary shelter; temporary housing; and permanent housing [1]; consequently reconstruction of housing stock after a disaster is not the same as providing shelter immediately following an event [2]. A number of what are intended to be permanent housing projects funded by charities and NGO's in response to disaster events are deemed to be inappropriate [3] [4] [5] due to poor project management and limited resources which may comprise one or more of the following: limited knowledge of local climatic conditions; local materials; and the way people live and work within their communities; and often simply lack of experience. Habitually it is believed that there is neither the time nor resources to undertake detailed analysis to ensure what is being constructed is 'fit for purpose'. Large amounts of funding, often from charitable giving, are used to plan, design and build permanent housing projects, projects unlikely to be sustainable due to ineffective and inefficient use of resources. Rushed decisions, made without appropriate consultation have resulted in inappropriate and unwanted housing provision, including housing which cannot be used by local communities [6].

Following the 2005 Tsunami the Royal Institute of British Architects (RIBA) made public statement in 'Building Design' that it had contacted BRE and Construction Industry Council to make sure the reconstruction effort's in Asia were sustainable and able to resist any future natural disaster. The RIBA also called from an education programme to ensure that rigorous construction methods would be used in countries vulnerable to future tsunamis [7]. It is uncertain whether this can be seen as a realistic goal or even attainable where there are innumerable relief and aid agencies working in isolation using different approaches and different solutions to meet people's needs.

Recent research undertaken by Levine *et al.* on disaster relief as it relates to housing provision and associated social concerns, has demonstrated that it is still deficient [8]. There is a perceived gap in the understanding of the longer-term impacts of post disaster reconstruction. It has been demonstrated that more research is needed on the effectiveness of longer-term development in communities where international aid and expertise have been provided. Implementing agencies rarely have the time and/or expertise to document properly what they have done or undertake comprehensive research on the value of their interventions. The aim of the wider research project is to capture tacit, implicit and explicit knowledge and map the project management practices of leading aid agencies (NGOs and charities working in disaster relief) to understand decision making practices in the final stage of housing recovery (permanent housing); decision making processes which have lead to best practice amongst these organisations. In this paper the major issues surrounding post disaster housing reconstruction are discussed.

2. Natural hazards and disaster events

There has been a significant rise in the number of disaster events over the past decade, as well as in the number of people affected by disasters associated with natural hazards; as documented since the beginning of reliable recording in the 1960s [9]. Far from being under control, evidence suggests that losses associated with the built environment due to these extreme natural hazards are increasing rapidly [10]. Indeed, there is a broad consensus that the number and cost of natural disasters is escalating worldwide[1] [2]. Traditional coping methods in both rich and poor societies are breaking down while evidence indicates that climate change is bringing new hazards as well as increasing risk from known hazards. In all this uncertainty, there is one undeniable fact; there is an unequal burden of disaster mortality [11] and climate change impacts on poorer countries.

[1] This increase is as a result of more frequent disasters; the growth of global populations located in increasingly vulnerable areas; and continued environmental degradation.

As a result disaster relief work has increased substantially in the past two decades [12]. However questions have arisen surrounding the appropriateness of the responses made to these disasters and how they are monitored in order to assess their effectiveness over the short, medium and long term [13].

Waiting for events to occur is no longer a viable option. The 'crisis survival' mindset needs to change to one of anticipation, intervention and prevention [14]. It is not enough to return hazard-hit communities to their frequently impoverished and vulnerable pre-disaster state [15], it is now necessary to 'future proof' design rather than adapting buildings for a changing climate once complete [16]. It makes economic sense to build in resilience and when there is adequate time and resources to make these sorts of design decisions. Rebuilding operations can be seen as an opportunity to create a more sustainable environment [17]; one which can withstand future hazards and builds in climate change considerations**;** making housing and communities safer, reducing the potential impact of any future disaster [18]. Consequently, **'**hazard risk reduction' and 'vulnerability planning' can and should be seen as a subset of sustainable development [13].

3. Climate change and increasing vulnerability

Since the beginning of this millennium, natural hazards have resulted in human disasters, which have in some instances reversed years of development work [11]. Climate change is expected to lead to changes in temperature and precipitation patterns over the next century that will, amongst other things, significantly affect human livelihoods. The predicted increase in extreme weather events disproportionately impacts the poor located in these at-risk areas [20]. Indeed some of the most significant impacts of climate changes are expected in tropical and sub-tropical regions, where most developing countries are situated [19]. In the context of past and present day failures to address poverty adequately, climate change is an additional obstacle to the achievement of sustainable development, the result of which is an increase in vulnerability of the poor[2] [8].

As climate change exacerbates vulnerability, measures to mitigate increased risk need to focus on reducing built environment vulnerability in the context of development efforts; particularly building adaptive capacity and technology transfer [21] [11]. Indeed the unpredictability generated by climate change places more emphasis on the need to identify and support generic adaptive capacity alongside hazard-specific response capacity [11].

The supply of appropriate housing is intrinsically capable of reducing vulnerability amongst the poor, not only against future disasters but in the shocks and crises that occur in routine life for the poor [22] living in the most vulnerable of geographical locations. Permanent housing must, above meeting basic accommodation needs [23][3] provide for peoples' psychological, social and

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[2] Vulnerability is also increasing due to rising poverty, a growing global population, armed conflict and other underlying development issues. People can be exposed to physical and social vulnerability. The former includes old, poor or inadequate buildings. The latter considers the ability of an individual, household or the community to respond appropriately to threatening conditions and their aftermath [8].

[3] Article 21 of the UN universal declaration of human rights promotes the concept of housing as a right of all peoples [23].

economical expectations; in essence provide a starting point from where they will rebuild their lives [24].

4. Hazard risk and appropriate mitigation

4.1 Lessons learnt

As discussed above, the demographic distribution of hazard risk tends to be inequitable because geographical locations are frequently related to residents' demographic traits. This pattern is very common in developing countries where residents cannot afford homes in geographically safe areas [25].

As the incidents of natural disasters increase, it is imperative that NGO's and other agencies involved in disaster relief manage risk by learn as much as possible from each disaster recovery and reconstruction process they are involved with; both successes and failures [26]. NGO's play important roles in different stages of the 'disaster cycle' and different elements are attributed to its successful operation. For example, technical skills are important for rescue, whilst coordination is essential relief activities. These require different knowledge skills, competencies and attributes.

The disaster recovery period is a time with immense potential for confusion and conflict [27][4]. A successful NGO intervention should exhibit sustainability principles, working flexibly with local people and include multi-stakeholder cooperation [28]. Indeed, post disaster recovery processes can be used as a catalyst for sustainable development [18] [29]; upgrading livelihoods and living conditions leading to the potential revitalisation of local economies. However, post disaster rehabilitation projects have not always been effective [28], because they have not always taken a sustainable development approach.

Whilst structural/physical risk reduction initiatives, such as conventional and traditional engineering or planning which can easily create false security, are decreasingly seen as the solution, few alternative strategies are being developed to replace them [30]. Previous disasters must hold valuable lessons for those designing new buildings, and this tacit, implicit and explicit knowledge should be exploited. Detailed surveys of damage, particularly of smaller domestic buildings, can yield valuable information on areas where there is little research; for example how buildings perform compositely in a tsunami or earthquake, including the interaction between non-structural and structural elements [17]. Cross-disciplinary hazard risk-based management strategies to meet the challenges of climate change, together with design guidelines that account for both historical local climate conditions and scenarios for future changes, should be an important step forwards a more active and dynamic way of ensuring a high-quality construction process and sustainable development result [31].

[4] Research undertaken by Wu and Lindell [27] demonstrates that having a pre-impact recovery plan in regions of high risk appear to increase the speed of housing reconstruction following a disaster event.

4.2 Disaster risk management strategies

There is a clear role for disaster risk management as a response to future climate change, and there is no better time to implement it than when reconstructing post disaster. Any disaster risk management strategy must encompass political social, economic, cultural and engineering issues [17]. Where disaster risk reduction and climate change mitigation can be incorporated into development plans, sustainable development can be realised [11]. However, whilst risk reduction is becoming increasingly recognised as a key challenge for development, very little work has been undertaken to date to identify how this can be done [32], it has been suggested that "…the need to work on disaster risk has tended to 'fall between the cracks' of the grander framework of development cooperation and emergency relief." [33, pp186]. Indeed, there is evidence that risk reduction and planning are two marginalised activities within international aid organisations; hindering interest in a more integrated approach [30][5].

Consequently, there is a general consensus that disaster management should shift its focus from response and recovery to sustainable hazard mitigation [34] [35]. Hazard mitigation and planning should therefore be considered as more than an auxiliary issue and disaster risk reduction needs to be incorporated into the construction management process.

4.3 Construction project management and sustainability

The construction management decision-making process requires an in-depth integrated understanding of how to avoid and mitigate the effects of natural disasters. In order to be effective, resilience needs to be systematically 'built in' to the planning and design process and not simply added on as an afterthought [36]. It is therefore necessary to increase the participation of NGO's and the affected community within the construction process [37]. If mitigation strategies are to be successful, they must incorporate public participation at the local decision-making level. This will increase the likelihood that the solutions provided can be sustained [35].

The existing concepts of sustainability and sustainable development by definition have a focus on the medium to long term processes but need revision to include the implications of extreme events, regardless of whether these are natural or anthropological. In particular, those working on issues of preparing for climate change need to be informed by the body of established knowledge on natural hazards [13].

Mitigation of natural disaster within the context of sustainability requires changes and adjustments in the ways human settlements are planned, built and managed. Resources, technologies and organisational processes should be inextricably linked to the quality of the environment and to meeting people's needs. In this way, mitigation approaches can combat the real causes of

[5] Wamsler [30] undertook a study to determine the underlying reasons for the lack of integration of planning and risk reduction within international aid organisations. The study differentiates between people working within the field of development and those employed in the areas of disasters. It is suggested that these two groups lack the appropriate knowledge and adequate institutional structures required to effectively support their contribution to risk reduction and to co-ordinate their efforts.

vulnerability, and prevent and counteract the unnecessary creation of environmental and socio-environmental problems. Such an approach could have productive and lasting results, which would lead to continuity between mitigation and the sustainable development of human settlements [34]. This may only be achieved through appropriate housing design; activities that strengthen physical conditions, increasing self-reliance and community participation; and institutional reform at different levels to increase cooperation, awareness and effectiveness [34]. By supporting reconstruction programmes that promote community-based approaches to disaster mitigation, resources within the community and neighbouring areas could be exploited, which in turn would build capacity thus reducing vulnerability [38].

5. Sustainable Strategies

5.1 An appropriate response

Reconstruction programmes can experience challenges on unparalleled scales; examples include the aftermath of the Tsunami in Sri Lanka and the earthquake that devastated northern Pakistan (both in 2005), where a lack of strategic and professional expertise, coupled with a shortage of skilled labour and materials [39] [40], made it extremely difficult to supply permanent homes. There was widespread public criticism of the Sri Lankan government from the Western World and many organisations and individuals who had donated money; frustrated that one year on their money had not been spent and was not reaching the people. This criticism did not take into account the fact that an appropriate response and thus sustainable solution requires extensive and thorough knowledge transfer and management; and without appropriate and structured decision making processes in place, with pressured time constraints, significant mistakes can be made [39].

An appropriate response when reconstructing housing environments following a disaster is one that delivers solutions that optimise the design (its functionality and configuration) and manufacture (materials) of the build in terms of ecology, economy and social needs [37], for a sustainable solution is to be found. All too often reconstruction responses are driven by technology, limiting wider engagement with cultural and social issues [13]. These solutions must meet the basic needs of shelter and aliment. Adequate does not mean basic, as well as being long-lasting they need to be socially sustainable and meet the local peoples' cultural needs [12]. It is necessary to remember that **e**ver country, region even, may have its own cultural and socio-economic setting [29]. The housing must meet physical needs (functionality and configuration), but it also has to meet economic and technological (including practical building systems and building materials), as well as social and aesthetic needs (thus respecting the culture of the affected population) on a local scale [24]; if it is going to deliver sustainability. Local knowledge is essential to fulfilling these requirements and NGO's can play an important role as the interface between the people and government, by communicating people's needs and priorities to the government [28].

With this approach to decision making, end user satisfaction, environmental protection and disaster mitigation can be provided and achieved [41]. However this is not always the case as the decision making process is both complicated and fractious. Learning from the experiences of successful and not so successful projects could help with future project decision making processes, but very little is published that relates to the longer-term outcome of relief and reconstruction programmes; despite the sizeable amounts of (international aid) money involved [42].

5.2 End users and stakeholders

The design and implementation of any post-disaster housing reconstruction programme must find a balance between affordability, technical feasibility and quality of life. It must also recognise the end users as active stakeholders, aware and conscious of their own needs and wants, rather than as passive recipients, who need to be educated [43]. Freeman [2] and Schildermann [44] argue that governments and agencies need to actively engage end users, building on existing skills and capabilities within local communities, rather than rushing in to 'reconstruct' for them. Nowadays, the managers of most reconstruction projects claim that their projects are participatory, but the extent and nature of such participation is not always apparent [42]. Large, centrally planned and contractor-built housing is still the standard approach to post-disaster reconstruction [10] and whilst community participation may be widely encouraged by NGO's, policy makers, and scholars, very little knowledge exists about how this is applied at the project level and despite often good intentions, this level of participation is rarely obtained and the capabilities of the users are often significantly wasted [45].

Indeed, Davidson *et al.* [45] examined a number of post disaster reconstruction projects to analyse community participation. They determined that, in the majority of cases, community participation does not occur; demonstrating a significant gap between theory and practice. Where community participation is known to take place, up front involvement is more successful than when community participation is introduced to the later stages of reconstruction projects.

However Architects without Frontiers (AWF), a small organisation specialising in developing strategies which contribute effectively to the regeneration of communities and addressing underlying social or political issues, has demonstrates some success in this area. Critical to the process has been working closely with locals, educating and training them in the skills being provided, thus fostering self sufficiency [46].

5.3 Technological solutions

Despite the fact that a top-down, technology-driven, end-product approach is decreasingly seen as the solution [30], it remains dominant in post-disaster reconstruction, with the exception of a few isolated and relatively small-scale NGO projects [42] such as the work of AWF [46] and the Catholic Relief Services (CRS) [12].

Unfortunately, in a majority of incidences external technical consultants exercise considerable influence over technology choice. Indigenous building knowledge is often devalued by outsiders and indeed by local people themselves, who prize 'modern' building styles as symbols of development, and believe that they are more secure against natural hazards [42]. These beliefs are not unfounded as, for example, only steel and concrete technologies can actually withstand the forces involved in e.g. a tsunami, however these materials are not a sustainable options for the majority of people affected [47]. As a result post-disaster humanitarian assistance can increase vulnerability in the medium-long term [48] when what is built cannot be sustained.

For any reconstruction project to be sustainable, the building technologies need to be appropriate to local needs, resources and cultures. Indigenous technology, in its most advanced form, is the only technology that can sustainably rebuild devastated settlements [47]. Indigenous technology is particularly valuable for sustaining livelihoods because local skills and labour can be utilised during the reconstruction process. Indeed indigenous building technologies are well adapted to hazards. For example, certain timbers and bamboo structure resist earthquakes well because they are flexible. Despite the fact that traditional building technologies are capable of mitigating the effects of hazards if built appropriately, they have frequently been dismissed as inadequate and replaced with concrete based technologies, constructed by outsiders [22]. Marginalising local labour in this way can actually increase vulnerability to future hazards, as once the reconstruction project is over and the imported labour have left, the skills needed to extend, modify and repair houses using the new technologies are lacking, and in many instances the local people revert to traditional methods which can result in dangerous hybrid structures [42]. This is not to say solutions cannot and should not be adaptive or innovative; but these adaptations or innovations, which may originate elsewhere, must be guided by local knowledge and conditions. Also, when local people are involved in the reconstruction process, these approaches are more likely to be broadly accepted and to endure [26].

Indeed sustainability can only be achieved by using local resources (materials and labour) and cultivating skills and knowledge, thus creating micro-economies for those trying to get on with their lives post-disaster [47]. For example, following the earthquake of 2005 that devastated Northern Pakistan, CSR undertook to rebuild some of the most remote and neglected villages there. Reconstruction of permanent housing had been neglected because there was not sufficient expertise amongst those organising the relief effort [12] CRS found that the most effective way to rebuild housing that was safe, adequate and durable was to assist (through provision of materials and skills) local people to build permanent housing with materials they were familiar with. Indeed CRS's overriding aim is to train local people with the skills and knowledge necessary to do the job the next time [40].

When considering the additional burden of building for unpredictable changes in climate, it has been suggested that housing with a higher climatic safety level than considered necessary under the climate regime of today be adopted. However with limited funds this approach may not be considered cost effective, although weighing cost and benefit in this context is certainly not straightforward and introduces new challenges [31]. If there is a clear strategy for sustainable development post-disaster, climate change risk and adaptation must be considered and may in fact inform and contribute to an improvement of previous strategies.

5.4 Organisational and management issues

In regions where natural hazards are more frequent, it may not be possible to reconcile every risk [10], particularly risk associated with climate change. Ultimately, the success of any project hinges on co-ordination (organisational and managerial), both at local and regional levels, within and between organisations. Project leadership is also an important issue in any community-based activity and vital in post-disaster reconstruction [29]. Johnson *et al.* [49] undertook a study of post-disaster environments which demonstrated that the performance of housing reconstruction projects was directly related to the design and management of the project team itself; highlighting the importance of studying decision making in project teams and analysing organisational processes for best practice.

In the past concerns have been expressed that organisations with the necessary available expertise to provide assistance are not necessarily matched up with the expert bodies capable of delivering where help is needed and lack of co-ordination has been blamed [50]. The development of more integrated, interdisciplinary projects is restricted by competition for limited funding and by donors' separate budget lines for emergency relief and redevelopment. There are reports of tension between disaster specialists, development workers and urban planners, and the incompatibility that ensues impedes the establishment of more integrated projects, much needed if a sustainable solution is to be found [30].

6. In conclusion

There are large uncertainties associated with the future performance of the built environment due to changes in regional and local scale climatic conditions. Up until now major natural disasters have been regarded as individual, one-time, localised events, as opposed to regional and potentially frequent. Until the scale, complexity and potential size of these hazards are examined, adequate responses will not always be developed, much less implemented [8].

To secure a reduction in losses to natural disasters, the meeting of the UN's Millennium Development Goals [51], widen human development objectives, and implement successful responses to climate change, it is necessary to undertake a more integrated approach to disaster relief reconstruction [11]. To ensure that every house that is reconstructed following a disaster will work with or withstand future potential disasters, there needs to be an understanding and awareness of potential future risks (including climate change mitigation) alongside the development of strategies to survive or combat them. In order to develop these adaptation strategies, effective ways must be found to strengthen capacity [31] of all those involved. One way of doing this is through the study of current best practice. Meeting the challenge of creating sustainable and self-replicable approaches, approaches that enable large numbers of poor and vulnerable people who need safe, affordable housing to achieve this is the aim of organisation working towards sustainable development. Understanding best practice and how to replicate it, is the first step in achieving this goal.

7. Ongoing research

This study of the literature reveals that it is both prudent and necessary to establish to what extent local knowledge and technical and scientific information is exchanged between the different stakeholders (which includes the end users) and what is encouraging or constraining locally adapted solutions [31], particularly with respect to design, technology and materiality but also construction and building maintenance, in post-disaster housing reconstruction.

Research is currently being undertaken to capture tacit, implicit and explicit knowledge and map the practices of leading aid agencies (NGOs and charities) currently undertaking post-disaster housing reconstruction projects, to understand decision making practices that are working towards sustainable solutions and demonstrate best practice. The results of this research will be published at a later date.

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Capacity building for sustainable post disaster waste management: construction & demolition waste

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Abstract

Disasters, both natural and man-made, have been occurring with increasing frequency and effect in recent decades in many countries around the world. Among them, Sri Lanka is yet to recover from the effects of December 2004 Tsunami. Among many other reasons it has been identified that lack of awareness of the mechanisms and systems for post disaster waste management is a critical issue of concern. None of the Sri Lankan academic institutions related to the field offer courses designed for the management of disaster waste within the country. Furthermore, none of these institutions conduct awareness programmes aimed at the public on new mechanisms and systems of management of disaster waste. To address these issues, this research aims to enhance capacities to develop new mechanisms and systems for sustainable post disaster waste management focusing on construction and demolition waste. To achieve the identified aim, the research will explore current status of disaster waste management in Sri Lanka and a framework will be proposed for enhancing capacities for sustainable disaster waste management in economical, social and technological aspects. The research methodology includes a comprehensive literature review, semi structured interviews and case study with selected personal views on management of disaster waste management. In this context, the objective of this paper is to present the current scenario of disaster waste management based on the results of a secondary survey.

Keywords: Capacity enhancement, Post disaster management, Waste management, Construction and demolition waste.

1. Introduction

1.1 Background

Disasters cause substantial damage around the world every year [1]. There has been an increase in natural disasters over the past few years and their impact in terms of human, structural and economic losses has also increased considerably. According to statistics issued by the Centre for Research on Epidemiology of Disasters (CRED) and United Nations International Strategy for Disaster Reduction (UNISDR) in 2006, natural disasters killed 91,963 people and destroyed US $ 159 billions worth of property and infrastructure in 2005. Apart from the tragic cost in lives it destroyed and damaged buildings and other infrastructure including building contents, even where buildings were not physically damaged it damaged vegetation at or near coastlines.

According to the European Commission - a key player in post disaster humanitarian assistance processes – the key issues that need to be addressed after emergency relief are: the creation of a foundation for sustainable and long term reconstruction and the commencement of governance structures and projects in critical areas of recovery, recreating communities and livelihoods, rehabilitation of the environment including waste management, rebuilding infrastructure and transport processes, and strengthening local governance [2].

Thus, it is evident that effective waste management strategies and strengthening local governance in related aspects following a disaster is emerging as an important area of consideration.

1.2 Research problem

Both natural disasters and conflicts often result in damage beyond economic repair of large quantities of building stock and infrastructure facilities requiring demolition with the subsequent removal of debris. The demolition of ruins and the reconstruction of buildings generate further construction waste.

According to official figures available on the Marmara Earthquake, Turkey, an estimated 13 million tons of total rubble quantity were generated as debris. Although a stationary recycling plant was implemented for processing this waste stream, due to practical difficulties the majority of construction and demolition waste were not processed. Ultimately, waste was disposed of at 17 dump sites, including some illegal dumping carried out at coastal lines during the emergency phase [3]. In the case of the Hansshin-Awaji earthquake in Kobe, Japan an estimated total quantity of over 15 million cubic metres of demolition waste were generated. Of this only a minor proportion of it was recycled with the majority being either disposed of or used for land reclamation [4].

Unplanned disposal causes numerous problems with an increasing population since it consumes a considerable proportion of already scarce landfill sites. According to statistics, in the USA, construction and demolition waste contributes approximately 29% to overall landfill volumes, in the UK it contributes more than 50% and in Australia it contributes 20–30% [5]. Hence, it is an increased necessity to reduce levels of waste generated in the post disaster scenario due to environmental and economic reasons.

The management of this debris, as well as waste generated during reconstruction works poses significant challenges to national and local capacities. If such waste is not properly managed, it may cause serious environmental and economic burdens on normal living conditions as well as on the reconstruction phase itself. This includes the negative effect that debris can have on general municipal waste collection and handling operations, which is one of the major challenges following disasters. These critical issues bear evidence to the fact that construction and demolition waste is becoming a global dilemma in post disaster scenarios.

1.3 Scope

In recent years, several major disasters have occurred in coastal areas worldwide. Among these the Asian Tsunami that hit the coast of Sri Lanka on 26th December 2004 was an unique experience which occurred within recent memory, where nearly one million people (234,000 families) were affected in 13 districts. Since the coastline of Sri Lanka is heavily populated, where most of industrial and commercial activities take place, the country's economy was seriously affected. In addition to loss of life, the tsunami destroyed and damaged buildings and other infrastructure facilities, damaged building contents, even if a building was not physically damaged it further destroyed or damaged vegetation at or near the coastline [6]. According to the Joint Report of Government of Sri Lanka and Development Partners (2005) [7], it destroyed US $ 900 million worth of assets and infrastructure in Sri Lanka. This is considered the highest ever recorded value of disaster/destruction damage caused by a single event, in the Sri Lankan context.

A specific proportional breakdown of the tsunami-generated waste is not available. A rapid inspection of waste generated at damaged areas, observed at unauthorized dumps and unplanned landfills, indicate that a large part of related waste consist of spoiled soil, damaged building material and vegetative matter, including branches, wood and domestic refuse. Smaller proportions of waste include plastic, metal (of various types and condition) and items of undetermined origin was also noted. No significant presence of hazardous chemicals or technological items (e.g., computers, televisions) was noted. Overall, an estimated 80% of waste consisted of either spoiled soil, building materials or vegetative matter.

According to the Progress Report of the European Commission Post Tsunami Rehabilitation and Reconstruction Programme (2006) [2], there are no such significant developments being made in respect of waste management in Sri Lanka, among the worst affected countries such as Indonesia and the Maldives. Local government authorities and volunteers worked diligently to remove debris and clean up neighbourhoods. Land owners also cleaned their own premises and disposed of waste off their lands by depositing it at outside locations for collection and removal. At present, collected waste is deposited at unplanned landfill sites in environmentally sensitive areas. (For some time now, dumping of waste on beaches or common lands has been made illegal. Some burning of waste still continues, but has been reduced by a general clean-up effort.) Limited, unorganised scavenging is taking place but it is focused on easy ways to collect high value items, principally usable sawn wood and metal. Owners of some waste, for instance a destroyed building, also retrieve bricks, wood and other reusable objects. These efforts, which shall be encouraged, reduce the waste stream, but probably not in significant proportions. Therefore, clearing, salvaging, rehabilitation and reconstruction work fully or partly require serious efforts of the government sector.

However, United Nations Development Programme Report (2005) highlights poor performance of post-tsunami rehabilitation operations affected by a lack of responsive capacities with local government institutions to address the needs of an event of such magnitude. This was mainly caused by the fact that the strategic and operational level capacities of institutions responsible for public and commercial facilities were not expected to cater for a devastation of this magnitude. As such it has been identified that capacities of relevant institutions in Sri Lanka need to be improved to launch successful post disaster recovery programmes and to face any future challenges similar to the Asian Tsunami (United Nations Educational Scientific and Cultural Organisation, 2005; Asian Disaster Reduction Centre, 2005). In particular, the Joint Report of Government of Sri Lanka and Development Partners (2005) [7] revealed that the construction industry in Sri Lanka did not possess the adequate number of contractors, equipment, skilled workforce, modern management practices or access to easy finance necessary to maintain the required speed of post tsunami reconstruction work. This is a critical issue that needs to be addressed for the purposes of effective post disaster rehabilitation. There are no readymade solutions and every programme must be appropriately designed for a given post disaster scenario. This concept is very effective for developing countries, since most of them lack resources and suffer from inefficient use of available resources.

Among many other issues, capacity building is becoming crucial to increase an organisation's access to information and technical know-how by improving internal management structures, processes and procedures as well as strengthening partnerships among various players in waste development process.

1.4 Aim, objectives

According to above discussions it is apparent that to implement effective post disaster waste management strategies, among many key issues, the capacity of a local area to cope with waste generated by a disaster emerges as a crucial issue. Therefore, the primary aim of this study is to identify capacities that need to be enhanced for a sustainable post disaster construction and demolition waste management process. The following are the objectives identified to achieve this aim:

- Understanding of key concepts of disaster management, waste management and capacity building
- Identification of relationships between construction and demolition waste within the context of post disaster scenario.

- Identification of adopted strategies in post disaster waste management at recent Asian Tsunami disaster.
- Identification of key factors hindering progress of construction and demolition waste management within the context of the recent Asian tsunami disaster.
- Identification of key enabling factors of capacity building in post disaster waste management process.
- Developing a framework to enhance capacities of post disaster construction and demolition waste management processes.

2. Research methodology

A comprehensive literature survey and review will be done on the concepts of post disaster management, waste management and capacity building by referring to official reports on rehabilitation and reconstruction efforts, text books, journals, articles, conference papers and electronic sources to familiarise and build up the research. The review will be extended to identify the relationship between construction and demolition waste within the context of the post disaster scenario.

The Tsunami, which hit Sri Lanka on the 26th December 2004, has been selected as the case study for this research since it was the major disaster which occurred recently in coastal areas of the Asian region, killing nearly 250,000 people around the Indian Ocean. A detailed documented survey will be carried out on post-tsunami waste management processes in order to identify the different waste management strategies adopted. Furthermore, both structured and unstructured interviews will be conducted with selected personnel in governmental and non-governmental organisations to collect information on post tsunami waste management strategies, their suitability, applicability and to identify key factors which hinder progress of disaster waste management. In addition, a questionnaire survey will be conducted among tsunami victims in order to identify issues relating to post tsunami waste management programmes already adopted.

An in depth analysis will be carried out to identify the key enabling factors of capacity building in post disaster waste management processes, based on the data collected through the local field survey.

A framework will then be developed by incorporating the above findings to enhance the capacities in terms of economical, social and technological aspects which contribute to sustainable post disaster waste management processes. The framework will be tested with real life scenarios and evaluated using domain experts.

3. Literature findings

Since the study is at initial stage, scope of this paper is mainly based on the secondary data that is collected through a detail literature review. The following section of this paper presents the literature findings on disaster management, waste management and capacity building in both a local and global context. In the later part a discussion will be provided on the current status of construction and demolition waste management in the Sri Lankan context referring to the case of the tsunami disaster.

3.1 Disaster Management

The world is facing a increased frequency and intensity of disasters – natural and man made with devastating impacts. Disaster Management Centre, Sri Lanka 2007 [8] defines “a hazard is a rare or extreme event in the natural or human-made environment that adversely affects human life, property or activity to the extent of causing a disaster”. International Strategy for Disaster Reduction – ISDR (2004) [9], has defined disaster as a “serious disruption, of the functioning of a society, causing widespread human, material or environmental losses, which exceed ability of an affected society to cope using its own resources”.

With reference to above definitions, key words and phrases in disaster are “sudden or unexpected, crisis situation, serious disruption of functioning of a society, causing widespread human, material, or environmental losses and overwhelms local capacity”. It should also be noted that in disasters there are no prior warnings and thus, people are not adequately prepared. This can result in disruption of an entire system. This study considers only one natural disaster, in the recent tsunami, which is categorised under Earthquake Hazards. A tsunami is a series of enormous waves created by an underwater disturbance such as an earthquake, landslide, volcanic eruption, or meteorite.

Disaster management is a “collective term encompassing all aspects of planning for and responding to disasters, including both pre- and post-disaster activities” [10]. It may refer to management of both risks and consequences of a disaster. Amarasinghe *et al* (2006) [11], defined disaster management as “an applied science, which seeks, by the systematic observation and analysis of disasters to improve measures to prevent, respond and recover from effects and consequences of a disaster”.

The disaster management cycle illustrates the ongoing process by which governments, businesses and civil society plan for and reduce the impact of disasters, react during and immediately following a disaster and take steps to recover after one has occurred [12].

According to Warfield at the Global Development Research Center [12], a disaster management cycle includes four phases: mitigation, preparedness, response, and recovery. According to his explanation, four disaster management phases illustrated here do not always, or even generally, occur in isolation or in this precise order. Often phases of the cycle overlap and the length of each phase greatly depends on the severity of the disaster. According to RICS (2006) [13], the disaster management cycle is visualised as a two-phase cycle. The main phases are pre-disaster risk reduction phase and post-disaster risk recovery phase as presented in figure 1.

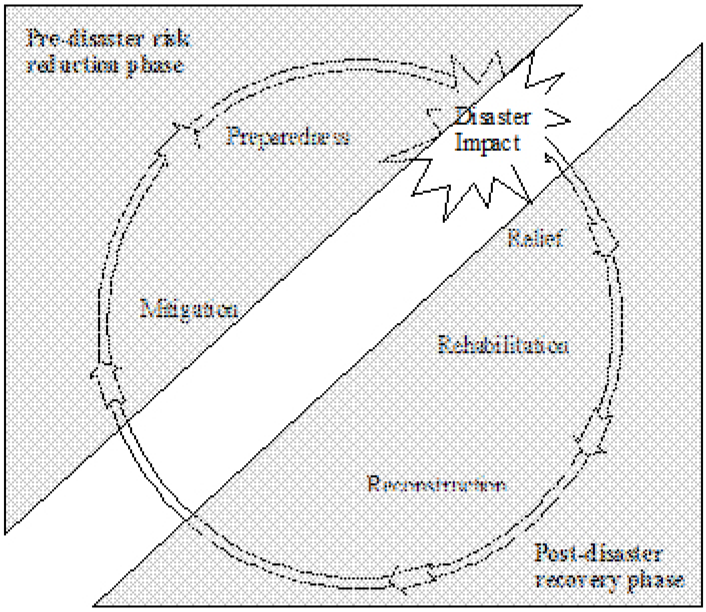

Figure 1: Disaster management cycle by RICS (2006)

This research mainly concentrates on the rehabilitation phase of the disaster management cycle. The rehabilitation phase is also known as the transitional phase. The main activities of this stage include removal of debris, assessment of housing needs and establishment of a baseline and eligibility criteria; plan and construct transitional shelters/repair lightly damaged property, provide job opportunities to survivors, public work programmes etc. To initiate other phases of the disaster management cycle it is important to apply appropriate strategies to expedite the rehabilitation phase and reduce future impacts of similar disasters.

3.2 Waste management: construction and demolition

There are scores of definitions introduced by many researchers on construction and demolition waste (C&D), which is posing to be a major environmental problem in many countries nowadays.

In general, waste is best defined as any material by-product of human or industrial activity that has no residual value [14]. But Pinto and Agopyan (1994, cited [5]) argue that construction industry waste has a residual value. Hong Kong Polytechnic (1993 cited [15]) defined construction waste as “the by-product generated and removed from construction, renovation and demolition work places or sites of building and civil engineering structures”.

All these definitions suggest that construction and demolition waste generated from construction, renovation or demolition of works, have a unique characteristic over other types of waste due to their residual value. Many researches proved that demolition waste contains higher proportion out of total solid waste generated in any country ([5, 16]).

As discussed at the beginning, the construction industry is the leading waste generator in the world. Many researches prove this fact ([5, 15]). Despite being a major generator of avoidable waste the industry has been slow to embrace environmentally friendly practices ([5]).Therefore, it is important to maximise environmentally sustainable values through minimising construction and demolition waste. Sustainability is a systematic concept, related to continuity of economic, social, institutional and environmental aspects of the human society [17]. Sustainable development or ecologically sustainable development is defined by the UN as “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [17].

Therefore this study will propose a framework to enhance capacities to achieve sustainable post disaster waste management strategies.

3.3 Capacity building

The term “capacity building (CB)” and “capacity development (CD)” are highly elastic, in that they can be stretched to embrace different activities. Such activities include capacity building in various unrelated organisations, management schools, agricultural research and development, non-governmental etc. The term capacity building often implies activities which are carefully planned and executed in order to build the capacity. Capacity development can be defined as a process by which individuals, groups and organisations improve their ability to carry out their functions and achieve desired results over time (Peter, 1997 cited by [18]). This definition highlights two important points: that capacity building is largely an internal process of development and that capacity development efforts should be results oriented.

Capacity building is defined in multiple ways. With reference to United Nations Center for Economic Development (UNCED) (1992 cited [19]), capacity building encompasses a country’s human, scientific, technological and resource capabilities. A fundamental goal of capacity building is to enhance the ability to evaluate and address crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environmental potential and limits perceived by people of a country concerned.

Capacity development is often needed to raise performance levels of a particular organisation. Organisational capacity refers to staff and resources, as well as its structure, management systems and linkages with other organisations. Organisational motivation refers to the culture and inducements which influence capacities of an organisation in pursuit of its goals. Finally, an organisation’s performance is reflected in its effectiveness, efficiency, and sustainability. The relationship between four dimensions is presented in figure 2.

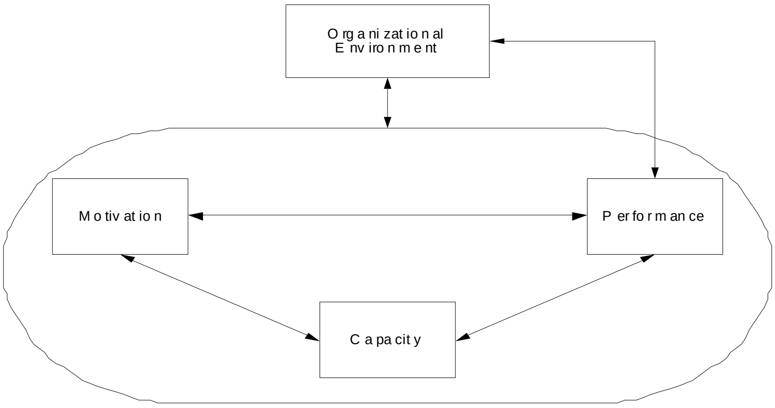

Figure 2: Relationship between organisational environment, performance, motivation and capacity.

Capacity development efforts may focus on different levels, ranging from micro level of the individual to the macro level of national and international organisations. According to Hortan, 2002 [18] capacity development efforts generally include one or more of the five approaches. They include information distribution, training, facilitation and monitoring, networking and feedback to promote learning from own experience.

Practically all capacity development efforts distribute information in one form or another. Training is another common tool used in developing participants' knowledge, skills, and attitudes. Facilitation by a change agent is generally more effective. However, facilitation tends to be labour intensive and considerably costly. Capacity development can also be promoted through exchange of information and experiences among people working on similar tasks in different settings, as well as through workshops, networks, and communities of practice. Learning within an organisation can also be promoted by internal evaluations that provide rapid feedback to individuals and groups (Leeuw and Sonnichsen 1994, cited by [20]).

Capacity development should not be viewed as a one-time event such as a training event or installation of a new accounting system. Capacity development is a process that needs to be managed over time. Research and development organisations need to continuously develop their capacities to deal with new opportunities and threats arising from changes in technology, markets, politics, and other factors. In this sense, there is no final, achievable goal for an organisation's capacity development.

4. Discussion

The following section provides a brief discussion on post disaster waste management strategies applied for the tsunami and its successfulness is based on information collected through secondary surveys.

The tsunami hit the coast of Sri Lanka on 26th December 2004. Nearly one million people (234,000 families) were affected in 13 districts namely, Puttalam, Gampaha, Colombo, Kalutara, Galle, Matara, Hambantota, Ampara, Batticaloa, Trincomalee, Mullaitivu, Kilinochchi and Jaffna. Since the coastline of Sri Lanka is heavily populated where most of the industrial and commercial activities take place, the economy of the country was seriously affected. In addition to loss of life, the tsunami destroyed and damaged buildings and other infrastructure, damaged building contents, even when a building was not physically damaged it damaged vegetation at or near the coastline. The destruction and damage has generated a large volume of solid waste.

Local government and volunteers are working diligently to remove debris and clean up neighbouring areas. Land owners are also cleaning their premises and depositing waste at locations for collection. At present, the waste collected is being deposited in unplanned landfills in environmentally sensitive sites. (Earlier dumping of waste on beaches or common lands was stopped. Some burning of waste continues, but has been reduced by the general clean-up effort.) Limited, unorganised scavenging is taking place but it is focused on easy ways to collect high value items, principally usable sawn wood and metal. Owners of some waste, for instance a destroyed building, are also retrieving bricks, wood and other reusable objects. These efforts, to be encouraged, will reduce the waste stream but probably not significantly.

The observed composition of waste suggests that a large portion of waste can be recycled. This would reduce the overall waste steam and the need for landfill space. Discussions with institutions indicate that a good part of recyclable waste (dirt, construction materials, and vegetative matter) can be used to rehabilitate near-shore areas degraded by mining for coral and later flooded by the tsunami, or as fill for areas damaged by erosion. Although initial discussions focused on shifting disposal from landfills to filling near-shore areas, agreement was reached that any rehabilitation work should be done with properly selected and prepared waste materials to avoid future environmental problems.

The collection and disposal of tsunami-generated waste should expand to include recycling of all appropriate materials. A large part of recycled material can be used to assist in the tsunami recovery process, including rehabilitation of affected land. Recycling will also reduce the volume of material which needs to be deposited into landfills, thus reducing overall negative impacts of cleaning and disposal processes.

In addition, responsible institutions need to fulfil the following requirements to effect a successful waste management process:

- Characterisation and quantification of waste
- Operations and logistics of recycling site set-up
- Disposal of items which cannot be easily recycled.
- Establishment of a permanent landfill

5. Conclusions

The generation of waste during a disaster is unavoidable and the only solution is waste minimisation. The primary area observed through this secondary review is the available opportunity to divert construction and demolition waste into reusable/recyclable building material. It can be mentioned that even though there are large number of opportunities in this regard in Sri Lanka this is still at the preliminary stage. Many constraints such as inconsistent nature of demolition debris, instability in the secondary material market, lack of interest, lack of government regulations, lack of interest for sorting, unavailability of required technology, improper and insufficient attention paid to quantification and identification of waste materials were identified as main reasons for being at the preliminary stage of waste management programmes. Finally, it can be concluded that the impact on the environment and economy from disaster waste can be minimised through proper benchmarking, being aware of consequences and trying to eliminate them.

Recently, the local industrial sector was changed to a certain extent, from its traditional fragmented processes towards a more client oriented business approach, which recognizes the importance of innovation, training and research. It was encouraged to modernise an organization by developing capacity and adopting collaborative and sustainable approaches within industrial sector of the country. This issue has still not significantly influenced the construction sector when compared to manufacturing and other industrial sectors. Therefore, this study will focus on enhancing capacities of post disaster waste management processes that will lead to sustainable waste management.

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Post tsunami recovery capacity gaps in Sri Lanka

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Abstract

Poor response capacity has been identified as a major inhibitor for successful post tsunami recovery attempts in Sri Lanka. Despite level of incentives aid and help which have been received from the international communities, both governmental and nongovernmental organisations, have evidently failed to deliver expected levels of performance in post tsunami recovery activities. It is of utmost importance to identify and overcome the related capacity gaps if Sri Lanka is ever to recover from the December 2004 devastation and any future disasters. Within the light of this, as the first step towards recovery, the country must fully understand the nature and scale of its capacity gaps related to the post disaster recovery.

Addressing this issue, the EURASIA (European and Asian Infrastructure Advantage) international collaborative research programme has conducted a series of interviews with key personnel in Sri Lanka to explore the nature and magnitude of this problem. The main objective of this paper is to present the outcome of these key expert interviews highlighting the priority attention areas and possible actions towards minimising the post tsunami recovery capacity gaps in Sri Lanka.

Keywords: Capacity building, Disaster management, Developing countries, Post disaster reconstruction, Long term recovery.

1. Background

1.1 Disasters and the developing world

During the past decade, the number of worldwide disasters has risen sharply. The Annual Disaster Statistical Review 2006 [1] highlights that the number of natural disasters that occurred in the period 1991 to 1999 varied between 200-250, while the figures have almost doubled during the period 2000 and 2006. Despite the continuous and rapid growth in the number of natural disasters, the number of actual victims affected by disasters has varied considerably along the timeline and across regions. During the last two decades, the average annual number of victims affected by natural disasters ranged between 100,000,000 to 300,000,000 [1]. Further, the Asian continent has experienced the greatest loss of life in absolute terms and in proportion to the population, due to natural disasters. As CRED [2] reports, the figures accounted for an average of 83.7% people killed in natural disasters in Asia, compared to Europe (10.55%), America (3.54%), Africa (2.16%) and Oceania (0.05%) during the period 2000-2005.

Within these fatality rates, a significantly higher number of death tolls is evident in developing countries compared to the developed countries [3, 4]. For an example, the earthquake which hit central California in 2003 with a magnitude of 6.5 on the Richter scale, took two lives and injured 40 people [5] whereas the earthquake which hit Iran four days later with a magnitude of 6.6 killed at least 26,000 people [5]. As one would suspect, this immense difference in the death toll is not uniquely related to factors such as population densities, as both events took place in areas with high-density populations. Not only do developing countries experience higher levels of mortality during a disaster, they generally require longer periods for post disaster recovery.

Within a typical disaster management scenario, 4 distinguishable stages exist [4]. Those are:

1. Pre-disaster planning
2. Immediate relief
3. Transitional phase
4. Medium/Long term recovery

Within the pre-disaster planning stage, the vulnerable counties prepare strategies and plans of actions to meet the demands of the future disasters. Just after the disaster itself, the immediate relief stage starts, within which the focus is on providing immediate relief to the victims. Often during this stage, the disaster receives the maximum attention from relief agencies and media exposing the affected communities to possible routes of obtaining required resources and help. After the immediate relief phase, the affected communities often go through a transitional period between the aftermaths of the disaster and their normal way of life. However, without a proper medium/long term plan for the recovery, the affected communities will experience a prolonged transitional period leading to an unsettled society.

As the “Mind the gap” report [4] highlights, even though the developing countries often receive financial and other humanitarian support from international communities, nongovernmental organisations and donor agencies as immediate relief aid, generally long-term recovery has primarily been identified as a national, sub-national and local government-led matter. As such, traditionally the donors and other organisations working towards humanitarian relief pay less attention to the long term recovery aspect of disaster management. Thus, not surprisingly, developing countries who witness disasters, often fail to launch successful long term disaster recovery programmes especially due to lack of resources and capacities, both in financial and intellectual terms. Consequently, this inability hinders the value of the resources dispersed and services rendered by the donor agencies within the immediate relief stage. For these reasons, there is a need to assess the long term disaster recovery issues in developing countries.

1.2 The case of post tsunami Sri Lanka

The case of post tsunami Sri Lanka exemplifies the issues related to the post disaster long term recovery in developing countries. Sri Lanka is a small island situated close to southern tip of India near the equator. It is a developing country with the total population just over 20 million. Before the Indian Ocean Tsunami, Sri Lanka was known to be a safe haven where outrages of nature scarcely occurred except for occasional floods and landslides. However, the Tsunami affected 75% of the coastline of Sri Lanka. It also resulted in the destruction of more than 100,000 houses [6] which in turn also resulted in the taking away of several livelihoods such as fishing, farming, tourism and handicrafts-related activities. In addition to commercial and non-commercial property damage, the number of deaths apportioned to the Indian Ocean Tsunami is estimated to be in excess of 130,000 with at least 31,000 of those in Sri Lanka [7]. The lack of awareness of the nature of a tsunami, among the Sri Lankan public, is quoted as one of the reasons for this mammoth death toll [8]. Indeed, the term “Tsunami” was heard by most of the ordinary Sri Lankans only after this devastation.

During the immediate relief stage, Sri Lanka received humanitarian relief aid from donors all over the world. This aid was in the form of financial assistance, equipment and materials and human resources for rescue/relief missions. While most of the aid was aimed at providing immediate relief to the victims, some of the funds were meant to be utilized for long term recovery attempts such as reconstruction of houses and infrastructure facilities.

Four years on, Sri Lanka is yet to recover fully from the devastation of the December 2004 tsunami. In fact, after a successful immediate relief phase [9], Sri Lanka is going through its transitional period between the short term relief and the medium/long term recovery. The Sri Lankan government started the long term recovery programmes with optimism and expectations for speedy recovery [9]. In fact the government expected the post tsunami recovery programmes to be completed within 3-5 years [10]. Further to this optimism, as Weerakoon et al [9] highlights there were pronouncements at political level about even speedier recovery intentions, such as meeting all permanent housing needs within one year of the devastation. However, this target has not been fully met even after three years [9].

With reference to the infrastructure, the pace of recovery of larger scale infrastructure projects, has reported been slow with an estimated 50% of construction projects yet to commence by end 2006 [11]. As GOSL [11] highlights, by end 2006, 134 of 182 damaged schools were estimated to be in various stages of construction. However, by the end of 2005, construction work had started only in 18 schools. Similarly, within the health sector only 55 of a total of 102 damaged buildings have been completed by June 2006 [9 cited 12].

1.3 Capacity building for post disaster recovery

From the above figures it is clear that the post tsunami recovery (long term) attempts in Sri Lanka were less than successful compared to the government's expectations and plans. One of the problems the governments of developing countries often face, with regards to post disaster recovery, is their response capacity. Generally, capacity at local government level to plan and implement post disaster recovery strategies is limited and incapacitated as a result of the disaster itself. In the light of this, strengthening local capacities for this process has been identified as a main priority [10, 13].

Strengthening national capacities of developing countries towards post disaster recovery predominantly demands financial incentives. Such incentives given by donors during a disaster are generally routed towards short term relief efforts rather than long term recovery programmes. As a result, the governments of affected countries (specifically developing countries) are financially incapable of launching successful long term recovery programmes [4]. As such, it has been identified within recent reports (e.g. [4, 10]), that the main focus of the donor organisations should be to achieve the appropriate balance of fund allocations between the immediate/short term relief and the medium/long term recovery. The donor organisations such as UN have recently recognised this aspect as a timely priority[10].

Lack of financial capability is a major contributing factor preventing a county from obtaining required physical resources such as equipment and infrastructure to launch successful long term post disaster recovery programmes. A lack of appropriate intellectual capacity can be recognised as another factor hindering the implementation of successful recovery plans. In this scenario, lack of intellectual capacity refers to lack of knowledge, expertise and training related to post disaster recovery within the relevant local authorities/institutions. Affected countries could be intellectually incapacitated for various reasons and at various levels. The Brain Drain, the lack of proper coordination between relevant authorities/institutions and immature organisational processes can also be highlighted as behind intellectually incapacitated countries. In some instances, mere lack of expectancy can also be a reason for a county to demonstrate intellectual incapacity in long term disaster recovery. For example, some of the Sri Lankan authorities [13] may have been incapacitated when responding to post tsunami (December 2004) recovery attempts due to the fact that Sri Lanka had not experienced a tsunami for centuries and there was no reasonably predicted reason for them to be prepared for devastation of that scale.

Highlighting the importance of improving local capacities in post disaster recovery, various reports (e.g. [11, 13, 14]) have highlighted the development of institutional mandates and capacities as a key focus area in achieving success in implementing its post tsunami long term recovery measures. These reports further acknowledge that identification of the capacity gaps in relevant institutions and authorities is a prerequisite placed above the task of developing institutional capacities and still very much to be completed along the country's journey to long term recovery from the December 2004 tsunami. In the light of this, this paper addresses the following research question:

“What priority capacity gaps exist within relevant authorities and institutions in Sri Lanka that need to be addressed to achieve successful long term recovery from the December 2004 tsunami?”

2. Methodology

The rest of this paper presents the outcome of an empirical investigation carried out by the authors with the intention of addressing this research question. This research work was carried out as part of an international collaborative research project, EURASIA. The **EUR**opean and **AS**ian **I**nfrastructure **A**dvantage (EURASIA) is a 3 year research collaboration between Europe and Asia funded through the ASIA-LINK programme of the European Union. The specific objective is to enhance the capacity of the partner institutions for training, teaching and research activities required for the creation and long-term management of public and commercial facilities and elements of infrastructure associated with post tsunami activities in Sri Lanka.

The overall approach to this research took the shape of a case study. This helped to meet the challenges of the research question being answered, specially to investigate the phenomena deeply and thoroughly, within the limited context of post tsunami Sri Lanka. The case study approach further supported the exploratory nature of the study where the concepts related to questions being answered gradually enriched throughout the investigation. Within this scenario, the boundary of the case study was defined as the post-tsunami recovery attempts in Sri Lanka. The unit of analysis was defined as the capacity gaps prevailing within the above boundary. The study was conducted as a single case study as the phenomena being investigated is unique, considering all the economical, cultural and geographical parameters related to the context.

The data collection approach was centred around a series of semi structured interviews conducted with 12 organisations involved in the post tsunami recovery programmes. These organisations were selected based on their level of involvement in the recovery actions in Sri Lanka. Main offices of all the organisations selected are based in Colombo, Sri Lanka, while the activities carried out by these organisations are geographically widespread to include all the Boxing Day tsunami affected areas, including the Eastern part of the island. All the interviews were conducted between 1st June 2007 and 30th June 2007, in English. Due to the high sensitivity of the issues being discussed, an agreement has been reached between the investigator and the organisations involved regarding maintaining the anonymity of the participants. For this reason, the true identity of the participating organisations or the interviewees has not been revealed within this paper. However, all the personnel interviewed within this study are either top level or medium level managers as the information intended to collect was of strategic level rather than operational level. During the interviews, information about the experiences of the interviewees regarding the successes and failures of the post-tsunami recovery attempts in Sri Lanka were collected. The interview guide prepared for the semi structured interview was structured in such a way that, as the interview progresses, it captures the issues related to the failures of recovery attempts and reasons behind success stories experienced by the interviewees. The preparation of the interview questions was informed by a literature review to note the capacity gaps already identified within the above context. This ensured that this research was not attempting to re invent the wheel.

All the interviews were transcribed and analysed to identify key capacity gaps that hinder the success of post-tsunami recovery in Sri Lanka. The data analysis strategy is based on the principles of content analysis where the concepts related to the phenomena are captured through analysing the contents of the interviews qualitatively. To ensure all the data captured during the data collection stage was treated with care and consistently, the authors used a qualitative data analysis tool namely, NVivo (version 7). This is a computer based qualitative data analysis tool to help organise and analyse qualitative data systematically and transparently.

The next section highlights the outcome of the analysis.

3. Analysis and results

3.1 The analysis process

The first step of the analysis was to identify “concepts” which emerged during the interviews. For this purpose, the interview transcripts were carefully reviewed by the researchers within NVivo while highlighting the main ideas presented by each interviewer for each question asked. These “concepts” were then recorded within NVivo as “free nodes”. Within NVivo a free node represents an idea that has emerged from a data source (in this instance from an interview transcript). Figure 1 below shows the list of free nodes identified within the transcripts analysed.

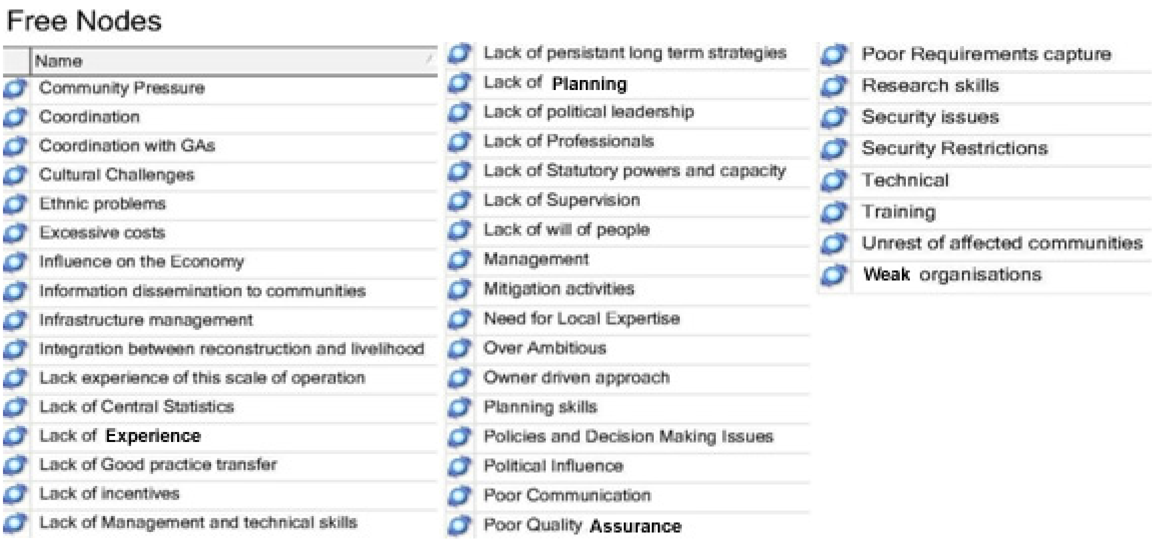

Figure 1- Concepts identified from the interviews as free nodes

Each of the free nodes identified above are based on comments made by the interviewees. While identifying these key concepts as free nodes, NVivo keeps a track of references about which interviewee(s) commented about the concept, and on how many occasions. There were instances where the same concept has been referred to by several interviewees more than one time. For example, lack of planning skills was identified as a capacity gap in 5 occasions by 2 interviewees during the interviews. During the first part of the analysis, these concepts were recorded in free nodes to ensure all collected data was considered in the analysis. The second stage of analysis focused on identifying how these initial concepts map together to answer the research question.

During the second stage of analysis, the initial concepts were mapped with the various aspects of the research question being answered. While the main aim of this research was to identify the main capacity gaps in post tsunami recovery Sri Lanka, the interview guidelines have been prepared to capture various elements of the main issue. For an example, the interviewees were motivated to talk about the capturing post tsunami recovery capacity gaps in Sri Lanka in four main areas. Those areas are:

1. Financing
2. Human resources
3. Institutional (both governmental and non governmental)
4. Skills References

Determination of these four areas is based on the outcome of a literature review, where the key elements of post disaster capacity gaps have been discussed based on previous work in the field. This discussion is considered to be outside of the purpose of this paper and is being prepared to be presented elsewhere.

Further, during the interview process the interviewees were guided towards revealing possible causes for capacity gaps and possible solutions to overcome them. For example, with the help of the focus of the interview guideline, the initial concepts identified in the first stage of the analysis could be converted into a grouped layout, which gives a clearer image about how those concepts map with the research question being answered. In NVivo this grouping of concepts can be presented as “tree nodes”. With the creation of these tree nodes, some key “themes” emerged about post tsunami recovery capacity gaps in Sri Lanka.

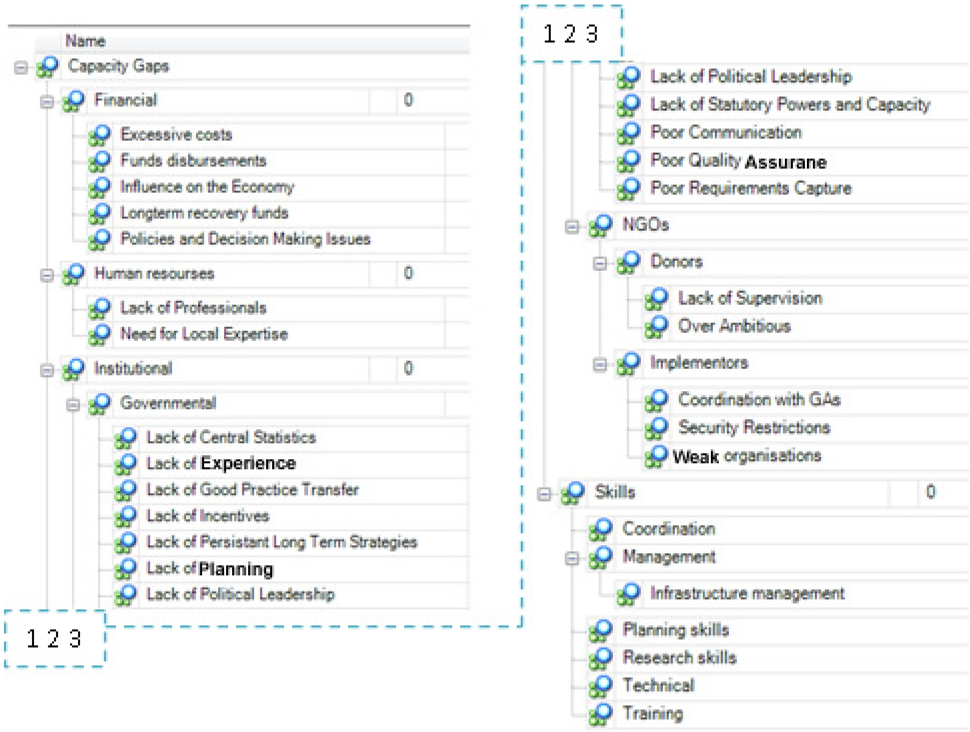

Figure 2 - Key themes organised as tree nodes

In addition to this "grouping", the researchers identified "relationships" within and between the concepts and themes. These relationships lead to present the identified capacity gaps with causal-effect explanations. The identified concepts, key themes and relationships were then modelled using NVivo to understand and represent the results more thoroughly. The next section discusses the results of the analysis in more detail with the help of the models.

3.2 Results

As discussed above, within this research, the capacity gaps in post tsunami Sri Lanka have been investigated in four main areas. The rest of the paper discusses the results of the empirical investigation with reference to these areas of capacity gaps. Further, under each area the results will be discussed with the aim of answering the research question "what are the main capacity gaps identifiable within Sri Lanka while attempting to recover from the devastation of the December 2004 tsunami?" Additionally, the causes and effects related to the identified capacity gaps will also be discussed, where appropriate, through the concepts and themes identified from the interviews.

3.2.1 Capacity gaps related to skills shortages and human resources

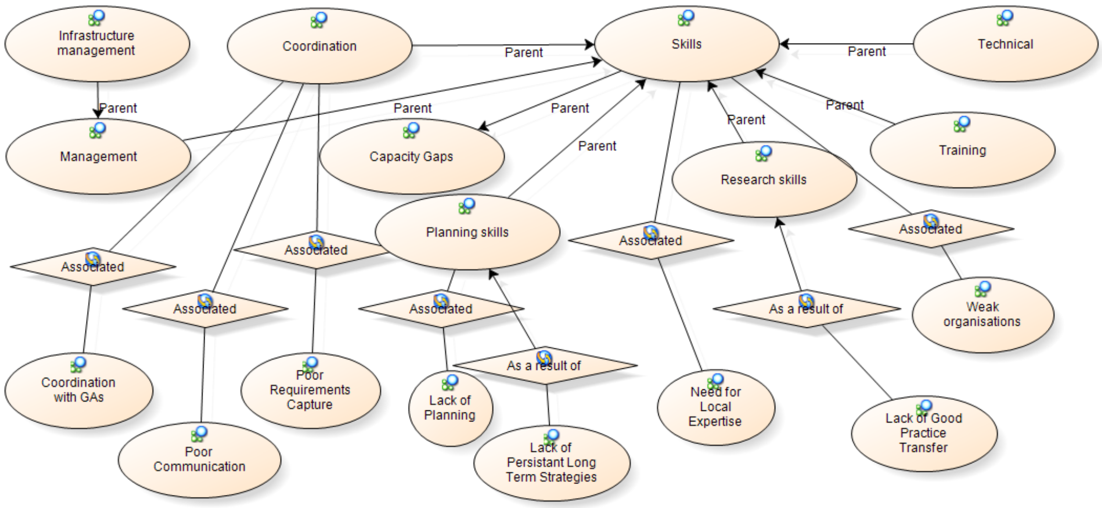

Figure 3 - Skills shortage as a capacity gap - links and relationships

During the interviews, skills shortage has emerged as a main capacity gap in post tsunami Sri Lanka. In fact 18 references were made by the interviewers in 9 occasions about various skills shortages as capacity gaps. As illustrated within the Figure 3 above, 6 main skills areas that require capacity enhancements have been identified from the research. These are:

1. Coordination skills
2. Management skills
3. Planning skills
4. Research skills
5. Technical skills
6. Training skills

Out of these capacity gaps in skills; coordination, management and planning have been identified as key areas of concern. Post disaster recovery attempts in general require a great deal of coordination between various parties, planning of appropriate actions and management of the work. Within the context of this research, the interviewees highlighted significant gaps in the above areas including the requirements capture actions to resettlements. For an example, during the interview, one interviewee pointed out that post tsunami housing reconstruction work in some areas do not appeal to the affected communities as the houses are constructed without giving much attention to the infrastructure availability within the area. In another interview, the same point was raised and highlighted the fact that some of the affected communities are not willing to be settled in the newly built areas as they were constructed without giving due consideration to the livelihoods of the affected communities (e.g. fishermen are reluctant to be relocated away from the coastal area). This highlights that the relevant authorities have not demonstrated required planning, coordination and management skills within the context of post tsunami recovery in Sri Lanka. Highlighting a planning issue, one interviewee commented that there is a visible lack of persistent long term strategy to implement the post tsunami recovery actions in Sri Lanka. For example, the interviewee pointed out that the government had to change its position on the costal buffer zone consistently to address the issues such as the community pressure. Had this strategy been reviewed thoroughly before the decision, the actions could have been implemented more successfully. These issues are not visible only in government authorities. In fact the interviewers have highlighted that fact that these issues exist in government authorities, donor agencies as well as in NGOs who are involved in post tsunami recovery actions. This issue will further be discussed under the section 3.2.2 below.

In addition to the skills gaps identified above, the capacity gaps in research and training have also been identified as shortcomings to implement successful post tsunami recovery actions. In terms of the capacity gaps in research, the interviewees felt that in general, the research activities are under-funded in Sri Lanka. Some interviewees specifically identified that disaster management research and training activities in Sri Lanka were not especially strong before the tsunami. Even though there is evidence to support improved research and training activities related to disaster management recently, interviewers raised their concerned about the current research and training capacities in Sri Lanka to deal with the demands of post tsunami recovery activities.

It has also been identified that some of the required technical skills for post disaster recovery in Sri Lanka are lacking. Interviewees commented especially about the shortage of construction technical skills in post tsunami Sri Lanka to cater for the massive demand created with the start of the post tsunami reconstruction work. As an example, two interviewees mentioned that labour rates in construction has risen sharply recently, demonstrating a shortage in skilled labour. Further, particular emphasis has been drawn to the fact that there are tsunami affected areas where the security problems exist due to the ethnic problem in Sri Lanka. Due to the reluctance of skilled construction workers to work in these areas, a prominent technical skills shortage exists.

As mentioned above, these skills shortages are not limited to one particular organisation, group or sector. Rather these have been identified in various authorities and institutions that perform main roles in post tsunami recovery activities in Sri Lanka. As such, the next section discusses the institutional skills gap identified within the post tsunami Sri Lanka.

3.2.2 Institutional and financial capacity gaps

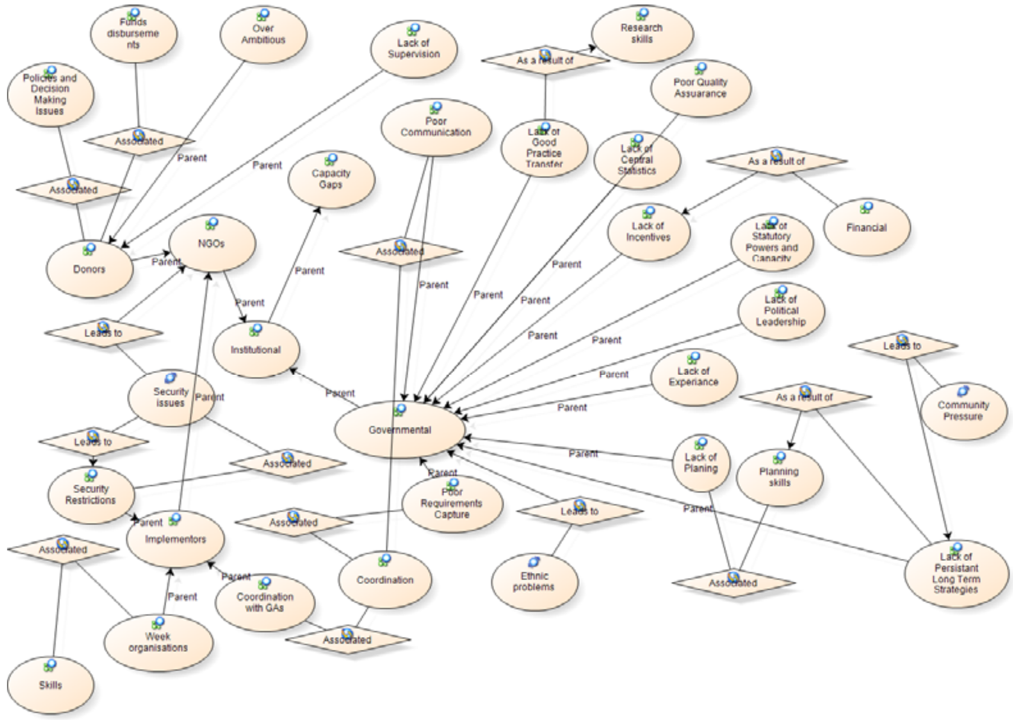

Figure 4 - Institutional capacity gaps identified within post tsunami Sri Lanka

Figure 4 above highlights the key institutional and financial capacity gaps and causal – effects relationships identified within the context of the research. Primarily, the institutional capacity gaps have been identified within two main groups of organisations involved within the post tsunami recovery context. These are:

1. Governmental organisations – These are the government owned organisations that carries the authority and responsibility for the overall post tsunami recovery strategies and actions.
2. Non-governmental organisations – These are the organisations that are involved within the post tsunami recovery process, outside the governmental direct control.

Out of these two groups, governmental organisations have been the most cited with relation to the areas of lack of institutional capacity in implementing post tsunami recovery actions. In fact, 8 areas of concerns have been cited by the interviewees in 16 instances, through 21 references. The areas of concern are:

- Lack of central statistics
- Lack of experience
- Lack of good practice transfer
- Lack of incentives
- Lack of planning
- Lack of communication

- Poor quality assurance
- Poor requirements capture

Out of these areas, lack of planning and poor communication has been cited frequently by the interviewees. This coincides with the discussion presented within the section 3.2.1 above, where these have been identified as the main capacity gaps related to the required skills. In addition poor quality assurance has been identified as an area where the government institutions show significant capacity gaps. For example, one interviewee highlighted that, despite the existing policies about construction quality, the houses constructed and allocated for effected communities varies significantly in terms of their quality, questioning the capacity of authorities to check and enforce the expected quality levels. During the investigation it was identified that the lack of experience to deal with the scale of the December 2004 tsunami was a main cause for the governmental organisations to demonstrate capacity gaps in various areas. For example, during the last 2 centuries Sri Lanka had not experienced a tsunami on any scale. This fact itself justifies, to a certain extent, why Sri Lankan governmental organisations were not able to handle a post disaster recovery attempt of this scale. Furthermore, this leads to the fact that the country is not ready with required central statistics to effectively handle the demands of this recovery attempt. One interviewee commented that the number of constructed houses in one of the relocation areas is greater than the affected communities in the surrounding. This highlights that the planning and requirement capture capacities of the relevant authorities were not optimal in this particular instance, and at the same time it highlights the issue of lack of central statistics about those affected.

From the non-governmental organisations' (NGOs) point of view, the institutional capacity gaps have been identified in two perspectives. The NGOs operate in post tsunami Sri Lanka under two capacities; as donors and implementers. From the donor's perspective, a number of interviewees have mentioned their rigid policies and decision making capacities on funds disbursement as a main capacity gap. As the interviewers pointed out, most of the time, the donors are less flexible with funds disbursement. Most donors prefer to fund short term relief actions and allow fewer funds for long term recovery actions. And often the donors were criticised for being over ambitious leading problems in implementing recovery actions. These gaps have been identified not only as the capacity gaps in donor organisations, but have been continuously discussed under the financial capacity gaps that post tsunami Sri Lanka is facing.

When an NGO operates as an implementer for post tsunami recovery actions, most of the capacities required are connected with reconstruction work. The main problem identified by the interviewees in this regard is their incapacity to carry out relevant reconstruction work in some areas due to security issues. Due to the ethnic problem prevailing in Sri Lanka, some of the worst tsunami affected areas cannot be reached by the organisations who are carrying out the reconstruction work. This hinders the effectiveness of such programmes. Moreover, some interviewees commented that some of these organisations demonstrate poor communication and coordination capacities especially when maintaining the link between the government authorities and themselves. Since the same is visible within governmental organisations, these organisations need to monitor the situation carefully to overcome this issue.

While essential, identifying the main capacity gaps which hinder the post tsunami recovery attempts in Sri Lanka is just a starting point. As discussed above, most of these capacity gaps have roots in problems which go beyond the scope of disaster management. It is therefore the role of the parties involved to analyse these factors and gaps in detail prior to embarking on post tsunami recovery actions.

4. Conclusions

Identifying capacity gaps is an essential task for Sri Lanka to overcome the problems they face with their post tsunami recovery attempts. It is evident that the government had ambitious plans and high expectations for speedy recovery but with less success rate. The capacity gaps existing in various scales under various organisations and circumstances have been identified as influential factors limiting the success of post tsunami recovery actions in Sri Lanka. Among other factors, various skills shortages such as coordination and planning skills have been identified as main capacity gaps which need immediate attention. Further, some of these capacity gaps in skills have led to the country to demonstrate capacity gaps in human resources such as lack of construction professionals and skilled construction workers.

In addition to the capacity gaps identified in general as above, institutions involved in the post tsunami reconstruction activities are also suffering from institutional capacity gaps. Among these, governmental institutions suffer from capacity gaps such as lack of central statistics and poor quality assurance. From the perspective of non-governmental organisations such as donor agencies and implementing organisations, a lack of coordination, security restrictions and policy issues have been identified as the main areas of concern. Dealing with donor organisations, unrealistic ambitions, rigid funding policies and lack of coordination with government organisations have been identified as issues which are needed to be addressed and at the same time as leading to financial capacity gaps that Sri Lanka is experiencing within the context of post tsunami recovery.

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Study of factors affecting Post Disaster Housing Reconstruction

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Abstract

Disasters are now considered as one of the biggest obstacles to sustainable development and social security of nations. Sri Lanka is prone to natural disasters such as floods, landslides and drought. In December 2004, Sri Lanka was hit by a Tsunami that affected severely. Recovery is a momentous challenge with less experience in large scale post disaster reconstruction. In this research paper, factors affecting for delays in housing reconstruction programme in Sri Lanka and related issues are addressed. Data were gathered through interviews from government organizations, NGOs and affected communities. The findings reveal various reasons that prolonged post Tsunami reconstruction and disturbances caused to smooth flow of reconstruction process by certain gaps. Inconsistencies of post Tsunami housing policy, land titles, government's lack of planning and recovery strategies, enforcement of buffer zone are the main factors affecting post Tsunami housing reconstruction programmes in Sri Lanka.

Keywords: Tsunami, Housing Reconstruction, factors , Disaster

1. Background

The world is immensely experiencing intensity of disasters – natural and man made - with devastating impacts. When a disaster strikes individuals and communities are affected, by seriously disrupting normal functions. The disasters cause widespread human, material and environmental losses. As reported by the Secretariat of International Strategy for Disaster Reduction [1], the last ten years saw 478,100 people killed, more than 2.5 billion people affected and about US $ 690 billion in economic losses caused by disasters. Disasters trigged by hydro-meteorological (weather related) hazards amounted for 97% of total people affected by disasters, and 60 % of total economic losses [2].

While the number of geophysical disasters - earthquakes, Tsunamis and volcanic eruptions - has remained steady, number of hydro-meteorological events – including droughts, windstorms and floods- has more than doubled since 1996. This could be linked to climatic change and scientists predict that global warming will result in more extreme weather patterns. [3]. Therefore, challenges of recovery from natural disasters will be with us for an unforeseeable future, with the need for effective post disaster response strategies.

On December 26, 2004 the deadliest Tsunami known in the history hit Sri Lanka, triggered by a massive earthquake of moment magnitude 9.0- largest earthquake recorded in 40 years. According to the Joint Report of the Government of Sri Lanka (GoSL) and Development Partners 35,322 people were killed, 1,000,000 people were displaced and over two thirds of the island’s coastline was affected by the Tsunami. [4]. Sri Lanka faced a big challenge in rebuilding the nation as a country that had not previously experienced such a disaster.

Relief, recovery, rehabilitation and reconstruction are the main activities in rebuilding an affected nation, where Government and Non Government Organizations are main stakeholders. However, as reconstruction and rehabilitation proceeded it is clear that moving from immediate relief effort to addressing the massive reconstruction tasks. Reconstruction involves different tasks and a set of large scale complex challenges. Donor-driven and owner driven are the main housing reconstruction programmes that are observed in current post Tsunami reconstruction process. Whether reconstruction of housing started at proper time, executed properly to achieve appropriate recovery of livelihoods as the planned output are some of the major factors affecting the success of the reconstruction process. Also, it is evident that the need for effective reconstruction and rehabilitation has reduced through time. A careful and in depth consideration is necessary to ascertain successfulness of the reconstruction process. Identification of challenges which delay reconstruction programmes will help in achieving better future for affected communities. As natural disasters are recurrent in Sri Lanka, in depth understanding of post-disaster reconstruction processes will help facing another disaster. This research paper addresses issues related to post Tsunami housing reconstruction in Sri Lanka.

2. Research Methodology

Interviews, semi-structured and unstructured, were conducted with governmental and non-governmental organizations and communities to collect data on post Tsunami housing reconstruction work to identify involvement of various stakeholders in reconstruction processes, their successfulness and factors which hindered progress such post Tsunami housing reconstruction work. Leading government and non government organizations, each numbering 5, were selected for the interviews. House owners from owner driven and donor driven housing reconstruction programmes were also interviewed.

3. Survey Findings: Factors affecting post Tsunami housing reconstruction

Several factors affecting related to post -Tsunami housing reconstruction programmes were identified through interviews, which are discussed below under several topics.

3.1 Inconsistencies in Tsunami housing policy

<u>Tsunami Housing Policy</u>

Tsunami housing policy consists of three phases as imposing of a buffer zone, relaxation of the buffer zone and the conversion programme.

a. Imposing of buffer zone or setback zone - Phase I

After the Tsunami, the government adopted a "no development" 100 meter buffer zone policy for districts of Kilinochchi, Mannar, Puttlam, Gampaha, Colombo, Kalutara, Galle, Matata and Hambantota; and a 200 meter buffer zone for districts of Jaffna, Mullaitivu, Trincomalee, Batticaloa and Ampara. The policy prohibited any new construction of buildings (permanent or temporary), reconstruction of completely or partially damaged buildings, and additions and alterations to existing undamaged buildings within the buffer zone. The introduction of buffer zone led to two types of housing programmes. They are:

Home Owner-driven housing reconstruction (In-Situ)
Donor-driven housing reconstruction (Relocation)

Home owner-driven housing reconstruction programme (in-situ)

Damaged (fully or partially) houses located within the buffer zone were repaired/reconstructed at the same premises. The GoSL provided grants provided by development banks and bilateral donors to affected homeowners to reconstruct their houses. The financial criteria included an assessment of damages on a point basis where a house deemed to be more than 40% damaged would qualify for a grant of Rs. 250,000 in four instalments, based on progress. A grant of Rs. 100,000 was made available to rebuild a house damaged less than 40%, in two instalments. However, as revealed by house owners, high costs of raw material and labour charges made it impossible to complete a house with such amounts at phase 1.

Donor-driven housing reconstruction programme (relocation)

Donors, of private, government and non government sectors, local and international, built or assisted in building houses at relocation sites for families who lived within the said buffer zone. The donors provided each new settlement with an internal common infrastructure while GoSL provided utility services up to the relocation site. The beneficiary remained the legal owner of his/her property within the buffer zone and received a full title to the property at the resettlement site, as well.

The buffer zone of 100m and 200m was revised in late 2005 and in April 2006, the RADA issued a revised housing policy. Enforcement of the buffer zone retarded commencement of reconstruction programmes by more than six months. Due to lack of reconstruction activities in Sri Lanka, some donors left with their unutilised grants to other Tsunami affected countries. Sri

Lanka missed a considerable amount of such intended grants while completion stages of reconstruction programmes are affected due insufficient funds.

As per the MoU signed by the government and some NGOs to carry out donor driven housing reconstruction programmes, GoSL was to provide lands to donors to construct houses and also to provide utility services up to such relocation sites. Delays in providing them caused further delays in providing necessary assistance by donors when constructing houses.

b. Relaxation of buffer zone - Phase II

In 2006, GoSL revised its post Tsunami housing policy by relaxing the buffer zone along with a "Revised Tsunami Housing Policy". Buffer zone relaxation changed numbers of housing units falling within one type of housing reconstruction programme to the other. Revision of buffer zone created immense confusion amongst beneficiaries. Only a few realised clearly about their housing entitlements at the beginning. With the switch from one scheme to the other, district/divisional secretariats had to revise lists of beneficiaries falling under each particular scheme. In addition, government had to arrange fresh funding sources and allocate funds for additional new beneficiaries.

c. Conversion programme – Phase III

Phase three of permanent housing reconstruction programme is the conversion programme. Major facts in the revised Tsunami housing policy are as follows.

<u>Revised Tsunami Housing policy</u>

* Government land + donor built house under a donor driven housing programme primarily for those who lived within the previous buffer zone.

* Government land + a government cash grant (Rs.250,000) to construct a new house + donor assistance to complete a house (not less than Rs. 250,000 depending on costs to meet a minimum standard) through a co-financing agreement.

* Government cash grant (Rs. 150,000 for 3 divisions in Ampara and Rs. 250,000 for Colombo) to purchase a land + government cash grant (Rs. 250,000) to construct a house + donor assistance to complete a house to a minimum standard) through a co-financing agreement.

* A housing reconstruction grant (Rs. 250,000for fully damaged and Rs. 100,000 for partially damaged houses) + donor assistance to complete only a fully damaged house to a minimum standard, through a co-financing agreement.

It allowed families to take government grants and build their houses at relocation sites. It included extended families, lessees and squatters. At phase III, house owners were granted a number of installments by co-finance agreements between GoSL and donors. Though the first instalments were released rapidly, subsequent instalments were subjected to thorough verification and approval processes. In some cases, monitoring visits and approval processes have taken much time which lead to small gaps in the reconstruction process.

d. Co-financing policy

According to the revised housing policy, NGOs and INGOs co-funded reconstruction of partially damaged units. The co-finance policy formulated by GoSL stipulated an equitable approach and recommended to address funding needs of most vulnerable families with regard to reconstruction of fully damaged houses. However, in practice this policy was not followed. Approaches implemented by co-financing agencies are built compensatory framework.

e. Rules on selecting contractors to reconstruction process

Government stated in the MoU that NGOs should select only contractors who have registered with the Institute for Construction Training and Development (ICTAD) to carry out housing reconstruction programmes. By that time, some donors have already started reconstruction programmes with the participation of affected communities themselves (community based system) in certain districts such as Galle. There was stoppage of work due to this rule which was later it was discontinued with.

Contractor selection for donor driven housing reconstruction programme was done by NGOs themselves. Thus, there was a tendency was to select the lowest cost rather than such other factors as quality. Hence, this necessitated some defected reconstructed houses to be demolished.

3.2 Conflicts on land titles

In the post Tsunami housing reconstruction process in Sri Lanka, donors were given lands to construct houses in donor driven housing programmes. For owner driven housing programmes, their own lands were used, while at phase III, house owners were allowed to buy lands from grants provided.

Scarcity of land

After imposing the buffer zone, GoSL was unable to provide sufficient lands for relocation housing projects because of scarcity of land. According to MoU signed by the donors and GoSL, it states that number of housing units agreed to be reconstructed by donors will also be determined by the availability of land. There are about 2880 damaged units that not relocated due to scarcity of land within Colombo.

Inappropriate conditions of provided land

Government provided marshy, futile lands to construct houses for some donors funded projects. It was necessary for donors to develop the land before constructing houses. However, donors did not accept to develop lands as according to the MoU, land and infrastructure development was to be carried out by the government. Due to insufficient funds, the government failed in that, and therefore, later the donors had to develop lands. A considerable time was taken to arrive at a decision through discussions. Besides, by engaging in additional works of land development, donors were unable to complete number of housing units they agreed to reconstruct. They spent more time on revising budgets several times as they had to spend more for constructing a house including land development. There is a special issue in the case of Homagama-Kahathuduwa housing reconstruction project, experienced by the Red- Cross Society. They were asked to construct 700 units as flats while the affected community preferred single storey houses. The land was sufficient for only about 350 single storey houses. Hence, none of the donors agreed to fund construction at that site. Even after more than 2 ½ years, still the construction has not started.

Land acquisition

Government provided both state owned and acquired private lands to donors to construct houses under donor driven housing programme. However, some land owners initiated legal actions against such acquisitions. Due to court orders some housing projects were discontinued with. It has taken a considerable time to solve these problems legally. Due to such, donors were unable to start reconstruction processes which ultimately has created gaps.

3.3 Ineffectiveness in monitoring funds

NGOs were allowed to manage funds themselves in the reconstruction programmes. Corruption has taken place in managing these funds which ultimately reduced the actual amounts made available for reconstruction. Actual amount of funds received by house owners also diminished in similar fashion due to absence of government monitoring. As emphasized by RADA, some house owners were over granted while others were inadequately granted. Total funding requirement for the owner driven programme is Rs. 10,690 million as they estimated in end of 2006.

3.4 Insufficient capacity of the construction industry

Capacity of the construction industry in the aftermath of Tsunami in terms of professionals, material, labour etc. was insufficient to carry execute construction smoothly due to high demand. Prices increased due to lack of material, labour etc. Due to high inflation rates also, house owners were unable to complete reconstruction of houses within limited grants in phase I of housing reconstruction programme. Specially for international NGOs, it was difficult to complete number of houses due to the complex situation of the construction industry in Sri Lanka. In addition, they had to hire technicians from foreign countries to carry out construction work.

3.5 Affected community’s crappy behaviour

As experienced by the National Housing Development Authority which assessed damages for compensation, conflicts have arisen when identifying houses as partially and fully damaged. In some cases, house owners have damaged their houses to obtain Rs. 250,000. Houses were built in different standards, sizes and costs by agencies and donors for a great variety of reasons. Some families received government grants as well as many other grants from agents while others received little or no grants at all. This resulted in inequity in districts, leading to social/communal tensions. As a result, beneficiaries were switching donors or waiting for the “best offer”, delaying the reconstruction process. Some house owners misspent their grants. It also delayed the process and raised complexity for NGOs in handling funds.

3.6 Government’s lack of planning and recovery strategies for post Tsunami reconstruction

Absence of a quality control system in donor driven housing reconstruction programmes has led to many issues. Due to inferior quality, some of the houses constructed by donors have been advised to be demolished and reconstructed, specially in the Galle district. It is stated that a policy is being drafted in respect of providing grants to people who live in inferior quality donor driven housing programmes to rectify damages, and enhance quality of constructions. Establishment of organizations such as TAFREN, TAFRER, RADA etc. to implement reconstruction programmes with less experience in housing has resulted in lowered effectiveness. Absence of the National Housing Development Authority in carrying out housing reconstruction programmes is a significant point of interest, as the NHDA is a well experienced mass scale national house builder.

Although it is stated in the MoU that donors shall enter into contracts with ICTAD registered contractors and that the work should confirm to ICTAD specifications, it is a questionable feature to note inferior quality in reconstructed houses.

3.7 Lack of communication and coordination among stakeholders

While some house owners eligible for to receive donor driven reconstructed houses continued to live in temporary housing, those who were ineligible have been granted with such reconstructed houses. It was also noted that while some affected families who are entitled to be relocated under donor driven housing programmes have been assisted with rebuilding, others who were eligible to rebuild with grants under the owner driven housing programmes have been relocated.

There were difficulties in coordination with more than 200 organisations involved in reconstruction programmes all over the island. Signing MoUs at both national and district level has led to several difficulties such as reconciling commitments and progress; NGOs were inconsistent in reporting progress and attending coordination meetings. Some information at national level is ambiguous and resulted in misinterpretations at district levels. Furthermore, frequent cancellations of coordination meetings have caused many gaps in a continuous programme. This is evident by oversupply of houses in the South with an approximately 6,000 housing units. NGOs emphasized that within a project team conflicts have arisen as different parties are involved with their own objectives, in the process. Specially, some foreign elements possessed private agendas over the post Tsunami reconstruction programme of Sri Lanka.

3.8 Existence of hostilities

Due to the conflict/ violence in the North and East provinces, gaps have occurred in both categories of reconstruction programmes. From distributing subsidies to completion of permanent shelters, gaps have occurred at certain phases of the reconstruction process. According to NGOs, difficulty in access, refusal to allow construction companies to function, inadequate facilities for NGO staff and labourers, restrictions on transportation of building materials are the main reasons. Both time and money has been wasted due to repetition of construction works from the damages occurred over the civil war. Worldvision, a NGO, emphasized that after building about 40 foundations for a relocation housing site in Sampoor, they were moved due to security reasons and restart the construction works. Both time and money has been wasted due to inaccessibility.

4. Conclusions

Successfulness of the post Tsunami recovery largely depends on successfulness of the housing reconstruction programmes. Family is the basic unit of the society and need to be recovered well in moving to develop a country. The findings by survey revealed that various reasons have prolonged post Tsunami housing reconstruction processes in Sri Lanka. Smooth flow of construction process is disturbed by certain gaps that occurred through out the reconstruction programme.

Relocation housing programmes are delayed mainly due to unavailability of appropriate lands to build large housing schemes, unavailability of clear beneficiary lists for consultation, unwillingness of beneficiaries to be relocated and inadequate provision of infrastructure by government and unavailability of good construction companies. Donors were unable to complete the number of units pledged due to challenges of the construction industry, complexity of work, high inflation, rates of row material and labour etc. After relaxation of buffer zone some families preferred to return to their own lands even though they were provided with houses built under donor driven housing programmes. Some donor driven houses are unoccupied, to date due to this. Absence of a technical quality control system in donor driven housing programmes is another major issue. It resulted in inferior quality houses funded by donors. Some of those houses were demolished and reconstructed, wasting both time and money.

Owner driven housing reconstruction programme is affected with gaps mainly due to insufficient grants. Specially in phase I, house owners were provided with a maximum grant of Rs. 250,000 to reconstruct houses. It was not sufficient due to high inflation and increasing prices of construction material, labours and professionals charges etc. To overcome this, the government changed the way of granting at phase III. However, there were lot of equity issues. Absence of government in handling regarding top up grants is the reason behind this. In some instances, the beneficiaries have misspent grants on alcohol etc.

In addition to that, all reconstruction programmes were affected by inadequate technical capability and unclear delegation of responsibilities among divisional, district and central government agencies and lack of coordination among community and various other parties such as affected/non-affected communities, INGO, NGOs, private sector, donors etc. Enforcement of the buffer zone delayed the housing reconstruction programme for about six months. Due to lack of construction activities, some donors left Sri Lanka and missed a considerable amount of grants which now delay the latter stage of the reconstruction programme. In the first phase, community based reconstruction is not allowed and some donors and communities who started the construction works face certain problems there. Declining security situation is the main reason for the slow progress of housing reconstruction in North and East provinces.

Absence of a government entity to control grants has caused equity issues all over the country. Government, as the leader role in reconstruction programme has to be more concerned regarding involvement in reconstruction programmes in depth. Due to absence of any programme regarding this, there are no records regarding top up grants and it is difficult to manage due to this. Furthermore, absence of clear records about how much the reconstruction programme cost to the country is a point where considerations have to be paid.

A huge amount of money from foreign countries/local donors as funds is misspent due to inefficiency of the government to handle a reconstruction programme. Hence, opportunity given by the Tsunami to develop the country has not been optimized. Number of completed houses can be used only to measure progress or successfulness of a post disaster housing reconstruction programme. Post disaster housing reconstruction programmes has to be more humanitarian than other developments. The ultimate goal of post disaster reconstruction processes shall be to attain a standard of living that is even better than what existed before the disaster. As a large scale disaster, the Tsunami is a completely new experience to Sri Lanka. Therefore, conducting a 100% successful housing reconstruction programme can not be expected. In the present context, shortcomings of post Tsunami housing reconstruction process have realized by government authorities and other responsible persons up to a certain extent. However each person who involve in post disaster reconstruction process have to be knowledgeable on their responsibilities, capacity to achieve the goal of reconstruction in moving to development goal of the country.

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Economic development perspectives of post-disaster infrastructure reconstruction in Sri Lanka

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Abstract

Sri Lanka was found to be a disaster prone country in the recent past. The impact is more severe when developing countries are faced to various natural or man-made disasters. Impact appears in many forms; loss of lives and property, economic impact, social impact etc. As a developing country, Sri Lanka is much more concerned with the country's economic development. Therefore, it is wise to look into post-disaster activities in development perspectives and integrate disaster risk reduction concerns into economic development activities. This paper reveals the importance of post-disaster infrastructure reconstruction in economic development. A comprehensive literature review was carried out regarding the role of infrastructure in disaster management, economic development together with the key indicators of economic development.

Keywords: Tsunami 2004, Disaster management, Post-disaster infrastructure reconstruction, Economic development.

1. Background

The whole world is prone to natural disasters. Developing countries are faced with various natural risks leading to disasters, which cause immense loss of life and property [1]. The Tsunami of 2004 is enough to substantiate this argument. Disasters, man-made or natural, aggravate inequality and hinder progress towards the 'development goals'. Many researches have concluded that disasters damage the entire economy of the country including physical and human resources when disasters predominantly exist in the developing countries [2 and 3]. An average of 354 natural disasters occurred a year in the period 1991 to 1999. From 2000 to 2004, this rose to an average of 728 a year. The total number of people affected each year has doubled over the last decade. However, the most noticeable thing is, most of the victims are from developing countries [2 and 4]. Of the world's ten most severe natural disasters in 2004, five occurred in the Asia and Pacific Region, causing damage amounting to $55 billion, about 70 percent of the total damage, estimated at $80 billion [2].

Sri Lanka has experienced frequent natural hazards commonly caused by floods, cyclones, landslides, droughts and coastal erosion for generations with increasing losses to life and property in the past few decades [5]. Moreover, the tropical climate and heavy rainfalls, the climatically differentiated 'dry-zone', which subjects it to periods of drought while seasonal monsoons regularly bring about flash floods, river floods and storm surges in certain parts of low-lying river basins can also be seen. The Mahawansa' (Sri Lanka's ancient history chronicle dating from the Sixth Century) tells of a wall of water flooding the land 2,000 years ago. The undersea earthquake near the west coast of Northern Sumatra set off a series of other earthquakes, in December 2004, which led to a widespread disaster. The Tsunami in 2004, particularly in Sri Lanka, India, the Maldives, Indonesia and Thailand, also caused damage in Malaysia, Bangladesh, Somalia, the Seychelles and Kenya. The devastation caused by the tsunami in 2004, however, took Sri Lanka by surprise, warning that Sri Lanka is also vulnerable to low-frequency, high impact events causing extensive damage [5 and 6]. Sri Lanka faced one of the worst natural disasters with a large proportion of losses in housing and infrastructure. The destructive ocean waves killed more than 35,000 people and displaced nearly 2,500,000 people in Sri Lanka. The coastal infrastructure, namely roads, railways, power, telecommunications, water supplies and fishing ports were also significantly affected. The damage to its infrastructure is estimated to be over $1.7 billion [7]. As more infrastructure, is developed in rural areas, to combat poverty, and as the frequency and severity of natural disasters increase, the impact on the poor will become more critical [8].

2. Enormity of impact on infrastructure due to recent natural disasters

Natural catastrophes destroy essential rural infrastructure. According to Munich Re 1998, Asia, which accounts for half the number of the natural catastrophes in the world and 70% of all floods, the average annual costs of floods over the past decade is approximately 15 billion USD [8 and 2]. Much of the damage inflicted by floods is to the infrastructure [8 and 2]. By some estimates, infrastructure loss accounts for 65% of all flood loss [8 and 2]. For Asia, this would account for an average annual infrastructure loss of approximately 12 billion USD for the past decade [8].

If the size of the loss to infrastructure is compared to the worldwide lending activity of the World Bank, approximately 50% of the World Bank's total lending is equivalent to the total cost of damage to infrastructure due to natural disasters in the Asian context [8 and 2]. Over the past decade, the Bank has annually loaned approximately 25 billion USD [8]. The annual investment needed for post-disaster reconstruction of infrastructure and economic recovery in developing countries of the Asia and Pacific region would require an estimated $15 billion, for a total infrastructure-financing requirement estimated at $55 billion per year [2].

3. Disaster management and infrastructure reconstruction

3.1 What does infrastructure mean?

The term ‘infrastructure’ has different meanings in different fields. Infrastructure is generally structural elements that provide the framework supporting an entire structure. Infrastructure appears in many forms as economic infrastructure, social infrastructure, IT infrastructure etc. Economically infrastructure could be seen to be the structural elements of an economy, which allow for production of goods and services without themselves being part of the production process.

Economic infrastructure primarily consists of transportation (road, railways and bridges), energy and utilities (electricity, gas), water supply and sanitation services, telecommunication systems, health services and essential government services. The economic infrastructure system is composed of manifold elements. These are organised in hierarchical levels.

- Level of sectors (Ex: Energy, Information & Telecommunication, Transportation)
- Level of infrastructures (Ex: In Transportation: Road, Railway, Waterway, Postal)
- Level of components (Ex: In Railway Tracks, Stations, Control Centres, Vehicles)

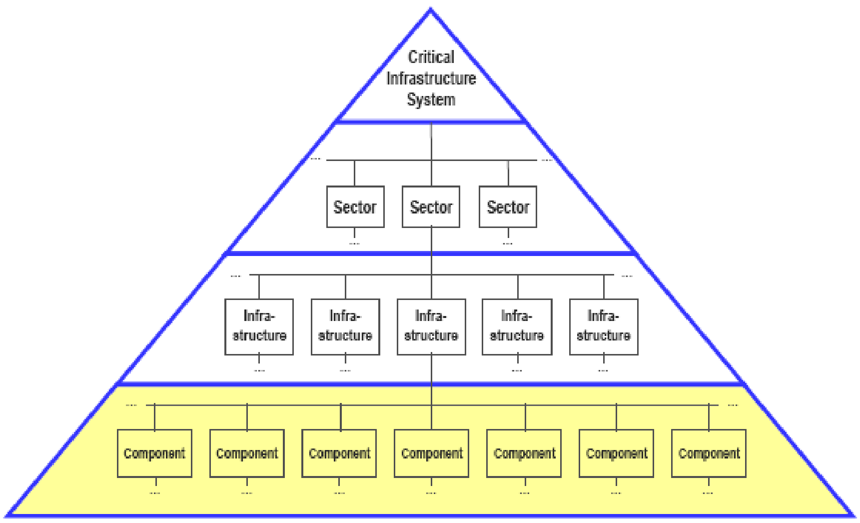

Figure 1: Critical Infrastructure System [Source: 9]

Social infrastructure consists of health, education, safety nets etc. However, in other applications, infrastructure may refer to information technology, informal and formal channels of communication, software development tools etc. The term “critical infrastructure” has been widely adopted to distinguish those infrastructure elements that, if significantly damaged or destroyed, would cause serious disruption to the dependent system or organisation. Natural disaster damage leading to the loss of certain transportation routes in a city (for example, bridges crossing a river), could make it impossible for people to evacuate and for emergency services to operate; these routes would be deemed critical infrastructure. Critical infrastructure is broadly defined to include the systems, facilities and networks, which support the health, safety and economic well-being of the population, during and after natural disasters [2].

This paper deals with the economic infrastructure, which comes to the society as an output of the 'construction industry'. The infrastructure of a country is part and parcel of the construction industry. Morton (2002) stated that on the whole, the built environment is designed, built and maintained by the construction industry, which includes civil engineering and infrastructure work such as roads, bridges and railways [10]. Construction is the one industry most likely to be beneficially impacted, at least in terms of increased activity, by an actual disaster [11]. Natural hazards potentially cause severe damage to buildings and infrastructure, resulting in considerable post-disaster construction. On the other hand some argue that in the longer term a major natural disaster can even generate a construction-led economic boom, for example Albala-Bertrand, 1993 [11].

3.2 What happens if infrastructure fails during disasters or if post-disaster infrastructure reconstruction process fails?

Infrastructure is critical to a safe and a resilient economy. Natural or even man made disasters have a profound impact on the quality of life through various means, such as the destruction of aspects of the built environment [2]. Therefore, a sudden disruption of infrastructure affects the whole humanity. Creation of significant negative consequences to infrastructure together with other built environment facilities due to disasters would lead to pathetic economic consequences and depauperated quality of life often for long periods of time [12]. There is a more limited sense of their broader macroeconomic significance or the problems they could pose for longer-term development [13]. This is partly because most assessments of the economic impacts of disasters have concentrated on the most easily measured direct losses and the practical difficulties of isolating and measuring the indirect and secondary impacts that result from the transmissions of a disaster shock through the economy [13]. Thus, when events such as natural disasters destroy infrastructure, their opportunity cost becomes painfully evident [2].

'Ignorance of infrastructure' affects the society in many ways. It exacerbates civil imperfections, demoralizes staff working in remote locations, mainly in vulnerable areas and thus further delays the process of state rebuilding, and undermines the effectiveness of the rebuilding process [14]. It also leads to poverty, hunger and infectious diseases [14]. Moreover, infrastructure failures can act on gender and other aspects of identity and exaggerate powerlessness, vulnerability and disability [14]. Admittedly, due to the strong dependency of society on goods and services provided by critical infrastructure, their failure may lead to disaster [9]. Poorly planned development can turn a phenomenon into a human and economic disaster. Infrastructure failures in the post-disaster period can become the fundamental reason for another series of devastating effects followed by other natural disasters. Whilst infrastructure can increase productivity, reduce the cost of production, increase trade and reduce poverty, it can create major disasters or can enhance the effects of one in a completely negative manner.

3.3 Role of the construction industry in managing disasters: Special emphasis on infrastructure

Ofori [3] has documented the importance of develop the construction industries of the poorer nations in order to equip them to manage disasters. Although the developed countries are considered to be well prepared to tackle disasters there are instances where even developed countries lacks the proactive measures to prevent them. For example, Bosher et al. [10] report that the construction industry in the UK does not appear to play a sufficiently integrated role in emergency management.

At the disaster reduction/mitigation phase, where the population returns to pre-disaster standards of living after the event, people recognise the need for certain measures, which may be needed to make the impact less severe during the next similar event. Investment in the infrastructure for disaster management is essential in this context as it can result in reduced loss of lives. The physical infrastructure can be developed to withstand disasters, reduce and even prevent damage from natural disasters [2]. For instance, drinking water systems can be very effective for flood management [2]. Infrastructure reconstruction programmes should however aim to change the vulnerable conditions for the development of the country. Reconstructing the infrastructure is often essential to sustain recovery after major disasters [14]. Moreover, critical infrastructure reduces the risk of failure and thus contributes to disaster reduction and prevention [9]. Investment in the infrastructure for disaster management is essential in this context. At the same time, it is necessary to explore the management of infrastructure systems and an association between natural disaster reduction/mitigation with infrastructure management and development.

As Asia and Pacific regional cooperation in developing the physical infrastructure for disaster management has so far been limited, the ‘United Nations Economic and Social Commission for Asia and the Pacific’ has recently declared their priority concerns on rebuilding infrastructure and investing in infrastructure for disaster prevention and preparedness [2]. The increased frequency of major disasters, such as the December 2004 tsunami and earthquakes in Gujarat, India; Bam, Islamic Republic of Iran has underlined the importance of technical cooperation in the region for developing better physical infrastructures [2].

It is claimed that the developing countries are less able to face the impacts of disasters and so it is imperative to develop the construction industries of the poorer nations in order to equip them to manage disasters [3]. The prevailing demand for development of infrastructure of the poorer nations is apparent as infrastructure can facilitate the day-to-day activities, reduce the losses resulting from disasters and facilitate post-disaster recovery [2]. Every nation must ensure that damage to the critical infrastructure is kept to a minimum during disasters through the necessary mitigatory measures. If mitigation activities before disasters aim, in particular, at protecting these critical infrastructures, it would result in effective and efficient relief and reconstruction activities in post-disaster phases [2]. As a nation, Sri Lanka should demonstrate a firm resolve in protecting infrastructures from further disasters, compared to what was significantly affected by the Tsunami 2004. The basic community infrastructure must be secured as much as possible and immediate approaches to such infrastructure and smooth recovery and reconstruction of them are very important in assisting humans on an emergency basis and immediate fulfilling of sanitation requirements of the community. Without doubt, major disasters require effective planning and programming for post disaster reconstruction, including rehabilitating physiologic, social and economic infrastructures, which are badly mutilated as a consequence of these disasters [1].

When the Tsunami struck the Sri Lankan coastal belt, there were no early warning systems to communicate the impending event to government or to coastal communities [15]. Physical infrastructures including early warning systems can make a major contribution both to preparedness for disasters and recovery from them [2]. Disaster planning and preparedness, is an important phase in the disaster management cycle. Construction and operation of signaling and communication systems like earthquake observation systems, meteorological observation systems and early warning systems, facilitation of additional water supplies and sanitation systems are a few activities coming under this phase. On the other hand, necessary preparedness measures are required to protect the infrastructure from coming disasters and also the infrastructure has a key role to play in saving people and other property at this phase.

After a disaster takes place, the most challengeable issue is to restore the society back to its original status or moreover restore it to a better state. Muzaffer and Faruk [1] have clearly identified one of the serious challenges confronting the developing countries is to provide sustainability of interventions undertaken as part of post disaster reconstruction. Sufficient examples have been identified to show that in many cases, reconstruction serves to reinforce and sometimes even increase the vulnerability of rural and urban areas [1], for example, in Turkey in the case of reconstruction following 1999 Marmara earthquake [1]. According to Anand [14], in post-conflict contexts, the infrastructure planners need to cope with the problem of the 'missing baseline'. This is basically applicable to natural post-disaster reconstruction process. The process needs to address not only the infrastructure that may have been damaged in the disaster but also the infrastructure that never existed or that has been damaged due to lack of maintenance over years. Within each phase of the disaster-management cycle, short-range goals can simultaneously contribute to long-range ones, such as strengthening people's capacity to withstand disasters. For example, the reconstruction of water supplies should merge naturally into on-going development activities (such as community mobilisation) to further improve the water-supply systems (or other agreed environmental health goals). During "normal" times, these health development activities should aim to reduce the vulnerability of people and infrastructure to future emergencies and disasters. Thus, the routine construction of water works should, for example, incorporate design features that protect them from known hazards.

4. What is economic development?

The major task of development economics is to explore the possibility of emancipation from poverty for developing countries [16]. From a policy perspective, 'economic development' can be defined as efforts that seek to improve the economic well being and quality of life of a community. It should be strongly focused on low-income developing countries where poverty is especially acute [16]. There are significant differences between ‘economic growth’ and ‘economic development’. The close link between these two is simultaneously a matter of importance as well as a source of considerable confusion [17]. ‘Economic growth’ has a connotation of quantitative expansions in economic variables, especially aggregate and per capita national incomes as measured by such statistics as GDP and GNI [16]. On the other hand, ‘economic development’ refers to not only quantitative expansions but also improvements in non-quantitative factors such as institutions, organisations and culture under which economies operate [16]. In linking infrastructure development with economic development, economic development encompasses policies and programmes to provide infrastructure and services.

A very wide variety of indicators can be used to measure the economic development differences between developed and developing countries. The key indicators among those are GDP per capita, life expectancy, literacy rates, quality of infrastructure, access to safe infrastructure, poverty reduction etc [16, 17 and 18].

5. Economic development through post-disaster infrastructure reconstruction

5.1 Overview

Calls have been made for a country like Sri Lanka to inform and design development efforts to reduce natural disaster related losses and contribute to truly sustainable social and economic development. Post-disaster infrastructure reconstruction can do a lot towards the achievement of this. Whilst the need for mitigation and reduction of natural disaster risks has been widely recognized all over the world, achieving this ambitious goal has proven difficult in Sri Lanka. The recent Tsunami in December 2004 is one of the best examples to demonstrate this. The tsunami in 2004 is distinctive among other natural disasters due to the massive economic impact it caused in a developing country like Sri Lanka. The tsunami struck at a time when the Sri Lankan macro economy was already under pressure on several fronts, reigniting fears of a slide into the kind of a crisis that was seen in 2001 when the economy contracted by 1.5% [19]. Overall damage to the Sri Lankan economy has been estimated at around US$ 1 billion (4.5% of GDP) except the assets losses in the informal sectors. However, the disasters have the ability to make an immense contribution to the particular economy where it took place and also to the surrounding economies. For example, the Kobe earthquake of 1995 killed over 6,000 persons, and destroyed more than 100,000 homes, still the economic recovery not only of Japan but also of the Kobe economy was rapid [20]. Lewis [21] has reported that the economic impact of disasters, especially on island states, has been for matter for concern and analysis (e.g. Lewis. 1991 b) and the impact upon development of disaster is frequently deplored (e.g ECLAC, 1978; 1988) – but what of the impact of development upon disasters?

The discipline of economics has very wide coverage, as it is underpinned by a matrix of political, religious, social, technological and environmental strands (Broadbent and Broadbent, 2006). It is therefore understandable why economics should play such a key role in both reconstruction and development initiatives, even though it can have a very frustrating impact when efforts set out to accelerate progress or achieve quick results [22]. Economics in disaster management is necessary to be looked in to several perspectives. According to Broadbent and Broadbent [22], a deeper comprehension of the role of economics in disaster management is required to improve the current way things done. It shows how economic analysis can be used to advise decision-makers about alternative policy options. Backhouse (2002) reports the role of economics in the shaping of history is very interesting and relevant to disaster management [22]. Economics applied objectively can lead to the selection of the best of all alternatives given a range of options [22].

5.2 Importance of post-disaster infrastructure reconstruction in it's contribution to economic development: Literature review

5.2.1 Role the economics perspectives play in post-disaster reconstruction phase

According to Jigyasu [23], the link between disasters and development is very critical. Lewis [19] reports that linkage between development and disasters has to be forged. Davis (2005) has claimed that looking at disasters as development opportunities is becoming one of the core principles of disaster and emergency management [24]. Disasters provide physical, social, political and environmental development windows of opportunities that can be used during the post disaster recovery and reconstruction not only to reconstruct the impacted areas, but also to improve the socio-economic and physical conditions of the impacted population in the long- run [24]. For developing countries or regions, it is a good opportunity to change its original economy development model and to push the urban and rural renewal forward [23]. Lewis [21] questions which way round should it be; disasters and development' or 'development and disasters'? Which comes first and which has the greater influence upon the other? However, disasters are not only consequences of existing 'development' processes, they can also serve to provide new opportunities for development through post-disaster rehabilitation [23]. The 'disaster continuum' approach positively attempts to align post-disaster assistance with development, recognising the intervening stages of recovery, rehabilitation and reconstruction as each stage should lead to the other in that sequence [21]. However, conventionally, reconstruction and development were perceived and represented linearly [21]. In reality however, they are simultaneous, each 'stage' overlapping with others and in responses to the same or different disasters [21].

Lewis [21] clearly admits that, in any case, development will have been taking place appropriately or inappropriately, planned or unplanned, successfully or not, for a long time. However, development does not have a universal frame of reference and it is determined by different 'world-views' and 'perceptions' on what development implies for a particular community or group of people [23]. It is argued, however, that there is a limited time frame of approximately two years for such opportunities to be utilized efficiently [24].

It is difficult to imagine a modern world without infrastructure and therefore the role of infrastructure in people's daily activities and economic growth of a country is apparent [2]. Along with supportive economic and financial policies, infrastructure has long been recognised as a key element of the enabling environment for economic growth [25]. The physical infrastructure is the nation's economic backbone as it constitutes the arteries for the facilitation of productive activity and the spreading of the benefits of growth by enabling goods and services to be distributed [3]. Construction represents most of every nation's savings [30]. Critical infrastructure provides society with essential goods and services on which the society strongly depends [9]. Infrastructure has strong supply and demand side economic linkages and caters directly to demand [2]. Infrastructure can contribute directly by providing and supporting the delivery of key services, such as those seeking to increase households' access to safe drinking water, basic sanitation, and secure tenure [25]. Similarly, the goals related to human development (education and health) rely on services that require supportive infrastructure—water and sanitation to prevent disease, electricity to serve schools and health clinics, and roads to access them [25]. Thus, it is evident that ultimately society strongly depends on critical infrastructure [9]. Improving trade efficiency can do much more to spur economic growth than tariff reform and improving infrastructure is a major factor in improving efficiency of trade [2]. It is found that availability of good quality physical infrastructure improves the climate for foreign direct investment (FDI) by reducing the "cost of total investment" incurred by foreign investors and thus raising the rate of return [2].

In the World Development Report 1994, The World Bank makes the direct link between infrastructure to poverty [8]. Freeman [8] has admitted that the clear link of natural disasters to poverty is through infrastructure. Accordingly, it is convinced that the linkages can be described in at least three components:

- access to infrastructure is often a measure of poverty,
- infrastructure is a key component of economic growth,
- loss of infrastructure may have significant indirect and secondary costs that directly affect the poor [8].

As stated by The World Bank, lack of access to infrastructure is a welfare issue. Further, access to infrastructure for the rural poor, primarily irrigation and transportation, increases income that enables the poor to manage risk [8]. The maintenance of infrastructure is essential to maintain economic growth, the primary linchpin in reducing poverty [8].

As many researchers have identified, Yaoxian [26] too has admitted that reconstruction following a natural disaster is a complicated problem concerning social, economical, cultural, environmental, psychological, and technological aspects. However, post-disaster reconstruction is relevant to development discourse. It is essential, not only to cope with the impacts but also to help ensure that the region sustains its economic growth [2].

Many international organisations work towards socio-economic development of developing countries. But among all such, The World Bank stands out as its mission is to 'reduce poverty and improve living standards through sustainable growth and investment in people'. In achievement of the above aim, The World Bank has a clear objective of promoting economic growth strategies based on expanded infrastructures, which are environmentally responsible and socially acceptable and bringing a sustainable future closer to today's reality. Virtually all World Bank activities have a bearing on poverty. Tackling natural or man-made disasters is an important part of this mission. Disasters represent a significant source of risk for the poor and providing assistance to prepare for and recover from natural and man-made disasters is an important activity of the Bank in achieving their above mission. The World Bank's 'Hazard Risk Management Team' aims to reduce human suffering and economic losses caused by natural and technological disasters by helping provide a more strategic and rapid response to disasters and promoting the integration of disaster prevention and mitigation efforts into the range of development activities. The Bank's operational policy on 'Rapid Response to Crises and Emergencies' deals with the issues related to emergency operations, but does not address long-term economic issues, including those triggered by economic shocks and requiring a policy response from the government that the Bank normally supports through development policy operations. The World Bank aims to contribute with sound economic foundations to infrastructure policy making. The 'infrastructure economic' approach emphasises the links between infrastructure service provision, economic growth, and poverty alleviation; while providing instruments of dialogue between different sector specialists, policy makers, and macroeconomics. The World Development Report 1994 [27], the seventeenth in the annual series, examines the link between the infrastructure and development and explores ways in which developing countries can improve both the provision and the quality of infrastructure services. In recent decades, developing countries have made substantial investments in the infrastructure, achieving dramatic gains for households and producers by expanding their access to services such as safe water, sanitation, electric power, telecommunications, and transport. In Sri Lanka, rehabilitation of the infrastructure focused initially on restoration of key transport and services, initiated speedily by the Government with donor support. Line ministries took the initiative on the repair of (or temporary provision for) broken portions of major roads, railway, electricity, telecommunication etc. on a priority basis. This raises the dilemma of what is to be prioritised, because the identification of priority infrastructure reconstruction issues is important to sustain the recovery.

5.2.2 Importance of post-disaster infrastructure reconstruction for millennium development goals

If we look at the role economic perspectives play in post-disaster reconstruction and the economic and development perspectives of natural disasters, it is worth further investigating the necessity of infrastructure in achieving Millennium Development Goals (MDG) of the United Nations and the World Bank because MDGs are set with a greater expectation of contributing to the economic development. More recently, the development community has emphasised that by promoting growth; reliable and affordable infrastructure can reduce poverty and contribute to the achievement of the Millennium Development Goals (MDGs) and there have been many recent attempts to quantify these linkages between infrastructure and growth, poverty reduction, and achieving related development goals [25].

Both the policy and the academic debates on the Millennium Development Goals of the United Nations have been a source of some frustration for infrastructure practitioners [28]. There is a sense that the goals fail to recognise the relevance of transport and to a lesser extent energy (since rural energy was recently added as a priority) in the fight against poverty [28] except for water and sanitation and to some extent telecommunications. This is partly because there is little knowledge about the basic relationship between infrastructure coverage and household income [28]. The frustration among practitioners has not been met by academics [28]. Indeed, while there has been a lot of talk about the MDGs in the development community and many publications on the health and education goals, there has been little academic work on the water and sanitation goals or the MDG gaps [28].

6. Sri Lanka's situation with regard to infrastructure reconstruction and development

An efficient network of economic and social infrastructure is a pre-requisite for achieving sustained high economic growth and development. Development, reconstruction, continuous improvement and maintenance of infrastructure network are vital to attain a sustained high level of economic development. Now, more than two years after the tsunami disaster, it is worth questioning whether these development opportunities have been used or lost? In Sri Lanka, although several initiatives were taken by the governments in the past to mitigate disaster damages they were mostly reactive emphasising relief and recovery rather than proactive with damage prevention or minimisation strategies [5]. In the aftermath of the tsunami, three task forces were set up; (1) Task Force for Rescue and Relief (TAFRER), (2) Task Force for Law and Order and Logistics (TAFLOL), (3) Task Force to Rebuild the Nation (TAFREN). Immediately after the tsunami 'The Centre for National Operation' (CNO) was set up in order to facilitate and coordinate emergency rescue and recovery needs. Later, in January 2005, the CNO was replaced when TAFRER and TAFLOL were merged to form TAFOR (Task Force for Relief), with a mandate for looking after the well being of affected groups. In November 2005 another institutional change took place - the TAFREN was replaced with the Reconstruction and Development Agency (RADA). However, the 2004 Tsunami made responsible parties act collectively for a comprehensive, long term and holistic disaster risk management framework (Jayawardane, 2006). In May 2005, the Sri Lanka Disaster Management Act No 13 of 2005 was enacted providing a solid legislative and institutional arrangement for Disaster Risk Management establishing a powerful National Council for Disaster Management under the President and the Disaster Management Centre (DMC) as the lead agency for disaster risk management. In November 2005, the Ministry of Disaster Management was established to provide undiluted leadership. The Ministry of Disaster Management declared its Road Map in December 2005 focusing on seven thematic components. 'Towards a Safer Sri Lanka - The Road Map for Disaster Risk Management – Volume II Project Proposal' [6] is a key Government policy document. The Road Map aims to provide an overall framework for disaster risk management in the country and is an effort, through the MoDM to unify efforts of different agencies [15]. The Road Map recognises that the tsunami has highlighted policy and institutional weaknesses in disaster risk management in the country [15]. It is expected that proper implementation of this Road Map will go a long way towards saving Sri Lanka from natural disasters. ‘Towards a Safer Sri Lanka - Road Map for Disaster Risk Management – Volume II Project Proposal’ [6] is not just about the tsunami. It is part of a need to fill the gaps, creating the social and political will to manage disaster risk and to coordinate activities [15].

‘The Road Map’ [6] has well documented that disaster events reported in the history have affected infrastructure facilities in varying degrees in Sri Lanka and resulted in people suffering for lack of basic facilities. This has lead to the responsible agencies struggling to get the facilities back to normal functioning conditions. This policy document is focused on seven thematic components, which are consistent with ongoing and past efforts in the field of disaster risk management and development planning, and as Hyogo Framework of Action 2005-2015. Critical infrastructure is deemed to be included under the theme called ‘Mitigation and Integration of Disaster Risk Reduction (DRR) into Development Planning’. ‘Providing safer critical infrastructure in hazard prone areas’ has been prioritised as one of the project proposals under the theme called ’Mitigation and Integration of DRR into Development Planning’. The above project proposal suggests that all critical infrastructure facilities must be designed to a given level of safety from disaster impact. Moreover, it suggests that such guidelines must be provided to designers and an adequate monitoring system be in place [6]. The activities identified in the proposal are;

- Formation of an Expert Group to cover different types of infrastructure
- Implementation of guidelines, codes for hazard resistant infrastructure construction
- Conduct a training programme for the infrastructure facility providing agencies and the engineers, planners and technical officers on the use of guideline
- Identify the critical infrastructure to be provided in hazard prone areas
- Develop guidelines for construction of critical infrastructure in hazard prone areas
- Review construction programmes to ensure adoption of hazard mitigation measures in all infrastructure development activities

(Source: [6])

The expected outcome of these actions is to increase the disaster resilience in critical infrastructure in hazard prone areas ensured through use of planning and construction guidelines.

On the other hand, the Ten-Year Horizon Development Framework (2006-2016) of the Government (The Ten-Year Vision) has recognised the importance of infrastructure to accelerate economic development [29]. For example, a series of large-scale infrastructure projects are to be implemented during 2006-2016 under the Ten-Year Vision. This includes power projects such as upper Kotmale hydropower plant, coal power plants at Norochcholai, Trincomalee and Hambantota, combined cycle power plant in Kerawalapitiya, transport development projects such as upgrading the Colombo – Matara railway line, new railway lines of Matara – Kataragama and Kurunegala – Habarana, light transit systems connecting Ratmalana - Battaramulla and Dematagoda - Battaramulla, [29]. At the same time small-scale infrastructure projects are also being developed under the Maga Neguma (road development) and Gama Neguma (village development) programmes [29].

Experience increasingly affirms that the post-disaster recovery phase provides a critical opportunity to introduce measures to reduce future disaster risk through new physical infrastructure. The study concludes that infrastructure can both reduce the losses resulting from natural disasters and facilitate easy post-disaster recovery and thus more investment in infrastructure reconstruction is needed while lessening the challenges confronted in the post-disaster reconstruction phase.

Sri Lanka has achieved an acceptable recovery in the southern part of the country but the northern region is lagging behind expectations, largely because of escalating conflict in the north and east of the country. What Sri Lanka was doing has not been working well enough in light of the enormous challenges faced by developing countries. The current infrastructure reconstruction process in the country is basically hindered due to the lack of institutional capacity and current security problems prevailing in the north and east region of the country. However, the main issue is whether these construction and reconstruction projects consider the economic development perspectives during the process**.** Moreover, whether they take into account the disaster reduction measures in the long-term construction?

While the infrastructure needs are increasingly well recognised, in many developing countries key infrastructure services are still in serious short supply and of poor quality. In particular, the coverage is typically much lower in rural areas where most poor people live in developing countries. But urban coverage is also under pressure, partly because of rapid rural-urban migration in many countries [25]. According to 'The Central Bank of Sri Lanka Annual Report–2005' [30], infrastructure facilities have been expanding in Sri Lanka but are not adequate or competitive yet, thereby constraining economic growth. Although these problems are most severe in low-income countries, they remain sizable in most middle-income countries too [25]. In Sri Lanka, the adequacy and quality of services provided by public enterprises in the areas of electricity generation, transmission and distribution, passenger transportation and water supply leave much to be desired while infrastructure facilities in the liberalised service sectors such as ports and telecommunications have demonstrated improved performance and an ability to face competition [30]. Also according to the report, the country has the potential to develop these service sectors and turn them around to be significant foreign exchange earners.

After the Tsunami 2004, the initial restoration work of infrastructure was completed within a relatively short period of time. Even though reconstruction and rehabilitation of the infrastructure is often essential to sustain recovery, there are some clearly identified key challenges in infrastructure sectors in post-disaster phases in Sri Lanka, particularly in Post-Tsunami 2004 [31]. The South Asian Disaster Report called, 'Tackling the Tides and Tremors' authored by Duryog Nivaran [15] has identified a key challenge with respect to the longer-term and larger task of developing the infrastructure and services along the devastated coastal belt and to new settlements; whether recovery is used to address disparities in quality and access of infrastructure and services to communities? Duryog Nivaran [15] questions, in particular, the extent to which infrastructure re-development extend towards and deals with issues related to poor people's infrastructure and service needs, reconcile environmental-development complexities and link development to future disaster risk management? [15].

7. The way forward

Within this context, it is worth studying how post-disaster infrastructure reconstruction projects address the above loopholes compared to general infrastructure construction projects. This leads to investigation of the speciality of post-disaster reconstruction projects compared to general infrastructure construction projects and whether the current post-disaster infrastructure reconstruction activities consider long-term sustainability and its contribution to economic development? In other words, how should reconstruction of infrastructure be carried out in a way that would contribute to the economic development of developing countries. Should there be any added or special strategies, features, objectives or concerns in post-disaster infrastructure reconstruction projects compared to general projects? If so, what are those? How can the above theoretical contribution of infrastructure on economic development be boosted? Identification of key indicators of economic development may be the first step towards this. Assessing the projects' special strategies, features, objectives or concerns against their impact on the indicators of economic development may lead to identification of necessary improvements in the post-disaster infrastructure sector, particularly sector wise impact of implementation of measures on mainstreaming of future disaster risk reduction on economic development.

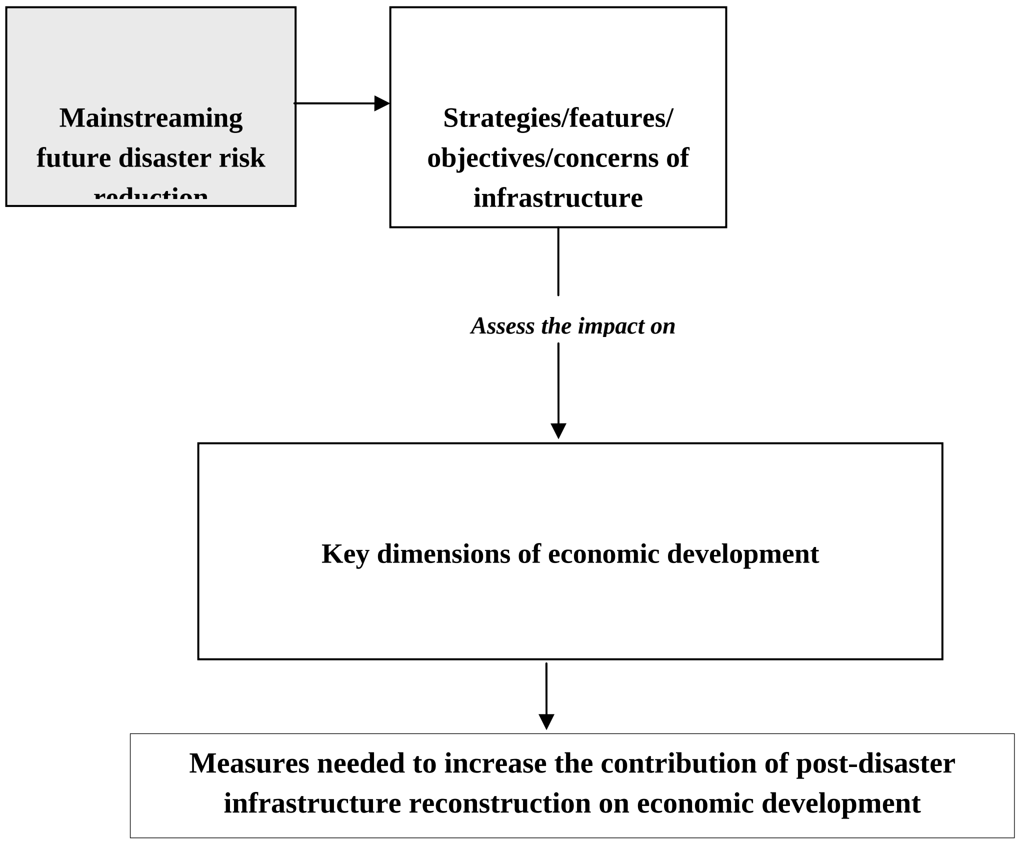

Figure 2: Research focus

8. Conclusion

Natural disasters destroy critical infrastructure. Through this research, an effort was made to identify the importance of post-disaster infrastructure reconstruction in economic development. Many researchers have affirmed that infrastructure has a strong link to economic development and then largely to the economic growth. Infrastructure development plays an essential role in reducing poverty in developing countries. Post-disaster reconstruction is found to be a good opportunity for focusing activities into development perspectives. In Sri Lanka, infrastructure facilities have been expanding but are not adequate or competitive yet, thereby constraining economic growth. In addition, the quality of some of the services remains insufficient. In the post-tsunami context, a key challenge with respect to the reconstruction of infrastructure is whether recovery is used to address disparities in quality and access of infrastructure and services to communities.

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Lessons learned from Asian tsunami disaster: sharing knowledge

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Abstract

Creating an organised common platform to capture, organise and share the knowledge on disaster management strategies is considered vital to enhance the effectiveness of future disaster management efforts. Hence, ensuring the availability and accessibility of accurate and reliable disaster risk information when required entails an efficient system for knowledge sharing. This paper highlights the importance of knowledge and good practice sharing in disaster management strategies, and discusses key lessons learned from 2004 Asian tsunami, particularly relating to the Sri Lankan context. Good practices and lessons learned are discussed on five different themes: social, technical, legal, operational and environmental. Further, the ISLAND website is introduced and developed as part of a research aimed at increasing the effectiveness of disaster management by facilitating the sharing of appropriate knowledge and good practices.

Keywords: Disaster management, Knowledge sharing, Lessons learned, Good practices.

1. Background

Disasters, both natural and man-made, have been occurring with increasing frequency and effect in recent decades in many countries around the world. According to the World Disaster Report 2005 [1], the number of reported disasters has increased steadily over the past century and risen sharply during the past decade. This reflects the high value of the infrastructure and assets at risk. Disasters bring about the loss of lives, property, employment and damage to the physical infrastructure and the environment. The Asia-Pacific region has experienced the greatest loss of life in absolute terms and in proportion to the population, due to earthquakes, tsunami, floods and tropical cyclones. The Asian tsunami that struck on the morning of December 26, 2004 is widely acknowledged as the largest, most devastating natural catastrophe in the Asian region. This left behind widespread destruction, killing over 250,000 people, damaging natural ecosystems and coastal infrastructure [2]. As such, there is a conscious effort for disaster management at national, provincial and sub-provincial level.

Effective lesson learning should reduce the risk of future disasters through well-informed mitigation and preparedness planning. Ensuring the availability and accessibility of accurate and reliable disaster risk information when required entails an efficient system for knowledge sharing. Despite its importance, knowledge appears fragmented, although there are undoubtedly many successful practices and lessons to be learned from 2004 Asian tsunami [3]. The UK Higher Education Disaster Relief Project Report 2007 [4] highlighted a lack of mechanisms at national level in the UK to link the expertise, skills and knowledge that resides in UK Higher Education with the practitioners in the humanitarian agencies. A lack of prior knowledge and proper point of reference have made most of the recovery plans guessing games, eventually failing without adding appropriate values to the recovery attempts [5]. In view of addressing the perceived need to share knowledge relating to disaster management strategies, the School of the Built Environment, at the University of Salford, undertook the research project '*ISLAND*' (Inspiring Sri-Lankan reNewal and Development), partly funded by the RICS Education Trust.

The paper aims to share good practices and lessons learned from 2004 Asian tsunami, while highlighting the importance of knowledge sharing in current disaster management strategies. It identifies appropriate good practices relating to several themes, based on case materials collated as part of ISLAND project. Accordingly, the paper is broadly divided into three sections. Initially, an overview on disaster management process and the need to share knowledge relating disaster management strategies are discussed. Secondly the paper introduces ISLAND project, where aims, objectives and methodology are presented. Finally, it provides an analysis on good practices and lessons learned from Asian tsunami disaster.

2. Disaster management process

Disaster management efforts aim to reduce, or avoid the potential losses from hazards, assure prompt and appropriate assistance to victims, and achieve a rapid and effective recovery [6]. As shown in Figure 1, the process of disaster management is commonly visualised as a two-phase cycle, with a post-disaster recovery informing pre-disaster risk reduction and vice versa. As Warfield [6] states, the disaster management cycle illustrates the ongoing process by which governments, businesses and civil society plan for and reduce the impact of disasters, react during and immediately following one and take steps to recover after it has occurred.

The significance of this concept is in its ability to promote the holistic approach to disaster management as well as to demonstrate the relationship of disasters and development. Recovery and reconstruction are commonly identified within the post-disaster phase, that is the period that immediately follows after the occurrence of the event. However, the terminology of disaster relief and recovery, rehabilitation and reconstruction is used without precise and commonly agreed definitions, although in practice, a distinction is drawn between the emergency relief phase and the subsequent non-emergency recovery [5]. Once a disaster has taken place, the first concern is effective 'recovery' – helping all those affected to recover from the immediate effects of the disaster. 'Reconstruction' involves helping to restore the basic infrastructure and services that the people need so that they can return to the pattern of life which they had before the disaster [7]. The importance of the 'transitional phase', linking immediate recovery and long-term reconstruction, is also stressed by a number of publications [2, 5]. With the recovery of social institutions, the economy and the main infrastructure, transition to the longer-term recovery and reconstruction process can be implemented.

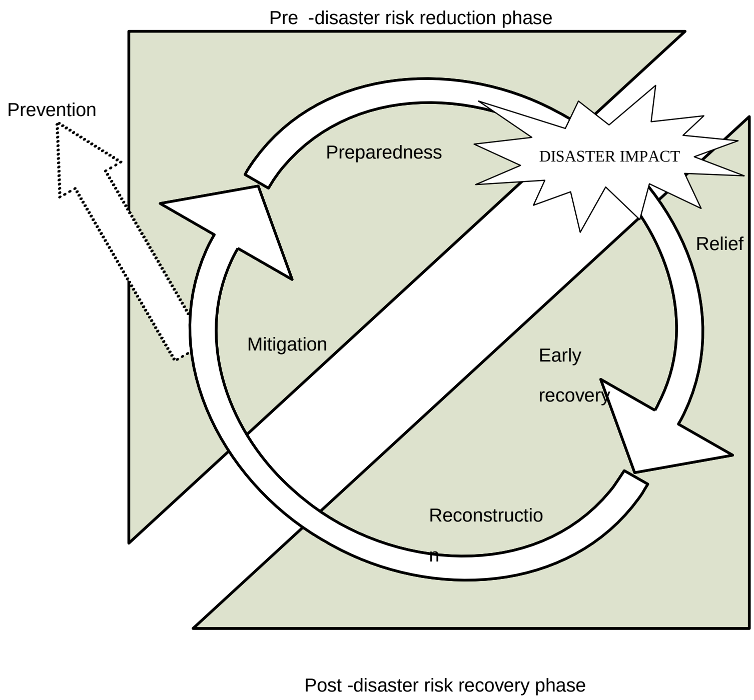

Figure 1: Disaster management cycle (adopted from RICS [5])

The pre-disaster phase of the disaster management cycle includes both mitigation and preparedness. As RICS [5] defines, disaster mitigation refers to any structural and non-structural measures undertaken to limit the adverse impacts of natural hazards, environmental degradation and technological hazards. 'Mitigation' measures may eliminate or reduce the probability of disaster occurrence, or reduce the effects of unavoidable disasters. As Warfield [6] describes, these measures can include building codes; vulnerability analyses updates; zoning and land use management; building use regulations and safety codes; preventive health care; and public education. In the ideal case, mitigation eliminates the risk of future disasters by effective sharing of lessons learned through 'preparedness' planning. Hence, the attention to disaster mitigation and risk reduction, which comprises the development portion, is equally important as disaster recovery and reconstruction, and rehabilitation. Greater attention to pre-disaster planning and preparedness, and sharing the lessons from previous disasters, could considerably reduce the risk associated with such events. Thereby, the mitigation phase, and indeed the whole disaster management cycle, includes the shaping of public policies and plans that either modify the causes or mitigate their effects on people, property, and infrastructure. Appropriate actions at all points in the cycle lead to greater preparedness, better warnings, reduced vulnerability or the prevention of disasters during the next iteration of the cycle [6].

Natural events however only become potential hazards when they threaten people or property [7]. As Warfield [6] states, natural hazards themselves do not necessarily lead to disasters. Natural hazards like earthquakes, however intense, inevitable or unpredictable, translate to disasters only to the extent that the population is unprepared to respond, unable to cope, and consequently, severely affected. An earthquake will cause little damage if it takes place in an empty desert. It may also cause little damage if it takes place where people can afford to be well protected. Hence, a natural event only causes serious damage when it affects an area where the people are at risk and poorly protected. Disasters occur when these two factors are brought together (as shown in Figure 2):

- People living in unsafe conditions
- A natural hazard such as a flood, tsunami, hurricane, earthquake.

Figure 2: Components of a disaster

Thereby, the threat from natural hazards can only be minimised through the elimination of unsafe conditions, as much as possible, in terms people, property and infrastructure. The role of the pre-disaster risk reduction phase, also referred as development portion, is considered to be vital in bringing unsafe conditions to a controlled safe environment, through mitigation and preparedness.

3. The need to share knowledge

There is a conscious effort for disaster management at national, provincial and sub-provincial level. Despite this, knowledge appears fragmented, although there are undoubtedly many successful practices and lessons to be learned [3]. Hence, there is a perceived gap in information coordination and sharing particularly relating to disaster mitigation. A lack of prior knowledge and proper point of reference have made most of the recovery plans guessing games, eventually failing without adding appropriate values to the recovery attempts [5]. The lack of effective information and knowledge sharing, and dissemination on disaster mitigation measures can thereby be identified as one of the reasons behind the unsatisfactory performance levels of current disaster management practices.

Knowledge can be differentiated between explicit, tacit and implicit forms of knowledge. Tacit knowledge represents knowledge based on the experience of individuals, expressed in human actions in the form of evaluation, attitudes, points of view, commitments and motivation [8]. Explicit knowledge, in contrast, is codifiable knowledge inherent in non-human storehouses including organisational manuals, documents and databases. In an organisational context, knowledge management is about applying the collective knowledge of the entire workforce to achieve specific organisational goals and facilitates the process, by which knowledge is created, shared and utilised [9]. However, within the disaster management context, knowledge management is about getting the right knowledge, in the right place, at the right time [3]. As a strategic approach to achieve disaster management objectives, knowledge management will play a valuable role in leveraging existing knowledge and converting new knowledge into action through the knowledge management cycle. In essence, knowledge organisation and human knowledge conversion processes can bring a comprehensive foundation to the common operating picture, interoperability, intelligence, training and acquisition [2]. In the light of this, it can be perceived that valuable knowledge on disaster management is present at three different levels: institutional, group and individual, in the forms of both tacit and explicit knowledge.

Thousands of organisations and institutions have been supporting the efforts on disaster management over last few decades. The linkages among all agencies working on disaster management need to be strengthened in order to derive the regional best practices and coping mechanisms [5]. In order to enhance the information sharing and management of the knowledge generated in institutions, it is essential to knit these organisations and institutions, and moreover groups and people working within them [2] more closely together. There are many gaps that could be bridged by the appropriate use of professional skills, but access to these by the local organisations on the front line of the recovery effort is highly constrained through lack of recognition of their existence. Therefore, recognition needs to be given for the institutions and organisations operating not only at international and national level, but also at the local level. In addition, this local knowledge can reside among the groups operating within different communities; hence, it can be extended to the existence of these formal and informal groups involved with the disaster management process.

The knowledge and experiences of disaster practitioners remain mainly in the individual domain. Due to its large geography, the experiences, approaches and adopted modalities for disaster management is not codified and remains with individuals as a tacit knowledge [3]. Acknowledging the need for a disaster knowledge-networking platform to facilitate interaction and have simultaneous dialogue with all related expertise dealing with disaster management, a knowledge management initiative was envisaged as a tool to store, retrieve, disseminate and manage information related to disaster management.

4. ISLAND project

ISLAND (Inspiring Sri-Lankan reNewal and Development) is aimed at increasing the effectiveness of the current disaster management strategies by sharing appropriate knowledge and good practices about post-tsunami programmes, particularly in the Sri Lankan context. To this effect, the research was built around following objectives:

- To create an infrastructure for developing, sharing and disseminating knowledge about disaster management for land, property and construction.
- To develop a knowledgebase on post-tsunami recovery efforts, including but not limited to, disaster mitigation strategies.
- To develop case materials on post-tsunami responses.

Although the initial research focused on tsunami mitigation strategies and Sri Lanka in particular, the infrastructure developed during the project is scalable to permit growth in the knowledgebase to address other aspects of disaster management.

4.1 Methodology

The research was carried out according to three Work Packages (WPs). Details of WP specific objectives and description are provided within the WP outline.

Work Package 1: Develop knowledgebase infrastructure

Aim: WP1 aimed to develop the infrastructure for capturing, sharing and disseminating knowledge about disaster management in land, property and construction. Going beyond the scope of mere information management, it integrated knowledge extraction and dissemination techniques within this WP. The objective of this initiative is to ease and speed-up the decision making process within disaster management exercises. Specifically, mechanisms were developed to extract and disseminate explicit knowledge from materials gathered in WP2. This provided the necessary scalability for the knowledge dissemination exercise within the proposed project, be it internal to an organisation or accessible worldwide, as the database can be hosted centrally. A dynamic web portal was created as the front end of this database, providing the search and update facilities, to ensure enhanced user friendliness and self expansion of the proposed knowledgebase.

Work Package 2: Populate knowledgebase

Aim: WP2 aimed to populate the knowledgebase with a range of land, property and construction information related to tsunami mitigation strategies. Accordingly case materials focusing on good practices and lessons learned from the 2004 Asian tsunami disaster, particularly Sri Lankan post-tsunami context, were collated and analysed. The portal user interface developed in WP1 provided the capability to upload case study information to the backend database. In addition, professional bodies and relevant research groups were identified and invited to contribute materials to the knowledgebase. This included: disaster recovery strategies, their effectiveness, drawbacks and current good practices; the level of community involvement; details on the allocation of funding to recovery and reconstruction programmes in the region;

details on short term relief and its benefits; plans for long term developments including the consultation process between the government and the local community, knowledge on planning and building settlements that respond to community needs while providing a more secure environment; and finally, information on reporting frameworks.

Work Package 3: Disseminate research and identify future research directions

Aim: WP3 aimed to disseminate the research outputs and identifying future research directions. The web portal forms the focal point for the research's dissemination strategy. However, the project will also use and integrate with other appropriate dissemination mechanisms. A range of academic publications and prestigious International Conferences on relevant themes were targeted as a means of promoting the portal and disseminating the case material to a wider audience.

5. ISLAND website

As part of WP 1, the ISLAND web portal and knowledgebase was developed to capture, process, and disseminate the lessons learned from the Indian Ocean tsunami in the form of policy advice and good practices to guide future post-disaster interventions. Hence, the web portal provides an organised common platform to capture, organise and share the knowledge on disaster management strategies and create a versatile interface among users from government, professional bodies, research groups, funding bodies and local communities.

Figure 3: ISLAND website - Home page

The knowledgebase was created to address several themes of disaster management based on published case materials collected on Asian tsunami disaster 2004, particularly cases from the

Sri Lankan context. Case materials are organised into types of disaster, phase, country, source, research methodology followed, level, scope and access to the study is stored in a MySQL database using a PHP-Database interface. With the usage of SQL query, simple and advance searchers are provided to retrieve and view data. Also a key word search function is provided in the same manner to search the relevant keywords in the description provided of the materials.

The web site provides an introduction to the ISLAND project and project output together with the publications of the project. The web portal acts as the public interface to share and disseminate the lessons learned and good practices in disaster management. Further, the portal provides tools to capture, acquire and organise knowledge, through which the knowledge database will be kept up to date and live with disaster management strategies.

6. Good practices and lessons learned

As part of WP2, an analysis of good practices and lessons learned from the Asian tsunami disaster was carried out based on case material collated, particularly from Sri Lanka. Good practices and lessons learned, relating to different phases of disaster management cycle, are summarised into several themes that emerged from case material: social, technical, operational, legal, and environmental.

6.1 Social Issues

The importance of community participation within reconstruction process, public awareness and education, and job creation programmes like Cash for Work (CFW) are emphasised in most of the case material collated. Within the last decade, growing recognition of the necessity of community participation for sustainable disaster reduction was translated into actions to realise community based disaster management. Major benefits of the community based risk assessment, mitigation planning and implementation processes underscored include [10]; building confidence, pride in being able to make a difference, and enhanced capabilities to pursue disaster preparedness, mitigation as well as bigger development responsibilities at the local level. Additionally, individual and community ownership, commitment and concerted actions in disaster mitigation, including resource mobilisation produce a wide range of appropriate and innovative mitigation solutions, which can be cost-effective and sustainable.

As Doocy et al. [11] state, job creation programmes have been used to provide aid to less well-off citizens and can be considered as antecedents to CFW, which are an increasingly common element of humanitarian assistance in food-insecure settings, disaster-affected areas and post-conflict environments. The tsunami of 26 December 2004 caused massive devastation and hundreds of thousands of people were no longer able to participate in their routine employment activities. Considering the benefits of harnessing idle labour in the immediate post-disaster period, cash for work programmes can be recognised as a logical response that provide a structured mechanism to engage people in low-skilled constructive activities while injecting cash into the economy and promoting decision-making at the community and individual level.

Experiences in implementing large-scale CFW programmes [10, 11] in the Asian post-tsunami phase have led to the following set of recommendations:

- Communities need to be informed of benefits and limitations of CFW.
- It is helpful to identify potential community coordinators as well as be aware of what other agencies are doing.
- Adequate attention should be paid early on to procurement, warehousing and the delivery of supplies and equipment in order to expedite CFW activities.
- Cash for planning is seen as a good way of working; aids participation in the planning process and promotes informed choice.
- CFW implementers either limit the need for technical expertise by providing simple project design or ensure the availability of skilled labour needed to complete CFW activities.
- Train local staff to lead these programmes and for community leadership
- Consider work groups with no more than 25 workers and a ratio of no more than four work groups to one supervisor (overall maximum ratio of 100 workers: 4 group leaders: 1 area supervisor) to ensure quality and efficient work.
- There is a need for synergy in communication/coordination between organisers and the community.

Public awareness and education are essential to protect people and property from disasters. A lack of awareness has been identified as a major reason behind the huge loss of lives and property from the 2004 Asian tsunami. Indeed, the term “Tsunami” was heard by most of the ordinary Sri Lankans only after this devastation. As Briceno [12] states, in Thailand more than 1,800 people were saved because a tribal chief recognised that there was something wrong and decided to evacuate his people up to the hills. A 10-year-old girl from England saved 100 tourists on a beach in Phuket, Thailand after alerting her mother of the imminent tidal wave and prompting a speedy evacuation to safety. The girl recognised the signs after learning about tsunamis in her geography class. Knowing what to do and when to do it is the key to saving lives. The media also have a social responsibility to promote prevention. Journalists need to be sensitised and maintain an ongoing focus on prevention aspects of disasters [12]. These disasters are happening on an almost daily basis around the world. Not to be overlooked is the media’s role essentially in early warning systems. The Asian tsunami disaster could be a trigger for the media to play a more active role in improving lines of regional and global awareness, and communication using new media technologies.

6.2 Technical know-how

The tsunami affected two-thirds of the coastline of Sri Lanka, and it also resulted in the destruction of nearly 100,000 houses and infrastructure such as roads, bridges etc [2]. Depending on the wave height, various types of structures were affected. Waves of up to 2m in height caused 1–2m high boundary walls to collapse. As wave heights increased, single-storey masonry structures were significantly damaged and were completely swept off their foundations at wave heights of around 4m. Buildings of two storeys and higher, especially those with concrete frames, had their infill masonry walls that were perpendicular to the waves knocked down by waves of up to 4m, but waves of even 5m did not cause the complete collapse of such buildings [13]. Partial collapse occurred, however, if foundations were undermined by waves of 3–5m in height.

According to Dias et al. [13], there are two common threads that run through the structural failures. The first is that structures have to be tied down in addition to being held up. The latter is obviously the focus of everyday attention, since gravity loads will assert themselves almost immediately otherwise. However, when natural disasters such as cyclones and tsunamis occur they have the effect of trying to lift up or push aside structures. Such actions can be resisted only by having a continuous chain of tying down from roof to foundation, and also by having sufficient gravity load to resist the overall upward or lateral forces. The second thread is that soil scouring has to be accounted for, or anticipated [13]. This can be done by improving the soil properties, especially soil that has been backfilled; deepening foundations, whether in buildings or bridges; and also by providing sufficient structural redundancy to prevent catastrophic collapse even if some foundations fail. The strategic use of natural features such as sand dunes and provision of vegetation barriers are also ways of mitigating potential tsunami damage [14]. In Sri Lanka, newly published national guidelines for reconstruction emphasise the importance of tying down structures against upward and lateral loads as well as the need to anticipate and reduce soil scour around foundations, especially of backfilled earth.

However, it was not only buildings that were destroyed due to the tsunami tidal waves, civil engineering structures like roads and bridges were also damaged. An investigation [15] on infrastructural damage in Sri Lanka due to the tsunami revealed the following:

- Damage to roads induced by the tsunami included erosion of embankments, erosion of abutment backfills and collapse of bridges following the loss of stability of the abutments.
- Erosion of embankments tended to have occurred at locations where the land was relatively low, presumably because the back flow of the tsunami concentrated on those parts of the land.
- No bridge girders were washed away by the direct impact force of the tsunami. However, it is too optimistic to conclude that bridges are always safe against the impact force of a tsunami.
- Existence of detour and quick restoration weakened the socio-economical impact of the damage.

6.3 Operational issues

Coordination is often a scarce resource in disasters, yet remains the key operational principle for effective response. It is important in order to avoid duplication of effort that resources are directed to those most severely affected by the disaster. Good coordination can also facilitate the learning of lessons. The importance of effective coordination of disaster management work at international, regional, national, organisational, group and individual level is overwhelmingly highlighted within the case material. Reducing risk depends on communication and information exchange between the scientific community and politicians. The Asian tsunami disaster showed that in the absence of an open dialogue, valuable information and research from technical sectors is redundant. As Senanayake [16] argued, there was a striking absence of expertise and professionals, from the region in the post tsunami operation in Sri Lanka, despite the stated aim to develop regional disaster response capacity in the Asia Pacific Region by a number of agencies. Hence, it is necessary to strengthen the link between scientific institutions and national and local authorities that need to react to avoid human, economic and social losses from disasters.

International, regional and national organisations should work better together and be better coordinated. Coordination is an essential element of disaster prevention, mitigation, preparedness and response for the entire UN system, governments and non-governmental organisations. Efforts need to be made to promote complementary services and avoid duplication [12]. A number of reports [2, 12, 16] emphasised the primary role of national authorities in coordinating and directing national and international assistance. Existing inter-agency coordination arrangements should be further strengthened, particularly concerning the sharing of information and knowledge in the early phases of the disaster response. Mechanisms should be devised to ensure the participation of smaller organisations and institutions with less international experience to the coordination process. Further, governments need to demonstrate their political will and commitment to disaster risk reduction through concrete measures e.g. reserve national budget line for disaster reduction, and strategic donor funds to support and build capacity for disaster risk management.

6.4 Legal concerns

Coastal zones and small islands are often densely populated areas that increase the risk to and vulnerability of people. Nearly 3 billion people, or almost half the world population live in coastal zones, which in many cases are prone to hazards including tropical cyclones, floods, storms and tsunamis [12]. Often coastal populations are dependent on the sea for their livelihoods (e.g. fishing villages) and do not have the choice to live elsewhere. Small island countries such as the Nicobar and Andaman islands are barely a few metres above sea level, which means that evacuation to higher land is almost impossible. Governments and local authorities need to take human habitats into consideration in long-term development planning, ensuring that risks are minimised.

Beyond preparing for evacuation and emergency response, communities can reduce their tsunami risk by modifying their land use planning and development approval practices. Although planning for tsunamis will not be a top priority for most coastal communities, relatively small efforts to plan for this hazard can significantly increase community safety. The US National Tsunami Hazard Mitigation Program’s publication ‘Designing for Tsunamis’ stresses the importance of understanding site planning. Through zoning, creation of open spaces and not allowing new development in potential tsunami areas, safer land use will be better able to protect people and buildings. Specific site planning strategies to reduce tsunami risk can include [14]:

- Avoiding inundation areas: site buildings or infrastructures away from hazard areas or locate on a high point.
- Slowing water: forests, ditches, slopes, or burns can slow down waves and filter out debris. The success of this method depends on correctly estimating the force of the tsunami.
- Steering: water can be steered to strategically placed angled walls, ditches and paved roads. Theoretically, porous dikes can reduce the impact of violent waves.
- Blocking: walls, hardened terraces, burns and parking structures can be built to block waves.

Several reports [12, 17, 18] emphasise the necessity for a national and institutional level legislative framework governing disaster management efforts. From the institutional point of view, the law should bring about a reform of the entire national institutional arrangement for disaster management, provide for the allocation of resources for preparedness and emergency response at all levels of governance, and create a permanent liaison mechanism with the international humanitarian community. Decentralisation of decision-making authority should feature prominently in the new set up. Administratively, such law should promote the development of detailed contingency plans at local level. Such plans should include [18]:

- Risk analysis, zoning and mapping,
- Comprehensive air, sea and road transportation arrangements (including stand-by agreements with the national air carrier and shipping companies),
- The pre-positioning of relief supplies and – notably - of fuel, and
- Backup emergency communications arrangements, notably assigning an institutional role to amateur radio communications.

Further, drafting of a National Disaster Management Bill is recommended, which should:

- Deal with the creation of policies/provisions/regulations at sectoral level to enable special conditions applicable for emergency response,
- Formulate operating policies for the mobilisation of military assets in disaster management and emergency response,
- Regulate the role of NGOs in the national setup for disaster response, and
- Specify provisions for the request and reception of international assistance.

6.5 Environmental concerns

The tsunami reduced some coastal communities to piles of bricks, tin and wood mixed with car and boat parts, construction materials, ocean mud and dead bodies. While the December 2004 tsunami killed more than 250,000 people in 12 countries and left millions of homes and businesses in ruin, officials were most worried about the killer wave's environmental aftermath. In many cases, the tsunami worsened pre-existing environmental management problems on the inhabited islands. The Joint United Nations Environment Programme (UNEP)/United Nations Office for the Coordination of Humanitarian Affairs (OCHA) Environment Unit (Joint Unit), integrated in the Emergency Services Branch of the OCHA, is the principal United Nations mechanism mandated to assist countries facing environmental emergencies.

As Casey et al. [19] argue, a common best practice approach to debris removal should be developed to minimise negative environmental impact. Related guidance material should be translated into local languages and effectively disseminated. Re-mapping affected areas before redevelopment begins can ensure the identification of hazardous areas created by tsunami-induced changes, such as mass graves and locations vulnerable to flooding. Remapping is therefore an important tool to help ensure that tsunami victims do not face new dangers when they resettle, and can also reassure affected populations of the safety of the locations where they rebuild. In this regard, local expertise and capacities in recycling, composting and environmental management can play a key part in clearing efforts. However, as Calvi-Parisetti and Pasche [20] argued, immediately following the tsunami, the inclusion of environmental issues into disaster management efforts at the national level was limited. Another revelation that has emerged from several studies is the fact that many operational agencies of the United Nations system have very little awareness of the potential environmental threats in the aftermath of disasters.

In Sri Lanka, the key environmental findings from the Rapid Environmental Assessment (REA) carried out on 2004 tsunami disaster included the following [19]:

- While there is damage to the natural and built environment in affected coastal areas, there are no major life-threatening environmental emergencies as a result of the tsunami.
- Specific coordination needs to enhance environmental risk mitigation efforts.
- Remapping needs to ensure effective reconstruction efforts.
- Areas of acute environmental concern requiring immediate attention include management of tsunami waste and debris, and sanitation and sewage issues in settlements.

Calvi-Parisetti and Pasche [20] prescribes the process to be followed when assessing environmental impacts after a tsunami disaster. Assessments carried out in the first 48-72 hours after a major disaster should aim at identifying major secondary risks through a relatively simple checklist that should become a standard feature of the overall emergency assessments. If such risks are identified, specialised expertise should be quickly mobilised for further assessments and quick response. The initial environmental assessment should also look at those issues that are not immediately life threatening but may become so at a later stage if not dealt with immediately. Once the most acute phase of the response is over, the environmental consequences of the disaster on the livelihood of the affected population should be assessed and programmes designed to address them. Finally, the environmental consequences of the disaster on ecosystems and habitats should be assessed in order that they may be addressed through programmes in the reconstruction/rehabilitation phase.

7. Conclusion

Information and knowledge play an extremely important role in effective disaster reduction and response. Good communication and exchange of critical disaster management information and knowledge could enhance coordination and integration of stakeholders' actions in disaster mitigation and response. This paper highlighted the importance of knowledge and good practice sharing in disaster management strategies, and discussed the principal lessons learned from the 2004 Asian tsunami disaster, particularly relating to the Sri Lankan context. Several good practices and lessons learned, from 2004 Asian tsunami disaster, are explored relating to five different themes: social, technical, legal, operational and environmental. The ISLAND website introduced an organised common platform to capture, organise and share knowledge on disaster management strategies. However, the UK Higher Education Disaster Relief Project Report [4] highlighted the lack of mechanisms at national level in the UK to link the expertise, skills and knowledge that resides in UK higher education with practitioners in the humanitarian agencies. Neither is there a comprehensive overview of the expertise which exists and who is willing to offer it. Therefore, ISLAND could be extended to create mini-hubs of academic (and non-academic) expertise in order to act as the mechanism by which needs for expertise in a range of areas could be identified by the humanitarian agencies. Further, case material relating to different phases and types of disasters could be collated and populated using the available infrastructure of the ISLAND website.

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Post disaster Housing Reconstruction: Comparative Study of Donor Driven vs. Owner Driven Approach

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Abstract

Besides human casualties one of the most visible and striking effects of any major disaster is the destruction of houses. Construction of houses will be a major activity in the reconstruction phase of a disaster. The quickest and the most effective way to rebuild houses after a disaster is to employ what is know as the " Donor Driven" approach. In this approach the government or an external agency who is funding the project will lead the reconstruction process with the help of consultants and contractors procured for the project. The major limitation of this approach is that it may lead to housing that does not respond to the need of the victims. As an alternative, the so called "Owner Driven" approach has been used by some donor agencies as well as the government in many disaster situations. In this approach the disaster victims reconstruct their houses by themselves. The role of the external agencies is limited to the provision of financial and technical assistance.

Past research on the suitability of these two approaches to various disaster situations is limited to very few cases. The massive reconstruction programme implemented in Sri Lanka after the Indian Ocean Tsunami has used both these methods with varying degrees of success. Therefore, lessons learned in Sri Lanka would be a useful contribution to this growing body of literature on different approaches to post disaster housing reconstruction.

This paper aims to contribute to this discussion through a questionnaire survey conducted among beneficiaries of Tsunami housing programmes in the Matara District of Sri Lanka. The study found that Owner Driven approach has a number of advantages over Donor Driven approach. Nevertheless, Donor Driven approach cannot be totally dismissed as unsuitable because it has scored very high on some important parameters that are relevant for disaster situations.

Key Words: Disaster reconstruction, Housing, Sri Lanka

1. Background

Disasters cause a substantial amount of damage around the world every year [7]. In recent years several major disasters have occurred in coastal areas worldwide. On the 26th of December 2004, a major Tsunami occurred in the Asian region killing nearly 250,000 people around the

Indian Ocean. The Joint Report of the Government of Sri Lanka and Development Partners[3] issued in December 2005 highlights that the Tsunami on 26th December 2004 killed 35,322 people and destroyed US $ 900 million worth of assets and infrastructure in Sri Lanka.

One of the major challenges after a disaster is how the redevelopment activities should be undertaken. To rebuild the nation after a disaster, Governments adopt different reconstruction strategies. Different reconstruction strategies give different outcomes. Serious decisions must be made on how risks could be reduced to acceptable levels and these decisions have to be reflected in the reconstruction and recovery strategies that should be adopted. Identifying the most suited and applicable strategy for each situation is of utmost importance in order to provide better assistance to the victims and to avoid possible future vulnerabilities and environmental degradation.

Therefore, the aim of this research is to analyze the strategies used in post Tsunami reconstruction work in Sri Lanka. The main objective of the research is to identify the post Tsunami housing reconstruction strategies used in Sri Lanka, their applicability to Sri Lankan context and their successfulness.

2. Disaster Management & Reconstruction

2.1 Disaster management

Disasters are not totally discrete events. Their possibility of occurrence, time, place and severity of the strike can be reasonably and in some cases accurately predicted by technological and scientific advances. It has been established that there is a definite pattern in their occurrences and hence we can to some extent reduce the impact of damage though we cannot reduce the extent of damage itself. This demands the study of disaster management in methodical and orderly approach [5].

Disaster management has different emphasis in different disciplines. According to Central Emergency Relief Organization [2], disaster management is a collective term encompassing all aspects of planning for and responding to disasters, including both pre-disaster activities and post-disaster activities. It may refer to the management of both the risks and consequences of disaster.

Disaster management can be divided into four steps as: Emergency Response and Relief; Recovery and Reconstruction; Mitigation; and Preparedness [8].

2.2 Reconstruction Strategies

According to Kishore [6], any reconstruction programme has to meet a range of complex and often conflicting needs of affected people. i-Rec Coference held in 2004, has identified that reconstruction programmes often fail to take in to account the desires of disaster affected populations. If proper attention is not given to needs of affected people there is a possibility that the newly constructed facilities become obsolete from the day the construction is complete.

Therefore, reconstruction strategies should be implemented after studying the desires of the affected people.

According to Asian Disaster Reduction Center[2], post disaster reconstruction is a complex issue with several dimensions. Government, non-governmental and international organizations have their own stakes in disaster recovery programmes, and links must be established among them, as well as with the community. SMEC Group of Companies [8] mentioned that, reconstruction is one of the most demanding forms of activity after a disaster, because it operates in conditions of uncertainty, often in remote locations and within severe time constraints. Therefore, proper planning is of utmost importanance to reduce future vulnerabilities and to improve long-term sustainability. A good housing reconstruction strategy will take in to account the social need together with long-term disaster mitigation and sustainability. Barenstein [9] has studied these strategies following the earthquake that hit Gujarat in India on 26 January 2001. Barenstein [9] identified five approaches, namely; the owner-driven approach; the subsidiary housing approach; the participatory housing approach; the contractor-driven approach in situ; and the contractor-driven approach ex nihilo, that have been used during the reconstruction. The author has compared these five approaches and discussed the issues related to implementation of each of these methods.

Indian Ocean Tsunami provides an opportunity to study the different approaches used in housing reconstruction, their success, and related issues. According to Wegelin [10], Indonesia’s Reconstruction Master Plan for post Tsunami reconstruction set two core standards for tsunami victim household support. Each surviving household would be entitled to a grant of US$3,000 per house to rebuild the houses if it needed to be rebuilt from scratch and US$1,000 for damaged houses that could be renovated. Unlike in Gujarat, Sri Lanka used only two distinct approaches in housing reconstruction. They are, Donor Driven approach and Owner Driven approach [10].

Donor Driven reconstruction program is completely handled by the donor agencies as relocation of affected families within the buffer zone from the buffer zone became a necessity. All affected families were entitled to a house built by a donor agency in accordance with Sri Lankan government standards in a new location. In addition, the donor provides all common infrastructure for the new settlement, while Sri Lankan government provides the services up to the relocation site [10].

Houses got damaged partly or fully outside the buffer zone were included in the Owner Driven reconstruction program. The Sri Lankan government provided a cash grant to the affected homeowners for the reconstruction of their houses at the same site. The owner of a partly damaged house received a cash grant of Rs.100,000 and the owner of a fully damaged house received a cash grant of Rs.250,000 [10]. The Owner Driven approach enables the affected communities to undertake construction work by themselves with external financial support and technical assistance.

3. Methodology

First a comprehensive literature review has been carried out on disaster management and reconstruction strategies by referring books, reports, journals and research publications. The Tsunami, which hit Sri Lanka on the 26th of December 2004, has been selected as the case study for this research. A detailed documentary survey has been carried out on post-Tsunami reconstruction activities in order to identify the different housing reconstruction strategies adopted. Also 100 newly constructed or repaired houses have been inspected in the District of Matara in order to get a clear idea on issues such as buildability, sustainability, etc.

Both structured and unstructured interviews were conducted among officers of 11 Governmental and 6 non-Governmental Organizations, to collect information on post Tsunami housing reconstruction strategies, their suitability and applicability. A questionnaire survey has been administered among 531 Tsunami victims in the District of Matara, to identify the beneficiery satisfaction of the housing they obtained. The profile of the sample used in the questionnaire survey is given in Table 1.

Table 1: Profile of the sample

Category	No. of Dwellers	%
Donor Driven Housing Relocation Programme	261	49 %
Owner Driven Housing Resettlement Programme	255	47 %
Received only Temporary Housing	21	4 %
Total	537	100%

4. Results

With all findings from questionnaire survey, unstructured interviews conducted among Tsunami victims together with observations of the researcher and the views of officers of the relevant Governmental and Non Governmental Organizations, the successfulness of the housing reconstruction programme has been measured separately for Donor Built Programme and Owner Driven Programme using the parameters given below.

- Coverage
- Adequacy and sufficiency of the relief received
- Timeliness
- Overall satisfaction of the victims
- Other issues based on the observations of the researcher (Buildability, Sustainability, Extendibility)

4.1 Coverage

According to statistical details 74.30% of the housing units have been completed and 18.63% of the housing units are been progressing by September 2007 [11]. So the tsunami housing reconstruction progress in Sri Lanka is in fairly success stage when considering total planned duration of 3-5 years period. Beyond the above facts, the present housing coverage in Matara district has been concluded in following topics under two housing reconstruction strategies in order to identify the successfulness of the housing reconstruction programme.

In the case of donor driven housing programme in Matara district that total 62 numbers of sites assigned for relocation and out of that 48 numbers of sites have been completed. Although the 10 sites are currently in progress and 08 numbers of sites are not commenced yet. When concerning the total number of houses required for district of Matara has planned as 1678 units and already 1856 housing units have been completed. Also 371 housing units are in progress and 423 houses are not begun as it planned at the decision making stage. So as a conclusion it can be mentioned as more than 100% of total housing requirement has been achieved at the moment in donor driven housing programme in Matara district with an excess of 178 numbers of housing units [11].

Up to end of September 2007 that 96.70% of total number of housing unit in overall fully and partly damaged housing unit in owner driven housing programme has been completed in the district of Matara. So the remaining 2.7% is on progress and 0.6% of housing units are not begun yet. In the case of owner driven housing programme the housing progress in fully and partly damaged housing units are summarized in separately as following Table 2.

It can be seen in the 89% of completion in fully damaged houses and 99% of completion in partly damaged houses. So the money disbursements do not inevitably denote that the reconstruction of the housing units are completed from Rs. 250,000/= is given to fully damaged victims in 4 installments and Rs. 100,000/= is given to partly damaged victims in 2 installments. It has been observed when the dwellers have failed to show the progress of the work with in the stated requirements, and then the victims have been unable to collect the next installment according to disbursement schedule. So that they had to wait for further money arrangement from top up grants, loans and other assistances from third parties to complete their houses and that has affected a fairly less progress in owner driven housing programme especially in fully damaged houses.

Table2: Progress in Owner Driven Housing Programme

	Fully Damaged Houses		**Partially Damaged Houses**	
	Nr. Of Houses	**%**	**Nr. Of Houses**	**%**
Completed	1250	89%	4821	99%

In Progress	142	10%	25	0.50%
Not Started	11	1%	25	0.50%
Total	1403	100%	4871	100%

4.2 Timeline

To carrying out the research in several parameters that the scale has been used as “very satisfied”, “somewhat satisfied”, “somewhat dissatisfied”, and “very dissatisfied”. As shown in Table 3, the greater parts of the victims were at either categories of “somewhat dissatisfied” or “very dissatisfied” scales in both housing reconstruction programme. It is not an uncertainty issue due to that reconstruction has been designed to complete within 3-5 years of timeframe and still it has only taken nearly 3 years.

Furthermore, when concern about the views of the victims on the timeliness of the delivery of permanent houses that the Table 3 shows a fairly satisfied response to owner driven housing programme when compared to donor driven houses. In the case of owner driven programme has taken less time to arrange the financial assistance and other aspects but donor driven programme has get more time than owner driven due to acquire lands, design, contractual arrangement and construction in the whole procedure due to large scale of housing projects.

Table3: Satisfaction level regarding Completion Timeline

Reconstruction Strategy	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied
Donor Driven	0%	7%	42%	51%
Owner Driven	5%	25%	43%	27%

4.3 Dwellers view on their permanent residence

One of the most visible and outstanding effects of any major disaster is the devastation of houses which destroys livelihoods, protection and privacy. So that, without framing to the timeline and cost of the reconstruction activities it is essential to evaluate the dwellers’ views to gain an overall satisfied output. Under this heading, the dwellers’ views were gained on their permanent residences while covering the nine salient factors and condition generally assemble with housing programmes in both donor driven and owner driven, which are mentioned at the beginning of this chapter. Although the scale used was the previous one used in the above that "very satisfied", "somewhat satisfied", "somewhat dissatisfied", and "very dissatisfied".

4.4 Quality / Strength / Durability

As shown in Table 5, in the case of donor driven programme, only 5% of the dwellers were very satisfied and 15% were somewhat satisfied while 47% were somewhat dissatisfied and 33% of the dwellers were very dissatisfied. Due to much more reasons are behind that and the dwellers were not satisfied with strength, arrangement of structure, quality of material used, improper land fillings and cuttings and dreadful manner of construction of the houses. Alos due to increament of intermediate dealers, in each transactions have end resulted to minimize the amount of money for single housing unit. Finally that has affected to carry out contractors' duty in less cost target, which reflected to select low cost and poor quality materials, offensive method statements, etc. By the way most observed projects are with small to sever defects and some houses are taken leave off. In most case the dwellers involvement to construction activities was less and that 5% of very satisfied has succeeded due to the dwellers participation.

Throughout the survey result 55% of the dwellers of the owner driven programmes were very satisfied and 34% were somewhat satisfied. Dwellers in owner driven houses argued that high level of quality standards can be achieved when the inception to completion is done with participation of the resident. Most often the owners have recognized that better design and structural stability with superior quality maintenance of their newly residences is well important to future vulnerability. Financial assistance gained from the state was reinforced by the top up grants provided by the private donors in most of owner driven programme and other than that further money recovered from loans, own money, relations and friends assistance, etc. So comparing the outcomes of the survey it should be noted that in the case of owner driven programme is in high position than donor driven programme in respect to quality, strengthen and durability of their permanent residences.

4.5 Functionality

In the case of functionality, according to Table 5 the majority of the donor driven programme (41%), was very satisfied and according to Table 6 majority of owner driven programme (52%), was somewhat dissatisfied. Most of deign in donor driven houses are done by the qualified architect by concerning the Sri Lankan culture with basic amenities. And some of international participant involvement caused to restrict that the local complimentary designs. It is a common intention when constructing a house by the owner that is tried to achieve better house in respect to present financial strength with basic amenities or less and remain part with further arrangements will be done in future after occupied. It is what that has been observed in most owner driven houses.

4.6 Space availability

According to the survey results, it has been recognized that equally fair distribution can see in according to Table 5 in donor driven progrmme in the case of space availability, which depend on several aspects such as members in a family, livelihood pattern, living standards, etc. And according to Table 6 the majority of the owner driven programme (59%), was very satisfied due to most of dwellers have identified their requirements and well established it concerning the number of family members. Although most fully damaged houses in owner driven programme have been observed as two storied houses by providing better space in vertical arrangement. Inadequate financial gainers have constructed their houses with less amenities and allocating insufficient spaces, which has resulted 15% of dwellers in somewhat dissatisfied category.

4.7 Aesthetics

As shown in Table 5, the majority, which is 52% of the dwellers of donor driven programme were somewhat satisfied and 22%, were very satisfied. In the case of owner driven programme 31% of dwellers were somewhat satisfied and 34% were very satisfied while amounts of 34% were somewhat dissatisfied in according to Table 6. In both cases, it has been observed that some of middle class people who were not satisfied as they lived in better appearance houses before the tsunami. In most of the cases, it has been identified that donors have got better appearance houses which were designed by the qualified architect. Also the most owners have designed their houses according to their concept with better appearance.

4.8 Flexibility to make any changes in the future

As shown in Table 6 & 5, the majority, which is 54% of the dwellers of the owner driven programmes, were somewhat satisfied and majority of donor driven programme which amounts to 56%, were somewhat dissatisfied with the case of flexibility to make any necessary changes in the future. It has been noted that most of the dwellers in donor driven programme do not have any intention to change it presently due to that the original deeds were still not handover to them and either allowable land area is not enough to do horizontal alignment or that the design is not concern the vertical alignment to further developments.

4.9 Agreeing to change the design as required

In the case of the agreeing to change the design as required too, in owner driven programmes 45% of the dwellers were somewhat satisfied and 33% were very satisfied, while donor driven programme 56% of majority were somewhat dissatisfied. Dissatisfaction of dwellers in the donor houses were high due to that involvement of victims in the design stage can not be seen throughout the survey, but only few of projects had been allowed to inspect their houses to victims in the construction stage that couldn’t support to change the design. So as a conclusion it has been noted that owner driven programme is in high satisfactory level compared in it to donor driven programme in respect to the support given to change the design.

4.10 Land size

In the case of land extent, the majority of donor driven programme (47%) was very dissatisfied and the majority in owner driven programme (52%) was very satisfied. It has been observed that major part of people who have moved to donor driven houses were not satisfied as they lived with adequate size of land area before the Tsunami. But now the most of donor's housing area is from 6 to 12 perches and it is nothing when it compare with pre tsunami owned land. Also there were no ground areas to most donor driven houses, which have been granted multi storied housing schemes but with some common area to social works. It is obvious to seen that most part of the owners were in satisfied level regarding their previous land extend, but only few cases have been identified as restricted areas to construction activities because of the buffer zone concept.

4.11 Location

According to Table 6 & 5, the majority, which is 66% of the dwellers of the owner driven programmes, were very satisfied and majority of donor driven programme which amounts to 41%, were very dissatisfied with the case of location. Most of the people in the Matara district who were affected to the tsunami are occupied in fishery industry. And most of other's livelihood activities are based with the sea. So majority of owner and donor dwellers have responded as it as major opportunity to located as near as the sea. But some of middle class peoples in both owner driven and donor driven programme have been observed that the relocation in inside villages is better than the previous coastal location, considering social and cultural issues.

4.12 Overall facilities provided

(Electricity, Water connection and Sanitary)

As per the result of the survey it has been identified that the overall facilities are available in donor driven programme and owner driven programme are in better position, which are shown in Table 4 categorizing in to three basic services that are electricity, water connection and sanitary facilities.

Table 4: Services in the house

Services	**Donor Driven**		**Owner Built**	
	Nr. Of Houses	**%**	**Nr. Of Houses**	**%**
Water	246	94.25	253	94.12
Electricity	231	88.51	234	91.76

Sanitary	210	80.46	210	82.35

If the above facilities are connected to both progammes in adequate manner, due to several reasons the dwellers satisfactions for those facilities are not parallel. According to Table 5 & 6, it shows the satisfactory level of two different housing programmes in the case of the overall facilities, which in owner driven programme 41% of the dwellers were very satisfied and 39% were somewhat satisfied, while donor driven programme 39% of majority were somewhat dissatisfied. It has been observed that at the beginning the facilities are connected to donor house, but it has been made grave malfunction outputs due to some issues, unexpected situations and conditions.

Furthermore Table 7 specifies the percentage of dwellers under each category on the two reconstruction programmes that the majority, which is 40% of the dwellers of donor driven programme were somewhat dissatisfied and 31% were very dissatisfied. In the case of owner driven programme 50% of dwellers were somewhat satisfied and 33% were very satisfied. So it is comprehensible that the dwellers, who were under donor driven programme were not happier with their permanent houses than the dwellers, who were under owner driven programme in the district of Matara.

Table 5: Satisfaction of the Dwellers – Donor Driven

Factors	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied
Quality/ Durability	5%	15%	47%	33%
Aesthetics	22%	52%	23%	3%
Functionality	26%	41%	24%	8%
Space availability	20%	26%	29%	25%
Agreed to change the design as required	4%	18%	56%	22%
Flexibility to make any changes in the future	4%	23%	56%	17%
Location	16%	20%	23%	41%
Land size	6%	15%	32%	47%

Overall facilities provided	23%	28%	39%	10%

Table 6: Satisfaction of the Dwellers – Owner Driven

Factors	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied
Quality/ Durability	55%	34%	11%	0%
Aesthetics	34%	31%	34%	1%
Functionality	13%	26%	52%	9%
Space availability	59%	24%	15%	2%
Agreed to change the design as required	33%	45%	20%	2%
Flexibility to make any changes in the future	22%	54%	19%	5%
Location	66%	19%	13%	2%
Land size	52%	26%	20%	2%
Overall facilities provided	41%	39%	20%	0%

Table 7: Dwellers' Total Satisfaction regarding their Permanent Resident

Reconstruction Strategy	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied
Donor Driven	12%	17%	40%	31%
Owner Driven	33%	50%	15%	2%

5. Conclusions

The recent increases in frequency and magnitude of natural disasters have raised issues of increasing vulnerability of communities. The impact in terms of human, structural and economic losses has risen in recent years. The reconstruction process has very much depended on the administrative, political, social, economic and cultural context that coupled with many other unforeseen factors will affect the speed and coverage of the recovery programmes. In order to derive a better conclusion, the reasearch mainly focused in acutely on the successfulness of post tsunami housing reconstruction programme based on two strategies, namely, donor driven and owner driven.

Main outcome from this survey is that dwellers in owner driven housing programme is more satisfied than the dwellers in donor driven housing programme when concerning more parameters. In other word, it can be concluded as that owner driven housing programme is more successful than the donor driven programme concerning the dwellers' view. According to the research, it has been argued that the owner driven housing programme has been in prominent level in term of: Quality / Durability, Space availability,Flexibility to make any changes in the future, Agreeing to change the design as required, Land size, Location, Overall facilities provided (Electricity, Water connection and Sanitary). When looking at these parameters, which are superior in terms of owner driven, have proved that the dweller involvement throughout inceptions design to construction stage resulted better success in owner driven housing programme than those who were under the donor driven housing programme.

But contrast with the owner driven housing programme that the donor driven housing programme has been more superior in term of; Aesthetics and Functionality. Furthermore, it has identified those two main reasons behind that are, the donor houses have been designed by professional architects and most of the houses in the owner driven programme were half built and occupied with the intention of completing in the future.

Reconstruction process should be considered as development opportunities and should open the access of different types of innovative solutions. These innovations should lead to vulnerability reduction, and should enhance human and other activities security in long term. By providing buffer zone that the government has identified the vulnerable area in future disasters and it emphasized to categorized the post disaster housing reconstruction programme to the above discussed two strategies. By the way the donor relocation programme started later than owner resettlement programme, the progress at the district of Matara in the donor driven is fairly high compared to the owner driven. Comparing to other districts, the coverage in the both programmes in Matara district is high, but that dwellers' view on timeliness to delivery of permanent houses to the donor driven and compensation to owner driven house have been identified in less figure. And that is seriously shown in donor driven programme. Although, that have been found excess amount of donor driven houses at the present, still the victims are living in temporary houses. Also the assistance given to sub families' victims could be seen in erroneous manner and after 3 years back that most of the sub families still in the temporary house, when the excess amounts of donor houses are vacant.

It has also been observed that the dwellers' view on the State assistance throughout the housing reconstruction programme is fairly high in the owner driven houses, but view on the NGO assistance throughout the housing reconstruction programme have been fairly low compared to those donor driven ones.

By evaluating the overall information on the post tsunami housing reconstruction programme, the successfulness of the process as well as the victims' view of two different reconstruction strategies will be helpful to decision makers to get comprehensible idea regarding their applicability and drawbacks on both the programmes.

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Capacity of the Construction Industry in Post Disaster Reconstruction

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Abstract

Natural and man-made disasters are causing increasing losses to human lives and damages to property over the years.Srilanka is prone to natural disasters and there is growing recognition that there should be more concern on the area of Disaster. Housing sector is with the significant damages compare to other sectors. The need for managing disasters through construction industry is gaining importance in recent years. Construction industry has a much broader role to play in order to obtain the successful implementation of reconstruction. Capacity of the construction industry is therefore a critical issue. Capacity building and construction industry development are becoming inevitable in successfully managing disasters. The Srilankan construction industry did not posses required finance, human resource, management and etc for an accelerated tsunami reconstruction work. Purpose of this study is to explore the capacity of the construction industry in post disaster housing reconstruction.

This study was done through systematically reviewing the literature in capacity and the reconstruction principles. Data collection mode used for the study is questionnaire survey and documents survey. Data are collected from contracting organizations who are involved in post disaster housing reconstruction. Findings of the research reveal that, Contractors give importance to the human resource, finance and management capacities in the elements of the capacity building. Contractor's financing base changed about a considerable smaller proportion in response to reconstruction circumstances. Capacity in terms of contractor's organisational capacity was explored. Credit facility of the contractor's shows the increasing nature in the last three years. Main challenges they face in the successful implementation of the reconstruction are; non availability of labourers and materials. Significant Remedies to overcome such challenges are Planning of material requisition and pre-demand for construction workers.

Keywords: Capacity, Construction Industry, Housing, Post-disaster, Reconstruction

1. Background

Disasters, both natural and human-caused, have been occurring with increasing frequency and effect in recent decades in many countries around the world. They have had a disproportionately heavy toll on developing countries both in terms of loss of lives and damage to property [1]. More concerns have been given to the area of disaster and it is becoming main area of research, Due to its impact on the human lives and assets

According to Dilley et al [2], “Earthquakes, floods, drought, and other natural hazards continue to cause tens of thousands of deaths, hundreds of thousands of injuries, and billions of dollars in economic losses each year around the world”. EM-DAT, a global disaster database maintained by the Centre for Research on the Epidemiology of Disasters [3] in Brussels, records upwards of 600 disasters globally each year. It continues that Disaster frequency appears to be increasing. Disasters represent a major source of risk for the poor and wipe out development gains and accumulated wealth in developing countries.

Sri Lanka is prone to natural disasters commonly caused by floods, cyclones, landslides, droughts and coastal erosion for generations with increasing losses to life and property in the past few decades [4].He further indicates that the devastation caused by tsunami in 2004, however, took Sri Lanka by surprise warning that Sri Lanka is also vulnerable to low-frequency high impact events with extensive damage. The devastation according to Sisira et al [5] the earth quake that caused the tsunami on 26th December occurred at 6.58 am Sri Lanka time with the large wave hitting the east coast at 8.35 within a very short time over 36,000 people were dead, and several hundred thousand had been displaced. In addition, massive damage had been inflicted on thousands of houses and other buildings, railways, bridges, community networks and other infrastructure and capital assets. From this, it is very much clear about the magnitude and the significance of the impacts by the tsunami in 2004.

Considering the progress of the housing sector it is stated that in the IUCN 2005a [6] that the construction of semi-permanent and permanent homes began at government-designated resettlement sites located outside of the buffer zone. However, reconstruction was unevenly distributed and paced throughout the country.Even though several initiatives were taken by the governments in the past to reduce these damages they were mostly reactive actions rather than proactive actions to minimize the cause of the disasters.

It is further stated in the ADB’s Report 2005 [7] that the national construction industry does not have the necessary contractors, equipment, skilled workforce, modern management practices or access to finance required to speed tsunami reconstruction work. Inflation of construction material is a problem. Further challenges include procurement delays, environmental safeguards, security in uncleared areas, and capacity constraints. Capacity building is the critical element of the recovery and reconstruction process [7].

It is evident from above that the construction industry must be developed in terms of their capacity. It is necessary to provide the construction industry with the requisite capacity and capability [1].So that the srilankan construction industry can be able to carry out the required reconstruction, especially the in the housing sector, with the proper concerns on the capacity development.

Considering the factors which cause the delay in the successful housing reconstruction, capacity of the construction industry is one of them.Therfore Aim of this study is to explore the organizational capacity of the contractors in post disaster housing reconstruction and to investigate the remedies to face the challenges in successfully implementing the housing reconstruction. The objectives to achieve the aim are; to recognize the concept of capacity and capacity building, to identify the important elements of the capacity building in the housing reconstruction, to explore the demand created by the tsunami and the current status of the housing reconstruction, to explore the organisational capacity of the contracting organizations and to identify the challenges and remedies in successfully implementing the housing reconstruction.

2. Research Methodology

Research Methodology started with identifying research question which is from the literature survey. The literature review was done on the research subject area to understand the basic concepts on the capacity and the reconstruction. The collected literature was used to achieve some objectives and to identify the factors for capacity building elements, organisational capacity, challenges and remedies to the successful housing reconstruction .The literature shows that there is no academic work that examines the current situation of capacity of the Srilankan construction industry in relation to natural or man-made disaster reconstruction.

This study, for the purpose of data collection set its boundaries within the context of the contractors for construction industry. So that the ‘unit of analysis’ selected for this study is ‘Contracting organisations’ in the Srilankan construction industry. In this research 30 contractors who are involved in the housing reconstruction were contributed in the Colombo region to explore their capacity. Their ICTAD grading was ranging from M1-M6. The research design revealed the demand for primary as well as secondary data. For this Questionnaire and document survey was used. Data or information collection mainly dealt with the type of data, and the appropriate data collecting techniques that were employed for the study.

The purpose of analysis was to provide evidence of relationships and to aid the understanding of the objectives. The structured questionnaire was prepared from the literature synthesis and it comprised check list, and Likert scale rating. After data have been checked and entered, the next step was to display them for exploratory data analysis, by way of tables, bar charts, etc. The relative importance index (RII) and the Frequency analysis was used as analysis techniques. Contractor’s capacity was considered for the construction industry’s capacity and the housing was considered for the reconstruction process and contractors who contributed were only from Colombo region, are the limitations of this research.

3. Literature Synthesis

3.1 Housing Reconstruction In Post Disaster

The Center for Research on the Epidemiology of Disasters [8] in Brussels, Belgium, uses the following definition for disaster. “A disaster is a situation or event which overwhelms local capacity, necessitating a request to a national or international level for external assistance”. According to Songer [9] disasters are commonly categorized by their origin; natural or man-made. Most disasters investigated in the literature are natural disasters. He further follows as disasters may occur suddenly in time (a quick onset), or they may develop over a period of time (a slow onset). Most occur suddenly and perhaps unexpectedly. However, some events develop gradually, including some floods and famines related to drought. Factors that contribute to the vulnerability of communities and societies to the impacts of hazards are many. CERO [10] lists down the causes of disasters as poverty, population growth, rapid urbanization, lack of public awareness and information, changes in cultural practices, environmental degradation, war and civil strife.

Aftermath of the disaster should be given much consideration in terms of development. Shanmugaratnam [11] states a post-disaster situation can be seen as one of new opportunities for reconciliation, investment and growth, sustainable resource utilization, human capital formation, employment generation and human development.Therfore proper planning should be made in order to obtain maximum benefits. International and consequently national capacities for coordination, funding and implementation post-disaster are structured to offer support in independent sequential ‘relief ’, ‘recovery / rehabilitation’ and ‘reconstruction / development’ phases, regardless of whether the support is to water supply or shelter [12]. Further it continues to state that reconstruction is a high-cost and long-term commitment per capita, required after the Disaster.

Disaster management is a new and innovative method for preparing companies and organizations to address the substantial risk of disasters in the workplace [13]. Disaster management aims to reduce, or avoid the potential losses from hazards, assure prompt and appropriate assistance to victims of disaster, and achieve rapid and effective recovery [14]. According to Asian Disaster Reduction Center [15] the disaster risk management cycle, consists of four phases: Prevention/Mitigation and Preparedness in the pre-disaster stage, and Response and Rehabilitation/Reconstruction in post-disaster stage.

Jayawardane [4] in indicating the natural disasters and Srilanka, natural disasters in Sri Lanka are commonly caused by floods, cyclones, landslides, droughts and coastal erosion. The author further argues that the devastation caused by Indian Ocean tsunami in 2004, however, took Sri Lanka by surprise warning that Sri Lanka is also vulnerable to low-frequency high impact events with extensive damage.

According to ADB’s report in 2005 [7], it was estimated that Sri Lanka had 9.6 million building units of which 4.6 million or 48 percent were used as dwellings. 1.12 million Building units (around 12 percent of all building units in the country) are located in administrative divisions along the Srilankan coast which was affected by the tsunami. A damage overview and recovery need was produced by the ADB 2005 [7]; the tsunami surge completely destroyed around 99,480 homes and partially damaged about 44,290. The completely and partially damaged houses together comprise 13 percent of the housing stock in the administrative divisions along the coast. The net replacement cost for housing is estimated between LKR 46 to 51 billion ($437 million to $487 million).Since most of the affected housing stock was built over a long time period, its replacement value was depreciated by 30 percent to determine the damage estimate, which is in the order of LKR 32 to 36 billion ($306 million to $344 million) [7].

Demand for housing reconstruction was immensely created by the tsunami devastation. Following statistics shows the demand created by the tsunami and the current status of the housing reconstruction. From the RADA report [16], number of shelters after the tsunami struck as at 31.12.2005 was 57057 temporary shelters and in 31.12.2007 it was reduced to the percentage of 77.78% to 12682 temporary shelters. The original count after the tsunami struck was 98,525 and the revised count was 116135 .78.10% of the permanent houses have been completed up to the month of August 2007 and 22.08% of the houses are in progress according to the revised count. In the permanent houses completed 19.82 % are Donor driven and 77.79% are owner driven houses.28.14% of the houses were owner driven and 70.68% were donor driven in houses which are in progress.

In considering the housing reconstruction, Southern province has the completion percentage of 105.87% and western province is with 17.65%. In the North western province it has reached the 100% and in the Eastern and Northern provinces were respectively with the completion percentages of 80.02% and 36.71%.There are still some outstanding works to be carried out in the reconstruction of housing. The government of srilanka expects the outstanding works to be completed by the end of this year.

From the above data it is evident that the progress of the housing reconstruction is not within the stipulated time framework. Despite the many reasons which hinders the planned progress of housing reconstruction, the capacity of the construction industry is among them. Since the Srilankan construction industry lacks in capacity to fulfil the requirement due to a disaster, it is very important to make sure of the capacity of the contracting organizations to face any kind of challenges in relation to capacity for natural or man-made disasters. The need for understanding of the Construction industry’s capacity to carry out the reconstruction and to predict the performance on future disaster is becoming inevitable. Therefore the consideration must be given on the capacity of the construction industry in detail.

3.2 Capacity of The Construction Industry

In considering the Capacity of the construction industry, lots of attention has to given to the organisational capacity. Since the most of the stakeholders in the construction industry can be categorized into an organisation. In simple terms, organizations capacity is its potential to perform its ability to successfully apply its skills and resources to accomplish its goals and satisfy its stake holder’s expectations [17].The aim of the capacity development is to improve the potential performance of the organization as reflected in its resources and its management.

Therefore, to improve the capacity of any organisation there should be capacity building activities. The meaning of capacity building varies depending on the context where it is being used. According to the International Development Research Centre [18] in referring to the framework for organisational assessment, Organizational performance, Organizational capacity, external operating environment, internal environment are the main elements. Organizational performance refers to the ability of an organization to meet its goals and achieve its mission. Organizational capacity refers to the resources, knowledge, and processes employed by the organization. External operating environment refers to the external environment in which the organization carries out its activities. Internal environment refers to internal factors that influence the direction of the organization and the energy displayed in its activities.

Ofori [1] indicates that it is necessary to provide the construction industry with the requisite capacity and capability. The author further states that In particular, the construction industries in developing countries need to be equipped for these purposes, given the apparent differential frequency and severity of various types of disasters. This can only be achieved through deliberate, planned, strategic, systematic efforts. Further the author states that First, human resource development should equip construction professionals with the knowledge and skills required to undertake appropriate designs and construction .Second, a programme of materials development should be instituted in each region to find high-performing (disaster-resistant) materials which are suited to the local context and are of good quality, durability and affordability. Third, it is necessary to put measures in place in pursuit of the technological development of the industry to ensure that it has the capability to handle the various projects which will be required to provide protection against disasters, and those which the post disaster reconstruction process will involve.

Due to the high demand created by the tsunami, in order to cope with the planned progress, the contractors must increase their capacity. When they must increase their capacity in quantity and speed, more experienced and skilled resources are required to actually manage the projects. In addition to construction expertise, possibly large-scale, basic project management experience was also essential. For both of these skill-sets, smaller developing countries may not have people with this large-scale time-critical management experience, and ex-patriots with these skills frequently do not have the experience to understand the environment adequately.Rex 2006, as cited Haigh et al [19].

According to Haigh et al [19], there is growing recognition that the construction industry has a much broader role to anticipate, assess, prevent, prepare, respond and recover from disruptive challenges.

4. Key Findings

4.1 Important Elements of the Capacity Building In The Housing Reconstruction

The main identified capacity buildings elements of the Organisations from the literature review are Management system, Financial, Human Resource, Information System, and Marketing. Of which the respondents have indicated the importance of each element to their organisation in carrying out the housing reconstruction.

All the elements of capacity building were ranked using RII (Relative Important Index). According to RII calculated from the survey results, the Human resource took the first rank (RII - 75%). Therefore, it is evident that Human resource, especially the labour, is important as capacity building element in post disaster hosing reconstruction.

The Financial system was the second (RII – 73%) mostly needed element in the capacity building in post disaster housing reconstruction. The respondents believed that it is important because it decides on how much they can commit to any work in the post disaster reconstruction and the Donors and government agencies were looking into this because other factors such as experience would not be relevant in this case due to the fact that the housing construction in this big scale, very new to every one.

Further, the respondents believed that Management was important in order to carry out the disaster housing without any disruptions to the housing reconstructions. Which was one of the main backlogs in the housing reconstruction in Sri Lanka.This took place in the RII, third, with the percentage of 72%. The other elements of capacity building such as Information system, Marketing and other were concerned relatively low by the contractors who are in the housing reconstruction activity.

4.2 Exploration of The Current Capacity Of The Contracting Organizations

Explorations of the Current capacity of the contractors were focused through the Organisational capacity. Organisational capacity was considered in terms financial management system, financial stability, diverse and sustainable funding, management and staffing capacity, internal performance analysis, and customer service orientation. In addition to these, credit facility of the contractors was considered after the years of tsunami struck which is from years of 2005-2007.

Financial Management System

A well-functioning financial management system puts internal policies and practices in place for a contractor to monitor and maintain its financial health and to help ensure its long-term sustainability.90% of the contractors have stated that they conduct yearly or biannual audit. Conducting an audit represents good business practice for the contractors. It assesses whether the financial reports of the contractor are presented fairly and whether the contractor has complied with applicable laws and regulations. 76 % stated that they received the qualified opinion on its audit.70% indicated that they have no substantial concerns with the internal controls. Internal controls are an organization's accounting and other fiscal control policies and procedures that seek to minimize the likelihood that assets are misused or accounts are misstated. These must be due to good management practices among the contracting organisations to keep up their grades and to perform well to achieve their objectives.

Financial Stability

Financial stability refers to an organization's ability to manage the flow of funds into and out of the organization, and its ability to deal with a short-term cash shortfall. A contractor's total annual budget serves as an indicator of its general size, and perhaps the scope of its works and the size of its client base. About 65% of the contractor's total annual budget is over 20 million. 90% of the contractors indicated that they have reserve of funds or ready access to cash. Well-managed organizations maintain a line (or lines) of credit or at least some access to cash in case they experience a short-term shortfall or otherwise need access to cash quickly. 14% of the respondents have stated that they have delayed the payments.14% percentage of the respondents stated they have cancelled the contracts in particular circumstances. In considering the types of clients they treat ,since one contractor serve many types of clients, 54% are the Residential clients, 62 % are government clients, 46% are Industrial clients, 53% are Commercial Clients. It shows the client's base is on average and the contractor can expand in a reasonable manner to take advantages of opportunities for growth in the market, while not overextending itself.

Diverse and Sustainable Funding

97% of the contractors have indicated that they plan to grow the business in the future. Because all of the contractors are profit oriented in the stream of contracting business. However, growth that occurs too quickly or without forethought can actually hinder sustainability, if a contractor's revenues cannot keep up with its increase in staffing and other expenses.66% of the contractors finance base is changed 0-15% in response to reconstruction circumstances and 20% of the contractors funding base is changed above 20% in response to Reconstruction circumstances. Since all of the contractors are involving in the housing reconstruction and reconstruction works became their part of the business and it is a smaller proportion.

Credit Facility

Credit facility of the contractor was calculated by the adding the total credit facility of each contractor type in the years of 2005, 2006 and 2007.Then the Percentage change in the year from 2005-2006 and 2006-2007 was calculated. Weighted average was used get the final Credit facility changes in the sample size with the different number of contractors in each type. Final credit facility of the contractor graph shows the increase in the year for 2005-2006 and 2006-2007.The percentage of the increase in the year from 2005 to 2006 was higher than the year from 2006-2007.This may be due to the fact that the tsunami housing reconstruction activities were higher in the year of 2006 compare to the years of 2005 and 2007.

Management and Staffing Capacity

The leadership and staffing of any organization are critical to its ability to provide high quality and reliable construction to their clients .26% of the staff have 0-20% of the sufficient relevant education experience in relation to the construction industry and 46 % of the staff have 40-60% sufficient relevant education experience. It is resulted because most the local construction industry doesn’t employ well educated staff.53% of the staff has been well trained in the contractor’s general approach. This is because the most of the contractors doesn’t provide a standard training system or there are no proper rules and regulations governing the training for the staff. Capacity building is needed in these areas to the existing staffs.

Internal Performance Analysis

Any organization that is interested in maintaining and improving its organizational capacity should conduct regular and thorough analyses of its work and how it could improve its service delivery, as well as its overall outcomes.17% have stated they assess and review its own performance monthly, and 33 % stated they do quarterly, 40 % stated that they do annually and 10% stated that they neither assess nor review its performance. Most of the contractors review their performance in order to find whether they are in line with their objectives and for good organisation practices.83% have stated that they do solicit information from clients to determine their satisfaction. Majority of the contractors solicit information because it leads the contractor to review its performance and proper functioning of their business.

Customer Service Orientation

Contractors will be working closely with the staff, potentially over a long period of time, customer service is of particular importance 55% stated that they do provide adequate and appropriate customer service resources. It is on average level and most of the contractors do not offer client service orientation except the big contracting organisations. 52% have indicated that the resources are readily available to client and to client’s staff. Customer service orientation is on average and indicates the need for development to provide a satisfactory service orientation.

4.3 Challenges and Remedies In Successfully Implementing The Housing Reconstruction

Challenges in successfully implementing the housing reconstruction were identified in the literature synthesis and given to contractors in the form of questionnaire with the 5 scale Likert scale rating. The RII was calculated to each challenges and ranked. The same procedure was done to the remedies to overcome the challenges in the post disaster housing reconstruction.

It is very evident that the contractors have suffered in housing reconstruction by the non availability of labourers and the non availability of the materials. Availability of the labourers were the biggest challenge with the RII of 86%.The availability of materials was the second biggest issue with the RII of 83%.These two problems took forefront place compare to the other challenges they faced in the housing reconstruction. This is due to high demand of materials and labourers aftermath of tsunami. The devastation led the country to provide more than 100,000 houses in a moment. It caused a very high demand for materials and labourers. The effect indirectly affected the wages for labour.

Third issue they face mostly is the project management which was with the RII of 79%.The reasons due to the fact that the availability of the labourers and the availability of the materials caused the lagging effect on the project management. Other factors such as insurance processing, poor IT infrastructures were lowest in the contractor’s priority. This is because the srilankan construction industry is not that much developed compare to the other developed countries. So that the poor IT infrastructure, insurance processing were not considered much, since most of the contractors are small in size, by the contractors as the challenges for them.

In considering the remedies to the challenges, according to RII calculated from the survey results, the Planning of Material requisition took the first rank (RII - 81%). Therefore, the majority of the respondents stated that Planning of material requisition is important in post disaster hosing reconstruction to overcome the challenges. This was due to the challenges biggest issue of non availability of materials. The Pre-demand for construction workers was the second (RII – 75%) mostly needed in the overcoming of challenges in post disaster housing reconstruction. This was due to the reason that the higher demand situation existed for the labourers after the tsunami.

Further, the respondents believed that Proper co-ordination is important in order to carry out the disaster housing without any disruptions to the housing reconstructions. Which was one of the main backlogs in the housing reconstruction in Sri Lanka.This took place in the RII, third, with the percentage of 70%. The other factors such as better cost planning and control, earlier assessment of the impacts of the disaster elements and other factors were concerned relatively low in prioritizing the factors which could be used to overcome the challenges by the contractors who are in the housing reconstruction activity.

5. Conclusion

According to the results, it can be concluded that the most of the contractors have involved in Tsunami housing reconstruction work compared to other disaster. This may be due to the magnitude and significance of damage caused by the Tsunami devastation in srilanka.

Capacity of the construction industry was not in a position to cater the demand created by the tsunami. From the results of the document survey, the demand was not met by the existing capacity of the construction industry within the stipulated time to complete the all houses. The comprehensive literature review further reinforces this conclusion. The capacity building elements for an organisation is important for any organisation in considering the development. From the contractor's perspective, human resource, finance and management are considered as the most important elements in capacity building in the housing reconstruction.

Financial management system of the contractors is well above the average and shows the good capacity level and the financial stability of the contractors is also above average level. Diverse and sustainable finance of the contractors showed the above average level. This shows that the financing capacity is above average level. Management and staffing capacity is below the average level and shows the need for development of the capacity. Most of the contractors do review their internal performance and that is above the average level. Client satisfaction orientation is below the average level and shows the avenues for the improvement of the capacity in terms of organisational.

Credit facility of the contractor's shows the increasing nature according the years after the tsunami. This shows the contractors ability in the housing reconstruction after the tsunami in financial terms. Among the many challenges faced by contractors in successfully implementing the housing reconstruction, availability of labourers and availability of materials are the main factor which hinders the planned progress of the housing reconstruction. Planning of Material requisition, Pre-demand for construction workers were prioritized by the contractors to overcome the challenges in the housing reconstruction.

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The Role of Knowledge Management in Post Disaster Housing Reconstruction

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Abstract

A disaster is a serious disruption for the operation of a society, causing extensive lives and property losses. Since construction activities are highly knowledge-intensive, knowledge management (KM) practices will encourage continuous improvement, distribute best practices, quick respond to beneficiaries, share valuable tacit knowledge, reduce rework, improve competitiveness and innovations, and reduce complexities in post disaster housing reconstruction. Therefore, this research is to study and explore the degree to which the KM is involved in post disaster housing reconstruction and the effect that (KM) have on it (post disaster housing reconstruction) in the Sri Lankan context.

This study was done through systematically reviewing the literature in Knowledge (K), KM to highlight the basic principles. Data collection mode for the study was close end questionnaires and semi structured interviews. Data was collected from donor and consultancy organisations who are involved in post disaster housing reconstruction in Sri Lanka.

Findings of the study revealed that most of the donors and consultancy organisations carry out permanent disaster housing reconstruction for tsunami devastation. Further, the study reveals that organisations use competences and repositories as the main sources of knowledge internal and external to the organisation. Project reviews, task teams, face-to-face interactions, and electronic mail systems were used highly to support KM. Even though the performance of the work was improved through KM, lack of compiling and synthesizing the accumulated data, information and knowledge, storing and organizing would be the main challenge faced by these organisations. However, this study is limited to the donor and Sri Lankan construction consulting organisations, who are involved in the post disaster housing reconstruction in Sri Lanka due to natural disasters.

Keywords: KM sub process, KM, Knowledge, Natural disasters, Post disaster housing reconstruction

1. Background

1.1 An overview of disaster

A disaster is a serious disruption of the functioning of a society, causing widespread human, material, or environmental losses, which exceed the ability of affected society to copy using only its own resources [1]. Disasters can be classified as sudden or slow (according to onset speed), or natural or man-made (according to cause). Disasters are often named by the hazards that cause them [2]. A disaster occurs when the hazards impact badly upon a community, which is susceptible to that hazard. There are several hazards like floods, tsunami, tropical storms, landslides, drought, high wind, rock falling, etc. affect Sri Lanka from time to time.

Natural disasters attack the poor at three levels: they interrupt income, reduce personal assets, and destroy essential public infrastructure (World Bank, 2000a cited [3]). The World Bank estimates that losses due to natural disasters are 20 times greater (as a percentage of GDP) in developing countries than in the industrialized nations [4]. According to National Construction Association of Sri Lanka [5], a joint study by donors in January 2005, damaged over a US$ 1 billion worth of infrastructure (about 4.5 percent of GDP), but the replacement costs were estimated to be between US$ 1.5 billion to US$ 1.6 billion (7.5 percent of GDP). Further, Ofori [4] states that disasters have a greater impact on the built environment of developing countries than industrialized ones.

1.2 Post disaster housing reconstruction

Reconstruction means the action of constructing new buildings to replace buildings, which have suffered damage, or repair of damaged buildings (UN, 2006 cited [6]). Reconstruction stage develops after the rehabilitation stage and aims to provide proper permanent housing for the victims in a short period of time [7]. The stakeholders of post disaster projects are the government, donors, lending agencies, beneficiaries, contactor, and social, environment and religious groups.

Whilst relying on routine processes proved adequate in many ways for these small-scale disasters, a higher level of coordination and management would be needed for programmes of reconstruction following a larger disaster [8]. Further, Gunasekera [9] added that all the phases and activates of a project done under normal conditions have to be done when managing projects after a disaster and all phases and activities need to balance with the time factor. Most of the time, this is done at a cost, because there is a minimum quality level and scope requirement that each project has to achieve [9].

As per Barenstein and Pittet [10], one of the most visible consequences of many disasters is the widespread devastation of houses. Quarantelli (1995 cited [11]) proposed four stages of housing in the recovery process such as immediate relief (within hours), immediate shelter (within day or two), temporary housing (preferably within weeks), and permanent housing reconstruction (probably within few years).

Post disaster housing reconstruction is considered by many experts as one of the least successful sectors in terms of implementation [10]. Further, a lack of effective information and knowledge dissemination can be identified as one of the major reasons behind the unsatisfactory performance levels of current disaster management practices [12]. According to Banerjee (2005 cited [12]), a lack of prior knowledge and proper point of reference have made most of the recovery plans guessing games, eventually failing without adding appropriate values to the recovery attempts. Therefore, applicable external knowledge support based on actual recovery processes can play a crucial role in promoting post disaster recovery [13]. However, in case of the Sri Lankan construction industry, there has not yet been any appropriate research done in this area. Thus, little is known about how knowledge is managed in Sri Lankan post disaster reconstruction works.

2. Knowledge Hierarchy

2.1 Data, Information, Knowledge

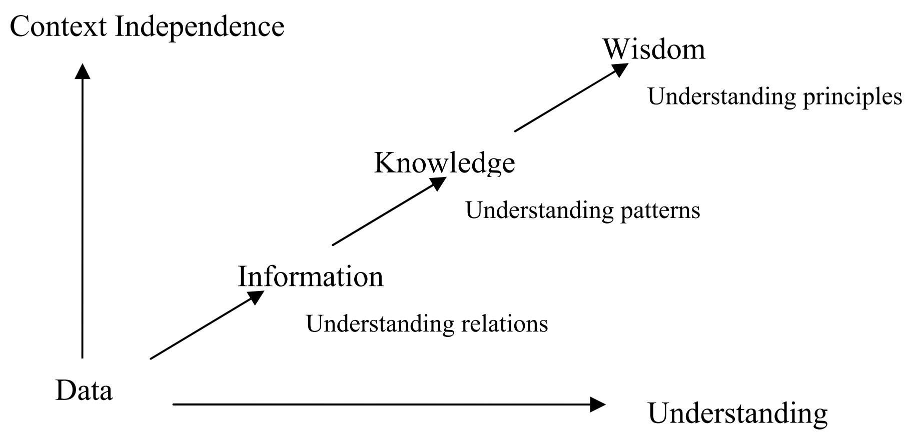

Figure 1: The relationship for data, information, knowledge and wisdom

Source: Gene Bellinger (cited [14])

A common theme in the KM literature is that data is combined to create information, and information is combined to create knowledge [15]. Information is data that has been interpreted, verbalized, translated, or transformed to reveal the underlying meaning and context [16]. For example, when a disaster occurs, different types of information might come from different sources, such as the disaster field, remote sensors, public information centres, and the World Wide Web [17]. Knowledge can be defined as a dynamic human process of justifying personal belief toward the "truth" (i.e. a justified true belief) (Nonaka and Takeuchi, 1995 cited [18]). According to Siemieniuch and Sinclair (1999 cited [18]), various classification of knowledge include: formal (explicit) and tacit (expertise) knowledge; foreground and background knowledge; classifications with respect to the role of knowledge for business relevance (e.g. knowledge of business environments), or with respect to the functional roles within an organisation (e.g. knowledge for control activities). One of the most practical distinctions is that between tacit and explicit knowledge (Nonaka and Takeuchi, 1995 cited [19]). As per King

[16], tacit knowledge is the personal knowledge resident within the mind, behaviour and perceptions of individual members of the organization. On the other hand, explicit Knowledge is the formal, recorded, or systematic K that can easily be accessed, transmitted, or stored in computer files or hard copy [16]. Knowledge sources, in this context, mean the ‘reservoirs of knowledge’, which a knowledge-worker has to fall back on in fulfilling his/her responsibilities [20]. As per Egbu, et al., [20] there are two main categories of knowledge sources, i.e. sources internal to the organisation (other individuals, team(s), routines, competences, and repositories) and sources external to the organisation (other individuals, communities of Practice, other networks, repositories, and knowledge gate-keepers).

2.2 Knowledge Management (KM)

Knowledge Management: the systematic strategy to collect; store; and retrieve knowledge, and then help distribute the information and knowledge to those who need it in a timely manner [16]. However, the KM has not only limited to human centered asset but also extended to intellectual assert. While some definitions specify the management of intellectual assets, it also spells out the benefits of KM. However, the parameters to be managed, has been fairly addressed by some academics like Huber (1991 cited [21]), King [16], and Robinson et al., [22].

Organizations who are successful in leveraging knowledge, normally witness increased efficiencies in operations, higher rates of successful innovations, increased levels of customer service, and an ability to have foresight on trends and patterns emerging in the marketplace [23]. The lack of common knowledge has been known to impede the flow of knowledge, resulting in failures to stimulate innovation and creativity in the organization (Simonin, 1999; Szulanski 1997 cited [23]).

2.3 Knowledge Management (KM) sub processes

The KM sub process has been identified as locating and accessing, capturing and storing, representing, sharing, and creating [20]. Knowledge acquisition is the process that involves imbibing information including making meaning of situations and other stimuli from the internal and external business environment [21]. Nonaka and Takeuchi (1995) defined knowledge production as a continuous, social process, which is a never-ending spiral of tacit and explicit knowledge through knowledge conversion, socialization, externalisation, combination and internalization [SECI] (Sverlinger, 2000 cited [20]). This is quite true when it comes to post disaster housing reconstruction, where the participants have to act according to the situation, which will have the above triggers and leads to knowledge production. According to Kululanga and McCaffer [21], knowledge sharing encompasses thinking, speaking and perceiving and is not merely ‘transferring’ knowledge and such a process is called ‘creative sharing’. National Disaster Management Division [24] suggests that in order to enhance the information sharing and management of the knowledge generated in these institutions, it is highly essential to closely knit the organizations and moreover people. Storage of knowledge involves the keeping of intellectual assets in a form that promotes its preservation, retrieval and-utilization (Walsh and Ungson, 1991; Miyashiro, 1996 cited [21]). Knowledge transfer can be defined as a sub – process of KM that occurs when two or more individuals exchange information, in order to move towards each other (or apart) in the meaning they ascribe to certain events [25].

2.4 Knowledge Management tools

Anumba et al., [26] distinguishes between KM tools, the terms ‘KM techniques’ and ‘KM technologies’ are used to represent ‘non- IT tools’ and ‘IT tools respectively (Table 1).

Table 1: A comparison between KM techniques and technologies

KM techniques	KM technologies
Require strategies for learning	Require IT infrastructure
More involvement of people	Require IT skills
Affordable to most organisations	Expensive to acquire/ maintain
Easy to implement and maintain	Sophisticated implementation / maintenance
More focus on tacit knowledge	More focus on explicit knowledge

Source: Anumba et al., [26]

2.5 Knowledge Management in Post Disaster Housing Reconstruction

KM initiative has been thoughtfully envisaged as a tool to store, retrieve, disseminate and manage information related to disaster management [24]. Furthermore, Johnson et al., [27] states that organisations, such as governments in continuously disaster prone countries needs the ability to act as learning organisations and channels of information as well; however they do not seem to take advantage of this opportunity. The value of KM is that it provides senior management with a rationale to support the creation and maintenance of repositories of project histories [28]. In order to improve housing reconstruction projects we need to look back at past experiences, which the processes that created them. The demand for efficient KM to help the agencies make post disaster housing widely recognized.

3. Research Methodology

Since the most of the objectives of this study was to identify and explore several parameters related to KM, ‘what’ type of question was more suitable for the study and therefore, the structured questionnaire survey was carried out. Seventy-five randomly selected sample of forty-five donors, and thirty consultancy firms were used for questionnaire survey. Semi-structured interviews were done to identify the KM sub processes involved in post disaster housing reconstruction. Twelve semi-structured interviews, six from donors and six from consultancy organisations were done to achieve the above objective. While the relative importance index (RII) was being used as an analysis technique for questionnaire survey, the semi-structured interviews were analysed using data matrix.

4. Research Findings

The total number of targeted respondents for the research was 75 organisations consisting of 45 donor organisations and 30 consultancy organisations. The total response rate was around 74.67%. The largest respondents were from donor organisation constituting 53.57% of the total respondents, whereas the other 46.43% of the respondents were from the consultancy organisations.

Post disaster housing reconstructions were done in Sri Lanka for several disasters such as draught, rock falls, tropical storms, fires, landslides, high wind, floods and tsunami. However, according to survey, it was found that in Sri Lanka, most of the post disaster housings were done for the tsunami (Figure 2) through donors and construction consultancy organisations. According to Figure 3, majority of the respondents (100%) stated that they were involved in permanent housing reconstruction. However, these figures were only relevant to the donor organisations and construction consultancy organisations, who were involved in post disaster housing reconstruction.

In this study, the sources of knowledge were categorised as internal to the organisation and external to the organisation. Table 2 indicates the list of sources of knowledge internal to the organisation in descending order of 'usefulness' as perceived by the respondents.

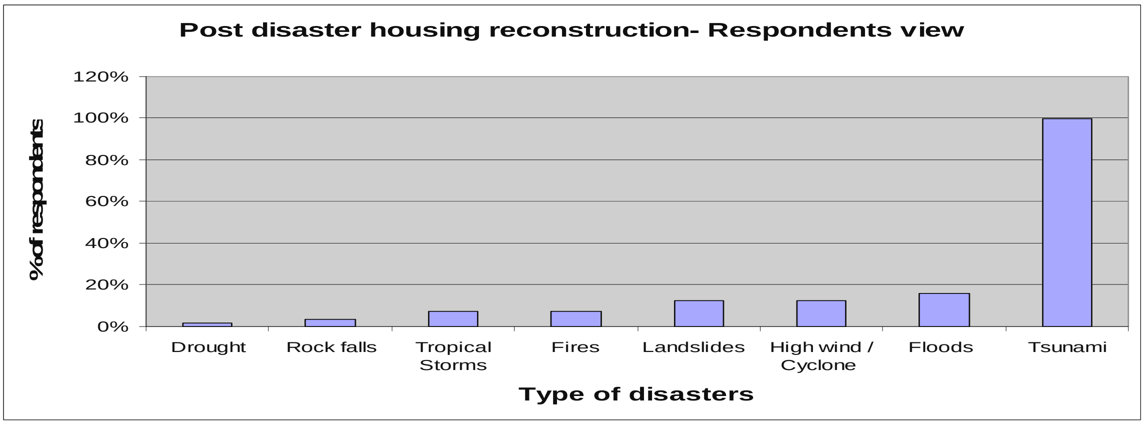

Figure 2: Post disaster-housing reconstruction

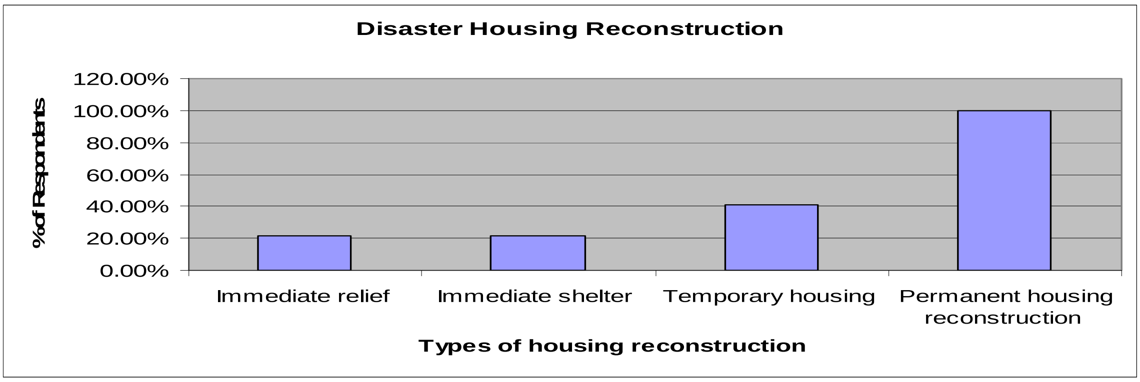

Figure 3: Types of post disaster-housing reconstruction

Further, Figure 4 illustrates the repositories used internal to the organisation. Majority of the respondents responded that they have used project-monitoring documents (87.50%) more often than other repositories. Reports (82.14%) were the second mostly used repositories.

Further, Table 3 suggests that the most significant external source of knowledge related to post disaster housing reconstruction in Sri Lanka was repositories. Moreover, the knowledge gatekeepers were the least significant external knowledge source.

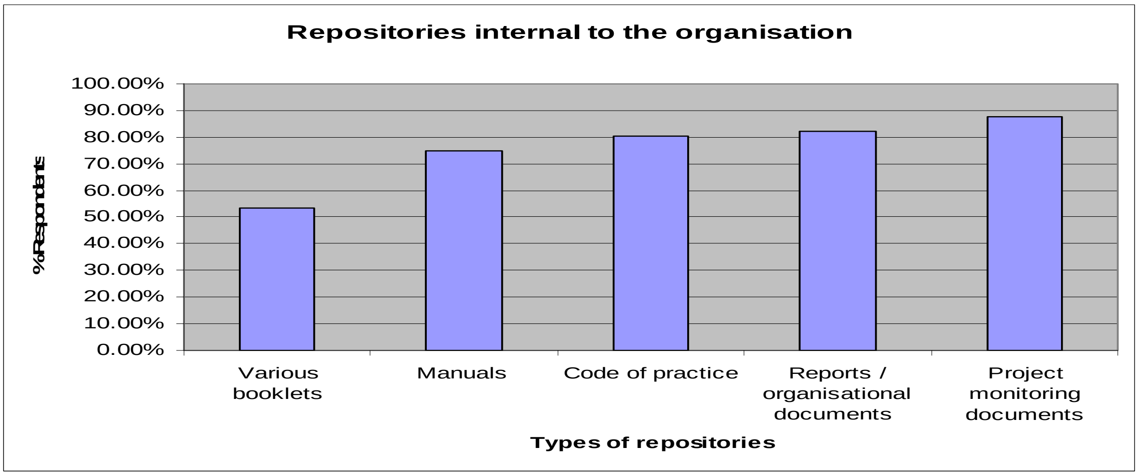

Figure 4: Repositories – internal to the organisation

Table 2: knowledge sources – Internal to the organisation in descending order of use

Competences
Lessons learned
Repositories
Team(s)
Other individuals
Routines

Table 3: knowledge sources – External to the organisation in descending order of use

Repositories
Communities of Practice
Other individuals
Other networks
Knowledge gate-keepers

Table 4 stipulates that the e-mail system was the high-useful KM technology used in post disaster housing reconstruction by donors and consultants. Next significant tool was the costing and cost management system. According to Table 5, the face-to-face interactions, task teams, and project reviews were the most significant non - IT based tools in post disaster housing reconstruction.

Table 4: KM Technologies

IT Based Tools in descending order of usage	
1. E-mail system	**9. Skills Yellow Page**
2. Costing and cost management system	**10. Groupware**
3. Document management system	**11. Technical call centre**
4. The central project file	**12. Web based application**
5. Intranet	**13. Taxonomy / Ontology**
6. Knowledge bases	**14. Extranet**
7. On-line project management	**15. On-line procurement system**
8. Data and text mining	**16. On-line KM system**

Table 5: KM Techniques

Non - IT Based Tools in descending order of usage	
1. Project reviews	**9. Seminars**
2. Task teams	**10. Training**
3. Face-to-face interactions	**11. Communities of practice**
4. Formal meetings	**12. Focused group sessions**
5. Brainstorming	**13. Knowledge gatekeepers**
6. Site liaison initiative	**14. Apprenticeship**
7. Quality circle	**15. Share fair**
8. Recruitment	

While lack of compiling and synthesizing the accumulated data, information and knowledge, storing and organizing was the most significant challenge, conflicting priorities between KM and other business functions was the least significant challenge to KM in post disaster housing reconstruction (Table 6).

Improved performance was the key benefit that the respondents got through KM and the other benefits like effective monitoring of initiatives, efficiently and effectively use available resources were some of the highly rated benefits among respondents (Table 7).

Table 6: Challenges to KM

Challenges to KM in descending order	
1. Lack of compiling and synthesizing the accumulated data, information and knowledge, storing and organizing	**10. Organisational culture**
2. Lack of systematic collection of standardized data	**11. The difficulties associated with communicating the benefits of KM**
3. Lack of documentation of knowledge and application of lessons learned and best practices for decision-making	**12. Poor IT infrastructure**
4. No validation mechanism	**13. Bureaucracy associated with KM**
5. Lack of measure to value the performance of knowledge assets	**14. People’s fears**
6. Unstructured KM approach	**15. Conflicting priorities between KM and other business functions**
7. Overload of information in the form of reporting	**16. Change management**
8. Changing people’s behaviour	**17. Employee resistance**
9. What knowledge should be managed	**18. Lack of top management support**

Table 7: Benefits of KM

Benefits of KM in descending order	
1. Improved performance	**11. Innovation**
2. Effective monitoring of initiatives	**12. Organisation can retain tacit knowledge**
3. Efficiently and effectively use available resources	**13. Dissemination of best practice**
4. Improved decision-making	**14. Increased intellectual capital**
5. Improved reconstruction project delivery	**15. Risk minimization**
6. Improve effective acquisition, sharing and usage of information within organisations	**16. Lower cost in managing the projects**
7. Reliable, useful, up-to-date and timely knowledge can be created and shared	**17. Promoting fair practices among the disaster management community**
8. Can avoid repeating past mistakes	**18. Creates competitive advantage**
9. Better valuation of Resources and services	**19. Increase profit, market share, market size and reduce cost**
10. Respond very quickly to client’s needs and external factors	

Most of the KM sub processes were practiced by the donors and consultancy organisations, but in an informal way. The respondents believed that the knowledge capturing is important to function effectively, work quicker, plan better, reduce cost, give good out put to beneficiaries, get more resources (attract new donors), carry out future disaster reconstruction, give good solution, learn from, and have a win-win situation. Further, the importance of knowledge creation or production was to improve performance, motivate staff, increase organisational asset, etc. While knowledge sharing was vital in order to grow knowledge; get best decisions; avoid duplication; save time and energy; share correct and timely knowledge; improve relationships, the knowledge storing was essential to get accurate information future; reduce cost; justify and accountable to donors and communities; and to show transparency. Moreover, the significance of knowledge transferring was to learn more, increase effectiveness and efficiency of the work force, reduce cost, change the quality of construction, capacity building for local technical people, get timely advice, and disseminate knowledge.

5. Conclusions

This research has investigated the concept of KM in the post disaster housing reconstruction in Sri Lanka. Mostly, the construction industry is relied on expertise of key members of staff. KM can be used as a tool to store, retrieve, disseminate, and manage information related to post disaster-housing reconstruction. It can be concluded that the most of the donors and consultancy firms, who do housing reconstruction, have got involved in tsunami housing reconstruction work compared to other disasters. Further, the respondents were mostly determined on permanent housing reconstruction rather than other types of disaster housings. While competence was the most significant internal knowledge source to the organisation, repositories were the most significant external knowledge source to the organisation. Analysis of the sample revealed that project-monitoring document was the highly used repository internal to the organisation.

While the e-mail system was used predominantly as IT based tool for KM, the project reviews; task teams; and face-to-face interactions were the most significant non – IT based tool for KM. This was further supported by the semi-structured interviews. The findings suggest that lack of compiling and synthesizing the accumulated data, information and knowledge, storing and organizing was the major challenge in managing the knowledge faced by the donors and consultants who do post disaster housing. This may be due to the sense of urgency shown by the parties. The improved performance was viewed as the key benefit of KM in post disaster housing reconstruction.

The KM sub processes are important in order to avoid duplication of knowledge creation, store knowledge on local technical people, carry out future disaster reconstruction, change the quality of construction, disseminate knowledge, grow knowledge, get best decisions, get more resources (e.g. attract new donors), give good output to beneficiaries, improve performance, improve relationships, increase organisation asset, plan better, reduce cost by avoiding repetitive tasks, save time and energy etc.

Even though the study presents most of the elements of KM, most of the organisations have not implemented KM formally into post disaster housing reconstruction. Although, it can be concluded that the awareness of KM is there in the industry to implement KM in post disaster housing reconstruction to improve the performance. During the course of research, the researcher came across some interesting research opportunities. They are, study the same research question with additional unit of analysis, i.e. with donor, owner, consulting, and contracting organisations, study the each KM sub processes individually to deeper scope with regard to disaster reconstruction, study the role of KM in disaster management, and studying the procurement arrangement in post disaster housing reconstruction.

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Post disaster reconstruction as an opportunity for development: women's perspective

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Abstract

In the past few decades many nations have experienced quite a large number of natural disasters. Although they are developing new systems to avoid or reduce the devastation caused by disasters still many countries are struggling to recover. The literature on disaster management has begun to recognise the activities carried out during post disaster as an opportunity for nation and communities to develop. Post disaster reconstruction is a significant period in disaster management where it becomes a window of opportunity for communities and nations. Since women are one of most vulnerable groups in disasters and, as there is a need to recognise this human resource for their own development and for community's benefit, this research looks into the experiences of women in post disaster reconstruction. The study aims to present their experiences in post disaster reconstruction by considering their roles and challenges in this process in order to analyse the importance of post disaster reconstruction towards their development. This research has been based on theoretical and practical knowledge obtained through comprehensive literature review.

Keywords: Disaster management cycle**,** Empowerment, Post disaster reconstruction, Women

1. Introduction

The occurrence of natural and human-caused disasters has increased over the recent decades in many countries around the world. Disasters are generally large intractable problems that test the ability of communities and nations to effectively protect their population and infrastructure and, its capacity to recover rapidly [1]. During disaster management, post disaster reconstruction stage is confronted with many barriers in making the disaster an opportunity for development due to its ineffectiveness and inefficiency. Reconstruction is a rebuilding measure which involves not only constructing physical structures but also building the confidence, self-respect, self-esteem, self-dependency, mutual support and mutual trust and, the rebuilding of communities. This long-term process focuses on human and material resource development, coordinated effort towards independence, sustainability and empowerment. The United Nations [2] defines disaster as a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental loss that exceeds the ability of the affected community or society to cope using its own resources. The disasters can be in the form of a battery of floods, droughts, cyclones, land slides, earthquakes, communal riots, armed conflicts, fires, volcanic eruptions, epidemics and industrial disasters.

This study focuses on naturally occurring disasters and their effects. However though these disasters are naturally occurring phenomenon, the intense impact of a disaster is exacerbated by human actions including incomplete development practices. Although there have been improvements in the emergency response to natural disasters, permanent reconstruction is often inefficiently managed, improperly coordinated and slow to get off the ground [3]. However post disaster reconstruction (PDR) is an important stage in disaster management where it becomes a window of opportunity for the community's development.

Present literature on disaster management emphasises the importance of gender sensitivity in PDR [4]. It argues that gender consideration will help for better targeting of resources to reach people in greatest need; for more accurate service provision to meet actual needs; to decrease vulnerability to future disasters and to prevent or mitigate negative impacts to second generation [4]. In addition earlier studies found that the gender composition of the population tends to change following a disaster where the percentage of female-headed households typically increases [1]. Furthermore it states that, during the post disaster phase the roles and responsibilities of women can change dramatically. In addition, the level of risk experienced by women to disaster is more than men and women are also more vulnerable in post disaster stages [5]. Therefore it is important to study women's experiences in PDR in order to improve their development.

Although the roles of women have changed noticeably in the past decades still they find it difficult to improve their status within the community. This research aims to present a review of literature related to women's experiences in PDR in order to analyse the effects of post disaster reconstruction towards their development. The study identifies their experiences with regard to their participation and confronts challenges related to women's development during PDR in the disaster cycle. In addition this study discusses whether PDR fosters or hinders women's development. This research has been based on theoretical and practical knowledge obtained through a comprehensive literature review.

2. Natural disaster management cycle

Natural disasters can occur as slow-onset natural disasters such as droughts or as rapid-onset disasters. The magnitude of disasters is documented by reference to the degree of vulnerability of the affected population [5]. A population's level of risk to disaster is determined by the type of hazard and the calculation of the level of vulnerability which is determined by social, physical and attitudinal variables [5]. Although in disasters it is difficult to differentiate between different stages, for management purposes there is a standard disaster cycle and each phase merits special considerations. The cycle includes disaster mitigation and prevention, preparedness, emergency, rehabilitation and reconstruction [1]. Each phase in the cycle requires particular types of interventions and programming. According to Ariyabandu and Wickramasinghe [5], disaster management is a collective term encompassing all aspects of planning for and responding to disasters which includes both pre and post disaster activities. Further they state that the disaster management cycle includes the shaping of public policies and plans that either modify the causes of disasters or mitigate their effects on people, property and infrastructure. Disaster management should not be seen in isolation but it should be considered at various phases of management in addressing the issue.

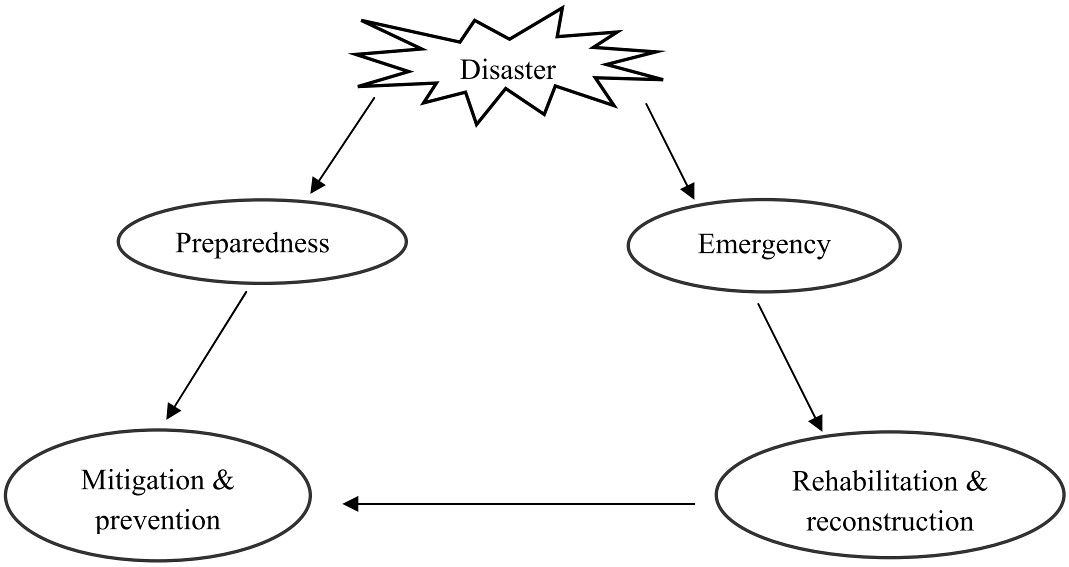

Figure 1: Natural disaster cycle (*Source: [1])*

2.1 Disaster mitigation and prevention

In the natural disaster cycle, the pre-disaster phase includes mitigation and prevention and, preparedness. During mitigation stage activities are related to elimination or reduction of the probability of the occurrence or reduction of the effects from unavoidable disasters. The mitigation process includes building codes; vulnerability analysis; zoning and land use management; building safety codes; preventive health care and public education. The success of mitigation measures depends on the integration of appropriate measures in national and regional development planning. Its effectiveness will also depend on the availability of information on hazards, emergency risks and the counter measures to be taken.

2.2 Disaster preparedness

During the disaster preparedness phase, measures are undertaken to control the impact of the event through ensuring a structured response and establishing mechanisms for effecting a quick and orderly reaction to it [6]. These are not aimed at preventing the occurrence of a disaster. Further this stage includes the development of awareness among people on the general aspects of disaster and how they need to behave in future by educating them about the disaster signs, methods of successful evacuation and first aid measures. In addition formation and training of local committees, building of communication systems, meteorological observation systems, facilitation of basic utility systems such as water supply system and sanitation are some of the activities undertaken during this phase.

2.3 Emergency phase

The emergency response aims to provide immediate assistance to maintain life, improve health and support the morale of the affected population. The emergency phase involves immediate post recovery which can last for days, weeks or months depending on the nature of the disaster and local conditions [3]. During the emergency phase, relief agencies or groups focus on preventing additional loss of life through actions such as search and rescue, emergency food and water, temporary shelter, and temporary transport. The focus of this phase is on meeting the basic needs of people until more permanent and sustainable solutions can be provided. Humanitarian organisations are often strongly present during this phase in the disaster management cycle.

2.4 Rehabilitation and reconstruction phase

The recovery activities, which include both short and long term, continue until all systems return to normal or improved status. The rehabilitation phase includes medium term interventions such as construction of transitional housing, provision of basic food to the affected population, provision of social services, road clearing, income generation, water system rehabilitation [1]. As the emergency is brought under control the affected community is capable of undertaking a growing number of activities aimed at restoring their lives and the infrastructure that supports them. There is no distinct point at which immediate relief changes in to rehabilitation and then into long-term reconstruction development.

The reconstruction period includes the long-term and often substantial investment in rebuilding the physical and social infrastructure of affected regions. PDR is a process that is the interaction of complex social, technological and economic factors and actions [7]. There will be many opportunities during the reconstruction period to enhance prevention and increase preparedness, thus reducing vulnerability. However though many organisations are involved in relief and rehabilitation most often they focus on the emergency and reconstruction remains neglected [8]. Therefore it is necessary for organisations which are concerned about disasters to utilise the opportunities and develop the community’s capabilities.

3. Women’s experiences in post disaster reconstruction

3.1 Women's participation

Generally the role of women in the post disaster stages are categorised under three main areas: reproductive roles; community roles and productive roles [5]. Reproductive roles include roles within household and the family: inclusive of bearing, nurturing and rearing children; cooking; cleaning the house and yard; marketing; caring for sick and elderly, etc. These roles may be expanded to include agricultural work in the home stock within household, long-term work of rebuilding family and community spirit, etc. which do not give economic values. Women's community roles include: maintaining kinship relations; religious activities; social interactions and ceremonies; communal sharing and caring activities; communal survival activities, etc [5]. These are generally done voluntarily and do not provide economic returns. Although these are usually related to reproductive function, there are instances where it includes work related to relief and reconstruction including the physical reconstruction of their homes [9]. Finally, productive roles give economic remuneration for manual labour, professional labour and subsistence activities. Although generally women's roles are classified under above three categories, Fordham [10] states that there is no simple distinction between private and public labour of women which usefully frames neither women's disaster responses nor can women's work be neatly confined to discrete categories.

The degree of vulnerability among women and their participation during post disaster differ considerably. Disabled, elderly, pregnant and lactating women and widows often require assistance on a longer term or sustained basis, whereas other women can be supported up to the point where they achieve food and economic self-sufficiency. These distinctions are important in determining the types and levels of support to be provided to them. Therefore more local knowledge and wisdom needs to be incorporated into post-disaster recovery and development planning, particularly as they relate to women. According to the International Labour Organisation [13], it is now widely accepted that women are not only responsible for attending to the basic needs of their children and families, but also account significantly for productive and income-generating activities. In addition, in a disaster situation women have demonstrated their capacity as income-earners, producers and managers of food production, providers of fuel and water, participants in cultural, religious and political activities.

The reconstruction phase is a significant period in disaster management as the results of the process are directly open to evaluation and criticism. The literature on disaster management [11] suggests that women's work around the household, on the job and in their neighbourhood contributes significantly to the social construction of daily life under extreme and routine conditions [12]. However the recognition of the importance of their work and their development is sill remains a question.

During the reconstruction phase and especially in temporary shelters, women take on a triple duty of reproductive work, community organisation and productive work in the informal economy, while men tend to return to their traditional role of waged work outside home. The tremendous impact of the disaster on children and elderly are largely shouldered by women. Generally in post disaster situations the officials in charge for reconstruction activities finds it difficult to obtain timely and accurate information. This is partly because of decision making which does not follow its usual procedure due to the urgency and the pressures and flow of information to lower ranks does not work in its routine way. In certain cases the implementation does not happen effectively. Thus, the contribution of women to this will be of great help.

Recent literature on PDR emphasises the dominance of men in development processes. Further, women remain marginal to the process and the study recognises the importance of offering diversified packages to women in post disaster stages as not all women are from educated backgrounds.

3.2 Women's challenges

According to the International Labour Organisation report [13], there are four general impacts that disasters have on the work of women. Firstly, women's economic insecurity increases. Since their productive assets are destroyed they often become sole earners, their household entitlements may decline, their small-businesses are hard-hit and they lose their work. In developing countries, after natural disasters, women lacking in land titles or farming small plots may be forced off their land [13]. Moreover, since land and employment arrangements are often negotiated through men, women may lose access to both without a man to represent them. Most importantly the gender stereotypes limit women's work opportunities especially in the post disaster reconstruction stage. In addition, due to economic downturns after natural disasters women lose their jobs more quickly and in greater numbers than men [13].

Women's workload increases significantly following a disaster and their working conditions in the household and paid workplace deteriorate e.g. through lack of child care and increased work and family conflicts [13]. The increase workload stems from damaged infrastructure, housing and workplaces; the need to compensate for declining family income and social services and the responsibility to care for orphaned children, the elderly and the disabled. This in turn limits women's mobility and time for income generating work. Furthermore this leads to women recovering more slowly than men from major economic losses, as they are less mobile than male workers, are likely to return to paid work later and often fail to receive equitable financial recovery assistance from the government or external donors [13]. In certain communities since women often take on more waged or other forms of income generating work and engage in a number of new forms of disaster work, they have also expanded their responsibilities.

While women are severely affected by natural disasters this often provides women with a unique opportunity to challenge and change their gendered status in society. □Women have proven themselves indispensable when it comes to responding to disasters [4]. Following Hurricane Mitch in 1998, women in Guatemala and Honduras were seen building houses, digging wells and ditches, hauling water and building shelters [4]. Although often against men's wishes, women have been willing and able to take an active role in tasks that were traditionally considered as male tasks. This can have an effect of changing society's perceptions of women's capabilities. Women are most effective at mobilising the community to respond to disasters. They form groups and networks of social actors who work to meet the most pressing needs of the community.

According to a study on past disaster experiences, a pre-existing pervasive culture of acceptance or denial concerning violence against women including no existing criminal legislation on domestic violence, presents compounded problems for organisations attempting to support women in the wake of the tsunami. The denial or trivialising of violence against women by authorities only adds to the problem [14]. In certain developing countries the prominent finding of male dominance and its negative implications is what underscores the importance of the longer-term vision for structural change to address gender inequality [14].

4. Discussion

The reconstruction is a rebuilding measure that involves building the confidence, self-respect, self-esteem, self-dependency, mutual support and trust and the rebuilding of communities. In order to have a successful completion of disaster reconstruction it is important to include the participation of social actors of the community. During PDR, in addition to men, women are also engines of recovery who possess qualities vital for disaster response and who can help to keep the fabric of society in tact. Since crises present an opportunity to break-down gender barriers and as coping prompts men and women to step out of their traditional places, unequal pre-disaster gender roles can be changed. During recovery periods women have been able to carry out community mobilisation for recovery programmes in developing countries with critical support and planning [16]. In many instances, after gaining economic independence through income generating projects, women have been largely instrumental in promoting youth projects. Thus, their mobilisation capacity can be increased through their economic independence.

Reconstruction is a long-term process and it focuses more on human and material resource development, coordinated effort towards independence and sustainability. In order to achieve the above objectives the concept of empowerment can be used as a tool. In reconstruction the most vulnerable and marginalised sections like women, children, the poorest section of society, etc. are the primary stakeholders who need to be considered as partners in the empowering process [8]. In disaster circumstances, empowerment would enable women to increase their human and economic developmental goals. Through women's participation in planning, design, implementation, monitoring and evaluation, the processes of recovery and reconstruction can go beyond the provision of basic needs. Their participation may engender a level of community cohesiveness and security, with greater potential for realising development goals. However it is advisable to organise and implement community measures that do not violate the stability of the family structure. Working in traditionally male fields like construction; launching small businesses; contributing to discussions on reconstruction; and pursuing education, even while displaced, can empower them. In addition, if men are absent, gender roles are obviously open to change. These circumstances can increase women's economic independence, their ability to provide for their families, their decision making skills and social prominence. However such positive changes need support.

According to report by UN-HABITAT [15], when women are empowered they have the capacity and the inner will to improve their situation and gain control over their own lives. Further it states that, this can lead to an equal share in economic and political decision-making, and control of economic resources. The report by Department of Economic and Social Affairs [16] states that, in addition to poverty, environmental degradation and differing needs of men and women, the marginalised role of women within many organisations and their absence from decision-making structures contribute to their vulnerability in post disaster situations. Kumar-Range (1999 cited [16]) points out that though women tend to be active in communities and households they are marginalised by agencies and organisations responding to the disasters.

In a study by Bradshaw [17], in post Hurricane Mitch, participation rates of women in community based projects and programmes have increased from under a quarter to over half the women interviewed in the four communities considered for the study. The lowest levels of participation are recorded amongst young female partners or wives in male-headed households and the highest levels are amongst female heads of household. This is perhaps not surprising since women heads are assumed to take on dual responsibilities of male heads and female partners when they head their own households. This was supported by the fact that female heads appear to have been actively targeted in reconstruction. While over half of the number of women interviewed think women are participating in reconstruction only a quarter state that it is women who benefit the most from reconstruction and the majority see benefit as being for family. This shows that mere targeting of women as better deliverers of services and resources may indirectly reinforce traditional gender roles and relations rather than transform them [17].

Although an understanding of the factors that affect vulnerability is crucial, the focus on women's empowerment draws attention to the importance of understanding both women's and men's capacities and potentials as well. This understanding is only possible through the consistent use of participatory methods and a focus on understanding and strengthening women's forms of organisation. Women should be involved in disaster reconstruction processes as having an active role in planning, needs assessment in the construction.

Generally, disaster creates a socially acceptable and legitimate reason for women to get into the public arena. In a way it creates a kind of recognition for women’s mobilisation to advocate for their needs and also their initiatives. This coincides with the present concern about the willingness to recognise and responsibility to act. Thus, women’s priorities like the provision of community services, collective businesses and access to credit, housing cooperatives, safe housing, etc., become concrete issues of engendering local governance. However, this is always at stake, and the critical issue for women here is building a critical mass to continue to advocate for them. Most importantly women need to become aware of their potential and this opportunity during their experiences.

Training for women must respond to the full range of their aspirations and potential. Interventions also must include those working informally or in the home. Women often know local conditions better than anyone. Therefore they bring crucial knowledge to the planning and implementation of reconstruction projects and decision-making structures [6]. Their participation in turn helps to develop an economic, social, and legal environment propitious for women’s success. Long-term recovery strategies should capitalise on positive changes and avoid reverting to pre-disaster patterns. With PDR activities both women and men can find new opportunities for decent work to aid the recovery of their families and communities.

5. Conclusions and the way forward

Disaster response needs a partnership between all the actors in society including the marginalised groups and individuals at all levels, most importantly at community level, where women normally operate. When disasters strike, associations for women and youths can be mobilised and play key roles in relief and recovery. During the PDR phase some activities can be resuscitated. It is wise to search for the hidden resilience displayed by communities affected by disasters and then to build upon it. This would entail a conscious strengthening of local knowledge and wisdom, applying appropriate solutions to crises. One goal should be to increase economic possibilities that promote political, social and economic empowerment of communities wherever possible, without introducing externally generated institutions.

One of the main sustainable means for disaster victims to overcome their marginal condition is through an adjustment process of empowerment, allowing them to fulfil their basic human development needs. When designing protection and assistance programmes for women during and following emergencies it is essential for planners to broaden the concept of women's status from the narrow conceptualisation as daughter or mother or wife. The capacity of women to mobilise people and manage change should not be underestimated. Instead of feeling that their voices cannot be safely heard, opportunities for women to engage in management and decision making related to all levels of disaster response and reconstruction should be offered. This can enable disasters to provide physical, social, political and environmental development opportunities that can be used during the PDR. This would lead to not only reconstruct the affected areas, but also to improve the socio-economic and physical conditions of the impacted population in the long run. This study has been undertaken as part of a research study which focuses on the empowerment of women in post disaster reconstruction.

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Supply chain and material procurement for post disaster construction: the Boxing Day Tsunami reconstruction experience in Aceh, Indonesia

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Abstract

In order to accommodate the growing complexity of construction process, various management systems and methods have been developed through academic research and applied in industry practices. Among those, supply chain management (SCM), as a significant component in construction material procurement, becomes increasingly popular, especially within the context of broader cooperation, vertical disintegration and the viewpoint of a networked supply chain in the construction industry.

Following the Boxing Day Tsunami in 2004, the procurement and supply of sustainable and legitimate construction material for the massive reconstruction became the first priority of almost every organisation involved in this process in Indonesia. As a result, the competition for limited resources and the lack of effective coordination between reconstruction agencies has nearly tripled the cost of a standard house and leaving thousands of people in transit living conditions two years after the disaster. Based on the reconstruction experience in the worst affected area, Banda Aceh, this paper will examine the modern literature on supply chain management (SCM) and analyse this process in practice associated with construction material procurement, review the problems inherited in the Indonesian context and analyse the proposed procedures of local and international procurement of construction materials to streamline the supply. Conclusions will then be made based on above-mentioned analysis for future development and adoption of an integrated SCM concept in post disaster reconstruction.

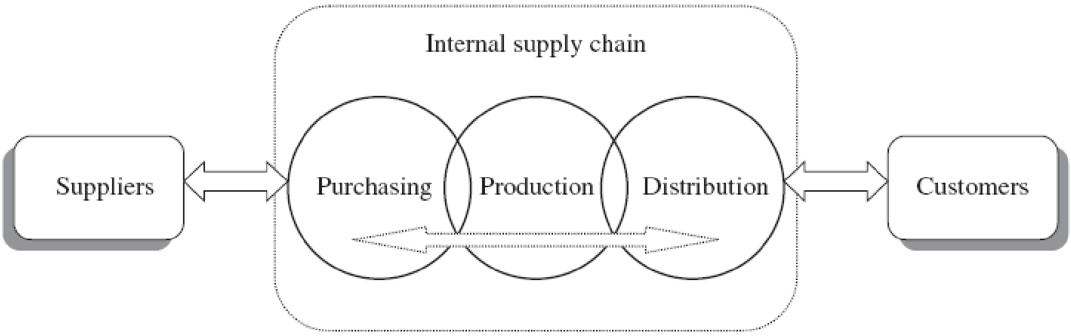
Keywords: Supply Chain Management, procurement, disaster reconstruction, Tsunami, Aceh

1. Literature review

1.1 SCM Literature Overview

In order to accommodate the growing complexity of construction process, various management systems and methods have been developed in academic researches and well applied in industry practices. Among those, supply chain management (SCM) becomes increasingly popular; this especially within the context of broader cooperation, vertical disintegration and the viewpoint of a networked supply chain in construction industry. Its popularity has been stimulated by a range of sources including the quality revolution (Dale et al. 1994), notions of materials management and integrated logistics (Carter and Price 1993), a growing interest in industrial markets and networks (Ford 1990, Jarillo 1993), and influential industry-specific studies (Womack et al. 1991, Lamming 1993). ‘Supply chains’, ‘demand pipelines’, ‘value streams’, ‘support chains’ are some examples of the terms used to describe this process.

A typical supply chain is illustrated in the following model developed by Chen and Paulraj (2004) as “simply a network of materials, information and services processing links with the characteristics of supply, transformation and demand”. The term SCM was originally introduced by consultants in the early 1980s (Oliver and Webber 1992) mainly focused on the lines of physical distribution and transport and has subsequently gained tremendous attention (La Londe 1998). Besides its initial interests gathered to explain the logistics activities and the control of materials and information flows, researchers have also explored into other areas such as strategic, inter-organizational issues (Cox 1997, Harland et al. 1999), to discuss an alternative organizational form to vertical integration (Hakansson and Snehota 1995), to identify and describe the relationship a company develops with its suppliers (Narus and Anderson 1995), and to address the purchasing and supply perspective (Farmer



1997).

Figure 1: A typical supply chain model (Chen and Paulraj, 2004)

The main body of SCM literature has been explosively enlarged during the latter half of last century due to its various contributing knowledge fields such as purchasing and supply, logistics and transportation, marketing, organisational behaviour, network, strategic management, information systems management and operations management. However, only some critical elements of SCM and its performance measurement, which are relevant to the current process of post-disaster reconstruction in Aceh, will be covered in this literature review.

1.2 Supply Management Overview & Communication Needs

A predominant approach to SCM research is the so-called ‘supply management’, which emphasizes primarily the buyer-supplier relationship (Leenders et al. 2002) within the process. Since suppliers have a profound and direct impact on cost, quality, time and responsiveness of the buying firms, the management of relationships with other members of the supply chain (i.e. buyer–suppler relationship) is increasingly being referred to as SCM (Chen and Paulraj, 2004). The literature on SCM has constantly emphasized the importance of effective two-way communication to the above relationship. Hahn et al. 1990, Galt and Dale 1991, Krause 1999, Carr and Pearson 1999 argue that in order to jointly find solutions to material problems and design issues, buyers and suppliers must commit a greater amount of information and be willing to share sensitive design information. However, this is often achieved through engineer-to-engineer communication on design issues keeping in mind to improve process capability, manufacturability and performance without affecting profit margins (Bhote 1987, Dobler et al. 1990, Turnbull et al. 1992). Poor communication was often a fundamental weakness in the interface between a buying firm and its supplier, which undermined the buying firm's efforts to achieve increased levels of supplier performance (Lascelles and Dale 1989). This is a major problem experienced by various agencies involved in the Aceh reconstruction and embodied in competition for resources and increased difficulty in materials procurement.

1.3 Supplier Base Reduction and Long-term Relationships

Traditional practices of supply chain management tend to contract with multiple suppliers even for the same material or component. This is partially due to the consideration of risk reduction with multiple options and avoidance of becoming source dependent. However, reduction of the supplier base is a unique characteristic of contemporary buyer–supplier relationships (Newman 1988, Helper 1991), because the administrative or transaction costs associated with managing a large number of vendors often outweigh the benefits (Dyer 2000). This is especially the case in the Aceh reconstruction given the limited availability of construction materials and often inadequate administrative abilities of reconstruction agencies. Many firms are reducing the number of primary suppliers and allocating a majority of the purchased material requirements to a single source (Pilling and Zhang 1992, Kekre et al. 1995). The benefits attributed to this practice often exceed those achieved through traditional bidding from multiple sources, which often emphasizes low price at the expense of performance (Mohr and Spekman 1994). Moreover, supply base consolidation sets the stage for future development of the chosen suppliers (Handfield 1993).

Long-term relationships between supplier and buyer have become a crucial characteristic of modern supply chain relationship (Shin et al. 2000). Through close relationships, supply chain partners are willing to share risks and reward and maintain the relationship over a longer period of time (Cooper and Ellram 1993, Stuart 1993). Hahn et al. (1983) compared the potential costs associated with different sourcing strategies and suggested that companies would gain benefits by placing a larger volume of order with fewer suppliers using long-term contracts. Moreover, through a long-term relationship, the supplier will become part of a well-managed chain and will have a lasting effect on the competitiveness of the entire supply chain (Choi and Hartley 1996, Kotabe et al. 2003). A well-coordinated joint order of similar construction materials by several NGOs would be a good example of sustainable management of such practice.

Selecting suppliers for specific goods and services is a critical decision for most organizations, since supply performance can have a direct financial and operational impact on the business (Bailey et al. 1994, Ittner et al. 1999). A quality focus in supply management is supported by many conceptual studies. Choi and Hartley (1996) found that companies place more importance on consistency (quality and delivery) and the least importance on price. On the whole, quality, on-time delivery, and uninterrupted supply become critical selection criteria because supplier failures on these dimensions have more serious adverse effects on the buyer's operations (Ellram 1990). Trustworthiness, integrity, commitment, and characteristics that imply 'fair dealing' are also considered with importance in selecting the supplier (Anderson and Narus 1990, Lewis 1995). Specifically, suppliers who are unwilling to share information on cost, quality and production can be screened out, because willingness to share information is viewed as a signal of the trustworthiness of the supplier (Dyer 1997).

A recent trend of supplier certification provides a potential solution to the procurement problems related to selection of tenders. It involves the thorough examination of all aspects of a vendor's performance and is expected to enhance buyer–supplier trust and communication, to improve supplier product quality, to reduce communication errors, and to reduce inspection and inventory costs for the buyer (Schneider et al. 1995, Larson and Kulchitsky 1998, Ittner et al. 1999). Recently, supplier certification has been extended to include the logistics function. American Quality Foundation and Ernst and Young (1998), in their international quality study of over 500 organizations, reported that formal programs for certifying suppliers showed an across-the-board beneficial impact on performance, especially in quality and productivity.

1.4 Supplier and Logistics Integration

Integration is another key word in SCM involving the new building construction process. The involvement may range from giving minor design suggestions to being responsible for the complete development, design and construction of a specific part of the building (Wynstra and Pierick 2000). According to reports by Naumann and Burton in 1980's, suppliers accounted for approximately 30% of the quality problems and 80% of product lead-time problems. Studies by Mabert et al. (1992) found supplier involvement to be an important part of the strategy in five out of the six firms they examined who were attempting to collapse new product development time. Furthermore, research has concluded that the effective integration of suppliers into new product development can yield such benefits as reduced cost and improved quality of purchased materials, reduced product development time, and improved access to and application of technology (Ragatz et al. 1997, 2002, Primo and Amundson 2002).

Besides the supplier integration, other internal and external integration issues in supply chain logistics are recognized and attracting more and more interest from researchers. Logistics has traditionally been defined as the process of planning, implementing and controlling the efficient flow and storage of goods, services and related information as they travel from the point of origin to the point of consumption (Chen and Paulraj, 2004). Some major activities included in the logistics domain include transportation, warehousing, purchasing and distribution. The traditional approach of logistics integration across functional boundaries within a firm is termed 'internal integration' (Bowersox and Daugherty 1987), whereas a more recent approach of logistics integration across firm boundaries is termed 'external integration' (McGinnis and Kohn 1990, Stock et al. 1998). External integration has been the subject of a good deal of research in logistics management, the name underlines the needs for mutual completion of procurement, production planning and distribution in order to carry out a unitary process (La Londe et al. 1970, Busch 1988, La Londe and Powers 1993). Enterprise logistics integration is the extent to which a firm implements both internal and external integration. It can be characterized by integration of logistics activities across functional departments within the firm, as well as integration of the firm's logistics activities with the logistics activities of other supply chain members (Stock et al. 1998).

2. Methodology

The methodology used in this research includes firstly a comprehensive review through the modern literature of SCM, focusing on several aspects closely related to the post disaster procurement process in Banda Aceh, namely, communication needs, supplier base reduction, long-term relationship, and supplier and logistics integration. Those topics would later be addressed and referred to in case experiences discussions. Two authors of this paper spent a monthly fieldtrip in Banda Aceh 2 years after the Tsunami with the Indonesian branch of an international humanitarian aid organisation involved in the houses reconstruction project for local refugees. During the fieldtrip, extensive interviews were carried out with construction managers, procurement managers from different NGO's and UN agencies; representatives from local authorities overseeing the reconstruction process in Aceh; and local staff in those NGO's, members from local Village Development Committee and affected communities. Major obstacles associated with construction materials procurement were identified during interviews. Two typical methods representing local and international supply chains for timber procurement were selected out for detailed analysis. Data collected and ideas generated from this series of interviews and pilot case studies were incorporated and expressed in the discussions within the following sections. Several recommendations were made in the conclusion to tackle the problems encountered in post-disaster procurement and to streamline the supply chain for reconstruction.

3. Supply chain and material procurement experiences in the Aceh Tsunami reconstruction

During the 2004 Boxing Day Tsunami, some 130,000 people were killed in Aceh alone and 37,000 remain missing. 3 months later, another big earthquake on March 28 2005 added 1,300 to the death toll in Nias, Simeulue and southern coastline of Aceh. These consequent tragedies caused immense economic, social and environmental devastation to Aceh and surrounding areas that were already under the poverty line. It is estimated in an official report (BRR April, 2006) that approximate 123,000 new houses are needed for re-establishment, relocation and resettlement of Acehese tsunami victims, let alone the accompanying tremendous reconstruction of infrastructure.

There are approximately 290 NGOs and donor organizations operating in Aceh and Nias in 2006 managing as many as 828 projects. In order to generally coordinate and manage the reconstruction effort in an overall prospective, the Agency of the Rehabilitation and Reconstruction for Aceh and Nias (BRR) was established by Indonesian Government Regulation No. 2/2005 on 28 April 2005, 4 months after the Tsunami. It is estimated that at least US$5.8 billion will be needed in the recovery phase for Aceh and Nias. The situation now is that US$4.4 billion1 has already been allocated to different projects, and the people of Aceh and Nias may have a chance to better build back their

[1] US$4.4 billion: The Government of Indonesia has allocated 1.1, NGOs 1.5 and official donors 1.8 billion in US dollars.

livelihood with total pledges of US$9 billion (3 billion more than least budget required). The major issue is becoming how to spend this money wisely and in the most needed areas.

A major problem faced by almost every organization involved in the Aceh reconstruction is the supply and procurement of legal and sustainable construction materials, especially the massive needs of timber. As mentioned in a NGO's report on supply chain management, "whilst timber has been previously procured, it has not been without delays and the quality in some cases has been questionable." A review and general introduction of timber supply problems inherited in the Indonesian context will first be made, followed with the analysis of the possibility and proposed procedure of procuring local and international timber.

3.1 Timber supply problems

Although seriously damaged during 2004 Tsunami in coastal areas, 70% of mainland Aceh is still covered by natural tropical forests, the best remaining tropical forests in Indonesia and rich in biodiversity. One can easily visualize the beautiful green land under the plane when flying over the Sumatra Island. It is the natural gift inherited by generations of Indonesian people but now forced "open for exploitation" (Indonesia-Relief News). In spite of a moratorium on logging in Aceh implemented pre-Tsunami, extensive illegal logging is currently taking place in Aceh forests, this is usually referred as related to a so-called "Timber Mafia" situation, this term is used to describe a consortium of government officials, army, police, businessmen, etc who allegedly conspire together to gain large profits from the illegal logging of the forest estate. Problems in getting legal and sustainable timber supply for reconstruction are frustratingly experienced by almost every agency over the past year and this situation could continue for longer.

The Government of Aceh (represented by BRR regarding reconstruction) is reviewing its timber policy in light of the Tsunami and the need for timber for recovery. The acting Governor is in favour of a "Green Aceh" with no logging and supporting WWF and other conservation NGOs' programmes promoting the use of imported timber from sustainably managed forests for reconstruction. This is also supported by the Ministry of the Environment. On the other hand, Government of Aceh realized the tremendous needs for legal timber supply within the area. At the end of 2005, Indonesian Ministry of Forestry decided to restore forest concession (HPH) to 11 companies in Aceh to enable them to supply timber needed for the Aceh reconstruction and agreed to increase timber quota for Aceh to 400,000 cubic meters for 2006. This decision had to be made since timber suppliers from other provinces, such as Riau and Kalimantan, are reluctant to cater for the needs in Aceh due to high cost of transportation and the complicated process of applying for legal documents (i.e. SKSHH) to facilitate the transportation.

It is estimated in a recent survey (BRR and The World Bank 2006) conducted by BRR and The World Bank that bribes and illegal payments that truck drivers pay on the Banda Aceh - Medan road to corrupt police, military, state officials and preman (criminal) groups at various security posts and weigh stations are Rp. 340,000 on average (single trip on either direction). This not only constitutes a major cost for timber transportation but also has negative influences to potential timber dealers from outside provinces. However, the number of illegal payments experienced a significant decline in last 3 months associated with the pull-out of troops and police from Aceh province mandated by the Helsinki peace agreement.

There are other specific problems in timber procurement in Aceh, such as the legitimacies of importing timber and associated timber treatment methods. It is partially due to confused and sometimes conflicting information from different government sources, which could only be explained as internal uncertainty and inconsistency with Indonesian timber policies or failure in execution of established standard regulations. A list of 25 local timber supplier companies approved by BRR was given to representatives from various NGO's during a BRR's timber policy meeting in July 2006, which several days later was reduced to a list of 5 and handed out to local project managers during another local staff meeting. These were only recommended as reliable and not guaranteed as legal. The responsibility of ensuring legality of procurement with those companies remains on NGOs' shoulders. It is almost impossible for any organisation to take on such a big risk (even one piece of illegal timber will result in the whole package being confiscated) and continue operating.

3.2 Timber procurement procedures

In spite of these difficulties, timber for Aceh reconstruction is still procured legally and sustainably, or at least non-illegally and non-unsustainably, from some sources to some organisations. All of them can be categorized either as locally supplied or internationally imported/donated. The procedure followed in each will be introduced and generally reviewed:

3.2.1 International timber procurement

A flow chart of international timber procurement procedure has been developed as below based on an introductory paper of suggested purchase flow prepared by Ralph Douglass from British Red Cross (Douglass July, 2006).

1. prepare house design and detailed Bill of Quantities	2. prepare purchase documents: a. Request for Quotation, b. Technical specification schedule, c. Proforma Invoice	3.send above documents to potential suppliers and invite to bid
		4. submission of bids and tenders evaluation
7. the Irrevocable Letter of Credit (ILC)[2] prepared by purchaser's bank accepted and confirmed by supplier's bank using the information in Proforma Invoice (2c)	6.successful tenderer accepts the offer and submits a Proforma Invoice (2c), thus a contract relationship is formed	5. notify successful tenderer and confirm intent by issuing a purchase order
8.production initiated		
9. shipping schedule organised and notified to the purchaser by the supplier	10. shipping documents[3] sent to the purchaser by the supplier on port of departure	11. purchaser applies to the BRR for tax free gift status on the basis of being a registered tsunami reconstruction programme in Aceh
		12. ILC payment and documents exchanges occur
	14.following logistics from ship at arrival port (Belawan, Medan) to final destination	13. purchaser or its shipping agent arranges customs pre-clearance, phytosanitary etc. using the shipping documents and support letter from BRR

Table 1: Flow chart of international timber procurement procedure for Aceh reconstruction

[2] the basis and payment terms of international timber trade, almost no suppliers will start purchasing logs or initiating production without a satisfactory ILC confirmed by their bank first.

[3] including documents of clearance of goods through customs and quarantine requires: a. Invoice b. Packing list c. Phytosanitary certificate from port of loading d. Air Bill or Bill of Lading (B/L) as a substitute for other documents but only possible for a temporary period

Imported timber from New Zealand or Canada using the above procedures has usually been treated as a Hazard Class H3.1 standard for an above ground application. The specific treatment method is LOSP (Light Organic Solvent Preservative) rather than CCB and CCF used in Indonesia. The prices range from USD$420-590/m3 CIF (Cartage, Insurance and Freight) at Medan depending on required grade, treatment and processing options, while local timber prices are usually within USD$350 – 550/m3 from legal sources. Although the price is understandably higher than the local one, there are several advantages of importing timber for the Aceh reconstruction.

The first advantage is the longer and guaranteed durability and protection from weather changes and insects and fungi attack under Indonesian conditions. It has an internationally recognized guarantee of sustainable management and production of timber with other internationally recognized 3rd party certification and audit of treatment standards, certificate of origin and chain of custody. Another advantage is the large amount available (30,000 – 40,000 m3/month if long term orders are placed) while uncommitted local supply is limited to approximate 1/10 of that from international sources. The supply chain is simplified and bureaucratic process of applying SKSHH[4] and other legal documents from the Government of Aceh could be avoided. Most importantly, for every log sourced internationally for use in Aceh, one tree from local tropical forests could been saved.

However, some disadvantages are obvious and make this option less attractive when decisions are made at an individual organisational level. Besides the higher prices, longer delivery schedules (at least 4-6 weeks, but generally believed as 10 weeks) often excludes it as an option. The required amount of timber is limited at each time of procurement thus the large availability of international sources is no longer an advantage. This is partially due to the lack of overall supply chain management and communications between procurement and project teams. A large order of timber, could be streamlined and procured at a lower price, then subdivided into small packages with only several hundreds cubic meters each and procured once in a while creates a longer and complicated timeline. Storage of a large amount of international timber is another problem because of the associated demurrage charges that are extremely expensive if the shipment has to be left at the port. Timber is a natural product that must be kept dry and out of direct sunshine if possible. Thus the warehousing facilities are essential in the logistics of transporting timber from port to construction site, while local timber could be delivered to the site at vendor’s expenses as required each time. The uncertainty of legitimacies within the Indonesian context related to imported timber, together with issues related to donation and standard treatments required, further contribute to the unpopularity of international timber procurement in Aceh.

[4] a legal document for cross-provinces timber transportation in Indonesia, only valid per truck per travel

3.2.2 Local timber procurement

Similarly, in order to understand the local timber procurement procedure, a flowchart developed and handed out as a suggested guideline by BRR is attached below:

Procedure for obtaining recommendation of timber transportation
Program Rehabilitation and Reconstruction NAD-NIAS

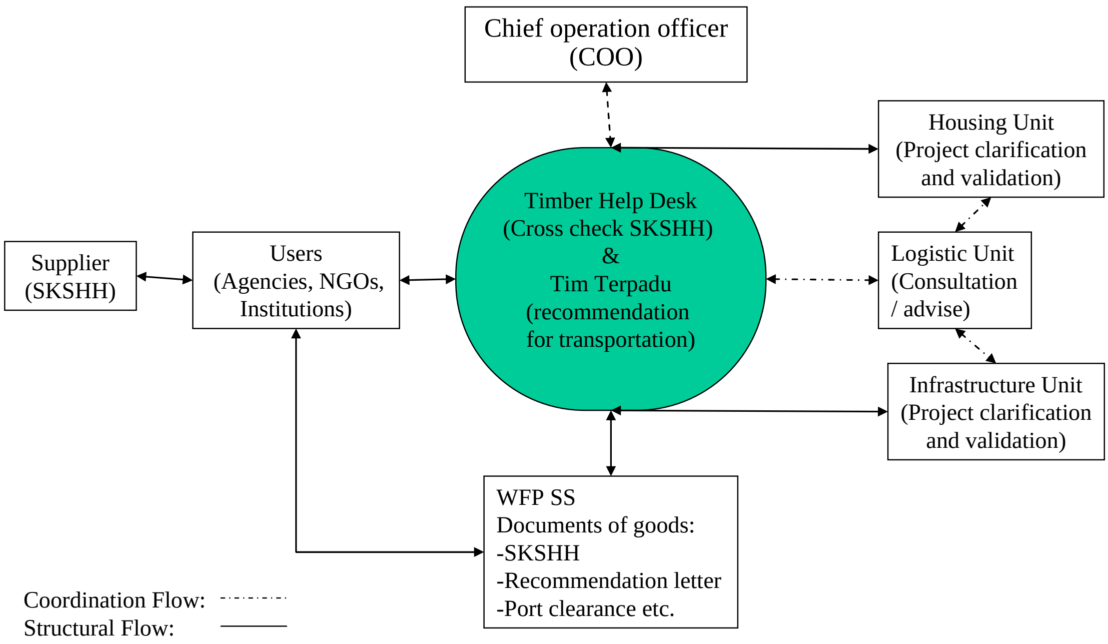


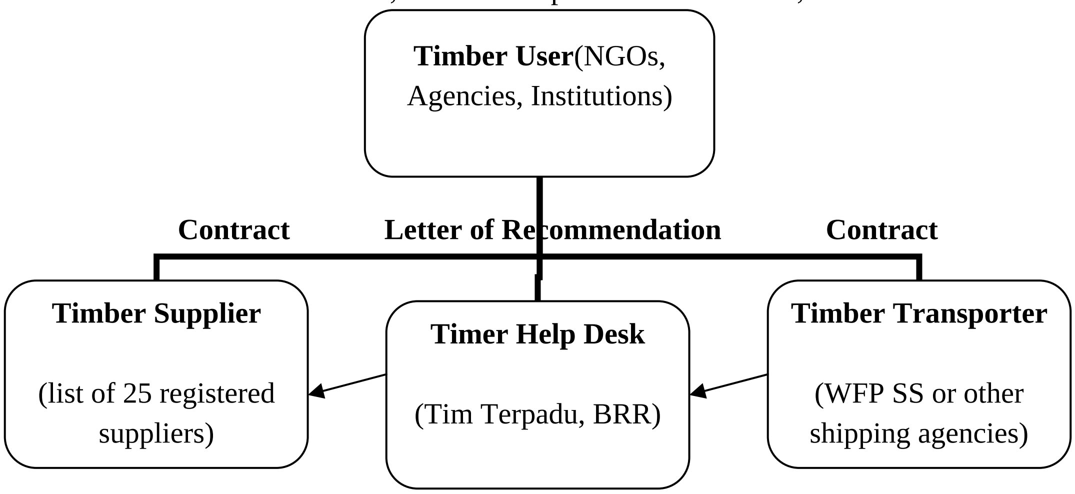
Table 2: Local Timber Procurement Suggested Procedure from BRR

Although aiming at providing recommendations for timber transportation, this flowchart could also be used as a guideline for local timber procurement and associated logistics. There are some terms used only in Indonesian timber industry that are worth explaining. The big circle in the flowchart represents Timber Helpdesk and Tim Terpadu in BRR headquarter, the most important interface to users, suppliers, shipping agencies and other departments in Government of Aceh. Timber Helpdesk was designed by BRR in order to address timber issues for reconstruction and rehabilitation in Aceh and Nias. It has a dual role to facilitate the demand and supply of timber and to monitor the timber used for reconstruction within this region. SKSHH appears many times within the flowchart, as explained in footnotes before, it is a set of documents used to define the legality of timber and it is required when the log is transported from the concession companies to the industry or when semi-wood products are ready to be marketed and transported to their final destination. It is worth noting that SKSHH is not required for imported and donated timber.

A typical procedure for local timber procurement could be categorized into 3 steps with different relationships between timber user/ purchaser and other involved parties, demonstrated below:

Table 3- Typical Procurement Procedure for local timber supply

As can be seen from above table, in order to procure local timber, the user has to contact a



potential supplier based on the names registered with BRR in step 1. Then the classical tendering process needs to be completed within this step and an agreement or formal contract needs to be entered into with the preferred supplier. After this, the user moves to step 2 and submits a request to Timer Help Desk or directly to Tim Terpadu in BRR for a Letter of Recommendation to purchase timber. In order to process this request, Tim Terpadu has to check with its Housing Unit and/ or Infrastructure Unit for the project clarification and validation to make sure that the user is permitted to order timber and that the amount and type of timber requested is in accordance with their needs (see flowchart in Table 3). Photocopies of the user's Project Concept Note5 and the Contract in previous step are required in order to issue the recommendation letter. Then in step 3, the user has to provide photocopies of documents gained from step 1 and 2 (Contract and Letter of Recommendation) together with an order request to the timber transporter and enter into another contract for transportation. The transporter recommended by BRR to reconstruction agencies in Banda Aceh is the shipping services provided by WFP (World Food Programme).

Overall, it is important that timber users understand the definition of legal timber and the assurance measures in obtaining only legal timber. Legal timber as defined in a BRR guideline (BRR July, 2006), means that the timber is harvested from legal concessions in accordance with national regulations. Legal concession is a legal timber company that holds a permit for forest utilization from the Ministry of Forestry. The user can purchase timber or timber products directly from merchants, but the responsibility for obtaining legal timber remains that of the user. It is recommended that all the timber bidders for the Aceh reconstruction are required to provide valid forestry permits as well as SKSHH as a pre-qualification for tender.

[5] Project Concept Note should be approved beforehand by BAPEL BRR, the executing agency.

3.3 Review of other options

Alternatives to limited timber supply and other options for sourcing materials for construction are explored and reviewed by organisations involved in the Aceh reconstruction. Those alternative methods and suggestions include using steel trusses (or steel high-pitch roof), windows, doors and ventilation frames or coconut trees as structural component as replacements to timber products.

The high prices associated with using steel trusses as replacements to timber are the main obstacle. Several factors may contribute to the problem. It is understandable that steel is more expensive than timber, but this shortfall could be reduced if less steel is needed for a roof than the amount of timber needed for a timber truss. Actually, a steel high-pitch roof requires much less steel in volume than a traditional timber truss roof. The high price is partially because the steel roof systems commercially available now are in mass production, mainly cater for the needs as factory storage and heavy industry buildings. The pricing of steel roofs for Tsunami relief houses could be significantly reduced if all the reconstruction agencies with the same intention in Aceh organize their individual requests into a bulk order and choose both local and international companies with reliable reputations for a competitive tender for mass production. However, this is moe easily said than done. The current coordinating agency BRR has growing power and may be able to do this for its prefabricated houses in the future. Another concern about the use of steel trusses is the acceptance by the community. People are more conservative in remote areas and it is still unclear whether they are willing to move into a “light and shining” steel roof house. This will require a significant amount of on-site community participation and socialization beforehand.

Coconut trees as another source for timber as “palmwood” is a relatively new process but has huge potential to ease the pressure on the world’s rainforests, especially in Banda Aceh coastal area, as an ecological substitute to endangered and limited hardwoods. They usually come from farmed plantations of old coconut trees and really are an enormous source of timber that until now have been a wasted by-product from the fruit and food industry. In recent years people have recognized and explored the potential use of this vast, alternative supply of timber and found that it performs as well as or even better than traditional hardwoods.

Usually, the outer, harder part of coconut trees is used in structural materials for building construction, flooring/decking and furniture design, while its relatively soft inner core is suitable for cladding, screening and homewares. These could be used as profitable by-products for the milling workshop owners if mass production of coconut timber for construction is feasible in Aceh in the near future. Another advantage is that the coconut palm is branchless; palmwood is free from knots, which makes it an ideal timber. The issues related to the level of acceptance by the affected community and forestry authority remain. The mass production of coconut timber in Aceh remains a good theory. However, since more and more research results and real life experiences in favour of this option become available internationally, it is a good opportunity to explore this idea further in Aceh using a government or community-based initiative to cater the massive needs for timber.

4. Conclusions and recommendations

The needs for improved communication between reconstruction agencies and their material suppliers are well recognized, but hardly addressed. As mentioned earlier in the SCM literature review, buyers and suppliers must commit a greater amount of information and be willing to share sensitive information to achieve increased levels of supplier performance. Good communication is the basis for building a long-term relationship with reliable suppliers. This should be encouraged in order to reduce the supplier base and minimise the administrative or transaction costs associated with managing a large number of vendors. Certain certificates or well-designed criteria for pre-qualification will contribute to the supplier selection process and supplier base consolidation (e.g. require timber bidders for Aceh reconstruction to provide valid forestry permits as well as SKSHH before further consideration of their tenders). Integration, another key principle in contemporary SCM, is suggested in the Aceh reconstruction practices at both supplier and logistics levels.

In relating to timber procurement process, the procedures of international and local timber supply for reconstruction in Aceh are reviewed in the paper followed by discussions on alternative ways of using steel trusses or coconut timber as solutions to the current problem. It is suggested that reconstruction agencies should seek every possible way of using local timber sources with policy clarifications and transportation suggestions from local reconstruction authority BRR, while exploring the legal, economic and logistic feasibility of imported timber. In order to facilitate the process, it would be better to have an overall procurement plan for the whole project rather than the range of small ones before starting any negotiation with potential vendors. This should streamline the supply in later stages and result in a better supply arrangement. More studies are required into the use of coconut timber. It remains an attractive potential for rural areas and isolated islands when policy barriers have been removed. The possibility of milling and use of seized timber or timber from other sources should also be investigated.

The use of familiar and locally available materials for reconstruction should be encouraged. The sustainability dilemma with the use of timber is the balance between the preservation of the environment and the provision of housing. The supply of timber offshore might provided great relieves at initial response, but in long term, it means that the important economical "kick start" provided by aid in country (and specifically in Aceh) is lost and the aftermath are housed people in a context of greater poverty. This leads into the need for alternatives such as the use of coconut timber and possible substitutions for the major uses of timber in house reconstruction.

Recycling certain construction materials from damaged houses remains another possibility since most steel doors and window frames from the disaster were not seriously damaged and are in large demands. Substitutions could be the use of light gauge steel sections, roofing that can span without the need for timber trusses, and different door and window frames. Furthermore, there is also the option to use shorter life span materials for doors and windows with the idea that they would need to be replaced earlier than usual (lowering quality). Although more expensive than timber, steel trusses could be a back up option given the short time and high demand. With a more integrated supply chain, the price could be lowered with mass production. This could be made possible with joint efforts of other reconstruction agencies.

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SECTION XI

DEVELOPING THE LAW CURRICULUM IN BUILT ENVIRONMENT EDUCATION

The Teaching of Law to Non Lawyers

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Abstract

Teaching law to non law students can raise concerns of perceived relevance, accessibility, engagement, purpose and pedagogic issues surrounding delivery. This paper considers these matters against the background of law teaching on the RICS (Royal Institution of Chartered Surveyors) accredited rural practice estate management programme at Harper Adams University College. Various teaching methods engaged by the authors are explored, with particular concentration on the introduction of case studies / scenarios at an early stage of studies to ensure the relevance and practicality of the course, in the context of future careers, is better understood by all students.

Key Words : law, teaching, non-law students, estate management.

1. Background

This paper is based largely on the experience of teaching law to students of rural land management at Harper Adams University College.[1] Harper Adams was, until 1995, known as an Agricultural College and was founded in 1901 on the monies left for the purpose by Thomas Harper Adams upon his death in 1892. The College occupies a rural site in north Shropshire and has a working farm of 500 acres together with 175 acres of woodland. The agricultural roots of the college are evidenced by signs outside each classroom urging students to remove their wellies before entering! The designation University denotes degree awarding status and the word College indicates a limited range of subject matter. In 2007 we became the only land-based HEI to have research degree awarding powers.

Agriculture is still a major area of operation with other key subjects being agricultural and off-road vehicle engineering, countryside and environmental management, agri-food business and marketing, rural leisure and tourism, veterinary nursing and, the course with which the authors are most closely involved, land management, an RICS accredited course aimed predominantly at prospective rural practice chartered surveyors.

[1] For a useful comparative discussion of the legal content of construction and surveying courses across seven institutions, see Hutchinson (2005).

Law modules, or modules with a substantial legal element, delivered to students of land management at Harper Adams include :

- Law for Estate Managers (first year introductory module)
- Planning and Environmental Law and Practice (second year)
- Agricultural Tenancy Law (final year)
- Business, Residential Tenancies and Land Law (final year)
- Revenue Law and Statutory Valuation (final year)

Other modules, such as Taxation and Rural Professional Practice, also have a substantial legal aspect and use the materials and techniques of the law.

The subject matter and learning outcomes have evolved with reference to various sources. Several members of staff are practicing chartered surveyors, examiners for the RICS professional qualification, members of the RICS Rural Faculty Board and members / examiners of other relevant bodies such as the CAAV (Central Association of Agricultural Valuers) and the ICF (Institute of Chartered Foresters) and are thus well placed to know what students require in their future working lives, as is vital on vocational courses. A recent questionnaire to rural practice surveyors seeking course evaluation highlighted law (notably land law and taxation) as being of major importance. This echoes studies into the teaching of law on other non law degree courses (see Monseau, 2002 based on Finance students at Rider University, New Jersey, USA), and indeed within built environment education itself (Morris 2007). The appropriateness of questioning of practitioners on the content of academic courses has been doubted (Brack, 1997) but the focussed nature of a professional accredited degree would seem to validate this approach, indeed QAA (Quality Assurance Agency) codes of practice urge employer liaison (QAA 2000).

The RICS qualification requires students, in their two years pre-qualification work experience (the Assessment of Professional Competence - equivalent to a solicitor's training contract), to gain experience in many 'competencies' (RICS, July 2006, i) and, of these, many are law based or have a substantial legal element, including :

- Access and rights over land
- Building control - legal / regulatory compliance
- Capital allowances
- Capital taxation
- Compulsory acquisition and compensation
- Contract practice
- Housing management and policy
- Landlord and tenant (includes rent reviews and lease renewals)
- Planning
- Procurement and tendering
- Purchase and sale

In addition to substantive competencies, the overall objectives of the APC is that students demonstrate awareness of the 'professional and commercial implications' of their work and they have an 'up-to-date and developing knowledge of legal and technical matters' relevant to work and the law of the region or country in which they practice (RICS July 2006, ii).

The relevance of law on any business degree needs no underlining (Byles and Soetendorp, 2002) and the above gives an introduction to the very specific context and relevance of teaching law to prospective chartered surveyors. . In addition to the substantive content of a law module, in considering the QAA objectives for honours degree students in a number of disciplines, the study of law clearly develops a range of transferable skills. In course accreditation, the land management degree at Harper Adams makes reference to the QAA subject benchmark statements for Agriculture, Forestry, Agricultural Sciences, Food Sciences and Consumer Sciences (QAA, 2003) and General Business and Management (QAA, 2007).

Intellectual skills raised in the QAA subject benchmark statements include :

- The ability to define and solve problems
- The ability to analyse, synthesise, summarise and critically evaluate information
- The ability to integrate lines of evidence from a range of sources to support findings and hypotheses
- The ability to appraise academic literature and other sources of information

Practical skills include :

- The ability to apply a range of methods to solve problems
- The ability to present research findings in a number of forms

Communication skills include :

- The ability to seek out, recognise and use a range of information sources
- The ability to communicate effectively in written, graphical and verbal forms

ICT skills include :

- The ability to use the internet critically for communication and information retrieval

Law is also highlighted as relevant subject matter in the Building and Surveying benchmark statements, notably : '… *law relating to land tenure, use and development of land which could include building control, statutory planning, health and safety, project procurement, dispute resolution, employment legislation, equal opportunities* …'. In the understanding and skills section the statement also stresses legal principles and the legal context (QAA, 2002). Although in designing the law modules at Harper Adams the subject discipline benchmarks have been referred to, others may conclude that they also need to refer to the Law benchmark (Byles and Soetendorp, 2002).

This paper concentrates on teaching law in the context of the requirements of a professional body (the RICS), and many other non lawyers undertaking legal studies would have a similar remit (e.g. accountancy students). However, law is taught across disciplines where other rationale are at play, such as the concept of citizenship (Byles, Linda and Soetendorp, Ruth, 2002) or business (Skwarok, 1995) and the problems and approaches relevant to our land management students may well be relevant in other environments where law is a vital element of vocational preparation but is not central, either for work or in students' perceived hierarchy of importance (Lampe, 2006).

Having established that law needs to be taught for substantive content, to comply with professional, educational and business needs and to develop transferable skills beyond the acquisition of core knowledge - what problems have been encountered in attempting to impart the law syllabus to these non law students?

2. Academic Range

Some issues have been raised due to the wide academic range on arrival, of students accessing the course, a result of the very specific professional focus of the course and the limited range of institutions offering a rural practice specialism.[2] We have students ranging from those with three, or even four, A grade A2s to students together with entrants holding a National Diploma in Agriculture, access course transfers, HND transfers and GNVQs. This level of academic diversity - means that teaching methods, particularly in the first year, need careful consideration (Davis, 2003).

As a College, we have a higher than average number of students with dyslexia,[3] perhaps due to the practical / vocational nature of many of our courses. As well as the obvious problems with written English, dyslexia also compromises attention span, the ability to take notes and a myriad of other skills which can no longer be taken for granted in higher education (Association of Dyslexic Students in Higher Education, 2007).

3. 'Law is Irrelevant'

Some students clearly understand the relevance of their legal subjects, particularly so after their work placement year (all Harper Adams BSc degrees are four year sandwich courses). However, although, as lawyers we might live and breathe Lord Wright's : '*Law in its own way covers the whole range of human activity - there is no side of life which it does not touch …*' (in Gower, 1950) others, who have not really addressed the practicalities of what their chosen profession actually involves, wonder what law has to do with surveying and valuation (Allen, 2006)! Any hope of effective teaching requires, as a point of commonsense, underpinned by academic study, that the raising of student awareness of relevance and of student engagement is constantly to be strived for and monitored (Ramsden, 1992 and Corbin, 2002). Morris (2007) suggests that the goal in teaching law to built environment students is twofold: to be able to work intelligently with lawyers, and to keep themselves out of trouble through the practise of 'preventive law *and its counterparts, preventive leadership, preventive networking and so on*'.

4. 'Law is Hard'

A broad range of areas are covered although, particularly in the introductory first year module, they are not covered in any great depth. Nevertheless, the wide range of material to which students are introduced and the unfamiliar terminology makes the subject forbidding for some. This is not the place to explore changes and any perceived 'dumbing down' of

[2] The Universities of Cambridge, Reading and Aberdeen offer closely related courses but only the Royal Agricultural College has a direct equivalent.

[3] In 2005/06, 16% of HAUC (Harper Adams University College) students declared a disability (HAUC Registry 2006), compared with a national average of 7.9% (Houghton and Wray, 2007). Dyslexia was the disability of 85% of that 16% (i.e 13.6%).

secondary education - we are where we are (Datta and McDonald-Ross, 2002), but it is clear that the written language of law can be unfamiliar (Douglas, 2004), inaccessible (Christudason, 2004) and generally overwhelming (Allen, 2006).

The perceived demands of Law modules are often exacerbated by comparison with other modules. There has been a consensus, following discussions in Course and Examination Boards, that the level of the more testing subjects (Taxation and Agricultural Tenancy Law have been particularly singled out) is appropriate and that all modules on a course need not be of precisely equal demands, if such an exact science were possible.

5. Law Lecturers

A final issue that can arise in the teaching of law to non lawyers, which should not be overlooked, is the background of the lecturer. Those who read law a considerable number of years ago may be heavily immersed in 'black letter' content, unimaginative delivery styles and the traditional domination of the study of sources of law (Soetendorp and Byles, 2000) probably through the medium of lectures, tutorials with a heavy pre-reading load and assessment through essays. There has been, then, the temptation to develop learning through the instrument of primary sources of law (Carrington, Schlegel, La Piana and Kalman, 1995) with a somewhat narrow pedagogic range (Carter and Unkerlesbay, 1989).

That a blinkered concentration on cases and statutes, with no reference to context and the wider world, is limiting was recognised over 100 years ago by commentators such as the estimable Oliver Wendell Holmes : '*For the rational study of law the black-letter man may be the man of the present, but the man of the future is the man of statistics and the master of economics.*' (Holmes, 1897). It is, then, clearly apparent that the black letter approach is not appropriate to courses where, in particular, (a) the students will not / cannot engage in the volume of reading and (b) where many subjects have to be covered in less detail. In an era of widening participation and the atypical student, limited reading may be due to a myriad of reasons such as work and family commitments or health issues and must not simply be seen as a reflection of academic skills on arrival to higher education. A defence or denial of black letter teaching for *law* students is left for others to consider.

We are, then for reasons of practicality and accessibility, into the realms of 'translating' the law rather than having students make extensive use of primary sources. The materials are reduced to a core. Although there are dangers in this (Ward and Slater, 1990) there is a considerable need (regardless of an academic ideal), in many of the legal subject areas, to get across a level of 'prophylactic law' - a minimum level of knowledge to avoid dangerous or expensive mistakes (Soetendorp, 1996) in professional life. To recognise legal issues, to avoid causing problems, and knowing when to refer to a lawyer is what is needed. Side arguments about the purposes of higher education, the development of abstract thought and learning for its own sake are important and diverting questions for another forum but it is taken as a given for the purposes of this paper, that the law teaching is directly related to the education of future surveyors, rather than an isolated academic frolic. An emphasis on skills (Cox, 1992) and context (Saunders and Clarke, 1997 and Tyler, 1995) rather than purely 'knowledge' (Harris, 1992) has become a feature of the law, as well as non law, curriculum, as encouraged by the Marre Report (Committee on the Future of the Legal Profession, 1988). This enables a greater interaction between law and non law pedagogic literature and lecturers with an inter-disciplinary relevance that was, perhaps, not previously the case.

The need for context is ideally embedded in course objectives (Woodcock, 1989) - how will the law affect the working life envisaged by the students (Endeshaw, 2002, and see the quotation from Morris 2007 above)?

These, then, are some of the problems which the teacher of law on a non law course needs to work through. There needs to be a consideration, *regardless* of practical problems, of what the students actually need to get out of their law modules. Subject benchmarking statements, professional guidance (both from the RICS Practice Guidance and anecdotal evidence from practitioners) and the experience of colleagues has been drawn on to determine the mix of factual, substantive knowledge and the transferable (Committee of Inquiry into Higher Education, 1997) research and evaluation skills needed on the law modules which also seek to support ' … *diversity, flexibility and learner autonomy*' (Hinett, 2002). Over all of this is a sense that, although not teaching future lawyers, there are key features to be transferred across the disciplines, which might encompass :

- where the law is to be found
- that the law is constantly changing (Soetendorp, 1999)
- the ability to identify legal issues (Cownie, 2004)
- the ability to go beyond the surface learning of facts, through to a deeper understanding (Marton and Säljö, 1976 and Meyer and Land, 2005)

This latter ambition for our non-law students has often been ignored by vocational law modules which have resorted to a diluted delivery of facts, without the contextual framework offered to law students (Broadbent, 2005).

We would argue that the context of another profession adds a further requirement, the ability to solve multi-faceted problems which contain a strong legal dimension. In this context law is only one of several competing frameworks, none of which will 'win' but all of which must be reconciled for an optimum technical or client-orientated 'solution'. This is normally at its most evident in practice, and the final assessment of the RICS APC can be interpreted in these terms. Within the academic component of professional development, the multi-faceted complexity of professional problem-solving can be seen to develop from year to year. Therefore first year students might solve problems within a single dimension, while final year students will have to incorporate several competing academic and professional paradigms. Although Morris (2007) has argued that : '*Both students and practitioners alike need to see that various subjects and disciplines are like islands of the sea, all seemingly standing apart and discreet; but the law is the sea itself, and under the covering water, all the islands are actually connected in one*', this is perhaps to overstate the centrality of the law in comparison with the other disciplines. A similar analogy may be drawn for economics or management studies for example; nevertheless the general idea has considerable utility.

The remainder of this paper relates to the attempts to improve the engagement of students and the effectiveness of module delivery as measured by attendance, tutorial engagement, exam performance and the quality of written work.

6. Lectures

Given the oft quoted ineffectiveness of the lecture (Gibbs and Habeshaw, 1996), why is the average module still based around this ‘traditional’ (Le Brun and Johnstone, 1994) medium? The lecture is almost inevitable due to the size of groups involved which, at Harper Adams are not large by many standards but are too large for other methods of teaching for at least part of the course (up to 90 students). Other methods can and are being explored, such as the delivery of materials by internet / intranet and having fewer, small classes, e.g. meeting once every fortnight with a far greater emphasis on student centred learning (di Napoli, 2004) which is, of course, in line with Dearing (Committee of Inquiry into Higher Education, 1997) and other reports (Department for Education and Employment, 1998). However, the lecture it is, for now at least.

Much has been written on ways to improve lectures (e.g. Jenkins, 1992; Gibbs, Habehsaw and Habeshaw, 1997; Fry, Ketteridge and Marshall, 2003 and, particularly enjoyably, Blight, 1998) and over-emphasis on black letter content can do little to ameliorate the problems noted above. Although keen to develop effective ways of engaging and educating non-law students, the dissemination, or at least introduction, of a base of information is still most effectively done through the lecture and although primary sources do not hold a central position (Carrington, 1995) for the education of non-lawyers, an explanation of the existence and mechanisms of primary sources of law still usefully forms the firm foundation onto which a more free-ranging case study methodology can be constructed.

7. Notes

To avoid the problems of incomplete notes and to aid private study, the notes for the entire first year law module have been bound into book form which includes :

- lecturer prepared study notes of the ‘translation’ order mentioned above, i.e. abbreviated key points of law
- a small number of law reports in full and extracts from statutes
- gapped quizzes and questionnaires, either for revision or to take the student through the self study of a discrete subject area
- a few oddments for added excitement, e.g. the Carbolic Smoke Ball advertisement (*Carlill v Carbolic Smoke Ball Co.* [1893])

Although the notes do not obviate the requirement that students refer to text books (given the nature of the course, there is a limited requirement for them to refer to primary sources of law), it has been found that many text books, even when specifically for non-lawyers (the module reader is *Estate Management Law*, Card, Murdoch and Murdoch, 2003) are not easily accessed by our students. Putting law into standard English (Asprey, 2003 and Balmford, 2001) and explaining terms which it does not always occur *need* explaining (Allen, 2006) aids teaching effectiveness and the retention of interest considerably (see Cruikshank, 2002). A regular vocabulary test carried out in week 1 of the first year including words such as 'dissenting' and 'rebuttable' gave rise to concerns as to how much of a lecture or demanding text was being followed, with a greater need for 'translation' materials.

8. Scenarios

In addition to the notes, the idea of a greater emphasis on problem based learning was developed through the introduction of a rather contrived 'Law Story', written as a starting point to underline the relevance of legal studies to the students' personal and professional lives. Each chapter takes no more than a side of A4 - a lot less in most cases - and on the back of each page a list of the legal issues is given, together with the relevant cases or statutory references. Having used Law Story in various ways, it has been found that giving it out towards the end of the semester is more beneficial when students (hopefully) have a chance of spotting some of the issues rather than being overwhelmed. Short periods of time at the end of tutorials are set aside to look at a given chapter with students working individually for five minutes and then coming together in small groups to see how many points can be identified.

9. Case Studies

The most fundamental development in teaching practice which has evolved to address the problems encountered in teaching law to non-law students has been the introduction of the case study as a *starting point* to learning. (That is 'case study' meaning problem / scenario, not in depth study of a legal case.) The aim is to lead the student to clearly see the relevance of their legal studies, to direct the lecturer away from too dry and formulaic an approach, and help make materials more accessible in giving purpose and focus to private study. Morris (2007) found that the majority of students wanted '*more detailed illustrations*' and case studies, '.. *perhaps for the vivid exemplary or story content of case reports, which are more accessible to new learners than 'black-letter law*.'

Case studies have traditionally been used after a body of legal rules and information have been imparted by lecture, addressing none of the problem issues raised above and resulting in students lacking engagement before they ever get to assimilate the information and attempt to reach the higher level educational objectives of analysis, synthesis and evaluation (Bloom, 1956 and Anderson and Krathwohl, 2001) to apply their knowledge. In an expansion of the 'Law Story' exercise, larger problem cases / scenarios have been given early in the module with learning centred around information needed to deal with the situation, i.e. self-study is focussed on the problem in hand.

An example of such a scenario, in the area of professional negligence with the added complication of contractual relationships, is as follows :

> Henry Harper-Smythe, FRICS FAAV, a chartered surveyor and an employee of Edwin Harper-Smythe & Co., carried out a full structural survey on a small Victorian cottage which Mr and Mrs Adams were thinking of purchasing for their daughter to live in whilst she was at university, for approximately £90,000.
>
> Mr Harper-Smythe was employed by the building society who were loaning Mr and Mrs Adams 50% of the asking price.
>
> There was considerable evidence of alteration in the house in the form of wall and fireplace removal. As a result of his examination of the property the surveyor submitted a report which valued the property at the asking price with no recommendation for any further work or investigation.
>
> Six months later the bedroom ceiling collapsed as, it was discovered, the support system had been compromised by the removal of a wall without the necessary reinforcement.
>
> There was extensive damage to the property and Miss Adams was badly bruised and severely distressed.
>
> **Advise Henry Harper-Smythe and Edwin Harper-Smythe & Co. as to their potential liabilities.**

Rather than starting with the rules of negligence and discussions of decomposing snails in Scottish cafés nearly 80 years ago (*Donaghue v Stevenson* [1932]), students can see immediately that the issues relate to work they may well be undertaking, or be closely involved with.

The evidence of the effectiveness of this approach is currently anecdotal but another year through the module will see the introduction of formal evaluation in terms of :

- attendance
- student evaluation a month into the module
- student evaluation at the end of the module
- a comparison with both examination results and qualify of question answers

Interim results, from student module evaluation and discussion groups, indicate a greater understanding of context and a slightly greater engagement with self-study, although this has had to be very carefully directed. Clearly, some of the problems which this approach sought to address would indicate that, once a student discovered or was told that a problem involves negligence, they are unlikely to engage in wide background reading around the subject!

There also needs to be a confidence on the part of the lecturer that there may be gaps in the imparting of what might be considered standard basic cases and statute law in a given area in exchange for a greater engagement and understanding of the legal implications raised in a practical situation.

A second example of a case study is drawn from a final (honours) year module in the same programme called Revenue Law and Statutory Valuation. This module addresses the relationship between the legal frameworks in which many valuations are undertaken, and the implications of this for valuation methodology and practice. There is also a wider practical dimension in that the work of the valuer in practice does not just stop at the preparation of formal valuation reports, but is also concerned with the negotiation of optimum outcomes for a client in practical land management and development terms. *Arthur's Yard* is a case study designed to tease out some of these relationships for students.

COMPULSORY PURCHASE - COMPENSATION FOR LAND TAKEN

1. Study the plans to see the location and proposals for Arthur's Yard.

2. Arthur's yard itself started life many years ago as a roadside petrol station, garage and cafe. Externally it has degenerated over the years to become a 'greasy spoon' paradise for bikers. In recent years he has built up quite a scrapyard to the rear of the premises with an unparallelled collection of British bikes, past and present, in it. This development just happened as time went along, without the formality of planning permission etc.

3. The area to the rear of Arthur's has been designated for housing development in the local development plan. The only access to this area is down the side of Arthur's, opposite Greenacre (a rather plush bungalow which obtained planning permission many years ago, but which in fact has never been built). However, this area is too narrow for access and Arthur has let it be known that he would be willing to make available a strip down the side of his premises (of which he has little need) to widen the accessway to acceptable standards. The problem with this is the burden of the restrictive covenant enjoyed by the owners of the Greenacre site preventing Arthur from building on this part of his property. It was made many years ago, before the nearby row of houses was built.

4. The outline proposal for a nearby new road has been known in the area for many years. To Arthur's astonishment, the detailed proposals for the new road show his entire premises to be required for the construction of a new roundabout. This has prompted a number of angry, but rather random, thoughts on Arthur's part :

   He had ambitions of a roadside restaurant or similar development on the new junction if it became difficult to continue the parts business with the new housing at the back;

   He should be compensated for the loss of the 'ransom' he was going to extract for access to the rear land, but now they have put in an access off the new roundabout!

   There is no way he is going without payments well above the odds for all the aggravation this has caused him!

They'll have to pay him to set up a new business just the same somewhere else; in fact they will have to provide the site and new replacements for some of the specialist bike-repairing machinery he has put together over the years (that will be some consolation as most of it is worn out anyway).

There aren't many specialist bike scrap yards around, and so that should be worth extra payments on the compensation as well.

etc. etc. etc

Now to the rather dry bit :

Arthur has appointed you as his expert advisor on these matters (good luck!). Identify and evaluate the issues raised as far as compensation for land taken is concerned.

As well as material on statutory compensation, you may also find it useful to refresh your knowledge of planning from earlier modules, and to consult a land law textbook on the circumstances in which restrictive covenants can be removed or discharged.

Students find this a challenging exercise as it integrates a knowledge of statutory valuation principles, the development planning system in the UK under which policies for the direction of new development are determined, valuation methods, and general land law concerning the circumstances in which restrictive covenants can be discharged or modified (including the criteria under which the Lands Tribunal will discharge a restrictive covenant). Finally the students can see how these various facets must be combined to generate a strategy for dealing with Arthur's requirements as a client - this includes the management of the client himself through the process. Fifty-four students studied the module in 2006/07, of whom 48 responded to an evaluation questionnaire. Of these students 46 students rated the module 'excellent' (21 students) or 'good' (25 students). Amongst the written comments offered by students of relevance to the use of case studies were:

> ".. makes compulsory purchase lively and interesting - quite a hard task."
>
> "Very practical examples when teaching"
>
> "Good up to date subjects and case studies"

10. Conclusion

The two case studies show how the complexity of professional problem-solving can be developed from a first year module with its emphasis on two complementary legal strands (contractual and tortious liabilities), to the final year module which seeks to integrate a number of disciplines which make up the modern estate management syllabus. Both case studies are grounded in an appreciation of the professional context in which students and practitioners must apply and interpret the law, while the latter study also provides an opportunity to explore some of the specialised legal decision-making machinery which covers landed interests (the role of the Lands Tribunal).

In conclusion, the teaching of law to a diverse range of students whose primary interests might lie well outside the content of the law modules requires careful thought, planning, a willingness to try a range of teaching and assessment ideas and the grace to alter and abandon 'pet' theories which fail to engage or prove effective.

It is hoped that the combination of course materials and delivery vehicles has, at least in part, addressed some of the problems in the law modules at Harper Adams and may provide some ideas for others.

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Landlord and Tenant Law for Surveyors – A Problematized Case Study

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Abstract

A lawyer new to higher education reflects on the initial delivery of a Landlord and Tenant Law module to Level 2 full time surveyors. The paper identifies specific challenges to learning that this delivery posed. These include the relative inexperience of the lecturer; the amount of syllabus to be covered; the tension created by the twin characteristics of the module, being at the same time both obligatory and, arguably, peripheral to the main degree; the aptitude and inclination of the students; and the teaching and assessment methods implemented. These challenges are contextualised against the assessment performance of the students. Having problematized the delivery, the paper assesses it in the context of current thinking regarding pedagogical 'best practice' for facilitating deep legal learning in non-cognate cohorts and proposes some areas for development..

Keywords: Law, Pedagogy, Non-Law Students, Teaching and Learning

1. Context and Methodology

1.1 Overview

This paper is a reflection on the delivery of a series of lectures on the topic of Landlord & Tenant law to level 2 undergraduates enrolled on non-law programmes by a novice lecturer. These reflections on practice were prompted primarily by the stark mismatch between the lecturer's expectations of student achievement and actual achievement as demonstrated by the end of course exam. The aim of this paper is to draw out ideas for the future development and improvement of this, and similar, courses.

1.2 Context of Lecturer

When I stepped into a classroom in February 2007 to deliver the first lecture in a series relating to landlord and tenant law, I was not within my comfort zone. Though, at 36, hardly in the first flush of youth, I was a novice lecturer.

Pickering [1] argues that the novice lecturer experiences to a heightened degree the feelings of isolation, uncertainty, multiple role conflict, dependency on management, expanding administrative loads and juggling work and home responsibilities, which have been identified as characteristics of the academic role by Knight and Trowler [2]. In the relatively short time I have been in academia since that 'inaugural' lecture, I have experienced all of those feelings, but on the day itself I was, if anything, bemused. Unlike Pickering's subjects who, though novice lecturers were expert in their field, I was a novice lecturer who, prior to preparing the lecture series, had only distant memories of learning (a small part of) the subject some 12 years earlier, while studying to become a solicitor.

As well as being new to the subject, my formal pedagogic knowledge was also minimal, being limited to an acquaintance with (an old edition of) McKeachie's Teaching Tips [3]. My informal pedagogic knowledge was a collection of largely unarticulated feelings regarding the 'right' way to teach, drawn from my own experience as a learner. Cownie [4] makes a persuasive case that legal academics who teach should be fully conversant with educational theory, failing which their rationale for their chosen pedagogic approach is 'a mere assertion of belief' [4:232]. Bailey [5] draws on Freire's concept of *praxis* - the union of reflection and practice – to argue that 'theory without action is a form of mental game playing and that action without theory is simply flying by the seat of your pants' [5:308]. Adopting Bailey's imagery, Cownie argues that the majority of academics are 'flying by the seat of their pants', because they are engaged in the action of teaching, without any knowledge of the relevant theories.

That aptly describes my situation as I commenced my lecture series.

1.3 Context of Learners

The course was delivered to a mix of Building Surveying students and Property Management and Investment ('PMI) students. Both these degree programmes are designed to conform to the QAA benchmark statement on Building and Surveying [6]. The programmes also benefit from accreditation from the Royal Institution of Chartered Surveyors [7] and the Chartered Institute of Building [8]. All of these sources of curriculum guidance afford some place to the learning of law, though, understandably, law is not accorded a leading role. The QAA guidance, for example, includes the study of what may loosely be described as built environment law (e.g. law relating to land tenure, building control, planning, dispute resolution, procurement, health and safety) as one of 6 themes which 'curricula may include as appropriate' [6:2]. Likewise there is a legal component to 2 of the 6 groups of 'knowledge and understanding which graduates are expected to acquire'[6:3].

These requirements are reflected in the proportion of law specific modules which the two streams of students must study at the University of Salford. Four out of the eighteen modules which comprise the Building Surveying curriculum (six modules per level, at 20 Credits each) are devoted to legal subjects. The PMI course has three law modules.

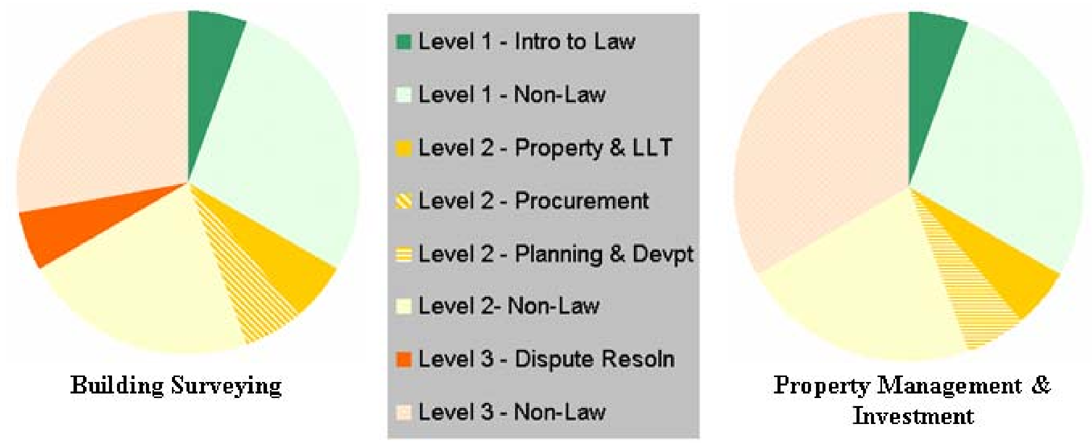

Fig 1. Comparative Breakdown of Legal Aspects of 2 Undergraduate Programmes

The course I delivered was the second half of the Level 2 module in Property and Landlord and Tenant Law. For efficiency the first half of the module is delivered to 4 cohorts of students, but only two of these go on to study Landlord and Tenant law.

1.4 Context of course

38 students were registered to the course, 24 in Building Surveying and 14 in PMI. Average attendance ran at around 24, and 3 students (1 BS and 2 PMI) attended no sessions at all; simply submitting coursework and attending the exam. Eleven face to face sessions were allocated to the course, each time-tabled for two hours.

Baderin [9] contends that the conventional learning and teaching method for undergraduate *law* courses is a combination of large-group lecture sessions and small-group discussion sessions,, these smaller sessions being designed to 'encourage student understanding of the subject area and to motivate and energize them to think creatively about relevant and appropriate issues' [10:335]. Similarly Tribe and Tribe, describing the situation some 15 years earlier, indicated that the prevailing norm was two hours of lectures per subject per week, consolidated by small group work [11].

The two hour slot earmarked for the course under consideration was allocated by the timetabling department on the basis of a one hour lecture and one hour tutorial. However, as only a single hour was provided either in teaching space or work-load allocation for the entire cohort's tutorial, the reality was that I had two hours per week with all the students together.

2. Approach to delivery

Absent any significant level of educational theory I approached the initial delivery with a positive, but inelaborate desire to get the students interested in the subject and so incline them towards learning.

2.1 Relevance of subject

One aspect of my conception was to encourage the students to engage with legal principles and primary legal sources in a way which replicated practice. It seemed intuitively right that highlighting links between the subject and the 'real world', particularly possible future career activities, would be more engaging for students and more likely to be remembered. Subsequent consideration of theory reveals that my 'assertion of belief' (à la Cownie) in this regard has some theoretical support.

Examined more closely, the core element of my 'belief' is the use of knowledge the students already have – the real world referred to above – as a foundation from which to explore the new knowledge covered in my lecture series. Such an approach finds its justification in many of the oft-cited pedagogical texts, including Biggs [12] and Bligh [13], and the innovation in law teaching described by Tribe and Tribe [11] is expressly based upon work done by Ausubel which highlights the value in facilitating learning by building from pre-existing cognitive structures.

The exercise I adopted which most clearly implemented this approach was conducted in my third lecture, which happened to fall St Valentine's Day. To encourage the students to think about the essence of the landlord and tenant relationship, I posited the macabre (and unlikely) scenario that the Capulet family, having no current requirement for *Casa di Giulietta*, were in negotiations with the Montagues who were interested in renting the premises to exploit as a tourist attraction. Students were formed into opposing teams, representing the landlord or tenant, and asked to draw up a list of issues that they, assuming their assigned role, would want to address. The students engaged enthusiastically and although the final result was simply the drawing up of a list of the sorts of conditions (as to rent, user, alienation etc) that tend to be found in leases, this was achieved by working from the students' own knowledge.

2.2 Primary Legal Resources

Another belief which underpinned my approach to course delivery was the importance I placed upon students personally engaging with primary legal resources, particularly reports of judicial decisions. This belief was based on my awareness that these resources provide access not only to the law, but also to examples of practical application, since in each case the tribunal must articulate a view of the prevailing law, and then apply that view to the relevant facts. Consequently I provided significant quantities of detailed case expositions, supported by provision of full transcripts via the Virtual Learning Environment ('VLE').

Whilst undergraduate *law* courses require considerable engagement with primary legal resources, this was a course where law was a subsidiary subject. The QAA benchmark statement for Law [14] suggests that where law is a subsidiary subject, in-depth study will probably be in other areas, and students are expected to engage with secondary resources - text books - rather than with primary legal sources. The same point is made by Soetendorp and Byles [15], who identify that a series of studies indicate the 'inappropriateness of teaching law [to non-lawyers] through the study of primary sources as outlined by statutory and case material'. The alternative approach often implemented is described – though not endorsed - by Soetendorp and Byles as 'prophylactic law' – where students bound for a particular profession or occupation are provided with a simplified set of fixed rules, which provide the bare minimum of knowledge to protect the student from breaching the law when in practice.

One solution to the law for non-lawyers problem posited by Soetendorp and Byles is a case study workshop, designed to encourage students to maximise their existing knowledge of the law and to contextualise it in their subject discipline. The justification for not exposing students to primary legal resources is that the intended learning outcome of the 'micro-module is to encourage awareness of relevance of specific law, not its detailed application'. In the context of my course, this approach is relevant – and resonates with the *Casa di Giulietta* exercise outlined above – but does not seem to offer a complete solution where more extensive learning outcomes are defined.

Allen [16] provides a thumbnail sketch of non-lawyers' responses to learning law. Student feedback indicates that law is considered difficult, with overwhelming quantities of reading, and confusion regarding how to study the subject. There is a certain inevitability that low marks and frustration on the part both of students and lecturers will ensue. However, Allen widens the debate by arguing that what is really at issue is not the characteristics of law *per* se but its position as a discipline secondary to the one which the students chose. This can impact student learning in a number of ways.

First, in terms of motivation, it may not safely be assumed that even the primary subject chosen is one which the student is keen to learn, potentially leaving the secondary subject foundering. Secondly, in terms of understanding, Allen draws on Meyer and Land's 'threshold concepts'. These are defined as 'concepts that bind a subject together, being fundamental to ways of thinking and practising in that discipline' [17]. A student who has succeeded in internalising a threshold concept is better able 'to integrate different aspects of a subject in their analysis of problems', whereas a student who has not internalised that threshold concept will 'have little option but to attempt to learn new ideas in a more fragmented fashion.' [17] Clearly, where a student is studying a number of different disciplines to varying degrees, the risk is that the threshold concepts of the subsidiary discipline are not grasped.

Allen posits that in law threshold concepts include an appreciation that much reading is required, specific disciplinary language (jargon) is used, and a particular approach to both problem-solving and writing is required. If this does represent an effective application of threshold concepts in the legal milieu, the corollary is that focus should be on encouraging students to 'get' these concepts – and that my initial insistence on exposing students to large volumes of primary legal sources may be misplaced; if the students are not guided to an understanding of legal discourse, then little may be gained by repeatedly exposing them to yet more such discourse.

Pickering cites the views of a novice lecture who had intially taken a purist line to lecturing, being reluctant to ‘flog’ his subject to those who were not interested, but his reflection on his first year’s experience indicates a more nuanced position:

> *‘The good students are here because they are interested anyway and they’re not a problem. It’s the students who are here because they weren’t sure what to do after finishing their A levels and they didn’t actually do very well in their A levels and they’re not committed to the subject. . . . And it’s trying to get them interested so that they then become receptive to the ideas and concepts that you’re trying to put across. And so there has to be some interaction so that you can gauge where their interests are. And it varies. . . . And you have to keep probing to see what makes them tick.*[1:326]

There are aspects of my own initial approach that could be described as purist, particularly my insistence on using large amounts of primary legal resources. What prompted my deeper consideration of this, and indeed, all aspects of my approach to the course was the shock of the exam results.

2.3 Exam Results

All but one of the 38 students registered on the course took the exam. I set the questions and marked all papers. The papers were anonymised until submission of marks, but I have since had an opportunity to correlate individual student marks to other data held, notably attendance records, and performance in course work.. Consideration of the data establishes that on average just short of 70% of Building Surveying students attended each session, whereas only just over 50% of PMI students did so, and the only occasion when PMI students outnumbered BS students was in the final revision session.

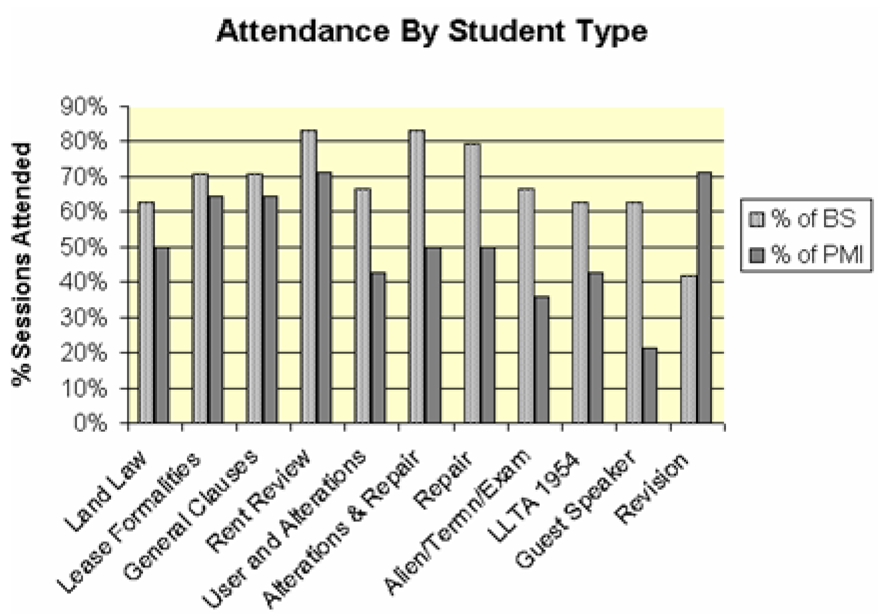

Fig 2. Comparative Attendance Figures

Despite these attendance figures, on average PMI students slightly out-performed Building Surveying students, gaining 56.6% on average as against 55.8%. Building Surveyors did do better in coursework, (63.4% as against 61.1%), but in the exam, whilst neither group did very well overall, PMI students scored on average 47.1% as against 43.6% for Building Surveyors. One interpretation of the figures is that, at best, on average there was no correlation between attendance at my lectures and student performance overall. This is most vividly illustrated in Figure 3:

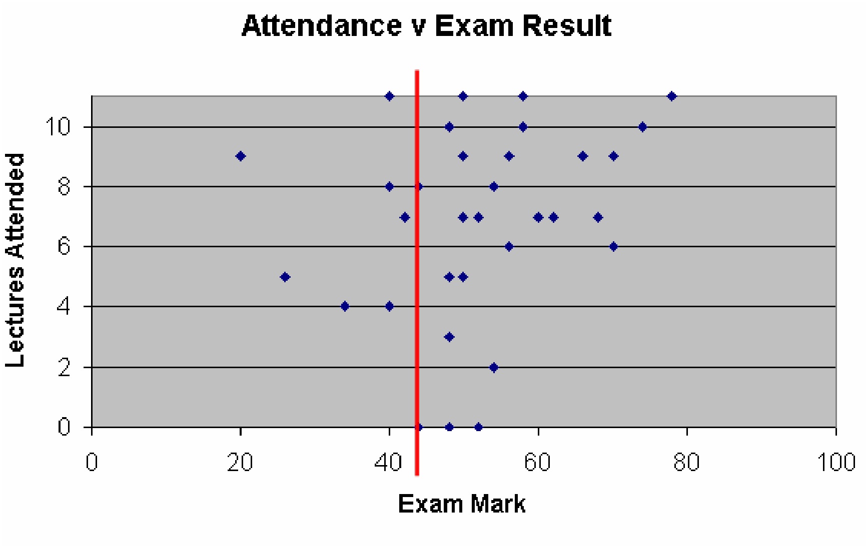

Fig 3. Plotting Lecture Attendance against Exam Result

The 7 results to the left of the red line are those students whose exam performance was less effective than the performance of any of the three students who attended no lectures whatsoever. There could be any number of variables which these figures do not make explicit, but an application of Occam's razor to analyse a situation where one student who attended every single lecture does worse in an exam than three who attended none, does tend to a conclusion that there are aspects of the delivery which could be refined.

2.4 Lecture Practice – The Good Points

Considered reflection on my practice does suggest that my lectures - as lectures - had quite a lot to commend them. Moreover, though they may have been manifestations of belief not theory, and were certainly examples of 'flying by the seat of my pants', along the way I stumbled across quite a few practices that are supported in the literature.

I adopted a pretty informal delivery style. I was keen to get input from the students and tried to bring the subject matter to life as best I could. This type of approach is arguably what Eble describes as a 'generous' attitude towards knowledge [18:207] whereby knowledge is freely shared with students, not retained as mysterious arcana by the academic 'priesthood'. Similarly, research into student attitudes and response to varying teaching styles is strongly in favour of *enthusiastic* lecturers (e.g. Hodgson [19], Coats and Smidchens [20], Murray [21]). As Ramsden notes [22:95], 'truly awful university teaching is most often revealed by a sheer lack of interest in and compassion for students and student learning'.

This is not a criticism that could fairly be levelled at me. During course delivery I captured student views on two occasions. First during the fifth session when I sought views via a stop/start/continue exercise [see Race and Brown 23:34] when 22 of the 38 registered students were present, and around 10 provided feedback; and again in the 9th session when I administered a Module Evaluative Questionnaire ('MEQ'). On that occasion 21 of the 38 students were present and 18 provided feedback. No comments specifically regarding lecturing style were captured on the first occasion, but in the MEQ 78% of the students polled noted as a positive the 'engaging' lecture style. This was the most unanimously expressed view by a factor of around 3; 5 other groups of positive points were noted, but each of these polled at around 30%.

I also structured my lectures carefully using diagrams to illustrate points, and picking images to associate with certain concepts. Research confirms that individuals are better able to recall sentences that have meaning than sentences which do not [24]. At a micro-level, this suggests the importance of lecturers using simple language to explain themselves, whereas at a macro-level it suggests the importance of giving students information in a logical and structured way [13]. Bligh further argues that it is not enough that the material actually has a logical structure, that structure must be shared with the students, and consistently and repeatedly referred back to, in a cyclical 'taking stock' exercise, as, otherwise, students risk losing the thread of the lecture [13:70]. There is also support for the use of visual representations to assist explanations, as these are more likely to be retained in long term memory [25], although the effectiveness of such resources depends not so much on the resource themselves but on how they are used [26]. This implies there must be a clear rationale for the choice of resources and a strategy for how they are to be used within the lecture to enhance student learning.

I also provided hand-outs, generally in the form of powerpoint slide printouts. I did not operate consistently with the timing of the provision of these; sometimes I provided them at the end of the lecture on the basis that I wanted the students to concentrate on what I was saying. Whilst the literature is supportive of the use of hand-outs, it is not supportive of providing them retrospectively in this way. Research indicates that handouts should be used to get students to make notes, not just to write down what is being said or to copy slides [27]. Creativity and variety in handout design, including short learning tasks to encourage interaction, enables students to make good notes in lectures [28]. If intended as a guide to the structure of the lecture with spaces to make notes, there is support for issuing these at the beginning of the lecture [13], whereas Neuble and Cannon indicate that handouts which provide additional or more detailed information should be issued at the end [29].

Whilst there remains considerable room for improvement, it is also encouraging that some of my intuitive approaches can be justified theoretically.

2.5 Lecture Practice – The Bad Points

The belief which arguably did most to shape my approach to course delivery was the belief that I had to cover all of the topics in the Module Specification. This document has a broad reach ranging from the doctrine of tenure, through adverse possession, and on into landlord and tenant law. Despite my belief that I had to deal with all items, fitting all that content into 11 two hour sessions was an impossibility and I rationalised coverage (see Fig 1). Nonetheless, I did endeavour to cover as much of the syllabus as I felt was possible.

In both the informal and formal feedback captures referred to above, a recurring feature was that I went too quickly. 50% of those who completed MEQs expressed this view, and this was the most unanimous negative view expressed; 6 other groups of negative views were provided, but with a frequency ranging between 6% and 33%. Fewer responses were provided in the informal feedback exercise - a total of 18 comments provided by around 10 students – but of the eight 'negative' comments, 3 were heartfelt requests for me to slow down. If additional confirmation were needed, my teaching sessions were observed on 4 separate occasions by 4 separate academic colleagues as part of my study for the University of Salford's Post Graduate Certificate in Higher Education Practice and Research. Each of these observers, while commenting favourably on other aspects referred to above, also noted that I was moving quickly through material.

I did incorporate interactive elements into each of my sessions – and these were well received - but my desire to achieve coverage kept such elements within quite tight bounds. Likewise, I did provide guidance regarding assessments, but did not provide an opportunity – in class time – for students to practise their skills. Large amounts of primary legal material was made available on the VLE, but little guidance regarding how best to exploit it.

Engagement with the literature suggests, to quite an extreme degree, that this is precisely the wrong approach to take in the circumstances of my course. Much pedagogical literature centres around the opposition, posited by Marton, F. & Säljö [30], between deep and surface approaches to learning, with the surface approach being characterised by rote learning, and the deep approach being based on conceptual understanding. Biggs [12] emphasises that a teaching approach driven by a desire to achieve syllabus coverage will tend to encourage a surface approach to learning. Bligh's substantive review of the literature relating to the didactic lecture mode indicates that, on its own, the mode is not well suited to promoting deeper levels of understanding noting that 'little thought can take place in a lecture' [13:129]. Fyrenius identifies two stages in the process of understanding; 'sifting', where information is received and condensed, and 'building', where the information received is related to previous knowledge in order to understand it, own it and eventually reshape it [31]. The didactic lecture typically promotes the sifting stage but does not tend to encourage the building.

In opposition to this, the type of learning which is needed in order to perform to a high level in law is deep learning. Allen cites Cownie et al that 'law is an argument not a statement, it is to be debated and discussed' [16], and to engage in a debate a student needs to have absorbed the arguments, merely pushing superficial facts around will not produce a quality response.

Formalised feedback to students was also not factored into my course delivery, save in relation to the one piece of coursework. Yet, it is considered that formative assessment is crucial to knowing how well students understand and to enable continuing development of effective practices in teaching and learning [28].

A final underpinning – but unarticulated - belief that I brought with me to my course delivery was that of the *teacher* being central to the learning process. This is implicit in the approach to course design which I adopted. There is a considerable body of literature which argues for the reverse with the student being placed at the centre of learning (e.g. Ramsden [22]). Maharg [32] highlights the potentially revolutionary implications for legal education of Rogers' argument that that 'the only learning which significantly influences behaviour is self-discovered, self-appropriated learning.'

3. Conclusion

The reflection on practice informed by theory which this paper represents, however incompletely, enables some conclusions to be drawn which have particular significance for me, as I prepare the next iteration of the Landlord and Tenant module, but which may also have wider relevance for those facilitating the legal learning of other cohorts of non-lawyers elsewhere.

My driving force remains to encourage students to acquire a real understanding of the legal concepts that form the basis of the course; I have no wish simply to dole out 'prophylactic law'. Yet my approach must take into account the circumstances of course delivery, including the amount of student contact time, and the degree of student aptitude and inclination. It is these which must dictate the approach, regardless of the literal extent of the curriculum.

A student-centred approach, in the model of that implemented by Soetendorp and Byles has its attractions. Certainly the focus of delivery should be to encourage the development of understanding in those who struggle with the subject (those to the left of the red line in figure 3). Adopting a less didactic stance, covering less material, but in more student focussed ways, to achieve deeper understanding must be the aim. There must be concentration on encouraging the acquisition of threshold concepts and providing more opportunities for students to practise the skills and knowledge deployment which will be assessed.

It is these considerations which will guide me in my development of the next cycle and this time around I hope not to be 'flying by the seat of my pants'.

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BELFAST: Built Environment Law, *Flowing* Assessment.

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Abstract

The formal assessment process acts as an extrinsic motivator of learning in the Built Environment Law curriculum. The old adage "what gets measured gets done" applies. It is widely recognised by teachers in Higher Education (HE) in the U.K. that learning is more enjoyable and meaningful when motivation to learn is intrinsic and accords with Csikszentmihalyi's [1] 'flow' theory; yet the HE system requires formal assessment. Students focus on this assessment for the parameters of their learning. The purpose of the paper is to instigate a dialogue on assessment design for Built Environment Law through an examination of assessment practices, and to report on what works, in terms of promoting student learning whilst satisfying the demands of the HE system. The paper reviews key literature to construct a conceptual framework on why we assess, what we assess, and how to assess. It reports on a longitudinal study of the developing assessment design of an undergraduate Built Environment Law curriculum that focuses on construction contract law and administration, and a postgraduate Built Environment Law curriculum that focuses on legal studies for the construction Project Manager. The paper includes an examination of those factors external to the learning process that impinge on, and shape, assessment design. The prescriptions in the paper are informed by generic findings of data collected from interviews with academics on their constructions of assessment practices, and from focus group interviews with students on their attitudes to assessment. The conclusions highlight those things that create educational difficulties and argue that curriculum design for Built Environment Law, that incorporates only informal assessment with inherent flexibility and freedom, can promote intrinsic motivation to study and promote deeper student learning in this discipline.

Keywords: assessment, flow, motivation, learning, impingements.

1. Introduction

1.1 Background

This paper emanated from a larger study that I carried out to answer the research question: "What are academics' constructions of assessment practices?" The idea for the paper was instigated as a consequence of an in-house teaching and learning debate, in the School of the Built Environment, on student engagement and motivation in construction management subjects. There was a strong consensus that new thinking is required on teaching and assessment methods generally to motivate students to engage more deeply with their learning. It was put forward that textually based subjects, such as Built Environment Law, need particular attention because there is an increasing reluctance to read on the part of many students today. The purpose of the paper is to instigate a dialogue on assessment design for Built Environment Law through an examination of assessment practices, and to report on what works, and suggestions for enhancement, in terms of promoting student learning whilst satisfying the demands of the HE system.

1.2 Data sources

The paper was informed by the general findings of data collected from the larger study. These data were collected from interviews with academics on their constructions of assessment practices, and from focus group interviews with students on their attitudes to assessment. The data on the development of assessment strategies for Built Environment Law was collected from an ongoing longitudinal study of an undergraduate and a postgraduate module in the discipline. The interviews with academics consisted of three distinct stages:

1. The first stage formed the main body of data on which the study was based. This involved in-depth interviews with a sample of 16 academics in order to explore their constructions of assessment practice. The sample was drawn from two ‘different’ universities: one a long-established, red-brick, Russell Group university, and the other a modern university which had its roots as a former Polytechnic. These interviews were designed to be free-flowing with interview questions guided by a prepared interview guide which was used as an *aide-memoire* as opposed to a more strict question schedule designed to elicit responses related only to predetermined questions. On a scale of structured – unstructured interviews, these semi-structured interviews would fall towards the unstructured end of the scale. The rationale for this was to make the interviews more conversational with less stringent boundaries to give the interviewees more scope to introduce issues which would be of importance or significance to them and which otherwise might not have been catered for in an interview.

2. The second stage of the active research was carried out as an extension to, to check and inform this main body of data and to consolidate the findings from the initial 16 interviews. This second stage consisted of five further interviews with three academics from institution A and two from institution B.

3. The third stage consisted of interviews with a further nine academics, who, for pragmatic reasons, were from the Institution A. To effect data for comparison and to facilitate recording of responses in note form, a more structured and briefer approach was taken using a specified set of research questions to be investigated, based on issues which emerged from the initial interviews. The data thus collected were used for triangulation purposes to highlight any significant differences between, or additions to, what emerged from both the main, first stage interviews and the follow-up, more structured interviews.

2. ‘Flow’

The term ‘*Flow*’ as used in this paper, refers to the work of Dr. Mihalyi Csikszentmihalyi [1], a Hungarian-born painter and psychologist who gave the term ‘flow’ a new meaning in his 1990 publication. In an interview with Debold [2], Dr. Csikszentmihalyi explained ‘flow’ as follows:

> ‘*In the early seventies, I spoke with chess players, rock climbers, musicians, and inner-city basketball players, asking them to describe their experience when what they were doing was really going well. I really expected quite different stories to emerge. But the interviews seemed in many important ways to focus on the same quality of the experience. For instance, the fact that you were completely immersed in what you were doing, that the concentration was very high, that you knew what you had to do moment by moment, that you had very quick and precise feedback as to how well you were doing, and that you felt that your abilities were stretched but not overwhelmed by the opportunities for action. In other words, the challenges were in balance with the skills. And when those conditions were present, you began to forget all the things that bothered you in everyday life, forget the self as an entity separate from what was going on—you felt you were a part of something greater and you were just moving along with the logic of the activity. Everyone said that it was like being carried by a current, spontaneous, effortless like a flow. You also forget time and are not afraid of being out of control. You think you can control the situation if you need to. But it's hard because the challenges are hard. It feels effortless and yet it's extremely dependent on concentration and skill. So it's a paradoxical kind of condition where you feel that you are on a nice edge, between anxiety on the one hand and boredom on the other. You're just operating on this fine line where you can barely do what needs to be done… So "flow" seems to be a phenomenological state that is the same across cultures. What people do to get into that state varies enormously, but the experience itself is described in very similar ways.’*

Wikipedia [3] records that Csikszentmihalyi identifies the following as accompanying an experience of flow:

- *Clear goals* (expectations and rules are discernible and goals are attainable and align appropriately with one's skill set and abilities).
- *Concentrating and focusing*, a high degree of concentration on a limited field (a person engaged in the activity will have the opportunity to focus and to delve deeply into it).
- A *loss of the feeling of self-consciousness*, the merging of action and awareness.
- *Distorted sense of time*, one's subjective experience of time is altered.
- Direct and immediate *feedback* (successes and failures in the course of the activity are apparent, so that behavior can be adjusted as needed).
- *Balance between ability level and challenge* (the activity is neither too easy nor too difficult).
- A sense of personal *control* over the situation or activity.
- The activity is *intrinsically rewarding*, so there is an effortlessness of action.

- People become absorbed in their activity, and focus of awareness is narrowed down to the activity itself, *action awareness merging* (Csikszentmihalyi [4] p.72).
- Not all are needed for flow to be experienced.

With the rugby world cup taking place at the same period as the writing of this paper, there have been many references to players and teams ‘*being in the zone*’. I like to think that this is analogous to the flow experience. As a Built Environment academic, I would argue that our Built Environment assessment strategy should be constructed using a goal of transforming the learning experience into one that *gets students in the zone* and engenders the ‘state of flow’ during appropriate and significant learning episodes. Our aim should be establish assessment strategies that focus on instilling a deep learning approach by students so that students retain the requisite knowledge and study skills for their professional careers.

3. Conceptual Framework: why we assess, what we assess and how to assess.

Assessment of student learning in higher education is required to fulfil a multiplicity of purposes and play several different and, possibly, conflicting rôles. The same assessment task can be used in a formative way, in a diagnostic way and in a summative way in respect of the individual student learning. The outcomes of this assessment task can be, and are, also used, individually or collectively, as an evaluation of a module, a subject, a programme or an institution. The variety of purposes and rôles played by assessment of student learning in higher education influences the method and type of assessment used. It is proposed that the design, setting and marking of assessment should ensure that the utility of the key, central function of student assessment is not lost to these collateral purposes and rôles, and is properly dealt with.

The assessment of large student numbers in a semesterised system imposes a heavy burden on academics and the process of assessment can be tedious and slow. Assessment of student learning can become routine and mechanical and it is easy to lose sight of why assessment is necessary, what is being assessed and the best method(s) of doing so. Assessment is often perceived as a mechanism for *measuring* academic achievement. This concept of educational measurement suggests precision and accuracy. Kelly (in Blenkin & Kelly [5] p4) argues that:

> *‘Accuracy of assessment is related inversely to the complexity and the sophistication of what is being assessed. And, since education is a highly complex and sophisticated process, educational assessment can be regarded as measurement only in the remotest of metaphorical senses’.*

Although Blenkin’s and Kelly’s propositions, theories and arguments studies relate to early childhood education and compulsory education, it will be apparent from later chapters that they transfer quite easily to higher education.

Good assessment practice requires considerable thought, preparation and execution on the part of the academic. In today's climate of diminishing resources, the administrative demands made of academics and the requirements for achievement in the latest Research Assessment Exercise, a juggling of priorities is required of both the individual academic and of the institution. Assessment has to be effective and efficient and these two elements should be balanced. However, *if* assessment is viewed as a low priority, or low-status, activity, the weighting may move towards efficiency to the detriment of effectiveness. We need always to be careful that assessment does what it is supposed to do.

Kelly pulls together his propositions and argues in summary that:

> '*Educational assessment, therefore, must be recognised as being a highly imprecise activity at all but the most basic levels, and as being* ***judgemental*** *rather than* ***metric*** *in character, as requiring the making of sound professional* ***judgements*** *rather than of objective, mathematical* ***measurements****.'*
>
> (this author's bold font)

This dichotomous view of whether assessment is a measurement or a judgement or, indeed, a combination of these and, perhaps, other factors is debated in the literature without consensus but it seems that there is a place for both measurement and judgement. In arguing for a more ipsative approach to assessment, Kelly (P6) says:

> *'What is needed … is a recognition that assessment is of personal experience and not merely of individual progress, that it is a matter of judgement rather than of measurement, and that, as a consequence, the standards against which such judgements can best be made are those based on the characteristics and previous achievement of each pupil rather than those of his/her peers or those derived from some external and impersonal concept or definition either of particular subjects or of the educational process itself'.*

3.1 Why assess student learning?

The literature presents an array of the purposes of assessment of student learning in higher education. Two contributions follow:

1. The Quality Assurance Agency for Higher Education in its Code of Practice for the assessment of students [6] states that assessment serves many purposes and that assessment:

- Provides the basis for decisions on whether a student is ready to proceed, to qualify for an award or to demonstrate competence to practice.
- It enables students to obtain feedback on their learning and helps them to improve their performance.
- It enables staff to evaluate the effectiveness of their teaching.

2. Mutch and Brown [7], writing for the LTSN Generic Centre, agree with these set of purposes but expand them further under three categories of purposes of assessment of student learning, viz.: learning; certification and quality assurance. They expand on each of these as follows:

Learning

- To provide feedback to students to improve their learning
- To motivate students
- To diagnose a student's strengths and weaknesses
- To help students to develop their skills of self-assessment
- To provide a profile of what a student has learnt

Certification

- To pass or fail a student
- To grade or rank a student
- To licence to proceed
- To licence to practice
- To select for future courses
- To predict success in future courses
- To select for future employment
- To predict success in employment

Quality Assurance

- To provide feedback to lecturers on student learning
- To improve teaching
- To evaluate a course's strengths and weaknesses
- To assess the extent to which a programme has achieved its aims
- To judge the effectiveness of the learning environment
- To ensure the course is credit worthy to other institutions and employers
- To monitor standards over time

The reasons for assessment are multi-factorial and not solely focussed on the student learning activity.

3.2 What ought to be assessed?

Contemporary thinking in the literature evidences a shift in emphasis in defining learning in higher education away from the traditional accumulation of declarative, or propositional, decontextualised knowledge towards the notion of being competent and able to perform in preparation for the workplace. Work-based learning and problem-based learning have come to the fore in recent years as methods of learning in preparation for the workplace. Assessment too reflects this shift and contemporary thinking in the literature proposes the use of authentic assessment, e.g. Biggs [8], Torrance [9]. Higher education has seen a parallel shift in emphasis from teaching orientated curricula to learning orientated curricula by which is meant that the students now take more responsibility for their own learning. Indeed, Boud [10] (pp27-28), for example, argues that students should become independent of their teachers and should be expected to make decisions about what they learn and how they learn much more than they currently are. What ought to be assessed should be aligned with that which is defined and specified in the learning outcomes.

3.3 How should assessment be carried out?

The approaches to assessment can have a manipulative effect on student learning and it seems that the context of assessment and the beliefs and orientations of the teacher can influence assessment. Rowntree [11] makes the point that 'The teacher … must *plan* and *evaluate* his (*sic*) assessment methods in relation to the *purposes* he is pursuing' (italics in original). It is fundamentally important therefore that the focus is on the purpose of the assessment as defined by those responsible for the assessment. Heywood [12] (p58), arguing for multiple-strategy assessment, illustrates this point using Furneaux's criticism of engineering examinations in which it was identified that the examinations were all measuring the same thing. Rowntree [11] sets out conflicting modes of assessment in a way that provides a useful summary of the issues which should be considered by academics approaching assessment of student learning. These are:

- formal v informal
- formative v summative
- continuous v terminal
- course work v examination
- process v product
- internal v external
- convergent v divergent
- idiographic v nomothetic

To this list can be added from Biggs [8] (p166):Norm-referenced v criterion referenced (and to which could be added: v ipsative)

- Quantitative v qualitative
- Holistic v analytic
- Contextualised v decontextualised
- Teacher assessed v self/peer assessed
- Time constrained v not time constrained
- Invigilated v not invigilated

The link between learning and assessment and the effects of assessment on student learning and student approaches to learning need to be considered when making decisions about assessment and choosing appropriate assessment methods.

3.4 'Traditional' and 'Progressive' assessment.

The literature illustrates a variety of purposes and functions of assessment of student learning, but, although there is overlap, the literature distinguishes assessment as acting in two contexts. The first is assessment that emphasises its purpose and function as a mechanism for determining whether a student should proceed to the next stage of the course or whether the student should have an award conferred. In this case, assessment acts externally to the system of learning as an independent, auditing mechanism. I would refer to such assessment as assessment in the 'traditional' context, or traditional assessment. I would propose that significant features of traditional assessment are:

- The use of the measurement model of assessment in which norm-referencing predominates;
- The use of end of unit assessment methods, usually a time constrained, unseen, written examination with and/or without a choice of questions;
- Minimal use of formative assessment;
- Minimal feedback on formal assessment
- An emphasis on discipline-based propositional knowledge over general transferable, or key, skills

The second context is one in which assessment emphasises its purpose and function as a vehicle that shapes, drives and influences learning. In this context, assessment acts not only as an integral part of the system of learning but to a significant degree, the driving force behind what is learnt and how it is learnt. This second purpose is one that has been the subject of considerable research and opinion over the past couple of decades. It has many advocates and is being promoted through seminars and publications as the way forward in assessment. Assessment in this context differs from the first in that the concern is to do with clear statements of what the student should know and be able to do on completion of the module with methods of assessment designed to drive the learning towards these stated, intended learning outcomes. I would refer to such assessment as assessment in the 'progressive' context, or progressive assessment. I would propose that significant features of progressive assessment are:

- The use of the standards model of assessment in which criterion-referenced assessment predominates;
- The alignment of assessment and learning;
- An inclination towards continual assessment which is sequenced to match the curriculum programme;
- An emphasis on formative assessment;
- A high value placed on feedback;
- The use of authentic assessment by which the assessment task meets the learning objective and assessment is based on performance;
- The integration of general transferable skills with discipline-based propositional knowledge;
- A propensity to include self assessment and peer assessment during the module;
- An inclination towards different modes of assessment.

How assessment should be carried out is driven by the requirement to have as an outcome of the teaching, learning and assessment regime, a number representing academic attainment. The reliability and validity of this number depends on:

1. Whether the assessment is intended to be descriptive, metric, judgmental or a combination of these determinants, and
2. The orientation to assessment of the academic in terms of whether the academic's beliefs are 'teaching-centred' or 'learning-centred.

The prescriptions in the literature recognise that the approach to assessment should relate directly to the purposes of assessment and that appropriate valid and reliable assessment methods are used to achieve this relationship. The practice of assessment may be influenced by the academics' orientations to assessment practice and their beliefs about assessment and its relationship with learning approaches. The type of assessment used is dependent upon the purpose or purposes of the assessment and appropriate methods should be utilised to achieve this purpose or these purposes.

4. Factors that impinge on, and shape, the assessment process.

I would argue that assessment is impinged upon and shaped by factors external to the students learning process and, as a consequence, assessment is a compromise and because of this the learning experience is likewise compromised. Figure 1 illustrates a theory through an analogy of a journey to propose that students' learning, by whatever means, and its assessment should travel smoothly together and in parallel on a learning highway to arrive at a destination of pre-determined learning outcomes with no hold-ups. However, the higher education system creates hold-ups on this learning highway by impinging on it with a variety of barriers. To optimise student learning in Built Environment education, we need to remove these barriers to maintain an effective and efficient learning highway.

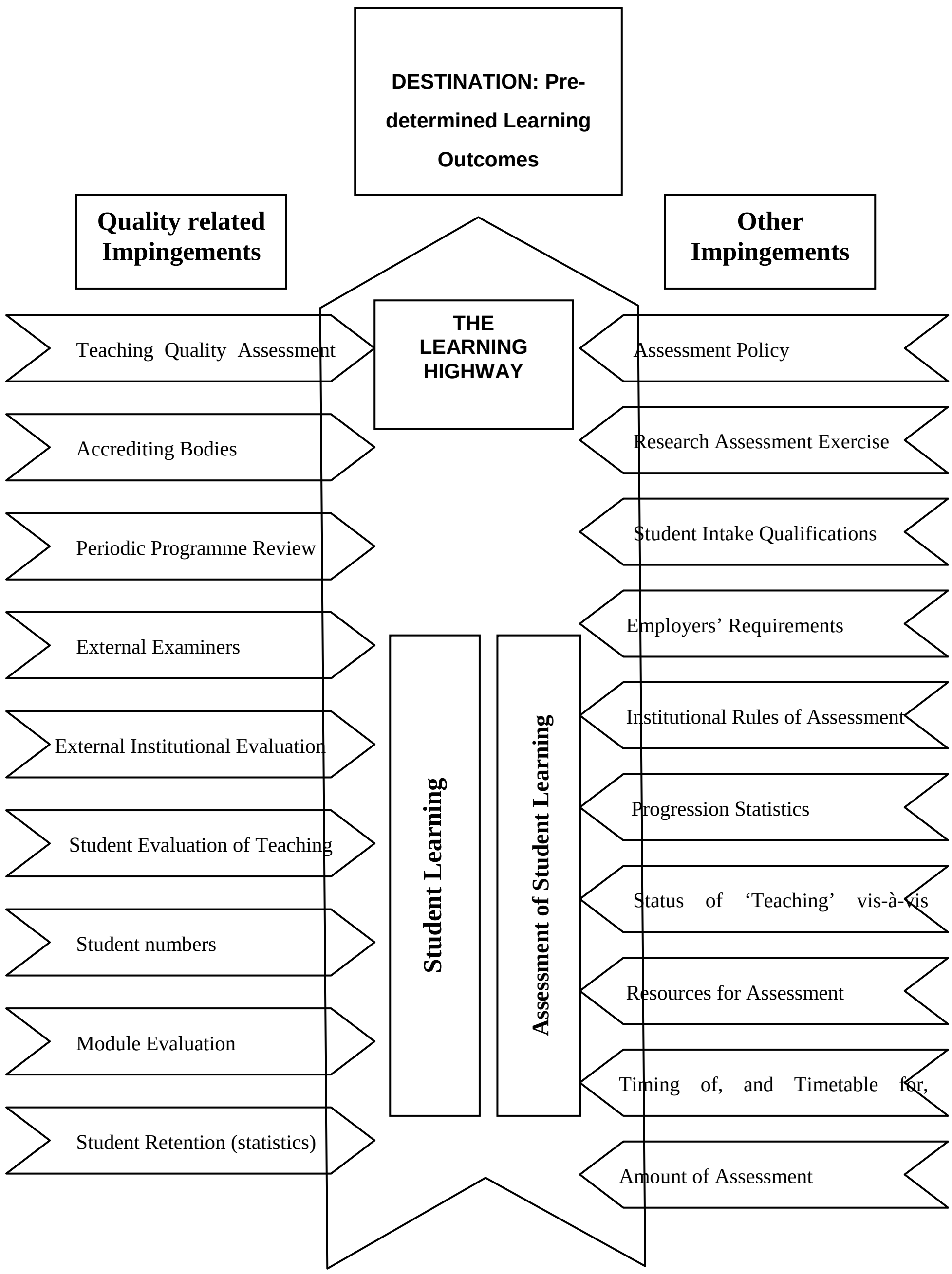

Figure 1- Learning Impingements

5. Longitudinal study of developing assessment design for Built Environment Law

The development of assessment of Built Environment Law over the past ten years has been the subject of monitoring research using an undergraduate module and a postgraduate module. This section reports briefly on the changes and developments of these two modules. The rationale for these changes emanated from a study and presentation by McLernon *et al* [14] in which was coined the term 'disguised learning' to describe a means by which students acquire particular knowledge from carrying out a task not expressly related to that knowledge.

5.1 The undergraduate curriculum

Ten years ago, this module was assessed using ‘traditional’ methods of one essay of two thousand words and an end-of-module, unseen written examination that required the student to answer five questions from an eight-question examination paper. This assessment regime had worked reasonably well up to that point because the module had smaller student groups that benefited from more class contact time and in-class dialogue than subsequently. Owing to the significant changes in student traits and in the higher education system, students were found not to be sufficiently engaged in their studies. The assessment strategy was revised to require the student to engage continuously with their studies and to incorporate employers’ requirements for students to have better presentation and communication skills. The assessment regime developed into the format below:

Assmt	Handout date	Description	Weighting	**Latest** Submission Date
1	Week 1	Semester Paper 1	15%	Week 5
2	Week 1	Semester Paper 2	15%	Week 10
3	Week 1	Reflective Log	10%	Weekly, 1 – 13
4	Week 1	Final Case Study	30%	Week 13
5	Week 1	Construction Contract	10%	Week 6 (in class)
6	Week 1	Duo Seminar Presentation	10 %	As Seminar Prog.
7	Week 1	Individual Sem Presentation	10 %	As Seminar Prog.

Whilst this has worked well, a pilot change has been introduced this year in an attempt to engender more of a **flow experience** into the learning. In essence, the Case Study has been replaced by an assignment which runs in parallel with the module over its duration and which requires students to be creative. Students were given the following initial instructions:

> ‘You are Contracts Manager for a large construction company. You have been asked by the Contracts Director to prepare a training manual for junior staff in the company, ***who have absolutely no knowledge of Law or construction contracts***, on the Law of Tort, the Law of Contract and The Standard Building Contract 2005 Edition with an emphasis on the ‘With Quantities’ version. The design of the manual is left completely to yourself.’

This approach will be evaluated using qualitative feedback from students and student results.

5.2 The postgraduate curriculum

The assessment regime that has worked on a postgraduate module entitled ‘Construction Legal Studies’ has been one that is problem-based and continual. Two years ago, a pilot assessment strategy was introduced to instil in students an element of individual creativity with the aim of making the learning experience more enjoyable through a trial means of encouraging the flow experience to happen during the students' studies. The key aspect of the specification for this assignment directed students as follows:

> ' This assignment requires you to carry out a short research exercise on a legal matter associated with the management of a construction project. The final product should be an A1 size poster, which explains your study, illustrates the research design and research method(s), and shows your findings and the conclusions reached.'

The evaluation of this approach did not find any significant improvement in the student marks for the module. However, the qualitative feedback from the students, on completion of the module, demonstrates that the students liked doing the assignment and learned a lot about the subject through this method of illustration and presentation. The pilot will continue for at least another academic year.

6. Conclusions

Built Environment Law is a vital component of the body of knowledge needed by the construction professional to operate successfully in the commercial world of construction. Those things that create educational difficulties by interfering with the pedagogy and smooth implementation of proven educational practices should be removed from the curriculum delivery. The goal of deep learning is more likely to occur if students are motivated to learn and enjoy their studies. Students need an enjoyable incentive to engage deeply with textual studies such as Built Environment Law. An assessment strategy and regime which encompasses the theory of 'flow', which has an element of informality, and which focuses on the optimal attainment of the pre-determined learning outcomes, goes some way towards the achievement of this goal.

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Injecting Real-Life Law into Construction Education Role-playing in Group Projects

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Abstract

Practical applications of principles of law are common in the construction industry. Thus students of construction project management need to acquire relevant basic legal knowledge and practical skills for solving problems with legal implications that they may encounter. Yet, traditional lectures and tutorials still seem to dominate preferred methods for teaching law in construction education at many universities. With the emerging experience gained from the development of legal education, a variety of methods have been experimented with, to facilitate the uptake of legal knowledge and their practice in real-life problem scenarios. One of these is through role-playing.

The University of Hong Kong used role-playing in a group project in a postgraduate course on construction contract claims, for developing an authentic type of learning experience. This paper reviews the above, along with other experiences, such as in mock mediations, as well as in role-playing in non-legal courses. Comparing with traditional teaching methods, this paper illustrates how role-playing can be better used in a group project for enhancing the effective learning of law in construction education. In addition, it also highlights some tested approaches to providing feedback and conducting more reasonable assessments of individual students within such group activities that have proved effective at The University of Singapore. Through this paper, it is expected to share useful examples with other construction educators as well, with a view to enhancing the learning processes and outcomes in our field.

Keywords: Legal Education; Construction Education; Role-Playing; Group Project; Assessment

1. Teaching Laws to Construction Professionals and Students

Construction professionals need to handle much more application of laws now than previously. The regulations on affecting construction professionals are building up [i]; expectations from the society and clients are becoming more and more demanding [ii]; the responsibilities and liabilities on construction professionals are expanding [iii].

The increasing numbers and success of combined engineering and law undergraduate and postgraduate programmes [iv] at universities around the world also evidences a growing awareness among the construction educators, the students and the professionals of the importance to learn and be able to apply legal knowledge in the daily situations that construction professionals need to handle. Yet, teaching laws is challenging in itself. Teaching laws to construction professionals and students [v] can be even more challenging in view of the usual limited time assigned in such programmes [vi], the scope and depth of the topics to cover, and, in many cases, the limited exposure to legal education of construction professionals and students during their prior training.

Construction problems usually call for solution by a combined and balanced use of technical knowledge, management skills and legal principles. Doing this can of itself be complicated. Teaching does not make this easier. Hence, how best to deliver a course that can bring about interactions among the technical, management and legal knowledge and considerations as applied in the construction field in solving and handling the daily problems that construction professions encounter or will encounter is a real-life challenge to most construction educators.

2. Conventional Methods

Like many other countries, lectures are one of the overwhelmingly used methods for primary delivery of course materials for teaching law in undergraduate courses in the built environment in Hong Kong. Similar observations, for example, are made in relation to the learning methods for law in undergraduate courses in construction management and surveying in United Kingdom [vii].

Lectures are helpful in providing the ‘know-how’ and ‘know-why’ on a topic. Apart from delivering knowledge, experience shows that lectures are good to establish the broad outlines of a body of materials and to cultivate students’ interest in a topic or perspective that is relatively new to them. Lectures are also good if the topics to be covered are under heavy time constraints. In an industry like construction, the use of guest lectures can provide favorable results in providing a new way for the students to see and to understand the real-life implementation of theories. There can even be a continuum of format in which lectures are delivered, from a completely one-way scripted mode to a highly interactive mode.

However, effective learning is a highly cognitive activity in which students can engage the task appropriately, meaningfully seeking understanding [viii]. It has also been suggested that, from the students' perspectives, students learn 10% of what they read; 20% of what they hear; 30% of what they see; 50% of what they see and hear; 60% of what they write; 70% of what they discuss; and 80% of what they experience [ix]. For teaching 'soft' skills, it has been recognised that conventional teaching styles such as lectures and seminars alone are not always appropriate [x].

3. Role-Playing as a Learning Tool

In the education and training context, role-playing is a structured, target-oriented technique that uses the acting out of a part in a specified context to give participants a hands-on opportunity to apply knowledge and skills in a classroom setting. Role-playing is an approach for intensifying and accelerating learning. Also, one aspect of role-playing is that of diagnosis or assessment, and a test of how a person would act when placed in an imagined or pretend problematic situation.

Role-playing in education has been gaining popularity with recognition of the benefits that it can bring via combining the use of problem-based learning and collaborative learning principles. It has been engaged, for example, to teach educators [xi], nurses [xii], and government officials [xiii]. Role-playing has been particularly applied to teach courses with a focus on 'soft' skills, like communications, management, planning, problem-solving [xiv], but it is also used in a much wider context in education, teaching in history [xv] , economics [xvi] and even law-making [xvii].

In the context of legal education, role-playing has been widely adopted in the teaching and assessing of advocacy skills in post-graduate courses and professional training of lawyers[xviii]. As regards alternative dispute resolution methods, role-playing is almost universally engaged in the training and accreditation of mediators [xix]; in relation to negotiation skills, role-playing is customarily used for adult or post-graduate learning [xx].

So, why is role-playing so broadly accepted almost everywhere? There are certainly various positive aspects of role-playing. It enables the immediate application of knowledge and skills learnt; it allows the safe and structured practice of knowledge and skills gained and to obtain feedback; both its use and content can be flexible to suit the education needs; and it further offers the opportunity to learn from others, whether as a role-player or observer [xxi]. In relation to learning of 'soft' skills, such as problem-solving, critical thinking or presentation, role-playing has several other benefits. First, it encourages hands-on training, putting students into real-life situations and encouraging more effective application of knowledge, when compared with handouts, lectures or videos. Second, when performed in a group, it helps delivering brainstorming and developing teamwork skills, by students watching and participating in the role-playing sessions. Third, it enables students to approach problems from various perspectives, by the exchange of different points of views, such as from the employer, the architect, the engineer, the surveyor, the contractor and the subcontractor. Fourth, by allowing practices, it provides confidence to students for dealing with similar situations in their real-life work. And, fifth, it can be organised quickly, done inexpensively, performed almost everywhere, operated with very few training materials.

Thus, when properly designed, role-playing is an effective learning method, particular, for adult education since, with the working experience of participants, it enhances learning retention, provides hands-on training and, enables teamwork and communication. Above all, role-playing can also be fun.

Traditional use of role-playing goes through 3 stages --- briefing, role-playing and debriefing, depending on the goals and logistics. The design of a role-playing usually requires students to be briefed either on the situation or by written instructions. At the briefing stage, there is usually a set of common facts to kick off and individual role be may be given the ‘for-their-eyes-only’ additional facts for helping to bring out the problems to solve. Briefing to observing students may be different, for instance, by assigning a list of questions for them to observe and comment. When role-playing is staged, there will be more effective and productive learning by keeping everyone on their assigned roles. The role-playing process can be video-taped for reflective reviews and discussions. It is extremely important that students are debriefed after the role-play has been run. It is preferable to do this immediately following the role-playing is completed, while the verbal interactions are fresh in everyone’s memory. During the debriefing, the focus is placed more on learning by the class as a whole and elements of good practice or bad examples can both be utilized for learning during the discussion. In role-playing for teaching ‘soft’ skills, it may be a good idea for there to be a demonstration and for an opportunity for the students to do it again after the reviews to reinforce on the spot improvements.

4. Experience Sharing

The University of Hong Kong has used role-playing in a group project in a course [xxii] of its postgraduate programme [xxiii] for developing an authentic type of learning experience for construction professionals.

The role-playing group project formed part of the assignment and assessment of the students. The question was modeled on real cases, to stage typical disputes between the employer and the contractor in construction contracts, arguing over the four areas of extension of time, liquidated damages, valuation and payments. These were contained in four self-standing questions to be answered. The role-playing group project took the format of a group presentation. There were some 50 students in the course and they were divided into 8 groups. Each group was assigned to answer one of the four questions but from either the perspectives of the employer or the contractor. Hence, the question for each group was different, either in substantial issues or in perspectives. The group presentation was followed with question and answer sessions from the instructors and peer students from other groups. Each student was also required to submit an individual report, but covering the answers to all of the four questions. As to assessment, each student was given a group mark to represent the quality and substance of the group presentation, an individual mark to show his or her own performance during the question and answer sessions when propped with questions from the instructors and other students, and an individual mark for the written report on the overall answers to the four questions. During the presentation, questions were particularly invited from the students who were answering the same question but from the opposite perspectives and points or reasoning made in the presentation by the opposite group were put to the presenting group for responses and comments [xxiv]. The answers to the questions called for a critical analysis of the facts and the application of the relevant legal principles to the facts. The merits of the case of each side were factually sensitive and assumptions made could have the effects of changing the outcome all together. This was indeed the purpose in the design, with a view to helping students to be aware of the need to investigate these factors and their impacts in the real world.

The students all showed keen interests in participation, both in the preparation of the group presentation and during the question and answer sessions. The presentation indicated that many groups had carried out much more in-depth research for legal arguments than were provided for in the lectures or handouts. Exchange was particularly heated when questions or responses were made or given from the opposite groups answers to the same questions. Most of the students were so ‘in’ their roles and treated the presentation seriously. These seemed to benefit all by brining out all potential arguments for or against an issue for full discussion during the debriefing. There were of course some shortcomings in that students might take the case too personally. Some of the students looked for ways to defend their employer/contractor position by taking up too much of the roles of an advocate; some talked about using other commercial pressure (perhaps as inherited from their jobs) to ‘help’ the opposite side coming to terms with them; some even went a long way to invent new facts into the role-playing scenario to help their arguments. On the other hand, there were also some who gave away their employer/contractor position too easily by agreeing with some invented facts by the opposite group, which of course were adverse to their case. All of these were pointed out during the debriefing for the questions, and were made use of as a learning example from the converse point of views.

The overall feedback from the students on the course was quite positive, though there were some remarks on whether the role-playing group project was a bit too demanding in terms of resources required to be put in.

Apart from using group role-playing at the post-graduate programme, the University of Hong Kong has also recently engaged this model in a course [xxv] at the undergraduate programme of B.Eng in Civil Engineering (Law) [xxvi]. The focus of the learning was on design presentation and communication skills. This time, it concerned two groups of 3 students. They were given a factual scenario of an extension of time and liquidated damages disputes between an employer and a contractor. The groups were required to act an expert witness and prepare an expert report for the employer and the contractor respectively. Each group was required to prepare a fee proposal and inception report, an interim report and oral presentation, and a final report and presentation. At each stage, each student was marked and the overall marks formed the student’s result of the course. To make it more realistic, the two groups were asked to exchange the draft of their final reports so that response and comments to the opposite side’s report could be prepared during the final oral presentation. Again, positive feedback was received from the students who still talked to the instructors about the case and their presentations even a couple of months afterwards.

Another example of beneficial group work and role-play is seen in the course on ‘Engineering Design & Communication’ at the Department of Civil Engineering under the general B.Eng. in Civil Engineering [xxvii]. This involves problem-based-learning where synergistic group work leads to better results. Second years students were assigned in groups of around six to real-life problems from multi-discipline perspectives such as feasibility studies for a potential development for, say, sports stadium, cruise terminal, district-wide cooling system, centralised automated refuse collection system or multi-purpose culture centre. Students in the group would each take up the roles such as ‘architect’, ‘structural engineer’, ‘quantity surveyor’, ‘environmental engineer’, ‘geotechnical engineer’ or professional in other disciplines as needed for the assignment, thereby modeling the work life of a multi-disciplinary consultancy company. Similar to the above, they were required to prepare reports and make presentations to the client (role-played by the academic and industrial instructors).

In another example, year three civil engineering undergraduates are assigned in the groups of eight that include students from the architectural and building services engineering undergraduates to foster an even more real-life inter-disciplinary design project. Judging from feedback, group projects of this sort were welcomed by the students and the valuable learning outcomes were demonstrated by their high quality outcomes.

Role-playing in group projects of this type enables participating students to gain first-hand experiences of the pleasures and pains of working with other disciplines and help aligning their approaches to a project from more than one perspective. The common wish for completing a good project in time also assists the development of team building and co-operating skills.

5. Evaluating Groupwork More Realistically

The experience in Singapore may also provide further thoughts and options in the design of assessments for group projects. Apart from the traditional assessment by the instructors, there were two further initiatives adopted by a course leader at the National University of Singapore --- getting students to evaluate their group-mates and getting students to evaluate their peers’ performance [xxviii].

In group projects, it is not always easy to accurately assess the individual’s contribution to the overall output. One of the chief difficulties is the problem of identifying, or indeed discouraging, ‘free riders’ or ‘social parasites’ [xxix]. They get through the project abusing the extra efforts put in by other group members. Spotting these is not always easy, particularly when the output is represented by a mere report. By getting students to evaluate their group-mates and telling students up-front about this, it can help discourage, if not weed out, such free riders. For effectiveness, maintaining confidentiality in the evaluation by each individual student is preferable. This method can be summarized as getting a student’s own group mates to evaluate his/her performance during the *process* of preparing group project work.

Another method is to get students to evaluate their peers' *output* performance. This entails getting students in parallel groups to evaluate the performance of the group of students who are presenting their project *output* to the class. In order to make peer evaluation meaningful and motivating for student-evaluators, the marks awarded by them account for a significant portion of the student-presenter's continuous assessment marks, and the student-evaluators are given marks for making an objective evaluation. In order to give an accurate evaluation, student-evaluators not only have to read up on the presentation topics prior to the presentation, but they also need to listen attentively to the presenters during the presentations. Students acquire the ability to think critically and evaluate information objectively. As student-evaluators will only score marks if their ratings are within the specified range from the instructor's, they have to think critically, learn to respect other people's ideas and make sure that their evaluations are not affected by leniency or their own biasness. Students who are presenting need to defend their work and 'sell' their ideas; and through this process learn communication skills.

6. Conclusions

Experience in Hong Kong, Singapore and other locations show that role-playing helps in injecting real-life law into the study of construction project management, a subject that calls for the combination of technical, management and legal knowledge in practical applications to situations common in the construction industry. With proper design and sample innovation, role-playing using real-life problem scenarios can readily be adopted and be utilized as a 'learning-effective', interest provoking and initiatives motivating tool for teaching and assessing students in the legal education of construction professionals and students.

This paper provides a review of the experience in relation to the above and some suggestions and feedback on how role-playing, as an education tool, can be better used in a group project for enhancing the effective learning of law in construction education, with a view to enhancing the learning processes and outcomes.

References

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[i] See, for illustration, the recently revised Construction (Design and Management) (CDM) Regulations 2007 in UK.

[ii] For instance, the common use of adjudication and mediation calls for more realistic assessment of the legal strength and weakness at the project team level for bringing about a meaningful decision or settlement.

[iii] See, for example, the case of *Merrett v. Babb* [2001] QB 1174, where a surveyor was held personally liable for negligent misstatement in a report he signed for his employer.

[iv] See, for example, the M.Sc. in Construction Law and Dispute Resolution run by King's College London, also extended to a joint course in Singapore, and the B.Eng in Civil

Engineering (Law) programme recently launched at the University of Hong Kong. See also Ng, J. (1997) *Should Law be Introduced into the Engineering Curriculum*, International Journal of Engineering Education Vol. 13, No.1, pp.72-78.

[v] Here is meant to include engineers, architects, surveyors and project managers.

[vi] It is to recognise that the goal of the programme may be different, depending on factors like whether being undergraduate or postgraduate programme.

[vii] See Hutchinson, K. (2005) *Working Paper 8: Content, Learning Methods and Assessment of Law on Undergraduate Course in Construction Management and Surveying*, published by the Centre for Education in the Built Environment.

[viii] Oloke, D., Yu, H. & Heesom, D. (2007) *Developing Practitioner Skills in Construction Health and Safety Management: An Integrated Teaching and Learning Approach*, Journal for Education in the Built Environment, Vol. 2, Issue 1, June 2007 pp. 3-30 (28).

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[x] See Truscheit, A. & Otte, C. (2004) *Sustainable Games People Play Teaching Sustainability Skills with the Aid of the Role-play 'NordWestPower'* GMI Winter 2004/2004 48 pp.51-56.

[xi]See, for example, Robinson, L. & Kelly, B. (2007) *Developing Reflective Thought in Preservice Educators: Utilizing Role-Plays and Digital Video*, Journal of Special Education Technology, Norman, Vol.22 Issue 2, pp.31-43.

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[xiii]See, for example, Anonymous (1997) *Playing with Ethics*, Government Executive, Washington: Dec 1997, Vol.29, Issue 12, p.6.

[xiv]See, for example, Al-Shammari, M. (2005) *Assessing the Learning experience in a business process re-engineering (BPR) Course at the University of Bahrain*, Business Process Management Journal Vol.11 No.1 2005 pp.47-62.

[xv]See, for example, Tuovinen, T. (2003) *Role Playing Games as a Method of Teaching History*, University of Tampere (http://www.uta.fi/laitokset/okl/tokl/projektit/kaksoistutkinto/pdf/tuomo_tuovinen_proseminaari.pdf).

[xvi] See, for example, the University of Melbourne website at http://www.economics.unimelb.edu.au/SITE/TLdevelopment/roleplay.shtml.

[xvii]See, for example, the Australian Parliamentary Education Office website at http://www.peo.gov.au/teachers/index.html.

[xviii]For example, the advocacy training in the Post-graduate Certificate in Laws in the University of Hong Kong requires students to act as advocates in various applications using modified real-life materials for both learning and assessment purposes. This approach is also adopted in training of practising lawyers. Further details can be found in the website of, for example, the Australian Advocacy Institute at http://www.advocacy.com.au/aaimenu.htm.

[xix]See, for example, the UK Centre for Effective Dispute Resolution at http://www.cedr.co.uk/training/approach/.

[xx]See, for example, the negotiation course in the MBA programme run by the Dispute Resolution Centre of the Massey University, New Zealand.

[xxi]El-Shamy, S. (2005) *Role Play Made Easy: 25 Structured Rehearsals for Managing Problem Situations and Dealing with Difficult People*, Pfeiffer, Wiley.

[xxii]This is the course of Rights and Liabilities in Construction Contracts.

[xxiii]This is the M.Sc.(Eng) programme at the Department of Civil Engineering.

[xxiv]For example, when, say Groups 1 and 2 were responsible for Question 1 respectively from the perspectives of the employer and the contractor, students of Group 2 would be invited to question the reasoning and analysis of Group 1 after its presentation, and vice versa; and the reasoning of Group 1 would also be put to Group 2 for response during the presentation by Group 2.

[xxv]This is the course on ‘Engineering Design & Communication’.

[xxvi]For more details of the programme, see http://www.hku.hk/civil/h1c.htm.

[xxvii]This is used here, for convenience, to include also those students studying in the B.Eng. in Civil Engineering (Environmental Engineering) programme.

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SECTION XII

DESIGN

Design Management System with Collaboration for Curtain Wall Design Work

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Abstract

The finishing process in any construction project is very important that it takes up over 40% of the whole project. In particular, the outer walls of a high-rise building in the finishing process are often completed through the Curtain Wall method. There is a diverse range of materials and specifications regarding the Curtain Wall method, requiring a close decision-making process between the owner and the designer even in the initial stage of design.

However, the designer is often provided with only architectural design elements in the design-making process and the information on basic specifications of the Curtain Wall, and lacks detailed technical information on Curtain Wall and experience in its specifications.

Such a lack of information and experience often prevents the designer from acquiring the know-how and detailed information on Curtain Wall specifications even after the design documents stage, which often causes the Curtain Wall to be redesigned and follow-up repairs on defects in the latter stages of construction. Therefore, in this study, we aim to establish a product model for Curtain Wall information management with which participants in its design—the designer and Curtain Wall engineer/technician—can share in the decision-making process and design information with one another. The proposed model is a preliminary study for the establishment of a design management system that allows the parties involved in the design to determine the

information flow and conduct a continuous and consistent management in the decision-making process. In this study, we investigated the theoretical concept of collaborative design management system.

Keywords: Curtain Wall, Product Model, Collaborative Management, Design Management System

Background and Goal

The Curtain Wall design process can be divided into two stages: the basic design stage, which is conducted at an architectural design office, and the actual design stage, which is drawn just before the construction and is conducted by a Curtain Wall specialist.

From the process of the basic design stage to the actual design stage, the Curtain Wall design can often be executed by merely focusing on the results, and certain elements such as performance, specifications, and standards are overlooked. Moreover, the unidirectional flow of the decision-making process involved in the design of the Curtain Wall, in which the decision-making process in the latter stage is often overlooked, makes it difficult for parties formulating the design to communicate with one another.

Particularly, the design of the Curtain Wall design, which is conducted in the initial stage of an architectural process, fails to consider the aspect of engineering technology, a Curtain Wall specialist contracted for the actual construction process often have to revise the design or change the specifications, which causes a significant delay in the construction schedule. All of these may lead to insolvent design management of the Curtain Wall and other consequent problems.

Therefore, in this study, we aim at establishing a product model for Curtain Wall information management with which the parties involved in the design—the designer and Curtain Wall engineer/technician—can share and collaborate in the decision-making process by considering in advance the issues in the actual design stage before the Curtain Wall construction.

Research Scope and Process

In order to establish a system in which the architectural designer and the Curtain Wall specialist can collaborate in both the basic design stage and the actual Curtain Wall design stage in the finishing process of a building, we propose a product model for the establishment of a system model and database. The proposed information management product model, which is a preliminary study for establishing the proposed system, allows each party in the design stage to share design information and collaborate in the decision-making process. In this study, we implemented the following methodologies:

(1) performing a theoretical investigation on the collaborate ground for the Curtain Wall design management;

(2) performing a theoretical investigation on the concept of *Problem Alternative Solution*;

(3) establishing a Curtain Wall information model based on the concept of *Problem Alternative Solution* for sharing engineering information and performance D/B in the design stage;

(4) analyzing Curtain Wall design management information; and

(5) proposing a product model using the information created, referred to, and discussed in the Curtain Wall design process based on the analytical results and *Problem Alternative Solution*.

Theoretical Review

1.1 Collaboration in the Architectural Design Stage

Collaboration is a broad concept,[1)] and includes judgment, decision-making, dialogue, and feedback after a decision has been made. Terminology such as collaboration should be considered essential when managing curtain wall work for a high-rise building, which has complex processes that require many participants to communicate with one another frequently.

Therefore, in order to support the active information sharing and decision-making of various participants, such as an architect, a designer, a consultant, and an owner, we analyzed information exchange systems related to design management and collaboration system-building, based on a review of previous studies. The results are shown below.

Since there are many choices to be made in the design stage, a smooth decision-making system and collaboration-based technologies that allow participants to intelligently save and share design information are required to implement the final design choice selected from among the alternatives.

In their early stages, collaboration systems were restrictively used within individual companies via an intranet, for the purposes of database-building and integration of information. However, the idea of collaborative design was not fully utilized or established due to the way work was done in the domestic construction industry prior the early 1990s. As well, there were restrictions in terms of support for communication between participants due to technological constraints.

Since the rapid spread of the Internet in the late 1990s, multiple studies on collaboration systems have been conducted. Moreover, "network-related" functions have been added to CAD

[1] Lee Seong-ryong, "A Review on A Collaborative System, The Korea Operations and Management Science Society, 2003

programs, which make it possible for people to conduct design via the Internet[2]. As a result, many studies on professional systems and information integration systems related with these have actively conducted.

Considering not only domestic but also overseas research trends, studies on collaboration-based design can be largely classified as relating to information management to integrate design information, and support decision-making by each participant. Concept of Problem Alternative Solution

The Problem Alternative Solution is the concept of improving linkage between the existing PMIS (Project Management Information System) and the KMS (Knowledge Management System), to support decision-making in the project being implemented. The PAS derives the optimal solution from the diversity of alternatives suggested, in order to solve the problems that arise during the process of decision-making. Based on the personal knowledge and experience of each participant, the alternatives provided to solve the problems refer to historical data, such as existing similar cases and related literature, in order to create and deliver internal information from each participant, which other participants can use to make the optimal decision. In this way, each participant can accumulate more knowledge and experience, by obtaining knowledge from conventional similar cases and references, in the process of making the optimal decision. Fig. 1 is a diagram of the concept of the information model, based on the Problem Alternative Solution.

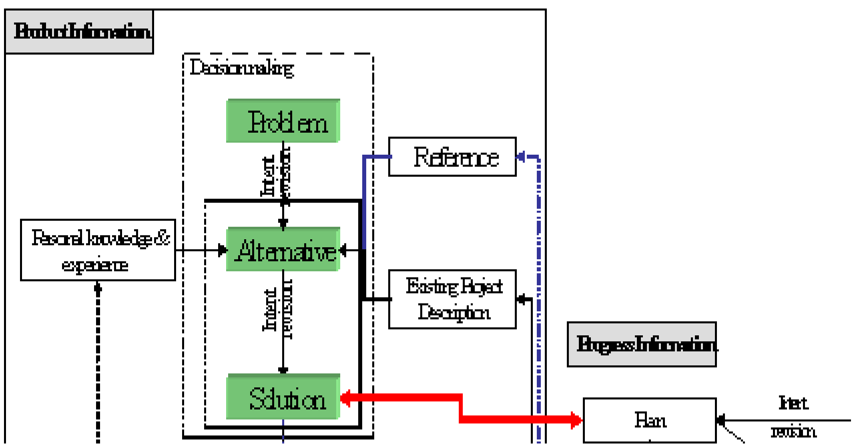

Figure 1: The concept of the Problem Alternative Solution-based information model

Curtain-wall Design Decision Making based on Problem Alternative Solution

2 Lee Myeong-sik, “The Web-based Collaboration System Building Plan for Small- and Medium-sized Architecture Design Offices,” Proceedings of Industrial Technologies of Dongguk University, 2003

The decision making process in relation to the curtain wall can be divided into the curtain wall design standard and the resistant and specification of materials. The curtain wall design standard

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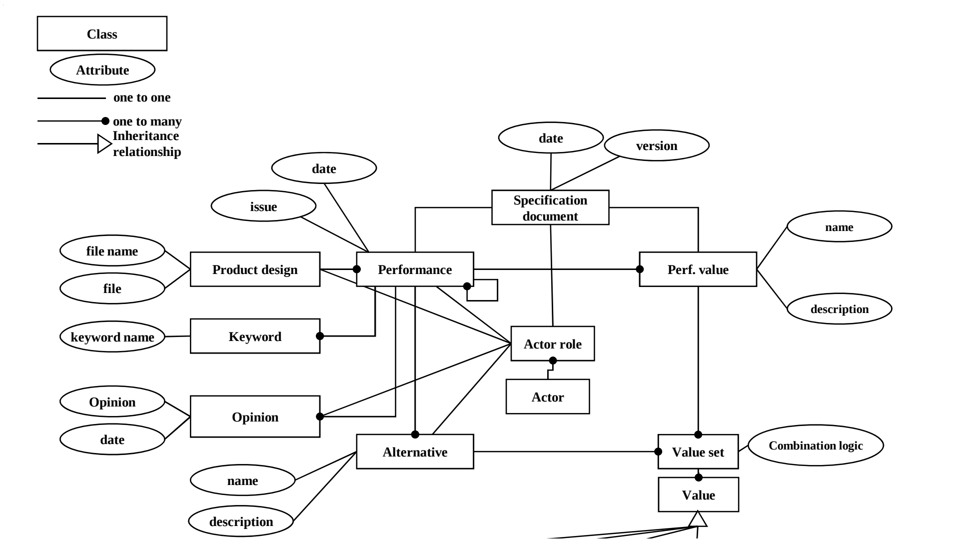

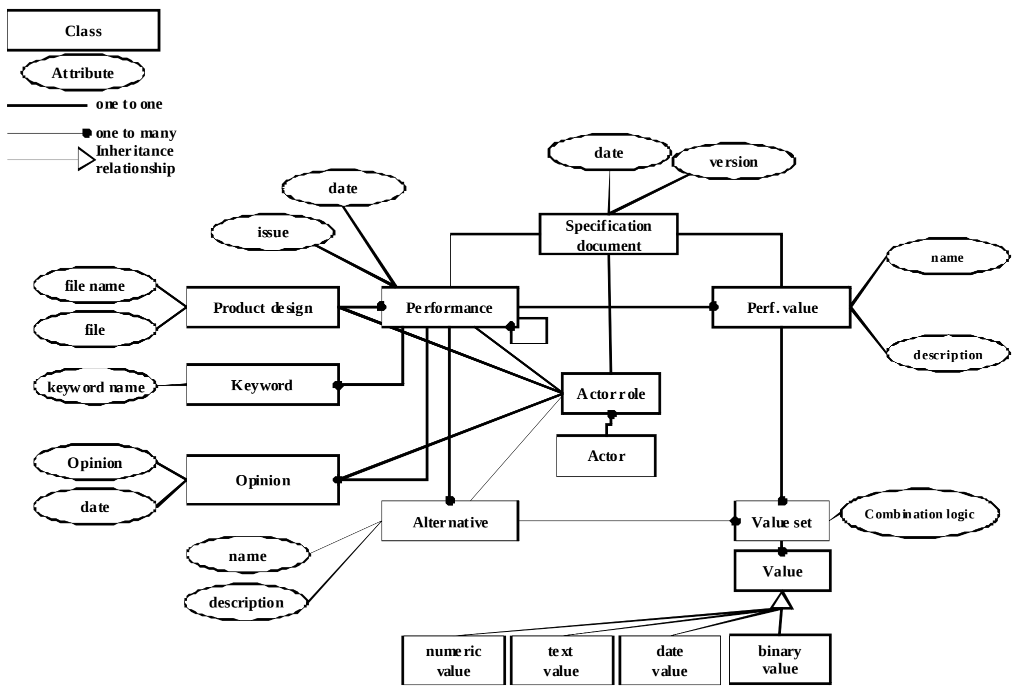

Figure 2: The Problem Alternative Solution-based information modeling of resistant information

Analysis of the curtain wall product information

1.2 Considerations in Decision Making for the Curtain Wall Performance

This chapter discusses the main decisions to be made related to characteristics of the curtain wall by each participant in the curtain wall design stage based on the curtain wall process model and influential factors on decision making.

Of all the characteristics of the curtain wall, the characteristics that affect the whole building design and the curtain wall design are found as wind pressure, air infiltration, water penetration, sound insulation, thermal insulation, moisture condensation proof, fire resistance, seismic-resisting and smoke characteristics. In calculating the wind pressure, the calculation method recommended by the KS(Korea Standard) takes the region and conditions into consideration, but there are no Standards for other items, or although there is KS for them, people are using the ASTM (American Society of Testing Materials,) AAMA (American Manufacturers Association), and JIS (Japanese Industrial Standards) as shown in Table 4 in order to supplement the KS Standard due to its ambiguity and omissions. There are many factors to be considered in decision making for material resistant. Table 1 show the factors to be considered.

Table 1: Main factors to be considered & Technical requirements for decision making for design Standard

Item	Considerations & Standards
Wind pressure	◆ Taken into consideration in calculation ◆ Whether there is zoning or not
Air infiltration	□ KS Standard(ASTM)
Water penetration	□ KS Standard(ASTM)
Sound insulation	□ KS Standard
Thermal insulation	□ KS Standard(AAMA Standard)
Moisture condensation proof	□ AAMA Standard
Fire resistance	◆ Under the article 2.8 of the Architecture Law ◆ Notification No. 528 announced by the Ministry of Construction
Seismic-resisting	□ AAMA Standard
Smoke characteristics	□ Enforcement Ordinance, Article 35.2 and Enforcement Regulation No. 20

1.3 Curtain Wall Product Information Model

The curtain wall information consists of the standard specification, particular specification, materials to be used, design standard, the curtain wall time, a variety of documents and references. The product model proposed in Fig. 3 comprises of five parts: the curtain wall type class related to the curtain wall type, the curtain wall document class showing the curtain wall drawing and related documents, the engineering performance class showing design standards for the curtain wall, specification class showing specification information of the curtain wall and the reference class used as references in decision making for material and design standards.

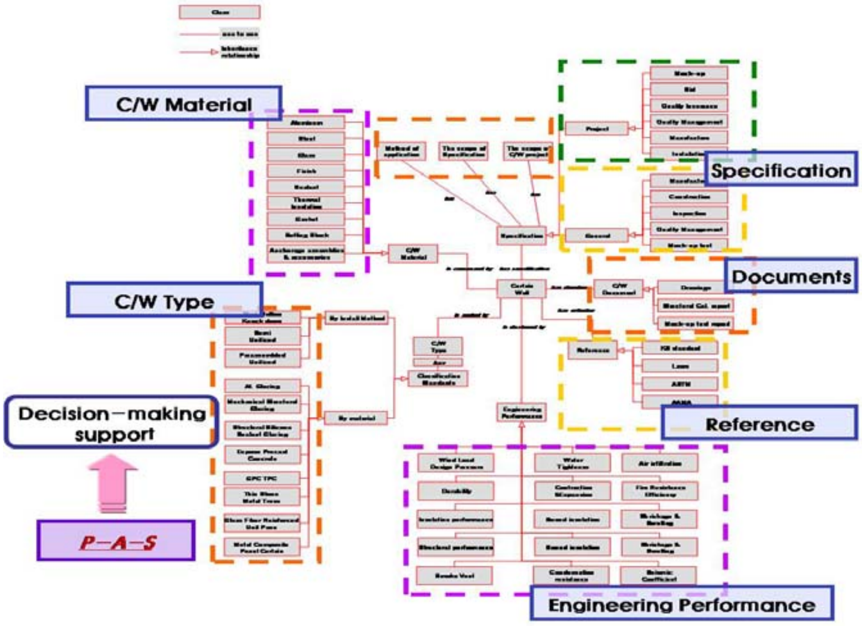

Figure 3: The Curtain Wall Product Information Model

Conclusions

In this study, we proposed a product model with which the participants in the design of the Curtain Wall design and construction process will be able to effectively use and manage the flow of information involved in designing the Curtain Wall. As a follow-up study, we aim at realizing a prototype of the Curtain Wall design information management system based on the proposed product model. The Curtain Wall information management system should have the following functions:

(1) it should store, categorize, and revise effectively the information generated in the design and construction processes;

(2) the stored data should be available for participants to enable them to make effective designs

(3) it should enable the system manager to monitor the proceedings, as well as provide such a manager a document certification function to ensure the participants make no duplicate decisions. This study's key results are the following:

- solutions are proposed to create alternative Curtain Wall design methods based on *Problem Alternative Solution*;

- decision-making items are analyzed with regard to the performance among participants in the design stage, and established an information model based on *Problem Alternative Solution*, which aims at supporting the decision-making process; and
- a product information model is established aiming at sharing and storing information among parties by analyzing the Curtain Wall design information.

The Curtain Wall design information management system proposed in this study for collaborative design can support the management of documents and design scheduling as well as assist in each party's decision-making process. The product information model proposed by this study presented a simultaneous execution method, not a serial design method, in the design process for each design party by proposing a collaborative method through the sharing of information and enhancing the communication in the decision-making process of the Curtain Wall design stage.

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Universal Design for People with Disabilities: A Study of Access Provisions in Public Housing Estates

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Abstract

Freedom of movement from place to place is recognized as a basic human right. Everybody regardless of his/her age and physical condition should have proper and convenient access to certain places in their daily lives. In order to ensure that all residents including those with disabilities can access to places that the public is entitled or allowed to enter or to use, adequate provision of unobstructed access is required. In Hong Kong, Disability Discrimination Ordinance and the code for Barrier Free Access Design are two major pieces of legal control regulating unobstructed access. In this paper, a comprehensive review of these requirements or other relevant regulations is conducted in order to identify whether there is room for improvement in the building laws regulating access for people with disabilities (PWDs), to aim for Universal Design. In addition, this paper also presents the result of a study which has investigated the accessibility of PWDs in public housing estates serving the majority of Hong Kong population. This case study is valuable to identify the inadequacies of current access provisions for PWDs and highlight the areas requiring further improvement. Based on the review of existing legislative controls and the case studies, some possible solutions for improving present building regulations are generated.

Keywords: Barrier free access, Universal design, Public housing estates, Building Regulations

1. Introduction

The main purpose of this research is to review the current regulatory controls on unobstructed access, and investigate the accessibility of PWDs in public housing estates serving the majority of Hong Kong population. By conducting the checkwalk exercises, the accessibility problems in the selected public housing estates representing typical public housing estates built in different periods between the 1970's and the 1990's can be identified, and recommendations to be considered in the future design and construction of public housing estates in order to meet the needs of PWDs can also be highlighted.

2. Controls over unobstructed access for PWDs

2.1 Disability Discrimination Ordinance

The Disability Discrimination Ordinance (DDO) Cap.487 was enacted in 1995 and became fully operative in December 1996. It ascertains that PWDs have their entitlement to an equal right on accessibility. In addition, it prohibits discrimination against PWDs for failing to provide reasonable means of access to any premise that the public or a section of the public is entitled or allowed to enter or to use, or for refusing to provide appropriate facilities. For the purposes the DDO, the issues of accessibility by the PWDs will be considered with reference to the current needs.

2.2 Design Manual: Barrier Free Access

In order to legalizing disabled access requirements, in 1984, disabled access requirements were introduced into the Building (Planning) Regulation under the Buildings Ordinance and a guideline “Design manual access for the disabled” was announced. Since the promulgation of the DDO, an improved design guide called “Design Manual: Barrier Free Access 1997 (BFA)” was introduced. Compliance with the BFA is deemed to have satisfied the statutory requirements for barrier free access under the Building (Planning) Regulations. Basically, the BFA sets out design requirements for new and substantially altered buildings. It aims at providing proper barrier-free access to appropriate facilities in a building for PWDs. In 2006, an updated version of the design manual “Final Draft Design Manual: Barrier Free Access” was issued by the Buildings Department for consultation. The new draft version enhances the design standards to make the built-environment more accessible and aesthetically pleasing. It is still a consultation paper not yet implemented as part of the regulatory control

3. Universal design in public housing estates

The new draft design manual not only encompasses obligatory design requirements but also recommended design requirements to better provide a new concept of “Universal Design” environment for everyone. Barrier free design even with latest technological assistance may also result in separate and stigmatizing solutions. Universal design is a relatively new concept that emerged from "barrier-free" and "assistive technology" [5]. Universal design takes into account of other issues such as the aesthetics and appeals to a wide range of consumers. It provides a broad-spectrum solution not just for people with disabilities, but also for everyone. Experts of the Centre of Universal Design collaborated to establish the Principles of Universal Design to guide a wide range of design disciplines including environments, products, and communications. The following 7 principles may be applied to evaluate existing designs, guide the design process and educate both designers and consumers about the characteristics of more usable products and environments [2]:

- Equitable use

- Flexibility in use
- Simple and intuitive
- Perceptible information
- Tolerance for error
- Low physical effort
- Size and space for approach and use

Therefore, apart from the BFA code used in Hong Kong, this study also referred to barrier free design codes used in other overseas countries to look for ways to better provide a "Universal Design" environment for the PWDs. In this study, the major overseas barrier free design codes that have been consulted are:

- Barrier Free Design in Japan-Code of Practice for Design for Access and working Commission Report 1989, Kanagawa Prefecture
- Barrier Free Design in the United States-ATBC Board 1982, Minimum Guidelines and Requirements for Standards for Accessibility
- Barrier Free Design in Canada, Public Works Canada 1985, Barrier-Free Design: Access to and Use of Buildings by Physically Handicapped
- Barrier Free Design in Netherlands-Provinciale Stichting Gelderland 1984, Requirements for Access
- Barrier Free Design in Singapore-Public Works Department 1990, Code on Barrier-Free Accessibility in Buildings

4. Research methodology

To achieve the aims of the project, a methodology for carrying out this project was formulated and it could be described in 4 stages as follows:

- Establishment of local and overseas regulatory control references
- Selection of typical public housing estates;
- Preparation of checklists;
- Carrying out of checkwalks; and
- Data analysis.

4.1 Selection of typical public housing estates

There are more than 170 public rental housing estates under the direct management of the Hong Kong Housing Authority (HKHA) in Hong Kong. It would not be feasible to carry out a survey on each of them to reveal the accessibility issues for the PWDs. After a thorough desk top study and discussion among the Research Team members, 4 public housing estates were selected. All of these housing estates are located in the same district and the housing estates selected would be of significant value because they represent different types of estates built in a particular period. The 4 selected estates i.e. CH Estate and WH Estate, SL1 Estate, SL2 Estate are built in the 1970s', the 1980s' and the 1990s' respectively, and cover the housing block types i.e. Trident, Harmony, Linear, New Slab, Old Slab and Double H which are the most common building forms observed among estates in the district. Apart from the domestic blocks, a variety of communal facilities e.g. market, mall, car park, ball court and playground equipment provided in each of 4 selected estates were also surveyed.

4.2 Preparation of checklists

With reference to the design requirements in the Hong Kong BFA code and overseas' barrier free design codes to achieve Universal Design, the Research Team studied the building plans of the selected estates to recognize the material characteristics of the housing estates and to identify the critical areas for assessment on site. With a draft checklist developed for discussion with practitioners for refinement, a full checklist was created for the checkwalk exercise on site.

After preparing a draft checklist, the Research Team studied the building plans of 4 selected estates to recognize the characteristics of the housing estates. Then, the Research Team walked through the building plans mentally as users with the benefit of discussion among Architects and Building Surveyors. The checklist is refined and finalized in order to facilitate the checkwalks for assessing the accessible design of built environment in a logical sequence.

4.3 Carrying out of checkwalks

Checkwalks were conducted in 6 separate days to examine accessibility issues for PWDs on site. The Research Team spent 1- 2 days (about 4 - 6 working hours) on each of 4 selected estates in early 2007. In order to ensure that the most common types of housing blocks were covered in the checkwalks and increase the reliability of the survey findings, it was decided that at least 2 housing blocks of each type were selected for study in each estate, and at least 4 floors of each block type were studied. For example, 2 Trident blocks in CH Estate, 2 New Slab blocks and 2 Double H blocks in SL1 Estate, and 2 Harmony blocks in SL2 Estate, and 2 Linear blocks and 2 Old Slab blocks in WH Estate were studied. Equipment employed to measure and to record the relevant data during the checkwalks included a measuring tape for dimensions and a digital camera for recording, etc.

4.4 Assessment criteria and grading

For each estate, the Research Team assessed the accessibility of PWDs on site. Due consideration had been given to any special circumstance on site. The team members are qualified building professionals and had to bear their architectural and surveying expertise to assess items affecting accessibility of PWDs. The assessed items were classified into 4 main categories for data analysis. The first category included those items found to have fully complied with the requirements. The second category included those items found to be totally non-compliant or with no provisions at all. The third category included those items that were not applicable to the estate. The forth category included all other items that were provided on site but were non-compliant with the standards. Within this last category, the items were further graded according to the degree of compliance with the requirements. The grading assessment by the Research Team was based on a set of qualitative criteria including a combination of:

1) For each item provided/ observed along the checkwalk routing, the Research Team estimated the % of that item appearing to be completely non-compliant with the requirements or with no provisions at all;
2) For each item provided/ observed along the checkwalk routing but not classified under the category of total non-compliant, the Research Team assessed the adequacy and the completeness of that item provided on site;
3) The assessment would also take into account of the frequent use of the facilities provided and whether there were alternative provisions which were reasonably convenient.

The grading is not an exact science that could be justified simply by counting, but the grading relies very much upon the Research Team’s professional judgment with reference to the above criteria. The grades are only indicative of the degree of non-compliance with the requirements. The grading provided the Research Team one of the criteria to determine the priority for rectifying the non-complying defects.

5. Data analysis

5.1 Summary of findings for domestic blocks

The housing block types selected for this study are comprised of Trident, Harmony, Linear, New Slab, Old Slab and Double H due to their popularity among estates in the district. Block types of Trident, Old Slab and Linear were all built in 1970s. Both New Slab and Double H were built in 1980s whereas Harmony was built in 1990s.

The different block types are standard designs. During the visit to each of the 4 estates, the Research Team assessed the accessible design for at least 2 blocks of each block type. The rationale for assessment criteria and grading had been discussed in Section 4.4. The main purpose of the grades is to provide a record for the team members to check back in office when assessing the priority for rectifying the non-complying defects. With reference to the grades obtained for individual block in four selected estates, it is possible to obtain an overall grading on the degree of compliance by combining the survey results of all 4 estates for each block type.

After summarizing the survey results of all block types of all concerned estates, the team members found out that block type of Harmony in SL2 Estate, which was built in 1990s, has minimum defects comparatively while the rest of them has some common defects in the aspect of accessible design, for example, substandard ramp at lobby entrance, large door threshold of the flat entrance, deficient signage for exit, no tactile strip at landings and at bottom and top end of staircase, no raised directional signs on handrails, insensitive detection device and no infrared sensor, no audible signal and verbal annunciation for lift car, lack of indication system for lift and no visual alarm signal at prominent locations.

5.2 Summary of findings for communal facilities

Each of 4 selected estates has their own unique arrangement of transportation facilities, commercial complex, wet market, communal facilities and open areas between blocks. Different designs of each estate are due to local landforms, geographic locations, period of time and specific needs.

The overall comments on common defects existing in all 4 estates are shown below:

- Substandard access ramps are found in some locations. Not all handrails have raised directional signs. Dropped kerbs are not sufficient. No tactile strip at head and foot of ramps is provided even if ramps are constructed. Same case happens to staircases in commercial complexes in terms of the standard of handrails and the provision of tactile strips.
- Braille map and tactile guide path, for people with visual/hearing impairment, is missing.
- Some corridors of commercial centers and wet markets are not wide enough to ensure sufficient room of movement or the finished floor is slippery.
- The lifts, as a typical problem in all evaluated estates, were not upgraded to meet the BFA code in terms of the height of control button, the sensitivity of detection sensor and notification of both audible signal and verbal annunciation.

6. Recommendations

6.1 Criteria for prioritizing

Throughout the years, different departments of the Hong Kong Government have published a number of codes, standards and guidelines in order to create or promote a healthy and safe built environment for the local citizens. This study is based on the established document to set out the requirement/ criteria for assessing the accessibility of PWDs in the public housing estates. The assessment is based on the latest standards for the purpose of this checkwalk exercise; however, most of these documents are published in 1990s-2000s and therefore, many of the residential buildings including those of public housing estates built before their effective date may not be able to comply with the new requirements. In this way, the Research Team has to take into account of the constraints of those estates built earlier when making recommendations for rectification of the defects.

In addition, it is not absolutely clear whether the requirements for accessible design also apply to all external areas outside buildings, such as outdoor landscapes, pedestrian paths and areas between housing blocks. Since accessible design for outdoor areas and facilities are equally important and no standard particularly designed for the external areas can be found in the territory, the Research Team makes reference to BFA 1997 when assessing the accessible design of external areas.

Ideally, all items which do not fully comply with the current requirements set out in the checklist have to be rectified as soon as possible. However, it is not possible due to limited human and financial resources. Therefore, it is better to prioritize these items in the first instance in order to make the best use of the scarce resources. With the professional expertise, the Research Team prepares the priority list according to 2 major principles. First, with reference to the grade given to each item, the Research Team can consider a priority ranking for each item. Item with greater degree of non-compliance is given a higher priority. Second, the preliminary priority ranking is qualified with due considerations given to the following factors in the order of deserving higher priority treatment:

- Matter of urgency;
- Ease of rectification;
- Resources required;
- Special circumstances of the estates, such as natural landforms, and
- Promotion of good practice for future designs.

It should be noted that the priority assessment is based on the Research Team's professional judgment with reference to the above qualitative criteria. The details of each priority classification are shown below:

Priority 1: Requirements that are urgently needed for improving the accessibility of PWDs.

Priority 2: Requirements that can greatly improve the accessibility of PWDs without demanding too many resources.

Priority 3: Requirements that can improve the accessibility of PWDs but may require heavy consumption of resources.

Priority 4: Recommended requirements that can provide good guidance for future designs

6.2 Recommended priorities for rectifying defects of domestic blocks

Table 1 and 2 present the recommendations made by the Research Team on the defect rectification for housing block types in order to improve the accessibility design for the PWDs.

Table 1: Recommended top priorities for defects rectification in all block types

Items	Design Requirements
Dropped kerbs	• Dropped kerbs: provide properly designed dropped kerbs at prominent locations

Items	Design Requirements
Ramps	• Gradient: improve slopes to comply with BFA code • Handrails**:** provide properly designed handrails • Tactile strips: provide tactile strips to comply with BFA code
Steps & staircases	• Handrails: provide properly designed handrails • Tactile strips: provide tactile strips at every change of level
Indicative provisions	• Signage: provide clear signage to identify entrances, public toilet & parking spaces • Provisions for people with visual impairment: provide Braille map or tactile guide path • Intercom: Intercoms should be positioned ≤ 1.1m above finished floor level. Level landings in front of intercoms should be provided
Corridor & lobbies	• Projections: reduce projections
Public toilet	• Location: provide a clear space of 1.5m x 1.5m in front of the cubicle • Size: provide disabled toilet of not less than 1.5m x 1.75m • Design: provide properly design water fitment
Lift	• Detection devices: provide detection devices or infra-red sensor to all existing passenger lifts • Control buttons: (i) install indication light for emergency call; (ii) improve control panels to comply with BFA • Notification: provide audible signal and verbal annunciation to all existing passenger lift
Fire services provisions	• Fire alarms: provide visual alarm signal at prominent locations • Exit sign: provide exit signs at prominent locations on each storey

Table 2: Recommended future improvement in all block types

Items	Design Requirements
Level between corridors and rooms	• Doors threshold: reduce level difference to 25mm or provide dropped kerbs
Steps & staircases	• Nosing: use materials in contrast colour for nosing and steps
Corridors & lobbies	• Dead end: provide an area not less than 1.5m x 1.5m for wheelchair users within 3.5m of dead end

Items	Design Requirements
	• Colour: use finishes in contrast colour for floor and wall

6.3 Recommended priorities for rectifying defects of communal facilities

Another section of the research findings is a summary of the recommendations in response to major defects commonly found in the communal areas in 4 selected estates that need priority attention for rectification (Table 3 and 4).

Table 3: Recommended top priorities for defects rectification in communal spaces

Facilities	Design Requirements
Commercial centre & market	• Defects similar to those found in Table 1 for domestic block in terms of Dropped kerbs, Ramps, Steps & staircases, Indicative provisions, Corridor & lobbies, Public/Disabled toilet, Lift and Fire services provisions
Public transport terminal & car park	• Access: provide direct access from public street/ pedestrian way
	• Drop kerbs: provide properly designed dropped kerbs at prominent locations
	• Ramps: provide properly designed ramps if there is a level change
	• Steps & staircases: (i) provide properly designed handrails; (ii) provide tactile strips especially in front of crossings of terminal or car parks
	• Signage: provide clear signage to identify terminal entrance, car park & locations of disabled car parking spaces
	• Disabled car park: at least 1 reserved for persons with disability at each parking level
Leisure facilities	• Ramps: provide properly designed ramps if there is a level change
	• Signage: provide clear signage to major routes & common facilities signal at prominent locations

Table 4: Recommended future improvement in all estates

Facilities	Design Requirements
Commercial centre & market	• Steps & staircases: use materials in contrast colour for nosing and steps
	• Corridor & lobbies: use finishes in contrast colour for floor and wall
Public transport terminal & car park	• Disabled car park: (i) follow recommended size of 3.5m x 5.5m; (ii) provide emergency call bell at each disabled car park space
	• Pedestrian crossing: incorporate ticking-device (audible and tactile) into existing crossing posts

6.4 Recommended Future Improvements

In this paper, priority lists are recommended for existing buildings because the Research Team takes into consideration practical needs, difficulties in rectifying existing works, and any special situation. There is no justification for future newly built public housing estates not to comply with the latest BFA code. In this paper, the Research Team also suggested lists of recommended items for future improvement in all estates. The assessment exercise will also provide feedback to the new development design team to refine or improve their design for new buildings. The recommendations in this paper should be taken up to review the existing standard designs for public housing, and to look for design solutions that could incorporate the recommendations in their future housing designs.

7. Conclusions

This study was a meaningful exercise to investigate the accessibility of PWDs in public housing estates that affected a large proportion of residents in Hong Kong. Assessing the accessibility of PWDs in the public housing estates is a good indicator showing the effectiveness of current controls over unobstructed access in Hong Kong. The Research Team acknowledged the fact that the majority of the estates selected were built before 1997 and this factor had been taken into account in the priority setting for rectification to be made in the recommendations. As this study was constrained by the resources available, the team members tended to limit this study to 4 selected estates representing housing stocks built in the 1970's, the 1980's and the 1990's. In order to ensure that feasible recommendations were proposed, the Research Team had considered the assessment grading, the needs of the residents, technical difficulties, and resources to be consumed. The study was carried out with reasonable sampling for statistical analysis. Apart from relying on statistical data, the research also relies on qualitative assessments and objective site inspection based on the professional experience. The research confirms that those items in the top priority lists are basic need for disabled access and should be tackled as soon as possible. The 2006 new "Final Draft Design Manual" will incorporate more elements of Universal Design. As highlighted in this paper on the recommendations for future design improvement, the conditions of public housing are far from attaining the new ideal concept of Universal Design. These findings prompt the relevant government authority to undertake further pro-active investigation for improvement to achieve Universal Design.

Acknowledgement

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Towards a more ‘robust’ technology? Capacity building in post-tsunami Sri Lanka

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Abstract

In fast urbanizing economies such as Sri Lanka, the construction industry tends to fragment into almost separate spheres of production with little or no reciprocal connection in training, know-how and career development paths, and consequent limitations in internal knowledge dissemination and technology transfer. This type of industrial compartmentalization is detrimental to the social acquisition of skills, and restricts the operational frameworks of given technologies, especially in low-cost sectors. Attempts to stretch such boundaries almost inevitably lead to inadequate application or sub-standard performance-in-use of the systems selected.

Set against this background, the paper presents the results of a technical review of a small sample of ideal-type projects in Sri Lanka, developed with the intention of forming an empirical basis to address two key issues: (1) whether strategic planning of specific building technologies could lead to professional frameworks capable of narrowing the gap between high-quality architectural production, middle-quality commercial building and low-quality shelter supply; and (2) whether architecture can act as an engine of social and economic growth for those involved in its production.

Based on government statistics and building output analysis, the paper argues that the above should and can indeed be the case, provided that such an agenda is developed strategically, by examining the industrial base of region, and by defining a design and technological vocabulary that feeds off the analysis of place-specific conditions, limitations, and ambitions. Crucial to this process is the idea of ‘robust technology’, i.e., an approach to the definition of building implementation techniques that can adapt to the level of complexity required and the level of expenditure possible without penalizing the expected performance of the building, neither culturally nor technically.

Key words: developing economies, design practice, robust technology, capacity building, policy definition

1. Reconstruction challenges in Sri Lanka: the post-tsunami situation

The tsunamis that hit Sri Lanka in late 2004 caused an unprecedented natural disaster with huge loss of lives and severe devastation to infrastructure such as housing, roads, railways and bridges. According to the World Health Organization [1], up to one million Sri Lankans were displaced by the tidal waves. In the aftermath of the disaster, Central Bank sources predicted that the rebuilding cost of housing and townships alone would amount to US$2 billion [2]. There were initial pledges for assistance by the world community and United Nations-assisted groups, although many feared that such relief may not reach the displaced due to entrenched political graft and mismanagement. Others, however, believed that the sheer amount of aid pledged by donor countries, combined with the reconstruction effort, would spur the economy and give a fillip to the stagnant construction industry battered by the country's 20 years of war [1].

A more structural question however lingers as to the Sri Lankan construction industry's ability (or maturity) to absorb and put to effective rebuilding use all the assistance received. After almost three years from the day of the disaster, the people who have been made homeless are still residing in refugee camps or temporary structures built closer to their destroyed settlements. The townships are still plagued by damaged buildings and ruined infrastructure. Most of the new buildings that replaced the destroyed ones have failed in quality and character. Above all, the opportunity offered by the disaster to re-think and re-develop the coastal belt to a better vision and substance has been lost in the process.

These reflections gain further resonance when considering that the plight of tsunami refugees cannot be treated as an isolated problem; indeed, it is part of an increasing (and increasingly larger) phenomenon of people displacement, which is particularly pronounced in developing and transitional economies. Reasons vary. The 20-year old civil war in Sri Lanka, for example, has transformed a particular section of the population into what the international community now calls 'internally displaced people', or IDPs. According to 1995 estimates, there were about 85,000 IDPs in Sri Lanka; by 2004 this number was expected to have doubled [3].

Natural disasters and war conflict combine with economic restructuring and urbanization pressures. In Sri Lanka, the extremely limited opportunities offered by the dying economies of internal towns and villages have triggered large migration flows of rural population to Colombo and other significant towns. As a result, the form of many urban centres is losing its traditional shape and functional hierarchy to become part of continuous, over-stretched urban corridors characterized by noise, congestion, formless growth, and massive shortage of housing and infrastructure. A recent survey of the city of Colombo, for instance, suggests that 52% of its night population lives in under-served, informal settlements [4]. This is a staggering figure given that, out of a total population of 20 million in the country, more than 4 million live in the Colombo Metropolitan Region (CMR), and well over 2 million in the Colombo District alone. By 2010, the CMR population is projected to increase up to 6.4 million, placing even more pressure on the demand for building and services in residential areas. Demand for infrastructure by both local and foreign investors within the CMR is also likely to increase in the future [5].

Responding to these challenges is not going to be easy. If one looks at the whole spectrum of activities carried out within the building industries of developing economies, the relationship between product supply and product demand varies highly in social efficiency. Sri Lanka is no exception. Institutional and professional responses to urbanization and population pressures have largely ignored the spatial needs of the poor, and allowed the proliferation of informal settlements as a social pressure-release mechanism. The planning and implementation of social housing and infrastructure — the supply of which was seen as a government prerogative in the immediate post-colonial period — have not risen to the challenge. Market-based commercial development, by contrast, is being strongly encouraged by the government, and facilitated through zoning, land use concessions and tax cuts. Architectural design, for its part, has been limited to few individual buildings identified mostly by high patronage or top-end tourism uses.

This paper is the first result of a thesis-in-progress that, on the basis of the type and amount of building work carried out in Sri Lanka at the moment, is considering ways to overcome the inherent misallocation of intellectual energy behind it.

2. Organizational structure of the industry: Institutional networks and labour pools

The point to start is informal labour. In Sri Lanka, in fact, the formation of construction labour and the consequent transfer of knowledge across the industry occur largely through informal relationships. This is essentially so for two reasons.

The first reason is that the majority of construction work is still organized via traditional networks led by a small-scale, one-man contractor and craftsmen manager, conventionally known as the ‘baas’. These individual contractors establish informal organizations of limited size, assemble a small workforce, and obtain contracts through social contacts which supply them with steady work. They usually rely on a few skilled workers competent in all the aspects of traditional building construction, with a larger team, or work gang, usually formed around them. The acquisition of skills takes place informally on the job, through the relationship between stable and temporary employment, thus generating a tacit working knowledge of building. Although the institutional training of construction workers has grown in recent years, its numbers still remain substantially low compared to informal training.

The second reason is that rural-urban migration has led to a progressive growth of the informal sector by generating a steady supply of unofficial workers, characterized by low capital-labour ratio, lack of job protection, dominance of self-employment, easy entry, and low productivity [6]. The minimum levels of income earned by these workers contribute to entrench their social status and position in the industry: in fact, without spending access to housing and land, they become further confined to the informal sector. In Colombo, squatter residents constitute practically all the informal labour utilized in the building industry, the port and the municipality.

The informal nature of the construction sector can also be explained in light of the large prevalence of self-building activities, where a considerable part of the investment is non-monetised and reliant on sweat-equity. According to the MARGA Institute [7], most of the semi-permanent and improvised housing in Sri Lanka is constructed through family labour and the assistance of informal groups whose members offer help to one another. Within such a process, required materials are obtained locally, and construction work can be extended over long periods according to the availability of labour and resources. In the 1980s and 1990s, this model was even promoted by government under the banner of 'aided self-help programmes' as a reliable mechanism for low-cost housing. Yet the lack of support for users' access to basic resources and knowledge has resulted in the cloning of sub-standard structures all over the island.

It is not difficult to understand why, in such conditions, the evaluation of the true capacity of the construction industry in Sri Lanka has proven to be a difficult task. According to 2003 figures from the Colombo-based Institute of Construction Training and Development (ICTAD), the construction industry provides direct employment to around 300,000 people, who become more than 1,000,000 when considering the informal linkages serving the construction process. These numbers include the staff of around 2,000 ICTAD-registered building contractors, and 100 consultancy/design organizations belonging to state and private sectors. There are also approximately 200 private-sector property development entities, the majority of which, again, operate informally [8]. In addition, over a dozen major institutions provide assistance on construction industry issues [9]. Yet, the industry's involvement in public-sector development has been minimal in recent times, especially when compared to the scale of construction work required to upgrade the battered socio-physical conditions in many parts of the country.

3. Pigeonholing labour by building markets: Fragmentation of construction activity into separate production spheres

The informal nature characterising the social structure of building production in the country combines with the failure of the industry as a whole to respond appropriately to current challenges to suggest that new analytical models of the sector may be needed, not only to appreciate the structural limitations of the present situation but also to delineate adequate policy responses that could help Sri Lanka take advantage of the situation rather than becoming a victim of its own opportunities.

Workforce dynamics are likely to occupy a central place in this discussion. With regard to internal migration patterns, a model introduced by Lewis in the early 1990s foresees a one-stage process of labour transfer where, with unlimited human supply, migrant workers from low-productivity rural jobs are absorbed into high-productivity urban industrial jobs [10]. Other authors, on the other hand, are more inclined to envision a two-stage migration process, whereby migrants first enter the 'urban traditional sector' (informal sector) due to their limited access to the 'modern sector' (formal sector), and then acquire the necessary skills that will eventually enable them to graduate to the formal sector [11].

Yet the research conducted for this thesis in Sri Lanka shows that both positions lack the necessary dose of realism under actual market conditions. The reason is simple: the construction industry is fragmented into almost separate spheres of production, with little connection in training, know-how and career development paths, and consequent limitations in cross-system application of technology transfer. In such a context, the advance of labour from entry-level informal workers to skilled workers does not occur as smoothly as labour scholars may have implied: construction workers tend to find themselves confined to insular activity pockets, characterized by the building markets they serve and the original social status that brought them there in the first place.

In order to arrive at making this assertion, the research employed over a dozen ideal-typical case-studies to examine the way specific building systems — concrete block-work walls, pre-cast concrete beam and column structural systems, and steel structural and roof framings — are developed and erected in Sri Lanka, depending on the building markets in which they are used. Due to space limitations, only concrete block-work will be considered in the following text.

4. The gap between ambitions and reality

To start with, the relationship between particular building markets and the skill base of their labour pool was analysed from a socio-technical viewpoint (Figure 1).

Construction workers for low-cost residential and commercial building activities in Sri Lanka are sourced predominantly from social networks characterized by the use of local materials and processes as well as manual tools, where empirical and ‘conventional’ knowledge constitutes the basis for action and decision-making, and where informal labour structures are built around ‘self-builders’ or small-scale contractors (baas).

The limited level of building know-how available to such construction activities has a direct bearing on the formal, environmental and mechanical performances of the finished products. For example, the formation of roughened surfaces and irregular edges in concrete blocks due to errors in manufacture, assembly and handling are common to most block-work walls built in low-skilled construction sites. High porosity of blocks as a result of irregularities in the concrete mixture and curing process is also commonplace, thus creating failure chains in water proofing and thermal insulation. The mortar joints between blocks often appear ragged, untidy and irregular, and most walls have stained surfaces due to droppings of mortar and bad weathering. Moisture penetration through shoddily built joints is a major concern, while structural failure due to the use of sub-standard blocks is also common.

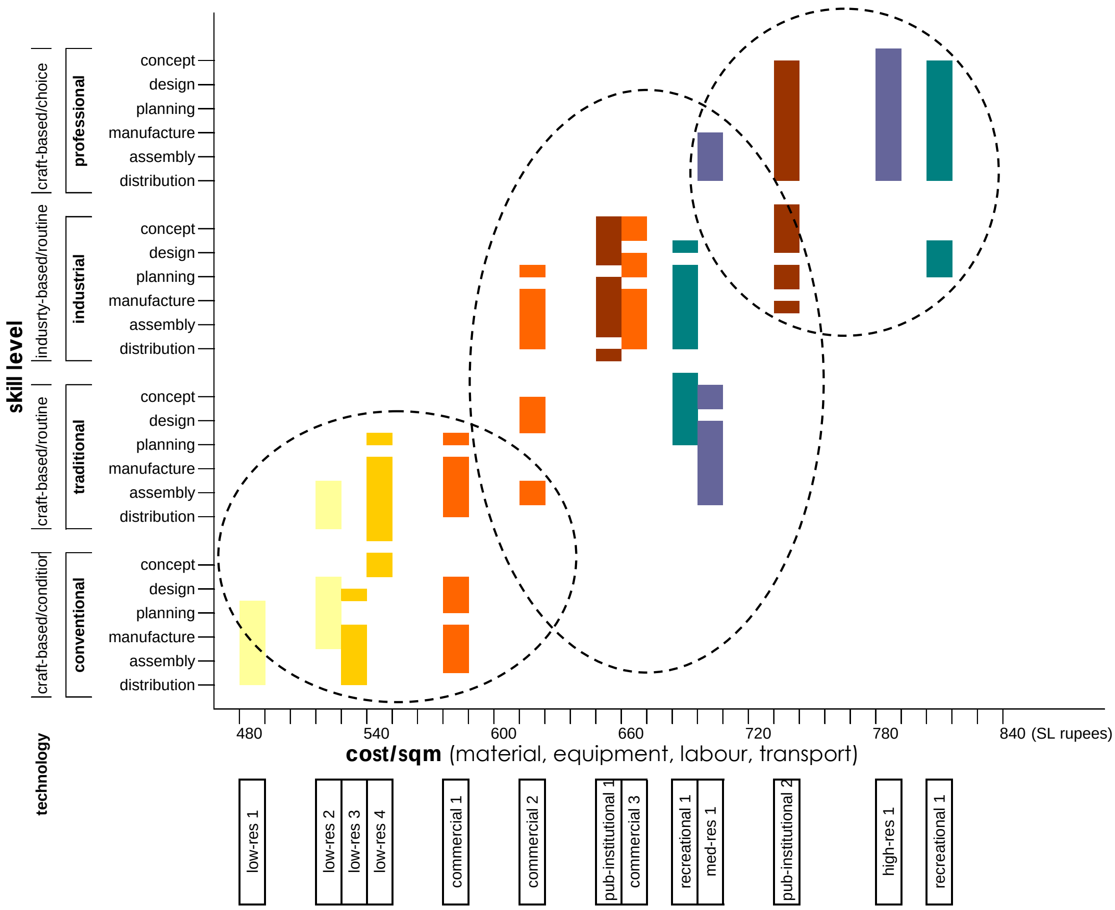

*Figure 1: **Application of block work:** Socio-technical economics*

For most large-scale commercial and industrial buildings, however, industry-based routine processes provide the basis for construction know-how and labour organization. Work in such building markets is often carried out by ICTAD-registered commercial builders or construction companies, supported by a pool of skilled/semi-skilled masons and plasterers. Block-work modules are mostly factory-produced by large-scale manufacturers, using skilled block-makers at their plants. There is a reasonable emphasis here on the use of proper block-laying techniques, although routine production protocols can also give rise to inflexible, and thus potentially compromised, technical solutions. Exposed block-work, for example, is rarely used for higher-end commercial buildings in Sri Lanka; plastering of walls is generally considered essential to cover shoddy junctions and ragged joints.

In buildings of high patronage such as resort hotels, museums or high-end residences, the involvement of design professionals and the set up of a highly craft-based socio-technical framework is deemed necessary, thus implicitly generating a demand for highly honed labour skills and efficient planning of work at the site. Since the architectural ethos informing most of this work finds its inspiration in a picturesque paradigm defined and achieved through high craftsmanship, the lack of precision that characterises building artefacts in low-skilled labour environments is aggressively rejected. Common techniques employed in these more ‘cultivated’ markets include the laying of blocks to different compositional strategies, forms and bonding patterns, and the use of custom-designed block-work that requires special instructions both at the factory and on site. The employment of skilled masons, plasterers and carpenters is seen as both natural and essential to carry out such jobs, thus depriving entry-level informal labour the opportunity to be contracted for higher-end work even as apprentices.

As Figure 1 shows, when construction activity takes place within areas with such dramatic differences in capital expenditure ability, access to materials and systems, and standards of use, technology itself gives rise to separate socio-technical pockets. This make it difficult for the workforce employed within each pocket — particularly the lower ones — to move across boundaries, learn from others, and improve their technical and economic status.

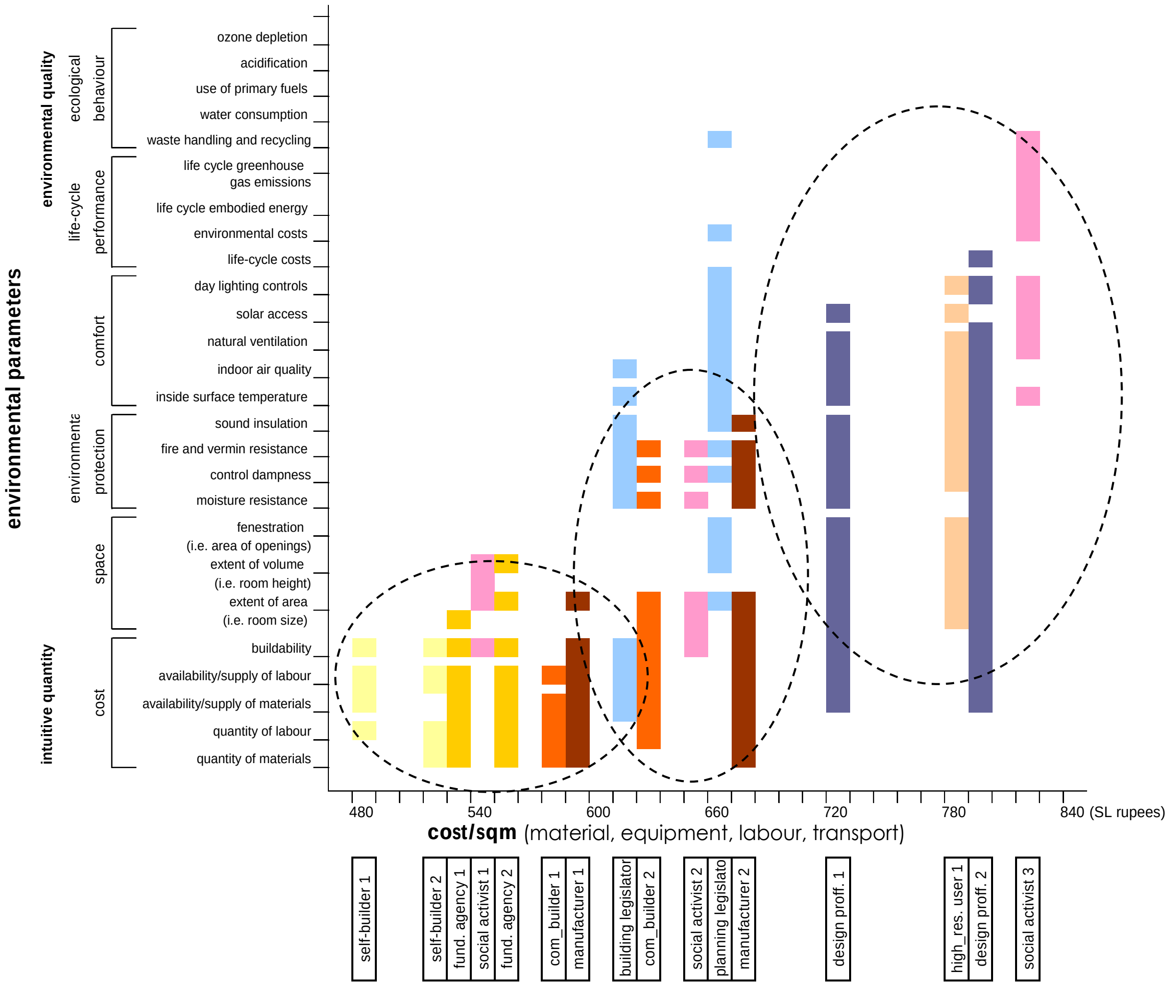

Figure .2: ***Application of block work:*** *Socio-cultural economics.*

5. From technology to ‘sensitive’ technology: Consequences of industrial compartmentalization

After looking at product characteristics as a result of labour skills and material resources, the analysis focused on the socio-cultural definition of acceptable (or expectable) building parameters. In Figure 2, particular technological decisions taken by various parties involved in the construction processes observed – e.g., self-builders, commercial builders, funding agencies, planning and building regulators, design professionals, social activists, etc. - are associated to a set of measurable factors, or ‘values’, which define the complex of surrounding circumstances, conditions or influences in which a person lives or operates. These factors are collectively identified as ‘environmental parameters’, and organized in the diagram under six sub-headings: cost, space, environmental protection, comfort, life-cycle performance, and ecological behaviour.

For the actors performing in the lower-end markets, the parameters related to cost of production — such as quantity, availability and supply of materials and labour, or easy constructability of chosen building systems — seem to be the most crucial and achievable at the same time. The actors involved in the process have neither the economic capacity nor the technical knowledge to respond to higher aesthetic and environmental product concerns. In other words, the environmental parameters pertaining to cost and constructability define the technological framework within which builders, users and facilitators of low-end residential and public projects operate. Even more so, these parameters form a combination of semi-independent constrains that define the real choice available to decision-making subjects in that particular building process. Groak [12] calls the result of this combination the ‘feasible set of available technological decisions’ of a given building program, and argues that attempts to stretch this boundary will result in ‘sensitive’ technological applications that may lead to building failures. For example, the construction of commercial and institutional buildings in Sri Lanka requires the provision of determinate levels of fire and sound resistance to comply with the occupational health and safety parameters set up by planning and building authorities. Due to lack of knowledge, skill and capacity, the lower-end building markets do not adhere to such regulations, thus exposing their buildings to potential failures. On the other hand, attempts to stretch their ‘feasible set’ to accommodate such concerns may result in failures elsewhere – i.e. lack of funds to spend on a proper waterproofing mechanism due to the different allocation of a very tight budget.

By contrast, larger ‘feasible sets’ are available for building markets with higher spending capacity and cultural ambitions. High-end commercial buildings, for example, have both the capacity and the need to facilitate proper response to regulatory requirements such as fire and sound resistance. Yet, concerns for life-cycle embodied energy in buildings, or for their impact to the ecological footprint, are not embraced by commercial builders and manufacturers.

What happens, in other words, is that the stated objectives of construction activity, be they physical, commercial or cultural, differ greatly according to the market. It is therefore unlikely that the knowledge required to respond to those objectives is produced outside the market where it is needed. Attempts to import the objectives without importing the work structure or the resources, then, may result in sub-standard results or relative failures.

The industrial compartmentalization of labour can be further understood in relation to the production systems in use amongst building component suppliers. As explained in Figure 3, concrete block-work wall production in Sri Lanka spans different industrial models. If one adopted Winch's taxonomy of production systems [13], the supply of block-work walls for low-end construction (in both residential and commercial buildings) is generally organized under 'make to order' or 'assemble to order' provisions, where pre-configured systems or sub-assemblies end up being used almost as raw (and thus imperfect) materials, with the understanding that they will be inevitably altered to adapt to the 'feasible set' of technological options. In other words, the 'order' for a standard exposed block-work wall system already allows for construction irregularities that come from both the manufacturing and the application context. The inevitability of formal and mechanical errors is almost accepted as part of it.

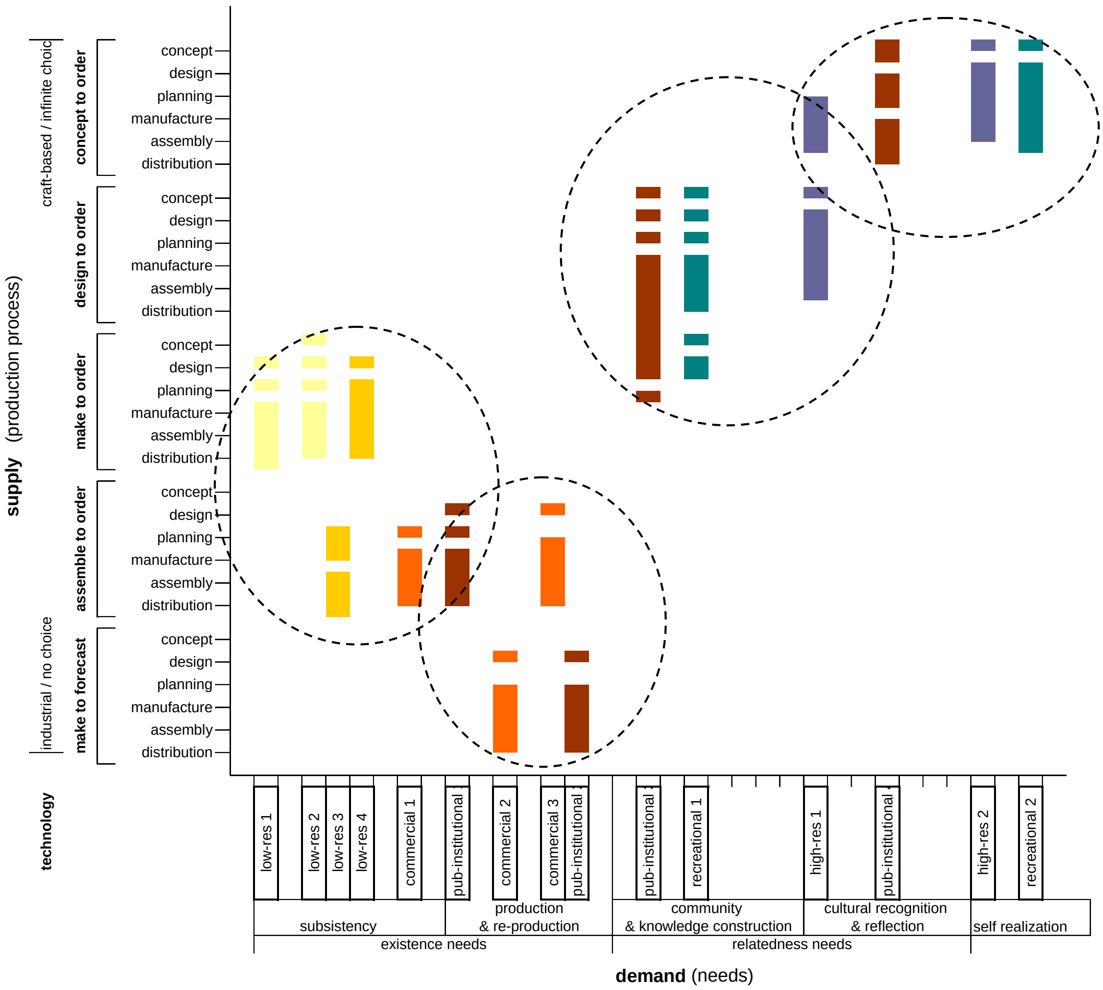

Figure.3: ***Application of block work:*** *Demand-Supply behaviour*

For construction activities based on routine re-production – i.e. commercial, institutional and industrial projects – off-the-shelf procurement is more widely used. Building components are produced for stock and sold after or during manufacture; the final product is always a reasonably well-built, plastered block-work wall.

High-end architectural creations for cultural programs, on the other hand, depend mostly on a supply chain where the client's involvement from early conceptual and design stages appears to be essential. In such a 'designed to order' process, significant design work — for example the laying of blocks to a particular pattern, or the manipulation of wall texture through the exposure of aggregates or particular pigmentation — is required even to conceptualise the basic product.

6. Planning for controllable failure

Succinct tough it has to be, the description highlights the contradictions that pervade construction activity in socio-economic environments such as Sri Lanka's, with a large portion of the workforce employed in the sector officially unaccounted for and yet central to the operations, and ultimately the outcome, of many of its sub-markets. The technical review undertaken of different projects depicts an industrial landscape, even at building system and component level, characterized by highly diverse demands, labour skills, achievable objectives, and conception-and-implementation horizons, which is structured and functions essentially as a series of separate socio-technical environments. The more internally efficient (or optimised) each of these environments becomes in terms of product definition and delivery, the less permeable its boundaries will turn out to be for the productive passage of labour force from other environments, particularly lower-end ones. This may not be critical to the ultimate realization of building structures (although it can lead to both better and worse construction results depending on actors' understanding of the requirements); but it is certainly critical to the building of technical capacity and, ultimately, the existence of social development paths.

The theoretical conclusion arrived at in the thesis, and currently under investigation through a series of pilot projects, is that the integration of technological development and broad socio-economic growth can be facilitated by 'open' (or 'incremental') industrial design strategies: rather than planning for design solutions and structures of production perfectly self-contained in their limitations and potential, from emergency shelter-relief work to sophisticated iconic hotels, it would be advisable to recognize that technological contamination and compromise can increase the rate of participation of the labour force to their own progressive training. What is proposed, in other words, is the definition of a broad technological framework at industry level that is both flexible and adaptable, and can therefore be used to expand the options available within any given project, helping the latter perform as training grounds.

Using building projects as training opportunities without losing productivity, however, means that the technologies employed must have latitude for errors and non-optimal application ― i.e., they must be inherently 'robust' as opposed to precise and therefore more 'sensitive'. In practical terms, this objective translates in the definition of technical options that can tolerate changes in the economic variables of projects on the one hand, and manage the intricacy of buildings' cultural and technical attributes on the other. A framework, that is, which can adapt to the level of complexity required and the level of expenditure possible in a project without penalizing the expected performance of the building, neither culturally nor technologically.

There are examples of the type of intellectual and technical robustness argued for above in the work of several Modern Architecture masters, who defined design and technological languages able to travel and develop consistently across markets to facilitate diverse spatial and cultural needs. Le Corbusier, for instance, designed the Maisons Jaoul in Paris in 1955 — possibly one of the most expensive small residential projects in France at that time — and then developed social housing structures in Chandigarh, India, a project built with much sweat-equity, without compromising his architectural ethos or the relative result. Eladio Dieste's church in Atlantida, made of reinforced concrete and post-tensioned brick tiles is the most renowned building in Uruguay, but his municipal bus terminal in Salto and the sheds for Massaro Agro-industries in Canelones use analogous solutions and are equally poetic and glorious. The India International Centre in New Delhi, designed by Joseph Allen Stein, has a monumental effect achieved by the unity of form and material. Yet, Stein's industrial structures for a bicycle manufacturing plant in Kerala have similar quality and character, but in a different sense of materiality as allowed by the limitations of its financial and cultural program.

7. In lieu of conclusions: the elements of a robust paradigm

Yet the construction of a pervasive robust framework cannot rely on the work of isolated masters taking advantage of discrete opportunities; rather, it has to be developed more 'generically' from the bottom up, by looking at the industrial base of region and defining a design and technological vocabulary that feeds off the analysis of place-specific conditions and limitations. Within this perspective, the architecture of a robust framework must incorporate, normatively, a series of performance parameters. Operating 'robustly' requires:

(1) The ability to save money and time

Scarce, expensive and labour-intensive materials and processes should be avoided, thus making the components and subsystems cost-effective compared to other systems available in the market. Clarity of design and the performance of technological systems should not depend on excessive craftsmanship so that flexible and economic use of labour across building markets can be achieved. A flexible programming of building process should be implemented to facilitate different demands of production, while easy-to-erect connection techniques and modular design for easy handling should be preferable engineering options to allow faster erection and use of cross-market labour.

(2) The ability to allow greater flexibility in production, assembly and use

Components and subsystems should be scalable, and subject to be coupled/decoupled as required to accommodate specific design and technological performances. Having the capacity for demountability, disassembly and reuse will allow systems to be used for different production requirements. Systems and subsystems should be also designed in such a way that discrete unit processes can be replaced with upgraded and enhanced technology as it becomes available through transfer from higher sectors.

(3) The ability to provide high tolerance for human errors of design, manufacture, assembly or use

To allow easy transfer across markets, resolution of a problem should be achieved via logic of construction and clarity of erection, without the need for care and precision in the making. When joining sub-systems together, different junctions should be allowed to accommodate diverse labour conditions. Strategies must be in place to prevent the failure of one module or element of a system from triggering a chain of failures.

(4) The ability to allow greater adaptability to social circumstances

Different permutations of products and processes need to be established, so as to give rise to different but equally valid solutions in terms of functional and social make-up of technical objects. Balancing of resources in the construction industry should be allowed, particularly by allowing users to take advantage of other users' investment in production, labour, land and machinery, thus optimizing factors' productivity. The capacity for disassembly and reconfiguration in components and subsystems should be supported, so that the same technology can respond to the changing needs of its users as well as to changing users across building markets.

(5) The ability to build workforce capacity

By implementing a mix of labour-intensive and capital-intensive processes for building production, less skilled labour can be used through limited training and modular breakdown of activities. Labour productivity should be increased by enforcing better health and safety standards, and by diminishing the extent of job casualization, fragmentation and traditional skill demarcations in the industry. The gap between operative and professional/technical skills (or informal/formal) should be reduced by translating explicit knowledge into tacit knowledge, and vice versa.

(6) The ability to establish organic links

Finally, organic cross-industry links, naturally connecting or acknowledging all participating actors, must be in place to facilitate easier transfer of knowledge across the construction sector.

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Cooperative Design Process in the Renovation Projects

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Abstract

The renovation project of an apartment building can be classified into four processes: ordering the project stage, planning stage, examination and judgment stage, design stage and construction stage. However, in the domestic renovation business, the project performance process has yet to be made systematic by stage. Of the stages involved in renovation, the design stage is the one that involves very complex roles and business processes of those involved in the project, including the project manager, architect, resident and engineer. In particular, in the design stage, the insufficiency in the ability to utilize the input information by project participants and improper decision making cause various problems in the subsequent construction and ultimately make it difficult to accomplish a renovation project that fully satisfies the residents. Therefore, the design of renovation is a very important stage to ensure a comprehensive understanding of the project performance process as well as the recognition of the design management technology. For this purpose, we aim to provide design work process in integrated respects and the role and responsibilities of every participant in the project, subject to the renovation design stage.

Keywords: Renovation Project, Cooperative Design Process, Participants Roles, Decision Making

1. Background

1.1 Research Objectives

A construction renovation project has various advantages, including cost savings, reduced project duration and minimal production of wastes in terms of resource recycling. In particular, an important factor of the performance of the renovation business is the provision of an opportunity to increase the value of the asset and create benefits through the performance improvement. On the other hand, as renovation should be performed under the controlled conditions of the utilization of existing resources, there is a limit on work space and methodology, along with the fact that recycling of the existing system should be considered and compatibility ensured. Therefore, the special, highly demanding field of building renovation requires complex factors and concrete process planning in the design stage. The major difference between renovation design and new construction design is that it is difficult to obtain the design information of an existing building, and any change in the design information occurs in the minute examination and judgment process. Moreover, the design of the structural reinforcing methodology is necessary to be progressed in detail from the design development stage. In this respect, the design management of a renovation project goes through a complex design process in which major requirements are simultaneously considered in the planning stage and the renovation workability in the construction stage.

Therefore, in this study, we aim to propose a basic project performance system for design management by analyzing the information the design work process subject to the planning →feasibility study→ design stages with various participant respects. The major contents proposed in this study are the following. First, we aim to set specific roles and responsibilities for all project participants and propose a general process for such projects in this study. Second, we will aim to establish a utilization method for the input information in order to propose an effective information management system for the renovation design in the after study.

1.2 Research Scope and Process

In this study, we aim to examine the basic process involved in a project in the renovation design stage and analyze the role and responsibility in the project of those in charge by each progressive stage. The performance method and the progress of this study are described in next paragraph. (1) Study of the process in the renovation design stage, (2) Comparative analysis work flow in the new construction design and renovation design, (3) Analysis of the roles and responsibilities of project participants at each renovation stage, (4) Constitute integrated renovation design process.

2. Design Cooperative Process and Participants

2.1 Renovation design process

A renovation design project can be classified into four stages: project ordering stage, planning stage, examination and judgment stage, design stage and construction stage. First, the examination and judgment stage involves the establishment of the remodeling requirements, preliminary examination and feasibility assessment, after which the design process begins. Renovation design has various limitations as compared with general new construction design. Unlike in new construction design on land, the considerable part of the structure of the existing building has to be maintained and the compatibility of the existing structure and facilities systems should be reviewed in consideration of performance improvement. Also, the range of renovation could be readjusted according to new conditions and situations that occurred with respect to social and economic demands. In this case, the design plan, construction technique, methodology, selection of materials should be comprehensively considered. Renovation design process differs according to the characteristics of the project and it can be always examined by design stage through job site investigation. In particular, the accuracy of the understanding of the current state regarding job site investigation is very important as it avoids later changes of order in the design and reduces such risks as reconstruction and removal, thereby ensuring an efficient performance of the project. The following Table 1 describes the major business details of the general renovation business.

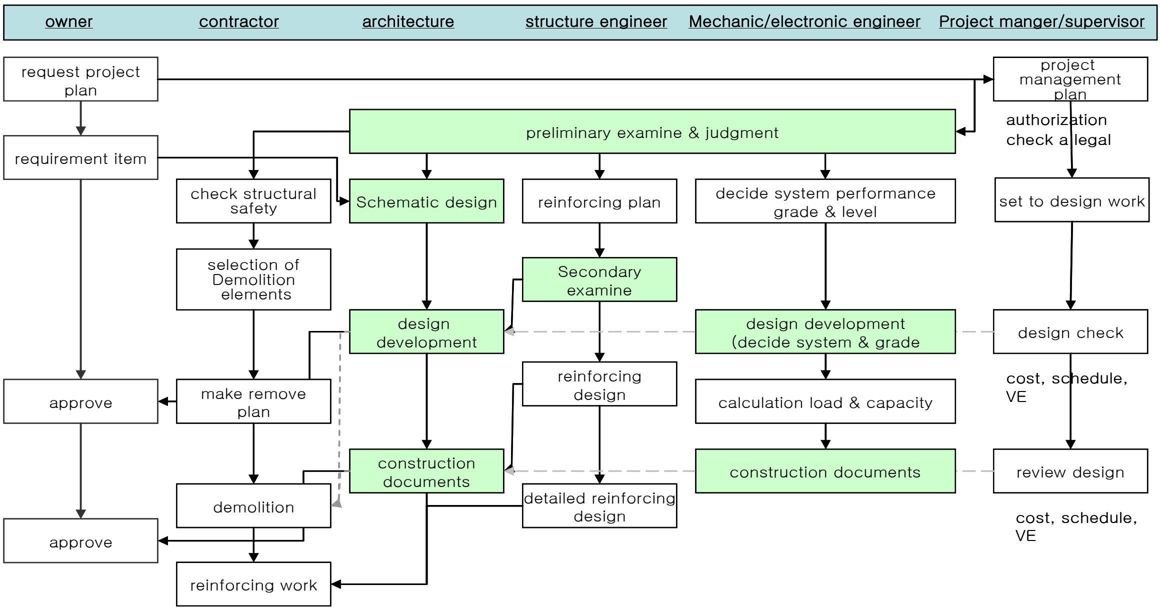
Table 1: Major business details by renovation design stage

Stage	Major Work Contents
Schematic Design	- Understanding of the renovation requirements - Review of the current status of the existing structure, performance and the plane figure - Checking of the renovation policy and plan-related items : Consideration of the pace suitable for the uses and goals of users and the establishment of the construction plan (e.g., Changing the type of stairs, extension of the floor, vertical extension and extension of the restroom and installation of new elevators) : Repair and structural reinforcement plan for structural problems arising from obsolescence. (e.g., alternative structural plan) : Setting the performance improvement rate of facilities, electricity and communication (e.g., adjusting the course of repair work and changing the plan according to the machinery facilities) - Need to review the adaptability and workability of the plan and relevant laws and regulations - Others, such as the setting of the establishment scale of the common basement space
Design Development	Concretely making the major details of the design plan - Review of the actual measurement of the plane of the jobsite and understanding of the major details of building components and checking of the bill of quantities of machinery facilities - Setting, review and application of alternatives for the plan for the removal work, change of the structural deign (e.g., drawing of the removal plan and establishment of the standards) - Advanced adjustment of the construction, structure, engineering, facilities and electricity by construction work types as well as the review of the structural design of the cooperative deign among construction works, and planning and review about the structural reinforcement methodology. (e.g., Extension of the floor structure, plan of beam and column, vertical extension, location of the stair hall, use of reinforced concrete structure or steel structure according to the parallel extension) (e.g., Establishment of new subordinate materials, enlargement of concrete placing of the section, adhesive methodology and prestressed methodology of the structural reinforcing materials) (e.g., Setting of the standards for vertical and horizontal piping and duct)
Construction Document	- Confirmation and approval of the details of the basic design - Confirmation of the uniformity and budget with the finishing methodology and structure of the design plan in various construction work areas - Determination of the structural reinforcement system and design of the structural section - Drawing and collection of bills of quantities, various other bills and specifications - Equipment and export planning related to the removal and construction

2.2 Design Process in New Construction and Renovation

Project participants in each stage of the renovation design have their own responsibilities and roles and the work is performed in consideration of their professional relationships in terms of cooperation, direction and supervision. In particular, regarding the architect, the relevance between the construction design part and the structural design is very important and structural supervision is performed separately to ensure a consistent structural review during the construction. Depending on the structural condition of the building, the extension, repair and remodeling plan is drawn and the appropriate structural construction methodology and the adhesive joints design are determined. Regarding the detailed design stage, the primary structural reinforcing plan is established in the schematic design stage. In the design development stage, structural reinforcing design is concretely made as secondary accuracy, examination and judgment, and further details are confirmed in the construction documents stage later. However, although all the aspects of the structural design are confirmed, as it is not possible to understand everything in the job site, changes and adjustments are usually undertaken during the construction, so that the exactitude of the information regarding accurate examination and judgment are considered very important. The goals and requirements of the renovation are established in the planning stage for the facilities and electrical parts. And based on the primary understanding of the project's current status, the scope and level of the renovation are determined. Eventually, the basic design alternative is established in consideration of various alternatives for system selection, assessment, and the maintenance and management afterwards. Considering the energy cost and load, among other factors in the construction documents, the plan is finally confirmed. Also, the owner and the project manager perform a design review and VE throughout the progress of the design and it finally goes through the VE review and the owner's approval. Removal works generally proceed with construction documents stage together to reduce the project's duration. In this case, a special construction methodology review for the removal of building elements related to remodeling and extension of the renovation should be considered prior to the construction documents stage. Figure 1 shows a diagram of the basic business cooperative design process of project participants.

Figure 1: Comparative Analysis Work Flow in the New Construction Design and Renovation Design



2.3 Roles and Responsibilities of the Project Participants

For the implementation of the renovation project, each project participant will have particular responsibilities and level of authority by work stage. The work to be done by the project participants must be classified so that the efficient implementation of the project can be ensured. It is difficult to implement the new construction and renovation designs without the cooperation of the project participants. Therefore, for the accurate implementation of the design, the work involved in the renovation project planning must be shared by institutions. Through this, the architect can more efficiently promote the design work and the sharing of information about the design, and the project manager can review and approve the results of the project. The following table (Table 2) outlines the responsibilities and level of authority of the project participants in the renovation design stage.

Table 2: Role and Responsibilities of the Project Participants

Phase	Work Contents	owner	project manager	architecture	contractor	occupants
Schematic Design	architecture programming	A/I	A/C	R	C	I
	make alternative plan	A	A/C	R	C	I
Design Development	decision methodology	A	A/C	R	C	I
	cooperate management	-	A/C	R	C	I
	design development VE	A/I	R	C	C	I
Construction Document	material & method decision system	A	A/C	R	C	I
	construction document VE	A/I	R	C	C	I

Explanatory notes: R: Responsibility, A: Approval, C: Consulting, I: Information

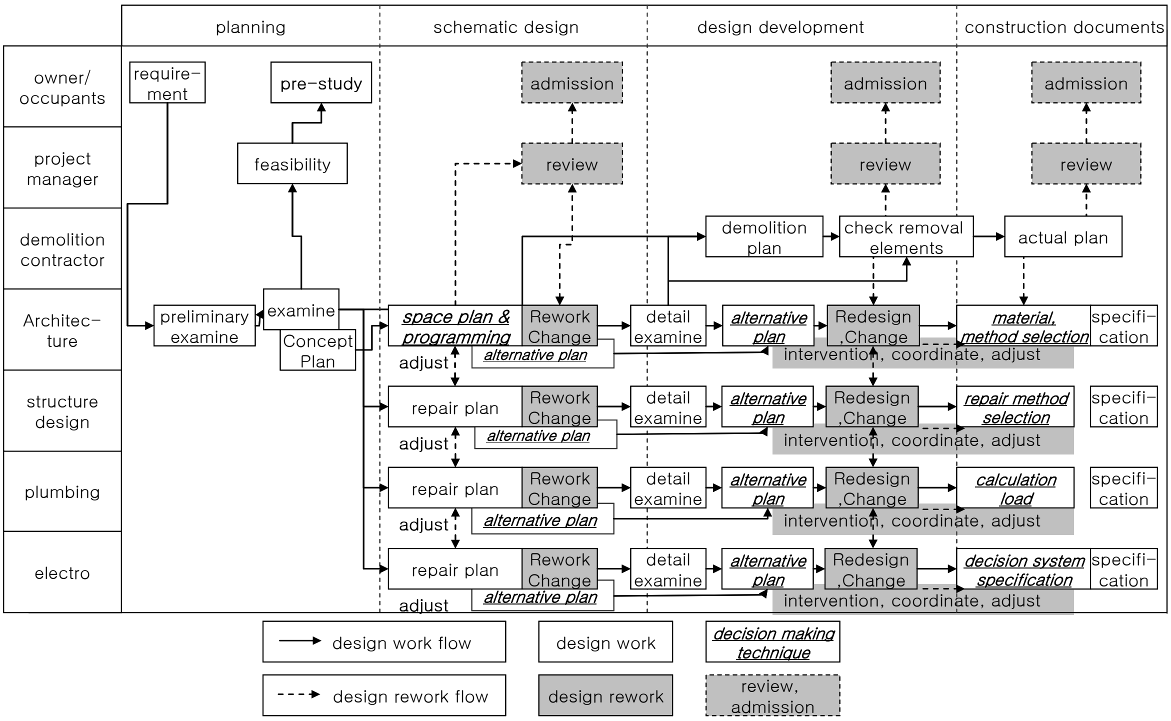
2.4 Cooperative Design Process

In the renovation planning stage, the promotion of the project is confirmed after considering the required design information as well as the results of the primary examination and judgment, and of the feasibility assessment. The schematic design stage is promoted afterwards, focusing on the construction area. The major contents of the project involve making the design concept concrete through the space plan and programming. In this process, the alternatives of each design item are determined and assessed by the architect again, and are reviewed and confirmed by the owner and the project manager. Also, the feedback process takes place in the review and confirmation stages, and the rework or change of design necessarily occur simultaneously. These serial processes are directly related to the performance and quality of the schematic design. Therefore, appropriate decision-making from the early design stage is the best preventive measure for the change of design well into the project, going beyond the projected construction cost, rework, etc.

In the basic design stage, which follows the schematic design stage, detailed secondary examination and judgment are conducted. The design work progresses by pre-screening the dimension, column space, floor elevation, and compatibility of the systems, and by considering the structure, engineering, electricity, communication, etc. in the construction work, along with the architect.

At this time, cooperative design is promoted by necessarily checking the mutual interference among construction works. Figure 2 shows a diagram of the design process's serial work process in integrated respects and by design stage.

Figure 2: Cooperative Renovation Design Process



3. Conclusions

Currently, the renovation business faces many problems due to the absence of a comprehensive evaluation system and performance assessment of a project. The design stage in the renovation phase is an important stage, to manage the quality and hit the targets of the entire project. Therefore, this study aimed to implement renovation design management system as it proposes the business processes by project performance stages focused on the design stage. As major contents of this study, it determined the roles and responsibilities of the project participants. And it presents a base study on design work process with various participant respects.

Renovation business is promoted in very various forms according to its conditions such as the characteristics of the project, the owner's ability and the job site conditions etc. Therefore, this study is expected to be utilized on the whole or in parts according to the characteristics of the project's requirement subject to apartment buildings. It is expected that consistent performance of the study will contribute to the improvement of the efficiency of the design work as it informatizes the project management system of the renovation business as well as systemizes the utilization process of the design information by the project participants.

This research performed a basic study to propose a prototype for the design management, which will boost and activate rational renovation.

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SECTION XIII

INTERNATIONAL AND COMPARATIVE LAW IN THE BUILT ENVIRONMENT

Special Features and Experiences of the Construction Industry- Arbitration in Sri Lanka

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Abstract

The construction industry in Sri Lanka covers a complex and comprehensive field of activities involving many operative skills and conditions, which vary considerably from one project to another. The dispute might arise at any point during the construction process. Generally, there is a low standard of contract formation and of contract administration in the construction industry, which lead frequently to unnecessary problems and disputes. The contract parties usually enter into a dispute as a result of differing expectations or misinterpretations of the contract documents.

Arbitration is a voluntary procedure available as an alternative resolution to litigation but not enforceable as the means of settling disputes except where the parties have entered into an arbitration agreement. In such cases the right of either party to have disputes resolved by arbitration will no doubt be beneficial to the country in the context of construction law and the foreign investment. Construction claims tend to be of the most technical nature - intensive and multifaceted than most other commercial disputes. Hence construction industry needs a fast and cost effective means for dispute resolution. The desirable features of arbitration is fast, inexpensive, fair, simple, flexibility, confidentiality, minimum delay. The main feature of arbitration is that it is consensual in nature and private in character. Sri Lanka Arbitration Act No 11 of 1995 stated various concepts or arbitration principles and UNCITRAL Model Law.

Keywords: Arbitration, Construction Industry, Special Features

1. Background

Disputes in the construction industry in Sri Lanka are normally those that arise under contracts for the procurement of supplies and services and the installation of equipment. In the early days of construction industry in Sri Lanka most disputes were settled on the job site at an informal meeting between the client and contractor with residential engineer on handshake. Nowadays construction disputes are more lengthy and complicated than ordinary civil cases in Sri Lanka. Most Arbitration Acts of world (including those following the UNCITRAL Model law) usually allow parties to change the substantive law to be applied, if it is a transactional contract. The Arbitration Act of Sri Lanka goes a little further.[1] The Sri Lankan courts refused to incorporate the arbitration agreement into a subcontract.[2] **(**Courts will in each case examine or interpret the language of the contracts in question to see whether general principles of construction are applicable. Arbitrators may keep away from writing reasons for the award and only the final decision of the Arbitrators will be enough for a valid award. This will be very useful for the settlement of disputes relevant to construction industry. Sri Lanka arbitration process has become very adversarial and very expensive. It is important to review and improve the process.

1.1 Conflicts, Claims and Disputes in Construction industry

Conflict has been defined (Collin – 1995) disagreement and argument about some thing "Serious important" and also as a difference between two or more beliefs, ideas an interests' since, conflict is 'inevitable in human relationships' (Rhys Jones) it is predictably preponderant in projects where human relationships proliferate as in construction. Figure 1 illustrates the many interacting potential sources of conflict in construction. Despite the potentially unpleasant connotations and consequences of conflict, beneficial aspects of conflict have also been recognized and conflict management has been said to be a major component in construction project management (Gardiner and Simmons- 1999).

Claim will be used to mean simply a request, demand, applications for payment or notification of entitlement to which the contractor, rightly or wrongly at that stage, considers himself entitled and in respect of which agreement has not yet been reached. Some construction claims are unavoidable and in fact necessary to contractually accommodate unforeseen changes in project conditions or unavoidable project conditions or unavoidable changes in client's priorities. While such claims may be settled amicably the prior presence of unhealthy conflict can trigger degenerations into unnecessary disputes. Such sceneries can in turn generate unnecessary and unreasonable claims that further escalate unhealthy conflict and disputes.

The possibility is also illustrated in Figure 1, which sets out the basic relationships between conflicts, claims and disputes in construction sceneries, Disputes are taken to imply prolonged disagreements on unsettled claims and protracted unresolved conflict.

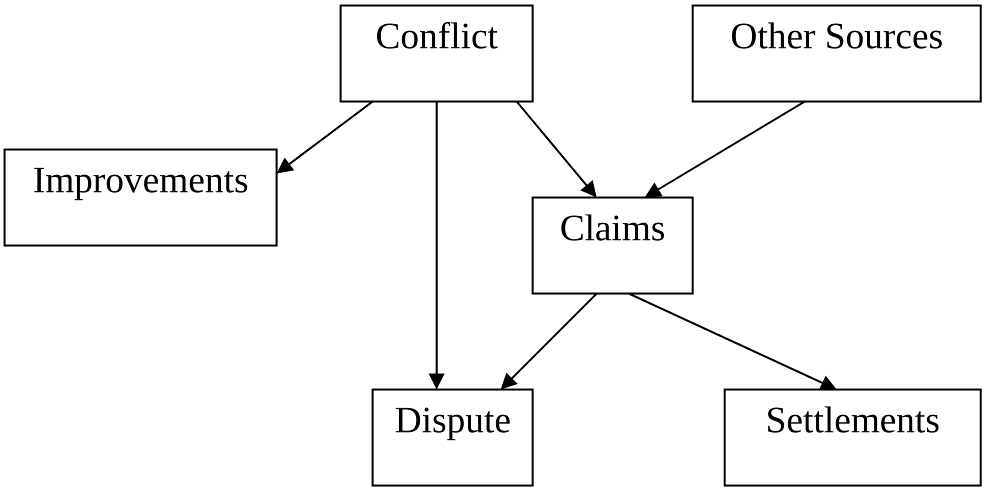

Figure 1: Basic relationships between conflicts ,claims and disputes

1.2 Reasons for construction industry disputes in Sri Lanka

Disputes in the construction industry in Sri Lanka are normally those that arise under contracts for the procurement of supplies and services and the installation of equipment. Main Reasons for disputes in Sri Lanka construction industry are namely,

- Breaches of contract by any party to the contract.
- Inadequate administration of responsibilities by the owner or contractor or sub contractors.
- Some plans and specifications that contain errors, omissions and ambiguities.
- Sudden tax and cost increase.

In the early days of construction industry in Sri Lanka most disputes were settled on the job site at an informal meeting between the Resident Engineer or owner or contractor by a handshake. Nowadays construction contract disputes are notoriously more lengthy and complicated than ordinary civil cases in Sri Lanka. Most construction disputes are resolved by negotiation. However , a dispute cannot be resolved only by negotiation between the parties. Resolution of the matter can be facilitated by the use of Arbitration techniques. Most of the contractors of Sri Lanka are unaware of the arbitration process, its benefits and low cost. Foreign investors particularly with foreign construction companies were reluctant to enter into contract agreements with local contractors due to an absence of an easy , accessible construction arbitration institute as well as specialised construction arbitrators in the country. As projects increase in size and complexity so the risks of cost and time overrun, which invariably lead to disputes.

1.3 Remedies for Breach of construction Contracts

When there is a breach of construction contract the following remedies may be available.

- A right of action for damages (the most common remedy)

- A right of action on a quantum meruit.
- A right to sue for specific performance
- A right to for an injunction.
- A right to ask for rescission of the contract.
- A refusal of any further performance by the injured party.

Construction Contract Law is part of civil law and concern the enforceability of agreements entered into between two or more persons. While all contracts are based on an agreement, all agreements may not result in contract. A construction contract is a legally binding and legally enforceable agreement. Whenever there is a breach of contract by one party, the other is entitled to bring an action for damages which is calculated in accordance with the special circumstances. Damages are the common law remedy consisting of a payment of money and are intended as compensation for the plaintiff's loss and not as punishment for the defendant. The plaintiff should not be put in a better position than if the contract had been properly performed. The aim is to put the injured party in the same financial position as he would hare been if the contract had been performed according to its terms. The client is trying to achieve the best – finished product possible within budgets, time and quality. The builder is trying to achieve this with the economic and market forces while trying to maintain builders profitability. If either party feels that the other party is hindering their goal a dispute may arise. Hence arbitration is a voluntary procedure available as an alternative to litigation but not enforceable as the means of settling disputes except where the parties have entered into an arbitration agreement. In such cases the right of either party to have disputes resolved by arbitration will no doubt be beneficial to the country in the context of construction law and foreign investment .

2. Disadvantages of litigation

Construction contract litigation is so common at present that District courts in Sri Lanka and the two Commercial High Courts in Colombo , Sri Lanka are unable to scope with the large volume of cases . The result is that today our courts are not in a position to dispense justice expeditiously to those litigants who have recourse to them .Construction claims tend to be of the most technical nature - intensive and multifaceted than most other commercial disputes. Hence construction industry needs a fast and cost effective means for dispute resolution. In this regard the Arbitration Act of Sri Lanka was enacted by Parliament of Sri Lanka, which became law on 1st August 1995. It expects to make the arbitration process more definitive, streamlined and effective. Today Arbitration is an alternative to litigation in Sri Lanka . It originated as a method of resolving disputes quickly and without legal formality.

Sri Lanka's court system and litigation method is based primarily on the British judicial system modified to some extent to suit our country's needs. After independence in 1948, the court system and litigation system was reformed to a great extent by the Administration of justice Law of 1973. Later, the Constitution of 1978 made several important changes for litigation method and these changes apply today.

District Courts have unlimited original jurisdiction in all civil litigation matters such, claims for breach of contracts ,breach of bonds and guarantees, applications for damages such as construction tort cases.

All too often the effects of litigation is ,

- Long – drawn – out proceedings (lengthy hearing)
- Cost of litigation are far too high (High legal cost)
- Wastage of the client's managerial time
- Damaged commercial relationships
- Some times judgment that is impossible to enforce .
- Use of deliberate delaying tactics by a defendant or respondent who knows how to play the system .
- Parties must comply with formal rules of procedure or evidence for litigation
- Possible over – simplification of complicated technical and legal issues

3. Advantages of Arbitration

There are several advantages in certain instances for the parties to dispute to refer it to arbitration rather than to commence an action in the courts. The principal advantages are,

- Economical – Arbitration is cheaper than a court action.
- Simplicity- Arbitration procedure is simple.
- Mutual agreement- Arbitration meetings can be conducted anywhere and at any time which is suitable for the parties. Parties do not have to wait for the court's free dates.
- When the dispute concern a technical matter such as a building contract, person chosen to arbitrate generally possess the appropriate special qualifications.
- The process can be speedier than a court case.
- There can be a saving in costs.
- Unwanted publicity can be avoided.-The arbitrator can view the subject in dispute at any reasonable time.
- Private- The entire hearing takes place in private.
- Speedily- Arbitration is speedier. A court action will take at least one or two but in arbitration can be agreed to settle the disputes within 6 months.
- Expertise- Arbitrator is normally selected for his expert knowledge but the judge will not have the knowledge of technical side of each field.

The desirable features of Arbitration is, Fast, inexpensive, fair , simple, flexibility, confidentiality , minimum delay. The main feature of arbitration is that it is consensual in nature and private in character. The concept of "Party autonomy" associated with arbitration not only allows the parties to select their arbitrators, the seal of arbitration and the rules of procedure to be followed by the arbitrators. (Article 10, 19 & 20 of the UNCITRAL Model Law) UNCITRAL – Arbitration Rules) The composition of the arbitral tribunal is critical for a good arbitration. The ability the parties have to choose their arbitrator taking into consideration *inter alia* their special expertise in the relevant field. Most countries have legislative provisions which enjoin the court to facilitate the process of constituting the arbitral tribunal. [3]

4. Arbitration Act of Sri Lanka and its Procedure

The Arbitration Act of Sri Lanka No. 11 of 1995 provides for a legislative framework for the effective conduct of arbitration proceedings as well as the most practicable or methodical mechanism for the enforcement of arbitral awards thereby making arbitration a viable and expeditious alternative to litigation for the resolution of commercial disputes. This Act treats arbitration in the field of construction without taking in to consideration the value of contract or the disputed amount.

A stated in the preamble of this Act, one of its objects is to make “Comprehensive legal provisions” for the conduct of arbitration proceedings and the enforcement of arbitral awards. The second object is to make legal provision to “give effect”, to the principles of the convention on the recognition and enforcement of foreign award of 1958 (The New York Convention).This Sri Lankan Act to a great extent follows the UNCITRAL Model Law. The Sri Lanka Act Provides that by an agreement “any dispute” can be determined by arbitration “unless the matter in respect of which the arbitration agreement is entered into is contrary to public policy or is not contrary to determination of Arbitration. [4]The Sri Lanka Act provides that an arbitration agreement shall be in writing. It can be contained in a single document or in an exchange of letters telexes, telegrams or other means of telecommunication which provide records of the agreement. It mentions challenge to jurisdiction, duties of the arbitrators , corrections and interpretation etc.

Most Arbitration Acts (including those following the UNCITRAL Model law) usually allow these parties to change the substantive law to be applied, if it is a transactional contract. The Arbitration Act of Sri Lanka goes a little further. The material part of section 24 (1) provides “An arbitral tribunal shall secede the dispute in accordance with such rules of law as are chosen by the parties as applicable to the substance of the dispute”. The construction industry appears to favour the resolution of disputes by arbitration proceedings. These proceedings enable a determination by a respected person usually from a discipline apartment from the dispute, and will be resolved in a manner, which reflects the contractual and commercial aspects of the project.

Applicable law will be the Sri Lankan Law and the proceedings should be held in the English language. Therefore parties can carefully draft an Arbitration Agreement to include Arbitration Clauses. It has to be done after careful scrutinizing the clauses that are in the English language . When there is an arbitration clause the aggrieved parties concerned cannot seek a remedy in courts because in such case the jurisdiction is ousted by virtue of the arbitration agreement. [5]

An arbitration agreement must be in the duly prescribed up or formulated form . There should be in the form an arbitration clause in Institute of Construction Training and Development/ICTAD condition of contract category provides an arbitration clause No.67 for building disputes). According to the arbitration agreement recommended by ICTAD the period for commencement of an arbitration must take place within a maximum of 90 days and in accordance with the ***Federation Internationale Des Enginieurs*** /FIDIC the maximum period to appoint an arbitrator is 154 days to arrive at the final decision. Sri Lankan present

Act does not specify a time limit .Section 48.1 of the Bidding document of the ICTAD (Guidelines of the Government of Sri Lanka) provides Arbitration clause for construction contracts . In Sri Lanka all disputes arising out of contract agreements should be dealt with in accordance with the provisions of Arbitration Act No: 11 of 1995.

FIDIC condition 1999 has introduced Dispute Adjudication Board (DAB) system as a pre-Arbitration requirement. Accordingly dispute between employer & contractor shall be referred to Dispute Adjudication Board as a pre-Arbitral step before reference same for arbitration –Clause 20 of FIDIC 1999. When there is no settlement before DAB only the same dispute can be referred for Arbitration.

As far as the nature of some contracts are concerned, involvement of more parties than two in a single dispute can be seen, e.g. involvement of employer, contractor and number of sub-contractors in construction contracts and disputes relevant to them. Construction projects usually involve sub contractors and a common problem is whether the term in a main contract, including the arbitration clause, have been incorporated into a sub contract.

The Sri Lankan courts refused to incorporate the arbitration agreement into a subcontract. Courts will in each case examine or interpret the language of the contracts in question to see whether general principles of construction are applicable.

Arbitrators may keep away from writing reasons for the award and only the final decision of the Arbitrators will be enough for a valid award. This will be very useful for the settlement of disputes relevant to construction industry. However, if the parties do not agree, the Arbitrators shall give reasons for the award under section 25 (2) of the Arbitration Act of Sri Lanka No: 11 of 1995.This Sri Lanka Arbitration Act treats arbitration in the field of construction on the same basis without making any distinction in the value of contract or the disputed amount

4.1 Arbitration institutes in Sri Lanka

Arbitration is a private means of dispute resolution whereby the parties agree to be bound by the decision of an arbitrator of their choice whose decision is final & whose award has the legal force of a high court judgment or order. In Sri Lanka there are several arbitration .They bonded with obtain the rules& they are guide how to arbitrate matters related to any field.

Same of them are,

- Institute for the Development of Commercial Law & Practice (ICLP)
- (Sri Lanka National Arbitration Centre (SLNAC)

ICLP is set up in 15th march 1995 as separate body but in 1992 it established in as corporate body under the companies act of No: 17 of 1982 of Sri Lanka. This is non-profit organization funded by sum private sector companies in Sri Lanka.

The centre provides free general information on dispute resolution by arbitration & maintains a growing library of books & publications which are available for reference to interested members of the public. The **Centre** is able to assist and make names available to potential parties who are unable to decide on suitable Arbitrators. In the event where the parties fail in agreeing on the appointment of a sole Arbitrator, the **Centre** shall act as the appointing authority. A list of qualified Arbitrators who have registered with ICLP is available for selection of arbitrators.

The Sri Lanka National Arbitration Centre is the institution in the country in the administrations of arbitration for the resolution of construction and commercial disputes. It was established and incorporated in the year 1985. The fundamental responsibility of the centre is to popularize the operation and practice of arbitration matters .

This is service by the ICCSL in Sri Lanka. The panel of SLNAC is consisted with,

- Retired judges of the court of appeal.
- Supreme Court & high court judges.
- Other professionals (Attorney-at-law, Engineers, Quantity surveyors)

5. New Trends by case decisions in Sri Lanka

Mahaweli Authority of Sri Lanka Vs. United Agency Construction (Pvt.) Ltd.[6] case was an appeal to the Supreme Court from an order of the Commercial High Court under section 37 of the Arbitration Act No: 11 of 1995 and it decided the time period necessary for leave to appeal.

In **Southern Group Civil Construction (Pvt.) Ltd Vs. Ocean Lanka (Pvt) Ltd.** Case [7] application for setting aside arbitral award under section 32 of the Arbitration Act of Sri Lanka . The need to set out in the application the grounds for setting aside the award period for making the application – whether grounds set out in written submission after lapse of that period can be considered.

These two cases were developed arbitration procedure of Sri Lanka . Hence we have seen Arbitration is a voluntary procedure available as an alternative dispute resolution method to litigation and disputes resolved by arbitration will no doubt be beneficial to the country in the context of construction law and foreign investment .

6. Loopholes of Arbitration and Recommendations

Sri Lanka arbitration process has become very adversarial and expensive. It is important to review and improve the process.[8]

Become very expensive. It is important to review and improve the process since construction is a process where people come together for a short period of time and then disburse after the construction. The proper appointment of the arbitrators with concurrence of the two parties, agreeing of the costs of arbitration. In the submission of the claim the parities have adhered to the procedure. Most professionals are not fully aware of the arbitration process. When we consider about disputes in the construction field, concerning or involving subjects relevant to Architecture, Engineering and Law , appointment of a Lawyer, Architect and an Engineer to the Arbitral tribunal may be very appropriate.

The serious criticisms against the arbitrations in Sri Lanka is the time factor. The Arbitration agreement incorporated in the ICTAD category of contract under clause No. 67 stipulates that the period within which the award should be made in 4 months, although the Arbitration Ordinance of 1948 stipulates a period of 3 months . The present Arbitration Act does not specify a time limit. Parties are free to fix a desired time period for proceeding and award the agreement. However this may be an extension if done with the consent of the parties. According to the arbitration agreement recommended by ICTAD the period for commencement of an arbitration must take a maximum of 90 days and in accordance with the FIDIC the maximum period to appoint an arbitrator is 154 days. Hence the time factor remains a major drawback in the arbitration process. Also, there are no facilities for construction arbitration other than in Colombo- the commercial capital city in Sri Lanka .

Arbitration Act of Sri Lanka (1995) should promote the formation of an association of arbitrators whose objective is to educate and train professionals in the field of arbitration and also promote special continuing development of skills of arbitrators . For example when Sri Lanka consider about disputes in the construction field, concerning or involving subjects relevant to Architecture, Engineering and Law , appointment of a Lawyer, Architect and an Engineer to the Arbitral tribunal may be very successful.

7. Conclusion

Alternative Dispute resolution methods are most popular dispute resolution methods in any legal system. Among those methods Arbitration is one of the best methods. Because of its flexibility wide range of disputes can resolve, not only the construction industry disputes, but every kind of commercial disputes without going to the court system. Flexibility in the sense, privacy & the time are the most important factors. Everyone in the business field likes to solve their controversies by having privacy to that problem & as soon as possible. So the arbitration is one of the most suitable ADR methods. Cost for the arbitration process is considerably high, but it hides automatically with its number of advantages. Sometimes there may be problems when hearing the Awards from arbitration tribunal. However clauses in arbitration act clearly describe how to react when having unexpected situations from tribunal. Arbitration is the most effective & famous method in resolving international disputes in any kind of corporation.

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The EU model: An integrated approach to water protection and management in the built environment?

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Abstract

The environment that buildings occupy cannot be divorced from the structures themselves and it is vital that consideration is given to the impact of the construction process and the subsequent occupation and operation of buildings upon the environment. Regard needs to be given not just to the physical impact of these activities, but also to the potential social and economic consequences. In the context of water protection and management, new approaches have recently been adopted that look at a more integrative approach. In particular, the Water Framework Directive represents a revolutionary shift in the way the European Union addresses water legislation. This paper considers two aspects of the Directive's possibilities to act as an integrative force. Firstly, it examines the provisions for river basin management in the Directive, in the light of modern definitions of 'integrated river basin management' and secondly, the paper aims to identify features within the Directive that contribute to effective inter-instrumental integration, integration between the individual media and inter-agency integration; all of which have been identified as key elements in achieving an overall aim of internal integration.

Keywords: Regulation, Environment, Water, Integration, River Basin Management

1. Background

The river basin concept is by no means a new one, indeed, management of water resources within a river basin framework can be traced back thousands of years to the fluvial civilisations of the Nile and Tigris-Euphrates [1]. The river basin unit provides a natural division for the consideration of water use and protection and planning in catchment areas has been a feature of legislative measures over a long period of time. One of the earliest pioneering river basin enterprises, and one that provided the prototype for others worldwide, was the Tennessee Valley Authority in the United States. This unique body took the form of a government corporation with wide-ranging powers of planning, development and operation of all kinds of projects and had, among its aims, the achievement of economic and social development goals [1]. The early ventures into river basin management featured highly autonomous corporate bodies with separate funding, responsible to central government and, although they led to a general acceptance of the river basin entity, they did not allow for the integration of stakeholders [2]. Valley authorities of more limited scope, dealing with just water supply and pollution abatement were established subsequently throughout Europe [2]. Characteristic of the European model is a composition of both local authority representatives and private enterprise and a two tier structure co-ordinated at national level but decentralised at regional/basin level [3]. The river basin concept is not alien in the United Kingdom, where administrative units have long been based upon river basins and the 10 regional water authorities created in 1973 were similar in nature to those in existence elsewhere in Europe.

Since the early days of regulating activities in river basin units, when management was purely for exploitation and usually single-use orientated, the notion of management of the river basin and its ambit and aims have changed significantly. As advances were made in engineering and technology and reliable data became available for stream and eco-system modelling, the management of water resources took on a more comprehensive character. An awareness of the interrelationships between ecological, socio-economic and political priorities and an increased ability to balance these competing interests brought still further elements into the management of the basin [4]. Over a period of time, management of the river basin unit came to adopt an eco-system approach. Following the Stockholm Conference of 1972 its scope was extended to include groundwater, and both the 1992 Dublin Conference on Water and the Environment and the 1992 Rio Conference called for comprehensive management of resources using the river basin as a focus. This theme was echoed at the World Summit on Sustainable Development at Johannesburg in 2002. River basin management entities generally now aim for 'integrated river basin management', although the terminology used is varied and somewhat confusing. Some commentators prefer to use the terms 'comprehensive' or 'holistic' [5] management and others draw distinctions between the different terms [6]. For the purposes of assessing the plans for river basin management within the Water Framework Directive, 'integrated river basin management' will be taken to include the five basic components identified by Downs et al [7], namely, water, channel, land, ecology and human activity. In addition, integrated river basin management should require consideration of all dimensions of water (surface water, groundwater, quality and quantity), the interaction between the water system and other systems (e.g. land and air) and its interaction with social and economic development [6]. This not only reflects an eco-systemic approach but also recognises the relationship between land use and water resources. Quite evidently, the idea of integrated river basin management, as it has developed and expanded in scope, has become increasingly complex, with a requirement to consider and to balance a multitude of often competing factors. In fact, it has been argued that this difficult and unwieldy task has led to disappointing results in effective management [5] and that a less comprehensive approach is necessary to gain practical success [6].

2. River basin management in the Water Framework Directive

Space does not allow for an exhaustive account of all the provisions for river basin management contained in the Directive but, in summary, the Water Framework Directive requires Member States to identify river basins and assign these to river basin districts. A competent authority with responsibility for river basin districts is also to be identified. River basin management plans are then to be produced, for which some technical specifications are provided in annex VII of the Directive. The plans are to include an initial analysis of the characteristics of the river basin, a review of human activity impact on surface and groundwater and an economic analysis of water use as required by article 5. Special protection areas are to be identified for drinking water, habitat protection, bathing water etc. and monitoring programmes put in place to provide an overview of water status. Details of the programme of measures required in article 11 to achieve the environmental objectives for good water quality status are also to be included in the plan. In essence, the plans are to provide an evaluation of existing legislation, highlighting any deficiencies and thereby indicating the measures required to address these shortcomings. They also allow for an evaluation of the cost-effectiveness of improvement measures, provide information and allow for public participation both before and after the plan production stage. The programme of measures that is to be drawn up for each river basin district will clearly be of significant importance. While seeking to attain the environmental objectives of the Directive, the programme will also take into account the analysis of the river basin district characteristics, the review of human activity and analysis of water use. However, there is no clear indication exactly what the measures contained in the programme should be. There is an obligation to include ‘basic measures’, for which a fairly comprehensive list is provided; these are clearly designed to meet the specific legislative objectives of the Water Framework Directive and other existing EU water law. ‘Supplementary measures’ are also to be adopted in cases where the ‘basic measures’ are inadequate to achieve the ‘good water status’ objective. Part B of annex VII to the directive gives a non-exclusive list of ‘supplementary measures’ with a final category of ‘other relevant measures’.

3. Integrated river basin management

It should be remembered that the outline for river basin management provided in the Water Framework Directive makes no claim to be integrated in any sense. However, the need for an integrated approach is acknowledged in the preamble of the Directive. Preamble 18 calls for co-ordination and integration of the overall principles and structures for protection and sustainable use of water, and Preamble 34, for the integration of qualitative and quantitative aspects of surface water and groundwater. Also the ‘Common Strategy on the Implementation of the Water Framework Directive’ sets out a clearly defined integrative role for the river basin management plans. How then do the provisions of the Directive contribute to the development by Member States of systems for river basin management that will be along the line of the modern, integrated approach? There is no doubt that the river basin management scheme outlined in the Directive is, in many respects, limited. In the first instance, it is restricted to water only and there is no consideration of the water system interacting with other systems. The key omission here is of any acknowledgement of the inter-relationship between water use and land use planning. The only concession to land use considerations within the Directive itself is a requirement to include, in the programme of measures, any measures required by the Environmental Impact Assessment Directive. The necessity to consider land use issues is, however, clearly identified in the guidance documents and it is also recognised by the Environment Agency in the United Kingdom in their call for ‘a clear and statutory interface between land-use planning and river basin plans’[8], which they see as ‘critical for the successful implementation of the Directive’ [8]. Specific inclusion of land use in the Water

Framework Directive was, however, always going to be problematical given the firm position traditionally adopted by individual Member States on retaining state control of planning issues, reflected in the requirement for unanimity for land use planning measures in article 175(2) and the strong reliance on the subsidiarity requirement in this area. In terms of considering the interaction between the water system and other systems, therefore, the provisions of the Directive do not contribute greatly to this feature of integration in river basin management and it will be in the hands of the individual Member States to legislate in order to tie land use into river basin management and to follow the non-binding EU level guidance in this respect.

Turning to the two other manners of contemplating integrated river basin management outlined by Mitchell [6], the Directive does, to some degree, succeed in considering all dimensions of water; both surface water and groundwater fall within its ambit, as well as transitional and coastal waters. Also, in terms of good groundwater quality, as required by article 4(1)(b)(ii) of the Water Framework Directive, status is to be determined by the poorer of its quantitative and chemical status and, as previously indicated, there is clear direction in the Directive's preamble to consider qualitative and quantitative aspects of both groundwater and surface water. It can be argued that the interaction between the water system and social and economic development is also recognised within the Directive itself. There is a requirement for the review of human activity impact and an economic analysis of water use, as well as recognition of the role of economic factors in attaining the goal of good water quality. However, the economic analysis is restricted to the carrying out of calculations to enable recovery of the costs of water services under article 9 and the impact review, although its requirements are fairly wide-ranging, looks only at the anthropogenic pressures on surface and groundwater and does not consider the social benefit or disbenefit of water protection and management. Also, a true view of the interaction between water and social/economic development would, once again, require land use planning issues to be incorporated. Clearly then, the framework for river basin management set out in the Water Framework Directive does embrace some of the features of the modern day concept of integrated river basin management. However, there are some glaring omissions, most notably a specific requirement to consider the interaction with other media, in particular with the land. Also, importantly, there is no elaboration within the instrument on how the river basin plans and programmes of measures are to serve the integrative aim. It should, however, be remembered that more comprehensive systems of integrated river basin management have been criticised for their complexity and lack of practical workability. Indeed, it has been suggested that, certainly at operational level, although an integrated approach is necessary, attention should be directed to a smaller number of variables that account for a large proportion of the problem [6]; an approach that may well be adopted by the Environment Agency in the United Kingdom. Nonetheless, land use planning should not be regarded as an expendable consideration when selecting the variables to be taken into account in river basin planning and management.

3.1 Internal integration

The framework for river basin management outlined in the Water Framework Directive could not, therefore, be said to fully match the modern approach to integrated river basin management. However, although there is no specific requirement for inter-media integration within the river basin management planning process of the Directive, there is potential for this to be fostered through various other facets of the legislation. The remaining part of this paper assesses the Water Framework Directive's potential contribution to the general end of 'internal integration'. This aim should be distinguished from that of 'external integration', which is the most common usage of the term integration in EC law terms and refers to the integration of environmental considerations into other sectoral policies and activities. Faure defines 'internal integration' as cross-media integration in decision-making [9] and contends that this is crucial for effective environmental protection [9]. He identifies two key aspects of internal integration: cross-agency integration (both vertical and horizontal) and instrumental integration. As identified above, there are undoubtedly features of the river basin management framework in the Directive that will contribute cross-media integration, but how does the Water Framework Directive deliver in terms of these other two key aspects?

3.2 Inter-instrumental integration

In order to gauge the Directive's role in inter-instrumental integration, it is necessary to step back in time and take a brief look at prior approaches to water quality law by the Community. Traditionally the EU approach was a sectoral one and legislation tended to be based on one or more of three control techniques: Where substances were considered inherently dangerous, an emissions control approach was adopted. Otherwise, quality objectives were employed and waters classified by end use (e.g. shellfish waters and bathing waters). With this second category of instruments the emphasis was on the impact of pollutants on a specified quality standard. A third group o f measures sought to regulate the activities that can result in water pollution (e.g. treatment of sewage). The first phase of early EU water legislation introduced quality objectives for drinking water, freshwater fish waters, shellfish waters, bathing waters and ground waters. The Dangerous Substances Directive on the other hand, primarily adopted an emission control approach but with a parallel alternative option for Member States to work with limit values for quality. By 1988, it was recognised by the European Commission that there were gaps to be filled. The second phase of water legislation, therefore, addressed sewage and agricultural sources through the Urban Waste Water Treatment Directive and the Nitrates Directive. Drinking water quality objectives were further tightened in a revised Drinking Water Directive of 1998. The only measure, however, that reflected an integrated approach and consideration of cross-media impacts came in the form of the 1996 Integrated Pollution Prevention and Control Directive, which looked at the impact of pollutants on all three environmental media.

The need for a more comprehensive approach to water legislation, was identified by the Council of Ministers, in 1988 and the Council then exerted pressure on the Commission who finally accepted a request to develop a new EU water policy made by the European Parliament and the Environment Committee in consultation with the Council of Environment Ministers in mid 1995. A dichotomy was recognised in the approach to EU pollution control between control at source and receiving environment quality objectives. Both approaches revealed problems; source control, on the one hand, can result in cumulative pollution load from multiple sources, whereas quality standards, on the other hand, rely on scientific knowledge as to the effect of the pollutants on the ecosystem. The Commission acknowledged that a combined approach was needed. The Water Framework Directive was the instrument designed to achieve this and to draw together and build on existing legislation in order to attain greater legislative coherence and to gain greater integration in the practical implementation of the law. In this instrument the legislators specifically aimed to achieve integration between; water quantity and water quality issues, surface water management and groundwater management, water use and environmental protection, control of pollution through emission controls and through quality objectives and between water policy and other policies.

There is a clear aim and role for the Water Framework Directive in contributing to inter-instrumental integration. The Directive, as its name suggests, sets a framework for attaining good water quality in all nature of water bodies and, therefore, consolidates by repealing (in due course) a number of existing measures dealing with specific water environments. A good many legislative instruments are kept in place, although these are firmly tied to the Water Framework Directive. The requirement to identify and make provisions for the protection of drinking water and protected areas is illustrative of the inter-instrumental integrative capacity of the Directive. Areas for conservation of habitats and species are also to be identified and dealt with under river basin management plans and, likewise, Member States are directed to ensure that waters used for the abstraction of drinking water meet the requirements of the drinking water Directives. It is interesting to note, however, that proposals to link more closely a new bathing water Directive to the Water Framework Directive have recently been rejected. The overall approach taken in the Directive, in order to tackle point and diffuse source pollution, is one of attaining the stricter standard between the legislative instruments that remain and the Framework Directive, thereby assuring a good level of integration between different pieces of water legislation. The Directive also takes a dual approach to protection of the water environment, requiring whichever is the stricter of emission standards or quality objectives to be met.

As previously noted, there is little in the Directive to link the regulation of the water system with that of other media and it is this feature of inter-instrumental integration that is crucial to the overall goal of internal integration. Apart from the consideration given to the IPPC Directive, there is no requirement to refer to legislation in the spheres of air and land and, despite the Commission's commitment in the Sixth Environmental Action Plan to the 'greening of land use planning and management decisions', there is little to tie the Water Framework Directive with instruments governing environmental impact assessment and strategic impact assessment. Once again the guidance documents are documents are not silent on these issues and advocate instrumental integration across the boundaries of the media. Whether this guidance is heeded or not will of course be a decision entirely in the hands of the individual Member States and one that will no doubt be informed by local pressures, policies and politics.

3.3 Inter-agency integration

Inter-agency integration in both directions is fundamentally dependent on the inclusion and participation of relevant stakeholders. The provisions for public information and consultation contained in article 14 of the Water Framework Directive will, therefore, be of key significance in attaining successful integration in this regard. Essentially there are three forms of public participation contained within the Directive each entailing a different degree of stakeholder involvement; information supply, consultation and active involvement. The first two of these are to be ensured and the latter encouraged. Annex VII – which dictates the content of river basin management plans - requires a summary of the public information and consultation measures taken, together with the results and any consequential changes to the plan and article 14 requires publication and availability for public comment of; timetable, work programme, statement of consultation measures, interim overview and draft copies of the plan. Background documents are also to be available on request and six months is to be allowed for comment. In terms of actual stakeholder participation in the planning process, the Directive encourages the active involvement of interested parties.

To what degree then will this stimulate inter-agency integration in the two necessary directions? In terms of vertical inter-agency integration, this can potentially be achieved by the means of active involvement of stakeholders on a multi-level basis (e.g. representatives of national, regional and local authorities) and likewise horizontal integration can be achieved by engaging stakeholders and the public in active involvement, but, as noted above, there is no absolute requirement for such a level of involvement in the Directive. The only obligations are for consultation and the provision of information, neither of which will be certain to foster inter-agency integration. Admittedly, it is difficult to legislate for the compulsory participation of stakeholders and how Member States approach the issue of encouraging active participation will be crucial in attaining the necessary inter-agency integration.

4. Conclusions

In summary, the scope of the Directive, in terms of contributing to internal or inter-media integration, is limited by its focus almost exclusively on one medium. Arguably, the Directive does have the potential to deliver on the European Commission's integrative aims in terms of bringing in all elements of water and consolidating existing legislation under a new and comprehensive piece of legislation, but it fails to succeed in inter-instrumental integration by virtue of failing to recognise the inter-relationship between water, air and, in particular, land use. The Directive does address the issue of stakeholder involvement. However, as is the case with so much of this framework measure, the comprehensive guidance on best practice in this respect is to be found in a non-binding guide to implementation. Reservations expressed by the UK Environment Agency suggest that the level of active involvement of stakeholders on either a horizontal or a vertical plane is likely to be limited.

The system of river basin management in the Water Framework Directive does not call itself integrated, but there are clear indications from both the Directive itself and the implementation guidance that an integrated system of management is envisaged. However, the task of introducing modern practices of integrated river basin management is mostly left in the hands of individual Member States, as is the option of incorporating land use issues in the planning process. It may, of course, be that there are valid practical considerations in operation here. Experience in existing river basin authorities has indicated that problems are likely to be encountered when too comprehensive an approach to river basin management is adopted at an operational level [6]. Not least of these is the time element involved and, given the timetable imposed by the Directive for production of the first river basin management plans, a fully holistic approach may well be unrealistic. Almost certainly, political concerns have been influential in the steer away from explicit mention of land use planning in the framework for river basin management provided in the Directive. It is to be hoped that some kind of statutory provision is adopted to allow for this in Member States and, of course, given the long, staged, implementation period, there is plenty of time yet to introduce more detailed requirements in future legislation. Although there is excellent and comprehensive guidance in place at EU level on integrated river basin management, it is inevitable that the systems ultimately adopted by individual Member States will vary considerably depending on the local environment and pressures.

The systems of river basin management that evolve in EU Member States may well serve the goal of ensuring that all environmental media are considered in decision-making and planning and thus achieve the internal integration that is crucial (along with external integration) for the protection and sustainable use of our water environment. However, to do so there must be integration between legislation in place in all the environmental media. Once again, measures to ensure such integration will fall to be adopted at a national level, albeit with some guidance from the European Union. The Water Framework Directive provides a skeletal outline of possibilities for stakeholder involvement that could serve the remaining key aspect of internal integration (inter-agency integration). Yet, once more, it is left to Member States to put flesh on the bones and practical difficulties and time constraints will almost certainly limit the degree of active involvement by agencies, authorities and the public. Without such involvement and the opportunity to draw in all interested stakeholders, it is unlikely that the goal of inter-agency integration will be achieved. As previously observed, these are early days in terms of the river basin planning process and it waits to be seen how systems of river basin management will develop and the degree to which Member States will make a determined effort to integrate legislation cross-media and allow active involvement of stakeholders. However, it is likely that across the European Union practice will diverge considerably as will the degree of internal integration achieved. The Water Framework Directive provides the potential, implementation guidelines fill in the gaps, but it will be in the hands of Member States to decide how best to serve the protection and management of their water resources for the future.

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Causes of Insolvency and Unethical Practices of Contractors In Pakistan Construction Industry

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ABSTRACT

A construction project traditionally involves two major professionals in the construction industry. These two professionals are the designer and the contractor. Within the industry, the contractors appear to be most at risk player. This study identifies the causes of insolvency in the construction industry and the unethical practices that may lead to such causes of insolvency in the industry. As contractors are the players who are most at risk, their inputs regarding the above issues were examined. To achieve the study objectives, a questionnaire survey was carried out to collect the relevant information. Questionnaires about issues relating to causes of insolvency and unethical practices were sent to 90 contractors. 30 questionnaires were eventually returned and ten face-to-face interviews were completed. After checking through the completed questionnaires, 30 questionnaires were found to be suitable for the data analysis. Eleven causes of insolvency were identified from the literature review in this study. These are diversification, absence of barriers, family firms, management buy-outs, cash flow problems, overtrading, poor financial control, knock-ion effect, overwhelming contract claims, imprudent diversification and onerous conditions of contract. Five issues that significantly caused insolvency of contractors in the industry were identified and explained. These are absence of barriers, cash flow problems, poor financial control, knock-on effect and onerous conditions of contract. It appears that all these five causes, with the exception of absence of barriers, can be caused by unethical practices. The study suggests that the construction industry should pay heed to ethical behaviour and practices in order not to jeopardize the financial stability of contractors in the supply chain. Special attention should be paid to the five significant causes of insolvency highlighted in this study to render the construction industry less onerous for the contractors.

Keywords: Construction, Contractors, Insolvency, Unethical practices, Pakistan.

1. Introduction

Projects are complex because they involve many human and non-human factors and variables [1]. The project process can be influenced by changing variables and unpredictable factors that could derive from different sources. These sources include the performance of the parties, resources availability, environmental conditions, involvement of other parties and contractual relations [2]. As a consequence, the projects may face problems possibly causing delay in the project completion time. It is commonly accepted that the construction industry has for many years been criticized for not developing consistent projects that are on time, within budget and with high quality standard [3]. Generally, failure to deliver successful projects has been considered in relation to schism between design and construction, lack of integration, lack of effective communication, uncertainty, changing environment, and increasing project complexity [4, 5].

Construction is a complex industry in which disputes are common, uncertainties and risks are inevitable, individual interests of parties are natural, delays are routine and cause huge loss of resources, and aggravations are an everyday occurrence [1]. Among the project players, construction contractor is the person who has to carefully look into all these matters and ensure that the project completes on time, within budget, and according to expected quality standards [6]. Most of the disputes, as numerous researchers have established, are due to lack of communication and coordination interface management in the design phase [7]. This deficiency leads to difficult access of working area and conflicts in the requirements of various subcontractors during construction, and a design that does not deliver an end product that satisfies the Client [8, 9].

The term “insolvency” means the financial failure of individuals and companies and their position before and after the start of a formal insolvency procedure [10]. There are two different categories of insolvencies, namely short term insolvency and long term insolvency. The former means that there is a cash flow crisis where not enough money is coming in to meet a company’s outgoings and the latter means that the company is able to pay its debts as they fall due but its balance sheet shows a deficiency of assets over liabilities [11].

Contractors in the building industry are known to have low profit margins, low fixed assets and low capital but high cash flow and high return on capital employed [12]. Financing of contractors is generated internally from positive cash flow and retained profits and externally from short term finance, which is usually an overdraft repayable on demand. The short term finance will be able to support items such as working capital, stock and work in progress. However, for growth, there is a need for long term external finance in the form of equity investments and long term loans.

The unique nature of the construction industry has caused a large number of insolvencies each year [6]. Due to high interest rates and a generally poor economic climate, significant financial pressures are imposed on many companies in the construction industry. Companies with high levels of borrowing and an insufficient capital base are therefore forced into liquidation. The construction industry always ranks high among the annual number of liquidation. There are two striking features of insolvency in the construction industry [13]. Firstly, a fifth of the bankrupts were builders. Secondly, the building trade is the only sector that has displayed obvious vulnerability towards insolvency.

Within the industry, the contractors appear to be most at risk player. A study by Burnett [14] suggests that apart from being one of the easiest industries to join, the construction industry is also one of the easiest in which to fail. It can also be safely assumed that the highest proportion of failures is in small sub-contracting companies.

Besides coping with economic and financial pressures, the contractors must also tackle profit squeezing from main contractors who abuse their rights to set-off, give late and insufficient interim payments and the introduction of onerous clauses into the forms of sub-contract [15]. In addition, the sub-contractor is less able to manage his accounts accurately. Furthermore, if the main contractor becomes insolvent, the sub-contractor will become an unsecured creditor and hence may also become insolvent due to cash flow problems.

The objectives of this study are first to identify and examine the causes of insolvency in the construction industry and second to identify and examine unethical practices that may lead to causes of insolvency in the construction industry in Pakistan.

2. Causes of Insolvency

Eleven causes of insolvency in the construction industry were identified [16, 17, 18]. These are discussed below:

2.1 Diversification

Many contractors diversify in order to use the cash earned from contracting higher profits, create assets as security for loans and seek financial stability by venturing into businesses that are counter-cyclical to construction. Whether the move was into property or into sub-contracting and materials supply, failed acquisitions undermining the financial health of a group were common [1, 19].

2.2 Absence of Barriers to Entry

Due to the ease of entry into the construction industry, there is a proliferation of small firms with little management expertise in the industry. In addition, the general lack of financial barriers to entry has created an industry where market forces are most ruthless [1, 19]. There are just too many contractors in the industry. This leads to the tendering of projects by small contractors who are not capable of doing the job. They become insolvent when they cannot manage the job.

2.3 Family Firms

Given the absence of a need to raise equity funds from shareholders, there are many family firms of contractors in the industry. The predominance of family firms has also contributed to a significant level of financial failure in the industry. This is because ingrained attitudes lead to financial complacency and an inability to adapt to a changing construction market [19, 20].

2.4 Management Buy-Outs

Management buy-outs have been a common exit from receivership as these provide a more feasible solution than in other industries. However, there have been cases where a management buy-out was soon followed by receivership due in part to the high level of debt that is required to finance. It may be possible to plan the receivership by appointing receivers to the parent company, allowing the target company to continue trading while a buy-out is negotiated [5].

2.5 Cash Flow Problems

Nearly all companies that went into solvency do so because of cash flow problems. Cash flow is more of a problem in the construction industry than in any other industries due to the fact that when tied to a fixed price contract, normal market forces are immobilized [5, 14]. It has been shown that cash flow problems are largely responsible for the high level of insolvency in the construction industry [21].

Construction is a labor intensive industry. Whether the contractor has been paid or not, the wages of the worker must still be paid. Cash flow is the lifeblood of the industry. Too often, people concentrate on whether they are making a profit. However, if this profit is tied up in debtors or work in progress and there is not enough left over to pay the bills, then that profit is of little utility.

Contractors frequently experience sharp decline in demand leading to reduced turnover and loss of cash flow. In the economic recession of the 1990s, excessive competition has forced many contractors in the UK to tender at below cost. Tenders for long term contracts were based on prices for contractors and materials whose prices have rose thereafter. These shortfalls cannot be sustained by the unstable sources of finance used by the contractors. Cash reserves built up in previous years were lost and contractors have to turn to their bankers and shareholders for support [19].

The situation for contractors is very much similar to the main contractors. It can even be worse especially when onerous contract clauses such as “pay-when-paid” and the “right to set-off” are in operation.

2.6 Overtrading

Another avenue, which small companies, like the contractors, can run into serious cash flow problems is when the company is growing faster than the capital base it can support [5]. A sub-contractor may or may not be receiving the monthly interim payments from the main contractor. However, during the month, he still needs to pay for materials, hiring of plants and equipments, overheads, labor wages, as well as loan repayments and other debts. The funds need to be drawn from the capital base since most of the sub-contractor’s money will be tied up in stocks, trade debtors and work in progress [14].

There can be a situation where the company has expanded so quickly that it finds that all its cash are tied up in stocks, trade debtors and work in progress. As a result, the contractors will have no money left to pay for additional materials, labor wages, hiring of plants and equipment and to make loan repayments to the bank. Although the company's assets may outweigh its liabilities, it is however unable to pay its debts and hence become insolvent [14, 20].

2.7 Poor Financial Control

Successful contractors do well in cash control and management. They employed highly sophisticated techniques of cash flow forecasting and monitoring. A well managed contractor maintains detailed financial, cost and management accounts which allocate cost in as much details as possible to specific contracts and to individual elements within them. Unfortunately, many contractors in the industry fall short of this practice [4].

Many contractors become insolvent due to the lack of proper accounts in their organizations. They fail to collect debts, especially retentions; thus allowing these to accumulate until their delays made them difficult to collect later. The adage of strategic cash flow is to "collect early and pay late". However, late payment is a two-edged sword [4]. It is serious problem and a contributory factor to the large number of insolvencies in the construction industry [19].

2.8 The "Knock-On" Effect

The majority of contractors in the industry are small firms with just a few employees. Small firms often fail because of the financial failure of another company which is further up in the supply chain. A significant number of insolvencies occurred as a direct result of the insolvency of another party [20]. This is known as the "knock-on" effect. There are three aspects related to this effect.

First of all, the knock-on effect is felt up and down the supply chain. The insolvency of a contractor in the chain may bring down a series of contractors and suppliers. However, it may also cause the failure of an employer due to the contractor's failure. Secondly, the effect can be felt across different companies in the same group. As for the third aspect, the effect can be experienced across industrial sectors to cause a major impact on the country's economy. The construction industry is cyclical and experiences boom as well as bust periods. A sharp decline in the market will reduce the demand for construction work which will cause insolvency among the contractors. The decline will be felt by contractors, suppliers and manufacturers of plants and equipments. Hence, a slump in house-building will inevitably lead to a contraction in demand for home furnishings, household appliances and Do-It-Yourself (DIY) services [19].

2.9 Overwhelming Contract Claims

If a construction contract goes wrong, it will go badly wrong. An exceptional claim against the contractor under one contract can be enough to cause insolvency. One such example is liability for liquidated damages due to failure to complete works on time. The greatest danger is when management is forced to concentrate on one problem contract and the effort to extricate the company forces it to draw resources from the rest of the company or group [2, 19].

2.10 Imprudent Diversification

Many contractors look to other sectors and businesses in search of higher profits. During the 1980s, many contractors were tempted into property development for this reason but have since withdrawn from the sector or worst of all, become insolvent [19]. Diversification can also be achieved by moving from one method of procurement to another. Insolvency could also result from an acquisition which turns out to be a financial liability. Substantial sums can be incurred in supporting a new subsidiary, even by means of orderly wind down of its activities, and in litigation to recover losses from the vendor. For some, the urge to build an empire in the industry is just too strong. Hence, much insolvency has resulted from corporate aggrandizement.

2.11 Onerous Conditions of Contract

When a sub-contractor submits a quotation for a contract to be "as per standard form of sub-contract", he will often receive an acceptance that is "subject to standard terms and conditions" of the main contract. Many a times, the sub-contractor does not want to be burdened with the conditions of the main contract. However, because he does not want to lose the job, the sub-contractor frequently has no choice but to accept [14]. Some examples of onerous conditions include use of "pay-when-paid" clauses; making contractors liable for their works until practical completion of main contract works; excessive retentions and discount percentages; and right to hold back money on one contract for unproven faults on other sub-contracts.

3. Unethical Practices

There has always been a general agreement that insolvency will result in a loss of time and cost [4, 22, 23, 24, 25]. However, this view does not appear to be universally accepted. One client asserted that he could actually make money out of a contractor's insolvency during the course of the contract [26, 27]. This could come about in three ways. Firstly, since clients usually pay in monthly installments, there would frequently be some payments outstanding at the time of the contractor's insolvency. Hence, a client who has doubts as to the contractor's financial position may well have deliberately withheld payments. The outstanding amount, coupled with the value of work undertaken since the last monthly valuation, means that the client is typically in possession of a six-week "buffer" [26].

Secondly, the client may be legally entitled to claim for its management time expended in dealing with the problems caused by the contractor's insolvency and to set-off this amount against the funds held, before handing them over to the judicial manager. Many clients appear to have done so [26].

Thirdly, there are contractors who are keen to impress new clients and may often take on the completion of a contract at cheaper rates for works that have been stopped due to a contractor's insolvency. The procedure adopted by the receiver of an insolvent contracting company is that the bids are invited from other contractors to buy the workload of the insolvent contractor. This means that the successful bidders will have to pay the receiver for the right to take over the insolvent contractor's part-completed contract, either through a process of novation or by entering into a separate contract for the outstanding items of works. Under a novation, the successful bidder will take on the responsibility to the client for the work already carried out by the insolvent contractor but if this is unacceptable, a separate contract will be used. However, in either circumstance, the contract under which the new contractor buys the workload from the receiver is entirely separate from the construction contracts between the new contractor and the clients, who will not normally be aware of the price agreed [27].

Normally, the receiver will insist that all the unfinished contracts must be taken over. The receiver will also attempt to tie each bidder to a "confidentiality agreement" which prevent them from making a direct approach to the clients under the relevant contracts. In deciding on how much to offer, the contractors will have to assess the value of the unfinished contracts to them. This value usually consists partly of the money representing work already carried out which is still held by the employer. There may also be resources on site which belonged to the insolvent contractor and the receiver may be prepared to include them in at an advantageous price. The new contractor will not take any responsibility for debts due to contractors or suppliers. These parties will take their place as unsecured creditors of the failed contractor [26]. From the client's point of view, the advantage of the procedures described above is that it enables completion of the contract works and in some occasions, it may be possible to secure completion at the same price and at the original or a sensibly re-negotiated date [2, 27].

4. Research Methodology

The research instrument used in this study is a questionnaire. Section A of the questionnaire is the demographic information section. Section B of the questionnaire consists of eleven causes of insolvencies in the construction industry. The survey was carried out only on contractors in Pakistan. Because the population of contractors in Pakistan is too large to be covered completely, sampling has to be carried out first before the survey can be conducted. Before the actual survey was carried out, the questionnaire was pre-tested with two contractors. The selected respondents have industrial experience of more than five years. The purpose of the pre-test was to obtain feedback on the questionnaire. Amendments like rewording, reconstruction of the sentences and omission of repetitive questions were made to improve the questionnaire.

A total of 90 questionnaires were sent to contractors randomly chosen, together with a covering letter explaining the purpose of the study and assuring them of anonymity. A self addressed, postage paid envelop was supplied with each questionnaire. The questionnaires were mailed to the president, vice-president, general manager or estimating manager of each company. Recipients of the letters were asked to complete the questionnaire themselves or to pass it to someone else in their company who are qualified to respond.

In addition to sending out the questionnaires, ten face-to-face interviews using the questionnaires were also used to ensure that all questions are answered and the respondents have a chance to clarify any doubts with the interviewer. 30 questionnaires were eventually returned and ten face-to-face interviews were completed. After checking through the completed questionnaires, 30 questionnaires were found to be suitable for the data analysis. This yielded a response rate of about 30%.

Descriptive statistics such as cross tabulation and mean ranking were used to describe and summarize the data. In addition, one-sample-test was employed to compare and find out the most significant issues that may cause insolvency in the construction industry.

5. Background of Respondents

32 contractors responded to the survey and 10 face-to-face interviews were completed. After checking through the completed questionnaires, 30 questionnaires were found to be suitable for data analysis. This yielded a response rate of about 33.33% as shown in Table 1.

Table 1 Survey response rates

Respondents	**Questionnaires sent**	**Responses received**	**Working experience**	**Valid responses**	**Percentage**
Contractors	90	32	1 – 4 yrs	3	10%
			5 – 10 yrs	12	40%
			11 – 15 yrs	11	36.66%
			15 yrs <	4	13.33%
Total	90	32		30	100%

Of the 30 respondents, 21% were Grade 1 contractors and 79% were Grade 2 contractors. Only 13.33% of the respondents were in the group of 1 to 4 years working experience. A majority of the respondents fall in the group of 5 to 10 years experience in the construction industry, which is about 40%. About 36.66% of the respondents were in the group of 11 to 15 years experience and 13.33% were with more than 15 years experience in the construction industry. Respondents who were in the group of more than 11 years of working experience in the construction industry were very likely to be better able to assess the causes of inconsistencies between the design and construction more realistically. As for those who were in the group of 1 to 10 years working experience, their assessment of the causes of inconsistencies was also a good representation.

As shown in Table 2, 60% of the respondents were project managers. 30% of the respondents were senior managers. 10% of the respondents were directors of their organizations. As a majority of the respondents were professionally positioned at management level or higher, a certain level of accuracy in the data collected was assured.

Table 2 Professional respondents' statistics

Respondents	Appointments	Responses received	Percentage
Contractors	Directors	3	10%
	Senior Managers	9	30%
	Project Managers	18	60%
Total		30	100%

6. Analysis Of Issues Causes Insolvencies

The questionnaire listed eleven issues that may cause insolvencies in the construction industry. Each respondent was asked to rate each issue according to how frequently they thought the issue will occur in the construction industry. In addition, the respondents were also asked to rate whether unethical practices will lead to the occurrence of each issue.

For the causes of insolvency, a score of 1 means that the issue never happen and a score of 5 means that the issue happens very often. The mean scores of these eleven issues are shown in Table 3. Of the eleven issues surveyed the five most frequently occurring issues that may cause insolvency are: diversification, imprudent diversification, management buy-outs, family firms and overtrading. Both diversification and imprudent diversification have the highest mean of 3.63. This may be because many local construction companies appear to lack commitment in their core businesses. Many local companies have become insolvent because they do not focus on their core construction businesses. They tend to diversify into other construction-related works. Worst still, the moment they have made enough profits, they will diversify into an area of work which is not related to construction at all. Many local construction companies appear to be very profit-oriented in the short term. Management buy-outs rank in third place with a mean of 3.57. Many construction firms, especially the larger ones, have become insolvent after they acquired another company with financial difficulties. The associated debts were simply too much for them to bear.

Table 3 Frequency of causes of insolvency

Causes of Insolvency	Mean	Variance	t-value
Diversification	3.63	0.37	5.64
Absence of barriers	3.23	1.15	1.19
Family firms	3.53	0.60	3.76

Management buy-outs	3.57	0.25	6.15
Cash flow problems	3.27	0.75	1.68
Overtrading	3.50	0.67	3.34
Poor financial control	3.30	0.97	1.66
Knock-on effect	3.27	0.82	1.61
Overwhelming contract claims	3.43	1.15	2.21
Imprudent diversification	3.63	0.79	3.89
Onerous conditions of contract	3.27	0.89	1.54

Many construction companies are actually family firms that have been around for many years. Firms that are family-run seem to be more resistant to changes. This resistance may be a cause for insolvency.

The critical point for t-distribution, having a degree of freedom of 29 and level of confidence of 95 percent, is 1.699. Table 3 shows the t-value results that have been generated using the one-sample t-test. From Table 3, it can be noted that out of the eleven possible causes of insolvency in the construction industry, only five of them are significant. These are absence of barriers, cash flow problems, poor financial control, knock-on effect and onerous conditions of contract. All these five causes have t-values lower than the critical value of 1.699. These five significant causes of insolvency are discussed below.

6.1 Absence of Barriers

Absence of barriers to entry in the construction industry has always been an important issue because of the ease of entry into the industry by companies who are not even professionally trained to do construction related works. 22 respondents viewed the absence of barriers to entry as a characteristic that does occur frequently within the industry that may cause insolvencies. Only 27 percent of the respondents opined that it rarely occurs within the industry.

Unlike other economic sectors, the construction industry does not restrict players from entering the industry although the Pakistan Engineering Council (PEC) maintains a registry for contractors in Pakistan. This registry is only for companies to list themselves for them to know which category of public sector projects they are financially qualified to tender for.

During a boom period, many companies will be keen to have a slice of the pie in the construction industry. However, in an economic downturn, companies which are not financially strong and do not have enough technical expertise in this area of work risk ending up insolvent.

The survey suggests that the absence of barriers to entry is a significant cause of insolvency in the construction industry.

6.2 Cash Flow Problems and Poor Financial Control

The next two significant issues that may cause insolvency in the industry are cash flow problems and poor financial control. Cash flow problems have always been a critical issue in the construction industry. The results from the survey showed that many respondents felt that cash flow problems have a higher chance of causing insolvency than other issues listed in the questionnaire.

80 percent of the respondents agreed that the cash flow problem is indeed occurring and that it has caused insolvency in the construction industry. Similarly, 73 percent of the respondents have rated poor financial control within companies as a significant contributing factor that may cause insolvencies. Out of this 73 percent, 37 percent of them rated it as a factor that often leads to insolvencies, especially during an economic recession. The reason is that subcontractors are unable to get their money back from the main contractors. Consequently, this leads to cash flow problems which eventually cause the bankruptcy of small contractors.

6.3 Knock-On Effect

The next contributing factor that may cause insolvency of contractors is the knock-on effect. This is a factor that is felt especially by contractors along the supply chain of contracts.

The downfall of a main contractor leads to the subsequent downfalls of other contractors. This is because the survival of contractors is usually dependent on the main contractors. The main contractor will usually tender out parts of the main contract to various contractors. Most contractors are paid on credit basis. Therefore, if the main contractor becomes bankrupt, the contractors, being unsecured creditors, will not be able to get their money back for any work done earlier. Hence, they may end up insolvent as well. 80 percent of the respondents felt that the knock-on effect is indeed one of the significant contributing factors affecting insolvency in the construction industry.

6.4 Onerous Conditions of Contract

The last contributing factor rated by the respondents for causing insolvency is onerous conditions of contract. 77 percent of the respondents linked onerous conditions of contract to insolvency. This is because the contractors will receive an acceptance of his offer to work as a sub-contractor for the main contractor "subject to standard terms and conditions of the main contractors".

Although the sub-contractor does not want to be burdened with such onerous conditions, he frequently has no choice but to accept them. Otherwise, he risks losing the job by objecting to them. Subject to such onerous conditions, many contractors were unable to survive and eventually become insolvent.

Some onerous conditions of contracts include “pay-when-paid” clauses, the contractors being liable for their works until practical completion of the main contract works, excessive retentions and discount percentages and last, but not least, the main contractor’s right to hold back money on one contract for yet to be proven faults on other contractors.

The “pay-when-paid” clause is one of the most onerous conditions of contract. It transfers the risk of a client not paying the main contractor to the sub-contractor. It provides some form of protection for the main contractor should the client becomes insolvent but at the expense of the contractors.

7. Unethical Practices And Insolvencies

Besides asking the respondents to rate their opinion on which issues they think would mostly cause insolvency, they were also asked to rate whether unethical practices will lead to the occurrence of these issues. The results from the survey are shown in Table 4 where it can be noted that out of the 30 respondents, 21 of them who think that absence of barriers to entry into the industry has caused insolvency in the industry have also felt that unethical practices do not lead to the occurrence of this issue.

Table 4 Cross-tabulation of causes of insolvency and unethical practices

Causes of Insolvency and Unethical practices	**Unethical Practices**		
	Yes	**No**	**Total**
Absence of barriers	9	21	30
Cash Flow problems	25	5	30
Poor financial control	20	10	30
Knock-on effect	27	3	30
Onerous conditions of contract	21	9	30

From Table 4, 25 of the 30 respondents felt that the issue of cash flow problems may be due to unethical practices within the construction industry. This is because cash flow problems have always been a critical factor that affects insolvency in the industry. Furthermore, cash flow problems within companies often occurred due to unethical practices such as failure to get back the debts owed etc.

From Table 4, 20 out of the 30 respondents felt that unethical practices have caused poor financial control resulting in insolvency. Like cash flow problems, poor financial control is often due to unethical practices as well. Some examples of these include the deliberate delay of payment by the main contractor even though the sub-contractor has finished the work and submitted the claim.

The frequency of unethical practices leading to the knock-on effect is high. In Table 4, 27 respondents, or about 90 percent, hold this view. This is because knock-on effect is a factor that occurs when one's action will affect another party. Hence, main contractors who are unethical in their daily scope of work will affect the survival of the contractors who are at the bottom of the supply chain. One example is payment delays by the developer to the main contractor who will then not be able to pay the contractors.

As shown in Table2, 21respondents felt that unethical practices do lead to onerous conditions of contract. This is because the respondents, who are contractors, felt that they were bound by onerous conditions of contract such as "pay-when-paid" clauses, making them liable for their works until practical completion of the main contract, excessive retentions when they accept the offer from the main contractor, etc.

The mean rankings of the six unethical practices for the five significant causes of insolvencies are shown in Table 5. For quantifying unethical practices, a score of 1 means "most likely" and 6 means "most unlikely" were used.

From Table 5, it can be noted that for "absence of barriers" to entry, the respondents felt that it is likely to be caused by an unethical practice that fail to reconcile with the sub-contractor's concerns (mean score of 2.81). As for "cash flow problems", the respondents felt that these are likely to be caused by the unethical practice of the main contractor deliberately delaying payments (mean score of 1.93).

As for "poor financial control", the respondents may feel that it is likely to be due to the misrepresentation of financial status by the main contractors (mean score of 2.17). This suggests that the main contractor may have created an impression for the contractors in making them think that they are financially stable when in actual fact, they are not.

Table 5 Mean scores relating to issues of unethical practices

Causes of Insolvency and Unethical practices	**Absence of barriers (Mean Rank 1)**	**Cash flow problems (Mean Rank2)**	**Poor financial control (Mean Rank3)**	**Knock-on effects (Mean Rank4)**	**Onerous conditions of contract (Mean Rank 5)**
Delaying of payments	4.19	1.93	2.71	1.67	3.24
Mishandling of sensitive information	2.94	4.41	4.13	4.59	3.38
Improper estimating practices	3.00	4.10	4.17	3.56	4.10
Abuse of resources	4.13	4.03	3.83	3.70	3.38
Failure to reconcile with subcontractor's concerns	2.81	4.34	4.00	3.67	3.05
Misrepresentation of financial status	3.94	2.17	2.17	3.81	3.86

The respondents may feel that "delaying of payment" is likely to have resulted in the "knock-on-effect" which in turn, caused insolvency in the construction industry. As shown in Table 5, this has a mean score of 1.67. Every player in the construction industry is somewhat connected contractually. Hence, if one of the players, especially the main contractor, deliberately delays payment to the contractors, this may result in the contractors running into cash flow problems and becoming insolvent. Last but not least, the respondents suggest that the failure of the main contractor to reconcile with sub-contractor's concerns has resulted in the occurrence of "onerous conditions of contracts" with a mean score of 3.05 in Table 5. This appears to be the case because most main contractors are profit-oriented to the detriment of others.

8. Conclusion

Out of the eleven possible causes of insolvency in the industry, five were identified as most significant causes by the respondents. These are the absence of barriers to entry, cash flow problems, poor financial control, knock-on effect and onerous conditions of contract. All these five significant causes have a response rate of more than 70 percent.

In addition, the respondents also perceived that all these five significant issues that will cause insolvency may occur because of unethical practices. According to the respondents, unethical practices such as deliberately delaying payments, misrepresentation of financial status, etc. are likely to lead to the occurrence of insolvencies among contractors.

On another note, 70 percent of the respondents have also rated the overall behavior in the construction industry as unethical and that this seems to be a major problem in the industry. In addition, more than 70 percent of the respondents have rated main contractors as unethical. Hence, it appears that some causes of insolvency arose because of unethical practices.

The research revealed that unethical practices are major cause of insolvency of contractors in Pakistan construction industry. It is therefore important for the construction industry as well as main contractors to pay heed to ethical behavior and practices in order not to jeopardize the financial stability of contractors in the supply chain. Special attention should be paid to the five significant causes of insolvency highlighted in this study to render the construction industry less onerous for the contractors. Further, it is also strongly suggested that proper code of ethics and professional conduct be developed. This would assist in addressing the undesirable state of the construction industry in Pakistan.

Finally, as this study only surveyed contractors, future works can be extended to survey the consultants on the ethical behavior and practices of the client.

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Contractor's Right to Stop Work on Non-Payment: A Comparative Perspective from Hong Kong

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Abstract

Cash flow is the lifeblood of the construction industry worldwide. Yet, unlike many other jurisdictions, Hong Kong does not yet have any security of payment legislation or any solid plan for the same. Hence, the right of contractors to stop work and terminate the contract in case of non-payment is essentially a matter still regulated by the ambit of the common law. In the circumstances, such unique features of Hong Kong also present a case worthy of investigation from a comparative perspective, in respect of the contractor's dilemma as to whether to continue working without payment.

Through reviewing recent case examples in Hong Kong and other jurisdictions, this paper examines and compares the legal landscapes regulating the right to stop work on the part of contractors in non-payment situations. In addition, it also seeks to highlight those factors affecting the exercise of such a right that those who find themselves in such situations, or those who need to deal with such situations should be alerted to, in order to guide appropriate approaches to their resolution.

Keywords: Non-payment; Security of payment; Repudiation of contract; Hong Kong

1. Lifeblood in Construction Industry

The construction industry in Hong Kong has gradually recovered from the economic recession in the past 3 years. This however does not necessarily mean that getting paid the right amount in a timely manner, will no longer be a problem for contractors. Indeed, there are some common features inherent in the worldwide construction industry, that make securing cash flow a vital aspect to the survival of every contractor in the business. The construction industry is an industry characterized by operations often with limited capital backing. Construction activities are often subject to a high level of risks and tender prices are inserted with significant uncertainties on the basis of technical and financial assumptions affecting the ultimate pricing; contractors are paid in arrears and capital funding for the works by overdrafts, trade credits or other interim means as the works progress is almost unavoidable. Most of the contractors are unsecured creditors of the parties whom they have contracted to work for, and, hence the cascade of payments from the project owners from the top downward is critical for the cash flow to all concerned. Indeed, as in many other jurisdictions, the typical organization of construction projects in Hong Kong is somewhat pyramid-like in structure. The project owner enters into contract only with a main contractor that sub-contracts out some or a substantial part of the actual works to various sub-contractors while retaining in itself the administrative and supervisory tasks. The various sub-contractors may well in turn further delegate the actual tasks of execution of the works to others. This chain of sub-contracting can go on much further. As observed in a April 2005 paper of the Environment, Transport and Works Bureau to the Hong Kong Legislative Council, it is remarked that: "*Sub-contracting is a common practice in the construction industry. If properly managed by contractors it will facilitate the execution of works in a cost-effective manner with efficient use of resources. However, in the absence of proper management, uncontrolled subcontracting could have adverse impact on the progress and quality of works, not to mention the adverse public image on Government.*". Thus, the inherent features of the construction industry, when coupled with the extensive use of further sub-contracting, renders cash flow critical for most small and medium sized contractors these days and, if payments are held up, it can be enough to tip them over the edge. This is the case in Hong Kong; this is also the case elsewhere [i].

'Non-payment' here is meant to cover situations where there is lack of correct or timely payment or refusal of total payment from the employer or upper tier contractor during the progress of the works, whether such payments are genuinely disputed or otherwise. When faced with the situation of non-payment during the progress of the works, the contractor has a huge dilemma to handle. Some standard forms of contracts in Hong Kong have provided for the termination by the contractor's giving notices to the employer in cases on non-payment. However, similar provisions are seldom found in sub-contracts in Hong Kong and it is not uncommon for such provisions to be deleted from the contracts in some private sector jobs. The contractor may naturally wish to suspend or stop the works pending receipt of proper payments. This, without express contractual entitlement to do so], is often a breach or even a repudiation of the contract. Repudiation means a fundamental breach that goes to the root of the contract and has the effect that, once validly accepted by the innocent party, it discharges the innocent party from further performance of the contract and to sue for damages immediately. As laid down in the case of *Hongkong Fir Shipping Co. Ltd. v. Kawasaki Kisen Kaisha Ltd.* [ii], as held by Diplock L.J., the test on whether an event which discharges one of the parties from further performance of his undertakings is this: "*Does the occurrence of the event deprive the party who has further undertakings still to perform of substantially the whole benefit which it was the intention of the parties as expressed in the contract that he should obtain as the consideration for performing those undertaking*s?".

Hence, in such circumstances of non-payment, there are competing considerations. Many construction contracts in Hong Kong do provide that disputes are to be resolved by arbitration and arbitration shall not be proceeded with until the completion of the works. See, for example, the Agreement and Schedule of Conditions of Building Contract for Use in Hong Kong (1976 Ed.) by the Hong Kong Institute of Architects and Royal Institution of Chartered Surveyors (Hong Kong Branch), which is still popularly used in the private sector. Also, with the nature of some payment disputes, they are not always suitable for resolution by summary judgement even if the disputes can be brought before court. Thus, on the one hand, if progress payments are not forthcoming, the disputes over such payments may need to be referred to litigation or arbitration, which can take months, if not years to resolve [iii]. Also, payment disputes are also complicated by the use of "pay-when/if-paid" clauses in the construction industry, allegations of defective works or delay to completion of the works, and set-off or abatement claims for contra charges or other deductions [iv]. This means effectively that such disputes cannot be resolved within a short time and no cash flow can be inward coming. Therefore, the contractor has to rely on its own means to finance the works if to continue the works. On the other hand, the contractor is often still under an ongoing obligations to proceed with the works with diligence to meet the agreed progress or programme. Failure in meeting these obligations is usually visited with deduction of damages for delay, whether liquidated or otherwise, and a right of the employer or upper tier contractor to terminate the contract and sue for consequential losses, where the contractor simply suspends or stops working on site. In such circumstances, instead of getting paid for the works done, the contractor may be held liable for damages for the delay and extra costs for the completion of the works by others. Accordingly, 'invalid' suspending or stopping the works all together, can expose the contractor to disastrous consequences.

2. Legal Landscapes for Right to Stop Work

This dilemma arises from the common law position as regards the right (if any) of a contractor to stop work, treating the contract as terminated, if not getting timely and correct progress payments as agreed in the contract. The starting point for this can be that there is no general right in common law to suspend work if payment is wrongly withheld. This is illustrated in the classic case of *Lubenham Fidelities & Investment Co. Ltd. v. South Pembrokeshire District Council* [v]. The employer in this case withheld interim payments by deducting liquidated damages on wrongful advice by the architect. The contract was in the JCT 63 form. The contractor wrote to terminate the contract for such a breach and ceasing work on site. This led to the employer sending out determination notices for the contractor's ceased works without reasonable cause and the contractor also served notices to terminate the contract for the employer's failure to effect interim payments as certified, also issuing a writ. The UK Court of Appeal held that the contractor, who was indeed the bondsman who choose to take over the contract to perform it rather than paying on the performance bond, had repudiated the contract by ceasing works without reasonable cause notwithstanding that the employer were wrong in deducting liquidated damages at that stage. Thus, by serving the notices of termination for non-payment and issuing a writ thereafter, the contractor was held to have indicated an intention not to be bound by the contract, leaving the employer with no alternative but to accept the repudiation. In giving the judgment of the court, May LJ said: "*Whatever be the cause of the under-valuation, the proper remedy available to the contractor is, in our opinion, to request the* *architect to make the appropriate adjustment in another certificate, or if he declines to do so, to take the dispute to arbitration under clause 35…*".

Also, in *Mersey Steel and Iron Co. v. Naylor, Benzon & Co.* [vi], it was held that on the facts of the case the party which had postponed an installment payment under erroneous advice had not shown an intention to repudiate the contract so as to release the other party from further performance. In the judgement of Earl of Selborne L.C., it was stated that "*You must look at the actual circumstances of the case in order to see whether the one party to the contract is relieved from its future performance by the conduct of the other; you must examine what that conduct is, so as to see whether it amounts to a renunciation, to an absolute refusal to perform the contract, such as would amount to a rescission if he had the power to rescind, and whether the other party may accept it as a reason for not performing his part.*" Therefore, how the legal consequence of a breach is to be ascertained is regarded as a matter to be determined primarily from the terms of the contract itself, and the facts and practical results of the breach have to be examined to see whether it will go to the root of the contract and accordingly amount to repudiation. As noted in *Decro-Wall International S.A. v. Practitioners in Marketing Ltd* by Salmon L.J: "*The contract may state expressly or by necessary implication that the breach of one of its terms will go to the root of the contract and accordingly amount to repudiation. Where it does not do so, the courts must look at the practical results of the breach in order to decide whether or not it does go to the root of the contract.*"[vii].

This approach has support from also the New Zealand case of *Canterbury Pipe Lines Ltd. v. The Christchurch Drainage Board* [viii] where McMullin J. held that: "*It is true that where a stoppage in payments is temporary only, in the sense of being no more than delayed rather than withheld, the contractor's rights may not extend beyond a right to sue the employer. There may be some cases in which the contractor can treat the stoppage as repudiation. Much will depend on the facts.*"

However, the difficulties associated with this approach for an innocent contractor is that non-payment, in itself, does not normally amount to a repudiation that can be relied on to discharge the innocent party from further performance of the contract. All the circumstances have to be assessed to search for an intention not to be bound by the contract on the part of the defaulting party. Indeed, a contractor in such situations is further faced with the risks and consequences of a wrongfully terminated contract or stopped work, when the non-payment is merely a breach and not sufficient to become a repudiation, whereby entitling the innocent contractor to sue for damages for the breach associated with the non-payment and, normally, merely to recover interest for late payment. . In that case, the 'innocent' contractor can be liable for wrongful repudiation of the contract by its act.

Uncertainty and complications in this regard are further highlighted by the cases like *James Shaffer Ltd. v. Findlay Durham & Brodie* [ix], *Sweet & Maxwell Ltd. v. Universal News Service Ltd.* [x] and *Woodar Investment Development Ltd. v. Wimpey Construction U.K. Ltd.* [xi], which firmly lay down the principles that a party who *bona fide* relies upon an express provision in a contract in order to rescind or terminate a contract, should not, by that fact alone, be treated as having repudiated his contractual obligations if he turns out to be mistaken as to his rights.

Partly to cater for these problems associated with non-payment, legislative solutions have been introduced in various common law jurisdictions, starting from the enactment of the UK Housing Grants, Construction and Regeneration Act 1996. A statutory right to suspend works on non-payment of contractual sums otherwise due is conferred on a contractor engaged in a construction contract by virtue of section 112 this 1996 Act. When a sum due under a construction contract is not paid in full by the final date for payment as regulated by Sections 109 to 113 of the 1996 Act, this right becomes exercisable by giving 7-day notice of intention to suspend performance, stating the ground(s) on which it is intended to suspend performance, unless an effective notice to withhold payment has been given to the contractor. This right to suspend work continues until the party in default makes payment in full of the amount due. For calculating time under the construction contract, any period during which performance is suspended in pursuance of the right conferred by this section shall be disregarded in computing for the purposes of any contractual time limit the time taken, by the party exercising the right or by a third party, to complete any work directly or indirectly affected by the exercise of the right. By requiring the use of notice to withhold payment, no one may withhold payment of money due to the other party without giving him advance notice of the intention to do so [xii]. Further, contract conditions which provide that pay-when/if-paid arrangements are also prohibited except in circumstances where the non-payment arises from insolvency of the upper tier payer [xiii]. Coupled with the use of statutory adjudication for interim binding resolution of disputes [xiv], the 1996 Act aims at reducing disputes in construction contracts and moving them upstream for resolution as early as practicable, on a provisional interim basis [xv].

Since 1996, legislation similar to the above have been enacted in various other common law jurisdictions. These include the Building and Construction Industry Security of Payment Act of 1999 in New South Wales, of 2002 in Victoria, of Queensland in 2004, and the Construction Contracts Act 2004 in Western Australia; the Construction Contracts Act 2002 in New Zealand; and of the Building and Construction Industry Security of Payment Act 2004 in Singapore. In Malaysia, a legislative move towards the enactment of the Construction Industry Payment and Adjudication Act 2007 is also in progress. Though operational details differ, all of these models of legislation have, *inter alia*, one common feature --- a mechanism to confer a statutory right on the contractor to a construction contract to suspend carrying out of the works when payment due is not effected in time [xvi].

Of course, every solution can breed new problems. For instance, in respect of the UK Housing Grants, Construction and Regeneration Act 1996, disincentives for exercising the right to suspend work are observed. These are centered on the costs of suspension and include considerations for the costs of suspending and remobilising performance, under a construction contract, the inconvenience and cost of remobilising immediately upon payment of the outstanding debt, and the inconvenience and cost of having to suspend all obligations under the contract [xvii]. Reviews and ways for improving the current legal regime created by these legislation are indeed ongoing [xviii]. However, the popularity of security of payment legislation being adopted across various jurisdictions indicate that payment problems, while not unique to the construction industry, are often seen to be worse in this industry than in others. The multi-tiered industry hierarchy, the low capital backing of contractors, the heavy reliance on cash flows to sustain business, and the not uncommon criticism for not maintaining consistently high standards of ethical conduct in the worldwide construction industry also are features of the construction industry in Hong Kong [xix]. However, as the matter now stands, Hong Kong does not yet have any security of payment legislation or any solid plan for the same. Hence, from the perspectives of common law principles, Hong Kong is a case worthy of investigation, from a comparative perspective, in respect of the contractor's dilemma as to whether to continue working without payment.

3. Approach in Hong Kong

Obviously, the starting point of a contractor's right to stop working on non-payment must be the contract.

As an illustration, clause 26 of the Agreement and Schedule of Conditions of Building Contract for Use in Hong Kong (1976 Ed.) by the Hong Kong Institute of Architects and Royal Institution of Chartered Surveyors (Hong Kong Branch) ("the HKIA/RICS Form") provides for the usual two-notice procedure for determination of the contract by the contractor for non-payment of certified payments. This entitles the contractor to give to the employer the initial notice stating that a notice of determination will be served if no payment of the certified amount is made within the next 7 days and the sending out of the notice of determination thereafter. There is a proviso that no such notices can be served unreasonably or vexatiously [xx]. To validly exercise such a right to bring the contract to an end, the contractor is generally required to strictly comply with all the stipulated procedural requirements, e.g. as to the timing and format of the notices [xxi]. Termination of the contract under clauses like this is often described as contractual termination, as distinct from common law termination, when repudiation exists to discharge the innocent party from further performance of the contract. . It is well settled that contractual termination co-exists with common law termination, as illustrated in *Trident Engineering Company Limited v. Mansion Holdings Limited* [xxii] ,where, applying *Lockland Builders v. Rickwood* [xxiii], it was held that, in deciding clear express words must be used to rebut the presumption neither party intends to abandon any remedies for its breach arising by operation of law.

In respect of terminating the contract at common law, the Hong Kong Court of Appeal has in a recent decision reviewed the governing legal principles. This is the case of *Creatiles Building Materials Company Limited v. To's Universe Construction Company Limited* [xxiv], an example of repudiation at common law arising out of non-payment of progress payments. The facts of the case arise from a sub-contract to apply spray coating to a building. The spray was to be applied to the four elevations of the building in five coats on each wall. Under the sub-contract, the contractor was to pay a 10% deposit upon signing of the agreement, 30% upon materials delivered on site, and the "…*balance by each 14 days interim payment during work-in-progress*". There was no problem with the deposit and the 30% payments. After commencement, the contractor did not settle the sub-contractor's debit note for 20% of the balance of the contract price due based on the progress of the spraying works, in breach of two subsequent promises to pay. Through its lawyers, the sub-contractor wrote to the contractor stating that if payment was not made by a certain time, it would treat the sub-contract as having been repudiated by the contractor. No payment was effected but the contractor wrote back stating that the reason for non-payment was that all five coatings to one elevation had to be completed before the sub-contractor could claim payment. The sub-contractor therefore left the site and claimed for repudiation of the sub-contract on the part of the contractor. At first instance [xxv], it was held that the non-payment by the contractor amounted to repudiation, entitling the sub-contractor to terminate the sub-contract. The contractor appealed arguing that the non-payment was not a fundamental breach amounting to repudiation and that the mere fact that it had insisted on its rights, even though it might have been wrong about them, was not to be treated as evincing an intention to repudiate the contract.

In the judgement of Cheung JA, the Hong Kong Court of Appeal re-affirmed the general principle, as a starting point, that there was no general right in common law to suspend work if payment was wrongly withheld but also accepted that the authorities clearly recognised that a deliberate refusal to make an interim payment was capable of amounting to a repudiation of the contract. After review of cases in other jurisdictions, the Court of Appeal concluded that "*…[u]ltimately one has to examine the facts of the case to see whether the non-payment amounted to a repudiation*", stating that "*…[t]he principle is to consider whether the circumstances of the non-payment show an intention not to be bound*". In applying this approach to the case, the Court of Appeal took into account the facts that the contractor was clearly required to make interim payment every 14 days; that the contractor was in breach of its promises twice to effect the interim payments; that the contractor, by its letter in response, expressed a clear refusal to pay for the work by unilaterally changing the payment method under the sub-contract. It was also observed in the judgement that: "*While it would not pay for the interim payment, it would expect the plaintiff to carry on with the work. In other words, the payment term would be changed from cash payment to that of credit payment. This clearly entitled the plaintiff to treat it as a repudiation.*" To the defence that the contractor was merely insisting on its own, although mistaken, interpretation of the sub-contract, the Court of Appeal was of the view that "*…it may not be a repudiation for one party to put forward his genuine, but bona fide, interpretation of what the contract requires of him but that where that party performs in a manner which is not consistent with the terms of the contract, it is no defence for that party to show that he acted in good faith*". In this case, the Court of Appeal also observed that, when the sub-contractor started work, the contractor was obviously aware that the plaintiff's method of working was to apply one coat to all the four elevations first before applying the next coat; and the contractor had never indicated that this method of work would disentitle the plaintiff from receiving the interim payment even after the debit note was presented. Thus, the defence of the contractor was rejected as there was indeed far from being a *bona fide* misconstruction of the terms of the contract and the reasons given were considered to be spurious reasons.

The approach of *Creatiles Building Materials* has been considered in a subsequent case of *Hongkong Underground Engineering Ltd. v. Welcome Construction Co Ltd* [xxvi], which concerns a specialist sub-contractor in underground tunneling work. The facts of the case are not uncommon. Under the sub-contractor, interim payment arrangement was to be effected via invoice submitted before the end of each calendar month with payment to be paid within 30 days of receiving invoice. The sub-contractor applied in its first invoice for HK$324,400 and the contractor, via its own assessment, calculated an amount of HK$169,800 but paid only HK$100,000 eventually. In likewise manner, the contractor paid over HK$150,000 for the second invoice, which claimed for HK$338,000 and was assessed by the contractor to be HK$288,000. For the third invoice, the contractor paid in full its assessed amount but with a delay for more than 2 months. No further payments were made in the fourth and fifth invoices. The sub-contractor wrote to the contractor stating that its non-payment evinced an intention no longer to be bound by the contract. To this, the contractor indicated that reasonable sums were withheld for liquidated damages that might be imposed.

In his judgement, Sakhrani J was of the view that the figures of HK$100,000 and HK$150,000 were without contractual basis and, using his words, "*…simply a figure plucked out of the air without any calculation…*" and, applying *Shyam Jewellers Ltd. v. Cheeseman* [xxvii], it was held that the 'potency' and legal effect of the concerned breach was to be judged in the light of the seriousness of the breach and its effect upon the continuing performance of the contract and this involved an examination of the circumstances of the breach itself as well as its implications for the future of the contract and any likelihood of repetition. In finding that the contractor did evince an intention not to be bound by the contract, it was also stressed, in doing so objectively, the court could only concern itself with the reasonable perceptions and reactions of the party asserting a repudiatory breach and it would not take into account concerns or fears, which, however naturally entertained, were not justifiably grounded in the actions and intentions manifested by the party alleged to be in repudiatory breach.

4. Factors for Review

The legal approach that can be drawn out from the above cases is quite clear, though the application may be more complicated as being highly facts-sensitive. What matters most in deciding whether there is a repudiation for non-payment, thereby capable discharging an innocent contractor from continuing the work, depends on an evinced intention not to be bound by the contract, rather than the mere fact of non-payment itself.

From the above, there appear to be certain indicators or factors to watch out for when practitioners in Hong Kong are facing the dilemmas highlighted in this paper, and risk consequences as a result of not getting paid in respect of interim or progress payments. These factors will be extracted from a range of cases and presented in another forum, given space limitations herein. The factors derive themselves from common law and, as such, should also be applicable or of guidance effects in other common law jurisdictions, which have enacted security of payment legislation though it is expected that the need to resort to common law termination in non-payment situation should not be frequent in those jurisdictions. However, some examples of the key factors and indicators to consider from a Hong Kong perspective are highlighted as below. It is stressed that these are neither meant to be nor capable of being exhaustive.

Examples of the above factors are:-

- Whether there is clear indication of refusal or inability to effect future payments;
- Whether there is a repeated pattern to pay the correct amount despite warnings;
- Whether there is a repeated failure to pay on time despite warnings;
- Whether payments already effected is of amounts with certain contractual basis;
- Whether there is response or reasonable response to support the refusal or default in payment;
- Whether there is prior or subsequent inconsistent knowledge or conduct against the alleged *bona fide* reliance upon the payment term to refuse timely or correct payment, based on mistaken understanding of the concerned term;
- Whether the reliance upon the understanding of payment term to refuse timely or correct payment is or otherwise can be *bona fide*;
- Whether there are other consequences evincing an intention not to be bound by the contract.

5. Conclusions

Among the common law jurisdictions, Hong Kong remains one of the few that does not yet have any security of payment legislation. The right of contractors to stop work and terminate the contract in case of non-payment is essentially a matter still regulated by the ambit of the common law. From reviewing recent case examples in Hong Kong and other jurisdictions, some factors affecting the exercise by the contractor of the right to stop work in non-payment situations can be identified and are presented in the format of a checklist of questions. In view of the uncertainties and risks surrounding the exercise of such a right, it will be prudent for those facing such dilemmas to prepare such a checklist, based on the contract conditions, governing legislation and precedents, in order to better assess and respond to such situations, avoiding pitfalls and effectively protecting the legal rights and interests of themselves or their clients.

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Impact of the ‘Security of Payment’ Act in New South Wales on clients, contractors and subcontractors

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Abstract

The *Building and Construction Industry Security of Payment Act 1999* (NSW) (‘the Act’) was introduced primarily to improve security of payment for small scale subcontracting firms. Nevertheless, the aim of the study was to examine the impact of the Act on subcontractors, contractors and clients in New South Wales (‘NSW’). Data for the study comes from a review of relevant literature by authors in the ‘security of payment’ field, on-going research by the authors, data collected and published by the NSW Department of Commerce, and face-to-face interviews conducted by the authors with three expert adjudicators in NSW. From subcontractors’ perspective, the impact of the Act has been largely a positive one with subcontractors’ being highly successful at adjudication. Contractors’, on the other hand, have been exposed to ‘ambush’ claims by subcontractors, which is viewed as an unintended result of the strict time demands the Act places on the parties. Whilst no direct evidence is available to reliably establish the impact (if any) of the Act on client organisations, there is an emerging trend that clients’ most commonly schedule to pay $nil in response to payment claims. Further research is needed to establish the reasons for this trend.

Keywords: Adjudication, Impact, New South Wales, Security of payment

1. Background

1.1 Introduction of the Act

The main reason for the introduction of the *Building and Construction Industry Security of Payment Act 1999* (NSW) (hereafter referred to as ‘the Act’) was to improve security of payment of small scale subcontracting firms by eradicating the practice of clients and contractors of arbitrarily delaying or denying payment [1]. While subcontractors are seen as the main benefactors of the Act, the provisions of the Act also extend to contractors, suppliers of materials and suppliers of services, who also experience security of payment problems. The only party excluded from the provisions of the Act are clients who enter into a construction contract for the carrying out of residential building work whereby the client resides in, or proposes to reside in, the residential building.

It is generally accepted that parties to the construction industry who seek payment under a construction contract for work carried out, services rendered or materials supplied experience consistent failure in receiving payment [2]. This practice not only affects profitability of those parties but it also causes serious cash flow problems particularly to smaller firms [3].

The Act sets out to "ensure that any person who undertakes to carry out construction work or who undertakes to supply related goods and services under a contract is entitled to receive, and is able to recover, progress payments in relation to the carrying out of that work and the supplying of those goods and services" [4]. The provisions of the Act are designed to reduce or eliminate delay in payment by introducing a range of revolutionary measures such as: a statutory right to progress payment; the use of default provisions for progress payment in the absence of express contractual provision; nullifying the effect of 'pay when paid' and 'paid if paid' clauses in a contract; introducing a fast process of notification and adjudication where a claim is disputed; giving security for a disputed payment when so determined by an adjudicator; and giving a claimant a statutory right to suspend work and the right to lien over unfixed materials [5].

The Act is the first security of payment legislative scheme introduced in Australia. It is based on the philosophy of rapid adjudication of payment claim disputes introduced in the UK in the form of the *Housing Grants, Construction and Regeneration Act 1996*. However, the NSW Act is substantially different in its structure and operation from its UK counterpart. Following the NSW example, similar legislative schemes have since been introduced in Victoria, Queensland, Western Australia, New Zealand and Singapore, with Malaysia planning to introduce its own legislation in the near future.

This paper examines the impact of the Act on the main parties to the New South Wales construction industry, namely, subcontractors, contractors and clients. Data for this paper comes from the literature review, on-going research by the authors and the information on the operation of the Act published by the NSW Department of Commerce.

1.2 Overview of the Act

The Act establishes a law that operates separately from, but in parallel with, a construction contract. A claimant of a progress payment claim may elect to seek a payment claim under the contract or under the Act. A payment claim, which is not endorsed as a claim under the Act, is processed strictly in accordance with the provisions of a contract. However, a payment claim endorsed as being made under the Act gives the claimant access to powerful provisions of the Act, which, in some cases, over-ride terms of a contract. The parties are unable to 'contract out' of the Act [6]. The Act applies to any construction contract, whether written or oral, or partly written and partly oral [7]. The provisions of the Act include, *inter alia*: a statutory entitlement to progress payments regardless whether the relevant construction contract makes provision for progress payment [8]; nullifying the effect of 'pay when paid' and 'paid if paid' clauses in a construction contract [9]; imposing a fast process of notification leading to adjudication of a payment claim where a claim is disputed [10]; giving a claimant a statutory right to suspend work [11]; and giving a claimant a statutory right to exercise a lien over unfixed plant or materials supplied by the claimant [12].

The Act provides a mechanism for resolving payment claim disputes in a quick and inexpensive 'adjudication'. This involves having the matter determined by a neutral adjudicator and ensuring that an adjudicated amount of payment claim is recoverable by the claimant.

The Act intended that an adjudicator's determination as to payment of a progress claim was to be merely interim pending final determination of the dispute in other proceedings. The intent was, however, misunderstood by the NSW courts in the first few years of the operation of the Act, insofar as the courts regarded an adjudicator as a quasi-judicial tribunal and decisions of adjudicators as final. For reason of error of law the courts set aside many adjudication determinations. The decision of the NSW Court of Appeal in *Brodyn Pty. Ltd. trading as Time Cost and Quality v Philip Davenport & Ors* [2003] NSWCA 394 reinstated the original intent of the Act and consequently removed the possibility of setting aside adjudication determinations for reason of error of law. However, respondents have been successful in exploited other apparent ambiguities in the Act upon which the courts continue to declare adjudication determinations void. This issue lies outside the scope of this paper and will not be discussed any further. The evolution of the security of payment law in the NSW construction industry can be found in Uher & Brand [13].

The Act requires that if the respondent disputes the claimant's payment claim, which the claimant endorsed as a claim under the Act, the respondent is required to provide the claimant with a 'payment schedule' within 10 business days of the claim being served. The payment schedule is a written response to the payment claim in which the respondent details the reasons for withholding payment. If the respondent chooses not to provide a payment schedule and not to pay the claimed amount by the due date for payment, the claimed amount becomes a 'statutory debt'. The claimant may then either: (a) proceed to recover a statutory debt due in a court of competent jurisdiction; or (b) to have the dispute determined by an adjudicator.

In case the claimant chooses to have a payment dispute determined by an adjudicator, the claimant is required to issue a notice to the respondent that the claimant intends to have a payment claim dispute referred to adjudication. By virtue of the notice, the respondent is given a second chance to provide a payment schedule within 5 business days. Thereafter, the claimant would lodge and adjudication application to the Authorised Nominating Authority (ANA) within the time specified in the Act. The ANA will appoint an independent adjudicator to determine the payment dispute. Only if the respondent has issued a payment schedule, the respondent is permitted by the Act to substantiate the reasons for withholding payment in an adjudication response lodged with the adjudicator. Not later than 10 business days of the adjudicator's acceptance to adjudicate the matter, the adjudicator will issue to the parties an adjudication determination.

If the respondent fails to pay the adjudicated amount to the claimant within the time specified by the adjudicator, the claimant may request the ANA to issue a certificate of adjudication. When filed in a court of competent jurisdiction, the adjudication certificate automatically becomes judgement for the adjudicated amount, without the need for a summons or a hearing.

Furthermore, the Act provides a claimant with a right to suspend work pending payment, and a right to exercise a lien over unfixed plant or materials supplied by the claimant to the extent of the unpaid amount of the progress claim.

Observance of the strict time constraints in which claimants, respondents and adjudicators are required to operate is the essence of the Act. The consequence of non-compliance with the time constraints may result in rights, otherwise available to claimants and respondents under the Act, being lost [14].

2. Impact on Subcontractors

The underlying objective of the Act is to give subcontractors (as claimants) a right to make, and a process to recover, progress payments. Subcontractors, particularly the small ones, are expected to benefit most from the provisions of the Act. Because of their limited financial resources, they are commonly unable to pursue recovery of progress payments through arbitration, litigation or other dispute resolution mechanisms under the contract and apart from withdrawing labour services, have no other means of recovering delayed payments. Needless to say, unscrupulous contractors are able to take full advantage of financially weak subcontractors by delaying or devaluing payments without good reason.

Payment claims that fall under the provisions of the Act are those that have been endorsed as payment claims under the Act. Thus, claimants are free to decide whether or not they intend, should the need arise in the future, to rely on the Act in pursuing recovery of a progress payment.

To be able to exercise the option of either endorsing or not endorsing a payment claim under the Act, a claimant needs to be familiar with the Act and its provisions. According to Brand & Uher [3] this is not always the case as small sized subcontractors are often the least knowledgeable group of claimants of the essential requirements of the Act. They reported that only 33% of the subcontractors surveyed endorsed payment claims under the Act.

Accepting that the aim of the Act was to improve security of payment of predominantly subcontracting firms operating in the NSW construction industry, it was anticipated that subcontractors would be the most frequent claimants under the Act. This hypothesis was verified by the literature. Two surveys carried out by the authors in NSW show between 53% and 71% of all claimants to be subcontractors [15]; [16], while in Queensland, where almost an identical security of payment legislation operates, subcontractors account for around 63% of all claimants [17].

While subcontractors are mainly claimants under the Act by virtue of being near or at the end of the supply chain, it is possible that where they further sublet work under their subcontracts, they may become respondents to payment claims made by their sub-subcontractors. The Queensland experience shows that this occurs in only about 4.7% of cases. No statistics on this issue are available for NSW. However, unpublished research by the authors suggests that subcontractors account for up to 10% of respondents.

Statistics published by the NSW Department of Commerce [18] show that claimants are highly successful in adjudication under the Act. The data shows that claimants are fully successful (i.e., they receive the full amount claimed) in about 43% of all adjudication determinations and that they receive at least a half of the claimed amount in about 74% of all adjudication determinations. On average, for all adjudication determinations made in NSW, claimants receive around 70% of the claimed amount.

The Department's statistics also show that claimants making smaller claims are more successful than those making larger claims; see Table 1. For example, for payment claims less than $5,000 in value claimants recover on average around 89% of the claimed amount, while for large claims of over $750,000 in value they only recover on average 24% of the claimed amount.

Table 1: Average claimed, scheduled and adjudicated amount

Range of claims determined (AUD)	Av. Claimed (AUD)	Av. Determined (AUD) (% of Av. Claimed)
< 5,000	2,920	2,604 (89.2%)
5,000 - 9,999	7,318	6,582 (89.9%)
10,000 - 24,999	16,688	13,300 (79.7%)
25,000 - 39,999	31,968	25,816 (80.8%)
40,000 - 99,999	63,634	44,714 (70.3%)
100,000 - 249,999	159,381	99,446 (62.4%)
250,000 - 499,999	350,963	256,112 (73.0%)
500,000 - 749,999	620,672	327,014 (52.7%)
≥ 750,000	9,456,585	2,291,368 (24.2%)

Considering that a majority of claimants are subcontractors, the above statistics clearly confirms that subcontractors are highly successful in adjudication under the Act, particularly those making smaller payment claims.

Because of their high rate of success in adjudication, subcontractors (as claimants) are not expected to pay a high share of the adjudication fees. Although no statistics are available for NSW, Uher & Brand [16] reported that only around 5% of claimants and 79% of respondents were required to pay the full amount of adjudication fees. In the remaining cases the parties shared the cost of adjudication. They also reported that it is common practice among adjudicators to require the losing party to adjudication to pay the full amount of adjudication fees. The Queensland experience suggests that claimants pay on average 23% of the adjudication fees and, for payment claims under $5,000, as low as 1.42% [17]. The Queensland statistics shows that claimant's share increases with an increase in the amount claimed. For example, claimants' share of the adjudication fee with regard to payment claims in excess of $50,000 is on average around 30%. This indicates that claimants are less successful in securing a satisfactory outcome from adjudication of large payment claims.

In-depth knowledge of the Act not only help subcontractors (as claimants) to comply with relevant provisions of the Act in their effort to improve the probability of a successful adjudication outcome, but it may also encourage them to use the Act to their advantage. Kennedy [19] alludes to the 'ambush' scenario employed by claimants in the UK construction industry. He describes two instances of ambushes: (i) when a payment claim is made against the respondent at the most inconvenient time for the respondent or (ii) when a claimant makes a payment claim prepared over a period of time, which is supported by a large volume of information and documentation.

There is no published information available which would confirm presence of the above two instances of ambushes in NSW. However, there is no shortage of anecdotal evidence indicating the prevalence of ambush claims being made under the Act.

For the purpose of gathering data on the issue of ambushes, the authors conducted face-to-face interviews with three expert adjudicators in NSW. The adjudicators interviewed agreed anonymously that the practice of ambushes is ripe in NSW. Specifically, they identified the period just prior to Christmas shut-down period as being popular for the lodgement of payment claims. Since a respondent has only 10 business days to provide a payment schedule in response to a payment claim, and in consideration of the fact that January is a common holiday period for construction industry organisations, the possibility that a respondent may fail to provide a payment schedule is being exploited. The expert adjudicators agreed that this practice is employed by both subcontractors and contractors.

They also agreed that there is evidence of the use of elaborate payment claims prepared by claimants over a long period of time with the assistance of claim consultants. When such a payment claim is made, the respondent has only 10 business days to prepare a payment schedule and, after the claimant lodges an adjudication application, only 5 business days to prepare a detailed adjudication response. Clearly, while the claimant is able to prepare a claim over a long period of time, the respondent is constrained by the Act in preparing a detailed defence within a relatively short time frame. According to the expert adjudicators, this practice is perpetrated mainly by contractors.

Another example of the alleged abuse of the Act by claimants is referred to as 'adjudicator shopping'. Davenport [20] reports that when a claimant is dissatisfied with the result of an adjudication determination by one adjudicator, the claimant is free to submit the same claim to a second adjudicator, hoping for a better result. The Act attempts to prevent 'adjudicator shopping' by requiring that, in determining the adjudication application, the adjudicator gives the work the same value as that previously determined. For example, if the first adjudicator determines the value of work to be $10,000, in a subsequent adjudication the second adjudicator is required to give the work the same value of $10,000 unless the adjudicator is satisfied that the value of the work has changed. However, if the first adjudicator rejects a variation claim because in the adjudicator's opinion the alleged work was not a variation, it is arguable whether or not the first adjudicator actually determined the value of that claim. It may well be that the second adjudicator may allow the claim if deciding that it was a valid variation. Whilst Davenport [20] does not explain whether 'adjudicator shopping' is wide spread, he points to a number of legal cases that indicate that this practice is being employed by contractors.

While it has been shown that subcontractors experience success in pursuing payment claims through adjudication under the Act, Uher & Brand [15] reported that only about a half of subcontractors, who have pursued a payment claim under the Act are satisfied with the adjudication process, particularly in relation to its time and cost efficiency. This finding may, at the first glance, appear to be surprising considering that subcontractors have largely been successful at adjudication. However, in the context of the results of the authors' previous research [3], which uncovered low level of knowledge and understanding of the adjudication process among subcontractors, it may well be that subcontractors have an unreasonably optimistic expectations of what the Act can deliver. The Act neither guarantees payment to subcontractors of the full amount claimed nor does it guarantee any payment. It only provides a powerful mechanism for a rapid and inexpensive resolution of payment claim disputes. It prescribes the manner in which claimants must prepare and serve payment claims and adjudication applications, and the time frame for making them. Non-compliance with such provisions may invalidate a payment claim or some parts of it, or may reduce the claimant's entitlement to payment. It is suggested that subcontractors' satisfaction with the adjudication process under the Act could be greatly enhanced through improved level of knowledge of the main provisions of the Act.

In conclusion it is evident that subcontractors are benefiting from the Act. More effort is however needed to enhance knowledge of the Act among particularly small sized subcontractors to improve their awareness of the benefits of the Act.

3. Impact on Contractors

The role of contractors as claimants under the Act was briefly referred to previously. Under the main contract, contractors make progress payment claims against clients, and those claims when endorsed under the Act, may be pursuit through adjudication. Although the NSW Department of Commerce does not report the proportion of adjudication applications submitted by contractors (as claimants) against clients, the research of Uher & Brand [16] suggests that contractors represent around 22% of all claimants. However, the predominant role of contractors under the Act is that of respondent.

It was previously established that claimants, as both subcontractors and contractors, are generally highly successful in adjudication of payment claims. It emerges from Table 1 that claimants of larger payment claims, who presumably are contractors, have been less successful than claimants of smaller claims.

The reason for large payment claims being less successful in adjudication than smaller claims is unclear. Assuming that large payment claims are predominately made by contractors, it may well be that such claims are either more vigorously defended by clients, or inflated, or both.

Brand & Uher [3] reported that the cost of preparing large payment claims (in terms of their dollar value) is considerably higher than the cost of preparing small claims. Although no data is available on the cost of responding to payment claims, it seems plausible to assume that such cost would be relatively high for large payment claims.

Brand & Uher [3] reported that claimants are assisted by law firms or claim consultants in the preparation of large payment claims. If claimants' seek assistance of lawyers or claim consultants, it is logical that respondents would do the same. The presence of lawyers or claim consultants in mounting a response to a large payment claim would support the proposition that large payment claims are more vigorously opposed, which could account for their lesser success at adjudication.

Furthermore, the expert adjudicators interviewed by the authors confirmed the presence of 'ambushes', particularly those involving very large payment claims supported by voluminous written submissions. Although respondents have only a very limited time to respond to such claims, with the aid of specialist law firms they are able to mount a formidable defence. According to the expert adjudicators, the potential for uncovering parts of such large payment claims which, for example may over-value the work claimed, or may include unapproved variations, or may be unsubstantiated, is relatively high. Assuming that adjudicators are consistent in arriving at their determinations irrespective of the amount claimed, the authors are inclined to conclude that a vigorous defence mounted by respondents in defence against large payment claims is a contributing factor for such payment claims being less successful for claimants at adjudication.

Based on the data in Table 1, which shows that the average adjudicated amount is about 70 percent of the average claimed amount across the whole range of claims determined, and taking views of the expert adjudicators into account, there can be no doubt that claimants attempt to inflate payment claims, particularly in the case of larger claims. To what extent small payment claims are inflated (if at all) is unclear. Considering that small size subcontractors' working knowledge of the Act and its requirements is generally only superficial, and that they do not generally seek assistance from lawyers in making payment claims and lodging adjudication applications [3], it may well be that the reason for the reduction in the value of small payment claims at adjudication is the failure of claimants to fully substantiate payment claims. While the Act has over its first six years of operation in NSW markedly improved security of payment, it has thus far been ineffective in preventing claimants from inflating and respondent from undervaluing payment claims.

Uher & Brand [15] reported that contractors (as claimants) are generally satisfied with the operation of the Act. However, the authors' unpublished survey of a small sample of respondents suggests that in the role of respondents to payment claims, contractors are less satisfied with the Act. This is not an unexpected result considering that as respondents contractors are largely unsuccessful at adjudication.

The reason for contractors being more successful as claimants than respondents at adjudication is unclear. As a potential claimant and respondent, they would be expected to be familiar with the Act and have in-depth knowledge of the Act's various provisions. It is open to conjecture as to why contractors, as respondents, generally fail at adjudication. It may well be that contractors simply have little or no time to respond to payment claims endorsed under the Act and may well be due to a large number of payment claims being made in the same claim period. Since contractors are required to issue a payment schedule within 10 business days of receiving a payment claim, the sheer number of claims and the limited time available for their processing may require contractors to focus on defending larger payment claims as their top priority at the expense of smaller ones. This may also explain why contractors, as respondents, fail to issue a payment schedule.

The failure to issue a payment schedule dramatically weakens respondents' ability to defend against a payment claim because the Act bars respondents making a submission to the adjudicator in the form of an adjudication response. Based on a research sample of 98 adjudication determination, Uher & Brand [16] reported that about one quarter of the respondents did not issue a payment schedule in response to a payment claim. Of those respondents, 77% were required by adjudicators to pay to claimants the full amount of payment claim; the consequence for not issuing a payment schedule is clearly an onerous one.

Another interesting outcome of Uher & Brand's research [16] is that when respondents provide a payment schedule, they most commonly schedule the amount that they are prepared to pay as $nil; see Table 2. The least preferred amount that respondents are prepared to pay is the full amount of a progress payment claim. They found that clients are more likely to schedule to pay a $nil in a payment schedule when responding to a payment claim from contractors than contractors who respond to a payment claim from subcontractors. They explained that the reason for that trend is likely to be related to contractors' superior knowledge of contract conditions, which enable contractors to make a realistic assessment of subcontractors' entitlement to payment under the contract. It may also be that contractors' superior knowledge of the Act helps them to realise the futility of denying payment in the presence of powerful provisions for recovery of payment in the Act.

Table 2: The amount of payments specified by respondents.

Scheduled amount as a % of claimed amount	**Frequency**
0% (nil payment)	45 (62.5%)
< 100% (partial payment)	21 (29.2%)
100% (full payment)	6 (8.3%)
TOTAL	72 (100%)

Probably the most detrimental provision of the Act from the contractors' point of view is barring of a 'pay when paid' provision in a construction contract. Contractors have relied extensively on a 'pay when paid' clause in subcontract conditions to improve their cash flow to the detriment of subcontractors. Although contractors continue to insert such a clause into subcontracts documents, they are unable to rely on it in an attempt to delay payment to a subcontractor, when a payment claim is endorsed under the Act. Contractors are therefore required to more carefully plan and manage their cash flow considering that they may need to pay their subcontractors prior to receiving payment for the same work from the client. They also need to ensure that the terms of payment are defined in subcontract documents; otherwise the default provisions of the Act for making a payment claim and for the due date for payment, which are the last day of the named month and 10 business days respectively, would apply.

In sum, the unique role of contractors under the Act as both claimants and respondents gives them the opportunity to better understand the operation of the Act and its various provisions, and use that knowledge in better defending against payment claims from subcontractors and maximising the adjudicated amount of progress payment claims served on clients.

4. Impact on Clients

No published information whatsoever is available on the impact of the Act on client organisations. The authors will attempt to extrapolate the data from their previous research studies to draw some inferences of the likely impact of the Act on clients. They will also rely on the expert advice provided by the three adjudicators interviewed.

As discussed previously, the frequency of issuing a payment schedule by clients is similar to that of contractors. However, it was noted that clients most commonly schedule to pay $nil in response to a payment claim. The reason for this is the subject of speculation. It is common knowledge that construction clients often withhold payment as a result of a dispute with a contractor under the main contract, whether that dispute is related to a progress payment claim or not. It is possible that clients employ the same approach even when a payment claim is endorsed as a payment claim under the Act. It may be that they are not aware of the fact that since the Act is only concerned with payment claim disputes in relation to a construction contract, other disputes between the parties cannot be used as a reason for withholding payment. This conclusion is plausible considering that respondents will, on average, pay at least 24% of the claimed amount in adjudication; see Table 1. It may also be that clients' reason for scheduling to pay $ nil in the payment schedule is their reaction to what they perceive to be an ambit payment claim. Further research is needed to provide an objective explanation of this trend.

An interesting aspect of the Act is that it excludes construction contracts for carrying out of residential building work where a client or owner of that residential building resides in or proposes to reside in. The rational behind this is that residential clients may not be familiar with the Act and its provisions, and thus could potentially fail to issue a payment schedule, the result of which could have serious consequences to such clients. However, while a payment claim made by a contractor against a client residing in a residential building is not a valid payment claim under the Act, payment claims of subcontractors against the contractor are, provided they are endorsed under the Act. It means that while subcontractors may rely on the adjudication process under the Act to recover payment, the contractor is denied assess to the Act. Perhaps this imbalance will need to be redressed in future revisions of the Act.

5. Conclusions

From subcontractors' perspective, the impact of the Act has been largely a positive one. Subcontractors (as claimants) have been highly successful at adjudication under the Act, particularly those making smaller payment claims. However, despite the positive impact, subcontractors generally have been shown to have a low level of working knowledge and understanding of the adjudication process. Thus, the extent of the positive impact is unclear.

The impact of the Act on respondents, both contractors and clients, appears to be much less positive; respondents' success rate at adjudication is relatively low while respondents' share of the adjudication fees, as determined by the adjudicator, is higher than that of claimants'.

Of concern for respondent contractors and clients is the emerging practice of claimants to submit 'ambush claims', which arise by virtue of the strict time constraints imposed on the parties by the Act, and the practice of 'adjudicator shopping' by unsatisfied claimants to a previous adjudication. Both of these practices, whilst not illicit under the Act, were clearly not intended to arise.

Finally, no direct evidence is available to reliably establish the impact (if any) of the Act on client organisations. In addition to being subject to ambush claims and adjudicator shopping in the same way as respondent contractors, it emerges that clients most commonly schedule to pay $ nil in response to payment claims. Reasons put for this trend are that clients are likely to have superior knowledge of contract conditions and superior knowledge of the Act than contractors. However, further research is needed to firmly establish the reasons for this trend.

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The meaning of the protection of the architects title in European countries

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Abstract

The title ‘Architect’ is legally protected in many countries. Only designers who have successfully completed the required academic education can be registered in the Architects’ Register and use the title. The purpose of this regulation is to give some basic quality assurance to consumers when hiring an ‘Architect’ for their design work. This should also contribute to the general quality of the built environment. In addition, it enables architects to work more easily in other EU countries. However, the requirements for registration as Architect differ considerably in the various countries. In some countries just the academic education is required, in others registration can only follow after a certain period of working in practice, sometimes with a prescribed programme. An extensive survey under young Dutch Architects that took part in a structured practice programme and others that just started in the working at the ordinary way, made clear that some years of experience adds considerably to the competences.

Keywords: Architects, title protection, profession, education

1. Introduction

In most countries not everyone that designs buildings is allowed to call himself an Architect. The title is then legally protected. The requirements for registration vary among countries. Sometimes candidates can register with their diploma of the appointed academic courses. In other countries an additional post-academic period is needed in which the candidate architects gain experience in the architects practice and may have to follow some additional courses. The purpose of this regulation is to give some basic quality assurance to consumers and also some basic contribution to quality of the built environment in general. In addition, it also enables architects to work more easily in other EU countries. Since 1985, EU Directive EEC 85/384, also known as the European Architects Directive [1] has regulated the legal position of architects in the European Union. The directive’s greatest asset is its provision for the mutual recognition of qualifications in architecture in EU Member States. The purpose of this provision is twofold: to safeguard the freedom of movement of architects within the EU, and to guarantee that architects from the different member states have the same basic skills and competences.

Since the requirements for registration varies in the countries, it is useful to examine the value of the post-academic requirements. What is the contribution to the competences and skills of the young architects of some years of practical experience and how should this be structured? These questions arose in discussions about the functioning of the Dutch law to protect the title of Architects. The responsible secretary of state had the intention to abolish his responsibility for the quality of the professions of Architects. He initiated an evaluation [2]. The conclusions were very clear: most of the people in the field were positive about the use of the legal protection, but they also found that the quality requirements of the protected title should be expanded with practical experience and 'life time learning', a professional code of conduct and indemnity insurance. Since then a study was undertaken to get an overview of the regulations in fifteen EU countries. This was followed by a series of discussions by a group of some 15 Dutch top architects to define the required qualifications of young architects to be ready to work as a professional. In 2003 an experimental structure for professional experience of young architects was set up by the State architect. About 40 young architects followed a programme that consisted of working in practise, the mentorship of an experienced architect and a series of workshops. After The Experiment was finished it was evaluated [3]. The opinion of the participants of The Experiment and mentors were compared to those of young architects working in ordinary architects' practice without any specific programme. This paper is build upon the results of the above mentioned studies. The purpose is to present some striking evidence of the use of a structured period of professional practice or internship that is of great value for young architects.

2. Professional requirements for architects in member states of the European Union

Although the European Architects Directive provides a common basis for the mutual recognition of diplomas and certificates from certain educational institutions, we encountered wide variations in the requirements regulating the (quality of the) architectural profession in different Member States. (See, for example, Orbasli and Worthington 1995 [4]; Dankelman; 1999 [5]; and Priemus et al 2001 [2]). This section focuses on the how the current European Architects Directive is implemented in the Member States? A comparative overview is given of the similarities and differences between the 15 Member States in this study. More than 350,000 architects are now active in the 15 member states, but their legal position varies greatly. We summarise the situation within 15 (old) member states of the European Union in table 1. Table 2 contains more elaborate information about legal requirtements. The EU member states can be divided in five groups with regard to the legal position of architects (see table 1), varying from a wide ranging regulatory system (group A) to no legal regulations.

Group A. Belgium, Germany, Luxembourg, and Portugal

In this first group not only the title is protected, but also the profession of architects. This means that the submission of building plans to the local authorities for obtaining a building permit is restricted to architects. To become a registered architect in Belgium it requires five years of study and an additional two years of internship. The National Order of Architects issues the licence to practice, manages the architectural register, determines the duties and rights of architects, and is responsible for (the formulation and execution of) disciplinary rules. The obligation for professional insurance is laid down by (public) law. In Germany architects are registered by the State Chambers of Architects. Architectural education can be obtained at universities or academies. After completing the educational requirement, a minimum internship period of two years is required before registering as an architect. Once registered the architect is subject to the professional and disciplinary rules of the chamber. In Luxembourg architects (and civil engineers) must register with the Order of Architecture and Consulting Engineers. To become registered, the aspiring architect must have a degree as defined in the EU Architects Directive plus one year of practical training. In Portugal the requirement to become a member of the Portuguese Association of Architects is a degree from a university of architecture as well as an additional period of two years practical training. Once registered a member has the right to practice architecture and to use the title of architect.

Table 1: Characteristics of the legal position of architects within the EU

		Protection of title	Protection of profession	Practical experience	Disciplinary codes
A	**Belgium**	Y	Y	Y	Y
	Germany	Y	Y	Y	Y
	Luxemburg	Y	Y	Y	Y
	Portugal	Y	Y	Y	Y
B	**Spain**	Y	Y		Y
	France	Y	Y		Y
C	**Italy**	Y	Y		Y
	Austria	Y		Y	Y
	United Kingdom	Y		Y	Y
D	**Greece**	Y			
	Netherlands	Y			
E	**Ireland**				
	Denmark				
	Sweden				
	Finland				

Group B. Spain, France, and Italy

In Spain a person is authorised to practise architecture by registering at a College of Architects. In order to register, a candidate must have a university diploma. Only registered architects may authorise and sign blueprints. Internship is not required to register. Architects in France must be registered at one of the regional Councils of Architects. After completing a course of study, no internship is needed to register. For buildings with a floor area that exceeds a certain number of square meters architects are required. In Italy architects register at one of the provincial rolls of architects. After completing a course of study, the candidate must pass a government qualifying exam, which is usually taken at least half a year after obtaining the degree.

Table 2: Overview of the main characteristics of the legal position of building architects in the fifteen EU member states in 2004

	Number of architects (approx.)	Number of architects per 1 million inhabitants	Educational institutions total	universities	academies	Minimum years of study	Protection of title	Protection of profession	Obligatory registration	Internship required (months)	Disciplinary code	Insurance required
Austria	2400	279	6	5	1	5	+	+	+	3	+	+
Belgium	10500	1014	19	5	14	5	+	+	+	2	+	+
Denmark	6500	1207	2	-	2	5	-	-	-	-	-	-
Finland	3500	672	3	3	-	5	-	-	-	-	-	-
France	25000	452	22	22	-	6	+	+	+	-	+	+
Ireland	2300	667	2	2	-	5	-	-	-	2	-	-
Italy	94000	1640	18	14	4	5+	+	+	+	-	+	+
Germany	102000	1236	72	15	57	4.5	+	+	+	2/3	+	+
Greece	14500	1315	2	2	-	5	+	-	+	-	-	-
Luxembourg	550	1227	-	-	-	-	+	+	+	1	+	+
Netherlands	8520	526	8	2	6	5	+	-	+	-	-	-
Portugal	8600	826	18	14	4	5	+	-	+	-	+	-
Spain	32600	705	14	14	-	5	+	+	+	-	+	+
Sweden	5400	603	3	3		4.5	-	-	-	-	-	-
UK	30400	512	39	18	21	5	+	-	+	2	+	+

+ yes; - no

Group C. Austria and the United Kingdom

In Austria registration at the federal Camber of Architects and Consulting Engineers is obligatory, and a minimum three-year internship is required (following five years of professional education). Furthermore, the regulations of the disciplinary code and professional insurance are mandatory. In the UK it takes five years of academic study and two additional years of practical work to become registered at the Architects Registration Board (ARB) [6]. The registered architects must comply with ARB standards of conduct and practice. This means that they must carry adequate professional indemnity insurance and that they must maintain their professional competence.

Group D. Greece and the Netherlands

In Greece the law requires architects to be licensed. Graduates of a five-year course of study from one of the two recognised universities of architecture are eligible for registration at the Technical Chamber of Greece (TEE). In the Netherlands architects register at the Architects Registration Bureau. Architects are eligible for registration if they have a degree from one of the two recognised five-year universities of technology or one of the six four-year, part-time academies of architecture. These academies admit students only after four years of vocational training. There are no legal requirements for practical experience or vocational training yet. This is going to change soon. The Architects Title Law will be renewed and will contain also requirements for 2 years internship, permanent education etc…..

Group E. Ireland, Denmark, Sweden, and Finland

In Ireland the Royal Institute of the Architects of Ireland (RIAI) is the representative body for professionally qualified architects. A member of the RIAI must have a degree from a recognised university, two years of approved practical experience, and pass an examination in professional practice. It is also possible to become an associate member or an architectural technician member. Some 80 per cent of the qualified architects are members of the RIAI. Irish architects are liable for the projects they carry out, but professional insurance is not obligatory. The Federation of Danish Architects is a private non-profit organisation of architects with qualifications that conform to the European Directive. Minimum length of study is five years. Student members are also admitted. The federation represents about 80 per cent of the Danish architects. In Sweden the National Association of Swedish Architects (the SAR) is responsible for the quality of architects. To become a member, the candidate must have a diploma from one of the recognised architectural training centres (at least four and a half years) and one year of additional experience as an apprentice architect. Approximately 80 per cent of Swedish architects are members of the SAR. In Finland a degree in architecture (representing five years of study) from one of the three recognised universities is required to be permitted to use the title of architect. No professional experience is needed. Almost all of the building architects are members of the Finish Association of Architects.

One of the goals of the European Architects Directive was to improve mobility for architects in the EU member states. Reliable figures on this are lacking, but the Dutch Architects Registration Board (SBA) believes there is a great deal of ‘free exchange of architects’. The Dutch experiences show that this process does not always run smoothly, however. Every year the SBA has to assist Dutch registered architects obtain their legitimate rights to practice elsewhere in Europe. And the Registration Board (SBA) believes these are not isolated incidents. The Architects Directive is interpreted very differently in different European countries. Although this variable interpretation has gradually improved, there are still some difficulties. An example can illustrate this point. Some years ago relatively many Austrian architects enrolled in the Dutch register. Austrian Law requires three years of practical experience before an Austrian architect can register. The market for architects is tight in Austria, so it is difficult to gain practical experience. Thus, Austrian architects are able to practice their profession in the Netherlands but not in their home country.

3. Experiment with structured internship in the Netherlands

In 2005, a two-year experiment came to an end in the Netherlands in which young architecture graduates were given the chance to gain experience in a structured way in every field of architectural professional practice. It was known as The Experiment and was organised by the Atelier of the State Architect. The initiative was the result of the evaluation of the Architects' Title Act. In a series of discussion meetings involving a group of leading Dutch architects in 2001-2002, besides the earlier intentions of giving more meaning to the title of Architects also consideration was given to what was needed to strengthen the role of the architect in the construction process. This led to the plan to offer young architects a programme of experience on a structural basis for two years, under the guidance of a personal mentor and a series of study meetings. The Experiment was evaluated [3]. This involved questioning the young architects and mentors taking part, as well as a large comparable group of young architects who entered regular practice without following any specific programme. It is precisely that comparison between participants and non-participants which has provided an insight into whether a period of structured practical experience offers added value. This section presents the evidence found in the Dutch Experiment for the added value of various elements of eduction and gaining experience. This can be compared to the results of other international studies. See e.g. Glasser, D. E. 2000 [7], Jones, C.B. 2006 [8], Nicol, D. and Pilling S. 2000 [9], and Quinn, B.A. 2003 [10].

In The Experiment, around forty recent architecture graduates were given the opportunity of acquiring experience at architectural firms where they would be supported by a mentor. For the practical side, a list of aspects of the profession of architects was drawn up, ranging from the initiatory phase all the way to the implementation phase of the construction process, with the intention being that the participants gained sound experience throughout. At the same time, several tools were deployed to lend the process structure and to monitor it. They included Personal Six-Month Plans, which laid down agreements between the young architects and their mentors about the activities to be undertaken in the six-month period. The architects kept a logbook of their progress, their findings and the results of their work. Visits were also made by the organisers of The Experiment to the place of work of the participants to discuss their programme. In addition to this practical part, The Experiment consisted of a joint programme. This took the form of a series of meetings with an educational character, during some of which the participants held project presentations on the designs they had been involved in. The other meetings were of an informative nature, and here the focus was on matters such as rules and regulations, local authority procedures, contract negotiations, and procedures for selecting construction companies. The research consisted of questionnaires completed by the young architects and mentors, and a comparative group of recently graduated architects who have worked in regular practice, but not specifically in a structured way. Around 80% of the young architects responded to the questionnaire, while the figure for the mentors was 65%. We looked at the added value of the structure of The Experiment by polling the comparative group. For this purpose, we sent a questionnaire to every architect who graduated between January 2001 and December 2003, and who is registered in the Architects Register (about 500). There was a remarkable large response, with some 200 completed forms being returned. It showed that these young architects that were not in anyway involved in the project, were very driven to answer this long questionnaire. The questionnaires revealed a great deal of information as to what degree architects working over a period of time acquired practical work experience in the various aspects of the profession of architects and to what degree they considered themselves able to perform in those aspects independently.

In general, the mentors and young architects were highly satisfied with the content and organisation of The Experiment and joint programme of study meetings. The relevance and the quality of all aspects were judged positively, while the score given by the architects to the importance of the meetings fluctuated from important to very important, around the eighty to ninety per cent mark. Of the architects in the comparative group, about sixty five per cent said they would have been interested in informative meetings after their studies that dealt with the subjects covered by The Experiment. The quality of the introductions to the joint meetings was, according to the young architects, very good, and although the quality of the accompanying documentation met with approval, this was to a lesser degree on average. They were less satisfied by the time given to the subjects being covered. The quality of the assignments, the expertise and availability of the mentor at the office was judged positively. Three quarters of the architects, and nearly seventy per cent of the mentors, thought that the number of projects they were involved in during The Experiment was sufficient to enable them to gain experience in all aspects of the architectural profession. Remarkably, the score of the comparative group was higher, with almost ninety per cent of them saying that they had worked on enough projects to gain experience with every aspect of the job. The difference is probably due to varying levels of expectation. The use of the Personal Six-month Plan, the logbook and the appraisal interviews were generally considered positive by architects and mentors alike. Finally, more than ninety per cent of the participating architects and mentors described the quality of the overall programme of The Experiment as good to very good.

Table 3 shows that the meetings on Construction methods versus budget, Local authority procedures, Construction process and Contract negotiations were considered as most important by the architects, while the meetings on Research at architectural agencies, the Programme of Requirements and the Mentor meetings were thought in relative terms to be the least important. The mentors were most enthusiastic about the Start meetings, the Project presentations and Building Decree (building regulations), describing them as important to very important. They were not as keen on Research at architectural agencies or the Programme of requirements. About sixty to seventy per cent of the architects in the comparative group indicated that they would have been interested in information meetings after completing their studies, in particular where Contract negotiations, Office and design management and Construction methods versus budget were covered, all of which scored well.

Table 3: The average scores for study meetings

	Participants	Mentors	Comparative group
Start meetings	4.1	4.5	-
Workshop project presentation	4.0	4.5	-
Building Decree (building regulations)	4.3	4.2	3.1
Office and design management	4.0	4.2	4.0
Social position of architects	4.0	4.2	1.7
Research at architectural agencies	3.7	3.6	3.0
Selection procedures	4.0	3.9	1.9
Contract negotiations	4.3	4.2	4.6
Partnership relationships	4.1	3.7	3.0
Giving direction in the construction process	3.9	4.0	2.9
The programme of requirements	3.9	3.6	2.7
Construction methods versus budget	4.4	4.2	3.8
Local authority procedures	4.4	3.9	3.4
The construction process	4.4	4.1	2.6
Positioning of the agency and publicity	4.1	3.7	3.2
Mentor meetings	3.8	3.7	1.7
Average	4.1	4.0	2.9

(average scores on a scale of 1-5: 5 = very important, 4 = important, 3 = neutral, 2 = not very important, 1 = not important at all)

The research produced a great deal of information about whether experience was gained with the different areas of architectural practice and to what degree the respondents felt they had a sufficient grasp of those areas in order to be able to carry them out independently. This was all highlighted by the questions of whether they could work as an independent architect and were experienced enough to run an agency of their own. We have pooled a lot of the information that emerged from these questions and worked out average scores in order to gain insights at a higher abstract level. This has led to the following observations: for the participants in The Experiment and the architects in the comparative group, the period of practical experience has made a significant contribution to their being sufficiently competent in the different areas of architectural practice. Before working in practice, there was already a reasonable grasp of the areas in the design phase, while this was much less the case in the assignment, construction preparation and construction process phases. The period of acquiring experience was useful for each phase in approximately equal measure. The result was that, after participating in The Experiment or gaining practical experience elsewhere, most respondents mastered the different areas of the design phase to the extent that they can carry them out independently. This does not apply to the other three phases. Based on the information received, it has not been shown that organising practical experience in the form of The Experiment gives added value when compared with experience gained in a conventional practical environment. Indeed, in some areas the comparative group scored better than those taking part in The Experiment. The question remains, though, to what degree the group of participants is comparable to those in the comparative group. However, there is no indication among the various characteristics of either group to suggest that one is ‘qualitatively’ superior to the other. The self-perception of both groups as to their own level of experience before working in practice was also very similar.

The mentors and architects taking part in The Experiment, as well as the architects in the comparative group, attached great value to a structured approach in gaining experience, with the former being very convinced of the added value it offered. The comparative group, too, believed that being involved in a structured programme may have provided greater opportunities for gaining experience than being in regular practice, although they were in fact satisfied with their own period of practical experience. Regarding the question of whether the respondents had gained enough experience to begin their own company, the comparative group scored noticeably higher than the participants. A possible explanation for this could be that the group of participants, by being involved in The Experiment and therefore focusing more attention than otherwise would have been the case on all the different fields of the architectural profession and analysing whether they had a sufficient grasp of them, had a more critical view of themselves than the average young architect.

The experience acquired by the young architects in The Experiment in the different areas of architectural practice, and the degree to which they, and the members of the comparative group, now have a good mastery of those areas, were measured extensively (see table 4). This covers the opinions of the young architects themselves and is therefore not necessarily an accurate reflection of the actual abilities of the respondents.

For both groups the period spent in practice made a very large contribution to gaining a good grasp of the different areas of the profession. Before starting work in practice, there was already a reasonable mastery of the various aspects of the *design phase*, while for the *assignment*, *construction preparation* and *construction process* phases there was only a very limited level of competency. The experience gained during the relevant period was spread fairly evenly over all the phases. The result was that most respondents, either after taking part in The Experiment or acquiring experience in practice, have a sufficient grasp of the aspects of the design phase to be able to perform them independently. This did not apply to the other three phases. From the research it appeared that those in the comparative group built up a similar level of experience of architectural practice to the participants in The Experiment. In some areas, the comparative group actually scored more than those in The Experiment. The question remains, though, to what degree the group of participants is comparable to those in the comparative group. There is however, as has already been stated, no indication among the characteristics of either group to suggest that one is ‘qualitatively’ superior to the other. The self-perception of both groups as to their own level of experience before working in practice was also very similar. On the basis of this information it therefore cannot be demonstrated that organising practical experience in the form of The Experiment (the mentors and the Personal Six-Month Plans) lends any added value when compared to gaining experience in regular practice. The architects and mentors involved in The Experiment, as well as the architects in the comparative group, believed there is great

Table 4: Percentages of respondents that are able to carry out the aspects of the profession of architects independently before and after the period of practical experience

	Independent before		Independent after		Independent (b+a)		Not independent	
	P	C	P	C	P	C	P	C
ASSIGNMENT PHASE	14	13	47	41	61	53	39	47
Acquisition discussions	19	16	31	51	50	67	50	33
Contract negotiations	3	4	19	28	22	32	78	68
Drawing up contract	22	4	78	27	100	30	0	70
Programme of Requirements	9	4	41	48	50	51	50	49
Assignment presentation	19	36	66	51	84	87	16	13
DESIGN PHASE	25	29	66	60	91	89	9	11
The design	22	29	69	63	91	91	9	9
Other projects	28	28	69	62	97	90	3	11
Presentation of the design	34	49	63	44	97	93	3	7
Repors of planning team	19	15	66	64	84	80	16	20
Correspondence	22	23	63	68	84	90	16	10
CONSTRUCTION PREPARATION PHASE	8	11	41	56	48	67	52	33
Construction preparations	6	12	44	64	50	76	50	24
Managing the project specifications	6	8	31	54	38	62	62	39
Contracting procedures	3	5	19	35	22	40	78	60
Correspondence	13	19	53	60	66	79	34	21
Consultation local authorities	9	13	56	68	66	80	34	20
CONSTRUCTION PROCESS PHASE	11	14	42	57	53	71	47	29
Attending the construction meeting	16	16	47	61	63	77	38	23
Reports of planning team	9	14	53	56	63	69	38	31
Correspondence	9	17	56	64	66	81	34	19
Inspecting drawings of third parties	9	15	44	63	53	78	47	22
Visiting the construction site	16	17	44	56	59	73	41	27
Attending the progress meetings	13	16	44	62	56	78	44	22
Delivery report	3	6	9	37	13	43	88	57
AVERAGE	14	16	48	54	62	70	38	30

P = participants in The Experiment; C= architects in the comparative group merit in gaining experience according to a structure. The former group were convinced of the added value it brings, while the latter thought that being part of a structural process could have given them more experience than being in regular practice. The members of the comparative group, however, were nonetheless satisfied about their own period in regular practice. With regard to the question about whether they now considered themselves to have enough experience to start their own agency, the comparative group scored markedly higher than the participants in The Experiment. A possible explanation for this could be that the group of participants, by being involved in The Experiment and therefore focusing more attention than otherwise would have been the case on all the different fields of the architectural profession and analysing whether they had a sufficient grasp of them, had a more critical view of themselves than the average young architect.

4. Conclusion

The answer to the question of whether there should be regulations that deal with the legal position of architects on a European level is ‘yes’. The work of architects affects the daily life of many Europeans, a fact that is appreciated by the European Council (Council of the EU, 2001). As we have seen, however, the current directive does not require a uniform standard of education and quality for architects. It has flaws with respect to ensuring the quality of architects as well as for the free movement of these professionals. These flaws will become far more important when the new directive on the internal market comes into effect. The aim is to require that an architect working in a country other than his own should comply with the regulations of his country of origin. But the current patchwork of national regulations will make this very difficult, not only for architects, but also for the (quality of) the built environment and for consumers. The recent expansion of the EU will undoubtedly contribute to a more complex (or even unworkable) situation. Therefore, it is important to regulate this professional group with a certain consistency across the continent. The current EU regulatory framework fails to realise this consistency. The directive should focus more on the essential demands on the quality of architects. The educational institutions and their respective degrees that are recognised in the EU member states should be reconsidered. Although the member states have various educational systems, in general the title of architect can be obtained in one of two ways: either through a university course of study or attending a school of (higher) vocational education. University education contains only a relatively small component of practical experience, while schools of vocational education place a relatively strong emphasis on practical components. The directive should acknowledge this situation (as it now does), but should also look at the details of the curriculum in the various educational institutions. It is highly unlikely that a vocational education alone (four years following secondary education) can provide all the training required to develop highly skilled architects. The same is true of a five-year university education that includes only limited practical experience. The directive should sketch more clearly the paths that can lead to the title of architect. On average it will take seven to eight years to become a skilled architect. Not only the educational demands but also the demands on practical experience should be established in the Architects Directive. Only architects who fulfil these educational and practical; experience qualifications are accepted in the architects register. In order to protect the consumer and the quality of the built environment the directive should ensure also that the knowledge, skills, and experience of a registered architect maintain a certain standard. To guarantee these qualities additional requirements can be made in the directive concerning continued education, a professional code of conduct and indemnity insurance. The member states should recognise this new and updated directive and include it in their legal system. States may set additional requirements, but these requirements must not go counter to the directive's ‘spirit’ or substance. Only registered architects should be permitted to use the title and freely practice architecture in all member states.

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An American perspective of the suitability of the SOCL's Protocols provisions for dealing with concurrency on Australian construction projects

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Abstract

Concurrent delays on construction projects have been described as being the most conceptionally challenging aspect of delay analysis. Few of the standard forms of contract commonly used give guidance as to how the issue of concurrency should be addressed, or analysed. Two organisations (the UK's Society of Construction Law and the USA's Association for the Advancement of Cost Engineering International) have produced guidance documents in the form of a Protocol and a Recommended Practice respectively, aimed at addressing the issues associated with delay and disruption on construction projects that contains an approach for dealing with concurrency. The aim of this pilot research, which was supported by the Chartered Institute of Building Australasia, was to carry out semi-structured qualitative interviews with those involved in the production of the USA's recommended practice to obtain their opinion of the adequacy of the clauses of the standard forms of contract for dealing with concurrency, and the suitability of the Protocol's proposed method for dealing with concurrency, for adoption and use on Australian construction projects. Results indicated that the overall approach of the protocol was considered to be correct, but its content needed to be expanded to address some of the issues in more detail, suggesting that an agreed overall standard approach would be beneficial for the industry.

Keywords: Claims, concurrency, delay, extension of time, protocol, recommended practice.

1. Introduction

Concurrency is a major issue should delays occur on construction projects. It has implications concerning the awarding of liquidated damages (LD's) and the granting of extensions of time (EOT).

When a single event occurs on a construction project that results in delay and/or disruption to the project completion date, one party is normally entitled to compensation typically in the form of an extension of time (EOT), and/or a claim for loss and/or expense due to prolongation, or entitlement to liquidated and ascertained damages (LAD). Entitlement is normally dependant upon establishing who was responsible for the delaying event, determining how the risks have been allocated by the provisions of the contract, and determining an amount of compensation in the form of time (EOT) or money (loss and/or expense/LAD) as appropriate compensation.

Typically, if the contractor is responsible for the event, and they have agreed to accept the contractual risk, and provided the contract stipulates, the contractor would incur liquidated damages in accordance with the contractual provisions as a result of any delay to the project completion date (known as an inexcusable [1] or non excusable delay [2]).

If the client or owner is responsible for the delaying event, and it is one in which they have agreed to accept the contractual risk, and provided the contract stipulates, the contractor would be entitled to an EOT in accordance with the contractual provisions for a period equivalent to the delay to the project (excusable delay [1]). They may also be entitled to a claim for any loss and/or expense incurred as a result of the prolongation of the project caused by the delaying event (compensable delay [1]).

Where the delaying event is the responsibility of neither party (a neutral event), and one where they have both agreed to share the contractual risk allocation, and provided the contract stipulates, the contractor would normally be entitled to an EOT equivalent to any period of delay to the project, but not a claim for any loss and/or expense (excusable delay [1], [2]).

Individual occurrences of such events are normally dealt with in this way.

1.1 The concurrent position

Difficulties arise where two or more events occur at exactly the same time or sequentially, that have the effect of delaying and/or disrupting the project completion date. This is known as concurrent delay, and has been defined as "*two or more delays that occur at the same time, either of which had it occurred alone, would have affected the project completion date*" [3], and has been described as "*probably the most conceptually challenging aspect of delay analysis*" [4].

True concurrency, where events occur at exactly the same point in time is considered to be rare [5], but the concurrent delaying and/or disrupting effects resulting from events occurring in sequence, or overlapping is common and cause many disputes. The difficulty is in apportioning responsibility for the combined effects of the events on the construction project in terms of time and money, in accordance with contractual provisions that rarely recognise or address the issue of concurrency sufficiently and adequately. Things are further complicated due to the fact that each of the concurrent events could have a different degree of consequence on the project, making it difficult to quantify and apportion damages (in terms of time and/or money), again with little guidance from the terms of the contract as to the most appropriate method of analysis. The range of techniques that are available for use in quantifying the effects of concurrency adds to the problem. Taken individually, each event could result in a different amount of delay and/or disruption to the project. When combined, the difficulty is in determining what proportion of delay and/or cost should be allocated to each event?

2. Protocols and recommended practices

In an attempt to rectify the lack of clarity that exists in standard forms of contracts for dealing with such issues, two organisations (the UK's Society of Construction Law (SOCL) and the USA's Association for the Advancement of Cost Engineering International (AACE)) have produced guidance documents in the form of a Protocol and a Recommended Practice.

2.1 Delay and disruption protocol

In October 2002, the UK's Society of Construction Law (SOCL) published a Delay and Disruption Protocol (the protocol) aimed at addressing the issues associated with delay and disruption on UK construction projects in the context of the UK's legal system and standard forms of construction contracts. Concurrency was one of the issues that the protocol attempted to clarify and provide guidance.

The protocol is not put forward as a benchmark of current good practice, but as a general statement and guide whose recommendations are to be applied with common sense. The protocols objective is to "*provide useful guidance on … the common issues that arise in construction contracts*" [6], whilst its purpose "*is to provide a means by which the parties can resolve these matters and avoid unnecessary disputes*" [6]. The protocol is not intended to be a contract document, and its contents are not meant to take precedence over the express terms of a contract, nor is it intended to be a statement of law. It is a proposed "*scheme for dealing with delay and disruption issues*" [6] in a balanced and viable way that is available for:

"Adoption by the parties to a construction contract, in order to provide the means to avoid extension of time disputes;

An aid to deciding issues that are not clearly covered by an existing contract;

An aid to decision makers … in dealing with delay issues" [7].

Implementation of the protocol is intended to be by agreement between the parties by whatever administrative procedures they consider suitable and acceptable. Where the parties have agreed to use the protocol as an aid to the management of the contract, the protocol is to prevail over any conflicting case law, but where the protocol is in conflict with any of the terms of the contract, the contractual terms are to take precedence.

The protocol [6] defines true concurrent delay as "*the occurrence of two or more delay events at the same time, one an employer risk event, the other a contractor risk event and the effects of which are felt at the same time*", and suggests that the term 'concurrent delay' is often used to describe the concurrent effect of sequential delay "*where two or more delay events arise at different times, but the effects of them are felt (in whole or in part) at the same time*".

Contained within the provisions of the protocol is an approach for dealing with concurrent delays as a means of minimising their affects on construction projects.

The distinction of the protocols approach with other approaches is:

the requirement for pre-agreement between the contracting parties;

i. that any contractor delay to completion that occurs concurrently with employer delay should not reduce any extension of time due.

2.2 Forensic scheduling analysis recommended practice

In July 2007, the USA's Association for the Advancement of Cost Engineering International (AACE) launched their Recommended Practice No. 29R-03: Forensic Schedule Analysis (FSA) in an attempt to "*provide a unifying technical reference for the forensic application of critical path method (CPM) of scheduling*" [8].

The AACE International is an industry independent organisation and is considered to be the leading professional society for cost estimators, cost engineers, schedulers, project managers, and project control specialists in the USA. It has been in existence since 1956 and has more than 5,500 members in 78 countries worldwide. It is considered to be the largest organisation serving the entire spectrum of cost management professionals.

Forensic scheduling analysis is "*the study and investigation of events using CPM or other recognized schedule calculation methods for use in legal proceedings*" [8] and is described as both "*a science and art*" relying upon professional judgement and expert opinion.

The RP is a taxonomy of schedule analysis methodologies. By defining terminology, identifying, and classifying methodologies being used, and then describing uniform procedures the AACE hope to increase transparency of the analysis methods and the analysts thought processes as a means of increasing the accountability and testability of the analysts opinion with the intention of minimising disagreements over the technical implementation of accepted techniques as a means of resolving disputes over substantive or legal issues.

3. Aim

The aim of this research was to obtain the opinions of members of the AACE's consultation panel who were involved in the development and production of the FSA concerning the provisions of standard forms of contracts and the suitability of the protocol's provisions for dealing with concurrent events on construction projects as a means of assessing the protocols suitability for adoption and use by the Australian construction industry.

3.1 Methodology

The research was conducted in accordance with the Commonwealth of Australia's National Statement on Ethical Conduct in Human Research [9], following procedures approved by the University of Newcastle's Research Ethics Committee.

Semi-structured qualitative interviews with members of the AACE's Recommended Practice consultation panel involved in the development of the FSA were carried out to obtain their opinions of the suitability of the protocols provisions for dealing with concurrent events on Australian construction projects, and their suitability for adoption and use by the Australian construction industry.

Details of those who were interviewed are contained in Table 1.

4. Common approaches to concurrency

Two issues prevail when trying to resolve concurrent delays:

(i) Who has caused the 'overall' delay?

(ii) How much delay is attributable to each of the delaying events?

One of the problems of determining responsibility for concurrent delays is that there is no singularly agreed or accepted approach for determining causation [10]. A number of approaches have been recognised and utilised by practitioners and authors in an attempt to apportion and quantify responsibility for the effects of concurrent events on projects, with varying degrees of support from the courts and industry, however, pre-agreement as to the most suitable or "best" approach to use is rare.

4.1 The protocols approach

McCredie [7], investigating how the protocol was likely to be received by the UK construction industry identified concurrency as being one of the main issues associated with delay and disruption. The protocols approach is for the contracting parties to pre-agree:

In terms of concurrent delay, that "*where contractor delay to completion occurs concurrently with employer delay to completion, the contractor's concurrent delay should not reduce any extension of time due*" [6].

Table 1: Background details of interview participants

Participant	Background
USA01	A director and co-founder of a specialist American construction and asset cost consulting Quantity Surveying Practice with expertise in commercial construction, procurement, and dispute resolution.
USA02	A lawyer, architect and schedule (programme) consultant specializing in forensic schedule analysis.
USA03	A forensic claims consultant and expert witness with some 35 years of experience in construction claims specializing in schedule delay and soft cost damage issues throughout North America, Egypt, China, Kazakhstan, and Trinidad & Tobago.
USA04	A project controls engineer with over ten years of experience of developing and monitoring schedules and provided expert forensic schedule analysis and testimony for contractors and owners in the highway, power, and commercial construction industries.
USA05	A world-renowned scheduling expert, author of a best-selling professional text on construction scheduling, and founder of an international company providing scheduling products and services to the global construction community.
USA06	A lawyer and claims consultant with over 30 years experience of resolving national and international construction claims disputes.
USA07	A certified planning engineer with over 15 years of experience of developing, monitoring, and resolving construction disputes on international projects.
USA08	The principal of a construction management consulting firm who is a certified planning, scheduling, and cost consultant involved in the resolution of construction disputes, with over 25 years of experience and involvement in the commencement, execution, and completion of commercial, public, and government projects.

4.2 The recommended practice approach

The RP describes the process of identifying and quantifying concurrency as "*the most contentious technical subject in forensic schedule analysis*" [8] and recommends that both parties agree on the theory employed. Where no agreement is reached the RP recommends that the analyst should become aware of the theory adopted by the adversary.

One of the major factors identified by the RP as having a significant impact on the determination of concurrency is contractual definition. The general rules, exceptions and considerations of the RP are applicable to the extent that they do not directly contradict contractual definitions and specifications.

In addition to the contractual variable, the RP lists a further five factors that influence the identification and quantification of concurrency:

Whether concurrency is determined literally or functionally;

Whether concurrency is determined on the cause or the effect of delay;

The frequency, duration and placement of the analysis interval;

The order of delay insertion or extraction in a stepped implementation;

Whether the analysis is done using full hindsight or based on knowledge-at-the-time.

The use of CPM concepts for the reliable identification and quantification of concurrency is stated within the RP as being universally accepted, and as such the RP's approach is heavily influenced by the various CPM techniques available.

The RP also introduces the concept of 'pacing' delay.

4.2.1 Literal concurrency vs. functional concurrency

The distinction between literal concurrency and functional concurrency is that literal concurrency is considered to be where events "happen at exactly the same point in time", whilst functional concurrency is where events (that may occur on different network paths) concurrently impact on the project.

Literal concurrency is considered to be a function of the planning unit used and is recognised by the RP as being unachievable since time is infinitely divisible.

Functional theory is considered to be more liberal in identifying and quantifying concurrency and more attuned to the workings of the critical path.

4.2.2 Cause of delay vs. effect of delay

This issue is described within the RP [8] as a "*philosophical dichotomy that complicates the evaluation of concurrency*" and is the difference between the proximate cause (as opposed to an ultimate or root cause) of the delay and the effect of the delay based on the observation that there is no delay until the planned duration has been exhausted.

4.2.3 Frequency, duration and placement of analysis intervals

The frequency, duration and placement of the analysis intervals are considered to be one of the "*most significant technical factors that influence the determination of concurrency*" [8].

4.2.4 Order of insertion or extraction in stepped implementation

The RP [8] states that "*the order of the insertion or extraction of the delay will affect the identity of potentially concurrent delays and the quantification of such concurrency*" and that if the chronological order of events are ignored, the resulting analysis "may not yield the data necessary for reliable determination of concurrent delays".

4.2.5 Hindsight vs. 'Blind-sight'

The RP identifies two schools of thought for recreating a partially statused schedule.

The hindsight method concerns the performance of the analysis after the project has been completed and involves the use of actual performance data to recreate the updates.

The 'blind-sight' method involves the analyst performing a retrospective analysis using only the data and information that was available to the original scheduler at the time the project update was actually being prepared, and thus requires the analyst to 'simulate' the schedulers mindset at the time of the original project update.

The difference in approach will affect the identification and quantification of concurrent delays due to the updating of the CPM schedule being partly dependent upon the value of remaining duration of activities at the data date.

4.2.6 Pacing delay

Pacing delay is described by the RP [8] as a delay in an independent activity that is the result of a "*conscious and contemporaneous decision to pace progress*" against a subject delay and is considered to be a "*real-life manifestation of the principle that work durations expand to fill the time available to perform them*". The distinction between a pacing delay and a concurrent delay is that a pacing delay is the result of a conscious decision by a performing party to pace the work, whilst a concurrent delay is a delay that is involuntarily delayed by factors independent of any problems arising from the subject delay.

5. Results

The responses obtained from the members of the AACE International's consultation panel who were involved in the collaboration and production of the RP are considered to be representative of those who were interviewed and are not put forward as being representative of the AACE International as an organisation.

Clarifying statements contained in the questionnaire, the questions, and relevant edited and responses from the participants are included below:

Statement 1: The AACE recommended practice states that contractual definition is one major factor having significant impact on the determination of concurrency.

Question 1: What is your opinion of how the clauses of the standard forms of contract deal with this issue?

Generally the respondents were in overall agreement that the clauses of the standard forms of contracts that they were familiar with did not adequately address the issue of concurrency.

Participant USA01 was critical of how the clauses of standard forms of contracts dealt with determining concurrency stating "y*ou're lucky if you even see a definition of it ... I don't think most contracts are that sophisticated, even with big consumers of construction … they are still back in the Stone Ages on some of these specifications*". This was reinforced by Participant USA02 who stated that "*they deal with it terribly and they primarily don't address what is actually a concurrent delay*".

Participant USA03 expressed an opinion that the lack of contractual definition was the cause of a number of issues, not just those concerned with concurrency, stating that "*most contracts in the United States are silent on the issue of ownership of float, and most are silent on the issue of concurrent delay, all are silent on the issue of pacing delay, and many of them are silent on the issue of what we call an impact as a result of the delay, not necessarily a delay to the critical path*" and that "*standard form contracts would … be great if they start dealing with the issues*" and this "*would go a long way to solving our problems*".

Participant USA04 stated that the contracts "*don't treat it, … giving cursory treatment if any treatment at all*", but admitted that it was "*a tough issue to treat in a contract*", and suggested that "*a reference to the SCL protocol would be a fair way to treat it or a reference to another standard document*", and that "*If we could develop more of a standard in terms of how these things are treated*". It was suggested it "*would be better for everybody, … and if you want to put something in your contract I would say you reference that standard … What would be nice is to see the owners acknowledge the standard and even go so far to reference it and say we are fully aware of the standard and that's what we're going to apply*".

Participant USA06 was of the opinion that generally "*the contracts are written terribly, the specifications are even worse*" and that "*we're starting to see more and more specifications which get incorporated by reference where the issue of float is addressed … you don't see concurrency mentioned very often at all. I've never seen pacing delay mentioned in a spec*".

Participant USA07 considered this to be "*one of the big issues*" but was reticent about how contractual clauses could address the issue stating that "*if I really want to get out of the claim and protect myself, I can play with it and find my loophole to get around it … I don't think there's anything where everybody is ever going to be able to fix it*".

Participant USA08 was also critical of the way standard forms of contract deal with the issue stating that "*generally what I've seen in various contract documents has been somewhat vague, and if anything they have been skewed or imbalanced a little bit towards the owner or employer, so I don't think they really explain fully the rights and responsibilities of both parties*".

Statement 2: Concurrency concerns the effects of an employer delay and a contractor delay occurring at the same time or sequentially causing concurrent delay. With regard to extensions of time, the protocol recommends that: "*Where contractor delay to completion occurs concurrently with employer delay to completion, the contractor's concurrent delay should not reduce any extension of time due*" (Society of Construction Law, 2002).

Question 2: The participants were asked to state their opinions of how the protocol deals with the issue of concurrency.

Overall there was a general appreciation of how the protocol approached the issue of concurrency, however, most of the participants were of the opinion that the protocol could have dealt with concurrency (and other issues) in more detail.

Participant USA01 was in general agreement that concurrency was one of "*the biggest issues*" and considered it to be "*another one of those issues right along with float we have to go in and look at the different philosophies regarding concurrency*", and was mildly critical of the way the protocol dealt with it in that it "*didn't deal with it enough*", but acknowledged that the protocol brought "*awareness of the concurrency issue to those who really haven't encountered it before*".

Participant USA02 agreed with the protocols description of concurrency "*as far as it goes*". Concern was raised at the apparent lack of how the protocol dealt with actually determining concurrency, and that this was considered to be "*a greater issue … that's where the fight is: not what is the meaning of concurrency but what is in fact concurrent*".

Participant USA03 was more cautious about the way the protocol addresses the issue of concurrency stating that "*concurrent delay is not a protocol issue in the United State's*", it was "*a legal issue*" with "*a whole series of court cases on what you do with things like concurrent delay where one is excusable and another one is compensable*", and that despite the production of documents like the protocol, in the USA at least, "*the courts will pretty well continue doing what they want … I don't think any society rule will change their mind*".

Participant USA04 was "*in agreement*" with the protocols approach in that "*if there's true concurrent delay then the contractor should be entitled to an extension of time. It's a one-for-one for the period of concurrency, it shouldn't be reduced*", *whilst* Participant USA05 considered the protocols approach to be very "*basic*" but "*in principle … very close to right*".

Participant USA06 stated that the issue of concurrency was a "*combination of factual and legal*" and that the courts in the USA were "*very protective of their ability to determine issues of law,* *and the resolution of concurrency and whether or not there is entitlement turns, as much, frequently on the legal issue as it does on the factual*".

6. Conclusions

Concurrency is considered to be one of the major issues involved in delay and disruption disputes, but was not seen solely as a protocol issue, but a legal issue governed by caselaw and precedent.

The courts in the USA are unlikely to be influenced by documents such as the Protocol and its approach and recommendations concerning concurrency (and other issues) and will continue to develop and follow legal precedent on a case by case basis.

The current clauses of the standard forms of contract rarely address the issue of concurrency adequately.

The protocols approach was considered to be fundamentally correct, and that it has raised the profile of concurrency as an issue in relation to delay and disruption claims, but its content needs to be expanded to address concurrency (and other issues), and include a suitable means of determining concurrency rather than simply defining what it is.

The development of a recognised industry standard approach to concurrency (and other issues) in relation to delay and disruption claims acknowledged and recognised by owners and contractors would be beneficial for the industry.

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SECTION XIV

ENVIRONMENTAL MANAGEMENT

Methodology to manage the sociological interplays of actors in sustainable urban projects

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Abstract

We developed a methodological framework allowing us to model the actions carried out collectively and individually by the project group. This methodology takes its origin from the strategic analysis suggested by Crozier and Friedberg. It aims objectively to anticipate convergences or "interplays of co-operation" and divergences or "interplays of conflicts" between the main participants in urban development. The project group, as a sociological system, exists by the interdependence of participants and actions whose objectives can converge or diverge. Individual strategies are analysed to determine the collective actions necessary for success. The municipality can then organize the running of the project in accordance with the participants' inherent stopping points. Our approach places each player within the environmental management of an operation. The tool developed on this methodological basis makes it possible to display several sociograms representing direct influences between participants and the impact of each participant on the objectives of an operation.

Keywords: Environmental management, strategic analysis, sociology of organizations

1. General context of the study

Since the launch of the programme “Ecology and Habitat” by the “Construction and Architecture Plan” in 1993, operators in the field of construction have progressively mobilised to promote the environmental quality of buildings. Once the first completed projects finally saw the light of day and a very large number of operations were currently in the design or construction stage in France, the formalisation of a system of certification for these operations - HQE”® - based on a clarified normative framework was called for and has been a tangible reality since 2005.

However, although the operators in the field of construction wish to make a real response to the challenges laid down during the United Nations Conference on the Environment and Development held in Rio de Janeiro in 1992, the environmental management of HQE® operations is no longer in itself sufficient at the level of buildings alone, but must perceive itself in a wider global concept of the “ habitat” at urban level. Our “Habitat” may indeed play a decisive role in bringing out new forms of association making it possible, on a daily basis, to reconcile preservation of the environment with economic efficiency and social equity. Such are the challenges that the 21st century habitat should be meeting.

Taking into account the significant number of housing developments or Designated Development Zones classed as “sustainable” currently being set up or under construction, recent years have seen an increase in the expectations of planners and municipalities that a systematic framework should be put forward, based on assessment tools adapted to suit the context of each urban project.

Our work places us at the meeting point of these expectations regarding:

- the widening of the field of environmental quality in buildings at urban planning level,
- the promotion of the consideration of environmental or socio-economic themes in development projects,
- the setting up of operational tools for assessing sustainability to be used by players in the field of urban planning

The work presented within the framework of “BEAR 2008” forms part of the direct consequences of research developed from the project “ADEQUA “ and the expert reports commissioned by a number of municipalities.

2. Proposal for a system of management by participants

Many pieces of work have focused on the compilation of sets of indicators making it possible to assess the results obtained in quantitative or qualitative terms. Now, the initial feedback shows that obtaining these performance figures depends largely on the management of the operation. However, the methodological questions regarding urban management have hitherto rarely been approached. It therefore appears essential to consolidate a proposal for a system of management that is integrated, structured and organised so as to articulate the questions of sustainable development during the various stages of a development operation

Our initial investigations clearly highlight the importance of developing, within a context that is often contentious, tools making it possible to assist a municipality in its decisions or negotiations. The proposed methodology aims to place the participants at the heart of our approach before moving on to the technical performance levels that are to be achieved within the framework of this type of operation. We will draw our inspiration from the theory of the strategic player as well as the strategic forecast. The strategic analysis proposed by Crozier and Friedberg allows us in effect to model the actions led collectively and individually by the project group. The individual is here included as both the actual person and the body that he represents within the project team. Each action or system of concrete action calls upon a set of mutually interdependent participants. The system exists through the very interdependence of actions and participants, whose own objectives may converge or diverge. Our method of analysis aims objectively to anticipate the convergences or "interplays of cooperation" and the divergences or "interplays of conflicts" between the principal players in the urban development operation. This analysis therefore starts with each participant and their individual strategies, and then makes it possible to put together the collective actions necessary for the success of the operation. It must allow the municipality to organise the running of the project according to what are likely to be the participants' inherent stopping points.

By starting from the premise that each participant is a key element in the sociological organisation of the urban development operation, we recognise that the project team is made up of interdependent participants playing a role that is defined in contractual terms. The actions of each participant have a direct influence on those of the others, thus obliging everyone to adapt to new interactions. In this way, the action of some feeds the action of others, even if they have opposing interests. Divergence becomes complementary, which leads to some complexity and involves new, endlessly repeated adaptation. As stated by P. BERNOUX in the sociology of organisations, each player is a strategic being seeking to satisfy his own needs. He acts according to his own logic, rationality, and individual strategy. By creating his own room for manoeuvre, he adapts his own resources to meet the expected objectives depending on the operational environment in which he finds himself. It is because he is in a relationship with the other participants that he will conceive that he may have priorities (for example, between the short term, which concerns this project, and the long term regarding another project).

The method of analysing the set of participants that we propose to use is based on the MACTOR method developed at LIPSOR, (Laboratory for Investigation into Prospective

Strategy and Organisation. This mathematical tool, that can be found in companies' long-term planning, has the principal advantage of being highly operations-focused, even with a large number of participants, as is the case within the framework of a development operation. This tool makes it possible to display a number of sociograms, schematic representations of the relationships between the players, ie. disputes, alliances, dependences, etc. We should point out that the quality of the data provided through the goodwill of the participants has a strong influence on the results. For this reason, it seems to us essential to show a zone of uncertainty corresponding to the faults of the system and producing zero-quality results, whether this is due to the pressures and deadlocks involved in the project, to professional habits … or quite simply to the fact that a participant does not yet know how he will position himself. The use of this tool requires the collection and entry of the following data:

- description and list of participants
- description and list of objectives
- entry of data in matrices for Direct Influence of Participants (MID)
- entry of data in matrices for Participants' Objectives (MAO).

The application of the Mactor method makes it possible to obtain two types of information: the direct influences between players and the valency of each participant regarding the contractual objectives of the operation.

The results drawn from the matrices of entered data are represented in the form of a matrix of Direct and Indirect Influences (MIDI) summarising the interactions between the participants. This matrix is obtained by taking into account both the degree of direct and indirect influence of each player by counting the direct and indirect influences of the player, and the degree of direct and indirect dependence of each player by counting the clear direct and indirect dependences of the player.

By taking account of these influences and dependences, we can then determine the 'balance of power' held by each participant. Furthermore, it is also possible to describe the valency of each participant with regard to the objectives of the operation.

3. Case study: the Mérigotte NEIGHBORHOOD in Poitiers

The neighborhood of Mérigotte, figure 1, is situated close to the centre of Poitiers, between Artillery Park in the west and the railway and the slopes by the Clain to the south. The urban project designed by AUP provides for several spaces that provide structure, reinforced pedestrian walkways, three viewpoints opening up the perspectives and, above all, a green corridor linking the town with the environment.

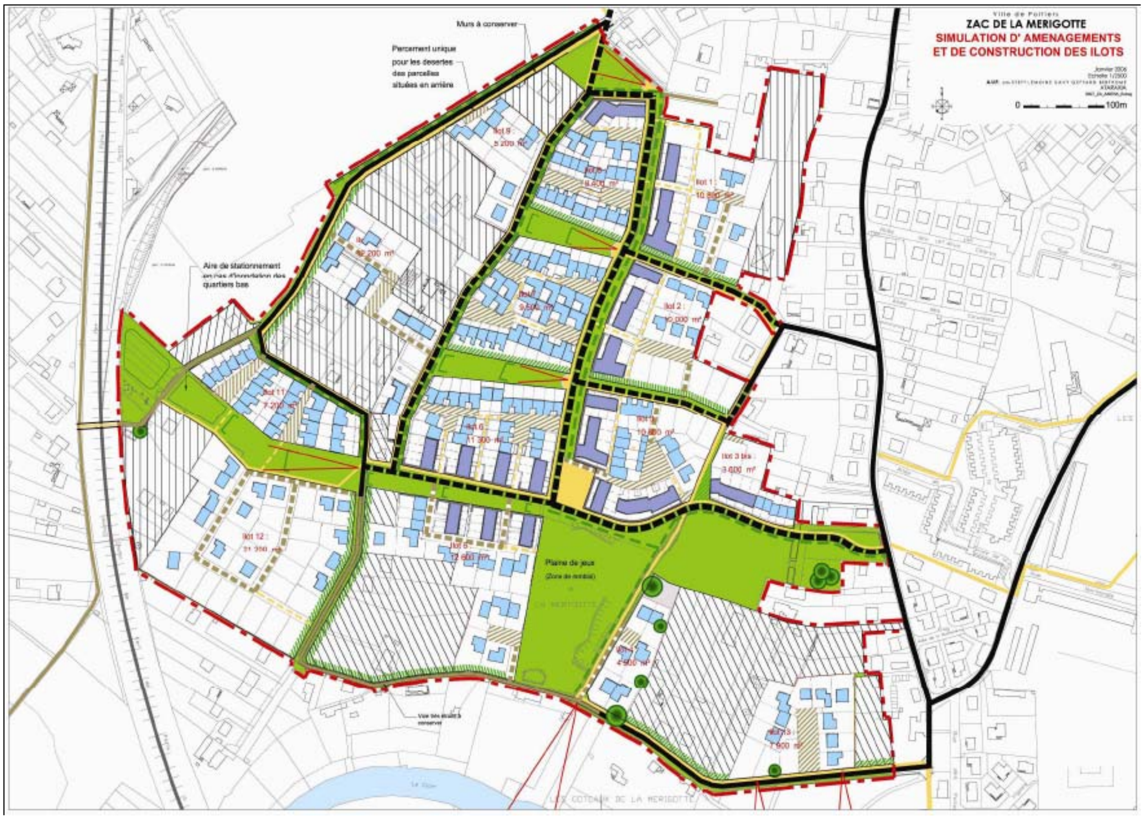

Figure 1. Development plan produced by AUP in January 2006.

In order to put together the table of players' strategies, we have identified a number of participants and initial objectives:

- The municipality, the Town of Poitiers (CP)
- The developer, ATARAXIA Development (A)
- A sample of private and public developers from amongst the principal players: OPARC, SIP, RAGONNEAU Foncier, FONCIER Service, ERMES, (P1, P2, P3).

Each player selected has been identified by means of a non-directive interview making it possible to specify his goals and objectives, plus his strengths and weaknesses.

OBJECTIVES	Conditions of contract for transfer/sale of land – DDZ
Energy efficiency	HPE label (*High Energy Efficiency*)
Management of water	Management of waste water for each plot Promote reduction in consumption of drinking water
Air quality / Health	Choose products listed as Class F + (fungistatic) Class B+ (bacteriostatic) R+ (very low radioactive emissions) C+ (very low chemical emissions) Alkyd paints or those meeting French environmental norms
“Green” building site	Organisation of site Checks and monitoring Keeping riverside residents informed Ensuring personnel’s awareness Limitation of nuisance Limitation of health risks Limitation of pollution Selective handling of waste products

Figure 2. Contractual objectives of the Mérigotte Neighborhood.

The first result that we can draw concerns the influences and dependences between the principal players selected for the study. In Figure 3, we may observe a significant dispersal between the participants. Overall, the role played by the Town of Poitiers within the framework of this operation is highly decisive, more so than that observed on the part of the main or subsidiary developers. The coordination and monitoring of the sustainable development process is therefore wholly incumbent on the municipality. In contrast to other operations in which the developer plays the role of an intersecting player, in this case the Town of Poitiers combines the functions of coordination, steering, negotiation, monitoring, etc., of the process that it plans to carry through itself.

The net balance of direct and indirect influences places the developer in particular outside the other participants, taking into account his potential for influence. The graph of convergences between players, figure 3, also shows the closeness of interests shared by the municipality and the developers. This represents an important guarantee of success in all the objectives linked directly to the “building” level. What is more, divergences on this subject are zero !

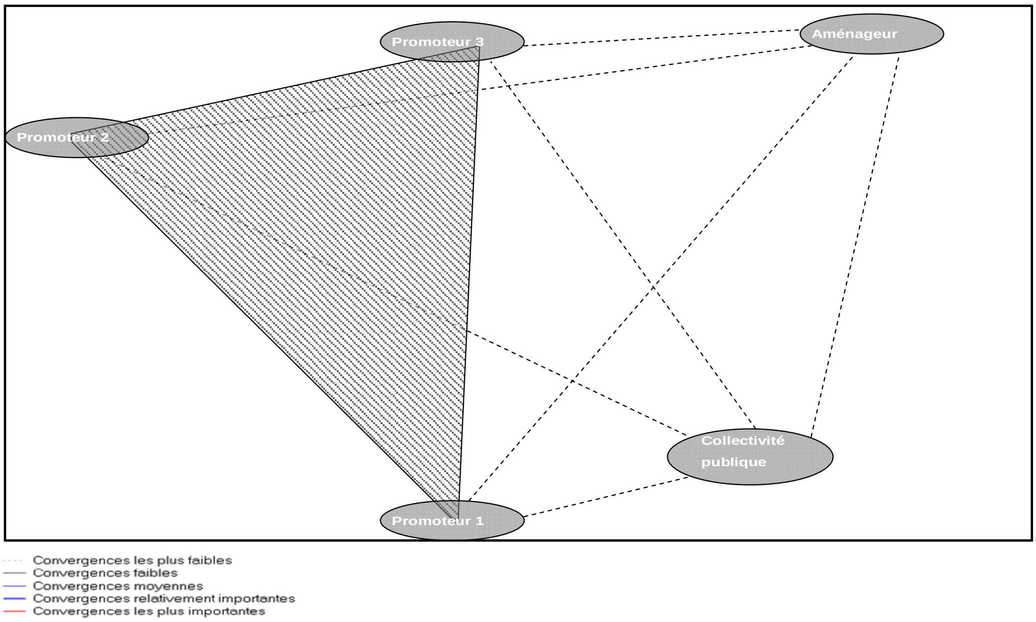

Figure 3. Graph of convergences

On the basis of non-directive interviews, we have also been able to draw up a histogram, figure 4, showing the involvement of all the participants in relation to the selected objectives. The favourable results obtained show a very good appropriation of the approach desired by the municipality, above all in matters relating to water and energy. The measured divergences are here also negligible. This would seem to demonstrate a fairly good level of cohesion between the participants with regard to the approach proposed by the municipality.

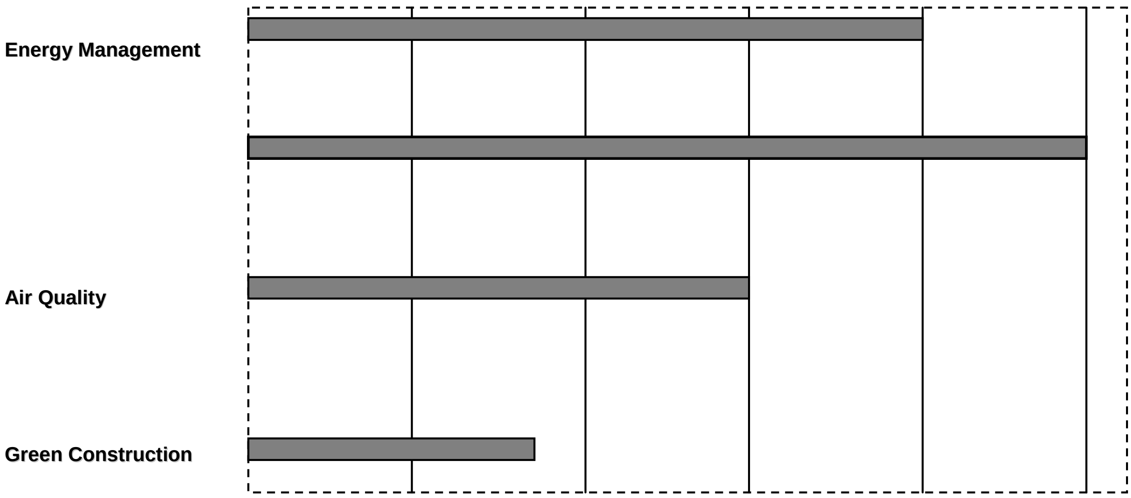

Figure 4. Histogram showing involvement of participants with regard to objectives

We must also point out that here is no ambivalence on the part of any of the participants, which reinforces our reading of the above results. The level of convergence and the appropriation of the approach to sustainable development have brought all the participants together in a highly positive manner.

The few sustainable neighbourhoods carried out in France were it within the framework of well defined operational procedures. These procedures make it possible the community to fix rules of urbanization complementary to the general code at the commune. It facilitates also the financing of the public equipment (roadway system, public space, schools…) by the promoters. Spaces external and envelopes of the buildings like certain internal characteristics. We identify three important phases during the which presence and the interests of the actors can change :

- Creation of the neighbourhood : the municipality and the developer work out the project which is finalized by a plan (see figure 1) and specific code of construction (see table 1). During this stage, promoters are sometimes consulted without there being no contractual relation with the promoters,
- Sale of the grounds to be built, general design of the buildings and detailed design of public spaces: this stage is completed by the delivery of the permit building by the municipality with the promoter and the final sale of the pieces by the developer. It starts with discussions between the developer, the municipality and the promoters interested,
- Detailed design and construction of the buildings: completed by the arrival of the inhabitants, the promoter is the principal pilot of this stage. The munipality and the developer take care of the respect of his engagements. Their influence is juridically limited, but it depends in fact of their capacity to slow down or accelerate the real project and to have later on other grounds interesting the promoter.

The study presented corresponds overall to the second stage. The perimeter of the actors is delimited gradually : during this phase, a first contractualisation is tied between the promoter and the developer in the form of a commitment to sell of the piece subject to obtaining the permit building delivered by the municipality. This stage the decisive actors are identified, but the promoters can still disengage themselves or to be isolated project.

The method suggested supposes a permanence of the logic of actor and interest with the various topics. In fact the renouncements of devices of environmental quality or energy performance prove to be frequent between the initial intention of the promoter and the finalization of the project. Several reasons can explain it:

- an initial ignorance of the benefit and costs of the constructive provisions innovating by the actors,
- a tactic of the promoter consisting in simulating an initial adhesion with the objectives of the developer and municipality while knowing that the principle of realism will precede at the times of the detailed design and financial figuring.

Do the projects of sustainable neighbourhood present sufficient technical and organisational innovations so that their design concerns a collective training during which, knowledge on the devices increases largely. A provision which an actor could considered initially as favorable to his interests can prove to be contrary at the stage design, in particular at the moment of the comparative economic analyses. Because of these multiple uncertainties, the protagonists can hope for an indulgence with respect to their renouncement.

4. Conclusions and prospects

This first application confirms our faith in the feasibility and relevance of our approach. We planned to model various development operations in this way in order to acquire and give structure to knowledge regarding the drawing-up of projects. Our objective is not to rationalise the action being taken. Modelling is not seen here as a predictive model, in other words for putting things in order. The objective is to acquire a better knowledge of the conditions under which the project is put together in order to improve organisation, in the knowledge that each project is unique.

We are seeking to model practices, to understand how decisions are organised and what the rules are governing actions and deliberations. If, within a project, each participant has the right to speak, one may wonder about the value attributed to it according to its origin, about the hierarchical structure and how it is constructed.

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Construction versus Environment: Their Reciprocal Impact During Different Stages of Construction and Maintenance

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Abstract

Is it possible to avoid ecological impacts on built environment instead of battling with the consequences? This paper is focused on mutual impact of environment and building from the viewpoint of selecting the appropriate management strategy. In order to create a built environment harmonizing with the natural world, it is important to manage related information in an adequate way. Systematic approach and methods of simulation modelling enable to assess environmental impacts and establish the balanced interactions between: building and environment; construction process and environment; maintenance and environment etc. The damage of buildings and infrastructure caused by disasters has caught the attention of the world. Even in such geographically calm region as Estonia there have been incidents that compel us to pay more attention to the environmental issues while designing and maintaining buildings. One of the aims of European and Asian Infrastructure Advantage (EURASIA) research project is to find out whether and how the prevention of ecological risks enables to minimize such damage.

Keywords: Built environment, reciprocal environmental impact, environmental risks.

1. Introduction

Building is an essential expression of human activity. Since the beginning of the society humans have shaped the environment by creating, changing and removing various structures. The built environment is a multi-faceted concept, including the natural, artificial, cultural, socioeconomic, political etc. components. It can be stated that buildings can not exist without the environment, but natural environment can exist without buildings as it has been for millions of years before the man. Thus natural background is a basis and human activity has to fit delicately into it. In a long run nature impacted by built environment is changing dramatically.

The assessable influence of each building is localized in various parts of environment into considerably smaller spheres of impact, and the impact outside these boundaries can be considered as marginal. We can find both objective and subjective components of impact, with the latter not being any less significant – e.g. in case of building the architectural attractiveness.

The environment with all its components in turn exerts reciprocal impact on the buildings. In the present paper the following questions are discussed:

- the phases of the life span of a building;
- the reciprocal impacts of the building and environment;
- why and how should the reciprocal impacts be identified;
- possibility of foreseeing and preventing harmful impacts.

The aim of the paper is to provide the starting points for future research in the field, enabling to develop the strategy of assessing the impacts at a more detailed level.

2. Reciprocal Impacts of Building and Environment

2.1 Phases of Life Span

It is possible to differentiate between various phases of building activity as: idea generation and specification; data collecting; initial task and drafting; preliminary assessment; design and planning; construction process; maintenance; the phase of depletion of the lifecycle of the building and its demolition; and finally utilization of waste or the spontaneous utilization of the building in the environment. The length of building life span might be very different as it depends on numerous factors, including both, the environment where it is erected and decisions made in the idea generating and planning or maintenance phase. Some buildings have a life span of hundreds and thousands of years in the form of extensions and rebuilding or architectural memorials, another building can complete its cycle already after a few years of its existence due to being erected in a discord with the environment or other human decisions, incidents, accidents etc. There are always numerous buildings in different phases of life span in the same observed area.

2.2 Classification of Reciprocal Impacts

The reciprocal impacts of the building and environment can be identified throughout all the phases of life span, concentrating most from the phase of construction process to the utilization phase as the impact in the design stage of a building is relatively small. On the other hand, the influence of waste dispersed after utilization has been less researched as well as the impact of the expired but un-utilized buildings. Therefore we have to treat the influence of the building and the activity inside it separately. In this paper general aspects and the reciprocal impacts of the building and environment, depending on the life span of the structure are differentiated as:

- the impact of the building on the environment;
- the impact of environment on the building.

The building affects the environment mainly by: placement, time of being located in an environment, the architectural and structural design, building materials used, suitability of the intended use, size and capacity indicators, building technology and intensity of construction, duration of construction period, intensity of usage, preparedness to environmental changes, labour intensity ratio of utilization etc. The harmful impacts and danger factors of the building on the environment include for instance: delays of planning and increase of cost; the logistic load of building, high energy and resource cost, disorders in waste and recycling arrangements, hazardous building materials, unsuitability of architectural decisions, high energy cost at the maintenance stage, leaking of heat, noise level, irresponsibility of energy saving, demolition waste, etc.

Environment (as a natural, artificial, cultural and socioeconomic entirety) influences the buildings by the location conditions, duration of stay in the environment, human activity, cultural and socioeconomic and political aspects of the environment. The location conditions and harmony of intended use of building and its parameters are here most vital. Out of natural harmful impacts for example the climatic circumstances not corresponding with the qualities of the building can influence the latter as well as the temperature, rainfall, winds, ground conditions, the groundwater level and its quality, fluctuation of water bodies, tides, seismic activity, harmful gas (radon, methane etc.), UV-radiation etc. Besides the artificial factors of the environment and impacts caused by human activity also other buildings, their insufficient infrastructure or energy supply, water, atmospheric and surface pollution etc. can prove to be detrimental to the observed building. The regarded building can become disharmonious with the cultural and socioeconomic and political components of the environment for example by cultural background, evaluations, convictions, human skills, expectations and needs, economic, social and technical conditions and opportunities, as well as strategic and political decisions and choices of individuals or human groups. Impact chains of various range, complexity and intensity result from the reciprocal impacts of the building and the environment, where the cumulating impacts and indirect reaction can be indirectly noticed (Environmental overview, 2005 [5]).

2.3 Significance of Reciprocal Impacts by Phases of Life Span

The extent and intensity of reciprocal impacts come from the properties of the building and environment. As the environment is a background to the building, we can state broadly that environmental impact on the building is the stronger and more intense, in a bigger disharmony the building has been erected with the surrounding environment. In case some essential environmental aspects of the building have been ignored at design, construction process or in maintenance phase, a contradiction will emerge at a definite moment of life span, exerting negative impact on the building and eventually on human health and welfare. The time of appearance of the harmful factor, its severity, possibility to discard it, cost and expediency will be an issue. In course of assessing the extent of the impact by different factors and stages of life span, the following indicators could be used:

- extent of impact,
- duration of impact;
- intensity of impact,
- significance of impact.

In purpose to create a comprehensive picture of the significance of different impacts of the building and to discover the harmful and aggressive impacts at the initial stage of assessment, the rating system has been suggested in the framework of the present research. In table 1 an example of rating sheet for sample building is presented. The impacts are graded as follows:

- "4" – severe influence;
- "3" – high influence;
- "2" – medium influence;
- "1" – low influence;
- "0" – no influence.

Table 1: Significance of Reciprocal Impacts of Building and Environment by stages of life span

Description of Impacts		Significance of Impact											
		Design Stage			Construction Process			Maintenance			Utilization		
		Extent	Duration	Intensity	Extent	Duration	Intensity	Extent	Duration	Intensity	Extent	Duration	Intensity
a) Impact of the building on the environment													
1.	Labour consumption	1	2	3	3	3	4	3	4	4	2	2	1
2.	Logistic load	1	1	1	3	3	3	4	4	4	2	2	2
3.	Construction waste	0	0	0	3	4	2	1	2	2	0	0	0
4.	Demolition waste	0	0	0	1	2	2	2	2	1	2	3	4
5.	Architectural unsuitability	0	0	0	1	2	2	2	4	4	0	0	0
6.	Structural unsuitability	0	0	0	1	3	2	3	4	4	2	2	2
7.	Waste of maintenance	0	0	0	0	0	0	4	4	4	2	2	2
8.	Energy consumption	1	2	4	3	4	4	3	4	4	2	1	1
b) Impact of environment on the building													
1.	Influence of climate	0	0	0	3	2	4	3	2	4	3	2	1
2.	Temperature fluctuations	1	1	1	3	2	3	3	2	3	1	1	1
3.	Wind force	0	0	0	3	2	4	2	2	4	1	1	1
4.	Ground conditions	0	0	0	4	2	4	1	1	1	2	2	2
5.	Groundwater level	0	0	0	1	1	1	4	4	4	0	0	0
6.	Stability of water bodies	0	0	0	2	2	3	3	3	3	2	2	2
7.	Tides	0	0	0	0	0	0	0	0	0	0	0	0
8.	Seismicity	0	0	0	1	1	1	1	1	1	0	0	0
9.	Harmful gases	0	0	0	1	2	2	3	2	2	0	0	0
10.	Impact of other buildings	3	4	4	3	4	4	3	4	4	3	4	4
11.	Faults of infrastructure	3	4	4	2	3	3	4	4	4	0	0	0
12.	Shortage of energy supply	3	4	4	4	4	4	4	4	4	1	1	1
13.	Environmental pollution	0	0	0	1	1	1	3	3	3	2	2	2

14.	Availability of resources	2	3	3	3	2	2	3	2	2	2	2	4
15.	Social discords	0	0	0	1	1	1	4	2	4	1	1	1
16.	Financial limitations	4	4	4	4	4	4	3	4	4	4	4	4
17.	Subjective shortcomings	3	2	4	2	3	2	1	2	1	0	0	0

3. Assessment of Reciprocal Environmental Impacts

3.1 Environmental Impact and Environmental Risk

Environmental impact is usually described as an impact that can accompany human activity and is expressed by changes in natural environment, cultural heritage or assets. According to its common definition environmental risk is a risk where the environment and through that human health, welfare and/or assets are endangered (Morris and Therivel, 2001 [7], Peterson, 2006 [8] and Põder, 2006 [10]. The regular definition of environmental impacts has been focused first of all to the impact proceeding from the building on the environment, leaving the reciprocal influence of the environment on the building as secondary. The definitions contain also no references to the impact division proceeding from the life span of the building.

In purpose to find information regarding the influence of the intended building on the environment and minimize the risks, most countries have adopted a routine to conduct a mandatory preliminary assessment; which can be done within legal framework and legislation, usually called the **assessment of environmental impacts (AEI)**. Focused on the dangers proceeding primarily from the building to the environment, typically the threats proceeding from the environment to the building are handled secondarily and only when it is required by legal instructions. In the present paper the AEI is considered as integral process, including reciprocal (mutual) impact assessment, i.e. assessment of impact exerted by building and *vice versa*, considering the life span of the building. The voluntary assessment of impact for research and knowledge obtaining purposes is also very important besides the legislative due.

3.2 Purpose of AEI (Assessment of Environmental Impact)

In purpose to determine a broader goal of AEI a systematic method should be applied to that. The framework of assessment existing in most countries at a legal level provides good assumptions to it. According to the concept of AEI the assessment is an administrative-regulating measure, characterized by its systematic, reproducible and interdisciplinary nature with a goal to provide the interested parties with competent information of environmental impact of all realistic versions and suggest the optimal solution. Assessment of environmental risk is thereby an activity used to assess the probability and severity of negative impacts proceeding from a source of risk, being exerted to a certain part of environment or by a part of environment to human health or property, as described by Põder, 2006 [10]

In a broader approach of environmental impact and risk assessment it is necessary that impact assessment is meant on one hand map the impacts and their ranges for research purpose (value of knowledge) and on the other hand to help the decision makers, so that all the interested parties might value the results of decisions (practical value). Therefore AEI should have planning and promoting the long term sustainable development by the life span phases of the building as its next essential goal (Peterson, 2006 [8] and Estonian National Strategy of Sustainable Development [6]).

3.3 Method and Procedure of AEI

It is possible to assess the reciprocal impacts and rate actual alternatives by method including the following activities:

- choosing possible alternative versions for AEI;
- identifying the reciprocal environmental impacts of chosen alternative versions;
- ranking the priority sequence of impacts;
- rating the extent, intensity, duration and significance of the impacts by phases of life span as shown in table 1;
- estimating the quantitative values of specific impacts or providing their qualitative assessments;
- analysing the results, selecting actual alternatives of construction and maintenance of the building,
- suggesting on sustainable development, risk level, priorities of impacts etc.

In most countries environmental impact assessment is regulated by legally set principles. Mutually complemented and reckoned environmental, planning and building laws and codes provide a general framework for AEI. Assessment of environmental impact is generally related to two procedures differing in their content and form as depicted in Peterson, 2006 [8] and Estonian National Strategy on Sustainable Development [6]:

- applying and issuance of activity licences (building permits, waste permits, pollution permits, water-special usage permits) and
- composing and validation of strategic documentation (plans, strategies, projects).

The possibilities of AEI on various levels are illustrated in Figure 1.

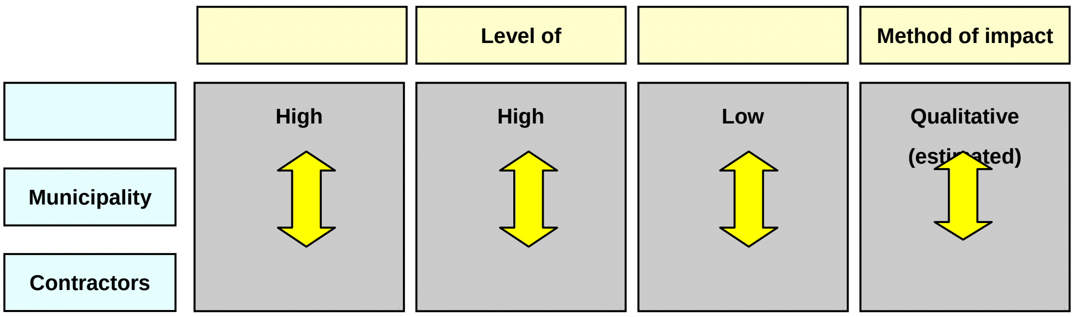

Figure 1: Possibilities of Environmental Impact Assessment on Various Levels

Different countries use different approaches to decide about the need for AEI. For example in Estonia the general conditions of a need for environmental research are provided by legislation as Building Act [7], Act of Environmental Impact Assessment and Environmental Management System [11] and Planning Act [12]. The most significant condition of environmental impact assessment procedure is that it has to be open to public. A special process has been foreseen for disclosure. Disclosure brings forth full preparation of planned activity, its strengths and weaknesses and enables people to track the decisions influencing their living quality. The involvement of the general public improves also the quality of assessment. In order to engage the general public a suitable set of methods excluding information noise and excessive conflicts in accordance with legally set boundaries will be selected.

The assessment of strategic impact should be differentiated from assessment of environmental impact. Environmental risk assessment is a separate measure in addition to regular AEI. Based on current investigation and findings of Peterson, 2006 [8], Põder, 2006 [10] and Veinla, 2006 [13] the present paper provides an outline of basic AEI procedure as shown in Figure 2.

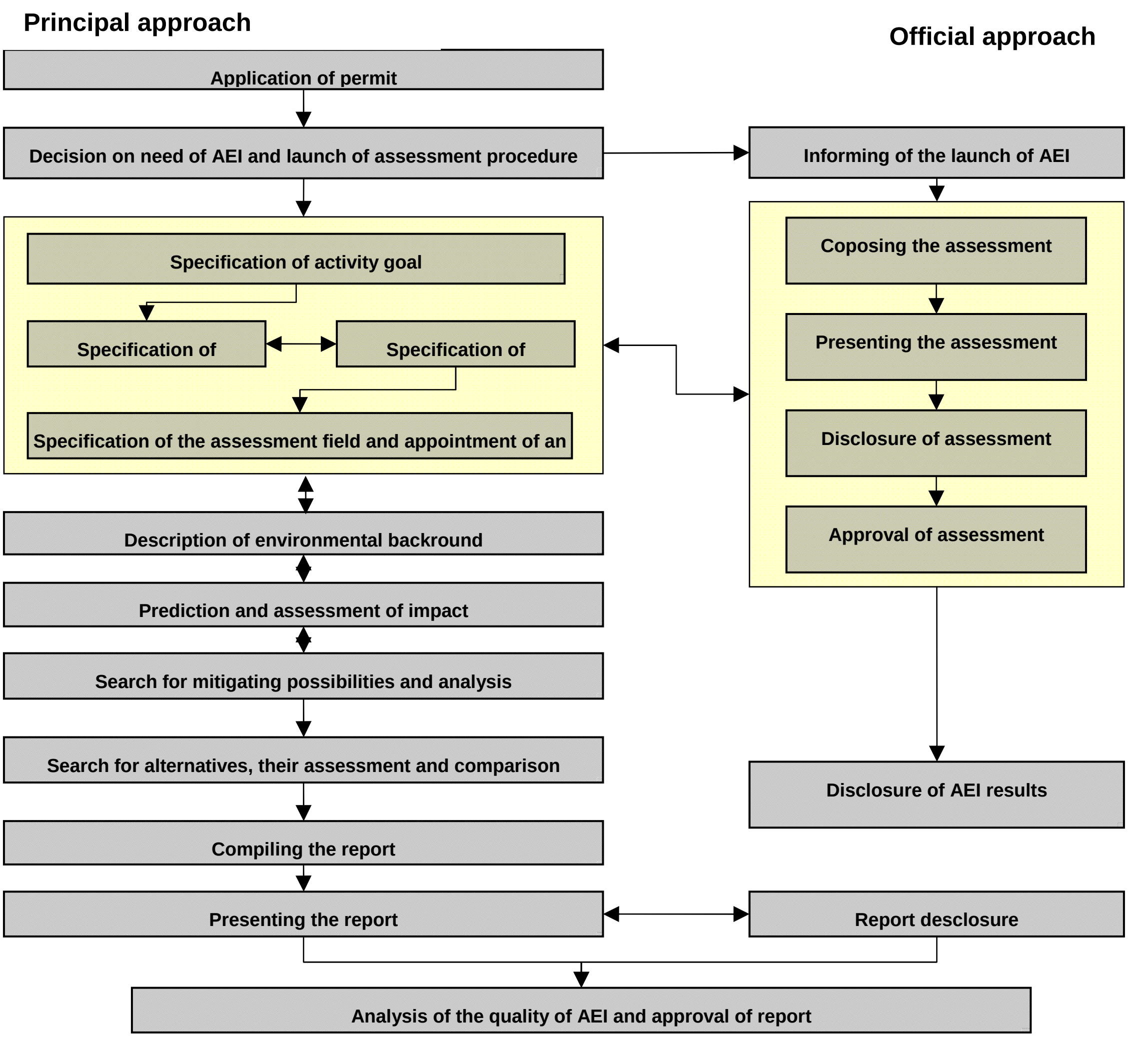

Figure 2: Procedure of Assessment of Environmental Impact (AEI)

3.4 Assessment of Indirect Impact

In the process of AEI one should always consider that besides the direct reciprocal impact the assumed indirect impact has to be specified also. The indirect impact of activity is formed by relational reason-result chains between different parts of environment. They can be manifested far from the immediate locality. The indirect impact can develop as a consequence of direct influences in the long run and it could hardly be predicted during the regular AEI. Impact chain is one of the resources to determine the indirect and cumulative impact. The whole environmental impact is completely specified when all the impact spheres, presumable direct impacts and chains leading to indirect impacts and according results have been ascertained. The field of impact can often be found only at the end of AEI when modelling regarding the distribution of pollutants, water regime alteration, range of changes in socioeconomic environment etc. have been made. The description of environmental background will be taken as the base point of simulation modelling and its parameters will provide an overview on the condition of the influenced object (environment or building) before the beginning of the process. Different environmental aspects and parameters will be described by appointing relevant indicators for the assessment process.

In order to determine the parameters special studies, environmental audit or expertise will be carried out or they will be derived from preliminary analogue projects or case studies. In principle the environmental impact can be assessed both as a by qualitative expert assessment or by mathematic quantitative simulation. The selection of prediction method depends on technical possibilities and nature of impact. The goal and the object will be specified during the simulation process. For modelling a sample model of ecosystem or building will be prepared, where the boundaries of the system, system elements and reciprocal relations of the elements, external factors and exchange processes with the other systems will be specified.

When the elements and relations of the system are determined, the next stage in creating the model includes the description of relations by mathematical equations, proceeding from the law of conservation and balance of systems. The simulation model consists from mutually related sub modules where the motion of critical process is defined. The solutions will be found as analytical or numerical answers, for example by appointing the network of calculation points to the system under investigation. The calculation ratios are used to characterize the intensity and run of the researched processes, using the approximate relations describing the processes. The values of model ratios will be required at calibration where the calculation results will coincide with the measurements. Calibration has to cover ignorance, revealing the limitation of the theoretical principles of the model.

4. Planning Strategy of Sustainable Development

4.1 AEI as a Method for Planning Sustainable Development

Following the AEI it is important to estimate the quality of completed assessment by checking if the evaluation of impacts met all the set terms. After picking up the reciprocal environmental impacts identified as a calculation model the next step will be to consider the mentioned impacts in every possible way at planning the activity in sustainable development. The respective activity in its initial stage is called spatial planning. According to Estonian National Strategy on Sustainable Development [6] and Development Plan of Estonian Country Life [4], the spatial planning is a long term planning of three-dimensional development, co-ordinating and integrating development plans of different fields, considering the tendencies and needs of the economic, social, cultural and natural environment. The goal of sustainable development can be defined also as understanding that our present actions would not endanger the welfare of posterity. Sustainable development is not a goal in itself, but a measure to balance the activity of mankind with its surroundings in a longer run (Sustainable Development Program of Estonian Fund of Nature: [12]).

The arrangement of strategic impacts in the framework of general planning is an essential starting-point of planning the strategy of sustainable development. The goal of preliminary and general planning is to determine the main tendencies and conditions of the territorial development of the area, prepare the underlying basis for detailed planning to set the land use and building terms. Assessment of strategic impacts creates thereby assumptions for the best application of the most vital environmental factor – the suitable location already in the general planning stage when the likely locations of buildings of specific purpose will be specified. Based on general plans it is possible to proceed to a more detailed level in the stage of detailed plans and to the resulting issuance of building and activity permits, by constituting the required conditions for sustainable development.

4.2 Management Strategy for Prediction of Harmful Impacts

The transition from general to the individual (more detailed) and considering the impacts of every activity should be an integral part of the management strategy in the course of assembling a general plan. Management strategy includes the developed systematic activities proceeding from a national policy covering the stages of from general to detailed plans, followed by building permit issuance and concluding with deliberate methods at construction, maintenance and utilization of the building in harmony with environmental sustainability. AEI must always precede the planning in accordance with the degree of detail. Building site management should be conducted according to the impacts of various phases of life span; considering the traffic scheme, infrastructure and engineering supplies. Various alternative versions from the viewpoint of the most suitable environmental solution should be reckoned over when selecting the architectural and structural design.

The natural factor of the environment is one of the strongest and most valid factors besides the artificial, social and economic components. The natural component of the environment deserves separate regard, as in spite of hidden agents the impact might be unpredicted and destructive, posing a direct hazard to a man as well as to the nature itself. In order to avoid the harmful effects exerted by natural environment the impacts must be gradually mapped, considering the functional and constructive alternatives of the building and searching for mitigating possibilities already before the planning of the structure or in the course of construction process. The dangers related to existing structures can be minimized to a certain extent by identifying potential impacts in various stages of life span and planning according protection measures. In case of the most vital aspect ─ the unsuitable location of the building, it must be considered that there might not be so many options at human residential areas to accommodate the desired building.

Natural impacts can be divided into general and local ones. The strongest general impacts are the climate, temperature, precipitation, winds, seismic activity and level of water bodies and its fluctuation etc. The local and weaker impacts are the impact of groundwater, ground conditions, harmful gases etc. Neglect of general impacts can cause large scale, fatal results to humans; in case of local impacts the effect will be more localized. For example the analysis of major natural disasters occurring in the past years all over the world (hurricanes, earthquakes, tsunamis, floods) and their destructive impact has revealed that often there has been insufficient knowledge in the planning of the buildings as probability of endangering hazard or destructive impact of cumulating events was not considered. According to Atwater et al, 2005 [1] it might be possible to forecast both ─ the most devastating disaster of the new millennium ─ the tsunami of South-East Asia in 2005 and the hurricane Katrina, that destroyed New Orleans. These resulted in thousands of victims and a very big economic and environmental damage by dangerous substances proceeding from buildings and ruins. One conclusion of the analysis of the disasters stated that even relatively realistic danger visions obtained by the time spent on predicting the impacts and fiscal means were unable to make the general public react beforehand in a sufficiently active manner with the present management system, economic model and level of responsibility due to traditions, decision making habits, political demands and support of the law between the short term (aggressive, planned to increase progressively) and long term (stable, sustainable) developmental strategy. The key words are versatile awareness of the participants in a decision making mechanism and willingness, resourcefulness and adequacy at searching the mitigating measures, fiscal policy reckoning with priorities and juridical framework sets guaranteeing the certainty of decision making.

As example from Estonia the establishment of buildings on the shore of coastal areas during the real estate boom of 2005-2006 can be brought; which is not negative in itself if all the reciprocal impacts would be considered. The environment influences the buildings located at shore areas mainly by stable water level, probable tides due to gales and wind, as well as the structure and stability of ground. Seismic activity and impact of precipitation have thereby been relatively small. Yet there are developmental areas in Estonia, where short term business interests hold a priority at development and where the dwelling houses and the infrastructure supporting them are established literally to shallow marshland, to the same height with the sea level. The rise of sea level that occurred in Pärnu, Estonia during the January storms in 2005, resulting in major water damage to buildings and facilities located even within a kilometre from the coastal area, let alone the damage to the property and indirect damage to nature, testifies of the insufficiency of danger prevention measures. According to Soomere, 2005 [11] the tsunami caused by earthquake will be also in future improbable in Estonia, but there might be a rise of water level again due to atmospheric phenomena. Therefore building to coastal areas is always an activity of enhanced risk level, that should be preceded already in the planning stage by a versatile analysis of strategic impacts to specify the suitability of building areas at coastal and shore areas and conduct the preliminary assessment of the adequacy of possible mitigation measures. When building to coastal areas one should particularly reckon with relevant foundation, increasing the water and wind resistance of structures, volume-spatial project solutions considering also the probable rise of water level, architecturally used water and wind resistant building materials and improved technologies, as well as the resistance of infrastructure and communications to the impacts of water and wind. The respective research requires more support and recognition, which enables to use derived knowledge already in the design and construction stage of the buildings. This demand nationally regulated policy and increased awareness of decision makers, but also programs and training at the local authority level.

5. Conclusions

The present paper provides a basic overview on the stages of the building life span, reciprocal impacts of the environment and building, their distribution in lifecycle stages, identification of impacts and structure of procedures.

It is important to acknowledge that the environmental impacts can be foreseen already on the planning stage of the building. The following gaps in common assessment of environmental impacts are revealed on the basis of current study:

- as a rule environmental impact assessment involves only the phase of construction process and maintenance, while design and utilization phase of construction life span are almost ignored;
- while impact of the building is usually accepted the reciprocal impact of environment is considered to be insignificant;
- the peculiarity of reciprocal environmental impacts by different phases of life span has not earned deserving attention.

In purpose to continue this research besides fulfilling the gaps mentioned above a list of the reciprocal environmental impacts should be established and a simulation model reflecting the dependences of the sets of reciprocal impacts created.

Knowing the direct and indirect impacts and impact chains it is possible to plan the built environment fitting into nature so that in each planning and building stage reciprocal discords will be minimized. Thereby it has become evident that only increasing the awareness of the general public and decision makers and creating the system of nationally recognized rules, balanced management methods and financing policy, can lead to a result where environmental impacts will be considered at planning stage in purpose to ensure a sustainable development.

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Optimizing Concrete Mixes by Concurrent Use of Fly Ash and Quarry Dust

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Abstract

The use of fly ash in concrete is desirable because of benefits such as useful disposal of a byproduct, increased workability, reduction of cement consumption, increased sulfate resistance, increased resistance to alkali-silica reaction and decreased permeability. However, the use of fly ash leads to a reduction in early strength of concrete. The use of quarry dust in concrete is desirable because of benefits such as useful disposal of a byproduct, reduction of river sand consumption, and increased strength. However, the use of quarry dust leads to a reduction in the workability of concrete. Therefore, the concurrent use of quarry dust and fly ash in concrete will lead to the benefits of using such materials being added and some of the undesirable effects being negated. The decrease in early strength by the addition of fly ash is ameliorated by the addition of quarry dust. The decrease in workability by the addition of quarry dust is reduced by the addition of fly ash. This paper investigates quantitatively the workability and strength of a concrete mix at 3-day, 7-day, and 28-day age containing 0% - 45% of fine aggregate as quarry dust and 0-30% of cementitious materials as fly ash. These findings guide the practitioner in selecting fly ash and quarry dust contents to meet strength and workability requirements of a concrete mix. The concurrent use of the two byproducts will lead to a range of economic and environmental benefits.

Keywords: Fly Ash, Quarry Dust, Economic, Concrete, Workability

1. Introduction

Concrete is the most popular building material in the world. However, the production of cement has diminished the limestone reserves in the world and requires a great consumption of energy. River sand has been the most popular choice for the fine aggregate component of concrete in the past, but overuse of the material has led to environmental concerns, the depleting of securable river sand deposits and a concomitant price increase in the material. Therefore, it is desirable to obtain cheap, environmentally friendly substitutes for cement and river sand that are preferably byproducts. Fly ash (pulverized fuel ash) is used extensively as a partial replacement of cement. Fly ash is a byproduct of coal consuming power plants but has not gained popularity in Sri Lanka as yet because the material is not generated in Sri Lanka, and transportation costs make fly ash not significantly less costly than cement. However, the material may gain popularity in the future with the commissioning of the Norochcholai coal power plant. More fly ash may also be produced worldwide in the future with the establishment of many coal power plants due to the rapid rise in petroleum prices. However, though the inclusion of fly ash in concrete gives many benefits, such inclusion causes a significant reduction in early strength due to the relatively slow hydration of fly ash. Nevertheless, fly ash causes an increase in workability of concrete. Quarry dust has been proposed as an alternative to river sand that gives additional benefit to concrete. Quarry dust is known to increase the strength of concrete over concrete made with equal quantities of river sand, but it causes a reduction in the workability of concrete. When examining the above qualities of fly ash and quarry dust it becomes apparent that if both are used together, the loss in early strength due to one may be alleviated by the gain in strength due to the other, and the loss of workability due to the one may be partially negated by the improvement in workability caused by the inclusion of the other. This paper is generated from a research project designed to determine whether such benefits could be obtained by the use of these two materials together, and to quantify such benefits. Positive results will lead to the possibility of using the two byproducts in large quantities, while reducing the dependency on chemical admixtures.

2. Properties of Fly Ash and Quarry Dust

The spherical shape of fly ash particles causes an improvement in the workability, and the particles alter the flocculation of cement, with a resulting lowering of the quantity of water required [1]. The addition of fly ash causes a reduction in the water required for a given slump, typically in the order of 5-15 % when compared with a Portland cement only mix. However, coarse fly ash with high carbon contents can adversely affect workability [2]. Fly ash in a mix has a retarding effect, typically of about 1 hour, which may be especially advantageous in hot weather such as those prevalent in Sri lanka, while on the other hand, in cold weather, an accelerator may be required. Only the initial set is delayed by the inclusion of fly ash, and the time between setting and final stiffening remains unaffected [3]. The improvement in ultimate strength obtained with the use of fly ash is due to its pozzolanic action and the ability of small fly ash particles to fit in between cement particles [3].

The reaction (hydration) of fly ash does not start until some time after mixing, and in the case of Class F (low calcium) fly ash, can be delayed as much as one week or more. An explanation offered is that the glassy material in concrete is broken down only when the pH in the pore water is at least about 13.2, which means that an amount of Portland cement must have hydrated [3]. Once the reaction does occur, products of hydration are formed around the fly ash particles, and with time diffuse away and precipitate within the capillary pores, causing a reduction in the capillary porosity. Conversely, Class

C (high calcium) fly ash reacts directly with water to some extent. Because the reactions of fly ash take a long time, extended curing times are required [2,3].

Fly ash causes an increase of strength because of the “packing” of the fly ash particles at the aggregate-cement interface, but the beneficial impact of fly ash on both strength and workability is not extended beyond 20 % of the cementitious material. Unlike in the case of strength and workability, fly ash does not affect the properties of creep and shrinkage [3] , though some authors state that the drying shrinkage is increased with the inclusion of fly ash [2]. As a result of the longer setting time for concrete containing fly ash, it is more permeable at a young age, but with time, the permeability drops down to very low values [3].

The median pore size becomes smaller when fly ash is included, and consequently the permeability is lowered; therefore, the use of these cementitious materials improves the durability of concrete [3]. However, Dias et. al [4] found that sorptivity, and hence, water permeability increased with increasing fly ash content in concrete that had not been cured at all. Amarasiri [5] showed that water permeability of concrete containing fly ash is significantly affected by duration of curing. However, the sorptivity of concrete that had been cured for 7 days or greater were independent of percent of fly ash content. Thus, it is possible that concrete containing fly ash, which hydrates slower than cement, needs longer curing times to become durable. In fact, it has been shown that concrete containing fly ash tested after 56 days of curing had smaller sorptivity than control mixes without fly ash. Researchers found that the carbonation of concrete containing fly ash was not significantly greater than in control specimens without fly ash. Significant benefits in resistance to chlorine ingress were noted, while slight increases in sulfate ingress were found. However, resistance to sulfate ingress was not adversely affected by the inclusion of fly ash, presumably because of the decrease in C_3A and $Ca(OH)_2$ in such concrete [4]. The evaluation of the effects of fly ash, and optimizing mix designs is complicated by the variability of the quality of fly ash, even though it may be obtained from the burning of coal at the same power plant. The periodic variations in the operation of the power plants and differences in the coal used causes changes in the particle size distribution and chemical composition of the fly ash produced. Conversely, ground granulated blast-furnace slag, and silica fume are byproducts of highly controlled processes, and have much more consistent properties [3].

Quarry dust is made while blasting, crushing, and screening coarse aggregate. Quarry dust has rough, sharp and angular particles, and as such causes a gain in strength due to better interlocking and a concomitant loss in workability. The use of quarry dust sometimes causes an increase in the quantity of cement required to maintain workability. A survey of samples from 6 quarry dust suppliers in the Galle region of Sri Lanka revealed that they were all more well-graded than the river sand provided by a supplier from the same region. The quarry dusts contained more fines smaller than the 200 μm sieve than the river sand (about 20% for quarry dust compared with 5% for river sand) [6] According to the guidelines for mix design according to the Department of the Environment of the United Kingdom [7], the finer the fine aggregate used in concrete, the higher the requirement of free water to maintain workability. However, the mix-design procedure limits the analysis of fines content of a fine aggregate to % passing 600 μm sieve. Therefore, the guidelines should clearly be used with trial mixes when inserting quarry dust.

3. Research Methodology

One mix design was used for this research with a target strength of 30 N/mm^2. River sand was replaced by 0 (i.e. totally river sand), 15, 30, and 45% quarry dust, whilst cement was replaced with 0, 15, and 30% fly ash. The slump of the resulting mixes and the strength at 3-day, 7-day, and 28-day age were obtained by testing three replicate 150 mm compressive strength cubes for each combination of mix and testing age. Ordinary Portland Cement from a leading manufacturer was used as it the widely used cement for construction in Sri Lanka. Gneissic crushed coarse aggregate of maximum size 20 mm was used. River sand was used as the primary fine aggregate, and gneissic quarry dust was used to partially replace it to find the effects of including quarry dust. One mix design was used for the entire research project and it was as follows per cubic meter of concrete..

Cement 362 kg
Water 210 kg
Fine aggregate 818 kg
Coarse aggregate 985 kg

The moisture contents in the stockpiles were 1.83% for river sand and 2.00% for quarry dust, and corrections were carried out for the differing moisture contents when partially replacing river sand with quarry dust.

The combinations tested were as shown in Table 1. For all test series, 3 replicates each were made for the three testing ages of 3 days, 7 days, and 28 days.

Table 1: Testing programme

Fly Ash Content (% replacement of cement)	**Quarry Dust (% replacement of river sand)**			
	0	**15**	**30**	**45**
0	Series 1	Series 2	Series 3	Series 4
15	Series 5	Series 6	Series 7	Series 8
30	Series 9	Series 10	Series 11	Series 12

A power driven drum type concrete mixer with revolving drum was used to mix the concrete, while weight batching was used. Steel moulds were used to prepare concrete specimens of 150 mm x 150 mm x 150 mm for strength determination for each test. The slump was also tested of the fresh concrete immediately after mixing. The concrete specimens were demoulded 24 hours after they were cast and continuously moist cured in a curing tank unit the time of test.

4. Results and Discussion

The average strengths and slumps obtained from the above tests are shown in Table 2. For ease of comparison and insightful analysis of the effects of replacement, the average strengths of the concrete with replaced materials are reported as ratios of the average strength of the control without river sand

and cement replacement. The strengths of the control mix at the three ages tested are shown in the first row of data.

Table 2: Test results as strength ratios between the control mix and mix with cement and river sand replaced

PFA (%)	Quarry dust (%)	Slump (mm)	Age (days)		
			3	7	28
			Strength ratio to control mix		
0	**0**	80	20.21 N/mm^2	25.31 N/mm^2	33.47 N/mm^2
	15	50	1.17	1.12	1.12
	30	35	1.20	1.13	1.13
	45	20	1.24	1.20	1.16
15	**0**	105	1.00	0.95	1.04
	15	58	1.05	0.99	1.09
	30	48	1.10	1.00	1.15
	45	25	1.10	1.04	1.15
30	**0**	88	0.85	0.86	1.05
	15	78	0.86	0.86	1.05
	30	55	0.83	0.82	1.03
	45	30	0.92	0.90	1.10

Examining the strengths at 3-day age, it can be seen that the increasing of quarry dust content from 0 % to 45% has caused an increase of strength for fly ash contents of 0% and 15%. The increase is not that consistent for 30% fly ash, though there is a distinct increase of strength for the concrete with 45% quarry dust compared with other quarry dust contents for concrete containing 30% fly ash. Interestingly, the increase of strength with increase of quarry dust content is most apparent in the concrete without fly ash, where a strength gain of 24% has been recorded by increasing the quarry dust content from 0% to 45%. When combining all contents of quarry dust, the concrete with 15% fly ash is about 8% lower in strength and concrete with 30% fly ash is about 25% lower in strength than concrete with no fly ash at 3-day age.

Examining the data obtained at 7-day age, it can be seen that the increasing of quarry dust content from 0% to 45 % has consistently caused an increase of the strengths of concrete containing 0% fly ash and 15% fly ash. Again the gain in strength with increase in quarry dust content is not as clear cut for concrete containing 30% fly ash. The increase in strength with increase of quarry dust content is most apparent for concrete containing no fly ash. When combining all contents of quarry dust, the concrete with 15% fly ash is about 11% lower in strength and concrete with 30% fly ash is about 23% lower in strength than concrete with no fly ash at 7-day age.

Examining the data obtained at 28-day age, it can be seen that, in general, there is an increase in strength with increasing quarry dust content though the increase is not as much as at 3-day age. Thus, the addition of quarry dust affects concrete at 3-day age (early strength) more than concrete at 28-day age. When combining all contents of quarry dust, the concrete with 15% fly ash is about equal in strength and concrete with 30% fly ash is about 4% lower in strength than concrete with no fly ash. According to some guidelines for mix design, only 30% of the fly ash should be considered when calculating the water-cementitious material ratio for estimating the strength of a designed mix. It can immediately be seen when examining the current data that this factor certainly underestimates the contribution to strength from fly ash, and how difficult it is to make generalizations regarding the effects of including fly ash in a concrete mix.

Considering the slump data, it is apparent that there is a rapid loss of slump with the addition of quarry dust, but the increase of slump with the addition of fly ash is not as significant. For the purposes of selecting fly ash and quarry dust contents to meet a certain slump requirement, the data was processed to generate a plot of equal slump lines, as shown in Figure 1.

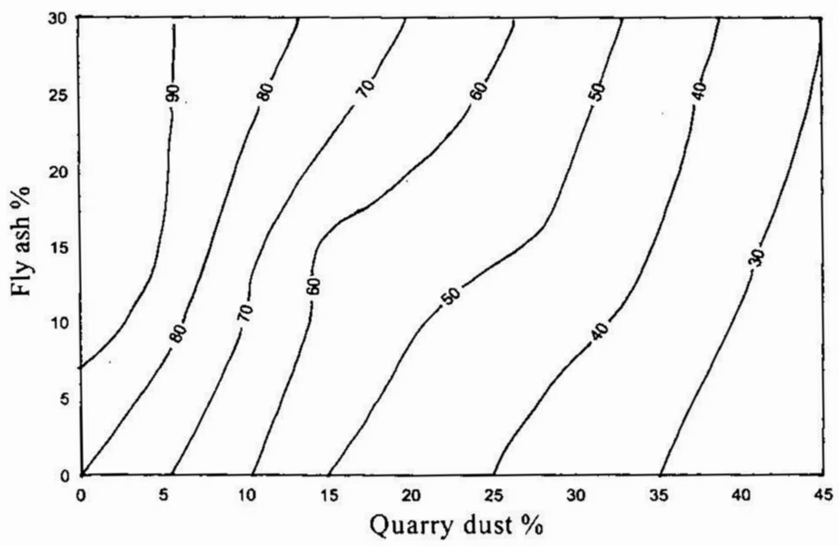

Figure 1: Equal Slump Lines (mm)

From Figure 1, it can be seen that if a slump of 80 mm is required, using the above mix design it is possible to use 0 % quarry dust and 0 % fly ash, or about 5 % quarry dust and 7 % fly ash, or 10 % quarry dust and 22 % fly ash. The question then arises, how will these variations affect the concrete strength at early age, say 7-day age. Then, based on data shown in Table 2 and interpolation, the 7-day age strength would be approximately 25.3 N/mm^2 for concrete with 0 % fly ash and 0 % quarry dust, 26.0 N/mm^2 for concrete with 5 % quarry dust and 7 % fly ash, and 23.3 N/mm^2 for concrete with 10% quarry dust and 22% fly ash. The last type of concrete is understandably weaker than the control, because fly ash inhibits the rate of early strength development. If the strength at 28-day is being targeted, it would be approximately 33.5 N/mm^2 for concrete with 0 % fly ash and 0 % quarry dust, 35.1 N/mm^2 for concrete with 5 % quarry dust and 7 % fly ash, and 35.6 N/mm^2 for concrete with 10% quarry dust and 22% fly ash.

From the above discussion, it is apparent that the concurrent use of the two materials is possible, causing environmental, monetary, and some durability benefits, while preserving the workability and slump requirements of the concrete mix. Gaining the required strength at 28-day age even though fly ash is included is feasible for all contents of fly ash and quarry dust tested. However, the loss of early strength (at 3-day age) due to the inclusion of 30 % fly ash has not been entirely compensated by the inclusion of up to 45 % quarry dust. Similarly the loss of strength at 7-day age due to the inclusion of fly ash has not been entirely compensated by the inclusion of up to 45 % quarry dust. The loss of strength at 3-day age and 7-day age due to the inclusion of 15 % fly ash can be fully negated by the inclusion of quarry dust.

However, making quantitative statements regarding the ability to use fly and and quarry dust concurrently is hampered by the variability of fly ash, even from a single batching plant [3]. Similarly, the presence of very fine particles in the fine aggregate causes the cement to disperse and increases hydration [8]. Therefore, two approaches are present to generalize the research showed herein for any fly ash and quarry dust. One approach would be to develop a large database of test results so that many types of fly ash and quarry dust are covered. Another, more practical solution may be to carry out limited testing on a particular fly ash and quarry dust that is to be used at site. The data presented in this paper may be valuable in estimating the ranges where substitution is practicable. The use of the second approach over a period of time, and the publication of the results obtained will lead to the data needed for the first approach being automatically generated.

5. Conclusions

Fly ash is a byproduct that can be used in concrete to obtain durability, cost, and environmental benefits. However, its use has a drawback in that early strength is adversely affected. This is due to the slower hydration of fly ash than cement. Quarry dust is a byproduct of quarrying, crushing, and sieving aggregate. It is a very good replacement of river sand, which is in short supply currently. However, the use of quarry dust causes a loss in workability of concrete. This paper looked at the concurrent use of the above two byproducts, with the expectation that the decrease in early strength by the addition of fly ash is ameliorated by the addition of quarry dust. The decrease in workability by the addition of quarry dust is reduced by the addition of pulverized fuel ash. The loss in early strength due to the addition of 15 % fly ash can be completely negated by the addition of 30 % quarry dust. The strength at 28-day age has not been adversely affected at all by the addition of up to 30 % fly ash. The addition of quarry dust causes a loss in slump; though such loss in slump can be significantly reduced by the addition of fly ash.

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Study on advantages of using coir dust in vertical drains for the improvement of soft clay

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Abstract

As a developing country, Sri Lanka has already launched major development projects such as highways and major road development projects, airport projects, harbour expansion projects and other larger construction projects, therein utilizing undesirable grounds due to limited spacious land. Normal practices such as removing and replacing of soil as well as pile foundations in overcoming undesirable conditions of ground may not be economically and environmentally feasible for a country like us. At the same time, solid waste management is becoming a major concern all over the world as it appears with many issues. Waste reduction, reuse and recycle have become major issues in recent days. As a major coconut producing country in the world, Sri Lanka produces annual net waste of coir dust around 527,800 tons [1].

Having considered the means of reducing and optimizing waste in a useful manner, the applicability of soft ground improvement with an introduction of coir dust in vertical drains as a filling material with sea sand was studied in this research. Permeability characteristics of mixed materials of coir dust and sea sand as well as sea sand alone were analyzed and the consolidation behaviour of high plasticity clay with vertical drains under two conditions, vertical drain filled with sea sand and the drain filled with mixed materials as well as without vertical drains were analyzed. It was observed that the coefficients of permeability of mixed samples were within the range of 10^{-2} (cm/s), which is a typical value for sand drains. The consolidation experimental results showed that with the introduction of coir dust in vertical drains, coefficient of consolidation of high plasticity clay was increased compared to the case without vertical drains.

The optimum percentage of coir dust to be used in vertical drains with sea sand as filling materials was figured out as the final outcome by considering permeability and consolidation characteristics as well as the cost analysis for practical applications.

Key words: Coir dust, Consolidation, Ground improvement, Sand, Vertical drains, Waste reduction

1. Background

Sri Lanka has encountered undesirable ground conditions with major development projects such as Southern highway, Katunayake highway, major road development projects, Weerawila airport, Hambantota harbour project, Colombo port development project and other larger construction projects. Normal practices such as removing and replacing of soil as well as pile foundation in overcoming undesirable conditions of ground may not be economically and environmentally feasible for a developing country like Sri Lanka. At the same time, solid waste management has become a major concern all over the world as it appears with many issues such as aesthetic appearance, financial problems in removing and treating, loosing an income and affecting human health etc. Hence, waste reduction, reuse and recycle have become major issues recent days. As a major coconut producing country in the world, Sri Lanka produces annual net waste of coir dust about 527,800 tons (i.e. 2150 m3) [1]. Since coir dust is a waste, it is needed to seek the possibilities of using profitably so that it will minimize some of waste problems in Sri Lanka.

Figure 1: Coir dust dumped aside at Hikkaduwa

Coir dusts are huge wastes and one of the major environmental problems in the coastal zone of Sri Lanka especially Hikkaduwa and southern coast line of Sri Lanka. It is a national need to utilize these wastes in a productive manner. So far no steps have been taken to use these wastes for the ground improvement in Sri Lanka. Sand drains are commonly used in the ground improvement projects. However, the present situation shows that river sand is a high costly material and a limiting material in Sri Lanka where river sand mining has become a major environmental issue. At present, one cube of river sand costs around Rs. 6000 whereas purified sea sand costs around Rs. 3550 mainly in suburban areas, especially in Colombo [3]. Therefore, it is a timely needed investigation to search whether coir dust can replace some amount of sand which is used in the sand drains.

Weak soils such as soft clay and peaty clay are low permeable and have high water content and thus cause excessive settlement when subjected to loads. While ground improvement helps to reduce settlement, increase the bearing capacity and decrease permeability etc., some ground improvement methods like preloading alone for the types of weak soils takes long time to get consolidated but preloading with vertical drains together accelerates the consolidation process.

2. Ground improvement techniques

It is obvious that structures should be constructed on good quality ground. The ground conditions of construction sites due to lack of suitable ground, however, have become worse than ever during recent decades throughout the world. It is often encountered to dredged soils, highly organic soil ground, loose sandy ground when any type of infrastructures is constructed, where large ground settlement, stability failure is anticipated. Lot of ground improvement techniques have been developed and applied in many construction projects. They can be classified into four categories generally as replacement, drainage, densification and admixture stabilization [4].

Under drainage, compression of soft soils prior to construction by means of static loading is widely applied in practice to achieve the required consolidation and proper strength increase, if sufficient time is available. In the method, a pressure (preload) equivalent to or exceeding a contact pressure of superstructure is applied to the ground in advance of the construction of superstructure. The consolidation of soft soil by the preload will increase the shear strength of the soil and hence reduce the residual settlement. Normally such a preload can not be applied all at once to soft ground. Thus, the preloading must be performed in several stages while confirming the strength increase of the ground.

In accelerating the consolidation of low permeable soil, the existing techniques are:

1. Preloading on ground surfaces.
2. Preloading with sand vertical drains.
3. Preloading with prefabricated vertical drains.

The slow rate of consolidation of a loaded cohesive soil is accelerated by providing horizontal drainage in addition to the normal vertical drainage by means of installing vertical drains, commonly use sand drains. The vertical drain method has been frequently adapted to gather with the preloading, surcharge or vacuum method to accelerate the rate of consolidation by shortening the drainage path. In general, vertical drains have been used with pre-compression technique on a wide variety of applications to increase the rate of consolidation of clay, results in a reduction of time required for primary settlement to take place and the increased rate of gain in shear strength of the clay enables the load to be applied more rapidly.

Sand drains are vertical columns of sand or other pervious material inserted through a compressible stratum. They enhance consolidation process by decreasing the drainage path and quite often taking advantage of a higher coefficient of consolidation in the horizontal direction and provide supplementary outlets for the expelled pore water. The Sand drains are mainly used in consolidation of extensive areas of loading such as airport runways, highway embankments, large storage areas and reservoirs etc., over compressible soils to ensure that most of the settlement will occur during and not after the construction. The diameter of sand drains vary in practice from 300mm to 600mm and the spacing vary from 1.5m to 4.5m. To be effective, the spacing of sand drains should be less than the thickness of the consolidating layer. The depth of sand drain is governed by the sub soil conditions such as the depth of the firm layer below the ground surface. Perhaps sand drains have been installed to depths of up to 45m [10].

3. Ground improvement using wastes

Different kinds of waste materials were used in ground improvement in the world such as oyster shell as mixed material of sand compaction pile (Okumura, 1995), wood chips as mixing material for back fill of retaining walls (Pradham, 1993) [7 and 9] and particularly coir dust in different applications.

Coir dust is very similar to peat in appearance. It is light to dark brown in colour and consists primarily of particles in the size range 0.2-2.0 mm (75-90%) [5 and 6]. Cresswell, G.C. (1992) has done studies on coir dust. According to his studies, coir dust is a spongy, peat like residue from the processing of coconut husks for coir fibre. Also known as coco peat, it consists of short fibre (<2mm) around 2-13% of the total and cork like particles ranging in size from granules to dust. Coir dust strongly absorbs liquid and gasses. This property is due in part to the honeycomb like structure. Coir dust is also hydrophilic (attract water) which means that moisture spreads rapidly over these surfaces [2]. Coir dust has better capillary wetting properties. Capillarity is the property that enables water to be drawn from a saucer or a capillary bed towards the top of the post. Capillarity is needed to distribute moisture already absorbed. In this way, it influences the maximum rate water from surround is absorbed as it drains throughout mix, the water retention efficiency. Therefore, coir dust can help to establish a capillary connection to fully wet the mix.

Non woven coir used in the manufacture of basket liners, mulching mats, grow sticks, cultivation mats for plants, roof green applications, portable lawn or instant lawn and many more applications. Non-woven erosion blanket protects the soil from effective erosion and creating microclimates and mulching action. The blankets will be much suited for dry lands and low fertile soil. The applications are road embankments; rail embankments, river embankments and hill slide slopes [8].

In Sri Lanka only 60 to 65% of annual yield of coconut husks is used for coir products with no waste and the remaining 35 to 40% is totally a waste. A coconut husk with an average weight of 350g consists of 150g of coir fibre and 200g of coir dust. One of the special features of coir fibre is that its durability which is unlimited under dry conditions and about 2 to 5 years under wet condition. Another important factor is coir dust has a moisture capacity of about 550% (Information from Industrial Development Board, Sri Lanka). Coir dust accumulates in large piles or "dumps" outside of the mills, which process the husks for extraction of the industrial valuable long fibres. The high lignin and cellulose content of the pith prevents the piles from breaking down further [5 and 6].

4. Materials and methods

Sampling and Preparation of Materials

The main materials; coir dust, sea sand and clay sample that classified as high plasticity silt (MH) were taken at closed proximity to the Faculty of Engineering, University of Ruhuna, Galle, Sri Lanka throughout the research work. The places of intake of those samples are given in Table 1. The places of intake of coir dust and unimproved clay are shown in Figure 2 and Figure 3 respectively.

Table 1: Details of collected materials

Material	Place of intake
Sea Sand	Coast of Galle fort area
Coir Dust	Nugaduwa Fibre Mill, Akuressa road, Nugaduwa, Galle.
Unimproved Clay	Southern Highway site (Chainage: 15 + 000 from Kurundugaha Hetekma)

Figure 2: Intake of coir dust at Nugaduwa Fibre Mill, Nugaduwa

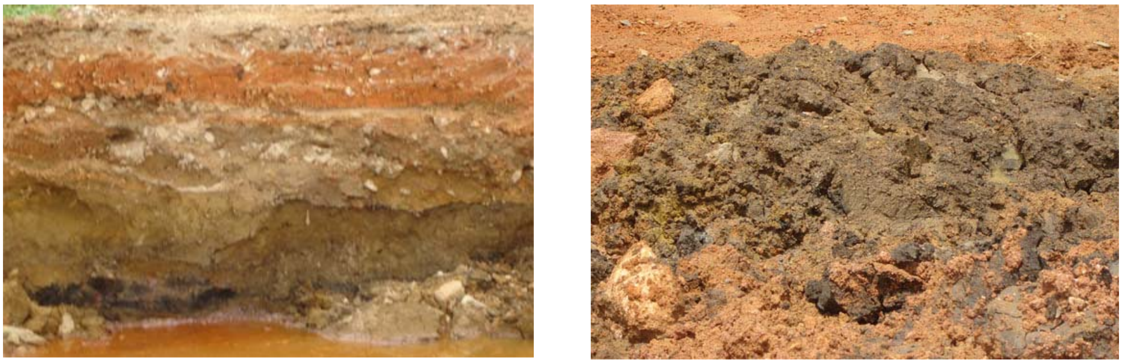

Figure 3: The intake of unimproved clay at the Southern highway (CH: 15+000 from Kurundugaha Hetekma)

Normal field samples kept under general environmental conditions at the laboratory were taken for mixing. Coir dust and sea sand were mixed based on weight and the percentages of individual materials are shown in Table 2. The maximum percentage of coir dust in the mixture was 50% as beyond that percentage the mixture experienced to separate as layers when allowing to get full saturation. The mixing of coir dust and sea sand was done by a mechanical mixer as shown in Figure 4 and each sample was mixed for 5 minutes and the usages of materials for different experiments are shown in Table 3.

Table 2: Percentage of coir dust in mixtures

Mix sample	Percentage of coir dust (%)
1	05 (18)
2	10 (32)
3	15 (43)
4	20 (52)
5	30 (65)
6	40 (74)
7	50 (81)

(Note: Percentage by volume is in brackets)

Figure 4: The mechanical mixer

Table 3: Various forms of material samples for different uses

Sample	Usage
Oven dried	To determine particle size distribution curves for sea sand and coir dust To use in Atterberg limit tests for unimproved clay sample
Fully saturated	To use in permeability analysis (Constant head) To use in consolidation test
Normal field	To mix materials to obtain various mixed proportions

4.2. Determination of Material Properties

Sieve analysis tests were carried out to analyse the particle size distribution of coir dust and sea sand. coefficient of uniformity (C_u) that indicates the spread (or range) of particle size and the coefficient of concavity (C_c) that indicates the shape of the curve between D_{60} and D_{10} grain sizes for both materials were obtained from the grading curves with the help of following equations.

$$C_u = D_{60}/D_{10} \qquad (1)$$

$$C_c = D_{30}^2/(D_{10}\ D_{60}) \qquad (2)$$

where, D_{10} is the diameter at 10% of weights are finer, D_{30} is the diameter at 30% of weights are finer and D_{60} is the diameter at 60% of weights are finer. The particle size distribution curves are shown in Figure 5.

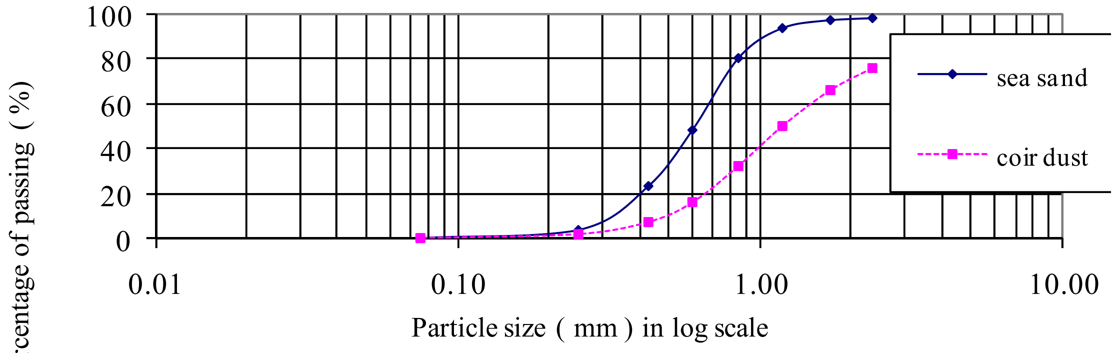

Figure 5 : Particle size distribution curves

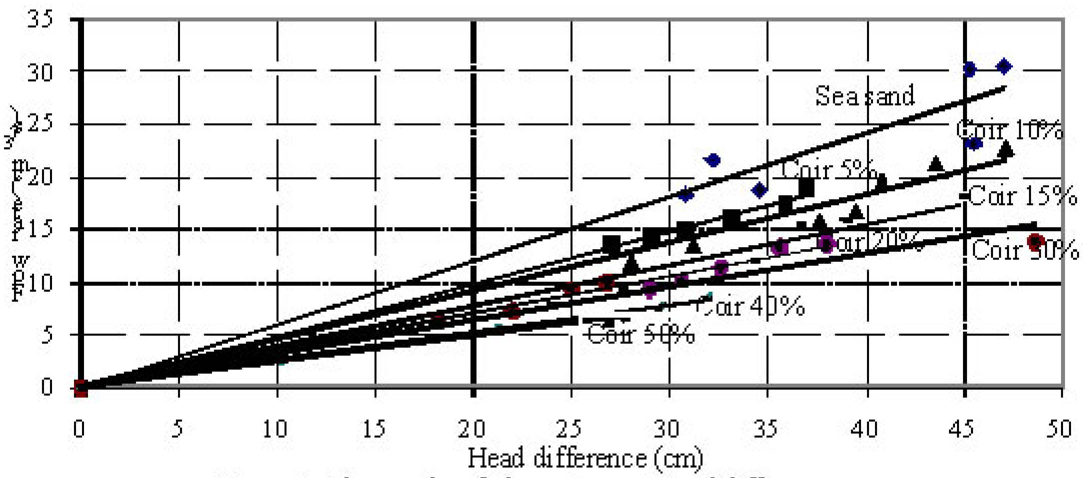

Figure 6: The graphs of Flow rates vs. Head differences

Series of constant head method of permeability tests were done to determine coefficient of permeability of materials due to both materials used for the research works are porous materials. Sea sand and mixed samples of different proportions were analysed under the same test conditions. Materials samples were packed in the apparatus under three layers and each layer was subjected to five blows with a rod while adding same amount of water so that to avoid formation of larger size air voids inside the specimen. Each test was allowed to get fully saturation as water flows through the specimen. Since there was no significant temperature variations observed, each analysis was done under normal room temperature of 30 ^{o}C. Using observation of each analysis the graph of flow rate vs. head difference was plotted as shown in Figure 6.

Laboratory one dimensional consolidation tests were carried out to study the consolidation behaviour and the effect of vertical drains on the settlement of unimproved clay sample. Diameter of the sample tested was 50mm and the thickness was 20mm. Graphical methods (logarithm of time method and square root of time method) proposed by Casagrande and Taylor were used to determine coefficient of consolidation (c_v).

A simple model for the application of vertical drain in the clay sample was prepared with an introduction of a cylindrical hole at the centre of the unimproved clay specimen (Figure 7). Two experiments were done with a vertical drain at the centre of the clay specimen, as one experiment was done as the vertical drain filled with sea sand alone and the other experiment was done as the vertical drain filled with mixture of coir dust and sea sand. As a typical sample, the mixture of 50% of coir dust mixed with sea sand based on weight was tested. The clay specimen without a vertical drain was also analysed to determine the coefficient of consolidation. The coefficient of consolidation was determined by using the following equation.

$$c_v = T_i H^2 / t_i \qquad (3)$$

where; T_i is Time factor, t_i is corresponding time for T_i and H is length of the drainage path.

Figure 7: Introduction of vertical drain in clay specimen

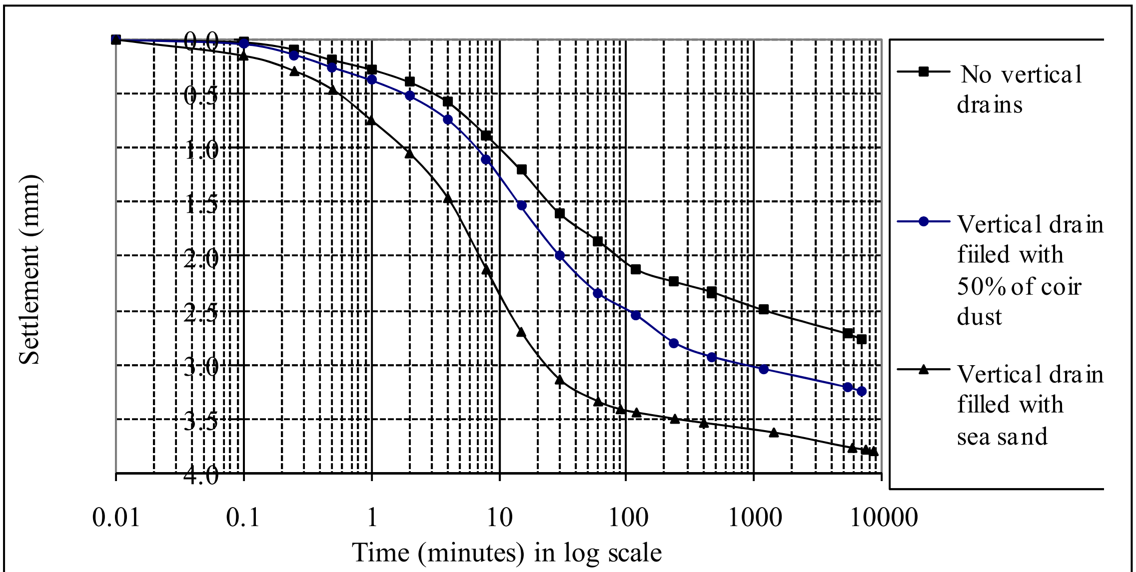

Figure 8: The graphs of settlement vs. log Time

The relevant graphs of settlement vs. time were drawn for three sets of test specimens used for the research works and shown together in Figure 8.

Engineering behaviour of fine grained soils depends on factors other than particle size distribution and it is influenced primarily by their mineral and structural composition and the amount of water in it. Fine grained soils can exist in any several states depending on the amount of water in the soil system. Atterberg limit tests were carried out to classify the type of clay sample used for the research. The plastic limit, liquid limit and plasticity index were determined in order to identify the type of clay and the clay sample was classified according to Unified Soil Classification System.

5. Results

The coefficient of uniformity and coefficient of concavity for both materials have been obtained and summarized in Table 4 and the observations from permeability analysis were processed to obtain coefficient of permeability from the graphs of flow rate (q) vs. head difference (Δh). These graphs were developed for material samples of coir percentages from 0 to 50% mixed with sea sand by weight (Table 2). The coefficients of permeability determined from the graphs in Figure 6 are shown in Table 5.

Table 4: Sieve analysis results

Material	C_u	C_c
Sea sand	2.11	1.04
Coir dust	3.04	0.96

Table 5: The coefficients of permeability

Material samples		k (cm/s) x 10^{-2}
Percentage of coir dust in the mixed sample (%)	0	12.06
	5	09.80
	10	09.08
	15	07.74
	20	07.00
	30	06.40
	40	05.20
	50	04.78

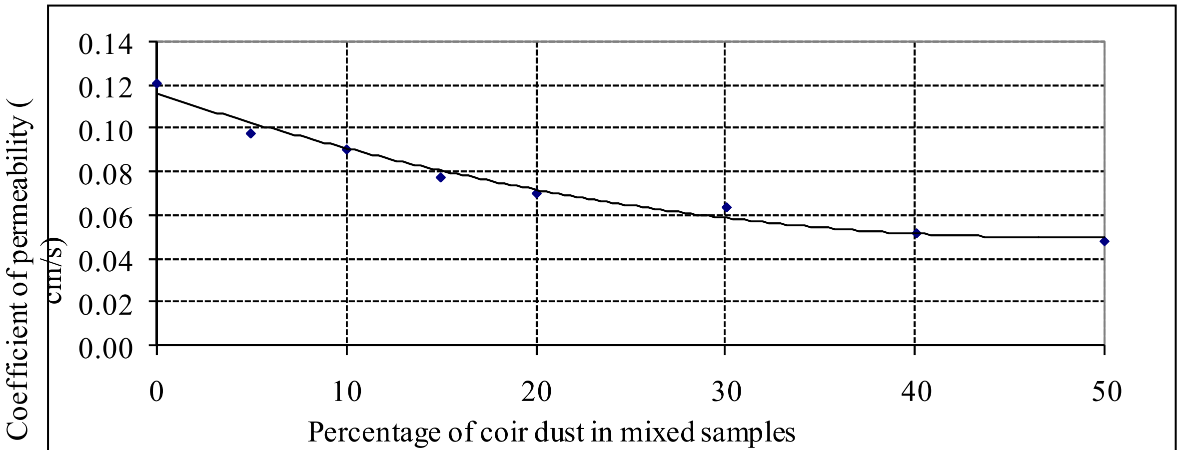

Figure 9: The graph of k vs. percentage of coir dust by weight

The graph of coefficient of permeability vs. percentage of coir dust measured on weight basis in the mixture is shown in Figure 9 and the same graph with the percentage of coir dust measured on volume basis is shown in Figure 10.

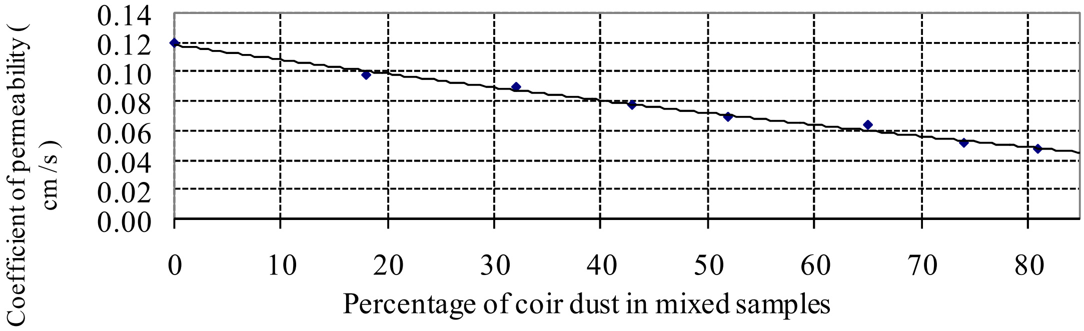

Figure 10: The graph of k vs. percentage of coir dust by volume

The coefficients of consolidation for three test specimens were determined using equation (3) for the graphs in Figure 8 and the results are shown in Table 6.

Table 6: The coefficients of consolidation

Test specimen	c_v (mm^2/min)
High plasticity silt	1.446
High plasticity silt with vertical drain filled with mixture of coir and sea sand	1.973
High plasticity silt with vertical drain filled with sea sand	3.457

The liquid limit, plastic limit and plasticity index were determined from Atterberg limit test and the results are shown in Table 7. The clay used for the research was classified as High plasticity silt (MH) according to Unified Soil Classification System.

Table 7: Results of Atterberg limit tests

Tests	Results (%)
Liquid Limit (LL)	67
Plastic Limit (PL)	40
Plasticity Index (PI)	27

6. Discussions

The permeability tests indicated that the coefficients of permeability of the mixed samples are decreased with increasing of coir dust in the mixture up to around 50% of coir dust based on weight. The 50% of coir dust by weight basis consists of approximately 80% of coir dust by volume in the mixture (Table 2). The coefficient of permeability for sea sand was 12.06 x 10^{-2} (cm/s) and it was 4.78 x 10^{-2} (cm/s) for 80% of coir dust by volume in the mixture. Those coefficient values showed that the introduction of coir dust as a substitution for sea sand in vertical drains did not reduce coefficient of permeability reasonably. Although coefficient of permeability is increased beyond the 50% of coir dust in the mixture, the samples were experienced to separate as layers. Due to practical difficulties to use higher amount of coir dust in the mixture (more than 80% by volume) it is recommended that the maximum coir dust percentage in the mixture applicable as filling materials for vertical drains, can be around 80% by volume.

The introduction of vertical drains for unimproved clay indicated that coefficient of consolidation increased significantly (Table 6). The vertical drain filled with sea sand gives a faster consolidation and it is more than twice as without vertical drains. The introduction of coir dust in vertical drain reduces the consolidation compared to vertical drain with sea sand but still gives reasonable higher consolidation. The introduction of coir dust in vertical drain is justifiable with time and economic considerations.

The particle size distribution curve for coir dust indicated that the percentage of coir fibres (more than 2 mm) was around 23% (Figure 5). The presence of coir fibres in mixed samples of coir and sea sand increases the durability and strength characteristics of vertical drains.

The justification of introduction of coir dust as a substitution for sea sand as well as for river sand to be used as a filling material for vertical drains largely depends on economical and environmental considerations. Table 8 shows approximate costs involvements for filling materials. Typical dimensions for vertical drains were assumed as 450mm diameter, 5m spacing and 15m depth. The total volume of filling materials per hectare was approximately 950 m^3. It shows that introduction of mixture of 80% of coir dust by volume instead of river sand in vertical drains reduces the cost more than 90% and reduces the cost 80% with compared to drains filled with sea sand.

The maximum amount of coir dust that can be used practically in vertical drains was justified as 80% by volume based. Since coir dust is still a waste in Sri Lanka, the introduction of coir dust in vertical drains reduces the filling materials costs significantly.

Table 8: Cost comparison for filled materials of vertical drains

Cost	Materials		
	River sand	Sea Sand	Mixed sample (80% coir by volume)
Per cube (Rs.)	6000	2000	400
Per hectare (Rs.'000)	2014	671	134

7. Conclusions

Although the coefficients of permeability are decreased slightly with increasing coir percentage initially, it is not significant as coefficient of permeability values are still in the range of 10^{-2} (cm/s) which is considered as a typical value for sand vertical drains. Consolidation tests showed that significant improvement of ground with vertical drains filled with sea sand. Although vertical drain filled with mixture of coir dust (80% by volume) and sea sand was not given the same consolidation rate as drain filled with sea sand, it gave reasonably higher consolidation with mixture of coir dust and sea sand compared to without vertical drains.

The usage of coir nets (or gunnies) in the vertical drains increases the possibility of using higher amount of coir dust in the vertical drains as it helps to maintain the drain dimensions. An application of coir net in vertical drains proposed is shown in Figure 11.

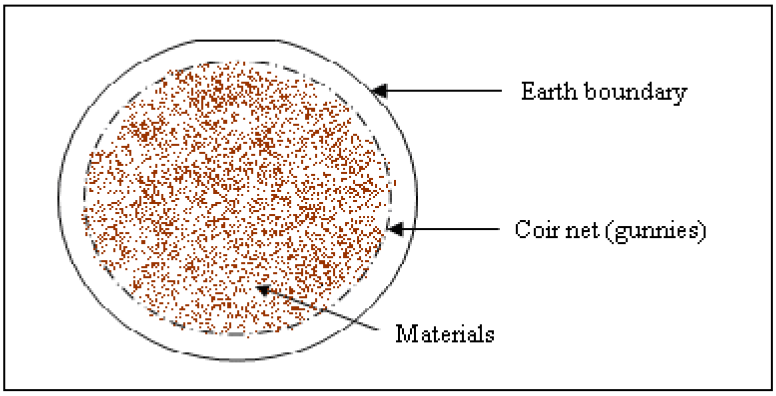

Figure 11: Plan view of a vertical drain covering with coir net

The required percentage of coir dust in the mixture can be determined using the graph of coefficient of permeability vs. percentage of coir dust (Figure 10) in the designing of vertical drains. The steps should be followed as;

- Calculate the required k for the vertical drain design depending on site conditions.
- Find the appropriate percentage of coir dust in the sample from the graph.
- Necessary precautions such as coir net should be included depending on coir percentage used.
- Proper mixing of coir dust and sea sand should be done.

The introduction of coir dust as a substitution for sea sand in vertical drains saves the cost as well as some environmental problems simultaneously.

8. Acknowledgements

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Modeling the tsunami wave propagation

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Abstract

A computer based numerical model, which can simulate the propagation of the tsunami wave, was developed for the coastal area of Galle city. TUNAMI N2, a computer code developed in Japan (2006) was used as the base model. Model includes bathymetry, fault and stability sub modules other than the main module. Bathymetry sub module was used to store all the co-ordinate data of the required area. Fault module was developed to create the initial wave due to the fault with the fault parameters. Stability sub module was prepared to check the stability of the prepared grids. Main module calculates the propagation of the tsunami wave. For that it requires the initial wave due to the fault as well as the prepared bathymetry data. The time series of water surface elevations at the given locations and water surface elevations at the given time steps are the main outputs of the model. Mathlab and surfer software were used for the interpretation of output files in pictorial form. Outputs of the model after applying the parameters of the fault, which caused tsunami in 26 December 2004, were verified with the observations. Under that the water levels in Colombo and highest wave arrival times at south and west coast areas were used. Model results were found to be matched with the observations. The model was applied for different tsunamis with different fault origins with different magnitudes. Different propagation patterns were obtained.

Key words: Tsunami, Earthquake, Propagation, Simulation, Numerical model

1. Background

1.1 Introduction

Gigantic tsunami waves, triggered by an under sea quake in Sumathra, battered Sri Lanka's eastern and southern coastal areas on Sunday 26^{th} December 2004 killing an estimated 50,000 people in what is believed to be the islands worst natural disaster to the date. Of all the countries hit by the tsunami, Sri Lanka has undoubtedly suffered the most byway of loss of livelihood, loss of housing and public infrastructural facilities. With the huge disaster of the recent tsunami most people in Sri Lanka tend to study about the tsunamis. Even though tsunamis are new to Sri Lanka countries like Japan, Indonesia and USA frequently face this type of tsunamis. As the awareness increases, damage due to the tsunami disasters are expected to reduce. It will be useful for Sri Lanka, if tsunamis can be predicted early. Further the knowledge about different tsunami scenarios will also help to reduce the risk. This research includes a preparation of a computer based numerical model which can forecast the tsunami wave propagation due to an earthquake around the coastal area of Galle City.

1.2 Literature review

Several attempts of tsunami propagation modeling were reported in literature. Several computational models are being used in the National Tsunami Hazard Mitigation Program, sponsored by the National Oceanic and Atmospheric Administration (NOAA) to produce tsunami inundation and evacuation maps for tsunami hazard zones in USA. These models are also used to design and operate early warning systems (Titov and Synolakis (1998)). The computational models include MOST (Method Of Splitting Tsunami) developed originally by researchers at the University of Southern California, Liu et al. (1994), COMCOT (Cornell multi-grid coupled tsunami model) developed at Cornell University and Imamura (1996) TUNAMI developed at Tohoku University in Japan. Most of the above models adopt a modified leapfrog finite-difference scheme to solve (both linear and nonlinear) shallow-water equations.

However most of these results require further validation by experimental results. Even though there are different types of modeling for tsunami propagation coastal area near to Galle city never had any of these modeling for the tsunami propagation as the tsunami had not happen in Sri Lanka during last few decades when the modeling of tsunami propagation developed rapidly.

2. Methodology used in developing the model

2.1 Theoretical background of tsunami propagation modeling

Tsunamis, which are mainly generated by the movement of sea bottom due to earthquakes, belong to long waves. In the theory of long waves, the vertical acceleration of water particles are negligible compared to the gravitational acceleration. Consequently, the vertical motion of water particles has no effect on the pressure distribution. It is a good approximation that the pressure is hydrostatic.

Based upon these approximations and neglecting the vertical acceleration, the equations of mass conservation and momentum in the three dimensional problem are expressed by shallow water wave theory.

Based on the shallow water wave theory the computer code has been prepared. Mainly it consists of 3 sub modules named Fault, Bathymetry and Stability other than the main module, which simulates the tsunami wave propagation.

1.1 Preparing bathymetric data around Galle city area

Bathymetry data of Indian Ocean covering Sri Lanka and possible tsunami generation locations were obtained from the etopo2 satellite data. Bathymetry data were stored as randomly spaced data files and those were converted into evenly spaced grid files using surfer as the first step.

Computational domain includes the origin of the tsunami and the area of interest (Galle in Sri Lanka) as shown in the Figure 1 and Figure 2.Through a mathlab code the selected area was taken as grid A in ASCII format. Since there is a larger number of values in order to run the program faster a nested grid system was used as shown in the Figure 3 and Figure 4.

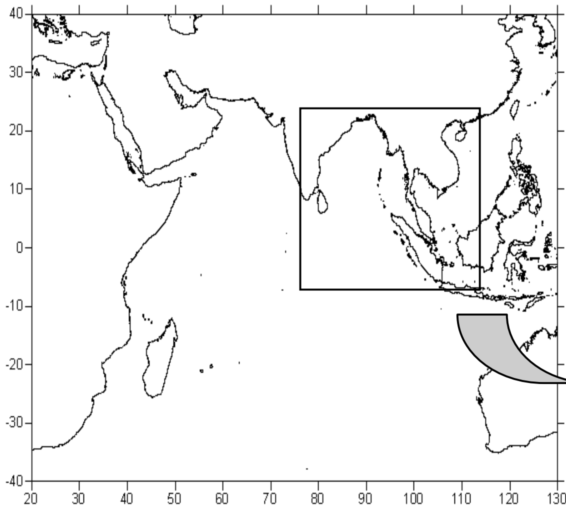


Figure 1: Map obtained from Etopo2

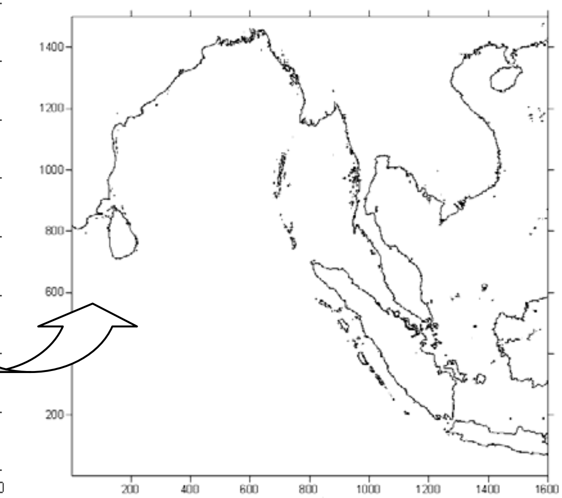
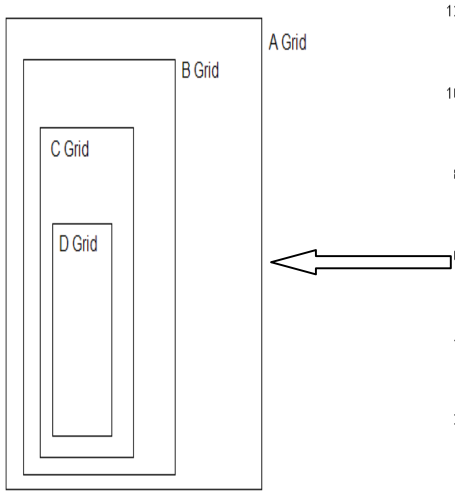


Figure 2: Selected areas for the model (Grid A)



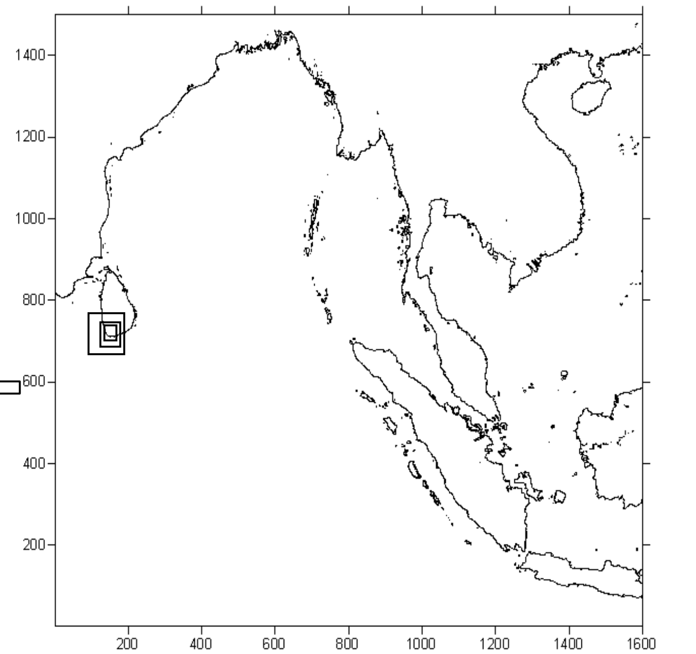


Figure 3: Nested grid system

Figure 4: Nested grid system in the map

2.2 Preparing sub modules

Apart from the main module in order to enter the information of the tsunami, several sub modules have to be prepared. Outputs of those sub modules are the inputs to the main module. Those are the computer codes to enter fault data and to check for stability.

2.2.1 Sub module fault

This is the module, which generates the initial wave due to the earthquake. Here the fault parameters are given as inputs. Using the input information it generates the initial disturbance of the water column. That was entered into the main module as an input. Fault parameters of December 2004 are as in Table1.

Table 1: Fault parameters-26th December 2004

Parameter	Value
Origin	3.30N,95.78E
Slip Magnitude(m)	20
Fault Length(m)	500000
Fault Width(m)	150000
Depth of the Fault(m)	20000
Dip Angle(degrees)	11
Rake Angle(degrees)	90
Strike Angle(degrees)	370

2.3 Preparing the main module

This module is prepared to calculate the propagation of the wave and run-up. It will do the numerical simulation with linear wave theory in deep sea, shallow water wave theory in shallow sea and on land. The main outputs of the model are time series of water surface elevations at given gauge locations and the water surface elevations in the given time steps.

2.4 Interpretation of output files

Since this is a numerical model all the results obtained as data or grid files. However in order to present the results effectively those are needed to be converted into graphical form, which can be easily visualized. Mathlab and surfer software are used to convert output data files into graphical form. Figure 5 to 10 are the propagation of the tsunami wave due the earthquake occurred in 26th December 2004.

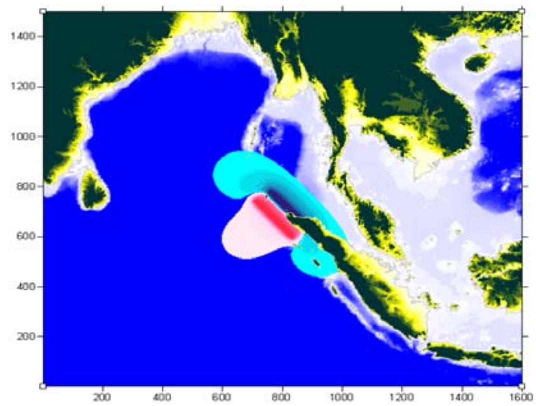


Figure 5: Just after the earthquake

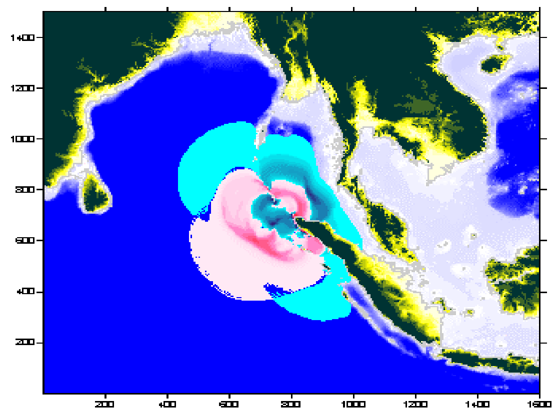


Figure 6: 0.5 hour after the earthquake

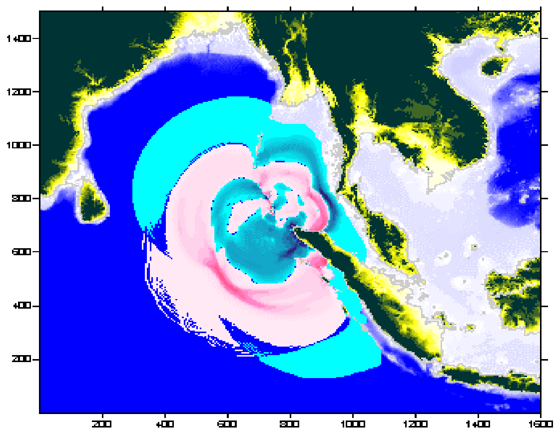


Figure 7: 1 hour after the earthquake

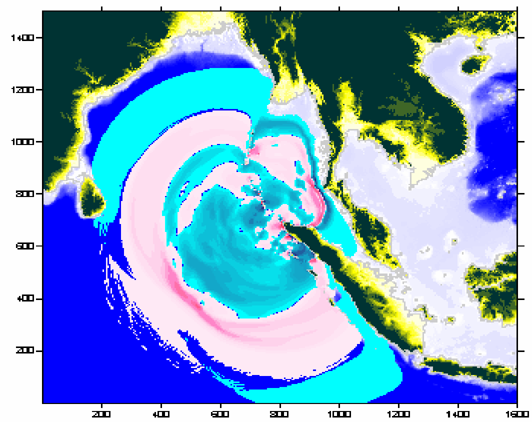


Figure 8: 1.5 hours after the earthquake

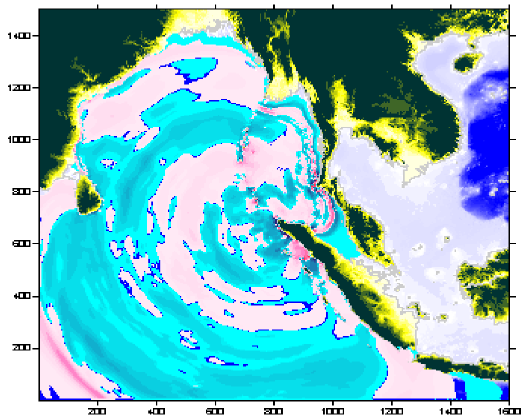


Figure 9: 2.0 hrs after the earthquake

Figure 10: 3.0 hours after the earthquake

3. Verification of the model

Here the values obtained from the model with the observed data (arrival times of the waves to the shoreline and the way they have arrived) during the recent tsunami December 2004 were compared. The propagation of the wave within nested grid system was clearly understood with the model. Observed water surface elevation during the December 2004 tsunami was available only at Colombo and that data was used for model verification.

As shown in Figure 11 the measured values and values obtained from the model for Colombo area was plotted. By comparing the two values obtained from the model and measured values obtained from Colombo the shape is nearly same. However there is slight mismatch in some of the figures. It can be due to the approximations used to simplify the governing equations. The values reasonably match up to 3.5 hours. However after that there are changes. The reason for that is, after 3.5 hours the reflected waves from India and Maldives have arrived. For the measured values it is accounted but for the values obtained from the model those were not accounted.

Other than that the first wave arrival time and highest wave arrival time are exactly matching with the model results as shown in the Table 2. The sea level drop due to the oncoming tsunami wave was clearly understood with the plots. Wave shoaling is always associated with water level reduction in the front side. In Galle area, Balapitiya, Hikkaduwa etc there were that type of waves before the arrival of tsunami wave. From the model also the same type of waves were obtained.

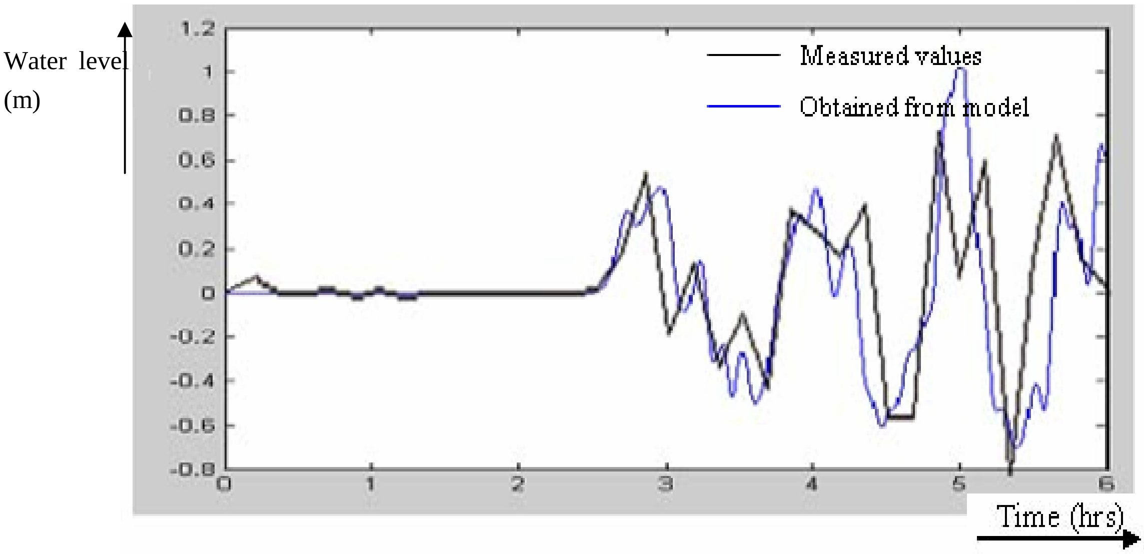


Figure 11: Water levels at Colombo - (Source: Lanka Hydraulics Institute)

Table 2: Highest wave arrival times to Sri Lankan coastal areas

Area	Real Values	Obtained From Model
Hambanthota	9.20 a.m.	9.15 a.m.
Matara	9.40 a.m.	9.45 a.m.
Galle	9.50 a.m.	9.30 a.m.
Hikkaduwa	10.0 a.m.	10.05 a.m.
Benthota	11.05 a.m.	10.05 a.m.
Kaluthara	11.30 a.m.	10.10 a.m.

After verifying the model it can apply to anywhere in the world with certain modifications. Since the model gives mostly correct values the model could be verified.

4. Study the different propagation patterns around Galle city area

Tsunami generation and propagation due to earthquakes with different fault parameters were studied. Different propagation patterns were obtained. Table 3 shows one of the possible tsunami source, which was used to study the propagation patterns.

Table 3: Source parameters

Fault parameters	Values
Co-ordinates	2.076N,97.025E
Fault depth	30 km
Length of fault plane	200 km
Width of fault plane	150 km

Strike, Dip ,Slip	300°,13°,90°
Dislocation	15m

(Source: USGS 2007)

Figures 12 to 17 present the propagation of the tsunami wave due to an earthquake as given in Table 3 which was different to that of earthquake occurred on 26 December 2004.

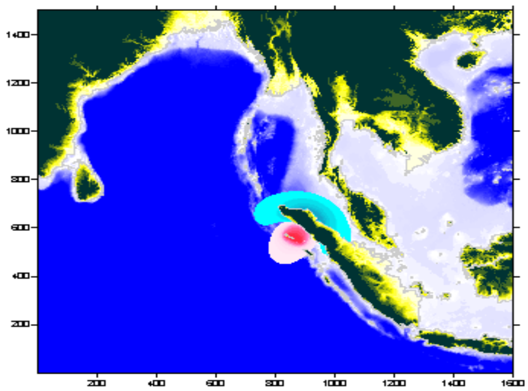


Figure 12: Just after the earthquake

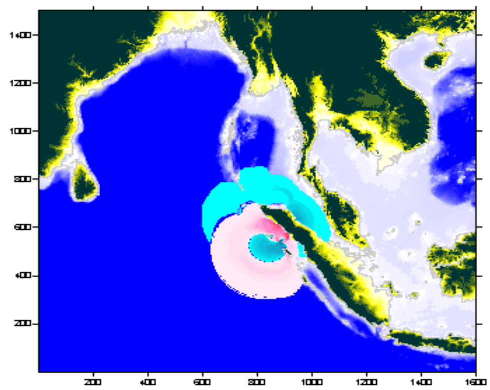


Figure 13: 0.5 hours after the earthquake

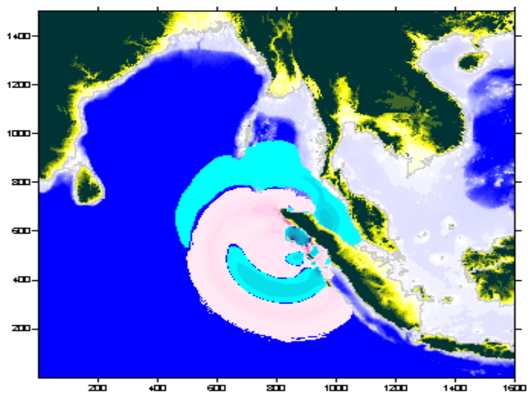


Figure 14: 1 hour after the earthquake

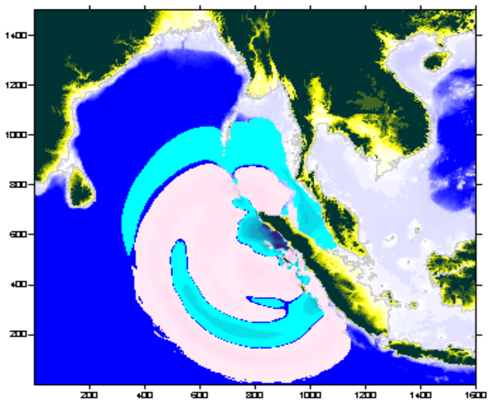


Figure 15: 1.5 hours after the earthquake

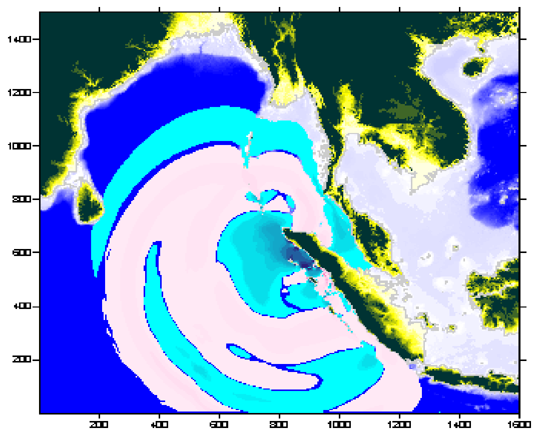


Figure 16: 2.0 hours after the earthquake

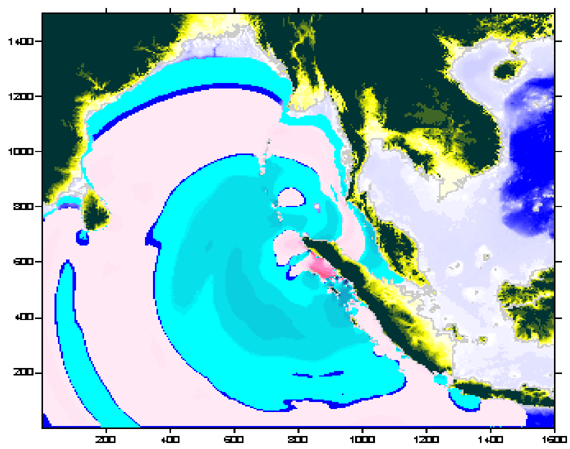


Figure 17: 3.0 hours after the earthquake

5. Conclusions

The model successfully simulates the propagation of the tsunami wave due to an earthquake. By replacing the high resolution near shore bathymetry data for Galle area inundation levels in the area could also be obtained. As the large number of bathymetry data was used for the model the nested grid system was used so that the program runs faster.

The model correctly shows the propagation patterns of the wave. As given in above Table 2 the highest wave arrival times were nearly same as those simulated by the model.

Other than that, the water surface elevation in the Colombo was obtained for 6 hours period due to the tsunami from the model. Those values were compared with the measured values in Colombo area. The shape of the graph and the values are nearly correct as shown in Figure 11.

As the grid size was larger the exact values could not be obtained. Further, because the reflected waves from India and Maldives were not taken into account as that area is not in the selected area.

Although a very coarse grid size was adopted for the numerical simulations, numerical results match with the field survey data as the arrival of highest waves, different characteristics of waves fairly well along the southern coastlines of Sri Lanka.

By replacing high resolution near shore bathymetry data in grid D inundation levels also could be obtained. Since the more detailed high resolution topography data is not available for Galle city area inundation patterns is unable to present in the paper. However the facility is there in the model and by replacing the high resolution near shore bathymetry data inundation heights also can be obtained. With that certain precautions can be taken in order to safeguard the lives from tsunami in Galle city area.

References

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The Ecological Restoration of Coastal Terrestrial Ecosystems in Southern Sri Lanka

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Abstract

This paper examines six different post tsunami ecological restoration projects conducted along the southern coast of Sri Lanka in 2006 by various Sri Lankan organisations. Eighteen months after the devastating 2004 tsunami, Sri Lanka's southern coastal zone has seen the replanting of an array of coastal vegetation ranging from *Rhizophora apiculata*, to *Borassus flabellifer* to *Cocos nucifera*. Local, national and inter-agency partnerships have been established as well as the formulation of local driven collaborative environmental restoration projects involving local communities Centred on the principles of ecological restoration, projects ranged from small and large scale mangrove replanting and sand dune stabilisation, to the re-establishment of home gardens. In addition to re-establishing nature's protective defences and acting as a natural barrier against possible future natural hazards, efforts are being made to realign the balance of damaged ecosystems by planting a selection of plants, which if utilised and managed sustainably can provide a wealth of socio- economic opportunities to coastal communities.

Keywords: Community, Restoration, Sri Lanka, Sustainable, Tsunami

1. Introduction

The past 250 years have seen in excess of 60 tsunamis in the Indian Ocean with nine of these tsunamis affecting Sri Lanka (excluding the 26th December 2004 tsunami) [4], [11]. Four of these tsunamis occurred in 1762, 1847, 1882 and 1946 in the Bay of Bengal impacting the eastern coast of Sri Lanka, three were related to earthquakes near the Nicobar Islands, India and two were triggered off the coast of Pakistan in 1819 and 1945 [11]. On the 26th of December 2004 at 00:59 GMT a 9.0 magnitude earthquake struck off the coast of Sumatra, Indonesia triggering a series of tsunami waves directly impacting coastal areas of Indonesia, Sri Lanka, Bangladesh, India, Thailand, the Maldives, Kenya, Malaysia and Mauritius resulting in the deaths of over 200,000. The worst natural disaster to have befallen Sri Lanka since historical times, the tsunami claimed over 35,000 lives, displacing over a million people and destroying homes, hospitals, roads and railways and other infrastructure [24].

As a result of the tsunami waves, the Sri Lankan coast suffered devastating ecological damage to more than two thirds of its coastline, with damage varying greatly and inconsistently from place to place [18]. Reasons for this included the differences in on-shore and off-shore coastal geomorphology, the presence/absence of off-shore coral reefs, the presence, maturity and width of mangrove belts and the location of human settlements [12], [26]. Depending on local land forms, the physical area of the tsunami impact varied from high-tide level to 1km inland [10]. The disaster was unusual in the sense that the total destruction of some areas was found metres from unharmed areas [23], [24]. Areas with estuaries and natural and artificial lagoons acted as channels for the entry of seawater, facilitating damage and leading to the intrusion of saltwater far inland; in numerous cases, several kilometres inland, leaving the land salinated damaging home gardens, agricultural crops and coastal vegetation such as *Cocos nucifera* and *Borassus flabellifer* in the process [13], [22], [23]. The tsunami struck ecosystems, previously strained by unsustainable practices including habitat destruction, over fishing, and the detrimental destruction of coastal wetlands and mangroves for prawn culture. Together these activities have threatened the state of biological diversity and the livelihoods of local communities [17], [12]. Other affected ecosystems include coastal sand dunes, lagoons, maritime grasslands, as well as environmentally sensitive areas including national parks, and special area management sites (table 1).

Coastal ecosystems have evolved over hundreds, and even thousands of years, adapting and evolving with natural catastrophes and disasters. The sheer magnitude of the 2004 tsunami had the potential to disrupt the natural stability of these ecosystems, yet the impact of the tsunami lasted less than thirty minutes, and initial environmental assessments concluded that the damage to Sri Lanka’s coastal ecosystems was disproportionately less despite the severity of impact on human life and infrastructure, with no irreparable damage occurring to terrestrial ecosystems [9], [18], [24].

Table 1: “Ecological impacts of the tsunami on coastal terrestrial ecosystems in Southern Sri Lanka” (Sources- Atapattu & Tharme 2005, Fernando et al.2006, IUCN 2005, MENR 2005, UNEP-MENR 2005)

Vegetation	Impacts
Mangroves	Various degrees of degradation and loss. Frontline and mangrove strips less than 10m devastated, broader stretches less affected. Sponge effect of mangrove swamps lessened damage. Large healthy mangroves seen toppled as far inland as 700m metres from the beach. Deeper mangroves left intact. Dense mangroves converted tsunami waves into a flood.
Sand dunes	Large, vegetated dunes absorbed wave energy and acted as a barrier stopping tsunami intrusion. Where dunes were disturbed, impact of waves was disastrous e.g. - a hotel resort, for the purpose of better scenic views, removed some of the dunes seaward of its hotel, the hotel was destroyed.
Pandanus tectorius and *Borassus flabellifer*	Seashore *Pandanus* cover reduced by up to 75%. Inland *Borassus flabellifer* less affected. Difficult to establish protective function as many settlements with interspersed palms suffered severe damage to houses.
Lagoons and Estuaries	Absorbed tsunami energy, but in doing so lost banks were scoured and lost seasonal sand barriers. However have recovered quickly. Various shifts in salinity concentration, Kalametiya lagoon transformed from a closed system separated from sea by sand bar to

	an open system- part of sand bar breached and now removed. Tsunami waters plugged estuaries.
Coastal waters	Sedimentation/turbidity of costal waters leading to algal blooms.
Casuarina plantations	Acted as an effective barrier in buffering destructive tsunami waves, although vulnerable to damage. Had little protection value on their own, although in places helped to stabilise sand dunes.
Beaches	Ecological impacts were severe where the beach was narrow and low in height. Scoured and eroded losing width and height from tsunami back-wash. Large amount of debris deposited on beaches.
Home gardens	Salt water intrusion destroyed production capacity due to high saline conditions. Up to 10 cm of topsoil was lost Approximately 27,710 home garden units were washed away or affected.
Other vegetation	Intrusion of seawater affected coconut plantations and agricultural crops (especially paddy). Salt water intrusion affected function and biodiversity in broader soil ecosystems. Sand casting occurred on productive lands.

The southern Sri Lankan coastline is characterised by sand dune systems vegetated with indigenous and alien trees (for example Casuarina), shrubs, creepers, occasional mangrove swamps and forests, *Cocos nucifera*, *Borassus flabellifer* and cashew plantations [1], [7]. Together, all these ecosystems provide coastal communities with a host of valuable services and goods including a resource of food and livelihoods, erosion control and sediment trapping, climate modification (micro and macro), habitats for wildlife and endangered species, biogeochemical cycling (nutrients, carbon sequestration), fuels and water (quality and quantity) and pollination [8], [19]. When the tsunami waves struck these services and goods were severely disrupted and in some cases, totally destroyed (Shanmugaratnam 2005).The geomorphological effects and physical characteristics relating to the impacts of the tsunami and the destruction caused to the built environment and society have been well documented [10], [12], [22], [23], yet few studies have analysed the effect of the tsunami on natural terrestrial ecosystems [10]. Post tsunami environmental issues chiefly consisted of waste management issues such as the clearing and removal of solid waste, focusing primarily on the immediate relief effort that was required, biodiversity and coastal ecosystem issues were not given due consideration [6], [18], [22]. Although at the time this was seen as an understandable focus and urgent priority, the most pressing issue to be addressed, eighteen months after the tsunami relates to the post tsunami restoration and rehabilitation of coastal ecosystems [1]. This paper reports research which evaluates this with regard to one key research question: What post tsunami activities are being conducted in southern Sri Lanka to restore coastal terrestrial ecosystems?

2. Methods

Research was conducted from April to June 2006 with the southern coast of Sri Lanka chosen as the focus of the research. Due to the physical impact of the tsunami waves being greatest on the East coast of Sri Lanka, numerous projects involving the rehabilitation of coastal greenbelts were established there in the aftermath of the tsunami. However due to increased violence and rising tensions between the Liberation Tigers of Tamil Eelam and the Sri Lankan government, it was deemed too risky to travels to these areas and so firsthand evaluation of these schemes was not possible. Therefore the southern coast was chosen as the basis for the fieldwork, with six projects being identified along the South and South-Western coast (table 2).

It was contented that by analysing six projects, a reasonable cross section of environmental restoration projects in Southern Sri Lanka would be reflected.

Table 2: A map of Southern Sri Lanka showcasing the project locations

Site 1: Kosgoda

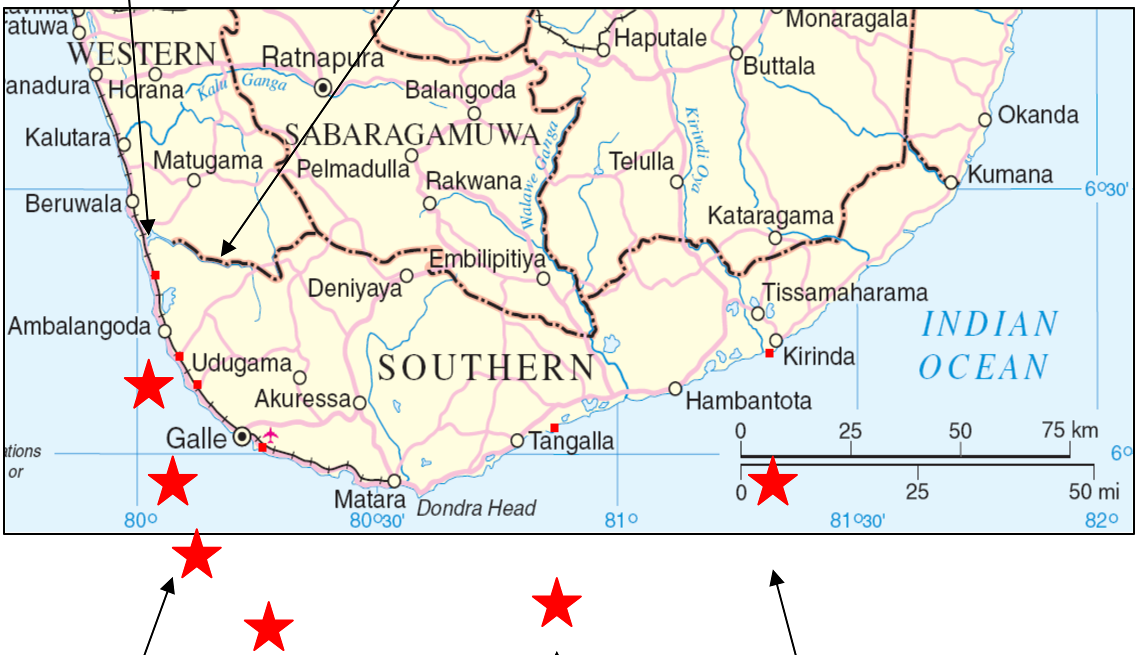
TURTLE CONSERVATION PROJECT

Replanting of mangroves and coastal vegetation

Site 3: Telwatte

RAINFOREST RESCUE INTERNATIONAL

Establishment of home gardens



Site 2: Pathamulla

NAGENAHIRU FOUNDATION

Planting of mangroves

Site 4: Galle

UNOPS

Tree plantation

Site 5: Tangalle

MANGROVE CONSERVATION PROJECT

Planting of mangroves

Site 6: Kirinda

HUMAN RESOURCE ENVIRONMENT PROTECTION ORGANISATION

Sand dune stabilisation and vegetation planting

Research was conducted using qualitative methods, namely in-depth, face-to-face semi structured interviews and visual observation. Interviews were used to ascertain participants' role and views regarding the ecosystem projects. Participants ranged from local residents and business owners to government officials and NGO representatives. In total twenty people were interviewed- one representative each from the IUCN and the CCD, twelve local residents (two residents; one female and one male from each project), and one representative from each of the six organisations in charge of implementing the environmental restoration projects. Guided by project representatives and local residents, visual field observations were undertaken to assess firsthand the state of the restoration process. Observations were supported by photographical documentation of fieldwork sites and hand written notes with secondary data incorporated into the research in the form of maps, journal papers, environmental assessments and policy documents.

3. Results

The Sri Lankan government together with the assistance and support of the local and international community has launched a major restoration and rehabilitation programme in a bid to bring the country to a point of recovery from the devastating effects of the tsunami. As a result, broader strategic efforts are being made by government departments, NGOs, INGOs, and Community Based Organisations (CBOs) in restoring and rehabilitating the vegetation along coastal areas affected by the tsunami [20].

3.1 The Coastal Reservation Green Belt (CRGB) Project

The Coastal Reservation Green Belt (CRGB) project was founded as a direct result of the tsunami and centres around the establishment of a 100m green belt around the island. The project's overall objective is to rehabilitate ecosystems damaged in the tsunami by greening and restoring the coastal reservation [21], [25]. The CRGB strategy has been adopted in the hope that it will protect the shoreline from coastal erosion, curtail the impacts of natural hazards including cyclones, hurricanes, and tsunami to the environment, development, infrastructure and coastal communities and support and sustain coastal community livelihoods by planting commercially viable plant species. The Coast Conservation Department (CCD) is overseeing the CRGB helping to initiate many short and long term projects designed to rehabilitate, protect and conserve Sri Lanka's coastal belt [21]. All post tsunami coastal rehabilitation projects/schemes in the country are part of the CRBG project and require the permission of the CCD. This island wide initiative, estimated to cost approximately £6.7 million pounds is implemented by the Central Environment Authority (CEA), Urban Development Authority (UDA), Coconut Development Board (CDB), Forest Department (FD) and Horticultural Department (HD) [16]. This figure covers plant materials, maintenance of nurseries, awareness and educational programmes, staff training, site selection and surveys and project administration costs. As of July 2006, under the scheme, more than 25,000 plants have been planted along the Southern coast. Details of the six projects analysed in 2006 are summarised below;

Project 1: Kosgoda lagoon and beach, Turtle Conservation Project: *Mangrove and shoreline ecosystem project*

Location: GPS- N° 06 20’41.8, E° 080 01’20.4

Project partners and funding: Implemented and funded by the Turtle Conservation Project (TCP). The exact cost of project is not known but has been estimated at Rs.500, 000 rupees (£2186). After the tsunami, the organisation took an active interest in coast conservation for the sake of the turtles and the turtle breeding grounds.

Impact of tsunami: The beach was hit by six metre waves which surged 1.5km inland. 63 turtle eggs and three TCP workers were lost to the tsunami. Waves reached a height of 6 metres and penetrated 1km inland. The total destruction of *Pandanus tectorius*, *Cocos nucifera* and various species of mangroves were reported.

Project and details and objectives:

- Well rooted plants and trees including mangroves have been planted in damaged areas on the barrier beach to prevent coastal erosion in the future and to act as a protective barrier. The TCP has also established several coastal plant nurseries which maintain over 1,000 mangrove plant species.
- The project aims to re-establish the ecological destruction caused by the tsunami, leading to the preservation of the turtle breeding grounds.

Vegetation planted: *Terminalia catappa, Pandanus tectorius, Cocos nucifera, Calophyllum calaba, Barringtonia asiatica, Rhizophora apiculata, Rhizophora mucronata, Bruguiera sexangula, Bruguiera cylindrica*

Project 2: Pathamulla**:** ***Nagenahiru foundation*****:** *Mangrove Restoration and Educational Programme*

Location: GPS- N° 06 10’53.8, E° 080 05’52.8

Project partners and funding: Implemented by the Nageniharu Foundation and funded under the “EU Post Tsunami Project” by the European Commission and the Global Nature Fund, Germany.

Impact of tsunami: The project area is situated 500m from the coast beside the Maduganga River, Pathamulla. Approximately 1200 people reside in the area. Extensive damage was caused to houses as tsunami water travelled along the river to the village damaging land and buildings. 20 deaths were reported in the area.

Project details and objectives:

A nursery was established to house 5000 seedlings. 3000 mangrove seedlings have been distributed for planting in selected areas with the remaining 2000 seedlings still present at the nursery.

- As of July 2006, a mangrove educational centre is being constructed for demonstrational workshops and training sessions.
- Project organisers anticipate that the planting of mangroves will provide natural protection against the flooding of the Maduganga River and natural hazard events.

Vegetation planted: *Rhizophora apiculata, Bruguiera gymmorhiza and Excoecaria agallocha mangroves.*

Project 3: Telwatta: Rainforest Rescue International: *Establishment of home gardens*

Location: N 06 10’14.4, E 080 05’31.3

Project partners and funding: Implemented by Rainforest Rescue International (RRI) and Funded by Swiss Solidarity, the project is estimated to cost in the region of Rs 2 million rupees (£8746).

Impact of tsunami: Waves reached a height of 1.3m, penetrating 500m inland. The majority of trees in the vicinity died with only *Cocos nucifera* remaining intact. 150 people perished. An increase of salinity in the soil as a result of seawater destroyed people’s home gardens. Located 300m from the coast, home gardens in the village were left devastated and suddenly people had no way to sustain themselves or earn an income.

Project details and objectives:

- To re-establish and introduce home garden production in affected areas. Various fruits and vegetables were cultivated, and used to satisfy nutritional needs, with surplus stock later sold at local markets or roadside stalls.
- The RRI have established seven nurseries producing 100,000 plants. Plants are stockpiled to supplement subsequent requirements of the affected communities. As of July 2006, 2500 home garden plants of 10 different species have been distributed to local communities (table 4).
- To preserve Sri Lankan agricultural traditions, provide supplemental nutrition and assist communities in enhancing the availability of food improving income security.

Vegetation planted: *Moringa olifera, Carica papaya, Mangofera indica, Artocarpus heterophyllus, capsicum annum, Murraya koengii, Artocarpus altilis, Bassela alba, Abelmoschus esculentus, and Cinnamomum verum*

Project 4: Galle: UN Office for Project Services: *Tree plantation*

Location: N 06°02’58.5, E 080°11’04.2

Project partners and Funding: Funded by the UN Office for the Co-ordination of Humanitarian Affairs (UNOCHA), implemented by the UN Office for Project Services (UNOPS) and supported by the CCD. The cost of the project is Rs.750, 000 rupees (£3280).

Impact of tsunami: A 10km stretch of coastline took the full force of the tsunami waves. Pre-tsunami vegetation consisted of 150-200 *Cocos Nucifera* trees. Initially the soil was made infertile by the intrusion of salt water and therefore the CEA supplied organic manure to help with the tree planting process. 1500 persons perished.

Project details and objectives:

- 10km of coastline has been earmarked for vegetation planting. *Pandanus tectorius* and *Cocos nucifera* sapling have been planted 1m apart along a 10km stretch.

The project aims to form a protective vegetation barrier against future natural hazards as well as preventing sea breeze and wind problems to landward dwellers.

Vegetation planted: *Pandanus Tectorius, Cocos Nucifera*

Project 5: Tangalle: Mangrove conservation project: Mangrove planting

Location: N° 06 03’47.3, E° 080 52’53.1

Project partners and funding: Implemented by the Mangrove Conservation Project, Bandaramulla. Funded by German Technical Co-operation and supported by GITEC. Rs.2 million rupees (£8746) were allocated for the entire project. Rs. 1.2 million rupees (£5248) have already been spent on the establishment of a mangrove nursery, and maintenance of plants.

Impact of tsunami: 37 families were living in the area when the tsunami struck. A few *Rhizophora* mangroves were destroyed, with 7 perishing in areas where no mangroves were present with homes and hotels destroyed.

Project details and objectives:

- A mangrove nursery was first established with planting of seedlings along a 50m stretch, 100m from the coast situated next to an inland lake.
- A baseline survey of mangrove species in the area was conducted before the tsunami leading to the identification of existing mangroves native to the area. 6500 *Rhizophora apiculata, Rhizophora mucronata, Bruguiera gymmorhiza* and *Excoecaria agallocha* mangrove species have been planted. The project is expected to last 5-10 years.

Vegetation planted: *Rhizophora Apiculata and Mucronata, Bruguiera Gymmorhiza, Excoecaria Agallocha*

Project 6: Kirinda: Human Resource Environment Protection Organisation: *Sand dune stabilisation and vegetation planting*

Location: N° 06 12’06.6, E° 081 19’06.0

Project partners and funding: Implemented by the Human Resource Environment Protection Organisation (HREPO) and funded by the UNDP at a cost of Rs.600, 000 rupees £2624). World Food Organisation also provided Rs.600 rupees (£2.62) worth of dried food products for distribution amongst the local community.

Impact of tsunami: Before the tsunami the sand dunes were intact and not degraded. *Borassus flabellifer* were planted in the area to act as a buffer to the coastal winds, and it was reported that the presence of the trees had a slight effect dissipating the tsunami waves. Waves reached a height of 8m penetrating 1km inland. Approximately 150 families were affected, with 14 persons perishing. Over 46 houses were destroyed. The presence of the dunes (roughly 6m high) obstructed tsunami waves protecting the village from serious damage. Consequently the dunes were damaged and in need of restoration. It was reported that neighbouring villages which did not have sand dunes, rather coastline buildings, suffered a far worse fate.

Project details and objectives:

- Destroyed, damaged dunes left communities vulnerable to future hazards. The project aims to stabilise and restore the dunes by planting gentle, sea-shore vegetation in order to encourage the rehabilitation process along a 10km stretch of coastline.
- It is hoped that the services provided by the dunes (e.g. wind erosion control, regeneration of interior agro biodiversity, aesthetically pleasing for eco-tourism opportunities) will be restored leading to the introduction of eco-friendly employment opportunities in the southern coastal region

Vegetation planted: *Spinifex littoreus and Ipomoea pescaprea*

Project objectives

The main objectives of the six projects evaluated are fourfold: to re-establish the ecological destruction caused by tsunami waves to affected flora and fauna, to realign the balance of damaged ecosystems and to restore the services provided by affected ecosystems, to help communities build a sustainable future by introducing eco-friendly employment opportunities by planting a selection of plants which can be harvested for local handicraft and lastly to form a protective barrier against coastal erosion, wind storms, and future natural hazard events.

Vegetation planted

In total, twenty seven different varieties of plant and tree species were planted (table 3 and 4).

Table 3: Review of the plant/trees species planted

Coastal Vegetation			
Scientific name	English	Sinhala	Tamil
Cocos nucifera	Coconut palm	Pal	Tennai
Rhizophora apiculata Rhizophora mucronata	Red mangrove	Kadol	Kandal
Excoecaria agallocha	--	Talakiriya	--
Bruguiera sexangula Bruguiera cylindrica	--	--	--
Pandanus tectorius	Pandanus	Mudukeyiya	
Ipomoea pescaprea	Bermuda grass		Muhubu bim thamburu
Casuarina equisetifolia	Casuarina	Kassa	
Borassus flabellifer	Palmyrah palm	Tal	Panai
Spinifex littoreus			Maha ravana revula
Barringtonia asiatica Barringtonia racemosa		Diya Mudilla	
Terminalia catappa	Indian Almond	Kottamba	
Calophyllum calaba		Guru Kina	
Thespesia populnea		Suriya	
Sonneratia caseolaris	--	Kirala	Kinnai

Table 4: Review of tree and plant species planted for the home garden project

Scientific name	Sinhalese name	English name	Tamil name
Tree species			
Moringa olifera	Murunga	Drumstick	
Carica papaya	Papol/Gas labu	Papaya	
Mangofera indica	Amba	Mango	Manga
Artocarpus heterophyllus	Kos	Jackfruit	
Plant species			
Capsicum annum		Capsicum	
Murraya koengii	Karapincha	Curry leaves	
Artocarpus altilis	Del	Bread fruit	
Bassela alba	Nivithi	Spinach	
Abelmoschus esculentus		Okra	
Cinnamomum verum		Cinnamon/Ceylon cinnamon	

Establishment of Plant Nurseries

For all three mangrove projects, temporary mangrove nurseries were established prior to the commencement of plantation in order to produce native seed stock and propagation materials. This was due to the general lack of sufficient numbers of suitable plant species, to the sheer amount of mangrove saplings required for the restoration effort and for growing the plants until they reached a suitable size for planting. New, good quality plant genetic material such as mangrove propagules were supplied (in some cases) voluntary by the CEA, the Palmyrah Development Board, and two NGOs- *"The Green Movement"* and *"Ruk Rakaganno"*. The propagules were planted in small, black plastic bags containing soil and kept in the nursery until they reached four-leaf stages. Propagation was necessary to ensure that newly planted vegetation acclimatised to the maximum effort. The time taken to reach this stage varied from three to nine months dependent on conditions of growth. Seedlings, grown from the seed were approximately 11 months old when distributed to local communities. A temporary plant nursery was also established for the home garden project. Vegetation is a critical factor in the formation and stabilisation of sand dunes and so *Spinifex littoreus* and *Ipomoea pescaprea* seedlings were planted in bare areas on the sand dunes to stabilise the dunes [5]. The area was then cordon off to protect the vegetation from being disturbed or destroyed by local inhabitants or animals. Naturally 3 of the 6 projects analysed were concerned solely with the planting and restoration of mangroves; this was to be expected when taking into consideration the highly publicised view of the role mangroves play in dissipating the energy of the tsunami waves [8], [15], and [16]. Mangroves were planted to replace those destroyed in the tsunami as well as to boost the existing mangrove population with the intention of providing a greater range of protection to human settlements from future natural hazards. Young [27] highlights the danger of unnecessary mangrove planting in unsuitable areas in Sri Lanka's coastal zone. This concern was put forward to project officers who made assurances that the mangrove restoration areas in each of the three projects were suitable, as mangroves species planted were native to the area; *"we analysed the remaining mangrove in the area, and so planted the same species"* (Nageniharu Foundation representative).

Environmental assessments and traditional ecological knowledge

In all six projects, local communities were fully involved in initial environmental assessments, surveys and site selections including the planning and planting stages**.** Basic post tsunami environmental assessments were conducted by project co-ordinators and staff members of the named charities/organisations in conjunction with local residents. Accurate data including satellite imagery and aerial before and after photos were either not kept, available, or were disparate for the six projects concerned. Consequently identifying the impacts of the tsunami on the natural environment became a tedious task. To compensate for the lack of scientific data available, traditional ecological knowledge possessed by the local population was identified and utilised in environmental assessments of the project sites. The use of indigenous environmental knowledge by scientists and researchers has been well documented [2], [3]. Berkes [2] highlights, "*traditional ecological knowledge is as old as ancient hunter-gatherer cultures*". That statement is especially true in Sri Lanka, where local ecological and environmental knowledge of the ecosystems which the community inhabits are built upon and passed down from generation to generation. Arguably the local community, especially the indigenous population possessed firsthand knowledge of the natural environment which in turn acted as a useful and practical guide as to what steps should be taken regarding the restoration of the ecosystems found there. Discussions with project co-ordinators and participants indicated that this local knowledge and information has been valued and utilised well; "*we had some guidance* *from several government departments but we also used the knowledge of local people, if anything they know more about the area than anyone else*" (RRI representative).

Although there are several environmental restoration projects in the East and South East of the country, there is not an abundance of environmental restoration projects as originally hoped for in the South and South-Western coasts, and it is only fair to say that the process of environmental rehabilitation is slow. It seems that it is only now, some 18 months after the tsunami that the environment is being given due consideration. When questioned why environmental restoration projects have taken so long to initiate, representatives replied that it simply a case of funding for projects being delayed. Projects co-ordinators also stated the need to be certain when planting or replacing new and damaged species; *"basically it was a case of receiving the funds, but we needed to be certain of how we were to approach the restoration of the mangroves, we needed to be certain of the species of the area before we proceeded otherwise it would have been a disaster to the nature of the area"* (Mangrove Conservation Project representative). One project co-ordinator shared Katz [14] view that damaged/destroyed vegetation should be left to recover naturally without human intervention. However it was evident that this view was not shared by other representatives: *"some things can take decades to recover, however I believe that we, humans should start the restoration process ourselves"* (TCP representative). Three of the six organisations did not initially deal with the natural environment but after the tsunami, they included environmental projects in their manifesto recognising the urgent need for post tsunami environmental restoration work.

Economic benefits

Communities were subsequently assured of financial benefits, through employment on cash for work basis as plant nursery entrepreneurs, landscape contractors and green belt managers (including long-term maintenance). A system of regular maintenance and management of the vegetation planted was established. This involved local residents monitoring the plantations, removing dead vegetation, weeds etc, ensuring that the vegetation was not being trampled upon or removed and keeping the plants and vegetation free from pests and diseases. There was a noticeable discrepancy in the incentives and rewards awarded in each project ranging from Rs100 to Rs1250 rupees (approximately £0.50p-£6.00) a week for maintenance. The home garden scheme has encouraged communities to be more self reliant by introducing low cost organic farming to the project area. In turn, communities have enhanced their availability of food as well as providing communities with an economic, sustainable livelihood. In addition to all the home garden crops which provide a regular, accessible and vital source of food and nutrition, *Pandanus tectorius* and *Cocos nucifera* vegetation, featured most prominently for both its protection factor against various natural hazards and its intrinsic economic value. For example the woven leaves of the *Pandanus tectorius* can be used to make indigenous local handicrafts such as handbags which appeal to foreign tourists. Project co-ordinators envision that the restoration of these ecosystems, the very resource base that provides these opportunities, will benefit local communities through the generation of economic opportunities.

4. Discussion and conclusion

It is evident that considerable efforts are being made to restore coastal terrestrial ecosystems in southern Sri Lanka. Although half of the projects evaluated were solely concerned with the replanting of mangroves, this is just one small step of many that the country is taking towards restoring the coast to its former state, providing moderate protection against any possible future natural disasters and rehabilitating ecosystems which provide a life support for coastal communities. Capacity building at local levels is seen as a key factor for securing the sustainability of Sri Lanka's coastal ecosystems. Local, national and inter-agency partnerships involving all stakeholders have been established and the formulation of local driven, collaborative environmental restoration projects have boded well for the progression of restoration projects. Nevertheless there needs to be a greater emphasis placed on the importance of restoring affected ecosystems to the pre-tsunami state of production activity including restoring the ecosystems to a functioning state where they could provide services and goods again to local residents. Efforts are being made to realign the balance of damaged ecosystems by planting a selection of plants, which if utilised and managed sustainably can provide a wealth of economic benefits to coastal communities. Good management practices have ensured that the maintenance of vegetation planted is both meticulous and consistent and it is imperative that these efforts are continually monitored and sustained for the restoration process to achieve its desired effect.

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Incentive Instruments for Government and Private Sector Partnership to Promote Building Energy Efficiency (BEE): A Comparative Study between mainland China and Some Developed Countries

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Abstract

Government plays different roles in promoting Building Energy Efficiency (BEE), among which the role in providing incentives is commonly acknowledged as significant by both professionals and researchers. In this study, two categories of incentive instruments, economic incentives and advocatory incentives, have been classified and defined, with related items described according to this classification. Based on this classification, investigation and comparative analysis on BEE incentive instruments have been carried out through literature review in four different countries: the UK, Canada, the US and mainland China. Finally, from comparative study of literatures, a list of factors, which are supposed to affect on the BEE incentive policy design, have been identified for future study.

Keywords: Building Energy Efficiency (BEE), Partnership, Incentive Instruments, Policy Design Factors, Comparative Study

1. Introduction

Construction industry has a great influence on the use of resources and the environment. Taking China as an example, the energy consumption of building accounts for 27.6% of the whole society and takes the lead among all industries regarding its proportion in the total energy consumption of the whole society [1]. Improving the efficiency of energy use in construction industry has become a well-recognized means to meet national objectives, such as increasing energy efficient investments, improving the security of energy supply, enhancing productivity and competitiveness, reducing release of greenhouse gases as well as local environmental costs associated with energy supply and use. At an international level, energy efficiency promotion is required to mitigate climate change, decrease global warming and improve the situation of air pollution [2].

Government’s involvement is regarded as one of the essential and effective ways to promote BEE. The four main roles of government on BEE promotion well recognized in literature are: (1) Policy-maker (2) Incentive motivator (3) Financing hub (4) Advocator [3], [4], [5]. Energy analysts consider that the deficiency in promoting energy efficiency from governments, such as insufficient information for the consumers and retailers, financial disincentives for the landlords, fragmentation of on-line production, leads to market failure. Thus the public intervention is essential to rectify the situation [3]. Due to the market failure, Dennis [4] believes that achieving optimal investment in energy efficiency necessitates innovative policy intervention from governments. Free market economists also agree to use minimal public action to overcome these obstacles [6], [7]. A common consensus is formed among energy analysts and economists that governments should play a certain role in the promotion of BEE [3].

Regarding the government’s roles on BEE promotion, market-based incentive schemes are thought to be significantly effective and cost-efficient instruments. A series of policy instruments has been suggested to address the BEE problems arising from the market failure [8]. Nowadays, researchers regard market-based incentives as well as forward-looking energy policies as addressing this market failure, together with the “non-market” problems to improve the situation for building energy consumption and environmental protection [4]. Economic literature has also formed a general consensus that market-based instruments (as opposed to command and control regulations) are the optimal choice of policy instrument for reaching an environment-friendly goal [9]. Furthermore, much research notes that voluntary-based environmental policies are more effective than regulatory control [10], [11]. These types of policy help to project better public image for government because the policies offer greater flexibility for building owners to reach targets and promote dialogues between government and private sectors and raise public awareness of environmental issues [12], [13], [14]. Building up a win-win partnership between government and private sectors through incentive policy design is one of the best incentive ways for the government to improve BEE. Although it is important, it is still leaving plenty of room for future study [15], [8], [16], [17].

This paper aims at contributing to the concept of collaboration between government and private sectors, by describing incentive instruments through comparative studies and a literature review. The structure of this paper is firstly, two incentive roles played by government on BEE promotion have been briefly reviewed and the operation of these incentive instruments between government-private sectors has been explored. Secondly, according to the two categories drawn above, the authors compare the incentive instruments in different countries (the UK, Canada, the US, and mainland China), and understand the different policy instruments used in different governments and their effects. Thirdly, from comparison as well as a literature review, a list of factors are identified which will affect the BEE incentive policy design that help to build up partnership between government and private sectors. Finally, we discuss what mainland China and some other developing countries can learn from each other on incentive instruments design for improvement. The road map of paper is shown as below (Figure 1):

Road map of this paper

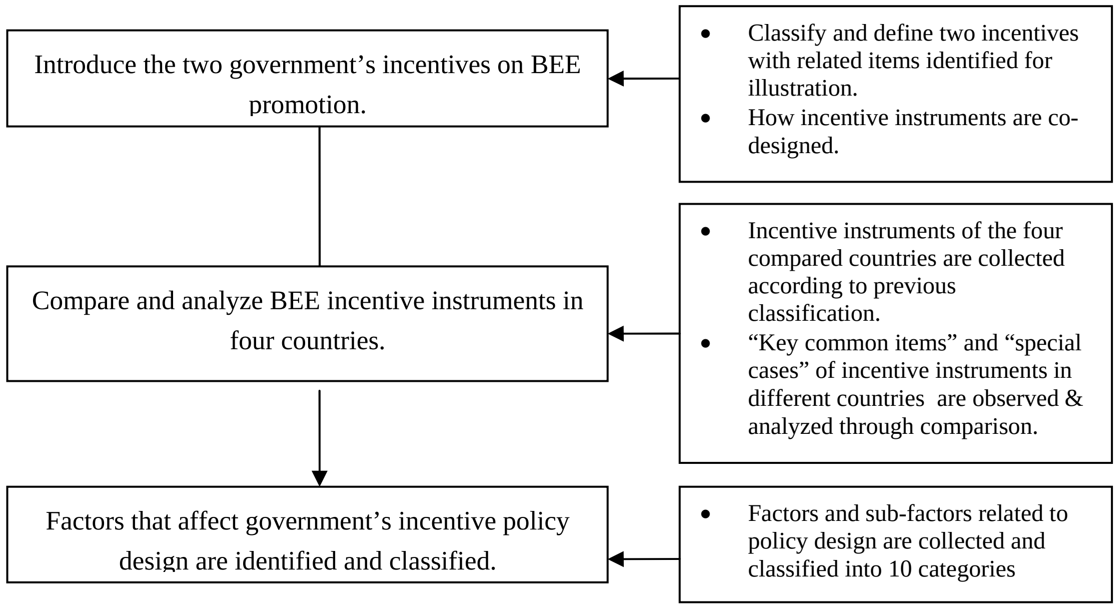

Figure 1: Road map of this paper

2. Government's incentive roles on BEE: promoting collaborations among government and private sectors

Literature review leads us to classify the government's incentive roles on BEE promotion into two categories, ***economic incentives*** and ***advocatory incentives*** [4], [18]. The items relating to each category are identified and the review result is summarised in the pattern as shown in Table 1.

Economic Incentives — Government's role is to set incentive policies to enhance the private sectors' interests in order to reduce the cost and increase the demand in the energy efficient building market, e.g., setting an feasible price for energy, tax deduction programs for energy efficient products, subsidy and rebate programs. It can also offer financial support to socially and environmentally preferred energy options through investment incentives and low-cost loans, and special funding for BEE programs [2], [4], [8], [17].

Advocatory incentives — Government's role is to advocate sustainable energy development and consumption through education, training, information publication and through activities such as product rating and labelling, energy audit and government procurement programs [18].

Table 1 Items relating to each incentive role

Economic Incentives	Advocatory incentives
• Implementation of further market-based incentives • Ensure prices reflect energy goals • Voluntary commitment and recognition • Taxation incentives • Subsidy and rebate programs • Investment incentives	• Marketing and consumer education • Information systems and databases • Decision support tools • Best practices guideline • Common user specifications • Demonstrations

• Low-cost loans • Leasing • Performance contracting • Special-purposed funds • Government procurement programs • Performance contracting • Vendor financing • Special-purpose funds • Utility financing programs • Setting an optimal price for energy	• Energy audit • Product rating and labelling • R&D and decision support tools • Government procurement programs • Advertisements and training
Reference: [2], [4], [8].	**Reference:** [2], [18].

Successful experiences from developed industries show that the BEE incentive instruments are co-designed by government and representatives from private sectors to avoid BEE market barriers[2], [19]. After these incentive policies are brought into effect, private sectors, namely market parties, would send out market signals and these feedbacks received by the government help to adjust their incentive policies on BEE promotion. With the full cycle of re-negotiation and re-design of the policy instruments, the collaboration between government and private sectors is built up and it helps the government promote BEE in a cost-effectiveness way. The diagram below shows the process of Incentive Instruments co-designed and re-negotiated by government-private sectors.

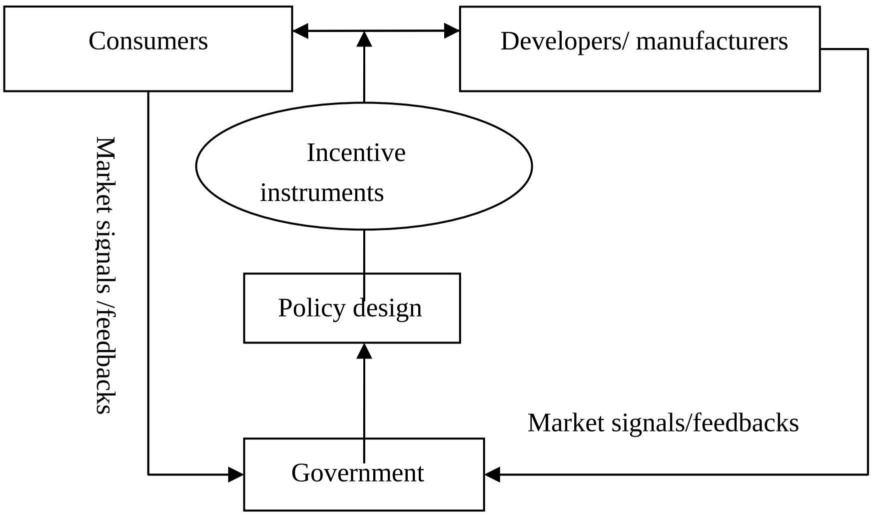

Figure 2 Process of Incentive Instruments co-designed by government-private sectors

3. Comparative study on BEE incentive instruments between China and developed countries

After clarifying the two incentive instruments that governments adopt to promote on the BEE market, we are able to make a systematic comparison between China and some developed countries through a critical evaluation of the items under the two categories: economic incentives and advocatory incentives. Table 2 shows a comparison of different incentive measures and policy instruments related to BEE in four different countries, the US, Canada, the

UK and mainland China. From the literature review, important items of incentive instruments from different countries are selected and compared under the two categories classified previously and the effect of these incentive instruments are discussed accordingly.

In table 2, it is observed that, although the incentive instruments adopted by different countries varied in some ways in practical terms at a certain period or according to their national situations, these governments' incentive involvements on BEE more or less converges to a certain pattern, especially among developed countries. Comparing to developed countries, China has a high potential to improve her current BEE situation by adopting incentive instruments. Moreover, successful experiences from developed countries also show that more incentive instruments are called for to enhance the effect and efficiency of BEE promotion in China.

Table 2 Comparative study on BEE incentive instruments

Country	Economic incentives	Advocatory incentives
The US *Ref.:[2],[20],[21],[22],[23],[24]*	Subsidy plan and turn-in programs Tax incentive schemes Green Building Tax Credit Program Market-based DSM programs Weatherization Assistance Program Discount loan and Mortgage loan for BEE Low-Income Home Energy Assistance Program R&D funding for new BEE technology Rebate System benefits charge	Voluntary assessment schemes: LEED, CHEERS and Green Building Programs Energy Star Program Home Energy Rating System; Builder Option Packages Voluntary products labelling
Canada *Ref.:[3], [17], [23]*	Commercial Buildings Incentive Program Subsidy and rebate program Tax incentive schemes Energy innovators initiative(EII) Industrial building incentive program(IBIP) Canadian Home Insulation Program (CHIP) Mortgage loan for BEE R&D funding for new BEE technology	New Home Warranty Program Building rehabilitation program EnerGuide for appliance, equipment and houses R&D, market-based research and demonstration projects to provide information Voluntary products labelling Canadian industry program for energy conservation (CIPEC Assessment)
The UK *Ref.:[24], [25]*	Subsidy and rebate program Tax incentive schemes R&D funding for new BEE technology low-cost loans	Voluntary assessment scheme: BREEAM Energy Efficiency Accreditation Scheme,1993 Energy Matters Program Voluntary products labelling
China China *Ref.:[2],[18],[20],[26]*	Provide low interest subsidies to enterprises to undertake "technical renovation" for the purpose of energy conservation, which is practically inefficient Tax benefits for energy conservation projects, which was eliminated in the late 1990's. Special funding for new wall material Low interest loans to state firms on energy efficiency projects by China conservation Investment Corporation in early 1980s, which was eliminated by 1994.	Energy-Conserving Products Certification

4. Observation of the comparative study

- ***Economic Incentives***

Analysis shows that subsidy and rebate programmes, tax incentive schemes, and low interest/ mortgage loans are all welcomed in the four countries compared, though these schemes were phased out in China in 1990s. In addition, all four governments believe that R&D funding for new BEE technology is one of the most significant ways to promote energy efficiency. Detailed remarks on the incentive instruments of the four countries are grouped under the heading of 'Key common items' of economic incentives as shown below:

Key common items:

- All the four compared countries believe incentive motivator to be an important role for government involvement.
- Tax incentive schemes, subsidies and rebate programs are the common policy tools.
- The US, Canada and the UK governments have all reported satisfactory and cost-effective results through the implementation of incentive tools.
- Government provides loans and funding for BEE promotion.
- Governments in the four countries all prefer to set a R&D funding for new technology.
- The US, Canada and the UK governments have established mature and well-functioning financing systems for BEE promotion. The financing system, with a high credit and influence, penetrates well in the BEE market.

- ***Advocatory Incentives***

Analysis illustrates that the enforcement of advocatory incentives varies according to technology development, BEE education, and particular national situations, etc. However, there are more overlaps among the developed countries. For instance, LEED, CHEERS and Green Building Programs in the US, CIPEC in Canada and BREEAM in the UK are all assessment schemes, which are adopted by different countries with some variations in terms of implementing period of time or according to their national situations. In addition, voluntary product labelling is all popular in developed countries. Up to now, however, there are no well-established voluntary assessment schemes and information publication systems for BEE in mainland China [20].

Key common items:

- All compared governments serve as an advocator to deal with market barriers.
- Voluntary assessment schemes, voluntary products labelling, education and information publication are the main functions for government's involvement in developed countries.
- The impact of these government involvements is cost-effective.
- The US, Canada and the UK governments have their own schemes to serve as advocators to promote BEE, though the purpose of each tool is similar.

5. Highlights of the Special Cases in different countries

The US

US utilities launched the first rebate-based DSM[1] program in the early 1990s, which has yielded encouraging result for savings [27], [28], [29]. Though DSM spending has fluctuated and encountered a downward trend during last decade in the US due to its own national situation, a number of utilities in various countries have introduced similar programs and gained significant savings [20].

Another incentive program in the US which undoubtedly deserves mentioning is the Energy Star Program. It is a government-backed voluntary scheme, which is well-accepted by industry. The Energy Star program was first launched in the US in 1992 and was designed to identify and promote energy efficient products. According to published data, around 30 different categories and more than 600 buildings have already earned Energy Star labels and the administrator of the Energy Star program had been working with organizations that represent approximately 17% of building square footage in the US [30]. In the recent years, EPA has licensed the Energy Star trademark to several countries, including Japan, New Zealand, Australia and Taiwan, and to the EU, but the use has been limited to office equipment only [29].

Canada

In Canada, ‘EnerGuide for House’ and ‘EnerGuide for Appliances and Equipment’ are two integrated incentive measures, both of which include information, education, motivation and labelling. ‘EnerGuide for House’ is a strategy measure, which persuades and assists housekeepers to enhance energy efficient capability of their houses. It also induces residential consumers to consider energy efficiency in their purchasing plan. The government of Canada partly subsidizes the cost of the evaluation, which helps to offset certain amount of the costs used for the energy-efficiency improvements. The amount of the grant depends on the degree of its energy-efficiency retrofits. ‘EnerGuide for Appliances and Equipment’ is a mandatory measure for new products. It gives a comparative assessment of energy efficiency and energy consumption for a range of appliances on the market, which complements the efficiency standards, and seeks to stimulate consumer awareness to influence purchasing decisions [17].

The UK

In the UK, the first building environmental assessment method, BREEAM, was launched and operated by the Building Research Establishment and came into prominence in the early 1990s.

[1] DSM (demand-side management) offers solutions to problems such as load management, energy efficiency, strategic conservation and related activities. The IEA Demand-Side Management Programme is an international collaboration of 18 countries working together to develop and promote opportunities for demand-side management (DSM).

It is the best-known scheme and has embraced 15-20% of the new office building market in the UK. In addition, BREEAM has motivated a superstore to incorporate all the current best practice in the environmental design of their operations, with the aim to half the carbon dioxide emissions that conventional supermarket designs incur. As the abovementioned worldwide acknowledged incentive programs, BREEAM has also been taken as a reference model when similar schemes were developed in Canada, New Zealand, Norway, Singapore and Hong Kong [29].

China

In China, locally made equipment and appliances are generally less efficient than those produced in developed countries are. In addition, direct financial support for energy efficiency is still weak. Up to now, there has been little government spending in support of BEE at a national level and there is almost no energy efficiency program sponsored by utility companies at present ([17], [20]). Though there are a few provincial government incentive programs for energy efficiency, they are fairly modest and are exceptions rather than a norm. So far, assessment schemes that developed and adopted in other countries, such as BREEAM in the UK, LEED, CHEERS and GREEN Building Program in the US, do not exist currently in China [29].

In the past, there used to be two incentive programs initiated by Chinese government for energy efficiency promotion in the 1980s. One was a low-interest loan program, which was phased out during government restructuring. Another one was a “technical renovation” subsidy program, which has been substituted by a larger program by 1998. The new program has failed to achieve the incentive effect due to a lack of clear rules on program qualification and application process ([20], [31]).

6. Factors that affect government’s Incentive Policy Design

In the above comparative study, important aspects of incentive instruments from different countries were selected and compared according to the abovementioned two categories. The common items of these incentive instruments as well as effect of special case study in each country have been discussed accordingly. In order to develop these incentive instruments, governments have to go through careful design of policy for implementing the incentives. The design of a public policy involves two major elements. First, policymaker must decide on the goal, which may take the form of a long-term or near-term policy goal. Second, with the goal established, policymakers must decide on how to implement their goal, through a variety of policy implementation tools (instruments) available at their disposal. The choice of instruments and implementation strategies can substantially affect the total effectiveness of any policy, and costs and benefits consideration is one major criterion for the effectiveness of any policy. Hence, the implementation policy instruments can influence cost effectiveness in the longer term, for example through investing in R&D and innovation incentive schemes [32]. For BEE policy study, it makes sense to question what lead to the various incentive policy designs in different countries; why a government choose this incentive one scheme rather than the others;

and what affect their decision-making in the process of incentive policy design. All these bring up the need for follow-up studies on factors that affect government's Incentive Policy Design (IPD).

Through literature reviews ([4], [17], [31], [33], [34], [35], [36], [37], [38], [39]), IPD factors are collected and classified into 10 categories and their sub-factors are identified and listed according to each category as shown in Table 3. These factors and sub-factors need to be critically reviewed and re-grouped and attributed with appropriate importance weighting through research methods such as Factor Analysis and AHP etc, in future study. It is hoped that with a list of well-structured IPD factors and sub-factors, government would have a better understanding of the process of developing BEE incentive policies.

Table 3 Preliminary set of factors that affect government's Incentive Policy Design (IPD)

IPD Factors	**IPD sub-factors**
Economic	• Combination of incentive policies / instruments • Inadequate / excessive fiscal constraints • Insufficient consideration of the potential trade-offs associated with the benefits of a proposed project • The constellation of economic actors within each particular sector • Land use planning reform (absence of commensurate planning and planning reform) • Institutional design • Cost effectiveness • Diversity and flexibility of instruments
Market	• Targeting (concerned groups) • Consumer needs and consumption patterns VS. Consumer habits and behaviour • Third party financing • Information / education / motivation • Accessibility • Bounded rationality of the average consumer • Competition within construction industry • Policy uncertainties VS. market stabilities
Political acceptability	• Policy regime & degree of coercion • Political risk VS. Political stability • Inherent national policies
Environmental	• Energy market reform and access • Strategic environmental assessment • CO_2 emission level • Embodied energy of building materials
Technology	• Technological evolution • R&D / Technology procurement to an international level • Technology mix • Technical based evaluation
Democratic and accountability	• Adequacy, transparency and clarity • Public participation / involvement • Effects of certain aspects of privatization • Public consultation • Recognition as a new political majority on governmental agenda or administrative capacities

Social & Culture	• Equalizing the community risk and cost-benefit distribution • Social-economic dynamic • Poverty • Efficiency extent / degree of resource use, BEE production, distribution and services • Shortages in supply of infrastructure services
Ethical principles	• Aversion to concerned policy-maker • Optimality, fairness and justice • Stewardship • Participatory decision-making • Prudence and control
Administrative easy or not	• Resource intensiveness • Manoeuvrability on its own territory • Lack of co-ordination between/within regulatory agencies • Contextual frameworks • Process-driven reviews • Assessment / monitoring VS. auditing / benchmarking • Well-defined objectives, resources and technologies • Appropriately applied incentives • Administrative operating cost • Implementation / operational performance
Globalization	• Degree of market globalization / integration • International cooperation / negotiation • Technology procurement to an international level • Costs of international negotiations, • Costs of the decision-making process in the individual countries

7. Conclusion and Recommendations

Policy study on BEE has already aroused worldwide concern and academic debates, as policy is recognised as a bottleneck to ameliorate problems of climate change, air pollution, and energy security, etc. Among all public interventions, incentive instrument with public-private sectors partnership through appropriate policy design are the most essential and significant shortcuts to win this BEE promotion campaign. This paper highlights the incentive roles that government plays on BEE promotion by classifying incentives into two categories: economic incentives and advocatory incentives. Through comparative study of four different countries, incentive instruments are identified and collected according to the abovementioned categories. “Key common items” and “special cases” of incentive instruments in these four countries are analyzed, which helps enlighten China and other developing countries to learn from each other. Finally, the importance of careful policy design is brought up and a list of factors and sub-factors, which could affect Incentive Policy Design (IPD), is collected. Further studies are recommended to study the criteria, which could quantify the IPD factors and the way to weigh out different factors that affect government’s choice.

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Extreme wave and water level conditions in the Baltic Sea in January 2005 and their reflection in teaching of coastal engineering

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Abstract

Windstorm Gudrun (January 7–9th 2005, also known as Erwin in some countries) was one of the strongest storms in the Nordic Region of Europe during the last decades. It caused widespread property damage, exceptionally high storm surge levels, and the loss of 18 lives. The storm surge in the Estonian city of Pärnu at the eastern coast of the Baltic Sea reached 275 cm above mean sea level, which is the highest flood ever recorded since regular measurements started in 1824. Extremely rough seas occurred in the north-eastern region of the Baltic Sea. The overall maximum significant wave height was estimated to be about 9.5 m off the coasts of Saaremaa and Latvia. Such wave conditions are extremely rare in this water body. Despite several atypical features of this storm, the reaction of water masses was reasonably forecast 48–54 hours ahead and accurately reproduced in 24–36 hour forecasts in the leading operational oceanographic centres. The lessons learned from this event led to re-launching of routine operational oceanographic services in Estonia and were used in regular courses for students specialising in port and coastal engineering in Tallinn University of Technology, and for students in hydrography at the Estonian Marine Academy a few weeks after the events.

Keywords: Coastal hazards, extreme wave conditions, storm surge, coastal engineering teaching

1. Introduction

Windstorm Gudrun, an extratropical cyclone, also known as Erwin in Ireland, the United Kingdom and Central Europe, attacked northern Europe on 7–9 January 2005 [1]. It reached the power of a hurricane in the North Sea region. Although in the Baltic Sea it remained slightly below the hurricane level, it was one of the strongest storms in Denmark, Scandinavia and Estonia for at least 40 years. It caused widespread property damage and exceptionally high storm surge flooding levels. According to the official statistics, 18 lives were lost. The storm caused extremely widespread forest damage in Sweden, perhaps the worst recorded in recent history. It caused power supply cuts in large areas of Sweden, Norway and the Baltic states, and excited the highest storm surge in the known history (275 cm above the mean sea level (MSL)) in Pärnu [2]. New records of water level were established in many locations along the Western Estonian coast as well in the Gulf of Finland. The storm flushed totally smaller shallow areas such as the Moonsund (Väinameri, an area between Saaremaa, Hiiumaa and the Estonian mainland) with the water from the Baltic Proper. Particularly intense transport of bottom sediments occurred in certain coastal areas [2]. Many smaller harbours suffered from massive damage, and substantial beach destruction occurred on exposed coasts [3]. The meteorological conditions, details of accompanying flooding, and the reaction of water masses to this storm in Estonian coastal waters are analysed in detail in [1] and [2].

A major feature of this storm were the very rough wave conditions. The main reason for the extensive property damage in affected coastal areas was evidently the combination of rough seas and extremely high storm surges. While sea level in the affected areas was correctly filed at about 20 sites, the network of wave measurements at the downwind side of the northern Baltic Sea (Fig. 1) consisted only of two directional waveriders operated by the Finnish Institute of Marine Research, and one temporary pressure-based recorder.

Figure 1: Wave measurement sites, marked by ⊗, in the Northern Baltic proper (buoy 1), near Helsinki and at the island of Naissaar.

Thus it is intuitively clear that the measured wave data only partially reflected the wave fields during this storm. The position of the waverider is such that it adequately reflects wave conditions occurring in the case of SW winds that have the longest fetch among strong winds in this basin. The strongest winds (W-WSW) in Gudrun, however, were oblique to the Baltic proper. The area of strongest winds crossed the basin between Gotland and Saaremaa where the fetch is relatively short. The wave sensors were located much further northwards from the maximum of the wave storm. Even with these non-ideal conditions for wave generation and detection of the roughest seas, very high and long waves were recorded.

The purpose of this paper is twofold. Firstly, we bring evidence about the extension of the highest storm surges and construct an estimate of the roughest wave conditions during this storm based upon available data. The analysis involves a comparison of wave measurements with the output of operational wave models from the leading operational centres in the Baltic Sea area, *viz.* the German Weather Forecast Service (DWD, Deutscher Wetterdienst), the Danish Meteorological Institute (DMI), and the Finnish Institute of Marine Research (FIMR). A second focus of the paper illustrates how the instructive features of this storm were used in courses in the Department of Hydrography of the Estonian Maritime Academy and in the Faculty of Civil Engineering at the Tallinn University of Technology. To give an impression of extreme wave conditions and related features of the local wave climate in the Baltic Sea (which is a relatively small water body in which hurricane-strength winds occur extremely seldom), we also present an overview of the existing wave data and numerical wave studies in this area.

2. Extremes of storm surge water level

The basic driving factors of synoptic Baltic Sea sea level are the wind and air pressure patterns [4]. Sea level variation due to the tidal forces does not exceed a few cm. Long-term statistics reveal that the annual maximum values of water level have significantly increased on the Finnish coasts during the last 70 years [5]. The trend is essentially asymmetric: the annual minimum values do not show any significant changes. The increase is the most pronounced in the Baltic Sea nodal area where the maxima have increased by about 10 cm in a half century. This feature indicates that the overall variability of the water level in the Baltic Sea has increased even more than its local variations and, generally, large-scale meteorological and hydrological phenomena rather than local storms have caused these changes.

Yet local storms cause the largest sea level variations and at times extremely hazardous storm surges. A common feature along the Finnish coast is that the higher sea levels are more probable than the low levels. The enclosed eastern end of the Gulf of Finland generally hosts the largest variation of sea water level in the whole Baltic Sea. The total range of historical extremes exceeds 5 m and the highest storm surge reached 4.21 m above mean water level in Saint Petersburg. During the January 2005 storm, the sea level reached a relatively modest value of 230 cm above MSL in St Petersburg.

While typically the Baltic Sea storms establish new water level maxima in quite limited sections of the coast, usually at the bayhead measurement sites, the January storm of 2005 set new sea level maxima at many observation sites of the eastern Baltic coasts (Table 1). New sea level records were established and in all four stations in Finland, and at Tallinn and Toila, while at other sites of the southern coast the water level was close to the historical maxima [2]. The reason is an unfavourable combination of a sequence of events. As a result of strong cyclonic activity preceding the storm, the Baltic Sea level was already very high (+70 cm above MSL) [2]. The storm itself had a very wide area of strong winds (a few hundreds of km) comparable with the extension of the whole Baltic proper.

Table 1: Water level during windstorm Gudrun (8-9 Jan 2005) and historical sea level maxima along the coast of the Gulf of Finland based on [2], [5] and data from the FIMR, www.fimr.fi. The sites where new records were established in 2005 are indicated in bold.

Location	Maximum storm surge level (cm) on 09.01.2005	Highest recorded level prior to 2005		Observations date from:
		Maximum, cm	Date	
Dirhami	134	148	18.10.1967	1954
Tallinn	**152**	135	15.11.2001	1842
Kunda	139	157	06.01.1975	1958
Toila	**160**	155	11.01.1991	1991
Narva-Jõesuu	194	202	23.09.1924	1907
Turku	**130**	127	09.01.1975	1921
Hanko	**132**	123	09.01.1975	1887
Helsinki	**151**	136	27.01.1990	1904
Hamina	**197**	166	07.12.1986	1928

3. Basic features of the wave climate of the Baltic Sea

The wave climate of the Baltic Sea is relatively mild. A reliable picture of the typical and extreme wave conditions may be derived from the longest instrumental wave measurements in the northern Baltic proper that were carried out between 1978–2003 by the Swedish Meteorological and Hydrological Institute near a caisson lighthouse of Almagrundet (Fig. 1). The procedure of establishing wave properties at this site is based on the classical zero-downcrossing method. An estimate $H_{1/3}$ of the significant wave height H_S is calculated from the 10th highest wave once an hour [6]. The overall average of the significant mean wave height at Almagrundet between 1978 and 1995 is 0.87 m. The median wave height is 0.7 m and the most frequent wave conditions correspond to the wave height ranging from 0.25–0.38 m [6]. Wave data from 1993–2003 show somewhat more intense wave activity with an average significant wave height of 1.04 m and a wave height median of 0.73 m.

Seas with $H_{1/3} \geq 4$ m have occurred about 400 times during the data observation period, that is, such wave conditions occur with a probability of about 0.42 % or, on average, during about 20 hours each year. The storms causing such high waves, however, usually occur several times a year, each lasting a few hours. The highest $H_{1/3} = 7.83$ occurred at this site in January 1984 [6], in the only storm that excited $H_{1/3} \geq 7$ m at this site between 1978–2003.

Long waves are infrequent in this area. The typical mean wave periods are 4–5 s for wave heights below 1 m, about 6 s for wave heights around 2 m, and exceed 7 s only when wave heights are 3 m or higher. Note that the data set in question contains the mean period. The corresponding values of the peak period are about 20 % larger than the mean period. Mean periods over 10 s usually dominate in remote low swell conditions when the wave height $H_{1/3}$ is well below 1 m. Large periods may also occur during extremely rough seas. For example, the mean period reached 11 s in one case of rough seas with $H_{1/3}$ around 4 m, and also in the final stage of the January 1984 storm, when waves with periods 11 s dominated the wave field with $H_{1/3}$ about 7 m.

Wave properties in the central part of the sea (buoy 1 in Fig. 1, 59°15’ N, 21°00’ E, water depth about 100 m) have been measured by the FIMR since 1996 [7]. A significant wave height exceeding 7 m has been recorded only 4 times at this location: twice in December 1999 and twice within three weeks from 22 December 2004 to 9 January 2005 during windstorm Gudrun.

The typical and maximum wave heights are much smaller in the sub-basins of the Baltic Sea. For example, data from a directional waverider deployed off Helsinki in the Gulf of Finland (GoF, Fig. 1, 59°57.9’ N, 25°14.1’ E, water depth about 60 m, buoy 2) in 1990–91, 1994 and from November 2001 indicate that the significant wave heights exceeding 4 m seldom occur. The highest $H_S = 5.2$ m in the GoF was measured at this site in November 2001 [8]. Practically no data are available from the coastal areas of Estonia and Latvia except for visual observations from the coast and for a few measurements with the use of pressure sensors [9].

The third generation wave models such as WAM [10] adequately represent the sea state in the northern Baltic Sea (e.g. [11]). Wave statistics for the Baltic proper has been estimated with the use of the second-generation spectral wave model HYPAS and wind data from 1999–2000 [12]. The spatial distribution of wave heights follows the well-known anisotropy of the wind and wave regime in the Baltic proper [13], [14]. Statistically, the regions of the largest wave activity are found along the eastern coasts of the Baltic. These areas are characterised by long fetches for the dominant winds. However, no comprehensive description of the wave climate or statistical estimates of extreme wave conditions exists in the whole Baltic proper.

4. Wave properties in the Baltic proper during Gudrun

4.1 Modelled wind data

We use in the analysis the output of operational wave models from the leading operational centres in the Baltic Sea area: the German Weather Forecast Service (DWD, Deutscher Wetterdienst), the Danish Meteorological Institute (DMI), and the Finnish Institute of Marine Research (FIMR). The models are driven by forecast winds at the standard height of 10 m above the surface level. Wind fields are provided by the atmospheric models (optionally nested into larger-scale models) with a horizontal resolution ranging from 1/16°×1/16° (DWD) of 0.08°×0.08° for the Finnish Meteorological Institute's model HIRLAM version 6.2.1.

The LSM wave model of the DWD provided operational forecasts for 48 hours twice a day in January 2005. The DMI and FIMR models were run four times a day with a 54 hours forecast length. The forecast wave and wind properties until the time of the subsequent release (that is, for the closest 6 hours for each release of the DMI and the FIMR models, and for the closest 12 h for the LSM model) are called modelled wave or wind data below. The results of the rest of each operational run are called wind and wave forecasts. Since the FIMR and the LSM models only save the wave properties three-hourly at 00:00, 03:00 GMT etc., for comparisons we use the average values of measured wave parameters (and of the DMI model output) during ±1.5 hours around the mentioned time instants. Several features of modelled wind patterns are interesting from the viewpoint of wave generation. Since the coastal data suffered from failures of equipment [2], we rely on the modelled wind properties.

The maximum wind speeds on the open sea, according to the DWD and the DMI, were 28–29 m/s between Gotland and Saaremaa (Fig. 2, cf. coastal data in [2]). All forecasts suggested that strong winds would blow for a duration of many hours. The early forecasts of the storm released on 06–07 January predicted the highest wind speeds to occur along the Norrköping–Hiiumaa/Saaremaa line. The significant wave height was forecast to exceed 10 m at buoy 1, to reach 11–12 m at the entrance of the GoF, and to be over 6 m in the central part of this gulf [15]. Such wave conditions were considerably rougher than during any other storm in this area in the history of contemporary shipping.

The area with the largest modelled wind speeds crossed the Baltic Sea somewhat more southwards than originally forecasted. They hit Gotland, the northern part of Latvia and the Gulf of Riga, southwards from the location of buoy 1 [1]. The highest waves were excited off Saaremaa and Latvia and the measured wave heights did not establish any new records. The significant wave height at buoy 1 reached $H_S = 7.2$ m at 03:00 and 07:00 GMT on 9 January [16]. The wave height was about 7 m during about 12 hours (00:00-11:00 GMT).

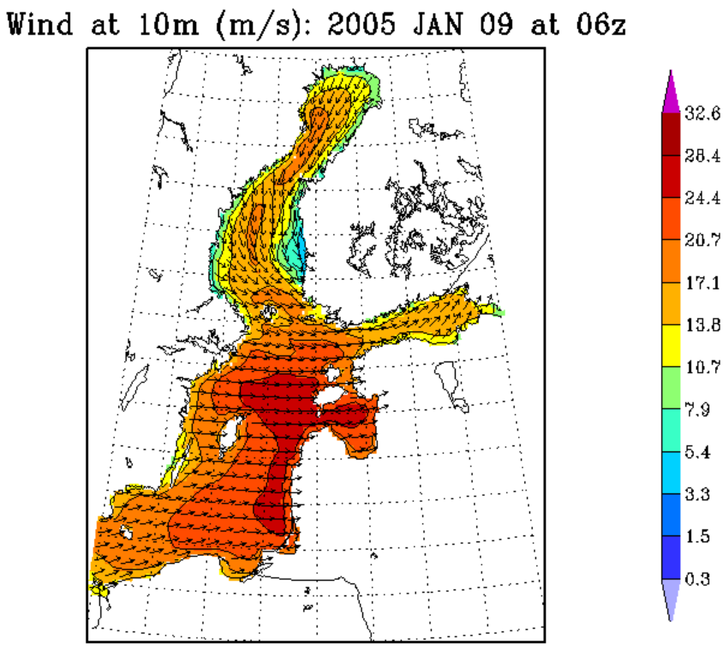

Figure 2: Modelled wind speed (m/s) and direction (arrows) 10 m above water surface at 06:00 GMT on 9 January in the DMI 6-hour forecast valid at 00:00 GMT on 9 January[16]. Courtesy of the Danish Meteorological Institute.

4.2 Wave models

All the above-mentioned centres run the third generation spectral wave model WAM cycle 4 [10] on a regular rectangular grid in shallow water mode without data assimilation. The models use different sources of wind information and their land-sea masks, bathymetry, computational grid, spatial and temporal resolution, and spectral range are different [16]. The mesh size varies from 1/10° along latitudes and 1/6° along longitudes for the LM model of the DWD down to 0.08°×0.08° of the FIMR model.

The WAM model calculates the two-dimensional wave energy density spectrum at each sea point for a set of equally spaced directions and logarithmically spaced frequencies. The LSM and FIMR models use 24 directions whereas the DMI model uses 12 directions (resolution 30°). The LSM and DMI models employ 25 frequency bands from 0.04177 to 0.41145 Hz (from about 2 to 20 s) in 10% steps. The FIMR model uses an extended range of 35 bands up to 1.073 Hz. The depth information and the land-sea mask of the LSM model are optimised for concurrent use with a circulation model. In some northern parts of the Baltic Sea they do not exactly follow the factual coastline. The FIMR model accounts for special features of the northern Baltic Sea such as the archipelago area between Åland and the Finnish mainland that is only partially passable for waves. The depth map of the DMI model is sampled from the ETOPO5 bathymetry map of the National Geophysical Data Centre with an imposed minimum depth of 5 m [16].

The available information about the validation of the models' results against measured data in the northern Baltic Sea suggests that, at least in typical wave conditions, all the listed models show reasonable performance. For example, the overall bias and standard deviation of the modelled significant wave height in the North Atlantic and the Baltic Sea from that of measured wave heights from satellites was 0.13 m (the model tended to slightly overestimate the wave heights) and 0.56 m, respectively during July 2004–March 2005 [16]. The mean relative error of the forecast of the maximum wave height in the 5 strongest storms is about 15 % for 13 buoys operated by the DMI in the Baltic Sea and in the North Atlantic [16].

The models showed good performance during windstorm Gudrun as well. The FIMR model well matched the roughest wave conditions in the early morning of 9 January: the overall maximum of H_S was overestimated by 0.44 m (about 6 %). The models of the DWD and the DMI to some extent overestimated the wave heights during the whole stormy week. The largest error (1.29 m and 1.91 m, or 16 % and 21 %, respectively) of the instantaneous wave height occurred during a short time interval when the modelled wave height reached its maximum but the observed wave heights dropped by about 0.6 m. The relative error of the forecast of the overall maximum wave height was 12 % and 20 %, respectively [16].

4.3 Maximum waves of the storm

It is of considerable interest to estimate the roughest wave conditions that occurred during this windstorm. Maximum wave heights of the storm evidently occurred much further southwards from buoy 1, off the coast of Saaremaa (Fig. 2) about 57ºN, 20.4ºE, that is, about 200 km south-eastwards from the location of buoy 1.

The overall maximum H_S during this storm can be roughly estimated from a comparison of the modelled spatial distributions of wave properties with the modelled and observed wave heights.

A sensible estimate can be constructed based on two assumptions. First, we suppose that the wave models adequately represent the spatial patterns of wave properties. Second, we assume that the relative error of the modelled wave properties is roughly the same over the entire area of intense waves. The estimate can then be obtained by correcting the overall maximum of the modelled H_S with the use of the relative error of the model at the measurement site. The results of doing so should be interpreted as indicative, because only one observation point is used as the ground truth. Yet this is a feasible way to estimate the maximum wave heights during the storm given the limited data set.

The FIMR wave model suggested that H_S up to 10.2 m occurred near Saaremaa at 00:00–06:00 GMT on 09 January [16]. Since it overestimated the maximum of H_S at buoy 1 by 6 %, the probable maximum of H_S was 9.6 m. The DMI model suggested that $H_S = 11.7$ m occurred in the same area; accounting for its overestimation at buoy 1 by 20 % leads to the probable maximum of $H_S \approx 9.4$ m. The DWD model predicted the maximum of H_S about 10.9 m at 00:00-03:00 GMT on 9 January. At buoy 1 this model gave maximum $H_S = 8.17$ m, and the overestimation of 12.4 %. The estimate for the overall maximum of H_S therefore is 9.6 m. The relatively small scatter of the results suggests that the overall maximum of H_S in the Baltic proper during windstorm Gudrun most probably was about 9.5 m. The threshold of 10 m apparently was not exceeded, however, the existing wave conditions were much rougher than expected to happen according to classical statistics, even once in a millennium.

5. The reflection of the windstorm in teaching

Although Estonia is a marine country, for historical reasons the teaching of marine matters at the university level has been fragmentary after World War II. Courses of marine physics and physical oceanography given in the Tallinn Pedagogical University (University of Tallinn since 2006), University of Tartu and in Estonian Marine Academy, were designed to offer a basic overview of the topic and did not contain questions of wave or storm surge forecast, or means of reducing the impact from coastal hazards in general. In addition, in the 1990s the department of marine forecasting in the Estonian Meteorological and Hydrological Institute, the main provider of operational forecasts, was closed. The forecasts of storm surge and wave conditions were since then constructed based on the simplest empirical relationships. Fortunately, the system of marine measurement sites was maintained.

Since September 2005, the Faculty of Civil Engineering of the Tallinn University of Technology launched teaching of port and coastal engineering as a specialization within the curriculum of civil engineering. This initiative is frequently related to the above-described extreme event. In fact, it was scheduled as early as in 2003 and was not affected by Gudrun. Yet the content of several new courses was considerably modified to reflect this event. Elements of the underlying theory and practice of wave and storm surge forecast were included into the course of wave dynamics. A thorough description of passive and active measures towards reducing the extent and costs arising from wave-induced coastal processes and of coastal floods as well as problems connected with the effectiveness of disaster management are presented in the course on coastal processes.

As a test case, a combined course containing key material from the listed courses was given jointly to students of the Tallinn University of Technology and the Estonian Marine Academy in February-March 2005. The teaching was performed a few weeks after the storm in the framework of the course of coastal hydrodynamics. Originally, the course was designed to cover generic questions of shallow-water dynamics, linear wave theory and coastal management issues. The Indian Ocean Tsunami in December 2004 and windstorm Gudrun, although not comparable in their scale of devastation, raised many questions in Estonian society about their driving factors, potential of devastation, return period, and physics of related phenomena. The series of lectures dedicated to these questions was most successful. The Indian Ocean tsunami was used to explain the role of long wave motion and related hazards. The impact of its specific geometry motivated students to learn more about dynamically similar shallow-water phenomena such as meteorological tsunamis, waves from fast ferries, and general questions of highly nonlinear wave propagation. The unexpectedly high storm surge raised a series of questions about the relative role of its driving factors and about statistical and dynamical methods of forecasting future events. The description of extremely rough wave conditions on the background of existing information about the local wave climate motivated several students to focus on attempts to reconstruct the wave climate in the Baltic Sea based on historical visually observed wave data. The series of lectures was later published in a cycle of articles in the popular science journal “Horisont.”

Analysis of more specific features of hydrodynamical processes in the coastal zone and their potential impact on local storm surge, and on the accuracy of forecasts has been included into the course of wave dynamics starting from fall semester 2006. The new key topics were wave-induced set-up and set-down, and their potential influence. Given a large number of low-lying areas potentially attacked by a combination of high water level and intense waves, such exercises are of considerable importance in the future life of students and training of their solving based on existing data is an important part of teaching.

6. Conclusions

The strong reaction of the water surface to windstorm Gudrun both in terms of sea level and high and long waves is the most interesting feature of this event that created substantial hazards both onshore and offshore. The maximum sustained wind speed (about 29 m/s in the Baltic Proper) was large but not exceptional. Also, the modelled strongest wind direction (from the West) was not particularly favourable for wave generation: the effective fetch was about a half of that for SW winds. Yet Gudrun excited very high and long waves. The central outcome of the above analysis is that that the overall maximum of H_S evidently exceeded 9 m off coasts of Saaremaa and Latvia and most probably was about 9.5 m in some areas. Such wave heights were unexpected based on the existing wave statistics from the northern Baltic proper. Another interesting feature of windstorm Gudrun is that very long and high waves also appeared in the interior the GoF, an area which generally is sheltered from long waves. The combination of such waves with uncommonly high water level is a probable reason for extensive damage to certain beaches, smaller harbours and jetties in sea areas where such long waves are uncommon [3].

It might be speculated that a future storm of the same strength and duration, but corresponding to more favourable wave generation conditions, may create even higher waves. A qualitative answer to this question follows from the analysis of the different reaction of the sea surface to wind patterns travelling in different directions. Very high waves may occur in the NBP when a strong and large cyclone travels in a NNE direction. Since only a few cyclones do so [2], such a 'perfect storm' is not likely to occur. However, if it did happen, it probably would excite even rougher wave conditions.

The comparison of modelled and observed wave data shows that the basic features of wave fields during windstorm Gudrun as well as during the following stormy period were mostly well captured by operational wave models [16]. The observed properties of the roughest windseas were generally found between the values predicted by different models. Consequently, a sort of consensus forecast based on the comparison of predictions of different models and analysis of their performance in extreme conditions might give a reasonable forecast for the future storms. This forecast method is well known in meteorology where it is used for more exact determining of sensitive parameters such as the position or trajectory of tropical cyclones or potential location of floods [17]. The performed analysis suggests that this method is also applicable in predictions of hazardous wave conditions.

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Cement and its effect to the environment: A case study in SriLanka

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Abstract

Cement is an extensively used material in Srilanka. In Srilanka, the demand for cement is high both in building and infrastructure development. However, the environmental impact of cement production process starting from preproduction stages is significant. This study scrutinizes the environmental impact due to cement production process in Srilanka. A case study of Puttalam Cement Company Ltd, (the only cement production facility that encompasses the entire production process) revealed that the production adopted the dry process, which includes supply of raw materials, clinker burning and grinding process. Further the study showed that, 4-5% dust emission is due to the kiln feed, while the other sources of dust emissions include the crushers, grinding clinker coolers and material handling equipments. The case study suggests that the major sources of CO_2 emissions are from the fuel burning and during the clinker production in kiln, which forms a part of the cement production process itself. The study found that 0.613 ton of CO_2 is emitted when one ton of clinker's produced.

Keywords: Cement, Srilanka, sustainability

1. Introduction

In Sri Lanka, cement industry was introduced four decades ago by the state and managed by the state until very recently. Sri Lanka is perhaps the only country in this region, which uses 100% dry process for manufacturing cement (Mohanty, 1997). Puttalam Cement Company Ltd is the only factory that involves cement production from raw material excavation to cement packing in Sri Lanka.

The use of cement has long been the basis for development of society and for the welfare of the people for generations. Concrete, which is made from cement, has been the ultimate material for construction. Cement manufacturing process is technology intensive. Raw material extraction causes serious environmental problems by damaging the landscape and most of these raw materials become scarce. The cement industry recognizes its responsibility to manage the environmental impact, associated with the manufacturing of its product. Mainly, there are two types of cement production process; such as wet process and dry process. The preparation of cement includes mining, crushing, and grinding of raw materials, calcining the materials in rotary kiln, cooling, resultant clinker, mixing the clinker with gypsum and milling and bagging the finished cement. The cement production technologies in use cause extensive power consumption, gas emissions, noise pollution environmental heating and emissions of fuel (CO_2, NO_X SO_2 and CO) from the kiln and precalciner. These are the major sources of environmental pollution in the cement industry to the best possible extent.

1.1 Research aim and methodology

This paper reports the findings of a research study conducted in Srilanka to investigate the cement production process and its effect on environment. The aim of the research study is to identify the cement production process and its impact to the environment. A case study research approach has been adopted, since this better facilitates to study real life context in depth. The case study was conducted at the Puttalam Cement Company Ltd. Unstructured interviews were conducted in order to have comprehensive reasoning behind the identified environmental impacts. Comparison analysis was carried out to analyze the data gathered from case study with standard and guide lines.

2. Cement production Process

A cement production plant consists of the following three processes: Raw material process, clinker burning process and finish grinding process. The raw material process and the clinker burning process are each classified into the wet process and the dry process. The major processes involved in production are excavation of limestone crushing of limestone, preparation of other raw materials, grinding of raw materials in the raw mill, storage of raw meal in a raw mill silo, blending of limestone powder to control CaCO3 percentage, burning of raw meal to form clinker, grinding the clinker with gypsum in cement mill and storage of cement in silo packing and distribution of cement.

The specifications of raw materials used for cement productions are limestone 2470 ***(ton/day),*** laterite 130 (ton/day), raw meal (ground raw materials) of approximately 2600 ton/day that are passed through the kiln towards the firing end where heat is applied with heavy furnace oil. Temperature generated from burning oil is raised in the raw meal up to about 1450 °c in order to form the clinker at the rate of 1500 *ton/* day. The kiln feed is prepared by proportioning, grinding and blending the raw material into a consistent and homogeneous composition so that, after mild heating CO_2 and water could be taken away. The raw materials are processed at very high temperature so that they can react by solid-solid reactions to form clinker. These final products determine the cement characteristics such as hardening time, the early strength and the final strength. The largest volume of raw material needed is CaCO3 or comparable materials such as oyster shells (in locations where appropriate). The CaCO3 is often mined in chunks up to a diameter of 750mm. These must be crushed to about 10mm, and then mixed with sand, shale, and other ingredients for further grinding. Grinding and reactions of raw materials such as limestone (97%-96%) and laterite (3%- 4%) takes place under controlled conditions in order to produce clinker. After grinding, depending upon the exact process, water may be added. The mixture is then taken to some high – temperature processing unit, known as rotary kiln for conversion to cement clinker. The clinker must be cooled before further processing. Then it is ground in the plant with gypsum and other possible additives to a fine powder of finished cement.

2.1 Raw material for cement

Minerals of natural origin as well as industrial products can be used for the production of cement. Starting materials for this purpose are mineral compounds, containing the main components of cement, lime, silica, alumina, and iron oxide. The two main components are generally limestone and clay. In cement raw materials. The lime component is generally represented by an amount of 76-80%. Limestone is of a predominantly fine-grained crystalline structure which influences its colour. The main component of clays is formed by hydrous aluminium silicates. Clays are divided into the following mineral groups; Kaolin group (Kaolinite Dickite Nacrite Halloysite) and Montmorillonite group (Montmorillonite, Deidellite, Nontronite, Saponite) (Watter 1977). Chalk is sedimentary rock, which is formed during the cretaceous period in geological time. Blasting is not required for quarrying chalk and the crushing process can also be omitted. This kind of raw material considerably lowers the cement production costs. Calcium carbonate ($CaCO_3$) which is wide spread in nature of all geological formations qualifies for the production of cement. The most common forms of Calcium carbonate is very similar to marble, limestone and chalk.

2.2 Production process

There are four basic types of cement kiln processes currently in use. They are wet process, semi wet process, semi dry process and dry process. The kiln can be considered as the heart of the plant as it constitutes clearly the most important step in the process of cement manufacturing. Out of these, the dry process is the most energy efficient and most commonly used technology nowadays. But these process are selected with due consideration given to the properties of raw materials, cost of fuel, condition of location and others. For the wet process, plant construction cost is rather low and high quality products are manufactured easily. On the other hand, dry process consumes less energy and its running cost is lower. The progress of technology is, however, eliminating the differences in quality between products from the above processes.

Cement is produced by heating calcium (usually limestone) silica, alumina (typically clay or shale) and iron (steel mill scale or iron ore) in cement kilns. The cement burning process (preheater) is rapidly changed and accordingly the heat consumption rate is remarkably improved. Preheater tower is the heat exchanger where the heat of kiln exit gas is transferred to the incoming material (Kiln feed). Regardless of the type, the clinker cooler is installed to improve the product quality by quenching the clinker. For drying and grinding of coal and feeding to the kiln systems such as direct firing, semi-direct firing and indirect firing are used. Generally, cement's initial strength is enhanced by improving the fineness of the product but the long-term strength is not enhanced. Therefore, excessive fine grinding should be avoided even to prevent waste of power. In cement production technologies, the recently spread roller mill makes a great contribution to the reduction of power consumption in this process.

3. Case study of puttalm cement company ltd

3.1 Introduction of Puttalam Cement Company Ltd

At present, there are two clinker grinding factories; puttalam and Kankasanturai cement factories. But Kankasanturai cement factory is not functioning for the last two decades due to the war in the north. Puttalam Cement Company Ltd is the only remaining clinker production company in Sri Lanka. Here, the clinkers are mainly obtained from Mitsui Cement and Mahaweli Marine. From the time of commissioning, for about three decades this plant was managed by a government corporation and was transferred to the pvt sector. Holcim (Lanka) with its Swiss parent company Holcim Ltd, brought worldwide experience to the Sri Lankan market, through technical and manufacturing excellence, plus a long-term commitment to Sri Lanka. Holcim Ltd focuses on long-term benefit and wishes to facilitate and be a part of the development process of SriLanka. Holcim (Lanka) Ltd operates its only fully integrated cement plant in Sri Lanka in Puttalam. It also operates a cement grinding station in Galle. The company's premium brand manufactured at Puttalam remains the only cement available in Sri Lanka that is made from local raw materials with technological know-how from one of the world's leading cement manufacturers. Its mission is to assist the growth of Sri Lanka's building and construction industry, through a long-term commitment to product quality and service excellence. These products conform to SLS 107 certification and ISO 9002 quality system.

Holcim (Lanka) Ltd continues to promote various environmental performance initiatives in its own facilities viz; reduce dust emission, create a healthy natural environment plantation, and also reduced electricity consumption. It also recognizes the importance of social responsibility as a part of its overall commitment to sustainable development. Therein, perform the following activities: maintain a community mini-hospital to provide medical services, receive proposals from premium dealers and local communities, shortlist and finalize awards to recipients, donations, press releases, workers' provident fund, community training, promote education and development.

The Putalum plant consists of several units from limestone crushers to packing plants. There are two lines of process called stage 1 & 2 each having separate processing facilities. The main processing units are crushers unit, raw mill, homogenizing plant, kiln system, cement mill and packing plant. Here, dry production process is used because energy consumption is less and running cost is also lower compared to other process. The raw materials used are in the following compositions; limestone 95-97% and laterite 3-5%.

3.2 Environmental effect due to cement manufacturing process

Emissions to air is the main environmental challenge faced by the cement industry. Main pollutions of cement productions include; cement dust, air pollution, water pollution, solid waste pollution noise pollution, ground vibration and resources depletion due to raw material extraction. Gases from the kiln and preheat are combined and used to dry and preheat the raw materials. Fuel gases consist of the components such as CO_2, N2, 02, S02, water vapor and micro components i.e. CO and NOx formation. Gases are emitted in two stages; (a) Calcinations: In high temperature, CO_2 will be released with water vapor during the CaO formation. (b) Fuel combustion: Successful operation of a rotary kiln requires an adequate source of heat that will first rise to the desired operating temperature, and then will maintain this temperature. The requirement of heat is obtained by the combustion of fuel, with a chemical reaction in which carbon, hydrogen, sulfur and nitrogen in the fuel mixes with Oxygen in the air. Dust emission is a significant source of environmental pollution during cement production.

Sources of diffused emission of particulate matters are identified in PCCL Cement. Blasting takes place at low frequency in the Arruwakkadu quarry site. The suction system of the crusher is unable to control this emission. Due to the influence of the wind, dust formation occurs at raw material storage (open yard) because of the low moisture content of the raw materials. Lots of dust is generated during the transport, loading and unloading of clinker for storage outside the silo.

3.3 Other Environments Impacts

In order to overcome deforestation, the PCCL Plant Company has a re-forestation scheme. Aruwakkadu site consists of large open space with forest. Destruction of forests depends on the quarry located. In quarry site, noise pollution is a problem due to the high noise level caused by blasting.

3.4 Gases emissions calculation

Table 1 shows, CO_2 emission per annum in PCCL plant over the period of 1990-2001 due to calcination. The below table was based on the calculation done based on the Puttalam Cement Company Limited plant report, 2001.

Table 1 CO_2 emission per annum

Year	Clinker production (tons)	Emission Factor	CO2 Production (tons)
1990	382370	0.613	234392.81
1991	398875	0.613	244510.38
1992	408925	0.613	250671.03
1993	423455	0.613	259577.92
1994	415380	0.613	254627.94
1995	403210	0.613	247167.73
1996	439190	0.613	269223.4 7
1997	453335	0.613	277894.36
1998	448505	0.613	274933.57
1999	378358	0.613	231933.45
2000	378286	0.613	231889.32
2001	379200	0.613	232449.60

The following emissions takes place in the cement production process; CO_2 emission, water vapour, SO_2 emission and NOx emission: NOx is formed from the reactions between nitrogen and oxygen in the air during combustion. According to the PCCl plant report the amount of NOx emission from cement kiln is around 200ppm (part per million), carbon monoxide (CO) is emitted in a very small quantity (approximately 0.05%) and carbon monoxide (CO) is emitted during the fuel combustion.

3.5 Particulate Pollution Abatement

One major pollution abatement method is through the use of dust collection system in various sections of cement process in PCCL plant such as cyclone separators, electrostatic precipitators (ESP), bag filters for removal and recycling arrangements for dust, except the crushers sections. During the maintenance of this equipment dust is discharged into the atmosphere without any control. However no stand-by units are available.

Dust collecting devices with the physical characteristics such as total dust load, particle size distribution, bulk density, electrical resistivity and gas volume determines the selection of suitable and efficient collection system. Some of these characteristics limit power input and collection efficiency. Dedusting equipment is in the form of bag filtering and cyclone separators. Cyclone separators (mechanical precipitation) utilize a centrifugal force generated by a spinning gas stream to separate the particulate matter from the carrier gas. It can be used at high temperatures and is suitable where coarse particles are present. Particles are removed from kiln gases by electrostatic precipitators or fabric bag collectors, either of which may be installed after the cyclone collectors. Scrubbers have had very little applications because of the problems in handling particles, which react with water. The bag filter system is one of the efficient dedusting units used in the cement industry. The filter medium is in the form of a woven textile fabric, which is arranged as tube on a suitable framework. In the course of operation, filtration efficiency will be low until a loose "floc" builds up on the fabric surface and it is this, which provides the effective filter for the removal of the fine particles. The cloth will require cleaning from time to time, to avoid excessive build up of solids, which gives room for high pressure drop. By giving knocks in regular intervals the cloth is cleaned. The Electro static precipitator has number of passages through which the gases pass. The passages are formed by two parallel rows of vertically mounted collecting plates and a number of discharges electrodes vertically suspended between the collecting plates. The high negative voltage applied discharges electrodes which creates a strong electric field between the discharge electrodes and the dust collecting plates. This produces large amount of gas ions and the positive ions being immediately attracted to the discharge electrodes, while the negative ions go towards the collecting plates. Due to these ions, dust particles are also charged. Through the influence of the electrical field, charged particles migrate towards the collecting plates. The temperature of the incoming gas stream and the voltage fluctuations greatly affect the efficiency of the extinguishers in E.S.P.

3.6 Comparisons with standards guidelines:

A comparison of the cement industries in Sri Lanka and WorId Bank group emission guidelines has been done to point out the major gaseous pollution and to improve potential application of energy efficient and environmentally sound technologies. Cement production technology based on the dry process compared to wet process is more energy efficient while it keeps running cost to a minimum. Gas emissions through kiln stack are nitrogen oxide, carbon dioxide, sulfur dioxide and carbon monoxide. Sulfur dioxide emissions are best controlled by the use of fuels. Findings show that 300mg/Nm^3 of SO_2 are stacked through due to fuel combustion. 90% of sulfur dioxide is absorbed in high alkaline condition. PCCL especially uses furnace oil which consists of low sulfur. NOx emission should be controlled by the use of proper kiln design, low NOx burners and use of optimum level of excess air. In this case, NOx emissions are 287mg/Nm^3 from the kiln stack. However the, World Bank allows maximum of NOx emissions to 600mg/ Nm3. In PCCL, the introduction of new technology of the suspension preheater kiln maintains the optimum level of excess air.

In this case, CO emission is 720mg/Nm3 from the stack kiln. However, the amount of CO emissions depends on the burner. Because, CO becomes as CO2 in high temperature. The study also found that 0.613 *t/ton* of CO_2 is emitted from the cement production process which is higher than the amount given by the standards *(0.507t1ton).* However CO_2 emission depends on the quality of raw materials and the quantity of fuel combustion. He study found that, 14-15% of green house gases are emitted into the atmosphere out of the total gases emitted from the fuel consumption in PCCL plant.

Particulate emissions are major pollution in cement industry. Here, the dust emission in a cement plant is due to improper maintenance and operation. But, all mills are provided with electro static precipitators (ESP) and bag house filters to remove and recycle dust except crusher in PCCL plant. The study revealed that, the dust emissions are approximately 52g/Nm^3 in kiln stack. World Bank standards allows maximum of 50mg/Nm3 for particulates in stack gases under full load conditions. However, the use of electro static precipitators on kilns has not been very successful in controlling pollution. Discharge of large quantities of dust into surrounding has caused drop in crop yield in nearby coconut plants and cause damage to other trees by settlement on the leaves.

3.7 Suggestions for production improvement

In this case, dust emissions can be reduced by proper maintenance of bag house filter. A schedule for maintenance should be prepared. In house dust emission measurement i.e. intensive monitoring of bag house filters should be carried out to gain more information about its effectiveness. Properly designed and operated ESP can reduce dust emission to as low as 25g/Nm3.The efficiency of ESP can be improved by decreasing the actual gas flow through ESP. It will have a positive effect on the dust collection. The reduction of the intake air leakage and a motor control system of fans will allow a better control of the flue gas flow. When the installed CO analyzer is taken out for maintenance, ESP is switched off to prevent explosion, which can occur due to high concentration of CO. CO measuring equipment should be installed in the stack of ESP, which can be connected to the sampling point of the CO analyzer after the preheater.

4. Conclusions

The cement production process consists of three processes; raw material process, clinker burning process and finish grinding process. The raw material process and clinker burning process are classified into wet process and the dry process consumes les energy while keeping running cost to its minimum. The processes are selected with consideration given to the properties of raw materials, costs of fuel, conditions of location and other factors.

Cement production is one of the main pollution contributors due to its extensive energy consumption and gas emission. Dust emission from kiln feed is 4-5%. Other sources of dust emissions include the crushers, grinding clinker coolers and material handling equipment. The priority in the cement industry is to minimize the mass load emitted from the stacks. According to the observation of study, PCCL dust collection system such as cyclone separators, electro static precipitators and bag house filters for removed and recycling arrangement is made for dust. But no standby units are available. So, during the maintenance of this equipment, dust is discharged into the atmosphere without any control. In this case, two significant types of control problems can encounter; automatic shut-off of systems related to plant, power failures leading to the emission of particulates to a higher level for shorter period of time and gradual decrease in the removed efficiency of the system over time because of poor maintenance or improper operation. Green house gases are produced directly from fuel consumption and additional cement production process itself releases carbon dioxide when the calcium carbonate in lime stone is converted to calcium oxide during the production of clinker in kiln. Also, 0.613 ton of CO_2 emission from one ton of clinker is produced.

In this case, NOx produced due to combustion of fuel. Based on calculation, the NOx emission is 287mg/Nm3. NOx should be controlled by adjustment of the kiln burner and use of an optimum level of excess air. Sulfur- dioxide emissions are best controlled by use of low sulfur fuels. In PCCL, the use of fuel consists of low sulfur concentrations. $S0_2$ emissions are 300mg/Nm^3, where 90% of $S0_2$ is absorbed by clinker in highly alkaline condition. In PCCL, the use of water is limited because the process is based on dry process. Through observation it was found that the water is used at its minimum, because the use of water for cooling purposes and water spray for dust is controlled.

The PCCL plant is situated in large area. In the surrounding there is no public living therefore, noise emission has not caused a big problem to people. With blasting at quarry site, the intensity of the vibration emission can, to some extent be controlled by the technique employed (number and spacing of blast holes, amount of explosive fired, depth of holes). Considering the energy consumption, the process of cement manufacturing process consumes two types of energy. According to observation, earlier the factory used large amount heavy furnace oil as a thermal energy. But, by changing to furnace oil, the cost of production could be reduced slightly and the gradual reduction of specific energy consumption is due to the introduction of 4- stages of suspension preheaer at factory. According to Holcim progress report June 2002 consumption of heavy furnace oil rate is 3.095t/h.

The industry can take range of steps to reduce its green house gases emissions. Introduction of Greenhouse Energy Management System (GEMS), which is based on the green gas monitoring and evaluation has streamed- lined identification of options for reducing greenhouse gas emissions, reduce thermal energy consumption, minimize dust by proper maintenance of bag house filters and ESP, optimizing of electro static precipitators and water sprayer at site to installation of complex pollution control equipment. The industry can take measures to reduce its green house gases through some kind of plantation in surrounding.

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Contribution of Commercial Buildings toward GHG Emissions: Sri Lankan Perspective

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Abstract

Adverse impacts of uncontrolled Greenhouse Gas (GHG) emissions have been identified by the global community and ratified by the Kyoto Protocol (KP). Clean Development Mechanism (CDM) under the KP is a flexible mechanism by which developing countries could harness benefits by way of offering GHG arrays through various GHG reduction measures. This study aims at investigating the "Contribution of Commercial Buildings towards GHG emissions", as an initial step towards offering GHG arrays through Commercial Buildings. The focus of the study is placed on 20 high rise buildings in the Colombo Metropolitan area as it attracts more investment than other parts of the country and also is the main financial centre of the country. According to statistics, more than 60% of financial transactions take place in financial institutions located in Colombo. The selected sample is a collection of ten office buildings, five hotels and five mixed developments. Monthly energy consumption details of the selected buildings were collected by analyzing electricity bills of Ceylon Electricity Board (CEB) and self generated electricity units consumed. In order to come up with the derived contribution of commercial buildings towards GHG emissions by the demand placed on the grid; existing thermal power plant data and their share of electricity supply on to the national electricity grid was examined. Based on the above data Derived Contribution of Commercial Buildings towards GHG emissions was quantified.

Key Words: GHG Emissions, Energy Consumption, Commercial Buildings

1. Background

1.1 Significance of Addressing GHG Issues

The complex global atmosphere which affects the climatic change is linked to the oceans, the biosphere and the world's water cycles. The industrial revolution and the human activities since then have fundamentally affected not only the atmosphere but also each of these systems. The resultant Global Warming trend that was inevitable has captured worldwide concern, especially in the developed regions. These regions mainly focus in mitigating the source of problem, namely the emission of GHGs. 80% of the anthropogenic emissions of GHGs are said to be directly related to energy consumption activities [1], and these GHGs are considered as stock pollutants and unlike many local air pollutants have an accumulating effect over time. These heat-trapping gases are generally well mixed in the atmosphere and as a consequence their impact is mostly independent of where it was emitted. The Kyoto Protocol (KP) ratified in 2005 which was initially negotiated by more than 160 nations in December 1997, at the third Conference of Parties to the United Nations Framework Convention on Climatic Change (UNFCCC), addressed the reduction in net emissions of certain GHGs, primarily CO_2. It has been estimated that over 70% of today's atmospheric anthropogenic GHG emissions are generated by the industrialized world. At the same time researches have predicted by the year 2015 China will be the largest overall emitter of GHG, and by the year 2025, the developing world will emit more GHG in total than the developed world [2]. The main complaint on this issue by developing countries is that they are being asked to limit their capacity to industrialize, reduce poverty and raise their standards of living. They are demanding the freedom of developing first and then taking actions to create an environmentally sound atmosphere, as been done by the countries that industrialized at an earlier time. Laboratory in Berkeley, California has found in an Asian study [2], that developing countries are already doing a lot to reduce their emissions, but these activities does not arise from climatic change concerns according to him. Stuart [2] further said, "They are improving their energy efficiencies and removing energy subsidies". But the studies show that they can do a lot more without jeopardizing their economic growth with any where from 5%-15% reduction in emissions possibly without negative cost". But he added that these countries need new capital and technology to achieve these reductions.

As a developing Asian country, Sri Lanka is only responsible for a relatively low content of GHG emissions, both in relation to the absolute as well as per capita terms.

Table 1: A comparison of CO_2 Emissions in Several Asian Countries

Country	Kg CO2/1990 US$ of GDP
Sri Lanka	0.63
Pakistan	1.62
India	2.17
Indonesia	1.37

Source: Ranasinghe, 2000 [3]

Nevertheless there is a high probability of increased GHG emissions from the country, in consequence of various development processes which are inevitable in upgrading the countries performance as a whole. Even then the anthropogenic GHG emissions from Sri Lanka will be negligible in comparison with the global scenario. However we must not forget the fact that as evident in the Global GHG scenario, little by little concentrations over years have grater impacts, and that prevention is always better than cure. Being a developing country Sri Lanka is equipped with the capacity to participate in the CDM, with respect to the Kyoto Protocol. The implementation of the CDM would result in competition among developed countries by offering arrays of GHG mitigating projects. Therefore it is high time to identify the prospective GHG mitigating projects in the country in various sectors. Commercial buildings sector plays a major role in the Sri Lankan economy, due to their contribution to the GDP via, various hotels, shops, offices, restaurants, etc. In addition the CEB statistics show that being responsible for a considerable number of consumer accounts as well as unit consumption and revenue generation; commercial sector represents the most viable means, where the demand on the national grid can be controlled.

The aim of the study reported in this paper is to derive the contribution of commercial buildings towards GHG emissions based on energy consumption trends.

1.2 Data Collection

The research is focused on a selected group of high-rise commercial buildings in the Colombo metropolitan region for a quantitative analysis. Because Colombo Metropolitan area is considered as the Heart of the commercial sector housing a large proportion of such facilities like Offices, Shops, Hotels, Mixed Developments, etc. Also the energy consumption of this sector peaks in this area due to the more sophisticated services supplied in these building to cater the target consumer groups. Even from these high rise buildings are significant energy consumers in this sector.

In order to select a sample a preliminary survey was carried out mainly by way of interviews with the personnel responsible for overall maintenance of a selected group of high rise buildings. This was made easy as a result of the comparatively low concentration of high rise commercial buildings in the area. This survey extended towards just above thirty buildings and due to various inconsistencies and problems a sample of 20 buildings were selected for the final survey. Table 2 shows the composition of building types chosen for the study. The selection was mainly based on; type of building, cooperation of the officials, availability of data, consistency and reliability of data, continuity of data, and ease of collection of data.

Table 2: Composition of Building Types

Type of Building	No of Projects
Office	10
Hotels	5
Mixed Developments	5

The final data collection concentrated on the energy consumption of these buildings from the national grid as well as by way of self generation. The data collection was on a monthly basis up to a minimum of two years in the case of demand on the national grid. However the data collection on the self generation was mainly restricted to the periods of continuous power cuts imposed by the CEB. Due to the lack of attention on record keeping of data, the main emphasis in the analysis was placed on the self generation during year 2001 in most cases. Based on the collected data possible contribution towards GHG emissions of these commercial buildings were derived based on several scenarios.

2. Generation of Energy Vs GHG emissions

2.1 Electricity Generation

The energy demand of Sri Lanka is supplied by the combination of the indigenous primary sources of energy, imported primary sources of energy and imported secondary sources of energy. Indigenous primary sources of energy are biomass, hydro potential energy, solar power and wind. Imported primary sources of energy are crude oil and small quantities of coal. Refined petroleum products are the imported secondary energy sources [4]. The aggregate supply of primary energy was estimated as 9.1 million Tons of Oil Equivalents (TOE) in 2003 [4]. As a developing country, Sri Lanka's per capita energy use is annually increasing. In year 2003, the total energy demand was supplied by the combination of biomass (48%), petroleum (43%) and hydro potential (9%). Meanwhile during the year 2003, industrial sector and transport sector respectively contributed 24% and 25% of the total energy demand in the country, and the rest of the demand was from household, commercial and other sectors [4].

Sri Lanka is one of the countries where electricity consumption has been increasing rapidly over the last few years. This is evident from both the trend of electricity generation and consumption by various sectors. Until 1996, Electricity demand of the country was completely met by the CEB owned hydro and thermal generating plants. The existing generating system in the country is still predominantly owned by CEB, which is about 93% of the total existing capacity where the balance is owned by Independent Power Producers (IPPs).

It has been projected the fossil fuel based electricity production will rise from 7.7% in 1991 and 48% at present to 74% in 2016 [5]. This will lead to consequent increase in the emissions of atmospheric pollutants. Further statistics indicate that the share of thermal electricity generation has risen drastically with a six year average growth of 66.9% and a ten year average growth of 33.4% opposite to -0.6% and 0.28% respective growths shown in Hydropower generation. When considering the electricity generation in the country it has been constantly increasing. However when considering hydro and thermal power generations separately it is evident that their cyclical nature in generation have been resultant from the thermal generation increases in order to meet any deficit in generation by hydro plants in drought periods.

The CEB owned thermal electricity generation share has visibly grown over the recent past. All these plant operations are based on three types of fossil fuels, namely Auto Diesel (AD), Fuel Oil (FO) and Residual Fuel Oil (RFO). The impact of thermal electricity generation on environment could be primarily due particulate or gaseous emissions. These gaseous emissions could take the form of CO_2, SO_x, NO_x, etc., where CO_2 and NO_x are identified as primary GHGs by the International Panel for Climate Change (IPCC).

2.2 GHG Emissions from Thermal Power Plants

80% of the anthropogenic GHG emissions are directly linked to energy consumption activities [6]. Thus fuel combustion, which constitutes a major process in both energy industries and energy consumption activities, invariably outshines others with regard to their contribution to GHG emissions in a country context. Figure 1 represents the totals of main GHG emissions from thermal power plants (TPPs). These figures were derived from calculations which were based on fuel consumption data of TPPs obtained from the statistical Unit [7], and emission factor for different fuel types from the generation planning branch [5].

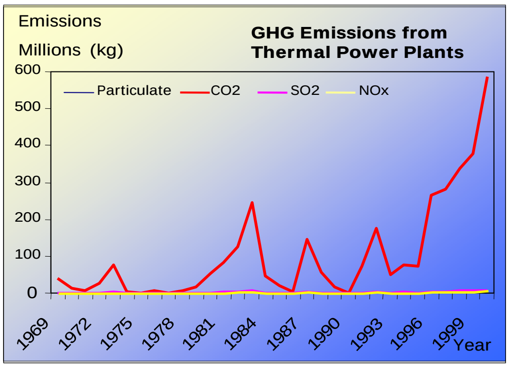


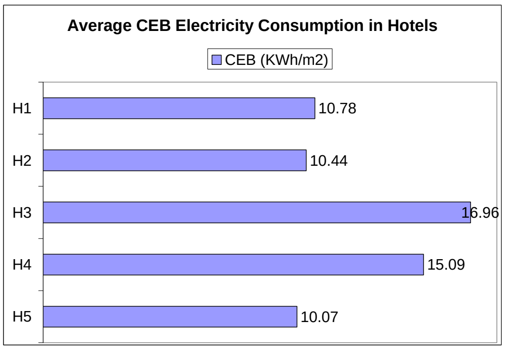
Figure 1: Emissions from Thermal Power

When taken as a whole as evident from above Figure 1, CO_2 emissions from TPPs dominates the others amounting to about 96.5% of the total emissions. Therefore the study is limited to derived CO_2 emissions as a result of energy consumption in commercial buildings.

3. Energy Consumption of Commercial Buildings

3.1 Hotels

In order to facilitate comparisons among the hotels themselves, the collected data on the monthly electricity consumption was summarized based on the monthly average consumptions and presented in Figure 2 below;



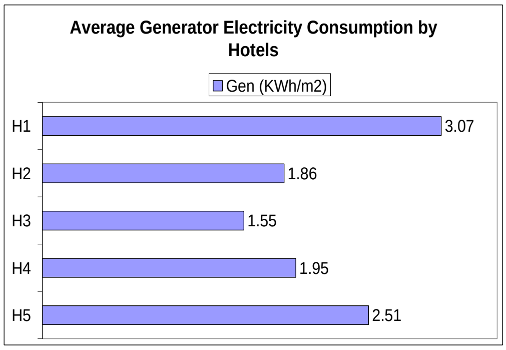
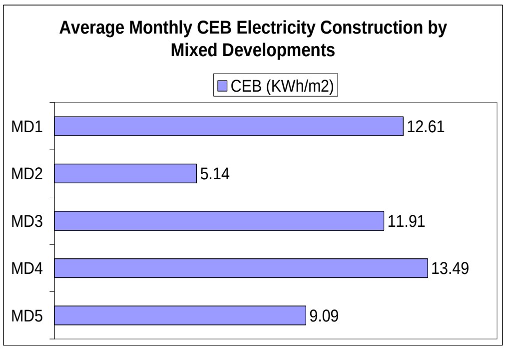


Figure 2: Average Monthly CEB and Generator Unit Consumption by Hotels

The above charts indicate that in considering the CEB unit consumption alone except for H4 and H3 whose energy consumption averages around 16.0 KW/m^2, the others shows a lower average of around 10.5 KW/m^2. However in considering the self generated unit consumption it can be said that the H3 while being the highest CEB unit consumer per GFA, have managed to become the lowest in this category with an average of 1.55 KW/m^2. All in all H2 show the lowest unit consumption of the Hotel sector amounting to 12.3 KW/m$^{2.}$ Further it was revealed that they were implemented various programmers, contests and discussions to increase the employee awareness on energy saving.

3.2 Mixed Developments

The collected data on the monthly electricity consumption of mixed developments were summarized based on the monthly average consumptions and presented in Figure 3 below;



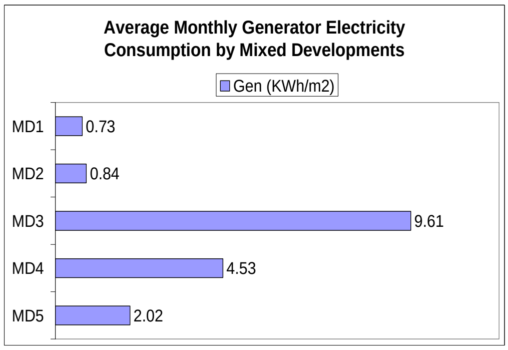


Figure 3: Average Monthly CEB and Generator Unit Consumption by Mixed Developments

On considering the actual unit and cost consumed by this sector a considerable deviation could be seen. This is could be mainly owing to the different levels of occupancy rates in these different developments. So in case of correcting the above figures, taking into account occupancy rates the data could be presented as follows

Table 3: Average Monthly CEB and Generator Unit Consumption by Mixed Developments- Corrected for Occupancy Rates

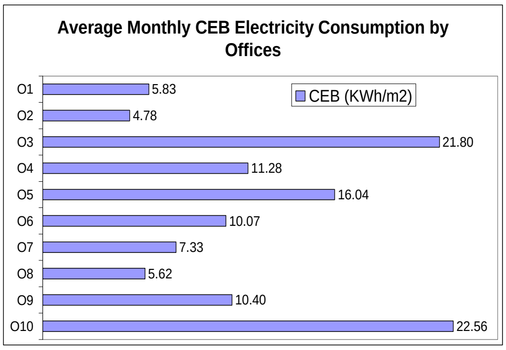
Mixed Developments	Occupancy %	CEB (KWh/m^2)	Gen (KWh/m^2)	Total (KWh/m^2)
MD5	75	12.12	2.69	14.81
MD4	100	13.49	4.53	18.02
MD3	90	13.23	10.67	23.90
MD2	55	9.34	1.52	10.86
MD1	70	18.01	1.04	19.05

The above table indicates that even with regard to adjusted electricity consumption levels MD2 still leads the others with a comparably low consumption rate of 10.86 KW/m^2. The buildings occupancy rate of 55% may have influenced this even after adjusting, which was done on a linear basis, where this may not be the case. Also the stringent control measures that are being implemented may have some effect on the above. MD3 building is recorded as the most inefficient building with regard to their generator unit consumption, which may be a result of inefficient generators and losses in transmission, etc. On considering the CEB unit consumption per m^2, MD1 seems to be the most inefficient building with a consumption rate of 18.02KWh/m^2. This may be owing to magnitude of the building which houses a range of services and the comparably high volume of common areas. The low level of generator consumption in this building is due to the inadequate generator capacity for supplying energy to the whole building.

However between the two extremes of 11KWh/m^2, around 17KWh/m^2 could be taken as an appropriate electrical energy consumption rate for these types of buildings, where the MD5 has been able to achieve with comparable margin with their energy conservation efforts. On considering the magnitude of the building MD4 tower can also be concluded to be somewhat energy efficient.

3.3 Offices

To facilitate comparisons between different office buildings the average monthly consumptions could be graphically represented as follows in Figure 4.



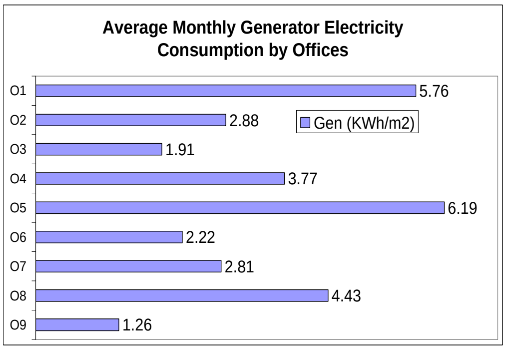


Figure 4: Average Monthly CEB and Generator Unit Consumption by Offices

The above figures contain two extremely high values with regard to CEB energy consumption per m^2. A major reason behind this could be that the existence of two telecommunication offices within the buildings which are believed to be equipped with heavy energy consuming transmitting equipment. In O10 almost half of the building energy consumption is being utilized by them, who only house around 20% of the GFA. On the other extreme the reason behind the lower CEB unit consumption per GFA in the O8 is a result of it being not totally air conditioned. With regard to the same in O2 it may be due to the building being still at the finishing stage of its construction, resulting in non utilization of it up to its potential, even though it's almost fully rented out. The recent commissioning of the building may have caused this low figure in case of the O1. With regard to generator unit consumption the O9 shows a very low figure of 1.26 KW/m^2. Here again even though they are equipped with the full capacity, they might be exercising the freedom of not providing the whole range of services during the power cut periods. The higher values retained by the O5 and O1 with regard to these may arise from one of the facts of trying to participate in the rebate scheme provided by the CEB or else inefficiencies during the generator power generation or distribution.

When taken as an average these types of buildings seem to consume around 15, 14, and 13 KWh/m^2 with regard to CEB and self total energy.

Table 4: A Comparison of Unit Consumptions of Building Types

Building Type	**KWh/m²**		
	CEB	**Generator**	**Total**
Hotels	13	2	15
Mixed Developments	10	4	14
Offices	9	4	13

On considering an overall picture of these 3 types of buildings it is evident that Hotels are the major consumers of electricity per building area with regard to CEB units consumed. The above may be owing to the higher electricity demand of these buildings to cater the required comfort levels through out the day. When considering the CEB electricity consumption of the mixed developments and Offices, the latter leads with regards to energy use.

4. Possible Contribution of Commercial Buildings towards GHG Emissions

4.1 Emissions from Thermal Power Plants

Derived emissions arise from the demand placed on these types of buildings on the national electricity grid. In order to come up with the emissions, the shares of CEB hydro and thermal supply proportions were considered. Based on the following data, possible shares of thermal power consumption of these buildings were calculated.

Table 5: CEB Hydro and Thermal Shares Used for Calculations

Year	Hydro %	Thermal %
1999	0.75	0.25
2000	0.59	0.41
2001/2002	0.62	0.38

Then based on the results the possible derived emissions from the buildings were quantified. On quantifying the emissions a CO_2 emission factor of 75.13kg/GJ was used. The factor was derived from considering the average of these factors of CO_2 emissions from 3 fuel types used in thermal power plants namely fuel oil, auto diesel and residual fuel oil [7],[8]. From the figures derived from above calculations, the following graphs were plotted to indicate the trends in total CO_2 emissions of the 3 types of chosen buildings based on yearly average. The charts represent somewhat a similar trend with regard to total CO_2 emissions for all three types of buildings. In all types an increment of emissions were visible in the year 2000. While a sharp decrease is shown in 2001 by Hotels while these are more gradual in case of the other two types. Then again all three show an in increasing trend.

Table 6: Derived CO_2 Emissions in kg

Building Type	CO_2 Emissions kg				
	1999	2000	2001	2002	Average
Mixed Developments	1,354,779	2,908,006	2,615,849	3,177,743	2,514,094
Hotels	2,920,915	4,126,402	3,270,434	3,881,414	3,549,791
Offices	801,353	1,974,481	1,638,066	1,788,536	1,550,609

As explained earlier the trend in emissions seems similar despite the deviations in their quantities. Here hotels seem to be the largest contributor when taking the total emissions in to account, amounting to 705,958 kg per year per building, followed by Mixed Developments and Offices respectively.

Here the contribution of offices per building is seen as very low where it is accountable for only around one fifth of emissions from Hotels and one Third of emissions in the case of Mixed Developments. In order to come up with a better consumption of CO_2 emissions from different types of buildings the above figures were divided from the associated Gross Floor Areas (GFAs), to come up with the CO_2 emission kg/m^2 per year, as shown in the following charts.

Table 7:CO_2 Emissions in kg/m2

Building Type	CO^2 Emissions kg/m2				
	1999	2000	2001	2002	Average
Mixed Development	6.75	14.48	13.03	15.82	12.52
Hotels	12.25	17.3	13.71	16.28	14.89
Offices	5.25	12.94	10.74	11.72	10.16

The trend seems to continue with regard to emissions per GFA of the selected types of buildings with Hotels leading and Offices being the lowest. However, in terms of the pattern of duration of occupation (on a daily or weekly basis), it can be claimed that offices are not so environmentally friendly compared to mixed developments and hotels.

Also from above figures it could be concluded that accountability of these three types of developments are almost same with regard to their contribution towards CO_2 emissions on the basis of per m^2.

4.2 Emissions from self Generation

Emissions from self generation were derived from the data collected of the units generated by these buildings together with the fuel efficiencies of the generators by way of KWh/I, which were collected during the survey. Then the derived quantity of diesel used was used to come up with the amount ofCO_2 emissions by the use of a factor of 2.7kg of CO_2 per diesel liter utilized [7],[8].

As mentioned several times earlier the power cuts imposed by the CEB have a great influence on the self generation patterns, thus on the emission levels by self generation .

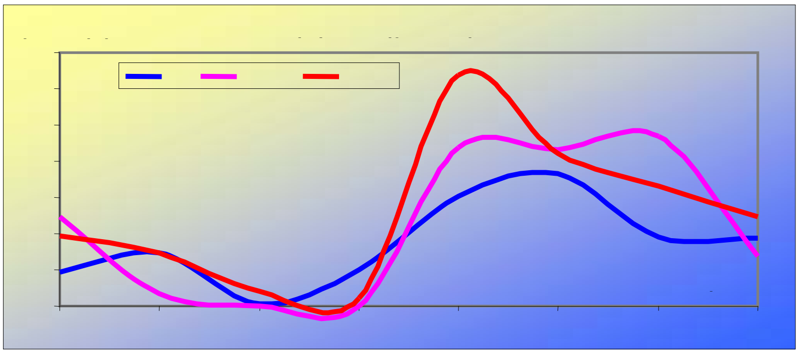
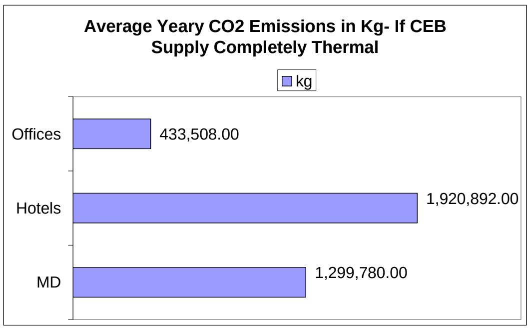


Figure 5: Actual CO_2 Emissions from Self Generation-A Comparison

4.3 Possible Emissions If Fully Based On Thermal Power Generation

The trend of power supply by the CEB is via the expansion of its thermal share as been discussed in the previous sector. Also the prolong droughts that may come about in the future may lead to the power supply being almost wholly based on thermal power. Taking the above extreme situation in to account in this sector a hypothetical case is examined, where the whole CEB supply would be based on thermal power. Based on this hypothetical scenario possible emissions of CO_2 by the electricity demand placed on the grid by commercial buildings was examined. The calculations were again based on the CO_2 emission factor of 75.13 kg/GJ as in the previous case. Yearly total emissions were calculated for the three types of buildings. Then based on these calculated figures yearly emissions of CO_2 per unit area were derived. In case of Hotels and Mixed developments it seems the possible emissions levels will increase drastically in the above scenario, due to the larger floor of the latter. Even though this is unlikely to fully realize in the near future expansion generation plans indicate a considerable increase in the thermal share (74% in the year 2016), which may in time to come have the potential of growing further. On considering the average yearly CO_2 emissions based on this hypothetical scenario, per building and per unit area of building, based on the three types of facilities the following graphs could be derived.

It could be observed that based on the above scenario, the trend in actual emissions has increased in a similar to the actual scenario but amounting to higher emission levels. In this kind of a scenario it could be concluded that the average emission level per m^2 of building could be taken as 34kg.



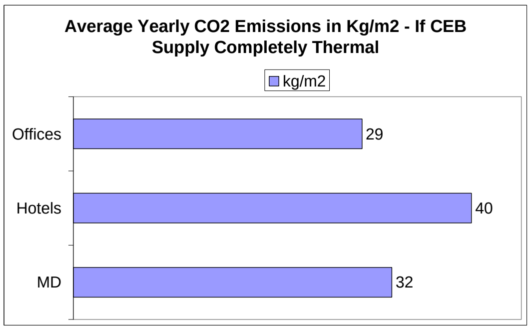


Figure 6: Possible CO Emissions in case of CEB Share fully Thermal-A Comparison

5. Conclusions

The significance of impacts on the natural environment resulting from the increased concentrations of GHGs and the importance placed on addressing these issues by the global community is well known. Despite the set backs placed by several economic giants, global community is ready to enter in to a carbon constrained world with or without their support. Ratification of the KP with binding GHG emission reductions is a mile stone achieved in this respect by the global community. In terms of the Sri Lankan context, the trend in fossil fuel based electricity production of the country has risen from 7.7% in 1991 and 48% at present, and is expected to increase further up to 74% in 2016. In addition to the above as a result of the candidate coal based power plants with higher GHG emission factors the countries contribution towards these emissions shows a drastic increasing trend. The commercial building sector is accountable for a considerable share of the demand placed on the national electricity grid and thereby become accountable for a considerable quantity of derived GHG emissions. A summary of findings with regard to this accountability can be presented as follows.

Table 8: Summary of Total Emissions by Different Types of Buildings

CO_2 Emissions by CEB & Self Generated Unit Consumption (kg) per year						
Building Type	Actual			Hypothetical		
	Per m^2	Per Building	Aggregate	Per m^2	Per Building	Aggregate
Hotels (5 Nrs)	16.58	791,042.75	3,955,213.76	41.70	2,001,976.54	10,009,883.71
MD (5 Nrs)	14.14	568,288.13	2,841,440.68	34.63	1,365,249.27	6,826,246.38
Offices (10 Nrs)	13.66	208,450.25	2,084,502.50	32.50	486,897.35	4,868,973.50

Even though the above indicate that the Hotels as the largest contributor towards GHG emissions, in reality they are already conscious of and are implementing a considerable amount of energy efficient measures. by which to become more energy efficient These are through various programmers, contests, discussions etc., aimed at mainly increasing employee awareness and exploring means. However the above concerns are mainly based on financial benefits derived. In this sector further increase of operational energy efficiency is questionable and may present low potential, as substantial measures are already in implementation for energy conservation. In case of office buildings, despite their low contribution towards the emission of GHGs, they present further potential for emission reduction, by adhering to various energy saving measures. Adhering to standard comfort cooling condition, switching off of unnecessary lighting fittings and efficient use of office equipment could be considered as some initial candidate options for above. In case of Mixed Developments the energy efficiency mainly depend on the tenants of the apartments. Here an option for operational energy efficiency increment would be awareness programmes, where by an environmentally friendly attitude could be planted on these users.

Apart from the above measures various energy efficient technologies could be used in all three instances to make them more energy efficient. The higher costs of adopting these technologies, lack of access or awareness, together with the associated risks were identified as major barriers for their popularity.

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SECTION XV

POST DISASTER RELIEF

Sanitation during disaster relief and reconstruction; the experiences of Asian Tsunami 2004

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Abstract

Sanitation is an issue often neglected in development decision making. This situation becomes more evident under the extreme conditions of a disaster aftermath, where lack of sanitation can expand from a mere inconvenience to a full-scale secondary disaster causing epidemic out-breaks, permanent degradation of water resources and social unrest. Furthermore neglecting the importance of sanitation during disaster rehabilitation may jeopardize the sustainability of entire rebuilding projects.

This paper is an attempt to delineate and suggest solutions to the critical problems encountered in providing proper and adequate sanitation during refugee situations and post-disaster rehabilitation projects in underdeveloped tropical countries. The author records the experiences gained in several projects carried out as a partnership of Government and NGO sector organizations during the aftermath of the 2004 Tsunami incident in Sri Lanka. The paper also discuss how "proper and adequate sanitation" can be ensured through a proper disaster management framework. The paper would critically review the institutional drawbacks and failures which lead to the above mentioned unfortunate situations.

Keywords: Disaster Sanitation, Post-disaster rehabilitation, Social Acceptance, Sustainability, Institutional frameworks, Governance

1. Background

1.1 Disasters and Sanitation

Sanitation was officially identified as a "Basic Human Need" under the Mellenium Development Goals declared by the UN prior to year 2000. Further efforts are currently underway to recognize Sanitation as a "Basic Human Right". The available technology and know-how in the sanitation sector is sufficient to provide "Proper Sanitation" in any major geographical/climatic region of the world. Despite all these technical and policy advancements, sanitation still remains a second priority in development decision making in many developing countries. This fact becomes woefully evident during disaster relief and rehabilitation.

Access to “Proper and Adequate Sanitation” is a factor that determines the stability of a community under extreme situations. This makes it an important concern in all the phases of disaster management. But during many recent disaster situations which occurred in the South / Southeast Asia, such as the Asian Tsunami of 2004, Great Earth Quake of Pakistan (2005) etc many failures were recorded in providing access to sanitation. This paper gives a Birdseye View of how the sanitation issues were handled during the Asian Tsunami aftermath in Sri Lanka reviewing technology, management systems and institutional aspects.

Any disaster management program can be divided into three phases, which are namely: a) Immediate relief b) Intermediate rehabilitation and c) Permanent rehabilitation. Provision of “Access to Proper and Adequate Sanitation” is an important aspect in all three phases, but the methods, technology and tools applicable may vary significantly from phase to phase. A proper and adequate sanitation scheme ensures hygiene, minimal environmental impacts, social acceptability, durability, comfort and safety of the users [7]. The adequacy of a sanitation scheme may be easily judged by the existing standards on sanitation(disaster guidelines, regulations etc.), but assessing the appropriateness (“proper”) is not that straightforward and may differ significantly according to the geography, social setup etc. During the immediate relief and intermediate rehabilitation phases the adequacy may be defined by disaster guidelines such as “Sphere Handbook” developed by UNHCR. In the Permanent Rehabilitation Phase the existing standards and regulations on sanitation in the country would ultimately define the adequacy.

An appropriate technology, proper awareness on sanitation among all the stakeholders and an effective framework for implementation should essentially be brought together for success of any disaster sanitation scheme. Failure to fulfil any of the above requirements would inevitably lead to an abrupt or gradual failure of the entire scheme (see figure 01).

Figure 01: Three Components of Disaster Sanitation

Again the nature of technology, strategies for awareness building and the structure of the management framework may change significantly among different stages of disaster relief and reconstruction. The paper will discuss the experience gained by the author during each phase of Tsunami relief and rehabilitation in Sri Lanka with regard to sanitation. It separately takes into account the aspects of Technology, Awareness and Implementation Framework for each phase.

2. Immediate Relief and Intermediate Rehabilitation

2.1 Situation Analysis of 2004 Tsunami

Tsunami wave of December 26th 2004 rendered nearly a million people homeless in the immediate aftermath. Food & Shelter, Medical attention and Sanitation were the three main aspects which had to be given focus by the organizations looking after the Internally Displaced People (IDPs). Although the first two issues were successfully coped with, there is evidence to believe that post tsunami relief operations failed to ensure access to proper sanitation facilities for the IDPs in some places. Table 01 gives a list of such typical failures and their causes along with some actual examples.

Table 01: Reasons and examples for lack of sanitation during the immediate aftermath [5]

Reason	**Example**	**Location**
Large number of IDPs concentrated in certain camps	1000 inmates with only one toilet at a transit camp near Colombo	Transit camp at Koralawella –Moratuwa managed by SERV Sri Lanka
Constraint of space	162 IDP families cramped in a 3-4 acre compound in a IDP camp in Negambo	Government IDP camp at Fisheries Training Centre - Negambo
Lack of funds	Allocated funds to provide sanitation facilities are inadequate or diverted to other needs	DO
Unhygienic habits of some groups of inmates	Fisher communities in Negambo had poor sanitation habits this lead to a difficulty in maintaining hygiene in the camps	DO
Lack of expertise & Lack of labor	Skilled workers were also among the affected people in many areas and could not render their services	IDP Camp Malharus Maha Vidyala, Sainthamarathu, Eastern Province
Unsuitable physical conditions	High groundwater level and none-soaking soils frequently found in the coastal areas of Sri Lanka made the conventional disaster latrine techniques inapplicable	DO

Lack of awareness about the importance of sanitation among the institutions involved in disaster management could also be observed generally in all the effected areas. The institutional capacity (i.e. Skills or Resources) to handle the issue of sanitation were either inadequate or non-existent. Therefore many weaknesses were observed during the immediate aftermath of the 2004 Tsunami in Sri Lanka in all the three components of Disaster Sanitation (Technology, Awareness and Implementation Framework).

2.2 Technology and Practice

The disaster sanitation techniques that were in practice prior to the 2004 Tsunami were confined mainly to open pit or trench latrine systems. Portable chemical latrines were available in the country, but were mainly hired by private companies for public events [5]. Provision of detergents and sanitation chemicals were not taken as an aspect of sanitation, it was looked after under provision of medical and health supplies. Therefore only the latrine construction techniques will be reviewed here. Some of the weaknesses of conventional disaster latrine techniques are given in Table 02.

Table 02: Weaknesses in conventional emergency latrine techniques [5]

Technique	Main draw-backs
Temporary pit latrines	In most areas the soil was not good for unlined pit latrines. Soil type found in most of tsunami affected coastal areas (Sandy Regasols) would easily collapse under self weight due to the low cohesion factor. The conventional slab and pit configuration can be very dangerous, if the slab is not constructed under proper supervision.
Shallow Open-trench latrines	Due to the fact that sewage or faeces remain exposed to atmosphere and insects/vectors (only covered by a thin layer of soil), open trench latrines may release bad odour and become a threat to public health. This situation will be aggravated under excessive-use conditions in tsunami IDP camps. Many elderly inmates as well as small children will find it difficult and psychologically unfit to use trench latrines.
Portable latrines or “Portaloos”	Both construction and maintenance of Portaloos are expensive in several folds than other emergency latrine types. Portaloos were not readily available with any government institution in Sri Lanka. Portaloos are heavy and bulky structures. The destruction of roads and railways due to tsunami would have hindered the transport of Portaloos to affected areas even if they were available.

Due to the scale and complexity of the Tsunami disaster, the weaknesses of the disaster sanitation techniques practiced until then became more evident. It was clear that these techniques should be replaced with a set of scientifically proven and systematic techniques which are applicable to different site-specific conditions. The author was involved in an intensive program to develop and implement a set of appropriate sanitation techniques for IDP camps in the immediate aftermath of the 2004 Tsunami. This was carried-out as a joint project of Department of Chemical and Process Engineering University of Moratuwa (Sri Lanka), Department of Civil Engineering University of Peradeniya (Sri Lanka) and Network for Women

Water Professionals, Sri Lanka. The project identified the points given in BOX 1 as the essential characteristics of an appropriate disaster latrine technique;

During the problem identification phase of the project it was observed that construction of lined pits, construction of sanitary toilet floors and discharge of effluent under un-soaking conditions were the main problem areas. Taking these into consideration and based on the above guidelines a series of disaster latrine techniques called the Sri Lankan Disaster Latrine (SDL) Series was developed. There were four versions in the series (SDL 1 – SDL Plat).

1. Technically sound and suitable for site conditions.
2. Hygienic and safe for any category of users.
3. Minimum environmental impacts
4. Low cost of construction and maintenance.
5. Simple technology (both construction and maintenance) & Minimum requirement of technical expertise.
6. Local availability of required construction materials.
7. Quick installation.
8. Social acceptance

BOX 1

SDL 1: Main objective of SDL 1 was to provide a successful fast-construction and low-cost alternative for brick or concrete lined pits. SDL 1 uses a steel or HDPE barrel in place of a brick or concrete lined pit. It was calculated that with proper perforation and providing adequate soakage area a simple 250l steel barrel could be used as a pit for 3- 5 moths by 20 people. Price of a used barrel is only a fraction of the original fabrication cost but the strength of the material remains intact.

SDL 2: With the delays in constructing intermediate camps and difficulties in providing permanent toilets in them, SDL 1 had to be modified to last longer. To extend the usable life SDL 2 was designed with a provision to for de-sludging and finished with anti-corrosive treatment so that it could remain underground without corroding for at least one year.

Bother SDL 1 & 2 were successfully constructed and used in two IDP camps in Negambo.

SDL 3: Both SDL 2 and SDL 1 could only deal with site conditions which permit soil soaking. In places where soils were water logged or none-soaking the effluent after solids retention had to be released to a surface drain. Therefore a new version had to be developed where the discharge from the barrel is further treated (secondary treatment) before released into the environment. After considering several methods available for low-cost insitu treatment of night-soil, it was decided that attached growth upward anaerobic filter (anaerobic filter) is the best method for secondary treatment in this case. Therefore SDL 3 was designed as a twin barrel system where one acts as the septic tank and other as the Upward Anaerobic Filter.

SDL 3 was constructed in a small IDP camp in Moratuwa (20km South of Colombo) only as a pilot project and was tested for performance.

SDL – Plat: A prefabricated ferro-cement sanitary platform for toiled floors. SDL plat was designed in a way that it can be installed within a site in less than 3 hours. But it is a prefabricated item which should be kept manufactured as disaster preparedness measure.

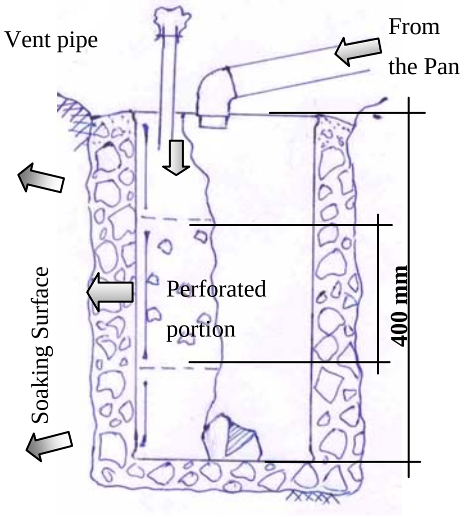


Figure 02: SDL 1

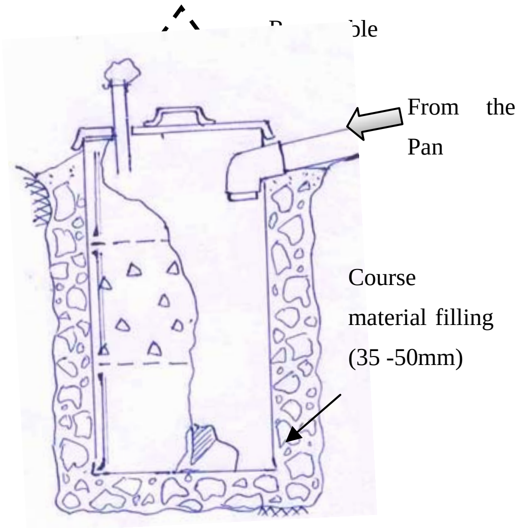
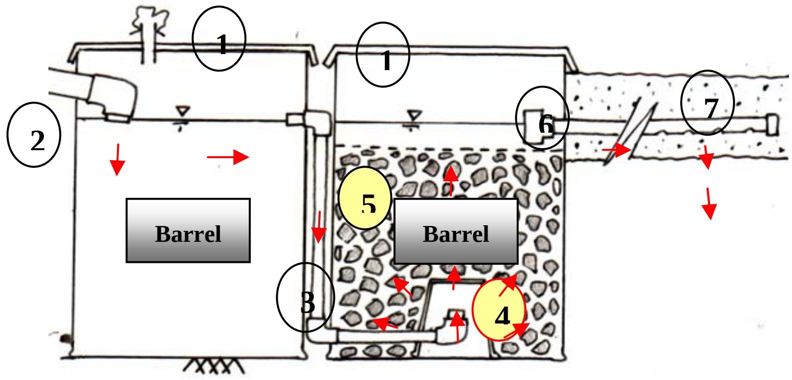


Figure 03: SDL 2



1- Removable Lid
2- Inlet Pipe
3- Internal plumbing
4- Dispersion bucket
5- Filter media (20 cm hard rock)
6- Outlet pipe
7- Soaking Trench

Figure 04: Sectional view of SDL 3

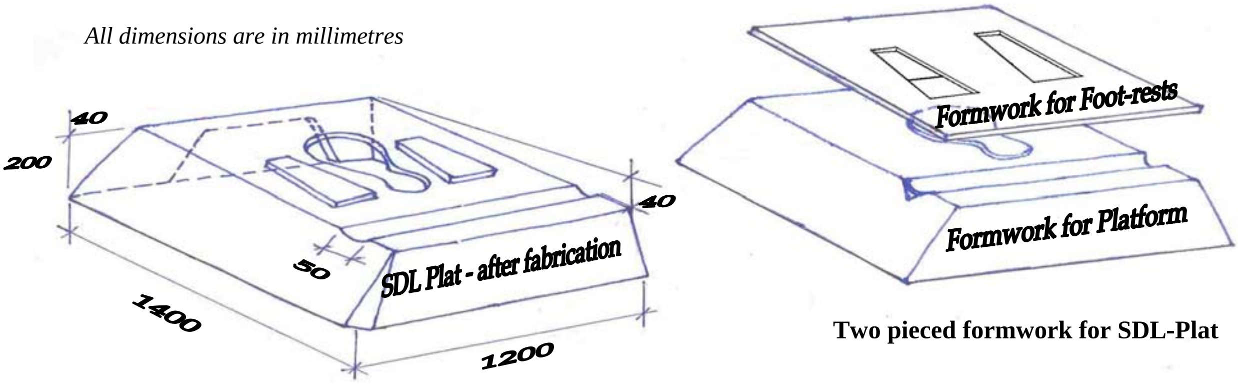


Figure 05: SDL – Plat and formwork

Table 03: Costs and comparison of different SDL units

Unit	**Cost (SLR)**	**Merits**	**Demerits**
SDL 1	800.00	Simple, Low-cost, No need to prefabricate	Short life time, not applicable to waterlogged conditions
SDL 2	1100.00	Simple, No need to prefabricate, Durable	not applicable to waterlogged conditions
SDL 3	3800.00	Applied to water logged conditions, Durable	Cost is higher than SDL 1& SDL 3, Pre-fabricated unit, Needs storage space
SDL-Plat	1200.00	Simple, Low-cost, Fast installation	Pre-fabricated unit, Needs storage space

2.3 Awareness

A general lack of awareness about the importance of sanitation was observed in the disaster management hierarchy of most organizations during the Tsunami Aftermath. A National Disaster Management Centre (NDMC) established in 1994 was already in operation at the time, there were disaster handbooks prepared by this centre for several disaster prone district of the country (Hambanthota, Rathnapura etc.). The sanitation aspects were mentioned in these handbooks but the emphasis given to the importance of it was inadequate [2]. Most of the NGOs involved in disaster management were using the “Sphere handbook” as their guideline, although the “Sphere Handbook” gives sufficient emphasis to the importance of sanitation most of the organisations failed to incorporate the provision of “proper and adequate sanitation” into their “Immediate Relief” check lists. In certain IDP camps some level of access to sanitation was provided but no attempts were made to assess the appropriateness or adequacy of these facilities.

2.4 Implementation Framework

A disaster management act was passed by the parliament of Sri Lanka in October 2005, mainly to cater for the grave concerns which emerged in the aftermath of the 2004 Tsunami. With this act a new Disaster Management Centre (DMC) was established under the Ministry of Disaster Management with a clear and nationwide mandate than its predecessor NDMC which was under the Ministry of Social Welfare. It is commendable that the organizational structure of DMC integrates the government institutions relevant to all aspects of disaster management. Figure 07 gives the Institutional Frame work for Disaster Response and Mitigation under the Disaster Management Act. Not taking into account the role of NGOs and CBOs whose contribution is immense at ground level implementation of disaster relief, is a notable drawback of this proposed institutional framework. Furthermore the arrangement is based mainly on vertical integration; lack of cross sectional consultation and delegation might lead into failures in practice.

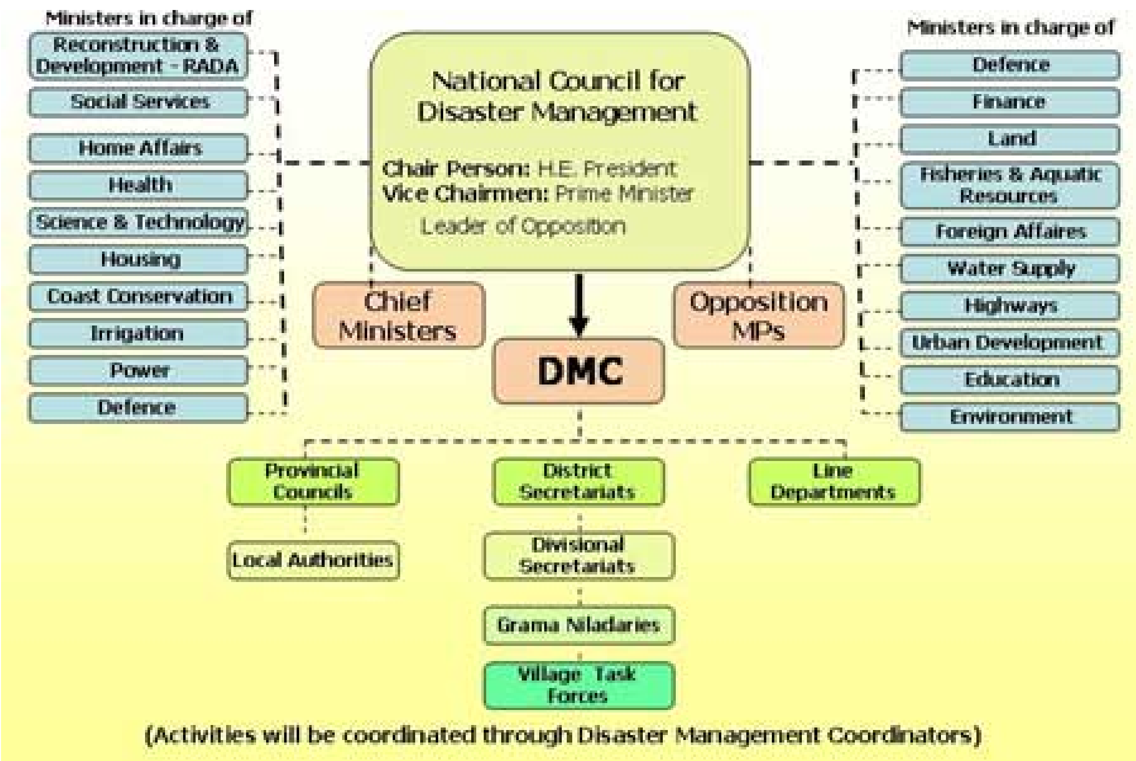


Figure 07: Institutional Framework for Disaster Response and Mitigation Proposed by the Disaster Management Act of Sri Lanka

From the experience of the 2004 Tsunami the author contends that a DRM program should have a mechanism embedded in its framework for providing access to proper sanitation to affected people. The main features of such a mechanism should be,

1. Preparedness ahead of the disaster
2. Training of volunteer foremen/technicians
3. Awareness material and Training kits

4. One subject agency to look after the implementation of work
5. Locations to store equipment and supplies during the pre-disaster period
6. Networking for Technical Support
7. Monitoring and Evaluation
8. Research and Development

Figure 08 gives a generic structure for such a framework. This was suggested as a sub-layer for the main DRM framework given by fig 07. The agency in charge of sanitation (subject agency) should preferably be a central government organization like the National Water Supply and

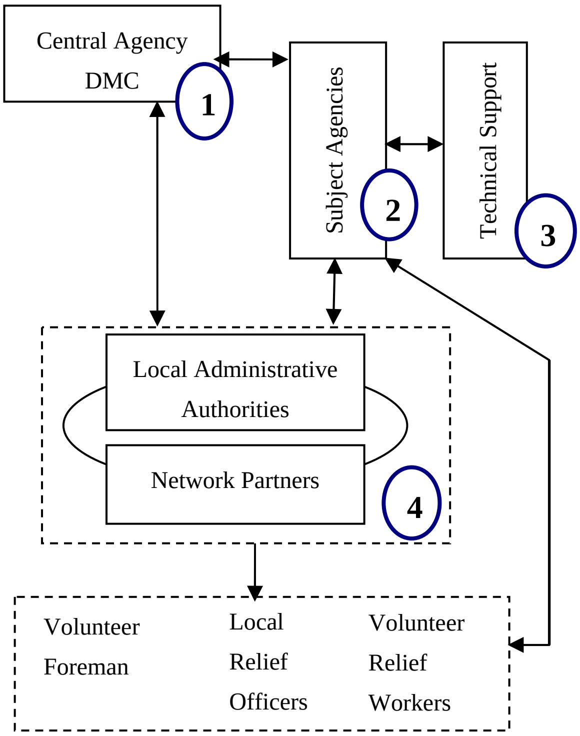


Figure 08: Implementation Framework for Diasaster Sanitation

Drainage Board (NWS&DB) which has the expertise and resources at local levels. The partnerships of local administrative authorities and CBOs, NGOs or Cooperatives are essential at community level to operate during a disaster. These partnerships can be assisted and overlooked by the Subject Agency. There should be some pre-identified organizations to provide technical support and R & D, learning from each disaster faced. The agency responsible for sanitation may have its own technical expertise, but it's always better to have relationships with other organizations such as State Universities for research and development work.

3. Permanent Rehabilitation

3.1 Situation Analysis of 2004 Tsunami

With the constrains encountered in allocating land for Tsunami permanent reconstruction projects, the "Environmental Suitability" naturally became a secondary concern. Once the construction of some of these projects started the environmental problems began to get highlighted. The author was involved in a study to investigate the potential environmental impacts of proposed permanent housing schemes for Tsunami Affected People. One of the major causes of pollution highlighted in this study was the possibility of ground & surface water contamination due to improper sanitation methods/ techniques used. Out of total number of housing projects investigated under this study approximately about 55% had sanitation related problems. The percentage was as high as 90% in Trincomalee district whereas it was less than 10% in the Gampaha district. Most of these problems were related to;

Improper disposal system: Soils soaking systems introduced in low permeability, water logged soils or excessively drained soils

Incorrect design: Incorrect sizing of tanks and soakage pits. Incompatibility with national standards. Inadequate setback distances.

Durability of Structures: Poor material selection, poor workmanship.

It should be noted that these weaknesses were not only encountered in the projects where design or construction was generally poor, but also in some sites where other aspects of design were quite satisfactory. Most of the problems were related to the back-end (disposal system) of latrines. In many cases where attached toilets were provided the front-end (superstructure) of latrine was considerably well designed and constructed.

3.2 Technology and Practice

The most established form of permanent sanitation in Sri Lanka is the onsite soil soaking system. Most of these latrines are single pit systems where solid accumulation and soaking happens in the same pit. Simple pit latrines are still in use but gradually disappearing due to their proven hazards and lack of hygiene. Apart from this Septic tank and Soakage pit systems are also widely used. Septic tanks followed by secondary and tertiary treatment systems such as Anaerobic Filters, Horizontal Flow Wetlands, Vertical Flow Wetlands and Percolation Beds are being introduced at different levels but are yet to enter the wide practice. Ecological sanitation methods are also being experimented with various communities of the country mainly in areas where conventional water borne sanitation systems are not applicable [3].

There are several guidelines and regulations governing the design and construction of septic systems and soak ways in Sri Lanka. The most comprehensive one out of these is the National Standard SLS 745 of 2003. *The Wastewater Manual of National Water Supply and Drainage Board* and the *Manual for the Sri Lanka Public Health Inspector published by the Ministry of Health* are the other guidelines available. Apart from this the National Housing Development Authority (Sri Lanka) published a guideline (CFRR Manual) on housing reconstruction for Tsunami Rehabilitation Projects, this also included a section on sanitation [6].

Although it's difficult to give an exact percentage, no soil permeability tests had been carried out before the design of soak-ways in most Tsunami Reconstruction Projects. Spacing of the soakage pits were insufficient in some projects especially in Galle, Kaluthara and Trincomalee districts because the land allocated for a single plot was small. The typical shortcomings related to design and construction of sanitation facilities were mainly caused by the following reasons;

1. Lack of knowledge about the sanitation techniques and methods available
2. Lack of awareness about the existing standards and regulations on sanitation in the country
3. Inadequate professional input in design and construction supervision
4. Ineffective monitoring by the relevant authorities (i.e. Environmental Officers/PHI of Local Authorities, Central Environmental Authority etc.)
5. Absence of a proper mechanism to evaluate the appropriateness of the sanitation facilities by the approving agency of the project.

It should also be noted that although the Sri Lankan regulations take the micro level pollution of groundwater by a single toilet into account, none of them cover the macro-level impact of large scale onsite disposal of sewage into a given aquifer. Therefore even the housing schemes which comply with the national regulations can contribute towards a long term degradation of the aquifer especially because most of the lowland aquifers near the coastal areas of Sri Lanka are discontinuous and highly sensitive to local impacts. The situation will be critical in the Jaffna Peninsula where a confined sedimentary limestone domain aquifer is present [1].

3.3 Awareness

The average sanitation coverage (Improved Access to Sanitation) of Sri Lanka is as high as 72.6%, but some areas affected by the 2004 Tsunami were fishing villages where sanitation coverage were particularly poor. Some of these areas (e.g Some parts of Duwa area Negambo) had zero coverage and open defecation was the standard practice in the sanitation culture of these communities. Therefore it was important to improve the sanitation awareness of the IDPs while they are in the Intermediate relief camps. There were some efforts made by the IDP camp mangers to accomplish this objective. Different strategies used by them for this purpose ranged from direct lectures to street dramas and film shows.

But unlike in the case of immediate relief & intermediate rehabilitation the institutions involved in Permanent Rehabilitation work had a basic understanding about the importance of providing access to sanitation. The shortcomings in awareness for them were as follows;

1. Inability to assess the appropriateness of sanitation techniques
2. Lack of awareness about the different technical options available in Sri Lanka for providing sanitation
3. Poor understanding about the environmental problems related to inadequate & improper sanitation

Therefore it is important to ensure a substantial improvement of sanitation literacy among the building industry professionals in coming years to avoid the repetition of mistakes and blunders made in the 2004 Tsunami rehabilitation work.

3.4 Implementation Framework

Developing an implementation framework for long term disaster rehabilitation is not as straightforward as in the case of Immediate and Intermediate Disaster Relief. It is difficult to coordinate the entire process through a central agency like a Disaster Management Centre. Usually long term rehabilitation work takes place in the form of any other development program and a Central Agency such as the DMC in Sri Lanka will bear only a monitoring responsibility.

Therefore ensuring access to Proper and Adequate Sanitation in the Permanent Rehabilitation Phase of Disaster Management has more to do with awareness building and improving the Skill levels and Capacities of the Institutions (Government or Non-governmental) with regard to sanitation aspects.

4. Conclusions

Many weaknesses and drawbacks were observed with regard to ensuring access to Proper and Adequate Sanitation during all three phases of the 2004 Tsunami disaster management process. The resulting failures extended from inconveniences for IDPs in the immediate response stage to considerable waste of resources in the permanent rehabilitation stage. From the observations made by the author it is clear that the technical resources available for providing disaster and permanent sanitation in Sri Lanka is satisfactory, the weaknesses exist mainly in the awareness and the implementation frame work of the institutions involved in disaster management. Improvement of Sanitation Literacy among general public is also an important requirement. Furthermore it was observed that a direct intervention and implementation approach will be affective in providing access to sanitation during the Immediate Response and Intermediate rehabilitation stages whereas a more indirect approach which involves awareness & capacity building, development of proper documents on sanitation standards and regulations etc. should be followed in the permanent rehabilitation stage. Mainstreaming the aspect of sanitation in Disaster Management decision making in the country should be the ultimate objective of this whole process.

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Shell - house steel/polyurethane sandwich systems ready to build

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Abstract

A shell formed architecture can be quickly obtained by a light steel bearing structure holding insulated polyurethane sandwich panels, shaped in shell form or straight. Lightweight façades could be shaded, in hot climates, with textile extentions and double roofs. Methodology follows very strict design phases which have brought to different systems with different, but a very simple, final shapes. Some prototypes have been realized in order to optimize the system and to verify all the theoretical calculations about wind loads and earthquake loads (above all the collaboration of the outside curved shell and the bearing structure). Many tests have been carried out to check natural lighting, optimization of spaces, static loads, dynamic loads, thermal behaviour, daylight factors analysis, logistic optimization, acoustic analysis.

One of these concepts has been named **L'Armadillo®** and measures 6,60mx8,00m (3,30 m is the radius of sandwich panel, frontal span of the arch is therefore 6.60 m and each arch span to next one is 4.00 m). The volume optimizes thermal behaviours and gives a high efficiency energy buildings which can be equipped with thermal or photovoltaic cells. Sandwich lightweight steel-polyurethane houses are a clear alternative to a normal house and can be quickly built with a goal to allow affordable spaces with good qualiy even in extreme situations. **L'Armadillo®** is a new system conceived from the Italian Company Brianza Plastica to find new options for its existing product Elycop® (curved sandwich panel). Therefore with a transfer of technology from an industrial product: Atelier 2 who designed it, link this project with previous experiences in design of **Hospitals for Emergency** (Italian NGO) with dry technology, **Casa Parasol** and **Casa Paraiso** with Dubosc and Landowski (Paris). Shell houses give multiple flexibility, are transportable as a kit in a container and easily assembled (and eventually disassembled) on site for different purposes: housing, hospitals, churches, schools, restaurants, etc. That is all those things which may disappear in a disaster contest.

Keywords: Post disaster quick built, Energy saving, Flexibility, Dismountability, Technology transfer.

1. Background

1.1 Structure Envelope (STREN) Technologies for quick construction

Simple construction principles and housing systems normally require complex processes of analysis that lead to the synthesis of their final form and technology. Industrialized systems of construction, based on sandwich panels or stratified layers supported by a frame structure, seem to offer several advantages in a quick reconstruction situation.

Jean Prouvè was the master in this area during the Modern Movement. His ability to interact with industry, opened a new era to the paradigm of the mechanical assembly of buildings. This allows to application of the the paradigm of mechanical assembly and connections to very ordinary buildings, with medium/low budgets, using a light structural skeleton and internal and external light weight envelopes. The use of steel sandwich panels with polyurethane (normally applied in industrial buildings or roofs) is an example of how existing technology can be used to make low cost homes, resistant to strong winds or hurricane, naturally ventilated and shaded, used in both normal conditions (thanks to the speed of construction) for temporary/emergency accomodation. The field of application of the stratified layer construction derives directly from vernacular buildings. Hybrid systems at low cost and low processing are possible and suitable in many emergency or post disaster situations, where is necessary a quick response to a often large amount of houses. The durability/quality of the solution is also very important considering that the temporary solution tends in most cases to become the permanent one [1]. As a consequence temporary accomodation have to fulfil higher performances than simple tents, caravans or containers. The light weight stratified layer building system is a Structure-Envelope system where the lightweight steel structure, supports the outside envelope [2]. The latter is made of sandwich steel and polyurethane panels (the inner envelope could be realized later on its own secondary structure). In the vacuum between the two main envelopes, further insulation could be added for winter and summer time. This would provide the necessary delay time of heat transfer from the outside to the inside in warm climates. Services can be applied both to the structure and/or to the sandwich panels. Close to the Tropics and to the Equator the hyper-insulation is less important because the envelope must mainly face overheating, which means shadowing the building and introducing natural ventilation are essential. A practical, technical and functional result can be obtained through aesthetical expression by using materials (such as simple wood panels or thin corrugated metal sheets or sandwich panels) used in a different way, from their normal purpose, with simple rules of stratified assembled and resistance. This shows that the value of each architecture is not contained just in the costs of the materials but also in the investment in intelligence, using very simple materials in a clever way [3].

1.2 Technology: "Shell-House", ready made industrialized home

A "Shell-House" is based on a simple concept but it is the result of integrated design among architects, engineers and building industry. This helped to achieve different goals: the use of products already available on the market, the weight optimisation and the logistic, transport optimisation, simplicity and speed of assembly, and last but not least important, pleasant architecture. The design approach has similarities to the one used in the automobile industry, where options can be added to the basic version. Self supporting corrugated steel shells have also been used by the military for many decades but a "Shell-House" is a different thing for many reasons. It is a "mechano kit" and this allows transport in rather small parts. On the contrary self supporting shells needed big spaces to be transported, therefore only using military trucks and never stored in a container like the "Shell-House" is. That is why there is no need for making the arches self supporting but using them only as envelope and using the steel "skeleton" structure as the bearing frame. This solution also allows the reduction as much as possible of the foundations to few points instead of being obliged to design a foundation platform (therefore using much water which can be a problem in some regions). Anyway, in case of need, also a concrete plattform could be realized as foundation.

The first "Shell-House"prototype, using curved and linear sandwich steel-polyurethane panels, was designed by Atelier 2 (Gallotti and Imperadori - Milano) with the Company Metecno. In that first case the unit was designed, free of charge, for the Italian NGO Emergency, organization which supports civilian war victims. It was meant to be a FAP (first aid post, or a small hospital unit in severe climates and dangerous war sites) and it has been erected and disassembled twice time (without any damage) before beeing given as a gift to another NGO who have built the unit for the third time (therefore showing its power of flexibility) as a site Hospital in the Rumanian countryside. This NGO is also italian, "Gruppo 29 Maggio", and they are building a orphanage village. The "shell-house" Emergency unit will function as small hospital for this new community. This unit was designed using a trapezoidal, self bracing, hollow tube steel structure which bears a secondary hollow structure and then the curved sandwich panel. This is the panel "Oyster" (thickness 80 mm, radius 3.50 m) produced from Metecno and normally used for industrial roofs. All façades and floors (formed by a steel beam optimized grid) are in structural sandwich steel-polyurethane panels (named "Glamet" – thickness 80 mm). Interior finishing is in wood but all the shelves and partitions are also made in sandwich panels. Each structural frame has an inter axis of 3.50 m, therefore with a frontal diameter of 7.00 m ("Oyster radius is also 3.50 m) the final units measure in ground around 100 sqm. The building is equipped as a small hospital unit [4][5].

Figures1,2,3 Delivery and construction of Emergency unit in Rumania as small hospital in 2007.

1.3 "L'Armadillo", ready made industrialized home

Figure 4 – L'Armadillo housing unit in Carate Brianza (Milano) integrating photovoltaic cells on the roof.

"L'Armadillo" is a clever evolution of the "Emergency" unit into a house or other living space. In this case it has been designed by Atelier2 (Gallotti e Imperadori – Milano) with the Company Brianzaplastica using their existing roof panel "Elycop" (sandwich with 40 – 80 mm thickness, radius 3.30 m). Bearing structure has been optimized into a 3 hinged arch (each frame is at 4.00 m span to the next one) supporting a secondary hollow section steel structure and then the sandwich “Elycop” panels. This solution, compared to the previous one used for the Emergency unit, allows a totally free space on the ground floor to be divided for any cutomized purpose. The building system is made of a light weight dry assembled kit. Foundations are in concrete on single elements (or platform/raft, depending on wind loads). Due to the light weight of the module the wind load becomes the critical factor to the foundation design. The principal bearing structure is made of galvanized steel profiles, shaped in a semi circular frame (linked at the base with a main beam to hold the secondary beams and the floor) which holds 2 secondary square tubes. Structural elements are connected with simple bolted connections. The curved Elycop sandwich panels are fixed to the secondary structure with steel screws. Sandwich steel panels are fixed to the ground floor secondary beams with steel screws. Façades panels are fixed to the sandwich floors and to the sandwich shell. The floor is totally above ground where only 3 steel supports for each main frame descend to concrete foundations and are fixed to them with simple bolted connections. Façades are completed with 2 sunshading made of textile that protect the building from sun radiation, which is much more intense on the vertical surfaces than on the curved shell, except from the top third where it is necessary to fix also a further metal sheet to ventilate the upper part of the sandwich arch. The main steel structure is made of three hinged arches that support square steel sections that act as purlins. The main arches are connected with a floor beam that distributes weight to three fitted stabilisers. Over the master beams there are secondary beams supporting the sandwich panel floor, suspended above ground and therefore ventilated, made of 80 mm-thick sandwich panels in pre-painted steel filled industrially with polyurethane hardened foam. Outer covering consists of end window walls made of aluminium pre-painted windows and doors inserted in the 80 mm-thick sandwich panels. Elycop panels are modular. Normally they are used for industrial roofs and their commercial dimension is 40 mm. For the “Armadillo” a new evolution of Elycop’s use has increased the panel thickness to 80 mm in order to give better thermal, acoustic and static performances. This product improvement has been introduced to guarantee the same performances are achieved by both the vertical façades and horizontal bearing floor (which are also made by 80 mm sandwich panels). To increase the thickness to 80 mm accurate studies in the fluidity of polyurethane foam and time of expansion have been undertaken. This permitted the adaptation of the same machines used to produce the 40 mm panel without the requirement of expensive technology. This has given very good results in terms of economy of the solution and the distribution of polyurethane in the curved sandwich has been successful without air voids.

Figures 5,6,7,8 The 3 hinged main arches are in ordinary steel profiles HEA 120 mm and they carry the secondary rectangular beam section profiles on which is fixed the curved Elycop panel. On the floor a sandwich panel of 80 mm which acts as bearing structure fixed on main steel beams. The final shape allows energy equipment to be integrated.

The Outer shell consists of three modules (a middle unit and two side units) which are shaped to fit at the joints after they have been made water tight; the conjunction of the curved panels is located always at one third of the arch. The internal space can be partitioned with gypsum board dividers or wooden panels. The underflooring is made with plywood planking, which allows for gluing the floor finish. In general aesthetic and functional characteristics of Armadillo make it available for a wide range of uses. It can be used as a single unit or assembled with other units in both of the main axis of expansion to create larger, living spaces, emergency hospitals, first aid, temporary houses, schools, emergency food storage areas or restaurants. The living unit, realized as a prototype and tested, is a small curved shell measuring 6.60 x 8.00 m, which can be divided into sub-units of 6.60 x 4.00 m, or enlarged into units measuring 6.60 x 12.00 or 16.00 m, by adding one or two spans to the basic module. Since the interior of the shell is completely empty, and can therefore be fitted according to the client’s needs, many different configurations, both for residential uses and other functions, are possible. Also different modules can be joined together along the transversal axis to obtain open spaces for different purposes. “Armadillo” is surprisingly spacious inside, and so any arrangement is possible. Internal dimensions clearly show the difference between this and other industrialised homes (especially containers or caravans), and also demonstrate its adaptability to different requirements. It can be assembled like a “mechano” construction system, in just a few days, on a simple loadbearing foundation. Elycop panels are fastened over the light, durable metallic frame, also to increase the whole structure’s level of rigidity. The system can be supplied in separate kits, depending on the project requirements. They can also be autonomously devised by the client who has the option of buying only the building frame and order separately the other components. Reliable insulation and the correct position of openings results in high savings on fuel for heating/cooling needs and also on electricity. “Armadillo” can also easily be equipped with photovoltaic systems or solar panels, and therefore be totally independent of fuels. The majority of the building components are made from recyclable, environmentally friendly materials [6].

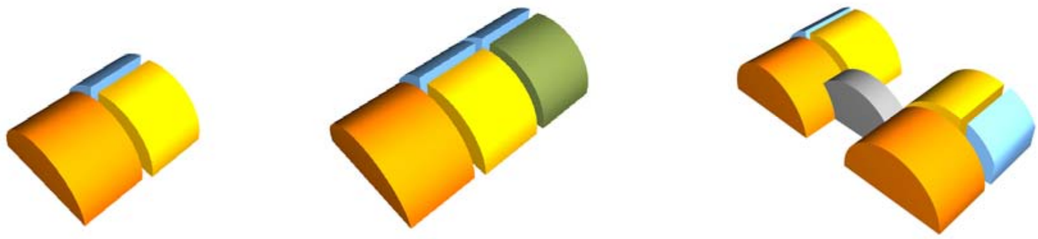

Figure 9 The multiple flexibility and evolutive design of L’Armadillo.

1.3 Prototype and site tests

A prototype has been constructed and was tested in 2005 in Carate Brianza (Milano). Dimensions are 6,60 m x 8,00 m (more than 50 sqm), which is the surface corresponding to the base unit. Interiors have been conceived as kitchen/living room, bed room, bath room and a terrace, 2 sun shading screens have been integrated with the front and rear facades. The 3 hinged main frames (spaced 4,00 m) are in ordinary steel profiles HEA 120 mm. The arches carry the secondary box beam section profiles. Main arches are linked with a base beam ILS 200 mm, connected to the foundation with 3 short steel legs, bolted in concrete. Secondary floor-beams ILS 140 sit on the main beams and carry the sandwich panel of 80 mm as a bearing floor. Thermal resistance of the 80 mm polyurethane panel has been shown to perform very well in winter-cold conditions and in summer-hot condition the system can rely on natural ventilation and the presence of a further ventilation layer on the shell improves the overall condition. The curved panel overlapping guarantees water and wind tightness and all the connections with vertical façades or floors are carefully protected for the same reason (in some cases also with additional polyurethane foam). In the prototype the internal space has been partitioned with gypsum board panels. The finished floor is a rubber layer glued on a wood layer which is fixed with screws to the floor bearing sandwich panel. The structural system has been calculated firstly with Straus automatic finite elements program both for stress and strains and the prototype has been tested to verify the structural calculations. Design and testing on site have been undertaken following the Italian Building regulations[1].

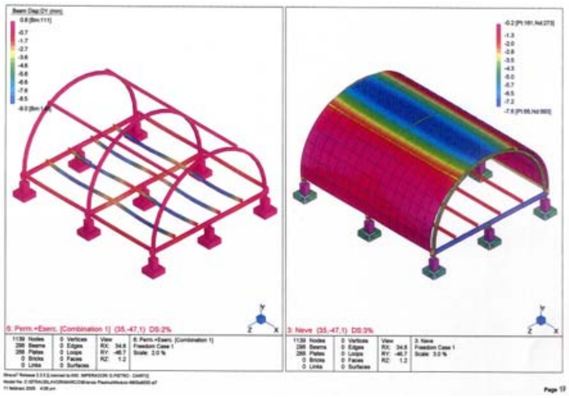

Figure 10,11 The structural system has been calculated with Straus automatic finite elements program both for stress and strains. A test programme has been carried out to verify the theoretical calculations.

Horizontal load tests have been carried out on the prototype by applying hydraulic jacks to the main frames and to the secondary structure in order to verify the theoretical model and also to prove that the presence of the sandwich permitted the structure in the direction of the load not to be braced. The introduced stiffness without additional bracing maximises the usable space and reduces costs. Different scheme tests have been carried out by adding curved panels to the bearing structure in order to prove the enhancement of stiffness thanks to the contribution of the sandwich shell. The 2 hydraulic jacks applied were driven by a oleodynamic system controllable and measurable with pressure manometer. Structural deformations have been evaluated with a tolerance of 0,5 mm and the results show a substantial elastic behaviour with some plastic corrections very probably due to a small plastic behaviour of the connectors and joints (bolted or screwed). Static analysis on the simple automatic model has given very good results compared with the real behaviour of the prototype. After analysing a partial model and testing the prototype on site, under horizontal loads to verify the increasing rigidity of the system due to shell panels, a full complex model automatic has been completed. This model has been finally checked under single or combined load actions (permanent loads, variable loads, snow, lateral winds, frontal winds, earthquake). All stress and strain outputs have been within the limits of safety and functionality, for this typology and for the applied materials.

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[1] Names and references of Italian legislations and norms applied: Legge 05/11/1971 n.1086 “Norme per la disciplina delle opere in conglomerato cementizio armato, normale e precompresso e a struttura metallica”; D.M. 11 Marzo 1988: “Norme tecniche riguardanti le indagini sui terreni e sulle rocce, la stabilità dei pendii naturali e delle scarpate, i criteri generali e le prescrizioni per la progettazione, l’esecuzione e il collaudo delle opere di sostegno delle terre e delle opere di fondazione”; D.M. 9 Gennaio 1996: “Norme tecniche per il calcolo, l’esecuzione ed il collaudo delle strutture in cemento armato normale, armato e precompresso e per le strutture metalliche”; D.M. 16 Gennaio 1996 “Norme tecniche relative ai criteri generali per la verifica di sicurezza delle costruzioni, dei carichi e sovraccarichi”; CNR – UNI 10011 “Costruzioni di profilati in acciaio formati a caldo. Istruzioni per l’impiego”; CNR – UNI 10022 “Costruzioni di profilati in acciaio formati a freddo. Istruzioni per l’impiego”; EUROCODES1/2/3.

Figures 12 Horizontal load tests have been carried on the prototype by applying hydraulic jacks to the main frames and to the secondary structure.

2. . Temporary Pub “Pian Cafè”

Figure 13 “Pian Cafè” has been quickly constructed in an exhisting square in Piancamuno – Italy.

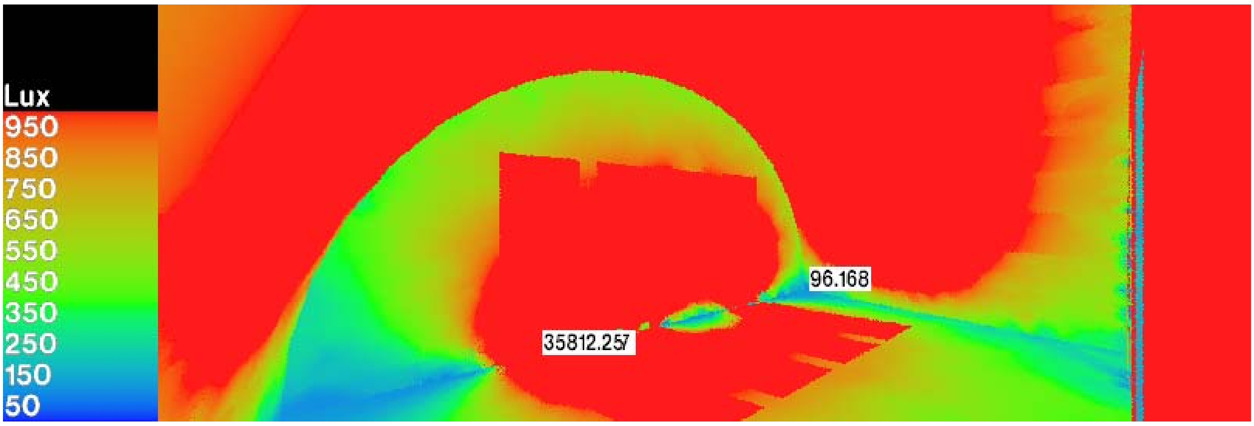
“Pian Cafè” is the direct application of “L’Armadillo” for a different purpose of temporary and dismountable unit. It has been conceived to be a Pub in a small town in northern Italy (Piancamuno) where Atelier 2 (Gallotti and Imperadori – Milano) also designed a new contemporary square for the town’s open air market.

Figure14,15 Construction assembly of external sandwich façade and internal gypsum board walls

A Pub with public toilets (also for disabled people) was then needed and the low budget of the community led to the application of a “Shell-House” concept. A corten steel skin applied with rivets on the Elycop panels was added to L’Armadillo. This was for an aesthetic reason (all the square walls has corten steel as a final layer) but also because it creates a ventilation layer between it and the corrugated Elycop panel. Façades have been conceived to be protected from summer sun by 2 huge exhisting trees and to be able to save energy in winter .

Figure16 South Façade and corten steel high durability outer shell

Foundations are on concrete plattform to resist winds prevailing in the Valley where it is placed. In winter the building profits of passive sun energy, through south façade, and also from all internal thermal loads (coffee machine, fridge, washing maschine) therefore doesn't use any extra heating source during the cold season.



Figures 17,18,19 Daylight factors and sun gain studies for the South façade.

3. Conclusions

Figure 20 Politecnico di Milano students visiting the prototype "L'Armadillo". A real vertical load test which shows the huge space of the single unit.

This building system shell-shaped, is a house composed by exhisting industrial products, the result of a commitment to specialization, research and product innovation between the company policy and a pool of designer and consultants always led by Atelier 2 (Gallotti and Imperadori, Milano).

The Shell House realized are modular units designed and built with quality products, present on the market and often used for non-residential purposes. "L'Armadillo" is designed to be shipped in a container, erected and dismantled, if necessary, through simple, quick procedures. It's streamlined conformation optimises the heat loss and win ratios between the internal volume and the outer surfaces. Application of solar and photovoltaic panels can transform the unit and make it independent from other energy sources in case of need.

This extremely durable living unit was even designed to be used in areas where seismic activity and high winds are actiing, according to Italian regulations, and therefore can be used in areas with extreme climate conditions. The use in other specific areas will request to verify the specific wind loads in order to verify the bearing and bracing structure (which is the shell itself) for the area selected to the application, as well as the dimension of foundations or concrete platform.

Figures 21,22 The modular nature of L'Armadillo allows a wide range of project solutions. Basic unit can be enhanced with a vast selection of complements and accessories, that make various applications possible in relation to the different needs and conditions.

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Thermal Comfort Tools for Emergency Shelter in Major Disasters

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Abstract

Many basic yet effective building environment tools are not used and moreover not included in courses on design and construction. This is evident in the gaps in the literature and more importantly by their non use in the field [12] [13]. Basic tools such as bio-climatic charts, the Griggs Putnam Defomity index for wind, house spacing to ensure natural ventilation and simple techniques for solar shading together with data and research applicable to emergency shelter are not accessed. Nonetheless, the need for such tools is recognised by the United Nations Inter Agency Standing Committee (IASC) Working Group whose "Report of Emergency Shelter Cluster November 2005" sought to improve the overall effective response of humanitarian assistance by the: "*… develop (and building on existing) guidelines and tools for rapid participatory shelter assessments and interventions in different climatic and geographical conditions and different contexts, including ways of supporting communities for clearing and restoration of damaged shelter immediately after the crisis*".

This paper gathers those existing thermal comfort tools presently available to site planners/civil engineers for the design of emergency shelter as a first step to filling the above gap.

Keywords: Thermal comfort, emergency shelter, tools, guidelines, climatic design, education

1. Background

Emergency shelter in a major disaster can be sought in various ways that includes one or more of the following:

- Shelter inside the damaged house.
- Shelter along side or as close as practicable to their damaged house in tents or temporary constructions.
- Shelter with relatives or friends that are nearby.
- Shelter with relatives or friends that are distant.
- Shelter inside requisitioned buildings (formal situation).

- Shelter inside vacant or public buildings (informal situation).
- Shelter in emergency centres provide by outside national or international agencies
- Shelter in emergency camp sites that are located in the area or region
- Shelter in emergency camp sites that are located outside the area or region (evacuation).

A major disaster (man made or natural) is defined by Lambert and Davis as being one where the death rate is greater than 1 per 10,000 people affected/day and 2 per 10,000/day is a major disaster out of control [12]. And such high death tolls are usually associated with developing nations. The approach in this paper is that emergency shelter, regardless of its geographical location and which of these shelter options above is selected will largely be tents in such a disaster with the basic objective of modifying the outside climate to achieve thermal comfort.

2. Climate Data

Climate data is the starting point for the tools and approaches listed below. Documents such as the "Climates of the World" published by the Dept of Commerce USA give minimum and maximum temperatures for many cities through the world. It can be down loaded from www.ncdc.noaa.gov/climate/climatedata.html#clim . This site also has the facility to format and down load recent monthly averaged climate data for 1,600 stations outside of the USA. This is a good starting point. Such data is usually not available for the precise site and when data is available from a nearby weather station (such as an airport or city) it usually requires mathematical modified for differences in terrain and topology. The required modification factors can be readily obtained from any structural loading code. Where the topology blocks the climate (rather than modifying it) such an approach of mathematical modified is not appropriate and other methods are required.

Once on the ground data can also be sought from both the Public Works Departments and Government Meteorological offices. And failing that, data can be measured on site and also inferred from prevailing topographical conditions. Simple recording devices such as the digital temperature and humidity measuring device as shown in figure 1 below can be used. These give immediate readings and "validates" in an informal sense data collected earlier. Temperature data are the easiest to obtain and can be extrapolate from "broad brush" temperature maps to obtain usable data. However, wind speeds (and particular wind direction data) remain problematic.

One approach is to estimate the extreme wind speeds in the area by count the stones holding down roofs. This load of stones can be taken as equivalent to the wind loading generated by a 5 year return period gust and by using standard wind coefficients design wind speeds (with a return period of 100 years) can be quickly derived. In addition, natural ventilation studies by Aynsley et al [1] have shown that such extreme wind speeds are 1.5 to 2 standard deviations above the average wind speeds (useful for natural ventilation analysis) and that such an analysis based on standard deviation data for the wider area provides useful results.

Figure 1: Simple Temperature and Humidity Measuring Device.

One approach is to estimate the extreme wind speeds in the area by count the stones holding down roofs. This load of stones can be taken as equivalent to the wind loading generated by a 5 year return period gust and by using standard wind coefficients design wind speeds (with a return period of 100 years) can be quickly derived. In addition, natural ventilation studies by Aynsley et al [1] have shown that such extreme wind speeds are 1.5 to 2 standard deviations above the average wind speeds (useful for natural ventilation analysis) and that such an analysis based on standard deviation data for the wider area provides useful results.

Wind direction (always the difficult factor) can be inferred from both the local geography and from the local landscape [2]. For example, consider the camp site in the bottom of the valley in figure 1 below. Provided,

$h_1 > L/5$

h_1 = the heights of the lower hills above the respective shelter site and
L= distance between the hill tops forming the valley

the wind direction will be predominantly along the valley. Similarly, if the emergency shelter is located on the side of the hills h_2 below the top of the hill then provided that $h_2 > L/5$ still holds then the wind direction will again be predominantly along the valley. When h_1 or $h_2 < L/5$ other tools such as the Griggs Putnam Index of Deformity (refer to Appendix A) can be used. The index gives the average wind speed (and direction) for the area based on the relationship between the trunk and canopy of trees.

Another option is to observe the typical buildings used locally and by referencing bio-climatic charts get a sense of what type of local climate one is dealing with in terms of emergency shelter requirements. A typical chart is included in Appendix B.

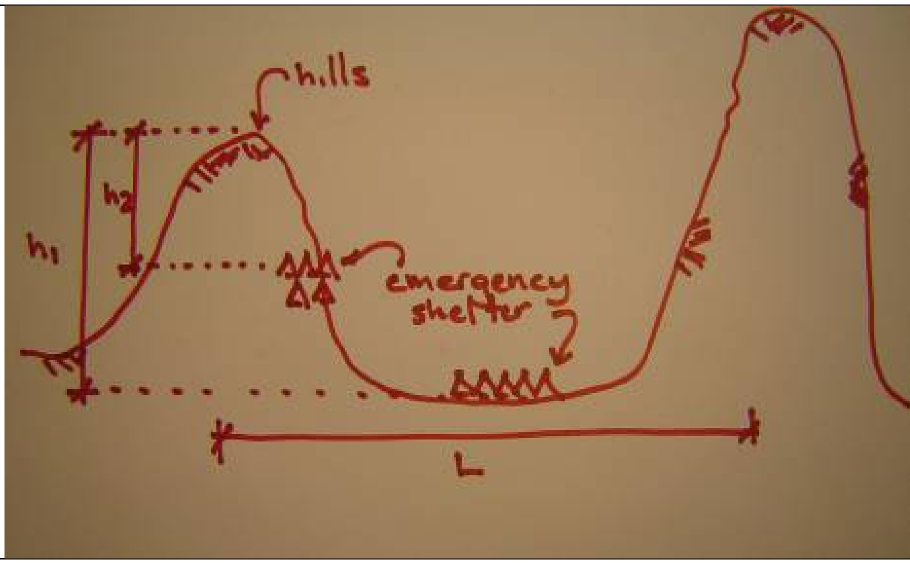

Figure 2: The Impact of Topology on Wind Climate.

And finally, local people can be surveyed as to what are the dominant climatic features for the area though usually as a check on earlier data collection. But by this point the site planner/engineer/ architect should have a good sense of the climate that they are dealing with and the driving requirements for the emergency shelter.

3. Geographical Areas and Building Typologies

Geographical areas (and there associated climatic zones) have been used to classify different building topologies and the example in Appendix C tabulates building topologies for different geographical zones that are characterised not only by their latitude/ longitude but also their vegetation and cultivation practices [3].

While interesting (and also stated in the IASC November 2005 report), such tables are not effective in the field. Differences within zones allowing several different climate typologies to exist concurrently makes there application problematic. Nonetheless, such tables can be useful for “checking and validating” other data and assumptions used to develop a workable emergency shelter strategy. Such checks are essential in an emergency situation where hard data is often lacking.

4. Thermal Comfort Models

Thermal comfort is a complex and contentious issue. The relationship between the objective measurement and the subjective response is not clear and remains at the centre of an ongoing thermal comfort debate. Field studies of free running or naturally ventilated buildings supported an “adaptive” rather than the “static” approach for essentially “sealed” buildings [4]. People were “adapting” to their environment and for example MacFarlane [5] had found as early as 1958 that Europeans in Singapore preferred temperatures that were some 2^{O}C warmer than those in Sydney.

This has led various researchers to develop algorithms for adaptive comfort models, the most recent by Brager and deDear [6] that appears to have brought some agreement on what algorithm should be used with their model which is as follows:

$$\text{Optimum Temperature} = 17.8 + 0.31\text{x } T_{a(out)}$$

Where $T_{a(out)}$ = the average temperature of the daily maximum and minimums for the previous month.

Such a thermal comfort model can be used in various applications. It can be used in either a warm/ humid climate or in cold climates. In cold climates it can be used to calculate the optimum temperature (and hence heating requirements) inside emergency shelter/tents. In warm/ humid climates it can be used in conjunction with other models to ensure that there is adequate natural ventilation potential in emergency camps and shelters. The importance of natural ventilation in achieving thermal comfort in such shelter is not readily documented nor understood in the field. Thus, thermal comfort modelling is central to providing not only durable solutions but also shelter with "dignity".

For warm/ humid climates, the MacFarlane [5] criteria can be incorporated into such thermal comfort models to adjust for the positive cooling effects of the wind and the detrimental impacts of higher humidity. MacFarlane's criteria are as follows:

- For each 10% increase in relative humidity above 60% the Optimum Temperature should be decreased by 0.8^{O}K.
- For each 0.15 m/s increase of air speed the Optimum Temperature should be increased by 0.55^{O}K for air temperatures up to 37^{O}C

Thermal comfort is then achieved for 80% of the population when the actual temperature is within $\pm 2.5^{O}$C of the Optimum Temperature modified as required by MacFarlane's criteria above.

5. The Cooling of Tents: Natural Ventilation

So how can the beneficial cooling effects of natural ventilation for emergency shelter be exploited in warm/ humid climates? Natural ventilation is caused by either wind induced pressures or by solar induced temperature differentials with wind usually being the dominant source. It is one of the few (and often only) options open to shelter occupants to achieve thermal comfort and hence the goal is to maximize the airflow through the tent or shelter. Consequently, the first requirement is to review the wind data gathered earlier. Tents should be within $\pm 60^{O}$ (and preferably $\pm 45^{O}$) of the dominant wind direction. Tents are typical placed "along" the dominant wind direction to achieve maximum airflow (and consequently the best thermal comfort conditions for shelter occupants). Screens and fences should be away from tents by at least 5 x the height of the screen or fence to ensure that wind flows initially disturbed by the screen "re-attaches" to the ground thus re-establishing their cooling potential. Where this is not spatially feasible wind catchers such as shades can be used to collect and channel wind down into the tent or shelter. And when the tent can not be placed along the wind small end walls can again be used to channel wind through the tent.

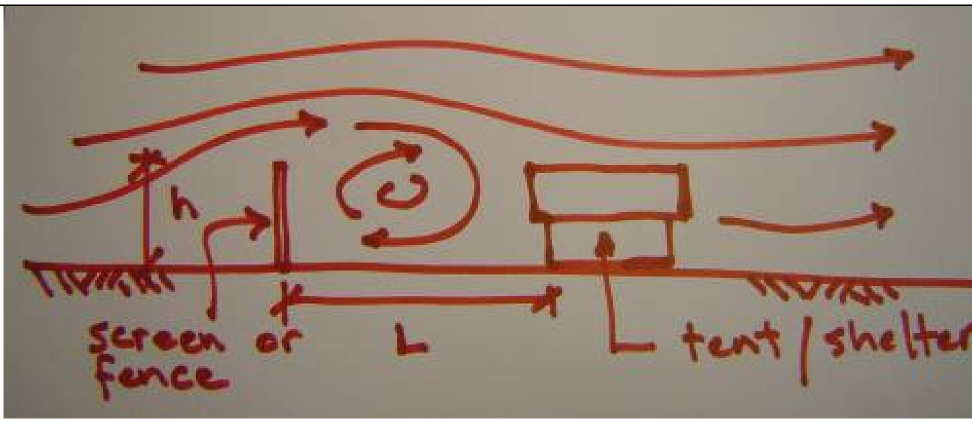

Figure 3: The Impact of Fences and Screens on natural Ventilation of Shelters.

The airflow around dispersed tents or buildings is quite different to the "infinite" or "semi-infinite" (in terms of their length to height ratio) screens or walls. Research by Lee and Soliman [7] has shown that there are three flow patterns for separation gap between adjacent buildings. These are as follows:

- Isolated roughness: The two buildings are sufficiently far apart that the air flow reattaches to the ground between the two buildings.
- Wake Interference: As the separation between the buildings is reduced a "horse shoe vortex forms. The air flow pattern is maintains circulation in the building separation.
- Skimming mode: Finally the separation distance is sufficiently reduced that the air flow "skims" over the separation between the two buildings.

A sketch of the first and last flow patterns are shown in figure 4 below.

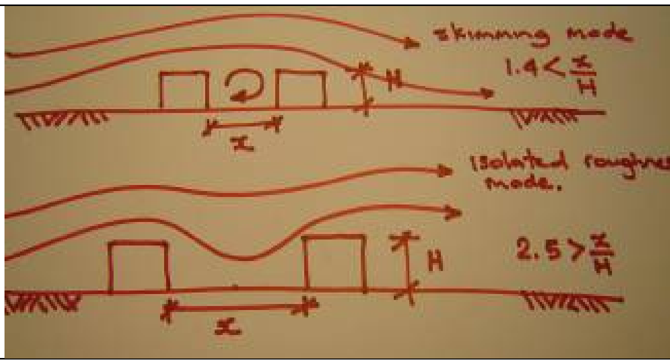

Figure 4: Airflow Patterns Around Numerous Equally Spaced Shelters.

Their research showed that this skimming pattern occurs when the ratio of the building separation distance "x", and the building height "H" is less than or equal to 1.4. In this instance the wind flow simply went over the top of the shelters and did not touch the ground in between. Between 1.4 and 2.5 they found a wake interference flow pattern and here the wind flow increasingly started to reach down into the gap between the shelters. At 2.5 an isolated roughness flow pattern developed and the wind flow finally re-attached to the ground between shelters producing similar wind conditions as up stream of the shelters. Mathematically this is represented below as:

$$1.4 < x/H < 2.5$$

x = the building separation distance
H = the building height

Consequently, the separation distance between tents or shelter should be at least 2.5x tent height or around 5 metres. Thus, for a 1 metre high fence there is not difference in the suggested separation distance. However, this difference between fences and discrete structures becomes important where each individual plot could be fenced or where large groups or families are assign blocks and the block is fenced instead. These two options are commonly used in emergency shelter situations.

Having achieved the best wind flow characteristics how is this realised at the tent? As mentioned earlier, the tent orientation is critical but within a wide angular range to the prevailing wind direction. Having achieved that orientation the need is to ensure a "cross ventilation mechanism" with openings on the windward and leeward ends of the tent or shelter. The leeward opening is often forgotten. The flow rate can be then calculated based on the British Standard for Natural Ventilation [8]:

$$q = C_D \times A_W \times U_r \times \sqrt{(\Delta C_P)}$$

q = flow rate
C_D = discharge coefficient usually taken as 0.61
A_W = ratio of area of inlet to outlet openings
U_r = reference velocity usually to the top or eaves of the building.
ΔC_P = pressure differential.

It should be noted that large increases in ΔC_P values (which are generated by the prevailing wind direction and the shape of the tent) produce relatively small increases in flow rate. For example, an increase in ΔC_P from 0.1 to 1.0 results in only 3 times more wind through the tent. However, it is more important to keep wind ward and leeward openings of similar area.

Natural ventilation is the only cooling strategy employed in emergency shelter programs. Yet it remains essentially unknown. More research is required to develop specific design guidelines for commonly used planning typologies such as the ("U" shaped layout advocated by UNHCR) and to develop guidelines as emergency shelter moves away from sole tent structures into more "permanent" materials.

6. The Heating of Tents

Recent aid following the earthquake in Pakistan have also highlighted that there are issues on the heating side for tents as well as the more usual cooling requirements discussed above. In Pakistan, aid agencies (initially) issued non winterised tents and there were significant issues in the field to resolve this problem before the onset of winter. This came to be known and publicised in the media as “the winter race”[9] and required a significant effort from the technical support teams in devising practical upgrade options. This section draws on the technical lessons learnt from that experience.

The heating requirements for tents are based around the Heat Loss Equation which is as follows:

$$Q = UA(T_{in}-T_{out}),$$

Q= rate of heat loss
U= “U value” or thermal transmittance or the inverse of the thermal resistance
A= surface area of tent
T_{in}= Temperature inside the tent
T_{out}= temperature outside the tent.

Thus to reduce heat loss requires one or more of the following:

- Lowering of the U value (or conversely increasing the thermal resistance of the sides, roof and ends of the tent). This is achieved by better insulation.
- Minimizing the surface area of the tent. This not a real option given the practical constraints on tent dimensions other than digging down into the ground.
- Rationalizing (and hence increasing) the outside design temperature T_{out}. If tents are in frost areas then an outside temperature of -2^{O}C would be appropriate. Moreover, if the presence of a nearby river means that temperatures would only reach say 0^{O}C and this is used instead than a lower heating loss would be achieved.
- Lowering the inside temperature T_{in}. This should be set by the thermal comfort model discussed earlier.

(It should be noted that there are many “home truths” about how people survive cold that should be analysed careful against the framework as outlined above).

These strategies above are now discussed in more detail.

6.1 Infiltration Losses from Tents

The heat loss equation above assumes that the tent is air tight. This is not the case and the canvas material used for many tents is “porous” allowing hot air to leak out. This process is referred to as infiltration.

This loss increases when there is wind on the tent which creates areas of “suction” on the leeward side of the tent and positive inward pressures on the wind ward side. This results in air inside the tent being “sucked” out by these pressures in addition to the natural movement of hot air upwards (and outwards) from inside the tent. The actual extent of this increase depends on the orientation of the tent and the spacing between tents (the opposite to what was suggested for natural ventilation). The fly only marginally mitigates this loss and in many cases increases it by creating higher negative suction pressures between the fly and the inner tent. Plastic is significantly less permeable and the installation of “plastic sheeting” over the inner tent (as opposed to the fly) significantly reduces loss by infiltration.

In the field it is common for the fly to be covered with plastic sheeting firstly because it is easier to install but primarily because it is also perceived as reducing dampness inside the tent. However, covering the fly only increases the wind pressure differential between the plastic and the tent with the fly caught flapping between the two. Consequently, any rain that makes it way into this gap between the plastic and the tent will quickly migrate inside the tent because of this increased flapping and contact between the plastic, the fly and the tent [10]. And hence any plastic cover sheets must be placed under the fly to be effective. From an operational perspective, this installation will not require tent occupants to move out nor require any access (and hence disruption) inside the tent.

Typical figures for infiltration (using a pressurized approach intended to simulate wind effects) are shown in table 1 below and are taken from a study by Spence et al [11]. Their liner was apparently on the inside of the tent and not on the outside as suggested in this paper. This difference should not be significant but could result in condensation if the thermal gradient through the tent is not adequately controlled. Nonetheless, table 1 below shows that the inclusion of the plastic sheet potentially reduces permeability by 50% in still conditions and by 25% in windy conditions. Looked at another way the figures also show that in still conditions most if not all the heated air in a typical tent will have dissipated within 30 minutes in still conditions and 10 minutes when there is a breeze. After that (short) time period, the temperature inside the tent would then be the same as the ambient (outside) temperature. In addition, if someone opens the flap of the tent to enter than these times will be shorter. These leakage times underline the permeability of canvas and the cooling speed of a tent. Later tent designs are minimizing infiltration losses by adopting impermeable and water proof polyester fabrics.

Table 1: Comparative Infiltration Rates.

	Air permeability at 50Pa ($m^3/hr/m^2$)	Air permeability at 5Pa ($m^3/hr/m^2$)
Damp canvas	45.6	9.56
Dry canvas	41.4	13.4
Liner, dry canvas	32.6	7.01

6.2 Insulation of Tents

Canvass, as well as being permeable, is also not a good insulating material. This means that heat inside the tent is quickly dissipated by conduction through the fabric to the outside. And its thermal conductivity is so high (or conversely its insulation resistance value (R) is so low) that heat inside the tent is quickly dissipated to the outside colder temperatures. Table 2 below gives typical thermal conductivity values for different materials. A higher value indicates that the material conducts heat away faster and hence canvas at 27 is only half that of steel at 50 and thus is conductive. On the other hand plastic with a value of 0.04 to 0.05 is more than 50 times less conductive than canvas. However, canvas is typically thicker than plastic sheeting but a 250 thick micron plastic (which is thin) would be equivalent to12 mm thick canvas. Interestingly, diamonds are one of the most conductive materials available.

But perhaps the most significant value from table 2 is that for air which (in the form of an air gap) has one of the lowest thermal conductivity values. And when combined with plastic sheeting provides a cost effective, logistically light solution to tent insulation.

Table 2: Conductance Values for the Tent Roof in w/m^{O}C

Diamonds	1,000-2,600	**Plastic sheeting**	0.04-0.05
Steel	50	**Fibre glass insulation**	0.04
Canvas	27	**Polystyrene**	0.03
Ice	1.6	**Air**	0.026
Wood	0.4-1.2	**Styrofoam**	0.01

6.3 Heating

Using the above "U" values in combination for the complete system (rather than just one material) then allows the calculation of the heating requirements for the tent. Upgrading options considered for the winterisation of the tents provided in Pakistan included the following:

- The addition of a plastic outside fly sheet and inner lining
- The addition of a plastic outside fly sheet and sewing the roof edge of the tent
- The addition of a plastic outside sheet over all the tent

and are tabulated in table 3 below. What was interesting was how close the in field solution came to the usual winterised tent version suggesting perhaps that instead of a winterised and non winterised version that there should be a non winterised version with a winterising kit supplied where required.

Table 3: Heating Requirements Inside the Different "Tent" Options.

Material	Calculated Heating(watts)	Heating Provided by People(watts)	Required Supplementary Heating.(watts)
Standard non winterized UNHCR tent (consisting of a canvas fly and inner tent)	4,178	500	3,678
Canvas fly and inner tent + plastic sheet + inner cloth type liner.	2,826	500	2,326
Canvas fly and inner tent + plastic sheet + sewing edge for air gap.	2,430	500	1,930
"Tent within a tent" approach	1,724	500	1,224
UNHCR Winterised tent	1,581	500	1,081

7. Solar Models

Much has been written about the importance of building orientation and controlled solar access. And when solving problems of orientation, sun control and predicting sun penetration and shading of buildings the use of models have proved extremely useful. Such models include:

Sun path Diagrams
Computer models and software packages
Refer Olgyay: 1992 for a full list of Solar Models.[14]

The most appropriate "in the field models" would be Sun-Path Diagrams and Computer software packages.

7.1 Sun Path Diagrams

The utilization of sun path diagrams aids the development of healthy living spaces by taking into account the hourly, monthly and seasonal changes in solar access to buildings. They also allow the designer to allow for shadowing from adjacent buildings or obstructions. Sun path Diagrams for locations around the world are available from local government publications, Texts dealing with solar control, international Web sites, and computer draughting software packages. An example is the University of Oregon Solar Radiation monitoring Laboratory Web site http:// solardat.uoregon.edu/SunChartProgram.html [15] Charts are available as Polar and Cartesian, selection of chart type is commonly a personal preference choice.

Issues of local clock time and solar time may need to be addressed, where solar noon does not match noon clock time due to local time variances eg. daylight saving time. Note: Sun path diagrams show Solar or true north, allowances must be made for magnetic north variances at specific locations where north is derived from a compass. Magnetic declination for world locations can be obtained via the World Magnetic Model: WMM-2005 Main Field Declination, from the National Geophysical Data Centre (NGDC) USA Web site http:// www.ngdc.noaa.govt/seg/wmm/data/wmm-D05.pdf

The essential concept is to take advantage of solar radiation through control. Control of the radiation transmitted into the spaces interior, and control of the interior space through ventilation. The important considerations are therefore, climatic zone, latitude, time zone, building orientation, solar access, shading, window or fenestration sizes, projections, solar obstructions, strategies for the effective control of ventilation of spaces. The optimal word here is **control,** control of solar access, control of radiation and the control of ventilation.

8. Conclusion

Much of what has been presented in this paper will seem straightforward and certainly has been known for some time (as can be seen from the reference list below). But it is not used in the field nor is it readily known operationally. And this is because the “Tools of Trade” have never been collected in one place and hence this paper. But the reason for such tools not previous being gathered together is because of the wide range of disciplines involved. Therefore, any training needs to reflect this wide ranging cross discipline approach required to adequately prepare site planners/ engineers and architects involved in emergency shelter.

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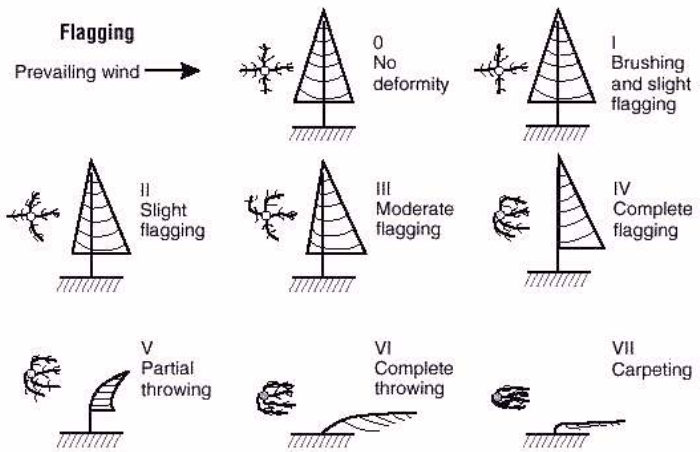
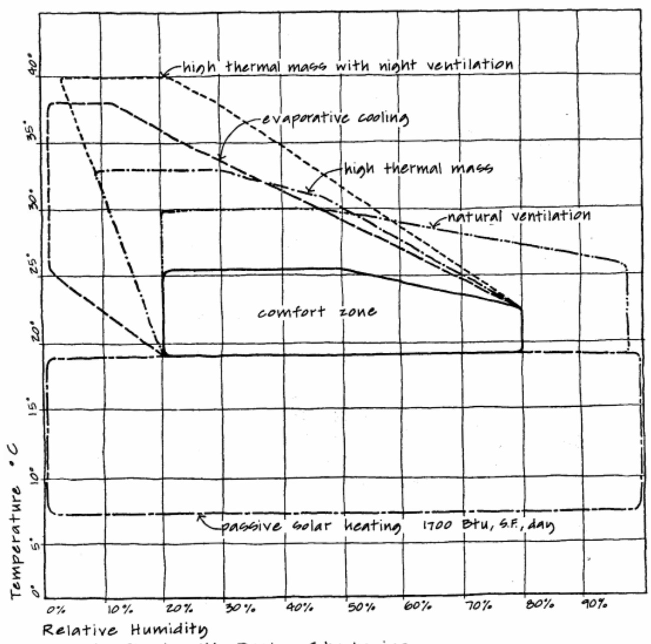
Appendix A: Griggs Putnam Estimate for Wind Speed and Direction.



Griggs-Putnam Index of Deformity

Index	I	II	III	IV	V	VI	VII
Wind, mph	7-9	9-11	11-13	13-16	15-18	16-21	22+
Speed, m/s	3-4	4-5	5-6	6-7	7-8	8-9	10

Appendix B: Bio Climatic Chart



Bioclimatic Chart with Design Strategies

Appendix 3: Occurrence and Characteristics of Main Climatic Zones in the Tropics.

Zone	Approx. Lat. Range	Natural Vegetation	Typical Cultivation	Climate	Problems	Requirements
Warm Humid Equatorial	7.5^{O}N-7.5^{O}S	Tropical Rain Forest	Banana, Palm Oil	Warm with high humidity and rainfall	Humidity prevents sweat evaporation, hot nights makes sleep difficult, high rainfall and glare from other cast sky, sun on east and west facades	Air movement from the fans or cross ventilation, low thermal capacity construction, sloping roofs and large overhangs, windows facing north and south.
Tropical Island	5-30^{O}N 5-30^{O}S	Rain Forest	Sugar Cane	Warm, humid but less cloud than warm humid zone	Similar to warm humid equatorial, but clear skies and bright sun more frequently	Similar to warm humid but with additional care in the design of shading the south facing windows (vice versa in the southern)
Hot dry Tropical	15-32^{O}N 15-32^{O}S	Desert, Steppe	Palms, Grazing (nomadic)	Hot and dry with high annual and daily variation of temperature	High diurnal range, very hot days in summer, cool winter days, low rainfall, very strong solar radiation and ground glare, sandy and dusty environment	High heat capacity construction, shading devices which allow solar heating in winter, small windows, flat roofs (often used for sleeping), small courtyards to give shade and protection.
Maritime Desert	15-30^{O}N 15-30^{O}S	Desert	Palms, Grazing	Hot, humid with low rainfall	Similar to hot dry climates but with higher humidity causing discomfort by preventing sweat evaporation	Similar to hot dry but air movement is desirable at times.
Intermediate composite or Monsoon	5-20^{O}N 5-20^{O}S	Monsoon Forest, Dry Tropical Forest	Paddy Rice, cane, Millet	Warm humid and hot dry seasons	Combines the problems of warm humid and hot dry climates	Compromise between the requirements of warm humid and hot dry climates or ideally (but more expensively) two buildings or parts of buildings for use at different times of the year
Equatorial	10^{O}N-	Broadleaf	Millet	Temperate to	Combines the problems of the warm	Designed to take advantage of solar

Upland	10^{O}S	Forest, Mountain Vegetation		cool depending on the altitude	humid and hot dry climates with those of a temperate or cold climate for all or part of the year	radiation when cool or cold. Heating and additional installation maybe required
Tropical Upland	10-30^{O}N 10-30^{O}S	Steppe, Cedars	Wheat	Hot summers, cold winters	As above	As above
Mediterranean	32-45^{O}N 5^{O}S	Mediterran ean Scrub	Vines, Olives, Citrus Fruits	Hot dry summers, cool wet winters.	Summers have some of the problems of a hot dry climate while winters are cold and humid with moderate rainfall.	Design with high thermal capacity, medium to small openings, and courtyards to give shade and protection.

Identifying Value Adding in Humanitarian Programs

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Abstract

Earlier work by Kestle had established a management model for design management in remote areas [1]. That model was subsequently tested in the humanitarian aid context of West Darfur in June 2004 and found to be very effective in modeling and understanding the issues related to the provision of humanitarian aid in remote locations [4]. And in this paper, the authors extend the application of that model into identifying where value was added (both perceived and actual) by the Jesuit Refugee Services (JRS), as part of it's Tsunami Relief Program in Aceh, Indonesia. It then suggests ways that this value could be enhanced. This need came about as part of an end of program evaluation of the TRP.

The mission statement of JRS is to "accompany, serve and defend" and it was interesting to see how this worked out in the field. Many/most of the JRS field team felt that their added value was linked to it's flat organisational structure and it's bottom up management structure that meant that JRS could respond rapidly to changing circumstances and beneficiary requests. The Kestle Model provided a framework to compare what was seen in the field against what was planned by management. And from that comparison and analysis demonstrate where value was being added.

Keywords: Added value, humanitarian, aid, management, framework

1. Background

How do different humanitarian aid organisations add value?

As part of an evaluation of their 2 year tsunami program in Aceh, it became clear that JRS believed that they did have their own particular way of doing things and moreover this was identified by those in the field as being the main way that JRS added value [7]. What was interesting for the evaluation team was that none of this "JRS way" was actually written down and this also appeared to be at difference to the organisation's mission statement. The mission statement of JRS is to "accompany, serve and defend" and it had been doing that in Aceh since July 2001 with a focus on relief, emergency support and accompaniment for refugees (those returning from countries outside

Indonesia) and internally displaced persons IDPs (those returning from other parts of Indonesia) to Aceh in North Sumatra [6].

The imposition of Martial Law in Aceh in 2003 severely restricted the work of all humanitarian agencies and in particular the work of JRS. By 2004, JRS's role in Aceh was to strengthen traditional coping mechanisms as a response to the impact of conflict and peace building. The earlier monitoring of human right abuses was still needed, and advocacy remained an important aspect with local authorities [2].

There was no change in the situation in Aceh when Martial Law ended in May 2004 and was replaced by a Civil Emergency period. And it was only the Indian Ocean Tsunami on December 26th, 2004 with it's massive death toll and extent of destruction that the Government of Indonesia (GoI) re-opened the area for humanitarian aid. JRS returned to Aceh just days after the tsunami and rapidly set up their Tsunami Response Program (TRP) [3].

The assessment (that formed the basis of the TRP) determined specific areas of assistance that included the following:

- The replacement of boats and the construction of new houses for the Pulo Aceh people that lived on an island just out from Banda Aceh, the provincial capital of Aceh.
- In Banda Aceh, JRS set up a medical program for the IDP's in various camps throughout the city, built permanent shelters and educational hostels.
- In Krueng Raya (a fishing port near to Banda Aceh) JRS set up a livelihoods program replacing lost fishing boats.
- In Lamno (usually an hours drive south along the West coast of Aceh) JRS supported logistics, education, livelihoods and health care.
- And in Meulaboh (the most southern city on the West Coast of Aceh affected by the tsunami) JRS built homes gave books and various basic needs for IDP children.

These programs were up and running well before those of the major International NGOs and UN Agencies. And it is the resulting program from this that is studied in this paper.

2. Methodology

The study used a conceptual design management model developed by Kestle [1][4][5]. The model was originally developed in terms of "reviewing and synthesizing theoretical published 'production principles' and 'sociological factors' associated with design management, and lean design management." And has it's theoretical basis in Just in Time (JIT), Total Quality Management (TQM) and Lean Production theories.

The model uncovers value generation within the design management process and the four areas of the model reflect the many stake holders participating in this value adding process. For example, developing a shared understanding of what is valued on the project and identifying, and then agreeing the objectives for a project with the stakeholders. How this was achieved was critical to the original evaluation but was particular interesting in terms of the usefulness of the model. Much of the lean thinking research falls into the tactical category rather than strategic and theoretical, that is, until the work of researchers Koskela and then Seymour [8][9]. Seymour suggested a proposal for implementing lean construction at an organisational rather than just at the operational level. This work was then followed up two years later by Seymour and Rooke using an ethnomethodological approach in terms of setting up an organisational culture that established how people may perform their site work activities in a visibly orderly manner, by changing their mindset, for instance. Similar findings were published by Howell and Ballard stating that changes of the mental model needed to be made [both are reported in 5]. They further suggested that lean thinking (applied at the beginning, or alternatively applied midway on well run projects) revealed the weaknesses of the current systems by mapping the project value stream. The lean design principle of 'flow' is relevant from a sociological and environmental viewpoint, as it tends to be focussed on a more holistic approach for theoretical and project development work. The thinking and principles associated with lean design management, made a significant contribution in terms of informing the development of the Process Integration factor for the conceptual design management model (for remote sites) [5]. The key factors of design management for remote sites were therefore established as being - 'value generation', 'knowledge integration', 'process integration' and 'timely decision making'. These are discussed in more detail below.

2.1 Value Generation

Value generation - refers to the value that the client and stakeholders place on the project and will vary according to the differing clients' and stakeholders' expectations of the projects. And for example in the West Darfur Humanitarian Aid Project in Sudan, value was concerned with making a difference to the lives of the aid beneficiaries through the provision of basic shelter and the necessaries of life [4]. The impression gained from the field as part of the evaluation was that flexibility and speed of response to beneficiaries needs was the main value added service that JRS provided and it was this view that needed to be reviewed as part of the evaluation. JRS's organisational structure consisted of only 3 levels from their National office in Yogjakarta to the field staff. And consequently there was some basis for what field staff were working to.

2.2 Knowledge Integration

Knowledge integration – is a complex process concerned with endeavouring to capture, and then integrate, the specialist knowledge of all those personnel involved on a particular project, prior to and during the project phases. To be successful, this requires that key personnel be involved with the pre-design briefing, pre-planning, and in the regular monitoring and review of the design and construction processes, as the project progresses. Specialist knowledge is required to ensure the best design solutions and end results despite frequently working with non-negotiable timelines.

The sense from the field was that this was not happening.

2.3 Process Integration

Process integration – involves the timely and cost-effective co-ordination and planning of a range of processes across the total project, such as construction planning methodology, logistics, information management, and design/ production interface management. In certain instances this may require alternative procurement strategies. Logistical planning and implementation is complex, as well as critical, for remote sites. The timing, costs and restrictions associated with shipping, or air freighting building components, add to the complexities of the logistical aspects of a design management model for these remote sites.

2.4 Timely Decision Making

Timely decision making - refers in the main to financial and design decisions, which are critical to the successful management of the design and construction of remote site projects. These decisions are made within the context of frequently non-negotiable windows of buildability, fixed budgetary constraints, and the need for "durable solutions" [10].

3. Interviews

Structured interviews were held with the 7 members of the management team and their responses for each of the 4 areas of the Kestle model summarised and then tabulated into a contextual spreadsheet. Such a spreadsheet (despite being a summary of the full interview) made comparisons and patterns more evident by being able to look across all the interviews at once and is included in Appendix A below.

4. Results

What did the spreadsheet show and how did that compare to what was happening in the field?

Value Generation for JRS was directed linked to outcomes for beneficiaries but these appeared to vary and fell into three areas namely:

- Direction and alignment (this appears to be intuitive and non personal)
- Team welfare (personal and intuitive)
- Reports (non personal and un-intuitive)

All managers were concerned about money flows, corruption and the accountability for both in their respective programs. Nonetheless, feedback from the beneficiaries through the management levels appeared to be driving programs. However, that feed back was not critically analysed and appeared to be accepted at face value. So that if beneficiaries requested boats they were supplied with boats if they were able to show they had a boat pre-tsunami. The pre-tsunami situation was not analysed as to whether the aid provided could not simply replace what was lost but better the village or community overall.

The team relied heavily on the reporting of transactional narratives with beneficiaries for it's knowledge integration. Again, this was not analysed as part of the various meetings in the field, at the Aceh sub office and at the National office in Yogjakarta. All managers saw the need for a better system but also admitted that it would be difficult to implement such changes. And finally managers conceded that there were issues in attracting staff let alone specialist staff on to their programs. This reliance on almost "word of mouth" may have come from the sensitivity of the work that JRS is usually involved with, often in conflict situations [1][2]. It was clear from the interviews and the evaluation that there was a significant amount of trust between managers (mostly Jesuit priests) and that work orders and programme changes were often based on an email. Emails were heavily relied on for knowledge integration.

Process Integration appeared to be "rule based" with a strong "go and see" approach. Improvement of the system centred on staff capacity building with the main responsibility of HR being solely to provide staff. And not the training or capacity building of staff.

Timely decision- making was centralised and depended on the "distance" from the field. Those based in the National office felt that the process was decentralised while those in the field felt it was centralised. Staffing and financial were centralised in the National office with other decisions made at sub office and field level. Both staffing and financial were strictly controlled by process and rule.

5. Conclusion

So where was the value that JRS added? And to what extent was the sense (as mentioned earlier in this paper) that flexibility and speed of response to beneficiaries needs was the main value added service that JRS provided, was this confirmed by the model?

The TRP had a strong and singular beneficiary focus. That clearly came through in the Value Generation and Knowledge Integration factors. But the flexibility and speed of response were not recognised as value adding. While it could be that both were treated as "givens" being evident in the reliance on feed back, field reports and the informal nature of the knowledge integration identified better value would have been realised by promoting flexibility and response in any future programs.

It is also evident from this analysis that there is the potential for further value adding to beneficiaries by the following:

- Value Generation- More emphasis on flexibility, response and the development of a stronger community of practice (COP) approach.
- Knowledge Integration- Analysis of the responses of beneficiaries
- Process Integration- Development of COP approaches.
- Timely Decision Making- Further decentralisation

This aside, the interesting (and surprising outcome) was the usefulness of the Kestle's framework in analyzing such a situation suggesting that the model was more robust and portable than perhaps originally thought?

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Appendix A: Contextual Spreadsheet Summarising Management Responses for the Four Key Factors of the Kestle Model.

QUESTION	Person 1	Person 2	Person 3	Person 4	Person 5	Person 6	Person 7
VALUE GENERATION:							
How do you know or measure the effectiveness of your role as it relates to Aceh?	Direction, alignment with JRS Regional and beyond. Staff resources	Direction and clarity	Difficult to get outputs without assessments	On time and finance report checked	Administration only	Difficult, probably how well the team is working esp. With staff changes	Based on reports and feed back from team.
Are there any rules of thumb that you intuitively apply?	Yes	Watch out for unbalanced verbal reports	Follow ups	None, but system is self checking	Not sure	Go where the need is, ensure beneficiaries talk to us?	Community pride with JRS
What and how do you get feed back from "clients"?	Feedback from regional, national and field staff	Oral and notes and reports from national office	Little and relies on stories	Feed back from Field	Mostly email and reports	Meetings discussions and field visits.	Meetings with beneficiaries
In what ways do you feel that you are accountable?	Money, no corruption and cash flow for projects.	Progress and openness	Not accountable no decision making power.	Responsible for money tracking	For system set up	Use of money for beneficiaries and helping beneficiaries	For project related matters.
KNOWLEDGE INTEGRATION:							
How is what you have learnt on Aceh recorded and passed on to others?	Calling teams together for planning and future. Tacit knowledge.	Discussions informal, information transfer.	Narratives, write ups posted on web and international newsletters.	Not clear	Visits to field office	Difficult to ans. Emails and documents	Reports
How are you or would you like to improve your	Character and spirit of JRS. Small and non	Structured without being too formal.	Set up info reqd. and lists	Quality of reporting	Better management system and	Info officer and media	Capacity building of field staff.

situation?	bureaucratic.				policy		
And are such changes easy to implement?	Potentially difficult because they are obscure. Unique.	Hard to move towards written	Difficult to get outputs without assessments	Can be difficult	Not clear		Some are hard, no writing culture in Indonesia.
Are their gaps in the specialist knowledge that you are aware of?	Yes	Yes, staff good at transaction but not technical	Yes, knowledge on basic principles and rights	Accounting staff for rural area difficult	Difficult to compare JRS with other NGO's	Engineer early on	Shelter
PROCESS INTEGRATION:							
What methods or approaches do you employ to achieve your goals and fulfil your role?	Co-ordination, belonging, ownership of JRS. Share holder and family.	Structure and analysis,	Field visits and talking to staff.	Process set by rules	Through policy and system	In discussion with field, used a sweeper team	Personal approach, focus group discussions, being in the field, reporting chain
How have you tried to improve on this or the system?	Staffing, personnel policy mapping staff, identify their training needs	Evaluate and systemise work	Collaboration	Not much room for improvement	Setting up new system		Better info and report
What role does HR play or could play (for example in staff training, skills and experience)?	Yes	Yes, staff good at transaction but not technical	Yes, in terms of suitable people but advocacy is understood by all staff taken on.	Yes, suitable staff are hard to find.	Training	Selection of spirited people. HR could provide training.	Staff only
DECISION MAKING:							
How are your decisions made?	Decentralised	Assessments are decentralised	Co-ordinate as a team based on what is	Centralised	Centralised	Centralised	Decentralised staffing centralised

Is this decision making centralised or de-centralised?		but ultimately decision of resources and staffing made by Nat. office.	reported from the field. Not considered important.					
How are budgets maintained?	Level of trust but multiple signatories.	Monthly for each field officer.	No budget for advocacy in TRP	Through process and rules	Not clear	Rough drafts that are approved	Systems	
How significant are sustainability issues in your role?	Accompaniment is important for JRS and while understood in a conflict situation may not be in a natural disaster.	Yes, cultural sustainability structure without strictness.	Yes, suggestions thru to program. Peace being the ultimate sustainable	Not clear	Not clear of application	Not greatly involved but some	Not clear	

Flooding in New Orleans, USA and Hull City, UK: Comparing Disaster Management Strategies

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Abstract

During the summer of 2007 the United Kingdom experienced some of the worst flooding in its history, with the city of Hull amongst the worst affected. An examination of the government handling of mitigation measures and disaster response in this instance raises comparisons to the 2005 Hurricane Katrina related flooding in New Orleans, USA. These events are especially appropriate for comparison given the vulnerability of each city and general feeling of dissatisfaction among residents. This paper examines each event individually and presents a comparison of the actions and inactions of each government. The result is a call for stronger and more decisive measures to combat climate change and protect vulnerable populations more efficiently against natural disasters.

Keywords: Flooding, Hurricane Katrina, Disaster Management, Disaster Response, Mitigation, Climate Change

1. Background

1.1 Parallels of two cities

In these times of escalating concern over global warming and its effects on weather patterns, as well as the size and frequency of natural disasters, it seems fitting to analyse and discuss how effectively governments are planning for disasters and whether they are responding to them appropriately. This paper will compare two recent natural disasters; Hurricane Katrina which devastated the US Gulf Coast in 2005 and the major flooding which wreaked havoc in the UK during the summer of 2007.

Both events brought extensive damage and material loss, as well as human casualties. Although hardly comparable in scale with regards to death toll or economic loss, these events have raised many parallel issues in government mitigation and response protocol and initiative.

Firstly, each disaster will be examined individually as will the government's role in putting mitigation measures in place prior to the event and responding to the crisis once in motion. The facts and figures of each emergency will then be compared and discussed. This paper will focus on two cities with many similar issues and which were two of the worst affected; New Orleans and Hull City. Each is topographically vulnerable and guarded by a pump system unable to cope with the most severe floods. The residents of each city ultimately felt that they were neglected and let down by the government in terms of the provision of mitigation against flooding and the disaster response effort which took place.

The overall efforts made by the UK and US governments to plan for and respond to these events will be examined and discussed, as will the feelings of affected residents. General public feeling towards governments and agencies responsible for their protection and aid will then be gauged and analysed.

Following a discussion of all these factors, conclusions will be drawn as to the extent of protection afforded each country and in particular each of the cities under scrutiny in the face of these events and the level and efficiency of aid given to affected residents once each disaster was in motion, as well as the ability of the affected population to recover post-disaster in light of assistance received from the government.

2. Flood Events

2.1 Hurricane Katrina related flooding

On August 29th 2005, Hurricane Katrina made landfall on U.S soil with the eye of the storm hitting about 55 km east of New Orleans. The storm at the outset brought most damage as it swept along the Louisiana and Mississippi coast but when several levees protecting New Orleans failed a day later, about 80% of the city filled with water.

This natural disaster crippled a city, left lives in chaos and caused colossal economic loss in the region to the tune of an estimated $81 billion [1]. The vast impact on the Gulf Coast made Hurricane Katrina the largest natural disaster in U.S. history [2] while triggering a massive relief and evacuation effort.

In the two years since Katrina struck questions over the adequacy of disaster mitigation measures prior to the storm and the speed and efficiency of response efforts to the crisis have been widely criticised in the world's media. From an early stage, multidisciplinary experts have advised on appropriate measures to be taken to ensure long term recovery in the region [3]. Even now the rebuilding process seems laboured and funding continues to pose a problem. Considering the facts and figures on the table, it is little wonder that many residents of New Orleans and the US Gulf Coast harbour ill-feelings in Katrina's aftermath towards the government and agencies which they feel have failed them in their time of need.

A combined failure of federal, state and local government to put in place mitigation measures against a storm of Katrina's magnitude has clearly occurred. In 1965, the government took responsibility for the long-term safety of New Orleans by passing the Flood Control Act of 1965 in Congress [4]. This authorized a flood protection system to be built by the U.S. Army Corps of Engineers and was projected to be complete in 13 years. This system was supposed to mitigate against the strongest storms characteristic of the region.

When Katrina passed east of New Orleans, this system failed in over 50 places. Nearly every levee in the city breached and caused 80% of the city to flood, along with many areas of neighbouring parishes [5]. 40 years after the Flood Control Act was passed in Congress, the protection system was still only 60-90% intact with an estimated completion date of 2015 [4]. This constitutes an extreme failure by the parties responsible for protecting the historic city of New Orleans and its population.

Over 1.2 million residents in the Gulf Coast were covered under a voluntary or a mandatory evacuation order as Katrina approached [1]. Based on Louisiana's guidelines for state evacuations, residents in the forewarned areas were supposed to be moved out in phases commencing 2 days before landfall. Even in this respect, there was an element of bureaucratic bungling as FEMA claimed Louisiana governor Blanco did not request aid for coastal parishes and therefore they were omitted from President Bush's declaration of emergency for Louisiana [6]. By the time Katrina made landfall, around 80% of the residents of New Orleans had been evacuated, with those still in the city either refusing to leave or without the means to leave [7].

There has been a drive following Katrina to implement better practices in construction and stricter building codes in the region. The Louisiana State University Hurricane Centre study found that had state wide building codes been in place, it would have saved Louisiana $7.9 billion and Mississippi $3.1 billion in economic damage and spared a total of nearly 40,000 buildings from destruction during Katrina [8,9]. However, the devastation that occurred in New Orleans has more to do with why so many houses were built in such a vulnerable position than it does with design and code failures.

We can see that even now the government is encouraging and funding rebuilding efforts in the same areas and using the same construction methods as before. At the same time protection measures in the Louisiana basin are not complete and will not be able to cope with a direct hit until at least 2010 and even then $4 billion must be spent to achieve this [10]. Surely questions must be asked when rebuilding is allowed to commence at such a large scale where a pump system cannot cope with catastrophic flooding coupled with levee failure that may indeed reoccur before protective measures are complete.

Comparisons have been drawn to the comparative ease with which the US government and agencies prepared and responded to Hurricane Rita which occurred on September 24th 2005, in the wake of Katrina. Aid was stockpiled on the ground two days before Rita made landfall while 10,000 national guardsmen were called to Texas in order to make the emergency response immediate [6]. Four weeks earlier, only 5,000 were summoned to Louisiana in preparation for Katrina. After Katrina, some people in New Orleans were left without basic aid for days afterwards while poor communication and allocation of resources meant that at one stage 5 helicopters arrived to rescue the same individual [6].

Thousands of people were crammed into 'relief centres' such as the Louisiana Superdome for as long as 6 days, without adequate food, water and medical supplies while what they really needed was to escape New Orleans. Some of these people even died while waiting for help [11]. Meanwhile 200 school buses were left unused and underwater following Katrina because of bureaucratic red-tape. These buses could have evacuated around 13,000 people [6]. The immediate federal response for relief was so incredibly inept it left many to wonder if the lack of support was deliberate and had any political, racial or social motivation. Experts had warned for years that New Orleans was a disaster waiting to happen [12], yet an effective emergency plan that would include all co-operating levels of government was still not in place.

The overall death toll associated with Katrina stands at 1,836, mostly from Louisiana (1,577) and Mississippi (238) [13]. Many people are still missing and many of the confirmed deaths are indirect; as such a total definitive figure is impossible. The storm displaced over 400,000 people from the region, primarily from New Orleans, and left many of these people living in poverty elsewhere [14]. The aftermath of Hurricane Katrina, the storm coupled with the failure of New Orleans' levees, presented arguably the worst set of catastrophes in the history of the United States.

2.2 UK flooding summer 2007

In the summer of 2007, the United Kingdom sustained widespread flooding caused mainly by unseasonably low pressure systems during June and July which dumped record amounts of water on certain areas that were simply not equipped to deal with such a volume of water [15]. This created a crisis for the government and hundreds of thousands of affected residents who even now are in the process of recovering and rebuilding their lives.

As the flooding involved many towns, cities, regions and as such many facets of local as well as central government, this report will concentrate on the mitigation measures put in place and the level and effectiveness of the disaster response in one city particularly hard hit by the floods, Kingston upon Hull.

Many of the issues faced in the crisis situation in Hull were similar to those faced across the country to a lesser extent. Hull was particularly vulnerable to begin with in its low-lying position but in recent years the pumping system had been significantly upgraded and this indeed may have averted a catastrophe [16]. Given the fact that the flooding was a 1 in 150 year event and the city was assessed as a 1 in 30 year flood risk, it is encouraging that key civil infrastructure did not fail [17]. Flooding occurred because the drainage system was full to capacity as were all waterways so effectively there was nowhere to pump to.

The build-up of water during the month of June meant that many areas were saturated to capacity by the time some of the heaviest sustained rainfall occurred on the 25th of June. This was especially true in Hull; a city built 90% below high tide level and entirely pumped. Large parts of the city are built on reclaimed marshland and some major areas are below sea level [18]. On this day in particular, emergency action needed to be immediate and decisive to minimise damage and casualties.

Although the pumping system performed well in the circumstances, there was no contingency plan in place in the event of the system being overwhelmed [17].A problem appeared during the crisis regarding co-operation between multiple agencies in charge of different areas of the drainage system; the Environment Agency, Hull City Council and Yorkshire Water. No agency accepts responsibility for any elements outside their own terms of reference and this is undoubtedly a problem nationwide [19]. During the summer floods, Prime Minister Gordon Brown announced a review of the handling of floods and the infrastructure much of which was bequeathed by the Victorians. [20] One has to wonder why it took a major disaster before the government would listen to calls for a drainage system overhaul when 3 years ago they were warned that a flood disaster was imminent with current drainage capabilities [21].

Concerns have been raised about flood warning systems in place in Hull and across the UK. Although the Environment Agency operates an automated system warning its floodline subscribers of danger from flooding, this system only deals with coastal, estuarine or river flooding. There is currently no provision to warn of flooding caused by heavy rainfall [17].This problem exists at a national level and as such must be addressed by central government. Meanwhile affected residents are left to wonder why a system like this was not in place given the inherent topographical vulnerability of Hull.

The Environment Agency issued early warnings of heavy rain beginning on June 22nd and 23rd. On Sunday 24th a flood watch alert was issued and on the 25th a major incident was declared triggering a rapid response and relief effort. Initial reviews of the response effort have shown that it was for the most part well organised. The Humberside Fire and Rescue Service went above and beyond their call of duty in order to keep casualties to a minimum although with more co-operation between agencies, the army could and should have been called in for assistance [17].

Local residents and councillors were unhappy at the lack of media coverage afforded Hull given the scale of devastation [22,23] and there has been some suggestion that if the flooding had occurred in the Home Counties (around London) the response would have been quicker and aid for recovery would be much greater. For these reasons City Council leader Carl Minns dubbed Hull "the forgotten city" [22].

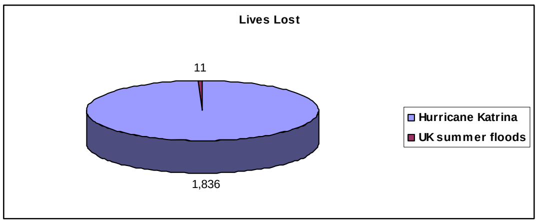
Residents were further outraged when it surfaced that the government had been warned months in advance by the Met office that summer flooding was probable because the El Niño phenomenon had weakened, but no action was taken [24]. There was time to warn local governments, agencies and indeed residents to prepare for the worst but this was not done. Liberal Democrat leader Sir Menzies Campbell accused the government of lack of preparation leading to a ‘summer of suffering’, and said, ‘With sophisticated weather forecasting as we now have, particularly in relation to what’s happened over the weekend, there are quite a few questions as to how it was that flood-prevention measures were not in place or were not more effective.’ [25]

In total, the floods are thought to have caused 11 direct deaths. The damage has affected thousands of businesses, tens of thousands of homes and further affected up to a million people [15]. Estimated damages are over £3 billion. Gordon Brown has promised to put pressure on insurance companies to pay out and also allocated recovery funds to individual councils to be distributed as they see fit [26].

3. Discussion

3.1 Comparing the figures

In terms of life and economic loss, the flooding in Hull does not come close to the catastrophe in New Orleans. Hurricane Katrina claimed an estimated 1,836 lives to the 11 killed in the UK summer floods 2007 [13,27,28]. New Orleans in particular saw mass displacement of its population some of whom still cannot return to uninhabitable conditions while in the UK, most people have now returned to their homes and started to rebuild. Katrina caused economic loss of around £40 billion ($81 billion) to the £3 billion estimated to be caused by the UK summer floods [1,26]. (see figures 1 and 2)



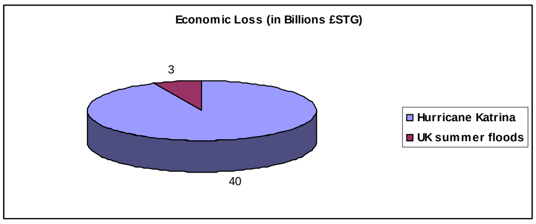


Figure 1: Comparing lives lost

Figure 2: Comparing economic loss

It is important to realise that although the scales of these disasters are quite different, we can draw many similarities between the respective disaster management strategy inadequacies.

3.2 Government mitigation measures and disaster response

Around the world when a natural disaster occurs, people generally notice the initial response and rescue effort and governments are commended or criticised accordingly. This study has revealed some lesser known facts and shows that both governments were forewarned about these disasters and should have ensured that appropriate mitigation measures were taken.

In New Orleans, the incomplete levee system should have been finished several decades previously and was not equipped to combat a hurricane of Katrina's magnitude [4]. The responsibility for this does not fall on any person or organisation, though many people in New Orleans hold the Army Corps of Engineers accountable for their design of the flood protection system while others assign blame to the federal government for lack of funding.

Meanwhile in Hull, a city in a similarly vulnerable topographical position, the pumping system is relatively up to date compared to elsewhere in the UK [16]. However the decision was made to protect Hull from a 1 in 30 year flood event when in reality the city was hit by a 1 in 150 year event. Suggestions have been made following the summer floods to provide additional areas to pump water into because in June all waterways and sewers were full to capacity [17]. The affected residents are left to wonder why additional measures were not put in place to protect against a 1 in 150 year flood before the event given the vulnerability of the city.

Before Katrina made landfall, bureaucratic mix-ups were already taking place within US government as has been outlined with regards to hurricane warnings, evacuations, the early stocking of supplies in the region likely to be affected and the positioning of enough emergency response personnel to deal with the crisis that was likely to unfold. In the UK, to a somewhat lesser extent, a similar lack of foresight meant that there was no warning system in place to account for flooding due to extreme rainfall [17].

In each case, a lack of action in the face of scientific warnings that such events were likely has cost dearly in terms of life and economic losses. Despite the knowledge that New Orleans was one of the most at risk cities in the country, funds were diverted away from the project meant to protect it [29]. In recent years scientists have repeatedly warned of the carnage that would ensue if a strong hurricane hit New Orleans [12] but people were still caught unawares when the disaster struck. In the UK, despite the fact that the Met office warned the government in the spring of likely widespread flooding in the summer no additional mitigation measures were undertaken and residents were not properly prepared for a crisis that the government knew was probably on its way [20,24].

The emergency response from both the UK and US governments to these disasters has created a mood of resentment within sections of the affected communities who felt that they were neglected in one way or another.

In New Orleans speculation has been endless as to the possible political, social and economic motives that could have delayed the disaster response effort [11]. Besides this sinister possibility, there was a plethora of mistakes made which influenced the speed and efficiency of the response. As outlined previously, not enough National Guard were positioned in the area prior to Katrina’s landfall, there was poor communication between agencies and different levels of government leading up to and during the crisis and bureaucratic mix-ups caused inevitable delays and missed opportunities to minimise the scale of casualties and losses.

Meanwhile in Hull many residents felt that the government was not as concerned for their region as it might have been had the flooding occurred in the Home Counties [22]. However, given the lack of co-ordination between agencies and the uncertainty over responsibility for overall flood response, the problem seems more likely to be rooted in a poorly specified chain of command and network of responsibility. The army were not called in when it was entirely feasible to do so and would have taken pressure off the Humberside Fire and Rescue Services who were operating outside of their remit already.

4. Conclusion

The probability of a hurricane the size of Katrina hitting the United States in any given year is relatively low, according to risk assessors [30]. However many experts warn that due to climate change the risks are growing along with the magnitude of hurricanes [31]. Recent climate model simulations show that a doubling of CO_2 may increase the frequency of the most intense cyclones [32]. Equally, the changing weather systems in the Pacific Ocean are likely to alter the magnitude and frequency of extreme events in the UK [24]. Climate researchers have suggested that the unusual weather leading to the floods may be linked to this year's appearance of La Niña in the Pacific, and the Jet stream being further south than normal [33].

In the face of scientific evidence that climate change is most likely causing an intensification of extreme weather events, governments worldwide must accept that change is necessary in both environmental policy and disaster planning and management.

It will never be a simple task to manage a natural disaster as events of nature are inherently unpredictable and unquantifiable; however the combined failures of the UK and US governments to prepare for and cope with these natural disasters exposes flaws in all levels of government.

In the UK, it would appear that the mistakes made were arguably more naïve than in New Orleans, where the total inadequacy of flood defences, evacuation measures and the relief effort makes it difficult to accept that the response was equivalent to what would have been done had a disaster crippled New York, San Francisco or Washington DC. Looking only at the figures, it is important to bear in mind that Hurricane Katrina was a much larger disaster management problem than the UK summer floods and therefore a portion of the errors made and inadequacies exposed were surely unavoidable given the scale of the disaster.

Claims have emerged by residents of Hull that they were similarly neglected by their government [23]. The failure to protect such a vulnerable city in the face of scientific advice and evidence and subsequently lend at best mediocre relief and financial support to the area [34] leads us to the conclusion that this may indeed be true to an extent. However, this could be in part because the eye of the media was drawn to Sheffield where the possibility of the Ulley reservoir dam collapsing would cause catastrophic damage but also create a major news event [35].

It is simply unacceptable that the US and UK governments have not done all that is necessary to mitigate as far as possible against such disasters, particularly when these countries are two of those responsible for much environmental damage and possessing the capability to implement change[36,37]. Perhaps there is still time to introduce extreme measures to slow down global warming but science tells us that if nothing is done, our weather will become more extreme and unpredictable and disasters will become more frequent and powerful[31,32]. Governments worldwide need to accept that the risk is now too great to leave their communities without adequate protection.

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Targeting Cash Assistance to Vulnerable Families in South Asia's 2005 October 8 Earthquake

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Abstract

The October 8, 2005 South Asian earthquake devastated the northern regions of Pakistan, destroying or damaging close to 600,000 homes, leaving more than 73,000 dead, and resulting in displacement of 3.5 million persons. Given the scale of devastation the government relied heavily on outside assistance, either in the form of direct aid or loan. One such grant aimed at rehabilitating livelihoods was the Livelihood Support Cash Grants which provided $50 per month for six months to 260,00 vulnerable families. We evaluate the implementation of this grant, in particular examining whether the grant was given to those families identified as vulnerable and as such focus on leakage and under-coverage of the program. We observe that one in two deserving families received the grant, and that the other family did not fulfil the criteria but was receiving funds. Through a multivariate analysis, we next built a parsimonious model to explain exclusion and false inclusion (leakage). We observe that for exclusions, families reporting a female as head were 8.1 (95% C.I. 4.1-15. 9) more likely to be excluded than families with male heads, and families with increasing number of children were 2.5 times more likely (OR=2.5, 95% C.I. 2.1-2.9) as compared with families with fewer number of children. The likelihood of exclusion was also higher with increasing age of family head (OR=1.1, 95% C.I. 1.07-1.2) and if a family resided in Azad Jammu and Kashmir (OR=2.6, 95% C.I. 1.2-5.7). With respect to leakage the model shows that families with younger ages (20-39 years) of family head (OR=4.4, 95% C.I. 1.4-14.1), increasing number of males (OR=2.9, 95% C.I. 1.8-4.6), and families living in Azad Jammu and Kashmir (OR=2.6, 95% C.I. 1.2-5.5) were more likely to be receiving the grant. In evaluating this program, we conclude that the Livelihoods Cash Grant Program was successful in only reaching half the vulnerable population as defined, and missed the most vulnerable families that is families with a female heads and increasing number of children.

Keywords: Cash assistance, Disaster mitigation, Social protection, Earthquakes, Pakistan, World Bank, Women, Targeting vulnerability

1. Introduction

The October 8, 2005 South Asian earthquake with a magnitude of 7.6 on the Richter scale, covering a total area of 30,000 square kilometers of the Northwest Frontier Province and Azad Jammu and Kashmir, took an unprecedented toll on the lives and livelihoods of people living in northern parts of Pakistan. The fault line of destruction extended north to south taking a heavy toll in five districts of North West Frontier Province: Abbottabad, Mansehra, Batagram, Kohistan and Shangla, and four districts of Azad Jammu & Kashmir: Muzaffarabad, Neelum, Bagh & Poonch. An estimated 73,338 persons died [1]; an additional, 69,400 suffered from injuries and 3.5 million persons were displaced from their homes [2]. In addition, an estimated 600,000 houses were partially or completely destroyed in 4,000 villages across nine administrative districts.

Given the scale of devastation, the government relied heavily on international assistance for funding relief and rehabilitation. A humanitarian appeal was launched for $6.5 billion (U.S.), and donors contributed $370 million for immediate humanitarian needs. Of the total amount requested for assistance, international donors committed $5.75 billion of which $2.6 billion were to be given in the form of grants and 3.15 billion as loans. One of the larger loans $400 million from the World Bank through the Earthquake Emergency Recovery was provided for reconstruction of houses that were destroyed in the earthquake. Included in this loan by the World Bank was allocation by ERRA, $85 million, for a program that provided direct cash assistance of $50 per month for six months to over 260,000 vulnerable families, the Livelihoods Cash Grants Program (LSCG). Our study focuses on cash assistance provided to vulnerable families for mitigation of any adverse affects on livelihoods.

Since cash assistance has been used as a mechanism for social protection, it is necessary to determine how effective the government targeting strategies have been in including vulnerable families. Relief Information Systems Earthquake –Pakistan (RISEPAK) based at the Lahore University of Management Sciences (LUMS) was contracted by the World Bank to determine whether funds reached families that truly deserved the cash assistance according to the vulnerability criteria determined by the GoP. For this purpose RISEPAK conducted a survey to determine under-coverage (exclusions of vulnerable families) and leakage (false inclusions--awarding grants to families that are not deserving as per criteria) in the LSCG program. We selected a sample of families from seven of the nine districts, excluding Kohistan and Shangla for reasons of security, based on the enrollment figures provided by NADRA. Our team of surveyors visited 2,612 families between October and November 2006, collecting information pertaining to the cash grant including the thirteen digit number printed on the Computerized National Identity Card (CNIC) of family head and respondent. Records were then matched between our dataset and the LSCG dataset on the basis of this national identification number. A total of 2,001 records matched, and it is for this subset that we evaluate under-coverage and leakage in the LSCG program.

2. Background

2.1 RISEPAK

Relief Information Systems Earthquake Pakistan (RISEPAK), established within the first two weeks of the October 8 earthquake, is a loose network of South Asian academics. It is based at the Lahore University of Management Sciences (LUMS) in Lahore, Pakistan, and has been involved in several surveys providing village level information on damage, deaths, and humanitarian relief. In May 2006, RISEPAK was awarded the Stockholm Challenge prize for the most innovative IT project in the area of public administration. In fall 2006, RISEPAK was contracted by the World Bank to conduct an evaluation of the Livelihood Support Cash Grants (LSCG) Program, with a main focus on determining exclusions (families who were eligible and did not receive the cash grant) and false inclusions (families who were not eligible according to the vulnerability criteria but receiving the cash benefit). To achieve our objectives we designed a field survey at the household level of families living in the earthquake-affected areas. Of the nine affected districts, we included seven and could not include two (Kohistan and Shangla) for reasons of security. These districts did not have as much damage compared to the other areas, and in both instances enrollment was small.

2.2 Livelihood Support Cash Grants Program

The Livelihood Support Cash Grant (LSCG) disbursed funds ($300) to over 260,802, and was conceived as central to recovery of vulnerable families. It enrolled nuclear families that could provide a national identification card (CNIC) of the family head and a valid bank account for transfer of funds if selected. Banks have been an important part of cash assistance programs, and need further study. The LSCG program included an elaborate framework for implementation and allocated 13 percent of overhead ($11.05 million) from the total funds ($85 million) of the program. Several international and local consultants were hired to develop the methodology and supervise the work. Special Targeting and Enrollment Teams (TET) were trained and hired that established a stationary presence in a village for a few days to week to enroll families. A Verification Facilitator, part of the TET was present in the field to assure that all information being provided was accurate. The completed forms were then transferred to Pakistan’s capital city, Islamabad, where they were entered and eligibility lists created by the National Database and Registration Authority (NADRA), a quasi-government agency that was specifically contracted for this purpose. Over 750,000 families enrolled in the program from the nine affected district of northern Pakistan, and the LSCG program claims that over 30 percent of families receiving the cash grant are considered as fitting the vulnerability criteria [3].

The LSCG criteria and priority of selecting vulnerable families was based on the following: (a) family with no male members between 18-60 years of age or a male member between 18-60 years that reported a disability and (b) families with five plus children. Selected families had to have reported house damage. Civil servants enrolled in the program had to have a rank of less than Grade 17 (non-professionals). The information collected by the LSCG enumerators included the Computerized National Identification Card number and other information on the head of household, family members under 18-years, disability amongst family members, house damage, livestock losses, and bank account information. This information was then verified in the field by a Verification Facilitator, and the completed form was sent on to the National Database and Registration Authority (NADRA) responsible for data entry.

The selection of eligible beneficiaries was made by members of the GoP and the World Bank: "In light of objective analysis of data by ERRA, the list of eligible families will be finalized in agreement with the province/state governments and the World Bank, subject to resource availability" [4]. Once a beneficiary family was selected then the cash grant funds were to be transferred through the banks to the beneficiary's account, which could take from three to six weeks. In addition, any family that had not enrolled or those who wished to contest their non-eligibility status could file an appeals process through local administrative offices within seven days of public display of lists of beneficiary families. The LSCG program was extended for another six months and provided funds "for the most vulnerable female-headed households" [5]. As of December 2007, it was providing cash assistance to 7,594 families in the Northwest Frontier Province and 13,272 families in Azad Jammu & Kashmir.

3. RISEPAK Survey

3.1 Objectives

The two main objectives of RISEPAK's study were: (1) to determine exclusions of families from the LSCG program or in other words to see if deserving families were left out as beneficiaries and (2) to document false inclusions or leakage in the program such that non-deserving families were receiving the cash benefit. While we had other interests such as the effectiveness of outreach and the use of banks, we do not focus on these aspects in this paper.

3.2 Methods

Between October and November 2006, RISEPAK conducted a household survey of 2,612 families in seven of the nine earthquake affected districts—Bagh, Muzzaffarabad, Neelum and Poonch in Azad Jammu and Kashmir and Abbottabad, Batagram and Mansehra in the Northwest Frontier Province. We constructed a two-tiered sampling frame based on the enrollment distribution by LSCG Program, figures that were provided by NADRA, the institution handling data management for the program. We first selected our sample proportionate to district-wise distribution of enrolled families, which gave us an estimate of the sample for each district. Next, Union Councils and Patwar Circle (UC/PC), lower administrative units, were ranked within each district based on enrollment distribution. We then chose those UC/PCs with the highest proportion of enrollment, and within each UC/PC identified villages while in the field on the basis of ease of access. At each location we selected a cluster of houses (sometimes the whole village) that were close to roads and those that required a twenty to thirty minute walk from the road. We carried global positioning devices, and recorded the coordinates of most location including altitude. Close to one third (11 out of 36) of the locations visited were over 1200 meters. The final figure was not based on any statistical calculation of sampling but more on what was feasible in terms of given constraints on fieldwork and an acceptable figure for understanding exclusions (under-coverage of the program) and false inclusions (leakage, i.e. grant given to non-deserving beneficiaries).

In both urban and rural locations, houses were selected in clusters with a random start and surveyors fanned out in numerous directions when houses were not contiguous. This was particularly the case in rural, mountainous settings, where homes were often far apart even though part of the same neighborhood (mohalla). In urban areas, we interviewed most houses in the same neighborhood before moving on to the next cluster of homes. In certain cases we were not allowed into homes, especially true for Batagram district where male surveyors were prohibited from entering homes with female and in most instances females spoke Pashto or a local dialect so female surveyors could not conduct an interview. In such cases, we sat near a mosque or a school to enroll families. We only enrolled families that could provide us with a Computerized National Identity Card (CNIC) or an old National Identity Card (NIC) for the family head. In the event that the original CNIC or NIC were not available, photocopies of the original card were acceptable in our survey. We completed forms for nuclear families—husband and wife and their unmarried offspring. If there was a married son/daughter living with his parents we filled out a separate family form. For as many cases as possible we asked the family head to identify his or her children under 18-years of age. This identification, including confirming female-headed households, was not always possible especially in the Northwest Frontier Province district of Batagram that is religiously conservative.

The questionnaire, developed by RISEPAK, included seven sections and took an average of 20 minutes to complete. The questionnaire was translated from English into Urdu, and then translated back to English. The first section began with noting the CNIC number of the head of household and respondent, and also included basic demographic information about the family. In this section information on members of the family including gender, age, education, employment, occupation and disability, and whether the family had taken custody of any orphan children was also noted. The second section evaluated the LSCG information campaign and enrollment in the program. The third section on program beneficiaries was asked only of those families that reported as having been selected by the LSCG program and included questions on when and how many payments were received. Section four assessed the appeals process and the status of appeals in cases where a family had filed an appeal. Section five addressed issues related to accessing banks, including time and monetary expenditure to determine beneficiary status of a family within the program. This was an important component given the high percent of illiteracy and the cultural issues surrounding women's mobility. The last two sections were on housing damage and coping mechanisms, including the receipt of cash assistance to mitigate adverse affects of the earthquake. The questionnaire was field tested, and a pilot conducted prior to beginning the field survey. The survey was conducted over a period of six weeks, and the forms that were filled during the day were checked and verified by the RISEPAK team in the evening, and whenever possible any mistakes by surveyors were corrected that day. The total numbers of forms were tabulated every night (including number of female headed households).

The data was inputted in a relational database designed in MS SQL, and a user interface was developed in Visual C# to facilitate data entry. Forms from the Northwest Frontier Province were entered by a team of volunteer students and that of Azad Jammu and Kashmir was outsourced to a data entry firm. Of the 2,641 interviews, we excluded information on 29 families as they had either incomplete and/or were missing critical information or were duplicates. The final dataset had 2,612 family level surveys with unique CNIC numbers which were verified by the RISEPAK team.

The cleaned dataset was then taken to NADRA for the purposes of matching exact CNIC numbers with the LSCG dataset. In cases where CNIC number did not match exactly, we next tried an exact match with the family number and name of family head. Altogether 2001 records or 77 percent of the sample matched between RISEPAK and LSCG datasets of which 1,932 matched exactly on the 13-digit CNIC and 69 records matched on the family number and family head name. This matched subset, as well as the overall RISEPAK data, was analyzed in SPSS version 15.0. For this analysis we report on the overall RISEPAK survey as well as the 2001 matched cases. Since the NADRA records can be different for selected variables, we report on any such differences only for the 2001 cases. For each dataset, we have reported the frequencies and percentages of our variables, and included the mean and standard deviation as required. For variables with multiple responses, a percentage ranking of the most frequent responses has been presented.

Our main analysis was on under-coverage (exclusions) and leakage (false inclusions) of the LSCG Program. We examine the 2001 cases by eligibility status and subsequent beneficiary status or non-beneficiary status as given in our dataset and according to NADRA's records. We calculate the percent of under-coverage and leakage in the program, as well as determine any observable pattern particularly vis-à-vis Union Councils or Patwar Circles. Next, we determine factors affecting under-coverage (exclusion) or leakage (false inclusions) in the program. For the univariate analysis, the association of the dependent variable (under-coverage in model 1 and leakage in model 2) with each independent variable was assessed. Variables were categorized into socially meaningful categories, wherever required. Prevalence odds ratio and 95% confidence intervals were computed individually for all the potential factors associated with leakage and under-coverage.

Multivariate analysis was carried out to see the independent effect of factors associated with the dependent variable identified in the univariate analysis using logistic regression. The approach towards building the final model sought out the most parsimonious model, which was meaningful in the context of the program. Variables with a p-value of less than 0.25 in the univariate analysis, along with the variables of known importance such as male adult between 18-60 years of age, were considered for inclusion in the multivariate analysis. However, before commencing multivariate analysis, correlation among the various independent variables was also checked. The model building exercise began with the variable found most significant in the univariate analysis and continued with the subsequent addition of the next most significant variable. Once a parsimonious model was built to explain under-coverage, the model building exercise was repeated for leakage.

3.3 General Demographics

Our distribution of all families in the survey by district is similar to the matched 2,001 cases (Table 1). In Azad Jammu and Kashmir only 74 percent of cases match between the two datasets and in the Northwest Frontier Province 80 percent of cases match. The district of Poonch has lowest matching percentage, 71 percent as compared to the other districts of Azad Jammu and Kashmir. The demographic profile also matches between the two datasets with the mean age of family head at 45 years with a standard deviation of 15 years. In our dataset as compared with the matched dataset, we observe that female heads of families were slightly different (15.4 percent in the overall sample and 13.4 in the matched sample). Otherwise, most other demographic information was similarly distributed between the larger and matched datasets.

Table 1: Distribution by District of RISEPAK, Matched and Unmatched Families

District	RISEPAK Survey (N=2612)	Matched Cases with NADRA-LSCG (N=2001)*	Unmatched Cases (611)
AJ&K	56.0 (1459)	53.9 (1079)	62.5 (382)
Bagh	15.1 (394)	14.5 (291)	16.9 (103)
Muzaffarabad	21.8 (569)	21.2 (425)	23.4 (143)
Neelum	2.3 (59)	2.5 (51)	1.8 (11)
Poonch	16.7 (437)	15.6 (312)	20.5 (125)
NWFP	44.0 (1153)	46.1(922)	37.5 (229)
Abbottabad	5.9 (156)	6.1 (122)	5.4 (33)
Batagram	14.5 (378)	15.5 (310)	11.0 (67)
Mansehra	23.7 (619)	24.4 (488)	21.1 (129)

*Two cases that we matched were reported to RISEPAK from Mansehra but according to NADRA records were from Kohistan and Shangla. These two cases are included in the analysis.

In examining the distribution of eligibility criteria, we observe that there are differences in the distribution of cases between LSCG Program and RISEPAK because in the NADRA dataset it is not possible to calculate the total number of economically active males or disabled males. The LSCG form was able to capture only family heads as reported by the respondent. For example, if a married female with a husband between ages 18 and 60 years enrolled herself as family head in the LSCG questionnaire, the form could only capture her marital status and not determine the age of her husband. The LSCG form also could not also differentiate between disabled family members as compared with a disabled male over 18 and under-60 years of age.

For our analysis on under-coverage and leakage, we used the more robust 2001 matched cases rather than our complete sample. In the 2001 cases, 603 were eligible according to our samples based on the specified criteria of families with no males or a disabled male between 18 and 60 years of age and those with five or more children. Eligible cases were distributed in the following mutually exclusive manner: 257 families with no male members between 18 and 60-

years of age; 83 families reporting a disabled male member between 18 and 60-years; and 263 families with five plus children. The remaining 1,398 families were ineligible.

In the matched sample, our dataset identified 363 families as beneficiaries or receiving the cash grant at the time the survey was conducted. However, not all families that were reported as beneficiaries were eligible according to the criteria. In our case, 195 families receiving the grant fit the eligibility criteria and 168 families did not. Leakage with respect to beneficiary status was 46.3 percent (168 ineligible families divided by 363 beneficiaries). In other words, nearly one in two families receiving cash assistance was not deserving of it but was getting it anyway. Furthermore, of the 603 eligible families there were 408 families that qualified according to the vulnerability criteria but were not recipients of the cash grant, and excluded from the LSCG Program. The exclusion or under-coverage in our matched sample was 67.7 percent (408 divided by 603 families). It would appear that two out of three deserving families were not receiving the cash benefit even though they were entitled to it.

Given that our survey was conducted in October/November 2006 and the matched analysis was done in February 2007, we observed that in the NADRA reported 247 new beneficiaries, families that were now receiving the cash grant but had reported to us as not receiving it at the time of the survey (Table 2). We therefore included these cases with the assumption of the possibility that these families received the cash grant after our visit. Of these 247 new beneficiary cases, 135 families were eligible as identified by our survey and 112 families were ineligible for the cash grant but receiving it any case. In terms of recalculating leakage or false inclusions, we observed an additional 112 ineligible families that were getting the grant according to the NADRA records that had reported to us as not receiving it at the time of the survey. These 112 families plus the 168 added up to 280 non-deserving families in receipt of the grant. These 280 cases divided by total families receiving the grant (610 families) meant that 45.9 percent of beneficiaries were ineligible and not deserving of the grant but receiving cash assistance. The leakage in the program therefore did not improve much from our original observation of 46.3 percent. However, with the addition of 135 new eligible beneficiaries, the under-coverage or exclusions improved from 67 percent to 55 percent.

Table 2: Matched Cases of Eligibility and Beneficiaries between RISEPAK and NADRA Datasets

	EliGible FAMILIES (n=603)	**INeligible fAMILIES (n=1398)**	**tOTAL cASES (n=2001)**
Non Beneficiary in both datasets	273	1118	1392
Beneficiary in both datasets	195	168	363
Beneficiary in NADRA dataset only	135	112	247
Total Beneficiaries Receiving Cash Grant	330	280	610

We next disaggregated cases of exclusions and false inclusions on the basis of RISEPAK's initially matched data for beneficiaries and eligible families across the various Union Councils. As to not get skewed results, we only included Union Councils in which we had interviewed more than 49 families. In looking at exclusions or under-coverage, we counted those Union Councils that were five percentage points higher than the overall exclusion percentage of 68 percent. And similarly, for leakage or false inclusion we identified Union Councils that were five percentage points above 46 percent.

In our matched dataset, the following Union Councils appeared as having a high percentage of exclusions: Barian (90%), Kaimanja (89%), Jambeera(76%), Muzaffarabad(75%), Garlat(73%), and Batagram(73%). Union Councils with high percentage of leakage were: Pachhiot(63%), Bagh(60%), Rawalakot(59%), Garlat(54), Batagram(52%), Bakot(51%). Garlat and Batagram, urban centers located in the Northwest Frontier Province, show higher than average percentage of leakage and under-coverage. Pachiot and Rawalakot in Poonch district and Bagh in Bagh district have high percentages of leakage and similar or lower than average rates of exclusions. Jambeera, Muzaffarabad, Barian and Kaimanja have higher than average exclusion percentages but very low false inclusions rates. The problems of false inclusions and exclusions seem greater in Azad Jammu and Kashmir than in the Northwest Frontier Province. In Azad Jammu and Kashmir, union councils with major urban settlements show percentages of false inclusion and exclusion that are above average percentage being reported for Muzaffarabad, Bagh, and Rawalakot.

Having determined that exclusions and false inclusions were a problem in Azad Jammu and Kashmir, we next developed a model to assess which factors were most predictive in deserving families not receiving the grant and undeserving families getting the cash grant. For the under-coverage model, we adjusted for distance to the program enrollment location and the number of males between 18-60 years in the family. We also included disabled male members in the model because of its significance in being selected for the cash grant. In our sample, there were 54 families with a disabled male member that did not receive the cash grant. The numbers were insufficient for inclusion in the model. These 54 families were evenly distributed between Azad Jammu and Kashmir and NWFP.

The final adjusted model for under-coverage (Table 3) indicated that the chances of exclusion were eight-folds higher in a family headed by a woman as compared to a family headed by a man (adjusted POR=8.1, 95% CI: 4.1, 15.9) while controlling for the effects of distance to the program enrollment center and the number of adult male members in the household. Similarly, not receiving grant money even when eligible almost doubled with every additional child under 18 years (adjusted POR=2.5, 95% CI: 2.1, 2.9) as well as with increasing age of the family head (adjusted POR=1.1, 95% CI: 1.07,1.2). Under-coverage was also significantly associated with families residing in Azad Jammu and Kashmir (adjusted POR=2.9; 95% CI: 1.4, 3.8). Therefore, an older female head of family with a large number of kids was at greater risk of being excluded from the benefits of the LSCG program even though she was deserving of assistance. The likelihood of being excluded was greater in Azad Jammu and Kashmir.

For leakage in the program, we built a multivariate model that adjusted for distance from the enrollment location and the total number of children (Table 4). In this model, we observe that a family whose head of family was less than 40 years of age (adjusted POR=4.4, 95% CI: 1.4, 14.7) as well families where there were greater number of adult male members (adjusted POR=2.9, 95% CI: 1.8, 4.6) were more likely to receive the cash grant money even when they did not meet the eligibility criteria. In other words, young males (20-39 years) were 4.4 times more likely to be recipients of the cash grant even though they did not deserve it. Moreover, with every one additional male member in the family the likelihood of the grant increased 2.9 times. Being located in AJ&K province (adjusted POR=2.6; 95% CI: 1.2, 5.5) was also significantly associated with leakage in the LSCG program. Undeserving families living in AJ&K were two and one-half times more likely to be receiving the cash grant even though they did not fit the eligibility criteria.

Table 3: Model 2-Undercoverage: Final adjusted model for factors associated with under-coverage (i.e. grant not received even when eligibility criteria was met)

	Adjusted Prevalence OR§	**95% Confidence Interval**
Head of Household Gender		
Female	8.1**	(4.1, 15.9)
Male	ref	
Age of household head	1.1**	(1.07, 1.2)
# of children under 18 yrs	2.5**	(2.1. 2.9)
Province		
NWFP	Ref	
AJK	2.6	1.2, 5.7

*p<0.05 **p<0.01 § adjusted for distance to the program enrolment center and the number of adult male members in the family

Table 4: Model 1-Leakage: Final adjusted model for factors associated with leakages (i.e. grant given even when eligibility criteria not met)

	Adjusted Prevalence OR§	**95% Confidence Interval**
Age of household head		
20-39 yrs	4.4*	(1.4, 14.1)
40-59 yrs	2.7	(0.9, 7.6)
60 yrs +	Ref	
# of male members in HH	2.9*	(1.8, 4.6)
Province		
AJK	2.6*	(1.2, 5.5)
NWFP	Ref	

*p<0.05 **p<0.01 § adjusted for distance to the program enrolment center and the number of adult males in a family

4. Discussion

There has been a growing trend in giving families cash assistance instead of material aid after a disaster [6]. Targeting assistance in the best of situations can be difficult given that money is clearly much more attractive in the community and it is easier to take advantage of it in the case of a targeted group [7]. Moreover, despite the best of intentions cash can be diverted by those in power and targeting agencies can altogether miss the most vulnerable families, especially women in patriarchic structures with rigid cultural norms that govern women's mobility. However, while accepting a degree of inclusion error (leakage) may be the most realistic option but a leakage rate of nearly fifty percent is problematic and unacceptable. On the flip side, what degree of exclusion error is acceptable in such programs? Although there is not much available on this aspect, evidence suggests that targeting cash may be more difficult than commodities [8, 9].

Our analysis on the effectiveness of targeting vulnerable families in the LSCG program suggests that exclusion and leakages criteria appear to mirror each other—one in two deserving families did not receive the grant even though they fit the criteria and one in two non-deserving families received the cash assistance. The exclusion of deserving families was most significant for the most disadvantaged group which is older female-headed families with a large number of children. Access and mobility of such families may be limited given the cultural norms in the earthquake affected areas. Although we have not included education in our model, the level of literacy may also be a factor. However, we cannot fully explain the reasons for why female heads of families which were the target of this program overwhelmingly excluded them, and on the other hand families with males were favored and 4.4 times more likely to receive the cash grants. The likelihood of leaving out deserving families and including non-deserving families was twice as likely to take place in Azad Jammu and Kashmir, which is politically sensitive vis-à-vis Pakistan. Given that local district level governments were involved in selecting beneficiaries it is possible that funds were misdirected to benefit their interests. In a patriarchic society such as Pakistan, where patron-client relationship is well entrenched even in administration and the culture and social norms discriminate against women's freedom of movement, the possibility of limited access to resources is an issue. Extra care is required to ensure that purported benefits reach those that are the target of the program, and at greatest disadvantage in society as a result of the disaster. The overall evidence appears to suggest that it is in the selection of beneficiaries that prejudices may have taken place. Cash transfers in this case targeted only one in two vulnerable families and missed out a substantial number of deserving families. We conclude that the targeting of cash did not completely serve the purpose for which it was intended that is to support vulnerable families through a critical time of recovery from the adverse impact of the earthquake.

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SECTION XVI
PROCUREMENT

Managing Projects to Reduce Delivery Schedule Failures

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Abstract

The problem of project delivery schedule failure is an old but recurring problem in the construction industry. In this study, the significance of forty-four sources of project delivery schedule failure were examined based on a survey of 35 construction contractors, 46 quantity surveyors, and 19 designers in Nigeria. The results shows that there is agreement between the three 3 groups of respondents regarding the ranking of the 44 sources of schedule failure. Clients' cash flow problems, contractors' financial difficulties, incomplete drawings, equipment problems, late instructions, poor supervision, material shortages, variation/change orders, planning and scheduling problems and price escalations were believed to be among the top significant sources of the problem. Using cost data obtained from 43 private sector- and 17 public sector- procured projects, the impact of variations orders and price escalation on delivery schedule failure were quantified. Simple Linear Regression Analyses show that about 16% percent of project delivery schedule failure can be explained by variations ordered by clients and their consultants while another 16% can be explained by price escalation. In order to lessen project delivery schedule failure, clients and their project management team need to pay greater attention to the most significant factors. In particular, they need to give adequate time for project planning in order to adequately capture client's needs, ensure adequate scoping of project, reduce incompleteness of design, reduce design errors and thereby reduce variations during construction. Clients need to arrange for sufficient finance prior to project award; and during tendering, consultants should conduct thorough due diligence investigation to ensure that the selected contractor is financial capable and has sufficient financial and management capability. The use of management-led procurement approach could also mitigate coordination and decision-making problems. Based on anticipated inevitable changes/variations and price escalation during construction, the regression models developed could assist professionals at the pre-contract stage when estimating projects cost and time.

Keywords: Schedule, Delays, Project delivery, Procurement, Contractors, Designers, Quantity surveyors, Nigeria

1. Background

Project delivery schedule are notorious for their inability to deliver according to plan. In Nigeria the problem is severe and is a major cause of cost overrun. Projects in Nigeria overrun their contract duration by between 50 and 420% [1]. Delivery schedule slippage could have significant effect on the completion cost projects [2]. It often generates conflict between parties when they are unable to determine and allocate responsibility for the problem [3]. Conflict and dispute could lead to further delivery schedule slippage. Factors contributing to schedule slippage are many. In an earlier study, variation order and price escalation were found to be factors significantly influencing schedule failures and cost overrun in Nigeria projects. However, there are few published quantitative studies making use of real life projects on the subject. Understanding of the sources of the problem and quantifying their impact using real life data would provide a better understanding of the problems and how they can be alleviated. The objectives of this study are:

- to understand how quantity surveyors, designers and contractors perceive the significance of the various sources of project delivery schedule failures

- to explore whether there is agreement between the 3 groups regarding the identified sources of delivery schedule failures.

- to quantify the impact of variation orders and price escalation on project delivery schedule failures.

- based on the findings, offer some recommendations on ways of managing projects to reduce delivery schedule failure.

The results provide useful information on ways of managing projects to ensure timely completion.

2. Literature Review

Dlakwa and Culpin found that variation orders, design errors, deficiencies in public agency organizations and deficiencies in contractor organizations, price fluctuation and late payment to contractor were among the most cited reasons for delay in public projects in Nigeria [4]. Mansfield et al found that the problem of financing of and payment for completed works, poor contract management, change in site conditions and shortages of materials are the four most important causes of delays and cost overruns in public highway and building projects [5]. Odeyinka and Yusif classified the causes of delays in Nigeria housing projects into 4 categories namely client-, consultant-, and contractor-caused delays, and extraneous factors [6]: Their findings show that Client-caused delays arise from variation orders, slow decision making and cash flow problems while contractor-caused delays results from financial difficulties, material management problems, planning and scheduling problems, inadequate site inspection, equipment management problems, and shortage of manpower. The causes of consultant -caused delays identified include: incomplete drawing, slow response by consultant, variation orders, late issuance of instruction, and poor communications. Inclement weather, Acts of God, labor dispute and strikes were found to be extraneous factors responsible for delays.

Elinwa and Joshua surveyed construction practitioners in Northern Nigeria and found that the relative contributions of the client, contractor, and others to time overrun are 62, 32, and 6% respectively [7]. Factors responsible for project delivery schedule slippage have been studied in other countries (see Aibinu and Odeyinka [8] for a detailed review).

Bramble and Callahan classified the causes of delays by looking at the responsibility of major parties to the design and construction process [9]. According to the authors, owner-caused delays could arise from late release of site to the contractor, late approvals, financial difficulties, contract administration responsibilities, change orders and interference while designers-caused delays could arise from design defects, slow correction of design errors, tardy shop drawings review, and delays due to test and inspection. Failure to evaluate the site and design, contractor management problems, inadequate resources and construction defects were listed as potential sources of contractor-related delays while weather, act of God, strikes and labour disputes were identified extraneous factors that could cause delivery schedule slippage.

In this study, the sources of project delivery schedule failure are investigated by looking at the responsibilities of project participants as highlighted by Bramble and Callahan [9]. The level of agreements among contractors, designers, and quantity surveyors regarding the significance of the sources are also tested. Empirical relationship between variation orders and delivery schedule failure, and between price escalation and delivery schedule failure were analysed, which is lacking is previous studies.

3. Research Method

3.1 Data Collection and Sampling

Based on the literature review and a pilot survey of selected construction industry practitioners, 44 sources of delivery schedule failure were identified and developed into a questionnaire (see Table 1). The respondents were asked to rate the extent to which each of the factors contributed to delivery schedule failure on projects they have been involved. They were asked to respond by assigning weights to each factor from 1 to 5 where *'1' is not significant and '5' is extremely significant'1'.* The questionnaire was sent to 60 contracting firms, 90 quantity surveying firms, and 50 design firms (architect/engineers) in South-western Nigeria.

3.2 Response Rate and Characteristics of Sample

Of the 60 contractors surveyed, 35 responded representing a response rate of 58% while out 90 quantity surveyors 46 completed and return the questionnaire representing 51% response rate. Of the 50 questionnaire sent to designers 21 were returned representing a response rate of 42%. Overall, the respondents have 22 years of experience, and on the average, they have been involved in 32 projects. The majority are bachelor's degree holders (83%) and are professionally registered (86%). Thus it is understood that the data obtained from the respondents can be relied upon with confidence.

4. Data Analysis and Results

4.1 Sources of Project Delivery Schedule Failure

To address objective 1, the contributions of the 44 factors to delivery schedule failure were determined by transforming the five-point Likert scale into Relative Significance Index (RSI) for each factor [10] using the following expression:

$$\text{RSI} = \frac{A}{B \times C}$$

Where:

A = total Score;

B = highest response option (5 in this study);

C = total number of responses; and

$0 \leq RSI \geq 1$.

The factors are then ranked based on their RSI's. RSIs were computed for quantity surveyors, designers and contractors (Table 1).

According to quantity surveyors (Table 1), the top 15 most significant sources of delivery schedule failure include: client change orders, client slow decision making, client cash flow problem, incomplete architectural drawing, architect late issuance of instruction, incomplete structural drawing, contractor financial difficulties, contractor planning and scheduling problem, contractor shortage of manpower, material shortages, late delivery of ordered materials, equipment breakdown/ maintenance, delays in manufacturer delivery, nominated suppliers cash flow problems, and price escalation.

Table 1: Relative Significant Indices and Ranking of Sources of Delivery Schedule failure

Variable Name	Quantity Surveyors		Designers		Contractors	
	*RSI	*R	*RSI	*R	*RSI	*R
Client variation/change orders	0.66	**13**	0.64	**13**	0.70	**11**
Client slow decision making	0.65	**15**	0.63	**15**	0.68	**15**
Client cash flow problem	0.84	**1**	0.82	**1**	0.81	**3**
Late contract award	0.52	43	0.56	28	0.52	40
Late preparation of interim valuation	0.53	41	0.56	29	0.66	18
Late valuation of variation	0.56	36	0.62	17	0.67	16
Incomplete architectural Drawing	0.78	**3**	0.62	18	0.83	**2**
Architect Late issuance of instruction	0.68	**11**	0.53	37	0.71	**9**
Architect variation/change orders	0.62	19	0.65	**9**	0.70	**12**
Architect inadequate supervision	0.59	27	0.54	35	0.58	31
Poor information dissemination	0.60	26	0.57	25	0.56	34
Architect delays in work approval	0.60	24	0.56	30	0.61	25
Incomplete structural drawing	0.74	**6**	0.56	31	0.76	**4**
Structural engineer change orders	0.59	28	0.49	41	0.62	24
Structural engineer late issuance of instruction	0.63	18	0.55	33	0.65	22
Structural engineer inadequate supervision	0.59	29	0.57	26	0.61	28
Poor structural design information	0.61	21	0.51	39	0.59	29
Incomplete services drawing	0.65	16	0.62	19	0.76	**5**
Services engineer change orders	0.56	37	0.59	21	0.65	23
Services engineer late issuance of instruction	0.59	30	0.56	32	0.66	19
Services engineer inadequate supervision	0.58	32	0.64	**14**	0.61	26
Poor services design information	0.61	22	0.55	34	0.54	36
Contractor financial difficulties	0.84	**2**	0.80	**2**	0.89	**1**
Contractor Planning and Scheduling Problem	0.74	**7**	0.72	**3**	0.66	17
Contractor inadequate preconstruction site inspection	0.58	33	0.59	22	0.53	39
Contractor shortage of manpower	0.66	**14**	0.65	**10**	0.58	32
Material shortages	0.67	**12**	0.65	**11**	0.70	**10**
Change in material specification	0.62	20	0.59	23	0.52	42
Unforeseen material damages	0.54	39	0.52	38	0.76	**6**
Late delivery of ordered materials	0.74	**8**	0.68	**5**	0.61	27
Material delivery not in accordance with specifications	0.55	38	0.63	16	0.54	37
Equipment breakdown/ maintenance	0.77	**4**	0.68	**6**	0.49	43
Equipment shortage	0.64	17	0.66	**8**	0.75	**7**
Equipment delivery problem	0.57	35	0.60	20	0.65	21
Inadequate skill of operators	0.60	25	0.59	24	0.65	20
Delays in manufacturer delivery	0.72	**9**	0.67	**7**	0.72	**8**
Nominated suppliers cash flow problems	0.77	**5**	0.72	**4**	0.57	33
Price escalation	0.70	**10**	0.65	**12**	0.69	**13**
Government regulations	0.59	31	0.54	36	0.54	38
Inclement weather	0.61	23	0.51	40	0.68	**14**
Acts of God	0.46	44	0.37	44	0.42	44
Labour dispute and strikes	0.58	34	0.47	42	0.59	30
Civil disturbances	0.54	40	0.46	43	0.55	35
Slow permit by government agencies	0.53	42	0.57	27	0.52	41

*RSI= Relative Significance Index; R = Rank; (Top 15 sources are highlighted)

According contractors (Table 1), the following are the top 15 significant factors that are responsible for delivery schedule failure on projects: Contractor financial difficulties, incomplete architectural drawing, client cash flow problems, incomplete structural drawings, incomplete services drawing, unforeseen material damages, equipment shortage, delays in manufacturers' delivery, architect late issuance of instruction, material shortages, client change orders, architect change orders, price escalation, inclement weather, and client slow decision making.

Designers perceived the following as the top 15 significant sources of the problem: Client change orders, client slow decision making, client cash flow problem, architect change orders, services engineer inadequate supervision, contractor financial difficulties, contractor planning and scheduling problem, contractor shortage of manpower, material shortages, late delivery of ordered materials, equipment breakdown/ maintenance, equipment shortage, delays in manufacturer delivery, nominated suppliers cash flow problems, and price escalation.

It is observed that there is almost a perfect agreement between quantity surveyors, contractors and designers regarding the ranking of the following: (1) Client change orders (2) client slow decision making (3) client cash flow problem (4) material shortages (5) price escalation and (6) contractor financial difficulties.

4.2 Test for Agreement between Respondents

The following sub-hypotheses were tested to address objective 2 of the study, which is to statistically determine whether there is agreement between the 3 groups regarding the overall ranking of the 44 sources of project delivery schedule failure:

Hypothesis 1: There agreement between quantity surveyors and designers regarding the ranking of the 44 sources of project delivery schedule failure.

Hypothesis 2: There is agreement between quantity surveyors and contractors regarding the ranking of the 44 sources of project delivery schedule failure.

Hypothesis 3: There is agreement between the designers and contractors regarding the ranking of the 44 sources of project delivery schedule failure.

Spearman's rank correlation analysis was employed to test the hypotheses. Spearman's rank correlation coefficient (r_s) measures the correlation between two sets of rankings and was determined using the expression:

$$r_s = 1 - 6\sum D^2 \Big/ n(n^2 - 1)$$

Where:

D is the difference between the rank given by one group and that given by the second group

N is the numbers of items being evaluated (44 items in this study)

The rank correlation coefficients r_s is from -1 to +1. A correlation of coefficient of +1 suggests a perfect linear correlation while a value of -1 means a negative correlation implying that a high ranking by one group is associated with low ranking by the other group. A zero value indicates that no linear association exists. Since the three groups of respondents are from random samples of population, we may test for true agreement in ranks by using the values of the observed r_s. We may test at a chosen level of significance the null hypothesis that the two groups under comparison differ as regards the ranking of the factors [11] i.e. that the rankings are independent in the population and the observed value of r_s differs from zero only by chance. Table 2 summarize the results. The results support hypotheses 1 (r = 0.612, p = 0.000), hypotheses 2 (r = 0.502, p = 0.001) and hypotheses 3 (r = 0.309, p = 0.041). Thus, we may conclude that there is agreement between contractors, quantity surveyors and designers regarding the contribution of each of the 44 factors to project delivery schedule failure. However, it is observed that agreement between designers and contractors is the weakest (0.309).

Table2: Result of Spearman's Rank Correlation Coefficient

		Designer	**Quantity Surveyor**
Quantity Surveyor	Correlation Coefficient	0.612**	
	Significance probability	0.000	
	n	44	
Contractor	Correlation Coefficient	0.309*	0.502**
	Significance probability	0.041	0.001
	n	44	44

** Correlation is significant at 0.001 level

* Correlation is significant at 0.05 level

4.3 Impact of Variation Orders and Price Escalation on Project Delivery Schedule Failure

Consistent with previous studies, the results from questionnaire analysis show that change order and material price escalation are among the top 15 most significant factors contributing to project delivery schedule failure. Thus a further analysis was conducted to address objective 3, which is to quantify the impact of variation orders and price escalation on project delivery schedule failure. This was achieved by analysing data on 60 completed projects obtained from quantity surveying firms. Two linear regression models (model 1 ad 2) were set up with project delivery schedule failure (Y) as dependent variable in each of the models and variation/change order (A) and price escalation (B) as the independent variables in model 1 and model 2 respectively. The models are expressed in mathematical form follows:

Y = f(A)………………………………………………………Model 1

Y=f(B) ……………………………………………………Model 2

Where:

Y is project delivery schedule failure (measured by the amount of discrepancy between contract and actual project duration.

A is the magnitude of variations/changes ordered by clients and their consultants (measured in terms of the monetary value of variations claims paid to the contractor as reflected by the final account statement of each project); and

B is Price Escalation (measured by the amount of fluctuation claims paid to the contractor as reflected by the final account statement of each project).

The hypotheses are that: significant changes in project delivery schedule failure can be explained by variation orders; and that significant changes in project delivery schedule failure can be explained by price escalation. Prior to data analysis, the monetary values of variation/change order and fluctuation claims for all the projects were brought to same base using the Consumer Price Index Published by the Federal Office of Statistics, Nigeria. The regression results (Table 3) show that about 16% changes in project delivery schedule failure can be explained by variations ordered by clients and their consultants ($R^2 = 0.157$, F = 11.966, p = 0.001).

Table 4 *Result of Regression Analysis*

Variable	Predictor	β Coefficient	Standard Error	t value	p value
Project Delivery Schedule Failure (Y)	Constant	5.139	0.698	7.360	0.000
R^2 = 0.171	**Variation (A)**	0.423	0.122	3.459	0.001
R^2 Adjusted = 0.157					
Project Delivery Schedule Failure (Y)	Constant	5.324	0.688	7.740	0.000
R^2 = 0.168	**Price Escalation (B)**	0.410	0.178	3.424	0.001
R^2 Adjusted = 0.154					

*Variables are significant at 5% level (p <0.05)

Also, 16% of the changes in discrepancy between contract and actual project duration (projects delays) can be explained by price escalation ($R^2 = 0.154$, F = 11.724, p = 0.001). The result suggest that variations ordered by project owners and or their representatives and price escalation both accounted for a significant change (about 32%) in delivery schedule failure. The following are the regression models of the relationships:

Estimated Regression model 1 (for Variation orders): $Y = 5.139 + 0.414A$

Estimated Regression model 2 (for Price Escalation): $Y = 5.324 + 0.410B$

Where: Y is project delivery schedule failure

A is Variation or changes ordered by clients and their consultants

B is Price Escalation

5. Discussion

This study shows that variation orders, price escalation, poor planning and scheduling, client slow decision-making, client cash flow problems, contractor financial difficulties, incomplete design, design errors inadequate supervision, and late issuance of instructions are the top most significant sources of project delivery schedule failure in Nigeria building projects. Variations ordered by clients and their consultants, and price escalation accounts for 32% of the problem.

The findings are not unexpected. Variations could disrupt the progress of work and prolong the contract period. Also, when not sufficiently provided for in the contract (by way of management reserve or contingency), price escalation could to lead to financial difficulties and clients putting aside projects for months before they are continued. It may also lead to contractor's financial difficulties when domestic sub-contractor and suppliers' price upon which tender estimates are based becomes outdated. These problems could further generate tension and conflict at all levels of the supply chain hence disruption to progress on site and further delivery schedule problems.

Price escalation is a serious problem in Nigeria. Over the last 2 decades the Nigeria economy has witnessed a high and fluctuating level of inflation rising from 4.1% in March 1991 to 78.2% in August 1995 and 16.8% in September 2005 (Federal; Office of Statistics, Nigeria) and 10.5% in 2006 (CIA World Fact Book). This puts Nigeria in number 32 out of 211 countries on inflation rate ranking (CIA World Fact Book). It is likely that the impact of price escalation on project delivery schedule failure is exponential rather than arithmetical in that during the period when projects are delayed due to price escalation, there could be further price escalation leading to further delays. To exacerbate the problem, contingencies included in contract sum are often based on 5 – 10% rule of thumb and often inadequate [2]. Regarding poor planning and scheduling, a most recent survey of the impact of ICT on professional practice in Nigeria shows that less than half of the respondents use project planning software [12].

Also, client’s slow decision-making is serious problem in public sector projects. The structure of most public clients’ organization is such that independent consultants engaged on projects are cut off from client’s top executives. In the author’s experience while monitoring a major public sector project in Nigeria, sometimes decisions on matters affecting time and cost of projects are made in the absence of the responsible professionals. The inputs of independent consultant project managers and professionals in the client’s decision-making are often frustrated by lack of independence and the bureaucratic nature of public clients’ organisations. Contractors sometimes openly disregard and despise directives of the independent project manager and professionals on believe that there will be no penalty enforced by the client (government departments or authorities) for lack of performance. It would appear that political ties dictate the tune.

Further, while integrated procurement method such as design and build; and management-led procurement such as management contracting and construction management are well known among stakeholders in Nigeria, the use of traditional method procurement method is still dominant [13]. In fact, all the projects analysed in this study were completed using traditional method of procurement. This may explain the problem of late instruction and slow decision-making.

6. Conclusion and Recommendations

Based on the findings of this study, it is apparent that clients and their project management team (quantity surveyors, designers, and other consultants) need to take responsibility for timely delivery of projects by paying greater attention to how projects are managed at the conception, planning and construction stage. The following recommendations are proposed for managing projects to reduce delivery schedule failure:

Building Capability in Project Management and Promoting Project Management Climate

Clients and construction practitioners need to build capability for managing projects and to promote project management culture. This is essential as there is now an unprecedented increase in size and complexity of projects, which cannot be ignored. To build project management capabilities, professional bodies in Nigeria need to mandate project management training and competence as core aspect of continuous professional development and criteria for registration of professionals.

When procuring projects, clients and their consultants need to give sufficient time for client’s briefing to understand client’s needs and clarify project objectives at project inception in order to reduce future variations to project scope. They need to spend more time on planning and design of project to reduce design errors and incomplete drawings. Poor planning and scheduling could be reduced by the use relevant information technology tools. Promoting project management culture and coordinating with the client could reduce late instruction, poor supervision, and slow decision-making.

Further, professionals are considered to be of superior knowledge and they owe a duty of care to their clients. In their advisory role, clients' project management team need to ensure that clients obtain sufficient finance prior to project commencement, conduct due diligent investigation to ensure that capable contractor with appropriate financial and management expertise is selected at the tender stage. In this regard, following due process in project procurement (especially in the public sector) and during tendering is a way forward.

Improving Clients Project's- and In-house Organisational Structure

The problem of client's slow decision-making (especially in the public sector) could be addressed by reforming public sector procurement policy to ensure due process, transparency and reduce bureaucracy. Such reform needs to provide for-, guarantee-, and protect- the independence of construction professionals in project procurement. While the new Public Procurement Act, 2007 (developed on behalf of the Federal government of Nigeria by World Bank and in collaboration by some Nigeria private specialist) passed by senate in June 2007 is a step forward in improving the performance of public project delivery, there is still a lot to be done regarding the provisions of the Act which are beyond the scope of this study.

Using Appropriate Procurement Strategy and Project Governance

There is need to consider the use of design- and management-led procurement approach for projects procurement in order to reduce project delivery schedule failure. However, choice of procurement arrangement option for each project should be subject to other project peculiarities such as risk, complexity of project, quality requirements and cost. The advisory role of Nigeria professionals who act as clients advisers is critical in this regard. Optimum procurement arrangement option should be chosen based on consideration of relevant criteria. A mismatch of procurement method and project peculiarities will certainly lead to failed project (delivered beyond budget cost and schedule and with poor quality). Thus professionals need to build capability in procurement management and project governance.

Improving the Accuracy of Project Time and Cost Estimates

Turning to the problem of price escalation, this study discovered that price escalation could explain a significant amount of project delivery schedule failure. While the problem of price escalation is national issue, professionals such as quantity surveyors have an important role to play. The challenge is to find ways of improving the accuracy of cost and time estimates of projects. Contingency estimate based on 5 – 10% rule of thumb is certainly inadequate in Nigeria. There would be need to improve methods for quantifying risks, including price escalation, and taking them into proper account when estimating project cost and time. This may be achieved by the use of appropriate risk management and modeling tools. Also, the practice where public sector clients in-house executives and professionals reduces project budget to get their favourite project approved need to be discouraged as it could be a major source of cash flow problems resulting from unrealistic and inadequate budget and time estimates.

In this study, 2 regression models were developed representing the relationship between variation orders and project delivery schedule slippage; and between price escalation and project delivery schedule slippage. The models could be used by professionals to predict the likely time overrun on projects based on anticipated uncontrollable changes to project scope and based on anticipated price escalation during construction period. The assessment could be factored into project time and cost estimate thereby increasing price and cost certainty prior to project commencement. It is likely that certainty of project cost and time could reduce lending institutions perceived risk of construction projects financing in Nigeria. This could increase their confidence in construction business thus increase in construction industry access to capital and inadvertently may reduce contractors and clients financial difficulties which are top ranked sources of project delivery schedule failure.

7. Significance of the Findings

This study provides useful information to stakeholders and foreign architectural engineering and consultancy (AEC) firms in Nigerian construction industry and to those contemplating venturing into Nigeria construction market on some of the forces that could influence project delivery schedule failure on their projects. It provides information that could support project planning and bid preparation. It also indicates areas in which firms could add value to project execution in Nigeria and thus increase their market share. It also provides vital information to pubic policy-makers in Nigeria and those who have control over the procurement of projects. While the new Public Procurement Act, 2007 is a step forward for improving the performance of public project delivery, the understanding gained from this study would assist when implementing the Act. The findings of this study also could assist in amending the Act in the future. Other levels of government proposing to develop procurement policies may also find the results useful. Although the data for this study is from Nigeria, the findings are applicable to other developing countries as they are faced with similar situation. This study is useful to international organizations such as World Bank, who are providing aid and supporting capacity building in developing economies. It provides them with independent knowledge of some of the problems and challenges of project procurement in Nigeria and developing economies. The findings are critical for poverty reduction in that a huge amount of public sector spending in developing countries and loans provided by international organizations as loans are expended on programs with huge construction element. Thus by improving public sector procurement policies to reduce project failure will be most beneficial to the common people in developing economies.

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The contractor–subcontractor relationship: the general contractor's view

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Abstract

Subcontractors play a significant role in the Palestinian construction industry. The relationship between the general contractor and subcontractors is one of the keys to any successful construction project. Despite this importance, little information is available about the actual working relationship which exists between general contractors and subcontractors. Subcontractors are specialist agents in the execution of a specific job, supplying manpower, equipment, tools, and designs. They respond only for the executed part of the workmanship, acting as agents of the production system of the contracting company. The aim of this paper is to explore the actual working relationship between contractors and subcontractors. This study was based on a questionnaire survey of general contractors in the Gaza Strip. Information was obtained on reason, for subcontracting, communication process, selection criteria, negotiation with subcontractors, commitment, type of contract, and control tools. The results indicate that more than 90 percent of the work is performed by subcontractors. General contractors select subcontractors according to the complexity of the work and previous experience with subcontractors.

Keywords: Contractors, subcontractors, relationship, construction, development.

1. Introduction

The contribution of subcontractors to the total construction process can account for 80-90% of the total value of the project [1; 2; 3; 4]. This large involvement of subcontractors can be attributed to the shift from the traditional craft base, to a greater reliance on increasingly sophisticated technology-based products [2]. This has resulted in general contractors concentrating their effort, on managing construction site operations rather than employing direct labor to undertake construction work [3]. Arditi et al [5] has also attributed the increased use of subcontractors to the increased complexity of both the construction of buildings and the organizational relationship.

Subcontractors contribute significantly to the capital risk, resources, managerial effort, and business expertise supporting the largest industry in the country. The trend toward more subcontracted work accelerated as the technical development of building materials and methods escalated the requirement for craft skill and knowledge. Quality control and labor management problems on construction projects became less complicated for general contractors utilizing specialty trade subcontractors in lieu for furnishing all craft labor themselves [6]. Hinze and Tracy [1] have studied the working relationship between subcontractors, and contractors in the United States from the subcontractor's perspective. They put forward a series of recommendations to improve the subcontractor-main contractor relationship. The purpose of this study is to explore the actual working relationship between general contractors and subcontractors in the Gaza Strip for the main contractors' perspective.

2. Overview of the construction sector

Construction sector is one of the key economic sectors and is the main force motivating the Palestinian national economy. Upon the establishment of the Palestinian National Authority and the assumption of its powers over the Palestinian territories in 1994, the construction sector has witnessed noticeable expansion and activities. The contribution of the construction sector to the GDP is currently rising in real terms and as a percentage of the total labor force. Construction sector contributes 33% to the Palestinian GDP. This is a large proportion covered by this sector, thus positively affecting various economic, social, educational and vocational sectors in addition to other Palestinian institutions. Construction is one of the most important sectors in the assimilation of labor force throughout Palestinian cities and towns. Construction sector employs an average of 22.3% of Palestinian labor force volume. It employs about 10.8% of laborers directly, and 30% indirectly in factories related to the construction sector and other service and productive sectors. Construction sector contributes largely to different sectors of investment, such as manufacturing of construction materials. In addition, it provides materials needed for construction, such as stone, marble, brick, floor tiles, etc. Further, the sector is one of the main resources of the commercial sector in Palestine [7].

This has resulted in the recovery of the construction contracting profession and subsidiary industries, encouraged the investment of the Palestinian expatriates' capital in the local construction sector, and contributed to the creation of jobs for thousands of Palestinians. Therefore, the construction sector has occupied the foremost position among the rest of sectors, mainly in the attraction of investments and creation of new jobs. In addition to subsidiary industrial and productive sectors, construction sector is the largest and most important of all other sectors. As such, the construction sector has been crucially significant, mainly in the past two years, for the role it plays in reconstruction, road rehabilitation and construction of infrastructure.

The typical image of the construction contracting profession, whether in the Arab World or in Palestine does not match the role active contractors' play in the building of their societies. Contractors are effective entities involved in all professions subsidiary to the construction sector through a complementary relationship. Further, contractors possess the skills necessary for financial management and project administration. Taking into account that a large number of Palestinian contractors are engineers, contractors' professional experience is also consolidated by Palestinian expatriates. Such status has led to the upgrading of the construction contracting profession in Palestine as regards quality, specialty and professionalism.

Construction contracting is considered the hub for construction sector in Palestine. Hence, Palestinian contractors have proved their national role and outstanding ability in construction and reconstruction. In addition, construction sector proficiency been enhanced following the establishment of the Palestinian National Authority in 1994. According to recent figures, contractors registered as members at the PCU have amounted to (1180) throughout Palestinian cities and towns in July 2003. Contractors registered as members in the West Bank have been (800), and those registered in the Gaza Strip have reached (380).

3. Previous studies

Subcontracting has been defined as a legal-economic relationship between two agents, in which the characteristic criteria are substitution and subordination. The substitution criterion means that the subcontractor executes the operation with technical and financial risks, instead of the job assignor; the subordination criterion means the subcontractor must follow the direction given by the contractor (Pagnani, cited in [5]. Another definition was given by Hinze and Tracy [4] who stated that the subcontractors are specialty contractors who are hired to perform specific tasks on a project. Subcontracting can be classified as volume subcontracting and specialist subcontracting. Volume subcontracting can be used when an enterprise commission a subcontractor because, while technically able to carry out the operation, it is overloaded and has to obtain additional capacity from another source. Specialist subcontracting can be used, when the main contractor obtains goods or services, which he does not produce or is not able to produce himself.

Beardsworth et al [8] pointed out that subcontracting could be seen as an organizational alternative for some economic activities. Firms are decentralizing their jobs more and more, allowing subcontracting to become a basic part of the work organization. Firm does not need to have the control of all the value string, being able to externalize non-strategical activities, aiming to reduce costs. The subcontractor's typical source of work is the general contractors that assume responsibility for complete construction of the project. At any point of time, the subcontractor is providing specialty construction services to a number of general contractors with varying expertise in subcontract development, subcontractor management and relations; project management, coordination, and control; and project cash-flow reliability. Decisions on individual projects are often influenced by the objective of sustaining an on-going relationship. Both the short-term (project) and long-term relationship with the general contractors are essential to the success of all specialty contractors [6].

Bennett and Ferry [9] described building firms as organized into a consistent operating core based on their individual capabilities. Construction companies are becoming construction managers or contractor managers, transferring construction work to specialists. Subcontractors are specialists' agents in the execution of a specific job, supplying work force, besides materials, equipment, tools or designs. They respond only for the executed part of the workmanship, acting as agents of the production system of the contractor company. Specialty contractors are construction "job shops", performing construction work that requires skilled labor from one or at most a few specific trades and for which they have acquired special-purpose tools and equipment as well as process know-how [10].

Chung and Ng [11] have studied the practice of subcontractor appraisal in the construction of Hong Kong. They have developed a common standard to monitor the performance of suncontractors and to uplift the quality standard of construction works eventually. Russell and Mcgowan [12] stated that up to 95% of the total project value was entrusted to subcontractors in Canada. The trends was similar in Asia countries like Japan [13] and Singapore [14]. Adriti and Chotibhongs [1] investigated a number of issues in subcontracting practice such as: safety issues, productivity issues, construction insurance, and subcontracting bonding.

4. Method

This study was based on a questionnaire survey of general contractors in the Gaza Strip. The questionnaire design was based on previous related literature [1. 3, 5, 6, 15] and contractors' expert. The content and understanding of the questionnaire have been reviewed and tested. 100 questionnaires have been sent to general contractors randomly. 53 (53%) completed questionnaire have been returned and descriptive analysis has been used.

5. Results

The results indicated that the majority of the general contractors' respondents stated that it is a common practice to use subcontractor to execute specific operation in the project. They added that more than 90% of the works are performed by subcontractors. This result is similar to previous researches results in USA, UK, Hong Kong, and Brazil. The main reasons behind using subcontractors were found to be shortages of skilled labor, maximizing profit, reducing overhead costs, and reducing the work pressure on the main contractors. In addition, monitoring and controlling quality control, safety management, and labor management problem, on construction projects become less complicated for general contractors.

Concerning communication process between major contractors and subcontractors, 50% of respondents indicated that informal, face to face communication was the main mean for communication. The results indicated that 33% of respondents communicate with subcontractors by telephone. Only 6% of the respondents have mentioned that they have formal communication (using letters) with subcontractors. This result reflects the informal characteristics relationship between general contractors and subcontractors. This type of relationship (litte documentation) can be a source of problems which may affect the progress and the quality of the work.

The majority of respondents (60%) have stated that they select subcontractors according to the required specific activity and to the nature and complexity of the work. It has been noticed from the results that 13% of general contractors' select subcontractors according to their previous experience with them. Surprisingly, 7% of the respondents select subcontractors based on their reputation. This can be traced to the trend of the major contractors in the local industry in selecting the lowest bid regardless of the safety and quality of work.

It has been found that 70 % of the respondents gave all necessary drawings and bill of quantities to subcontractors in order to estimate their costs for the required operations. It was noticed that only 7% of subcontractors have visited the construction sites during the estimation process. This has led, in many cases, to inaccurate cost estimation which affected the quality of the work as subcontractors are interested to make profit without enough attention to the quality of the work being implemented (this has increased the probability of a conflict and claims after construction work has begin). The general contractor required from subcontractors to submit in addition to bid price, method of execution, past experience in similar works, time schedule, expected obstruction, and any other special conditions.

The majority of general contractors' respondent committed with the selected subcontractors during the tendering stage when they awarded the contract. However, most respondents (87%) practiced negotiation with the subcontractors after winning the contract in order to reduce the agreed costs in the tendering stage. This may be due to the sever competition between contractors that enforce them to reduce the tender price, and thus asked the subcontractors to reduce their previously estimated cost. Regarding contract type between general contractor and subcontractor, it was noticed that more than 60% of the respondents used contracts similar to the one between owners and contractors. The other respondents used a simplified contract.

Regarding methods of measuring the performance level of the subcontractors, it was noticed that contractors (87%) have used bar chart and s-curve in monitoring the progress of the subcontractors. This reflects the formal procedures and gives a good tool to the management body of the project to correct any defaults that may occure by the subcontractors. Concerning the safety measures of the subcontractors, the majority of general contractors (93%) stated that subcontractors are obliged to adopt the safety measures as specified in the contract between the owner and the general contractor. This is a crucial point in the local construction industry as almost all works are implemented by subcontractors and general contractors.

The majority of the respondents have agreed that there is a close cooperation and a good flow of information exchange between general contractors and subcontractors. In general, the main contractors' respondents were satisfied with the performance of subcontractors.

6. Conclusion

This study has explored the working relationship between general contractors and subcontractors from the general contractors' perspective. A decision to subcontract part of the process should be a strategic decision, and not one driven solely by resource problems. It may involve long-term strategic views related to the core skills required for the company's future, as well as consideration of the importance of design re-use and internal control of the design and manufacture of the product. The general contractors have stated that, it is a common practice to use subcontractors to execute specific operation in the project.

There are many benefits to be gained from working with subcontractors. It provides skilled labore, reducing overhead costs, and reducing the pressure on the main contractors. Monitoring and controlling, quality control, safety management, and labor management problems on construction projects become less complicated for general contractors. It is apparent from the results that informal communication is practiced between general contractors and subcontractors. General contractors have indicated that they select the subcontractors according to the complexity of the work and previous experience with subcontractors.

Some subcontractors have failed to exercise the proper diligence and care when submitting their bids; even they do not have the time to visit construction sites during the estimating process. General contractors committed to the selected subcontractors during the tendering stage; they negotiate with subcontractors after winning the contract in orders to reduce the agreed costs in the tendering stage. This is due to the sever competition between contractors which enforce them to reduce the tenders price, and thus asked the subcontractors to review and reduce their previously estimated costs. Overall, general contractors indicated that they have good relationship with subcontractors and they satisfied with their performance.

Further in-depth study concerning all aspects of the relationship between general contractors and subcontractors is recommended. It is imperative to improve and develop the subcontractors position towards the general contractor, by upgrading the understanding of all contract terms such as; wording and potential for negotiations of conditions including indemnity, payment and retention terms, warranties and call backs, schedule of work, delays and liquidated damages, lien and bond rights, and of curse scope of work. It is advisable to establish a Palestinian subcontractors union for better networking improves the quality and conditions of work, improving the terms of contracting and place subcontractors in a good position in the local market.

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Developing Relational Approaches to Contracting: The Sri Lankan Context

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Abstract

The traditional construction procurement systems have come under constant scrutiny in the past decades for their numerous drawbacks, resulting in under-performance of the industry. International research in this area showed that the adaptation of approaches such as, partnering and alliances, which are based upon relational contracting (RC) principles, could lead to numerous benefits to all parties and uplift the industry performance. However, these practices still have not proliferated into the Sri Lankan construction industry, which continues to use the traditional system as the most popular procurement approach. Therefore, the need to identify the potential to develop RC cultures in the Sri Lankan construction industry was identified. Through the literature review, thirty factors facilitating RC and thirty-nine factors impeding RC was identified. A questionnaire survey was conducted among project team members of construction projects with Design-Bid-Build (DBB) and Design and Build (D&B) type arrangements, to gather the perceptions of the respondents in relation to the applicability and validity of these factors in the Sri Lankan context. The study revealed that overall, there is an environment conducive to the development of relationship-based procurement approaches in the Sri Lankan construction industry. It was identified that in general, the contractors were much more supportive towards adaptation of such practices and thereby shifting away from the traditional system than the consultants. In addition, it was revealed that as the level of integration within the project team improved, the project environment became more conducive towards RC approaches.

Keywords: Procurement, Relational Contracting, Facilitators, Impediments, Sri Lanka

1. Background

Most traditional forms of construction procurement rely upon segregated teams, fragmenting the construction process. The numerous drawbacks of this system such as, adversarial relationships, unhealthy competition, purely price-based selections, numerous change orders and improper risk-shedding tactics [1], creates a general atmosphere of poor co-operation, limited trust and ineffective communication in project teams, ultimately resulting in unsatisfactory project performance. In recent years, a number of studies and industry reports around the world have addressed these issues. Industry reports in Hong Kong [2], Singapore [3] and UK [4] have highlighted limited co-operation and fragmentation as impediments for proper consideration of issues such as, buildability, safety and life cycle costs in their respective construction industries [5]. Further, other studies, (for e.g. in Canada), have found that the cost of mistrust generated by confrontational situations inherent in the traditional contracts to amount to 8 – 20% of contract value [6]. All these have created an urgent need for new procurement approaches encouraging better relationships and team working within project teams, which has influenced a global shift towards "relational contracting (RC)" practices, such as partnering, alliancing, joint venturing, relationship contracting etc.

Recent local surveys have shown the dominance of traditional procurement systems in the Sri Lankan construction industry [7] and the stated weaknesses of these systems are quite common in the Sri Lankan context as well. Further, the future construction demands of the country are likely to call for increased efficiencies and performance from the industry. Therefore, considering all these, development of RC cultures in project delivery teams in the Sri Lankan construction industry, seems sensible and appropriate in the out set. However, RC is not a "one-size-fits-all" guaranteed fix, but rather a philosophy that must be tailored for each situation for which it is applied [8]. The successful implementation of a RC culture will undoubtedly present hard work, especially in an industry full of individuals well conditioned in working in adversarial climates.

Although, many countries around the world are quite advanced in the practice of RC approaches, it remains an unexplored area for research in the Sri Lankan context. The aim of this paper is to explore the potential for building a successful relationship-based procurement culture in the Sri Lankan construction industry. Specific objectives have been set to identify the factors (1) facilitating and (2) impeding the development of a RC culture in the Sri Lankan context and (3) to assess the capacity to adopt RC practices in the Sri Lankan construction industry.

2. Limitations of the traditional procurement system

Construction industry in any country is a complex, high-risk sector, dominated by contracts. It has strong backward and forward linkages with a large number of other industries such as, manufacturing, finance, labour etc. The construction industry has a direct impact on the national economy and is generally used as an indicator of economic well being of the country. It can influence a country's national economy in four aspects namely, production of specific and national basic needs, provision of fixed capital assets and infrastructure of a country, direct contribution to the Gross Domestic Product (GDP) and employment generation [9].

Despite its significance, the industry has and continues to suffer consistently from many weaknesses. There is a deep concern that the industry as a whole is under achieving [4]. The profitability and productivity levels in the construction industry are frequently acknowledged extremely poor in comparison to other industries. Studies have shown growing dissatisfaction among clients about the performance of the construction industry [4], indicating a rise in the demand for greater efficiencies and client focus. The industry is criticised for failing to meet the demands of the modern business environment, which require the ability to be competitive in the international market and provide best value for clients. Much of the blame has been placed on the traditional procurement systems and their limitations, which prevents the industry from performing up to its full potential.

It is the general view that the traditional Design-Bid-Build procurement approach provides a measure of protection to less informed developers and other clients, who lack faith in the professionalism of their contractors [8]. Fragmentation of the industry has been identified as one of the major disadvantages of the traditional system. A large part of the low performance of the UK construction industry has been blamed on fragmented teams over the past few decades [4]. The lack of co-operation, limited trust and ineffective communications between these fragmented parties lead to adversarial relationships, which often result in project delays, difficulties in claim resolution, cost overruns, litigation and win-lose mentality among parties. The traditional procurement environments are ineffective in managing interdependencies between design, construction and supply activities [10], thus affecting the quality and buildability of the design. Lack of communication and cooperation and fear of opening up claims exclude valuable contributions from parties. Furthermore, fragmented teams result in extra transaction costs being incurred between fragmented functions [11], which have a direct impact on the value of production. The transaction costs of competitive tendering may constitute 15-20% of the total project value [12] and includes, costs of negotiation, monitoring contractual performance, enforcing contractual promises and costs associated with breaches of contractual promises etc [13].

These limitations of the traditional procurement systems, makes such systems inappropriate in dealing with the changing market conditions, adapting new technological developments and meeting rising clients' expectations. This has lead many researchers to stress the importance of shifting away from the traditional procurement culture to improve the industry performance. Emphasis on Relational Contracting practices has been one of the most significant developments in this context.

3. Relational contracting

3.1 Concepts of relational contracting

The phrase "relationship contracting or RC" is intended to describe a spectrum of project delivery methods that emphasize and focus upon the relationship between parties to a construction project [14]. Relational contracts are regarded as informal agreements and codes of conduct between parties, sustained by the value of the future relationships that powerfully affect their behaviour [15]. In contrast to the traditional forms of construction contract, relational contracts are flexible in nature and provide a flexible response to information problems. It acts as a safe guarding mechanism designed to smoothen transactional friction and make provisions for "incomplete contract" in complex scenarios [16]. Relational Contracting (RC) defines the relationship of parties, who do not always govern themselves bounded by the strict legal framework of the contracts. They provide the relationship among the project participants the same level of importance as the project itself. The prominence given to the terms of the contract is less compared to that given to the relationship between parties. Practices such as, partnering, alliancing, joint venturing etc; are based upon these RC principles. RC approaches are useful in achieving the overall project objective of reducing the total of production and transaction costs. It offers a cost effective means of encouraging mutually beneficial behaviour, overcoming most of the limitations of the traditional procurement systems.

3.2 Benefits of relational contracting

A number of studies around the world have reported on the benefits of RC practices such as, partnering, alliancing etc. According to Thompson and Sanders [17], benefits achieved through partnering are in direct proportion to the risk assumed and dramatically increase as the relationship is unified and developed through the acceptance of uncertainty and a willingness to be vulnerable.

Most of the authors [17; 18; 19] have emphasised the lowering of the risk of time and cost overruns as main benefits of RC approaches, which are achieved as a result of better time and cost control over the project. Other than that, adopting RC practices is seen to provide an opportunity for innovation, especially in the development of value engineering changes and constructability improvement [19]. Evidence from the UK construction industry indicates that practices such as partnering and value management are providing a platform to develop sustainability strategies [10]. A case study on the National Museum of Australia [20], which was the first project alliance in building construction in the world, have observed significant added value to the client and many innovations resulting from the collective work of the parties to the contract. Many government organisations in UK that have adopted partnering have documented a decrease in litigation [17] owing to the framework for conflict resolution and improved communication. Furthermore, alliances are seen by smaller contractors, as an opportunity to join forces to work on large projects and to develop on the areas of work that need improvement [21].

Other than these measurable improvements, benefits of partnering (i.e. RC) include improvements in subjective areas such as worker morale as well [17]. This is achieved through the delegation of increased levels of authority in decision-making. Such authority raises the level of accountability of individuals and leads to increased commitment. A similar view is held by Lamont [22], who states that the empowerment, which is a direct result of partnering, can encourage individuals to work together more effectively.

The case studies and surveys around the world have proven and established numerous benefits of RC practices in the construction industry. The examples of such successful partnerships/alliances have encouraged a considerable number of clients and contracting organisations around the world to adopt these strategies. Partnering and alliances, which may be considered as the most widespread adaptations of RC in construction, has been well researched in many countries. Comprehensive case studies have been done on milestone projects, such as the National Museum of Australia [20], which has successfully adapted project alliancing to achieve significant benefits to all parties. Further studies in the area [8], have identified the factors facilitating and impeding partnering in countries such as, Singapore and Hong Kong. Sri Lankan construction industry however, is still far behind in this context. According to Rameezdeen [7], the only type of practice based on RC principles adopted in Sri Lanka is joint ventures (1-3%). This has also been attributed to the involvement of international contractors. However, in future as clients' expectations continue to rise, Sri Lanka will need to follow the initiative of countries such as, UK, Australia, Singapore etc; and shift towards project delivery processes encouraging cooperation and collaboration within project teams and supply chains, such as partnering. Therefore, it is worthwhile to investigate the factors, which are facilitating and deterring the adaptation of these practices in the present Sri Lankan context.

4. Research Method and Approach

4.1 Selection of respondents

The implementation of RC practices requires a change of attitudes and culture in the project delivery teams. This research sought to gather the perceptions of project team members, with respect to the applicability of thirty facilitators and thirty-nine impediments to RC identified through the literature survey in the Sri Lankan context. The inherent adversarial relationships present in the traditional DBB procurement culture was expected to form a barrier, in gathering data on the facilitators and impediments to RC, preventing any truly significant conclusion from being drawn up. To overcome this problem, two separate samples were selected from projects with traditional Design-Bid-Build (DBB) type procurement arrangements and projects with Design and Build (D&B) type procurement arrangements. It was decided that selection of ten construction projects with each type of procurement arrangement was a suitable and manageable sample size for this research. Selection of these two samples also enabled to explore any significant improvements in the facilitators to RC with higher degrees of integration in the project teams. The convenient sampling technique was used with the main purpose of securing a good response rate. In addition, the nature of the data collected was such that no bias could be expected by selecting the convenient sampling technique over random sampling.

RC approaches are generally advocated for large projects, which are able to gain the most benefits from implementing these approaches. This was also considered in selecting projects for this research and therefore, projects with large project values were selected. The project values of the selected projects ranged from Rupees forty-two million to Rupees ten billion. Out of the twenty projects selected, six (i.e. thirty percent) had project values greater than Rupees 1.5 billion. Only fifteen percent of the projects had project values less than Rupees 100 million.

In each DBB project, a member of the consulting team and a member of the construction team were selected and questionnaires were distributed to them. In the projects with D&B arrangements, the same team (from a single organisation) acted as the design and the construction team. Therefore, in this instance, a single questionnaire was given to a member of the project team.

Table 1: Facilitators and Impediments to RC

	Facilitators to RC		Impediments to RC
1	Senior management "championing" of the partnering (i.e. RC) process	**1**	Prevailing attitude of cynicism
2	Empowering decision making process at the lowest possible level	**2**	Rigid / preconceived attitudes about specific sectors / partners
3	Support and enthusiasm of the client	**3**	Lack of belief in the effectiveness of partnering
4	Client's knowledge about the project processes	**4**	Too narrowly focused role / job
5	Vertical intra-organisational trust	**5**	Restricted internal / external authority
6	Mutual trust among parties	**6**	Lack of understanding of RC concepts
7	Efficient communication	**7**	Inadequate partnering skills
8	Effective coordination of parties	**8**	Lack of RC experience
9	Team working spirit of all parties	**9**	Conflicting priorities
10	Timely responsiveness	**10**	Competitiveness (within sector)
11	Alignment of project objectives of parties	**11**	Intolerance of other sectors
12	Alignment of commercial objectives of parties	**12**	Incompatible organisational cultures
13	Adhering to mutual goals	**13**	Lack of competency to perform
14	Mutually agreed performance appraisal mechanisms	**14**	Poor communication
15	Mutually agreed dispute resolution mechanisms	**15**	Lack of top management commitment
16	Combined responsibility of parties	**16**	Up front time required and cost for implementing RC
17	Continuous periodic evaluation	**17**	Bureaucratic client organisations
18	Long-term commitment	**18**	Poor project planning
19	Adequate resources of parties	**19**	Inappropriate procurement strategies
20	Experience in RC approaches	**20**	Inappropriate risk allocation/sharing
21	Learning culture within project teams	**21**	Price only selection methods
22	Capacity for innovation	**22**	Ambiguous contract clauses/documents
23	Positive attitude towards continuous improvement	**23**	Lack of scope for innovations
24	Flexible contracts to address uncertainties	**24**	Lack of client's initiatives
25	Encouraging and motivating risk-reward plans	**25**	Lack of team working attitude
26	Inclusion of all key parties in risk-reward plan	**26**	Lack of trust
27	Equitable risk allocation / sharing arrangements	**27**	Inappropriate issue resolution mechanisms
28	Clearly defined risk allocation / sharing arrangements	**28**	Separate coordination and monitoring plans
29	External facilitators	**29**	Being conditioned in win-lose environments

30	Conducting work shops for relationship building	**30**	Potential legal liabilities in resolving non-contractual issues
		31	Commercial pressures of contacting parties
		32	Absence of a risk-reward plan
		33	Exclusion of consultants from the risk-reward plan
		34	Exclusion of major subcontractors from the risk-reward plan
		35	Exclusion of major suppliers from the risk-reward plan
		36	Externally determined reward system for middle management or site staff
		37	Separate / unrelated risk-reward plans for different parties
		38	Local social / political / economic climate
		39	Incompatible public sector rules and regulations

4.2 Profile of Respondents

All the respondents fall into the category of 'professionals'. Some held senior or middle management positions within their respective organisations. Therefore, all the respondents were actively interacting and dealing with members from other organisations working in the project team. Thus, their views on the facilitators and impediments to the development of more collaborative working relationships were developed through hands-on experience of working with other project parties. Table 2 gives the years of experience of the respondents in the construction industry. On average, respondents have worked in the industry for 14 years. Seventy-seven percent of the respondents had over six years of experience in the industry.

Table 2: Years of Experience in the Construction Industry

Years of Experience	Number	Percentage (%)
1-5	7	23
6-10	6	20
11-15	5	16
16-20	5	16
21-25	4	13
Over 26	3	10
Total	30	100

4.3 Design of the Questionnaire

The questionnaire was divided into two main sections. The first section sought general information about the respondents, while the second section sought the respondents' perceptions on the factors facilitating /impeding collaborative working between project parties in that particular project. Facilitators and impediments to RC, which were found through the literature review were analysed and factors such as, mutual objectives, external facilitators, past experience in RC practices etc; which obviously was not applicable to the Sri Lankan context, where no RC approaches are being practiced were excluded. The remaining factors were combined and thirty-seven items were obtained. The questionnaire requested the respondents indicate their degree of agreement, on a seven-point Likert scale ranging from disagree very strongly to agree very strongly, on each of the issues considering the selected projects. Therefore, care was taken to have a roughly equal number of positively and negatively worded items, to force the respondent to consider each item carefully, thereby minimizing the effect of responses automatically set towards either agreement or disagreement. A seven-point Likert scale was chosen as appropriate for the purpose of this research as it is easy to understand and interpret by respondents and discriminates well between respondents' perceptions. Furthermore, as this questionnaire dealt with factors, which may be perceived as sensitive to the respondents, it was decided to use a neutral point on the scale to avoid forcing the respondents to one side and alienating them, thus resulting in fewer completed surveys.

As the data collected using the Likert scale were ordinal in nature, it was not possible to carry out arithmetical calculations such as, mean or standard deviation [23]. Instead, the median and the inter quartile range were used. The median was taken to represent the average response of the respondents. The Mann-Whitney *U* test, which is the nonparametric equivalent of the independent samples t-test, was used to detect any differences in the respondents' perceptions between groups. The Mann-Whitney *U* tests were designed to distinguish between the perceptions of, (1) the project team members in Design-Bid-Build and Design and Build type projects and (2) the contractors and consultants in Design-Bid-Build projects

5. Data analysis and discussion

5.1 Factors Facilitating RC in the Sri Lankan Context

Considering the median responses given by the respondents, thirty out of the thirty-seven factors considered could be regarded as factors facilitating the development of RC in the current Sri Lankan context. Out of these, nearly seventy-five percent of the respondents 'agreed', 'agreed strongly' or 'agreed very strongly' that there is vertical intra-organisational trust and top management commitment towards developing cooperative relationships between project parties. The results also indicated that none of the respondents disagreed to the statements that their organisations possessed good competency to perform and that there was good capacity for innovation within the project team. Similarly, there was strong agreement among respondents to the statement that there was a mutually agreed dispute resolution mechanism in the projects. With respect to above three items seventy-five percent of the respondents stated that they 'agree', 'agree strongly' or 'agree very strongly' with the statements, whereas the remaining 25% of the respondents were 'undecided' on the issue.

Factors such as, open and efficient communication between parties, effective coordination between parties, team working attitude of all parties and mutual trust among parties, which are essential in building a RC culture, all had a median of 5. This meant that on average respondents 'agreed' that these factors were present in the current project environments. These factors, along with top management support were found to be the most important facilitators of RC in the works of Cheng and Li [24] and Kumaraswamy et al [8]. Thus, the presence of these factors to this extent in the present project environment, where polarisation of parties is expected due to past experiences of adversarial relationships, disputes etc; is an important aspect.

5.2 Factors Impeding RC in the Sri Lankan Context

On average, the respondents agreed that commercial pressures on organisations prevented them from working co-operatively with other project parties. This was especially relevant to the contractors, as increased competition, as well as lowest price selections, had forced them to operate in increasingly tight margins. Thus, they are forced to compromise and choose between developing collaboration and better relationships with project parties having conflicting objectives to their own and their own objectives of profit maximisation. The result was consistent with the findings of the Construction Industry Institute of Australia (CIIA) study, where there was strong agreement among respondents that commercial pressures on organisations was a barrier to developing successful partnering relationships.

In addition to above, median responses of ‘undecided’ were obtained for six items, where the responses were spread in an equal manner between agreement and disagreement. For instance, the results revealed that the respondents were divided between agreement and disagreement, with respect to long-term commitment of the other project member organisations, the ability of their own organisations to work collaboratively with competitor organisations, equality between project parties, timely responsiveness to problems, joint responsibility for the project outcome and arrangements to share rewards as well as risks. Therefore, it was necessary to investigate these items further and explore if the perceptions improved with integration of teams, by comparing between DBB and D&B projects before a conclusion could be made.

5.3 Differences in Ratings by Consultants and Contractors in DBB Projects

The Mann-Whitney *U* test was carried out using SPSS (which is a computer software for statistical calculations), to assess whether there were any significant differences between the contractors and consultants of DBB projects. The results show that thirty out of the thirty-seven factors considered had a significance level greater than 0.05. Therefore, the null hypothesis, H_0 is supported for these thirty factors. The remaining seven factors had a significance level lower than 0.05. Therefore, for these factors the alternative hypothesis, H_1 is accepted. This means that with regard to these seven factors, there are different perceptions in the two groups of respondents.

There were considerable differences between the opinions of the two groups with respect to four items. Seventy-five percent of the contractors were willing to allow small losses to their own organisations in expectation of end of the project mutual gains or future projects from clients. This was indicative of the long-term commitment of the contractors, which is an important facilitator to RC. However, all of the consultants were either undecided or disagreed with the statement. All the contractors were either ‘undecided’ or ‘disagreed’ with the statement that all project parties were held jointly responsible for the outcome of the project, while none of the consultants disagreed with the statement. The contractors’ responses were indicative of their frustration that the consultants were able to escape blame for problems in design and design communication. Altogether, the responses indicate that generally contractors have a more conducive attitude towards developing collaborative relationships within the project teams.

5.4 Differences in Ratings by Respondents in DBB and D&B projects

In addition, Mann-Whitney *U* tests were carried out to assess whether there were any significant differences between DBB and D&B project cultures. Results indicated that twenty-five out of the thirty-seven items considered have a significance level greater than 0.05. Thus, for these items the decision is to accept the null hypothesis H_0 that there are no differences in opinions between the two groups of respondents. Conversely, the remaining twelve factors had a significance level lower than 0.05, leading to acceptance of the alternative hypothesis H_1.

All the items, except one, showing significant differences between the two groups indicated better facilitators to RC in D&B project cultures. There were noteworthy differences between the two groups with regard to equality between parties within the project team and timely responsiveness to problems. In DBB, projects 50% of the respondents ‘disagreed’, ‘disagreed strongly’ or ‘disagreed very strongly’ to the statement that there was equality between project parties. Whereas, less than 25% of the respondents form D&B projects ‘disagreed’ with the statement. The consultants’ dominant position in the DBB project teams, especially in approving payments to contractors was significant in affecting the equality between parties in these projects. Furthermore, more than 50% of the respondents in DBB projects disagreed that there was timely responsiveness to problems arising in projects. This was interrelated to the fact that there was poor coordination in these projects. Over 50% of the respondents in DBB were undecided or disagreed (with 25% of the respondents stating they ‘disagree strongly’ or ‘very strongly’) to the fact that there was effective coordination within the project team. On the other hand, 75% of the respondents from the D&B projects stated varying degrees of agreement to the statement. Similarly, project team members from D&B projects were more supportive towards trying to reach win-win solutions to problems. This indicated that a change of adversarial attitudes was possible through better integration in the project process.

However, a surprising result was obtained for one item, where 100% of the respondents from D&B projects agreed that commercial pressures on their organisations were preventing them from working cooperatively with other project parties. On the contrary, the respondents from DBB projects gave a median response of ‘disagree’ to the statement, with less than 50% of the respondents stating that they agree with the statement. This may be explained by the fact that the D&B projects considered in the research had rigid lump sum contracts and the statement applied especially to the relationship between the D&B team and the client. In fact, in two of the projects considered there was expressed disagreement between the client and the D&B contractors with respect to claims for price fluctuation.

Overall, the test results revealed that the D&B projects had stronger facilitating environments to RC than DBB projects. Therefore, the hypothesis, that as relationships between project parties improve through integration of project teams, the project environment seemed more conducive to RC approaches was accepted.

6. Conclusions

In general, the results showed that there is a facilitating environment to Relational Contracting in the Sri Lankan construction industry. However, the factors facilitating better relationships between parties in the traditional Design-Bid-Build procurement environments are overridden by barriers to corporative working such as, adversarial climates, conflicting objectives, commercial pressures and other inherent pressures created by the traditional procurement environments. The dominant position held by the consultants in the traditional Design-Bid-Build project teams over the contractors had added on to these pressures. Commercial pressures on organisations were found to be the most prominent impediment to developing and maintaining cooperative relationships between parties.

Further, comparison of perceptions of contractors and consultants in Design-Bid-Build projects revealed that, contractors were more supportive towards the development of collaborative project environments than the consultants. This showed the frustration of the contractors towards the inferior position they are constantly given within project teams, as well as the unwillingness on the part of consultants to give up their dominant position. Mann-Whitney *U* tests between Design-Bid-Build and Design and Build project team members revealed that the factors facilitating RC were stronger in the Design and Build environments. Significant improvements were found in Design and Build projects with respect to equality between project parties, timely responsiveness to problems and the willingness of project parties to reach win-win solutions to disputes. However, a surprising finding was made with respect to one item. All the respondents from Design and Build projects agreed that commercial pressures on their organisations were preventing them from working cooperatively with other project parties, whereas, the respondents from Design-Bid-Build projects on average, disagreed with the statement. The discrepancy was attributed to the rigid lump sum contracts used in majority of the Design and Build projects, and their effect on the relationship between the client and the Design and Build team. Nevertheless, overall it could be seen that there were more or stronger facilitators to RC with increased integration in project teams. This complimented the findings of Kumaraswamy et al [11] and their statement that approaches to building a RC culture can be reinforced through measures to promote integrated teams could be held valid to the Sri Lankan context as well.

It was revealed that the research findings concurred with the findings of similar researches done in other countries. Therefore, it could be deduced that the results obtained have a high reliability. Further, these findings make all the relevant international literature on this area applicable to the Sri Lankan context as well. RC based approaches, such as, partnering and alliances are not practiced in the Sri Lankan construction industry. Therefore, the validity of the results could not be explored in a real RC culture.

Drawing from the results of this study, it is recommended that initiatives should be taken in shifting away from the traditional project delivery strategies towards RC. Measures should be taken to promote integrated teams in project delivery process. The government and other industry related institutions could initiate this movement by promoting integrated project teams and supply chains following the initiative of Construction Industry Review Committee (CIRC) of Hong Kong and Strategic Forum for Construction in UK. At the same time, awareness should be given to clients (especially clients of large scale or repetitive construction projects) on these RC practices and the potential benefits that could be obtained through their adaptation.

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A tool for strategic safety-rating of constructors

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Abstract

The construction industry has poor safety records in globally. Improving safety has been an important goal for the WorkCover, Australia. Setting up a rating system for contractors that evaluates them on their safety records and the workplace safety programs in place would be a good strategy towards this goal. This paper proposes a model that serves this purpose. The proposed model can derive a safety index for a contractor, which may be utilised as one of the factors for tender evaluations by clients whereby better-rated contractors may be favoured. It could also be used by insurance companies so that lower insurance premiums for better-rated firms. The implementation of the model in the WorkCover can facilitate accident control in the construction industry.

Keywords: Occupational health and safety, Safety index, Tender evaluation, Insurance, WorkCover, Australia

1. Introduction

The construction industry appears to have poor safety performance records globally. It was reported that the construction industry of the Unites States accounted for only 5% of the United States' workforce but claimed a disproportionate 20% of all occupational fatalities and 9% of all disabling injuries [12]. In Great Britain, construction accounted for 31% of all work-related deaths in 2002/03 [5]. The incidence of workplace fatalities in the Australian construction industry was 9.2 fatalities per 100 000 employees in 2002–03 which was three times higher than the national average of 3.1 fatalities per 100 000 employees [4]. Raising safety standards by introducing new laws and frameworks has been a goal for safety authorities like the Health and Safety Executive (HSE) in the UK, Occupational Safety and Health Administration (OSHA) in the US and the WorkCover in Australia. It is hypothesised that setting up a new rating system for construction companies that evaluates them on their safety performances would be a good strategy towards this goal. The rating may be utilised as one of the factors for tender evaluations whereby better-rated contractors may be favoured. It could also be used by insurance companies so that lower insurance premiums for better-rated firms. A company that pays lower premium for insurance would be more competitive in bidding.

Safety rating has received broad attention in the construction literature. There are few previous efforts that introduced models for safety rating including: Experience Modification Rating (EMR), Accident Rate (AR), Incident Rate (IR), Score Card (SC), and Safety Performance

Evaluation Framework (SPE). The EMR reflects the cost a contractor has to pay for workers' compensation insurance. Workers' compensation is directly related to safety performance via claims paid due to accidents. It is calculated by taking the ratio between the dollar amount of actual workers' compensation claims filed to the dollar amount of expected claims for a particular type of construction, and is a three-year running average starting one year prior to the last full year. Thus, an EMR of 1.2 means that a contractor has to pay 20% more for workers' compensation insurance than a similar company with an EMR of 1.00 [7]. However, this method is not reflective of the present safety performance of a company since the latest EMR is based on an average of a contractor's performance four, three and two years ago [9]. The AR measures a contractor's safety performance simply by the number of reported accidents. Contractors diligently reporting and investigating accidents are disadvantaged in comparison with less scrupulous contractors who under-report accident occurrence [17]. The IR is computed based on the number of lost time cases, number of days lost for all lost time cases and number of fatalities, injuries and illness with or without lost workdays. Similar to the AR, the accuracy of the IR depends on how honest a contractor in revealing the reportable incidents [13]. In the SC system, six key aspects are rated in projects including: provision and maintenance of plant, provision and maintenance of work environment, provision of information, instruction and training, provision and implementation of safety systems of work, employment of safety officers/supervisors, and site accident records. The weighted score reflects the safety performance of the contractor. However, the key weakness of the system is that it only considers safety commitment at project level [13]. The SPE framework takes into account of safety commitment at project and organisational level. However, this model totally ignores a contractor's accident history which reflects the actual execution of implemented safety programs. Hence, the aim of this study is to develop an effective tool for safety-rating of construction companies. The specific objectives are:

- Identifying and exploring the factors that need to be assessed for safety-rating of contractors;
- Developing an effective model for safety-rating of contractors; and
- Automating the model as a fuzzy system.

However, due to word limitation this paper discusses only the proposed safety-rating model for contractors, and the subject is discussed in various sections in due order. Firstly, the hypothesis, aim and objectives of the research are outlined in the introduction. Secondly, the literature review findings on safety performance evaluation methods and variables are described. Then a new model for safety rating is proposed followed by the conclusion.

2. Evaluating contractor's safety performance

It was found in the literature that the equal assessment of three key factors is important to evaluate the safety performance of contractors.

1. Dingsdag [4] quoted that sustained improvement in safety performance on sites will not happen without an established safety culture at organisational level. Thus, evaluating the

safety culture in a contractor organisation is a key factor towards safety performance evaluation.

2. Mohamed [11] argued that the existence of safety climate on sites leads to safe work behaviours by operatives and thereby lesser accident rates. Measuring the safety temperature on site is therefore a key factor for safety performance evaluation.
3. While the previous two factors are pro-active and they are good measures of risk exposure, it is important to monitor how safe work behaviour is practised at both organisational and project levels through an obvious indicator. Every contractor is required to procure workers' compensation insurance to transfer the compensation liability for occupational injury victims as set out by Workers' compensation ACT. Thus, it is likely that contractors will report all the incidents diligently to the insurer to relieve them from financial burden of compensating. Hence, the usage of workers' compensation data to develop a passive indicator would be a reasonable step in this regard.

2.1 Measuring organisational safety culture

Organisational culture is defined as "a complex framework of national, organisational and professional attitudes and values within which groups and individuals function" [6]. Part of that culture in hazardous industries relates to safety, which is the "ability of organisations to deal with risks and hazards so as to avoid damage or losses and yet still achieve their goals" [14]. In construction, the safety culture is concerned with the ability to manage safety with a top-down organisational approach [11]. Safety climate on construction sites is a product of safety culture in the organisation. Many authors defined the components of a good safety culture as described below.

- Jaselskis [10] and Parker [14] recommended the following features to cultivate a good safety culture in a contractor organisation:
  1. The availability of a safety department of adequate size and competency with set benchmarks, aims, objectives, action plans and responsibilities.
  2. Adequate safety investments by the organisation to strengthen upper management attitude towards safety.
  3. Adequate number of safety meetings conducted between upper management and field safety representatives and between upper management and subcontractors.
  4. Adequate number of informal site inspections made by upper management. Choudhry [3] reinforced that the top management of an organisation with good safety culture would commit to conducting safety climate surveys on construction sites to ensure employees are motivated to adhere to standard work procedures.
  5. The existence of reward systems to recognise good safety performances by the upper management and the safety department members.
- Reason [15] proposed that an organisation with an effective safety culture would have a safety management information system. The desired features for a construction safety management information system were recommended by various authors as described below.
  1. Sorine & Walls [18] emphasized the need of a module to store, analyse, update and communicate necessary safety information on standard job procedures which includes: (1) sub-steps, potential hazards associated with each sub-step, and recommended

precautionary measures; (2) history of previous incidents and near misses in sub-steps with causes and effects; (3) regulatory mandates regarding a sub-step.

2. Blotzer [1] suggested having a module for accident reporting and investigation, and safety reminders.
3. Rivers [16] recommended incorporating a module to capture direct and indirect costs of accidents, analyse these data and produce various accident cost summaries for the project and for the company as a whole for disseminating to site and upper managements. This information can motivate safety professionals to set safety benchmarks and goals both at organisational and site levels. The direct costs include: workers' compensations; equipment repair and replacement costs; fines, fees and settlements; damages to works and temporary structures. The indirect cost refers to the cost of production downtime.
4. Cheung [2] quoted that the integration of such computer technologies as web, database and knowledge base is essential to produce a robust safety management information system for construction.

2.2 Measuring safety climate on site

Mohamed [11] identified ten constructs that establish a good safety climate on site, viz:

1. Commitment construct – the greater the level of management commitment towards safety, the more positive the safety climate.
2. Communications construct – the more effective the organisational communications dealing with safety issues, the more positive the safety climate.
3. Safety rules and procedures construct – the better the perception of safety rules and procedures, the more positive the safety climate.
4. Supportive environment construct – the higher the level of support given by co-workers, the more positive the safety climate.
5. Supervisory environment construct – the more safety aware and relationship oriented the supervisors, the more positive the safety climate.
6. Workers' involvement construct – the higher the level of workers' involvement in safety matters, the more positive the safety climate.
7. Personal appreciation of risk construct – the higher the level of workers' willingness to take risk, the less positive the safety climate.
8. Appraisal of physical work environment and work hazards construct – the greater safety's integration in site layout planning to identify safety hazards, the more positive the safety climate.
9. Work pressure construct – the higher the perception of valuing expediency over safety, the less positive the safety climate.
10. Competence construct – the greater one's experience and knowledge of safety issues, the more positive the safety climate.

Imriyas [8] introduced a comprehensive list of factors with their respective attributes for facilitating safety climate measurements in construction projects, and Table 1 summarises those factors. Despite the table lists most of the key elements of safety climate measurement, it could be improved by adding two more factors: (1) Incentive systems for encouraging workers' involvement in ensuring the safety of oneself and co-workers, (2) Work pressure and operational targets that conflict with safe behaviours.

Table 1: Project safety auditing roster

Safety element	Audit aspect
1. Project safety organisation	• Adequacy of the team & duties & responsibilities
2. Hazards assessment & management	• Adequacy of the in-house hazard assessment system for the project
3. Safe work practices	• Application of safe work procedures & codes of practice • Permit-to-work systems • Personal protective equipment usage
4. Safety training and competency of people	• Safety training to management team • Certification & safety training of operators • In-house safety training to workers
5. Safety inspection	• Regular inspection of hazardous activities & the work site • Housekeeping
6. Machinery & tools use & maintenance regime	• Testing & certification of machinery • Inspection systems for machinery & tools • Maintenance systems for machinery
7. Sub-contractors' safety systems	• Sub-contractors' safety management systems • Sub-contractor monitoring
8. Emergency management system	• Emergency response plan • Emergency response team • Emergency response equipment and facilities

(Source: Imriyas [8])

2.3 Measuring safety implementation through workers' compensation

Workers' compensation provides valuable protection to workers and their employers in the event of a workplace injury or disease. All Australian employers must have a workers' compensation insurance policy to insure themselves against compensation claims for workplace accidents. Depending on the nature and severity of the injury, an injured worker may be eligible for the following benefits:

- Fees for medical and related treatments - include payments made to medical specialists, hospitals and other health service providers in respect of injured workers.
- Weekly benefits – if a worker becomes unfit for work for a short period due to a workplace injury (known as partial incapacity), the worker is entitled to receive weekly benefits until he/she becomes normal or up to a maximum of 52 weeks, whichever is lesser.
- Permanent impairment benefits - if a worker has a permanent impairment as a result of a workplace injury or illness, he/she may be entitled to receive a permanent impairment benefit.
- Death benefits and funeral expenses - the benefits payable when a worker dies as a result of a workplace accident include a lump sum and weekly payments, together with payment for reasonable funeral expenses.

The total amount of workers' compensation claims that a contractor has filed in a construction projects is a passive indicator of the frequency and severity of accidents in that project, which in turn is the result of the effectiveness of safety management. The EMR, as used in the US, represents the claims history of a contractor, but it does not take into account of the recent claims until after two years from the accident outbreak. However, a modified method would be a reasonable indicator of the previous and recent safety performances on site.

3. Proposed model for safety rating of contractors

Based on the finding of the literature reviews above, a new model for safety rating of contractors was developed as depicted in Figure 1. As per the proposed model, the Contractor Safety Performance Index (CSPI) is computed by assessing three intermediate indices using a fuzzy algorithm, as shown in Eq.1, and 0≤*CSPI*≤1.00. If a contractor's safety performance is excellent, the CSPI will yield a score of 1.00. Otherwise, it would yield a score between 0 and 1.00.

$$CSPI = f\left(PSCI, OSCI, ICLR\right)$$

Eq. 1

Where:

1. *PSCI* is the project safety climate index, which is computed by analysing 10 project safety elements as per the framework shown in Table 2. The computation of the *PSCI* adopts a fuzzy algorithm as shown in Eq.2 below.

$$PSCI = f\begin{pmatrix} PSO_{score}, HAS_{score}, SWP_{score}, STC_{score}, SIS_{score}, \\ MTS_{score}, SSS_{score}, EMS_{score}, WIS_{score}, WP_{score} \end{pmatrix}$$

Eq.2

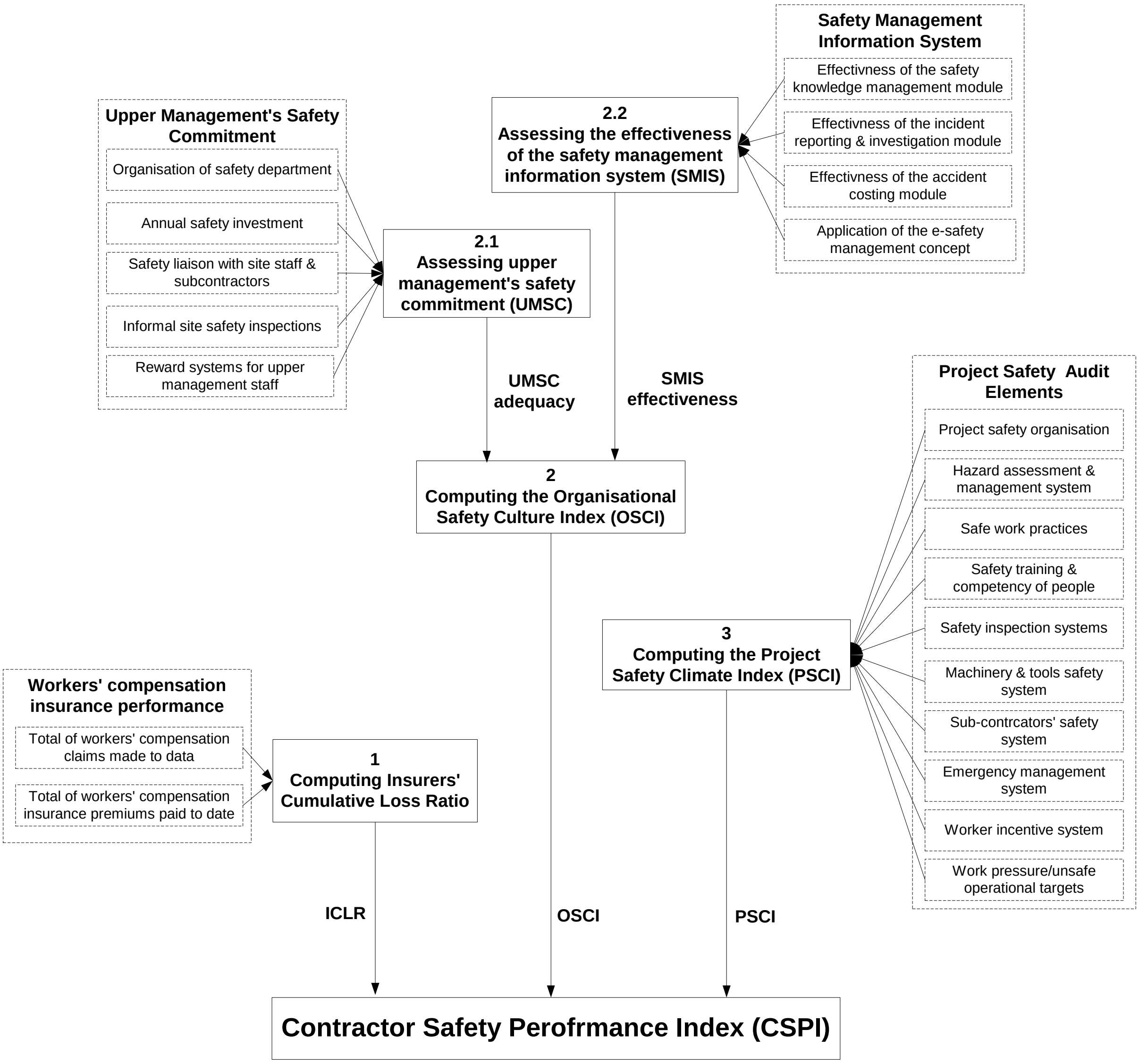

Figure 1. Proposed model for contractor safety rating

2. *OSCI* is the organisational safety culture index, which is computed by equally analysing the adequacy of upper management commitment to safety ($UMSC_{adequacy}$) and the effectiveness of the safety management information system in the organisation ($SMIS_{effectiveness}$), as shown in Eq.3.

$$OSCI = \frac{1}{2} x \left(UMSC_{adequacy} + SMIS_{effectiven\,ess} \right)$$

Eq.3

- The $UMSC_{adequacy}$ is computed by a fuzzy algorithm as in Eq.4, analysing five variables: organisation of safety department (SD_{score}), annual safety investment (ASI_{score}), safety liaison with site staff and sub contractors (SL_{score}), informal site safety inspection (SI_{score}) and reward system for upper management staff (RS_{score}).

$$UMSC_{adequacy} = f\left(SD_{score}, ASI_{score}, SL_{score}, SI_{score} RS_{score}\right)$$

Eq.4

- The $SMIS_{effectiveness}$ is computed by another fuzzy algorithm in Eq.5, analysing four variables: the safety knowledge management module (SKM_{score}), the incident reporting and investigation module (IRI_{score}), the accident costing module (AC_{score}), and the application of e-safety management concept (e-safety_{score}).

$$SMIS_{effectiven\ ess} = f\left(SKM_{score}, IRI_{score}, AC_{score}, e - Safety_{score}\right)$$

Eq.5

3. The *ICLR* is insurers' cumulative loss ratio, which is computed by analysing the total amount of workers' compensation claims filed by the contractor from the last 3 projects and the amount of workers' compensation insurance premiums paid for those projects. Eq.6 is utilised to compute the *ICLR* value.

$$ICLR = \frac{Total\ claims\ filed\ to\ date}{Total\ premiums\ paid\ to\ date}$$

Eq.6

The model was translated into a fuzzy expert system in which equations 1, 2, 3, 4, 5 and 6 were incorporated for computations. However, the development and the validation of the fuzzy system are not described here due to word limitations, and they are described in another paper by the author.

Table 2: Framework for evaluating safety climate on construction sites

Estimating the Project Safety Climate Index						
A) Project safety organisation						
Please rate the adequacy of the duties and responsibilities of the following personnel/team in the project safety organisation.	Low………………………...High					
1. Workplace safety and health coordinator	1	2	3	4	5	
2. Workplace safety and health auditor	1	2	3	4	5	
3. Workplace safety and health committee	1	2	3	4	5	
PSO $_{score}$						
B) Hazards assessment and management system						
Please rate the adequacy of the following aspects of the risk assessment and management system in the project.	Low………………………...High					
1. Risk assessment team and responsibilities	1	2	3	4	5	
2. Risk assessment procedures	1	2	3	4	5	
3. Reporting procedures to workers of identified risks	1	2	3	4	5	
4. Control measures for risks identified	1	2	3	4	5	
HAS $_{score}$						
C) Safe work practices						
C.1) Work procedures: Please rate the effectiveness of the work methods and procedures for the following trades.	Low…………………………….High					
1. Concrete works	1	2	3	4	5	NA
2. Structural steel and pre-cast assembly	1	2	3	4	5	NA
3. Erection and dismantling of scaffolds and false works	1	2	3	4	5	NA
4. Works at heights	1	2	3	4	5	NA
5. Demolition works	1	2	3	4	5	NA
6. Excavation works	1	2	3	4	5	NA
7. Piling operations	1	2	3	4	5	NA
8. Welding and cutting works	1	2	3	4	5	NA
9. Works in confined spaces	1	2	3	4	5	NA
10. Works in toxic/contaminated environments	1	2	3	4	5	NA
11. Use of construction plant such as excavators, trucks, etc.	1	2	3	4	5	NA

Estimating the Project Safety Climate Index						
12. Use of cranes	1	2	3	4	5	NA
13. Electrical installation and use	1	2	3	4	5	NA
Sub-section score						
C.2) Permit-to-work (PTW) systems: Please rate the effectiveness of the PTW systems for the following trades.	Low…………………………….High					
1. Working at heights	1	2	3	4	5	NA
2. Excavation works	1	2	3	4	5	NA
3. Working in confined spaces	1	2	3	4	5	NA
4. Welding and cutting works	1	2	3	4	5	NA
5. Demolition works	1	2	3	4	5	NA
6. Working in toxic/contaminated environments	1	2	3	4	5	NA
Sub-section score						
C.3) Personal protective equipment(PPE) use: Please rate the adequacy of the PPE use for the following trades.	Low…………………………..…High					
1. Concrete works	1	2	3	4	5	NA
2. Structural steel and pre-cast assembly	1	2	3	4	5	NA
3. Erection & dismantling of scaffolds & false works	1	2	3	4	5	NA
4. Works at heights	1	2	3	4	5	NA
5. Demolition works	1	2	3	4	5	NA
6. Excavation works	1	2	3	4	5	NA
7. Piling operations	1	2	3	4	5	NA
8. Welding and cutting works	1	2	3	4	5	NA
9. Works in confined spaces	1	2	3	4	5	NA
10. Works in toxic/contaminated environments	1	2	3	4	5	NA
11. Use of machinery such as excavators, trucks, etc.	1	2	3	4	5	NA
12. Use of cranes	1	2	3	4	5	NA
13. Electrical installation and use	1	2	3	4	5	NA
Sub-section score						

Estimating the Project Safety Climate Index						
SWP_{score}						
D) Safety training and competency of people involved						
D.1) Safety training to management team: Please rate the adequacy of the safety training to the following personnel in the project.	Low…………………………..……High					
1. Demolition supervisor(s)	1	2	3	4	5	NA
2. Excavation supervisor(s)	1	2	3	4	5	NA
3. Piling supervisor(s)	1	2	3	4	5	NA
4. Lifting supervisor(s)	1	2	3	4	5	NA
5. Scaffold and/or suspended scaffold supervisor(s)	1	2	3	4	5	NA
6. False work supervisor(s)	1	2	3	4	5	NA
7. Welding & cutting supervisor(s)	1	2	3	4	5	NA
8. Confined space work supervisor(s)	1	2	3	4	5	NA
9. Toxic/contaminated environment work supervisor(s)	1	2	3	4	5	NA
10. Project management team members	1	2	3	4	5	NA
Sub-section score						
D.2) Certification & safety training of operators: Please rate the adequacy of the certification & safety training of the following operators in the project.	Low……………………………..…High					
1. Crane erector(s)	1	2	3	4	5	NA
2. Crane operator(s)	1	2	3	4	5	NA
3. Riggers(s)	1	2	3	4	5	NA
4. Signal men	1	2	3	4	5	NA
5. Scaffold erector(s) and/or suspended scaffold rigger(s)	1	2	3	4	5	NA
6. Erectors of hoists and lifts	1	2	3	4	5	NA
7. Operators of hoists and lifts	1	2	3	4	5	NA
8. Operators of plant like excavators, bull dozer, etc.	1	2	3	4	5	NA
9. Construction vehicle drivers	1	2	3	4	5	NA
Sub-section score						
D.3) In-house safety training to workers:	Low…………..…………………..…High					

Estimating the Project Safety Climate Index						
Please rate the adequacy of the following modules of the in-house safety training to workers in the project.						
1. Site rules & regulations, and proper use of PPE	1	2	3	4	5	
2. Emergency response for various possible incidents	1	2	3	4	5	
3. First aid procedures	1	2	3	4	5	
4. Safe handling of tools and equipment	1	2	3	4	5	
Sub-section score						
***STC** score*						
E) Safety inspection system						
E.1) Inspection of worksite: Please rate the adequacy of the inspection system for the following items in the project.	Low………..……………....High					
1. Excavations by a competent person on a daily basis and after hazardous events (e.g. inclement weather)	1	2	3	4	5	NA
2. Scaffolding by a scaffold supervisor on a weekly basis and after inclement weather	1	2	3	4	5	NA
3. False works by a PE or other competent person before, during and after casting and after inclement weather	1	2	3	4	5	NA
4. Demolition by a competent person on a daily basis and after inclement weather	1	2	3	4	5	NA
5. Material loading platform by a competent person on a regular basis and after inclement weather	1	2	3	4	5	NA
6. Temporary structures such as site office, canteen, site hoardings & concrete batching plant on a regular basis	1	2	3	4	5	NA
7. Specialised structures or operations like use of customised shoring systems by a competent person	1	2	3	4	5	NA
8. General site by a safety personnel or the site manager	1	2	3	4	5	NA
Sub-section score						
E.2) Housekeeping: Please rate the adequacy of the housekeeping for the following locations/items in the project.	Low…...…………………High					
1. Construction worksite	1	2	3	4	5	NA
2. Workers' quarters	1	2	3	4	5	NA
3. Toilets and washing facilities	1	2	3	4	5	NA
4. Canteen or eating places	1	2	3	4	5	NA
5. Site offices	1	2	3	4	5	NA
6. Storages for materials, tools & wastes	1	2	3	4	5	NA

Estimating the Project Safety Climate Index						
Sub-section score						
***SIS**$_{score}$*						
F) Machinery and tools use and maintenance regime						
F.1) Testing & certification of machinery: Please rate the adequacy of the testing & certification of the following machinery in the project.	Low…………………….High					
1. Lifting gears (12 monthly)	1	2	3	4	5	NA
2. Lifting appliances (12 monthly)	1	2	3	4	5	NA
3. Lifting machines (12 monthly)	1	2	3	4	5	NA
4. Hoists and lifts (6 monthly)	1	2	3	4	5	NA
5. Air receivers (24 monthly)	1	2	3	4	5	NA
6. Explosive power tools (36 monthly)	1	2	3	4	5	NA
Sub-section score						
F.2) Inspection of machinery & tools: Please rate the adequacy of the inspection system for the following machinery in the project.	Low…………………….High					
1. Cranes by crane operators on a daily basis	1	2	3	4	5	NA
2. Electrical distribution board by a competent person on a daily basis	1	2	3	4	5	NA
3. Electrical equipment and tools by a competent person on a regular basis (weekly/more frequent)	1	2	3	4	5	NA
4. Construction vehicles like trucks, forklift, bull dozer, etc. by drivers or a designated person on a daily basis	1	2	3	4	5	NA
5. Temporary electrical installation by a licensed electrical worker	1	2	3	4	5	NA
6. Specialised equipment by a competent person	1	2	3	4	5	NA
Sub-section score						
F.3) Maintenance of machinery: Please rate the adequacy of the maintenance regime for the following machinery in the project.	Low……...……………..High					
1. Tower crane(s)	1	2	3	4	5	NA
2. Mobile crane(s)	1	2	3	4	5	NA
3. Gondola(s)	1	2	3	4	5	NA
4. Piling machine(s)	1	2	3	4	5	NA
5. Passenger hoist(s)	1	2	3	4	5	NA

Estimating the Project Safety Climate Index						
6. Mobile working platform(s)	1	2	3	4	5	NA
7. Construction vehicles like truck, forklift, bulldozer, etc.	1	2	3	4	5	NA
Sub-section score						
***MTS**$_{score}$*						

G) Sub-contractors' safety systems

Please rate the adequacy of the following items of sub-contractors in the project.	Low…………..…………...High				
1. Safe work procedures	1	2	3	4	5
2. Safe use of plant, machinery and tools	1	2	3	4	5
3. Safety inspection systems	1	2	3	4	5
4. Trained operatives and supervisors	1	2	3	4	5
5. Adherence to safety requirements during construction	1	2	3	4	5
***SSS** $_{score}$*					

H) Emergency management system

H.1) Emergency response plan: Please rate the adequacy of the emergency response plan for the following emergency scenarios in the project.	Low…………...…………...High				
1. Fire & explosion	1	2	3	4	5
2. Failure & collapse of structures/temporary supports	1	2	3	4	5
3. Failure & collapse of heavy machinery & equipment	1	2	3	4	5
4. Leakage of hazardous substances	1	2	3	4	5
5. Adverse weather & flooding	1	2	3	4	5
Sub-section score					

H.2) Emergency response team: Please rate the adequacy, competency and set-responsibilities of the following emergency response team members for various emergency scenarios in the project.	Low………......…………….High				
1. Emergency coordinator(s)	1	2	3	4	5
2. Site safety personnel	1	2	3	4	5
3. Designated rescuer(s)	1	2	3	4	5
4. First-aider(s)	1	2	3	4	5
5. Specialist operators(s)	1	2	3	4	5

Estimating the Project Safety Climate Index					
Sub-section score					
H.3) Emergency equipment: Please rate the adequacy of the emergency response equipment and facilities for the following emergency scenarios in the project.	Low………….…………….High				
1. Fire & explosion	1	2	3	4	5
2. Failure & collapse of structures/temporary supports	1	2	3	4	5
3. Failure & collapse of heavy machinery & equipment	1	2	3	4	5
4. Leakage of hazardous substances	1	2	3	4	5
5. Adverse weather & flooding	1	2	3	4	5
Sub-section score					
EMS_{score}					
I) Worker incentive system: Please rate the adequacy of the following incentives in the project towards motivating safe behaviours of workers and supervisors.	Low……………………………High				
1. Worker safe behaviour incentive	1	2	3	4	5
2. Co-worker safe behaviour incentive	1	2	3	4	5
3. Supervisor safety incentive	1	2	3	4	5
WIS_{score}					
J) Work pressure: Please rate the following items in the project that contribute to work pressure in the project.	Low……………………………High				
1. Reasonableness of operational targets	1	2	3	4	5
2. Workers' perception about work pressure on site	1	2	3	4	5
3. Supervisors' perception about work pressure on site	1	2	3	4	5
WP_{score}					

4. Conclusion

Improving safety in the construction industry has been a long felt need of the WorkCover in Australia. One of the strategies towards this goal is to set up a rating system that evaluates contractors on their safety performances. This study developed a model that evaluates contractors' safety performances analysing three such factors as organisational safety culture, safety climate on site and actual implementation of documented safety management system. The model can be used by the WorkCover, Australia for deriving safety indices for contractors. These indices can give manifest pictures of contractors' safety consciousness which can be a key factor for clients in tender evaluations, and for insurance companies in premium-rating of workers' compensation insurance. Contractors with lower indices would have competitive advantages in the industry, which will motivate other contractors to improve safety. Eventually, this would pave the way to an accident-proof construction industry.

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The Effect of Winner’s Curse on Post-Contract Management

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Abstract

This study aims to identify whether there is an adverse effect to the client when a project is awarded to a bidder with a large winner’s curse. The contractor is likely to run in to cash flow problems when he suffers from a large winner’s curse. Therefore it is suspected that this would also have adverse effect to the client.

The study is interesting because large winner’s curses are found to exist in Sri Lankan construction industry. Hence, some winning contracts may carry numerous problems due to very low or negative profits. The contractor may try to compensate his poor cash flow by submitting numerous claims and he may try to make profit by reducing the quality and time performance. Thus, this research intends to establish the relationship between the winner’s curse and post contract management difficulties.

The research was designed as a correlation research with a survey based on 20 building projects. The winning bid range and winning margin are used to measure the winner’s curse. Post contract management difficulties are measured using the contractor’s claim attitude index.

The research finds that winning margin showed better correlation to claim attitude than the winning bid range. This indicates that the perceived winner’s curse has higher impact than the real winner’s curse on post contract management difficulties. Therefore the findings suggest that a client should be cautious when awarding the contract to a bidder with a large winning margin.

Keywords: Disaster Claim attitude index, Post contract management, Winner’s curse, Winning bid range, Winning margin

1. Introduction

This paper presents a study conducted in Sri Lanka to identify whether there is an adverse effect to the client when a project is awarded to a bidder with a large winner’s curse. The study is interesting because large winner’s curses are found to exist in Sri Lankan construction industry [8] and the knowledge about their effect is limited.

1.1 Background

Awarding the contracts to the most appropriate contractor is one of the critical decisions to be taken by a construction client. This is very important to achieve successful project outcomes [11, 14, 15]. Awarding the contract to the lowest bidder is usually practiced in the public sector particularly because of its greater accountability. Many private clients also award contracts to the lowest bidder for cost reasons [4, 5, 6]. Therefore, the lowest bidder is typically the winner.

Successful bidders (that is, those who won the competition) tend to obtain returns that (on average) lie below initial projections. This discrepancy between realized and anticipated returns, and the possibility that winning bidders end up making losses, is called the winner's curse [1].

There is evidence that high probability for large winner’s curse to exist in the Sri Lankan construction industry [7]. This means that the winning contracts shall either carry losses with below average profits or even negative profits. The contractor is likely to run in to cash flow problems when he suffers from a large winner’s curse. Under the circumstance the contractor may try to compensate his poor cash flow by submitting numerous claims. He may also try to make profit by reducing time and quality performance [3]. Either context would lead to post contract management difficulties as the client and consultants would be required to take extra effort for corrective measures.

2. Winner’s Curse

The Winner's Curse is a term originally apprehended in the oil industry and it described a phenomenon that occurred in common value auctions with incomplete information [2]. In common-value auctions, the value of the item is the same to everyone but different bidders have different estimates about the underlying value [9].

For example, an oil field had an actual intrinsic value of \$10 million, oil companies might estimate its value to be anywhere from \$5 million to \$20 million. The bidder who erroneously estimated at \$20 million would win in the auction, but will later find that it was not worth the amount he paid. Accordingly, even when a bidder's evaluations are correct on average, a bidder's evaluations on the tract he wins are not correct on average: they are biased upward [1]. If he wins, he loses money and thus he is cursed.

2.1 Winner’s curse in the construction industry

Recall that the winner in the construction industry in competitive bidding is typically, the bidder who submits the lowest bid. When each bidder estimates the project cost and bids accordingly, the winner would probably be the bidder who has most underestimated project value. Thus he wins the contract and agrees to complete the project for a price which is less than the “right price” or the “true value” of the project. The winner therefore may become disappointed in the first instance of having largely underestimated; and later will look for means of rectifying it.

2.2 Detection of the winner's curse

The difference between the lowest and second lowest bids is often referred as "winner's curse." However, the correct quantitative measure of the winner's curse should be the difference between the "right price" of the project and the winning bid [13]. However, the "right price" is literally unknown and thus the measure is not practical.

To represent the winner's curse, winning margin is a useful measure. The term "winning margin" (*W*) is the difference between the second lowest bid and lowest bid. The "percentage-winning margin" (*PW*) is the ratio of the winning margin to the lowest bid and can be used to compare across projects of differing sizes [8]. These can be mathematically represented as:

$$W = (P_1 - P_0) \quad \text{, and}$$

$$\text{PW} = \frac{(P_1 - P_0)}{P_0} \times 100$$

where, P0 is the lowest bid and P1 is the second lowest bid. Since the winning margin is the obvious foregone profit to the winner, it represents the perceived winner's curse.

A recent study has shown that the winner's curse in the Sri Lankan industry is a serious issue. The average percentage-winning margin was equal to 9.323 [7]. This means that a second lowest bid is 9% larger than the lowest in general and this is significantly a high figure. The study further found that the distribution of bid prices was symmetrical and close to the normal distribution. Most of the bids were scattered closely around the average bid. With the conjecture that the majority is correct, the right price lies in the centre. When the lowest bid that lies in tail of the distribution, is the winning bid; there is a high probability for large winner's curse to exist.

With the presumption that the majority is correct, the winner's curse measured based on the average bid price would be a better representation of real winner's curse. Therefore to measure the winner's curse "winning bid range" (*B*) can be used and it is the difference between the average bid and the winning bid. The percentage- winning bid range (*PB*) is the ratio of the winning bid range to the winning bid. These are mathematically represented as

$$B = (P_a - P_w)$$

$$PB = \frac{(P_a - P_w)}{P_w} \times 100$$

Where, P_a is the average bid and P_w is the winning bid; and P_w is equal to P_0 when the lowest is the winning bid.

3. Research Methodology

The research was design as a correlation research based on an industry survey. The sampling population was Sri Lankan building projects, which were awarded to Grade M4 or above contractors and completed during last five years. A random sample of 20 projects was used for collection of data. All data was abstracted from the project documents. Both winning margin and winning bid range were used to measure the winners curse.

The challenge was to measure the project management difficulties. Current literature did not produce an appropriate quantitative measure. Thus, it became necessary to unfold a new measure.

Claim management is one of the main issues of the post contract management activities. And also cost performance is one of the main concerns when considering the contractor's performance [12]. If the contractor runs into the cursed context and tries to rectify it at the expense of client's time and money; the key strategy he would use, is to make numerous claims [10]. This would yield additional paperwork and negotiations for client and his consultants; and also cause adversarial relationships. Therefore the contractor's Claims Attitude Index (*Y*) was identified to measure the level of post contract management difficulties. It was the ratio between the amount claimed for the contractual claims such as variations, fluctuations and cost headings under time extensions by the contractor, and the actual amount approved for payment:

$$\text{Claim attitude index } (Y) = \frac{\text{Quoted amount by contractor}}{\text{Approved amount}}$$

4. Data Analysis

The correlation between variables was tested using the Pearson Correlation Coefficient. Two independent variables: Percentage Winning Margin (*PW*) and Percentage Winning Bid Range (*PB*), were analysed for correlation with dependant variable: Claims Attitude Index (*Y*). The analysis results are presented in Table 1 below.

Table 1: Pearson correlation analysis

Independent variables / **Dependent variable**		**Claim Attitude Index (Y)**
Percentage Winning Bid Range (PB)	Pearson correlation coefficient	0.051
	Confidence level (1- tailed)	0.584
Percentage Winning Margin (PW)	Pearson correlation coefficient	**0.274**
	Confidence level (1- tailed)	**0.856**

Both independent variables (*PB* and *PW*) showed a positive correlation with the dependent variable (*Y*). However, PB showed poor level of correlation and confidence. Percentage Winning Margin (*PW*) showed a better level of correlation at 85.6% confidence level. Even though confidence level is little below the general statistical norms to conclude the correlation is significant; for a research of this nature, it is a significant figure.

5. Conclusions

The evidence of high probability for existence of large winner's curse in the Sri Lankan construction industry, urged the need to identify if a contractor with a large winner's curse is an adverse selection. The winners curse was quantitatively measured by two variables: Winning Margin and Winning Bid Range. Claims Attitude Index measured the post contract management difficulties to test whether the contractor is an adverse selection.

The Pearson Correlation Analysis results showed both the winning bid range and the winning margin are correlated positively with the claim attitude. Thus, the relationship between Winner's curse and post contract management difficulties found to be positive. Therefore, awarding a contract to a bidder with a larger winner's curse could be an adverse selection. However, the correlations are not significant enough to statistically theorise this as a fact. But, the results provide clear indication about the relationship.

The Pearson correlation coefficient was 0.051 between winning bid range and claim attitude with poor confidence level; but it was 0.274 between winning margin and claim attitude with confidence level of 85.6%.

Since the winning margin is a measure of perceived winner's curse; it can be now concluded that the perceived winner's curse has larger adverse impact to the post contract management activities than that from the real winner's curse. This is because winning bid range, which is the selected measure for the real winner's curse shows a very weak relationship to the claim attitude. This is pragmatic because, the large perceived winner's curse gives the feeling to the contractor that he losses a significant amount from the contract. He would have bid 1$ less than the second lowest and still could win the contract. Thus, the Winning Margin is obviously a foregone profit.

With the conclusions of the research it is advised that a client should not award a contract to a bidder with a large winner's curse, especially when there is a large perceived curse.

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Impediments to the Development of Design and Build Procurement System in Sri Lanka

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Abstract

Design and build has become a popular mode of procuring construction work. It is now, regarded by majority of clients because is offer greater confidence to clients. Even most of the researchers had found that the design and build procurement method is better than the traditional method in most of the areas, in general it does not developing as dominant or highly practicing procurement method in most of the countries except France, Greece and also Norway and Mexico in private sector. In Sri Lanka, design and build has not extended as it is expected. Therefore, it is worthwhile to find out the reasons behind the drawbacks of design and build procurement system development. Thus this research is intended to identify the most significant impediments to the development of design and build procurement method in Sri Lanka.

A two round questionnaire survey facilitated to identify the significant impediments to the development of design and build procurement system in Sri Lanka and few unstructured interviews with most experienced professionals in the area were carried out in order to study and understand the context. Twenty significant impediments were identified and ranked according to the negative impact they create on the development of design and build procurement system. It is found that very less contribution given by the government to promote design and build is the first most significant impediment. Lack of clients' knowledge related to alternative procurement systems, less contribution to the development given by research and development institutes, unfamiliar of contractors' professionals with the design and build procurement process, clients' lack of experience with design and build procurement method, less contribution to the development given by professional institutes, and reflection of consultants' own interest in procurement selection are found as other six uppermost significant impediments.

Keywords: Design and build, Procurement method, Impediments, Sri Lanka

1. Introduction

Design and build (D&B) is becoming popular due to its advantages providing over the traditional procurement system. The D&B procurement route has witnessed significant growth in many countries over the world and considered as dominant procurement system too.

However, some researches shown than in Sri Lanka the traditional procurement system is dominating the procurement market over the years and D&B procurement system use as next alternative option among alternative procurement systems but, less in practice. There this paper presents a study undertaken to identify the impediments to the development of D&B procurement system in Sri Lankan based. The significant impediments found out through the surveys and unstructured interviews are discussed and explained in the appropriate sections.

2. Background

2.1 D&B procurement system

Design and Build procurement system is defined as, 'A construction procurement method where the contractor offers to undertake the entire design and construction of a project' by Cox and Townsend 1998 (cited in [1]). According to Moore and Dainty [2], D&B emerged as a procurement system to overcome the drawbacks of the separated system by offering greater confidence to clients seeking to avoid delays, exposure to costly claims, possible litigations and to improving project performance. D&B is now regarded by majority of clients than the for the traditional system, which providing the optimum route to obtain value for money and it is easy for the clients to enter in to a single contract rather than many where, the conflicts among parties are less. Its popularity arises from its perceived ability to bring design and construction processes closer together culturally, and associated improvements in cost and time certainty. Further, the system has also been advocated as facilitating a seamless procurement process, improving team relationships and producing a more efficiently delivered product. It offers a potential route for the implementation of new concepts such as: fair and equitable relationships, continuous performance improvement and changes in management and culture. The system reduces time to a minimum by eliminating traditional tendering procedure and produces more advantages to the clients and contractors when comparing to the traditional procurement system.

2.2 Trends in procurement systems

There was a time, when traditional system was the only option on the table to clients. An architect designs a building from beginning to its end and then contractors looked over the drawings and bid on the project. But the states now have changed and there are different project delivering methods to fulfil the client's need according to project requirements.

According to the research conducted by the Royal Institute of Charted Surveyors (RICS) Construction Faculty [3] over the years for United Kingdom (UK) construction industry, D&B is a single most prevalent alternative procurement method since year 1995. Until such time the Bills of Quantities dominated the industry. This was the time of major shifts in procurement strategies come up. This survey reinforces the dominance of D&B as a procurement strategy. D&B has remained steady at just over 40% of total workload value. Not only in UK construction industry but also in many other countries such as China, Denmark, Great Britain, Japan and United States of America (USA) D&B procurement method shows an increasing trend. In Private sector countries like France, Thailand, Norway and Mexico uses D&B system more than 50%. Public sector too in countries like Greece and France uses the D&B as the procurement system [4].

According to the research conducted by Rameezdeen and Ratnasabapathy [5], the Measure and Pay method dominates the Sri Lankan construction industry, but decrease in certain periods paving way for other systems. Majority of public works in Sri Lanka found to be procured using these methods by considering accountability and transparency. D&B has recorded a usage rate of 20-35% during the year 1977 to 2003. The management contracts, lump sum, prime cost contracts procured only few projects during the study period. Table 2 indicates the survey result of trend procurement systems in Sri Lanka [5].

Table 2: Trend in methods of procurement in Sri Lanka (by value of contract)

% of Use (average) / Procurement System	1977 -81	1982 -86	1987 -91	1992 -96	1997 -00	2001 -03
Measure and Pay	55	50	58	50	64	72
Lump Sum	12	10	8	7	10	5
Prime Cost	10	8	5	4	3	1
Design and Build	22	31	28	35	21	22
Management Contracting	1	1	1	1	1	0
Joint Venture	0	0	0	3	1	0
Total	100	100	100	100	100	100

In Sri Lankan context the growth pattern of D&B was positive up to year 1996 and then it began to decline up to year 2000, but there after no significant changes shown in its growth. The growth of D&B is not up to the expected level in Sri Lanka when comparing with the countries mentioned earlier. The traditional procurement system remains widely procuring method and it's seems to be strong. Therefore, it is essential to explore why the D&B procurement is not popular in the Sri Lankan context and identify the barriers preventing the popularity, in order to develop the innovative procurement system in Sri Lanka.

3. Methodology

This research is designed as a survey study to identify the most significant impediments to the development of D&B procurement system in Sri Lanka. Therefore, the data collection is done based on two round structured questionnaire survey. The first round of the survey was used to identify the presence of the impediments in the local context by using a sample of ninety professionals. The next round used to rank the impediments according to their negative impact to the development of D&B. Screening process, considering the respondent who are mostly complying with the first round results reduces the second round sample size up to thirty in number. The sample for both survey rounds consisted similar number of clients, consultants and contractors' professionals with different professional disciplines such as: Architects, Engineers and Quantity Surveyors. Some unstructured personal interviews were setup for the purpose of study the local context parallel to the first round questionnaire survey. Based on the literature survey, questionnaires were prepared and distributed to identify the current impediments that are emerged in the local context. In the basis of first round results the second round aimed to identify the significant impediments and Relative Important Index (RII) was used to analyse the data in the second round.

4. Impediments to the development of D&B procurement system in Sri Lanka

The impediments can be created externally or internally to the development of design and build procurement system. The factors that beyond the control of the stakeholders of the construction industry were identified as external factors and factors, which can be controlled by the stakeholders, were taken as internal factor. According to Rolwinson [6], the external environment factors that affect the construction industry as well as the development and use of procurement systems, which comprise political, economical, technological, financial and social aspects. The internal factors contain: issue imposed to the development of D&B procurement by client, consultant, contractor, government, statutory and regulatory bodies, research and development instituted (R&D) and professional institutes.

Twenty most significant impediments were identified both internally and externally, that effecting the development of D&B procurement system in Sri Lanka. The factors were discussed under appropriately categorized sections and explained. Table 3 shows the identified significant impediments in the rank order.

Table 3: Twenty significant impediments identified through the survey

Rank	Impediments
1	Government contribution in promoting D&B in Sri Lanka is very less
2	Clients' lack of knowledge regarding alternative procurement systems
3	Less contribution to the development of D&B procurement system by Research and development institutes in Sri Lanka
4	Contractors' professionals are unfamiliarity with D&B procurement system
5	Clients' lack of experience with D&B projects
6	Less contribution to the development of D&B procurement system by Professional institutes in Sri Lanka
7	Reflection of consultants' own interest in procurement selection
8	Government preferences for D&B only by only considering time factor
9	Poor relationships create by client with the consultants

Rank	Impediments
10	Barriers to enter in to D&B market by the construction contractors in terms of: not familiar with D&B projects earlier and incapability of contractors
11	Negative attitudes among consultants' professionals toward D&B procurement system
12	Inadequate in-house design team in contractors’ organizations to compete in the market
13	Poor project management practices by the D&B contractors
14	Contractors' professionals inflexible to accept the changes when involving in D&B process
15	Effect of political environment in procurement selection
16	Barriers to enter in to D&B market by the construction contractors in term of political environment
17a	Inadequate cover by the 'Standard Conditions of Contract'
17b	Very less contribution is given by the Ministry of Finance to the development of D&B procurement system as a regulatory body of Sri Lanka
19	D&B contractors’ profit making interest rather than thinking of client’s requirements
20	Less market strategies used by D&B contractors in order to promote their services

4.1 Clients related factors

The study point out that the lack of clients’ knowledge related to alternative procurement systems (ranked-2) act as a major barrier to the development of D&B in Sri Lanka. It is difficult for the clients to gain knowledge regarding new procurement system, since most of the construction clients are laymen and any institutes or contractors do not conduct awareness programmes for clients in order to educate them regarding the innovative procurement systems. Therefore, the clients do not intend to use alternative procurement systems other than the traditional system.

Clients’ lack of experience with D&B projects (ranked-5) widely effects the selection of D&B system in their projects. On the other hand it consequently reduces the probability of using D&B for most of the projects and this factor give a negative impact to the growth of D&B procurement method. Most of the clients fear to take an additional risk by selecting a procurement system, which is not familiar to them. Also there are lack of examples in the industry to show the success of such system due to only few projects are carried out using D&B procurement system in the industry.

Other than the clients' lack of knowledge regarding alternative procurement systems and lack of experience with D&B projects; maintain poor relationships with consultants by clients (ranked-9) act as impediment to the development of D&B. Clients are overemphasis on fee rather than services, ultimately they get poor consultants services for their projects by consider low cost. Ultimately, they provide insufficient project brief, provide inadequate time to prepare proposals to contractor, often change their scope of work, create lot of difficulties in the construction stage especially in quality control and creates conflict with contractors. Therefore, this gives a negative effect to the development of D&B.

4.2 Contractors related factors

The unfamiliarity of contractors' professionals with D&B process is the forth major significant impediment in ranked order, which effect the development of D&B in Sri Lanka. The reason could be Sri Lankan professionals are generally practice the traditional procurement system due to the domination of the systems in the market. It is found that the public contracting organizations are widely use the Measure and Pay rewarding method for D&B system even though Lump Sum method is conventionally used for D&B system. In some instances they bid for Lump Sum method and later change to Measure and Pay method due to the difficulties faced after the commencement of the project. This evidences the unfamiliarity of Sri Lankan public contracting organizations with the system. In addition, most of the private contracting organizations have lack of experience with D&B projects due to the ascendancy of the traditional procurement system in the market. Therefore, most of the contractors' professionals are not willing to work for D&B projects and this act as a barrier to the development of D&B in Sri Lanka.

Also, there are barriers to the construction contractors to enter in to the D&B service market due to their incapability and unfamiliar with D&B projects earlier. Inadequate in-house design team in contractors' organizations act as a barrier to D&B contractors to, compete in the market. However, the responses from contractors for this factor are little varied from consultants and clients. Most of the contractors in Sri Lanka go for joint venture with design teams for D&B projects and the contractors feel that it is easy and better to outsource the design team. In addition, unstable demand for D&B type projects discourages the contractors to establish in-house design teams. This might be the reason for absents of pure D&B organizations which only undertake projects under D&B system in Sri Lanka. But, the consultants and clients experienced that joint ventures bring additional cost factor to the project, more difficulties and conflicts after the project completion. The improper project management practice by the D&B contractors in Sri Lanka ranked 13th in order. It is obvious that this factor prevent the consultants and clients to select D&B as project procurement. Also, the contractors' professionals are reluctant to accept the changes when involving in D&B process due to strong uncertainty avoidance and rigid culture of the Sri Lankan construction professionals also found as another impediment to the development of D&B in Sri Lanka.

Other than the above mentioned factors, contractors' profit making interest rather than thinking of clients' requirements (ranked-19) and less market strategy used by the contractors (ranked-

19) identified as a significant impediments. The profit making interest leads to reduction in quality of the project and the clients are not in a possession to derive the benefits of this procurement method without sacrificing quality. Marketing or sales development long ignored by many contractors who depend on word-of-mouth in a defined geographical marketing arena, also the market strategy used by D&B contractors are very less compare to countries which use D&B widely and this factor act as a barrier to increase the D&B projects in the context.

4.3 Consultants related factors

Reflection of consultants' own interest in procurement selection (ranked-7) has given a considerable effect to the development of D&B. The reason for this could be that the consultants do not use systematic procurement selection criteria for project procurement selection. Therefore, the selection could always be bias rather than a logical approach. Thus, consultants select the traditional procurement system as project procurement, which they are well familiar in most of the cases. The selections are made without taking additional risk by selecting an unfamiliar procurement system. Ultimately, this leads to reduction in probability of use D&B system for appropriate project scenarios.

It is revealed through the study that, there are negative attitudes among consultants' professionals toward D&B procurement system in Sri Lanka. This is due to the image among consultants' professionals regarding D&B such as loss of their traditional leading role, authority and job satisfaction. Further the consultants' professionals are reluctant to change from the tradition and experience new challenging role in the innovative procurement system due to their rigid culture. Ultimately this factor effects the D&B procurement selection in project procurement and reduces the usage of D&B.

4.4 Government and political environment

It is found that the very less government contribution in developing D&B is the first most significant impediment to the development of D&B procurement system in Sri Lanka. The government started to procure more projects using D&B system from year 2001, after publishing 'Standard Bidding Document' for D&B contracts. But bidding for most of those D&B public projects are not open to the private sector contractors. Generally government goes for negotiated based D&B contracts with public contracting organizations. This discourages the use of D&B in private sector. If the government open the tenders to the private sector, the contractors may be encouraged to develop further their D&B knowledge in order to stay competitive to bid for future projects. Once they are familiarized with D&B, the level of adoption will be increased. As a consequence, the use of D&B is significantly promoted across a broad spectrum of the construction industry, which the government fails to do so. Therefore, initiation of the D&B procurement system in private sector by the government as a major client in the construction industry is the lagging contribution within the context in order to develop D&B procurement system.

Also, it is found that the government goes for D&B procurement system only to gain advantages from the time factor that the system produces, but excluding other advantages it provide and without any systematic review. Therefore this factor affects the use of D&B procurement system for most of the public projects. In addition the political environment interims of policies and directions act as a barrier to the contractors to enter in to D&B market and in procurement selection. If the government's directions are toward increasing D&B projects, the market entries and D&B procurement selection will ultimately increase in the context.

4.5 Contribution given by research and development (R&D) institutes in Sri Lanka

In the Sri Lankan context the R&D practices are less in the industries when compare to the developed countries. It is around 0.15% in the total GDP. The R&D institutes are imperative to construction industry, since they bring new knowledge and develop new cultures in the construction industry. The contribution of R&D to develop alternative procurement systems makes rapid impact to the industry and pilot to change the trend of procurement systems, which has not happened in the Sri Lankan context. Therefore, poor contribution by R&D institutes (ranked-3) acts as a significant barrier to the development of D&B in the context.

4.6 Contribution given by the professional institutes in Sri Lanka

Less amount of contribution given by the professional institutes in Sri Lanka (ranked-6) indicated as sixth major impediment to the development of D&B. Few professional institutes do not prefer the D&B system, some of them are against the development for the purpose of protecting the small and medium construction contractors who can not involve in D&B projects. This factor gives an unconstructive effect to the development of D&B.

4.7 Standard conditions of contract

The standard conditions of contract used for D&B contracts are use with considerable amendments due to inadequate cover by such documents in the Sri Lankan construction industry and it creates many problems during the construction process. It is found that the 'standard conditions of contract' published by the regulatory body of the construction industry with in the country: Institute of Construction Training and Development (ICTAD) for D&B is the widely used document for D&B projects in Sri Lanka.

5. Conclusions

In Sri Lankan context, the traditional procurement system is widely used for both private and public projects up to now, since the government and regulatory bodies promoting the traditional procurement method and widely use in public project procurement. In addition the clients are not knowledgeable regarding alternative procurement systems and the construction professionals are reluctant to change themselves from the system that they are well familiar.

However, the research and development institutes, and professional institutes also do not contributing to the development of alternative procurement systems.

The Design and Build (D&B) system has recorded a usage rate of 20-35% up to year 2003 in Sri Lanka and the growth of the D&B system is not up to the expected level comparing to some other countries like UK, France, Greece and etc. Therefore, this research was intended to identify the significant impediments to the development of D&B procurement method.

It is found that in Sri Lankan context: very less contribution is given by the government to promoting D&B, clients' lack of knowledge regarding alternative procurement systems, less contribution to the development of D&B by Sri Lankan Research and Development Institutes, contractors' professionals unfamiliarity with the D&B process, clients' lack of experience with D&B projects, less contribution to the development of D&B procurement system by Sri Lankan Professional Institutes and reflection of consultants' own interest in procurement selection are the impediments to the development of D&B respectively in the significant order.

The government acts as the single largest client of the construction industry and is responsible for all the public construction needs. Failing in initiation of D&B procurement as one of the major procurement system by the government and their policies in procuring D&B such as; offering the job to public contracting organizations in negotiated base and no systematic review in procurement selection are some major facts which create such significant impediment. Lack of clients' knowledge related to alternative procurement methods creates a major problem in developing D&B procurement method and it effects the selection of a suitable procurement method for projects. Since, the contribution given by research and development institutes and professional institutes are very less, it is difficult to develop an alternative procurement method as a dominant procurement method within the context, because these institutes play the central role in introducing innovations to the industry. Unfamiliarity of contractors' professionals with D&B process creates a barrier to the development of D&B procurement method. Since, professionals do not prepare to involve in the new process and face challenges due to the rigid culture and strong uncertainty avoidance it is difficult to develop an alternative procurement method as a dominant procurement system in the context.

Neglecting the procurement selection criteria in project procurement selection by the consultants (ranked..) is an issue in the Sri Lankan context. This creates a better opportunity to the consultants to select the procurement system based on their own interest. Since, the industry is well familiar with the traditional procurement system there is a higher probability to select the traditional procurement system as project procurement. Therefore, consultants' own interest in procurement selection negatively effects the development of D&B procurement system. Ultimately, all the above factors highly restrict the development of D&B as a dominant procurement system in Sri Lanka.

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Exploratory Study of External Environmental Factors Influencing the Procurement Selection in Construction

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Abstract

The construction industry is one of the backbones of the economy of many countries. The industry's characterization is determined by the external environment in which it operates. Therefore, the development and the use of project procurement systems are affected by such environmental factors. These environmental factors influence the industry in various ways thus determining the procurement shares and trends. Therefore, examination of such factors influencing the procurement selection in the construction industry is critical for the successful outcome of a project as well as to the development of the industry. In this context, the aim of this paper is to examine the significant factors influencing the selection of procurement systems from external environment. Four rounds of Delphi survey were conducted to investigate the most significant factors from external environment and their level of influence on various construction procurement systems in Sri Lanka. In addition, few interviews were conducted with selected industry experts in the view of interpreting the results derived from Delphi survey. It was found that the external environment significantly influence the selection of procurement system for any kind of projects. A statistically significant consensus on the weighting of the utility values for each procurement system was obtained from 25 experts from the industry. Based on the Delphi survey results, a set of exclusive selection criteria for five factor categories was established. The five factor categories formulated from this study include 'Market condition', 'Economic condition & Fiscal policy', 'Technology', 'Socio cultural suitability' and Regulatory environment'. Further, it was also found that Market conditions have significant influence on procurement selection compared to others factors. Therefore, it can be concluded that beside the commonly considered factors in terms of key selection criteria like client's requirements and project profile, clients should take into account other factors from the operating external environment that influence the procurement selection.

Keywords: Construction Procurement, External Environment, Procurement selection, Selection Criteria.

1. Background

The construction industry of any country is recognized as an economic regulator which contributes to the national economy in large scale. Thus, the well being of the national construction industry is of paramount importance for the economic development of the country. The construction industry's uniqueness throughout the world is determined by the external environment in which it operates. The external environment consists of several sub-systems such as economical, political, financial, legal and technological [11]. Further, the construction industry is an open system therefore, it is sensitive to change. This changing nature has resulted in the industry to be in a challenging position in addressing the changes forced by the subsystems of the environment in an efficient and effective manner. Consequently, construction project procurement systems practiced in the industry have also been subjected to changes resulting in many newly innovated procurement systems that could be used to meet the clients' contemporary requirements in a dynamic construction environment. Thus, the development & the use of procurement systems are also affected by the factors from external environment. These environmental factors influence the industry in various ways thus determining the procurement shares and trends.

Client's requirements and project characteristics are two major criteria to be considered in selecting a suitable procurement system for any kind of construction projects. The selection process is an open system, which receives information from its environment, transforms and returns as an output to the environment [9]. According to Sheath et al. [12] and Chen [4], client's requirements will ultimately be influenced by the context in which they operate; and this implies that the choice of procurement selection criteria may also be influenced by the predominant environment. On the other hand, Kumaraswamy and Dissanayake [6] have concluded that the most appropriate procurement system must necessarily depend on the project scenario or project profile that can be derived from contextual conditions such as external factors related to projects. As a result, client's requirements and characteristics of the project that dominate the procurement selection are influenced by the factors from external environment. These factors may have direct or indirect influence on the formulation of selection criteria and thus on the selection of suitable project procurement system.

There is no single procurement system which is suitable for all type of clients and all projects. Each project has its own characteristics and requirements and therefore, it is crucial to match the client's needs, project characteristics and influence of external environment with the most appropriate procurement system to achieve the correct balance between priorities and risks and ensure a successful outcome. Therefore, it is crucial to examine that what factors from external environment drive the procurement system and how these factors might influence the selection of procurement systems. In this viewpoint, the aim of this paper is to identify and analyze such environmental factors which influence the selection of procurement system and their level of influence. It presents a set of exclusive selection criteria formulated based on the influence of external environment in Sri Lankan context.

2. Literature Review

Researchers have argued that identification of relevant selection factors is the first step to formalize the selection process in a systematic manner. Previous studies in construction procurement selection have identified several coherent procurement selection parameters, such as time certainty, cost certainty, speed, flexibility, responsibility, complexity, price competition, risk allocation, and quality. While these parameters are crucial to procurement selection, doubts have been cast over the accuracy of decisions generated from a limited number of parameters [3]. Most of these identified factors are related to Clients' requirements and Project characteristics. Review of past studies on procurement selection factors reveals that the number of studies associated with the factors influencing from external environment is limited compared to internal environment. Table 1 summarises the review of past studies on factors governing the procurement selection in the frame work of external environment.

Table 1: Review of past studies

Factors	Authors						
	W	H	KD	AM	C	R	L
Market competitiveness	✓	✓	✓	✓		✓	✓
Technical feasibility	✓	✓		✓		✓	✓
Regulatory feasibility	✓	✓		✓		✓	✓
Material availability	✓	✓	✓				✓
Availability of experienced Contractor	✓		✓	✓	✓	✓	✓
Weather & natural disaster	✓	✓					✓
Political constraints	✓	✓				✓	✓
Cultural differences	✓	✓				✓	✓
Industrial actions	✓	✓				✓	✓
Objection from neighbour	✓	✓				✓	✓
Labour productivity	✓	✓	✓			✓	✓
Objection from local lobby groups	✓	✓				✓	✓
W – Walker (1989), H –Hughes (1989), KD – Kumaraswamy and Dissanayaka (2001), AM – Alhazmi and McCaffer (2000), C. - Chan et al. (2001), R – Rowlinson (1999), L – Luu et al., (2003)							

Findings from literature reveals that factors such as Market competitiveness, Technical feasibility, Regulatory feasibility, Availability of experienced Contractor and Labour productivity have been identified by several studies compared to others. Walker [13] and Hughes [5] identified a series of construction-related environmental influences pertinent to the project level, and these include political, financial, economical, sociological, legal, institutional, competitive, cultural, technological, environmental, physical and aesthetical aspects. They further signify that for instance, ''market's competitiveness and contractor's availability'', ‘‘labour productivity’’ and ‘‘material availability’’ may be associated with the competitive and economical aspects; while the ‘‘regulatory feasibility’’ and ‘‘technology feasibility’’ synchronises the legal, technological, environmental and physical aspects. In this regard, all the external environmental factors are inter-related and have direct or indirect relationship with the factors from project’s internal environment.

3. Methodology

Delphi technique was adopted as the main research method in this study. Delphi method is a highly formalized method of communication that is designed to extract the maximum amount of unbiased information from a panel of experts. It is conducted by rounds interspersed with group opinion and information feed back in the form of relevant statistical data [2]. Therefore, it was considered that it would be appropriate to adopt the Delphi technique for formulating a set of exclusive criteria in terms of external environment. Delphi method adopted in this study consisted of four rounds which targeted to derive the expert opinion on factors which affect the procurement selection. At the completion of the fourth round, utility values for significant factors were derived against various types of procurement systems which are commonly used in construction industry. The following Table 2 summarizes the formats of Delphi survey conducted for this study. In addition to the Delphi survey, few interviews were conducted with selected industry experts in view of interpreting the results derived from Delphi survey.

Table 2: Format of Delphi survey

	Round 1	**Round 2**	**Round 3**	**Round 4**
Instrument	Questionnaire 1	Questionnaire 2	Questionnaire 3	Questionnaire 4
Data base for Questionnaire	Literature review	Results from round one	Results of factor analysis carried out for round two results	Results from round three
Purpose	To gather a set of specific selection criteria for construction procurement	To identify the level of importance of each selection criteria	To assess the suitability of each factor against various procurement system	To reconsider and reassess the suitability of each factor against various procurement system
Duration	Two weeks	Eight weeks	Four weeks	Five weeks
Number of experts responded	35	35	30	25

4. Results and Analysis

The factors suggested by the panel of experts in the round one were carefully analyzed and a list of factors was formed for the Sri Lankan context. The list includes the factors suggested by the experts and the factors identified from comprehensive literature survey. Factors which conveyed similar meanings were combined and rephrased. Altogether 21 factors were consolidated to form a list of factors for the second round of Delphi.

4.1 Results of Delphi round two

The results from round two were subjected to several analysis which are included under main two steps as follows;

Step 01 – Identification of Significant Factors

- A mean weighted rating for each factor was computed to derive an indication of the importance of each factor.
- The Severity Index was calculated to rank the factors based on their significance on procurement selection.
- Coefficient of Variation (COV) was computed which expresses the standard deviation as a percentage of the mean to compare the relative variability of different responses.

Table 3 presents the results of the data analysis which is the indication of relative importance of each factor. Out of 21 factors, 14 factors were assigned by mean ratings of higher than the neutral point 2, and each of them maintained a Severity Index of more than 65%. This indicates that these 14 factors significantly affect the selection of procurement system. Remaining 7 factors which gained mean rating of less than 2 and Severity Index of less than 65% were removed for the third round of Delphi.

Step 02 – Factor Analysis

Unimportant factors identified from step one analysis were disregarded and only the significant factors were considered as eligible factors for factor analysis. Factor analysis was performed to elicit the underlying relationships among the eligible factors affecting the procurement selection and to reduce the factors into a small number of components [8]. The factor analysis was carried out using SPSS package. The first stage of factor analysis was to determine the strength of relationship amongst the factors affecting the procurement selection based on their Correlation Coefficients.

Table 3: Results of round two (Indication of the level of importance)

Factors	SI	M	SD	COV
Market competitiveness	76.67	2.30	0.868	0.3775
Technological feasibility	73.33	2.20	0.876	0.3983
Regulatory feasibility	66.67	2.00	1.095	0.5477
Availability of experienced Contractor	78.89	2.37	0.930	0.3929
Education of Contractors	72.22	2.17	0.785	0.3622
Availability of materials	66.67	2.00	1.033	0.5164
Cultural differences	66.67	2.00	1.155	0.5774
Government as a policy maker	66.67	2.00	0.966	0.4830
Government as a major Client	70.00	2.10	0.928	0.4419
Finance for the project : Donors	77.78	2.33	0.974	0.4173
Finance for the project : Aids	75.56	2.27	0.962	0.4245
Economic condition of the country	72.22	2.17	1.030	0.4752
Information Technology	66.67	2.00	1.033	0.5164
Environmental issues	66.67	2.00	0.966	0.4830
SI- Severity Index, M- Mean, SD - Standard Deviation, COV – Coefficient of Variation				

Based on the principle component method, the factor solutions with eigenvalues greater than 1 were produced. Varimax orthogonal rotation was employed to transform the factor matrix produced by un-rotated principle component matrix into one that is easier to interpret. The extracted five factor categories were grouped using Varimax orthogonal rotation. The Table 4 shows the key factor categories and associated variables based on varimax orthogonal rotation.

Table 4: Factor Analysis grouping using Varimax Orthogonal Rotation

No	Factors	Associated Variables
1	Market condition	• Market competitiveness • Availability of experienced Contractors • Availability of material
2	Economic condition and the fiscal policy	• Economic condition of the country • Source of finance: Donor/Aid • Government as a policy maker • Government as a major client
3	Technology	• Technological feasibility • Information Technology
4	Socio cultural suitability	• Cultural differences • Education of Contractors • Environmental issues
5	Regulatory environment	• Regulatory feasibility

4.2 Results of Delphi round three

In the third round of Delphi, experts were asked to provide the utility values for each factor against various procurement systems. A wide range of variants under each main categories of procurement system were adopted. The utility values were defined using a score starting from 10 to 110, in which 10 represents 'low suitability' and 110 represents 'high suitability' . The analysis was based on the utility values provided by the experts. The means of the utility values were computed for the responses. To obtain a measure of consistency, Coefficient of Concordance (w) of utility values were calculated using SPSS package in order to measure the rate of agreement. Coefficient of Concordance (w) ranges between 0-1 where, 0 represents 'No agreement' and 1 represents 'Complete agreement'. In this study, a concordance coefficient of 1 indicates that all experts ranked the procurement options identically (Chan *et al.*, 2001, p. 704).

Further, significance rate was calculated to gain the significance level of each factor. The significance level (α) is based on the asymptotic distribution of a test statistic. Typically, a value which is less than 0.05 is considered as significant. The asymptotic significance is based on the assumption that the data set is large. If the data set is small or poorly distributed, this may not be a good indication of significance.

The results revealed that the mean utility values provided for the five factors were sufficiently consistent at significance level of 0.05 or smaller. Compared to other related factors, market competition is having a considerable level of correlation among the participants. There is a considerable level of significance for the factors other than the socio cultural suitability, which scored 0.258 (> 0.05). This shows the less significance of the socio cultural suitability. Even though, significance level for the Socio cultural suitability is low, based on its influence on industry practice, it was considered to be appropriate selection criteria particularly for Sri Lankan industry.

4.3 Results of Delphi round four

The consistency of the experts' utility values was again tested by calculating the Kendall coefficient of concordance using SPSS package. Table 5 portrays the average utility values of five main factor categories against various procurement systems. Summary of the comparison of results obtained from round 3 and 4 are given in the following Table 6.

The re-assessment of utility values at fourth round made considerable improvement in the significance level. The socio cultural suitability was changed in to the significant level of 0.021(<0.05) which shows the higher level of significance. Economic condition and the fiscal policy were changed from 0.041 to the 0.012; this also indicates the increased level of significance. The significance level of Technology, Regulatory environment and Market condition for the project were increased to the maximum from the 0.011 and 0.001 respectively.

Table 5: Average utility values of factor categories against various procurement systems – Results of round four

Selection Factors	**Construction Procurement Systems**											
	Separated			**Integrated**					**Management Oriented**		**Collaborative**	
	Measure & Pay	Lump Sum	Prime Cost	Design & Build	Package Deal	Turnkey	Develop & Construct	PFI	Const. Mgt.	Mgt. Cont.	Partnering	Joint Venture
Market competition for the project	73.61	68.87	59.13	77.00	68.39	70.78	67.20	65.64	59.78	58.83	54.57	57.61
Economic condition and the fiscal policy	55.57	69.13	55.78	69.09	53.88	55.57	56.87	66.51	64.57	63.92	71.56	73.04
Technology	53.91	53.48	47.83	78.04	63.17	71.87	64.43	65.75	62.83	61.39	73.04	74.78
Socio cultural suitability	54.65	53.70	61.87	50.22	49.13	49.04	45.00	58.61	59.57	60.04	59.30	61.43
Regulatory environment	54.35	52.91	51.39	59.57	59.35	62.35	64.57	69.91	66.74	63.70	65.66	68.04
PFI - Private Finance Initiatives, Const.Mgt. - Construction Management, Mgt. Cont. – Management Contract												

Table 6: Comparison of Concordance Coefficient in Delphi round 3 & round 4

Factors	Concordance of Coefficient (W)			Significance Level	
	R-3	R-4	I (%)	R-3	R-4
Market condition	0.105	0.160	52.38	0.001	0.000
Economic condition & the fiscal policy	0.074	0.096	29.73	0.041	0.012
Technology	0.089	0.172	93.26	0.011	0.000
Socio cultural suitability	0.049	0.135	175.51	0.258	0.021
Regulatory environment	0.089	0.147	65.17	0.011	0.000
R- Round, I - Improvement					

On the other hand, the correlation between the respondents' view with regards to the external environmental factors was also increased. This indicates that the respondents possess closer opinion on the factors influencing the procurement selection. Significant change occurred for the socio cultural suitability, which changed from 0.049 to 0.135. Further, changes have been occurred to other factors such as Technology, Regulatory environment, Market condition and Economic condition & fiscal policy.

5. Conclusions

This study has formulated a list of 14 selection factors through four rounds of comprehensive Delphi survey, and these factors cover various aspects of the external environment. As some factors are interrelated, attempts were made to consolidate related factors using factor analysis. A five-factor solution for the formulation of procurement selection criteria was derived. These five factor categories include "Market condition" (Factor 1); "Economic condition and the fiscal policy" (Factor 2); "Technology" (Factor 3); "Socio cultural suitability" (Factor 4) and "Regulatory environment" (Factor 5). Further, it was also found that Market conditions have significant influence on procurement selection compared to others factors. Except the factor 5, all other factors include related variables which reflect the influence of various aspects of the external environment. Therefore, it can be concluded that beside the commonly considered factors in terms of key selection criteria like client's requirements and project profile, clients should take into account other factors from the operating external environment that influence procurement selection.

Pautz *et al*. [10] stated that the lack of structured procedures, based on good information, for the selection of construction procurement system sometimes inhibits the opportunity for clients to choose a procurement option in a fully informed manner. Therefore, in order to establish procurement selection procedures, clients should formalize a set of suitable procurement selection parameters based on their needs, objectives, project requirements and influence of external environments. The selection criteria established and the utility values derived by this study provides a solid base for clients in initial decision making on the selection of appropriate procurement system for any kind of building projects in the construction industry.

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An empirical study of the cultural and behavioural challenges in the UK construction partnering

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Abstract

Partnering and the related forms of collaboration have been seen as a way of tackling fragmentation and lack of integration that has bedevilled attempts to improve project performance over the years. This represents perhaps the most significant development to date as a means of improving project performance, while offering direct benefits to the whole supply chain. Partnering can have a substantial positive impact on project performance with regards to time, cost, quality and also more general outcomes such as greater innovation and improved user satisfaction. Despite the amount of interest shown in partnering, actual empirical research is rather thin on the ground and much of the work is notable for its prescriptive tendencies and heavy reliance on anecdotal data with the focus on the experience of the exemplar organisations. Conflict and failure could occur by a fundamental deviation in goals, especially in relation to accountability, thus hindering all cooperation that may have been attained by the partnering process. There is case evidence of the failure of partnering to meet performance expectations in construction. Thus it is important to adequately address and evaluate the challenges and potential problems in construction partnering. This paper looks into construction partnering challenges especially cultural and behavioural challenges in the UK. Empirical data is collected from expert opinion to find out the major partnering challenges and their root causes. Also, this paper stages arguments and discussions regarding the importance of the leadership role, in transforming culture, towards a cooperative and caring environment.

Keywords: Partnering, Cultural and behavioural challenges, Expert opinion, Leadership.

1. Background

In recent years there has been a growing interest in the use of partnering in construction [1-5]. This represents perhaps the most significant development to date as a means of improving project performance, while offering direct benefits to the whole supply chain [4, 6]. This needs a powerful change initiative to generate an appropriate project culture by reshaping the approaches and realigning attitudes of different contracting parties [7]. Literature synthesis on partnering shows the significance of cultural and behavioural challenges inhibiting the adoption of partnering arrangements. This paper looks deep into the empirical evidence of cultural and behavioural challenges to arrive at categorised/grouped root causes of these challenges. Furthermore, common to all partnering relationships is the formulation of mutual objectives, trust and an understanding of each other's commitments. It is, however, less than clear about the way in which these essential cultural and behavioural characteristics are tackled in construction partnering projects [2]. It is essential to bring about cultural change, encouraging project participants to go beyond the conflicting interests and to build a shared culture. It is certainly not easy to bring about cultural change to adopt a new set of behaviours as a consistent way of working among the people. To get a deeper level of understanding or to predict the future behaviour correctly one must attempt to get at its shared basic assumptions and taken for granted perceptions [8, 9]. As such, management has the most significant role to play in the transformation of attitudes. The discussion in this paper revolves around the root causes of cultural and behavioural challenges in construction partnering and proposes the necessity of leadership for cultural transformation.

2. Construction partnering

The UK construction industry is one of the strongest in the world, with output ranked top amongst top global construction industries [10]. The industry produces, maintains and adapts around 60% of all fixed capital investment [11]. Thus construction in the UK is considered as one of the pillars of the domestic economy, with its capability to deliver the most difficult and innovative projects, matches that of any other construction industry in the world [12]. Nonetheless there is a deep concern that the industry as a whole is underachieving. Successive independent reviews of construction have emphasised the need to improve the culture, attitude and working practices of the industry.

Change in major projects is driven by major clients and by government, as a means to champion better performance [12-17]. Perhaps the Latham report [15] has proved to be the most significant milestone as it indicated the construction industry especially the public sector should change procedures and methods to incorporate the concept of 'partnering'. Latham's proposals were undoubtedly the influence of the NEDC [18] and CII [19] reports. This initiative was further reinforced by Egan [12] by pointing-out that the UK construction industry languishes in the same unfavourable condition of that of the UK automobile industry in the 1960s. Partnering has been endorsed as one technique that could be easily adopted from 'design to manufacture' industries such as the car industry and retailing, and adapted, it has been argued, to give considerable benefits to all partners involved [20].

In the last decade there has been an enormous amount of interest in the use of partnering and to understand the factors leading to an inhibiting successful collaboration amongst construction firms [1, 4, 21, 22]. Partnering and the related forms of collaboration have been seen as a way of tackling fragmentation and lack of integration that have bedevilled attempts to improve project performance over the years [2]. It seeks to re-design relations between actors in projects by promoting the use of collaborative, more open, less managerial and less hierarchical relationships [13]. Many commentators argue that partnering can have a substantial positive impact on project performance, not only with regard to time, cost and quality objectives. It can also impact more general outcomes such as greater innovation, improved user satisfaction and reduced confrontations between parties, thus enabling an open and non-adversarial contracting environment [15, 23-26].

2.1 Concepts of partnering

According to Moore [27], contracting relationships can be seen in a continuum with 'spot buy' where transactions are purely incidental at one end, whilst 'partnering' at the other end under which the contracting organisations function cooperatively as a team to accomplish the transaction objective. Partnership appears to be a form to encourage integration of the project team and create competitive advantages to all that participate in the project by building stronger personal relationships and trust based on goodwill and cooperation. According to Naoum [16], this concept originated in Japan and the USA in the early 1980s where team building, cooperation and equality, rather than the single-sided relationship of adversaries to a project, were encouraged. A consistent theme discerned through the early construction industry commissioned reports was of fragmentation, short-termism, a lack of trust and a lack of collaboration within the client/design/construction team [11, 12, 15, 17, 20, 28]. These shortfalls were leading to consistently low levels of performance in areas such as cost, time, quality, running costs and fitness for the end user and as a result, when partnership/partnering was first debated in the US [19, 29] it was received with a level of enthusiasm in the UK [20].

As such, partnering has steadily gained popularity from the early 1990s in the UK. Radical changes in the way that the construction industry performs and provides services to customers, particularly those in the public sector has been supported by the British Government and as previously stated, both the private and public sectors in the UK contributed towards the 'client driven' change [12, 15, 16]. Since then, research into construction partnering has become widespread and has been seen as a primary management strategy for improving organisational relations and project performance. However, one thing that became clear from the literature synthesis is that there are many definitions of partnering in construction.

2.2 Partnering – the definitions dilemma

An early definition of partnering came from The US Construction Industry Institute [29] where it was defined as *'A long-term commitment between two or more organisations, for the purpose of achieving specific business objectives, by maximising the effectiveness of each participant's resources'*. It also emphasised the requirement of changing traditional relationships to a shared culture without regard to organisational boundaries, while the relationship is based on trust, dedication to common goals and the understanding of each other's individual expectations and values. Expected benefits included improved efficiency and cost effectiveness, increased opportunity for innovations and the continuous improvement of quality products and services.

This primary concern with maximising effectiveness and efficiency opened the gateway towards new management improvement techniques [20].

However, notwithstanding these definitions, different types of partnering relationships developed in the last decade. According to Matthews et al [30], there are no fixed definitions used when defining partnering in construction although common themes/elements prevail. He also noted that goals and objectives, trust, problem resolution, commitment, continues evaluation, group working and teams, equity, shared risk, win-win philosophy, and collaboration as common elements raised in partnering literature. While there is an agreement about these elements of partnering, there are varying views on its features. This includes a wide range of concepts capturing culture, behaviour, attitudes, values, practices, tools and techniques. According to Crowley and Karim [31], partnering also can be looked at as a process/means that leads to the intended results. In that regard partnering can be defined in one of two ways:

- *by its attributes - such as trust, shared vision, and long-term commitment; and*
- *by its process - whereby partnering is seen as a verb and includes developing mission statements, agreeing goals and conducting partnering workshops.*

Perhaps the most widely accepted definition is that offered by Bennett and Jayes [24] in the seminal work 'the seven pillars of partnering: a guide to second generation partnering'. Here, the idea of partnering revolves around three key principles applies by project teams, identified as:

- *agreeing mutual objectives to take into account the interests of all the firms involved*
- *making decisions openly and resolving problems in a way that was jointly agreed at the start of a project, and*
- *aiming at targets that provide continuous measurable improvement in performance from project to project.*

According to Naoum [16] partnering is a concept which provides a framework for the establishment of mutual objectives among the building team with an attempt to reach an agreed dispute resolution procedure as well as encouraging the principle of continuous improvement. Thus partnering is intended to reduce the adversarialism which is said to be typical in the industry and which has confounded previous attempts to encourage better integration and cooperation between contractual partners [12, 15, 32]. According to Li et al, [33] partnering is an establishment of an informal group among construction partners and creates non-legitimate but permanent relationships and is used to resolve disruptive inter-organisational conflicts.

Furthermore, mutual trust and understanding of each others commitments appears to be the prerequisites of changing traditional relationships to a shared culture in partnering [16, 25]. Ultimately partnering is about management of the relationship that must be trust-based [27]. Bresnen and Marshall [2] reinforce the requirement for the change in attitudinal and behavioural characteristics to achieve mutual trust. Barlow et al. [34] succinctly argues that, to achieve mutual trust, organisations must ensure that individual goals are not placed ahead of the team alliance. He also supports the idea of "gain-sharing" which effectively relates improvements back to all the participants. All these point out that partnering is built upon the attitudinal and behavioural characteristics of participants which lead towards mutual trust in order to move away from the traditional adversarial culture of the construction industry.

2.3 Benefits attributable to partnering

Several studies indicate that there is little doubt about the positive aspects of partnering arrangements [4]. Bennett and Jayes [24] suggest that performance, in terms of cost, time, quality, build-ability, fitness-for-purpose and a whole range of other criteria, can be dramatically improved if participants adopt more collaborative ways of working. Furthermore they illustrate ways to create undefined win-win relationships that involve a sophisticated strategy and require a willingness to improve the joint performance. Their research cites a remarkable potential savings of 40–50% in both cost and time [4]. However, the benefits were often cited in terms of cost and time [16] ignoring the other benefits to the team players which are more difficult to assess. This section briefly identifies and illustrates the common benefits of partnering cited in various partnering related literature.

Most of the research lists cost savings as the main advantage in employing partnering in construction. Chan et al. [35] suggests that partnering has great potential to improve cost performance and reduce the risk of budget overruns. There are many reasons quoted for better cost performance, such as: alleviating rework; reduction in variation; lower change order rates; maximised value engineering; reduction in costs of developing and supporting productive relationships; lower administrative and paper work; reducing scheduled time; reduction in scope definition problems, effective problem solving, and shared project risk [35-37]. As mentioned, better time control and reduced dispute and litigation contribute towards improved cost performance. Furthermore, Black et al. [38] believe that medium to long-term relationships compress the normal learning curve and thereby reduce the normal costs of developing and supporting productive relationships between the parties.

According to Chan et al. [35], an effective partnering agreement improves project quality by replacing the potentially adversarial traditional relationship and case building with an atmosphere that fosters a team approach to achieve a set of common goals. Partnering also provides a way for all parties to develop continuous improvement. With this joint effort and long-term focus barriers to improvement are eliminated. Hellard [37] suggests that partnering can increase the potential for innovation by encouraging partners to evaluate advanced technology for its applicability. These in turn produce high quality construction and service and reduce engineering rework [33, 38]. As one of the other quality benefits, the safety performance can be enhanced as partners better understand each other, taking joint responsibility to ensure a safe working environment for all parties [35].

Working with suppliers can improve the capacity of the organisation to meet the client's programme, quality, flexibility and cost requirements. According to Black et al. [38], one of the key benefits of partnering is the resultant synergy between project participants, enabling constant improvement in the key variables. In particular, the early involvement of contractors in the design stage can assist in constructability input and maximising value engineering, thus improving both cost and schedule [2]. Also, a fair and equitable attitude from project participants jointly resolves many disputes, discrepancies and changed conditions that arise during construction. Gransberg and Dillon [39] found that fewer numbers of liquidated damages were imposed on the partnered projects than the non-partnered ones.

As the partnering literature points out, a mechanism for problem solving is an inherent part of the concept [35]. Thus partnering aims to reduce adversarial relationship that will allow focus on mutual goals to the benefit of both parties [16, 38]. This encourages mutual trust and gain sharing which results in closer relationship, providing a better environment for the project [35, 40]. Improved culture enhances open communication between the project participants resulting in the elimination of blame shifting. Improved customer focus, augmented involvement of team members and joint satisfaction of stakeholders are achieved through this. Since partnering is seen as a recipe for potential benefits, its success factors are worthy of in-depth investigation. There is a lack of attention to these critical factors that needs to be addressed if partnering is to be successfully implemented as a strategy for performance improvement [41].

2.4 Critical success factors of partnering

Critical success factors are the key areas that are essential for management success. Cheng et al. [41] suggested that partnering can become successful by using pertinent management skills and developing a favourable context. It is essential to create an appropriate environment in which inter-organisational relationship can flourish. Management skills are vital for effective control of the relationships. They form the basis for initiating and facilitating the partnering process. Similarly some partnering characteristics can affect the partnering relationships. In consequence, it is important to identify these critical characteristics that form the favourable context conducive to partnering success.

Partnering requires timely communication of information and it encourages open, direct lines of communication among project participants [37]. Effective communication skills can help organisations to facilitate the exchange of ideas and visions, which can result in fewer misunderstandings and stimulate mutual trust. Similarly, effective coordination can result in achievement of stability in an uncertain environment by the creation of additional contact points between parties to share project information [41]. The other critical management skill is ‘productive conflict resolution’ which can be achieved by joint problem solving in order to seek alternatives for problematic issues. Conflict resolution techniques such as coercion and confrontation are counterproductive and fail to reach a win-win situation [41]. Furthermore, regular monitoring and early implementation of partnering process are essential to ensure partnering success [42].

Similarly, some of the critical characteristics form the favourable context conducive to partnering by establishing interdependence and self-willingness to work for the long-lasting cohesive relationship. Most of these contextual characteristics are soft critical success factors such as, top management support, long term commitment, mutual trust, willingness to share resources and commitment to win-win attitude [33, 41, 42]. Support from top management is always a prerequisite to initiate and lead a successful partnering arrangement. Commitment to win-win attitude represents the open airing of problems among parties and encourages risk sharing, rewards and willingness to exchange ideas [42]. This leads towards sharing of resources that can be used to strengthen the competitiveness and construction capability of a partnering relationship. However, there is a tendency within the partnering literature to concentrate on success stories [4]. Conflict and failure could occur by a fundamental deviation in goals, especially in relation to accountability, thus hindering all cooperation that may have been attained by the partnering process [43]. There is case evidence of the failure of partnering to meet performance expectations in construction [25]. Thus it is important to adequately address and evaluate the challenges and potential problems in construction partnering.

3. Partnering challenges and problematic issues

The concept of partnering, overhauls the ethics of traditional contracting with the paradigm shift towards cooperative and caring environments. According to Naoum [16] successful partnering could attain a win-win solution and gain sharing. In general, with a cultural shift in attitudes project partnering can be successful and bring benefits to the stakeholders involved in the process [43]. However, changing traditional relationships to a shared culture requires mutual trust and dedication to common goals [3, 4, 44]. An absence of mutual trust and scepticism within participants may result in various problematic issues.

According to Lendrum [1998 cited 43] a lack of open and honest communication may lead to degradation in the stakeholders' ability to efficiently resolve any problems. Thomas et al. [43] identified a lack of empowerment and technical knowledge from the client's side and usage of competitive tendering, failure to include key suppliers and subcontractors together, with lack of training as some of the main problematic issues in partnering projects. They argued that the role of client as the head facilitator of the partnering arrangement should take a leadership role, and ensure full commitment and correct facilitation throughout the entire duration of the projects. It was identified that the majority of problematic issues experienced in project partnering arrangements were related to the commitment provided to the attitudinal change and procedural implementation required in efficient project partnering [43].

As discussed, central to any successful partnering arrangement is the change in attitudinal and behavioural characteristics towards mutual trust and understanding. Green and McDermott [1996 cited 25] argue the attitudes and behaviour evident in the construction industry are deeply ingrained and that it is difficult to engineer any rapid movement away from such an embedded culture. According to Li et al. [33] partnering requires a long-term strategic plan with cultural change intervention in order to move beyond a traditional discrete project nature. In effect, the development of trust between organisations is seen as a function of the length of the relationship between them, and the mechanisms that led to this alignment are viewed largely as informal. On the other hand, researchers believe that it is possible to bring about change over the timescale of a single project suggesting the view that partnering can be engineered and does not have to evolve naturally [2, 23]. Despite the separation between informal developmental and formal instrumental views to alter the behaviour, behaviour is considered the result of conscious choices and actions and a complex interplay between structural imperatives and their subjective interpretation and enactment [2].

Since partnering is seen as changing behaviours and attitudes, cultural transformation cannot be forgotten in the process. Much of the literature tends to presume that cultural alignment is a prerequisite for partnering. However, it is certainly not easy to bring about cultural change to adopt a new set of behaviours as a consistent way of working among the people. Atkinson [45] identified fear, perceived loss of control, difficulty in learning to do the things differently, uncertainty, addition in work and an unwillingness to commit as the reasons for people to resist change. Hill and McNulty [46] portray fear and uncertainty as the main barriers to change. Conceptualisation of the relationship between partnering and culture [2]; resistance to change from traditional, adversarial and exploitative ways [32]; lack of cooperation based upon fundamental differences in interests between the parties to contract; profitability and uncertainty issues; unwillingness to commit fully to close, long term relationships, together with the construction industry perception of mistrust [26] can be considered as some of the reasons to resist cultural change towards collaborative relationships.

4. Research methodology

This study was launched as part of a Doctorial study on 'Rethinking leadership to address cultural and behavioural challenges in construction partnering'. Phase one of this research focuses on finding out the 'root causes of cultural and behavioural challenges in construction partnering' with empirical evidence. A questionnaire comprising of 10 questions was constructed from the synthesis of partnering literature. Thirty-nine potential problems were elicited from various partnering research, most of which were both economically and culturally driven issues. However, issues that were not culturally driven were excluded from the study with cultural and behavioural issues amounting to 34. These issues were then integrated, based on causality, to form the basis for 10 major questions to examine the magnitude and the root causes of the identified cultural and behavioural challenges in construction partnering in the UK.

Data was collected by means of self-administered expert interviews with each question containing both a quantitative and an open ended qualitative question. A total of 10 experts were randomly selected from academics and industry practitioners. Experience on partnering work of industry experts ranged from 2 years to 10 years while academic experts were selected with a minimum of 3 years of partnering related research experience. Experts were first requested to assess the extent of the identified challenges according to a Likert scale from 1 to 5, where 1='very low' to 5='very high'. They were then presented with an open question to express their perception on the root causes of the identified cultural and behavioural challenges. Most of the respondents were academics with industrial partnering experience and relevant partnering research.

4.1 Data analysis and results

A combination of quantitative and qualitative data analysis was carried-out in this phase to rank the collected data that gave rich details of the challenges and their root causes. Perceived root causes were rearranged with weightings taken from Likert scale to rank the root causes of identified cultural and behavioural challenges. Once again these root causes were integrated/grouped to form specific areas which leadership has to tackle to address cultural and behavioural challenges in partnering projects.

Table 1. A summary of major cultural and behavioural root causes

	Major cultural and behavioural root causes	Causations
1	*Organisational soft issues*	*Mistrust, attitude, culture, fear, resistance to change*
2	*Wrong partnering practices*	*Lack of mutual respect, risk avoidance and transfer, imbalance negotiations, faults with partnering arrangement, misrepresentations*
3	*Lack of understanding and resistance to understanding of partnering concepts*	*Lack of awareness and commitment, not realising the potential benefits, sceptical*
4	*Issues related to individual partners*	*Misalignment of objectives, negative thinking and mind set, inability to learn and unlearn, heuristics*
5	*Direct management issues*	*Lack of negotiation skills, lack of support from top management, imbalance of power*
6	*Lack of continuity of projects*	*Short term projects, lack of potential long term benefits*
7	*Bad experience*	*Past bitter experience with similar participants*
8	*Competitiveness*	*Perceived loss in competitive advantage, self cantered natural cautions*
9	*Financial pressure*	*Commercial imperatives and accounting issues*
10	*Traditional ways*	*Fragmented industry nature and common adversarial cultural problems*
11	*Issues related to project*	*Complexity, resource constraints, procurement routes*
12	*External environment*	*Social, economical, technological and political issues, public sector regulations*
13	*Immaturity of partnering concepts*	*Lack of dispute resolution techniques and related mechanism, lack of confidence*

5. Discussion: cultural and behavioural challenges of construction partnering projects in the UK

As shown in Table 1, 13 major cultural and behavioural challenges were identified, which were categorised in order to assist the next phase to determine suitable leadership practices to tackle these challenges. ‘Organisational soft issues’ were identified as the major area of root causes that focus on the non-suitability of cultural environment such as blame culture and adversarial attitudes. Fear, suspicion and mistrust were other causes of organisational soft issues. This area of challenge becomes more difficult as it associates with resistance and inability to change. Since this deals with changing ‘shared assumptions’, informal developmental and working solutions of leadership may only be the solution.

The study identified ‘wrong partnering practices’ as the second major area of challenge, which includes the absence of proper systems of communication, premature formation of partnering contract, corruption, lack of mutual trust, misrepresentation of ethos and ethics, imbalance of negotiation, absence of partners from the beginning other risk related issues. It is also perceived that clients normally use partnering as a cover for risk avoidance and risk aversion. However, few partnering projects were mentioned where the success of the project was achieved with the in take of major risks was taken by clients. The client’s muscle towards risk aversion can become a major hindrance to construction industry of the UK especially in this period of economic down-turn. Another area closely related to ‘wrong partnering practices’ is the ‘lack of understanding and the resistance to understand the partnering concept’. Lack of awareness of commitment, potential benefits, rewards and scientism are still in existence even after a decade of partnering in the UK construction industry. ‘Issues related to individual partners’ is the next major root cause with challenges such as individual reluctance to commit, negative mind set and different perceptions on win-win attitude.

The final major root cause worth mentioning is ‘direct management issues’ such as lack of negotiation skills, lack of support and undue pressure from top management, imbalanced power structures and lack of induction and training. Even though some of these are easy to overcome, it is important to be proactive. These management issues can also contribute and aggravate other areas such as ‘competitiveness’ and ‘financial pressure’. In short, most of these cultural and behavioural root causes will require cultural change to adopt a new set of behaviours as a consistent way of working among people. As stated above, leadership is originally the source of the beliefs and values that get a group moving with its internal and external problems [9]. Once a leader’s proposals continue to work, they gradually come to be shared assumptions of organisational culture. As such, leadership plays a very significant role in shaping the culture and it is very important to the change agents to lead the whole process, all the time.

6. Conclusion

The literature review shows the growing significance and evolution of partnering which is said to reduce adversarialism in the industry. Also the synthesis on partnering challenges shows the significance of cultural challenges to be tackled to improve the industry. Hence this research has been carried-out to identify the major root causes of cultural and behavioural challenges in construction partnering in the UK. Research found that organisational soft issues, wrong partnering practices, lack of understanding of partnering concept, individual partner’s issues and direct top management issues are the major areas of root causes and it is essential for leadership to play a very significant role in shaping the culture which in turn can bring further benefits by tackling cultural root causes in construction partnering projects.

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Failure of Applying PFI in Colombo Katunayake Expressway Project

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Abstract

Currently the PFI infrastructure projects through out the world include toll roads, power stations, bridges, ports, water treatment plants etc and has accepted it as best suited for developing countries since infrastructure development is essential for the development of the developing countries, where the governments can not afford finance for such huge infrastructure projects. Even though there were eleven small scale power projects and one port development on Private Finance Initiative (PFI) basis, toll road projects with PFI procurement methods was a new concept to Sri Lanka. In 1995 government had proposed constructing the Colombo Katunayake Expressway (CKE) as the first PFI road project in Sri Lanka to reduce the traffic volume in existing Colombo Negombo A3 road. Fifteen well established foreign concession contractors bid for the project but PFI arrangement was terminated after several negotiation sessions. The study revealed that inflationary economic environment in the country, uncertainty on the coming government’s political support, uncertainty on government’s policy changes, public perception towards tolling, competition from existing A3 road, inaccuracy on traffic forecasting, inability of handling toll revenue by the politicians during the concession period, terrorist problem, inability of realizing concessionaires’ long term plan to enter in to PFI agreements for irrigation and hydropower projects and inability of having duty waivers from the government for imports of concessionaire as main reasons for the failure of PFI in CKE. Two root causes were identified by analyzing the failure factors as unfavourable political situation in the country and the conservative society. Elimination of the identified Root Causes and failure factors will lead to have successful PFI agreements for the future road projects in PFI procurement system.

Keywords: Facilitators, Impediments, PFI, Road Projects, Root Causes, Sri Lanka

1. Private Finance Initiatives

Private Finance Initiatives (PFI) is an alternative method of procuring services for the public sector. The private sector will design, build and provide funding for the capital projects and operate facilities for the public benefit [3]. Private consortia will receive revenue from operating this service, hence make a profit. The PFI procurement methods could be identified through the literature as Build Own Operate Transfer (BOOT), Build Own Operate (BOO), Build Operate Transfer (BOT), Build Operate and Renewal of Concession (BOR), Design Build Finance Operate (DBFO), Design Construct Manage and Finance (DCMF), Build Lease (or Rent) Transfer (BLT or BRT), Lease Renovate Operate Transfer (LROT), Build Transfer Operate (BTO), Rehabilitate Own and Operate (ROO), Rehabilitate Own and Transfer (ROT), Modernize Own/Operate and Transfer (MOT) and Build and Transfer (BT).

As mentioned by the Akintoye et al [1] there are many advantages of implementing PFI projects as they grant “value for money”, transfer of risk away from the public sector to the private sector and facilitate creative and innovative approaches, cap final service costs at pre-determined levels, reduce administration costs, reduce the amount of public money tied up in capital investment, reduce total project cost and improve the buildability and maintainability of projects, accelerate project development and avoid delays in project, give benefits to local economic development and transfer technological knowledge to local enterprises, solve the problem of public sector budget restraint and enhance government integrated solution capacity.

Success Factors for implement PFI projects from investor’s perspective can be identified according to the phases of a PFI project as follows:

Decision Making Phase: Appropriate project identification, available financial market, thorough and realistic cost benefit assessment, favourable legal framework, political support, sound economic policy, stable macro-economic environment and government involvement through providing guarantees

Preliminary Qualification Evaluation Phase: The capability of project promoter and experience with PFI project by promoter

Tendering Phase: Shared authority and responsibility, multi benefit objectives, competitive tendering system, transparency in the procurement process, technology solution advance, acceptable toll/tariff level and attractive financial package

Concession Award Phase: Multilateral investment guarantee agency insurance, special guarantees by the government, reasonable risk allocation, concrete and precise concession agreement

Construction Phase: Selection of suitable subcontractors, quality control and supervision, standardization of engineering contract, a multidisciplinary and multinational team and good relationship with government

Operation Phase: Management control, training local staff and sound environmental impact

Transfer Phase: Technology transfer and operation in good condition

In considering the opportunities presented by the PFI market, the contractors have identified a number of barriers to entry in to PFI market which were hindering their involvement as Lack of appropriate skills, high participation costs, high project values, lack of credibility and contacts, demands on management time and high risk. PFI risk can be identified as traffic revenue risk, land acquisition delay, demand risk, delay in financial closure, completion risk, cost overruns, debt servicing risk, political risks, financial risks, State-rooted risks such as prolonged negotiation period prior to project initiation, unfavourable economy in the host country, import or export restrictions, rate of return restrictions. Concessionaire-rooted risks can be identified as lack of creditworthiness, inability of debt service, bankruptcy, unfavourable economy of the country of the main stakeholders, high bidding costs, high design costs, high construction costs, errors in forecasting the demand, wrong estimate of cost trade-offs between different phases in the project's life cycle, risks regarding pricing the product, complex financial structure of the PFI projects, lack of co-operation in case of new initiatives, insufficient performance during operation, lack of guarantees, financing risk. There are Market-rooted risks as loan risks, fall of demand, taxation risks, fluctuation of the inflation rate and currency risks.

The scale and structure of huge infrastructure requirement, shortage of public sector financing, growing debt crisis and reduction of their external borrowing capacity have compelled many developing countries to shift their focus towards PFI in infrastructure projects [2]. Sri Lankan government is actively encouraging private sector investment in infrastructure on the PFI basis mainly for telecommunication sector as well as power generation sector due to their less risky nature. Five telecommunication projects, eleven power projects and one port development were implemented under PFI in Sri Lanka.

2. Background of the CKE Project

Even though in other countries PFI is successfully used in massive road development projects giving much more benefits to the government, it was not realized in Sri Lanka. The Government of Sri Lanka (GOSL) had initially considered PFI procurement methods for procuring the Colombo Katunayake Expressway (CKE) to minimize the government funding but received no proposal bids. Consequently the project was awarded in Design Build and Turnkey (DBT) procurement method. However, the DBT Contract was mutually terminated when overall construction work progress was 35%. This led to a further engagement to undertake study and prepare documentation with several negotiation sessions with foreign concession contractors for completion of the project under PFI arrangement, but ultimately it was also failed. Therefore, the government is now conducting negotiations to implement this project with Engineering Procurement and Construction (EPC) Turnkey basis. As a result of all these, there is a question "Why the application of PFI was failed in CKE project?" which is also the question of this research.

3. Methodology

Single Case Study Design was selected with In-Depth Study with Multiple Source Evidence to represent this critical case in application of a well established PFI theory.

Since, case study research generates a huge amount of data the multiple sources of evidence were collected and stored methodically and systematically in formats that can be referenced and sorted. The most important source of information was semi structured interviews which revealed the failure of applying PFI in CKE. Interviewees at different levels of the organization were targeted. Initially this was to ensure that any findings were not based on data coming from "one side" only. As it turned out, the different views that appeared through this multi-level focus became a major point in the findings from the study. To gain further information regarding the case and background details, documentation and the web data facilitated a great deal and it was capable of offering to double-check other information. The data collection also included a wide range of written material: annual reports, web sites and negotiation reports so on.

Snowball technique was used to recognize and select the interviewees. Snow ball technique involves concentrating groups of ideas pertaining to the same problem. In its simplest formulation snowball sampling consists of identifying respondents who are then used to refer researchers on to other respondents. But in most cases one person in a particular organization recommend people with same opinions. Therefore, for collecting multiple source information, different group of people were interviewed in the same organization with different opinions.

The questions for a semi-structured interview were ideally constructed some time before the interview and were sent to the expert so he/she can start to prepare responses. Printed or electronic list of questions were distributed to predetermined selection of interviewees prior to interview including questions such as; what are the PFI facilitators which were presented and not presented in the CKE project, what are the reasons for the absence of those facilitators, what are reasons for inability to make available those facilitators for the project, what are the PFI impediments which were presented in the CKE project, what are the reasons for existence of identified impediments in CKE project and what are the reasons for inability to eliminate identified impediments.

There were eleven interviews with the professionals such as Project Engineers and Project Directors from the PFI bidders and related government authorities for the project who were acted as the government's representatives. For an interview lasting 2 -3 hour, around 10-15 questions were asked. This allowed time in between the prepared questions to ask supplementary questions to clarified points and asked for more detail where necessary. Direct questions were also asked for respondents to answer "yes" or "no." when the answer is "yes" it became an open ended discussion. As well as, respondents had to give reasons when the answer was "no." The answers of one respondent showed to the other to get his opinion on other's answers. An important aspect of the technique is that the interview was recorded and later transcribed providing a protocol for detailed analysis.

Manual code based content analysis was selected as the methodology for analysing the collected data to identify PFI facilitators which were not presented, PFI impediments which were presented and their Root Causes.

4. Research findings

When analyzing the case of CKE it was obvious that both GOSL and concessionaires have agreed to enter in to a build agreement and the main disagreements within the government and also the within the concessionaires were rooted on the operation of the toll road by the selected concessionaire, because of the operation responsibility is with the concessionaire, it has to recover the total project cost plus profit from the toll revenue.

4.1 Impediments Present

Identified impediments of the CKE on PFI basis can be recognized as political risk, traffic revenue risk, financial risk, disagreement among upper level politicians and other unfavourable conditions in the country.

4.1.1 Political risk

The risk on the continuous political support and policy changes were identified by the respondents as the most important political risk factors which impeded concessionaires from taking the operation responsibility of the CKE. There was an uncertainty among the foreign contractors on the actions of the coming governments, such as terminating the concession or imposing taxes or regulations on the project that severely damage its value to investors; not allowing the private partner to charge and collect tolls as specified under the concession agreement; preventing investors from transferring earnings out of the country; or not allowing for contract disputes to be settled fairly under neutral jurisdiction.

It was obvious the importance of having a firm legal framework for the PFI projects in Sri Lanka to avoid such uncertainties that can arise from the government changes and policy changes. From the foreign contractors' point of view, it is essential to get the support from multilateral or bilateral financial institutions by the GOSL to mitigate political risks.

4.1.2 Traffic revenue risk

CKE is being the first Sri Lankan toll road project, foreign concessionaires had uncertainty on the user's willingness to pay tolls which is mainly affected by user's wealth, their attitude and value they assign for time saving. According to the government authorities' point of view, to change the people's attitude, people should be educated on the real meaning and the benefits of the PFI arrangements, difference between the privatization and PFI and on the importance of having a foreign concessionaires' involvement for the infrastructure development of the country.

Concessionaire also had a doubt on their ability to draw traffic from existing Colombo Negombo A3 road to generate new traffic. Further, foreign concessionaires have requested a minimum traffic revenue guarantee an extension of the concession term or cash compensation when the traffic volume falls below the minimum expected traffic levels from the GOSL in negotiation sessions as a treatment for the traffic revenue risk.

Concessionaires also had distrust on the accuracy of the traffic forecasting by the GOSL. Arguments were carried out on the factors such as land use and population growth along the route, public acceptance and use of the expressway, and various economic indicators used in traffic models with inherent uncertainties, which affect the traffic forecast. Some respondents suggested using refining methodologies and empirical equations for improving the long term accuracy of traffic volume estimates. But they have mentioned the importance of cross-checking of forecasted traffic volume by at least one independent consultant.

Possible toll rate issues were also discussed such as limitations of increasing toll rates with the inflationary economic environment in Sri Lanka, which is quite a sensitive issue, both politically and socially. Another issue was whether toll rate adjustments should be left to discretion of GOSL or be based on a formula that is usually linked to changes in some price index. Therefore, the respondents suggested establishing a straightforward, transparent, fair, and binding Toll Adjustment Mechanism by the GOSL and private concessionaire.

4.1.3 Financial risk

As mentioned by the relevant government authorities, for the CKE project GOSL highly expected the contribution of foreign financial institutions and sponsors for the project financing and conversely foreign concessionaires also expected a high financial security from the GOSL. The main impediments which discouraged foreign concessionaire for financing of CKE project was their uncertainty in the import export policies of the GOSL. They were in doubt whether the GOSL restrict their repatriation of profit by imposing taxes. Another main negative feeling was the unexpected increases in the construction cost due to the inflationary economic environment which will seriously affect the economic plan of the concessionaire.

Introducing a firm legal framework for the PFI arrangement of CKE project to avoid influences for the project from the government policy changes was the main solution which was proposed to encourage foreign investors to finance for the CKE project. Respondents also suggested expanding the concession operation period or compensating the concessionaire by GOSL to cover the increases in the construction cost due to inflation.

Another major impediment pointed out by the respondents was the currency risk, because if Rupees are not convertible at the expected exchange rate, it will not be able to pay the return on investor’s foreign currency for his capital. Therefore, the foreign concessionaires always assumed the exchange rate risk and inconvertibility risk, in the negotiation sessions even though the political risk insurance covers the inconvertibility. The main cause for the exchange rate risk is the inflationary economic environment in Sri Lanka and interviewers’ proposal was to mitigate exchange rate risk by indexing the toll rates to local inflation rate or to the exchange rate of the investor’s foreign currency. They recommended to use consumer price index as the inflation index and adjustments to be made according to a fixed schedule. Disagreements among upper level politicians

When considering the responses of the interviewers it was obvious that there were disagreements among the upper level politicians regarding the foreign concessionaire's operation of the CKE for the concession period. There had been several reasons behind the upper level objection. Under the PFI arrangement, toll revenue handling is completely with the foreign concessionaire for the agreed period usually more than ten years and during concession period politicians have no control over the toll revenue. The politicians had also thought that foreign operation of CKE would make a bad public impression of the government similar to privatization, and it would have adverse affect during elections. Respondents also believed when the top level decision makers' impression is bad towards the foreign contractor's operation, the lower level educated people also have to agree on their decisions even their own opinion is not the same. Therefore, it is essential to educate politicians on the benefits of having a PFI arrangement for realizing the CKE project.

4.1.4 Other unfavourable conditions

According to respondents, CKE bidders expected to involve in irrigation and hydropower sectors for concession contracts while staying in Sri Lanka by operating the toll road. But in negotiation sessions they understood that they will not be able to realize their long term plans due to public resistance to pay tariff for infrastructure facilities. On the other hand foreign concessionaires did not prefer to stay for a long operation period in Sri Lanka due to the terrorist problem. Respondents also pointed out that the foreign concessionaires do not like to live in such an uncertain environment for a long period even though it is possible to have an insurance cover.

4.2 Facilitators Not Present

The PFI facilitators, which were not presented in CKE project and the way of implementing those facilitators for a successful PFI agreement, are discussed next.

4.2.1 Unavailability of local financial market

As mentioned by the respondents, local financial market is not strong to finance for the whole project, due to high project cost and long payback period, although they will receive annual interest payments. Therefore, the project has to be financed by the foreign investors. So as mentioned under the financial risk, if there are local financial sources to invest for CKE project it will facilitate to reduce the effect of the currency risk.

4.2.2 Less supportive legal and policy frameworks

The respondents pointed out the main difficulty of developing a proper PFI agreement for the CKE project as inadequate assurance from the country's legal system to investors, which avoid obtaining an objective settlement of contract disputes. According to the respondents, political support for the CKE project negotiations was not much flexible. Concessionaires requested Minimum Traffic Revenue Guarantees, exchange rate guarantees, Toll Adjustment Mechanism and a firm taxation procedure from the government to draw the political support for a successful PFI arrangement. It is essential to have a comprehensive legal frame work for PFI projects including the operation of the project which is not available in Sri Lanka.

4.2.3 Unavailability of Sound macroeconomic environment

According to the respondents, a favourable country and concession environment is crucial for attracting finance and limiting the need for government undertaking of risk for the project. But in Sri Lanka there is a high inflationary economic environment which discourages financing sources to invest in CKE project as well as caused for the impediments such as revenue risk, currency risk and financial risk due to construction cost increases.

4.2.4 Lack of Government involvement: providing guarantees

Concessionaires supposed a variety of mechanisms to support their financings. They were discussed on the Equity Guarantees, Debt Guarantees, Exchange rate Guarantees, Grants, Subordinated Loans, Minimum Traffic Revenue Guarantees, Shadow Tolls, Revenue Enhancements and Concession Extensions. If the government provided guarantees for the PFI concessionaries, most of the impediments such as political risk, traffic revenue risk and financial risks could be minimized.

Impediments, which were not presented in the CKE, project to implement PFI procurement system could be identified as Lack of Appropriate skills, high project costs and lack of credibility, prolong negotiation period and completion risk.

PFI facilitators presented in the CKE project were the proper project identification, thorough and realistic cost benefit assessment, capacity of the project promoter, attractive financial package, acceptable toll or tariff levels, technology solution advantage and transparency in procurement process and reasonable risk allocation.

4.3 Root Causes

When the existing impediments and missing facilitators are scrutinized, it becomes obvious that some impediments have occurred due to lack of several facilitators and some missing facilitators have caused for presenting several impediments. Further, making available of some missing facilitators is the identified methods of eliminating certain impediments.

According to the analysis of the previous section it can be recognized key failure factors of PFI in CKE project as Inflationary economic environment in the country, Uncertainty on the coming government’s political support, Uncertainty on government’s policy changes, Public perception towards tolling, Competition from existing A3 road, Inaccuracy on traffic forecasting, Inability of handling toll revenue by the politicians within the concession period, Terrorist problem, Inability of realizing concessionaires' long term plan to enter in to PFI agreements for irrigation and hydropower projects and Inability of having duty free waves from the GOSL for imports of concessionaire

Further analysing of failure factors illustrates two Root Causes for the existence of all failure factors as Unfavourable Political Situation in the country and Conservative Society which are explained below.

4.3.1 Unfavourable Political Situation in the country

Failure factors which have occurred owing to the Unfavourable Political Situation in the Country can be recognized as Uncertainty on Political Support and Policy Changes, Inflationary economic environment, Inability to handling toll by politicians, Terrorist Problem and Inability of having duty waivers.

1. **Uncertainty on Political Support and Policy Changes**

Construction in Sri Lanka, as in many other developing countries, affects mainly by the national plan of each political group who is in power. When a new government comes in to power, previous government's working procedures and policies are changed, which has become a common scenario today. Governments can change government expenditure and taxation by imposing fiscal policies and money supply to the economy and interest rates can change by applying monetary policies. Further governments can change grants and subsidies, productive enhance measures, tax concessions and financial incentives by imposing supply policies. It can be expected several government changes within the concession period of the CKE project which can be defectively affected to the concessionaire by means of less supportive political plans and policy changes.

2. **Inflationary economic environment**

Normally inflation of an economy is occurred due to demand pull and cost push situations. In demand pull situation the demand for the goods and services is increased but the supply is not increased to fulfil the increased demand. In the cost push situation input prices of the producers are increased. In both situations, the prices of the goods and services are increased. Political decisions are also caused for the inflation as getting huge loans from developed countries as well as starting massive development projects with government funds. Therefore, to regulate the inflation of the economy the government of the country should be able to apply demand side policies as well as supply side policies at the correct time. But in Sri Lanka government seems not to be applied correct policies and if not change the country's unfavourable political situation, current inflationary economic conditions will prevail for the concession period of the CKE project.

3. Inability to handling toll by politicians

As mentioned by the respondents of government authorities, in Sri Lanka there is no standard procedure to handle public money by the politicians and therefore, more corruptions are occurred. Thus, most of the beneficiaries in superior levels have disagreed to allow concessionaires to handle toll revenue for the concession period, which takes generally more than ten years.

4. Terrorist Problem

Terrorist problem in the country also caused to keep away concessionaires from staying in the country for longer period for the operation of the toll road. As mentioned by the respondents, two main political parties in the country have two different responses towards the terrorist as peace talks and war. Therefore, it is very difficult to have a firm solution for the terrorist movement in the country.

5. Inability of having duty waivers for the concessionaire

Further the foreign concessionaires supposed to have duty free waves for their imports during the concession period. But the government refused to provide such facilities and did not respond favourably to accomplish a successful PFI agreement. Therefore, it is needed to educate politicians on the importance of having flexible procedures as well as collaboration between both government and concessionaire to form a proper PFI agreement.

4.3.2 Conservative society

Public perception towards tolling, Competition from existing A3 road , Inability to realizing long term plans by the concessionaire and Inaccuracy on traffic forecasting can be discussed as results from Conservative Society.

1. Public perception towards tolling and Competition from existing A3 road

Sri Lankan people used to get the infrastructure services free of charge from the government. Therefore, it will be really difficult to change their attitudes towards paying money for the free services that they have received earlier. Further, due to financial problems, there is an uncertainty whether the people will get use to pay money for tolls or will use the existing A3 road.

2. Inability to realizing long term plans by the concessionaire

CKE bidders expected to involve in irrigation and hydropower sectors for concession contracts while staying in Sri Lanka by operating the toll road. But, Sri Lankan people have used infrastructure as a free facility, specially in irrigation sector. Therefore it will not easy to get agree farmers to pay money for water.

3. **Inaccuracy on traffic forecasting**

Main component of the traffic forecasting is the public acceptance. Therefore due to the conventional society it is a risk to forecast public acceptance of paying tolls or tariffs for infrastructure facilities.

Further educational programmes are needed to educate both public and politicians on the benefits of having PFI arrangement for the infrastructure development of the country.

5. Conclusions

When studying the procurement history of the long waited Colombo Katunayake Expressway (CKE) project, it was apparent that there have been four attempts of project, but initial three attempts had been failures. The specialty was with the second bidding effort, which was the first Sri Lankan PFI procurement process in road sector.

This study revealed five main impediments to implement the project on PFI basis as political risk, traffic revenue risk, financial risk, disagreements among upper level politicians and other unfavourable conditions.

Uncertainty on the coming government's political support and government policy changes were the main causes for political risk and it was proposed to mitigate those unfavourable factors by forming a comprehensive legal framework and getting support of multilateral or bilateral financial institutions. Another significant obstruction for PFI was the traffic revenue risk, which had formed because of public perception, competition on existing A3 road, increase of tolls and accuracy level of the traffic forecasting. It was suggested to educate people on the benefits of PFI to make a better public impression. Inflationary economic environment was the reason for the increase of tolls and proposed to implement straight forward, transparent, fair and binding toll adjustment mechanism to reduce the affect on concessionaires from inflation. It was also advised to use refining methodologies, empirical studies and cross checking by independent consultants to improve the accuracy of the traffic forecasting. Grounds for the financial risk were the currency risk, uncertainty in policy changes and increase in construction cost. Currency risk was occurred due to inflationary economic environment. Index toll rates to local inflation rates, index toll rates to exchange rate of the foreign currency and involve local funding sources were the major currency risk reducing proposals. It was suggested to form a comprehensive legal framework to reduce the uncertainty on government policy changes. Inflationary economic environment caused for the construction cost increases and as mitigation, it was proposed to compensate the concessionaire or expansion of concession period. Fear of negative public impression, which can influence for elections and inability of handling toll revenue until the end of the concession period were the main sources for the disagreement among the upper level politicians on concessionaire's operation of CKE. As a remedying measure, it was proposed to educate politicians on the benefits of PFI. Other unfavourable conditions were the concessionaires' objection on staying longer period by operating the toll road due to terrorist problem and inability of realizing long term plans such as concession contracts for irrigation and power sector projects. Inability of having duty free waves from the GOSL for the imports of the concessionaire also was a negative factor.

Some of the main facilitators, which were discussed in the literature for a successful PFI road projects, were not present in the CKE project. Key facilitators found to be absent were; unavailability of local financial market due to high project cost and long payback period; less supportive legal and policy frameworks which can be eliminated by providing flexible government actions as minimum traffic revenue guarantee, exchange rate guarantee, toll adjustment mechanisms and firm taxation policies; unavailability of Sound macroeconomic environment due to inflationary economic conditions which can be reduced by providing sound economic policy to compensate concessionaire in highly inflationary situations; and lack of government involvement through providing guarantees.

The bidders for the CKE project were well established foreign concession contractors. Therefore, they were well equipped with appropriate skills and consisted with in house capacity. Hence, the impediments mentioned in the literature as lack of appropriate skills and high project costs, lack of credibility and contacts were not presented in the CKE project. Conducted negotiations were not too lengthy and completion risk was not with the contractor because the government had already settled all public interferences against the project, environmental clearances, government approvals and land acquisition at the first attempt of the CKE project.

When comparing with the facilitators identified in the literature, proper project identification, thorough and realistic cost benefit assessment, high capacity of the concession contractor, attractive financial package, acceptable toll level, technology solution advantage, transparency in procurement process and reasonable risk allocation were present in the CKE project.

Through the analysis, Two Root Causes were able to identify for the existence of the PFI failure factors as Unfavourable Political Situation in the country and Conservative Society. Therefore it is needed to educate both public and politicians on the benefits of having PFI arrangement for the infrastructure development of the country to eliminate the effect from the Root Causes for the CKE project.

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SECTION XVII

E-LEARNING

Improving co-learner interactions through Web-based online assessments within distance learning settings

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Abstract

Distance Learning (DL) is an educational model that is fast growing both in the UK as well as in the international education context. It has come into prominence with the advent of the internet technology particularly during the last two decades of the 20^{th} century. Due to the nature of delivery of DL programmes, the methodology in which students are assessed varies from one programme to another. One of the major influencing factors for achieving intended learning outcomes in a programmeme is the assessment strategy adopted. Tutors in DL programmemes have adopted various methods of assessments that could broadly be described as formative and summative assessments. A well documented formative and summative feedback for learners, especially early on in a course, will facilitate in their learning and provides opportunities for students to gain insight into their understanding of the course content. Learners often express their need for more empowerment within their modules to enhance their active involvement and interactions within the programmes. This is the main focus of this ongoing research under the Teaching Learning Quality Improvement Scheme (TLQIS) of the University Of Salford, UK.

This paper disseminates the first stage of the research project. The paper first examines literature within the area and explores the various online assessment tools available that can be incorporated to DL. It then sets out the overall methodology and conducts two case studies of DL courses within the School of Built Environment (SOBE), University of Salford. The next stages of this research project will evolve into DL courses conducted in other schools and faculties at University of Salford and other Higher Educational Institutes (HEIs) both in the UK and overseas. It is expected that the final results of this study will lead to recommending of guidelines on improving co-learner interactions within DL settings.

Keywords: Distance Learning (DL), co-learner interactions, web-based online assessments

1. Introduction

Advances in information technology (IT) is continually evolving; opening up additional channels for today's higher education (Chen *et al*, 2001). Distance education technologies have become more prominent during the last decade of the 20th century (Ingirige *et al*, 2005). Moreover, Chen *et al* (2001) noted that the application of IT have allowed universities to deliver multimedia course contents and enable students to communicate with their instructors and fellow students in both synchronous and asynchronous formats; hence making distance learning (DL) possible. DL, an educational model in which the student and the instructor are separated by time and space, is considered the current fastest growing model of domestic and international education (Poley, 2000).

Distance education had been around for more than a century, which according to Belanger and Jordon (2000), the history of technology-based DL was correspondence education, which started in Europe and the United States in the mid 19th century. Web-based technologies (WBT) in particular have expanded the interactive capabilities of distance education from solely asynchronous communications with long delays in response to highly interactive class meetings via text, e-mail, video and many more (Murphrey, 2001).

In the domain of higher education (HE) in the construction industry, DL has become a major source by which many HE institutes conduct their courses, particularly at postgraduate level. At the University of Salford, the School of Built Environment (SOBE) itself utilises the distance education technology tools in delivering Masters and PhD programme over the Internet (Ingirige *et al*, 2005). The new developments in technology have impacted the overall delivery process of the DL construction programme. It has been considered that one of the major influencing factors for achieving the intended learning outcomes of these programmes within an overall information and communication technology (ICT) enabled delivery process is the assessment strategy adopted.

Assessments can be considered as a significant way of interaction and providing feedback from the instructor to the learner and a medium for the co-learners to interact with each other. And, due to the significance of this area, SOBE received funding to conduct a one year study to improve the interactions of co-learners through web-based online assessments tools within DL settings through the Teaching and Learning Quality Improvement Scheme (TLQIS) within the University of Salford. This paper reviews literature within the field and examine the shortcomings and the overall utility within the available tools in improving co-learner interactions.

The paper has been designed and structured as follows; first, it will describe the methodology adopted. Then, it will look into research problems and subsequently the literature within the area;

e.g. definitions and characteristics of DL and enlisting available web-based assessment tools within the DL settings. Then, through two case studies of DL courses within the School of Built Environment, University of Salford, it is intended to identify currently used web-based online assessments tools within the DL settings and other issues within the area in improving the co-learner interactions within the DL. Finally, this paper concludes by suggesting the way forward.

2. Methodology

The research methodology approach adopted for this paper embraces the distillation of core research material gathered from a detailed literature review. The literature review encompassed concepts and issues surrounding DL. Two DL Master programmes (MSc 1 and MSc 2) within the School of Built Environment, University of Salford were looked into and used as case studies to achieve the following objectives:

i) To identify the delivery methods currently implemented within the DL settings;
ii) To identify the methods of assessment currently implemented within DL;
iii) To identify the available web-based online assessment tools used within DL;
iv) Identify gaps within the available tools and their capabilities in improving co-learner interactions;
v) Identify barriers in improving co-learner interactions within DL;

Interviews were conducted with the DL tutors in achieving the above mentioned objectives. The result and conclusion from this paper will recommend the way forward and inform the next stages of this research project.

3. Research Problem

Learners often express their need for more empowerment within some of their modules to enhance their active engagement. With all types of learning, including web-based learning, it is useful for students to receive constructive, timely and relevant feedback on their progress even within DL settings. Therefore, a mix of computer marked and tutor marked essays could be adopted for summative assessments. Online marked assessment is sometimes constrained by the medium in which it is operating. Computer marked assessments alone are not appropriate for marking or giving feedback on assignments such as essays or projects that require more than the mere production of knowledge. With the increase of DL programmes being offered there has been a corresponding increase in both synchronous and asynchronous mechanisms being developed to facilitate these assessments (Dede, 1996; Wilson and Whitelock, 1997).

Despite addressing the needs of the programme in developing a regime of assessment strategies, most learning communities express a feel of isolation. However, barriers in the form of resource constraints, sometimes affect the provision of pedagogic requirements such as maintaining appropriate co-learner interactions within the masters DL programmemes. This paper aims to address issues within the area in improving the co-learner interactions within the DL (e.g. factors and barriers in improving co-learner interactions, gaps and flaws within the available tools, etc) and proposing a way forward.

4. Distance Learning

4.1 Definitions and Characteristics

Several definitions have been cited for the term DL; among others; Majdalany and Guiney (1999) define DL as “instruction and learning practice utilising technology and involving students and teachers who are separated by time and space”. Jonassen (1992) defines DL as the volitional control of learning by the student rather than the distant instructor, while Perraton (1988) and Verduin and Clark (1991) define it as the separation of the teacher and the learner in space and / or time during at least a majority of the instructional process.

Hall and Snider (2000) characterised DL with three criteria; (i) a geographical distance that separates the communication between the trainer and the participant, (ii) the communication is two-way and interactive and (iii) some form of technology is used to facilitate the learning process. Keramiyige *et al* (2006) supported this view by considering the two significant characteristics of DL; which is (i) the distance between the tutor and the learner (either geographically or timely) and (ii) the learner centred learning mechanisms as opposed to the teacher centred learning in a traditional classroom based learning environment.

The additional characteristics of DL that has been discussed by Keegan (1986) include:

- The influence of an educational organisation both in planning and preparation of learning materials and in the provision of student support services; which distinguishes DL from the private study and teach-you programme;
- The use of technical media, print, audio, video or computer to unite teaching and learner and carry the content of the course;
- The provision of a two-way communication so that the learner may benefit or even initiate dialogue; a characteristic which distinguishes DL from the other uses of technology in education; and
- The quasi-permanent separation of the learning group throughout the length of the learning so that people are usually taught as individuals and not as groups, with the possibility of occasional meeting for both didactic and socialisation purposes.

There are many terms in relation to distance education and training, defined as follows in Table 1 (Du Mont, 2002):

Table 1: Definitions of Terms(Du Mont, 2002)

Term	**Definition**	**Source**
Asynchronous learning (sometimes referred to as Networked learning)	"A type of learning in which learners and instructors use computers to exchange messages, engage in dialogue and access resources" at any time and any place.	Commonwealth of Learning (2000) and Schocken (2001).
Distance education	"Planned learning that normally occurs in a different place from teaching and as a result requires special techniques of course design, special instructional techniques and special instructional techniques, and special method of communication by electronic and other technology, as well as special organisational and administrative arrangements."	Moore and Kearsley (1996)
Distance learning	"Instructional and learning practice utilising technology and involving students and teachers who are separated by time and space."	Majdalany and Guiney (1999)
Distributed learning	"Learning environment [which] exists among a dispersed student population, is structured according to learner needs, and tends to integrate traditional institutional functions (e.g. classroom and library)….through both synchronous and asynchronous communication."	Oblinger and Maruyama (1996)
e-Learning	"Can be a subset of distributed learning. Relies on digital content, experiences through a technology interface, and is network-enabled. Collaboration is a desirable feature of e-Learning…"	Lundy, Harris, Igou and Zastrocky (2002)
Open learning	"An arrangement in which learners work primarily from self-instruction, completing courses structured around specially prepared, printed teaching materials, supplemented with face-to-face tutorials and examinations."	William, Paprock and Covington (1999)

According to Du Mont (2002), definitions of DL exist which emphasise the *process* of educational and structure. Sherry (1996) noted that the terms "distance education" or "distance learning" have been applied interchangeably by many different researchers to a great variety of programmes, providers, audiences and media. Berge (1998) however note that there is a difference between the term 'distance education' and 'distance learning'. According to Berge (1998), distance education is seen as the formal process of DL, with information being broad in scope; e.g. college courses. DL however is seen as the acquisition of knowledge and skills through mediated information and instruction, encompassing all technologies and other forms of learning at a distance. In addition, Gotschall (2000) described DL as a broadcast of lectures to distant locations, usually through video presentations.

5. Distance Learning, Interactivity and Feedback

Butler and Winne (1995) define feedback as information that a learner receives about his or her learning processes and learning outcomes. Moreover, Gagne (1985) mentioned that learners may find frequent feedbacks useful and feedback to learners may be essential to effective learning (Reiser and Dick, 1996). DL conditions usually constrain when, where and how DL feedback occurs, because feedback is a function of interactivity, and interactivity changes from traditional to DL environments (Wolcott, 1996). According to Ley (1999), an instructor in a traditional classroom can more easily interact with students by easily giving simple knowledge of result feedback with more complex feedback as students require or demand. In DL environments, most distance instructors lack the logistical support or the technology to return papers and answer questions during the same session.

Planning for adequate and useful feedback through web-based online assessments can lessen the DL instructor's feedback burden, hence, improving co-learner interactions within the DL settings. Moreover, according to Ley (1999), without a feedback system in place, distance students engage in learning under the handicap of inadequate or no feedback at all. In traditional distance education settings, learners are often left to go through the process of learning in isolation with very little contact with tutors and peers, thus are confined to basic, 'static' interaction with material delivered through one-way media in the form of printed text, audio cassettes and/or video (Karaliotas, 1998). In addition, according to Karaliotas (1998), with the advent of new media and technologies, the use of affordable and well integrated two-way communication is now possible in distance learning, which in turn enables dynamic interactions.

According to Moore (1989), interactions take place in the learning environment in three ways; e.g. (i) with contents, (ii) with other co-learners and (iii) with instructors. This particular research concentrates more on the interactivity between co-learners in a DL setting. Karaliotas (1998) mentioned that DL environments offer plenty of opportunities for interaction with other learners, far more likely to be productive and complete than in traditional HE learning environments as they are independent of time and place due to their asynchronous nature, and more in line with the learning to learn process as they can be highly motivated and goal oriented. Interaction with learners takes place within collaborative activities, in threads of sociable exchanges, or philosophical and self-searching discussions. They are generated as; (i) asynchronous, Bulletin Board System (BBS) and email interactions and (ii) real-time moo and chat interactions. Asynchronous, BBS and email interactions seem to offer a more in depth discourse as responses are spread over time, to the convenience of the participants, while real-time, moo and chat interactions offer a fuller experience and rich content for a later asynchronous follow-up.

Learners' abilities to interact with the instructor, the peers, and the content can affect their performance in DL. Acker and McCain (1993) mentioned that "interaction is central to the social expectations of education in the broadest sense and is in itself a primary goal of the larger educational process and that feedback between learner and teacher is necessary for education to develop and improve" (p. 11). Online interactions take into consideration the characteristics of the learners as well as the communication technology. The interactive features of the current computer-mediated communication (CMC) systems, such as two-way video and instant feedback, have provided more options for learner interactions. Moreover, Gunawardena *et al* (1998,pp. 141) have interpreted interaction as "the process through which negotiation of meaning and co-creation of knowledge occurs in a constructivist learning environment". Wagner (1998) however argues that interaction can serve as a means to an end of enhancing learning and performance. Learner interactions require planning and structure in order to achieve the goal of active learning. According to Rohfeld and Hiemstra (1995), tasks such as debates, guest lecturers/discussants, polling, brainstorming, or student moderated discussions via CMC networks can help to increase student interactions for learning. The principles of student-centered discussion accord the students the responsibilities of facilitating online conversations. When the activities and tasks become an integral part of the learning process, learner interactions can be conducive to learning (Chou, 2000). This is where this research emphasises that web-based online assessment would be able to help enhance co-learners interactions within a DL setting.

6. Assessment

In addition to interaction and feedback, assessment is also considered an indispensable part of teaching and learning (Govindasamy, 2002). It can be considered as a way of interaction and providing feedback from the instructor to the learner and a medium for the co-learners to interact with each other. Basically, assessment supports the learning approach a student adopts. According to Marcus (2006), a varied combination of assessment activities provides sufficient opportunity for the student to demonstrate learning, while several assessment options allow learners to respond to different evaluation strategies. The choice of assessment methods is an important decision in instructional design (Stephen *et al*, 2007). This is especially more important in a DL programme, in which students often focus heavily on formal assessment requirements. In addition, assessment choices should support intended learning outcomes and also consistent with the desired learning approaches (Stephen et al, 2007).

According to Govindasamy (2002), assessment is typically divided into two types, namely the summative assessment and formative assessment. While summative assessment is used to grade students to demonstrate students' achievement and involves in making a final judgment of the students' achievement relative to the predetermined objectives; formative assessment is used as a diagnostic tool for students and teachers to identify and improve areas of weakness (Williams, 2000). In short, the purpose of a summative assessment is to justify students' grades and a formative assessment help to gather information on what students know and what they can do.

Many researchers (Brown and Knight, 1994; Buchanan, 2000; Henly, 2003) have emphasised the importance of formative assessment in student learning achievement. A learning environment with formative assessment has numerous benefits for learners. Many studies indicate that integrating the DL environment with web-based assessment have positive results (Velan *et al*, 2002; Henly, 2003). Formative assessments refer to activities that are used to help students learn, e.g. short tests and quizzes, question and answer in a lesson, assignments, homework and so on. Buchanan (2000) showed that a web-based formative assessment strategy is able to improve student learning interest and scores. Formative assessment is often done at the beginning or during a programme, thus providing the opportunity for immediate evidence for student learning in a particular course or at a particular point in a programme.

Summative assessment is what students tend to focus on. It is the assessment, usually on completion of a course or module, which says whether or not you have "passed". It is usually undertaken with reference to all the objectives or outcomes of the course, and is usually fairly formal (http://www.dmu.ac.uk/~jamesa/teaching/assessment.htm) and comprehensive in nature which provides accountability and is used to check the level of learning at the end of the programmeme (http://www.provost.cmich.edu/assessment/toolkit/formativesummative.htm). For example, if upon completion of a programme, students will have the knowledge to pass an accreditation test, taking the test would be summative in nature since it is based on the cumulative learning experience. Programme goals and objectives often reflect the cumulative nature of the learning that takes place in a programme. Thus the programme would conduct summative assessment at the end of the programme to ensure students have met the programme goals and objectives and attention should be given to using various methods and measures in order to have a comprehensive plan. Summative assessments can be seen as necessary for accountability and guiding instructions, whereas formative assessments are necessary for learning.

Efforts to implement DL will eventually move towards total automation of administrating the teaching and learning processes by means of a software known as Learning Management Systems (LMS). According to Govindasamy (2002), generally LMS include test builder tools that automate the process of authoring questions. In addition, most of these tools offer easy-to-use templates for authoring automatically scored questions; e.g. multiple-choice questions (MCQ), true/false questions (TFQ), matching questions (MQ), or short answer questions (SAQ). However, essay questions, projects, assignments, and case studies have been totally omitted, yet this should not be taken to mean that these forms of assessment are not needed to perform valid and reliable assessment, as computer marked assessments alone are not appropriate for marking or giving feedback.

Having additional developers of current LMS were probably driven by technology in choosing the question builders to be included in the system (Govindasamy, 2002). Creating quiz questions, possible answer options, assigning weights to the answers, automatically scoring the answers, and programme appropriate feedback for different answers provided by learners require a working knowledge of HTML, Java Script, and other programming languages. This is definitely too much to expect of instructors, therefore, the developers of the LMS probably felt it was necessary to provide instructors with these tools. In order to assess students by means of projects, case studies, assignments, and other artefacts of learning, what the instructor would normally do is to post the message on the bulletin board. Students would then be able to complete their assignments and submit their work to the instructor via e-mail or upload it as a web page for the instructor to assess manually (Govindasamy, 2002).

Upon receiving 'non-standardised' comments from tutors, students would then be encouraged to discuss the comments made with other co-learners within the DL community through discussion board participations and other medium of interactions. This is considered as a way to encourage co-learner interactions within the DL settings. Even while in the process of completing the projects, case studies, assignments and other forms of assessments, students are encouraged to discuss and interact with other co-learners within the DL community.

7. Web-Based Assessment Tools Available For DL

Educators usually spend a lot of time in creating assessments to measure students' knowledge and comprehension. Among the advantages of educational technologies are the web-based assessment tools made available to provide feed-back and improve co-learner interactions listed as follows (Ley, 1999):

- *Discussion board participation*
  According to Savage (1999), students seem to perform better when the discussion boards (or asynchronous communication) are required, where participation is 'rewarded' by a grade. This incentive of a grade brings a higher level of participation to the discussion, where students engage in dialogue begun by the instructor but often taking off on its own soon after (Greenlaw and DeLoach, 2003). Moreover, students then become co-constructors of the materials, examine alternative viewpoints and reach a consensus on a topic together (Greenlaw and DeLoach, 2003). Hence, discussion board participations can be seen as a mechanism in improving the interactions between co-learners within the distance learning settings.

- *Online quizzes*
  Online quizzes enables the instructor to regularly assess student understanding of the materials presented (Martyn, 2003), thus keeping the instructor on track of the students' performance.

- *Electronic paper and project submissions*
  Paper and project submissions can be performed using the Digital Drop Box, or file sharing. By submitting the paper electronically, students do not have to make physical contact with a

particular location in order to submit, and, there is less chance of the instructor losing the paper (Ley, 1999). In addition, an electronic receipt is automatically generated when the instructor receives the submission, enabling accurate records to be kept of who submitted the assignment and when (Thomas *et al*, 2002).

- *Reading outside of the assigned textbook (including hyperlinks and electronic formatted documents)*
  By posting hyperlinks to sources of information, and labelling them as required or recommended, the instructor can share these sources of information with students very quickly and easily at any point during the course (Horton, 2000; Palloff and Pratt, 2001). This therefore also encourages discussions and interactions between co-learners on the topics and information shared by the instructor.

  The internet also offers helpful resources that can be used to reduce the time it takes to create rubrics for projects, experiments, portfolios, and other performance-based items. There are also online resources to generate traditional, formative and summative assessments such as True/False and multiple choice questions.

8. Web-Based Assessment Tools within the School of Built Environment, University of Salford.

Based on the case studies conducted on the two DL Master programmes within SOBE, the following results have been achieved:

8.1 MSc 1

This programme delivers lectures through “Horizonwimba” and corresponds with the distance learners through emails generally. “Horizonwimba” is being used to accommodate for the need of using audio and visual modes of communication between the tutor and the learner. The visual and audio communication is accomplished through a web conferencing based system capable of establishing video and audio based communications between the tutor and the learner. It uses the voice transfer, application transfer and chatting facilities to deliver synchronous lectures. One of the problems both tutors and learners encounter in utilising web conferencing is the time that it takes to learn the various functionalities of the tool (Keraminiyage *et al*, 2006).

As mentioned in the previous heading, electronic paper and project submissions are seen to be one of the web-based assessment tools made available to provide feed-back and improve co-learner interactions. This programme has adopted written coursework comprising legal scenarios as a method of assessment which students will then submit via Blackboard (Bb) once completed. Any questions or enquiries regarding the coursework can be discussed with the DL tutor through email. There was no emphasis on co-learners interactions when deciding on the method of assessment to be implemented for this programme. Although this type of assessment is considered to be one of the web-based assessment tool available; it does not really encourage co-learners interactions unless if the DL tutors promotes the students to discuss and interact with co-learners by starting up a discussion forum in conjunction with the coursework in a discussion board or any other means of communication medium.

According to the DL tutor, no other web-based assessment tools have been used within this programme. There have been reports from students regarding the late feedback that they get back from the DL tutors. From the interview conducted, the DL tutor suggested that co-learners interactions through web-based assessment tools could be improved by conducting more group work assignments, support more interactions and discussions through discussion boards, emails and chat rooms.

8.2 MSc 2

This programme is taught via the internet with support that takes the form of an induction and other events such as networks that are all optional, plus a summer school that has a compulsory attendance requirement. Lecture materials are presented in accessible format which comprise text, diagrams and drawings (for which descriptor alternatives are available) and video presentations (for which audio and text captioning are available). Tutor support is provided via online tutorials, group discussions and individual communication (i.e. through email). Learners not only can engage with other co-learners formally through tutorials and email based group discussions but also informally through the student common room. The discussions and tutorial support is given both synchronously (time tabled online discussion forum) and asynchronously.

The method of assessment for this programme is designed to evaluate the student's abilities in achieving the intended learning outcomes for the module. During the start of the module, students are provided with details of learning activities and assessment dates. Students then participate in learning activities and non-assessed formative feedback is provided to them during the module to assist with motivational reinforcement. For each module, students are required to complete a piece of end assessment and the nature of this varies according to the module. In one of the modules, students' work was authenticated by practical assessment through an access appraisal and audit. The end assessment is considered as an electronic paper and project submission.

Based on the information given by the DL tutor, although it is found that no specific web-based assessment tools have been used for this programme, interactions between co-learners is basically encouraged through tutorials and email based online discussion forum as mentioned before, as well as interacting through the student common room. This is in line with the web-based assessment tool made available to provide feed-back and improve co-learner interactions as mentioned by Ley (1999).

9. Conclusion and Way Forward

The literature review along with the findings from the initial interviews done on DL programmes within the School of Built Environment, University of Salford, UK have provided the methodological basis for this paper.

Most of the DL programmes within SOBE delivers lecture materials in accessible format which comprise text, diagrams and drawings (for which descriptor alternatives are available) and video presentations (for which audio and text captioning are available) through online environments such as the "Horizonwimba". The delivery methods currently used within the programmes are both synchronous and asynchronous. The result from this study identifies that there is a lack of implementation of specific web-based assessments tools within the DL settings as per the various online tools available for online learning. However, several structural considerations of using some of the DL tools such as the nature of the student community (students with various disabilities) imposes constraints on the use of some of the tools although they provide opportunities for improving interactions among the co-learners.

Based on the in depth literature, web-based assessments tools have been found to help improve co-learners interactions within DL settings. Most DL programmes have just gone for the traditional assessment method, which is the written coursework due to lack of emphasis on co-learners interactions when deciding on the method of assessment to be implemented. Co-learners interactions within this method of assessment could be improvised by encouraging learners' interactions and discussions through discussion boards, chat rooms, etc. Written coursework could also be done as a group work instead of individual.

Further interviews will be conducted within SOBE for all the other DL Master programmes, which will enhance the guidelines on improving co-learner interactions within DL settings. The next phase will concentrate on other schools, faculties at University of Salford and finally on other HEIs in the UK and overseas.

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Exploring the Effectiveness of an Electronic Classroom Communication Response System

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Abstract

The growth in career interests in the built environment and recent changes to the structure and curriculum at Anglia Ruskin University has resulted in increased numbers of students studying the core subjects of building technology and services. Large lecture sizes create difficulties in engaging all students in the learning process, with particular problems of maintaining student attention, promoting discussion and debate, and checking student understanding of the subject matter. Feedback opportunities are also very limited. This paper gives an overview of how electronic classroom communication personal response systems (PRS) can be used to overcome some of these difficulties. This includes a brief description of how the technology works, examples of potential uses and benefits, and an examination of some of the issues to be aware of when using PRS. It is clear that the technology itself does not guarantee success, but, if used appropriately, there is evidence that it can have a positive effect on student learning, particularly when used in large group settings.

Keywords: Lectures, handsets, interactive, discussion, student engagement.

1. Background

1.1 The Problems of Teaching Students in Large Class Settings

The impact of the new curriculum changes at Anglia Ruskin University, introduced in September 2006, has produced fewer and larger credit modules (an increase in size of modules from 10 and 20 credits to 15 and 30 credits). In the Department of the Built Environment, the importance of Construction Technology and Services on these programmes has been increased, with 30 credits in Stage 1 and 30 credits in Stage 2. A deep understanding of this core area is central to the development of built environment graduates. Both of these changes have resulted in many more students in much larger groups - classes comprise 150 or more students with contact time of three hours per week, consisting of a lecture, workshop and tutorial.

With the move towards mass higher education, there may be an increased risk of student failure in the early parts of course provision. Firstly, with an increased number of mixed ability first year candidates, it is dangerous to assume that all students can be treated as mature adults who are well motivated to undertake their own learning. Secondly, the increase in class sizes counteracts substantial educational research that stresses the necessity of engaging the student with the subject matter in order to foster deep and lasting learning (see, for example, Laurillard, 2002 and Mayes, 2001). Engagement in the learning process is the key to success, but how can lecturers engage with students in large lecture groups when the amount and quality of interaction is limited and many students seem determined not to learn?

In his research project on student failure, Frame (2003) observed that some of the less able students:

- don't turn up to lectures at all (popular technique amongst failing students)
- turn up late, bring nothing with them, and sit at the back
- don't listen to the lecturer, instead they just copy everything down from the data projector (very effective ignorance strategy)
- never read their notes or handouts later (this risks reinforcing any accidental learning that has taken place)
- talk to friends in class, send text messages to each other, or listen to their MP3 players
- simply look out of the window, doodle, scribble and generally daydream or even sleep (popular on Friday afternoons)
- never make eye contact with the lecturers, as this may accidentally convey interest in the subject (a very dangerous learning activity)
- never bring a calculator for the more mathematical sessions or possess one that is so complicated that no one knows how to use it
- never ask any questions or answer any questions.

And if all else fails…

- divert the lecturers onto their favourite subject, away from the topic in hand (in the male-dominated built environment, football or cricket is a useful subject, or gossip about another lecturer always works).

For these students, conventional means of teaching in the lecture theatre may make it difficult for learning taking place. New techniques may be needed to ensure that the less motivated students are encouraged to behave like their more able counterparts in ways that promote learning.

Many genuinely interested and able students may still however have difficulties making the best use of the large lecture situation. Some students:

- are intimidated by the size of the group
- misunderstand the nature of learning and think that It is about being a passive listener rather than an active learner
- do not want to draw attention to themselves by asking embarrassing questions
- have difficulty concentrating for long enough periods (the concentration span of students during lectures is often quoted as 20 minutes)
- have few ways of checking on learning during the lecture.

It can be very difficult to stimulate, encourage and manage useful dialogue or debate in a large class setting. Question and answer techniques can be effective, but sometimes are just limited to a sub-set of the group responding rather than all students. Additionally, students at the back of the lecture may have difficulty hearing student comments at the front. In some lectures the flow of information is largely one-way, so lecturers will have difficulty in assessing if students are experiencing problems (see Figure 1). There is often little opportunity to obtain quick feedback that would assist in changing teaching approaches to meet the needs of students, particularly in the identification of those students who may require extra help and attention. This can facilitate the desire of the less able student to feel securely hidden within the large cohort.

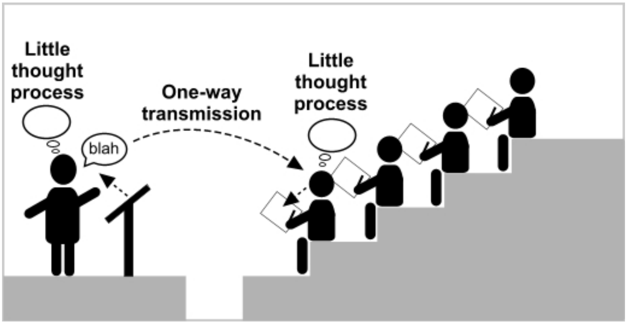

Figure 1 Transmission of information in the large lecture theatre

One definition of ‘a lecture’ useful to keep in mind is that, if you are not careful, a lecture is the means of transfer of information - from the lecturer’s notebook to the students’ notebook, without stopping to register in the brains of either. Thus, real meaningful learning in the lecture theatre may not occur.

A very simple model of learning modified from Race’s work (2001) is:

Doing + Feedback + Reflection + Modified Doing + Final Evaluation

= Proof of Successful Learning.

If all these components are present, candidates should have a strong chance of being successful in their studies. This can be very difficult to achieve in short modules delivered over one semester; during which perhaps only doing plus final evaluation takes place. There is little time for students to submit work within the module, receive meaningful feedback from the lecturer, reflect on it and then submit new work before undertaking the final examination not sure whether they are prepared or not. This lack of time for feedback may increase the likelihood of student failure in this final examination. One of the best ways of learning is to get on and do it, have a go and not be too worried about the risk of failure. Indeed, failure often has more of an impact and usually results in a change in behaviour reducing the risk of further failure. This failure however must take place before the final evaluation. Rust (2002) argues that we need to "build in regular tasks" to help students pace their learning. For this to be achieved however, students need regular feedback on what is going well and what is not. The challenge for lecturers is to devise methods of active learning with regular feedback to students on their performance, without producing a work overload for both student and staff, all within the very short time-span of a 12 week semester. Meaningful feedback can be achieved with small groups of students but becomes very difficult when lecturers are faces with very large (150+) cohorts of students.

2. Electronic Classroom Communication Personal Response Systems

In order to address some of these weaknesses, the Department of the Built Environment at Anglia Ruskin University is considering new ways of motivating and stimulating students in the subject matter in large lecture and tutorial settings. One possible solution is to implement an electronic classroom communication personal response system (PRS). Most people's experience of this type of technology is in popular television programmes, such as "Who wants to be a millionaire?" where the participant can ask the audience to assist in the response to difficult questions. This technology is increasingly being used within the higher education sector, as it enables the lecturer to interactively engage with a large number of students at the same time.

2.1 What is an electronic classroom communication personal response system?

The process of using a PRS, illustrated in Figure 2, involves the lecturer posing a question, which can either be carried out verbally or displayed using presentation software or from within the PRS software itself. Each student has a handset that allows them to choose the preferred option for the answer. The handset is then used to transmit this information to a receiver which is attached to the lecturer's computer. The software can be used to aggregate the responses and produce a graphical representation of the results, which can be displayed to the students via a data projector. These results can be discussed and the lecturer can then choose how to proceed with the next part of the lecture.

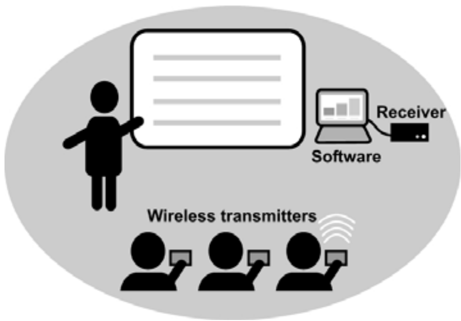

Figure 2 How an electronic classroom communication response system works

The Department of Built Environment is planning to pilot the use of a PRS with students during the academic year 2007/8. The system being used in the pilot study is the InterWrite PRS (Personal Response System) RF which consists of the following features:

2.1.1 (a) Handsets

These pocket-sized radio based handsets (Figure 3) comprise a variety of buttons for transmitting responses to different question types (such as multiple-choice, true/false and numeric questions). They include an LCD display that enables students to see their answers, as well as notification that their answer has been received. Each handset is encoded with a unique number that can be mapped to a student's name or identity number.

Figure 3 Radio frequency handset

2.1.2 (b) Software

The software gives the lecturer the flexibility to create questions within the PRS and/or utilise PowerPoint presentation slides. The lecturer can set up parameters such as time limits, number of choices, number of chances, and other options, as well as import questions from external sources. The lecturer can also select whether answers are anonymous (so no records are kept on individual responses) or known (where each response is recorded in a data file). With the latter option, individual responses can be graded and the results can be recorded and exported to a common Excel format.

2.1.3 (c) Receiver

The handsets transmit to the receiver which uses radio technology. This technology is faster in operation and more accurate in receiving signals than infrared. One receiver can support lecture halls of up to 2000 students.

3. The potential benefits of using an electronic classroom communication response system

As with any technology, a PRS is a tool rather than a teaching approach. Its educational impact, therefore, depends on how effectively it is used. Without careful consideration of how the technology can enhance the learning experience, there is a danger that its implementation could have a negative impact on both the student and the lecturer. Additionally, it is worth noting that a PRS is not necessarily introducing anything new to the lecture theatre - many interactive techniques have been implemented through non-technological means (see, for example, Bligh, 2000). However, teaching large group sizes presents particular issues that make it difficult to encourage interaction between students and between lecturer and student. In the literature reviewed, PRS has been used in a variety of ways, with students at all levels of education and in a range of subject areas. This next section summarises some of the uses and potential educational benefits of using this technology.

3.1 Encouraging participation

The main advantage of this technology is that it enables the active involvement of large numbers of students, not just one or two individuals - a major weakness of conventional lecture teaching. As Draper et al (2002a) states, the equipment requires “each learner independently to generate an answer whereas otherwise only the handful who put hands up really do this”. As such the lecturer receives responses from all students, rather a small section of the group. A common approach, based on Mazur’s (1997) “peer instruction” method, is to pose a question that students have to answer without thinking about it for too long. Without revealing the answer, the lecturer asks them to discuss it with their neighbour, which involves having to provide explanations and reasons for their choice. They are then asked to attempt the question again (Draper et al, 2002b). In Stuart et al’s study (2004), they found a greater number of students giving the right answer on the second attempt and concluded that it was likely “that the students who had a better grasp of the subject were able to convince their neighbour to change their mind and vote differently the second time.”

3.2 Providing timely feedback

A common problem in conventional class settings is the provision of suitable feedback to students about their performance. Often students have to wait until assignments are marked and returned before they receive any indication of how they are doing. With a PRS, answers are marked electronically and automatically, so feedback on performance can be given almost immediately. For students, the system allows them to see how their performance compares to the rest of the group and enables them to measure their own understanding. For lecturers, the system not only provides them with “a very useful means of checking students’ understanding of material covered”, but they can “more accurately determine what material should be revisited in tutorials, as well as in the lectures” (Elliott, 2003). In Draper at al’s (2004) study, one lecturer commented that “I could see exactly which points I had not conveyed clearly and could rectify it straight away”. The system can be also used for evaluation purposes in the same way questionnaires are used for soliciting student feedback about the overall course. The advantage of using a PRS for conducting course evaluation is that it can actually benefit the student group that provides the feedback - it can be done at regular intervals (rather than at the end of a course), it takes minutes to implement (rather than days) and enables modifications to be made during the current academic session (rather than a year later) (Draper et al, 2002a).

3.3 Increasing confidence levels

As Draper et al (2004) points out, it is not hard “to imagine that a first year student in a group of 300 people they don’t know, faced by a lecturer they have no personal relationship with, is reluctant to answer in public”. One way to foster student confidence at the beginning of a class with new students is to use the system for icebreaker activities. Through informal questions that elicit some background information about the group (such as age, gender, interests, etc.) and displaying the responses, mutual awareness is raised which may contribute to the feeling of belonging to a group (Draper et al, 2002a). The use of a PRS to display collective responses to the whole class can also be a reassuring experience for many students because they can see that other class members are thinking along similar lines. The anonymity of the system also provides better privacy than conventional ways of soliciting student response (such as 'show of hands' type activities) which is more likely to encourage participation from less confident students (Sharma et al, 2005). Additionally, the more accurate counting of the responses (compared to, for example, guessing the number of a show of hands) can make all students feel that their views are important, “and are not just lost in crudely approximate estimates” (Draper et al, 2002b).

3.4 Issues to consider when using an electronic classroom communication response system

While it is evident that the PRS-facilitated activities described above can contribute to creating a lecture environment that is active and engaging, the benefits of using the technology very much depend on how effectively it is integrated into the learning and teaching experience. In Draper et al’s study (2002a), student feedback was poor when it was felt that insufficient preparation had gone into implementing the technology and it was just being used ‘for the sake of it’. Effective use of PRS, as an integral part of the lecture, not only requires clear pedagogic goals, but, moreover, a willingness of the lecturer to move away from the Figure 1 model of lectures, which views them simply as a means of transmitting content (Van Dijk et al, 2001).

4 Research Pilot Study

The main objectives of this current project are (1) to review the added value of electronic classroom communication systems in large class settings, and (2) to ascertain whether the technology can help to address the issues of student engagement and motivation in the teaching of Built Environment students. The results of this work carried out in Semester 1 September 2007 to December 2008 will be presented at the conference as well as a demonstration of its use with delegate participation using the handsets.

A range of evaluation methods are being used, including:

- Observation of lectures (with and without the technology)
- Short informal interviews/ focus group discussions with sample groups of students
- Short informal interviews/ focus group discussions with lecturers
- Mid and end-of-semester surveys for students and lecturers (web-based via a VLE)
- Qualitative and quantitative analysis of the response data that is automatically collected by the electronic classroom communication systems.

One of the values of this PRS system is that at a conference presentation, delegates can be given the opportunity to experience for themselves the value of a PRS system by answering multi-choice questions using the handsets provided. They can express their views by voting on whether or not they feel that the system could be of value to them and in doing so, become part of future research finds.

5 Conclusions

This paper has outlined some of the problems and issues that can be encountered when teaching large lecture classes. It has explained the nature of one possible solution to overcoming some of these difficulties, in the form of PRS. Through a review of the literature about PRS, this paper has discussed some of the potential merits of using the technology, as well as some of the possible pitfalls.

The pilot study being conducted during the academic year 2007/08 will assess the added value of PRS (what can this technology provide that conventional class settings cannot?) and appraise how appropriate use of the technology can assist in increasing student participation and engagement with the subject matter in large class settings. Markers that will be important in assessing the success of the study will include such factors as: improvements in summative assessment results (exam marks), improvements in retention rates, improved student attendance at lectures, and favourable data from the evaluation surveys.

Alongside the potential benefits outlined earlier, it is hoped that the technology will assist in the sharing of knowledge about current practice across professions that is not easily obtained via the conventional class setting. Given that students are drawn from varied discipline backgrounds in the modules covered in this pilot study, this would not only benefit the students from different disciplines, but also inform the lecturer about up-to-date developments within that professional practice. Teaching staff will need time to become accustomed to the technology and develop its usefulness for their own teaching purposes. It is envisaged, though, that the sharing of experiences can be used to develop good teaching practice with using PRS, as well as build on work being carried out within Anglia Ruskin University and elsewhere.

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An e-learning approach to quantity surveying measurement

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Abstract

Quantity surveying measurement adopts prescriptive processes which are underpinned by an understanding of construction technology. The rules for measuring are complex, and are designed for experienced practitioners. Some students struggle to acquire the mix of skills and knowledge within the timeframe allowed. At Newcastle University (Australia) we are preparing high quality teaching and learning materials for both on-campus and on-line distance learning students. We are collaborating with the Department of Civil and Building Engineering at Loughborough University (UK) to develop e-learning measurement packages utilising 3D images. This paper describes and discusses some of the merits and challenges of the approaches we have adopted. The findings of an evaluation survey are also briefly described as well as plans we have for future developments.

Keywords: e-learning, measurement, quantity surveying.

1. The Context

According to the Australian Institute of Quantity Surveying [1] quantity surveyors get their name from the Bill of Quantities, a document which itemises the quantities of materials in a construction project. The quantities contained in bills of quantities are measured from design drawings, to be used by the contractors for tendering and for progress payments, for variations and changes and ultimately for statistics, taxation and valuation. Various dictionaries provide similar definitions including: *cost assessor for building work: somebody who assesses the cost of a construction job based on the amount of labour and materials required to complete it* [2], and *a person whose job is to calculate the cost of the materials and work needed for future building work* [3]. It is clear that quantity surveyors need to measure what goes into a building before they are able to assess costs. Indeed the Australian Institute of Quantity Surveying [4] considers measurement / quantification as a basic quantity surveying ability.

This need for would-be quantity surveyors to develop measurement skills is set in a changing job environment. In Australia, a buoyant construction industry is currently fuelling high student expectations. Job opportunities for graduates as well as for students as part-time employees are attractive. Students embarking on their studies come from a wide variety of backgrounds. Many are of mature age and already have a construction background. Few are female. Many are highly computer literate and expect to engage with their studies using computer systems. An increasing number bring with them financial imperatives of having to work to support their tuition. This latter point is emphasized by Mills and Ashford [5] in their investigation into part-time employment of construction management students. They identify a trend of increasing levels of student engagement in the workplace. More recently an Australian Vice Chancellors' Committee report [6] entitled 'A summary of findings from a national survey of students in public universities' confirmed that increasing financial stress was undermining students' abilities to study effectively.

These financial pressures cannot be ignored. A response that the National Tertiary Education Union Newcastle branch president Bert Groen [7] recently suggested might be occurring is where academics ask students to choose between their work and their studies. This is clearly unsatisfactory, and is obviously not to be advocated. Students require flexible alternatives that respond not only to their pecuniary requirements, but to different ways of learning that many of them engage in.

Barnes, Marateo and Ferris [8] cite Bonamici, Hutto, Smith, and Ward (2005) who claim that the current (Net or 'Internet') generation is unique in that it is the first to grow up with digital and cyber technologies. They observe that not only are NetGeners acculturated to the use of technology, they are saturated with it. By the time s/he has reached 21 years of age, the average NetGener will have:

- (spent) 10,000 hours playing video games,
- (written / responded to) 200,000 e-mails,
- (spent) 20,000 hours watching TV,
- (spent) 10,000 hours on cell phones, and
- (spent) under 5,000 hours reading.

The last point warrants further consideration. Anecdotal evidence suggests that many lecturers teaching quantity surveying courses may have unrealistic expectations of their students' reading skills. If Barnes et al's [8] data are indicative of Australian university students, lecturers need to recognise that the skills students enter University with are evolving and that many prefer to use digital materials rather than paper. Indeed, some staff may be structuring their teaching based on traditional learning preferences rather than those of NetGeners.

To further complicate the issue, quantity surveying students need to be able to ‘read’ construction drawings. To do this students need an amalgam of skills, knowledge and understanding: they need knowledge and understanding of construction materials and construction technology; they need to be able to visualise how various components fit together; and they need to have an understanding of construction plant and equipment, occupational health and safety issues, relevant legislation and so on. Clearly, measurement might be seen as a ‘basic’ quantity surveying skill, but it needs to be underpinned in a multitude of different ways.

The approaches to teaching quantity surveying measurement described in this paper are those adopted in the Bachelor of Construction Management (BCM) program in the University of Newcastle, Australia. We have responded to some of the abovementioned challenges in several ways.

- We offer our BCM program in face-to-face as well as on-line modes. This allows our students to study on-campus or as distance-learners, and provides them with the flexibility to decide at what pace to progress their studies.

- We deliver our courses using problem-based learning approaches.

- We have collaborated with the Department of Civil and Building Engineering at Loughborough University (UK) to develop several on-line measurement tutorials. These respond to students’ NetGen skills by harnessing the appeal of information technology, and exploits students’ preferences for engaging with e-materials. The tutorials have been developed by industry practitioners and are presented in a professional and engaging manner. They are short and ‘punchy’ (none are longer than 12 minutes), and can be viewed through Blackboard (the learning management system [LMS] our University uses) and / or downloaded to an iPod or to a Windows based Personal digital assistant (PDA).

This paper briefly describes the skills involved in quantity surveying measurement, illustrates the materials we have developed and then describes how they have been used. Indicative student evaluation data are also presented as well as brief plans we have for future developments.

2. The skills involved in measurement

In their paper on quantification skills in the construction industry, Fortune and Skitmore [9] comprehensively summarise traditional measurement skills and competencies. They cite Fletcher and Bannister (1931) who identified the "essential" attributes of a person quantifying construction work. These include: a thorough knowledge of building construction; acquaintance with the ordinary rules of mensuration; knowledge of the customs of each trade; tact; patience; accuracy; energy; common sense; initiative; and imagination to visualise building design details. Fortune and Skitmore [9] also refer to Willis and Newman (1988) and add to the aforementioned list the ability to write clearly, take care, think logically and possess a sound knowledge of building materials. Furthermore, Fortune and Skitmore [9] note that many of the qualities Mudd (1984) considered to be associated with contractors' estimators were very similar to Fletcher and Bannister and Willis and Newman but add: a good basic numerate education; experience on site; ability to read and interpret drawings; a neat, methodical and tidy habit; ability to cope with vast amounts of paper work; curiosity; confidence; and the flexibility to pick up useful information. Finally, in this respect, Fortune and Skitmore [9] mention Skitmore's (1985) work with practising quantity surveyors in early design-stage estimating and identify four further perceived characteristics as: good organisational ability; intuition; application; and aptitude.

We acknowledge the traditional skills identified above, but question the relevance of traditional modes of delivery for NetGen students. Many researchers question the efficacy of traditional lectures [10, 11 and 12]. Barnes et al [8] observe that the Net Generation represents nearly 7% of the population today (Bartlett 2005) and with nearly 49.5 million students enrolled in schools in 2003 (Enrollment Management Report 2005), responding to the specific needs of this generation of learners is becoming increasingly important. They go on to observe that the challenge of evolving pedagogy to meet the needs of Net-savvy students is daunting, but say that educators should note that this generation values education. Furthermore they emphasize that these students learn in a different way than their predecessors did, but they do want to learn.

A significant challenge for those teaching measurement is (and always has been) to ensure students have sufficient knowledge and understanding of construction technology to enable them to measure. Measurement (or 'taking off') is a process which requires a technical knowledge and understanding of building or civil engineering technology. However, at the time students are required to learn how to measure, many of them do not yet have this underpinning knowledge and understanding.

Taking-off may be considered analogous to the accounting profession's system of double entry book keeping and requires students to follow a prescriptive set of rules provided by published standard methods of measurement (SMMs). These publications do not explain the taking-off process. They are designed to provide experienced quantity surveyors with rules for taking-off in a standardised manner and rely heavily on readers understanding the 'technology'.

From a teacher's perspective the challenge lies in teaching SMM based taking-off processes to students who have just enough knowledge of construction technology to comprehend the measurement rules. This needs to be done without losing focus on demonstrating taking-off. Traditional lecture based approaches deal with taking-off and technology as two separate topics. Students learning taking-off have to continually refer to technology texts which are generally not compiled in the same order as SMMs (There are very few published construction technology texts that complement SMMs). This is clearly frustrating for students and must hinder their learning. We have adopted a different approach. By judicious use of image capture software and 3D modelling we have blended the necessary construction technology with the teaching of the measurement process as will be seen in the following sections.

3. Description of the QS materials

We have developed digital learning materials in a manner that enables them be used in a variety of ways including lectures, tutorials, or as reference materials. The range is due, in part, to the concise and focussed presentation we have adopted, and represents a continuation of our earlier work into Integrated Learning Objects [13 and 14].

The materials comprise:

- Video presentations which describe relevant measurement procedures and incorporate relevant documents such as selections from the Australian SMM [15], dimension paper, construction drawings, site layout plans and site photographs

- Supporting documentation including drawings and specifications (in hard as well as softcopy)

Materials for the following topics have been developed:

- Taking off and the Australian SMM

- Siteworks

- Excavations

- Concrete, formwork and reinforcement

Further materials for the structural steelwork, masonry and roofing are to be developed for delivery in Semester One, 2008.

4. Development of the QS materials

The QS materials were developed using two software packages, Camtasia Studio [16] and Google SketchUp [17]. Camtasia is a fourth generation screen capture program that provides a timeline which accepts video, images and audio. Video and images are arranged on a timeline and finally a voice-over is added. Figure 1 shows a developer's view of how these media are combined on screen. In addition, Camtasia provides a number of tools that enhance useability from an end-user's perspective. It is possible to 'zoom' and 'pan' to explore aspects of interest, and to access additional information / explanation by clicking on symbols which are available at various locations.

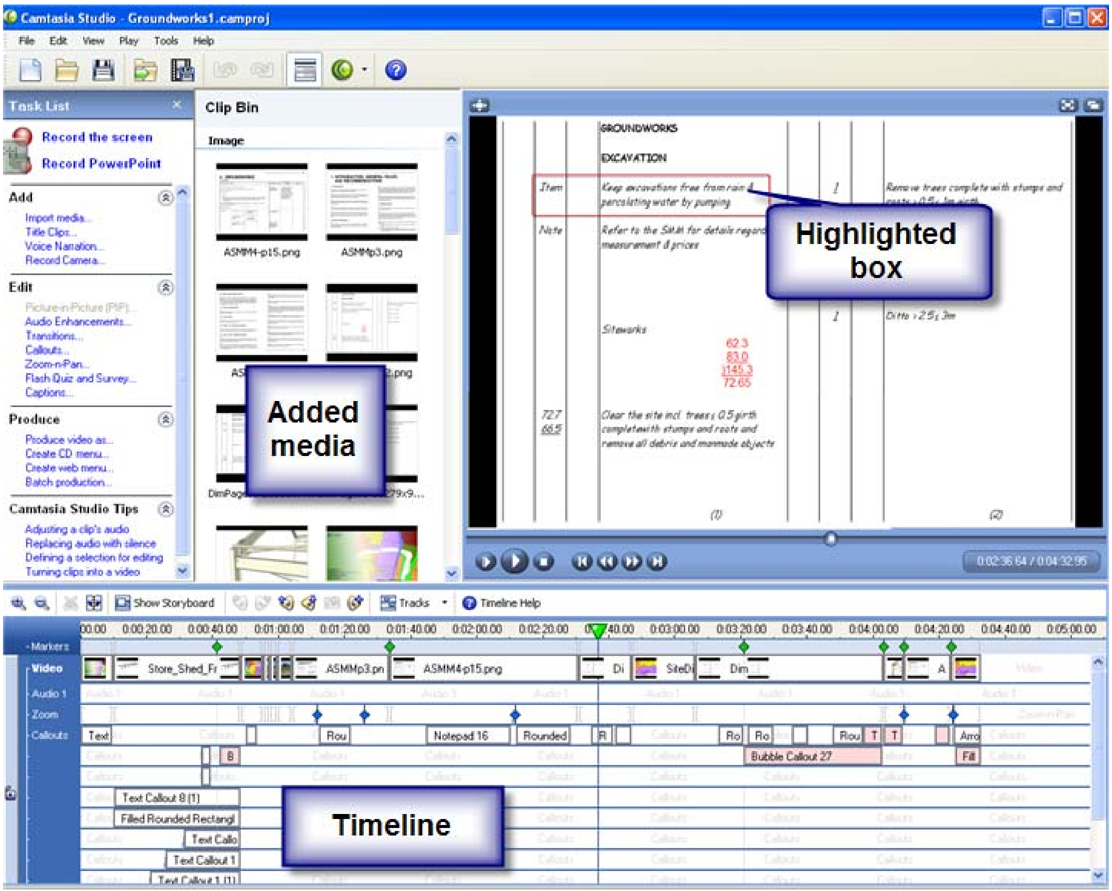

Figure 1: Camtasia workflow with media, images/video inserted on a timeline

Camtasia provides output in several formats including AVI, Flash, WMV, QuickTime, RealMedia, iPod video and mp3 audio. The Flash format has significant advantages; it streams particularly well without dedicated streaming software and allows interactivity via hot spots (which, when invoked, take users to another image, video or URL).

5. How we have used the QS materials

The digital measurement materials may used in a number of different ways.

- When used in lectures the materials may be presented as a discrete element around which discussions ensue.

- To service our distance learning students we use Lectopia, a system which gives distance learners access to lectures delivered on-campus. Lectopia allows lecturers to record their lectures from suitably enabled venues. Staff present their lectures as normal, and what they say and display (from their computer or visualiser) is recorded in a digital format. Once a lecture is over it is automatically processed and is ready for students to access through Blackboard within a short space of time. Distance learners are thus able to engage with the measurement materials in a similar manner to on-campus students.

- Our student population is dispersed over a wide geographic area. Some students work on remote construction sites without Internet access, and in these cases we make CD versions of the measurement materials available to them.

- Self paced learning is also possible. Students can work through the materials at a time and pace that suits them. When used in this way the materials are delivered through BlackBoard. iPod and Windows PDA versions are also available.

- We have also used the measurement tools during tutorials. Students are shown the materials and discuss various aspects face-to-face with tutors (for on-campus students) or via electronic discussion boards on our BlackBoard LMS (for distance learners).

We have explored a range of delivery routes. The measurement materials have proved to be versatile, and provide benefit to students as well as to staff.

6. Student evaluation

A representative sample of students (28 out of 76 students, 37%) responded to an on-line survey. They were split almost evenly between on-campus and distance learners ensuring that the views of both cohorts were represented. The majority (76%) used the measurement materials on-line from home (two students used iPods and two used PDAs), while 12% accessed the Internet from work and a similar percentage gained access from University. Three students experienced technical difficulties using the materials. The problems they encountered included the font size displayed on the iPod version, sound quality and old hardware. Our intention was to keep the materials short and 80% of students said that the length of the tutorials was about the right length of time. The remaining 20% felt that the materials were too short. We also anticipated that students would access the materials several times. This was indeed the case, with 64% of respondents saying that they had accessed each tutorial 2 to 4 times. Virtually all students found the materials easy to use. When asked whether they thought the materials would help them with their assignments, 88% of students said yes, and a similar percentage said that they would like to see more tutorials prepared in this way. Some free format questions were also asked. Students were asked how the materials had helped them. They said:

- It was explained in a straight forward manner and if I wasn’t quite sure about something I could listen to it again and understand how the example works. Sometimes when you read something its not always as straightforward as hearing it explained.

- It has provided a basic starting point and simplified each step involved in the assignments. It was easy to refer back to when I got stuck.

- It was helpful in that it put into practice what we had learnt in class. It also made some of the more difficult concepts clearer.

- You can go back to sections you don't understand, and listen again. Easy to follow and outlines the areas the tutorials is talking about. The ability to click for more information in some sections is very good.

We wondered whether students would prefer on-line tutorials to face to face ones. Their response was ambiguous: 56% wanted on-line as well as face to face tutorials, 40% wanted only on-line tutorials and 4% wanted only face-to-face tutorials. When asked whether they would like to be quizzed about what they had learned from each tutorial, 82% of students said that this would be useful, but did not want these quizzes to count for marks. All students saw 24/7 access as being useful or very useful.

Whilst the above views are acknowledged to be those of a small sample of students, they support our hopes and expectations, and encourage us to continue our developments.

7. What improvements / changes will we implement?

As previously mentioned, many novice quantity surveying students are not familiar with how to read and interpret construction drawings. A discussion of whether or not these students need to be able to prepare technical drawings before they can fully understand them is outside the scope of this paper. However, many software packages are currently available to help students overcome the limitations of 2D drawings. We have trialled 3D models developed using Google SketchUp and have been encouraged by the ease with which these have been created, and by the verbal feedback students have provided. Google SketchUp [17] is a powerful yet easy-to-learn 3D software tool that combines a simple, yet robust tool-set with an intelligent drawing system that streamlines and simplifies 3D design. From simple to complex, conceptual to realistic, Google SketchUp enables you to build and modify 3D models quickly and easily.

An example of a 3D model for a reinforced concrete pumping station is shown in Figure 2. Students are able to rotate, pan and zoom in on the model to gain an overall appreciation of the manner in which components fit together.

We intend to develop quizzes for students to use in conjunction with the measurement materials. These will be aimed at facilitating reflection and are likely to be non (or minimally) weighted assessment tasks. The questions we ask will provide a focus for students and will provide feedback that they have understood key aspects presented in the materials. Formative assessment, such as the quizzes, are important for giving regular feedback, providing opportunities for revision and for improving reflection and understanding [18].

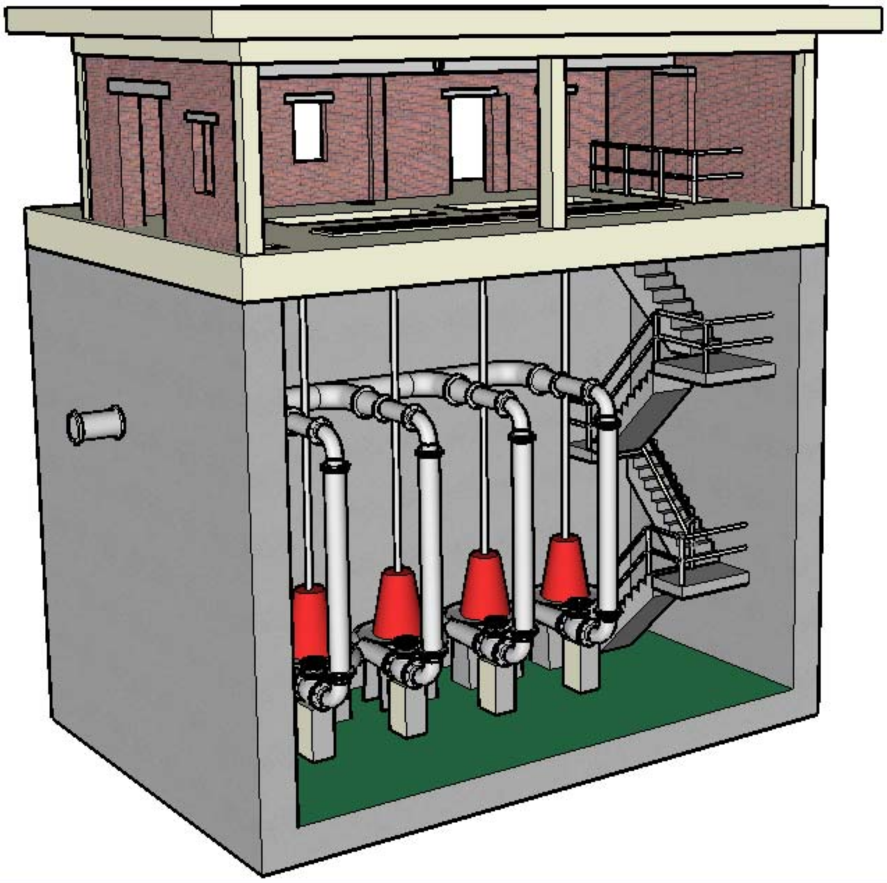

Figure 2: Various views of a pumping station, prepared using Google Sketchup

8. Concluding comments

This paper describes a modest step in harnessing the power of high performance processors now standard in all personal computers. 3D imaging and graphics have come of age and are no longer solely in the domain of design studios and TV stations. We have demonstrated what can be done on a relatively small budget with mature software and imagination. The scope for future development is constrained only by the foresight and imagination of developers. These tools are not intended as a replacement for traditional course delivery. They complement conventional approaches by providing students with convenient access to repositories of knowledge and procedures.

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Practical Application and Improvement of VEBER Online Questionnaire within VGTU e-Learning Environment

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Abstract

Lately, distance studies, which are attempting at the best possible education for students and satisfaction of as many of their study needs as possible, are gaining wider popularity. Online questionnaires are increasingly used to get detailed opinions of distance learning students on various issues of studies. During the project EurAsia, it was identified that VEBER online questionnaire can be a useful tool for VGTU beyond the scope of the project EurAsia. An online questionnaire has been developed to facilitate the process of surveying related to implementation of the project EurAsia. The assessments helped to recognise that this tool helps VGTU to enhance its institutional system related to e-learning. Having identified the potential of this tool outside the scope of the EurAsia project, further experiments have been carried out to assess how this tool can be further developed to accommodate the requirements of the project EurAsia other institutional systems. The research showed that distance learning students not only want to express their opinion about the study process but to be active participants in shaping of strategic alternatives of the study process by electronic means, as well. In order to implement this idea, the authors proposed the Web-based Model of Multiple Criteria Ethical Decision-Making for Ethical Behaviour of Students and used as a basis to develop the Ethical Web-Based Decision Support System (E-DS). Using the features of the VEBER online questionnaire, the developed Model and the E-DS System the process of distance learning can be additionally humanized and adjusted to ethical norms, which would have a positive effect on the whole distance learning process. Thus the institutions participating in the project EurAsia or offering distance learning studies could use the features of VEBER online questionnaire, the developed Model and the E-DS System in their activities. It would stimulate more efficient application of moral norms in the distance learning process.

Keywords: Distance Learning, EurAsia project, Ethical Decision-Making Models, VEBER Online Questionnaire, Decision Support System.

1. Introduction

The e-learning Master degree studies "Real Estate Management" was introduced at Vilnius Gediminas Technical University (VGTU) in 1999, Master degree studies "Construction Economics" from 2000, and Master degree studies "Internet Technologies and Real Estate Business" from 2003 (see **http://odl.vgtu.lt/**). There are currently 226 master students from all over Lithuania studying in these three e-learning master programs. In order to get the opinion of learners, traditional student surveys were frequent. The participation in the project EurAsia allowed to organise e-surveys. A survey of distance learning students on ethical issues of studies is reviewed in the article as an example.

The VEBER online questionnaire has been used within VGTU distance learning environment to administer student feedback questionnaires and surveys (see [16]). With the success of the VEBER online questionnaire being used in VGTU, the intention of join institutional systems development process within the EUARSIA project is to share the experience and the technology across all the partners and beyond. The practical application of VEBER Online Questionnaire (ethical behaviour of distance learning students at VGTU) within VGTU e-learning environment and proposals for join institutional systems development process within the EUARSIA project are briefly analyzed in the paper on the basis of ethical questions. The authors have developed the Web-based Model of Multiple Criteria Ethical Decision-Making for Ethical Behaviour of Students and the Ethical Web-Based Decision Support (E-DS) System, which are briefly analysed further in the article.

2. Web-based Model of Multiple Criteria Ethical Decision-Making for Ethical Behaviour of Students

Corey et al. [18] noted that because ethical codes cannot be applied in a rote manner and they are incomplete guidelines that reflect the values of the majority, practitioners are more likely to respond to a dilemma based on fundamental principles. The proposed Web-based Model of Multiple Criteria Ethical Decision-Making for Ethical Behaviour of Students is based on ethical principles of autonomy, beneficence, nonmaleficence, justice, and fidelity that are viewed as fundamentals of the stages that make up ethical decision-making. Also, the proposed Model is based on decision-making principles (i.e. principle of a life cycle's analysis, principle of the interrelation of various sciences, principle of multi-variant design and multiple criteria analysis of ethical alternatives and principle of close interrelation between the alternative's priority and the interested parties and their aims). The decision-maker' freedom of choice is stressed in the principle of autonomy. The stakeholder is encouraged to take responsibility for his/her actions and assess the effects of these actions on others. According to the principle of beneficence it is important to meet the integrated university stakeholders (students, student community, lecturers, professors, deans, the Rector's Office, etc.) needs, e.g. physical, economical, social, political, emotional, spiritual, etc. The principle of nonmaleficence is strongly linked to the principle of beneficence and means doing no harm to others.

The principle of justice means the support of equal allocation of burdens and benefits among all university stakeholders. For example, universities must be the places where all of the campus, including the student community, lecturers and the Rector's Office, are actively cooperating to achieve their goals. Almost two decades ago, this fact was noted by Ernest Boyer [8], who claimed: "honesty cannot be divided. If high ethical norms are applicable to students, university staff must also have a perfect record."

Efforts are made to achieve a truthful, ethical and efficient solution, i.e. to optimize the life cycle of the ethical alternative (principle of life cycle's analysis). The problems of truthfulness, ethics and efficiency of the solution may be successfully solved only when the achievements of various sciences, such as philosophy, ethics, Law, psychology, management, administration, economics, etc. are used. The use of a principle of multi-variant design and multiple criteria analysis makes it possible to develop many ethical alternative versions and carry out their ethical and other kinds of optimizations throughout life cycle of the alternative.

Determination of ethical alternatives that are under consideration and their description in a quantitative and qualitative form (VEBER online questionnaire, data bases of best practice, etc.)

Stage 1. Obtaining objective and subjective information about ethical behaviour of stakeholders

Stage 2. Analysis of stakeholders (students, student community, lecturers, professors, deans, the Rector's Office, etc.)

Stage 3. Definition of the problem and determination of the nature of the dilemma of ethical behaviour of students

Stage 4. Search for the description of analogous typical situations in the available literature and a development of the best practice database. Determination of the ethical ideal is made in concrete circumstances.

Stage 5. Determination of the philosophy theories according to which the alternatives will be evaluated and the decision made

Stage 6. Development of comparative tables of ethical behaviour of students

Stage 7. Evaluation of ethical alternatives of ethical behaviour of students

Stage 8. Implementation of a course of action

Stage 9. Monitoring of the action and its outcome

Stage 10. Rehabilitation of the external and ethically advantageous environment in order to avoid potentially conflicting situations or to diminish their negative impact

Figure 1. Main stages of the developed Web-based Model of Multiple Criteria Ethical Decision-Making for Ethical Behaviour of Students and their relation with EDSS

The above principles are landmarks of the proposed Model and as support to solving the dilema of ethical behaviour of students. In different situations a few ethical principles sometimes oppose each other, and grading them are difficult. According to Garfat and Ricks [17], ethics is no longer about determining "right answers", but whether and how the decision maker decides what action to take. Ethical decision-making is a process governed by ethical principles. Also, when confronted with a complicated ethical dilemma that is not evidently analyzed in codes of ethics, the decision-maker should check with an ethical decision-making model.

Based on the analysis of the above ethical decision making models (Cottone et al. [4], Robson et al. [11], Doolittle et al. [5], Greene et al. [6], Tymchuk [13], Walden [14], Bombara [3], etc) a Web-based Model of Multiple Criteria Ethical Decision-Making for Ethical Behaviour of Students was developed by the authors of this paper. Some stages of the Model described in the paper (see Stages 1-3, 8, 9) are partly similar to the stages of the models proposed by some other authors. All other stages differ in principle, since the methods of multiple criteria analysis created by authors are applied and also, this Model is meant for the buildup of the Web-based decision support system. The proposed Web-based Model of Multiple Criteria Ethical Decision-Making for Ethical Behaviour of Students provides a logical system and gradually guides and helps the stakeholder in the creation of acting in a way that includes moral behavior. These stages are the main steps of action and can be shaped into the framework of particular circumstances.

The ten stages of Web-based Model of Multiple Criteria Ethical Decision-Making for Ethical Behaviour of Students are as follows:

Stage 1. Obtaining as much objective and subjective information about ethical behaviour of students (historical information, institutional, administration, legal, societal expectations and limitations, ethical principles involved, identified conflicts, etc.) as possible. Further, if possible, the decision-makers have to develop suitable arguments on diverse aspects of the dilemma so as to have a high-quality perception of the range of concerns and advantages for each position.

Stage 2. Analysis of university stakeholders (students, student community, lecturers, professors, deans, the Rector's Office, etc.). The university stakeholders are identified as the interested parties who are directly or indirectly influenced by the decision that is to be made. For a better understanding of the current situation, discussions among the various interested parties are often necessary. Also, some ethical dilemmas can be prevented through dialogue between university stakeholders. The discussion should engage all those who are the key university stakeholders, some of who may be the decision-maker and some of whom may be influenced by the decision. The reaction that results from such discussions clears personal values while determining value conflicts. University stakeholders have to act as a team in an effort to come to some commonly suitable decisions. All university stakeholders should accept some responsibility for the existing ethical behaviour of students and have to be a part of any proposed decision. The personal values, theoretical orientation, experience and other stakeholder features play a part in achieving ethical decisions. University stakeholders have to analyze their own value judgments, moral codes, experience with similar ethical behaviour of students, and decide how to avoid injecting personal biases into decisions. Also, the decision maker must examine the values of others university stakeholders. Compromises that may diminish harmful consequences should be analyzed. On the ground of the Model offered, decisions may be made from the viewpoint of one, several or all the interested groups.

Stage 3. Definition of the problem (conflicting ethical principles, value conflicts) and determination of the nature of the dilemma of ethical behaviour of students. According to Joseph (1982), an ethical dilemma is a conflict in which a person must make a choice between several correct and conflicting decisions, generally with some negative consequences. Traditionally, dilemma (ethical, legal/moral, etc.) involves a choice between competing goods with possible harmful consequences. Assessment of a dilemma involves the detection of different conflicting ethical principles. Typically, the ethical dilemmas are inherently problem ethical behaviour of students that do not lead to easy decisions and there is no right or wrong one that can be easily recognized. Therefore, conflict between values of the different university stakeholders leads to an ethical dilemma where there is no easy solution and no right or wrong answer to ethical behaviour of students.

Stage 4. Determination of the philosophy theories (e.g., utilitarianism, deontology, justice, etc.) according to which the ethical alternatives will be evaluated and the decision made. Determination of the ethical ideal is made in concrete circumstances.

Stage 5. Search for the description of analogous typical situations of ethical behaviour of students in the available literature and a development of the best practice database.

Stage 6. Development of comparative tables of ethical behaviour of students. The aim at this stage is to build options for the decision, in preparation for making the ethical decision and arguing for the choice. Results of the generation of all possible courses of action have been submitted in the table. By submission, such a display, of the multiple criteria comparisons can become more effectively supported. As in any problematic circumstances, the university stakeholders search for potential compromises by trying to find one that is most ethical and with the least negative consequences.

Stage 7. Evaluation of ethical alternatives of ethical behaviour of students. A decision maker must examine a large number of ethical alternatives, each of which is surrounded by a considerable amount of information. Ethical alternatives are analyzed along with the involved ethical principles and philosophical theories. The expectations and obligations of different university stakeholders are then considered. Ethical alternative solutions are compared in terms of the possible outcomes and according to the selected philosophical theories. Following on from gathering this information, the priority and utility degree of the ethical alternatives is then calculated. The utility degree is directly proportional to the relative effect of the values and weights of the criteria and is considered on the efficiency of the alternative. This helps a decision-maker to decide what ethical alternative best fit the ethical behaviour of students that is under evaluation (i.e. the best solution achievable given the available resources and the circumstances of the dilemma). Several decisions will have priority and the choice is according to the preferences of different university stakeholders and philosophy theories (e.g., utilitarianism, deontology, justice, etc.)

Priority of decisions depends a lot on whether one group or several interested groups make the decision, because different university stakeholders bring diverse experiences, beliefs, and moral codes into the decision-making process. The Ethical Web-Based Decision Support System (EDSS) developed on the basis of this model enables the analysis of ethical alternatives from the viewpoint of different interested groups. However, there is seldom an ideal decision to an ethical dilemma.

Stage 8. Implementation of a course of action. Implementing the decision may be the most difficult stage of the decision-making process. Ethical decisions are individual choices that may not be shared with other university stakeholders. The decision-maker may be in a solitary situation in implementing some decisions and willing to admit the consequences of a decision that is not supported by others.

Stage 9. Monitoring of the action and its outcome.

Stage 10. Rehabilitation of the external and ethically advantageous environment in order to avoid potentially conflicting ethical behaviour of students or to diminish their negative impact. Truthfulness, ethics and efficiency of the solution depend on the micro- and macro-levels of the external environment. Macro-level factors of the external environment such as religion, the existing cultural, social, ethical dimensions of the country, the executed university policy and the society influence the arising ethical problems and the ethical solution making. The micro-level factors (the university stakeholders, the applied formal code of ethics, rules, criteria of ethical behavior, ethical standards, codes of conduct) stipulate the ethical solution making to a significant degree as well. Therefore, on the grounds of cumulative experiences it is suggested that there be changes under these possibilities of the surrounding environment in order to decrease the possibility of a conflict situation arising in ethical behaviour of students or to diminish their negative impact. Developing an ethical environment also provides a background for ethical questioning, significant exchange, informed decision-making, and human consensus, in which all university stakeholders are satisfied. A few trends of rehabilitation of the external and ethically advantageous environment in order to avoid potentially conflicting ethical behaviour of students are following.

McCabe [9] propose to involve the whole campus community (students, faculty, and administrators) to effectively educate a student. If university only goal is to reduce cheating, there are far simpler strategies university can employ. But if university have the courage to set our sights higher, and strive to achieve the goals of a liberal education, the challenge is much greater. Among other things, it is a challenge to develop students who accept responsibility for the ethical consequences of their ideas and actions. University goal should not simply be to reduce cheating; rather, university goal should be to find innovative and creative ways to use academic integrity as a building block in university efforts to develop more responsible students and, ultimately, more responsible citizens. University campuses must become places where the entire "village" - the community of students, faculty, and administrators - actively works together to achieve this goal. As Ernest Boyer observed almost two decades ago – [1, 2], "integrity cannot be divided. If high standards of conduct are expected of students, colleges must have impeccable integrity themselves. Otherwise the lessons of the ‘hidden curriculum' will shape the undergraduate experience. Colleges teach values to students by the standards they set for themselves."

Students claimed that while they see numerous cases of cheating in higher education institutions and in the society, the role of disciplinary actions is important striving to reduce the amount of cheating in university.

The above-described Web-based Model of Multiple Criteria Ethical Decision-Making for Ethical Behaviour of Students can provide decision-makers with quite a secure means of making difficult ethical decisions. This model can also help university stakeholders to make the best feasible decision in certain given circumstances. The proposed Model does not make ethical decisions, but explains the process for investigating a ethical behaviour of students. Based on the proposed Model of Multiple Criteria Ethical Decision-making an Ethical Multiple Criteria Decision Support Web-Based System (http://dss.vgtu.lt/ethic/index_eng.htm) was developed by the authors. In order to demonstrate practical application of the Model, a survey was carried out in Vilnius Gediminas Technical University (VGTU). The survey gives a more detailed explanation of Stages 1 and 2 of the Model.

3. Ethical Behaviour of Distance Learning Students at VGTU

The form of a survey was selected for the research of ethical issues related to behaviour of distance learning students in the Faculty of Civil Engineering at Vilnius Gediminas Technical University. The VEBER online questionnaire of 24 questions has been used within VGTU distance learning environment to administer student feedback questionnaires and surveys (see [16]). The experience of many analogical surveys [1, 2, 9] carried out in the world shows that when students think that organisers of surveys will find out the authorship of a questionnaire, then such surveys give the results which distort the real situation greatly. None of students wants to reveal his/her confidential information to the staff of the university.

Therefore all distance learning students could answer all questions anonymously by using the VEBER online questionnaire. The survey consisted of two steps. One step when a student selects the most appropriate answer to the question. The other step when the student specifies the theory of ethics on which he/she based the answer. Theories of ethics were introduced to students before the survey, i.e. the students were briefed on the main points of different theories of ethics. The questionnaire included four main theories of ethics: deontology, utilitarianism, justice and teleology. For example, when carrying out an analysis of university stakeholders, it is expedient to apply the utilitarianism theory. In such an analysis the objectives and needs of university stakeholders can be analyzed, various decision ethical alternatives worked out and positive and negative consequences of these ethical alternatives on university stakeholders that are under consideration can be determined. According to the utilitarianism theory, whether a certain action is considered bad or good depends on its consequences and not on intentions. Utilitarianism says that what is morally right is whatever produces the greatest overall amount of pleasure, happiness, ideal values (freedom, knowledge, justice, and beauty) and preference satisfaction to as many university stakeholders as possible. The criterion of a moral action consists of those rules of conduct, which give most utility to all the university stakeholders. Actions that meet the needs of university stakeholders are considered to be good. However, when conducting such an analysis of the stakeholder's requirements various problems occur. For example, what is of the greatest good for the greatest number of university stakeholders without violating individual rights in different situations? Is it goodness, efficiency, profitability and/or pleasure? Which needs of which university stakeholders are to be given priority? How can one take into consideration the qualitative parameters (health, security, public benefit)? By using experts and multiple criteria analysis methods one can solve these problems, to some extent.

Thirty-nine distance learning students participated in the survey anonymously: 26 male (67%) and 13 female (33%) respondents of ages from 20 to 60. Most students were from 20 to 30 years old (27 people; 69%), a smaller number of respondents formed the group of ages between 30 and 40 (8 people; 21%), and the least number of people were of ages from 40 to 50 and from 50 to 60 (2 people in each group; 5% each).

Given the question whether they would cheat during an examination, 12 students (31%) answered that they would if they knew nothing. Slightly smaller amount of students answered that they would cheat if they were sure that they would not get caught (9 students; 23%). Two students (5%) would cheat during an examination. Seven students (18%) would not cheat during an examination. Six people (15%) would not cheat even if they knew nothing. Three students (8%) would not cheat even if they were sure that they would not get caught. Students based their answers to the question about cheating in an examination on the following theories of ethics: deontology (6 students; 15%), justice (23 students; 60%), teleology (4 students; 10%) and utilitarianism (6 students; 15%).

Similar results have been obtained in other countries too. For example, in 1993 McCabe [9] surveyed nine medium to large most USA competitive colleges and universities, thirty years earlier, had participated in the landmark study of college cheating conducted by William Bowers [2]. Bowers's [2] project surveyed over five thousand students on ninety-nine campuses across the USA and provided considerable insight on how often students were cheating and why. Two outcomes of McCabe [9] 1993 project are particularly noteworthy in comparison to Bowers's results. First, there were substantial increases in self-reported test and exam cheating at these nine schools. For example, 39 percent of students completing the 1963 survey acknowledged one or more incidents of serious test or exam cheating; by 1993, this had grown to 64 percent. In 1993, many students simply did not see cheating as a big deal, so it was easier to acknowledge - especially in an anonymous survey. Second, there was no change in the incidence of serious cheating on written work; 65 percent of students in 1963 acknowledged such behavior, and 66 percent did so in 1993. However, student comments in the 1993 survey suggested that this younger generation of students was more lenient in defining what constitutes plagiarism [9].

Lecturers have the most important role in exercise of ethical standards, because students consult both their contemporaries and their lecturers about their studies process. In order to foster a proper attitude of a student, lecturers must acknowledge and validate academic honesty as the most important value. Without such acknowledgement of values, many students may find cheating meaningful, because they can revert to the secondary school strategies, i.e. cheating to get a better mark and blaming excessive loads, lack of time and providing other similar reasons, i.e. students presume that if lecturers fail to act in cases of obvious cheating they sort of invite cheating. This stimulates dissatisfaction of students who learn honestly. They feel deceived because of lecturer inactivity.

Most students, 28 people (72%), do not consider a peek at notes as cheating, whereas other 11 (28%) claim that a peek at notes may be equal to cheating. Students based their answers to the question whether a peek at notes is equal to cheating on the following theories of ethics: deontology (7 students; 18%), justice (16 students; 41%), teleology (7 students; 18%) and utilitarianism (9 students; 23%).

Three students (8%) would copy a course project or homework of another person, 5 people (13%) possibly would copy, 9 people (23%) possibly would not copy and 22 people (56%) would not copy. Students based their answers to the question about copying a course project or homework of another person on the following theories of ethics: deontology (6 students; 15%), justice (19 students; 49%), teleology (6 students; 15%) and utilitarianism (8 students; 21%).

One (3%) probably would inform against a cheating student, two (5%) probably would not inform against a cheating student and 36 (92%) would not inform against a cheating student. Students based their answers to the question whether they would inform against a cheating student on the following theories of ethics: deontology (6 students; 15%), justice (13 students; 34%), teleology (9 students; 23%) and utilitarianism (11 students; 28%).

Most students (18 people; 46%) probably would allow another student to copy from them during an examination, 16 (41%) people would allow to copy, three people (8%) probably would not allow to copy and two people (5%) would not allow to copy. Students based their answers to the question whether they would allow another student to copy from them on the following theories of ethics: deontology (7 students; 18%), justice (13 students; 34%), teleology (6 students; 15%) and utilitarianism (13 students; 33%).

Eleven (28%) of the respondents would ask help from another student during an examination, 20 (51%) probably would ask for help, five (13%) probably would not ask for help and three (8%) would not ask for help. Students based their answers to the question whether they would ask help from another student during an examination on the following theories of ethics: deontology (10 students; 26%), justice (11 students; 28%), teleology (3 students; 8%) and utilitarianism (15 students; 38%).

Among the actions that are considered the least ethical for students, 24 students (62%) selected informing against another student for cheating or copying of course project/homework, 13 respondents (33%) selected copying of homework or a course project and only two people (5%) selected cheating during an examination.

Analysis of Codes of Ethics of students from other universities showed that such examples of inappropriate student's behaviour as denunciation of another student for cheating or copying of course projects or homework were absent. Thus, according to the Students' Code of Ethics, such behaviour would be ethical; however, the majority of students not only would never inform against another cheating student (97%) but also consider it to be the least ethical student's behaviour (62%).

Students based their answers to the question about the least ethical acts of students on the following theories of ethics: deontology (4 students; 10%), justice (18 students; 46%), teleology (8 students; 21%) and utilitarianism (9 students; 23%). Analysis of Codes of Ethics of students from other universities showed that such examples of inappropriate student's behaviour as denunciation of another student for cheating or copying of papers or homework were absent. Thus, according to the Students' Code of Ethics, such behaviour would be ethical according to all or the majority of theories of ethics.

Two (5%) students would bribe a lecturer to pass an examination, four (10%) probably would bribe, eight (21%) probably would not bribe and 25 (64%) would not bribe. To summarise, six students (15%) would bribe a lecturer in certain circumstances and 33 students (85%) would not bribe.

In December 2003, Group for Social Analysis surveyed students from Lithuanian higher education institutions on corruption. The sample of the survey included 14 universities and 25 colleges. 33% of students who participated in the survey admitted to giving a bribe to a lecturer and 6% bribed staff of higher education establishments. First and second year students are the most bound to bribe a lecturer [10]. Students based their answers to the question about bribing a lecturer on the following theories of ethics: deontology (8 students; 21%), justice (20 students; 51%), teleology (6 students; 15%) and utilitarianism (5 students; 13%).

Six distance learning students (15%) would agree to pay for preparation of homework, a course project or a graduation thesis, 10 (26%) probably would agree, eight (20%) probably would not agree and 15 (39%) would not agree. To summarise, 16 students (41%) would agree to pay for preparation of homework, a course project or a graduation thesis in certain circumstances and 23 students (59%) would not agree. Students based their answers to the question whether they would agree to pay for homework, a course project or a graduation thesis on the following theories of ethics: deontology (5 students; 13%), justice (19 students; 49%), teleology (6 students; 15%) and utilitarianism (9 students; 23%).

We see the following inviting offer in the website of the company "Auksinė Plunksna" which offers graduation theses for sale: "Our country's situation makes students work while studying in order to earn living and to pay for education, which becomes more and more expensive each year. Therefore, the studies suffer, and it becomes more difficult to find a balance in life. What are the choices? To postpone the graduation thesis to the next year or to complete the studies nevertheless?". Without a context, we could think that this company does not suggest ordering a graduation thesis but offers consulting services on specific studying issues instead. In fact, a student who uses services of this or other companies is not a passive observer. He/she must submit exact information about his/her faculty to the company and specify the requests and remarks of his lecturer, the academic adviser, in the course of preparation of the thesis: “The thesis will be written gradually, its parts will be corrected by your academic adviser, thus we grant quality and high evaluation. Practically, the academic adviser is the guarantee of quality: his/her pieces of advice will determine the contents of the thesis”.

These increasingly spreading phenomena cause obvious concerns. Not because of the cheating on lecturers and administrations of higher education institutions but mostly because such acquisition of diplomas is based on a peculiar “clear conscience”. Advertisements of such service companies do not hint on the fact that those who use their services would not be able to get such or even a better diploma with own efforts. The students who earn their grades through efforts of other people probably do not encounter any moral dilemma. Hardly ever they doubt their ability to complete higher education independently, “if they would study”, “if they had time to learn”, “if they were not forced to earn their living”. Thus the circumstances, the general situation of studies and other problems as if not subjected to the student’s conscience are the biggest culprit in this case. The process of studies becomes a most primitive relationship of product exchange based on laws of time saving. Graduation theses are written by those who have time and are acquired by those who can pay for them. Moral issues are usually disregarded in a market [12].

Among the top penalties for cheating students, one student (2.6%) selected a lower grade, three students (7.7%) selected increased tuition fees, seven students (17.9%) selected public announcement of names of cheaters, 14 students (35.9%) selected warning and 14 students (35.9%) selected elimination from the university. Students based their answers to the question about the top penalties for cheating students on the following theories of ethics: deontology (7 students; 18%), justice (19 students; 49%), teleology (7 students; 18%) and utilitarianism (6 students; 15%).

4. Conclusions

In order to humanize VGTU distance studies and to strengthen their ethical nature, the VEBER online questionnaire was implemented and the Web-based Model of Multiple Criteria Ethical Decision-Making for Ethical Behaviour of Students developed within the project EurAsia; the latter was used as a basis for the development of E-DS System. Besides, the performed research allows to make different conclusions. For example, today’s students are more concerned about the reaction of their contemporaries and the university administration to the norms of honest behaviour promoted by staff and administration than about the norms themselves. Indeed, students expect the university administration’s to declare how they should become honest, non-cheating and respectful towards teaching and learning. Even when students hear the statements but watch other students cheating and lecturers being tolerant by ignoring, students will take cheating as a means to pass an exam with a better possible mark. Many students ask: “If lecturers are not concerned about cheating, why should I be?”

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Biometrics Technologies, Intelligent Library and Tutoring System within the EURASIA Project

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Abstract

The aim of this paper is to study the contribution of the new technologies (Search Engine Rankings, Multi-variant Optional Module Design and Multiple Criteria Analysis; Voice Stress analysis, IRIS recognition) to Intelligent Library and Intelligent Tutoring Systems. The article briefly describes use of these newest technologies in e-learning. The authors of the article have developed a voice stress database, which contains students' answers given during an examination, and a specific algorithm, which is a core of the Voice Stress Analysis Subsystem and which can evaluate a student's knowledge by giving a rather precise mark after a psychological test performed prior to the examination. A similar research of IRIS recognition technologies is being performed successfully. Practical application of the Biometrics Technologies, Intelligent Library and Tutoring System within the EURASIA Project is briefly analysed in the paper.

Keywords: EURASIA Project, Intelligent Library and Tutoring System, Voice Stress analysis, IRIS recognition.

1. Background

The EURASIA (EURopean and ASIan Infrastructure Advantage) Project is being carried out with the financial assistance of the European Union under the Asia-Link Programme. EURASIA project aims to enhance the capacity of the partner institutions for training, teaching and research activities required for the creation and long-term management of public and commercial facilities and infrastructure. One of the main activities includes development of a professionally accredited postgraduate curriculum, and design and delivery of training courses. In order to increase the efficiency and quality of delivery of the above-mentioned training, teaching and research activities, an Intelligent Library and Tutoring System within the EURASIA Project (ILT-EAP system) was developed. The features of ILT-EAP system include the search for and finding of useful material, multi-variant optional module designs, multiple criteria analysis and selection of the most rational alternatives of teaching material according to students' requirements. The personalized scenario is dynamically generated with emphasis on the requirements of each student. Besides, the System combines concepts of voice stress analysis and IRIS recognition technologies.

2. Intelligent Library and Tutoring System for the EURASIA Project

Search engine rankings have been adopted in most advanced intelligent libraries (Alexandrov [1], Gutwin [5], Hsinchun [6], Kaklauskas [7], Ruch [10], Trnkoczy [11], Wang [12]) and tutoring systems (Armani [2], Brusilovsky [3], Day [4], Lucence [8], Pouliquen [9]). As part of the ongoing Illinois **Digital Library** Initiative project, research proposes an intelligent personal spider (agent) approach to Internet searching, which is grounded on automatic textual analysis, general-purpose search and genetic algorithms (Hsinchun [6]). Pouliquen [9] use parsing techniques to extract information from texts, and provide a proper semantic indexation which is used by a medical-specific **search engine.** Day [4] use the Jakarta Lucene full text indexer to index full texts of textbooks. Jakarta Lucene is a high-performance, fully-featured text search engine library written entirely in Java. Its technology is suitable for nearly all applications that require full-text searches. It is also readily available and has a good API for our needs. ITA [9] index chapters, sections, and subsections of textbooks. Highlighters are used to highlight the index context. Finally, the ITA provides reading recommendations for students via a chapter similarity function. However, intelligent libraries (Alexandrov [1], Gutwin [5], Hsinchun [6], Kaklauskas [7], Ruch [10], Trnkoczy [11], Wang [12]) and intelligent tutoring systems (Armani [2], Brusilovsky [3], Day [4], Lucence [8], Pouliquen [9]) with search engine rankings cannot select chapters (sections, paragraphs) of a specific text, which are the most relevant to a student, cannot integrate them into learner-specific alternatives of teaching material and cannot select the most rational alternative, i.e. cannot develop alternatives of training materials, perform multiple criteria analysis and automatically select the most effective variant. However, an Intelligent Library and Tutoring System within the EURASIA Project (ILT-EAP system) can perform the aforementioned functions. No-one thought of the above function before, so this attempt is the first. The approach helps students to obtain suitably tailored material for an e-learning course. The above and other improvements are possible by using the ILT-EAP system.

A lack of optional alternative modules provides lesser opportunities to satisfy students' needs. Students, who gain basic knowledge in their field, often lack knowledge necessary for specific work. Students usually waste too much time in finding useful study material. Discovering the most rational study material among all that is available in a vast number of modules can have more meaningful outcomes for students. The main objectives of our work is development of the methods, algorithms and ILT-EAP system for searching and finding useful material, carrying out multivariant optional module designs, multiple criteria analysis and selection of the most rational study material alternatives according to students' requirements. Also the ILT-EAP system combines concepts from voice stress analysis and IRIS recognition technologies.

The ILT-EAP system consists of nine subsystems: Domain Model, Student Model, Tutor and Testing Model, Voice Stress Analyser Subsystem, Iris Recognition Analysis Subsystem, Subsystem of Multivariant Optional Module Design and Multiple Criteria Analysis, Database of

Computer Learning Systems, Decision Support Subsystem and Graphic Interface. The Domain Model, Student Model, Tutor and Testing Model, Database of Computer Learning Systems and Graphic Interface are quite similar to existing Intelligent Tutoring Systems. The Voice Stress Analyser (VSA) Subsystem, Iris Recognition Analysis Subsystem and Multivariant Optional Module Design and Multiple Criteria Analysis Subsystem are innovative Intelligent Tutoring Systems solutions. VSA and Iris Recognition Analysis Subsystems are briefly analysed below.

3. Voice Stress Analyser Subsystem

The muscles of a human throat vibrate in a range of 8-12 Hz and this range is called a micro-tremor. When a person is emotional or stressed the vibration shifts from 8-9 Hz to 11-12 Hz, and the more intensive the stress the higher the frequency of such vibrations. The Voice Stress Analyser Subsystem (VSA) measures stress in a human voice. The research aim was to compare data received during an examination with ILT-EAP (information on correct and incorrect answers, time periods for each question, and the number of times a student changed an answer to each question of a test) with similar data received from the Voice Stress Analyser (VSA) Subsystem, to make practical conclusions and to plan future research. This research helped to determine changes of students' psychophysical conditions during examination. During an e-test, students were asked to select one correct answer from the provided alternatives and to say the answer aloud. The sound record of each answer was then saved into a PC memory with an identification code for listening and further analysis. Records were analysed by using the VSA Subsystem and the frequency range of micro-tremors for each specific answer to an e-test question was determined. Higher frequency of voice vibrations was determined when analysing voice answers to "unknown/difficult" questions. It was found out that the emotional stress of a student was higher when answering "unknown/difficult" questions.

The reliability of the results was assessed by making a correlation analysis of emotional stress and of evaluations of correct answers (in percent) to test questions. The analysis showed that a correlation exists between emotional stress and the correctness of an answer. During the experiment, a total of 4,000 voice records in four student groups were examined and analysed. The research helped to determine whether questions can be classified (in respect to students) as "known/simple", "unknown/difficult" and remaining questions in-between these two groups. Higher than average emotional stress was experienced when answering the "unknown/difficult" questions, and zero or minor emotional stress in case of "known/simple" questions. Having analysed the whole set of answers, a direct relationship was noticed between the emotional stress and the correct answers (in percent) to an e-test. During the research, the average micro-tremor was calculated for each question. Part of the results is shown in Figure 1.

Figure 1 shows the relation between a student's correct answers and the average micro-tremor frequency of the answers to test questions. The x-axis shows numbers of the test questions for students who were passing the examination. During examination, students had to mark and to say aloud the right answers to 20 questions within 10 minutes. The left side of the y-axis shows the correct answers (in percent). The right side of the y-axis shows the average micro-tremor frequency of each student during the examination. Besides, the Figure 1 shows two correlating curves obtained during the research; they show the direct relationship between the correct answers and the average micro-tremor frequency.

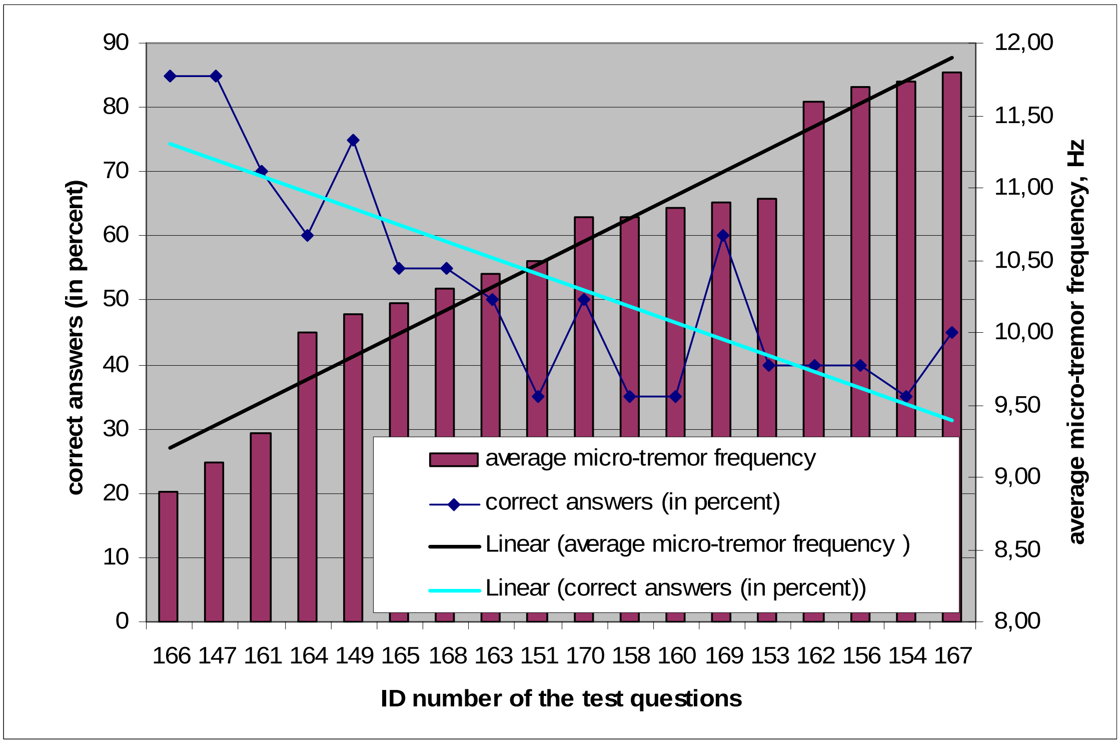


Figure 1: Correlation between the emotional stress and the correct answers (in percent) to the e-test: the x-axis indicates the numbers of the test questions, and the y-axis indicates the average micro-tremor frequency (Hz) in the student's voice (on the right) and the correct answers (in percent) (on the left)

Currently students' knowledge can be automatically assessed (instead examination) by using VSA Subsystem on the basis of student psychological tests, accumulated historic voice stress data, determined regression equation and special developed algorithm. The VSA Subsystem automatically assessing a student's knowledge before examination according to the student's spoken/oral answers. For example, when a teacher gives a student such 9 questions as "Are you well-prepared for the exam?," "What mark would you give to your knowledge?", "Have you learnt everything?", etc. before examination, and the student can be assessed quite precisely by giving a mark by using VSA Subsystem (special developed algorithm). Figure 2 illustrates the comparison of the marks given to students during the e-psychological test performed prior to the examination (using the Voice Stress Analysis System) and of the marks given during the examination itself (using the Intelligent Testing Subsystem). The regression-correlation curves seen in Figure 2 show interrelation between the marks given during the e-psychological test and the marks given during the e-examination itself.

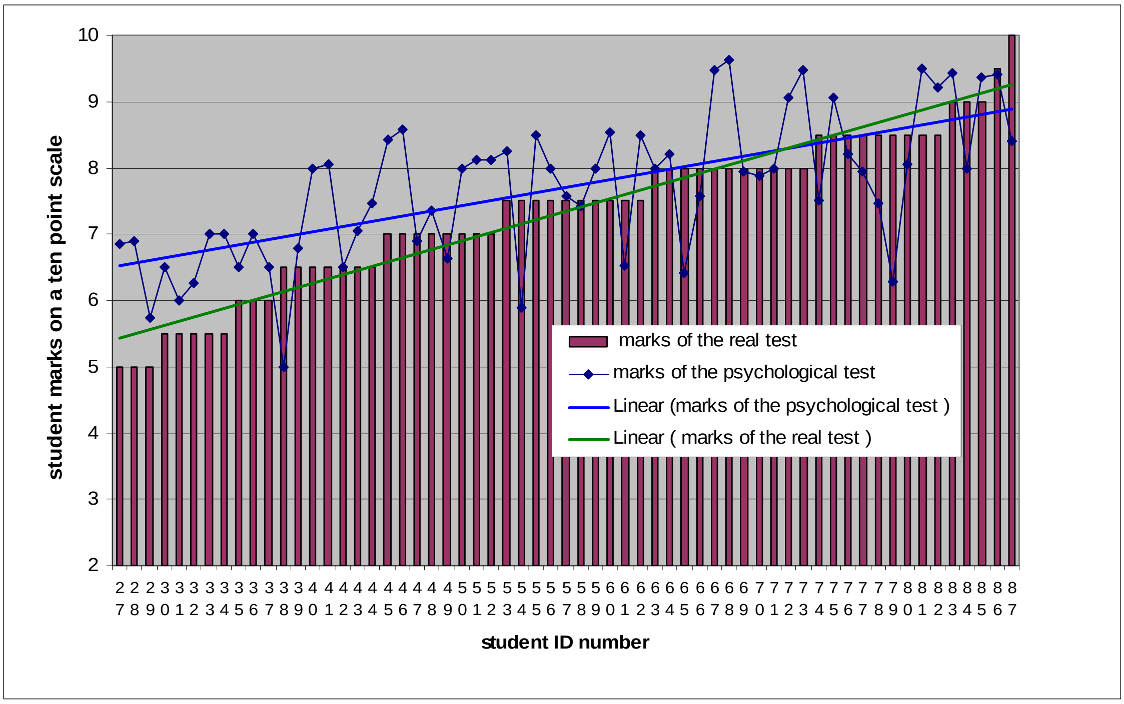


Figure 2. Comparison of the marks given to students during the e-psychological test prior to the e-examination and of the marks given during the e-examination itself

Legend:
y-axis: marks of students on a ten-point scale;
x-axis: students' IDs;
"marks of the e-psychological test": marks given to students during the e-psychological test prior to the e-examination using the Voice Stress Analysis System;
"marks of the real test": actual marks given to students during the e-examination using the Intelligent Testing System;
"linear (marks of the psychological test)": regression-correlation linear trend, which describes the marks given to students during the e-psychological test prior to the e-examination using the Voice Stress Analysis System.
"linear (marks of the real test)": regression-correlation linear trend, which describes the actual marks given to students during the real e-examination.

4. Iris Recognition Analysis Subsystem

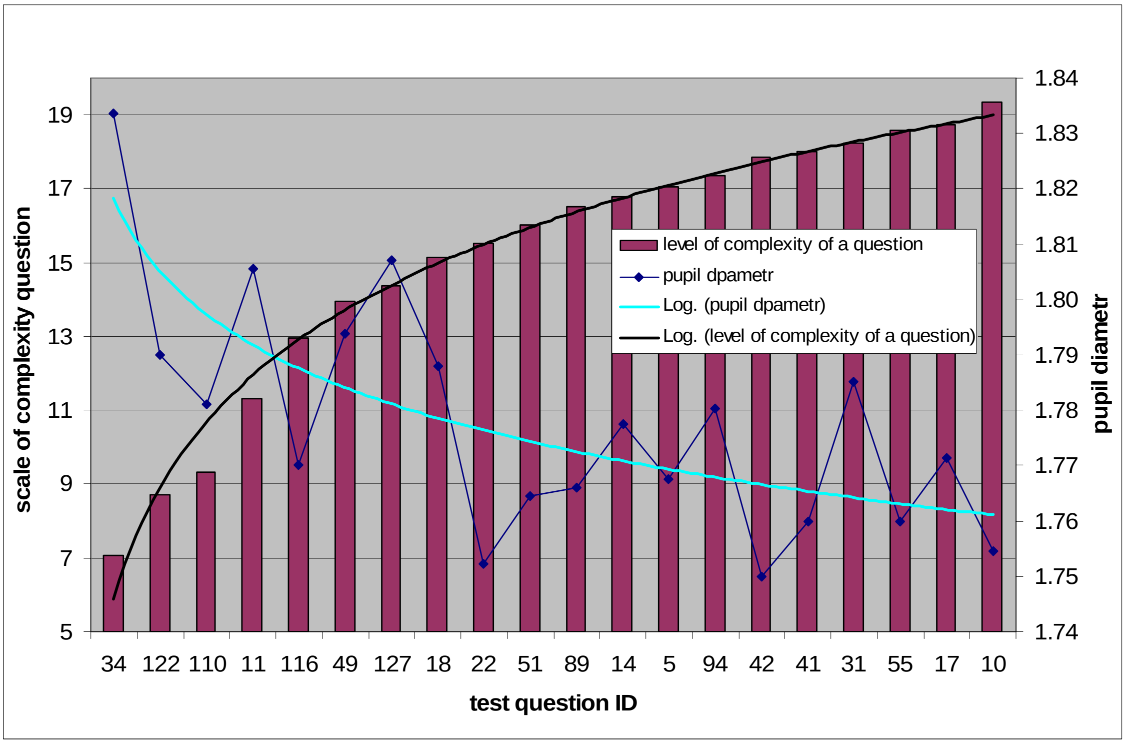
Students, sitting at a computer during the exam, were invited to answer 20 questions. It was a multiple-choice test. The questions were classified according to their complexity: from the easiest to the most difficult. The complexity of a question was determined according to the percentage of the students who answered it. Most of the students gave correct answers to the easier questions. Certainly, each person has a different opinion of what a difficult question is. However, previously, data has been collected and statistically processed, on the grounds of which such levels of complexity were determined, taking into consideration the exam results of the majority of students.

Currently, the research is in progress, and the interdependence between the changes in the eye iris diameter and the emotional state of a person is being investigated. During the research, a micro video camera, which records the changes in the diameter of a student's eye iris and transfers the data to the computer, is mounted in front of a student. Employing special software, an iris is photographed every three seconds and the results are saved in the PC hard disk drive, in separate files. Employing the *Matlab* software environment and adjusted scripts, the eye iris diameter is calculated from the video pictures, and the recorded changes are saved in the database. A database was obtained as the final result, where the students' answers to the e-questions and information about the changes in the iris diameter during the exam were stored.

All the students were provided with the same questions. Answers had to be given in 15 min. During the exam, the changes of the eye pupil were recorded by a video camera fixed on the head. Photos of a pupil were taken every three seconds in order to determine the moment of the change in the diameter as precisely as possible. Another step was to measure the diameters of all the pupils. Eye pupil is then digitised and stored in a PC database of enrolled students. The whole procedure takes less than a few seconds, and can be fully computerized with voice prompts. Moreover, while a student was answering, the time when the student progressed to another question and when he/she pushed the button to choose the answer was recorded automatically. The taken photos were matched to the provided questions with reference to the time, and the average pupil diameter was calculated. Thus, a pupil diameter is determined, which corresponds to a particular question, e.g. if a student was thinking for one minute before answering the question No. 1, then all 20 photos are taken (as the eye was photographed every three seconds), and the average of measurements is deduced. All the 20 pupil diameters corresponding to 20 questions were determined by such a sequence. According to them, it was possible to determine the student's reaction to each provided question. The changes in the eye pupil of some students were very clear and obvious (the pupil diameter might have changed by up to 5,5 mm); in others, the changes were insignificant (5,25 to 5,35 mm). We may draw a conclusion that those students, whose pupil diameter underwent minor changes, were better prepared for the exam, they worried less and questions did not seem so complicated to them.

The research helped to find out, whether an actual interdependence exists between the correct answers (in percent) and the changes in a pupil diameter. Figure 3 depicts the dependence of a pupil diameter on the correct answers (in percent). The *x*-axis indicates the ID numbers of the questions answered during the e-test and the *y*-axis indicates the average of a pupil diameter (*on the right*) and the correct answers (in percent) (*on the left*). In case a student answers all the questions correctly, he/she may collect a maximum of 20 points (100 percent). Figure 3 also shows two correlated curves obtained during the research that indicate direct dependence of correct answers (in percent) on the changes in a pupil diameter.

Figure 3 shows that the more complicated was the provided question the bigger the diameter of a pupil was. It widened most when answering the question No. 34. And actually, only 7 people out of 20 answered this question correctly. We may draw a conclusion that this question was most complicated. Moreover, a reciprocal process may be observed: the easier the question (more students answered it) the smaller the diameter of a pupil is. Figure 3 obviously shows that the assumption was proved. The higher the pressure a person experiences (uncertain of his/her knowledge or sees the question for the first time) the wider the pupil of his/her eye becomes and its diameter increases.



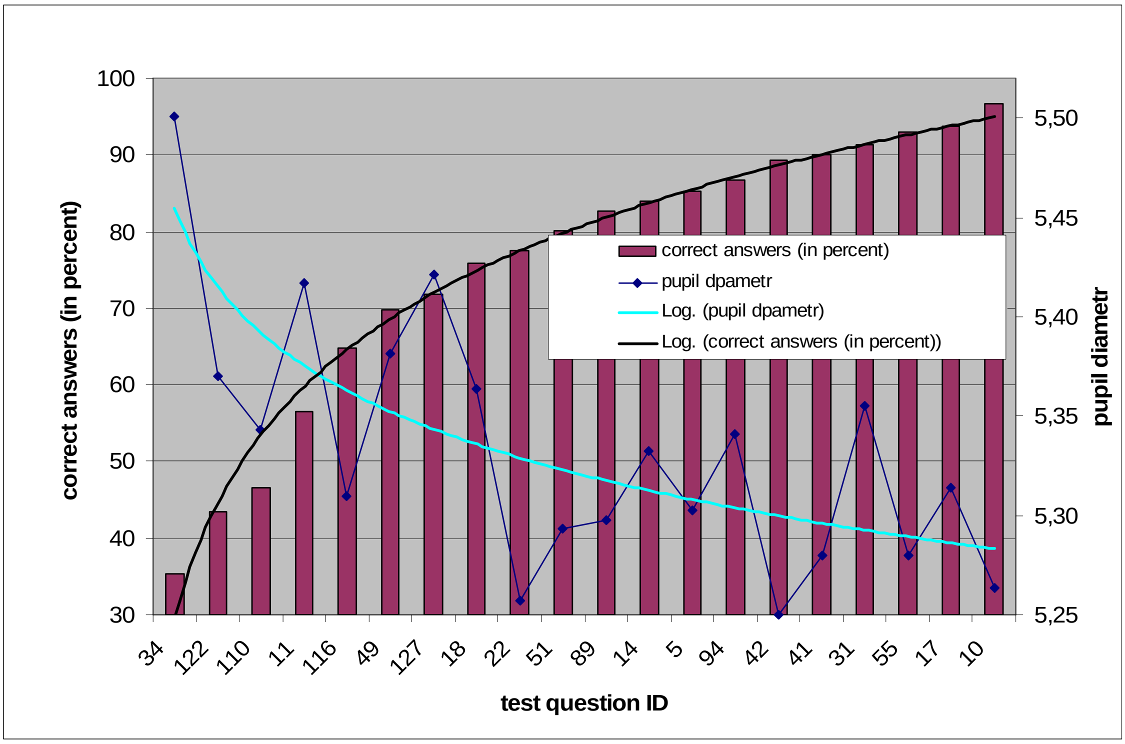


Figure 3: Dependence of a pupil diameter on the correct answers correct answers (in percent): the x-axis indicates the numbers of the test questions, and the y-axis indicates the average of a pupil diameter (on the right) and the correct answers (in percent) (on the left)

Supposedly, in the future, student's knowledge will be evaluated automatically taking into consideration the obtained data and determined interdependences. For example, a lecturer gives several questions to a student about the level of preparation to the exam, and the Iris Recognition Analysis Subsystem, with regard to the changes in the average of the student's eye iris, and taking into consideration the obtained data as well as determined interdependency, will be able to perform an automatic evaluation of his/her knowledge.

5. Conclusions

EURASIA project aims to enhance the capacity of the partner institutions for training, teaching and research activities required for the creation and long-term management of public and commercial facilities and infrastructure. One of the activities includes development of an Intelligent Library and Tutoring System within the EURASIA Project (ILT-EAP system). Authors of the paper applied the new technologies (Search Engine Rankings, Multi-variant Optional Module Design and Multiple Criteria Analysis; Voice Stress analysis, IRIS recognition) in the development of ILT-EAP system. The current features of the developed ILT-EAP system include the search for and finding of useful material, multi-variant optional module designs, multiple criteria analysis and selection of the most rational alternatives of teaching material according to students' requirements, application of biometrics technologies, etc. Future research intends active application of other biometric technologies (pulse measurement, blood pressure, biometric mouse, etc.) in e-learning. Also the future of this research is to study how to implement the new e-learning technologies (Search Engine Rankings, Multivariant Optional Module Design and Multiple Criteria Analysis, Voice Stress analysis, IRIS recognition) in e-teaching of MSc and PhD students of construction and real estate sector according to the objectives of the EurAsia Project.

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Mixed-mode delivery of construction management degree programs

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Abstract

The profile of students reading for construction management degrees is changing. In Australia, a buoyant construction industry is currently fuelling high student expectations. Job opportunities for students (as part-time employees) and for graduates are attractive. Students embarking on their studies come from a wide variety of backgrounds with a profile that is significantly different from the early 1990's when the Bachelor of Construction Management (Building) program started at Newcastle University (Australia). This degree was conceived to meet the needs of the local building industry. It embraced problem-based learning as its main tenet and was developed to be delivered to on-campus as well as to distance learners. Reviews by the Australian Institute of Building and the Australian Institute of Quantity Surveying as well as the University have highlighted the need to respond to market requirements and student expectations. Over the past two and a half years the degree has been redeveloped to embrace mixed-mode delivery of courses to on-campus as well as to distance learning students. This paper describes how the degree has evolved and the manner in which e-learning has been harnessed to deliver an innovative problem-based learning curriculum in mixed-mode.

Keywords: e-learning, problem based learning, distance learning, mixed-mode learning, blended delivery.

1. Background

The opportunities for would-be construction managers are considerable. A recent KPMG survey (2007) notes that the demand for construction is expected to increase significantly over the next five years. The report observes that the "single overwhelming conclusion that can be drawn from our study is that the shortage of qualified contractors is without doubt the biggest challenge to new construction projects in the future. Furthermore, with market demand expected to increase significantly over the next five years, this issue looks set to intensify as the pool of qualified contractors able to bid for projects is reduced and the wider shortage of skilled labour contractors impacts the ability of teams to deliver on projects." The findings of this survey are significant as they address the global market for construction. Closer to home, a recent survey conducted by the Master Builders Australia (2007) acknowledges marked differences between states and sectors but goes on to note that in "the non-residential sector conditions are strong and are expected to continue to improve. In contrast, current conditions in the residential sector are reported as poor. However, in a significant finding after negative results in previous surveys, builders now expect residential activity to improve over the next six months."

There are clearly good job opportunities in the construction industry, and these are reflected by buoyant recruitment to tertiary level construction programs. Students embarking on their studies at the University of Newcastle come from a wide variety of backgrounds. Many are of mature age and already have a construction background. Few are female. Many are highly computer literate and expect to engage with their studies using computer systems. This profile is significantly different from the early 1990's when the Bachelor of Construction Management (Building) program started at Newcastle University (Australia). Then the degree was conceived to meet the needs of the local building industry, and focused largely on domestic and commercial opportunities in the region. It embraced problem-based learning as its main tenet and was developed to be delivered to on-campus as well as to distance learners.

In addition to the changed profile of our current intake of students, an increasing number of them bring with them financial necessities of having to work to support their tuition. This latter point is emphasized by Mills and Ashford's (2004) in their investigation into part-time employment of construction management students. They highlight a trend of increasing levels of student engagement in the workplace. More recently an Australian Vice Chancellors' Committee report (2007) entitled "A summary of findings from a national survey of students in public universities" confirmed that increasing financial stress was undermining students' abilities to study effectively.

These financial pressures cannot be ignored. A response that the National Tertiary Education Union Newcastle branch president Bert Groen recently suggested (McKenny, 2007) might be occurring is where academics ask students to choose between their work and their studies. This is clearly an unsatisfactory approach, and is obviously not to be advocated. Students require flexible alternatives that respond not only to their pecuniary realities, but to different ways of learning that many of them engage in.

Hodgson, Sher and Mak (2007) note that the profile and expectations of construction students is changing. Not only are many of these students acculturated to the use of information technology, they are saturated with it. Lecturers need to recognise that the skills students enter University with are evolving and that many prefer to use digital materials rather than paper.

2. Current developments in the BCM program

Our Bachelor of Construction Management program is delivered by staff in the School of Architecture and Built Environment. The School comprises three disciplines viz., construction management and quantity surveying, architecture and industrial design. Degree programs at our University are subject to scrutiny from accrediting bodies as well as from the University itself. In 2004, our construction management degree (Bachelor of Construction Management [BCM]) was reviewed as part of our own internal quality assurance procedures, and by the Australian Institute of Building and the Australian Institute of Quantity Surveying. Several recommendations were made and we have responded in various ways. In the context of these recommendations the BCM program was re-conceptualised to address the changing needs of our stakeholders. Figure 1 shows the context within which the program was re-conceptualised.

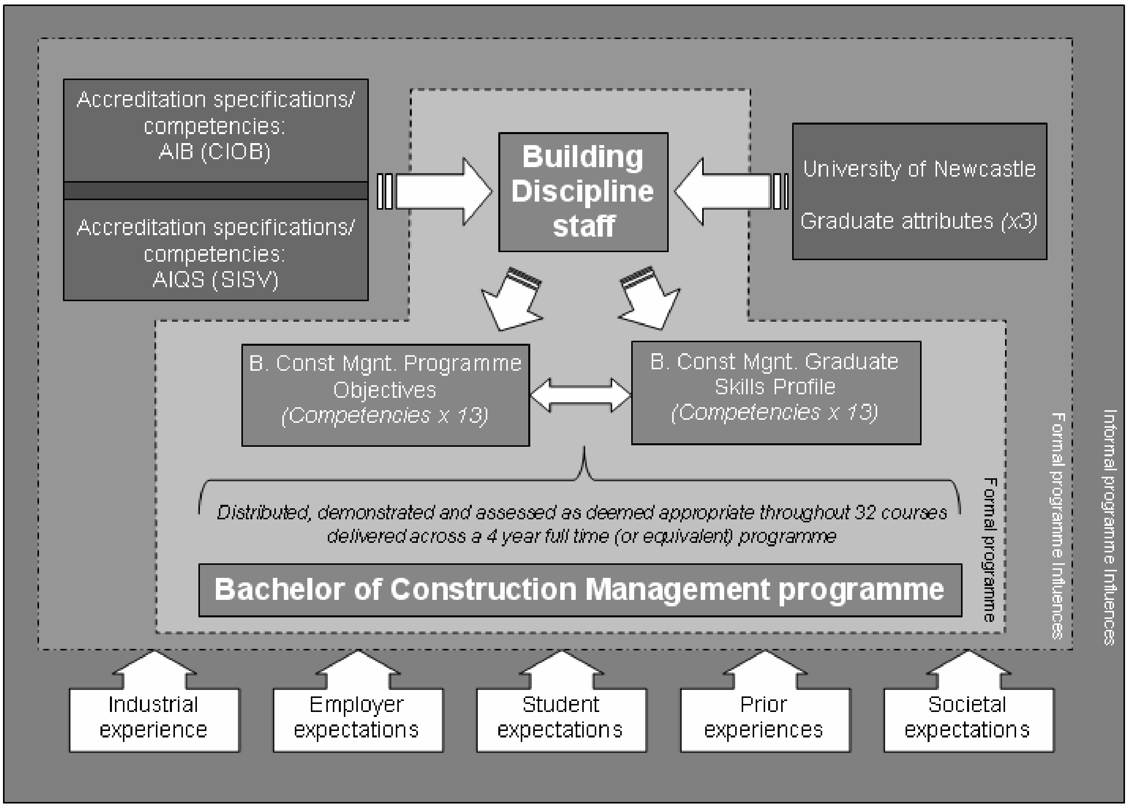

Figure 1: Context within which the BCM program is embedded

The re-conceptualised BCM program has responded to the review recommendations and the general trends in the Australian higher education sector (mentioned above). The re-conceptualisation was aimed to:

- Cater for the changing demands/needs of students

- Increase efficiency of the program delivery
- Re-conceptualise the teaching philosophy to enhance student learning and to conform to stakeholder requirements
- Enhance the quality assurance processes

This paper discusses how the new BCM program has addressed these issues through the following strategies:

- We use of Information Technology to facilitate flexible learning and improve efficiency. We now offer our BCM program in mixed-mode. This allows our students to study on-campus or as distance-learners, and provides them with the flexibility to decide at what pace to progress their studies.

- We have improved teaching efficiency and quality by combing the delivery of BCM and Architecture courses that were previously taught separately.

- We have approached PBL integration differently and introduced electives.

- We have developed a robust map of graduate skills and knowledge that links to all stakeholders' requirements.

3. Use of IT to facilitate flexible learning

Our program employs range of IT and online tools to create flexible and effective learning environments for students. We use the Blackboard learning management system, Lectopia on-line lecture system, Audio recording systems, online tutorials and tele-tutorials to facilitate student learning.

3.1 Blackboard

Staff have been using Blackboard for several years, and have developed expertise in most aspects of on-line pedagogy. Blackboard provides the equivalence of an on-campus classroom experience to on-line (distance learning) students. For example, all courses on our BCM program provide students with access to electronic course outlines, course materials (lecture notes, lecture recordings, reading materials), and relevant websites.

In addition, specific assistance is available from our Library to help students locate relevant materials. Our University's Teaching and Learning unit have developed targeted electronic materials to support our construction students in working in groups and in writing technical and other reports. Members of staff are skilled in engaging on and off-campus students in groupwork and in electronic discussions (Sher and Williams, 2007).

3.2 Lectopia

The University of Newcastle has invested significant funds in information technology infrastructure to service on-line delivery of teaching and learning materials. A major component is Lectopia, a system which gives students access to recorded lectures via the Internet. Lectopia allows lecturers to record their lectures from specific venues (there are currently 31 Lectopia-enabled lecture theatres in our institution). Staff simply present their lectures to on-campus students and what they say and display (from their computer or visualiser) is recorded in a digital format. Once a lecture has finished it is automatically processed and is ready for students to access via Blackboard within a short space of time (usually a couple of hours). Lectopia also provides podcasts of classroom lectures, which students subscribe to for automatic download of classroom lectures.

3.3 Audio recorded lectures

In addition to Lectopia, staff audio record their lectures (and some tutorials). These recordings are then made available to students via Blackboard in mp3 format. This approach is designed to service students without broadband access, as well as those who wish to use their iPod's to listen to lectures (whilst travelling to and from work, or at other convenient times).

3.4 Tele-tutorials

Notwithstanding the abovementioned array of (largely) asynchronous electronic teaching and learning aids, it is sometimes convenient for staff to communicate synchronously with students. In such instances, tele-tutorials are conducted.

3.5 On-line quantity surveying measurement tutorials.

A significant challenge for those teaching measurement is (and always has been) to ensure students have sufficient knowledge and understanding of construction technology to enable them to measure buildings. Measurement is a process which requires a technical knowledge and understanding of building or civil engineering technology. However, at the time students are required to learn how to measure, many of them do not yet have the requisite technical knowledge and understanding. Measurement requires students to follow a prescriptive set of rules provided by published standard methods of measurement (SMM). These publications do not explain the taking-off process and are designed to provide experienced surveyors with rules for measuring in a standardized manner. From a lecturer's perspective the challenge lies in teaching SMM based measurement processes to students who have just enough knowledge of construction technology to comprehend the measurement rules. We have collaborated with the Department of Civil and Building Engineering at Loughborough University (UK) to develop several on-line quantity surveying measurement tutorials that assist on and off-campus students to understand these processes (Hodgson, Sher and Mak, 2007).

3.6 3D models

As previously mentioned, many novice quantity surveying students are not familiar with how to read and interpret construction drawings. A discussion of whether or not these students need to be able to prepare technical drawings before they can fully understand them is outside the scope of this paper. However, many software packages are currently available to help students overcome the limitations of 2D drawings. We have trialled 3D models developed using Google SketchUp (2007) and have been encouraged by the ease with which these have been created, and by the verbal feedback students have provided. We are currently developing 3D construction drawings in addition to traditional 2D drawings to facilitate students' understanding of the manner in which buildings are constructed.

4. Program rationalisation and re-conceptualision of our the teaching philosophy

The changes to the BCM degree are significant, and extensive resources and effort have been directed to developing and delivering what is effectively a new curriculum. Delivery of the redeveloped courses to on-campus BCM students commenced at the start of 2006. The new program structure is illustrated in Figure 2. This approach allows efficient utilisation of cross disciple skills for student learning.

4.1 Problem-based learning

The BCM program is based on a Problem Based (PBL) curriculum. Traditionally, in universities, PBL is expressed in terms of the content that is taught and the sequencing of this content, embodied in courses. It is argued that a PBL curriculum consists of the:

- application of concepts and theories to practice/real world situations,
- concepts and theories that inform practice of the discipline
- processes of the discipline
- processes of learning

The problem-based learning (PBL) approach adopted in the BCM degree builds on an established body of knowledge, at the heart of which is the intention to improve the effectiveness and relevance of student learning (Brubacher, 1977, Boud and Feletti, 1991). Students should be 'empowered learners' who have the capacity for autonomous learning and an inner drive towards continuous and lifelong learning (Candy, Crebert and O'Leary, 1994). The motivation must be initiated by an assessment process that places the student's development at its heart (Newble and Entwistle, 1986). Since its inception, the BCM program has incorporated PBL as one of its central tenets. Continuing this approach, the redeveloped program retains PBL as an integral part of students' learning experiences. Integrated PBL courses are included in all years of study, and provide opportunities for students to assimilate and exercise newly acquired knowledge, understanding, and skills by engaging in a variety of different exercises.

SEMESTER 1 — 1ST YEAR [1000 LEVEL]	SEMESTER 2 — 1ST YEAR [1000 LEVEL]
Construction Integrated Project 1	Construction Law and Legislation
Communication in the Built Environment 1	Building Condition Reports and Surveying
Construction Technology 1	Communication in the Built Environment 2
Construction Ecology 1	History & Theory in the Built Environment 1

SEMESTER 1 — 2ND YEAR [2000 LEVEL]	SEMESTER 2 — 2ND YEAR [2000 LEVEL]
Open elective	Construction Technology 2
Construction Integrated Project 2	Health and Safety in the Built Environment
Measurement of Building Works	Estimating and Tendering
Economics in the Built Environment	Construction Procurement

SEMESTER 1 — 3RD YEAR [3000 LEVEL]	SEMESTER 2 — 3RD YEAR [3000 LEVEL]
Construction Ecology 2	Research In The Built Environment 1
Construction Technology 3	Open elective
Construction Business Management	Construction Integrated Project 3
Construction Project Planning	Construction Integrated Project 4

SEMESTER 1 — 4TH YEAR [4000 LEVEL]	SEMESTER 2 — 4TH YEAR [4000 LEVEL]
Construction Technology 4	Construction Integrated Project 5
Construction Ecology 3	
Research In The Built Environment 2	Construction Integrated Project 6

KEY		
	Courses taught to BCM & Architecture	Courses taught to BCM students
		Integrated Projects taught to BCM students

Figure 2: Structure of redeveloped BCM program

The question of choice for the implementation of a PBL curriculum is based on the characteristic of PBL to facilitate a fully integrated curriculum. This is defined in the goals of PBL programs, and includes an ability to *(a) develop high professional competency (b) reason critically and creatively (c) make reasoned decisions in unfamiliar situations (d) adapt to and participate in change (e) appreciate another person's point of view (f) make self evaluations,* *identify own strengths and weaknesses and undertake appropriate remediation (g) work productively as a team member*

The mixed mode delivery re conceptualised the PBL integration. The 30 units subjects (courses) that allowed cross subject integration in the old program were discontinued. Now subjects (courses) are delivered as specific knowledge delivery courses and integrated project courses. Knowledge and skill delivery courses employ PBL to allow inter-subject integration, i.e. integrating concepts with in a subject domain (Micro integration). Integrated Projects employ PBL to allow intra-subject integration of knowledge and skills of students (Macro Integration). Moreover, targeted reflection has been introduced to promote reflective practice.

4.2 Reflective practice

Central to PBL is the idea that students develop as reflective practitioners, requiring them to develop the ability to "think-in-action", to develop an awareness of "knowing how they think", which progressively translates into managing their own thinking, increasing their problem-solving skills, ultimately developing as a life-long learner (Fonteyn, 1998). This practice is mirrored by the staff in the BCM program who actively develop new and innovative ways to foster and gauge the students' developments as reflective practitioners (e.g. Brewer, Jefferies, Gajendran and Williams (2007); Brewer, Gajendran, MacKee and Williams (2004) and Brewer, Gajendran, MacKee and Williams (2003)). These have variously included reflective journals, the combination of reflection and self-assessment in reflective self-assessment tools, and most recently the inclusion of student reflection within assessable items as reflective footnotes. The efficacy of each of these innovations has been evaluated using multiple perspectives.

5. Quality Assurance: continuous improvements

5.1 Aligning and mapping student learning

The PBL curriculum is aligned with the development of students' graduate attributes. The proficiencies of graduates then become the basis for the development of course objectives. The University of Newcastle identifies three broad domains of graduate attributes as important outcomes of a university undergraduate degree: professionalism, community responsiveness and scholarship. The domains of attributes are generic to all undergraduate programs and reflect the University's scholarly values in relation to teaching and research, the employability of graduates and partnerships with the community. They define the abilities of each graduate that transcend disciplinary outcomes. The program specific attributes within the domains are developed in various disciplinary and interdisciplinary contexts. The BCM program has developed 12 program specific graduate skills. These skills and the corresponding university attributes are listed in Table 1. Each course identifies which specific attribute is targeted in that course, and all of these attributes are delivered across the program.

Table 1: Construction Management Program Skills Mapped against University Graduate Skills

	Professional Graduate Skill	**University Graduate Skill Profile**
1	Use knowledge of the construction industry, the environment and social processes that inform and contribute to construction practice, to optimise decision-making and evaluation of construction practices and processes.	Professionalism[1]
2	Be able to develop, implement and evaluate strategies that result in and/or contribute to successful construction and construction related projects.	Professionalism Scholarship[2]
3	Be able to communicate effectively with stakeholders and members of construction teams to facilitate project delivery	Professionalism
4	Demonstrate leadership as appropriate, to manage construction and construction related projects and/or processes	Professionalism Community responsiveness[3]
5	Be able to work effectively both independently and collaboratively in interdisciplinary and multi professional environments and teams to facilitate clients centred construction project outcomes	Professionalism
6	Function ethically, and within legal parameters, and conduct themselves in a professional manner.	Professionalism Community responsiveness
7	Perform the range of industry skills required by professional bodies, appropriate to their employer and context	Professionalism Community responsiveness
8	Be able to conduct and critically evaluate construction industry research and demonstrate an understanding of its contribution to the development of construction industry knowledge and practice.	Scholarship
9	Demonstrate professional and personal behaviour consistent with a commitment to lifelong learning, accountability in practice and the promotion and development of construction industry professions.	Community responsiveness Scholarship
10	Demonstrate creativity, lateral thinking and/or promotion of entrepreneurship and innovation within the context of work processes and procedures.	Professionalism Scholarship
11	Demonstrate understanding of social, cultural, global, environmental, ethical and business opportunities in the construction industry, and an understanding of the need for and principles of sustainable development	Community responsiveness
12	Demonstrate a capacity to inform themselves, their clients and the community of the social and environmental consequences of the actions and projects in which they are involved and the capacity to apply their skills and knowledge in the interest of their employers and clients without compromising the welfare, health and safety of their community	Scholarship Community responsiveness

5.2 Student evaluation

The Discipline of Building engages in a constant process of improvement in the BCM program. This is only possible because it undertakes frequent evaluation of courses, teaching, and the program itself, using techniques that provide multiple perspectives. These include student evaluations of each course, every time it is offered, using a standard University survey instrument, the results of which are recorded, reported and publicly published on our University website. Graduates of the program are also surveyed prior to exit, and again some time after they have graduated to elicit feedback on their overall experiences. The results are then fed back into the Discipline as an input into the continuous improvement process. Focus groups are also conducted with the students in each year of the program to augment the Student Evaluation of Course surveys, providing fine detail on the issues. Finally, many individual staff members conduct student evaluations of their own teaching, using centrally administered, anonymous survey questionnaires customised to investigate their particular style of teaching and assessment. The combination of all of these evaluative techniques invariably results in a program that continuously evolves and improves in order to meet the needs of the students.

6. Concluding comments

Like other disciplines, construction management and quantity surveying education needs to adapt to widespread changes. For example, measurement and other office and site practices have been revolutionised by computer technology, and industry practices have evolved in response to changed contractual conditions. These changes have necessitated revisions to traditional CM & quantity surveying curricula. The problem based learning CM degree program that has been successfully implemented at the University of Newcastle has been revised over the past three years. It is now delivered in mixed-mode, providing on and off-campus students with innovative and flexible education. This structure is continually evolving, and it is inevitable that the curriculum currently being delivered at our institution will be different to that of the future.

Endnotes

[1] **Professionalism:** An attitude or stance towards work and activity: Graduates of the university, through well-founded knowledge and skills within their fields of study will be enabled to act professionally with honesty and integrity. They will be enabled to act effectively and ethically in decision-making and problem-solving and work both autonomously and collaboratively. They will have the ability to respond effectively to change and to seek continuous improvement in practice.

[2]**Scholarship:** An attitude or stance towards knowledge and learning: Graduates of the university will have a scholarly attitude towards knowledge and learning, having a commitment to the expansion of knowledge and a respect for intellectual integrity and the ethics of scholarship. As scholars they will be enabled to apply logical, critical and creative thinking to the advancement of knowledge and understanding through a capacity for rational enquiry and self-directed learning. They will be able to communicate their knowledge effectively.

[3]**Community responsiveness:** An attitude or stance towards society: Graduates will be enabled to play effective and responsible roles as members of local, national and global communities. They will have a capacity for perspective forming and an appreciation of the philosophical and social contexts of their

disciplines. They will have the capacity to engage in constructive public discourse to sustain communities.

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Technology Enabled Learning – Lessons Learned from Irish Initiatives

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Abstract

The presentation of lifelong learning opportunities for construction professionals in an effective yet flexible manner presents a number of challenges for educational institutions. The changing profile of full-time undergraduates highlights they encounter similar challenges. This paper outlines an EU project that addresses these challenges and describes the methodology adopted in developing a portal for continuing professional development (CPD). Features of the portal are outlined in addition to a methodology to evaluate its continued development and maintenance. The paper concludes with an analysis of a module delivered through Technology Enhanced Learning (TEL) and how the lessons learned from this exercise assist refining the CPD portal towards its full-scale implementation.

Keywords: blended learning, lifelong learning, portal, technology enhanced learning.

1. Introduction

Bridging the gap between lifelong learning needs of construction professionals and higher education using technology is a challenging undertaking if it to be executed effectively and successfully. One of the most significant changes in education has been the increased availability of information and communication technologies (ICT) at work, school and in the home (Condie and Livingston, 2006). Given the increasing evidence that ICT and the Internet are transforming the way in which society accesses information, there is growing support for Garrison and Kanuka's (2004) observations that these tools will be a significant transformative innovation for higher education in the 21st century.

A consortium of European third level institutions and a multimedia company collaboratively formulated a framework for deploying blended Continuing Professional Development (CPD) to the construction industry. The consortium secured funding from the European Union (EU) in the field of Information and Communication Technology (ICT) and Open and Distance Learning (ODL) in education. The rational behind this project was to create an innovative international learning resource that is widely accessible to construction management professionals. The resource serves to improved knowledge and skills within the industry. In the paper, the development of the CPD portal to date is outlined and the output compared with the findings of an independent undergraduate module running at the University of Limerick using the open source virtual learning system, Sakai. The findings of this study are used to fine-tune the professional CPD template towards full implementation.

2. Designing a CPD model for Construction Management Professionals

In the original proposal, an open source learning management system, e.g. Moodle or Sakai, was the agreed host to receive any of the resources that maybe deployed. This was a strategic decision made at the onset of the proposal. The choice of using an open source solution was made based on cost and the greater flexibility that it brings to the collaboration as the project evolves.

The design process applied in the development of this separate learning resource is presented in figure 1 while the key activities in each phase are outlined in table 1.

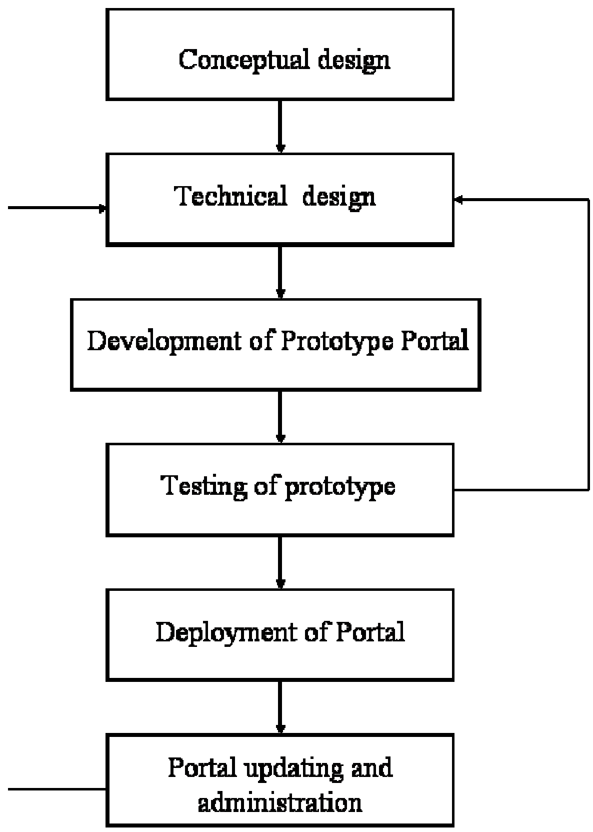

Figure 1: Separate Resource Development

Table 1 Key Activities for each Phase of Portal Development

Phase	**Features**
Conceptual design	The development of a brief to define the conceptual, functional and technical requirements of the CPD Construction Portal
Technical Design	The conceptual solutions and modifications identified in a series of partner meetings as part of brainstorming sessions to facilitate the technical design of the educational portal design
Development of Prototype Portal	The development of a small prototype of the portal to facilitate testing
Testing of prototype	Initial testing of the features and functionality of the prototype portal was undertaken in some of the partner institutions
Deployment of the portal	Based on the initial testing of the portal, the portal was deployed
Portal updating and administration	An ongoing requirement as part of the maintenance and sustainability of the initiative

Figure 2 illustrates the fundamental concept driving the development of this independent resource in a fashion that will strike a balance between traditional classroom instruction and technology-facilitated learning. This is a complex issue and achieving the correct blend is a challenging undertaking that requires innovation and ingenuity in the resource design.

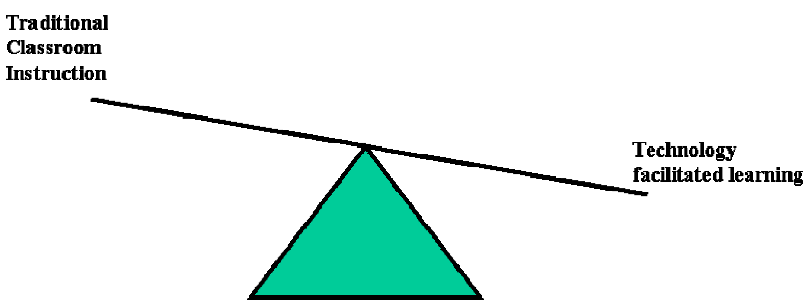

Figure 2 Striking a balance between traditional and technology facilitated learning

To date the major output of the project has been the development of a framework that hosts a series of on-line training modules, a reference bank of materials, web-based services such as discussion groups and bulletin boards to act as a forum for the exchange of information and ideas between educational institutions, industrial and professional bodies. As a part of the project, manuals and good practice guides, based on the interim and final evaluations have been formulated and are available for download by the subscriber. Figure 3 summarises the components that constitute the CPD Portal.

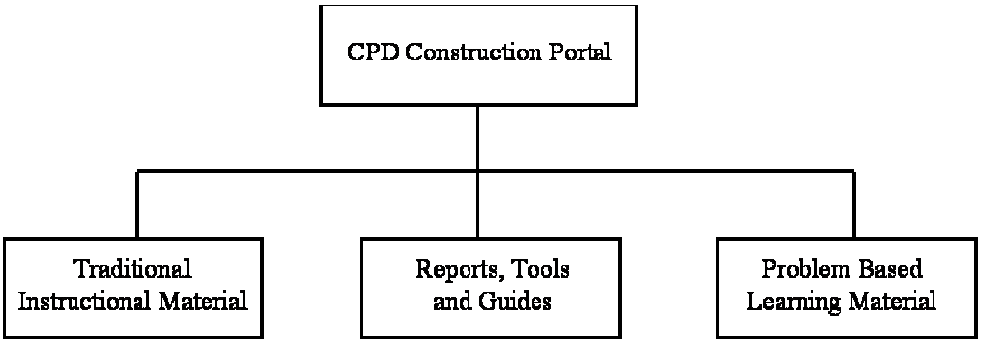

Figure 3 CPD Construction Portal

3. Portal Functionality

The Home page for the Portal for Continuing Professional Development (www.cpd-construction.com) is outlined in figure 4. Once an individual navigates to the homepage for the portal for CPD, there are a number of elements that the user can engage as part of the portal. There is an open access area contained under the Main Menu page. Included on the homepage is a description about the project, a description about the project partners, research papers presented as part of the project work, guides for both participants and teachers, a contact details page and a link to a framework for deploying CPD based on research carried out on the project. There is also a course categories section and a login section. These are controlled access areas within the portal.

Figure 4 Home Page Blended Learning Construction Portal

In this CPD Construction Portal, there are a number of key functional requirements and elements to be considered for the viability and sustainability of the initiative. There are a series of overlapping elements in developing a portal for CPD for construction management. Figure 5 outlines the various parameters to be considered for the Blended Learning Construction Portal.

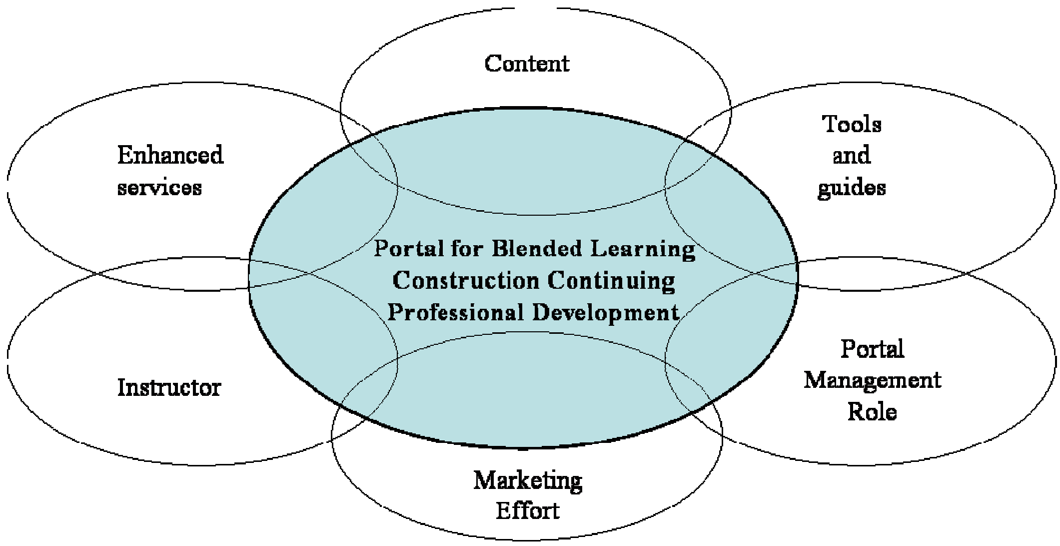

Figure 5: Responsibility for Blended Learning CPD

As content aggregators, web portals provide efficient access to information and services online (Neumann et al., 2005). The dissemination potential of the developed CPD Constriction Portal is endless and is only bounded by the thought and effort dedicated by the partners to this initiative to promoting the outputs. Internet marketing can play an important element in the dissemination of the information. With the well established networks of each of the partner institutes and the strong established linkages with professional bodies and construction representative adssociations in each of the countries cross links from each of these websites to other partners of the programme could be established. This could broaden considerably the dissemination potential of the project.

Table 2: Responsibilities and Key Activities for CPD Portal

Responsibility	Key Activities
Enhanced services	The enhanced services element includes the Moodle Learning Management System, which hosts the resources. Technical support for both participants and tutors on involved with the portal is part of the enhanced services role. Much of the technical troubleshooting and general administrative support and backup services should all be encompassed as part of the enhanced services element.
Content	Currently there is material developed for a number of areas in construction management. The challenge in developing any content for a blended initiative is striking a balance between what can be facilitated online and what may be delivered traditionally. To date content has been developed that covers subject matter in areas including: (i) Project Scope Management, (ii) Project Planning, (iii) Network Analysis, (iv) Risk Management and (v) Project Cost Estimating. Problem based learning where participants are allowed to share experiences can operate very effectively. Resources developed to support this include: ➢ Scottish Parliament ➢ Hoover Dam ➢ Sydney Opera House ➢ Bell Rock Light House Much of the content has been designed to facilitate independent and self-directed learning.
Instructor	The instructor has a key role to play in any blended learning initiative. Ensuring that instructors are aware of all the resources available, the functionality of the portal, and understand the role that they have to play in the ultimate deployment and facilitation of the resources is a key consideration. The instructor must change the way he or she performs their role from the more traditional role. Learning new skills, embracing a more flexible approach, an openness to using various technologies and assuming much more the role of facilitation are key skills that the instructor must embrace.
Marketing Effort	To ensure the longer-term sustainability of the portal for continuing professional development there is a requirement that a professional approach is undertaken. Involving new partners, countries and networks beyond the period of support for this project is key to the long term financial sustainability in growing the database of

	learning material, dissemination of the information and the possible establishment of a separate organisational structure charged with the delivery of CPD focused on the needs of the construction industry.
Tools and guides	The tools and guides element consists of suggestions on how to integrate resources and tools available developed into blended learning programmes along with some of the key issues to be considered. A series of support tools such as web-links for the problem based learning elements have been created and uploaded into the framework.
Portal Management Role	The certification of the accuracy and appropriateness of scholarly and teaching material placed on the resource is a fundamental issue. The portal management role is a key aspect of this initiative looking to the future. As well as supporting the instructor and participant with technological issues and challenges, the verification of content, quality assurance and monitoring of both the traditional and online elements of this initiative will be crucial in the longer term.

4. Case History: Pilot TEL Survey Using an Undergraduate Cohort

The time demands placed on full time undergraduate students is fast approaching that of the professional practitioners. In addition to attending college, many students hold a part-time job in addition to managing a birage of other personal and social interests all competing for an ever-reducing amount of personal time: there is little doubt that a major sea change has taken place in 21st Century education, at least in Ireland. The change has been coming for well over a decade and can be linked to Ireland's increased prosperity and thriving economy. The full-time student now seeks greater flexibility and autonomy in the way they receive and advance their education.

To this end, the second case study looks at the delivery of an introductory module on geology and soil mechanics using TEL. This virtual learning system supplements lectures and laboratory exercises by offering greater flexibility for the student to manage their education. Announcements on the course and other matters are automatically emailed to the student while the interactive calendar acts as a reminder of key project milestone dates well in advance of submission deadlines (Figure 6). Frequent assessments are undertaken throughout the module (Figure 7) within a timeframe agreed jointly by the learner and lecturer. This approach promotes learning throughout the module and facilitates active reflection on the course material; a more desirable outcome when compared to traditional rote learning for a heavily weighted end of semester examination.

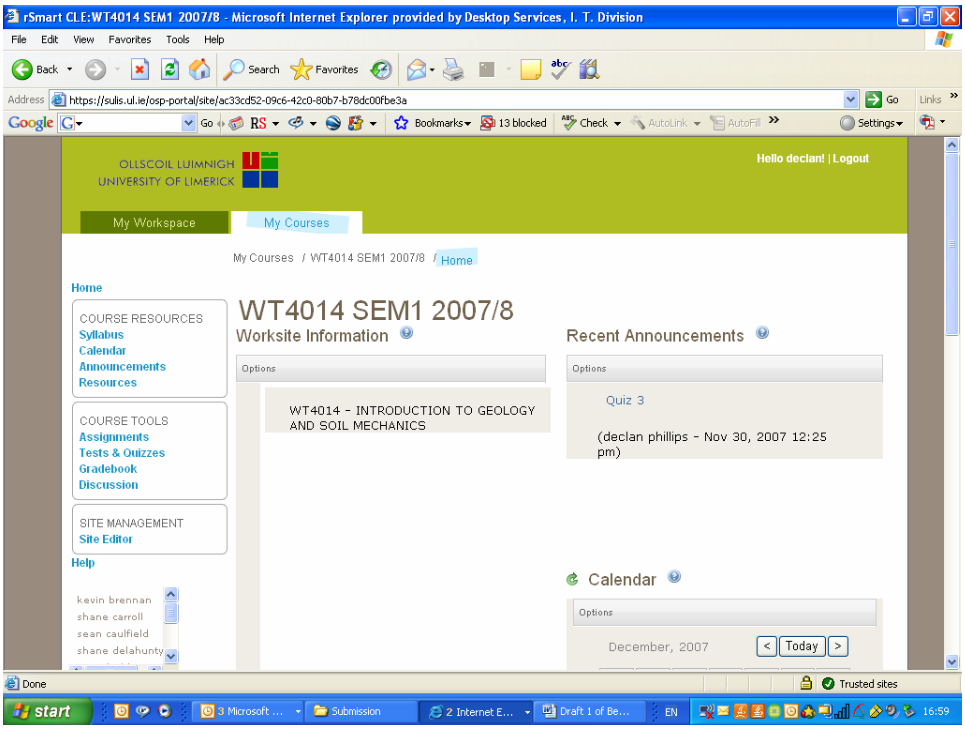

Figure 6: Module Site Displaying Communication Tools

The features utilised in Sakai are similar to those presented in Figure 3. Second year construction management & engineering students encounter TEL for the first time in this module and therefore receive a short briefing on the key features of Sakai. Funadmental issues such as logging-on and accessing the course material are outlined. Later in the module a short follow up session on the use of tools for 'assessment' and 'tests and quizzes' are presented. The continuous assessment element of the module accounts for 50% of the course marks and all submissions and course material are delivered digitally thereby creating a paperless 'green' module!

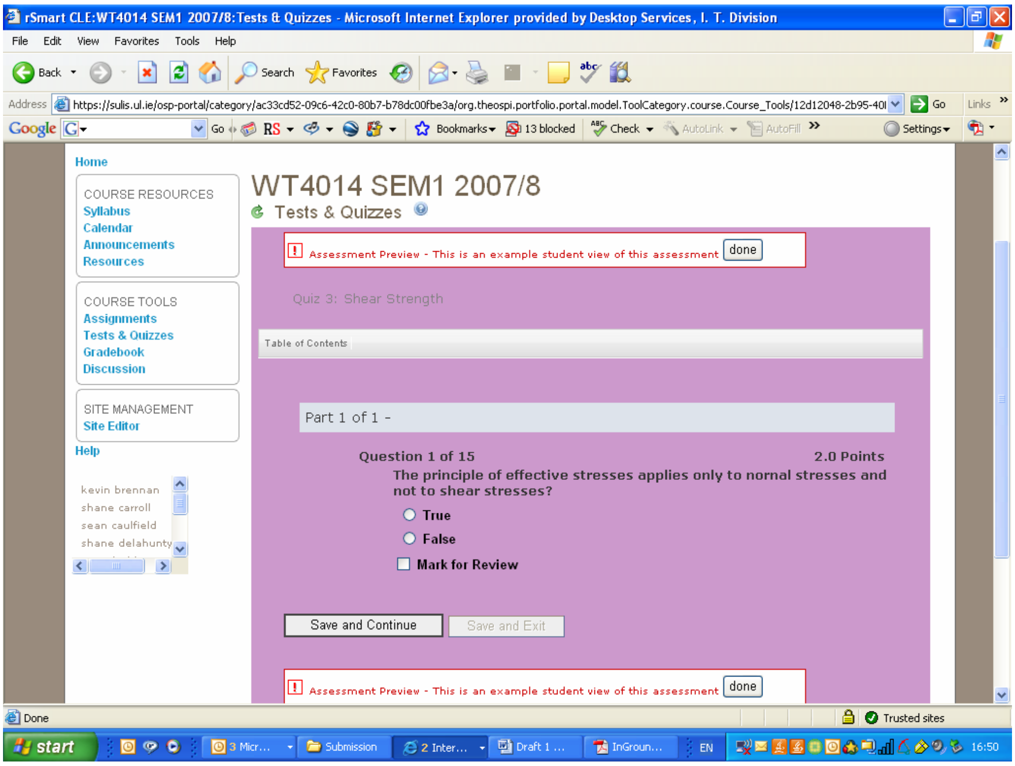

Figure 7: Typical Quiz

The opportunity to assess the experience garnered from this approach along with learner feedback provides an interesting pilot exercise that is used to troubleshoot the efficiency of the professional CPD portal. These tools contribute to learning throughout and module and provide prompt feedback on performance; a welcome addition to closing the 'learning circle' for the student. However, substantial difficulties remain with slow network speed when accessing Sakai either on or off campus. Moreover, after a preset period of inactivity, the system automatically logs-off students[1] and blocks assessment submissions with large file sizes (due mostly to digital images embedded in the documents). These difficulties are no more than teething problems that can be easily overcome with proper planning and technical support. They were nevertheless a source of immense frustration for the students who, perhaps due to a personal rapport developed with the lecturer, tend to be more accommodating when these difficulties arise. This tolerance is less likely with professionals' up-skilling via a web based blended learning programme.

[1] This was particularly a problem as students undertook research when answering quizzes on line

5. Longer Term Sustainability of CPD Construction Portal

The potential access to the outputs of this project is unlimited. The principal beneficiaries from this project's outputs are; construction management professionals across a wide range of disciplines that will profit from the collaborative development, lecturing staff from the institutions participating in the project, teaching staff at higher level institutes outside of participation institutions and researchers in the construction management field. Professional bodies charged as part of their charter to ensure that CPD opportunities are available, taken by members can also be encouraged to be involved, and can benefit from the project.

There is a requirement that the portal and the infrastructure to support the portal is an environment that facilitates and encourages access to lifelong learning opportunities. Active collaboration with both industry and the various professional bodies is key to the sustainability of this initiative. Collaboration of like-minded partners and peers will offer the opportunity to break out of the confines of traditional institutions and allow innovators to collaborate. If other private companies wish to use the learning objects as part of corporate development, programmes assistance and guidance can be offered as well as access to the learning material and framework on an agreed annual fee basis.

Encouraging collaboration is viewed as key to sustaining this project initiative as the EU funding ceases. This project network can act as a forum for dialogue and exchange. Research carried out by DG Education and Culture of EU Commission (2004) highlighted that there are different models that educational institutions are embracing with respect to incorporating e-learning into curriculum. The CPD in construction portal is a pioneering attempt to put forward a new model that may facilitate educational institutions integrating technology in the delivery of lifelong learning programmes.

Involving both professional institutions and construction representative bodies is seen as a key to the long term sustainability of the project. Any certification of the training and learning offered, possibly during and certainly after this project, will be based on it meeting the requirements for CPD of these professional bodies. The offering of these programmes could generate a revenue stream that can be re-invested into the network.

Other higher level institutes external to the partners will be invited to become involved in the network. In order to achieve the longer term goal of developing a database of learning material, a sharing of costs and benefits will be encouraged to sustain this initiative. Professional bodies in each of the partner countries will facilitate access to and ensure the availability of the material to construction management professionals throughout Europe.

6. Discussion

The facilities and capabilities offered by e-learning and technology in the delivery of training are considerable. Bruce (*2003; p 24)* notes "*today's students think of the Internet the way their parents and their grandparents…viewed electricity: ubiquitous and only noticeable when not available.*" For undergraduates' integrating technology into the process of learning is not a significant challenge. This may not be the case for more mature construction professionals accessing lifelong learning opportunities, where ICT presents a significant challenge.

Based on the research carried out as part of the EU programme, there is potential for such a portal and an opportunity for more collaboration to take place between the professional bodies, industry and higher education in the delivery of CPD using technology. If CPD becomes an obligatory requirement for continued professional recognition, this will have knock on effects for the professional bodies in terms of resource requirements to manage and police the content of the material delivered. Therefore, the professional bodies have to make a strategic decision that policy and policing of CPD is an essential component for the future success of the industry and profession. However, studies such as Hurst et al. (2007) in the UK indicate that industry does not place the same importance on CPD as the professional bodies.

As Thomas (1995) suggested for CPD to be well supported and regarded there has to be collaboration between employers, employees, the professional bodies and educational providers in developing an environment that encourages and facilitates access to CPD. To capitalise on this research and bridge the gap between, (i) higher education, (ii) the requirements of the various professional bodies and (iii) the needs of industry, there are a series of steps that should be undertaken:

1. Establish and test the infrastructure and framework which will act as the host platform for the technology facilitated CPD initiative
2. Establish the appropriate learning outcomes and competencies required by the professional bodies
3. Determine the breakdown of traditional and online delivery of the learning. As part of this ensure that as many methods of instruction and learning as possible, i.e. both formal and informal methods of learning are encouraged
4. The content delivered must be eligible for CPD credits by the relevant professional body. For educational institutions this means building links with the professional bodies and ensuring the quality of the delivered learning will meet both the competencies and learning outcomes required by such bodies
5. Where appropriate, register on the network of training providers compiled by the professional bodies. This will ensure, where applicable, that professional bodies' logos can be used. It will also assist in dissemination of the programme.

Through the execution of these various steps, an effective programme of CPD, meeting both the professional institutions and industry's learning needs can be deployed. Educational institutions are in a better position than most to capitilise on this though the formal QA systems that exist in the sector and in individual institutions, through undergraduate programmes developed which fulfil the criteria of the various professional bodies to meet industry needs.

7. Conclusion

The rational behind the first case study is to create an innovative international learning resource that is widely accessible to construction management professionals thereby facilitating improved knowledge and skills within the industry. It is well recognised that the integration of e-learning and blended learning into programmes is led by motivated and enthusiastic individuals with little extrinsic rewards structures to encourage these initiatives.

To date the major output of the project has been the development of a framework that will host a series of on-line training modules, a reference bank of materials, web-based services such as discussion groups and bulletin boards to act as a forum for the exchange of information and ideas between educational institutions, industrial and professional bodies. However, unless a strategic approach is adopted, resources deployed, and an appropriate support infrastructure is put in place, the longer-term sustainability of this initiative will be jeopardised.

The undergraduate case study presented highlights many of the benefits of delivering course material using TEL. In general, there was unanimous recognition that TEL improved the learners' experience, particularly the easy access to module documentation and the frequent assessment of course material using the 'tests and quizzes' option. These tools have contributed to learning throughout and module while prompt feedback on performance is a welcome addition towards closing the 'learning circle.' The instant emailing of module announcements and the highlighting of key milestone dates on the module calendar were also popular features. The system was not however without flaws, in particular, the following findings should be addressed if a professional CPD portal is to operate successfully:

1. Accessibility and slow of network speed were the greatest source of frustration for the users. A number of respondents noted being automatically logged-out by the system particularly when undertaking a module quiz. It is likely that these issues will also be concerns for the lifelong learner using technology as part of CPD.
2. Network restrictions on file size came to the fore when assignments with large file sizes (due to digital images) presented unforeseen difficulties for students submitting work close to the deadline.

While these difficulties can be overcome with appropriate advanced planning and the establishment of a proactive technical support team, the undergraduate pilot survey of TEL serves to stave off negative sentiment that would inevitably exist were these difficulties encountered by the construction professional. Moreover, the part time learner accessing material online from remote sites and poor ICT communications infrastructure may be de-motivated by slow or untimely access to resources. In conclusion, this work incrementally advances the CPD portal towards its full-scale implementation.

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The use of online asynchronous discussion forums in the development of deep learning among postgraduate real estate students

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Abstract

The role of learning management systems in real property education is examined in this paper with particular emphasis on the use of asynchronous discussion boards. The research shows that students readily respond to the use of online tools for communication and as an administrative tool discussion boards have a significant role in reducing the level of one to one communication required. They also enable student engagement with their peers in providing feedback. The use of discussion boards to achieve reflective writing and deep learning among students is demonstrated with a significant number of students participating at this deep learning level. The research clearly supports the use of these tools in enhancing learning in postgraduate courses and demonstrate that students are strategic in their approach to learning and will only fully engage with learning tasks where they are assessable and thus contribute to their objective of passing the course.

Keywords: real estate education, learning management systems, discussion forums, reflective writing, assessment.

1. Background

1.1 Developing technologies

Higher education is experiencing an explosion in online teaching tools. It is little more than ten years since anyone had heard of learning management systems but now everyone asks do you use WebCT or Blackboard. Hardly a semester goes by without a new building block being added to the range of online tools available to academics to 'enhance their teaching'. There is limited research however, as to the added value these systems bring to increased educational outcomes for students. Educational research has struggled to keep pace with the developing technologies. This has led to some criticism that it is the technology that is dictating the approach to teaching rather than sound pedagogy adopting the technology as an enhancement over traditional methods of course delivery.

This paper will explore the pedagogical rationale for the use of online tools in the delivery of postgraduate real estate courses and, in particular, explore the value of asynchronous discussion forums in engendering deep learning among students. The learning management systems commonly used in higher education, typically WebCT and Blackboard along with a range of other software packages and bespoke systems, offer the ability to communicate between members of a group in a threaded open communication visible to all members of the group.

1.2 Discussion forums in education

Discussion forums in which instructors and students post to a threaded asynchronous discussion provide a convenient mode of communication, but do they add to the education of students? Do they ‘change the way in which people understand the world around them, rather than as an accretion of facts and figures’ and thus lead to learning? (Ramsden 2003;79)

Discussion has long been a part of traditional class interaction. Online discussion forums, however, provide a very different format in that students are required to write their responses and post them for all to see. The process of writing in itself causes the student to engage in reflection: ‘Writing is the manifestation of thought. It is guided by and grounded in knowledge and experience. It is self-generated, constantly reviewed, questioned and revised’ (Redmon & Burger 2004;158). Thus the very act of writing is a learning activity that contributes to knowledge (Knowlton 2005;165; Pena-Shaff, Altman & Stephenson 2005). There are other benefits attributed to the written approach to discussion in that it is less prone to be dominated by a single participant and allows students not interacting in their first language to be able to spend time constructing their contribution (Havard, Du & Olinzock 2005). The asynchronous nature of the discussion is seen by Redmon & Burger (2004;158) to be a distinct advantage as it is ‘less bounded by convention’ and as such it can become a more effective medium for reflection. It would seem that there are strong positive outcomes for teaching and learning in adopting this written form of online interaction.

The literature shows that some negative aspects of online discussion are evident. Some students report a fear of presenting written thoughts for class comment (Havard, Du & Olinzock 2005). Other authors report an initial reluctance in students to participate largely linked to the unstructured nature of the process (Beyth-Marom, Saporta & Caspi 2005; Grandon 2006; Redmon & Burger 2004), indeed Pena-Shaff, Altman & Stephenson (2005;416) report that 51% of students do not view discussions as an efficient learning medium. The extent that these negative aspects are outweighed by positive aspects will be explored in this paper.

The literature on online discussion clearly shows that it is a challenge to motivate students to participate. Most research on the application of discussion forums indicate that active participation only occurs when the task is a formal class requirement with contribution towards grades (Grandon 2006;374). The compulsion to participate is argued by Knowlton (2005) to be an inhibition to active participation, as students seek to meet minimum standards rather than actively participate and reflect freely on others’ contributions. Pena-Shaff, Altman & Stephenson (2005;421) report a negative impact on participation where discussions are graded and found that some students ‘rebelled against the fact that discussions were graded.’ These students consider assessment counter to the aims of free and open participation in the discussion.

Thus the literature shows that asynchronous discussion forums, where reflective writing is required, can add to the learning experience of students and result in a deeper understanding of the subject under review. The literature shows that obstacles exist to successful use of discussion forums online; this is particularly so in engendering student participation and where assessment is not applied to the discussion, but on balance positive outcomes are reported across a number of disciplines.

1.3 Deep and surface learning in discussion forums

In the literature, it is recognised that student participation can vary widely from very shallow 'I agree' postings to deep reflection on the issue under discussion. Several authors have developed taxonomies to assist in classifying postings (Grandon 2006; Greenlaw & DeLoach 2003; Havard, Du & Olinzock 2005; Knowlton 2005; Pena-Shaff, Altman & Stephenson 2005). Each of the taxonomies of discussions have a common goal of differentiating between surface and deep reflective participation in the discussion. Greenlaw & DeLoach (2003;38), for example, provide a six level taxonomy of 'Critical Thinking', defining levels from 'unilateral descriptions' to 'merging values and analysis.' In this latter level students are 'able to move beyond objective analysis to incorporate subjective interests' (Greenlaw & DeLoach 2003;39). Similarly Knowlton (2005) provides a five point taxonomy ranging from passive to meta-cognative which closely resembles the stages from shallow to deep reflective learning to achieve 'internal mental representations of the learning process' and an 'environment well-suited for examining personal transformation' (Knowlton 2005;169). Other taxonomies are more about the level of discussion than the quality. Grandon (2006) provides a table of five discussion types, differentiating between support and administrative discussion through to participative discussion. The metric in this taxonomy is related to the level of use and satisfaction, and the former only where participation is voluntary. This taxonomy identifies that self-efficacy is important within participative discussion thus recognising the need for reflection and the need for more than surface learning. What is evident from all of the literature is that some measure of the student use of discussion forums is desirable and, that if real learning is to be achieved rather than just the transfer of administrative information, then students must be encouraged to be more than 'lurkers' within a forum, they need to actively participate and reflect on the postings of others (Knowlton 2005) . The measures applied to a forum must reflect this desired outcome.

1.4 The role of the instructor in online discussion

The level of instructor participation within an online discussion forum seems to fall into two distinct schools of thought; those that see the instructor as an active participant or leader (Dennen 2005; Pena-Shaff, Altman & Stephenson 2005; Redmon & Burger 2004) and those that strongly advocate that the instructor's role is one of moderation only (Dennen 2005; Heckman & Annabi 2006). The moderator role is only considered effective, however, when participants are encouraged to actively participate and reflect on the postings rather than instances where the instructor is imparting information in a more administrative discussion (Havard, Du & Olinzock 2005). Most authors conclude that the instructor must provide timely feedback to students in order for participants to value the discussion process (Pena-Shaff, Altman & Stephenson 2005;425).

The literature clearly supports the use of online discussion both at a surface administrative learning level and, more importantly, as a method of achieving deep learning and cognitive maturity in students (Pena-Shaff, Altman & Stephenson 2005;423). A clearly articulated taxonomy that recognises higher levels of deep and reflective learning will encourage active student participation at this level. The need for compulsory participation has its pros and cons but most authors recognise that assessment is part of the learning process and can encourage greater active and meaningful participation. The asynchronous nature of online discussion supports a written, more measured participation, which can negate some of the negative aspects of class discussion felt by those for whom the discussion is not in their first language or who are reluctant to speak freely in classroom situations.

1.5 Discussion forums in real estate education

There is considerable anecdotal evidence to suggest that the use of discussion forums in the education of built environment students is widespread. Certainly within the Australian context most courses delivered in the region are supported by learning management systems and a good number utilise discussion tools to some degree or another to enhance those courses. There is, however, little published research on the outcomes of utilising these tools and little research into student attitudes to online learning.

This paper reports research into the attitudes and practices of postgraduate students studying real property courses in a traditional on campus setting. It examines attitudes towards the use of online tools to support traditional classroom based learning with a particular emphasis on the use of asynchronous online discussion boards. The research compares the results from undergraduate students and postgraduate students studying real property courses within a traditional on campus setting. The paper examines the development of deep learning among students via the use of online discussion as a component of a wider course design.

2. A survey of student attitudes to asynchronous online discussion and an analysis of learning in online environments

This paper reports on a survey of both undergraduate and postgraduate students studying real estate courses. Students in these courses were encouraged to utilise the discussion forums within the learning management system, in this case Blackboard, to complete a range of tasks.

2.1 Methodology

In order to evaluate the use of asynchronous online discussion forums in real estate education, both quantitative and qualitative research methods have been employed. Two iterations of student perception questionnaires were used, each containing both open and closed questions.

In addition student discussion board postings were analysed. The use of a case study approach to draw on experiences of conducting online discussion in nine courses over a period of three years is also discussed.

The principal research method comprised a questionnaire which was developed to determine student's perceptions of the online teaching environment and the use of discussion boards as teaching enhancement tools. The questionnaire design for this initial survey was kept deliberately short in order to attract the greatest response rate from students. The questionnaire comprised ten separate questions. Nine of these were closed questions and required either a Yes / No or Don't Know response, or they sought an opinion based on a Likert scale of five possible responses plus a Don't Know option. The final question was open ended requiring an opinion from students of their experiences. The survey questions asked student attitudes to the broader use of online teaching tools and, more specifically, their practices using the discussion forum tools. The discussion tool used within the courses under study was at two distinct levels. All the courses had a very general level discussion designed to answer student concerns and queries relating to the course and to provide feedback. This discussion is superficial and fulfilled a more administrative role than seeking to attain any learning benefit. The second level of discussion, administered to a single cohort of postgraduate students, required active posting and critical thinking around a series of questions relating to content from the course and established by the discussion moderator.

This initial survey was administered online via Blackboard in the last week of semester. Participation in the survey was voluntary and responses were anonymous. The survey was administered to both undergraduate and postgraduate students undertaking courses across all years of the real property degree programs. It is acknowledged that by choosing to administer a survey using a web based learning content management systems that there is a bias toward students who are familiar with and comfortable using the technology. This constraint is considered, however, to be minor given that all students in the courses surveyed are required to use the technology for obtaining course materials and submitting assignments and, as such, must be familiar with its use.

A second questionnaire was developed for use with a group of postgraduate students who, as part of an assessment item, were required to actively participate in three separate online discussions each lasting over a four week period. Each discussion was initiated by the discussion monitor by posing a question relating to a provided reading. Students in this course were required to make a minimum of three postings to each discussion forum. This second questionnaire, in addition to the first survey described above, sought student feedback on the specific discussion forum assessment item. As with the initial survey this questionnaire was administered via Blackboard in the last week of semester following completion of the discussion forum assessment item.

In addition to the direct survey of students a review of participant's contributions to the three discussion forums described above provides insight into the students' abilities to undertake the assessment task. The instructions given to students clearly articulated a requirement that they be reflective in their postings, building on fellow students' postings and developing a depth of understanding of the discussion issue. Prior to commencement of the course students were provided with a guide to reflective writing and it was clearly articulated that the requirement is to not just report but to critically analyse and reflect on the postings of others. Textual analysis of the discussion against the assessment taxonomy provides insight into the extent of student participation and depth of learning achieved through this task.

3. Data analysis and results

The student survey of three separate cohorts at both undergraduate and postgraduate level provides a rich data source from which to derive an understanding of real property students' attitudes towards the use of online technology to augment traditional teaching practices.

3.1 Use of online learning management systems

Students were asked to rate their use of the Blackboard learning content system. Using a 6 point Likert scale, they were asked if the Blackboard system helped with their learning, in the course. The majority of students either agreed or strongly agreed that Blackboard helped their learning with 84% of undergraduates and 89% of postgraduate students responding positively. Those that strongly agreed were 44% and 67% respectively, which clearly shows that a majority of students are very positively oriented toward the use of Blackboard. Indeed, only one student, a first year undergraduate, responded negatively to this question.

The frequency of interaction with the Blackboard system could give an indication of the level of engagement with the course. Interaction may be through posting to the forum or simply by viewing the postings of staff and other students. When asked how frequently students viewed the discussion forum 45% checked the discussion more than twice a week and, of these, 30% check more than three times per week. The less frequent observers of the discussion were, 18% who viewed the discussion less than once per week and 6% less than fortnightly. Postgraduate students were less frequent viewers with just 33% checking more than twice per week. Weekly checkers were the largest group at 28%, with 22% in both the less than once per week and less than once per fortnight categories. The lower rate of views by postgraduate students is perhaps a reflection of their lower level of participation in the discussion which is discussed below.

3.2 Use of discussion board tool for course administration

There is a clear role for the use of discussion boards to help in administrative functions particularly in larger classes. Answering student queries can be addressed via a discussion board where students, themselves do not consider the communication of a personal and private nature. It has become increasingly evident over recent years that the ease of communication via email has resulted in increased communication from students to teaching staff. By addressing queries via a 'Frequently Asked Questions' discussion board and encouraging students to offer answers and opinions to their peers can significantly reduce the time spent by staff and students in dealing with these administrative procedures.

Students across all of the courses were asked a series of questions relating to their use of the administrative discussion board. There is a clear disparity between the results obtained for undergraduates than postgraduates to the question. Did they use the frequently asked questions (FAQ) discussion forum on Blackboard? Undergraduates reported a 73% usage of the discussion board, while only 28% of postgraduates used the site. This disparity of results between the two student groups is also reflected in the response to the usefulness of the discussion forum. Using a Likert scale question, 71% of undergraduates found the discussion forum useful while only 33% of postgraduates found the site of use. The level of negative response was only minor with 7% in both groups falling into this category. A neutral response was given by 56% of postgraduates.

There is no explicit reason indicated as to why there is a difference in response between postgraduates and undergraduates to the usefulness of a FAQ discussion forum. Students were asked if they had directly emailed the course leader during the semester with questions, a practice that had been discouraged in favour of the FAQ discussion forum. Undergraduates had a 45% positive response, while 61% of postgraduates responded positively. It is evident from these figures that a large number of students continue to use the more direct and individual email approach over the open discussion forum. This shows that there is still a strong preference to use email or other direct contact methods particularly by postgraduate students. There is however considerable scope to enhance the discussion approach and build further on its use, requiring students to use the FAQ and only responding to questions posted to the discussion forum are among the simpler ways of encouraging greater use. A more subtle approach might be to anonymously post simple questions and answers in order to encourage students to emulate what appears to be one of their peers using the forum.

The differing, lower level of use of the forum by postgraduate students is not explained within the survey. One possible explanation may be the difference in class sizes which facilitate a closer discursive approach to teaching within postgraduate lectures. This would not explain, however, the higher level of email correspondence directly with teaching staff. This aspect of the research requires some follow-up investigation in order to explain the difference before a greater reliance on discussion forums is pursued.

The promotion of peer interaction within the administrative discussion board was seen as a positive feature. The ability to answer fellow student's queries was reported as a positive feature by 87% of undergraduates and 83% of postgraduate students within the courses. When asked how many students answered their peer's queries, 26% of undergraduates said yes while only 17% of postgraduates responded positively. It is evident from this data that students value the ability to interact in this way although only a modest percentage had actually utilised the ability to respond. A review of the discussion board confirms these figures. It is interesting to note that in posting questions almost two thirds did so anonymously, and yet when answering other students a greater proportion were prepared to put their name to the response.

Students were asked if they thought that postings to discussion boards should be allowed to be anonymous. Only 13% of undergraduates thought that they should, the majority 67% neither agreed nor disagreed. This contrasts with the postgraduate findings where only 16% thought posting should be anonymous, 33% were neutral and 45% disagreed with anonymous posting. There is no explicit reason given for this difference, however, one might surmise that it reflects the closer relationship that postgraduates enjoy in smaller classes together with a more mature attitude to learning.

One important factor revealed in the literature on discussion forums is that students should not feel threatened by the experience of posting their thoughts in an open forum. To try to investigate students attitudes to this, students were asked if they felt supported by their peers in posting to the forum. Undergraduate students responded positively with 59% agreeing or strongly agreeing with the statement that they felt supported by other students in posting to the discussion. A neutral response was given by 23% while only 4% did not feel supported by their peers. A similar result in terms of a positive response, 56%, was reported by postgraduates, although 22% posted a negative response revealing that they did not feel supported by peers when undertaking online discussion. This result shows that the majority of students felt positively supported; however the larger negative response from postgraduates raises some questions as to why this might be the case. It must also be considered that it is unlikely that students would always feel completely supported by their peers as they are working in what many conceive as a competitive environment where grades have to be fought for against competing students.

3.3 Use of assessable discussion boards

The second part of this research relates to a single postgraduate course where, as part of the assessment, students were required to participate in an asynchronous online discussion covering three separate topics each over a 4 week period. In addition to the questions posed above this group of students were also asked to evaluate the course based discussion board.

The discussion was made an assessable item within the course. It was made assessable as in the previous year a similar discussion was promoted with students and participation proved minimal. Students responded very positively to the question should the discussion be an assessment item, with 71% saying they agreed or strongly agreed, while only 14% disagreed with it being assessable. In a related question they were asked if they would have made fewer postings if the discussion was not assessable; 29% responded with much less and 42% with less. Only 14% said they would have posted the same. This result clearly indicates that students are motivated by assessment and passing the course and will avoid items that do not directly contribute to that goal.

While students appear oriented to strategically participating in learning activities that contribute to the final grade, 72% found the discussion a worthwhile learning tool for the course. No students posted a negative response to this question although 15% were neutral. This is a good indication that students enjoyed the discussion task. Students also felt that the asynchronous nature of the discussion allowed them to give a more considered answer than they would in a classroom discussion, with 70% responding positively to the question.

An analysis of the discussion forum itself provides some insight into the usefulness of the tool. It should however be noted, however, that only 15% of students made more than the required three postings to the forum compared to 25% that did not even make this minimum. Looking at the text of the students that made below requirement contributions their postings can be categorised in the marking taxonomy given to students as superficial. They report on information researched but not necessarily fully in tune with the discussion or they provided unsupported opinion. These students demonstrated that they were going through the motions rather than engaging in deep learning. The students who fulfilled the discussion requirements provided a mixture of approaches. About half of the students took a minimalist approach, posting articles and other research items addressing the issue posed. The results from 36% of the participants achieved assessment scores equivalent to meeting the required level of critical analysis and reflection. These students clearly demonstrated an engagement with the issue under consideration but also built on the dialogue of others adding critique of items posted. Of those students achieving high marks, 12% performed at distinction level, demonstrating a high level of learning and critical analysis of the problem.

The results of analysis of the discussion board content show that a many students did not achieve a level of deep learning from the exercise, or at least did not demonstrate that learning in their postings. What is evident, however, is that at least 36% of students engaged in the discussion demonstrated a deep understanding of the issue under discussion and were able to enter into critical argument with peers as to the value of any particular item posted. This level of engagement in deep learning demonstrates that asynchronous discussion forums can achieve sound learning outcomes for at least a third of students within the cohort and, as such, justifies the use of this technology as a supplementary tool in teaching real property courses. Further work is required however to refine the discussion tool to achieve even greater levels of learning.

4. Conclusions

The literature shows that the use of technology in teaching is growing almost daily and that there is an ever increasing array of tools available to support higher education. The literature also shows that very limited research has been undertaken to demonstrate the pedagogical rationale for utilising many of the available technological solutions. This research paper has attempted to link the literature on the benefits of reflective writing in engendering deep learning among students with the use of asynchronous online discussions.

The research has clearly shown that at both undergraduate and postgraduate levels there is a widespread acceptance of the learning content management software, in this case Blackboard. Students readily interact with the online system and welcome its use in teaching and as a primary means of communication. It also demonstrates that most students are active users of the systems and if not active participants they are certainly monitoring postings. The results in terms of the use of discussion forums for administrative uses is certainly positive, showing that the majority of students are prepared to use open, asynchronous communication to ask and receive feedback on course related queries. This finding has significant implications for academic staff leading larger courses as it provides a tool for reducing the level of one on one interaction via email and telephone. It also provides a forum in which students are able to assist peers and to work as a group in providing assistance and feedback. This ability to ask and have answered questions in an anonymous form is seen as a valuable attribute, that removes the possible embarrassment that may be otherwise felt in asking a simple or naive question. There is also a positive aspect of students responding to their peers in that they themselves need to be fully engaged with the content and procedures within the course in order to post a meaningful response. It of course remains essential that lecturers monitor and moderate the postings so that students are aware that any statement made by a peer in error is quickly addressed. The level at which this peer assistance occurs could be increased but at any level must be a positive over the non-involvement that occurs when communication with staff is constrained one on one.

The other and more pedagogically important aspect of the use of online discussion is in its use as a teaching tool that seeks to achieve an increase in students learning and understanding of the subject. There has been some debate in the literature as to the merits of assessing online discussions. The results of this project clearly show that postgraduate real estate students strongly favour the assessment of discussions. This is reinforced by the clear indication that if it were not assessable then discussions would not receive the same level of attention. Indeed experience from previous years and using the same discussion format support this finding. It is a fact of life that postgraduate students with their heavy work, study and home commitments are strategic in their approaches to education and will ‘cherry-pick’ those elements within a course that contribute directly to passing the subject. That said a proportion of students are driven to achieve high grades and have a passion for understanding the issues, and, as such, will seek within a discussion to go beyond the base requirement with more detailed and a greater number of postings. The evidence from this study shows that while an assessed discussion many will still seek to undertake the minimum requirement in terms of postings and do not engage in any deep reflection of fellow student’s points. A significant number of students do however use the discussion as intended, and research and critically assess postings of others. Analysis of contributions has also shown that these students are engaged in deep reflective learning of the course materials and, as such the use of asynchronous discussion forums in real property courses has proved a pedagogically sound approach to enhancing learning in real estate students.

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The use of an e-Support system to enhance student guidance in an Eco-House design project

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Abstract

This paper describes the development of a web-based support environment for students undertaking the first year Eco-House design project as part of the Environmental Building Degree Programme at the University of Plymouth in the UK. This e-Support environment provides students with a flexible and extendable search structure that allows them to obtain deeper information on specific systems they can apply in their designs, or on fundamental issues that the project raises. The resource links into websites of manufacturers and product data as well as giving access to serious academic papers. It will be developed further over future years to provide an expanding source of information and inspiration for subsequent generations of students. This paper describes how the e-Support environment was developed using an action research cycle, which included using critical reflection and feedback from different stakeholders. It presents the current form of the environment, an estimate of the impact on the Eco-House design projects, and areas identified for further development and improvements.

Keywords: web-based resources, studio teaching, support, Eco-House

1. Introduction

The Eco-House project is the main element of coursework on the Domestic Construction Technology module ENBS 111, taught to first-year students working towards accredited degrees in Building Surveying, Environmental Construction and Construction Management at the University of Plymouth, England. The project is embedded in the Environmental Building Programme which aims to support students through a variety of mechanisms, which include formal lecturing, close tutorship relations, and self-learning, see for instance Murray *et al*. [1]. The Eco House project is carried out as group work in a studio teaching setting culminating in a range of outputs including drawings, models and product information (Figure 1). More general information on the Eco-House project is provided in de Wilde and Pilkington [2].

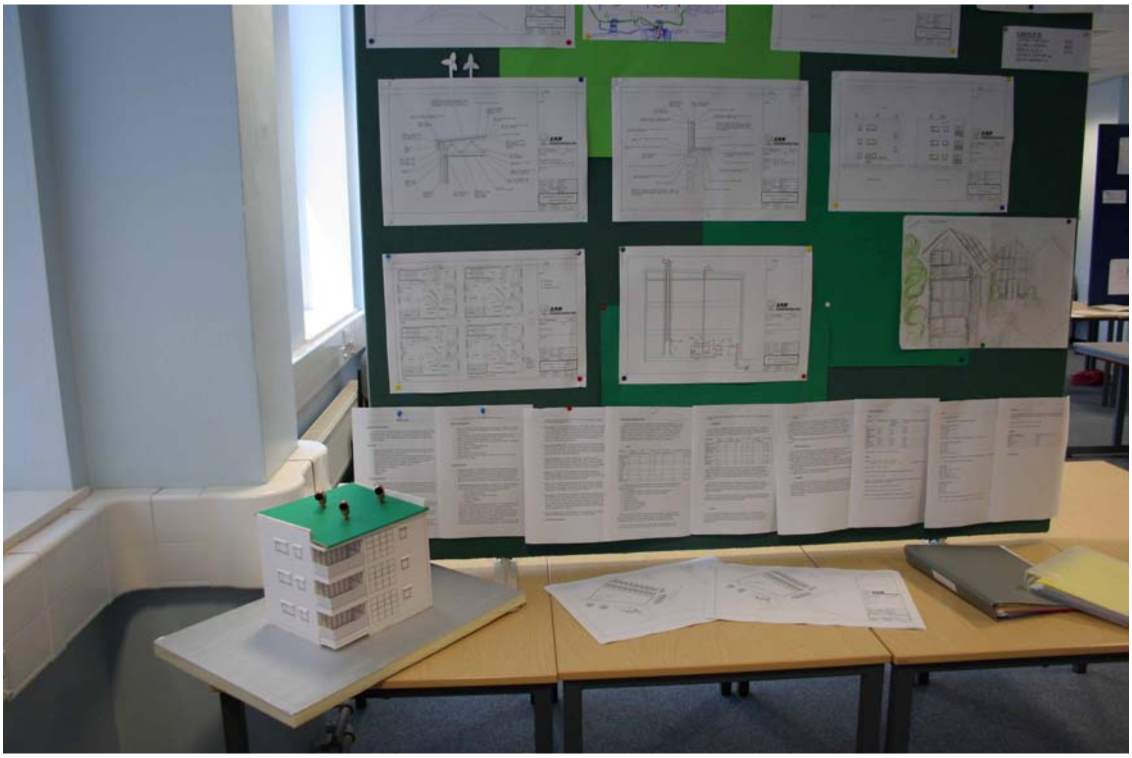

Figure 1: Eco-Project final results from the 2006-2007 academic year.

While the Eco-House project is viewed by students and staff as a valuable element of the course, previous experience indicates that there is insufficient time during design surgeries for the tutor to advise in depth on specific construction and services systems, materials and other issues that students may enquire about. This problem is inherent to the nature of studio design where students are asked to come up with different ideas and approaches, which cannot all be covered in contact time. The e-Support environment has been developed to address this issue by providing students with a search structure that allows them to obtain access to in-depth information on specific systems they may apply in their designs. To do this the e-Support environment links into websites of manufacturers, product data and serious academic papers and will be developed on an ongoing basis to provide an expanding source of information and inspiration for subsequent generations of students undertaking the Eco-House project.

2. Objective

The overarching aim of the e-Support environment is to provide flexible opportunities for students to deepen their knowledge of key aspects of domestic eco-construction. To achieve this aim a student portal or independent website has been developed to achieve the following objectives:

- Provide a (flexible and extendable) search structure that allows students to obtain deeper information on specific systems they apply in their designs, or on fundamental issues that get raised;

- Provide links to websites of manufacturers, product data as well as serious academic papers;

- To inspire the building designs of subsequent generations of students doing the Eco-House.

The main beneficaries/stakeholders for the development of an e-Support environment are the first year students that undertake the project. The environment allows students to work and learn flexibly (at their own pace, at the time of their choosing, and in the environment of their choice), by integrating the resource within the university's web-based intranet, which is available to all enrolled students. A second beneficary is the module leader because the support environment helps teach, guide, inform and support the students in their coursework in a way that would previously have had to be done on a one-to-one tutoring basis.

Other parties that might have some interest in the e-Support environment include:

- Students on other years / modules of the Environmental Building Programme, who might have an interest in some of the subjects covered or might be doing similar assignments.

- Other lecturers on the Programme, who might want to use it in their teaching.

- The ICT Support team of the University, including the library, who might want to ensure set-ups like these fit into the overall university-wide system, or might want to bolt-on to this structure.

3. Methodology

The underlying thrust of the work presented in this paper is the development of a a major learning resource through an incremental, informed, reflective and ongoing process. The overarching methodology used in projects that aim to improve (teaching) practices, and the environment in which this practice takes place, is known as action research. The main characteristics of action research have been defined by Martella *et al.*[3] as research: 1. where the researchers have a stake in the outcomes; 2. that addresses real-life situations; 3. where the ultimate goal is to make changes to some practice; 4. where the researchers participate in the process; and 5. that sees solutions disseminated in some manner.

The main aim of the action research presented in this paper is to improve the learners' experience. The research has the form of a cycle of diagnosis (identifying or diagnosing a problem), action planning (consideration of alternative courses of action for solving a problem), action taking (applying course of action), evaluating (studying the consequences of an action) and specifying learning (indentifying general findings), all of which revolve around developing a system/structure serving the main aim [4].

Within the cycle, one of the most important elements of data gathering is obtaining feedback on learners' experiences. Here, triangulation involving the use of different data sources in order to overcome the problems inherent in using a single one, [3] has been applied in gathering feedback. The following information gathering techniques have been used:

- Previous feedback on the 2005-2006 Eco-House project has been revisited in order to identify any trends or findings that might guide the provision of additional support for the future academic cohorts. This has been based on reviewing existing, collated data at the disposal of the lecturer.

- Informal, unstructured feedback from students who undertook the project in 2005-2006 has been solicited from the current 2nd years students by means of a brainstorm session at the end of a lecture, in order to solicit their views and experiences and to obtain an informed opinion on the proposal to produce this resource.

- First year students undertaking the Eco-House project were encouraged to explore and use a prototype e-Support environment as a pilot. They were asked for feedback both in a very informal way, inquiring about findings during design surgery sessions and formally by means of an anonymous, structured questionnaire upon completion of the project.

- Specific in-depth feedback was requested from colleagues on the Environmental Building Programme. This feedback was structured by asking colleagues for feedback along the same lines set out for the students, but with the request to view the whole effort from an educational view next to the practical 'face-value'. These colleagues are also all experts on the topic covered by the e-Support, and hence able to comment on contentual matters.

- Directed technological feedback has been obtained from the ICT support staff by means of directed email questions.

4. Background on Support Environments

In construction education, especially architectural, studio teaching has been a central concept to teaching design for most of the twentieth century [5]. This is because studio teaching sees students involves students in learning by doing, experiencing the design process in an active, hands-on manner, and integrating the different disciplines needed in design. Design projects and studio teaching are also successfully being used in other fields of engineering [6].

The e-Support environment, as envisioned for the Eco-House project, makes use of advanced ICT facilities that are seeing an ever-increasing uptake in academic programmes. A good overview on the role of such systems in teaching construction technology to undergraduate students in provided by Chung *et al.* [7]. As stated by Race [8], the use of internet as a tool in teaching has some risks, like getting side-tracked by fascinating things that are unrelated to the actual task. One solution is development of a set of interactive pages by the lecturer, which might help in directing the students to appropriate sources of information, rather than having the students search for themselves [9]. When using the internet in this manner within a course, the teacher/lecturer can be considered to be a 'coordinator of learning experiences' [10]. A more detailed breakdown is provided by Garrison and Anderson [11] who discern three main teaching roles within the area of e-learning:

- design and organisation;
- facilitating discourse;
- and direct instruction.

To guarantee the integrity of a website, one needs a team to maintain the site and a regime for updating and vetting the information it provides. In creating an interactive support instrument like a website, lecturers developing such resources need to be aware of five main issues [10]:

- the *time* needed to develop and maintain the material;
- the *role of technology*, which might both help or hinder the lecturer and students;
- changing *barriers arounds topics/issues* in the context of the web;
- the need for *training* of the learners in using the instruments available;

- and *infrastructure* requirements.

For the development of the e-Support environment, the context has been the status of the ICT-infrastructure at the University of Plymouth in the year 2006-2007. Basically this consists of a 'Student Portal' facility, which is a web-accessible folder structured within the constraints of Microsoft Outlook on the intranet of the university [12]. Whilst undertaking the development of the resource it has become clear that the ICT-infrastructure within the University of Plymouth would be significantly upgraded in the new year [13], which had to be taken into account when planning for the future use and enhancement of the resource .

5. E-Support for the Eco-House Project

5.1 Development Process

The development activities have been undertaken through the following cycles within the overall framework of action research:

1. Diagnosis – identification of guidance information and subsequently aims and objectives for the project.

2. Action planning – development of a plan of action for the creation of an e-Support prototype

3. Action taking – actual creation of the e-Support prototype (version 1).

4. Evaluation – analysis of preliminary learners' experiences with the initial prototype (mostly technical glitches)

5. Diagnosis – identification of technical problems with the prototype

6. Action planning – involvement of ICT Support to solve technical issues

7. Action taking – technical solutions by ICT Support implemented, resulting in migration to e-Support prototype (version 2).

8. Evaluation – gathering of data on learners experience with e-Support prototype (version 2).

9. Diagnosis – analysis of contentual feedback, problem areas as identified

10. Action planning – development of ideas for migrating the e-Support prototype version 2 to the new ICT infrastructure, and making it a core element of the upcoming Eco-House project (2007-2008).

The above activities are graphically represented in figure 2.

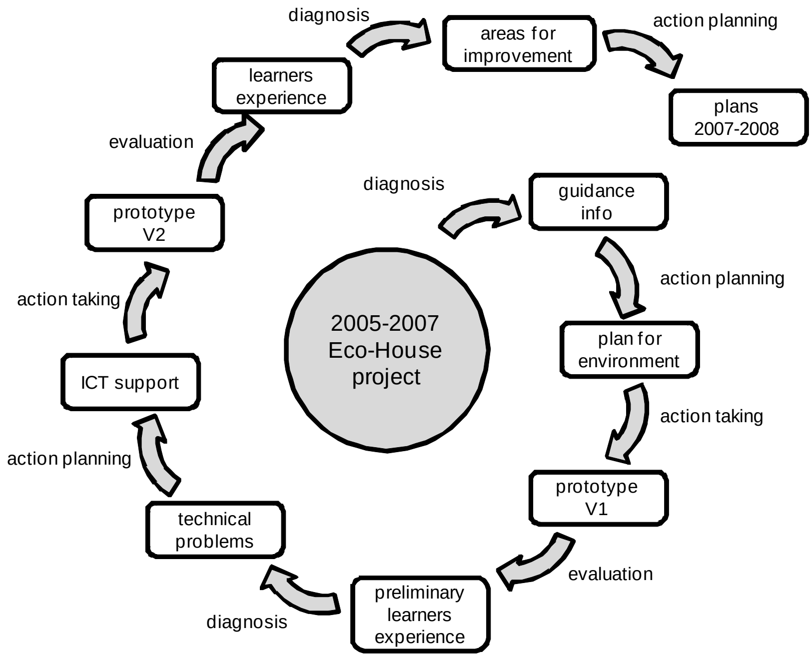

Figure 2: Activities and processes undertaken in the development project of the e-Support

5.2 E-Support Prototypes

Feedback collected over last year's (2005-2006) Eco-House project has been reviewed, in order to inform the development of an instrument to support the 2006-2007 cohort. While the feedback collected was general in nature and for instance included remarks over the split-up in teams, timing of end presentations in relation to the exams, it also suggested that the Eco-House project 'should provide learners with opportunities to do some of their own research', and that one way of improving the project would be to 'put more emphasis on background reading'. At the same time a recommendation was to 'make the project less formal', seeming to indicate that students like some amount of freedom in how they go about this particular piece of coursework.

A small group of four students from the same group from which the above data was collected (2005-2006) was informally asked about the idea of developing an e-Support environment before embarking on the project. It must be noted that these were mostly the high-performing students who enjoyed the project, and had a good working relationship with the lecturer. Overall these students supported the idea of developing a 'support website'. They suggested that the resource should include a number of local Eco-Houses in England, preferably even South-West England where the eco house project site is located (the examples provided in the course notes [14] are mostly international). Furthermore, they suggested that links could be provided to the local authoraties relevant to the project, and requested inspirational material for the selection of house building systems.

The initial development of the e-Support environment has been based on the notion that it is generally recognized that one of the prime ways of promoting access to the internet is to develop a clear and organized page (“hub”), with a clear and simple style [15]. It was decided to keep to this hub theory without adding additional features. One could easily make a more complex e-Support system that includes for instance technologies like a blackboard messaging system, virtual meeting facilities, project data repositories and RSS feeds; however, such aspects might distract from the basic information gateway that was envisioned. Furthermore, including these in the Student Portal facility might result in practical difficulties that are beyond the scope of the one term effort allowed for in the project.

The basic layout of the hub has been designed based on access from a starting page on the portal. This starting page has been used to set the context for a prototype support system, and to carry basic instruction for users. From the start page, a link is provided to the actual hub. This allows a quick overview and access to the main categories of information included in the prototype version. Categories of information provided are based on the suggestion of last years students to include links to UK-based case studies, and categories defined by the lecturer: case studies, design principles, design tools, planning & regulations, energy systems, water systems, and construction materials.

Each category has its own separate page, where a collection of links is provided, together with a short description of what information is accessed by following the link. This additional information is useful as it allows the lecturer to make students aware of commercial context, slightly opiniated subpages, etcetera. The content of the webpages has been based on an organically grown collection of weblinks collected on the topic of Eco-Houses by the lecturer over the 1996-2007 period, completed with an intensive websearch tool to add links where specific topics were felt to be missing. While the original idea was to have students undertaking the design project to find and suggest links, it was deemed better to set standards by grounding the e-Support system in academic experience.

The e-Support system has been created using Microsoft Frontpage 2000. Resulting HTML-files have been uploaded on the portal, and tested for accessibility through the student portal from the lecturers office computer. A typical screendump from one of the e-Support pages is shown in figure 3.

6. Evaluation

The key deliverables of the project were identified as:

1. To provide a flexible and extendable search structure to find information that can be used in the design project

2. To provide links to external websites of manufacturers, products, academic information

3. To inspire the actual design work of students undertaking the Eco-House project.

A prototype e-Support has been developed and improved, with the process described in the previous sections, delivering key outcomes one and two. Key outcome three, inspiration of student's design work, is hard to measure by its very nature. However, feedback obtained from students leads the author to believe that some success has been obtained in this area.

Going beyond the strict deliverables, the underlying critical factor for the e-Support system has been to develop an environment that serves the students undertaking the Eco-House project, enhancing the learning experience.

Evaluation of the learner experience has been taken to be a continuous process. Data collection for student feedback, supporting evaluation of this learners experience, has been ranging from very informal (literally a discussion with students while undertaking design surgeries) through to formal feedback questionnaires. Furthermore, academic colleagues have been asked to comment on the prototype system with the learning experience in mind.

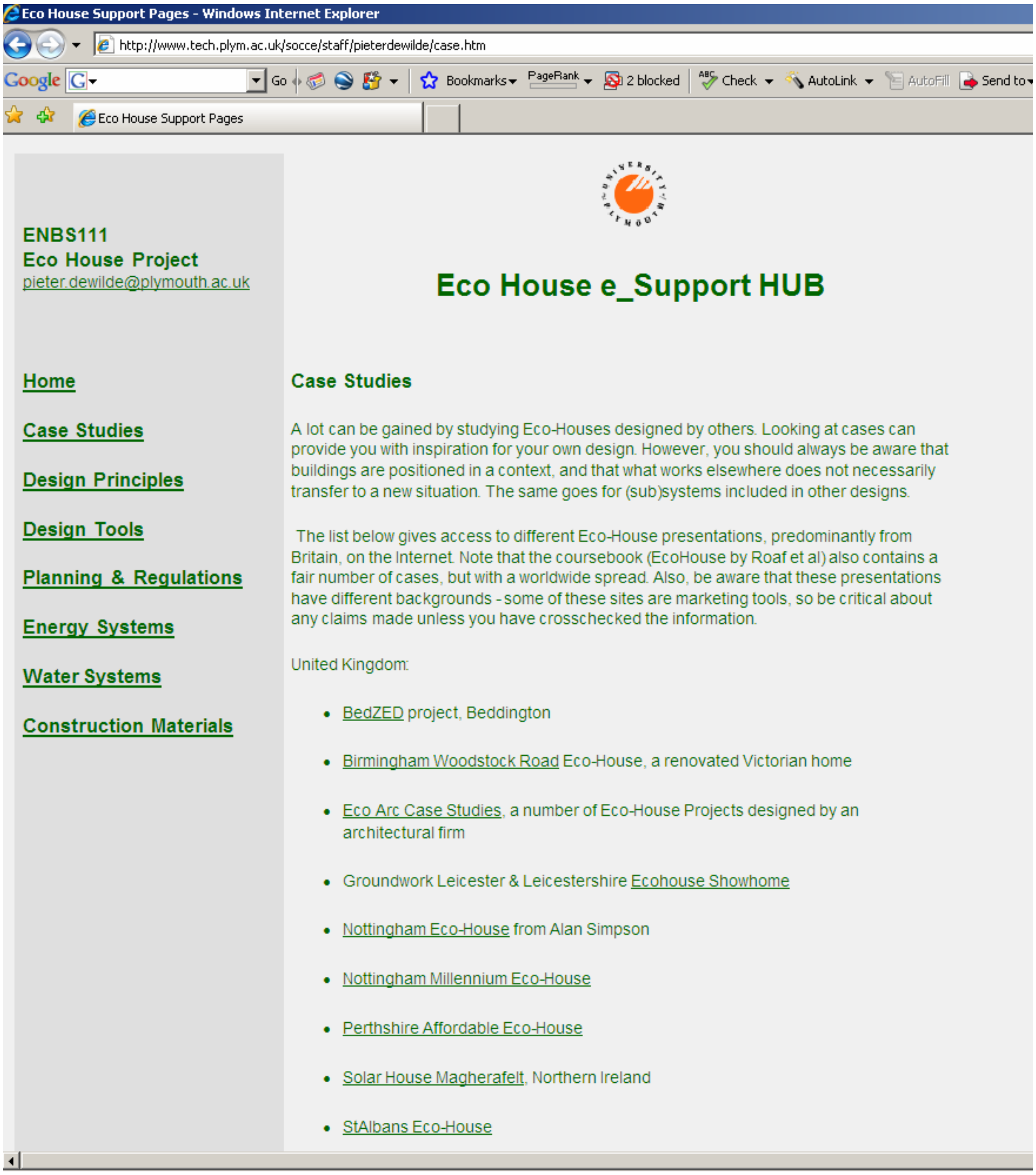

Figure 3: screendump from one of the e-Support pages

The scope of student feedback received to evaluate the e-Support is limited. Many of the informal discussions revolved about technical access to the system, which was mainly related to the University of Plymouth Student Portal currently in use, (due to be replaced in the next academic year). In general, the tutor's experience was that getting students to access and use the system proved hard. For instance, an end-of-project feedback questionnaire showed that out of 21 responses; 9 students said to have used the e-Support system (43%), while 12 did not (57%). The actual percentage of non-users is probably higher; as this might be amplified by non-respondents to any queries or email (overall response rate was 21 out of 47, i.e. 45%). This might be due to the fact that a cautious approach was taken, including the use of a full ethics protocol, which might have been taken by some students as 'voluntary material only, no need to bother'. In future, further monitoring of student's use of resources provided and reasons for not using material available will be a priority. Interestingly, this finding was mirrored by the feedback received from colleagues. One of these pointed out an observed parallel with a module where students were supplied with module books as a baseline reading resource, but failed to use this. From here it can be said that students should be actively encouraged to make use of such resources, for instance by requiring the underpinning of their designs by referencing to such information as provided in the e-Support system. This suggests the development of an active link between the project assignment and resources provided (text books and e-Support) for the next academic year.

Overall however, the general feedback on the structure of the e-Support was positive. There does not seem to be any need to change the basics, only further development with more links, and perhaps a few more commenting words on selected topics. The information linked to by the e-Support has been deemed very useful and interesting, and might be of use outside the scope of the ENBS 111 module. For instance, it has been suggested that the resource might be made available to students on a related Master Programme.

A minor aspect brought to the attention by deep feedback from colleagues is the need for a constant monitoring of whether links work, due to constant changes on the websites to which an e-Support systems links. In the current year this was all checked when the prototypes went online; even then a short time later already shows some links becoming erroneous. This seems another area where learners might take control of their own resource/support, and might be asked to feedback any problems encountered.

7. Conclusions and Discussion

In general, the reactions by those who used the e-Support offered were encouraging – students for instance found the system '*very good and easy to use. Really in depth and the stuff you need.*' and commented on it as having a '*good, nice and simple structure. Good information. Not any suggestion to improve right now.*' It seems therefore that the lay-out and content of the e-Support system is working well in supporting students, and can be kept as-is for future years.

The author of the system feels less successful in getting the students to engage with the support provided. The e-Support environment was intended to be offered as additional help, and therefore a lot of effort was put into making the system easily accessible. However, this was not sufficient to get all students to access or make good use of the resource. This finding reflects a general trend noticed in the cohort, where students seem to be making little use of the textbooks suggested, and seem overly reliant on lecture presentations and hand-outs in preparing for the exams. The suggestion to tie the e-Support into the assignment and require students to make use of it will be taken forward, as this can only help the students in becoming aware of the availability of the resource and encourage wider use and search later. Another option might be to work on making the environment more attractive and interactive, while maintaining the present focus on good contents.

In terms of providing support for the design project, it is believed that the e-Support has benefited students in carrying out their project, but linking the use of the system to specific characteristics of the final projects has been evasive. A more direct link between parts of the assignment and information contained in the e-Support system might benefit this link as well.

On the short term horizon, the e-Support environment will migrate to the new Student Intranet Module Website in September 2007. The basic structure will be kept in place, with links updated and expanded. The coming year will also see the modification of the Project Assignment, to encourage students to engage with the resource by means of specific tasks, making some basic use compulsory. Further options will also be investigated. Topics to be investigated include positioning the e-Support environment in such a way as to support continuing professional development (CPD), as suggested by for instance Wall *et al.* [16], including a part of the website to support online collaboration and lecturer input as described in Zimrig *et al.* [17]. Providing web-based project presentations and assessments will also be explored in the long run.

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SECTION XVIII

SKILL DEVELOPMENT

Women's career advancement and training & development in the construction industry: The research strategy

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Abstract

The UK construction industry has a particularly low participation rate of women, both for those employed in the industry and for those engaged in training. The statistical analyses reveal that women are earning a greater number of professional degrees and entering the labour force; however, these women are not reaching the top corporate management tiers. It has been identified that lack of training has helped to prevent entry of women into the management ranks in many organisations and keeps women at lower levels within management. In this context, it is vital to consider the impact of proper training and development (T&D) towards the women's career advancement in the construction industry. Accordingly, this paper highlights those aspects which will be addressed when designing a feasible research methodology for the study under consideration. The paper illustrates how the philosophical issues directed the use of case studies as the suitable research strategy and selection of Individual as a case in this particular research. The paper will be concluded with a discussion on the importance of case study design in gaining the maximum outcome from the research.

Keywords: Case Study, Research Philosophy, Research Strategy, Training and Development, Women's Career

1. Background

The UK construction industry accounts for 10% of GDP and employs 2 million people [1], of which under 11% are women [2]. This makes the construction industry one of the most male dominated industries, which thus presents challenges relating to equal opportunities [3]. However, there is now a noticeable widening of the debate around the business benefit of diversity [4]. Recent research has highlighted one of the objectives in the diversity movement in construction is to increase numbers of women in the industry [4]. It is assumed that a greater number of women will be a clear sign of increased equal opportunities policies working, and reduce the skills gap and labour shortage in industry [4]. Thus, a logical solution to increase the number of women in the industrial professions is attracting more women to the industry initially and then subsequently increasing the retention of them [5]. Hence, both recruitment and retention is equally precious to raise the number of women. Numerous research studies have been conducted into how to attract women into construction [6] [7] [4]. However, the desired effect hasn't as yet been seen in the construction industry. The problem at the moment appears to be that women are leaving the industry before they have reached higher management positions, or that they are remaining in junior positions longer than their male peers. Several barriers have been identified which prevent them progressing within the industry. Furthermore, structural barriers exist to exclude women from the sector, such as facilities, training, career progression, education, lack of promotion prospects, industry culture, and flexible working hours [8] [9] [10] [11] [12] [7]. Additionally, [6] identified that lack of training has helped to prevent the entry of women into management ranks in many organisations and kept women at lower levels within the management hierarchy. The [13] study highlighted a lack of T&D as a particular barrier to the career progression of women in any sector. Through the literature, it was identified that the concept of women's career advancement and construction T&D is not adequately exploited. Therefore, this study intends to address the gap in construction T&D and women's career advancement in the construction industry. Accordingly, the aim of the study is to explore the impact of T&D towards women's career advancement in the construction industry. Accordingly the following research questions were formulated in order to fulfil the research aims;

1. Why is women's careers advancement important to the construction industry?
2. Why is T&D important to women's career advancement?
3. What is the current status of T&D, on women's careers advancement?
4. What are the barriers faced by women, receiving T&D in the construction industry?
5. How can T&D address the issue of women's careers advancement in the construction industry?

This paper discusses the research methodology adopted for this study with particular reference to the use of Individual as a case in the research strategy selection. The philosophical undertaking of the research pertaining to the study is presented firstly followed by a discussion on the selection of research approach and research strategies. The case study design is presented in the next section, highlighting the rationale behind the use of Individual as a case in the case study design. Next, the paper examines the research techniques, data analysis are used in the study and finally the conclusion.

2. Designing a research methodology

Research methodology refers to the overall approach of the design process from the theoretical underpinnings to the collection and analysis of the data [14]. There are many factors to be considered when choosing an appropriate research methodology; the topic to be researched and the specific research question are the primary drivers in the choice of methodology [15]. The study is focused on women, who are working within the professional capacity in UK construction organisations. The boundary of this study is considered as an environment, where women's career advancement is carried out. The conceptual model given in the below illustrates the concept of this research derived from the literature review. It shows how the research problem is embedded within the scope of this research. The core of the model represents the unit of analysis of the study; women's careers which are embedded in construction organisations within the construction industry. It indicates different career phases and the need of different T&D in each career phase in the organisations. Accordingly, investigation of different T&D requirements in different career phases such as; Idealism, Endurance and Reinvention phases will be the scope of the research. Further, it shows the need for identification of different T&D in the different career phases may help to advace women's careers in the construction industry. Therefore conceptual model (Figure 1) maintains the direction and cohesion of elements by representing a holistic research methodology.

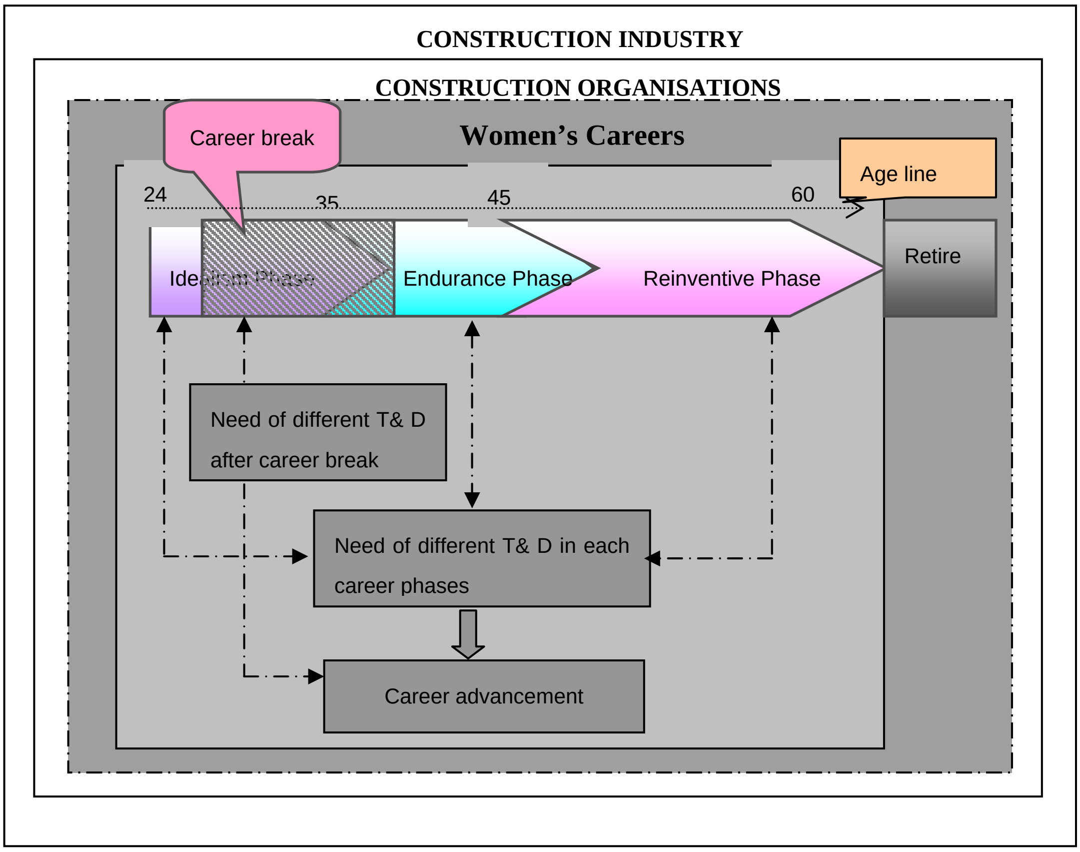

Figure 1: Research conceptual framework

For this purpose, the hierarchical model of research methodology by [16] is used. Within this research "onion" as shown in Figure 2, the research philosophy found at the outer ring, "guides and energises the inner research approaches and research strategies. Further, choices, time horizons and data collection and data analysis are constituted" [16] .The following sections further describe the research philosophy, research approaches, research strategies, techniques and procedures.

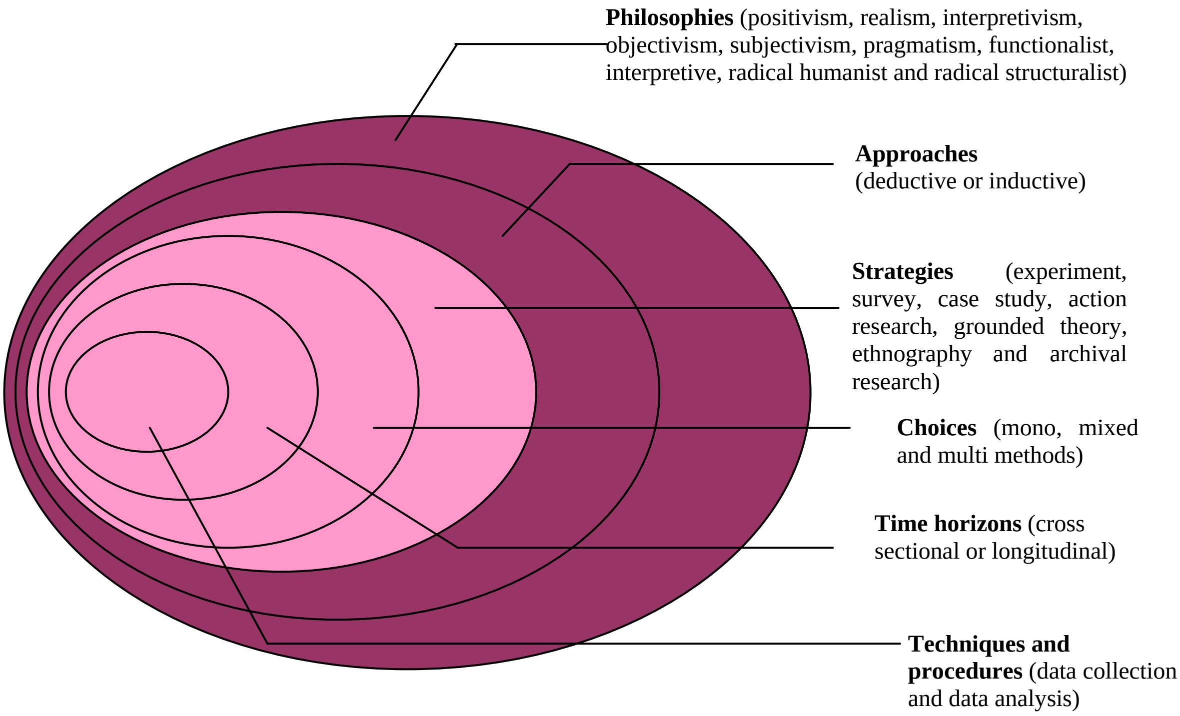

Figure 2: The research "onion" [16]

2.1 Research philosophy

The research philosophy contains important assumptions about the way in which we view the world [16]. In part, the philosophy the researcher adopts will be influenced by practical considerations. However, the main influence is likely to be the researcher's particular view of the relationship between knowledge and the process by which it is developed [16]. In this discussion, three major ways of thinking about research philosophy are identified: epistemology, ontology, and axiology [16]. Epistemology concerns what constitutes acceptable knowledge in the field of study [16]. [16] identifies three traditions of philosophies: "Positivism," "Realism" and "Interpretivism". Positivism argues that "working with an observable social reality and that the end product of such research can be law-like generalisations similar to those produced by the physical and natural scientists"[15]. Realism is another epistemological position that relates to scientific enquiry. The essence of realism is that what the senses shows us as reality is the truth: that objects have an existence independent of the human mind [16]. Interpretivism emphasises the different between conducting research among people rather than objects [16], where the social scientist should welcome and appreciate the different views and meanings that people place upon their experiences [17]. Ontological assumptions or the assumptions that are made about the reality of the nature is other important aspect within the research philosophy [16]. Moreover, this raises questions about the assumptions that researchers have about the way the world operates and the commitment held to particular views. Within the research philosophy, Axiology involves the values, ethics, and belief systems of a philosophy. It is a brand of philosophy that studies judgments about value [16]. Axiology concerns assumptions about the value the researcher attaches to the knowledge. Interpretivism (social constructionism) suggests that the research is value-laden [18] whereas positivism suggests the researcher should retain a value free view.

This discussion provides a basis to judge the philosophical base of the study in question. As set out by the aims and objectives, this research involves the study of complex interactions between people in real-life settings. Furthermore, this study requires the researcher to be a part of the environment and interaction is needed within the environment to identify the different views of people and to interpret them. For instance, the views about the importance of women’s role in the construction industry, factors which are needed for the successful attainment or enhancement of women’s career in construction, suitable T&D models and methods for their career enhancement. It requires appropriate understanding of the context and the process of women’s careers, and acquire knowledge by the use of reasoning, intuition, or perception. Accordingly, it can be argued that Interpretivism is preferred over positivism and Realism stance of epistemological undertaking for this research. This research involves women in different construction organisations, in different career phases. So, individual woman will perceive different explanations on the impact of T&D towards women’s careers in construction industry from their own experience in the industry. Further, the research environment is not expected to control and simplify with assumptions as in deductive research methodologies and the free flow of ideas, perceptions will be encouraged and studied. Hence, it can be seen that this research favours a subjectivism rather than an objectivism stance in the ontological assumptions. The research requires respondents to come up with their own views on T&D and women’s career enhancement issues in the industry. Whilst interviewees engage in different career phases of women in different organisation and will have different experiences, finally different answers may appear. Therefore, it may be difficult to arrive at sensible answers. Hence, research may add her own value to those answers since, the researcher is quite familiar with this area of research due to personal experience of the career enhancement process and T&D programme. In this sense, this research is based in the value laden position in axiological purposes. Subsequently, the selection of suitable research approach is discussed in the next section.

2.2 Research approach

The research will involve the use of theory which, may or may not be made explicit in the design of the research, although it will usually be made explicit in the presentation of the findings and conclusions [16]. This is dependent on whether the researcher should use the deductive approach and design the strategy to test the hypothesis, or the inductive approach, in which the researcher would collect data and develop a theory as a result of his/her data analysis [16]. By considering the above facts and aim & research questions of the research, the researcher will be able to interview women working in the industry to share their experiences on career enhancement and identify the impact of T&D has towards their career enhancement, and the barriers they faced during their career. The result of the analysis would be the formulation of the theory. Thus, this particular research adopts the inductive approach. By considering the research approaches, it leads towards the selection of suitable strategy for the data collection. Thus, the following section outlines the discussed research strategy.

2.3 Research strategy

Each research strategy can be used for exploratory, explanatory and descriptive research [19]. Some of these belong to the deductive approach; others to inductive approach [16]. They are guided by philosophical underpinning and focuses the appropriate methods of research strategy. There are a number of different research strategies ones research can be based upon [19] [10]. Figure 3 illustrates how the research strategies can be positioned within the epistemological and ontological continuums. It can be seen that experiments and surveys are governed by positivist and objectivism stances whereas case studies, action research and ethnographic approaches are towards interpretivism and subjectivism stances.

[19] identifies three conditions which have to be considered when selecting the appropriate research strategies;

- the type of research question posed
- the extent of control an investigator has over the actual behavioural events
- the degree of focus on contemporary events

According to Figure 3, experiments and surveys take the positivism and objectivism positions in terms of the epistemological and ontological undertakings respectively. Since this research takes the interpretivism and subjectivism with regard to the philosophical stances, use of experiments and surveys are unjustifiable. Experiments and surveys are conducted under controlled environments wherein the former situation the phenomenon and the context is separated and in the latter situation investigating the context is difficult due to the limited number of variables set out [19].

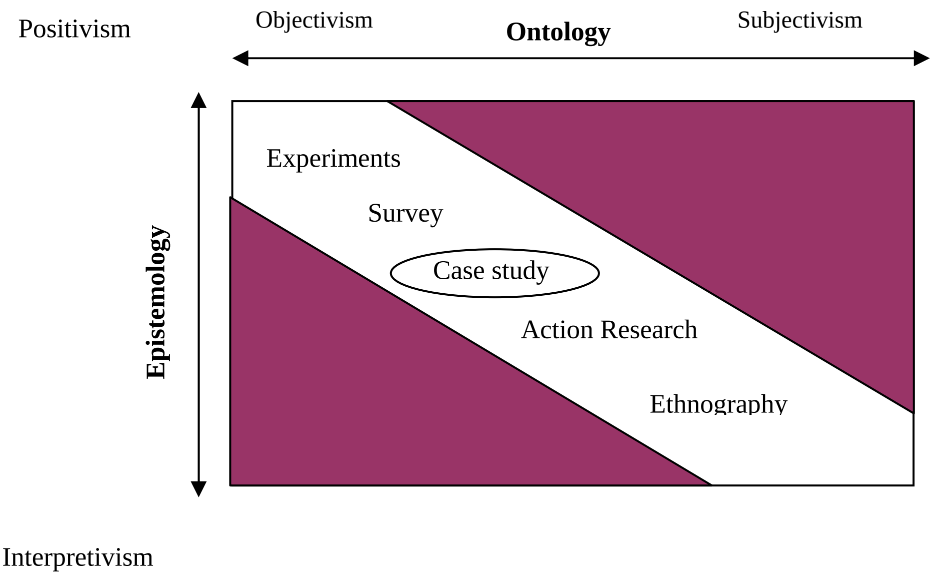

Figure 3: Research strategy (Adopted [29])

Since this research falls under the interpretivism and subjectivism stances, the researcher has to make a choice between ethnography, action research, or case studies. According to [20], the Ethnography approach provides the researchers insights into the beliefs and values of human, social, and organisational aspects of socio-cultural phenomenon. Further, Ethnography research takes a considerable time period [21]. In action research, the researcher will be a part of the environment under study, tries to solve practical problems [22], and attemptss to influence and change the attitudes and behaviours of the participants [22].

[23] defines case study as “a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence”. Moreover [19] highlighted the importance of contexts, adding that, within a case study, the boundaries between the phenomenon being studied and the context within which it is being studied are not clearly evident. Case studies are carried out in a way that incorporates the views of the “actors” in the case under observation [24]. Due to the open ended inquiry used in case studies, it is suitable to build theory and generate hypotheses [25]. Further, case studies provide the opportunity of dealing with a full variety of evidence such as documents, interviews, and observations [19].

Research under consideration does not intend to influence or change the attitudes or procedures of the participants or the environment. Nor does it intend to study behavioural patterns or physiology of the participants as in the case of ethnographical studies. Hence, the use of case studies is preferred over action research and ethnography. Case study approach is therefore, suitable for this research to explore the women’s career within the context of construction industry and T&D aspects within the case study organisations. The case study approach too provides the opportunity of carrying out an in- depth study about the links between women’s career advancement and construction T&D. Additionally, this research has the characteristics of exploratory and explanatory case studies. According to [19], the nature of the research questions posed has an effect on the research approach. [19] argues that “how” “why” questions favour th*e use of case studies and the use of "what" question is suitable for the exploratory type of researches. Research under consideration has a combination of "how" "why" questions coupled with "what" questions. The following reasons could be listed as the key points for the selection of case study methodology for this research;*

1. Does not intend to control/ manipulate the environment under examination
2. Does not intend to interfere with the attitudes, perceptions or the procedures of the environment (as in the case of action research)
3. Analyse contemporary events
4. Requires an in-depth study on the selected environment. Thus, it will be advantageous to rely on multiple sources of evidence and the selection of a small sample to allow an in- depth study
5. Requires exploring and analysing the "real life" context of women's careers in construction industry and T&D.

Above section describes the selection of the most appropriate research strategy for this particular study. Case studies were identified as the suitable research strategy. The following section therefore describes the design of the case study.

2.4 Case study design

A research design has been identified as the "logic that links the data to be collected (and the conclusions to be drawn) to the initial questions of study" [19]. [26] argues that the research design guides the researcher to collect, analyse and interpret the observations made. Four major types of case study designs exist according to the 2 x 2 metrics suggested by [19]. They are single holistic, multiple holistic, single embedded and multiple embedded. In order to select choices between the holistic or embedded case study, the unit of analysis is a vital fact to be considered in the research. According to [27], they have identified the unit of analysis is a "phenomenon of some sort of occurring in a bounded context". According to [14] it is the focal point where the variables, phenomena and the research problem refer to and about which the data is collected and analysed. Therefore, the unit of analysis of the research under consideration is women's careers as highlighted in the section 2. Further, the research is consistant with a single unit of analysis, thus research is towards the holistic case study. The use of single case studies is preferred when the study represents a critical case, extreme or a unique case, representative or typical case, revelatory case or a longitudinal case [19]. The research in question does not fall under these categories, thus multiple case studies are preferred over a single case study. [28] argues that the evidence gathered form multiple cases studies is often considered as more compelling which resulted in a healthier and a stronger study. Sampling logic will not be used to select the case studies i.e. to select a sample from the pool of respondents/whole population (such as with surveys). Thus, analytical generalisation is preferred over the statistical generalisation where the findings will not reflect the whole population. However, it is intended to claim literal replication by comparing the findings from the multiple case studies. The research under consideration is more towards the multiple holistic case studies. Women's careers will be the focal point of the research. Therefore, Individual woman is a case when considering the unit of analysis in the research. Consequently, collection of data from more than one woman will be the multiple case studies in this research and replication logic is used in order to justify the reliability of the collected data. The approach to case studies in this research involves theory building and verification. That is to build up research questions via the literature review and verification of them through multiple data collection methods, analysing the data within and across case studies and finally reaching the conclusions.

The section above discussed how the case studies will be designed to facilitate the theory verification process. The following section discusses the research technique, which will be used in the data collection and analysis stages of the research.

2.5 Research techniques

As discussed in section 2.1 this research takes the interpretivism, subjectivism and value laden stances in terms of research philosophy. Having identified the research philosophy and research approach, the next step is to determine the appropriate research techniques for the study. Accordingly, the section below will look into research techniques which are suitable for the research.

Intended data collection techniques describe the ways and means to fulfil the "aims and objectives" of this study by carefully addressing the research questions. In this research, semi-structured interviews will be conducted among the top female mangers and middle level mangers in the organisations, to understand the context of women's careers in the construction industry and the applicability of T&D towards their career enhancement. When the same results are obtained through different mechanisms, the confidence of the results is high, as the weaknesses of one method will be compensated by the strengths of another. Thus, results obtained from this research will be more convincing and accurate, increasing the "construct validity" of the research.

In addition to the use of multiple sources, a case study data base will be created which consists of case study notes (resulting from the interviews), tabular material obtained from the case study or created from the researcher, narratives produced by the researcher. The database will be used to store and retrieve the sources of evidence in a presentable manner. During the data collection stage, it is also expected to use case study protocol which consists of interview procedures, general rules that will be followed during the case studies. In addition, consistent interview guidelines are expected to be used. The use of a case study database, case study protocol and consistent interview guidelines will increase the "reliability" of the research. Having discussed the data collection methods, the following section now describes the data analysis methods of this research.

2.6 Data analysis

Data analysis consists of examining, categorising, tabulating, testing or otherwise recombining both quantitative and qualitative evidence to address the initial propositions of a study [19]. It is important to have a data analysis strategy as it will guide the researcher to select the appropriate data analysis tools, to make sure that the evidence is treated well, and to generate sound and convincing analytical conclusions while discarding alternative interpretations [19]. This research will match the data gathered from semi-structured interviews through top managers and middle level managers. Content analysis will be used to code the textual data gathered from the semi-structured interviews.

Before starting the data analysis, all the interviews were converted into text. Thus, the transcripts of the interviews will be made ready for analysis. The data reduction is done by reading through the transcripts and extracting the most relevant data for all of the questions listed in the interview guidelines plus any additional questions that were raised during the interview. To display and identify the relationships of concepts derived from the interviews and observations, cognitive mapping techniques will be used. In order to facilitate the data analysis process, computer software packages are expected to be used namely NVivo and Decision Explorer, for content analysis and cognitive mapping respectively.

Arriving at conclusions for the study involves interpretation and drawing meanings from the displayed data [27]. The data from this research will be summarised and conclusions will be drawn.

3. Conclusions

This paper identified the need of developing a research methodology in fulfilling the aims and objectives of a study and thereby addressing the research problem. The investigation of women's career advancement in the construction industry concept within T&D process demanded the interpretivism, subjectivism and value laden stances in terms of the research philosophy. The aforementioned philosophical understandings and need for carrying out an in-depth analysis without interfering in the research environment led the way to selecting case study as the most appropriate research strategy and individual as a case in this research. Selection of individual as a case in this study is more suitable than the stakeholders in the case study. Selection of individual women in different career phases is more appropriate since the unit of analysis is women's careers. It can also be concluded that the proper understanding of the philosophical issues followed by a clear definition and design of research strategy are essential elements in developing successful research. The philosophical understanding of the research ensures the compatibility and consistency between research philosophy, approach and techniques while the clear definition and design of research strategy would generate unbiased and more convincing research outcomes.

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Role of women leaders in the UK construction industry and their career barriers

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Abstract

The issue regarding lack of women leaders in construction has been a prominent concern for many years because women in mainstream management reduces potential managerial skills shortage in the industry and increases women's interest for construction related occupations. This paper is based on a study, which was designed to identify the role of women in leadership positions in the UK construction industry and the barriers confronting their careers. A literature review has been carried out followed by four case studies that were developed around four female leaders in the industry in order to identify the role and the barriers confronting them. Results of this study revealed that role of women leaders in construction is yet to be improved both in terms of number of leaders and the significance of their role. However, the findings of the case studies show that the majority of women leaders do not find problems in their leadership ability and the recognition which is received, however working in a site environment brings additional inconveniences to women in performing their role as leaders. Further the study revealed that women leaders in construction face career barriers which prevent them from advancing towards leadership positions. The results from the case studies indicate that the task of balancing family and work commitments, childcare problems and old boys networks are the most common barriers encountered by women in leadership positions in construction.

Keywords: Barriers, Construction industry, Leadership, Women

1. Introduction

This paper is based on a study, which aimed to identify the role of women leaders in the UK construction industry and the barriers confronting their careers. In identifying the role of women leaders, the study attempted to examine the duties and the job satisfaction of female leaders, their leadership styles, characteristics and abilities and the significance of their leadership in terms of number of women leaders in the industry, the extent of contribution and their positions in the organisations. The study also explored the experiences of female leaders in order to identify the barriers confronting their career in leadership positions. Since the examination of barriers is an important step for developing women leaders in this industry the research study was structured to identify the areas of obstacles from organisational and personal dimensions by considering the perspectives from women leaders and their co-workers.

Accordingly, the following section of this paper provides a background to the study addressing the role of women leaders in the UK construction industry, their leadership styles, the determinents of leadership styles in construction and barriers confronted through a literature review. The subsequent section describes the methodology adopted to collect and analyse empirical data of this study followed by the findings and the discussion. Conclusions are given in the final section of the paper.

2. Background

2.1 Women leaders and the construction industry

According to Vinnicombe and Singh [1] senior women are rare in many male dominated companies, so that many women managers have few role models. According to Kanter and Burke and McKeen, more feminine ways of managing may be included in the acceptable behaviours for future senior roles by female role models in the organisations [1]. A survey carried out in the UK construction industry shows that the ratio between male and female management staff is 6%:94% [2]. In the "managerial and administrative category", in the construction industry, women are concentrated in specialist positions (including personnel and public relations) rather than mainstream management [3]. When women in managerial positions are dis-proportionate in organisations, they become more vulnerable as well being in a minority [4]. Increased access of minorities has been identified as an effective way of changing the existing culture of the industry, in order to overcome its various problems including lack of women, as acknowledged by many construction professionals [2]. Improving women's participation in leadership roles will enhance the rights, freedom and opportunities of women [5] in the industry.

Helgesin [6] argues that women's central involvement in managing households, raising children and juggling careers gives them a capacity for prioritisation in a leadership role that men typically do not possess. Women generally, possess feminine characteristics like emotional, sensitive, expressive, co-operative, intuitive warm and tactful nature while masculine characteristics such as being aggressive, independent, objective, logical, rational, analytical and decisive are commonly associated with men [7]. Although feminine characteristics are the most commonly associated qualities with women, Korabik [1] found that women in leadership positions were higher in masculinity than the general population. Grant [8] suggests that as women move up the corporate ladder, their identification with the male model of managerial success become evident and some of the women mangers consequently reject even the few managerial feminine traits they may have earlier endorsed.

However, It has been found that female leadership tends towards a style defined as ‘interactive leadership’ and women adopt more democratic and participative leadership styles, [9]; [10] that involve: encouraging participation; sharing power and information; enhancing self-worth; changing self interests for an overall good; relating power to interpersonal skills; and believing in better performance when feeling good.

However, the nature of an industry and its characteristics are extremely influential in determining the most effective leadership styles for it. According to [8] especially, issues about the gender of leaders cannot be fully understood without reference to organisational culture. Not only culture but socialization within the society and the workplace, nature and demographics of an organisation, gender and gender ratio of the industry also influence leadership styles [6]. In considering leadership styles, the unique characteristics of the construction industry such as project characteristics, contractual arrangements, project life cycle and environmental factors can have an impact on leadership styles in construction [11]. Since construction is a project-based industry it creates temporary multi organisations with extensive team work that has a significant impact on leadership behaviour of managers. Cleland [12] argues that project leadership should be appropriate to the project situation because leadership is a continuous and flexible process.

2.2 Career barriers to women leaders

The literature on women in construction identifies that women have progressed slowly and have confronted a greater number of barriers in their development than their male counterparts. Previous studies found that although there is no discrimination in formal announcements, some of the construction organisations have differentiated pay levels for men and women in leadership positions. According to the Employment Service [13] it was identified that full-time non-manual women workers earn less than 60% of that paid to their male counterparts in the industry. In addition the informal networks and cultures that are male-dominated often become barriers to women's progression. Most importantly the corporate inequities in advancement opportunities and rewards discourage women from seeking top management positions. It was also found that women are less frequently offered rotational job assignments to areas that are on the revenue producing side of the business, which ultimately decreases their chances for promotions to top management of the organisation [14].

After mining and quarrying, the construction industry is renowned for its male dominated culture. According to Powell et al. [15] engineering in the UK has a popular image of being tough, heavy and dirty and these powerful cultural images have helped to reproduce occupational segregation whereby engineering is perceived as unsuitable for women. In many instances male senior executives and professionals have old boys network which have shared experiences between themselves [16]. Therefore women find it difficult to fit into this atmosphere except in appendage roles. Furthermore the prevalence of gender stereotyping and the incidence of sexual harassment also remain major threats to women especially for their career development into senior managerial positions.

Women are given tasks which are intended to test their ability to work in a male environment [3]. This is a challenge especially to those who are interested in developing their career in construction. Some researches found that, refusal to carry out such tasks led women to be accused of incompetence and be seen as a legitimate target for further harassment. In certain instances this became a black mark for their future offers. However poor performance in these tasks led women to reinforce gender stereotypes and jeopardise their chances of acceptance for their promotions. Female managers emphasised their personal qualities as critical factors in their career such as, capacity to hard work; integrity; desire for responsibility and positive attitude [3]. Due to barriers created within them and from the external environment women lack confidence and assertiveness to go for positions of power [17]. Their reluctance to compete for senior jobs is a major barrier created by them. In addition, their lower aspirations and inappropriate expectations [18] hinder their careers in leadership positions in senior management.

Although most female students are continuing to perform well in studies, their choice of educational field segregates them from the field of construction. Their educational segregation limits their access to higher level construction related courses, which require formal qualifications. This seriously undermines their opportunities to enter the construction industry at a managerial or professional level. Their entrance into lower levels or into middle level at later stages of their career, affects their progress towards leadership positions.

Most importantly the construction industry fails to consider the issues associated with women's commitments towards job and family life [19]. The long hours of work required from senior managers to actively participate in the management is incompatible with women's domestic responsibilities. In addition to above, the time, duration and location of the meetings sometimes create role stress to women. Women have felt that they are the only or one of very few women attending the meetings [20]. In addition, women's commitments to child care and elder responsibilities prevent them from carrying out these tasks. This challenge of balancing the career and the family is a major barrier for their career advancement and women's career break due to maternity is a blow to their advancement. Some women even drop their job, do not take any interest in developing them or do not take an interest in promotions.

3. Methodology

Case studies were selected as the most appropriate research strategy for this study because it is considered that case studies provide the opportunity for studying real-life phenomenon in detail without any control over it. Four case studies, which were developed around four female leaders representing different disciplines within the construction industry (Table 1), were carried out in order to achieve the aims of this study. The unit of analysis of the case studies was decided as the individual leaders because on them only the conclusions were drawn at the end of the study.

Table 1: Case Studies

	Description
Case Study A	• She is the Assistant Director of Estates and Facilities Division of a public body, which is attached to a university hospital in England. Her division looks after the management of estates, property, facilities and construction projects of the hospital and these responsibilities direct her to deal extensively with different teams. • She is in her early fifties, married and mother of two children who depend on their parents.
Case Study B	• She is the Financial Director of the UK's northern wing of an internationally wide construction company. Her main responsibility is built around managing company accounts. All financial related issues of the company including accounts of their construction contracts are handled by her subordinate staff. • She is in her mid thirties, single and expecting her first child.
Case Study C	• She is an Associate Architect in a well established architectural design firm in the North of England. Her responsibilities range across a broad spectrum, i.e. design to contract administration. She has to interact with different categories of people including subordinates of project architects, designers and technical staff as a leader and also with clients and building contractors. • She is in her late thirties, married, mother of two young children and expecting her third child.
Case Study D	• She works as a Site Quantity Surveyor on a construction site, located in the North West of England. Her employer is an internationally reputed large construction company. In contrast to the other three cases, she does not have direct subordinates under her according to the organisational hierarchy but she has to get some work done through the assistant site quantity surveyor and influences sub contractors and site workers in certain circumstances. • She is in her late thirties, married and mother of four children where the eldest is employed and not a dependent on her and her husband.

A detailed study was carried out on each female leader's career, career progression, leadership style and ability, and the barriers faced during their career progression. Views regarding the selected female leaders' leadership and her career difficulties were obtained from their superiors, peers and subordinates to gain an overall perspective. Semi-structured interviews were conducted with the leaders, their superiors, peers and subordinates in order to collect data on the leaders' careers, career progression, their leadership styles and ability and, the barriers confronting their career towards leadership positions.

Further, the Personal Attribute Questionnaire [1]; [21]; [22] which was developed by J.T. Spence, R. Helmreich and J. Stapp in 1975 was used in order to assess the personal characteristics of leaders. There are twenty-four items in this questionnaire each measuring one personality characteristic. There are eight questions on socially desirable instrumental traits generally associated with males, eight questions on expressive traits which are known to be associated with females and the remaining on androgyny traits, the characteristics of combined male and female qualities. All these items are presented in a five-point bi-polar format with a masculine label at one end and a feminine at the other [1]. The questionnaire was given to all four female leaders and asked to indicate the extent to which they possess each of the eight masculine characteristics, each of the eight feminine characteristics and each of the eight androgyny characteristics on the 1 to 5 scale.

In addition to the interviews and the questionnaire, organisational documents such as organisational charts, employment records and other relevant documents of the respondents' organisations were studied in order to understand the positions of respondents in the organisational hierarchy, their duties, roles and number of female employees in the organisations.

The data collected through the semi-structured interviews was analysed using a three step process of data reduction, data display, and conclusion drawing. A data matrix was produced by tabulating the interview data; the respondents are listed as columns and the questions as rows for data display. This system makes it easy to identify patterns in the responses. Two data matrix were constructed in order to analyse the data gathered from the interview. Firstly single site matrix were constructed using information from each case. Secondly cross site matrix were constructed using information from different cases in order to compare and analyse the experiences of women leaders across different cases [23].

The questionnaires were analysed by adding the scores on each item of a particular set (masculine, feminine and androgyny) together and dividing by eight. According to the set of attributes, which scored the highest average among above three, the nature of personal attributes of a particular leader was decided.

4. Findings and discussion

4.1 Leadership of women managers

According to the interview data, women leaders of all four cases admitted that they perform all the duties which have been prescribed to their designations. They have never felt that their roles were under-estimated except in the experience of case D leader about misusing her skills for some clerical work in the absence of the site secretary. These leaders were satisfied with their roles and they are confident with their skills and competencies whilst they all agreed that they have to learn more through experience.

Further, all four leaders perceived leadership as an essential and critical skill for their career advancement. Leaders of case A, B and C, believed that their leadership style depends on the situation to be tackled and the people who are to be dealt with and perceived themselves as more democratic styled leaders. The leaders in the first three cases, who were in higher positions in the organisations and whose work was not based on construction sites, were confident about their leadership ability and believed that they receive the recognition and acceptance from their working environments. The superiors, peers and subordinates irrespective of their gender were extremely positive about these three leaders' leadership abilities and agreed that they do not have any problems in their leadership. Similarly, the leaders did not think that their leadership is undervalued compared to male managers' leadership. However, they all disclosed that they need to have a thorough knowledge on their subjects, they have to be familiar with the culture of the organisations and they have to possess internal organisational knowledge to be successfully accepted as leaders.

In contrast to the other three leaders, the case D leader possessed a negative attitude about her leadership ability and the acceptance and the recognition she receives from her site working environment. She was not confident about her leadership skills and believed that it is harder for women to gain the necessary respect as leaders in the construction industry.

According to the data collected through the Personal Attributes Questionnaire, leaders of case A, C and D possessed more feminine attributes and the other leader perceived herself as a more masculine personality. A close relationship between the self-perceived personal attributes and the nature of the leaders' careers could be seen through the questionnaire findings. Apropos, the case B leader, whose self-perceived personal attributes are more masculine, had a similar career to a male leader because she had lesser family commitments with no childcare responsibilities and she hadn't had any career breaks as yet.

4.2 Confronting barriers to women leaders

The difficulty in balancing the family and work commitments is a more frequently quoted barrier within the study. Although women and men want a successful career and a happy family, it has been a difficult task in finding the balance between work and family life for them. Since women generally perform a large share of household tasks, this has been found to be a major barrier for women in continuing their job career. Three case studies show that women in leadership positions who have families are confronted with difficulties in balancing their family and work commitments. However the case B female leader from a construction contracting company, who does not have family responsibilities or any dependents, didn't consider the task of balancing her commitments as a barrier to her career. She did acknowledge the difficulty of balancing work and family commitments for women leaders.

Child care is one of the important aspects in family commitments that needs time and priority. Three of the female leaders from this study stated that they have faced difficulties with regards to child care. It has been noticed that the importance which women give to their child care and the adequacy of child care facilities has had an effect on women's careers. Case C female leader who is from a consultancy firm, while explaining her career she said that she would have moved up in her career faster but it was hindered due to distractions by having children and maternity leave. However her commitment towards work through working from home and making few visits to the work place during the break helped her to progress to a higher level. She also mentioned that in addition to women's commitment to continue their career, the understanding between the employer and female employees has significant effect on their career continuity. Although generally women take larger share of child rearing activities, one of the subordinates of case B leader said that it is also`a problem to men, as nowadays men also take the responsibility of child caring. However he stressed the importance of improvements in child care facilities to facilitate both men and women to progress in their careers.

The old boy network is found to be another common barrier in the construction industry since it is a male dominated industry. Among four female leaders, two females from construction professions have faced problems with old boys network. According to female respondents, when women attend meetings or events where there are no other women or very few women they generally find it more uncomfortable and which sometimes leads to their lesser contribution towards decision making specially in executive meetings. This ultimately affects their promotion and advancement opportunities.

In addition the culture of organisation has a significant impact on those who work within it. An inhospitable culture within construction organisations is one of the most significant barriers to women's advancement and also a major factor in diminishing their satisfaction in work. It has been mentioned as a mitigating factor by the case D leader who works in a construction site. However case B female leader who comes from a different discipline has not felt any difference with regard to the culture in her work division though she is from a construction company. Further, one of her subordinates who is also from the same discipline, when explaining his view about the culture of his work environment said that they are sheltered by their professional background as they have an equal number of women and men. However he recognised that in construction there are probably more hurdles to cross for women due to the nature of the people who work in the industry.

Stereotyping can have an influence on the way in which men and women are perceived in the workplace. Among all four cases, the female leader who works in the construction site has experienced this difficulty. The use of stereotypes as the basis for assessment can result in dissatisfaction in work. When case D female leader from the construction site explained about her experience on site said that it is harder to get respect for women in construction. In addition it was found that women face problems when they give instructions to get the work done. However this is often noticed in construction sites.

The industry wide practice of working long hours is seen as a barrier to women. However three of the female leaders commented that the flexible working hours and home working are a great advantage to them. In addition they stressed the importance of better understanding between superiors and women in their view. According to the female leader from the construction site, when work is judged based on the number of hours worked then women face problems unless proper facilitates are provided to overcome them. Although she has recognised the need to work for long hours on a regular basis she found it difficult to challenge this.

In addition to the female leader from the construction site who realised the need for better working policies for women, case B leader recognised the difference between policies in construction and other sectors. She said that very minimal facilities are given in construction, such as minimum legal requirement for maternity leave. Furthermore a lack of female leaders in higher positions in the organisation leads to difficulties in obtaining the required facilities or allowances as certain facilities are not in place before a need was recognised. Gaining the knowledge regarding the policies which can facilitate them to continue their job career while giving importance to family life as well was also mentioned.

In order to obtain views of others about the barriers faced by women interviews were conducted among superiors, peers and subordinates of the female leaders. However most said that their female leaders do not face any difficulties. Interviews were conducted among male peers of female leaders who were considered for the study in order to understand their views on barriers faced by them during their career. However in contrast to female's perspectives about their own barriers, male employees stated that they didn't face any problems.

5. Conclusions

The findings of the literature revealed that there is significant under-representation of women in the managerial positions in the construction industry, especially in mainstream management. However, according to the case study findings, women's leadership was highly appreciated by their superiors, peers and subordinates in the organisations and they did not see any problems of women being leaders as far as they have the necessary skills and competencies. Apropos, the case study findings of this study illustrated that women leaders in construction make a significant contribution to the industry.

As the literature illustrates, it is believed that women possess more democratic styles of leadership. This was confirmed by the case study findings of this study because all the female leaders perceived themselves as more supportive and understanding in their leadership. Although the literature says that there is a tendency for women to adopt more masculine attributes when they move up their career ladder, the results of the case studies did not prove it. However, a close relationship between the self-perceived personal attributes and the nature of the leaders' careers could be seen because the leaders who had close career characteristics to male leaders perceived themselves as having more masculine characteristics.

The case studies revealed that the female leaders who were in the higher positions in the organisational hierarchies were extremely confident about their leadership skills. It can be stated therefore that the level of authority a leader possesses has a significant influence on the recognition and the respect received.

The results reflected that the difficulty in balancing family and work commitments, childcare problems and old boys networks are the mostly mentioned barriers encountered by women in leadership positions in the construction industry. In addition female leaders mentioned that the unfriendly environment when she is the only female in the meeting or event also leads to career problems. It was noted that women working on a construction site also encountered more problems. However the barriers encountered by women in leadership positions and its extent differ from one discipline to another although they all work in the construction industry. Further the study found that employees who work with the female leaders expressed that there are no problems to women leaders. However some recognised that there are problems which still prevail in a few segments of the construction industry. They expressed that this situation will change with time while recognising the need for more women to the industry.

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The Construction Supply Chain and Supervisory Skills for Housing Market Regeneration

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Abstract

In the UK a key driver for the regeneration of failing neighbourhoods is the housing market renewal programme. As part of this process the specification and the management of the physical regeneration of the existing housing stock is a prime concern in order to achieve appropriate project outcomes. Achieving quality and customer satisfaction in existing homes and new build designs, using locally sourced contractors, workforce and supply chain, presents key challenges in meeting the decent homes agenda and in achieving best value through a framework procurement process.

The series of market intelligence reports produced by the UK Sector Skills Council, Construction Skills have identified critical skills gaps in the national and regional market place. This research paper explores the recommendations of this data, linking to demand led initiatives, which are now operating regionally. The issues arising from this work relating to supervisory and management shortfalls are explored. The research was initially conducted with regional and local construction contractors, to gauge the extent to which such higher level skills are developed. From this study, it was evident that deficiencies are apparent and that a proactive process of development of local and accessible educational and training provision is required. A focus group study was conducted to validate the survey outcomes and to develop a practical development plan to bridge the gap between skills and people.

The study progresses to make recommendations regarding professional skills needs, supply chain development and seeks to define options for the development of a sustainable local industry base.

Keywords: Construction management, skills gaps, regeneration

1. Background

Forecasted figures (Construction Skills, 2006) show that 285,300 people will be employed by the construction industry in the North West of England this year and that this figure will rise to 305,600 in the next 4 years. Of these, nearly 12,000 new entrants are to be expected by 2011 and the vast majority of these will be non-professionals. Despite the overall increase in numbers employed, slightly more (12,000) will be leaving the sector than will be joining (11,600) by this time. As the previously quoted report notes, "*these inflows, transferring from other industries…are likely to need some form of training*". It may be that the provision of a clearly defined career path would go some way to retaining these new entrants.

For those already employed in the sector over the period from 2006 – 2010 will also see a situation, whereby "*Three out of the four occupations with the highest Average Annual Requirement…are focused on management and organisation*". In order to attract these individuals the availability of educational opportunities (either further or continuing) will be instrumental.

Evidence from elsewhere in the North West of England (J21, Oldham / Rochdale Pathfinder Report, 2006), suggests that those skills developed for business activities are influenced by existing strategies and do not relate to innovation and new practices. It could be argued that this is a short term approach to capability and capacity, and as such provides evidence that limits many construction companies in the North West as a whole in their failure to fully benefit from the opportunities presented by the various regeneration projects now operation in the region.

Within the East Lancashire sub-region, the Elevate Housing Market Renewal pathfinder focuses upon wards within 5 local authorities (comprising Borough Councils include Blackburn with Darwen, Hyndburn, Pendle, Rossendale and Burnley and Lancashire County Council). These districts are subject to the extremes of housing market failure and societal collapse. As a means of addressing the issue of poor housing conditions, failing neighbourhoods and the decent homes agenda, Elevate are progressing a programme of new housing development and repair using a combination of best value procurement and local supply chain development. As part of its procurement process, Elevate has focused upon a key objective to trap as much of the regeneration spend (£100m 2006-2008) in the sub region as possible. This is through actions and key performance indicators to use of local labour, contractors and suppliers, where ever possible. Unfortunately, this aspiration is currently is not fully realised due to capability and capacity issues. In this respect, it is clear that issues such as skills, capability and vision are critical factors. The evidence for this is based upon Elevate's own review of company capability through an ongoing tendering and feedback process provided by the Centre for Construction Innovation (CCI NW Pre-Qualification Questionnaire Feedback Report, 2006). Therefore with the knowledge the Elevate programme has a further 10 years to run, it is of utmost importance that that these capacity issues are resolved for the long term economic benefit of the area as a whole. The availability of a relevant, accessible and flexible education and training provision will be a critical driver in achieving this goal.

2. Supervisory Skills in Context

The issue of supervisory skills within the construction sector in East Lancashire is not a purely a local one. Indeed the issue of skills within the sector as a whole is an area of some concern as the construction industry moves towards the target of a fully qualified workforce (Turner, 2004). Recent legislation with respect to taxation arrangements suggests that the industry as a whole is subject to an externally imposed modernisation agenda (Chan and Dainty 2007). For many smaller construction companies, who are predominant within the sector nationally (Chan and Dainty 2007), this poses significant problems and challenges.

The complete range of skills which are required to achieve successful project management are extensive and demanding, if effective lasting and sustainable regeneration is to be achieved. Both the English Partnerships Report (2004) and the Egan Review of Regneration Skills (2002), both identified the need for the creation of a skills structure to increase the performance and enhance the delivery by regeneration teams. The Academy for Sustainable Communities (ASC) explicitly links construction management skills with skills in regeneration (amongst others). If the aspirations of and for sustainable communities are to be realised then there are other concerns. In this respect, regeneration practioners, within the sub region, regard their competency levels as not sufficiently high. (Platten et al, 2006).

Of the skills most lacking in publicly funded, but privately delivered projects, partnership working, where a shared set of values is important, is the biggest cause for concern. This lack of familiarity with partnership working causes other problems, as Platten et al (2006) note, "*There is often a reluctance on the part of both local authorities and contractors to take the lead in joint projects and this reluctance is due to a lack of project leadership in terms of both capacity and capability, in both the public and private sectors*."

Elevate East Lancashire are of the opinion that any sucessful regeneration project in the sub-region will involve building capacity in terms of project management and partnership working skills in both the public and private sectors. Given that these skills generally need to exist at the supervisory or managerial levels, there are very obvious implications for the skill sets needed within the construction sector.

If one focuses specifically on the construction sector, then current training provision is stongest at the skills and crafts level, indeed the sub-region hosts Accrington and Rossendale College, a nationally recognised Centre for Vocational Excellence. However, managerial and supervisory skills provision is less well endowed, further what little provision that does exist does not offer a route for aspiring construction professionals with the appropriate professional body accreditation, which is critical to job proomotion. The lack of professional skills such as, Quantity Surveyors, Planners and Project Managers within the sub-region means that often these services have to be sourced outside the region, which often drives up the salary base (Turner & Townsend 2005). There is also a difficulty in retaining skilled individuals, who tend to migrate from the area to more well paid opportunities elsewhere. It is critical to note that there is significant evidence of employer lead demand for this type of educational provision in a format that is accessible through the medium of blended learning, including modes of learning such as part time provision, on line learning and workshop style presentations.

In summary, there is a wealth of information available in the form of studies, reports and academic papers that both highlight and illustrate the need for a more coherent and acessible educational infrastructure in East Lancashire.

3. Methodology

The aim of this paper is to assess how small to medium enterprises (SME's) in the East Lancashire construction sector currently manage their training needs in terms of professional skills. This assessment takes account of what training is currently available, how it is delivered and also investigates the issues of barriers and accessibility to prospective candidates. Regionally, this approach has implications for the development of a robust, qualified and professional construction industry that meets the increasingly demanding conditions for supply chain entry. If these attributes can be attained through the delivery of a high quality, industry specified and accessible skills training, then the long term sustainibility of the sector should be assured. To date, preferences would seem to be given by employers to more vocationally orientated qualifications rather than those which are purely academic in nature and delivery.

This paper builds on the work of and draws from, a number of previous studies notably the Construction Skills Network Employment Forcasting Model (Construction Skills, 2006), The Construction Skills Gap Analysis and places their findings and recommendations in the context of the East Lancashire construction industry.

The fragmented nature of the construction industry in the sub region makes quantative data collection difficult, companies are often too small to have the spare the time to complete surveys and as a secondary consideration, they are often suspicious of the stated objective. This finding in itself provides scope for further study in how SMEs and mirco organisations interact with the representative industry bodies. However, for these reasons a varied range of methods of methods were used to reach the reported conclusions in this study.

In order to scope the investigation, an initial telephone survey was carried out with a sample of 24 local companies (this listing was selected from a market of 1800 local companies using the Businesslink Northy West database, from the post code area of East Lancashire and who employed more than 5 persons). From figure 1, it can be seen that the majority of these companies (66%) have 20 or less employees.

The telephone survey involved a number of information gathering questions such as the company name, location, turnover, number of employees and main work areas. Questions relating to the employment of supervisors were also asked with regard to number of employees at this level and their qualifications. Further, interviewees were asked to provide a Likert scale reply to the relative importance of particular construction related supervisory skills areas. These areas were selected from a variey of sources including the National Occupational Skills

Standards and contract performance criteria. These skills included: the monitoring of quality, regulations and health, safety and welfare; obtaining and assessment of technical information; enhancing working relationships; providing guidance on problems within an ethical framework; monitoring contract progress, quantities and certification; confirming and monitoring the dimensional control of construction and installation projects; ensuring the handover of engineering products; recording the condition of projects, assets, facilities and installations and finally implementing the maintenance of projects, assets, facilities and installations.

Opinions were then gauged on how these skills could be met through bespoke training solutions or through public access courses such as a recognised NVQ award or an academic award such as a HNC/D, foundation degree or undergraduate honours degree. In addition the interviewees were also asked whether this training could be provided locally or with an established provider from outside the catchment area of the regeneration zone.

The results of this preliminary phase were then used to shape and inform the secondary phase.

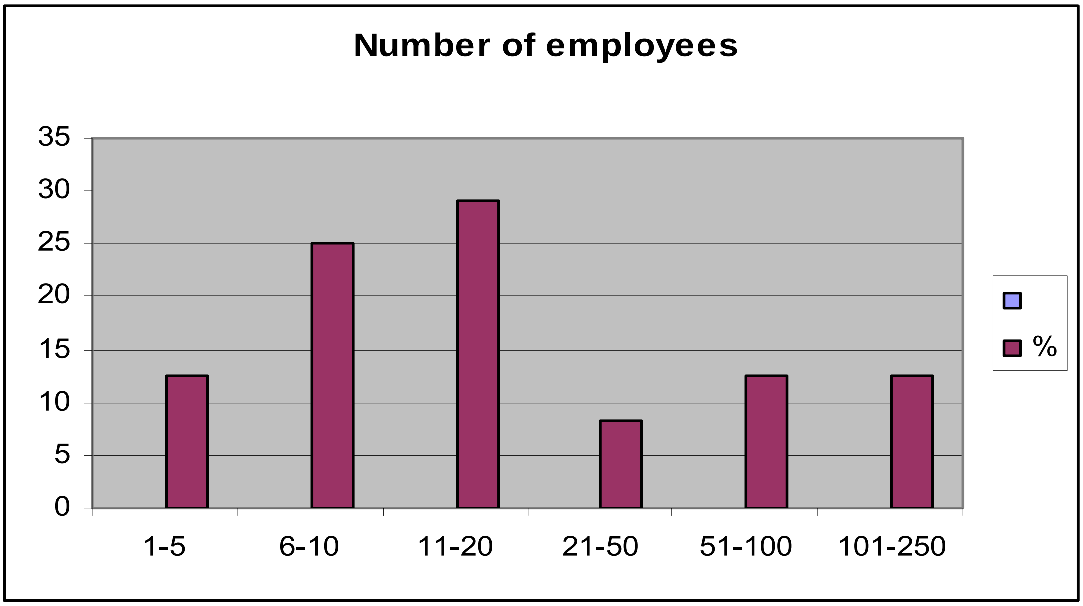

Figure 1: Range of company size in the East Lancashire sub-region.

The second phase of the study comprised a series of innovation circles conducted with attendees at a series of best practice events hosted by Elevate East Lancashire with the assistance of the Construction Knowledge Exchange NW (CKE), which is a practice development project, based at the University of Salford. In addition, the study used the round table discussions arising as part of the Elevate supported Independent Training Group (ITG). The ITG is a Construction Skills funded project, which seeks to provide support to SMEs in development training needs and promoting access to training solutions. Participants in these events were asked a series of questions by a group facilitator that were informed by the initial research.

These questions included a confirmation of how supervisory skills were obtained and for which skills areas, such as site supervision; health and safety management; Quantity Surveying or

Project Management. Participants were also asked to comment upon why this mode of training was undertaken, for example the facilitator prompts included function; person based; a business need or as a legal requirement. In addition, the regionality of that provision and preferred modes of study were also investigated. The meetings functioned by seeking an open discussion on the issues raised by the questions. The facilitator also worked with the group to find a collective solution to the issues raised and an action plan to take forward the items discussed. In this study, the innovation circle outcomes are not reported in full in order to control the focus and content of this paper. A third input to the research originated in work, which was completed in parallel to the above studies, which was geared to support a bid for development funding. In this study, Elevate through its partner Further Education Colleges accessed a range of local and regional companies to gauge the demand and support for a locally based training provision for supervisory skills.

4. Study Findings

From the first phase of the study, table 1 presents the findings of the survey responses concerning the relative importance of the nine skills areas, which contribute to the supervisory qualification. The companies rated the attainment of formal skills, as more, rather than less important, with the exception of "Ensuring the handover of engineering products". Many companies felt that this was not an area in which they had any or much experience. A clearer picture emerges, if the total weighted value attached to each area is measured and the Likert preferences are assessed by the use of a preference index (PI)[1]. In this case, the most siginificantt area is felt to be "Monitoring quality, regulations and health, safety and welfare". The explanation might be that this is criteria that is strictly monitored and can leave a non-compliant company exposed from a legal standpoint.

Table 1: Importance rating of Supervisory Skills

Importance of achieving formal supervisory qualifications in:	**1**	**2**	**3**	**4**	**5**	N/A	**Total weighted value**	**PI**
Monitoring quality, regulations and health, safety and welfare	1	0	5	3	15	0	103	0.85
Obtaining and accessing technical information	1	1	11	6	5	0	85	0.70

[1] PI = ∑w / W x N (w = score assigned by each respondent over the range 1 to 5 where 1 represents the lowest weighting and 5 the highest. W = the highest weighting factor (5) and N = the number of respondents (24).

Enhancing working relationships	1	0	7	7	9	0	95	0.79
Providing guidance on problems within an ethical framework	1	1	4	7	11	0	98	0.81
Monitoring contract progress, quantities and certification	1	1	3	6	13	0	101	0.84
Confirming and monitoring the dimensional control of construction and installation projects	1	0	4	5	14	0	103	0.85
Ensuring the handover of engineering products	0	3	3	4	5	9	56	0.46
Recording the condition of projects, assets, facilities and installations	2	3	1	9	9	0	92	0.76
Implementing the maintenance of projects, assets, facilities and installations	1	4	3	9	7	0	89	0.74

zzThe next two most important areas are “Confirming and monitoring the dimensional control of construction and installation projects” (103) and “Monitoring contract progress, quantities and certification” (101). These are clearly supervisory type duties and recognised as such as is the importance of being qualified in them.

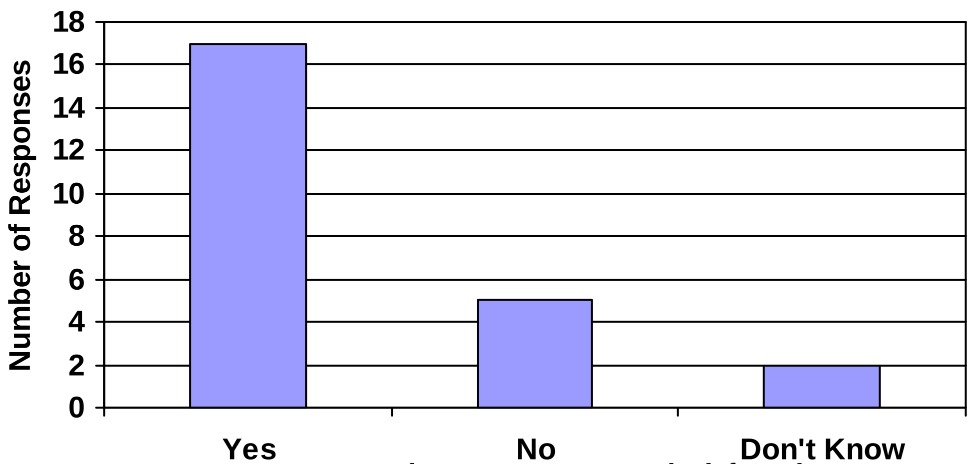

Figure 2: Questionnaire responses to the question “Do you think formal supervisory qualifications are likely to become more important in the future?”

With regard to the growing importance of supervisory skills, figure 2 indicates that over 70% of companies commented in the telephone interviews that these skills will become more important in the future, but as the next question will illustrate, they have no firm plans as to how they will manage this issue. From the telephone survey, 5 companies (21% of the sample), who said that they did not think this to be the case cited their belief that “experience is more relevant than qualifications”.

When asked if such skills should be provided locally to meet the needs of the local working population, an overwhelming majority of 96% (23) of the companies asked cited that they would like to access local provision. Whilst, one company that answered this question negatively, noting that they already complete all their own training in house.

In the second phase of the study, two focus groups events were conducted, the first of these was with 20 construction companies from within the region. Working in four sub-groups, each group was asked to reflect on how the companies currently met their training needs and what factors they anticipated might change how they meet these needs in the future.

It was apparent from the focus group outcomes, that all claimed to have training plans in place and while tending to be the smaller SMEs, they were all making strenuous efforts to makes themselves fit-for-purpose in terms of entering the HMR supply chain. For many, however, they found problems in terms of finding time to complete Pre-Qualifying Questionnaires and gathering the requisite information. The survey also asked companies to demonstrate how they approached responsibilities ranging from health and safety to waste management. The respondents claimed to be coping adequately in terms of acquiring the necessary supervisory skills, mostly via the Construction Skills 5 day Site Managers’ Safety Training Scheme (SMSTS), but were aware that acquiring more senior managerial qualifications, when the time was right, would pose its own problems. The focus was to prefer tailor made training and personnel develop solutions, which met with their commercial needs.

This preference for a vocationally based training solution over a more academic programme, begs a wider question as to whether the academic provision available meets the needs of employers. By further prompting, comments relating to the flexibility of provision, start and finish times of courses and duration were all common responses.

It was reported that development needs were met in a variety of ways, mostly using external training providers from the private sector, on an ad-hoc basis and as per specific project requirements. Many seemed aware that this was a time consuming exercise in terms of sourcing training, when needed and felt that both the local colleges and professional associations needed to develop “courses which are more applicable to requirements of developing supervisors to managers” (sic). This specific need to progress supervisors to managers and the wherewithal to do so was a recurring theme in the focus group.

The second focus group was conducted with members of the Independent Training Group (ITG). This group is composed of six contracted construction companies, who have satisfied the requirements for entry into the Elevate supply chain. These companies are currently working on a £30 million building refurbishment programme across the sub-region. Both the survey results and the initial focus group reflections were used to inform the structure and content of the second ITG focus group.

In their focus group, they stated that they had training plans in place for trades and crafts, but felt that the 5 day SMSTS course was sufficient for the supervisors and managers. The group expressed the view that only the training and development of Quantity Surveyors warranted a formal academic qualification. This gives rise again as to whether the academic courses currently on offer truly reflect the needs of the industry and whether current perceived shortfalls have reduced the view point that higher education can provide a workable solution for employers. This same point was made in a research conducted by the University of Northumbria on behalf of the Chartered Institute of Building concerning higher education (CIOB, 2003), which specifically stated that "University providers must meet the changing needs of the Industry, for example preparing students for CSCS registration."

In terms of capacity, when a purely East Lancashire perspective is adopted, the sub region tends to reflect, if not accentuate the regional trends and attitiudes. Research completed by the Centre for Construction Innovation North West (University of Salford. 2004) identified a series of shortcomings in local construction companies that actively mitigated against their benefiting from programmes such as housing market renewal. The shortcomings are predominently centered around the following areas; wherein (i) The vast majority of companies employ less than 5 people, this placed limits on capacity to support training and places challenges in developing this approach, which in turn limits capacity to grow and develop, which in turn limits capacity to bid into HMR projects, that (ii) Qualifications are not widespread with 69% hold NVQ 2 or none at all. However, there is an apparent paradox at play here because; 55.% feel their current skill level does not match requirements and that 48% had difficulty recruiting managers/supervisors.

Companies are aware of their deficiencies, because they also cited in the inovation circle sessions, that management planning as a area of concern as part of the national drive toward a fully qualified workforce. ie. they have positively identified managerial skills as a barrier to expansion. When the barriers to accquiring these skills are addressed, time (81%), resources (42%) Commitment of staff (30%) and availability of training (27%) were cited as the major barriers. A more flexible delivery method offering a variety of accessibility and delivery opportunities might be the solution sought by many smaller companies expressing a wish to expand, but felt unable to take advantage of the current avenues to expansion due to percieved risk. As the research concludes, the task facing construction companies in East Lancashire, is to change their collective culture from the short term to the medium and long term. Changing this culture is about gaining the confidence to develop capacity.

5. CONCLUSIONS

The development of construction skills and the supply of professional trained candidates is a prime focus for development in the North West region as defined the sector skills council strategy documents. Management skills needs for the construction sector a concern both nationally and in the regions, wherein there has been an increasing emphasis on the need for higher level skills as a key driver for productivity. There are however, unique aspects of the construction industry that make the acquisition and retention of skills problematic. This issue was also identified as a key issue in a regional housing market renewal study (Dewhurst 2007).

Once a construction company has attained significant size and capacity, then the flow of work becomes continuous particularly through long term partnership programmes. For companies to attain this status will require a set of pre-conditions which relate to human resources, investment in knowledge capital and project experience. Currently and despite the gradual economic slow down the private housing market, the regeneration areas are experiencing an unprecedented amount of public sector investment. In the period 2006 – 2010, the projected regeneration spend in the East Lancashire sub-region is £623m (Elevate 2005) which arises from Housing Market Renewal (HMR), Building Schools for the Future (BSF) and the various NHS primary care initiatives. It would appear therefore, that the pre-conditions for growth are in place and the challenge is to ensure that local companies can leverage maximum benefit from these opportunities.

The access to available and appropriately formatted training and education programmes is extremely limited however, with no accredited course provision that will lead to a recognised award for construction managers. This poses significant access problems for new and existing managers in the industry and for aspiring companies to develop their skills base. In an effort to resolve the educational provision, Elevate, in conjunction with three Further Education Institutions in East Lancashire, have attempted to achieve a common approach to this issue.

Further, Dewhurst (2007) concludes his report by noting that the continued trend of the local and regional industry to focus upon short term solutions will be ill prepared for future challenges and to develop a lasting sustainable solution to the current skills issues. Given the size and scale of construction projects (both current and proposed) in the sub-region over the next 5 – 10 years, it would appear from this study that the local construction industry must receive continued and significant support if it is to take advantage of the opportunities for growth, which are now in place in the sub-regions.

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Developing Cost Effective Mid-Career Learning Support for Construction

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based on Case Materials of Construction Action Learning facilitated by Dr Caroline Davey and Jennifer Powell, also of Salford University &Drs Elvira Lantelme and Ercilia Hirota of Universidade Federal do Rio Grande do Sul

Abstract

Over the past decade with significant support from the North West Development Agency, under a project which became known as NetworkingNorthWest (the "educational micronetworking of Small Medium Enterprises (SMEs)" project), the author conducted international benchmarking of best learning practices for skills development in construction across the world. This paper will compare and contrast the experience of developing a balanced learning approach for SME's from within the construction industry in Brazil, South Africa and the UK. The balanced learning used is a combination of facilitated Action Learning, traditional and e-Coaching and eLearning materials developed specifically for small contractors. A critical aim of the work, which it is believed has general applicability, has been to understand the contribution more relevant skills development can have to construction modernisation and improvements of the construction industry in terms of process productivity, product quality and human work conditions in particular. In striving to achieve these objectives the studies revealed the main barriers for effective innovation and how these might be overcome (by processes such as action learning and eCoaching) to support innovation implementation in construction businesses. It also showed that Action Learning (AL) component of the learning, with SETS of 'construction partners in adversity' finding "common ground" for useful discussions led to innovation for wealth creation. In particular once common ground was established SET members often continued to network and form alliances outside of the Action Learning environment. SME construction owner-managers felt able to discuss both personal and business issues that have such an influence on each other. Finally, AL offered the opportunity to take time out of the business and "disengage" with the operational allowing them to become more strategic.

Keywords: Mid Career Professional Learning, Action Learning, Business Bridge, Effective Learning

1. Context

1.1 Construction Research at Salford and Universidade Federal do Rio Grande do Sul

For many years research in construction at Salford University and at the Universidade Federal do Rio Grande do Sul has been particularly directed to contributing to the development of construction solutions and service support based on a systemic approach. As such, its research considers all aspects that influence the construction of building environments, as well as the performance of the construction industry as a whole. In a systemic approach the construction process is considered in very broad terms from conception, through design, materials production and execution, to use and maintenance. The approach is an integrative one, taking account of all interactions between these diverse construction phases.

The two universities' main objective has been to develop highly capable teachers, researchers and technicians, as well as producing scientific research of the highest international standing with respect to Lean, Agile and Advanced Construction. All our researchers have a strong focus on application. This can be attested by the numerous collaborative projects the group has developed with the industry over the year and with a myriad of international partners. Its main areas of research to date have been on topics such as: Sustainability; Construction Management and Economy; Materials Technology, Components and Construction Systems; and Information Systems.

Much of the research in both these university construction departments has been to contribute to construction modernization and the improvement of the industry performance in terms of process productivity, product quality, and human work conditions. There has been a particular concern to build a strong theoretical basis to our research and development. Such theory – concentrated learning according to Lauri Koskela - was needed to ensure that our growing systemic understanding of how best to improve the construction management process actually finds its way into successful built solutions. From this firm theoretical base we have then moved on to develop better learning approaches, to turn theory into practice, which is the subject of the present paper. Our hope in doing this is that improved learning approaches will enhance the fast and effective transfer of new and useful managerial concepts into the practical context and encourage their full uptake to enable better working on building sites and for the industry as a whole.

1.2 Mid Career Learning for Construction SMEs– a European Perspective

Governments and their training organisation across Europe are extremely pessimistic about engaging small to medium sized enterprises (SMEs), especially from construction, to become more innovative and for wealth creation as a result of higher learning. In the UK funding has been consistently available to help such SMEs take advantage of this enterprise learning [1], but the Council for Excellence in Management Leadership (CEML) [2] report that is much more currently available is disconnected to the real needs of SMEs and as a result poorly used [3]. In such a context, the present author was keen to develop a demand driven approach for mid-career construction learning which would recognise the real needs/demands of SMEs, help them learn how to learn from themselves how to cope, indeed flourish, by developing new ways of working suitable for themselves, thus enabling them to respond quickly and effectively to new opportunities. Construction SME owner-managers are action oriented and much of their learning therefore is context-dependent and experientially based. Rae and Carswell [4] have shown clearly that SME learning which occurs primarily through activities such as; trial and error [5], problem solving [6], discovery [7], experimentation and copying [8], facing success and setbacks [9], making mistakes [10] often occurs opportunistically and incidentally [11].

1.3 'NetworkNorthWest' – The Change Agent

The NetworkNorthWest project ran from 2003 to 2005 funded by approximately 1.3m Euros of grant from the North West Development` Agency (NWDA). It was scoped at a time when there was a growing concern about the failure of agencies and universities across Europe to engage successfully with Small to Medium Sized Enterprises(SMEs) to encourage development and creative thinking to stimulate innovation, which would result in improved performance, growth and wealth creation. *There are 360,000 such SMEs in the NW City:Region, who require for survival to be at the leading edge in the global knowledge economy, but who have rarely been considered as a key audience by Higher Education.*

There had been concern for some time within the UK's Northwest Development Agency that while innovation in big business was being supported, little was being done to develop innovation in SMEs in the region. Meanwhile, traditional business support was being seen to be intimidating or inappropriate and failing to meet the needs of the majority of the regions SMEs with engagement with businesses with less than 50 employees around 14%, while for those with less than 10 employees it was likely to be below 5%. The figures for engagement with universities were equally low with only 20% of businesses following that route. Besides the time commitment required, the main issues here appeared to be the perception that offerings were too theoretical, academics were out of touch with the reality of running a business, language used in resources made them less accessible or that previous poor learning experiences indicated that "university is not for me".

The challenge therefore was how the University of Salford (and its partner Universities such as the Universidade Federal do Rio Grande do Sul) could be creative about engaging with SMEs who failed to seek business support, in a way that they might learn how to be more innovative for wealth creation. Previous studies by Salford had shown it was possible *to engage and empower small businesses in a cost effective way by developing an approach which: answered the SME's, 'what's in it for me' question; fitted their normal ways of working, but also set them realistic and fund earning challenges; and finally used a real world language and 'just-in time' learning approach. It was also felt that such an approach would only work by sharing the responsibility for the development of educational materials and the delivery in a broad university partnership*

1.4 Being Creative about engaging and empowering (construction & other) SMEs

The intention of the project was to provide a new and creative *way of offering business support* for SMEs which would allowed the SME rather than the provider to set the learning agenda so that learning was relevant to their own situation.

We already knew that the action learning process, which originated from the work of the late Prof Reg Revans here at Salford, had a strong following in the global corporate business community where it was regularly used for leadership and organisational development. However, evidence from research here at Salford had also suggested that the process would be equally valid for groups of managers from similar positions in different SMEs. Furthermore, our international benchmarking work also suggested that there was little use of action learning as a process for supporting SMEs, but where it was used, it created a real difference.

Salford's unique approach was to work with its higher education partners, both across the Manchester city-region and internationally (especially for construction in Brazil and South Africa) who had already *formed a powerful partnership with its own formal quality assurance framework*, bringing SME managers together in action learning groups (SETs). In such learning contexts, participants were encouraged to learn with, and from, one another and draw down additional academic or business support as required. Key to this process was the *development of the participant's ability and confidence to challenge one another's preconceived ideas, enabling them to be creative about how they approached business challenges so that they became innovative about how they did business and their offerings to market*. They formed strong 'learning partnerships-in-adversity, their SET against the world, working for each other; a social context where profound questioning of each other led to deep and useful learning. The construction SMEs were also supported by learning facilitators, who acted as coaches to deal with individualised problems and issues of each SME.

The project was also keen to ensure that the SME participants had fun as part of their learning experience and hence the Let's Bounce brand was developed which distanced the project material from more serious academic and business support offerings. This material was in hard copy and e-Learning forms available through the www.networknorthwest.co.uk web site and could be accessed by all SMEs in the City:Region; *all these materials were developed by SMEs , with the help of others, in a form that could be immediately used in their businesses with effect a toolkit for successful innovation and enterprise action.*

2. Action Learning – A fuller perspective of the adopted process

2.1 The Basic Principles behind Action Learning, especially in the Brazilian Context

Quite early in its development, the universities already mentioned in this paper[1] began to develop research concerning organizational learning and managerial competence development. This research developed as our staff recognised the need, not only to understand the main technical problems facing the construction industry, but also how the industry could properly and easily learn for themselves how to implement, with greater effectiveness and efficiency; the new solutions, concepts, principles, and innovative technologies developed by the two universities. Important principles concerning organisational learning and competence developments also soon revealed themselves in two areas and were thought to be worthy of further consideration. In particular two questions appeared key to our researchers:

- What are the main barriers for innovation implementation in construction?
- How can they best be overcome?

In trying to answer these questions, both Elvira Lantelme and Ercilia Hirota, key researchers in organisational learning at the Universidade Federal do Rio Grande do Sul working under the supervision of the present author, undertook a detailed literature review. From this they proposed that one of the major barriers standing in the way of managers seeing, thinking and acting more appropriately in their normal practices related to the existing learning (or rather training) processes adopted by most in construction as they tried to understand the new. The team believed a better educational approach was needed to help mid career professionals learn new competencies quickly and with effect.

For her PhD research, Lantelme investigated several approaches that could be used for managerial competence development which were to be led by herself and her colleague, Hirota. With respect to one of these, action learning, she and Hirota visited the Revan's Centre of Action Learning and Research at the University of Salford. Action Learning is a process where groups of 5 to 7 professionals (a SET) come together to tackle real problems and issues from their working lives, develop solutions and reflect upon the success and failure of their resulting actions – thus learning from self and other reflective processes. SET meetings, facilitated by an Advisor, are characterised by certain accepted 'soft' rules and benign structures designed to encourage being 'authentically present' in someone else's issues – a truly empathetic response where a 'reciprocity of perspectives' enables both the questioner and the questioned to learn new ways of learning in context.

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[1] Six other British Universities were also involved in the overarching project which provided the resources to undertake the case studies upon which the following findings were drawn. These were the universities of Bolton, Liverpool John Moores, Manchester Metropolitan, Lancaster and Central Lancashire.

Through joint working between the Universidade Federal do Rio Grande do Sul and University of Salford, supported by the British Council, a firm partnership was developed between both Institutes who were considered to be developing best national practices for their own country for construction. The Brazilian researchers had a period of apprenticeship at University of Salford to learn to become SET Advisors in the context of Action Learning. Although the literature they had explored emphasised the effective use of Action Learning in managerial development [12], they had found few studies giving a sound contribution to understanding the learning processes within Action Learning programmes [13]. Therefore, while in Salford they took the opportunity of talking to SET Advisors from the Revans Centre, as well as participating in SET meetings as observers, to see how the process worked and gain their own understanding of how to implement a learning process that initially seemed quite unusual compared to traditional training.

After this visit, these researchers, became very enthusiastic about Action Learning and especially its potential for the development of managers' competence with respect to innovation for wealth creation in construction. Action Learning seemed to fit well with the concept of competence *development,* which had been adopted by the Universidade Federal do Rio Grande do Sul as a guiding principle to all their work. In particular they saw the potential of Action Learning in the way it enabled:

- a proper focus of learning towards better working practices; this was through explorations of real and actual problems faced by managers in their daily activities;

- penetrating questioning of issues, challenges and problems at a sufficiently deep level to enable those practices with better practice to develop quite naturally; this included enhancing construction managers ways of exploring, reflecting and listening about those human and informational resources (knowledge, skills, attitudes – formal and informal) and enabling managers to mobilise better on site leadership through their actions thus improving a site's effectiveness and efficiency. This learning process was also felt to be useful in helping managers to recognise their managerial and leadership deficiencies, giving them deeper understanding of personal issues and emotional intelligence requiring improvement. Through exploration of the meanings people give to certain ideas and concepts in the context of their action, they believed the managers could self-learn new process of real value to themselves;

- better action in context as an exercise of knowledge mobilisation; early research had shown this to be a vital to competence development for construction.

In an attempt to understand the Action Learning approach better, its general processes and especially how best to be a Set Advisor for themselves, during 2000 they formed two experimental SETs in Brazil; one with five post graduate students and another with a group of three directors of small and medium construction companies. Hirota acted as the SET advisor for this exploration and Lantelme participated mainly as an observer.

It is important to stress that all the Action Learning SETs developed at the Universidade Federal do Rio Grande do Sul had the clear objective of understanding construction managers´ learning processes during the Action Learning, as well as the Action Learning process itself. The focus of this Brazilian project was with individual learning, not with the results or impact of that learning process on any construction enterprise performance. Furthermore, most of the companies they worked for were not even aware that participants of the experiment were actually participating in an Action Learning programme. They decided to not to tell the companies about the detail of Action Learning, but worked with committed volunteers, because they did not feel themselves at this stage to be sufficiently experienced in Action Learning SET advice. Before developing regular educational programmes in an area new to themselves, they wanted to undertake these early explorations to become more professional as SET Advisors, to build up their confidence in the Action Learning process and their control of it, and to understand its real value before going further.

After supporting the first two short experimental SETs, to sensitise herself to the process, Hirota started a third Action Learning SET with construction managers responsible for general site management to put her newly acquired SET Advisory experience into action. This SET lasted for 4 months, had fortnightly meetings and was formally studied as part of Hirota's own doctoral programme. One of the members of this SET was actually interviewed as part of the first benchmarking exercise, because with only a short period of induction in Action Learning, he had learned sufficient about the process to adopt its major principles in the normal working processes of his company with great effect. For her own doctoral research Lantelme thought she still needed to understand better how Action Learning could be used to develop managers' competencies and also to investigate deeper the relationship between the learning and action. By this stage she had convinced herself of the validity of this learning process, but was determined to undertake a rigorous experiment to prove the concept to others. More details of the style of Action Learning adopted, the nature of the learning development she led and the findings from her doctoral studies form the remainder of this benchmark report.

Hirota and Lantelme were both highly influenced in their choice of a better educational approach to support practical learning about change, by the research of Schon [14] and also by other literature on the topic of organisational psychology. This is stressed, in some detail beyond the scope of this case study, in Hirota's successful doctoral thesis (in Portuguese, 2000) where she investigates in detail the relevant relationships between cognition and action. This led her and Lantelme, who was to be the SET Advisor to the major case reported here and in the appendices, to adopt strategies as SET Advisors which were much influenced by the ideas of 'inducing managers to expose and reflect on their own mental models for action, to reveal the beliefs, feelings and emotions that guided their actions to others who could help them understand their strategies against the best of currently espoused theories expressed in a practical way'. Hirota and Lantelme initiated their SETs in a traditional Revan's type way, but gave greater early emphasis on helping managers understand their personal psychological values and behaviour. NORIE researchers also believed in providing as full a feedback service as possible to the learner managers in the progress of their Action Learning. They did this, using 'learning trend' charts, which showed plots of the progress of the learner against key concepts with respect to these.

2.2 Action Learning in the British and South African Context

The previously mentioned NetworkingNorthWest project undertook examination of Action Learning in the British and South African context. In Britain 133 SME businesses were supported through 19 SETs established across the North West region, in processes essential similar to that used in South Africa; 28 businesses of those study related to the construction industry or its partner organisation. Since the scale of this British development was extremely large, each partner of the programme agreed to deliver a number of action learning SETs but the precise methodology to be used was not prescribed. This project was prepared to be flexible about many aspects of delivery, as long as core principles were adhered to, it was felt that flexibility not only allowed the team to capture best practice but also allowed participants to customise their own experience to meet their needs. Data from these SETs was collected for external project evaluation and forms the basis of the more general findings mentioned later in the paper.

Unlike other forms of facilitated meetings, the Action Learning process used in both the British and Brazilian cases, dictated that the SET members own the process of the SET meetings. They set the ground rules and, within reason, dictate the time, precise frequency and location of the meetings Good action learning facilitators become part of the team and often take a relatively minor role in the proceedings, their key skills are to use good listening skills and ask excellent questions that challenge the status quo, drill down into issues and keep the process of the meeting on track. At the end of the session *they ensure that participants take away actions to be completed, and that the subsequent outcomes are reflected on and reported to the next meeting to share the learning from the action taken.*

Also as part of the NetworkingNorthWest project, international benchmarking was undertaken to enable the production of a set of resources and guidelines on true global best practice in this type of intervention with SMEs as part of the development of resources to support this type of learning. The Brazilian example was described in full in section 2.1, but I also undertook a case study of a learning development used in South Africa, based on a Liverpool development, known as Business Bridge. Business Bridge is a peer-to-peer network, used in and around Johannesburg which seemed to have been used with much effect to encourage innovation and wealth creation in South African SMEs.

Just as in the British and Brazilian Action Learning, there are facilitators who keep the learning process developing, however in the Business Bridge Meetings they take on an extremely proactive role, especially between meetings, in providing coherent support for any SME's actual enterprise development and in setting up themes for future meetings. Action Learning advisors in the NetworkingNorthWest Action Learning SETs could learn from this that the power of the telephone in supporting early constructive actions for change stimulated by SET members is also valuable. Similarly, in Business Bridge, the use of Action Learning style minutes to give immediate feedback of the learning from the meeting is seen by it's facilitators, to be helpful and constructive in support of SME change. As in the NetworkingNorthWest SETs experience, BBM found the neutrality and responsiveness of the facilitator to be key.

2.3 The Research Project and Integrating the Findings of the projects

The project, formally known as "Networking North West" and informally as "Bouncing Higher", was funded by the NWUA so that the authors Mid Career Construction Professorial Learning Research Team could undertake a comprehensive R&D study into the learner needs of small to medium sized enterprises. Using a full action learning approach, the learner needs and learning processes of about 40 owner managers of SME construction companies, working in 7 AL SETs, were elicited using a portfolio of methodologies including: thematic interviews, empirical observations, case study explorations, ethno-methodology and full learner reports of all action learning meetings. All the material were content analysed and, using a grounded theory approach, a new model of mid career professorial learning was developed known as "Consilient Leadership". The funding from this research led to further formative evaluation and to the development of a "balanced and open learning portfolio "of materials suitable for SMEs. Finally a summative evaluation was also undertaken. 'Research' in this project relates to the original investigations of the learning needs of SMEs.

The project was managed by a researcher with an academic background, she had worked for worked for many years in industry and was skilled at communicating at many different levels to overcome the difference in "languages" between SME participants, academics and business support agencies. She also acted as a SME in her own right and *therefore acted both as a participant observer on the development and an observing participant in the personal testing and evaluation of materials and support.* Her role was to undertake relevant content analyses of all materials and thought successive summarising to elicit the major findings and other interesting conclusions. Shown in the next section are some summary findings from all the projects taken together as they concern those SME’s relating to the construction sector.

3. Major Impacts and Overall Findings

In general the only limitation to the action learning process relates to the time limits of the meetings themselves. This was on the basis that the ‘learning space’ provided for the managers had the right balance between deep reflection to give confidence and deeper understanding on the one hand and learning from creative and innovative actions at work – the required implementations from each meeting. Hirota (15) had also noticed some reluctance on the part of the managers to implement actions which emanated from the meetings. SET Advisors always tried to provide compelling advice to encourage action for change with respect to the most difficult skill to learn from the beginning of the SET. If not handled sensitively and correctly, through good SET support, the real benefits of Action Learning - to improve work and actual processes at work - may well not be followed through with action and hence the real benefit maybe reduced.

Table 1- Examples of some of the learning outcomes reported by the evaluation team and Facilitators

Management Development	**Realisations**	**Technology**	**Information Transfer**	**Tangible Outcomes**
Development of production management skills through ensuring enough materials are on site for continuous work The use of Microsoft project to help the practical management of their businesses Adoption of longer-term strategic focus and longer-term goals Development of time management skills Manager moving away from operational aspects of the business Review business plans Learning to share worries/issues with SET A more strategic approach towards the business. Movement from "employee" to "entrepreneur" mindset – e.g. knowing the market, staying ahead of the market, and paying attention to small but important things. Listening to the variety of perspectives within the group has allowed members to build confidence and move on to growing their businesses	Development of understanding of customer needs through questioning and reflection from other SET members An understanding that computers are not to be feared rather they can be used to help and improve businesses Development of understanding that a business can grow through effective marketing strategy Understanding of how new technologies can be applied in a way which will help to grow the businesses. Realisation of underlying problems with businesses e.g. realisation by owner – manager that their business had no clear direction or strategy Learning can be fun Realisation that original aims and plans for the business were out of touch with the current direction of the business. Realisation that growth must be in accordance with the owner-managers own ambitions and hopes for the business. In one case this meant continuing the businesses ethical stance. Realisation that "experts" don't always hold the answers – more useful to start asking yourself the right questions(as you are the expert on your own situation) and then take action as this is the best way to learn. You can learn from any action you take whether the outcome is positive or negative There has been a realisation that a balance has to be sought between running these companies as a "creatives" and as profitable businesses.	Computerisation of files Development of websites after formal input on web design Use of Microsoft Project and other business packages Discussions and action in the area of internet marketing Development of understanding of the use of SAGE programme for accountancy related purposes. Use of new software tools	Community awareness Where to gain help and advice in order to make decisions about expansion Development of Knowledge around the use of Microsoft programmes Gained knowledge of funding opportunities for SMEs How the action learning process can stimulate innovation Alliances formed with university departments with a view to a future joint venture. Employment of a marketing expert to help with strategy Use of techniques to achieve longer-term focus such as "futurising" Opportunity Cost Understanding of how to examine profit and loss accounts Information has been transferred regarding: Limited Companies VAT Outsourcing Business Link services Further courses Information about potential investors Sharing expertise in certain areas.	Development of new construction products and services e.g. new light lunch menu and eye tests after 5pm. Networking and building alliances with former competitors to bid for larger contracts and manage peaks in workload. Increased turnover Seeking further development through courses Development of more sophisticated marketing strategies helped by website design Employment of new staff to meet increased workload Networking and alliances e.g. several members from different backgrounds are currently working together who would not have previously considered this as an option. In line with more strategic approach, new staff employed to deal with technical work to free up owner-managers' time The purchase of new premises Employment within in the SET

All SET members who sustained their involvement in the SET to its completion, clearly enjoyed the process and gained a great deal concerning their own self-awareness especially with respect to valuable personal (‘therapeutic help as they called it) lessons. Nevertheless, *most of the volunteer action learners were prepared to spend more than*

30 hours contact time working in their action learning SETs, while the remainder (less than 10%) had at least spent between 3 and 30 hours in the process; this is a considerable commitment from busy construction professionals who often loathe giving up even the most minimal time for training and education. All participants grew in confidence and every participant had a different learning outcome; see table below for just some of the many examples of successful delivery, outputs and outcomes.

4. Specific Findings

The research also revealed some more specific findings with respect to the learning of mid-career professionals. These findings are now reports item by item.

4.1 Key Learning Point 1

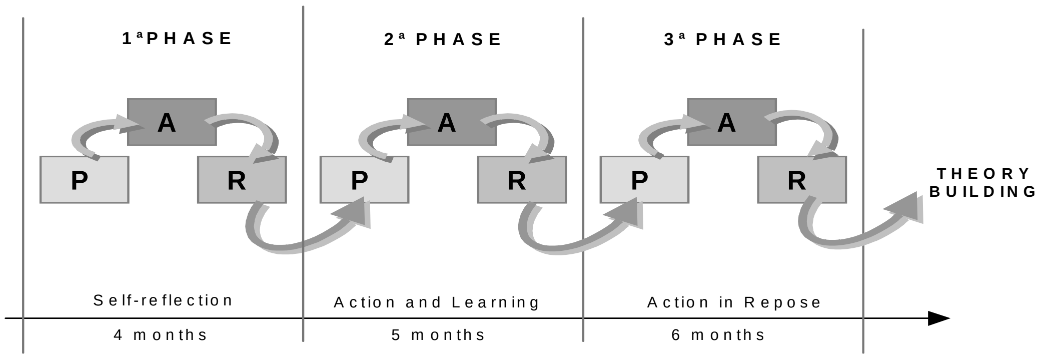
It is important to have facilitators for all forms of educational micro networking for SMEs to have: an empathy with, and personal professional expertise to share with their SMEs; be capable of coaching, rather than advising their SMEs; and willing to be supportive in difficult areas of their enterprise development

4.2 Learning Point 2

Even fairly inexperienced SET Advice can lead to best practice in SME learner development by sticking to the basic principles of Action Learning as espoused by Professor Reg Revans. This finding complements previous ones by Powell et al [17] and the Networking North West Evaluations [18]. Explaining this in more detail, using the Brazilian Action Learning SET as an example which operated for fifteen months, from December 2000 until January 2002. It consisted initially of five construction managers, all civil engineers, and finished with four. Two managers left the SET as they felt unable to give the time to it and one new one was invited by the SET members to join them after the fourth month. The professional profiles of the SET members completing the exercise are shown below. The managers who were involved were well known to the Universidade Federal do Rio Grande do Sul and seemed open to action and change.

Bernardo	Production Manager of medium sized construction company responsible for the development and construction of major residential and commercial buildings. He was also the manager in charge of the company’s maintenance department.
Alexandre	Production manager of a small construction company that works as a contractor for private residential, health and commercial clients. During his participation in the SET he had co-ordinated the process for implementation of the ISO 9000 certification in his company.
Roberto	After a long period of working as an assessor for the state government in the ‘Secretario de Habitaçao’ this manager returned to private construction work as a self employed engineer. During his participation in the SET he was working as a site manager in a medium sized project developed for a private client. He was hired by the design office that developed the project.
Klaus	Director of a small construction company in the interior of the state of Rio Grande do Sul. His company developed and constructed many different projects; commercial and industrial buildings; industrial ‘pisos’, steel structures. He mainly works for private clients.

All of the managers were invited individually and volunteered to take part without their companies being aware of their detailed involvement excepting in the case of the company director. However, the companies had all been working with the University for sometime and welcomed their approach. Most of the managers were interested in the possibilities offered by the SET to exchange understanding of practice and learn more from each other. To the managers it was an opportunity to develop new competencies in order to deal better with their practice in their own work context. The four managers had never worked together before, although they were acquainted with each other. There was another member of the SET who acted as a participant observer - Claudio Antonello, an organisational psychologist was undertaking her own doctoral studies and helped Lantelme record the activities and behaviour of the SET during its operation. The resulting SET ‘Action Minutes’ provided useful feedback to the SET members on their individual learning processes. Elvira Lantelme – the doctoral researcher undertaking the Brazilian case - provides her own short narrative to give the reader a feel of the progress of the SET during its fifteen months of operation in her doctoral thesis (18) for those who read Brazilian Portuguese. In summary here, starting with the overview, during the development of this AL Set there were three planning-action-reflection cycles.



The actions determined different SET members reactions which established three different Set phases. The analysis and reflection done in each cycle allowed for better understanding of AL process and redirections in Set Adviser strategies and actions for facilitating the Set. Set advisers Changes in managers’ behaviour can be observed in the graphics below, mainly by comparing the curves on the different phases of the set.

As Bernardo moved into the second phase of his Action Learning experiences he was much more conscious about his controlling and centralising management style as well as about his resistant (reactive) behaviour in the set. On the second phase he developed some changes in the way he was managing his team at the maintenance dept., giving them more autonomy to take decisions. His behaviour in the set also changed, as it can be observed in the graphic (resistance – b) below. He was more open to the set questioning and more committed to contributing to the learning of others (a)

In his second phase, Alexandre managed to improve his own engineers’ participation and commitment in the improvements his companies were making as a consequence of quality certification. In different moments in the SET he asserted that his participation in AL resulted in many changes in his behaviour in the work and in his personal and family life. He said he developed his capacity to listen to others, paying attention to their opinions and being less resistant to them.   These changes reflected also in his behaviour as a set member, more committed with his SET partners’ learning and less resistant to questioning as the *graphic below shows. He was very satisfied with the results achieved in his work and also about the changes he observed in himself.*

Roberto radically modified his behaviour in the SET. As a good listener and observer he had always had a good perception of the others problems and as such could contribute with challenging and penetrating questions. The graphic below, shows the frequency of his interventions, and also reveals his commitment increased in the second phase. As a consequence he acquired the respect of the other SET members. He did not actually say much in the SET, but when he said something the others stopped to listen. But, in the second phase, the graphic reveals that his own behaviour was still very resistant to questioning.

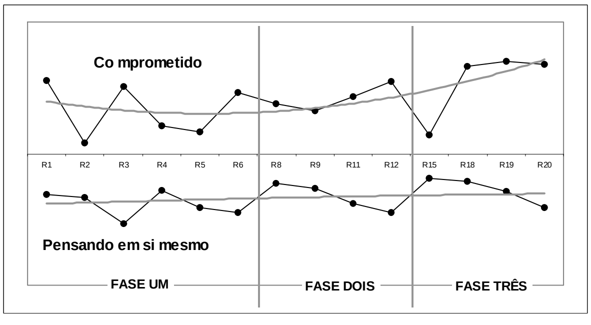
Klaus also modified his behaviour as a SET member during the second phase of the Action Learning. When he first participated (in the 4th SET meeting), it had already started. He said he felt like a substitute member, not part of the group. In the 2nd phase he started talking more, asking more questions and also demonstrating more commitment with the other learning (graphic a). Klaus was more conscious about his insecurity and difficulties in taking decisions in order to put his ideas in to practice. In different moments he discussed this issue with the SET. His difficulty in acting became a true barrier to his learning.

If we analyse the graphic below for the SET as a whole, we can observe a tendency for them to become less resistant to questioning and have a greater commitment to the process itself. Except for Klaus, who was very much confronted by SET members in the second phase of the Action Learning, the Managers perceived themselves to have developed more trust and commitment

"I think the group became more friendly. It was very sincere when someone commented, when you said you would leave: that does not matter, the set will continue. This is something that characterises the set. This process has been important to everybody" (Roberto, final interview)………..".I would say, it was a good reflection moment. We have a lot of trust between ourselves. There is a true preoccupation about the others. Commitment developed" (Alexandre, final interview). "I think trust in the group evolved, confidence evolved. For me, this programme is very good, that is because I don't mind travelling" (Klaus, final interview)

At the end of their formal Action Learning support, only Bernado expressed his doubt about whether the SET should continue. However, in his interview in this benchmark, he made it clear that his view had now changed and was supportive of the SET continuing in some form.

a) as a SET member



b)) as a problem owner

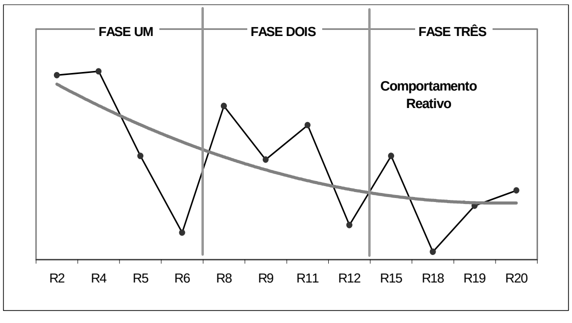


Figure 1 Bernado's behaviour as a SET Member

In his opinion at the end of phase three of support, the SET lacked a clearer systematic way of working. He was also fairly conservative about the level of trust and confidence that had been developed in the SET.

"I felt the SET oscillated, there were meetings that did not add value. He seemed to be walking in circles…

I think it oscillated a lot, it could have added more value". …..“I think Action Learning should have a more systematic way of working, sometimes we were lost (…) but in terms of learning it was good. I think it could be better. We are more mature, but not that much".

a) as a SET Member **b) as a problem owner**

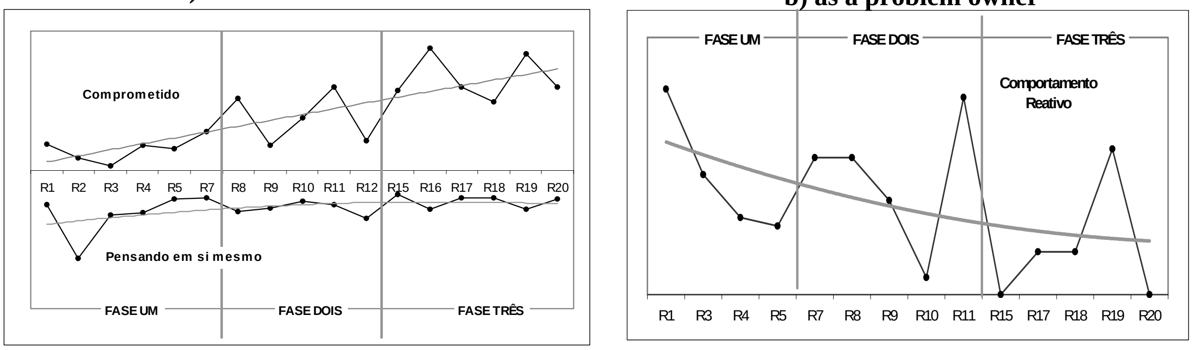


Figure 2 Alexandre's's behaviour as a SET Member

a) as a SET Member **b) as a problem owner**

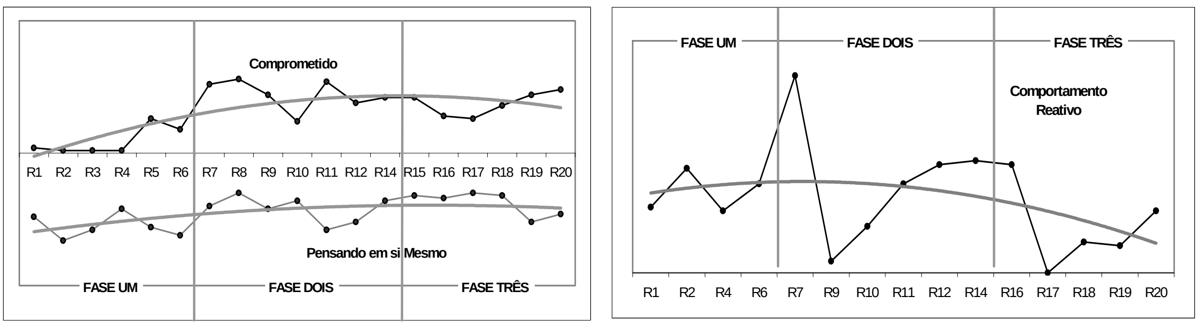


Figure 3 Roberto's behaviour as a SET Member

a) as a SET Member **b) as a problem owner**

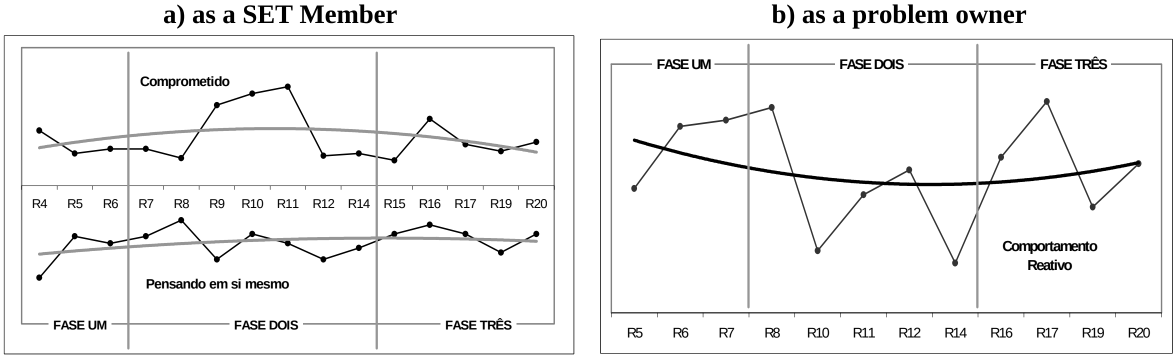


Figure 4 Klaus's behaviour as a SET Member.

4.3 Learning Point 3

It is clearly important for SET members to want to participate in an Action Learning SET voluntarily. Those who left the SET did so of their own accord. Since the results of any SET meeting involve putting change processes into action, there will be a clear impact upon any participants own company. Without the support of the company to enable the testing of new actions at work it is not possible to follow through educational purposes with effect. This is unlike traditional workforce training which requires no implementation, so any learner needs the full support of his/her company, supervisors and the bosses to take full part in the process. This was possible, in the main, for the four managers with respect to their own actions.[2]

The AL SETs in this paper focus towards the psychological, self-awareness and emotional intelligence aspects of Action Learning which have particular effects that are mentioned later in this paper. Initially, for the first six months, the meetings were held fortnightly and then on a monthly basis to the end of the period in which formal learning support was provided. Network North West Educational Micro Networking meetings were held mainly at monthly intervals.

4.4 Learning Point 4

Our Experience of the right frequency of the learning process shows that fortnightly Action Learning meetings were essential to keep up the momentum of understanding about Action Learning and indeed for one SET participant in Brazil he had understood sufficient about the general principles of Action Learning during such a short period to introduce it into the mainstream working of his company to good effect.

All SETs went through different phases. In phase one, which was called ‘the therapeutic phase’, SET members mainly discussed their personal problems relating to their work such as, job satisfaction, difficulty in controlling their different workforces and general emotions and feelings relating to their jobs and their colleagues. In short, it was found that ‘it is impossible for the small business to separate the personal issues from the technical when dealing with SMEs and indeed it may be extremely counter productive so to do’.

4.5 Learning Point 5

Those who had experienced the Action Learning in this experiment indeed enjoyed this unusual and counter-intuitive process; counter-intuitive in the sense that they were learning from each other, rather than a teacher. They also found it valuable to their own self-development and put themselves in charge of their own learning – an experience unlike any other they had found in conventional training. Two of them were sufficiently enthusiastic about the process to introduce it into their own companies with positive effects. Spreading these positive experiences of Action Learning in this way by ‘enthusiastic word of mouth’ firstly indicates their own positive evaluation of the process and secondly shows their willingness to share this experience with others. NORIE, as in the Networking North West, has shown this form of marketing for SMEs is the best way of attracting new participants into this novel educational process.

[2] One of the SET members – Alexandre - was so enamoured of the Action Learning process that he tried to develop an in house initiative with his own production managers based on the benefits from his own experiences in Action Learning. Lack of support by his own directors for this, curtailed progress on the initiative. Action Learning meetings were regularly interrupted by other work requirements and some managers left the SET because they did not have time for full participation. Other managers wanted to take part, but again time was not made available to ensure adequate SET participation. However, Rio Grand du Sol and Alexandre are now working with other directors with a view to further implementing Action Learning within the company.

All SET members, when asked, felt this was the best way to enrol new SET members and were even prepared to be captured on short marketing 'video clips' themselves giving reasons and recommendations to others. They suggested they could be of two types:

- For those initially intrigued by the idea of the AL process, the best way would be to indicate simply how, and in what way, the process had particularly changed their working lives; how it had enabled them to penetrate more deeply with effect into socio-technical issues that had previously been impenetrable - 'let me tell you how it was for me!'

- For the more cynical, who might feel the process odd and, even counter-inductive and long winded, a more subtle approach might be to stress the eventual long term impacts and benefits of this learning process and to ask the cynical just to "suspend their disbelief" and give the process a chance. Through continuous, slow, subtle but gently persuasive support, the aim would then be to win colleagues over. Roberto had most interesting thoughts in this respect. He had learned so well how to win people over in this that he had developed a new consultancy practice to offer this as a service to colleague engineers.

4.6 Learning Point 6

Providing learners with concrete information on their learning progress, through learning trend charts, proved to be an extremely positive way of marketing and overcoming barriers to change and those "bad but common" practices normally highly resistant to change. Good feedback at the right time can provide realistic ways of sustainable and competent new "good" practices, when the learner is ripe to learn.

4.7 Learning Point 7

It is important for work focused learning of real benefit to the industrial participant learners, that Action Learning SET Advisors ensure the right balance of learning support between enhanced manager's self-awareness, empathising with the workforce and understanding the social aspects of the working context on the one hand, with building new professional capabilities, adopting relevant new technical approaches and gaining a good systemic understanding of new competencies in practice on the other. All our researchers confirm that, properly delivered, Action Learning does allow deeper useful learning that is sustained beyond the support of SET advice. However, to ensure quality impact on site management does require careful intervention of the Advisor to guide SET members towards the sort of simple questioning approach proposed by Revans. With such a focus major work-based improvements in managerial action are engendered, tested, and honed to become useful new "tools" in support of change.

4.8 Learning Point 8

While significant therapeutic and personal development seems to occur, no matter what kind of SET advice is given, experienced SET Advisors know how to carefully refocus individuals to be able to face up to real work issues, problems and challenges. The learning charts developed in this study have helped give the necessary feedback to facilitate better development in this respect. Such focusing is essential in ensuring the earliest "return-on-their investment" for the participants in Action Learning, and especially for their companies.

4.9 Learning Point 9

All SET members welcomed the role of the SET Advisor in focusing them towards deeper and more useful questioning of work activities. They all reported her improvement of this focusing as her experience increased and the way she gently opened up their emotional intelligence aspects of their working lives, thus helping them put all things – technical, managerial, process, methodology – into a more complete perspective enabling them to act in a more integrated way.

4.10 Learning Point 10

Even for SETs lasting for some time, the role of the Advisor still continues to be useful in "shaking members out of their complacency" and focusing them onto work relevant issues with the right kind of questioning at he right time.

4.11 Key Learning Point 11

Coach facilitators can act as intelligent brokers to enable corporates and SMEs to learn from each other in a virtually beneficial way.

4.12 Key Learning Point12

The Action Learning process does seem to be a good way of getting those who are traditionally weak learners, such as in construction, who often those who fail in the traditional educational system, to fully engage and grow in capability and competence.

4.13 Learning Point 13

The South African benchmarking exercise particularly showed that it can be extremely useful to have between meeting contact with SET members in order to:

1. *prompt them to do the actions they agreed;*
2. *find difficulties they were experiencing in i);*
3. *learn what sort of problems, issues and challenges were likely to be discussed at the next meeting so the Advisor could prepare better.*

4.14 Key Learning Point 14

The facilitator in the Business Bridge Meetings took an extremely proactive role, especially between meetings, in providing coherent support for any SME's actual enterprise development and in setting up themes for future meetings. This is much like John Whatmore's between meeting support in his Creativity Clubs [20]. Action Learning advisors in UK and British Action Learning SETs could learn from this with effect; the power of the telephone in supporting early constructive actions for change, stimulated by Set members, is also seen to be valuable. The use of Action Learning minutes to give immediate feedback of lessons learning directly from the meeting themselves is further seen by the facilitator, as in our experience, to be constructive in support of SME change.

5. Conclusion

This case study provides a powerful benchmark revealing the value of an “action learning type” approach to engaging and empowering construction SMEs, with a whole range of capabilities and levels of knowledge, to learn from each other, and their supply chain corporates, for mutual benefit. The similarities of the underlying learning process between the UK, Brazil and South Africa in implementing such an approach is clear and reinforce other evaluations of its overwhelming success in engaging busy managers to learn how to participate in many new ways both tactically and strategically. Their new skills developed include learning how to question others in a penetrating and useful way, to actively listen to peers, bosses and subordinates equally and act with understanding as a result and to learn from all their actions, these now seem to have been embedded in useful ways to the benefit of their mainstream working. Interesting other detailed learning points have arisen when comparing the more proactive, professional disciplinary and advisory role of facilitators. These learning points have been fed into the educational packs developed for the training of future coach facilitators for “education micro networking” in the North West and beyond; these packs are available from the author.

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Assessment of Demand & Supply of Quantity Surveying Professionals to the Sri Lankan Construction Industry

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Abstract

Quantity Surveyors are the cost consultants in construction. They possess expert knowledge in construction costs, material usage, and labour norms. Quantity Surveyors have their expertise in project finance, project cash flows, contractual procedures and legal aspects pertaining to construction. Due to the present scarcity of labour, material and finance, Quantity Surveying profession has got recognized in both domestic and international markets.

Sri Lankan construction sector has shown 6.7 % growth as per central bank bulletin in the third quarter of 2005. Tsunami reconstructions also contributed to the above growth. Simultaneously demand for Quantity Surveyors has also increased significantly.

This research is focused on analyzing the demand and supply of Quantity Surveyors to the Sri Lankan construction industry. Several demand factors were identified for the period of last five years, which has caused to increase the number of job opportunities.

Supply sources of Quantity surveyors were also identified and compared for the contribution. As per this study on evaluation and forecast of demand and supply, Supply of graduate and non graduate Quantity Surveyors is insufficient to cater the future demand. Therefore, supply sources are to be stimulated to meet the demand of the industry.

Key words: Quantity Surveying, Demand, Supply, Graduates ,Non-Graduates

1. Background

1.1 Introduction

The construction industry, being the means by which society shapes the built environment, carries considerable responsibility in ensuring that building and civil engineering work of the highest standard is achieved in prevailing constraints. Historically, the construction industry has played an important part in meeting the social, economic and technological demands of developing civilization. The role can therefore be defined as being the management of resources in the development, production, maintenance and disposal of capital assets [3].

But with the likely changes in society, the role of the Quantity Surveyor has been evolved constantly and the present Quantity Surveyors practice their competencies in diversified paths within the construction industry and as well as beyond the boundaries of the construction industry [1].Since the construction industry becomes more significant in the economy and it has created more employment opportunities to the nation [8].

The market forces regulate demand and supply for the labour which decides the price of the labour which has a greater impact on the business, government policies, general education and the technical and vocational education. Demand for labour is the number of employment opportunities available in the public and private sector institutions within the country and overseas as well. Supply of the labour represent the number of workers enter into the world of work from schools, universities, and technical and vocational training institutions.

The visible changes and growth of Sri Lankan construction industry have forced the Sri Lankan Quantity Surveying profession to evaluate its demand and supply.

1.2 An overview of the Quantity Surveying Profession

A Quantity Surveyor is the person controlling the financial aspects of a building project. They are the 'accountants' of the building industry does planning and managing the cost of building projects from start to finish. More descriptively, the Quantity Surveyor is the one who “ensures that the resources of the construction industry are utilized to the best advantages of society by providing, inter alia, the financial management for projects and cost consultancy services to the client and designer during the whole construction process”. (Ashworth and Hogg 2002 cited by [4]).The role of the Quantity Surveyor is currently more vital than the profession when it was originally established in England in 1785.

The Quantity Surveyors work in conjunction with architects, consulting engineers and contractors safeguarding the client's interests as an independent professional with specialist skills. Once the Quantity Surveyor has been employed or commissioned by a client, Quantity Surveyor turns considerable expertise to ensure that the client gets full value for money. So that they have to keep in touch with appreciate and understanding all aspects & disciplines of building, construction practice, design and engineering combined and be able to cost fairly, accurately and precisely [7].

The origin of Quantity Surveying in Sri Lanka can be traced back to the British era. British Quantity Surveyors were employed during colonial period in the Public Works Department of Sri Lanka. During World War II these Quantity Surveyors left the country. Later, Sri Lankans who had the opportunity of obtaining foreign education returned and practiced as Quantity Surveyors [5]. As per Miskin 1993 [3], in the past the only course available in Quantity Surveying was the Builders' Quantities course at Ceylon technical college. Today, there are number of Quantity Surveying programmes, in Sri Lanka such as a four year BSc honors degree course in Quantity Surveying at University of Moratuwa (started in 1985), a three year part time National Certificate of Technology course conducted by technical colleges throughout the country and other courses conducted by private sector organizations.

1.3 Significance of Quantity Surveying Profession in Sri Lanka

Labour as a factor of production plays an important role in the socio economic development of the country. A labour market is the place where both suppliers and buyers of labour meet together. In the case of Quantity Surveying profession, it has a significant importance in the construction industry both in local and international labour market. Following data (Refer table 1 and 2) represents the fact that, how much Quantity Surveying profession is significant in the industry. The data have been obtained through LABOUR MARKET Information Bulletin published by the Tertiary and Vocational Education Commission, Ministry of Vocational and Technical Training.

Table 1-Ranking for High Demand Foreign Jobs

Occupation / Jobs	**Rank**				
	2001	**2002**	**2003**	**2004**	**2005**
Nursing	1	1	1	---	1
Computer operator	2	2	---	4	2
Civil Engineer	3	3	2	1	3
Accountant	4	4	3	2	**5**
Quantity Surveyor	**5**	**5**	**4**	**3**	**4**

Source: LABOUR MARKET Information Bulletin 2005

Table2-Foreign Job Orders

Job Category	**Job Orders**				
	2001	**2002**	**2003**	**2004**	**2005**
Technical general	765	862	1281	833	1,898
Technical- AC & Ref.	1079	711	1017	468	1,102
Quality Controller	387	648	734	307	710
Nurse	1065	657	1147	---	687
Computer Operators	507	532	109	219	445
Quantity Surveyors	**115**	**110**	**132**	**197**	**255**
Technician-MEP	106	137	167	145	290

Source: LABOUR MARKET Information Bulletin 2005

Due to the continuous changes in the industry and development of technology, the profession has faced many, threats and opportunities. In whatever the dimension profession shapes, the financial management expertise of the Quantity Surveyor remains in the demand [8].

1.4 Aim

The ultimate aim was the assessment of demand and supply of Quantity Surveying professionals to the Sri Lankan construction industry.

1.5 Research Methodology

Research methodology was mainly divided into two sections as far as there are two main categories in this research. The two main categories are Demand and Supply Measures of Quantity Surveying profession.

In order to identify the factors that are being demanded by industry, news paper survey was done by referring weekend papers from January 2002 to December 2006. All the local Quantity Surveying advertisements were taken into consideration monthly wise when analyzing the factors. When the sample of Quantity Surveying vacancies in the news papers was selected, convenience sampling method was used since this research is under exploratory category. Forecasting was done using Time Series Analysis.

In the supply measures, it was mainly done to establish the number of Quantity Surveyors passing out from relevant institutions from January 2002 to December 2006. Three sources of evidence were used for data collection in this study. They were documentation, archival records and semi structured interviews. The table 3 provides variety and mix of interviewees comprising the respondents from Universities Grants Commission Sri Lanka , University of Moratuwa, Vocational Education Commission, Ministry of Vocational and Technical Training.

Table3-Variety and Mix of Interviewees

Name of the organization	Nr of Interviewees
University Grants Commission Sri Lanka	2
University of Moratuwa	3
Tertiary and Vocational Education Commission	3
Ministry of Vocational and Technical Training	3

2. Research Findings and Analysis

2.1 Demand Side

The figure 1 illustrates number of job advertisements published in news papers for gradates and non graduates since 2002. Compared to year 2003, year 2004 has shown 140% growth. Reason for this hike in year 2005 is tsunami reconstructions and there are number of preferred fields specified in advertisements.

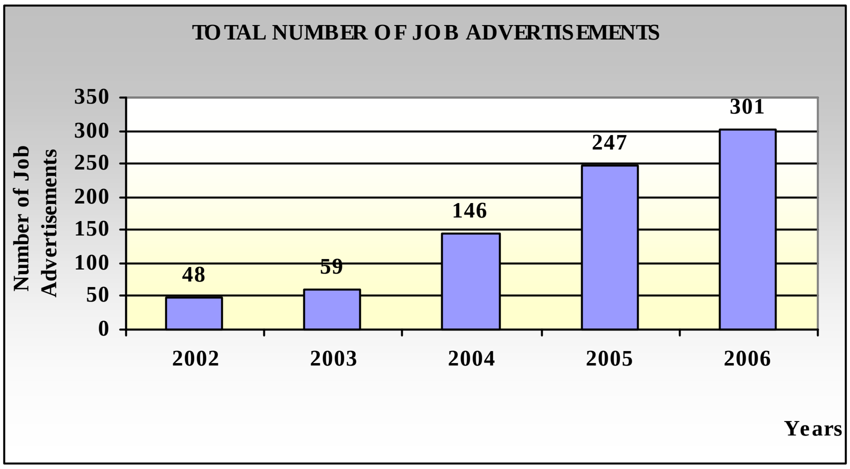

Figure 1- Total Number of Job Advertisements

2.2 More Preferred Fields

In this research, major areas/fields of preference were identified as building, civil, both building & civil and mechanical, electrical, plumbing (MEP) work. The percentages were taken considering total number of advertisements. According to the findings, employers are looking for specialize Quantity Surveyors for relevant field. There are many opportunities available in building sector rather than civil engineering sector. However, Quantity Surveyors who have both civil engineering construction and building construction experience shows increasing demand. Quantity surveyors in MEP sector is minimal, because its complexity or unavailability *of Quantity Surveyors in the market. Category "field unspecified" is for open ended advertisements which are advertised without the required field. However, field unspecified advertisements have been reduced over the period (refer figure 2).*

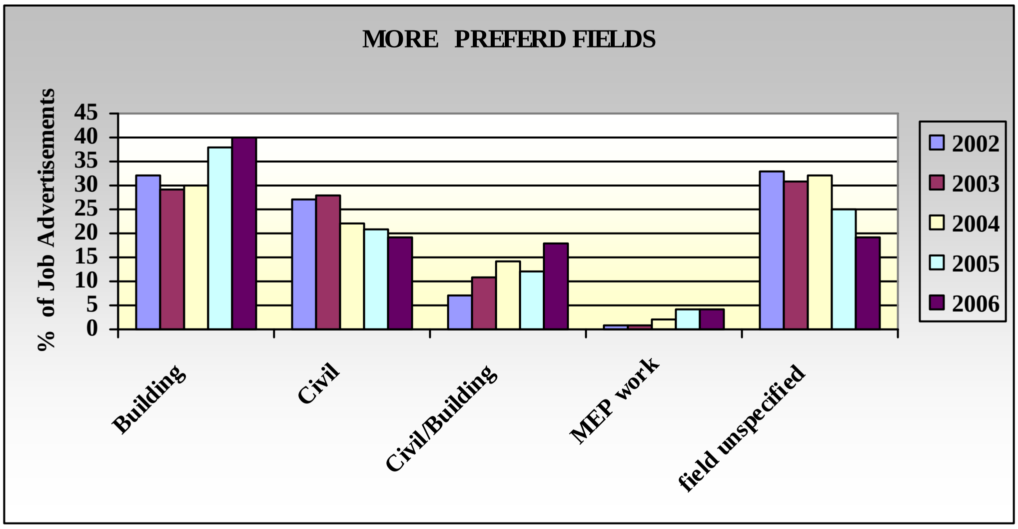

Figure 2 - Graphical Representation of More Preferred Fields

2.3 Experiences Requested

Most of the advertisements used to request work experience (refer table 4 and 5). In graduates category 1 – 3 years experience is the popular request.14 % - 17 % of advertisements have invited without any experience for graduates. In non graduates categories 5 – 7 years group is in better side. It is only 4% - 7% of non graduates are invited without experience. However, "field unspecified" has diminishing over the years.

Table 4 - Percentage Experiences Requested for graduates

Category	**Year**				
	2002	**2003**	**2004**	**2005**	**2006**
Without Experience	14 %	14 %	12 %	15 %	17 %
1 - 3 Years	**25 %**	**33 %**	**31 %**	**34 %**	**37 %**
3 – 5 Years	22 %	24 %	23 %	22 %	21 %
5 – 7 Years	14 %	12 %	16 %	13 %	10 %
More than 7 Years	9 %	7 %	8 %	7 %	7 %
Field Unspecified	16 %	10 %	10 %	9 %	8 %

Table 5 - Percentage of Experiences Requested for Non Graduates

CATEGORY	YEAR				
	2002	**2003**	**2004**	**2005**	**2006**
Without Experience	4 %	7 %	5 %	4 %	4 %
1 - 3 Years	4 %	6 %	10 %	14 %	16 %
3 – 5 Years	18 %	21 %	21 %	22 %	21 %
5 – 7 Years	**30 %**	**33 %**	**30 %**	**29 %**	**31 %**
More than 7 Years	23 %	15 %	16%	17 %	16 %
Field Unspecified	21 %	18 %	18 %	14 %	12 %

2.4 Graduate and Non Graduate Share in the Market

According to the data collected on market share of graduates and non graduates (refer table 6), market share of graduates have been reduced during the last five years. Only in year 2002 they have higher market share. Rapid incensement of non graduate supply, constant graduate supply, employment boom for graduates in middle east and low return from overseas, are the reasons for the decrease in graduate share.

According to the above table 6 , it can be undoubtedly seen that share of the graduates has been decreasing. Since 2003, share of non graduates has been increasing while maintaining a 60 % average mean. This may be due to several issues as such availability, high salary rate and increases in supply.

Table 6 - Graduate & Non Graduate Share

CATEGORY	YEARS				
	2002	2003	2004	2005	2006
Graduate	53%	42%	40%	35%	34%
Non Graduate	47%	58%	60%	65%	66%

According to the above table 6 , it can be undoubtedly seen that share of the graduates has been decreasing. Since 2003, share of non graduates has been increasing while maintaining a 60 % average mean. This may be due to several issues as such availability, high salary rate and increases in supply.

2.5 Graduate and Non Graduate Demand Forecasts

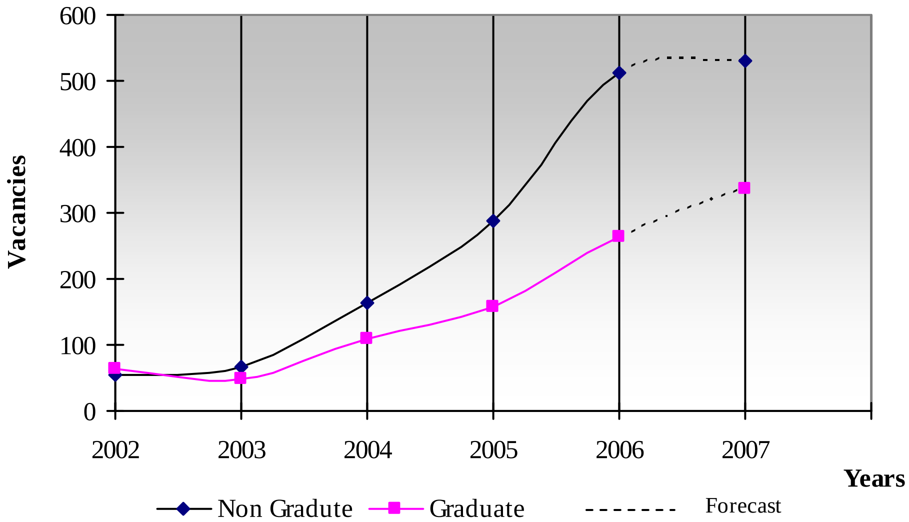

Figure 3 - Graduate & Non Graduate Demand forecast

This section mainly focuses on detail evaluation of demand and forecasting the future demand of both graduates and non graduates by analyzing Quantity Surveying vacancies appeared in last five years. More precise forecast was done for year 2007 using time series analysis. In order to identify the variation of this time series, vacancies are counted yearly and shown in the figure 3. It can be stated that still graduates have increasing trend in their graph while non graduates are proceeding with small variations. In between 2005 and 2006 the rate of increase has changed. The more information regarding those scenarios has been elaborated in demand and supply evaluation.

2.6 Evaluation of Demand & Supply

2.6.1 Graduate demand and supply

When comparing the demand and supply for Quantity Surveyor's, the supply is not keeping with demand (refer figure 4 and 5). According to the figure 4, the gap between the two graphs is increasing. Even though supply is not up to satisfactory level still demand has been continuing to increase. It can also be clearly seen by the forecast. The demand in year 2005 and 2006 has increased significantly due to Tsunami reconstruction works. Figure 4 has been presented using all pass out graduate students. However the average supply of graduates to the Srilankan market is still lower than shown in the graph since most of the graduates are leaving the country after six months time from their graduation.

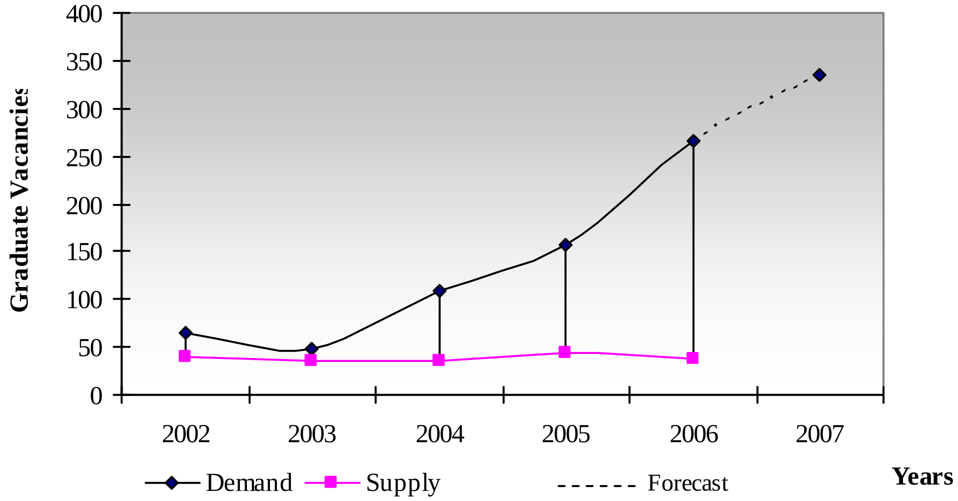

Figure 4 - Graduate Demand and Supply Forecast

2.6.2 Non Graduate demand and supply

The figure 5 illustrates the demand and supply curves for non-graduates. The year 2002,2003 shows the higher supply than the demand. But since 2003 the trend has reversed and the gap between demand curve and supply curves are increasing significantly with a similar trend to the graduate graph. The Figure 5 also illustrates the impact of Tsunami reconstruction work, where there is a significant raise in demand between 2005 and 2006.

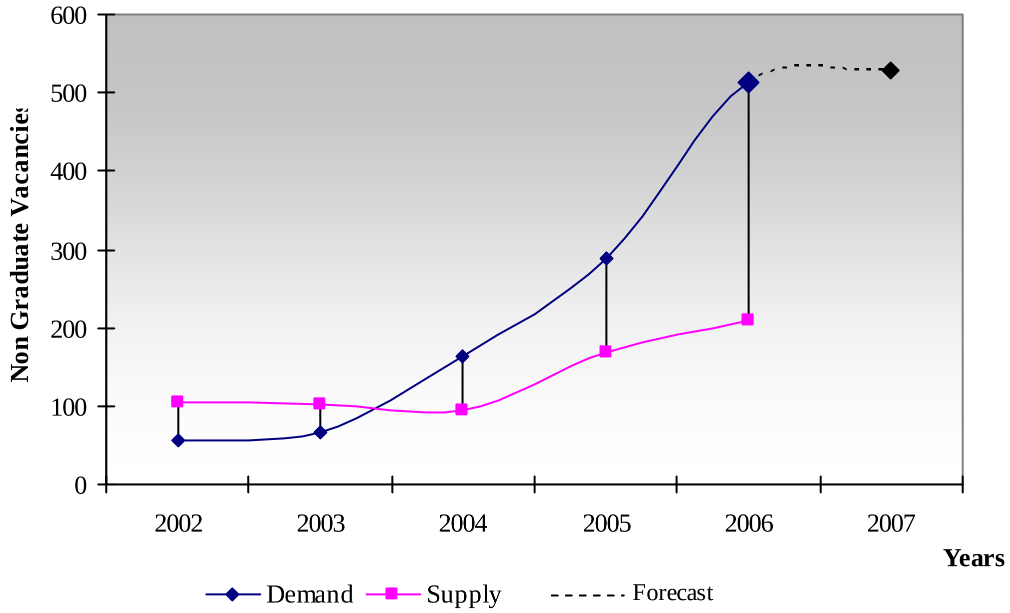

Figure 5 - Non Graduate Demand and Supply Forecast

3. Conclusion

The profession of Quantity surveying has to meet demands of the market as all other professions. Quantity Surveying profession explored opportunities and expanded today due to scarcity of economic goods, improved living standards, and advancement of the technology in Sri-lanka. In order to forecast the future demand, it was required to assess the demand and supply situation of the profession in the present market.

According to the identified demand factors, Quantity surveyors who have experience in civil engineering construction and building construction are the individuals who have highest demand. When considering the professional qualifications and experience, graduates who have minimum two years experience and non graduates with more than four years of experience are the most attractive range for employers. Further for the period under review the market share of 60% has been filled by non graduates due to the non availability of graduates in the domestic market.

To fulfill the above demands, most of the non graduates are produced by technical colleges. An average of 235 students sat for the final year examination of each year and 60% of them have passed out from technical colleges at the end of each year. The University of Moratuwa is the sole supplier of graduates, where it produces 40 students per annum.

As per the market demand analysis and the supply side assessment, it can be recommended to significantly increase the supply of graduate and non graduate Quantity Surveyors and further to acquire experience in civil engineering construction. This would definitely enhance the quality of Quantity Surveying practice in Sri Lanka as well as reap higher financial benefits to the individuals with both civil and building experiences.

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Contribution of women managers towards construction industry development: Methodological perspectives

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Abstract

This paper endeavours to explain the methodology for researching the contribution of women managers to the construction industry development. The research is concerned with gender segregation in the industry and its impact on skills shortages. It further identifies how an increased number of women managers in the construction industry will help to change the gender segregation pattern and how this may contribute to the development of the industry by resolving the problems within it. This paper therefore mainly focuses on the research methodology that has been adopted in this research. Justifications are made for the most appropriate choice of methodology in terms of its philosophy, strategy and techniques. This paper further elaborates the chosen methodology, by explaining the data collection and analysis techniques, the research design and the design tests.

Keywords: Research philosophy, Research strategy, Research techniques, Research design, Research tactics.

1. Introduction

A research, in simple terms, is defined as something that people undertake in order to find out things in a systematic way, thereby increasing their knowledge [1, p.3]. The overall research process contains several activities such as topic selection, literature review, scoping, choice of research methodology, data collection, data analysis, provide findings and drawing conclusions. The appropriate selection of research methodology is very important in order to achieve valid and reliable findings. Thus, the choice of methodology plays a vital role in the overall research process. This paper endeavours to justify and explain the methodology for researching the contribution of women managers towards the construction industry development. The first section provides the overview of the study within which the background, research problem, aim, and research questions are briefly discussed. The next section justifies the selection of appropriate methodology followed by a further elaboration on the chosen methodology including the design tests.

2. Overview of the study

This section provides an overview of the research study. Before deciding the methodology it is important to understand the subject area as it will help us to choose the appropriate methodology. In this context, the background for the study, research problem, aim, research questions, focus of the research and the conceptual framework are detailed in this section.

2.1 Background for the study

Construction in the UK is one of the pillars of the economy. UK construction at its best, including its capability to deliver the most difficult and innovative projects, matches that of any other construction industry in the world [2]. Nonetheless, there is a deep concern that the industry as a whole is under achieving. It needs to modernise in order to tackle the severe problems such as low and unreliable rates of profitability, little investment in research and development, crisis in training, dissatisfaction among clients, and fragmented culture [2, 3]. With all these, the shortage of people with the technical and managerial skills to fully utilise the new technologies has been a problem in the construction industry for many years [2, 4, 5]. This skill and labour demand may be a threat to the long term growth of the industry and it may also challenge the industry's capability to deliver the projects on time, within budget and of the desired quality. Gender segregation within the construction industry could also be seen as a problem as it restricts individual's choices. This gender segregation damages the UK's economy by contributing to skills shortages and to the gender pay gap [6].

Although, the issue regarding the lack of women in construction has been a concern for many years, it has been made more prominent due to the potential skills shortage facing the industry. The constant reliance on a limited recruitment base, disadvantages the industry by disregarding half the population and the diversity of skills these people have to offer. By restricting the possible workforce, the industry is limiting the choice of applicants, which in turn may lead to the recruitment of lower quality employees. Currently, construction employers recruit and rely increasingly on workers from overseas, either inside or outside the European Economic Area (EEA) giving rise to immigration issues and an increasingly diverse labour force [7]. Increasing the number of women in the construction workforce may also contribute to solving the skills and labour shortage problems. Davey et al. [8] identify that increasing the number of women working in construction may go some way to improving the current status of the industry, firstly by utilising the full range of skills available in the population, and secondly by assisting construction organisations to become more efficient and adaptable to the needs of its customers. Women are of benefit to construction organisations because they are, by nature, good with people, less confrontational and are more likely to listen to the opinions of others, which will be beneficial when dealing with clients [9]. More women working in construction will improve the industry's image and will go towards improving the current skills shortage by also aiding the recruitment of other under represented groups, not just women [10].

The low number of women in the construction industry illustrates the under utilisation of human resources based on gender patterns. As per the CITB [11], women account for 9% of the construction workforce, of which 84% hold secretarial posts, 10% are employed in a professional capacity in design and management areas and the rest are craft and trade level employees. In this regard, women who really perform construction specific jobs fall under either managerial jobs or craft and trade level jobs. The under-representation of women in managerial positions may discourage potential female candidates who want to choose a career in construction by limiting the number of role models. It may also be a challenge to convince employers to consider the recruitment or promotion of women in the industry. Women gaining managerial positions will be a clear evidence to show that their career progression occurs in construction. Their presence in managerial positions is one of the most effective ways of ensuring their participation in decision-making. Thus, having more women managers will provide much inspiration for young girls interested in construction careers, reduce some of the barriers associated with recruitment practices and improve the culture in the long run. Further, women's characteristics may be used to tackle the problems in the industry as they possess more diverse skills than the traditional male workforce.

2.2 Research problem

The background of this study highlighted the problems in the construction industry and indicated the importance of having more women, and women managers in particular. These two concepts can be combined to investigate the ways women managers can contribute towards the construction industry's development by tackling the problems that the industry faces. Organisations have paid attention to the leadership styles of the people who occupy managerial positions, holding the belief that leadership is an important factor in achieving business success [12]. One of the major issues raised by Egan [2] is the shortage of people at top management level with the commitment to being best in class and with the right balance of technical and leadership skills to manage their business accordingly. The real issue in leadership differences lies in the equity in selecting the right person with the appropriate skills and qualities to ensure the effectiveness and success of the organisation [13]. A very recent article by Stevens [14] proposes a leader-manager model as the effective one for construction. He believes the leader-manager skill is the new driver in the industry, as the reality of the construction industry demands dual roles. Thus, he concludes that in order to better serve the construction industry the leadership role is to be redefined as having a business management component. In view of that, the contribution of managers can hardly be studied without considering the leadership component. In this context the leadership component has been identified as the primary area to be studied. The following sub-section provides the aim, objectives and the research questions of the research.

2.3 Aim and the research questions

The aim of this research is to explore and investigate the ways in which the leadership styles of women managers may contribute to the UK construction industry's development. To achieve this aim the following research questions have been formulated.

1. What are the characteristics of women managers?

2. What roles do women managers play in the construction industry?

3. What are the leadership styles exhibited by women managers in other sectors?

4. What are the leadership styles exhibited by women managers in the construction industry?

5. Whether or how may the leadership styles exhibited by women managers help to resolve the problems in the construction industry?

6. What benefits may women managers bring to the UK construction industry?

2.4 Research focus

Managers and professionals in industry can be categorised under four types as outlined below [9]. Women managers who fall under category 3 and 4 below will be taken into consideration for the purpose of this study.

1. Non management role: These positions are generally self-directed.

2. Supervisory role: These positions typically fulfil a supporting role to middle management.

3. Middle management role: These positions are mainly responsible for managing the whole process of a project and leading a project team.

4. Senior Management role: These positions are often the ones of power where company-wide decisions are made.

With an emphasis on leadership, the people recruited into construction, women managers in this case, need to demonstrate a strong base and offer the abilities that construction needs from them. Lack of empirical evidence on leadership styles of construction women managers shows the necessity to study it, in order to make a contribution to the existing body of knowledge. Hence, this research will focus on whether or how the leadership styles of women managers, at the top and middle level management in construction organisations, may contribute to the UK's construction industry development. This in turn may highlight the necessity to have more women managers in the construction industry.

2.5 Conceptual framework

A conceptual framework explains, either graphically or in narrative form, the main things to be studied – the key factors, constructs or variables – and the presumed relationships among them

[15, p.18). The study aims to explore and investigate the ways the leadership styles of women managers may contribute to UK's construction industry development. The primary objectives are to identify the characteristics and leadership styles typically exhibited by women managers and investigate the same in order to explore their contribution towards the development of the construction industry. It further identifies the appropriate leadership styles for construction women managers by learning lessons from other sectors. Figure 1 shows the conceptual framework of the study.

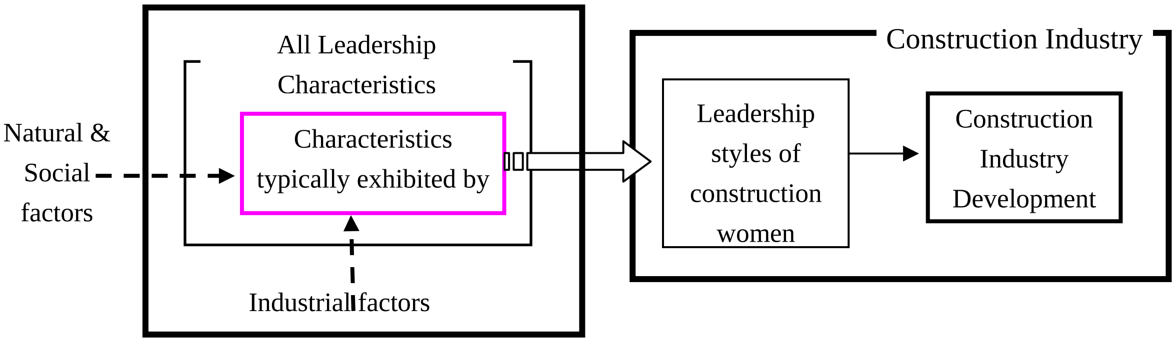

Figure 1: Conceptual framework of the research

This section briefly introduced the research study. The following sections, which are the core of this paper, deal with the methodology that could tackle the above-mentioned research problem and could answer the formulated research questions.

3. The justification of the methodology selection

Research methodology refers to the overall approach to a problem which could be put into practice in a research process, from the theoretical underpinning to the collection and analysis of data [16, 17]. There are many factors that determine the most appropriate methodology. The topics to be researched and the specific research question are the primary drivers in the choice of methodology [17]. In order to choose the most appropriate one it is important to understand the philosophical underpinning of this research. This section, which comprises three sub-sections, justifies the choice of methodology adopted to this research. Firstly, the positioning of this research within the overall philosophical continuum is explained. Secondly, the reasons for the appropriateness of a particular approach are illustrated. Thirdly, the techniques to be used with the data collection and data analysis are discussed.

3.1 Research philosophy

The basic beliefs about the world will be reflected in the way the research is designed, how the data is collected and analysed, and even the way in which the findngs are presented. Therefore, it is important to recognise and understand the personal paradigm as this will determine the entire course of the research study undertaken [16]. The term paradigm refers to the progress of scientific practice based on people's philosophies and assumptions about the world and the nature of knowledge [16].

The two contrasting views on how a research should be conducted can be labeled as positivism and social constructionism/phenomenology [18, 16, 17]. The key idea of positivism is that the social world exists externally, and that its properties should be measured through objective methods, rather than being inferred subjectively through sensation, reflection or intuition [18]. The positivist philosophical stance assumes that the researcher is independent of, and neither affects nor is affected by, the subject of the research [17]. Unlike the positivist, the phenomenologist does not consider the world to consist of an objective reality instead focuses primarily on subjective consciousness. Thus, the phenomenological paradigm assumes that the reality is not objective or external but is socially constructed and given meaning by people [18]. This research intends to explore and investigate the ways leadership styles of women managers may contribute to the UK's construction industry development. Leadership characteristics and styles mean different things to different people [19] and the extent of women's contribution towards industry development is highly subjective. Thus a socially constructed idea should be obtained in order to explore the contribution of leadership styles of women managers towards the construction industry development. In this context, it could be argued that this research takes the overall phenomenological stance.

The research philosophy that is adopted contains important assumptions about the way in which one views the world. These assumptions will underpin the research strategy and the methods a researcher chooses as part of that strategy [1]. The three major ways of thinking about research philosophy are ontology, epistemology and axiology [1, 16]. These ontological, epistemological and axiological assumptions are concerned with the nature of reality, the acceptable knowledge in the field of study and the values respectively. These three assumptions will help to position the research within the philosophical continuum.

3.1.1 Ontological assumption

Within the ontological assumption, the researcher must decide whether to consider the world is objective and external to the researcher or is socially constructed and only understood by examining the perceptions of human actors [16]. The first aspect is objectivism or realism and the second is subjectivism or nominalism [1, 20]. Within these two extremes the intended study could be positioned more towards the subjectivism because the perceptions of people in the society have a greater influence over the behaviour of leadership. Therefore the meanings given to leadership behaviour and the ideas on its effectiveness in addressing the problems in the construction industry are subjective. But this research does not take the extreme subjectivist view where there may be no social world apart from that which is inside the individual's mind [16]. Thus it takes the ontological positioning where the social world is created by individuals, through language, actions and routines, and the meanings sustained through process of human actions and interactions.

3.1.2 Epistemological assumptions

The epistemology involves an examination of the relationship between the researcher and that which is being researched. On one hand, being a positivist the researcher is working with an observable and measurable social reality by taking an independent and objective stance. The positivist assumes that there is a reality that exists independently of the observer and the job of the researcher is merely to find out this pre-existing reality. On the other hand, the social constructionist viewpoint does not assume any pre-existing reality; the aim of the researcher is to understand how people invent structures to help them make sense of what is going on around them [18]. Accordingly this research takes up the social constructionist viewpoint where it intends to find out how may the leadership qualities of women can contribute to the development of the construction industry. However it considers only the leadership practices as an issue for industry improvement, though there are several other factors contributing. In this regard this research avoids the extreme constructionism perspective of the epistemological continuum where the multiple realities are taken into consideration.

3.1.3 Axiological assumptions

In axiological assumptions, positivists believe that science and the process of research is value free, where they further believe that the objects they are studying are unaffected by their research activities [16]. These assumptions are less convincing in the social sciences research which is concerned with the activities and behaviour of people. Thus at the other extreme, phenomenologists consider that the researchers have values which help to determine what are recognised as facts and the interpretations which are drawn from them [16]. The understanding about axiology, positions this research more close to the value-laden end as the researcher is involved with that which is being researched and the researcher's own values play a role in all stages of the research process.

3.1.4 Research positioning

Based on the foregoing discussion, Figure 2 shows the positioning of this research within the philosophical continuum in terms of ontological, epistemological and axiological assumptions.

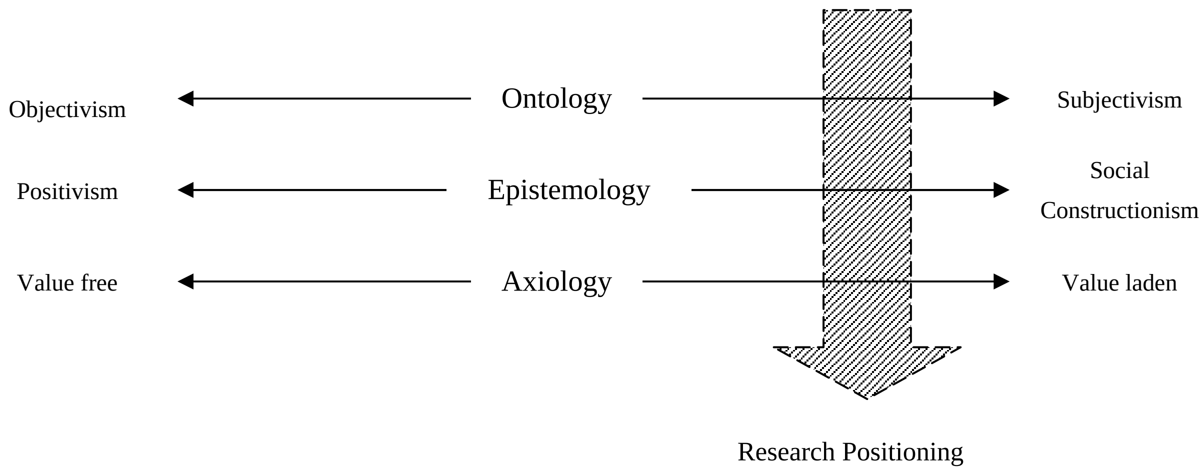

Figure 2: Positioning the research within the philosophical continuum

3.2 Research strategy

A research strategy may be thought of as providing the overall direction of the research including the process by which the research is conducted [17]. The type of research questions posed, the extent of control an investigator has over actual behavioural events and the degree of focus on contemporary as opposed to historical events are the three conditions that govern the choice of an appropriate strategy [21]. In addition to the research questions and objectives, the choice of research strategy will be guided by the extent of existing knowledge, the amount of time and other resources available and our own philosophical underpinning [1]. The commonly used research strategies in business and management research are experiment, survey, case study, action research and ethnography [1, 17, 18]. This section justifies the choice of research strategy used for this study.

The overall philosophical positioning of this research, as outlined above, takes a social constructionism stance. Experiments are generally governed by positivist epistemological undertakings and an ontological assumption tilted towards objectivism with value neutral research. Ontological assumptions of strong 'pre-existing reality' in experiments, require a high extent of control over the environment by which the investigator directly, precisely and systematically manipulates the reality [21]. These can basically be conducted in a laboratory where the extent of control the researcher has over the environment is high. The leadership styles cannot be manipulated in a real life context. Therefore, this strategy is not compatible with this research. In action research, the researcher tries to solve the problem by becoming a part within the problem environment, with the goal to change the status quo of the participants [22]. The action research operates in a partly controlled environment and the aim of the research may be to have a direct and immediate impact, and hence it attempts to change the environment. Ethnography is defined as the study of people in naturally occurring settings or 'fields', by means of methods which capture the social meaning and ordinary activities, involving the researcher participating directly in the setting, if not also the activities, in order to collect data in a systematic manner [23]. According to the aim of this research, an immediate change does not need to be incorporated into the research process as it merely intends to explore and investigate the contribution of leadership styles of women managers to construction industry development. Further, both these approaches need high participative observation from the researcher. As this research doesn't take these qualities, it disqualifies actions research and ethnography from being an appropriate strategy.

Hence, it leaves both survey and case study strategies as the suitable choice for this research. The survey does not require high control over the environment and it is designed to address the 'what' type of exploratory questions and they can be applied in social science research [21]. This research intends to explore the contribution of women managers towards the UK's construction industry development and identify the appropriate leadership styles for construction women managers by learning lessons from other sectors. It also intends to explore whether or how the leadership styles exhibited by women managers can address the problems that persist in the construction industry. The perceptions of subordinates, superiors and peers towards the women's leadership characteristics and styles within their real life context, are also to be captured in order to make sure that their contribution is beneficial towards the construction industry's development. Accordingly this research requires an in-depth analysis of the construction industry. Therefore case study approach is more suitable compared to the survey.

Thus this research proposes the case study is the most suitable strategy. The case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident [21].

3.3 Research techniques

Research techniques refer to the specific methods used to collect and analyse the data. Data collection and analysis are developed together in an interactive process in a case study [24]. The following sub sections discuss the data collection and data analysis techniques used within the case study approach.

3.3.1 Data collection

According to Yin [21], evidence for a case study may come from six sources; documents, archival records, interviews, direct observation, participant observation and physical artifacts. In order to identify the leadership styles of women managers, a questionnaire will be distributed among the women managers, their superiors, peers and subordinates. For this purpose the Multifactor Leadership Questionnaire (MLQ) will be used. The MLQ offers researchers the most validated and efficient measure of transformational leadership, as well as a full range of leadership behaviours [25]. MLQ, which measures, explains and demonstrates a broad range of leadership styles, has been widely used throughout the world in many, diverse cultures and organisations, and has shown to be reliable [26]. Further, the Personal Attributes Questionnaire (PAQ) by Spence et al. [27] will be used to measure the degree to which a person can be classified according to masculine or feminine adjectives. It is a 24 item self-report questionnaire in which people are asked to indicate the extent to which they can be characterised in terms of various adjectives. The analysis of the PAQ will help to find out the personal characteristics of an individual in terms of masculine, feminine, or androgynous qualities. These characteristics will also help to determine the leadership styles. Semi-structured interviews have also been chosen as one of the techniques to get the perceptions of the industry personnel to explore and investigate the ways the leadership styles of women managers may contribute to the UK's construction industry development. This has the advantage of being a 'halfway house' between the rigid layout of a structured interview and the flexibility and responsiveness of an unstructured interview [28]. In addition to these, expert interviews are preferred to identify the leadership styles that could address the problems that persist within the construction industry. These expert interviews are not covered within the case study approach.

3.3.2 Data analysis

Data analysis consists of examining, categorising, tabulating, testing or otherwise recombining both quantitative and qualitative evidence to address the initial propositions of a study [21]. The objectives and the research questions of this research are developed through the identification of theoretical propositions. It is important to have a data analysis strategy as it will guide the researcher to select the appropriate data analysis tools, to make sure that the evidence is treated well, and to generate sound and convincing analytical conclusions while discarding the alternative interpretations [21].

The data collected through expert and semi-structured interviews will be analysed using content analysis. As per the process outlined by Miles and Huberman [15], qualitative analysis involves three activities: data reduction, data display, and conclusion drawing. The first stage of analysis identified is data reduction, which is the process of selecting, focusing, and simplifying the interview transcripts by extracting the most relevant data for all of the questions and from the responses to additional probes. This process will identify a number of issues addressed under the major subjects of the research. The second stage in the analysis process is data display. This will be done by producing a data matrix through tabulating the interview data; with the respondents listed as columns and the questions as rows. The final stage of analysis will be to display the data and draw conclusions. In addition, the quantitative analytical techniques adopted with the MLQ and PAQ will be used to analyse the data collected through MLQ and PAQ surveys respectively.

This section provided the justification for the selection of research methodology in terms of its philosophy, strategy and techniques. The next section further elaborates the chosen research strategy explaining its design together with the tactics used in order to ensure the quality of the research.

4. Case study design and tactics

4.1 Case study design

In the most elementary sense, the design is the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions. It can be understood as a logical model that helps the researcher to collect, interpret and analyse the relevant data in order to effectively find out the answers for the research questions. The case study approach may potentially fall into at least four basic types of study, in terms of the differences in design within each type [21]. They are single (one case) or multiple (more than one case) studies and can be holistic (single unit of analysis) or embedded (multiple unit of analysis) design. Case studies can also be classified as exploratory, descriptive or explanatory.

A research design should include three basic components: 'study questions', 'its propositions' and 'its unit of analysis'. This section explains the research design for the case study bearing these components in mind.

The first component - the research questions - sets out in this research to cover both 'what' type of exploratory questions and 'how' type of explanatory questions. However, the overall objectives are of an exploratory nature. Thus an exploratory type of case study is adopted for this research. The second component - study proposition - directs attention to something that should be examined within the scope of study. In this regard, it is assumed that the leadership styles of women managers may contribute to the construction industry development. The third component - the unit of analysis - is related to the fundamental problem of defining what the 'case' is. A case can be an individual, an entity, an issue, or an event. As this research focuses on the women managers' contribution, it takes the 'individual' as the case for the purpose of this research. The rationale for a single case is when it represents the critical case, extreme case or a unique case or when the case is the representative or typical, revelatory or longitudinal case [21]. Since the case in this research is the 'women manager', the selection of a multiple case design is preferred over single-case designs as it provides analytic benefits from having two or more cases. Analytic conclusions independently arising from two cases will be more powerful than those coming from a single case alone [21]. Furthermore, the proposition would still be needed to help identify the relevant information about the individual, as it is simply impossible for a researcher to cover 'everything' about an individual. The more a study contains specific propositions, the more it will stay within feasible limits. Accordingly this research considers the 'leadership styles of women managers' as the unit of analysis in order to analyse their contribution to the construction industry. Hence it takes a holistic type. All in all, this research adopts an exploratory, multiple, holistic case study design.

4.2 Case study tactics

This section identifies the case study tactics that are used to judge the quality of the research design. Table 1 lists the four widely used tests and the recommended case study tactics, together with the respective phase of research when each tactic is to be used.

Table 1: Case study tactics for four design tests (adopted from Yin, 2003 Page 34)

Tests	**Case Study Tactic**	**Phase of research in which tactic occurs**
Construct validity	Multiple source of evidence	Data collection
Internal validity	Pattern matching	Data analysis
External validity	Replication logic	Research design
Reliability	Case-study protocol and database	Data collection

Construct validity and reliability are tested during the data collection stage. In order to satisfy the construct validity, which is concerned with establishing the correct operational measures [21], multiple sources of evidence will be used. Any findings or conclusion in a case study will be much more convincing and accurate if it is based on several different sources of information. This will be achieved by using theory triangulation and methodological triangulation. Theory triangulation uses the 360 degree review method in order to get different perspectives to the same data set. Accordingly, the information about the 'women manager' would come from her subordinates, peers, and superiors in the organisational hierarchy, as well as from any other external stakeholders who can provide the relevanet information about her. This will ensure that the data is from a rich pool of people from different levels. The use of both quantitative (MLQ, PAQ) and qualitative (semi-structured interviews) data collection methods ensures the methodological triangulation. Further, the principle of the case study protocol and developing a case study database will be employed to address the reliability of the design test and to demonstrate that the operation of the study can be repeated with the same results. Internal validity refers to establishing causal relationships, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships [21]. This is tested during data analysis stage by using pattern matching; a technique which compares the theories and observed data [21]. Accordingly, this research will compare the data collected through expert interviews and semi structured interviews with the theoretically predicted one. If the patterns coincide, the results can help a case study to strengthen its internal validity. External validity means establishing the domain to which a study's findings can be generalised and it is to be tested during the research design stage. The findings from one case study will be replicated by conducting the second, third and additional studies. The cases could either predict similar results or contrasting results but for predictable reasons. Hence, using replication logic in multiple-case studies satisfies this external validity.

5. Conclusions

This paper explains the methodology for researching the contribution of women managers to the construction industry development. It introduces the subject area in which the researcher intends to undertake a study. It further justifies the selection of the appropriate methodology to achieve the objectives of the study. The topic to be researched and the research questions are the primary drivers in the choice of methodology. In addition, the researcher's knowledge, availability of time and other resources, and accessibility of information sources are also to be considered as they have an influence over the choice of methodology. Based on these factors an exploratory, multiple, holistic case study has been chosen as the most appropriate research strategy. Semi-structured interviews, expert interviews, questionnaire survey are the data collection methods adopted for this research. The data collected through interviews will be analysed using content analysis whereas quantitative analytical techniques associated with MLQ and PAQ will be used to analyse the data collected through MLQ and PAQ respectively. Multiple sources of evidence, pattern matching and replication logic in multiple case studies will satisfy the construct, internal and external validities respectively. Case study protocol and a case study database will be developed in order to ensure the reliability of the research. In summary, this paper will be a supportive resource to any reader interested in defining a methodology for a specified research study.

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Employability of women managers in higher education sector: a study on their leadership qualities

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Abstract

The teaching profession both in this country and internationally is, with few exceptions, dominated by women as it has traditionally been seen as a 'suitable' job for women. However, a look at the statistics reveals that despite the large number of women in the profession, they are greatly under-represented in positions of management in higher education (HE). Thus this under-representation of women continues to be a matter of some concern. The background of this paper identifies the status of women managers within the higher education sector. The leadership styles typically adopted by women managers are then discussed. These styles are taken into further analysis in order to find out whether any such styles are of use in terms of filling the leadership gaps in higher education. In this context, this paper examines the literature relating to gender, leadership styles and higher education in order to explore how the leadership qualities of women managers will have a contribution towards the higher education sector.

Keywords: Higher education sector, leadership, women managers

1. Background

The higher education sector is characterised by specific aspects that make it distinguishable from the business world. However, in higher education, as well as in business, men and masculine values are dominant [1]. According to the Higher Education Statistics Agency (HESA) female students in higher education institutions in the UK reached nearly 45% in 2001. Research revealed that the women entering higher education in the UK has continued to increase over recent years and now account for over 50% of students [2]. However, the participation rate of women at senior management level in higher education is relatively low. The senior management level, in this paper, refers to academic professionals such as professors, senior lecturers and senior researchers in higher education institutions. Table 1 below shows the status of the academic professionals by gender.

Table 1: Full-time academic staff by grade and gender in 2005/06

Tests	Female	Male	Total	Female 2004/05 (%)	Female 2005/06 (%)
Professors	2320	11730	14050	15.8	16.5
Senior lecturers & senior researchers	7575	17015	24590	29	30.8
Lecturers	14900	20075	34975	41.8	42.6
Researchers	12330	16930	29260	42.2	42.1
Other grades	3620	4915	8540	42.5	42.4
Total	**40745**	**70665**	**111410**	**36.1**	**36.6**

Source: Higher Education Statistics Agency (HESA)

The proportion of full-time female academic staff has risen slightly from 36.1% in 2004/05 to 36.6% in 2005/06. Full-time female academics account for around 42% of staff members at lecturer, researcher and other grades. At the grade of 'senior lecturers & senior researchers’, females represent 30.8% of full-time staff, while at professorial level, just over 1 in 6 full-time staff are female. Compared to 2004/05 there has been a small increase in the proportion of females at ‘professor’ and ‘senior lecturers & senior researchers’ levels, while at other levels the split in gender has remained almost static. However, managers in education are predominantly male though there is some evidence of a growing willingness of women to take up leadership positions in higher education.

The major reason for this under-representation of women at senior management level in higher education is the barrier women face to progress their career in educational leadership [3, 4, 5]. Socialisation and stereotyping are the major barriers for women seeking a senior position in education. Some internal barriers such as lack of confidence, lack of competitiveness and fear of failure have also been identified for women’s entry into leadership positions [3, 4].

In this context, this paper reviews the employability of women at senior management positions in the higher education sector. The leadership concept cannot be entirely discounted when discussing the employability of women at managerial level as organisations have paid attention to the leadership styles of the people who occupy managerial positions, holding the belief that it is an important factor in achieving business success [6]. In recent years, both mainstream management literature and organisational policy show evidence of a marked turn to leadership rather than management as the means to enhance organisational performance in contemporary organisations. This is matched by a growing trend in the UK to attribute ever-greater significance to leadership as a way of solving organisational problems not only within the private sector, but also within the public sector in general, across education (in schools and in universities), health and local government organisations [7].

Accordingly this paper first identifies the leadership gaps in higher education and then the leadership styles typically adopted by women managers. These finding will lead to the discussions on the employability of women managers within the higher education sector.

2. Leadership in higher education

Leadership is defined as ‘the ability to influence – either directly or indirectly – the behaviour, thought, and actions of a significant number of individuals’ [8]. Educational leadership refers to “leadership influence through the generation and dissemination of educational knowledge and instructional information, development of teaching programmes and supervision of teaching performance” [9, p166]. The real issue in leadership differences lies in the equity in selecting the right person with the appropriate skills and qualities to ensure the effectiveness and success of the organisation [10].

The number of students studying at universities and colleges has increased dramatically, with over 2 million students at higher education institutions today. Higher education is part of ‘lifelong learning’, which is not limited to the compulsory school years, but extends through an adult’s working life and sometimes into retirement [11].

The main purposes of higher education as per the Higher Education Funding Council for England- (HEFCE) [11] are to:

- enable people to develop their capabilities and fulfil their potential, both personally and at work;
- advance knowledge and understanding through scholarship and research; and
- contribute to an economically successful and culturally diverse nation.

The nature of higher education in the UK has changed significantly over the past years. During the last 5-10 years UK Higher Education Institutions (HEI) have been developing and implementing significant levels of structural change, influenced by both internal and external policy and environmental developments [12]. These changes appear to have been made in the formal and informal structures. The senior management structure of many institutions is being re-framed or conceptually restructured. As a result the balance of power between groups at different levels is changing and identifying the focus of power and influence within senior management has become more difficult and complex [12]. Consequently it may affect the efficient functioning of senior management in higher education.

Birnbaum [13] argues that, in general, interventions from leaders should be limited in order to allow the self-correcting mechanisms of the institution to operate effectively. In relation to that, Kathleen [14] also argues that the traditional sense of providing direction in the carrying out of tasks was likely to be less significant for professionals like university employees than for some other occupational groups. Supporting these arguments, Bryman [15] revealed that the traditional form of leadership may sometimes be more significant for the problems it can foster than for its benefits. This suggests that a key issue in higher education is not so much about what leaders should do, but what they should avoid doing.

Mumford [16] identified some of the characteristics of the managers who are good developers of their staff. These characteristics include: “drawing out the strengths and weaknesses of their staff rather than suppressing them; rewarding their people both materially and psychologically for the risks that they take in attempting to develop themselves; positively seek to identify learning opportunities for staff; giving personal time to the development of staff; involving their subordinates in some of their own tasks and not simply delegating tasks they do not wish to do themselves; share some of their problems and anxieties with their staff as one way of enhancing staff development; listening rather than talking; not seeking to shape individuals as replicas of themselves; and taking risks on the desired results of the departments in pursuit of relevant learning opportunities for their people”. These characteristics could be closely linked to that of a leader in the centre of the organisation and not at the top.

Effective leadership is a success of any organisation and academia is no exception to this. In a recent research, Spendlove [17] identified the competencies for effective leadership in higher education as shown in Table 2.

Table 2: Competencies for effective leadership in higher education

Attitudes **What good leaders are**	**Knowledge** **what good leaders know**	**Behaviour** **what good leaders do**
Self-aware Flexible Open Honest Discrete Visible, outgoing Willing to be wrong/accept advice/support Sensitive to the views of others	Knowledge of university life Understand how the university system works Understand academic processes	Work to maintain academic credibility/respect Act as role models Think broadly/strategically Engage with people Listen to others Consult with others Negotiate Communicate clearly Delegate Motivate others Act as mentors Build

The above table illustrates that the attitudes and behaviours for an effective leadership in higher education tends to lean more towards people-oriented than task-oriented. Thus, leadership in today's academia must take into account the needs and demands of various stakeholders and to include these major stakeholders in the change process [18]. The practice of transformational leadership by the department Chair, has been found to be related to faculty satisfaction and a willingness to expend the extra effort required in the change process [19]. However, Pounder [20] found that the styles of leadership that reflects a combination of transactional and transformational dimensions may be most effective in providing the university with the flexibility it needs to make subsequent changes. New systems of management that emphasise behaviours such as nurturing and caring, interpersonal sensitivity and preference for open and cooperative relationships, have been advocated as the most effective response to change in an organisation's environment [21]. Nevertheless, the traits and behaviours of the individual leader matter in terms of determining the effectiveness of the leadership styles that are practiced.

The following sections discuss the influence of gender over the leadership styles and the leadership styles typically adopted by women managers.

3. Gender and leadership

Although mainstream research on leadership generally continues to ignore gender relations, over recent years there has been a major expansion of international research on gender relations in leadership, organisations and management [22]. Fitzgerald [23] suggests that it is impossible to create conceptualisations of leading and managing without taking into account issues of gender. The way gender is defined by society determines how a male or a female should behave within a society. This also seems to affect the leadership characteristics men and women exhibit. These gender role definitions can be discussed in two broad perspectives. One perspective assumes gender as a social institution and thus the role that men and women perform are defined by society. The second perspective argues that gender is a biologically determined element, and thus, the gender role is determined by the biological nature of the male or female. Researchers have tried to find out the relationship between gender role and leadership style as they assume that gender role is an important personality trait that influences leadership style. Some researchers found differences in leadership styles between men and women, whereas others argue that there are no significant differences [24].

Discussions on the gendered differentiation of leadership have centered on the different qualities and styles of leadership of men and women; that is, the so-called masculine and feminine styles of leadership [25]. While men still dominate leadership positions, research suggests that when women do occupy leadership positions, they display different leadership styles compared to men. The presence of feminine or masculine characteristics in leadership styles is related to the construct of gender [26]. Thus, they have related masculinity with task-oriented leadership style and femininity with relationship-oriented leadership styles. Male gender qualities are characterised as aggressive, independent, objective, logical, rational, analytical, decisive, confident, assertive, ambitious, opportunistic and impersonal. These are distinguished from female gender qualities that are characterised as emotional, sensitive, expressive, cooperative, intuitive, warm, tactful, receptive to ideas, talkative, gentle, empathetic, and submissive [27].

Contrary to the above discussion, some researchers argue that there are no significant differences in leadership styles between men and women. Powell [28] in his analysis of a number of research studies found that male and female leaders exhibit similar amounts of task-oriented and people-oriented leadership characteristics. Further to this, Pounder and Coleman [29], citing a number of studies undertaken by various researchers (Davidson and Bruke, 1994; Brenner, 1982; Carless, 1998; Komives, 1991; Maher, 1997; Vilkanas and Carton, 1993, Thomson, 2000; Evetts, 1994) have summarised the idea of ‘little or no difference’ and ‘no evidence for any dissimilarity’ in the leadership styles, leadership effectiveness and competencies of men and women. Further, a study by Oshagbemi and Gill [30] examined gender differences and similarities in the leadership styles and behaviour of UK managers. Their study found that women managers delegate less than their male counterparts but their directive, consultative and participative leadership styles were similar. There are more similarities than differences found in their study on the leadership styles and behaviour of their managers, unlike the findings in other research studies where there are significant differences between males and female in the leadership styles and behaviour of their managers. However, the authors suggest that although women are relatively similar to men in behaviour and effectiveness, women leaders tend to be more participative and less autocratic.

4. Leadership styles typically exhibited by women managers

This section examines the leadership styles typically exhibited by women managers. The growing numbers of women in managerial positions have created interest in the concept of women as leaders [31]. As women increasingly have a more prominent presence as managers and executives in organisations, more attention has been devoted to the possible differences between the leadership styles of women and men. Intuitive reasoning suggests that early socialisation patterns develop different qualities in women and men that would likely result in variations in leadership styles [32].

Hey/McBer, a consulting firm, has leadership style typology which is based on the work of David McCleland [7]. Hey/McBer categorises leadership into six distinct styles based on two major classes: they are transactional and transformational [33]. Under transformational leadership, the most prominent behaviour used is inspirational motivation, followed by idealised attributes, intellectual stimulation, idealised behaviours, and individualised consideration. Under transactional leadership, the most prominent behaviour used is contingent reward, followed by management-by-exception active, and management-by-exception passive [34]. In this regard corrective style (‘do what I tell you’) and authoritative style (‘come with me’) fall under transactional style whereas affiliative style (‘people come first’), democratic style (‘what do you think’), pacesetting style (‘do as I do, now’) and coaching style (‘try this’) fall under the transformational leadership styles [33].

Female leaders seem to prefer a transformational leadership style [35]. Another research carried out by Rosener [36] revealed that women are more likely than men to use "transformational leadership", i.e. motivating others by transforming their individual self-interest into the goals of the group. The characteristics of transformational leadership relate to female values developed through socialisation processes that include building relationships, communication, consensus building, power as influence, and working together for a common purpose. This is supported by Shane et al [37], stating that femininity is found to positively correlate with transformational leadership. Further several studies focusing on transformational leadership indicated that women are perceived, and perceive themselves, as using transformational leadership styles more than men [38]. Bass [39] and Bass and Stogdill [40] also suggest that women are slightly more likely to be described as charismatic, as women scored higher on transformation factor than men. This is further supported by Comer et al [41] where they noted that female business managers tend to be rated higher than male managers on the 'individual consideration' dimension of transformational leadership styles. Yammarino et al. [42] also noted that female leaders rather than male leaders tend to develop the individualised, unique relationships with subordinates necessary to effect the transformational leadership style. In describing nearly every aspect of management, women made reference to trying to make people feel part of the organisation from setting performance goals to determining strategy [36]. Men, on the other hand, were found to be more likely than women to: adopt "transactional" leadership styles (exchanging rewards or punishment for performance); use power that comes from their organisational position and formal authority [36]. Likewise, many authors refer to transformational leadership as a feminine leadership style. However, research by Hackman et al. [43] show that transformational leadership is a stereotypically gender-balanced style.

The notion of male and female gender qualities facilitates the argument that male gender qualities are oriented towards the more impersonal, task oriented or transactional approach to leadership, whereas female gender qualities tend towards more nurturing, relationships oriented style of leadership that underlies the transformational leadership approach [29]. Rigg and Sparrow [44] state that female leaders emphasised the team approach more than men and were regarded as more people oriented than their male counterparts, while male leaders were considered more paternalistic and authoritarian than female leaders. The empowering and collaborative style of leadership associated with women is also compared with the more directive and authoritarian style traditionally associated with male leaders. In other words, women seem to lead in a rather democratic way, while men show a more autocratic leadership style [45]. Research findings of Trinidad and Normore [46] show that women adopt democratic and participative leadership styles in the corporate world and in education.

Apart from these leadership styles women are said to be better than men in terms of multi-tasking. In a research carried out by Priola [47] almost all of the participants interviewed referred to multi-tasking, presenting it as a female quality and ability. The belief that women are better at managing different activities simultaneously finds its origins in the role of women in various societies. Priola's research further identified four major discourses that refer to aspects generally associated with femininity when identifying female traits within educational institutions. These are: the ability to manage multi-tasks (including administration); people and communication skills; the ability to focus on support and care for the staff; and the implementation of a team-based approach rather than an authoritarian style approach. The ability to juggle several things at once was reported as one of the differences between women and men in Deem's [48] study of 137 manager-academics (women and men). Helgesen [49] argues that women's central involvement in managing households, raising children and juggling careers gives them a capacity for prioritisation in a leadership role that men typically do not possess. Women are often carers of the family and the household in addition to external employment. Women are good in interpersonal and communication skills. Rosener's [36] study found that women managers put effort in building relationships and understanding the people they work with, so that they can adapt their style to each individual. Rosener [36] also found through her study that women use "interactive leadership" styles by encouraging participation, sharing power and information, enhancing peoples' self-worth. She further justified that women are much more likely than men to ascribe their power to interpersonal skills or personal contacts rather than to organisational stature. Women as leaders believe that people perform best when they feel good about themselves and their work, and the leaders try to create situations that contribute to that feeling. Earlier thinking emphasised that women who had achieved leadership positions were imitators of male characteristics, but later theories recognised feminine leadership styles [50]. Research into the feminisation of management suggested that contemporary managers were moving towards substituting the "masculine power" of decision-making, giving orders and being obeyed, with the power to give others (the work force) sustenance, nurture their growth and care for them [51].

5. Discussion

The issues related to the status of women in senior management positions in higher education, leadership styles in higher education and the leadership styles typically exhibited by women managers are discussed in this paper. It is the fact that women are under-represented in managerial positions in higher education. In order to study the employability of women in managerial positions, the leadership style has been taken as the primary area of the research.

From the previous sections, it is apparent that the management structure within higher education has become more difficult and complex. More than just the activities involved, it is the people who are to be motivated and to be trained in order to promote them into a state of self-correction. Accordingly it is understood that the higher education institutions should be friendlier and more accommodating for employees and the gaps between people at different levels are to be minimised to achieve this. Thus maintaining a personal relationship is vital in higher education. This cannot simply be achieved by placing the whole responsibility on the shoulders of one single leader. Leadership in higher education is therefore more complex as people in these positions should have the ability to motivate employees to excel beyond what is expected through the use of individual consideration. This could closely be linked with the typical characteristics of women managers such as empowering employees, caring for others and listening to others.

Teamwork is also an issue that is to be encouraged in higher education in most instances, especially when undertaking research projects. Furthermore, the leadership role should include the establishment of priorities, the design of appropriate early warning and communication systems, the coordination and balancing of the various subsystems within the institution and the directing of attention, symbolically and actively, towards the priority areas. Women are good at multi-tasking and have the ability to prioritise. Female leadership styles encourage teamwork, personal relationships, caring, and nurturing qualities, as they tend to lead in a democratic and participative way.

In summary, we could see that the transformational leadership, which is largely used by women managers, could be the preferred leadership style in higher education.

6. Conclusion

The higher education sector in the UK is changing and facing greater scrutiny and accountability from outside agencies that impact accreditation, funding and financial aid resources. The traditional sense of providing direction in the carrying out of tasks is likely to be less significant for professionals such as university employees. Therefore the idea of placing a traditional form of leadership in higher education sector is less convincing.

In summary, the democratic participative styles of consensus building, power as influence, working together for common purpose, ability to manage multi tasks, excellent interpersonal skills, caring and developing personal relationship are said to be the qualities typically exhibited by women managers. These qualities largely fall under the transformational approach of leadership.

However, leadership purely based on transformational style may not be sufficient. There could be instances where the leader has to use transactional style, for example when motivating people to perform in exchange of specific rewards. Similarly, when there is a situation where a job is required as a matter of urgency, the leader may have to use an authoritative style. Considering these, it cannot be concluded that higher education is effective merely with the transformational style of leadership. The managers, therefore, should be able to switch from one style to another depending on the situation.

Nevertheless, the authors intend to say that transformational leadership, which is largely used by women managers, could positively contribute to improve the higher education sector. Through this paper it could be concluded that the women have a greater potential to be employed in managerial positions within the higher education sector. An increase in the number of women managers in higher education will possibly help to reduce barriers in the long run and in turn may enhance the sector. This study will be a supportive resource to any reader interested in identifying women's leadership qualities to manage the higher education sector.

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Grounded theory as an appropriate methodology for leadership research in construction

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Abstract

Leadership research in the construction industry has been dominated by positivist methodologies resulting in a much larger proportion of quantitative studies than qualitative approaches. Thus, the richer interpretations which could be possible through the latter are not realised. With growing research focus on leadership in construction, it is pertinent for studies to utilize the grounded theory approach to uncover the basic social processes that drive the leadership phenomenon in construction. Research in the mainstream social sciences has recognized the vital benefits that the grounded theory approach offers. There is dearth of grounded theory application in the extant body of knowledge on leadership in construction. A case is presented here to advocate the strengths of grounded theory and the potential benefits it can offer to research on leadership in the construction industry.

Keywords: Leadership Research, Grounded Theory Methodology, Construction Industry

1. Background

The field of leadership research has changed considerably in how one thinks about, studies, and defines leadership [1,2]. This is mainly because of greater optimism about the field and greater diversity in the methodological approaches being employed by the researchers to study leadership [1]. Bryman [1] further notes the factors that have contributed to this increased optimism and greater methodological diversity, including: improved measurement and analytical methods; greater use of meta-analysis for developing systematic reviews; the surge of interest in transformational leadership and charismatic leadership; more and better cross-cultural studies; and greater diversity in the types of leadership and organizational contexts that became the focus of attention. However, many other researchers have argued that leadership remains a difficult phenomenon to capture and measure.

Research on leadership in construction has particularly been restricted to the use of positivist or quantitative methodologies. Very few studies have utilized qualitative methods to analyze the nature of leadership in the industry. This is ironical. Many have recently argued that leadership must be regarded as a social process [1-6]. Similarly, scholars have argued that construction is a social system in which people are the principal actors [7]. In order to uncover the dynamics of leadership and complex details of the social processes that take place among people in construction, there should be increased use of analyses suitable for studying social processes. This paper underlines the need for the application of more qualitative methodologies to study leadership in the construction industry. It focuses on three issues: (i) the current methodological trends in leadership research; (ii) why qualitative methodologies are more useful for leadership; and (iii) how the grounded theory framework can help to capture the basic social processes of leadership in construction.

2. Which research method?

Goulding [8] notes that choosing a research methodology is not an easy task. It is time-consuming, laborious and difficult. However, it is personal and reflective process. It also requires evaluation of oneself in terms of convictions, beliefs and interests. Goulding [8] views research as a part of an integrated process involving researchers, their beliefs and experiences, the cooperation of various stakeholders of the research, and suitability and implementation of a chosen methodology which results in an answer that is a single perspective and not an absolute explanation of the problem. In this process, Guba and Lincoln [9] suggest that researchers should address a few questions in relation to their own philosophy, including: (i) the paradigmatic question—"What is the basic belief system or world view that defines the nature of the world, the individual's place within it and the range of possible relationship to that world?"; (ii) the ontological question—"What is the relationship between the researcher as the would-be knower and what can be known?"; and (iii) the methodological question—"How can the enquirer go about finding out what he/she believes can be known?".

Buchman and Bryman [10] highlight a number of issues which play an important role in the choice of research methodology such as: aims of research, epistemological concerns, and norms of practice of the researcher who is also influenced by organizational, historical, political, ethical, evidential, and personal factors. Simply put, research method is an integral component of a wider, iterative, and coherent research system in which a number of unavoidable influences need to be accommodated in decisions concerning the choice of method. Buchman and Bryman [10] suggest that the design of organizational research work and the choice of data collection methods remain in part a creative process despite a number of constraints and influences. Therefore, it is important to recognize the role of personal interests, preferences, biases, prejudices, and creativity in addition to technical skills, knowledge, and competence of the researcher. This competence, as Buchman and Bryman [10] conclude, must encompass the ability to address, systematically and coherently, the organizational, historical, political, ethical, evidential, and personal influences on the choice of research methods.

3. Research approaches to study of leadership

3.1 Quantitative approach in leadership research

Quantitative research methods are characterized by the assumption that human behaviour can be explained by social facts. Such methods employ the deductive logic of the natural sciences [11]. Quantitative methods were mainly used for leadership studies during the 1960s and 1970s, due to the bend of leadership research towards psychology, giving rise to the use of the positivism and quantitative methods associated with research in psychology, especially in the US (Parry, 1998). House and Aditya [12] observe that about 98% of the empirical evidence in leadership research is American in character; empirical research on leadership has either been conducted within the US, America or been carried out by those who have studied or have some affiliation to American educational institutions. Other researchers confirm that the vast majority of empirical research on leadership originates in North America [13-15]. Reviewing 10 years of publications in "The

Leadership Quarterly", Lowe and Gardner [14] found that 64% of studies employed a questionnaire-based method of collecting data. They also reported that around one-third of all the articles were based on a qualitative methodological approach. Reviews by Bryman [1] and Lowe and Gardner [14] show that the number of qualitative studies on leadership is significantly lower than those using quantitative methods. Conger [15] also highlighted the dearth of qualitative studies on leadership.

There have been many criticisms of quantitative approaches for studying leadership. Bryman [1] observes that leadership research has been dominated by a single kind of data gathering instrument—the self-administered questionnaire. Most studies in the literature on leadership employed questionnaires in various contexts including experimental settings, cross-sectional designs, and longitudinal investigations. A few standard sets of questionnaires have been used in a large number of studies. These include: Leadership Behaviour Description Questionnaire (LBDQ), Multi-Factor Leadership Questionnaire (MLQ), Multi-Culture Leader Behavior Questionnaire (MCLQ), Leadership Practices Inventory (LPI), Least Preferred Co-Worker (LPC), Leader Effectiveness and Adaptability (LEAD), and Ethical Leadership Scale (ELC).

Surveys and questionnaires mostly measure attitudes towards behaviors and not the actual behaviors due to social desirability. Such surveys are also not useful as they mostly measure the static situations and do not explain the processes behind them. Such descriptions of leadership fail to help us understand the deeper structures [15] and dynamism of leadership phenomena. Moreover, Bass and Avolio [16] note that the inability of quantitative research to draw effective links across the multiple levels to explain leadership events and outcomes has been a major shortcoming. Yukl [17] shares this perspective and argues that quantitative approaches mostly focus on a single level of analysis and hence ignore several other mediating factors, such as the influence of groups or organizations. Alvesson [4] observes that the inadequacies of quantitative and hypothesis-driven approaches have encouraged researchers to look for alternative qualitative methods. Conger [15] argues that the symbolic and subjective components of leadership have serious implications for research methods [3]. Quantitative methods focus on objectivity and attempt to capture the reality. On the other hand, they are unable to explain the subjective and ever-shifting realities of the leadership process. Other criticisms of the quantitative approach in the social sciences is that it is pseudo-scientific, inflexible, myopic, mechanistic, and limited to realm of testing existing theories [8].

3.2 Qualitative approach in leadership research

Jones [18] observes that qualitative methodologies are strong in those areas that have been identified as potential weaknesses within the quantitative approach. For example, interviews and observations provide a deep, rather than broad, set of knowledge about a particular phenomenon. In a review of qualitative studies on leadership, Bryman [1] selected a total of 66 qualitative studies from social sciences journals from 1979 to 2003. He found that only 10 studies were based on qualitative methodology between 1979 and 1991 whereas 56 studies were published between 1991 and 2003. This increase in the number of studies shows soaring interest of researchers to employ qualitative approaches to research leadership. Bryman [1] observes that the upward trend in qualitative research on leadership did not begin until 10 years after an influential issue of "Administrative Science Quarterly" in 1979. He also found that a large number of studies employed the case study approach. With regard to the data collection method, Bryman [1] found that 56 studies (more than 80%) employed qualitative interviewing (semi-structured, in-depth, unstructured, and biographical interviewing). Interviewing was the sole technique of data collection in 25 studies. It is ironic that qualitative researchers tend to use interviewing when other techniques of data gathering (such as document analysis, observation and anthropology, discourse and conversation analysis, visual data, and case studies) could be used to complement interviewing. However, a number of issues often make interviewing the only option available. Particularly, observational techniques are hard to use for several reasons such as the need for greater investment of time; observing acts of leadership is a complex matter; observation involves a large expenditure of time for relatively little return in terms of data; problems finding gaining access to leaders who are willing to allow the observation; and potential of contamination of observation due to presence of the participant observers. There are also several ethical and methodological dilemmas in being an observer in a research setting associated with entering the field, positioning and disclosure, shared relationships and disengagement [19].

Conger [15] recognized that qualitative approaches may be intensive, complex, expensive and time consuming. However, they are rich in detail and illuminating in new ways to explain the complex phenomenon of leadership. Conger [15] also notes that qualitative research studies are particularly important during exploratory phases of researching a new area. However, he argues that, in leadership research, qualitative research plays an important role at all stages of investigation because of the extreme and enduring complexity of the leadership phenomenon itself. Parry [20] shares this sentiment and observes that qualitative approaches, due to their painstaking data collection and analysis techniques, have been under-utilized by leadership researchers. Parry [6] observes that greater use of qualitative approaches in the recent past is resulting in a fuller and richer understanding of the nature of leadership. Similarly, Martin and Turner [21] argue that qualitative approaches allow richer descriptions, sensitivity of ideas and meanings of the individual concerned, and increased likelihood of developing empirically supported new ideas with practical relevance. Qualitative approaches help in discovering new ideas and phenomena rather than verifying the old and existing theories [22]. Conger [15] advocates that qualitative methods offer a number of benefits, including: greater opportunity to examine the process in depth; the flexibility to discern other contextual factors; and more effective means to investigate symbolic dimensions.

However, qualitative research is not without shortcomings. Alvesson [4] suggests that qualitative research is as superficial as quantitative approaches; however, the shift to the use of qualitative methods should be welcomed. One of the most often mentioned limitations of qualitative research is its over-reliance on interviews as a principal methodology [15]. The qualitative approach to research methodology has been criticized as being exploratory, filled with conjecture, unscientific, and a distortion of the canons of ‘good’ science [8]. The approach and its results are also viewed as being soft hearted, pitying, and even too foolish to be taken seriously [23]. In opinion of Morse et al. [24] qualitative research leads nowhere and predominantly relies on inference, insight, logic and luck. Qualitative research is also accused of being novelistic, entertaining, descriptive, not sufficiently rigorous, incapable of explaining why things happen, and having no hard and fast rules of procedures [8]. Table 1 shows the differences and similarities between qualitative research and the quantitative approach.

Table 1: Characteristics of qualitative and quantitative methods

Characteristics	Qualitative Research	Quantitative Research
Goal/purpose	Understanding/meaning from the participation	Explanation/prediction from data
Theory	Generation	Testing
Sample	Participants	Subjects
Researcher/sample relationship	Direct involvement	External involvement
Instrument	Research is "tool"	Established, pre-tested tool
Findings	Narrative/inclusive for depth	Data/exclusive and limited to narrowed focus
Analysis	Meaning from findings	Numerical interpretation and significance
Significance	Applicable only to the sample	May be generalizable to the population

Source: Masters et al. [28]

3.3 Combining qualitative and quantitative approaches in research

The debate about quantitative and qualitative research at the epistemological level originated in the mainstream of the social sciences and was also known as 'the paradigm wars' [25]. 'Paradigm wars' refers to the competing perspectives of proponents of quantitative and qualitative research which are considered to be distinct and based on fundamentally different principles. The debate was predominantly initiated and extended by qualitative researchers who purported a distinctive philosophical position for their approach and presented an intellectual rationale for it in the face of the hegemony of quantitative investigations in journals and elsewhere. As a result, awareness of qualitative approaches grew and peace was slowly restored among the researchers. Bryman [26] observes that research that involves the integration of quantitative and qualitative research has gained popularity in recent years. Such approaches have been given numerous names, such as multi-methods, multi-strategy, mixed methods, or mixed methodology research. Bryman [22] suggests that more abstract philosophical issues should be linked with questions of research practice. This would be a more sophisticated way of treating the comparability of different methods of investigation than direct juxtaposition in terms of relative superiority. Rocco et al. [27] argue that 'mixing methods that bring together the strengths of both quantitative and qualitative methods will enhance research in the field' [27, p. 604]. Bryman [1] suggests that qualitative research on leadership can serve the area better by engaging much more with quantitative research in terms of its findings and literature. This way, it would become integrated into the field while simultaneously maintaining a distinctive approach to designing research and gathering data.

In the literature, several researchers have combined qualitative and quantitative approaches in their studies to achieve the research objectives [29-35]. For example, Rosner [32] studied women leaders and employed questionnaires followed by interviews. Egri and Herman [29] in their study of leaders in non-profit organizations, used both questionnaires and interviews to study the transformational and transactional behavior of leaders. Such studies are mostly cross-sectional in design, and use qualitative interviewing as the data collection tool. There are many reasons why researchers combine qualitative and quantitative research. In most cases, it is done to achieve triangulation of data and to examine how far the results from both methods are similar. Although there is no hard and fast rule about the sequence in terms of the method which should be used first, most researchers use qualitative research studies to prepare for quantitative data collection. However, many studies employ interviews to validate their quantitative findings. Moreover, the combining of quantitative and qualitative methods is also done to achieve different objectives and address different research questions.

Bazeley [36] and Bryman [26] discuss why and how quantitative and qualitative approaches can be combined to achieve the desired results. Bazeley [36] asserts that mixed methods research has several benefits including greater validity of results. However, the mixing quantitative and qualitative methods also has its problems in terms of definitions, paradigms, and methodology. Moreover, issues such as the nature of design, sampling techniques, research instrument, analysis techniques, financial and time constraints, and finally, adequate skills required to mix the research continue to find critique in research works. Bazeley [36] discusses triangulation. He argues that, as opposed to its original meaning, triangulation has recently been used loosely as a synonym for mixed methods without regard to either of the conditions inherent in the original concept. Triangulation was originally conceived as the conduct of parallel or otherwise duplicated studies using different methods to achieve the same purpose. This was mainly done to achieve the same results from different methods and find a stronger support for the conclusions. It was more like a validation technique. There has been criticism of the ability of triangulation to provide validation as each source must be understood on its own terms [37]. Bazeley [36] also argues that “Mixed methods are inherently neither more nor less valid than specific approaches to research. As with any research, validity stems more from the appropriateness, thoroughness and effectiveness with which those methods are applied and the care given to thoughtful weighing of the evidence than from the application of a particular set of rules or adherence to an established tradition.” (p. 9). Jones [18] observes that the vital feature in justifying a mixed methodology research design is that qualitative and quantitative methodologies have strengths and weaknesses. Adequate mixing both methodologies can be useful for combining the strengths of both methodologies. Hence, the researcher should aim to achieve the situation where mixing both qualitative and quantitative methods can produce a final product which can highlight the significant contributions of both [38].

4. Trends in leadership research in construction

In their review of empirical studies of leadership in the construction industry, Toor and Ofori [39] note that most of the studies utilized quantitative methodologies, using survey questionnaires to collect information. Few studies used qualitative methodologies based on interviews and case studies. However, such qualitative studies did not extend beyond interviewing the subjects or analyzing some official documentation to develop rigorous analyses. They also found that the studies were cross-sectional in nature. Thus, there was a heavy bias in static, cross-sectional analysis, and comparative statistics [2]. It is, therefore suggested in the mainstream literature that leadership, being temporal in nature, must be examined through longitudinal studies [40]. Particularly, in construction projects, some researchers have argued that project managers tend to employ different leadership styles during different stages of the project [41]. This conclusion should be further explored through longitudinal studies which can also investigate how project managers adapt their styles and approaches to new projects and what influences their leadership styles in a new environment. Toor and Ofori [39] also suggest the use, in leadership research, of more qualitative techniques such as the grounded theory approach; observational techniques [15]; narratives, personal writing, stories, or biographies [42]; ethnographic studies [43]; and psychometric neuro-scientific methods.

5. Leadership as social process

An important issue to address is whether leadership is solely about qualities, behaviors, and attributes of the leader, as advocated in many classical theories, or it is actually a social process comprising the leader, followers, and situations. Yukl [17] also claims that, after thousands of studies on the subject, a general of theory of leadership that can explain all aspects of the process adequately has not been developed. Most leadership studies have also focused on a single level of analysis, ignoring the influence of intra-psychic, group, or organizational factors. There seems an excessive focus on 'the leader' rather than leadership [44], especially in North American research [1, 44, 45]. Meindl et al. [46] share this sentiment, and note that outcomes are often linked to the leader, forgetting that many other factors also play a significant role. On the other hand, many scholars view leadership as a relationship between leader and led that can energize an organization [47]; an art of creating a supporting work environment [48]; a phenomenon that works on the system [49]; an inspiration and support of people to do things [50]; and creation of a common vision to achieve results by persuading others [51] in a trust-based environment [52]. It is primarily about influencing others [53]; it is not only the influence of a leader on followers but the collective incremental influence of leaders in and around the system [54].

Conger [15] views leadership as a complex and dynamic process which is a social construction, and exists at multiple levels of organizations. These views indicate that leadership is a social process of influence [6, 15, 17, 20, 55, 56] that engages everyone in the community [57]. Therefore, leadership is a function of the social resources that are embedded in relationships, the environment, structure and technology of organizations [54]. It is about bringing people together around a shared purpose and empowering them to step up and lead in order to create value for all stakeholders [58]. Others share the same perspective, noting that leadership is a process [1-4]. In this process, leaders interact and communicate with, and influence others. Parry [20] explains that a process involves change (which occurs over time), and the linking of interactional sequences. This implies that the relationship between leaders and followers is also a process which involves changes in beliefs and motivations of followers that occurs within organizations which act as communities.

Many consider leadership to be about the future [59], about creating and coping with change in organizations [60, 61]. Others note that change is inherent in leadership [5, 20, 54, 59]. Change incidents may form the basis for investigating the leadership process. Bass [55] noted that leadership involves restructuring of the situation. Kotter [61] argued that leadership can be differentiated from management due to the inherent notion of change in leadership. Conger [15] noted that achievements, failures, crises, changes, always reshape the experiences of the leader and the led. Leadership occurs within a group context as well as within a dyadic relationship [53, 62]. However, the effectiveness of leadership is largely dependent upon the context. Osborn et al. [53] argue that leadership "is socially constructed in and from a context where patterns over time must be considered and where history matters" (p. 798). The concept of context is similar to what contingency theories of leadership advocate, that leadership style cannot be separated from the conditions under which leadership is exercised [63]. Osborn et al. [53] suggest that contextual macro views need greater recognition than they receive currently. They suggest four contexts—stability, crisis, dynamic equilibrium, and edge of chaos—to explain the context of leadership in organizations. They consider leadership as a series of attempts, over time, to alter human actions and organizational systems.

From the above discussion, there is a conceptual basis for the conclusion that leadership is a process in a social context [20]. Therefore, researchers have purported that analysis of leadership as a process can enhance one's understanding of it [2, 20]. This is a conception of leadership which departs from "role" to "process". Kan and Parry [5] observe that defining leadership as a process supports the notion that leadership is not a linear or mono-directional phenomenon; it is rather multi-directional, involving formal leaders, informal leaders, and followers. Thus, Parry [20] argues that leadership research should focus on the social processes that go on between people and which have a leadership impact. This is because irrespective what behaviors people employ in leadership roles, many other variables influence the impact which these leadership behaviors have upon followers and upon the context of work.

6. Construction as a social system

The nature of leadership as a process which takes place within a social system—comprising groups, organizations, and so on—is further strengthened when it takes places in the construction industry. Love et al. [7], in their critique of methodologies in construction research, argue that construction is a social system and people are the principal actors in construction projects. They note that the social system that exists in a construction project is no more than the sum of individuals. Since humans change over time, undergoing different circumstances, their behaviour and the resulting structure of the social system they construct is also open to change. After it has been established that construction is a social system and humans are principal stakeholders in this social dynamics, it is pertinent to evaluate what research methodologies are adequate for construction leadership research.

7. Grounded theory as a potential research method

Originally developed in medical research [64], grounded theory is a method well suited to enhancing the development of knowledge on leadership. Grounded theory uses qualitative research methods with the aim of generating theory which is grounded in the data, rather than testing existing theories [65-67]. Glaser [[66] noted that grounded theory is useful for research related to human behaviour in organizations, groups, and other social configurations. Parry [20] suggests that as leadership is a process of social influence, this makes grounded theory a relevant method of analysis as it emphasizes theory development rather than testing an existing theory. In the opinion of Hunt and Ropo [2], grounded theory discovers the underlying social processes and forces that result in a particular activity or phenomenon.

7.1 Support for Grounded Theory for Leadership Research

Researchers in the mainstream social sciences research have employed, and called for the application of, qualitative methods to study leadership style and behavior [15]. Many researchers have also emphasized the application of the 'grounded theory approach' [64, 67] to theorize leadership [2, 3, 5]. The key argument here is that leadership is a basic social process [6, 15, 17, 20, 56, 68] with a number of intervening variables which makes it dynamic and complex. This, therefore calls for more grounded qualitative approaches that can dig deep into social realities and can uncover the intervening variables and forces that influence leadership [69, 70]. It can also be used to examine leadership incidents in various organizational contexts [5, 20, 71, 72]. The grounded theory approach will also be helpful to refresh and considerably compliment the existing works on leadership [8]. In the opinion of Kan and Parry [5], the grounded theory approach is capable of capturing the complexities of the leadership process without discarding, ignoring, or assuming away relevant variables. The richness of the data in the grounded theory approach ensures that the resulting theory is fully able to elaborate upon the leadership process for participants and fellow researchers alike. Many researchers agree that a full grounded theory approach can provide valid and reliable findings explaining the leadership phenomena under a given context [2, 3, 15, 20].

In addition to a detailed account of how grounded theory can be useful for leadership research, Parry [20] also underlines a number of aspects one should consider while using the grounded theory approach in leadership research. He observes that one must observe or undertake interviews in depth about the process of social influence. To do this, one must have a definition of leadership to ensure that the phenomenon under consideration is leadership and not something else. Also, such research should be more concerned with the leadership process rather than leaders themselves. The interview subjects for this purpose should be statistically random. Therefore, the interviews can come from a range of levels in the hierarchy, various functional areas and from different stages of the change process. During this whole process, until the grounded theory has been generated, it is not appropriate to consider any existing leadership theories. However, after the generation of grounded theory, its comparison with extant theories is useful.

The grounded theory approach for leadership research is not without weaknesses and limitations. These weaknesses mostly pertain to the validity and reliability of the generated theory. Parry [20] suggests that multiple sources of data collection are useful to improve the validity of the findings. However, in addition to multiple sources of data, an interviewing strategy should be the core of the data gathering approach for grounded theory research in leadership.

7.2 Application of Grounded Theory in Leadership Research

A number of studies have been conducted in leadership research using the grounded theory approach. These include Fernando and Jackson [73], Harchar and Hyle [74], Hay and Hodgkinson [75], Hunt and Ropo [2], Irurita [76], Jones and Kriflik [77], Kan and Parry [5], Kempster [72], Lakshman [78], Parry [79], and Sjoberg et al. [80]. Table 2 shows characteristics of selected studies that have used the grounded theory approach. These studies have been conducted across a wide spectrum of organizations, contexts, and leadership situations. They explore a number of topics related to leadership, such as administrative instructional leadership, leadership in turbulent change, indirect leadership, role of spirituality in leadership, leadership learning, and leadership in stressful and complex rescue operations. The studies have been conducted in manufacturing, the health, educational, and government sectors, the military, and rescue-services organizations. Unlike quantitative research, which is predominantly North American in nature, the grounded theory approach has been used in America, and many countries in Europe, and Asia-Pacific.

From Table 2, qualitative interviewing has been the primary data collection tool in the application of grounded theory in leadership research while some studies have used informal interviewing, observational techniques, and document analysis. Kan and Parry [5] used both qualitative and quantitative data for triangulation purposes. They used Multi-factor Leadership Questionnaire (MLQ) to bring quantitative psychometric data into grounded theory analysis. This innovative way of using quantitative data in grounded theory analysis is quite rare in leadership studies. Table 2 shows that several researchers have effectively used the grounded theory approach to research various topics of leadership. It also shows that researchers have predominantly used qualitative interviewing for data collection. This feature of qualitative research on leadership has been mentioned by some authors [1, 15, 5]. Kan and Parry [5] observe that leadership research traditionally tends to control for variables, such as hierarchy or groups, to comply with the positivist nomothetic tradition. On the other hand, the grounded theory method attempts to develop new theories and propositions rather than testing the existing theories. However, adequately mixing quantitative data with qualitative data helps to better understand the leadership phenomenon in more depth.

Table 2: Application of grounded theory for leadership research

Author(s)	Country	Sector	Nature of study	Research methods
Hunt and Ropo (1995)	USA	Manufacturing Industry	A CEO's tenure at General Motors	Document Analysis Interviews relating to Roger Smith's tenure as CEO at General Motors
Harchar and Hyle (1996)	USA	Educational Sector	Understanding administrative instructional leadership in the elementary school	Qualitative Interviewing
Parry (1999)	Australia	Local Government	Organizational turbulent change in local government settings	Qualitative Interviewing Participant Observation Document Analysis
Kan and Parry (2004)	New Zealand	Health Sector	Understand the leadership processes operating within the nursing environment of a hospital undergoing organizational change	Non-participant observation Qualitative Interviewing Document Analysis Multifactor Leadership Questionnaire (MLQ)
Bjorkman (2005)	Sweden	Military	Understanding of how indirect leadership is done in a military context	Qualitative Interviewing
Fernando and Jackson (2006)	Sri Lanka	Business	Workplace spirituality and leadership	Qualitative Interviewing Participant Observation Document analysis
Hay and Hodgkinson (2006)	UK	Educational Sector	Conceptualizing leadership afresh	Qualitative Interviewing
Jones and Kriflik (2006)	Australia	Public-Sector Organization	Leadership process within the substantive setting of a cleaned-up bureaucracy	Qualitative Interviewing Conversational-type Interviewing
Kempster (2006)	UK	Multinational Public Company	Understanding of underlying influences shaping leadership	Qualitative Interviewing

Author(s)	Country	Sector	Nature of study	Research methods
			learning within a single organization	
Sjoberg et al. (2006)	Sweden	Rescue Services	Understanding of leadership in stressful, complex rescue operations	Qualitative Interviewing
Lakshman (2007)	USA	Business Organizations	Role of leaders in knowledge management	Qualitative Interviewing

8. Conclusion

Leadership research in the mainstream social sciences as well as in construction continues to utilize positivist methodologies. However, there is evidence that qualitative or interpretivist methodologies have the potential to take leadership research in a new direction and to a high level by discovering the basic social process that drives the dynamics among leaders and followers under given circumstances. The grounded theory approach can be useful in helping to uncover the social processes that are fundamental to leadership. While mainstream researchers have already recognized the significance of grounded theory for leadership research, its use remains scarce in construction research. No evidence of grounded theory approach for researching leadership is found in the construction literature. Given the importance of leadership in construction, it is a timely for scholars to use grounded theory methodology to develop richer interpretations, frameworks, and theories of leadership in construction. It would be beneficial if a network of researchers could be formed comprising those interested in leadership and those who have previously used the grounded theory approach in their past research. This can be helpful in training potential grounded theory analysts who can then use this approach to study leadership and other related disciplines in the built environment.

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SECTION XIX

CURRICULUM DEVELOPMENT

The changing role of universities and flexible course re-development

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Abstract

This paper reflects upon the development of a suite of new courses in the Faculty of Built Environment and Engineering at the Queensland University of Technology in Australia. It describes the theoretical framework upon which these courses are founded and the broader pedagogical and structural implications and opportunities. It relates a model of transformative learning to the large scale issues of course design and contemporary course relevance. The paper illustrates such a relationship with a suite of courses in which the student takes a greater lead in the shaping of his or her own education. Notions of change and transition are presented as opportunities for continued renewal of course offerings, and as the catalyst for transformative learning wherein students become more active members in the teaching and learning process. What we find is that good pedagogical course design aligns with the changing role of universities in contemporary society.

Keywords: Cross-disciplinary, Curriculum, Design, Education, Multi-disciplinary

1. Introduction

“Universities are products of the late 19th and early 20th centuries… The question is how do you break them up in some way… How do you make them free to do something new and different?” Everett Hughes [1].

This paper explores and illustrates how university undergraduate courses can be designed and developed to respond to the changing role of universities within the broader social context. Further to that, it illustrates how a model of transformative learning [2] can be used to inform such course design and development. Universities need to prepare students for the real-world demands of professional practice, and classroom knowledge is increasingly seen as only a part of the knowledge needed to operate in practice. New courses need to adapt and embrace a broader more flexible approach to what constitutes disciplinary scholarly knowledge.

2. The changing role of universities

“Current changes in Western universities which are attributed to global and other international economic, social and cultural developments are variously referred to in a number of different ways including new managerialism, academic capitalism and academic entrepreneurialism” [3].

The purpose for the existence of higher education is changing. The role of universities within society has changed. One of the significant issues about this is that different stakeholders still have different perceptions of that changing role. For example, university is no longer seen as being as elitist as it once was, it is much more ‘normal’ to attend university with an increasing percentage of the population now studying at tertiary level. Higher education is now seen as an expected part of the process of getting a job or developing a career. This has not only affected the types of courses that universities offer, but more significantly the ways in which those courses are delivered. There is also increasing influence from industry and professional bodies with respect to student graduate attributes (employability skills), and within the disciplines of design, engineering and built environment, many courses are externally accredited by such professional bodies, whose influence on curriculum development is significant.

Many practitioners in the design, engineering and urban development industries require a period of formalised workplace training, either during or after university study, before being eligible to apply for statutory registration. This arrangement sees three significant stakeholders involved in, and influencing, education in these fields:

- Governments who are responsible for registering professionals, and administering registration examinations, and who control higher education policy and funding

- The professional industry bodies, who increasingly lobby governments and have their own education policies

- The higher education sector itself, responsible for curriculum development and delivery, often within guidelines provided by government and industry

This complex arrangement is fraught with all of the expected conflict between academia and industry and the ongoing differing visions of the role of professional education. In the example of architecture, the industry and professions have a vocational view and see the architecture course as “training for operation in the profession” [4], while many academics still see their role as “developing individual star architects as unique and gifted designers” [5].

2.1 Changes within society and Government

Until fairly recently university was considered as one stepping stone on a life-long career path. More recently however the notion of multiple careers in any one lifetime has emerged and university education is thus seen in a range of different ways, with multiple entry points, exit points and reasons for attending. This change in societal attitude has been driven by, among other things, significant changes in skill level in the workforce. Increasing internationalisation and automation in the 1980's saw increasing numbers of students attending university to raise their skill levels and improve their employability [6]. The new post-industrial society of that time was experiencing the rise of the information industries and the service sectors and Richard Florida's "creative class" were on the rise [7].

This increase in student numbers was primarily within the professional and technology sectors, not the arts and pure sciences, as students trained for changing career opportunities. This shifting focus towards employability also saw increasing concern among governments about the quality of higher education, and the balance of academic knowledge and practical (employability) skills. Many higher education providers, prompted by government, revised courses to incorporate graduate capabilities (employability skills) such as communication, teamwork, creativity, problem solving, and life-long learning [8].

2.2 Changes within the professions

On a professional level the building industry, and the roles of professional within it, has changed dramatically in the past few decades. What was once seen as a series of hierarchical industrial relationships, has changed to a team based industry with patterns of shared responsibility. These changes in professional practice have resulted in building industry professionals who need different sets of capabilities and skills, and more importantly who have a different view of themselves within their professional context. Such professionals must now see the value in participatory teamwork, client involvement, cross-disciplinary activity, multiple perspectives, and the capabilities for lifelong learning.

Problems in contemporary society are characterised as complex and not limited to one discipline, and our graduate must similarly work in multi-disciplinary or trans-disciplinary ways [9]. In particular our graduates need to be: outward-looking and connected, enterprising and innovative, community and society responsible, and providing and focussing on leadership [10]. This need for our graduates to be more focused on societal values rather than technical solutions means that university courses must respond to develop mode deeply a broader range of capabilities in our graduates. Together universities and the professions must develop policy and direction to assist in the development of higher education in this direction.

Professional organisations, as representatives of employers, "have been remarkably successful in influencing government policy on higher education" [11]. Such professional bodies develop education policies that rely heavily on performance criteria, employability skills, or graduate capabilities; all of which are permeating higher education. It is clear that such policies seek to make graduates more immediately employable, often at the expense of a more liberal education.

2.3 Changes within the higher education sector

Contemporary universities are "rapidly changing legal, social, economic and technological environments" characterised by the conflict they are experiencing between corporate and academic cultures [12]. With significant changes in the past few decades to society's attitude to higher education, universities have changed their management structures to become more entrepreneurial, competitive, strategic and bureaucratic [13]. The contemporary university-as-business may however be more concerned with responding to market demands than with the public good [14]. The need to capture a fair share of the student market is now a significant driving force. As long ago as 1980 David Riesman was investigating the effects of rising student consumerism on the higher education sector [15]. He talks of the decline of faculty (academic staff) dominance and the corporatisation of universities. More recently Sharon Beder [16] has noted the external demands on universities, and an increasing need to form partnerships with corporate employers, resulting in "university education… being increasingly turned into vocational training".

Such partnerships in BEE have been used to develop new commercial postgraduate courses, but such partnerships also manifest themselves in activities within the undergraduate program. Integrated projects may see undergraduate students working on research projects for external community groups, or commercial clients. Students may gain academic credit for work place learning with any of the Faculty's commercial partners.

3. Building a new Faculty framework

Within this complex and changing context, the Faculty of Built Environment and Engineering (BEE) embarked on a major process of renewal in the latter half of 2004. The process was guided in part by the works of two significant scholars in the field of higher education; Ernest Boyer's [17] work on scholarship and Burton Clarke's [18] work on successful entrepreneurial universities. The Faculty identifies its activities within the scholarly fields of teaching, discovery, and application. The Faculty conceives of Boyer's scholarship of integration as the role which academic leaders bring, at all levels of the faculty's organisation, to working these fields together (see Figure 1) [19].

Within the Faculty of Built Environment and Engineering at QUT, such partnerships have become an increasingly common mode of operation as guided by the Faculty White Paper [20] which draws much overt inspiration from the work of Burton Clark. The features of entrepreneurial universities identified by Clark, and reviewed by Deem [21], have been used to steer the Faculty to a more global, entrepreneurial, and integrated future, with industry partnerships, international activities, transdisciplinary courses, and a developing third funding stream.

We find that our courses must also fit this model of a contemporary faculty, sitting at the integration of teaching and learning, discovery, and application.

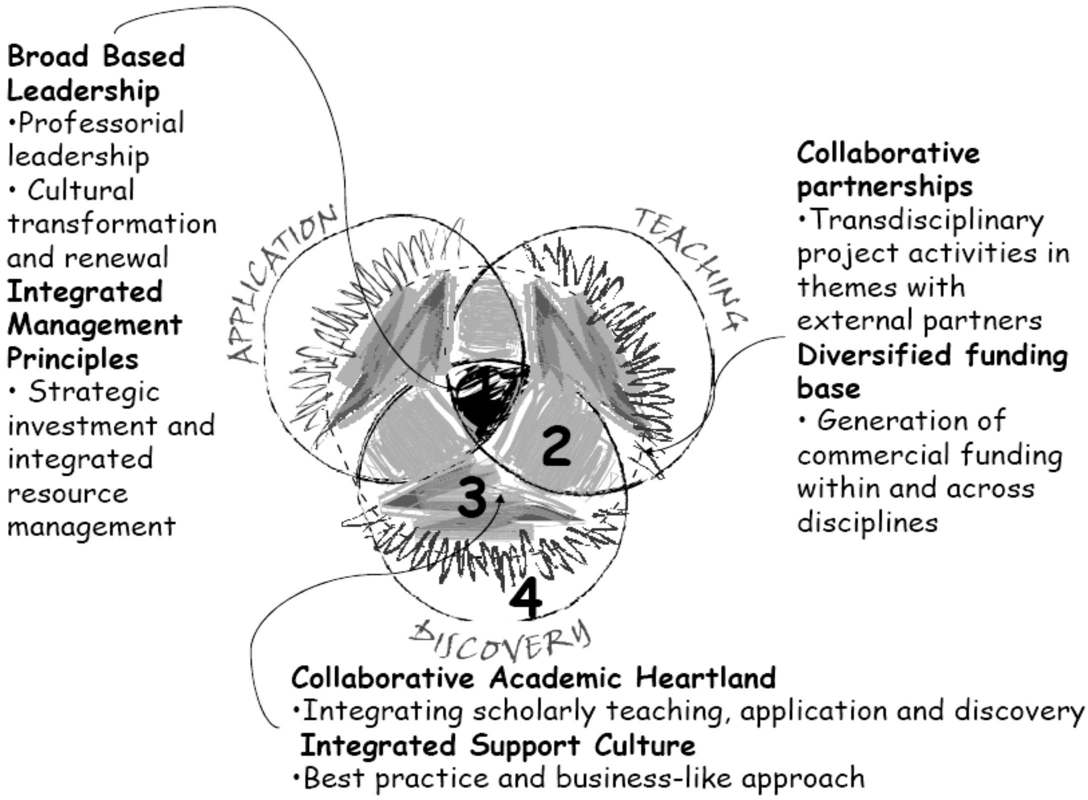

Figure1: Mapping Clark over Boyer; three areas of integrated scholarship ('Teaching, Discovery and Application') with an 'Integrated' core leading transformation of the Faculty.

The role of the contemporary university is to deliver education that responds to the changing needs of society, so different to just twenty years ago, within an increasingly global and entrepreneurial higher education environment. We must balance commercialism with social responsibility, while seeking the answer to "how an institution can be publicly funded, accountable and independent" [22].

4. Building a new course model

4.1 Up-scaling good practice

Closing the gap between outdated learning experiences and the changing societal expectations of the professions, and the changing role of universities, requires a shift from an educational model based on persuasion to one based on dialogue [23]. Where in the past, education has been seen as a process of doing it to them, to *turn* them into practitioners, it must now be about *enabling* them to become professional life-long learners by their own processes. This notion of 'becoming' suggests a transformative pedagogy as exemplified in the work of Jack Mezirow [24] [25].

The value of dialogue as opposed to persuasion is well explored by Mezirow in his work on transformative learning. Among other attributes, the communicative and participatory learning that Mezirow proposes is learning in which a student will be “free from coercion, distorting self deception or immobilizing anxiety... open to alternative view points… and have equal opportunity to participate in the various roles of discourse” [26]. This form of transformative learning involves critically questioning the assumptions of the professional and educational contexts around us, therefore a new educational context that embraces transformative learning will require students to have opportunities to question, and to play a greater role in shaping and forming their own educational environments, and this can certainly extend to large scale curriculum design.

BEE’s course development concepts stem from an understanding that Mezirow’s ideas of dialogically based learning environments can be used to conceive whole courses as well as classroom encounters. Within such a model of educational dialogue, students and teachers develop an understanding through conversation. The Faculty of Built Environment and Engineering has, in order to conduct that dialogue at a course scale, designed course structures that are not imposed upon students but rather developed individually by students, through their own choices, such that students can respond to changes in society, the professions, the higher education context in general, and changes in the role of universities.

The value of such student choice in not limited to transformative learning and professional alignment. Students who make their own choices are also more likely to use a “deep approach” to learning [27] due to higher levels of motivation and feelings of ownership. Such a deep approach, as opposed to surface learning, is one of improved understanding and application.

Engaging with transformative learning and preparing students for contemporary professional practice in the building industry will require an educational context with the following characteristics [28]:

- Divergent learning and teaching
- Dialogical learning and teaching
- Transformative learning
- Participation in practice
- Perspectivalism
- Revisability
- Creativity, inventiveness and innovation
- Self-construction and self-reliance

Courses in the contemporary university should therefore offer students opportunities for divergence, dialogue, and self-construction, along with opportunities for participation in practice and flexibility. Such courses will allow students to become different *types* of graduates with different types of capabilities more suited to contemporary circumstances.

4.2 Building course structures for dialogue

With these goals in mind, one of the major parts of the Faculty's transformative process was the development and introduction of a suite of new undergraduate courses to replace all existing ones. These courses broadly cover the fields of design, engineering, and urban development. Further to the pedagogical goals described above, these new courses were designed to integrate the scholarly activities of teaching, discovery and application, as described in the new structure of the Faculty. No longer would teaching and learning activities sit in isolation, rather students would engage with discovery (research) and application (external service) as structured parts of their programs of study.

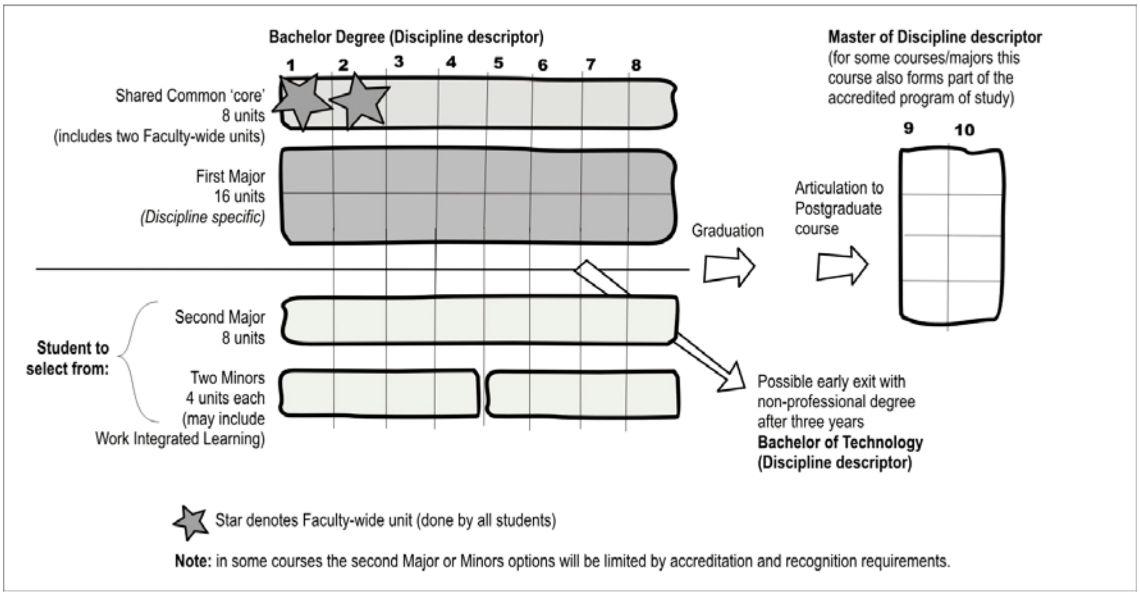

Figure 2: Model of the course structure of the Faculty of Built Environment and Engineering.

With a coming together of these Faculty goals, and ideas of transformative learning, it was possible to develop a common course structure (model) that would allow for the individuality of the disciplines to prevail, while also providing, and indeed encouraging, transdiciplinary activity. These two notions of discipline focus and flexibility/choice exist as shared possibilities that promote self-constructed, divergent learning. The courses (Figure 2) would provide the students with:

- Opportunities for self-construction and divergence
- Opportunities for integrated transdisciplinary study
- Opportunities to learn through and in practice (work place learning)

- Opportunities for articulation

- Opportunities to engage in discovery (research) and application (external and community service) activities through a thematic approach to faculty activities

The new courses all share a common model of a four year full-time structure (Figure 2, note that this diagram is not temporal but simply proportional), in which students self-construct one quarter of their studies to suit their own divergent paths. Further to this all students share a further quarter of their course with students from cognate disciplines, to enhance their broader professional capabilities. This commonality allows such groups of cognate disciplines to come together within single courses within which they share common subjects while still retaining individuality and diversity. This allows the Faculty's nineteen disciplines to form just three undergraduate degrees:

- Bachelor of Design (with majors in: Architecture, Industrial Design, Interior Design, and Landscape Architecture)

- Bachelor of Engineering (with majors in: Aerospace Avionics, Civil, Civil and Environmental, Civil and Construction, Computer Systems, Electrical, Infomechatronics, Mechanical, Medical, and Telecommunication)

- Bachelor of Urban Development (with majors in: Construction Management, Property Economics, Quantity Surveying, Spatial Science, and Urban and Regional Planning)

One useful way to think about the general model of these undergraduate courses is that they will contain three types of knowledge, or three types of units or subjects (Table 1).

Table 1: Three types of knowledge/unit within the undergraduate degree.

1	**Shared Core** (common to one degree)	A coordinated group of units (8 units in a 4 year degree) done by all students in the course. These are units of common content that are 'core' to all disciplines and therefore shared. Two of these units are also shared across the entire Faculty (*Introducing Professional Practice*, and *Introducing Sustainability*).
2	**Major** (the discipline that the student chooses to enter)	A coordinated group of units done only by the students of one discipline, to obtain a focused view of that field of knowledge.
3	**Self-selected units** (a coordinated suite of units structured as: second Major,	A selection from a range of coordinated groups of units (8 units in a 4 year degree). Students elect at the completion of their first year, a secondary field of specialisation (second Major), or two fields of specialisation (two

	two Minors, or Work Integrated Learning	Minors), or Work Integrated (workplace) Learning, or some combination of these. Students self-create their own divergent education, and career path.

The options for students to self-construct their course are wide and varied. They may select from as divergent areas as, cognate fields (within the Faculty), non-cognate fields (from other Faculties), work-integrated learning (learning in the workplace), research activities (engaging in the themed discovery activities alongside academic staff), and external services (community service and commercial application activities). Students are therefore able to construct courses in which they themselves also integrate the Faculty's scholarly activities of teaching and learning, discovery, and application (refer to Figure 1).

While this structure has been developed around nineteen existing majors (or disciplines) it is expected that new majors in emerging fields will be comfortably accommodated within the model proposed here. New disciplines of Design, Engineering, and Construction will be easily accommodated within the existing model. While notions of what such future disciplines might be will be led by changes in the professions, our students will also take an active role in such development.

New course Majors (disciplines) can be firstly tested, before full implementation, as Minors or Second Majors in which our students may take an active role in developing our education context, already characterised as 'innovative, creative, dialogical, and revisable'. The pathways that our students make for themselves, pathways that many of them will develop while participating in professional practice through workplace learning, will show us desirable and sensible course options for further development. Such pathways will not be restricted within the Faculty, but may stretch across the whole university to explore new professional career paths such as Sustainable Environment Design, Chemical Engineering, Design Education, Social Project Management, and Built Environment Law.

This larger scale flexibility, at a course level rather than at a student level, positions the Faculty where it can respond to an uncertain future, in the professions, in the higher education sector, and within the broader society.

5. Conclusions

The courses described here can be seen as a direct response to the changing role of universities, while implementing sound practices of transformative and dialogical learning environments. These courses have been running for two years now, and all evidence suggests that the aims of self-construction and divergence have been well received. The courses have been recognised by a university award for curriculum development; the model described here is now being copied by other faculties; student demand is high and rising in a climate of falling demand; and anecdotal evidence from student recruitment events shows that prospective students are highly interested in, and attracted to, the flexibility and self-directed possibilities that these courses offer.

Self-directed flexibility on this scale is not usual for ‘professional’ degrees, such as engineering and architecture; courses where so many stakeholders drive the agendas of curriculum, content, graduate capabilities, and course structure. This model shows however that the most important stakeholder, the student, can be given greater levels of involvement in their own course development with both desirable and successful outcomes. These courses offer students the opportunity to develop into different *types* of graduates, appropriate to changing professional and social context. “Adults do not learn for the sake of learning; they learn to perform a task, solve a problem, or live a more satisfying way” [29]. These courses seek to provide educational possibilities for the broadest range of tasks, problems, and ways of living.

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Shifting the Engineering Education Paradigm - Challenges and Experience in Curriculum Development and Delivery

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Abstract

It is being recognised around the world that educating future professionals as building practitioners requires a fresh approach. This school of thought stems from the fact that the industry puts higher value on efficient knowledge managers armed with emotional intelligence as compared to traditional knowledge sinks. Especially in the field of engineering, on the one hand engineered proprietary products, new construction materials and processes are becoming globally competitive and therefore technical data and design guides are readily accessible. This inevitably questions the prominence, teaching and learning effort and time invested gaining skills in numerically deductive reasoning in the traditional manner. On the other hand in the building industry, digital architecture, form finding techniques and computational mechanics skills are being complemented or replaced by ultra efficient software tools. In this fast moving and globally competitive environment, the industry recognises that what has been perceived as "know-how" can become stale in a much short time than the time required to acquire and preserve it. Forward thinking building education thus bears the challenge of training a new breed of practitioners who are robust self learners relentlessly in pursuit of skill transformation within short life cycles. This paper presents the teaching and learning paradigm which is aligned to the above school of thought.

Keywords: Engineering education, WIL, PBL, Co-rational design, PBL, Curriculum development

1. Background

1.1 Need for shifting the paradigm

The modern practice of building and construction engineering is evidence-based critical decision making achieved through team networks. However, engineering was traditionally taught in a content intensive, compartmentalized and prescriptive manner, focusing on numerically deductive reasoning. That approach had little focus on generic graduate attributes expected of the future engineering practitioner. There is an increasing trend to suggest that the professional and the tertiary education institutions are jointly addressing the concerns of this widening gap. For example, The Engineers Australia manual for the accreditation of professional engineering programs [1], issued in 1999, called for a major shift in the way universities train engineering graduates. This demanded the inclusion of generic graduate attributes in all programs, driven by capability agenda which was linked to re-accreditation in 2004. In a way, this was the first formal acknowledgement of the widening gap between engineering education and industry expectations mentioned above in Australia and the strategy adopted to address the issue. Those who have been practicing engineers involved in the graduate recruitments and mentoring schemes around the world no doubt would have great insight into the issue and appreciate the need for such a paradigm shift.

In response to this and also as a part of the general quality assurance process, the faculty of engineering at RMIT University issued, in 2002, a project plan titled: 'Renewal of the Bachelor of Engineering 2002-2004' [2], encouraging project based learning methods in teaching practices at RMIT. The paper discusses the challenges faced and the experiences gained transforming a prescriptive type teaching and learning paradigm in the field of civil engineering design stream aligning to a capability agenda. The curriculum development and the delivery presented here evolved over five years (2002-2007), and the first batch of engineering students benefited from this undertaking is graduating at the end of 2007.

1.2 Essential elements of change

In line with the Engineers Australia recommendations and the faculty directive, the author undertook creating and developing work integrated learning (WIL) environments using project based learning (PBL) methods to align the civil engineering degree program towards the set objectives. Six civil engineering design and analysis courses were created [3], and arranged in a scaffold-like, verticially integrated stream. By immersing students in realistic and team oriented integrated learning activities, analysis and problem solving skills were simultaneously developed with teamwork and communication skills (our core graduate capabilities). As demonstrated here through a sample of project descriptions and outcomes, the author managed to arouse enough curiosity and enthusiasm in them to foster independent learning which, in our view, would encourage them to become reflective practitioners later in their careers [4].

The fundamental difference we made was changing the mind set of the teacher and the student. To get more insight to the teaching and learning philosophy and the course development models influencing this change, the reader is directed to a 2004 publication [5]. The desired paradigm shift was achieved affecting the following three areas,

- Acknowledging, in principle, the problem or project based approach to teaching and learning (PBL) as the preferred method to simulate work integrated learning (WIL)

- Creating student centeredness within both teaching and learning opposed to content and teacher centeredness

- Acknowledging the engineering design as a multi disciplinary, evidence based decision making process where know-how of the whole of design process, negotiated compromise and project delivery capabilities are as equally as important as numerically deductive reasoning.

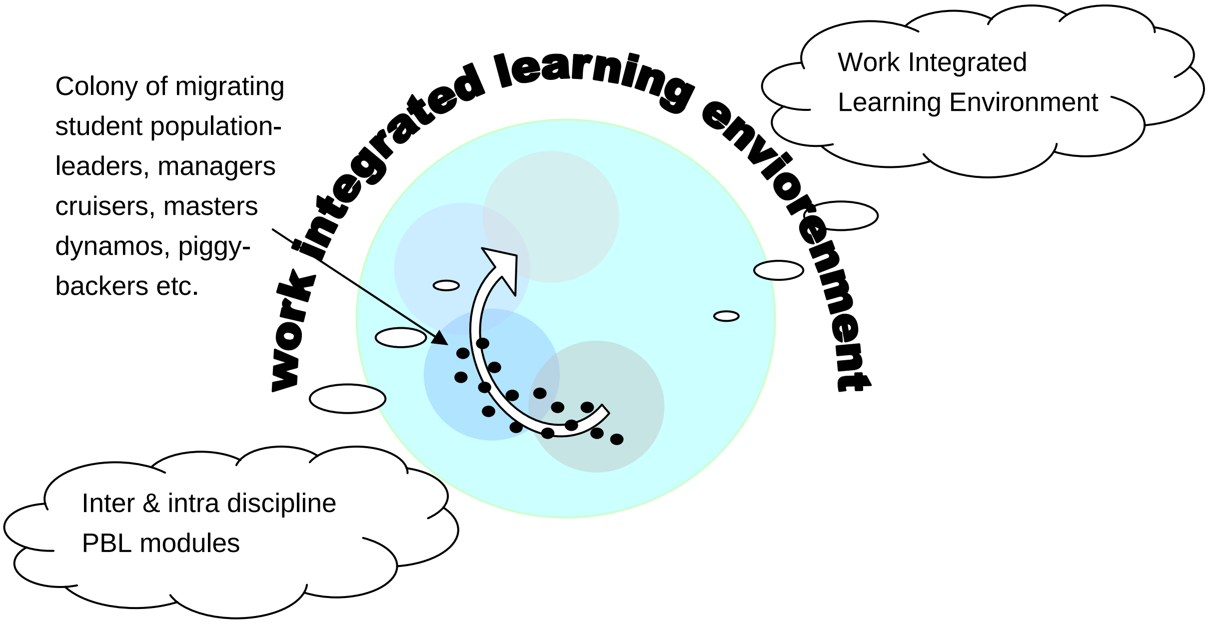

Figure 1: Model Illustration of Paradigm Shift

Figure 1 illustrates, conceptually, the new paradigm, its influence on our student population and our observations in seeing them grow. The important thing in student centeredness is that it is up to the student to reflectively and relatively evaluate how he/she travels within the population. More importantly, this is the best way we can observe them closely at play in a simulated work environment. We are convinced that this way, students have a far better opportunity to get feedback and seek suggestions in order to develop as rounded personalities in professional practice.

We give equal emphasis on the key skills discussed in sections 4.1-4.3 to their comprehension in technical content, in assessing engineering excellence.

2. Work integrated learning and audit readiness

Unlike a couple of decades ago, the current marketplace demands work ready graduates. Therefore the key focus of the forward thinking educational institutions in our view, striving for quality value added delivery, is to ensure students' readiness to work at different stages of their growth, even before they complete their degree.

Work Integrated Learning (WIL) basically refers to the institutions' ability to simulate or mimic workplace process mechanisms and emotional/behavioural intelligence within the constraints of the "class room" or learning environment. Audit readiness here refers to students' ability to be competitive in seeking a placement as early as possible in their undergraduate program. These two objectives require a significant departure from training graduates through text books, tutorials and exams. WIL can vary from designing a simple learning activity, a single course or an entire degree program. Problem or project based learning is increasingly being recognised as the means to that end. In a more provocative approach one can create functioning virtual communities where multi disciplinary student teams work in collaboration to solve simulated real life scenarios. For example, challenging students by engaging them in university capital development project initiatives or university asset management strategies where students offer solutions on competing teams can become a refreshing experience. In many cases we find that the solutions proposed by them are exciting and innovative to the extent that all involved exceed their own expectations.

Audit readiness is a concept we introduced to encourage our students to be confident and upfront in sharing and discussing their work in progress. This concept was introduced in 2004, after careful monitoring of students' lack of confidence and transparency in sharing and discussing their work in progress. I found this reluctance to be not very healthy from a professional education standpoint. Audit readiness and transparency at work are undoubtedly the pillars of quality and safety assurance mechanisms in the building industry. My concerns were further accentuated with the observation that even our best performing students had this reluctance. The concept of audit readiness was therefore introduced to reverse this bad habit, apparently a wrong perception of assessment inherited through traditional education.

To put this succinctly, our endeavour is to transform "student hours" to "engineering hours" as early as practically feasible within the degree program so that our students are highly sought after within the workplace.

3. Teachers' role

Obviously, re-defining teachers' roles and teachers' mindsets is fundamental to shifting an education paradigm, especially in creating student centeredness. This requires significant commitment, resources and bold decision making at the institution level. We acknowledge that the future role of quality educational institutions would need to change from being the "centre of knowledge" to being the "centres of opportunity/experience". In this regard the teacher's role would shift from being the knowledge provider to a facilitator's role in knowledge management. Although the volume of information available and the speed of accessing it have reached phenomenal levels of efficiency, the obsoleteness and the lack of credibility of the knowledge that is within reach are also on the rise. As a result, the teacher's role as the sole guardian of knowledge and the ability to police students' leaning is going out of fashion. In the new paradigm shift, the teacher can command respect only if she/he possesses great motivational skills, vision, reach, can interpret information in a speedy manner and is capable of real time responses to students' enquiries regarding various sources of information. In other words, building education is moving from having a pseudo-static status to a dynamic mode. It is certainly challenging and for many, it is outside their comfort zone. That is where institutional level intervention is required, and adequate resources should be utilised in ensuring that the teaching resources are continually groomed.

4. Curriculum, learning outcomes and performance indicators

In this endeavour work integrated learning (WIL) environments were created in a scaffold-like manner by a vertically integrated stream of engineering design and analysis courses offered from second year through to final year. By immersing students in realistic and team oriented integrated learning activities, analysis and problem solving skills were simultaneously developed with teamwork and communication skills (our core graduate capabilities). As demonstrated here through a sample of project outcomes, the author managed to arouse enough curiosity and enthusiasm in them to foster independent learning which, in our view, would encourage them to become reflective practitioners later in their careers. A brief sampling of curricula and learning outcomes is presented to support the conceptual model illustrated in Figure 1. They are discussed under three key performance indicators which are of great importance to future engineers and highly valued by the Australian building industry. Namely, gaining skills in co-rational decision making, skills in virtual mobility and work ethics are all required to succeed in inter-discipline and intra-discipline engineering services.

4.1 Skills in co-rational design

In a traditional structural engineering design office setting, there were two general process mechanisms evident – the pre-rational approach and the post-rational approach. In a pre-rational design process engineered structural solutions precede the architectural form. This approach is seldom used in current practice. In a post-rational design process architectural form finding precedes the engineering design process. This is probably the most common practice today. In both these traditional approaches process becomes inherently problematic and defeats the purpose as the architect or the engineer is in a reactive mode. This is especially the case when one considers the advances in digital architecture and its impact on engineering [6]. The co-rational design approach, which seems to be the future trend in the building industry, is more synergistic, encouraging the optimal outcome for stakeholders. In fact, from a constructability point of view, such co-rational design teams should also include building services and construction experts as well.

It is believed that during the Roman era the person in charge had a good understanding of engineering aspects such as the strength of material, structural stability, constructability as well as the architectural aspects such as form and aesthetic. Ardill [7] argues that this was the idea on which the “Master Builder” concept was evolved. Although this is still the reality, as discussed above, in practice universities around the world chose to educate and train the student counterparts in these complimenting fields in a number of different discipline specific silos which provide few opportunities for interactive team play. We observe this as a major anomaly which, in our view, warrants attention of the building educators. Our response is to bridge this apparent intra-discipline gap by engaging students and staff in simulated co-rational design projects.

A project based learning module was therefore developed under the theme “long-span and high-rise structures”. There is an ever increasing trend in constructing all-weather multi-purpose venues and tall buildings where state-of-the-art structural concepts and the new generation of materials and analysis tools are involved. Information on such high profile structures, designed and developed by the well known architect/engineer syndicates around the world on a competitive basis, serve as great case studies and learning resource for our students and staff. By engaging students and staff from engineering and architecture, we managed to mimic and enrich their learning and insight into how complementing fields can learn from one another. Figures 2(a) – 2 (d) present a representative sample of student projects developed through this course.

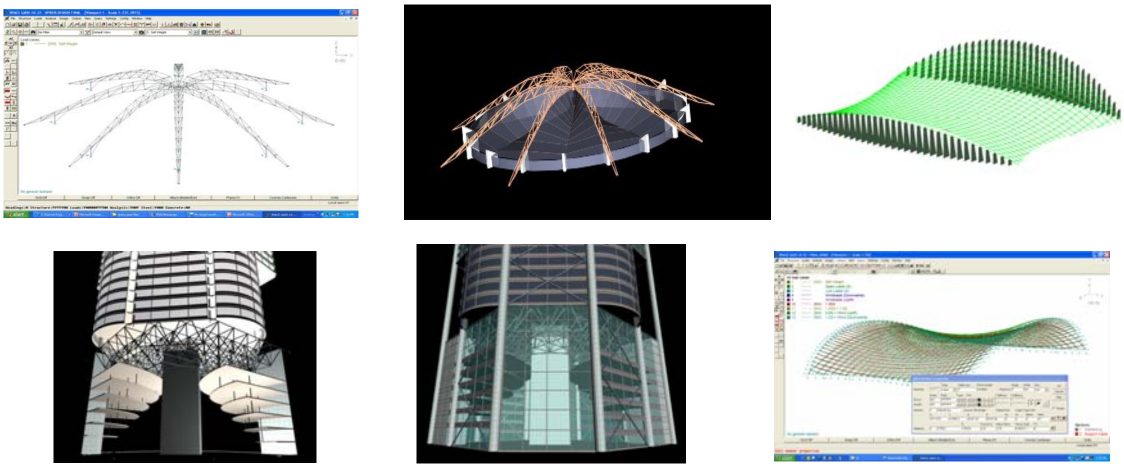

Figure 2: Students Co-rationally Design Long-Span and High-rise Structures

4.2 Skills in virtual mobility

Virtual mobility here refers to gaining communication and collaboration skills in order to transcend cultural, geographic, language and discipline barriers to establish new professional affiliations. We strongly believe our civil engineering graduates need such skills in the future, especially because the building industry is an increasingly globalising market. We have simulated a learning environment to provide experience and the gaining of such skills by engaging them in an internationally collaborated project. In this particular course our students have to engage with their counterparts, whom they have never met, from an international university to conduct a collaborative joint project. Our initial motivation was to provide an opportunity to expose students to international collaboration in order to gain skills in virtual mobility. The author has developed the pedagogy and provided the leadership for this ambitious project initiative, the first of it’s kind, between RMIT University, Melbourne, Australia and the Ecole Spéciale des Travaux Publics du Bâtiment at de L’Industrie (ESTP), Paris. In this course each project team comprised of two RMIT students and two ESTP students. The course, named “sustaining historical structures”, was designed in content to teach structural pathologies and structural forensics involved in extending the life of aging structures. There is limited opportunity for Australian students, being educated in a relatively young country, to investigate and learn about these aspects and how world renowned monuments are normally preserved beyond their designed life. Students from each university have met and communicated in a virtual class room environment over two months in scoping, researching and jointly investigating a monument in Paris of their choice. This was followed by a visit to Paris for two weeks where students were to meet their team members in person for the fist time and to finalise their project and make a presentation to an international academic panel. The idea was successfully launched in the summer of 2004/05 involving nine such teams. A total of 36 students took part from both universities, investigating nine world renowned monuments. All involved - students, the ESTP academic team and the RMIT team – were unanimous in their enthusiasm as to the success of the program. This success was measured in both the quality of the academic program and the interaction between students on an academic and social level. It is refreshing to see how such an ambitious and far reaching project can speed up their process of maturing to international arena.

4.3 Skills in negotiating more than one solution with intra-disciplinary and inter-disciplinary work environs

To our great disappointment, engineering students who are meant to be inherently pragmatic, logical thinkers with excellent numerical and reasoning skills appear to in fact be educated and trained to become "single solution" seekers. It is intriguing to see that within our traditional education paradigm, significant class time, effort and rewards appear to be granted in calculating a "decision", to a third decimal accuracy where as a rough estimate leads to the same outcome. More interestingly, students have no appreciation whether their solution could be acceptable to other stakeholders. It appears to us that we need to provide enough learning experiences within the classroom for our students to learn this reality and when and how to arrest obsession of over engineering, and to demonstrate that although the intent is good such endeavours can be perceived as being inefficient.

We were also keen to establish a leaning environment within which inter-disciplinary skills can be sharpened and students could experience how interface issues can become critical during the design and developing stage of a project. Here inter-disciplinary refers to the major specialization streams within the field of civil engineering such as water resources, structural, geotechnical and project management. This project based learning module was also intended to integrate three years of learning in different course to come together in a major project outcome.

The same group of students were again rallied, this time under the theme "re-imagining Australian suburb" to develop a medium density township with a sustainability focus. Such a task obviously demands a wide spectrum of expertise and skills and needs to work within a well coordinated complex organization structure. The Green Suburb Project is a 30 hectare development project to cater for a population of 2000 with 1-2% growth over a 50 year planning horizon. The project evolves in three phases. The first phase is to engage students through the competition between design consortia for the project, and through them conceiving and developing a master plan. A typical design consortium comprises of a mix of 8-10 students from different specialisation fields. The second phase is to engage students as part of a chosen specialist sub-team engineering and documenting civil works within the consortium; namely earthworks, roads, storm water drainage, and water supply and wastewater treatment. The third phase is to engage students, as individuals, in designing and documenting a building structure of their choice. The key motives are to simulate an environment where students see the "big picture" issues. That is, to experience and resolve typical interface problems for a coherent design, as mentioned, integrating their prior learning in water resources, geotechnical engineering, surveying, project management, transport, and structures. Figures 3 provide a representative sample of student project outcomes achieved through this course.

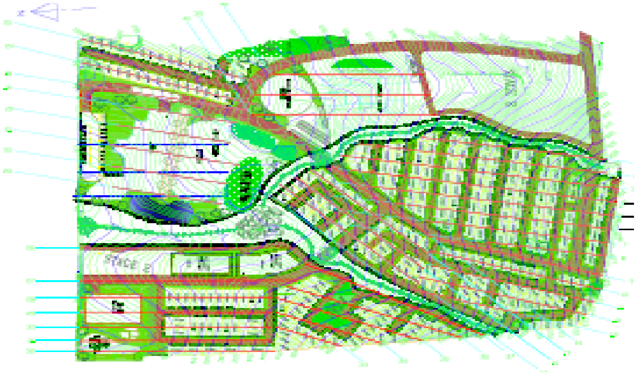

Figure 3: Inter-disciplinary Green Suburb Project Involving Specialising Streams of Civil Engineering

It is refreshing to note that in 2005, we used the tsunami as a catalyst to positively engage students in developing planned townships for tsunami affected regions. Instead of "Re-imagining the Australian suburb" students were engaged in developing a master plan for a new township to replace washed away unplanned cities in the region including in Sri Lanka. This demonstrated the strength of using a "theme" as a backdrop in curricular development, where real engineering issues can be taken on board with least effort. I was amazed at the vigour and commitment students showed in completing and documenting the task in 2005. The most interesting aspect was how swiftly students adapted themselves to think globally and their sense of a 'duty of care'.

One intra-disciplinary example is presented under the co-rational design section. Figures 4 illustrate a recently concluded intra-discipline pilot study where a team of thirteen students from engineering, social planning, architecture and management came together to propose a modern, responsive community centre for the Victorian Growth Authority, which was ultimately well received and commended by the client.

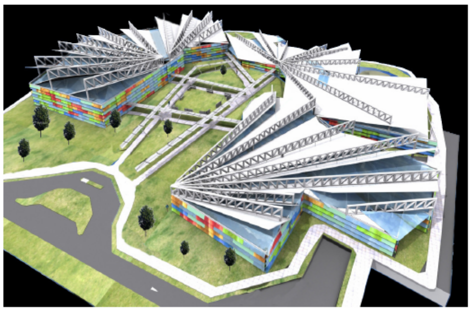

Figure 4: Intra-disciplinary project involving engineering, architecture, social planning and management disciplines.

5. Conclusions

- The tertiary education paradigm is currently being revived in many universities around the world which are aligning to a capability agenda. The need to create Work Integrated Learning environments in professional education is gaining recognition and Project Based Learning is regarded as the best form of delivery of a capability driven agenda. However, it must be emphasised that the intension is not to undermine basic and fundamental discipline specific skills but to enhance its application by creating exciting learning environments simulating the real work place. In other words, content is taught within the context of processes, emotional and behavioural patterns of the real workplace, providing students the opportunity to experience first hand.

- The skills needed by the quality educators and the future graduates for success are changing rapidly and can no longer be regarded as pseudo-static.

- Knowledge is widely and freely accessible. Training opportunities and experiencing first hand how to apply know-how in the working life are the reasons for students attending educational institutions. This can be achieved while safeguarding and nurturing tertiary institutions' traditional position as the institutions of scholarly learning.

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The perspective of students on under-graduate research methodology learning and teaching in the UK

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Abstract

Dissertations are used in many disciplines as the flag ship document for honours graduates. The skills developed help in completing work in other modules and are valued by potential employers. Bespoke research methods modules are used in some degree programmes to foster improvements. It could be argued that built environment dissertations still lack rigorous analysis. Students who have a dislike of mathematics will avoid quantitative techniques that involve statistics. Students who take a qualitative approach rarely do little more than content analysis. The methodology for the study is a literature review and survey of students in two segments (i) those who have completed a research methods module and about to embark upon dissertations (level two students), and (ii) those who have completed their dissertations (level three students). There were 50 replies. The survey measures 'student perception of success of learning outcomes' in research methods and dissertation modules. Overall mean scores were 68.4% for level two students and 72.1% for level three students, indicating 'good to very good' achievement in learning outcomes. The study finds that a research module is highly valued by most students. There are several areas where students need to improve, including analytical skills, time management, citing techniques, and the use of hypotheses and variables. It was found that tutors sometimes give contradictory advice about research methodology.

Keywords: Research methods, dissertations, analysis, teaching

1. Introduction

In the early 1990s, there was concern in the built environment that student dissertations were not of the appropriate quality. Holt [1], Fellows and Liu [2], and Naoum [3] published their first editions of research methodology texts for construction students in the late 1990s. Consequently, dissertations improved, and consensus was established about structure and content. Historically, students have not used robust analytical techniques, and academics did not agree on what constituted a 'good' dissertation. Dissertations skills 'spin-off' into other modules by encouraging students to take a more analytical approach to all their studies, and also to ensure that all material used is evidentially based. Some degree programmes prepare students for dissertations with formal teaching in the dissertation module itself, whilst others prefer to nurture research skills in all modules. There has been a trend to increase the weighting of final year dissertations on some programmes, perhaps constituting as much as one third of a final year programme. A case study which illustrates how dissertations are dealt with at the University of Ulster, Jordanstown, is articulated by Taylor [4]; research methods and dissertation are integrated into one module worth 40 credit points. Amaratunga and Senaratne [5] state that there is a need to enhance student learning and research skills. Students often avoid statistics to analyse data such as those illustrated in Ruddock [6]. Since there can be some complexity in understanding the intrinsic meaning of inferential statistical tests, there may be a danger that those students who do take-on the statistical challenge may not have real understanding of their results. Qualitative analysis is often limited to content analysis, and does not demonstrate the rigour illustrated for example by Taylor and Bogden [7]. It is probable that few construction undergraduate programmes use sophisticated software programmes to analyse qualitative or quantitative data. Such programmes are used in other disciplines, for example QSR International qualitative software XSight and NVivo7, used at the University of Southampton in the marketing profession [8], and SPSS quantitative software as illustrated by Bryman and Cramer [9]. There may be a feeling by tutors that they are unnecessarily complex for construction. It is unlikely that students will have the resource to take-on both quantitative and qualitative analytic methods within their work; that is triangulation or mixed-methods approach as suggested by Somekh and Lewin [10, p. 274]. Consequently as Strauss and Corbin state [11, p. 28] without at least appreciation of both, there is a danger that students will take into their careers 'dogmatic positions … in favour of either'. There is probably a tendency for students to design objectives around a data collection exercise and analytical method they are comfortable with, rather than, as Patton [12, p. 585] states 'to appropriately match methods to purpose'. Real understanding of the concepts of reliability and validity by students is arguably a challenge still to be addressed. Dissertations are often weak in the latter sections, because students do not understand the importance of well developed conclusions, and they also run out of time. A survey is undertaken of students who have completed their dissertations and those who are about to embark upon the process. The study explores whether research methods modules, in preparation for dissertations, are of real value, and seeks areas for improvement.

2. Literature review

Holt [1], Fellows and Liu [2], and Naoum [3] illustrate loose consensus about structure and chapters for dissertations, thus (i) introduction, (ii) review of theory and the literature, (iii) description and defence of methodology employed, (iv) data analysis, results and findings, (v) discussion and interpretation of results and findings with the literature, and (vi) conclusions and recommendations against objectives. However, Holt [1], and Naoum [3, p. 132] place little emphasis on the need for a separate discussion chapter.

Language used to describe research goals is consistent, that is aims, research questions, objectives and hypotheses. Aims and objectives are always stated as being key, and Fellows and Liu [2, p. 46] suggest one aim and three objectives. There is agreement that research in construction is often problem based, and this is supported by Creswell [13, p.74] and Silverman, [14, p.5] in the fields of human and social sciences. However, some terminology in texts is variable, for example according to Hart [15, p. 9] the first part of a dissertation should be a rationale; Holt [1, p. 9] asks for a broad discussion, Naoum [3, p.14] suggests a purpose, and Fellows and Liu [2, p. 9] a proposal. Also, there does not appear to be consensus about the rigour of analysis that should be present in undergraduate dissertations. This can stem from emphasis which is (or which is not) placed on the need to identify variables, explain influence between them and formulate hypotheses. Blaike [16, p. 35] states that this analysis is the ultimate objective in social research and is the most complex. Naoum [3, p.46] states that if sample size is small, relationships can be discussed intellectually, 'which is acceptable for the level of students reading this book'. But Holt [1, p. 100] states that a basic grasp of statistics is a pre-requisite to almost any successful dissertation. Fellows and Liu [2, pp. 9 and 28] argue that sometimes qualitative research is assumed to be an easy option for persons who do not excel in mathematical techniques and that qualitative approaches are actually considerably more difficult than quantitative, requiring a lot of filtering, sorting and manipulations. The danger is that students who undertake qualitative approaches do not do rigorous analysis, and that dissertations become what Holt [1, p. 15], describes as simply a comprehensive assignment. It is not helpful that construction research methods texts do not give examples of robust qualitative analysis, particularly that is in the context that as Creswell [17, p. 140] points out 'undoubtedly, no consensus exists for the analysis of … qualitative data'. Creswell [13, p. 4] also states that the issue is not quantitative or qualitative, but more how research practices lie somewhere on a continuum between the two.

The need for reviews of theory and literature to be critical is emphasised in all texts. Similarly, it is agreed that conclusions should be written against aims and objectives, and Holt [1, p. 126], reminds us that the length of time to compile them can be substantial in comparison to the volume of work produced. Holt [1, p. 29] and Naoum [3, p. 164] give typical programmes or work schedules to assist students with their time management.

Reliability and validity are arguably very important issues for students to grapple with, otherwise the whole basis of their research can be flawed. It is acknowledged they can be very difficult concepts to understand and particularly to apply to one's own work. Fellows and Liu [2] examine both; however Holt [1] and Naoum [3] are both silent. It is therefore questionable whether it can reasonably be expected that undergraduate students should display knowledge of reliability and validity in their dissertations.

3. Methodology

A questionnaire was used to collect primarily quantitative data. Useful qualitative information was obtained from a section at the end of the questionnaire under the heading 'please add further comments … constructive criticism welcome'. The population for the study was built environment students studying BSc (Hons) programmes in UK universities. The sample was one of convenience, that is full and part-time construction students attending The University of Bolton, UK. They were studying either Architectural Technology, Building Surveying, Construction Management or Quantity Surveying. A key feature of student intake was that many are mature students with non-standard backgrounds. This sample was in two segments: (i) level two students who had just completed a level two research methods module (10 credits) as preparation for their dissertations, and (ii) level three students who had successfully completed the research methods module and subsequently their dissertations (30 credits). Questionnaires were distributed by post to home addresses with pre-paid envelopes. There were 52 students in segment (i) and 50 students in segment (ii); these generated 23 and 27 replies respectively. The questionnaires sent to each group or segment were of a similar structure. For each group there were five questions collecting data about the following subject variables: degree discipline, age, whether studying full or part-time, gender and whether qualitative or quantitative analysis was used in their documents. A basket of statements was used to measure the variable labelled 'student perception of success of research learning outcomes'; there were 28 statements for level two students and 30 statements for level three students. A Likert scale as illustrated by Oppenheim, [18, p. 196] was used, whereby students were invited to indicate whether they strongly agree, agree, uncertain, disagree or strongly disagree with each statement. The five possible student replies were scored in the range of 0 to 4, with 4 indicating a positive perception of success and summed totals were calculated from the basket of questions. The minimum score was therefore 0 for level two and three students, and the maximum score 112 for level two students and 120 for level three students; results were converted arithmetically to a percentage scale, whereby for example a score of 60 out of 120 became 50%. Seven questions were reversed in the survey to improve the internal reliability of the question scale, but for the purposes of clarity in table 3 all questions are written in the same direction e.g. Q. 24 '*I am sure about how to cite other work Harvard Style'* was actually presented to students as '*I am still uncertain about how to cite other work Harvard Style*' [18, p. 197].

Inferential tests were undertaken to detect for differences in the perception of success scores for the five subject variables. Tests of internal reliability were undertaken; the p value was set at 0.05. Actual student marks from tutors were considered to help improve validity of the study.

4. Quantitative Results and Analysis

Table 1 indicates the profiles of those students who responded to the survey. There are approximate equal numbers in each of the four disciplines. The most popular method of analysis is quantitative for level two students, but qualitative for level three students. The gender profile is typical of that in the built environment in the university; that is 84% male, 16% female. It is perhaps to be expected that the mean age of full-time students at 25 years is below that of part-time students at 30 years.

Scoring scales used to convert the qualitative student responses (disagree/agree etc) into quantitative data are shown in table 2. Percentage scales are used to express the results with greater clarity, and adjectives or labels are also ascribed to assist summative qualitative judgements to be drawn.

Table 3 details all statements used in the main research instrument. Statements are listed in the order of highest scores for level two students in measurement of the variable 'student perception of success of research learning outcomes'.

Table 1: Demographic data

Level two students, n = 23				
Discipline	Architectural Technology 6	Building Surveying 7	Construction Management 3	Quantity Surveying 7
Type of analysis	Quantitative 14	Qualitative 5	Other4	
Gender	Male 20	Female 3		
Mode of study	Full-time 10	Part-time 13		
Mean age	25 years			
Level three students, n = 27				
Discipline	Architectural Technology 8	Building Surveying 7	Construction Management 8	Quantity Surveying 4
Type of analysis	Quantitative 6	Qualitative 12	Other 9	
Gender	Male 22	Female 5		
Mode of study	Full-time 11	Part-time 16		
Mean age	30 years			

The overall mean scores of 68.4% for level two students and 72.1% for level three students indicate good to very good achievement in measurement of the variable 'student perception of success of research learning outcomes'. The research methods module at level two was highly valued by students (item 1), and graduates found the dissertation process challenging (item 6). In the context that the research seeks to identify areas for corrective action, inferences are sought and interpretation undertaken below for all measures of success that fell below the mean score of 60% (those statements indicated by italics in table 3).

Items 22 and 23 indicate that students were not able to use quantitative or qualitative analytical tools appropriately at the end of their level two studies. This is important because a key learning outcome in the research methods module is that students should be able to use 'robust' analytical tools in their work. Also historically, external examiners on the programmes have criticised dissertations for their 'lack of analysis', and to the extent that analysis was present in dissertations it was superficial and not academically rigorous. There is reluctance for some students to grasp the challenge of mathematics or statistics in their analysis. Similarly robust qualitative techniques are avoided. Whilst on the one hand scores of 59.7% and 58.7% from table 4 for level two students may be disappointing, it is pleasing that student skills improved (70.3% and 72.2%) as they undertook further more in-depth analysis in their dissertations.

Table 2: Scoring scales

Possible student response	**Allocated score**	**Allocated score converted to a percentage scale**	**Adjective / label to describe achievement against learning outcomes**
Strongly disagree	0	0%	Highly unsatisfactory achievement
Disagree	1	25%	Unsatisfactory achievement
Uncertain	2	50%	Satisfactory achievement
Agree	3	75%	Good to very good achievement
Strongly agree	4	100%	Excellent achievement

Scores for item 24 (citing work Harvard Style) are 55.4% and 77.7% for level two and three students respectively. The improvement between the levels is noted, but both scores can be considered disappointing. Citing Harvard style is a concept introduced in a communication studies module at level one; it is emphasised to students that citing other work with precision is a fundamental concept underpinning academic work. It may be expected that even students who graduate with third class honours will be able to cite correctly.

Being able to include a clear hypothesis in work (item 20, 64.1% and 58.3%) and the identification of variables (item 25, 51.0% and 59.2%) are concepts that many students find difficult to grasp, and are reluctant to conquer. Many students who are able to give examples of variables cannot identify which are the independent variables (IVs) and which the dependent variables (DVs).

There are two items Nos 26 and 28 related to working independently and working in teams. Working independently scored only 31.5% and working in teams scored only 34.7%. It is observed that it would be excellent for students to work almost entirely independently and obtain excellent dissertation scores. However this is rare; those students who work very closely with supervisors often obtain better marks than those students who do not. The level two research methods coursework is a task set for pairs of students; many students do not like this on the basis that they become reliant on colleagues who may be less capable, and part-time students particularly can be difficult to get hold of especially when they are working in busy full-time jobs.

Table 3: Survey statements: mean scores for 'student perception of success of research learning outcomes'. High mean scores indicate high perception of success. Statements in italics indicate results below 60%

Item No	Basket of statements to measure the variable 'student perception of success of research learning outcomes' – possible responses strongly disagree, disagree, uncertain, agree, strongly agree	Mean % scores level two students	Mean % scores level three students
1	I found that the research methods module was valuable in helping me to prepare for my dissertation / coursework	86.9	74.0
2	I found that the dissertation gave me good insight into the world of research	84.7	76.8
3	I became aware of literature sources that otherwise I would not have known about	82.6	75.0
4	I understood that establishing clear objectives is a key premise for good dissertations	81.5	88.8
5	I was able to develop my skills in searching for information using electronic and other means	80.4	83.3
6	I found that the dissertation / coursework was really challenging	78.2	86.1
7	I understand the need to write conclusions against all my objectives	78.2	80.5
8	I was able to develop my knowledge of research methodology	78.2	78.7
9	I understand the limitations of my dissertation in the context of the 'real world'	78.2	78.7
10	I found the research methods class notes very useful	77.1	70.3
11	I was able to appropriately manage my own time in completing my work on time	76.0	75.9
12	I developed the skills necessary to write a literature review.	73.9	80.5
13	I was able to develop ideas about how to collect data	73.9	73.1
14	I understand the relationship between the aim, objectives and hypotheses	71.8	83.3
15	I was able to develop my specialist knowledge in my chosen topic area	71.7	75.0
16	I am very proud of my dissertation / coursework	65.2	75.9
17	I was sure what the concept of reliability means in the context of research	64.1	73.1
18	I found the key recommended text book by Naoum very useful	64.1	72.7
19	The modules helped me to develop my writing skills	64.1	72.2

Table 3 (continued):

20	*I was able to include a clear hypothesis in my dissertation / coursework*	*64.1*	*58.3*
21	I was sure what the concept of validity means in the context of research	61.9	72.2
22	*I had sufficient knowledge to be able to use quantitative techniques (numbers) in my dissertation / coursework*	*59.7*	*70.3*
23	*I had sufficient knowledge to be able to use qualitative techniques (words) in my dissertation / coursework*	*58.7*	*72.2*
24	*I am sure about how to cite other work Harvard Style*	*55.4*	*77.7*
25	*I was sure how to identify independent variables (IVs) and dependent variables (DVs) in my dissertation / coursework*	*51.0*	*59.2*
26	*I preferred to work independently in my dissertation / coursework without much help from my tutor*	*31.5*	*46.3*
Questions only to research methods students			
27	I was able to concentrate, to an appropriate extent, on research methodology in my coursework, rather than learn about the specialist subject area that I chose	68.4	-
28	*I would prefer to complete the coursework alone rather than working in pairs*	*34.7*	-
Questions only to dissertation students			
29	I think research has application to practice in the construction industry*	-	74.0
30	I was able to get further appropriate advice from my dissertation / coursework tutor about research methodology	-	61.1
31	*I found that tutors gave contradictory advice about research methodology**	-	*54.6*
32	*I think I learned more about research methodology in my dissertation than I did about my specialist subject area*	-	*44.4*
Mean percentage scores; 'student perception of success of research learning outcomes'		68.4	72.1

Tutors giving contradictory advice about research methodology is clearly a problem (item 31, success score 51.6%). It is expected that approaches to research can be different, and indeed the authoritative texts can be contradictory. Tutors may have their own preferred methods they may encourage students to use, and even discourage students to use some methods of analysis that they are not familiar with. Not all academics are researchers; some are 'merely' excellent ex-practitioners with a flair for teaching their own subject specialism. But as these practitioners become embedded in academic communities, there may be a need to ensure that departments provide seminars and staff development opportunities to ensure consensus exists as far as is possible. Finally item 32 (success score 44.4%), learning more about research methodology than about specialist subject areas, can be viewed in two ways. If the key learning outcome in the dissertation is to develop research skills that are transferable into all aspects of the workplace, this score is unsatisfactory. If however, the key learning outcome is to become an expert in a narrow specialist field, then this score may be construed as being satisfactory. In the context of this paper, the score is considered unsatisfactory, and it does warrant further discussion amongst academics.

Unrelated parametric ‘t’ tests were used to detect if differences occurred in the perception of success scores for the five subject variables (degree discipline, age, whether studying full or part-time, gender and whether qualitative or quantitative analysis was used in documents.); no such differences were found, and for all tests $p \geq 0.05$ (the lowest p value was 0.10). Tests of internal reliability on the basket of questions were undertaken, whereby each individual question was correlated against the total score for the basket. Spearman’s non-parametric correlation coefficients were calculated; the range for these coefficients was 0.40 to 0.90 and in all cases $p \geq 0.05$. It is therefore argued that the questionnaire was internally reliable.

The mean scores for the research methods module and dissertation for 2006/07, obtained from the university database, were 54.7% and 58.10% respectively.

5. Qualitative results and analysis

Part-time students have a one year gap between finishing the research methods module and starting dissertations. It was felt that this gap was not desirable, since students preferred to start their dissertation with research methodology fresh in their minds. Part-time students also felt that the period of time to complete their dissertations (September to March) was too short. Given that programmes are taught in semesters, level two students thought time to complete the research methods coursework was too short

Students reflected that they tried to do too much in the time available and time management was identified as being the most challenging aspect of completing dissertations. If students fell behind in their dissertations, this had a knock-on effect for their work in other modules. Interim targets and meetings with supervisors were thought helpful, particularly in development of dissertation problems and establishment of objectives. Some tutors were strict in the supervision process, setting tough interim targets for students and insisting on regular meetings. Other tutors were more laissez-faire. Some students emphasised that to maintain enthusiasm there is a need to select topics that students are really interested in. Collecting data was thought to be difficult, and it was suggested this should be done at a very early stage in the process.

The research methods coursework is set as a ‘pilot’ for the dissertation; students select their own problems to investigate. Some students felt that alternatively they should be ‘merely’ given sample data sets to analyse. Completing the research methods coursework in pairs was thought by many to be a ‘bad idea’; logistical problems and falling out between students being common. Working in pairs was also noted as being frustrating at times and some students completed the majority of the work whilst their partner did very little. There was concern that marks suffered as a result of poor performance by colleagues. However, some students did recognise paired work as being challenging and good preparation for inter-disciplinary working in industry.

Most students spoke very positively about the research methods module. They found it interesting, challenging and valuable preparation for the dissertation; one student questioned whether alternatively it would be adequate to have two or three lectures at the commencement of the dissertation process, and replace the research methods module with something more practical like land surveying. Also, one student reflected that more was learned about methodology in the research methods module, than in the dissertation. There was a request for more one-to-one tutorials within the module.

Differing and contradictory advice from dissertation tutors was again highlighted as a problem; for example there are different views on the length of literature reviews. Students found contradictory advice confusing and asked for a 'level playing field'. In one case a tutor struggled to advise a student about the design of a methodology that would meet the objective. There was a request for a university proof reading service, and for more copies of paper documents in the library rather than reliance on electronic sources. Some architectural technology students asked that the dissertation be replaced with or integrated with a design project.

The department has a detailed 'house style' for type font style and size etc, e.g. Aerial 12, 1 ½ line space. It is inconsistently applied, and some tutors refer to house style as Aerial 11, whilst others state Times New Roman 12. Also tutors give contradictory instructions about how to cite Harvard Style; and this is despite there being a university library booklet which seeks to promote consistency. More instruction and emphasis on referencing was requested at year one.

One student commented that the dissertation was the 'most joyful module', and wrote very positively about life skills that had been developed. Another looked forward to developing the dissertation idea into a PhD.

6. Conclusions

Trow in Bulmer [19, p. 15] wrote that 'every cobbler thinks that leather is the only thing … scientists have their favourite research methods … but we should try to be less parochial than cobblers … and get on with the business of attacking our problems using the widest array of conceptual and methodological tools'. Not all dissertation supervisors have the knowledge and skills to direct their students to a wide array of tools. It is for debate whether universities should seek to equip academics in this way, or if alternatively it is just a political fact of life that some academics are like cobblers, and students need to be mindful of this when selecting their supervisors. Similarly, it is for debate whether universities should seek to impose rigorous regimes on the supervisory process, or alternatively leave it as a matter for tutors and students to come together (or not) in a manner that reflects their own working preferences.

Time management is clearly a big issue for students. It may be possible for part-time students to do their dissertations over three semesters rather than two. There is a need to emphasise the need for personal plans or work schedules, and ensure that progress is monitored against them. More tuition work is needed in the areas of (i) citing Harvard style, (ii) identification of variables, (iii) house style, and (iv) analytical techniques. There is the possibility that working in pairs for the research methods module could become optional rather than compulsory. The issues about whether students should employ rigorous analytical tools (whether they be qualitative or quantitative) and specify variables etc, is perhaps best solved by ensuring that only students who do these things get the better marks.

An appreciation of the real life limitations of research can only be understood with good underpinning knowledge about the concepts of reliability and validity. The students report that they have 'good' knowledge in these fields (table 3, items 17 and 21, 64.1%, 73.1%, 61.9% and 72.2%). It is doubted that such high scores would be allocated by tutors to students; more work is required in this area. Further, it is argued, that only students who do demonstrate understanding of these concepts should be awarded marks in the first class category.

The overall mean scores of 68.4% for level two students and 72.1% for level three students indicate good to very good achievement in measurement of the variable 'student perception of success of research learning outcomes'. It is recognised that student perceptions about success in achieving learning outcomes is not the same as actual success; a more valid measure is obtained from tutor marks. The tutor marks for 2006/07 were 54.7% and 58.10% for the research methods module and dissertation respectively. These marks are comparable with student performance in other modules. It is argued that using a research methods module at level two improves student performance in dissertations. It is recommended that further work is undertaken to support this position, using samples drawn from more UK universities. Views should also be sought from tutors.

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Working in collaboration: a review of an overseas programme and development

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Abstract

The changing market for education in the UK and the growth of the global village has created needs and opportunities to seek alternative business for the education deliverers in the UK, and elsewhere.

This paper reviews the development of a collaboration between a post-1992 university in the UK Midlands and a university with a similar profile in Hong Kong to deliver a top-up programme to BSc (Hons) Construction Management and how this has led to the introduction of a Masters programme with the same partnership.

It considers the reasons for the relationship to be sought and the design of the programme delivered. A review of the internal validation process prior to first delivery, the professional body accreditation of the programme and the implications of this to achieving a viable demand.

The partnership has been in place since 2000 and has had to adapt to changing educational and political environments, greater competition in the local market, changing student cohort expectations, staff illness and travel restrictions (most notably due to the SARS epidemic and a virtual travel embargo on visits to the far east). The paper identifies key events during the partnership and how it has developed to meet these changing circumstances yet remain viable. It will also address how the experiences have influenced the introduction of a Masters programme. The paper concludes with best practice recommendations to assist other institutions in identifying opportunities for similar mutually beneficial partnerships.

1. Introduction

The development of a programme of study overseas was one strand of a School-wide strategy made by the School of Engineering and the Built Environment (SEBE) at the University of Wolverhampton (UoW) some ten years ago. From this strategy a collaborative programme was developed that has been delivered successfully for the last eight years.

UoW has long standing links with a numbers of overseas institutions in various countries including City University in Hong Kong (CityU). It was through an existing business relationship with CityU that areas of mutual interest were identified and potential collaborative opportunities considered. One such development was the introduction of a BSc (Hons) Construction Management top-up programme for graduates from sub-degree programmes at CityU.

The programme has been running successfully since 2000 but has not been without its challenges including internal validation and external accreditation processes, growing competition in the Hong Kong HE sector, resource implications for delivery overseas, international travel vetoes and a QAA collaborative links audit.

The experiences of the design, implementation, growth and development of the programme have been recognised within the university and are being fed into ongoing and planned collaborative links with both UK-based and international partners.

2. History

The commencement of the development of an overseas programme is as much about the relationships between the people that develop them as it is between the institutions themselves [1]. Any proposals for working together tend to evolve as the relationship builds between the staff and they develop as each institution gets to know the other better. The chances to identify opportunities for mutual benefit are more frequent and more easily exploited in the spirit of cooperation rather than by commercial necessity. The relationship between SEBE, City U and their sister organisation the School for Continuing and Professional Education (SCOPE) has developed in this way.

The scheme initially envisaged was one where Diplomats from the host institution's Diploma programme would feed into a programme of study consisting of three semesters to achieve a full honours degree in the UK.

This unfortunately was not successful. At a time when the construction industry in Hong Kong was particularly buoyant it was not possible to achieve a viable recruitment for this type of programme. It was necessary to consider alternative delivery options that met the requirements of students in Hong Kong and at the same time satisfy quite stringent quality assurance processes in the UK. Rethinking of the way the programme was to be delivered was necessary to enable recruitment to progress and it need to be recognised that fulltime delivery on a viable basis was unlikely to be achieved hence a part time programme of study was considered.

There were various obstacles to the development of this cooperative programme, not least of which is the intensive work environment in Hong Kong. There were also issues of Quality Assurance, QA, and agreement over memoranda of understanding and cooperation, which needed to be established to formalise the relationships.

2.1 Developing the relationship

UoW had an existing relationship with CityU and SCOPE as a result of previous international marketing initiatives; an additional initial contact was made between staff at each of the institutions through mutual contacts in HK. Through these two initial contact routes and meetings at various levels within the management of the departments the possibility of a joint initiative were discussed. The choice of the programme to be delivered was largely the product of fortune and of the existing relationship between the staff at the respective institutions.

Once the initial ideas had taken shape the three departments (SEBE, CityU and SCOPE) worked together to agree a viable structure and format for the programme that would satisfy both UK and HK internal and external requirements. All parties were involved at all stages of the design and validation of the programme through face-to-face meetings, via email, post, telephone conversations and videoconferences.

Throughout the years that the programme has run, whilst there have been changes of management and administrators in each of the organisations, communications between the parties have been given the highest priority to ensure that the good working relationships continue.

2.2 Identification of the market

In initial discussions CityU identified, through surveys with their existing cohorts and alumni, that students on the Higher Diploma (HD) in Building Studies would be interested in gaining an honours degree if a 'top-up' programme were made available and that sufficient numbers of students would be willing to travel overseas for 3 semesters to undertake their study in the UK. Despite such a programme being made available at UoW for a September 1999 start and approximately twenty students applying to join the programme none accepted the offers made and the programme did not run. A rethink was necessary!

Additional market research was conducted in HK which showed that there would be sufficient numbers interested in studying in HK in a part-time mode to make the programme viable. CityU identified that an initial cohort of 50 students could be expected with similar numbers in future years.

2.3 Competition

At the time the programme was first considered CityU was one of only two institutions in HK to offer full time degrees in building/construction management recognised by the Hong Kong Institute of Engineers; the proposed programme would be the only part time first degree programme in HK. The market research also showed that there were no similar part time degrees with professional recognition in the locale. The only way in which students from HD programmes in HK could further their studies was by going abroad or taking a diploma programme at HK University to bridge to their Masters degree in Construction Management.

2.4 PR China: handover and influence

In 1997, the former UK colony of Hong Kong had become the Hong Kong Special Administrative Region when sovereignty was returned to the Peoples Republic of China. Schooling, at all levels, within HK has traditionally been delivered in English and the primary language of business was English. Since handover, whilst English is still the main language used in schools and universities other languages have more prominence particularly Putonghua, the official Chinese language [2] and Cantonese, the dialect of Hong Kong and the southern Chinese province of Canton.

Over the time that the programme has been delivered in HK there has been a change in the standard of the students' English and whilst students must achieve an identified qualification in English their confidence in speaking in English in the classroom environment has diminished. This is thought to be due to less English being used in the schools, homes and workplaces.

A second influence of PR China is the increased number of students who are required to travel and work in the mainland for weeks at a time and this impacts upon attendance at taught sessions on the programme and applications for leave of absence and deadline extensions for submission of work.

3. Original Model

Delivery of programmes overseas can be expensive to operate. Taking due consideration of the working culture in Hong Kong which is highly intensive a model needed to be developed for the recruitment of part time students.

The original validated programme (for full-time delivery in the UK) was used as the basis of the design for the HK based programme. However, a formal relationship needed to be established with SCOPE to enable the programme to run. In order to create a viable product that would be financially sustainable for both SCOPE and SEBE a collaborative relationship needed to be created.

Collaborative working is not simply the delivery of a UK programme in an overseas institution using their administrative support. True collaboration needs to utilise all the resources of both institutions in the best and most efficient way. Early discussions on the division of workload suggested use of UK based lecturers, HK based tutors and HK based administration. Local tutors were seen as an effective way of contextualising the content of the UK programme to the overseas situation whilst being able to provided weekly student contact through tutorials.

SEBE had an overseas programme running in Singapore which used an intensive delivery mode to allow delivery of the modules whilst minimising the impact on UK students. This model was used as the basis of the design of the HK programme.

Programme structure

In preparation for the validation and accreditation of the UK based top up programme mapping of the Hong Kong HD programme was undertaken against the UK BSc (Hons) in Construction Management programme to establish where there were equivalences in studies at levels 1 and 2 and where additional subject areas were needed. This mapping was used in designing the part-time HK based programme and it was established that a top up programme consisting of four part time semesters would be sufficient to deliver the modules needed to achieve the honours award.

HK students were required to study 3 modules at level 2 (45 credits) and a full level 3 programme (120 credits). The level 2 modules were delivered in the first semester with the level 3 modules being delivered over the remaining 3 semesters (Figure 1). During the first two iterations students were allowed to vote on which of the two options they wanted to study, only one of the two was delivered.

Programme structure

Semester 1	**CN2248** Construction Technology 3	**CN2251** Integrated Project	**MN2236** Construction Management 1
Semester 2	**CN3331** Construction Technology 4	**MN3301** Construction Management 2	Option - one from: CN3334 Fac Man(O) CV3303 Plant Man(O)
Semester 3	**CN3337** Dissertation 1	**CN3332** Contractual Procedures 2	**CN3338** Development Economics Project
Semester 4	**CN3337** Dissertation 2	**AC3324** Construction Finance	

Figure 1. Original Programme structure for Part-time delivery in HK [3]

3.1.1 Intensive delivery mode

At the start of each semester there was a three-week period when each taught module was delivered by the UK lecturer. Lectures consisted of six 3 hour long sessions between Sunday and Saturday (Sunday 2 sessions; Monday, Wednesday, Friday: 1 session each day starting at 6.30pm; Saturday 1 session starting at 1.30pm); tutorials with local tutors were organised between semester weeks 4 and 11 (2 hours per module per week); UK lecturers returned for 9 hours taught sessions (3 hours on Monday, Wednesday and Friday) in weeks 12 – 14 with examinations being taken in week 15.

UK lecturing staff were also responsible for the provision of all teaching and assessment materials (including tutorials) as well as for grading all assessments (coursework and examination). SCOPE had responsibility for all administrative functions in HK and the appointment of local tutors via CityU. (All tutors were interviewed by the UK programme leader and subject to approval by UoW QA procedures).

A minimum of 1 week prior to the start of each semester the UK lecturers provided their module study materials including module guides, lecture handouts and coursework assessment materials. These materials were equivalent to those delivered in the UK and made available via SCOPE and through the UoW VLE (the Wolverhampton On-line Learning Framework, WOLF).

Assessments were returned to the UK where they were graded by the UK module staff; feedback and grades were returned to HK via SCOPE.

4. Revisions

4.1 Revisions to the programme structure

In April 2002 the programme was reviewed, as part of the ongoing quality procedures at the UoW. It was established that the intensive delivery mode together with the long working hours culture in Hong Kong was disadvantaging the students. People working in the construction industry in Hong Kong work for five and a half days per week, typically starting at 07:30 and finishing at 19:00. In contrast to the UK, Hong Kong construction managers tend to be site based. Feedback from students and staff suggested that students tended to struggle with the number of modules studies, particularly in the final semester when they were completing their dissertation, and there were concerns about the communication and report writing abilities of the students, which was particularly noticeable in the dissertation submissions and results.

As part of the review the award team also looked at extending the entry opportunities to students with HD qualifications in Surveying and Architecture, to students with equivalent qualifications from all HK institutions and to students with Associate Degrees (AD) in Building. Due to the proven success of the programme the UoW’s internal QA processes approved the business case put forward to extend the entry to these additional groups of students.

In order to address the concerns regarding the students’ report writing abilities an additional module was validated for study in semester 1 (*Communication and Research Methods*) and the programme was extended to 5 semesters to reduce the student workload (Figure 2). The revised programme allowed for Semester 3 to run during the summer months and thus the overall time from start to completion on the programme did not alter. (The programme was also fully prescribed: Plant Management was no longer offered as an option).

Semester 1		
Communication & Research Methods	Integrated Project	Construction Management 1
Semester 2		
Construction Technology 3	Construction Management 2	
Semester 3		
Construction Technology 4	Facilities Management	Dissertation
		Introduction sessions
Semester 4		
Contractual Procedures 2	Development Economics Project	Dissertation
Semester 5		
Construction Finance	Dissertation	

Figure 2. Revised Programme structure [4]

5. Quality Assurance

Quality assurance processes within the UoW required that the UK lecturing staff retain control over the preparation and delivery of lecture and tutorial materials and were responsible for all aspects of the design and grading of assessments. This meant that staff who teach the modules in the UK were also responsible for delivery in HK. This requirement had implications on the home programme as timetable requirements meant that lectures had to be covered in the UK when staff were in HK. These ‘overlaps’ were normally covered by visiting lecturers, colleagues or pre-set study weeks.

5.1 Assessment boards

The HK programme has to fit within the UK assessment board structure with module results being presented to subject boards, in the UK, and student transcripts being presented to progression and award boards, again in the UK. The HK programme reports module results to January, June and August subject boards in Wolverhampton and progression and awards to an overseas board convened in September (to cover students in Singapore and HK).

5.2 External examiners

It is also a QA requirement that the external examiner for the UK programme takes responsibility for the HK programme to ensure equivalence of provision and comparability in results. There have been three external examiners who have each visited HK, met with students, overseen taught sessions, by both UK and HK staff, and overviewed the assessment processes. Feedback from all three examiners has always been positive with identification of good practice for dissemination within the school, the university and the wider HEI community.

5.3 Re-validation 2006

The HK programme was internally revalidated in 2006 and was brought into line with the 2004 revalidation of the UK programme. Changes were made to the modules studied with Project

Planning and Control becoming a core module at level 3 and Facilities Management being dropped from the HK programme. There were also minor changes to module content and learning outcomes but the intensive mode of delivery did not need to be altered.

5.4 External Audit

The Quality Assurance Agency (QAA) undertook a Collaborative Audit of the UoW in March 2006 and SCOPE was reviewed by the QAA as part of this audit. The outcome was *broad confidence in the soundness of UoW's management of academic standards* and the *learning opportunities offered to students through its collaborative arrangements* [5].

6. Professional Accreditation

To aid marketing of the course to the Hong Kong construction industry professional accreditation of the BSc (Hons) Degree in Construction Management in Hong Kong was sought from the Chartered Institute of Building (CIOB).

When the top-up programme was originally developed the UK programme had full accreditation from the CIOB and this was extended to the full time UK based top-up programme. However, even though there were quality procedures and external examiners reports available there was a necessity for a full application for accreditation to be made for the overseas programme. At the time there were concerns about franchised programmes particularly with regard to quality control issues and the way control over assessments, marking and teaching was assured.

The model developed was not a franchise model; it was, in effect, a cooperative programme whereby full control over the content and delivery of the programme was retained by the home institution. The full accreditation application required the creation of detailed documentation including the submission of mapping exercises firstly for the entry Hong Kong diploma and secondly for the remaining top up program against the CIOB education framework document [6]. The application also required a visit to the host institution including the inspection of any paperwork records and administration that the programme had generated together with meetings with staff, local tutors and administrators. The part-time delivery in HK was fully accredited by the CIOB.

7. Challenges

Throughout the eight years that the programme has run there have been a variety of challenges that the award team have had to deal with; some of these were considered as potential contingencies in the programme design, others could not have been foreseen but had to be dealt with as they occurred.

7.1 Foreseeable challenges

The first expected challenge was the need for UK staff to deliver modules in both HK and UK, as well as undertake other academic duties. In the earlier days of the programme staff made ad-hoc arrangements to cover sessions when they were overseas; more recently SEBE have identified module teams who have joint responsibility for modules and thus can ‘cover’ for times when staff are overseas.

The second type of challenge that has had to be addressed is that of staff being unable to travel to Hong Kong for personal reasons or illness. There have only been two occasions when staff have been unable to travel for these reasons and these have both been within the last twelve months. As a consequence of the good relationship between SCOPE and SEBE and the use of local tutors the lectures have been covered by the local tutors with additional support from the UK staff via email and through the learner support mechanisms within the VLE e.g. discussion forums. Care was been taken to ensure that students were not disadvantaged when alternative lecturers were used.

7.2 Unforeseen challenges

The most far-reaching challenge to the programme organisation was the worldwide spread of Severe Acute Respiratory Syndrome (SARS) between 2002 and 2003, which resulted in the programme being suspended for several months when travel to HK was vetoed. The management team, in both UK and HK, took the decision to suspend the programme as the travel veto was imposed between semesters, rather than within a semester, and the impact on the students was therefore minimal. Once the travel embargo was lifted the programme restarted.

The majority of the UK based staff hold British passports and travel to HK to work in SCOPE is allowed without any need to apply for additional visas or permissions. However, newer members of the teaching team hold other passports that do not give the same automatic permissions. In 2007, one such member of staff made enquiries prior to travel and confirmed that he was able to teach in HK; prior to arrival in HK the local rules changed and on arrival in HK he did not have the correct permissions to work in SCOPE. There followed a number of phone calls between SCOPE, UoW and HK government to ensure that the lectures could be delivered on schedule and without contravention of visa regulations. It was fortunate that prior enquiries had been made and that the HK government had only recently changed their requirements; because of this they allowed the lecturer to work even though he had not met the new requirements.

7.3 Learning styles

Lecturing staff have experienced different learning styles than those encountered in the UK. Students in western countries, by comparison, have a relaxed educational experience. Students in Chinese countries face higher workloads and are usually more disciplined and offer the utmost respect to their teachers. The learning style normally adopted in the UK is more proactive and lecturers concentrate their efforts in providing student-centred learning experiences through problem solving and active engagement. In the Far East the learning culture tends to be one of learning by rote [7, 8].

The experience on the HK programme has been that initially students shows little interest in participation possibly due to having little confidence in their English language skills and of having been brought up in an education system which tends to rely on rote learning, timed controlled assessments and a degree of diligence in their approach to learning which can only be envied by teaching institutions in the West. However, with persistence and encouragement from the lecturers, students respond to the student-centred methodologies employed by the UK staff and give positive feedback on their new learning experiences.

8. Future developments

The first lesson learned from the development of this programme has been the necessity to forward plan. Despite the programme's success, it is currently delivering to its eighth cohort, the partner institutions must be mindful that the initial motivations for such collaborative programmes is for future development potential for both parties. Naturally for this to be successful the host institution should improve its abilities to deliver the programme and the partners should look for new areas of potential collaboration.

8.1 Competition

Competition in Hong Kong has vastly increased over the eight years that this collaborative programme has been in operation. As previously stated, at inception this programme was the only part-time first-degree programme in HK. This is no longer the case and there is now significant competition in the local market for this and similar awards. The most recent competitor to enter the market is CityU: originally a key contributor to the programme (through local programme management and provision of lecturing staff to work as local tutors) as well as the primary source of students to the programme, CityU has introduced a BSc (Hons) programme of its own, from September 2007. Despite the growth in competition SEBE, through SCOPE, has maintained its student intake at 50-60 students per cohort and the programme remains financially viable. However, this has not led to complacency by either SCOPE or SEBE and new market opportunities are under consideration.

8.2 New market opportunities

A number of alternative are currently being investigated by both SCOPE and SEBE; these include the introduction of a Masters level qualification to introduce a natural progression route to higher level qualification, alternative honours degree qualifications, work-based learning qualifications to enable students and their employers to benefit from experience gained through work, distance learning opportunities (to enable students working in mainland China to gain a qualification) and credit accumulation options (to meet needs of students who want to study at a slower pace than available on alternative routes).

8.3 The English test

A key feature of the programme is that it is delivered wholly in English; use of English, for all learning materials, assessments and taught sessions, is a requirement of the agreement made between the institutions and students much achieve a minimum set standard of in English as one of the entry requirements to the programme. Up until now students have had to achieve the specified standard through an externally recognised qualification e.g. IELTS, but this is not always a precise indicator of ability to undertake the studies on the programme, or to write English at the level needed. From 2008 students will be required to take an internal UoW English test and success in that will satisfy the language entry requirements.

9. Conclusions

This paper has reviewed the introduction and development of an honours degree in Construction Management through a collaborative partnership between a UK HEI and one in HK. It has identified the design of the programme and the delivery methodology as well as changes to the programme and reasons for the changes being made. The needs to meet internal and external quality assurance requirements and to achieve professional body accreditation were discussed. Challenges to the programme team, and how these were overcome, have been identified and potential future developments highlighted.

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Capstone Courses as the Vehicle to Employability Improvement of Construction Graduates

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Abstract

Although Bachelor of Technology (BTech) graduates in South Africa are employed in the construction and allied sectors many employers have expressed dissatisfaction with the abilities of these students to perform effectively in the construction sector. Given the current SA construction boom, and the severe skills shortage in both construction management and site skills almost all construction graduates from Universities of Technology are able to find employment despite their skills being inadequate. Traditional universities that offer a Bachelor of Science Honours (BSc. Hons.) degrees in construction studies, namely construction management and quantity surveying are perceived to produce a better graduate despite the BTech co-operative education and training being the preferred method of training for construction graduates. The offering of a capstone course may be seen as an avenue to achieve a better quality BTech construction graduate that meets the needs of the SA construction sector.

This particular paper presents the views of employers in an exploratory pilot study on their perceived acceptability and value of a capstone course to both students and industry practitioners.

Keywords: Construction, management, capstone course, quantity surveying

1. Introduction

Although Bachelor of Technology (BTech) graduates in South Africa are employed in the construction and allied sectors many employers hold that gaps exist between their academic performance and the importance of various subject areas relative to the workplace where the theory is required to be implemented practically [1]. Given the current SA construction boom, and the severe skills shortage in both construction management and site skills almost all construction graduates from Universities of Technology are able to find employment despite their skills being inadequate.[1]. Traditional universities that offer a Bachelor of Science Honours (BSc. Hons.) degrees in construction studies, namely construction management and quantity surveying are perceived to produce a better graduate despite the BTech co-operative education and training being the preferred method of training for construction graduates. This contrast with a study in the United States of America in their 1996 survey of Associate Schools of Construction members found the co-operative education method to be the preferred method of training construction graduates [2] and [3]. The offering of a capstone course may be seen as an avenue to achieve a better quality BTech construction graduate that meets the needs of the SA construction sector.

Construction education for BTech degrees in South Africa is based on the cooperative education model in terms of which, arguably, the gap is bridged between education and training to produce a graduate or diplomate that is both educated and trained and able to add value to the construction industry. Cooperative education, therefore, involves training and systematically developing students through the acquisition of the requisite skills, attitudes, values and knowledge required to adequately perform in their chosen careers. It incorporates productive work into the curriculum as a regular and integral element of a higher education course [4] and [5].In order to achieve stated national goals [6] universities in South Africa have a responsibility to adjust their programmes where the needs arise.

Capstone courses are designed to merge participatory learning with academic inquiry allowing student interaction in simulated environments organized around activities that require rigid procedures and processes and unique creative solutions [7], [8] and [9]. Where they have been used construction capstone courses are typically structured and focused around the procedures and operations of construction organizations. Management level decision making is emphasized such as development of alternatives, risk assessment, evaluation of opportunities and potential pitfalls, cost control and documentation, and a thorough analysis of cash-flow [10]. Students are expected to identify critical aspects of planning and tendering in a time-constrained environment. Capstone courses allow the assessment of the cumulative abilities of students, and to achieve optimum results the following aspects need to be addressed, namely,

- Clarification of the performance activities;
- Determination of what learning is to take place;
- Establishment of what knowledge is to be applied;
- Agreement of the basis of evaluation and the mastery required;
- Selection of the project teams; and
- Determination and agreement of the project outcomes.

Eight phases of the project life cycle has been identified [11] which include the following project aspects, namely project definition, scope, budget, planning, scheduling, tracking and close out. For capstone courses to be effective students need to be exposed practically to each of these phases. It is similarly argued that students should at least be exposed to the following aspects of construction management through the following broad project phases, namely

- The pre-design phase that includes the agreements with construction consultants and the definition and understanding of the project brief and scope management;

- The pre-construction phase that includes the development of the tender form the estimate stage through conclusion of the contract between the client and the preferred contractor. The contract documentation is included in this phase; and

- The construction phase that includes the management of the project integrating the construction and project management body of knowledge.

Capstone courses allow for the integration of subjects in a way that theory becomes practice [12]. The graduating student is arguably consequently better prepared for the work situation. The current trend of stand-alone subjects where student do not relate one subject to another is counter-productive [13]. Capstone courses provide the opportunity to address this weakness and integrate the learning experience.

2. Current Status

In South Africa the various Voluntary Associations and Professional Registration Councils have to date not recognized the BTech degrees in Construction Management and Quantity Surveying as vehicles for direct Professional Registration. Consequently, to be registered and obtain corporate membership of these councils and associations respectively, BTech graduates have had to satisfy additional and onerous requirements such as board examinations and extended post-graduate training. Recent research by [14] and [15] found that industry stakeholders had serious concerns about the ability of BTech graduates to perform adequately on construction sites and in construction and quantity surveying offices. They also questioned the suitability of these graduates for professional registration. It was found that construction employers in California, U.S.A. regarded students who had successfully completed the CalPoly capstone course as properly prepared for the rigours of construction employment [16]. This particular course integrated the theoretical components of the academic program into a final project that simulated project conditions and involved aspects such as company and job organization, tendering, award adjudication, project planning and scheduling, construction and project completion, and handover. The authors of this paper argue that the introduction of a capstone course could potentially produce similar results in South Africa.

3. Methods of delivery of capstone course

Capstone courses may be delivered in various forms. Typically, these may include any combination of the following, namely

3.1 Case Studies

Typically a record of a business issue, which actually has been faced by business executives, together with surrounding facts, opinions and prejudices upon which the executives had to depend. These real and particularized cases are presented to students for considered analysis, open discussion and final decision as to the type of action that should be taken.

3.2 Structured Interviews

Structured interviews with construction executives asking open questions with regard to specific issues that may have been raised during the study period or from case studies

3.3 Extended site visits

Students spend periods of at least 2 hours per day for three days a week under the guidance of a mentor on site specifically concentrating on a specific management issue. The University reserves the right to approve all management issues.

3.4 Integrated projects

Setting of a real or simulated integrated construction management project where the students are required to act as the project and construction manager in both bidding for the project as well as planning the construction implementation

3.5 Final year dissertation

A research project based on empirical research including the scholarly writing up of the discourse and presenting it as a complete document.

4. The research

An exploratory study was completed to determine the attitudes of construction employers towards capstone courses. The sample comprised of employers who employed BTech Construction Management and BTech Quantity Surveying students from the University of Johannesburg. A structured questionnaire comprising both open- and closed-ended questions was distributed among the 67 employers and 31 completed questionnaires were received, representing a response rate of 46% which was deemed adequate for an exploratory study. The data was analysed using the Statistical Package for Social Sciences (SPSS).

4.1 Sample Profile (Employer organisations)

Of the 31 employers who responded, 23% were construction and/or project management practices, 29% were quantity surveying consultants, 13% were general building contractors, 7% were civil engineering contractors and 26% were in the public sector. The majority (51.7%) of the organisations were medium to large with annual turnovers of more than 2 million Euros per annum and more than 50 full time employees (61.3%). These findings are shown in Tables 1 through 3.

Table 1: Field of activity

Field of Specialisation	Valid Percentage
Construction and /or project management consultants	23.3
Quantity Surveying Consultants	30.0
General Building Contractors	13.3
Civil engineering contractors	6.7
Public Service Employers	26.7
Total	100%

Table 2: Private sector average annual turnover

Turnover	Valid Percentage
≥ 200000<1 million Euros	14.3
≥ 1 million<2 million Euros	9.5
≥ 2 million<7 million Euros	14.3
≥ 7 million<21 million Euros	14.3
≥ 21 million Euros	47.6
Total	100%

Table 3: Average Labour force

Staffing	Valid Percentage
< 5 employees	3.2
≥ 5 employees < 15 employees	22.6
≥ 15 employees < 50 employees	12.9
≥ 50 employees	61.3
Total	100%

4.2 Sample Profile (Employer respondents)

The majority of the respondents (71%) had qualifications in quantity surveying followed by construction management (25.8%), civil engineering (25.8%) and architecture (9.7%). Respondents reported that they held formal qualifications in more than one field of construction. The majority of the respondents had post graduate degrees (61.3%), while 12.9% had National Higher Diplomas and 9.7 % either a National Diploma or undergraduate degree.

In response to whether respondents themselves or their staff had undertaken or presented capstone or co-operative education courses, they responded as shown in Table 4.

Table 4: Exposure to capstone course

	Yes	No	Unsure/ Missing
Have you ever undertaken or presented a capstone course?	16.1%	80.6%	3.2%
Have you ever undertaken or presented a co-operative education course?	29.0%	64.5%	6.5%
Have any of your staff undertaken or presented a capstone course?	12.9%	58.1%	29.0%
Have any of your staff undertaken or presented a capstone course?	16.1%	61.3%	29.0%

All respondents who completed National Diplomas and Higher Diplomas had participated in a co-operative education programme (22.6%). The findings suggest that although capstone courses are uncommon in South Africa they are not entirely unknown.

5. Data analysis

The respondents were requested to rank on a 5 point Likert scale the extent to which certain competencies were required by graduates and also the extent to which graduates possessed these competencies.

The comparative results of the expected and actual competencies are reflected in Table 5 using the means and standard deviations of responses.

It is evident from the findings that in all cases the actual competencies demonstrated by graduates were less than the level expected by employers. The responses were tested for reliability using Cronbach's Alpha test. Both sets of data satisfied the criteria of Alpha scores not less than 0.700, namely 0,795 in the case of expected competence and 0,907 in the case of actual achievement by graduates. By deleting a single item, namely ability to act ethically in business for expected competence the Alpha value increased to 0.813. The data set was deemed to be reliable.

In response to whether graduates were currently satisfactorily trained to enter the industry, respondents reported moderate satisfaction (mean= 2.93). Relative to their level of support for the introduction of capstone respondents were supportive (mean = 3.78).

Table 5: Comparison of expected and actual competencies

Competence	Expected Mean	Std. Dev.	Rank	Actual mean	Std. Dev.	Rank	Diff. in Mean	Rank
Ability to act ethically in business	4.74	.575	1	3.27	.907	3	1.47	1
Recognition that they need to constantly improve as scholars	4.39	.615	5	3.00	.743	7	1.39	2
Ability to adapt to circumstances as they arise	4.32	.653	6	2.97	.928	8	1.35	3
Ability to think critically through problems	4.48	.570	2	3.13	.937	5	1.35	3
Ability to understand a problem in its correct context	4.48	.570	2	3.13	1.042	6	1.35	3
Recognition that CPD is an important part of professional life	4.10	.662	9	2.83	1.060	9	1.27	6
Ability to lead a business	4.00	.775	10	2.80	1.064	10	1.20	7
Recognition of themselves as professionals	4.29	.864	7	3.17	1.117	4	1.12	8
Written communication ability	4.39	.558	4	3.40	.894	1	0.99	9
Oral communication ability	4.19	.543	8	3.33	.711	2	0.86	10
Ability to comment critically on architectural drawings with regard to aesthetics	3.32	1.137	11	2.60	1.102	11	0.72	11

From Table 6 it is evident that the inclusion of an integrated project in the capstone course was the most preferred component (mean=4.32). The extended site visit (mean = 3.970 and final year dissertation (mean = 3.90) were also preferred although to a lesser degree.

With regard to the timing of the capstone the respondents tended to support the capstone course being offered in the last year of the Diploma (mean = 3.93) and the Degree (mean =3.97).

With regard to whether or not the capstone should be throughout the year or only in the last term of the programme respondents tended to support (mean = 3.79) capstone be done throughout the academic year.

Table 6:Components of capstone course

Component	Mean	Std. Dev.	Ranking
Integrated project	4.32	.845	1
Extended site visits	3.97	1.140	2
Final year dissertation	3.90	.944	3
Case studies	3.55	.925	4
Interviews	3.16	.934	5

With respect to the method of evaluation of the capstone course, respondents preferred (mean = 4.10) a combination of a written submission and an oral presentation of the project. Written submission only (mean = 2.67) and oral presentation only (mean = 2.10) were not as popular means of evaluation. Relative to the extent of the industry participation in the evaluation of the capstone course, 68% of the respondents felt that industry should be involved throughout the course offering at every level and 26% felt that industry should only be involved at the final evaluation. With regard to the recommended pass mark for the capstone course the findings are shown in Table 7.

Table 7: Preferred passing grade

Pass Grade	%
50-64%	26%
65%	19%
70%	35%
75%	6%
>75%	13%

Most respondents (54%) reported that a mark of between 65% and 74% was preferred.

With regard to the contribution of the capstone course to the overall final grade, the findings are shown in Table 8.

Most respondents favoured either a 25% (45% of respondents) or 50% (34% of respondents) contribution to the overall final grade.

The respondents were supportive (mean = 3.55) of the capstone course leading to registration as Professional Construction Managers

Table 8: Contribution to overall final grade

Percentage of overall grade	%
<25%	10%
25%	45%
50%	34%
>50%	7%
Other	3%

Table 9: Comparison of expected skills and actual abilities in specific skills

Skills	Expected Mean	Std. Dev.	Rank	Actual Mean	Std. Dev.	Rank	Diff. in Mean	Rank
Estimating and pricing practice and knowledge of software packages	4.48	.580	1	2.95	.844	9	1.53	2
Knowledge, understanding and interpretation of specifications	4.44	.641	2	3.27	1.032	4	1.17	9
Quantity surveying practice and knowledge of software packages	4.44	.698	3	3.05	.899	6	1.39	4
Working in teams	4.37	.629	4	3.55	1.057	1	0.82	14
Financial management knowledge								

	4.22	.801	5	2.77	.869	14	1.45	3
Practical and theoretical knowledge of quality	4.22	.847	6	3.00	1.155	8	1.22	7
Cost engineering practice	4.19	.736	7	2.55	1.057	19	1.64	1
Set up and maintain contract administration procedures	4.15	.770	8	2.77	.922	15	1.38	6
Contract procurement strategies (not purchasing)	4.11	.801	9	2.95	.899	10	1.16	10
Organisational issue on projects	4.07	.730	10	2.68	.995	17	1.39	4
Feasibility studies	4.04	.980	11	2.82	1.140	13	1.22	7
Carry out commercial appraisal and economic analysis of projects	3.89	.698	12	2.82	.907	12	1.07	11
Concepts of Programme Evaluation and Review Technique (PERT)	3.85	.770	13	3.27	.703	3	0.58	18
Work Breakdown Structure (WBS)	3.85	.818	14	3.36	.581	2	0.49	19
Schedule on a project management software								

programme	3.85	.864	15	3.09	.811	5	0.76	16
Familiarity with temporary works required to produce permanent structure	3.78	.892	16	2.73	.883	16	1.05	12
Industrial relations	3.74	.712	17	3.00	.873	7	0.74	17
Knowledge of design and engineering processes	3.67	.734	18	2.86	.774	11	0.81	15
Knowledge of pre-design organogram	3.52	.849	19	2.55	.671	18	0.97	13

Table 9 reflects the comparison of the skills that employers expect construction graduates to possess, and the actual abilities that these graduates possess in the work environment. Apart from working in teams (ranked 4th) the dominant expected skills that a BTech graduate should have were largely related to the financial aspects of construction projects. Knowledge of design aspects was ranked the lowest of the expected skills.

On the other hand, working in teams, WBS, PERT, knowledge and understanding of specifications and ability to schedule using computer software ranked 1st through 5th respectively in terms of actual graduate abilities. This finding suggests some mismatch between the preferred abilities and that which graduates actually possess. However, it is important to note that the mean scores in all cases were lower for the actual abilities than those that were expected.

6. Conclusions

Construction employers employed current BTech Construction Management and Quantity Surveying students despite these graduates completing their final year/s of study and not being in possession of the expected skills to perform adequately in the industry. Both BSc (Hons) and BTech graduates are employed broadly in the SA construction sector. The study suggests that the inclusion and successful completion of a capstone course that includes multiple components such as an integrated projects and extended site visits will contribute to the improvement of the employability of BTech graduates. The course outline needs to cover all phases of the construction process with mastery levels set fairly high around 70% and comprising 25% to 50% contribution to the final overall grade. The gaps between the importance that employers accord certain skills and competencies and the actual perceived performance by graduates must be addressed. Overall construction employers are supportive of the introduction of a capstone course into future construction-related BTech offerings which would lead to professional registration with councils and corporate membership of voluntary associations.

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Are we changing students' perceptions of sustainability?

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Abstract

In the current 'Decade of Education for Sustainability' universities have responded by implementing initiatives to promote sustainability education. At RMIT University, a one-year action research project was conducted to embed sustainability into the property and construction management curriculum. The project aimed to create lasting change in organisational structure and curriculum content. One of the outcomes of this project was the development of a new course in sustainability for 3rd year students. The course, entitled 'Research and Sustainability' is now a core course in the undergraduate programme. This paper provides the results of a research project that was undertaken to examine student 'perceptions and awareness of sustainability' both prior to and after completion of the new course. As part of this investigation students were asked to complete a paradigm shift exercise both at the beginning and end of the semester in which the course was taught. The exercise asked students to consider four groupings of words. The word choices they made determined whether they had a leaning towards the 'status quo' or a 'green' paradigm. A leaning towards the 'status quo' was characterised by the adoption of a functional analytic *ontology*, an economic individualistic *values* system, the ruling elites as *agents* of change and an instrumental *process* approach to sustainability/change; whereas a leaning towards a 'green' paradigm was characterised by a social ecology *ontology*; a post-materialistic *values* system; community members as *agents* of change; and an experiential *process* approach to sustainability/change. The data collected were analysed to establish whether students' learning over the course of the semester had influenced the overall paradigm within which they operated, which could be either 'status quo' or 'green'. Results show that whilst few students adopted a 'green' paradigm, there was a statistically significant shift towards the adoption of a social ecology and community driven change approach to sustainability from the beginning to the completion of the course. Findings will be used to inform approaches to learning and teaching and improve knowledge of student perceptions so that that this generation of students cross the threshold to new sustainable ways of thinking and working.

Keywords: Education, Green paradigm, Perceptions, Sustainability

1. Introduction

Universities around the world have responded in a number of ways to the UN's 'Decade of Education for Sustainability' [1] which aims to ensure that all higher education curricula include a focus on sustainability and sustainable development. A number of initiatives to promote sustainability education within higher have been implemented in responses to this initiative. One example from the UK is the Sustainable Development Strategy which has identified sustainability literacy as a core competency for all graduates in UK universities [2].

In 2006, at RMIT University, a large dual sector technological university in Melbourne Australia, a one-year action research project was undertaken to embed sustainability within the core curriculum of programmes in three schools across the university (namely, the School of Property, Construction and Project Management, the School of Social Science and Planning, and the School of Management) [3]. Its design was action research based and focussed on curriculum and assessment change based on reflections from a previous study that identified the need for a strategic approach based on change management and supported by staff development [4]. The project aimed to create meaningful and lasting change in the student learning experience [5]. Within the School of Property, Construction and Project Management the project focussed on embedding sustainability capability into core curricula of four undergraduate programmes (construction management, property management, project management and valuations).

A third year core subject BUIL 1217 Research and Sustainability was created as part of the process. BUIL 1217 research and sustainability combined the topic "sustainable construction and green building" with "research methods". Students applied a range of research methods to critically examine a range of sustainability issues in order to facilitate understanding the often-complicated decision making that surrounds both sustainability and research methodology [6].

As part of the course students visited innovative green building projects, undertook building audits, questioned experts in the field, and determined their own impact on the environment using interactive web-based tools. Students carried out group-work research in an area of sustainability. In addition they completed an independent literature review on a topic relating to one or more aspect of sustainability, showing that they had grasped the key concepts and could apply critical thinking in their approach to developing a research question for their final year project. They also spent time in groups, at the end of the course, discussing their responses and what they had learnt about their perceptions and awareness of sustainability issues. During the course students were asked to complete a number of class activities to demonstrate both their tacit and explicit knowledge of sustainability. These were then used to explore the perceptions and awareness of sustainability issues held by students enrolled in construction and property management degree courses [7].

These students are entering an industry which is currently experiencing a significant move towards more sustainable developments. With increased awareness through the written and visual media, clients are 'going green' and starting to ask for elements of sustainability in their buildings, chiefly to reduce their carbon footprint. In addition the construction industry has recognised the need to implement environmentally sensitive and sustainable management policies, practices and operations in order to meet new government policies and legislation.

As a result, the concept of sustainable development is changing the way the construction and building industries operate, and the language of their business. Graduates and individuals working within the construction sector are now required to work within a green paradigm. This in turn must impact on the university curriculum, as it is necessary for educators to ensure that students are made aware of these issues and how to best approach them and engage with them. To produce construction graduates who meet this need it is necessary to redesign built environment programmes so that they integrate and embed sustainable philosophies and techniques for implementing them, across the curriculum.

2. Methodology

As part of the planned class activities students were asked, at the beginning (pre) and end (post) of Semester two 2006, to complete a paradigm shift exercise adapted from ‘A Green Questionnaire’ by Ariel Salleh [8].

The paradigm shift exercise required students to read a checklist of numbered words/phrases subdivided into four paradigm categories: ontology, values, agency and process (see Table 1) and circle the number by any word/phrase which regularly features in their writing or oral communication. These were then scored according to the frequency of odd numbers circled, and the frequency of even numbers circled in each grouping, in order to determine the student paradigms. The paradigm shift exercise therefore aims to assess whether the students are working in or have moved to a new ‘greener’ paradigm (more even than odd numbered words selected); or whether they are still operating in the ‘status quo’ (more odd than even numbered words selected). Students were asked to submit their results as part of the research project. Participation in the research was entirely voluntary (the research was approved by the University’s Ethics Committee).

Table 1: Outline of paradigm categories.

		Choice of Paradigm	
Word Group	**Theme**	**Paradigm 1: Status quo** (associated with odd numbered words/phrases)	**Paradigm 2: Shift to green** (associated with even numbered words/phrases)
Group 1	Ontology	Functional analysis	Social ecology

Group 2	Values	Economic individualism	Post-materialism
Group 3	Agency	Ruling elites	Community
Group 4	Process	Instrumental	Experiential

Salleh [8] suggests that depending on which paradigm students are operating in (‘status quo’ or ‘green’) their underlying *ontology* could either veer towards a conservative fundamentalist one characterised by a functional analysis perspective where societies and environments are treated as mechanical systems (more odd numbered words selected), or towards a more social and ecological perspective (more even numbered words selected). Student *values* could either be consistent with economic individualism which would prevail in ruling class circles (more odd numbered words selected) or veer towards an alternative post-materialistic generation (more even numbered words selected). *Agency* is divided according to whether the students emphasise the role of government and professionals, the ruling elites, as the movers and shakers of social change (more odd numbered words selected) or want to see community-based initiatives as agents for change (more even numbered words selected). Finally, student views about the *process* for change might veer towards an instrumental or manipulative approach (by circling more odd than even numbers) or appear to be more deeply grounded in an experiential or democratic process.

In summation, a student is deemed to be operating in the ‘status quo’ paradigm if he/she indicates a tendency towards piecemeal reforms that could be incompatible with the longer-term green vision (with more odd than even words circled) characterised by thinking that demonstrates a functional analytic *ontology*, an economic individualistic values system, the ruling elites as *agents* of change, and an instrumental *process* approach to sustainability/change. A student is considered to be operating in a ‘green’ paradigm if he/she demonstrates an understanding of how ecological sustainability and social equity are inter-related through his/her choice of words/phrases across all four groups (with more even words circled) [8]; characterised by thinking that demonstrates a social ecology *ontology*, a post-materialistic *values* system, the community as *agents* of change, and an experiential *process* approach to change/sustainability.

3. Data analysis

Data from the pre-post course paradigm exercises were collected and analysed to determine the paradigm in which the students were operating at the beginning (pre) and end of semester (post); and to establish whether there had been any change and whether participation in the course could be associated with this change.

At the beginning of the course 58 of 72 students enrolled in the course completed and submitted the paradigm shift exercise. At the end of the course 37 completed and submitted the exercise. Responses were matched so that only data from students who completed both exercises were analysed. Matching resulted in 28 of a possible 37 student surveys for analysis.

4. Results

The results of the analysis are represented in Figure 1 below. Student responses (n=28) are represented by two points, with a circle (pre-semester) and a triangle (post-semester).

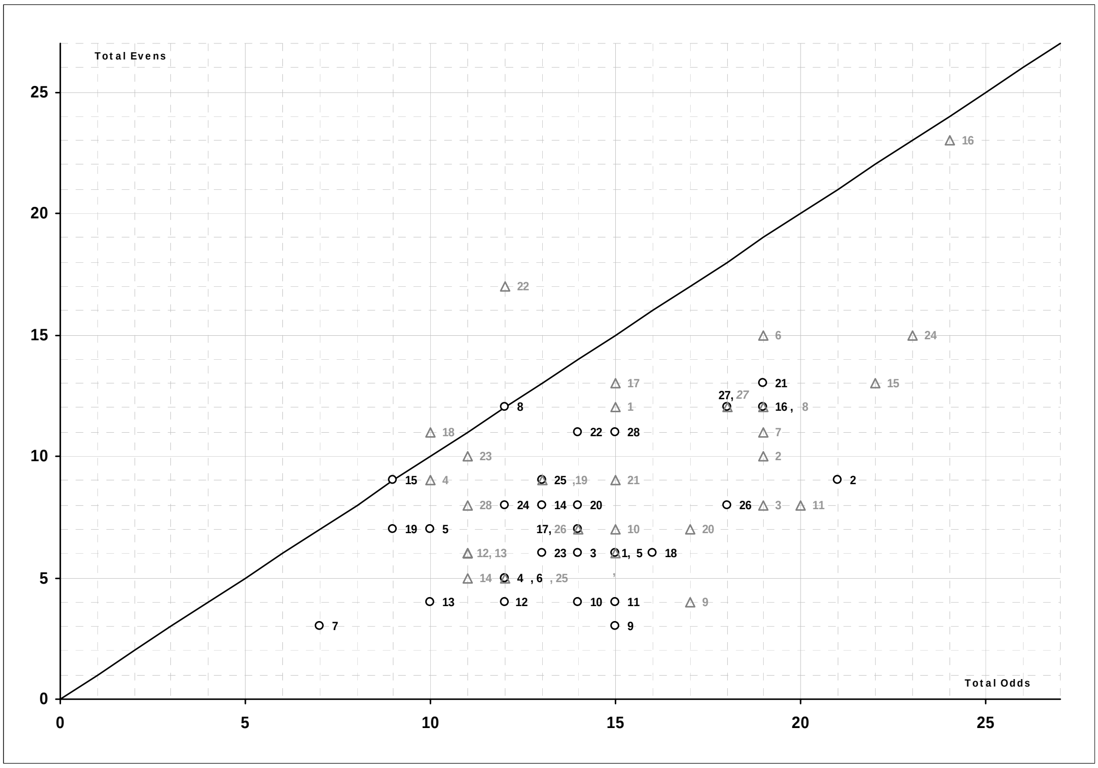

Figure 1: Frequency and distribution of student word choices pre (circles) and post (triangles) module delivery

These points represent the number of odd and even words chosen at the beginning of the course (circles) and on completion (triangles) of the course. The number of chosen *odd* words is graphed on the horizontal axis and the total number of *even* words is graphed on the vertical axis.

The straight diagonal line represents the threshold which must be crossed in order to operate in a ‘green’ paradigm. Points lying above the straight diagonal line or threshold therefore represent a situation where *even* words outnumber *odd* words. Each of these points is numbered in order to see movement pre-post semester.

Figure 1 demonstrates that none of the students were operating in a ‘green’ paradigm at the commencement of the course; however two of the 28 students had adopted a ‘green’ paradigm by the end of the course. In addition, as illustrated in Figure 2, the majority of students (n=15), whilst not crossing the threshold, did demonstrate a definite move towards the threshold, by choosing more even words in the post-semester exercise. Figure 2 graphs, for each respondent, the difference in even word counts denoted △E against the difference in odd word counts denoted △O. Again, number codes identify the individual students.

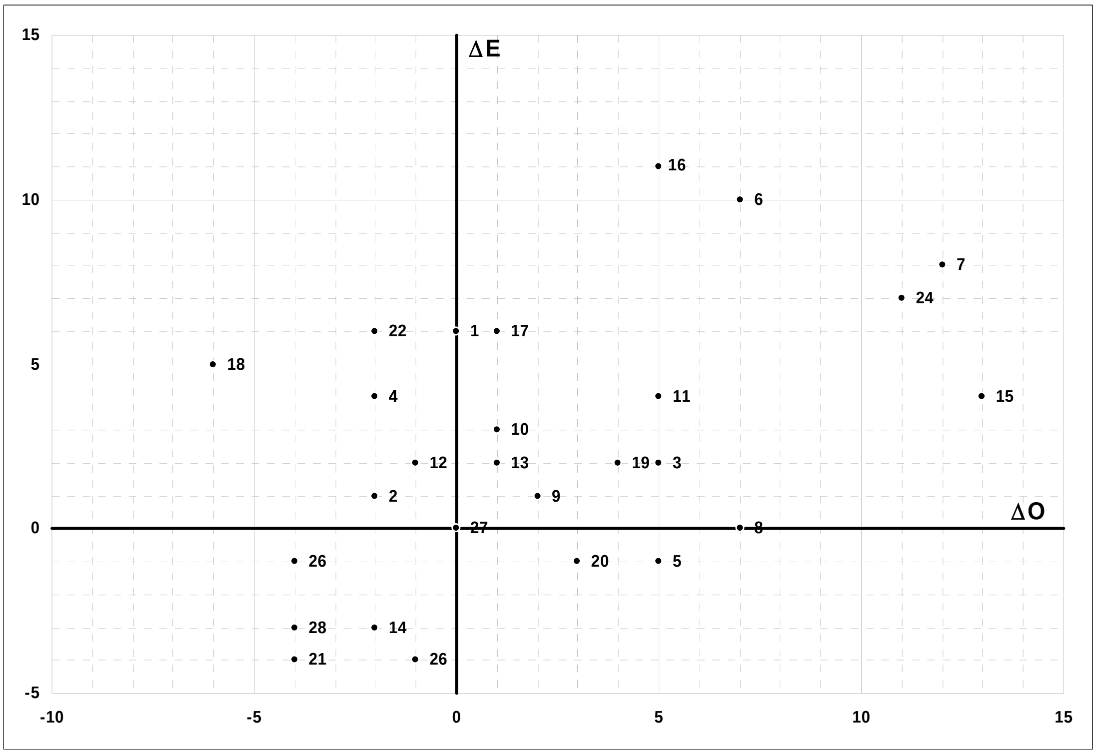

Figure 2: Frequency and distribution of even word counts against odd word counts

Quadrant one (top right) of Figure 2, represents students whose even word counts increased at the same time as their odd word counts increased. Quadrant two (top left) represents students whose odd word counts increased and even word counts decreased. Quadrant three (bottom left) represents students whose odd and even word counts simultaneously decreased and. Quadrant four (bottom right) represents students whose odd word counts decreased and even word counts increased.

An analysis of the difference in the words chosen by the students at the beginning (pre) and end of semester (post) was also undertaken. The results are presented in Tables 2 and 3 below. All asterisked mean differences were found to vary significantly from 0 at the 5% significance-level. The associated standard errors and p-values are also presented.

Table 2: An analysis of the difference between the numbers of even-coded words chosen pre-post semester (to 2 decimal places).

Groups	*Mean difference*	*Standard Error*	*P-value*
Ontology	*0.64**	*0.26*	*0.02*
Values	*1.50**	*0.37*	*0.00*
Agency	*0.29*	*0.33*	*0.39*
Process	*0.11*	*0.27*	*0.70*
Consolidated	*2.54**	*0.76*	*0.00*

The results presented in Table 2 are for even-coded words and show that students who completed the course broadened their lexicon to include words associated with a social ecology *ontology* as well as a post-materialistic *values* system, as opposed to a functional analysis *ontology* and an economic individualistic *values* system, by the end of the course. Whilst there is statistical evidence of a move towards the usage of words associated with a shift to a 'green' paradigm (refer to statistically significant result for consolidated groups in Table 2), there is no evidence of a trend to an increase in use of words associated with those who believe the community should be viewed as the *agents* for change as opposed to the ruling elites, or that the *process* for change should be democratic and experiential as opposed to an instrumental one (refer to statistically insignificant result for consolidated groups in Table 3).

An analysis of the difference between the number of odd-coded words chosen at the beginning of semester (pre) and at the end of semester (post) demonstrate strong statistical evidence that an increasing number of words associated with the 'status quo' were also adopted.

Table 3: An analysis of the difference between the numbers of odd-coded words chosen pre-post semester (to 2 decimal places).

Groups	*Mean difference*	*Standard Error*	*P-value*
Ontology	*0.79**	*0.29*	*0.01*
Values	*-0.21*	*0.37*	*0.56*
Agency	*0.43*	*0.34*	*0.21*
Process	*0.86**	*0.39*	*0.04*
Consolidated	*1.86*	*0.94*	*0.06*

There is strong statistical evidence that the students increased their usage of words associated with the notion that the process for change should be instrumentalist or manipulative.

Micro analysis of the consistency of the word choices pre-post semester was undertaken for each of the four groups of words presented to the students. For the words related to *ontology*, the lexicon nominated by the students was consistent 70.9% of the time. The consistency measure was slightly higher at 73.5% for the odd-coded words associated with the conservative functionalist ontology, and slightly lower at 68.4% for the even-coded words linked to the ontology of social ecology and the green spectrum.

For the words related to *values* the overall lexicon adopted by the students was found to be consistent 59.7% of the time. The consistency measure was 64.3% for the odd-coded words that reflected values associated with economic individualism. 55.1% of the even-coded words demonstrated a consistency with values of the post-materialist generation.

For the words related to *agency*, designed to reveal the students' desired agent of change, the overall lexicon adopted was found to be consistent 70.4% of the time. However the consistency measure for odd-coded words associated with change that is driven by ruling elite (government and professional) was higher, at 74.5%. The consistency measure of even-coded words associated with community-based change was 66.3%.

Finally, for the words related to *process*, the overall lexicon adopted by the students was found to be consistent 64% of the time. The consistency measure for odd-coded words associated with an instrumentalist or manipulative process was 61.2%, with 66.8% for even-coded words linked to an experimental or democratic process.

5. Discussion

On completion of the course, at the end of the semester, the majority of students demonstrated a leaning towards a social ecology ontology as opposed to functional analysis one; a post-materialistic values system as opposed to an economic individualistic one; the ruling elites as agents of change as opposed to the community; and an instrumentalist process approach to change as opposed to an experiential one.

Although only a small number of students were seen to cross the threshold to a 'green' paradigm, a majority of the students did move towards the threshold by the end of the course, particularly in the areas of ontology of social ecology and a post-materialistic values system. This may be associated with the focus of the course that encouraged students to explore their beliefs and values in relation to sustainability and to engage in learning activities that were designed and directed at supporting this.

Students' responses did not show the same pattern when considering agency and process. Responses showed that students still favoured ruling elites and an instrumental approach to change. This is not surprising considering these students are operating within an industry dominated by government regulation and policy, driven by cost and expedience, with a definite hierarchy in place. In addition, students who choose to enter the construction industry and to study in the area have been found to do so with a primary focus on gaining knowledge and skills for how to do the work in industry rather than on gaining academic skills around "…recognising and handling complexity, uncertainty and contested concepts." (p723). They are also more likely to be focused on gaining a professional qualification that is valued in the industry. Further, academic staff teaching this discipline traditionally come from within the industry and value changes that are driven by government policy and new developments originating in the field of practice, rather than those that are driven by empirical and innovative research that is focused on discovery. Therefore, education in the construction discipline tends to focus more on imparting professional skills than on facilitating critical inquiry into the processes of knowledge creation. As Griffiths points out, "…course elements that are concerned with developing research skills, and promoting a more research-oriented ethos, can find themselves out of step with, and not reinforced by, other course elements." [9]

Despite this, micro analysis of the consistency of choices did demonstrate a decrease of words associated with an instrumentalist or manipulative process, suggesting that students' concepts had begun to shift. This may be associated with the students' engagement with this course that introduced them to new ways to approaching the built environment; an approach that is more sustainable.

Findings therefore suggest that it is possible to help some students to change their conceptions, but that this is not easy to achieve through participation in a stand-alone, one-off course experience. Support for sustainability should permeate the curriculum and be aligned to the goals of the programme, learning outcomes and activities, as well as linked to the assessment [10]. Findings from a large body of research in supporting and facilitating understanding and overcoming student mis-conceptions in the areas of probability and statistics, science, mathematics and physics education echoes these findings and suggests a need for more research that is collaborative and cross-disciplinary [11, 12, 13].

Ramsden [14] reminds us that while higher education teachers expect that their students will change the conceptions of the world around them through the subjects they are studying he asks "[why] these changes do not always happen?" and "[w]hy students often obtain quantities of knowledge, yet fail to change their understanding of what it means?..." (p.40). He suggests that in order to facilitate student learning, that is to help learners change the way they conceptualise the world, the answer lies in how learning is facilitated and the context in which it takes place. By ensuring multiple opportunities for students to engage in learning activities that intentionally encourage the making of meaning and learning for understanding rather than recall or memorisation are more likely to result in changes to conceptions. Teaching that: aims to share; ensures that the material is interesting and stimulating; students are engaged at the level at which they are at; it is clear what is to be understood, at what level and why; shows respect and concern for students; supports and encourages independent learning and an ability to adapt to new demands; uses methods that require thoughtful, responsible and cooperative behaviours; focuses on helping overcome misconceptions; is assessed appropriately; ensures feedback is provided; and equally relies on the teacher being willing to learn from the students is more likely to result in deep learning and facilitate conceptual change is teaching [14]. While this is hopeful news for education for sustainable development, it also points to the need for much more connected work aimed at supporting student conceptual change.

Effective student learning that leads to conceptual change involves students actively engaging in learning for understanding, as opposed to memorization; based on experiential approaches that are underpinned by a learner-centred methodology where the focus is on students' experience of learning rather than the teachers' experience of teaching [15]. Whilst this course attempted to address these issues, education for sustainable development needs to be integrated in context across all courses and by all discipline instructors if we are to see lasting change.

6. Conclusions

This paper has described a study which was undertaken in 2006 to examine student paradigms as they relate to the 'green' agenda both prior to and after completion of a new course on sustainable construction and 'green' building. Students were asked to complete a paradigm shift exercise which consisted of choosing words they were familiar with and which regularly featured in their writing or oral communication from four groupings. The choices they made determined whether they had a leaning towards a functional analysis or social ecology *ontology*; an economic individualistic or post-materialistic *values* system; ruling elites or community as *agents* of change; and an instrumentalist or experiential *process* approach to sustainability/change. Their leaning determined whether they operated in the 'status quo' or a 'green' paradigm.

Results show that whilst few students adopted a 'green' paradigm, there was a statistically significant shift towards social ecology and community driven change from the beginning of the course to its completion, demonstrating that the course had a positive impact on student perception in these areas. The next stage of the research is to undertake the same exercise at the beginning and end of the degree programme to establish whether the programme contributes to helping students to cross the threshold to new sustainable ways of thinking and working.

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Personal Development Planning (PDP) using ePortfolio

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Abstract

The Dearing Report [1] identified that programmes in Higher Education need “to equip graduates with the skills and attributes needed to be effective in a changing world of work and upon which to found and manage a number of careers. Graduates will need to be able to identify their own development needs and be committed to lifelong learning”. Personal development planning is a term used to describe the “means by which students can monitor, build and reflect upon their personal development”. In order that students at Higher Education Institutes within the UK are so equipped the Quality Assurance Agency (QAA) *et al* [2] specified that all students in HE should be ‘given the opportunity’ to engage with Personal Development Plans (PDP) from 2005/06.

This paper reviews the action taken by a post 1992 University in the UK to introduce PDP to students on construction-related courses. The university heads the “league tables” [3] for ‘widening participation’ i.e. entrants to HE from non-traditional and underrepresented backgrounds such as ethnic minorities, students with disabilities, females, mature and first generation HE participants, and this itself brings new challenges in developing curriculum and methodologies to meet Dearing’s and QAA requirements.

The university developed a bespoke web-based PDP tool that is now used university-wide at all levels of sub-degree, degree and post-graduate delivery. The paper will explain how the use of this tool has been embedded in the built environment curriculum, the benefits to the students and how other HEIs can introduce such a tool within their programmes.

There is potential to exploit the tool more widely within general CPD. The paper concludes by identifying how this could be achieved and highlights the benefits to the individual, the professional bodies and the economy of this type of reflective approach embodied within an electronic personal learning system.

Keywords. Personal Development Planning, CPD, ePortfolio

1. Background.

1.1 The introduction of Personal Development Planning to Higher Education in the UK

In May 2000 the Quality Assurance Agency (QAA) *et al* [4] issued a policy statement on the development of a Progress File for Higher Education. This policy statement came from recommendations within the *National Committee of Inquiry into Higher Education* more commonly referred to as the Dearing Report [5]. Recommendation 20 of this report suggests that there should be a way to develop a progress file that has two elements:

a transcript recording student achievement which should follow a common format devised by institutions collectively through their representative bodies;

a means by which students can monitor, build and reflect upon their personal development."

All Higher Education Institutions in the UK were invited to endorse and implement this policy. The Policy Statement set out roles and responsibilities for implementation, (point 16 in the Guidelines for HE Progress files) that clearly state that the institutions are responsible for providing opportunities for students to engage with PDP, however the responsibility for gaining benefit from this process would be with the student but that the institutional stance, policies, support and attitudes would influence this.

The Guidelines gave an implementation date for Progress Files as the start of the academic year 2005/6, from this date the QAA could include PDP in their institutional audit.

Within the Guidelines PDP is defined as:

"a structured and supported process undertaken by an individual to reflect upon their own learning, performance and/or achievement and to plan for their personal, educational and career development." [2].

This definition is now widely used across the HE sector. Prior to the Dearing Report and then the QAA *et al* Policy statement, PDP was not a term that was commonly used. The term PDP is therefore a relatively new term. Grant and Richardson's report *What do we mean by PDP?* [6] tried to establish what activities might be seen as PDP, these included:

- Reviewing strengths and weaknesses (generic/subject specific)
- Stating and reviewing goals (short term/long term)
- Making plans to achieve goals/remedy areas of weakness
- Recording experiences, reflecting on what has been learned

- Recording achievements, reflecting on progress

The output of these activities generating such things as personal development records that might include:

- Initial statement of motivation for programme
- Review of a period of time - what have I achieved?
- Analysis of feedback received – what are my strengths and areas for development?
- Critical incident analysis
- Reflective learning log
- Action plan

1.2 PDP at the University of Wolverhampton

Within the University of Wolverhampton, PDP was strategically placed within the Institutions' Learning and Teaching Strategies 2002-05, 2005-06 and 2006-10 [7].

In the 2002-05 Learning and Teaching Strategy the emphasis for PDP was on development of policy and practice and then implementation. In Strategic Priority 6.3 the following was stated:

to develop our understanding of student independence in learning and our models of delivery in promoting this, so as to improve our retention and employability of students, within a national widening participation agenda.

Objective 6.3.5 was:

to develop the student progress file framework, including the improvement of student skills in reflective evaluation and models to ensure significant student participation

An outcome of this was the development of an institutional framework for the process of PDP which set out that the main outcome should be a formative student-centred process that provided a product that documented a student's achievement and experience at the university. The PDP processes are integrated throughout the whole of the student experience at the university, they are developmental and used by students with tutor guidance. The framework was re-titled from PDP (personal development planning) to PACE (personal, academic, careers and employability) planning and development (Figure 1) to reflect more closely the activities and outcomes that the institution wished students' to achieve.

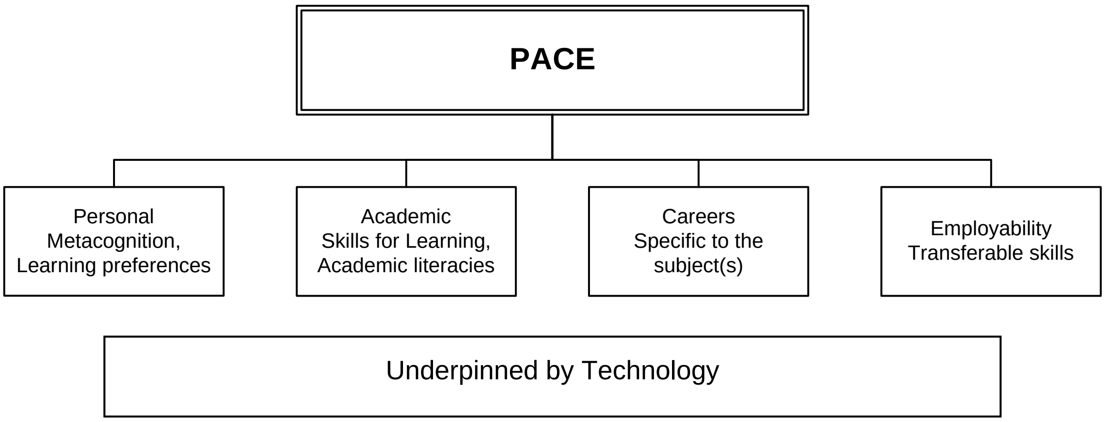

Figure 1. Formative student-centred ***process***

As a consequence of this framework came the development of an electronic tool - PebblePad© - to deliver and support the process.

We are now in the post-implementation phase of Progress Files moving towards embedding processes within the student experience that links directly to the University's Learning and Teaching Strategy 2006-10 [7] the main aim being to:

"*embed the quality, relevance, effectiveness and efficiency of our learning environments into the main stream processes and procedures of university planning and implementation, so to enhance the lives, the educational experience and employability of our students*"

2. ePortfolio.

In the academic year 2003/4 the University undertook a review of PDP practices across all undergraduate provision. That review showed that there were lots of activities that could be classed as PDP. Often this work was documented by paper-based tools that had been developed and used locally. At an institutional level it was decided that for both practical and pedagogical reasons to provide a paper-based system for recording PDP to all students would be inefficient and would go against the institutional ethos of using technology to support learning (for which the university is recognised as a leader) [8].

Best practice was gathered and suggestions were made to find some form of electronic student portal that would, as a minimum function, allow students to access Microsoft Word™-based PDP templates from both their own and other academic disciplines. From discussion between academic staff in schools and in the Centre of Excellence in Learning and Teaching links were made to development work on profiling learning that was happening in a fledging company of ex and part time members of staff from Wolverhampton. The company was developing a generic tool that was based on sound pedagogical practices that did not give one final product but allowed for it to be used in whatever way someone found meaningful.

In 2004/5 the University of Wolverhampton worked with an external company, Pebble Learning [9], to develop and pilot the software PebblePad©. At the start of the academic year 2005/6 this tool was rolled out across the whole of the University. All staff and students having their own personal accounts, icons for short-cut access to the software became a part of all desktops and could be found in the personal management page of the virtual learning environment, Wolverhampton On-line Learning Framework (WOLF).

Over 2005/6 and 2006/7 new communities of users emerged that were early adopters and 'champions' of the new software and an ePortfolio users group was established. This was outside but not exclusively new to the existing technology supported learning community. Over this time period 'Show and tell' events were organised to demonstrate how and why this new tool was being used. Since the University-wide roll out there has been a rapidly increasing use of the tool for staff led learning and teaching activities that ask students to use PebblePad© in some way for both formative and summative assessment. In June 2007 a review of PDP at level 1 [10] showed that all academic schools were using PebblePad© in some way to deliver PDP in the first year (undergraduate) curriculum.

ePortfolio and PebblePad© at the University are often used as interchangeable terms. For example the URL to access the PebblePad© software is http://www.wlv.ac.uk/eportfolio. The concept of PebblePad© is:

"a system which allows users, in any of their learning identities, to selectively record any abilities, events, plans or thoughts that are personally significant; it allows these records to be linked, augmented or evidenced by other data sources and allows the user to integrate institutional data with their personal data. It facilitates self-awareness, promotes reflection, supports enrichment through commentary and feedback from the recipients of shared assets. It grows, develops and matures as the user accesses it, without constraint, over time. It provides tools for aggregating assets in multiple forms; for telling myriad stories to diverse audiences and ensures absolute user-control over what is shared, with whom, for what purpose and for how long. It is a personal repository; a personal journal; a feedback and collaboration system; and a digital theatre - where the audience is by invitation only". Pebble Learning [9].

2.1 What is PebblePad©?

PebblePad© is a system designed to support both formal and informal learning, within the University of Wolverhampton it is defined as a 'personal learning space' as opposed to a 'managed learning environment'. The software allows users to build a diverse collection of items related to their studies, personal development, continuing professional development or any event of personal significance. Those items can then be published or shared with specified individuals or groups or to a public audience through the creation of a URL address. The software promotes reflection and gathering of evidence, any digital file can be linked to the software giving the ability to add such things as video, images and sound.

Within the tool there are a range of templates (Figure 2) that are used to generate items or assets (the term used within the software). As well as providing templates for such things as thoughts, action planning and experiences, Version 1 offers templates to create blogs, CV's and webfolios.

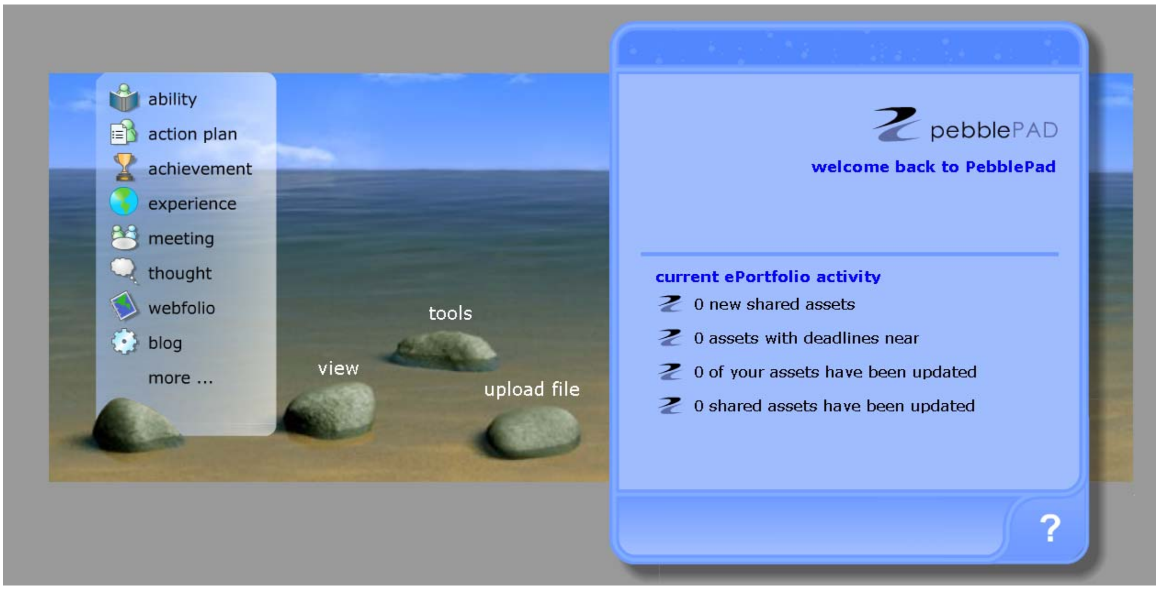

Figure 2. PebblePad© templates

The templates take someone through a stepped process of development and planning (Figure 3).

Figure 3. Creating and Action Plan in a PebblePad© template

The last two 'pages' are the same for any template and ask the users to reflect on what they have learnt by writing and using the template and finally what they would like to do with what they have created (Figure. 4).

Figure 4. Penultimate and ultimate pages in the templates

The templates then generate 'documents' in a user-friendly format (Figure 5) that look very different to the templates, adding headings and subheadings that are already embedded in the template.

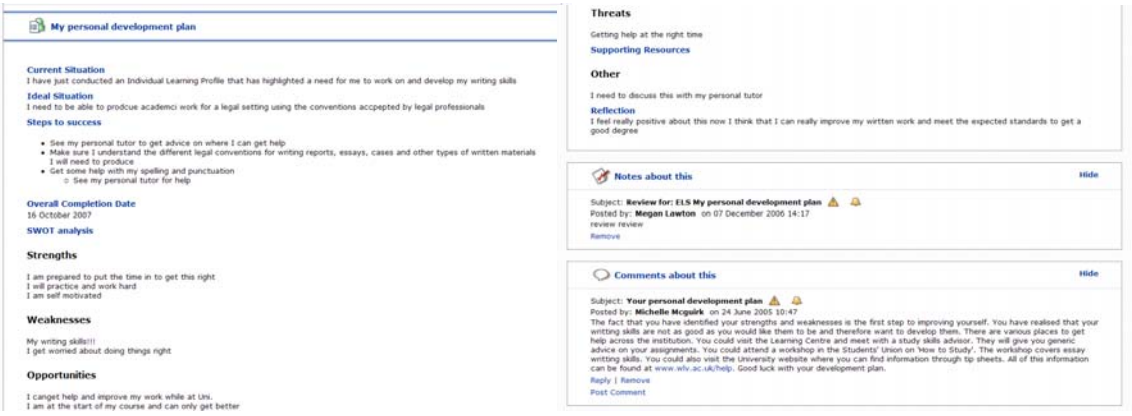

Figure 5. What the information from the template would look like when viewed

As stated previously, the tool has become more widely used members of staff are increasingly using it for formative and summative assessment. For example lecturers have used web folio templates that students can download and copy (Figure 6). They are then asked to personalise the web folio and undertake various assessment tasks. This template is shared with the tutor for comment and formative feedback throughout the module of study. When all tasks are completed the web folio is summatively assessed.

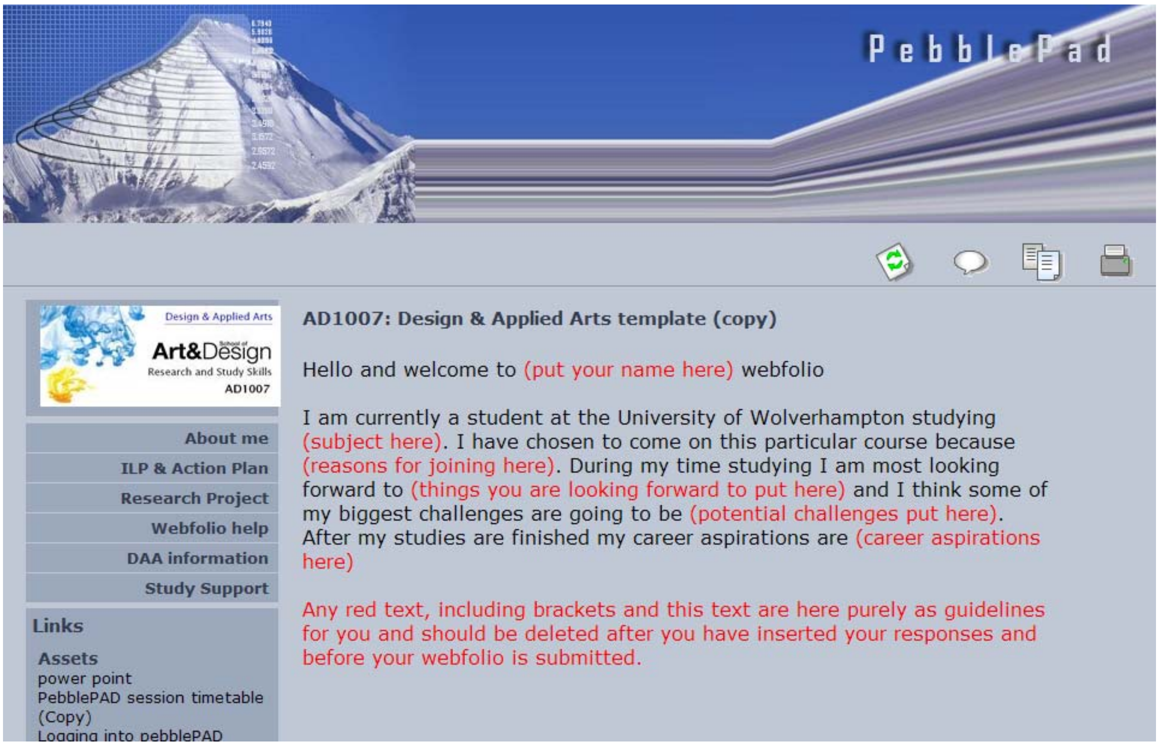

Figure 6. Web folio template for module AD1007 Research and study skills, The School of Art and Design (2006/7)

2.2 Pebble2

PebblePad© Version 2 (released 13th August 2007) offers two major new functions, the ability to create Profiles (self-evaluation questionnaires that staff can create to allow someone to audit their current knowledge, skills and abilities. Profiles can be created based on subject knowledge or skills or they may be based on professional standards from external organisations) and Proformas (forms that can be created for staff and students to fill in and save; files can be attached as evidence to a proforma).

3. ePortfolios within Construction related courses

The university's adoption of an ePortfolio has introduced a vehicle through which students on construction related courses, within the School of Engineering and the Built Environment can engage with PDP throughout their time at the university and on which they can continue to build throughout their professional career, particularly with the development of the Profile tool in Pebble2.

It was stated previously in this paper that use of PDP should be seen as *developmental and be used by students with tutor guidance* and that *PDP processes (should be) integrated throughout* the whole of the student experience at the university. This latter point has been the experience within the university to date: students are more likely to engage and to engage at a deeper level of learning if there is a structure to PDP use and it is integral to a student's programme of study. In addition, employability can be enhanced through PDP where students can "*see a 'pay-off' for the effort that they put in*" [11].

3.1 Embedding ePortfolios

Within the School of Engineering and the Built Environment the course leaders have identified core modules at each level of study for students on undergraduate programmes where there is already a requirement for reflection on personal development within the module. Having identified the modules within which the reflection will be both formatively and summatively assessed the course team develop the existing practice to incorporate engagement with the e-portfolio tool to ensure student engagement at an appropriate level and to show increased engagement and understanding from level to level.

Level One students take a module entitled *Communication and Key Skills* in their first semester. A key part of this module is self-reflection and action planning. Students are given tutor support to reflect on who they are at the commencement of their HE studies and how they change during the course of the first semester. In addition, they create action plans to address key aspects of their approach to study that will help them to develop as a professional in their chosen field. Templates are provided to assist the student in their self analysis and action planning. In previous iterations of the module all documentation was within Microsoft Word™ and was made available electronically through the VLE; with the introduction of the new features in PebblePad© Version 2 the templates are now accessed through this alternative electronic medium.

At level 2 students take a core module *Integrated Project* where they work in a multi-disciplinary team (Civil Engineers, Quantity Surveyors, Building Surveyors and Construction Managers) to put together a project proposal. Within the summative assessment of the module is a requirement for a written reflection on personal development during the module and how existing and new skills have been practiced and developed including positive and negative aspects of working within a team (in the HE context); students are given formative feedback on their PDP during the module.

At level 3 the programmes are more bespoke and there is no module that all students on construction related programmes undertake so at this level a core module for each award has been identified, for instance students on the Construction Management award will be both formatively and summatively assessed on the PDP within the *Development Economics Project*.

By introducing points of formative feedback leading to summative assessment using the ePortfolio tool students are given the opportunity to engage with PDP at each level of their undergraduate programme and are encouraged to expand the use of the ePortfolio tool to all aspects of their study. Key to their engagement is the demonstrable link to their future career and professional body requirements to maintain the currency of any professional qualification through CPD activities. By engaging with PDP within an undergraduate programme graduates will develop the abilities to recognise CPD needs and opportunities, to undertake effective and appropriate action planning and to reflect on their experience for future CPD.

3.2 And so to CPD…

The QAA [2] in their Guidelines for HE progress files state that:

Progress files support the idea that learning is a lifetime activity. The transcript and personal records will be important components of an individual's lifelong record of learning and achievement and the process of personal development planning is intended to strengthen the capacity of individuals to reflect upon their own learning and achievement and to plan for their own personal, educational and career development. This is a core learning process throughout the education system and in many work-based and continuing professional development contexts, and higher education will play a key role in developing this capacity in the context of advanced study

There is a requirement on most professionals to engage with Continual Professional Development; for instance the Chartered Institute of Building [12] state that: e*very member has an obligation under Rule 13 of the CIOB Rules of Professional Competence and Conduct to maintain the currency of the professional qualification through CPD*. And that *CPD is a key part of professional life for any CIOB member and underpins the value of the professional qualification. An institute that cannot demonstrate a firm commitment to CPD undersells its members.*

Individual members of professional bodies are normally responsible for their own CPD planning and achievement, and for the evaluation of the appropriateness and effectiveness of the activities that they undertake. The type and amount of CPD undertaken will depend on the individual, their responsibilities, ongoing development and career aspirations. The individual is normally required to maintain a comprehensive record of CPD activities and can choose how these are recorded. The CIOB [13] offer an on-line facility for keeping records of activity; use of this method is not compulsory and an alternative, such as the ePortfolio used at the University of Wolverhampton would also meet the CIOB's professional requirements.

Students at the University of Wolverhampton will become familiar with the ePortfolio tool during their studies, they will be able to use the tool to create soft copy, or hard copy CVs, to publish blogs and websites and to engage with personal development planning. Alumni will continue to have access to the tool beyond completion of their programme and will find it useful in maintaining their CPD records for both their personal / professional use and to provide evidence to their professional body, if required.

Through the adoption of a reflective approach to a student's personal and professional development an individual is able to identify reason and structure to their action planning to ensure that future activities are undertaken for appropriate reasons and with a particular goal in mind: whether that be for personal or professional needs. Structuring one's activities in this way will show long term benefits to the individual, their professional body, their employer and the economy in general by targeting time and effort to appropriate and effective uses.

3.3 Future developments

The ePortfolio tool used at the University of Wolverhampton (PebblePad©) has shown itself to be an effective and adaptable tool that is used widely within, and outside, the HE sector. As the growth in lifelong learning and development of alternative learning continues PebblePad© can be used as an effective tool within the professional's portfolio. A key potential use is for professionals to create personal learning records against existing professional requirements [14] for use in recording experiential, work-related and work-based learning that could be used towards achievement of a qualification at an appropriate level. The learning record created can be presented in a variety of either electronic or hard copy formats to suit the individual's needs whilst retaining the ability to be developed to reflect the user's changing professional development.

4. Conclusions

This paper has reviewed the introduction of Personal Development Planning within a post 1992 University within the UK and its development, implementation and embedding through PACE files (Professional, Academic, Careers and Employability) to an ePortfolio tool (PebblePad©). It has shown how ePortfolios have been embedded within Construction related courses at the University and offers a model that could be transferred to other HEIs.

The institutional stance, policies, support and attitude to the implementation of PDP influences student engagement with PDP processes through the use of an ePortfolio to enable students to evidence their reflection and personal development.

Through the students' experiences with ePortfolios at the University professional bodies will benefit from the students' ongoing CPD through their ability to target time and effort to appropriate and effective personal development that should be valued by all.

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Developments in the curriculum of Environmental Building at the University of Plymouth

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Abstract

The Environmental Building Group at the University of Plymouth educates students towards accredited degrees in Building Surveying and the Environment, Environmental Construction Surveying and Construction Management and the Environment; close links are in place with the local School of Architecture. The group has been active in this field for 10 years, and has pioneered the theme of environmental building surveying. Teaching efforts have led to national recognition in the form of a National Teaching Fellowship and membership of the Centre of Excellence in Teaching and Learning focused on Education for Sustainable Development (CETL-ESD).

This paper reflects on the strengths and weaknesses in the current curriculum, contributing to an upcoming course review evaluation in 2008. It aims to position the teaching at the University of Plymouth within a changing practice, where sustainability has become a mainstream concern. The paper will review the changes taking place in each of the major disciplines taught on the programme: surveying, building technology, renovation, law/finance, and project management. For each of these disciplines, the paper will discuss initiatives that are planned to keep the curriculum at the leading edge of the environmental building / sustainability field. The paper concludes with an overall analysis of the programme, taking a look beyond individual fields and assessing the overall content of the curriculum.

Keywords: Sustainability, curriculum, SWOT-analysis, future trends

1. Introduction to the Environmental Building Programme at the University of Plymouth

1.1 Programme Structure

The Environmental Building Group at the University of Plymouth offers students a range of courses that help them to prepare for a career in the fields of *Building Surveying and the Environment*, *Environmental Construction Surveying* and *Construction Management and the Environment*. These are offered at different levels: a foundation pathway course, BSc (Hons), MRes, MSc and PhD. The courses are all accredited by the relevant professional bodies, including CIOB (the Chartered Institute of Building) and RICS (Royal Institution of Chartered Surveyors). The programme is part of the School of Engineering, which provides excellent links with related areas of study like Civil Engineering and Mechanical/Marine Engineering. The programme also has close ties with the School of Architecture at Plymouth, with some shared modules and courses.

The programme is strongly related to professional practice in the building industry. Students on the undergraduate track are encouraged to spend a year on placement to gain experience and prepare for their career. While the programme offers all Higher Education Levels that students might undertake, there is a continuous influx of students entering academia at all levels after a period of working in practice. Furthermore, the programme has close ties with practitioners who provide guest lectures and take part in student assessment panels. The intricate interrelation between the courses and the building industry is graphically represented in figure 1.

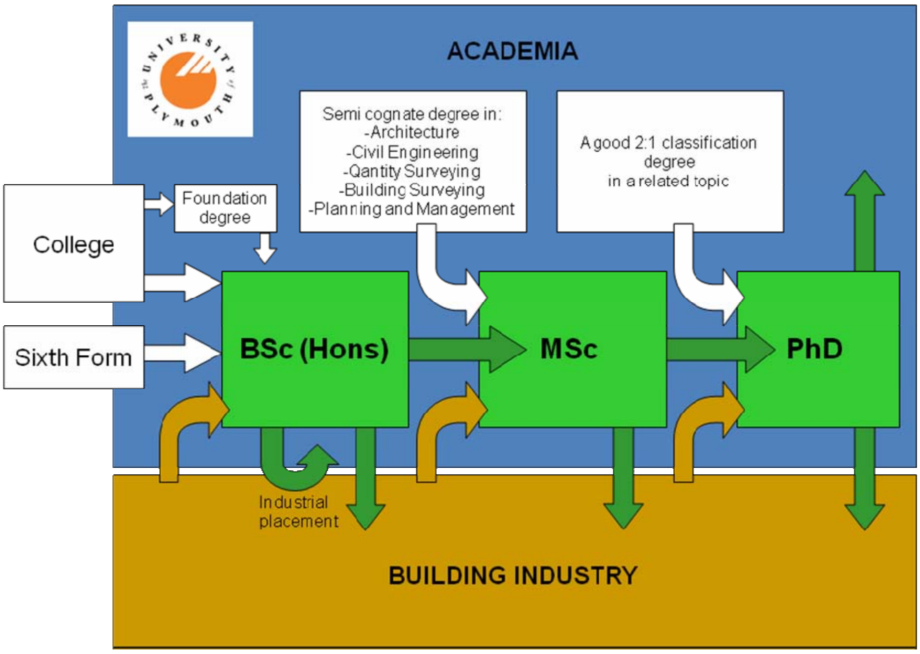

Figure 1: Interaction between Environmental Building Programme and the building industry at the University of Plymouth

The programme has a history that dates back to 1996, and has pioneered the theme of environmental building. Past graduates are sought-after by the industry, and have found their way to positions in the core disciplines but also into other areas like building control, development and historic building preservation.

The Plymouth programme has a strong track record in terms of pedagogical quality. In 1998 the programme was awarded the second highest aggregate grading (23 points out of 24) for teaching excellence in England by the Quality Assurance Agency. This was followed in 2000 by the award of £325000 from the UK government to transfer teaching excellence in flexible learning to other universities. In 2004 a prestigious National Teaching Fellowship was awarded to the then Head of Building Programmes for educational excellence and in 2007 the University of Plymouth received a Green Gown Award from the Higher Education Environmental Partnership Improvement organization for the contribution the Environmental Building Programme made to Education for Sustainability. The Environmental Building Teaching Team were also key contributors to the successful bid to set up a £4.5 million government funded Centre of Excellence in Teaching and Learning focused on Education for Sustainable Development (CETL-ESD). The fruits of these developments have been presented to national and international audiences over the last seven years, see for instance [1], [2], [3].

2. Curriculum development drivers

To stay at the forefront of the discipline the Environmental Building Programme at Plymouth needs to adapt to a constantly changing context. Over the 10 years that the programme has existed, important developments have taken place in the construction industry as well as in education. New technology and information sources have become available; the students starting their education today are different from those of 1996, and the industry has different expectancies of the skill and knowledge base they will be bring into practice. In general the building industry is increasingly aware that the environment and factors related to sustainability have become a major issue. Buildings have a huge impact on the environment in terms of energy use, waste, pollution and habitat destruction. As a consequence, there is a strong demand for graduates that have a background in the environmental aspects of construction. The programme at Plymouth is benefitting from this demand. Yet at the same time it also means that these is an increased offer of similarly oriented programmes from other Universities, and that the unique selling point that set the courses apart when they were launched in the 1990s needs to be reviewed. The changes in industrial practice are rapid, as exemplified by the ambition of the British government to require all newly-built homes to be carbon neutral at a time horizon of 2017. Such changes require the development of a strategic vision to maintain the programme at the cutting edge of ‘environmental building’.

The overall aim of this paper is to provide a position paper that evaluates the context of teaching environmental building at undergraduate, postgraduate and research level, identifying relevant changes and underpinning a vision for future development of the programme.

3. Changes within the major subjects of the programme

The main subjects that are taught within the programme are building surveying, building technology and building science, renovation and refurbishment, law and finance, process management, and land and environmental surveying. These disciplines are taught by a wide range of approaches, which involve student-centred learning [4], traditional lectures, workshops, laboratory experiments, site visits, design project work, and management games.

The following sections discuss the developments per subject, reflecting on changes that are apparent in industry, the implications of these changes for teaching the subject at the different course levels, and developing a view of required changes in the learning and teaching of the subject area.

3.1 Building surveying

The Building Surveying discipline traditionally centres on an understanding of the physical and functional performance of built assets. The central knowledge and skills of the building surveyor relate to building pathology - which involves a deep understanding of building decay mechanisms, analysing building condition and managing remedial works programmes. The discipline is overseen externally by the professional body, the Royal Institution of Chartered Surveyors which maintains standards educationally and professionally. In 2006 the RICS published new guidance on qualifying competencies for newly Chartered Building surveyors [5]; which as can be seen from Table 1 includes sustainability as a mandatory competency.

Table 1 RICS compulsory competencies for Building Surveyors (RICS 2006, p7)

Core competencies for Building Surveyors	**Mandatory competencies particularly relevant to Building Surveyors**
Building pathology Construction technology and environmental science Contract Administration Inspection Design and Specification Legal/regulatory compliance	Sustainability Conflict avoidance Health and Safety

As Table 1 demonstrates, building surveying as a professional discipline embraces a wide range of subjects associated generally with construction and the built environment. The inclusion of a compulsory sustainability competency however, is particularly pertinent development for the Environmental Building Programme as it sets a clear directional steer on educators to engage building surveying students with what is fast becoming a central professional theme. The RICS definition of what constitutes sustainability competency includes the ability to demonstrate how and why sustainability seeks to balance environmental, economic and social objectives at global, local and national levels in a built environment context, as well the ability to demonstrate and apply sustainability to practical and professional situations [5]. Efforts are also being made in teaching Building Surveying at Plymouth to integrate emerging themes such as flood risk assessment and remediation measures within the curriculum in response to the climate change agenda.

3.2 Building technology and building science

The subject area of building technology covers different aspects: it is involved with the systems and components that are used to construct buildings, the assembly and maintenance of the built environment, and last but not least with building science as a prime tool to understand how buildings and their (sub)systems function and perform.

The area of *building systems* and components is subject to rapid change in response to the increasing awareness of environmental problems. Structural systems made of in-situ and precast concrete, structural steel, timber and, mainly for domestic buildings, bricks continue to dominate the industry. Yet even these basic commodities start feeling the impact of high global demand and an increased scarcity of resources, leading to innovation and novel products in the field. Infill and cladding technology is evolving rapidly. Many large and representative buildings now employ active/intelligent/double facades, and increasingly integrate solar technologies and daylighting systems in the building shell. In terms of infill and partition walls industrialised, open systems are replacing traditional stud and sheet partitions. Some innovative buildings even experiment with the integration of phase-change materials in for instance gypsum board. New HVAC technology like micro-CHP units, small scale wind turbines, photochromatic glazing and heat pumps are quickly becoming commonplace in the industry. Interest in environmental friendly materials like cob, strawbale and timber from renewable sources is at an all time high. Within buildings, developments in ICT technology have large impacts, from the ICT connections provided for the occupants to the use of the same technologies for building operation/control and facilities management.

Assembly and maintenance are fast-developing under both economic and environmental pressure. With the decrease of skilled labour and continuous needs to make the construction process ‘lean’ there are continuous efforts to make the process more efficient and increasing quality of the end product. This coincides with the drive to reduce waste, both in terms of unwanted by-products as well as waste in productivity of construction equipment and staff. At the same time facilities management aims to guarantee reliability, maintainability, usability, and serviceability. Furthermore, there is an increased interest in looking at the whole building life cycle, bringing in interest in producibility and disposability and taking a cradle-to-cradle view.

The area of *building science* as an enabling discipline is relatively unaffected by the increased interest in environmental issues: the underlying physical principles like heat and moisture transfer, (day)lighting and acoustics remain the same, and have been the subject of physical research for a number of decades. Some progress is being made by developing new computer programs to evaluate different performance aspects, especially regarding air flow in buildings by means of CFD modelling and regarding daylighting. At the same time increased computational power allows a more holistic performance of processes, for instance combining lighting and thermal issues.

The impact of these developments on teaching in the Environmental Building Programme has different aspects. On the one hand, there is a continuous need to provide a strong scientific basis that allows students to understand and appraise novel systems, techniques and processes. At the same time there is a need to regularly update both the course content and lecturers experience with novel systems, ensuring the students are aware of the latest options available.

3.3 Renovation and refurbishment

Interest in the effective ‘use’ of buildings in the UK has undoubtedly been influenced by the increased ‘customer’ focus within the construction and property sectors within the last ten years, driven by the Egan Report and subsequent industry initiatives (M4i and Constructing Excellence). Coupled with this, the enabling technology within facilities management and maintenance, has ensured that the performance of buildings is mapped more accurately (e.g. BEMS and thermal imaging) and indeed related back to ‘user needs’ through various tools such as Post-occupancy Evaluation [6]. With this growing area of knowledge, more robust decisions about renovation and refurbishment can be made.

To be of most use in business, students need to appreciate the connectivity between science, technology and sustainability or performance assessments (leading to effective changes for buildings. Involvement with the CETL-ESD (see section 1) has enabled the Plymouth Environmental Building students to access real projects and hence gain appreciation of this holistic view in their undertaking of feasibility and refurbishment projects. Such student assignments have recently included final year students evaluating sustainability tools and thermal upgrading options for use on campus building projects, with feedback from this influencing some decisions by the University Estates Department (e.g. fenestration). Additionally, second year understanding of sustainability in this applied context has been achieved through sharing of information and views via a ‘Sustainability Forum’.

3.4 Law and finance

To inculcate “green” issues into the Law and Finance subject areas of the construction curricula, the simple addition of extra lectures “added on” to the programme is insufficient. Instead an approach has been developed that aims at “an active, constructive and cumulative process that occurs gradually over a period of time” [7], employing problem based learning [8]. In this context, , real life situations and problems in the field of law and finance are gradually introduced to students. For example, the first year syllabus includes a module where estimating is studied. Students are required to calculate unit rates for various construction trades. Traditionally this involved detailed calculations for labour, plant, materials, overheads, and profit for concrete work, bricklaying, roofing etc. The examples used in lectures have been expanded to include recycled and environmentally friendly products as well as traditional products. Later students are introduced to comparative estimating and are asked to investigate cost differences between various construction components such as cost differences between different mixes of concrete etc. Students are introduced to the notion that lowest cost might not be the only important factor in selection and are advised to consider the social and environmental costs of decisions. Students’ comparative estimating is expanded to a position where not only initial capital costs are considered but costs over the lifetime of a building are included using complex examples and case studies.

In the subject area of law, students study Environmental Law and Regulations as well as traditional legal subjects such as Contract, Tort, Property Law, etc. In the second year of the undergraduate curriculum, students study standard forms of contract and their applicability to project scenarios. Gradually students are introduced to the RIBA Programme of Work. Eventually The BRE guide to Sustainability is superimposed onto the RIBA Programme of work to reflect on how decisions affecting the environment can impact on every stage of a construction project. A problem based learning scenario based upon an actual construction law case is used for the law assignment in the second year undergraduate course. In addition, students are required to give procurement advice as part of their second year and final year projects. Students are also asked to produce budget estimates and life cycle cost reports as part of these projects.

At Masters degree level, students investigate cost modelling in greater depth than their undergraduate colleagues. Postgraduate students are invited to critique a journal paper, for example, Worth et al's [9] exploration of life cycle costs of four alternative types of roofing systems. The life cycle costs involve a wider scope of calculation than traditionally undertaken and include such factors such as carbon emissions, embodied energy and energy conservation. In the law subject area, Masters degree students consider wider issues of sustainable procurement and explore whether some construction contractual arrangements for the procurement of buildings are more environmentally friendly than others.

3.5 Process management

Process management is the knowledge area that supports the building process, rather than the building product. This is covered in most modules of the programme. The importance and benefits of thinking about the construction process at the very start of the project is being recognised by industry and leads naturally to (recent) innovations in construction, such as partnering, joint ventures, supply chain management and special delivery vehicles. However there is still a real lack of understanding of these ideas in the construction industry and this reinforces the need for all graduates to know the underpinning ideas for these new ways of working.

A theoretical model, underpinning and explaining these newer ways of working needs to be presented to students to ensure that they do not use a cookbook style of learning, and this is provided by systems theory. Theoretical ideas from research in trust, culture and collaboration are needed to enable the new strategies to work. Systems theory can also help understand the more traditional areas such as project management – how and why they fail or succeed for example; it also provides a better explanation of more recent ideas such as lean construction and more sustainable ways of managing the construction process.

The integration of both product and process into one model will become important in the future to enable the client to make fully informed choices from the range of alternatives. We will have to develop new theoretical ideas and ways of teaching these things to both the undergraduate and postgraduate students. It is essential that Plymouth provides its graduates with the ability to cope with future changes in the sector.

3.6 Land and environmental surveying

This area of the curriculum includes learning within the fields of level surveying and measurement, the regulation of land use through the Town and Country Planning System, the issues around the effects of change of land use by development which is assessed by environmental impact assessment and the problems caused by previous uses of land which have left it at the risk of being contaminated.

In environmental terms change has taken place towards consideration of the whole sites, not just the buildings. This requires students to consider both the hard and soft landscaping as a means of improving the setting of the building in its surroundings.

The awareness of the need to obtain planning permission for a project has to be extended due to new requirements relating to the granting of permission. These relate to changes, designed to take environmental and sustainability issues into account. This has been done through changes in planning policy as well as the revisions to the Environmental Impact Assessment (EIA) regulations [10, 11] which required EIAs to be carried out for smaller projects than was required by the original regulations and to cover additional issues such the consideration of alternative sites.

To reduce the amount of green field land used for development and to encourage the redevelopment of urban areas the government has introduced a policy of re-using brownfield (i.e. previously developed land). This requires more detailed coverage of this in the curriculum as many of these brownfield sites are contaminated. The pressure to use brownfield and hence possibly contaminated land required this to be covered in the syllabus as developers were going to need to be aware of a whole range of issues - definition of what constitutes 'contaminated land', how to avoid taking an unforeseen responsibility when buying it, and an overview of the investigation and remediation processes.

All of these aspects are becoming increasingly important for setting the context within which the construction of the actual buildings takes place and therefore are of considerable importance in achieving sustainable development.

4. New curriculum directions

Sustainability is fast emerging as a central paradigm for construction education as demonstrated by The RICS inclusion of sustainability as a mandatory competency for all types of surveyor [5], the UK government and other professional bodies such as the Chartered Institute of building and the Royal Institute of British Architects [12]. While the Environmental Building Group has taken structured and active steps both to assess and enhance the sustainability content of the Environmental Building Degree Programme the implications of this new paradigm is that within ten years the curricula of ***all*** construction-related programmes will be expected to fully embrace sustainability.

In order to maintain a leading position in this changing context, the Environmental Building Group is reflecting on the long-term changes expected for its discipline of construction. In this future, the group expects a larger emphasis on safety, and the role of industry in the general future of humanity – allowing the human race to cope with a range of pressing issues like climate change, population growth, shortage of fossil fuel, and ecological problems (ecodiversity, acid rain etc). Given the scale of these problems, it seems unlikely that mitigation is going to solve all; it therefore seems paramount that the discipline starts working on resilient technologies, and response to inevitable changes in our environment. Furthermore, the group recognizes two approaches towards a ‘sustainable’ future: 1) gradual change, with a residual gap between what is needed and what is actually achieved, and 2) step change, which requires instant changes in the workings of the industry.

Preparing itself for this future, the Environmental Building Group at Plymouth has put in place a strong base for ensuring the sustainability literacy of our students, by providing them with an understanding of the set of environmental problems faced, as well by handing them the knowledge and skills to contribute to changing the industry. At the same time a new impetus is given to work that aims at helping the industry respond and adapt to change; this work has a strong research component, as this a developing field. Both these efforts align well with gradual change to a sustainable future. On a longer horizon, the team is starting to contemplate the needs of working to step change, and its impact on both the understanding, knowledge and skills this will demand from future staff, students and construction professionals. These views are depicted in figure 2.

In practical terms, the Environmental Building Group recognizes a need to increase the research base if it is to contribute significantly to resilience, responsiveness, and step change. At the same time the compact structure of the group provides a flexible starting point for steering in a novel direction.

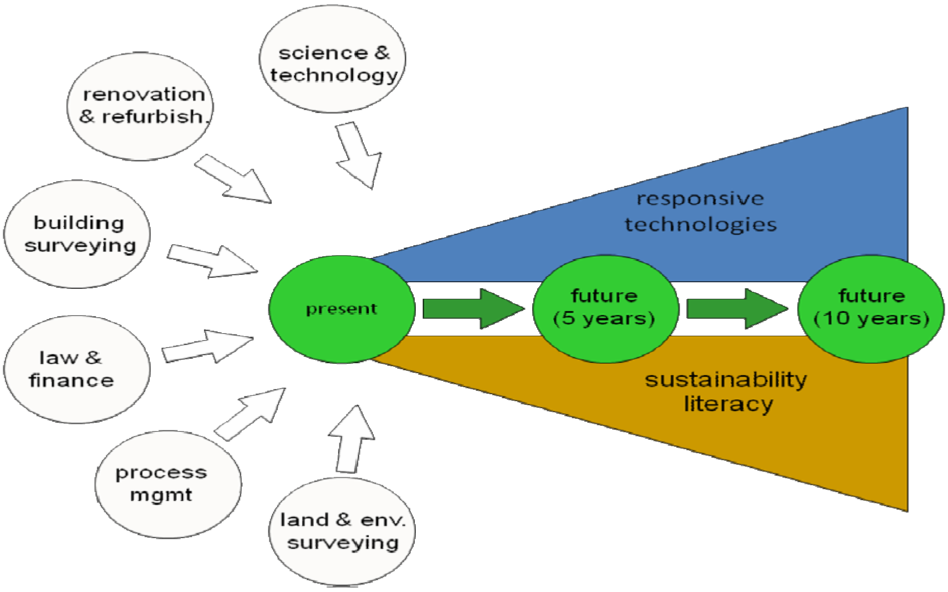

Figure 2:Curriculum development of the Environmental Building Programme at the University of Plymouth

5. Conclusions and remarks

The preceding sections underpin the following conclusions and remarks:

- ‘Environmental’ and ‘sustainability’ issues are having an increasing impact on the construction industry, and on the academia that prepare new professionals for a career in this field. Any curriculum needs a regular update, but students in this discipline also need to be made aware that Environmental Building is a rapidly developing field that is facing large changes. Students need to be equipped to take a leading role in guiding the industry into the future.

- Focussing on a developing discipline provides ample opportunity to combine teaching and research, and for growth of the programme. There are good job opportunities for graduates.

- Although the science underlying the curriculum in Environmental Building is quite stable, rapid changes are taking place in the application of these underlying principles in construction practice, building methods, and building systems.

- For the longer term future, the curriculum of the University of Plymouth will prepare for both gradual and step change. To do so, it has identified the subfields of ‘sustainability literacy’ and ‘responsive technologies’ as key enablers for what is to come.

- There remains a need to ensure that students become critical, independent thinkers, and that the programme does not slip towards what is named ‘greenwash’ in industry (a term used to denounce projects that seem more concerned with an environmentally friendly appearance than with actually addressing the underlying environmental issues).

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SECTION XX

INFORMATION AND COMMUNICATION TECHNOLOGY

Identifying and Confirming Drivers and Barriers to E-Procurement in Construction Organisations

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Abstract

E-business models are emerging in many business sectors [1], although the potential has been realised, the level of implementation and penetration has not been as predicted. E-business achievements in other industries exemplify the potential for construction. However, its poor uptake (less than 2.9%) suggests the lack of usage of e-procurement in UK construction [2].

There are many drivers and barriers to e-procurement. Previous studies in the US [3,4] and Australia [5] ranked these for the general procurement of goods and services. A pilot study for this research, Eadie et.al [6] ranked the drivers and barriers to e-procurement in construction from the perspective of contractors working for the Northern Ireland public sector.

Perera et.al. [9] suggested a methodology for the production of an e-capability maturity model for construction organisations. To strengthen this methodology a Delphi process was added to the suggested methodology. This paper collates the findings on identified drivers and barriers from literature and reports on the findings of the Delphi process, confirming those that apply to the construction sector.

Keywords: Drivers and Barriers, e-procurement, e-readiness

1. Introduction

1.1 E-Procurement in Construction

Alshawi et.al. show that the increased use of e-procurement has led to the development of models in a number of business sectors [1]. E-business savings and efficiencies in other industries show the benefits that construction could potentially harness. However, Martin [2] shows, that less than 2.9% of construction work is procured in this manner, suggesting that there is less usage of e-procurement in the UK construction industry.

In order to investigate the low uptake of e-procurement in construction, it was deemed necessary to identify the drivers and barriers to e-procurement. There is only a limited amount of research reported in this area. Eadie et.al.[6] attempts to address this issue with a preliminary study into drivers and barriers to e-procurement in construction. By utilising the application of established drivers and barriers from other industries and applying them to construction, it was possible to produce a ranking of drivers and barriers for this sector.

This paper collates the findings of the preliminary study [6] into drivers and barriers to e-procurement in construction and successfully rigorously verified the applicability of drivers and barriers to construction using the Delphi methodology.

1.2 E-Procurement drivers and barriers identified from literature

The drivers and barriers to e-procurement identified through literature contain a list of 21 drivers and 31 barriers. Table 1 lists drivers to e-procurement identified from literature.

Table 1 Drivers to construction e-procurement identified from Literature

No	**Drivers from Literature**	**Referenced in:-**
1	Process cost savings -(Tender / Purchase Process)	Knudsen[10], Minahan & Degan [4]
2	Service / Material / Product Cost Savings	Minahan & Degan [4]
3	Transaction Administration Cost Savings	Davila et.al. [3],Panayiotou et.al.[13]
4	Reduced Administration Costs	Egbu et.al. [14], Hawking et.al.[5]
5	Increasing Profit Margins	McIntosh & Sloan [16], Wong & Sloan [17], Ribeiro [18]
6	Strategic Cost Savings	Knudsen [10]
7	Enhanced Inventory Management	Hawking et.al. [5]
8	Decrease in Costs through reduced staffing levels	Kong[19], Davila et.al. [3], Egbu et.al. [14]
9	Shortened Overall Procurement Cycle Times	Minahan & Degan [4]
10	Shortened Communication Cycle Times	Knudsen [10]
11	Reduction in time through greater transparency (Less objections)	Panayiotou et.al. [13]
12	Reduction in Evaluation Time	Panayiotou et.al. [13]
13	Reduction in Time through improved internal workflow	Panayiotou et.al. [13]
14	Reduction in purchasing order fulfilment time - Contract Completion	Davila et.al.[3]
15	Reduction in time through increased visibility	Kalakota et.al.[12]
16	Increased Quality through increased competition	Kalakota et.al.[12]
17	Increased Quality through Benchmarking (Market Intelligence)	Hawking et.al. [5]
18	Increased Quality through increased visibility in the supply chain	Minahan & Degan [4], Hawking et.al. [5]
19	Increased Quality through increased efficiency	McIntosh & Sloan [16], Ribeiro [18]
20	Increased Quality through Improved Communication	Hawking et.al. [5]

No	**Drivers from Literature**	**Referenced in:-**
21	Gaining Competitive Advantage	Wong & Sloan [17]

Table 2 lists barriers to construction e-procurement identified from literature.

Table 2 Barriers to construction e-procurement identified from Literature

No	**Barriers from Literature**	**Referenced in:-**
1	Upper Management Support / Lack of Leadership	Davila et.al. [3], Hawking et.al. [5]
2	Other Competing Iniatives	Kheng et.al. [19]
3	Resistance to change	Davila et.al. [3]
4	Lack of a widely accepted solution	Davila et.al. [3]
5	Magnitude of Change	Kheng et.al. [19]
6	Lack of a national IT policy relating to e-procurement issues	Carayannis et. al. [20]
7	Lack of Flexibility	Carayannis et. al. [20]
8	Bureaucratic dysfunctionalities	Carayannis et. al. [20]
9	Complicated procedures and extended relationships	Carayannis et. al. [20] examine excessive state intervention.
10	Lack of technical expertise	Davila et.al. [3]
11	Staff turnover	Kransdorff [21]
12	Slowdown in the uptake of internet services since the dotcom bubble burst	Christensen et.al. [22]
13	Company access to the internet	Smith - BBC Webpage [23]
14	Religious objections to the internet	McMullan[24] CPD Correspondence
15	Insufficient assessment of systems prior to installation	Forrest [25]
16	Security in the process - Data transmission to the wrong person	Gebauer et. al. [26], Kheng et.al.[19]- 59% of companies in Singapore cite security as the main barrier.
17	Confidentiality of information - unauthorised viewing	Gebauer et. al.[26]
18	Prevention of tampering with documents - changes to documents	Gebauer et. al.[26], Feniosky and Choudary [28]
19	Data transmission reassembly - incorrect reassembly of data transmitted in packets	Jennings [29]
20	Partial Data Display - incomplete documents provided	Jennings [29]
21	Lack of pertinent case law	Hawking et. al.[5],Price Waterhouse Coopers[30]
22	Different national approaches to e-procurement	Carayannis et. al. [20]
23	Proof of intent - electronic signatures	Rawlings J [31], Dumortier et.al. [32], Wright [33]
24	Clarity of sender and tenderer information	Wright[33],Dumortier et.al. [32]
25	Enforceability of electronic contracts	Jennings[29],CITE website[34]
26	Information technology investment costs	Irani & Love[35],Wong & Sloan [17]
27	Cost of assessment of systems to find correct system to fulfil tasks	Forrest[25],Wong and Sloan [17]
28	Internal Compatibility	Davila et.al.[3],Boeing [37]
29	External Compatibility	Davila et.al.[3], Boeing [37]

No	**Barriers from Literature**	**Referenced in:-**
30	Investment in compatible systems	Davila et.al.[3]
31	Reluctance to "buy-into" one off systems	Irani and Love [35]

2. The Delphi Process

A full Delphi process was carried out to ensure that the drivers and barriers identified from general e-procurement studies applied to construction. It was also used to identify any further drivers and barriers to construction e-procurement.

2.1 The Delphi Process definition

The Delphi process can be defined as "*A social survey technique which involves polling experts and others for their prediction on important demographic, political, economic, technological, and social trends*" [38]. The Delphi Methodology is a defined process allowing the collection of tacit knowledge from a group of experts utilising a series of questionnaires and additional controlled opinion feedback [39,40]. It is well suited as a research instrument when there is imperfect knowledge about a problem or experience [39].

The Delphi technique was regarded as the most appropriate instrument to collect data to enable the formation of a list of drivers and barriers to construction e-procurement as it allows solicitation and aggregation of informed judgement from a group of experts on specific questions or issues [27]. The identification and confirmation of drivers and barriers to e-procurement does not befit precise analytical techniques but is more suited to the collection of group opinions from experts who can contribute their experience from diverse backgrounds within the construction industry.

The 'classical' Delphi method was used, where data is collected from experts individually over a number of consultations; results are fed into the following cycle until they are stable and a consensus level of 60% is reached.

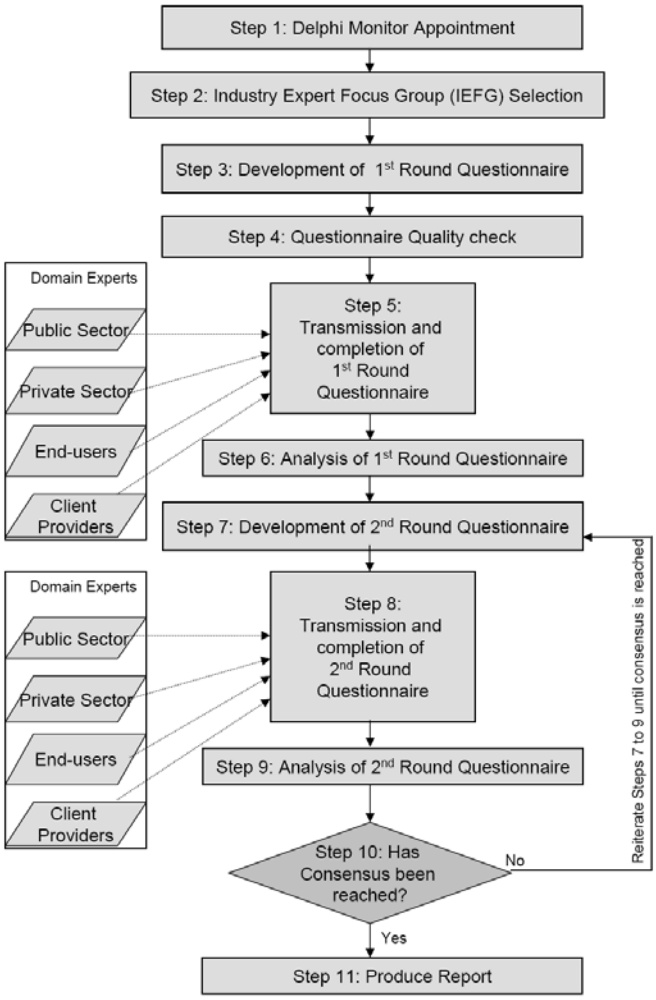

Figure 1: Schematic of the Delphi process as adapted for this study

2.2 Delphi Process Industry Expert Focus Group (IEFG) Selection

For Figure 1 Step 2 Dalkley[15] shows that "Using the expert as a surrogate for direct knowledge poses no problems as long as the expert can furnish a high-confidence estimate based on firm knowledge of his own". The entire industry expert focus group (IEFG) were stakeholders; had direct knowledge of e-procurement from a construction perspective and had used or implemented e-procurement systems within construction. This allowed the IEFG to add their extensive "everyday experience" to the incomplete data from previous studies in other fields. Linstone and Turoff [8] conclude that the selection of the expert group improves the accuracy to a greater degree than feedback or iteration. All but one of the IEFG had worked in the construction industry for more than 10 years. The final member had worked in the industry for seven years. Ludlow [7] concludes that respondents will be more receptive if the techniques are tailored to specific groups on the basis of their training and experience.

Stakeholders were chosen who had shown they were capable of acting as facilitators. As well as being directly engaged and involved in e-procurement each panel member was also chosen for his/her clarification, organisational, stimulation and analytical skills. Each panel member had written internal reports on contractual issues for their organisation.

2.3 Analysis of Representativeness of the IEFG

The IEFG for the Delphi process had to represent the entire construction industry, therefore, a list of attributes that measure representativeness was identified in Table 3. Two representatives from the public and private sector were selected to maintain a balance, with the last representative being from a wholly owned government company. All members of the IEFG had extensive experience and direct responsibility for e-procurement issues within their respective organisations.

Experiments by Brockhoff [36] and Boje and Murnighan [11] suggest that under ideal circumstances, groups as small as three or four can perform well. Brockhoff [36] also suggests that a general positive relationship between group size and group performance cannot be recognized and smaller groups perform equally as well as large. One prerequisite is that the panel must be homogeneous in its makeup. The IEFG for the Delphi process can be considered homogeneous as they are all members of the construction industry which enables the limitation of group size to five.

Table 3: Representativeness of the various panel members

Attributes necessary	Criteria	How Achieved with panel
Homogeneousness	Member of the Construction industry. Required 100% of panel	5 out of 5 **adequate**
Expertise	100% of panel require Membership of Professional Body to meet requirements of Shields et.al 1987	5 out of 5 **adequate**
Gender Balance	Male / Female - Equal number	3 – 2 **adequate**
Sector Balance	Public / Private Sector - Equal number	2 public – 2 private - 1government owned company **adequate**
Direct Responsibility	Implementation of a system of e-procurement from a client perspective	3 out of 5 – 60% of the panel had been instrumental in implementation within their organisation **adequate**
Experience	User (Formation of Documents from a client perspective) - 40% of panel – knowledge of issues relating to the use of e-procurement	4 out of 5 – 60% of panel had formed contract documents. 3 public and 1private sector. **adequate**
	User(Completion of Documents from an end user perspective) - 40% of panel – knowledge of issues relating to the use of e-procurement	2 out of 5 – 40% of panel had completed contract documents. **adequate**

Attributes necessary	**Criteria**	**How Achieved with panel**
Willing to take part in Delphi Process	100% of panel	5 out of 5 **adequate**

2.4 Delphi Process application

On the first round of the Delphi process the panel was provided with the initial list of identified drivers and barriers to e-procurement from literature (Table 2 and Table 3) in the form of a developed questionnaire (Figure 1 Steps 3 and 4). They were asked to rank these as to their importance to construction. The scale chosen was 1 – very important, 2 - important, 3 – necessary and 4 – not very necessary. IEFG members were requested to add other drivers and barriers that they felt would also impact upon construction e-procurement (Figure 1 Step 5). The results of the questionnaire were then analysed as per Figure 1 Step 6.

3. Findings

Boje and Murnighan [11] show that while confidence increased as the number of rounds increased, accuracy decreased. It is therefore important to get a consensus of opinion in as few iterations as possible. The first iteration reached a consensus level greater than 60% on all the drivers and all but three of the barriers. These were *"staff turnover"," slowdown in the uptake of internet services since the dotcom bubble burst"* and *"religious objections to the internet"*. These were forwarded to the second stage for further analysis. Eight additional drivers and four barriers were identified by the panel. However, after further contact with the panel only three drivers namely, *"Increased quality through increased accuracy (elimination of errors through computer use)"*, *"convenience of archiving completed work"*, and *"develops the Technical Skills, knowledge and expertise of procurement staff"* were added to the second round of the process and list of drivers. *"Perception of no business benefit realised", "lack of publicity / awareness of best practice solutions"* and *"a lack of a forum to exchange ideas"* were added to the list of barriers. It was agreed by those raising the additional drivers and barriers that five of the eight additional identified drivers and one of the barriers had previously been covered in the initial list.

These results were carried into the Delphi second stage questionnaire (Figure 1 Step 7). The second round questionnaires were split into three sections:-

Section A: - To get consensus as to the removal or otherwise of the three barriers identified in the first round of questionnaires. This was achieved with staff turnover being included and the other two being rejected after additional information being submitted to the panel.

Section B: - To get consensus as to the inclusion or otherwise of the additional drivers and barriers identified in the first round of questionnaires. Consensus was achieved that the following drivers and barriers would be included. *"Increased quality through increased accuracy (elimination of errors through computer use)", "convenience of archiving completed work"*, and *"develops the Technical Skills, knowledge and expertise of procurement staff"* were added to the list of drivers and *“perception of no business benefit realised”, “lack of publicity / awareness of best practice solutions”* and *“a lack of a forum to exchange ideas”* were added to the list of barriers.

Section C: - To examine if the amalgamation of the drivers and barriers identified through conversations would be acceptable to all. The amalgamation of the following drivers - Process Cost Savings - (Tender / Purchase Process), Transaction Administration Cost Savings, Reduced Administration Costs and Decrease in Costs through reduced staffing levels into "Process, Transaction and Administration Cost Savings", Shortened Communication Cycle times and Reduction in time through improved internal workflow into "Shortened Internal and External Communication Cycle times" and Amalgamation of Lack of a widely accepted solution and cost of assessment of systems to fulfil tasks into "Lack of a widely accepted e-procurement software solution" was also agreed by all the panellists.

Consensus on all items was reached after two iterations (Figure 1 Step 10).

4. Conclusions

The aim of using the Delphi process was to obtain a confirmed list of drivers and barriers to construction e-procurement that was agreed upon by representatives from all sections of the construction industry. Consensus was achieved and these findings have been used to produce an instrument for ranking drivers and barriers to Construction e-procurement (Table 4, Table 5).

Table 4 Final list of Drivers after completing the Delphi Process

No	**Drivers from Literature and Delphi Process**
1	Process, Transaction and Administration Cost Savings
2	Service / Material / Product Cost Savings
3	Increasing Profit Margins
4	Strategic Cost Savings
5	Enhanced Inventory Management
6	Shortened Overall Procurement Cycle Times
7	Shortened Internal and External Communication Cycle times
8	Reduction in time through greater transparency (Less objections)
9	Reduction in Evaluation Time
10	Reduction in purchasing order fulfilment time - Contract Completion
11	Reduction in time through increased visibility
12	Increased Quality through increased competition
13	Increased Quality through Benchmarking (Market Intelligence)
14	Increased Quality through increased visibility in the supply chain
15	Increased Quality through increased efficiency
16	Increased Quality through Improved Communication
17	Gaining Competitive Advantage
18	Increased Quality through increased accuracy (Elimination of errors through Computer use)
19	Convenience of archiving completed work

No	**Drivers from Literature and Delphi Process**
20	Develops the Technical Skills, knowledge and expertise of procurement staff

Table 5 Final list of Barriers after completion of the Delphi process

	Barriers from Literature and Delphi Process
1	Upper Management Support / Lack of Leadership
2	Other Competing Iniatives
3	Resistance to change
4	Lack of a widely accepted e-procurement software solution
5	Magnitude of Change
6	Lack of a national IT policy relating to e-procurement issues
7	Lack of Flexibility
8	Bureaucratic dysfunctionalities
9	Complicated procedures and extended relationships
10	Lack of technical expertise
11	Staff turnover
13	Company access to the internet
15	Insufficient assessment of systems prior to installation
16	Security in the process - Data transmission to the wrong person
17	Confidentiality of information - unauthorised viewing
18	Prevention of tampering with documents - changes to documents
19	Data transmission reassembly - incorrect reassembly of data transmitted in packets
20	Partial Data Display - incomplete documents provided
21	Lack of pertinent case law
22	Different national approaches to e-procurement
23	Proof of intent - electronic signatures
24	Clarity of sender and tenderer information
25	Enforceability of electronic contracts
26	Information technology investment costs
27	Internal and External interoperability of e-procurement software
28	Investment in compatible systems
29	Reluctance to "buy-into" one off systems
30	Perception of no Business Benefit Realised
31	Lack of publicity / awareness of best practice solutions
32	Lack of a forum to exchange ideas

A further detailed survey of the UK Construction Industry will be completed to rank these drivers and barriers to construction e-procurement.

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The Strategic Role of ICT within the Turkish AEC Industry

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Abstract

Today it is widely accepted that ICT is becoming a strategic asset for any organisation to deliver business improvement and achieve sustainable competitive advantage. However, traditionally the construction industry has approached investing in ICT with a lack of strategic focus and low level of priority to the business. The nature of such investments have been made very much in an ad hoc manner with the focus on improving specific processes predominantly driven by technology, rather than towards business improvement driven by the strategic objectives of the business. As such, this may have delivered isolated areas of improvement within the organisation but has contributed little in the context of strategic benefit. This paper presents a recent study focused on investigating the current strategic role of ICT in the Turkish Construction Industry. The study explores issues relating to the role of ICT strategy, reasoning behind ICT investments, barriers to the successful implementation of ICT and role of ICT through the lifecycle of a facility/project.

Keywords: ICT, Strategic Role, Investment, Turkish AEC Industry, Construction

1. Introduction

Over the last 30 years the evolution of ICT has led to construction organisations increasingly adopting technology in support of their businesses. ICT is now widely accepted as becoming a key element of any organisation as they strive to ensure sustainable competitive advantage. However, since the initial enthusiasm of the industry during the 70’s in their adoption of CAD applications, the investment in ICT has (in the main) been extremely ad-hoc. Traditionally, ICT investments have been driven either by demands generated at operational levels to satisfy particular needs (bottom-up) or requests issued by senior management to meet specific business requirements (top-down). This ‘Technology Push’ approach to investments in ICT results in the development of ICT-driven solutions that are unlikely to deliver real strategic benefit to the organisation. Furthermore, the nature of the industry has been such that ICT investments have not been perceived of strategic importance and a priority to the business. Although the introduction of several advanced ICT applications may have contributed to the improvement in the efficiency and performance of a number of processes, often the overall efficiency and performance of an organisation has not been realised in terms of meeting the strategic business objectives. This is a result of the development and implementation of ICT that is not part of an overall ICT strategy and/or the implementation of an ICT strategy that is not aligned to the strategic objectives of the business. Emphasis therefore in facilitating sustainable competitive advantage has to be on establishing strategic policies for ICT investment that are formulated to align with the business strategy thereby leading to more business-driven ICT solutions. The results of previous research on measuring the ICT use and trends in Turkey [1] indicated that, as similarly to many countries, the Turkish construction industry has been facing difficulties related to communication and loss of information due to fragmentation in the industry. In 2002, ICT was viewed as a strategic resource by senior industry figures in Turkey and they indicated that they were ready to spend time and effort in order to increase the ICT awareness and improve training. The overall research aimed to identify whether the Turkish construction industry currently views ICT as strategically important. The research methodology is summarised in the following section.

1.1 Research Methodology

The study began with a comprehensive literature review in the area by looking at the role of ICT in the AEC industry and the studies on evaluating the usage and benefits of ICT for AEC organisations. In the next stage semi-structured interviews were conducted with contractors and consultants in light of a questionnaire. During the interview process a range of areas such as the role of ICT strategy in the organisation, the reasons for investments on ICT and barriers to successful implementation of ICT for the organisation were investigated. The results of the literature review are summarised in the next section, followed by the findings of the interviews along with an analysis of these findings.

2. Background

2.1 The Role of ICT in the AEC Industry

The literature review identified numerous questionnaire surveys and case studies on investigating the usage and the strategic role of ICT in the construction industry. For example, Li and Wang [2] presented a “5Cs” evaluation framework to assist construction companies to predict, measure and evaluate the potential benefits that can or should be gained by the introduction of IT. Love at al. [3] presented findings of a questionnaire survey related with IT investments of SMEs in the Australian construction industry. Three findings were mentioned as (i) the different organization types significantly differ in the amount they invest in IT but this is not influenced by organisation size, (ii) strategic benefit varies with different organization types and (iii) the way in which employees adapt to change as a result of IT implementation differs with organisation size. Based on the above mentioned findings, Love *et al.* [4] proposed a pragmatic ex-ante IT evaluation framework which can be used by construction organizations to ameliorate their investment decision-making process. Peansupap and Walker [5] explored the factors influencing ICT adoption within construction organizations. As a result, researchers determined that individual and environment factors generally have a high impact upon ICT diffusion but management and technology factors have a slightly above moderate impact. Following this, Peansupap and Walker [6] stated that people-related factors are crucial in effective ICT implementation and support at the personal, workplace and organisational level is clearly needed. Hua [7] conducted an IT Barometer in Singapore and compared the results with previous IT Barometer studies on Nordic Countries. Hua [8] later conducted an industry-wide survey by adopting the IT Barometer questionnaire and applying stratified sampling to Singapore's AEC SMEs. In the study, the characteristics of ICT usage by the AEC companies were compared and the alignment of business and ICT strategies of the AEC companies was examined. Tse and Choy [9] investigated the differences in the use of IT by conducting an in-depth interview with three major quantity surveying organisations in Hong Kong. The authors found that the full potential of IT to improve organizations' efficiency, effectiveness and flexibility has seldom been reached and then they apprised that a sector to enter the IT era must employ the right sort of technology by a sufficiently large number of the supply chain and stake holders.

A significant amount of research has also been carried out related with the barriers for ICT implementation and the critical success factors to implement ICT. Stewart et al. [10] presented a conceptual framework for incorporating the impediments like operational factors, financial constraints, limited marketing and human resource management expertise, limited strategic planning and ineffective IT implementation. The authors [11] then explored the most effective coping strategies to overcome these impediments. A survey study was undertaken in Australia by Gajendran et al. [12] to identify the critical success factors that underpin the integration of ICT in supply chains. As a result, organizational commitment, organizational attitude to communication, rights and duties, investment drive and guarantee/protection/assurance were identified as critical issues to be addressed by organisations wishing to successfully adopt and integrate ICT into their supply chain operations. Ugwu and Kumaraswamy [13] identified two trajectories of IT project success and failure in construction, and the critical success factors that could be useful for IT applications, based on the research conducted over the period 2000-2004 in Hong Kong. Brandon et al. [14] identified the ingredients such as convergence, connectivity, culture, creativity, content improvement and collaborative working needed to "tip" the balance for an accelerated penetration of information technologies into the construction industry. The authors suggested that design and nD modelling, B2B and KM are the areas where current and future research may lead to a transformation of how the industry behaves.

2.2 Evaluating the Usage and Benefits of ICT for the AEC Industry

Another field of research to emerge during the literature review is that of evaluating the usage and benefits of ICT (and ICT applications). For instance, Andresen et al. [15] recommended a framework for measuring the benefits of IT implementations. Parasuraman [16] ameliorated a multiple-item scale to measure readiness to embrace new technologies in marketing.

Other recent studies in the area include El-Ghandour and Al-Hussein [17] who presented a holistic view of ICT applications in construction during the years 1992 and 2002, Rivard et al. [18] who conducted case studies about the usage of IT in Canadian construction industry, Oladapo [19] who investigated the level of use ICT usage and the factors impacting the level in the Nigerian Construction Industry, Scheer et al. [20] who sought the application experiences of IT in construction industry in Brazil, and El-Mashaleh [21] carried out a modified version of an IT Barometer survey in Jordan’s AEC industry.

In addition, [22] [23] [24] can be referred to as further studies related to the applicability and usage of ICT in Construction, while there have been other studies for determining the role of ICT in AEC which can be found in [25],[26],[27]

2.3 Background on Use of ICT in Turkish AEC Industry

The literature review in the field identified three research papers that investigated the role of ICT in the Turkish AEC industry. The first is entitled “*A survey of ICT use in the Turkish Construction Industry”* [1]. The study examined the ICT capabilities of the Turkish construction industry via 22 semi-structured interviews with senior construction professionals within government and private organizations. In the study the authors investigated the usage and applicability of current information systems and technologies and assessed priority topics for the future of ICT. As a result, ten priority areas where IT use can facilitate processes were identified. A second study entitled “*Use of Information and Communication Technologies by Small and Medium-Sized Enterprises (SMEs) in Building Construction*” [28] analysed four major research questions associated with perception of the impact of ICT, extent of investments in ICT, level of usage of ICT and the software preferences of the SMEs by conducting a questionnaire survey of 227 building construction organisations in Turkey. Finally, Tas and Irlayici, [29] investigated the current and the planned use of IT and its impact on the construction industry in the case of acquiring building product information in Turkey. The authors conducted a questionnaire with both the supply side (manufacturers) and the demand side (architects). In the paper, the supply side’s behaviour on providing building product information and the demand side’s methods of getting product information were discussed.

3. The Interview Process and Results

In the next stage of the research semi structured interviews were conducted with 21 major contractors and consulting organisations in the Turkish AEC industry in light of a questionnaire. A questionnaire was formulated consisting of 19 questions. The first group of questions investigated the role of ICT strategy in the organisation, while the next set explored the reasons behind ICT investments. Further questions focused on the role of ICT in recruitment, structure of ICT departments, barriers and facilitating factors for the successful implementation and management of ICT in the organisation and finally, the role of ICT through the various phases of the construction lifecycle.

3.1 Methodology

The semi-structured interviews were conducted generally with ICT managers by visiting each organisation. The interviews started with an informal introduction to the research which lasted around 20 minutes. The interviewees were later interviewed based on the questionnaire by two interviewers. The interview results were cross-checked by the interviewers and a copy of a completed questionnaire was reviewed by the interviewers and the interviewee in order to validate the answers given by the interviewee. The overall interview process with each organisation took between 1 and 1,5 hours. The list of interviewees is provided in Appendix 1.

3.2 Findings into the Strategic Role of ICT within the Turkish AEC Industry

Role of ICT Strategy

The first two questions investigated the general role of ICT in their organisational strategy. In response to the first question, the majority of the organisations mentioned the role of ICT as value adding (58%) and critical (38%) in order to gain advantage against their competitors. On the other hand, only a few organisations (10%) viewed ICT as simply a tool for supporting their business processes.

The second question investigated the role of ICT in order to win work, and in response more than half of the participants indicated the role of ICT as value adding (40%) and critical (20%). In fact, 40% of the participants found ICT as a non-critical resource for winning work, with30% viewing ICT as a supportive tool to win work, and the remaining participants (10%) argued that ICT does not have any positive impact for winning work.

The next set of questions was focused on the role of ICT strategy within the organisation and in the context of the organisations' overall business strategy.

The following question aimed to identify how organisations formulate their ICT strategy. The majority of the respondents (81%) indicated that their organisations' ICT strategy is formulated by focusing on their strategic business objectives. On the other hand, a few participants (19%) indicated that their ICT strategy is formulated primarily focusing on implementing the technological innovations. In response, the interviewees also mentioned that a successful ICT strategy can only be developed by focusing on both the technological aspects and the organisations' business objectives.

The fourth question asked whether the organisation has a well formulated and documented ICT strategy, i.e. an agreed set of actions to be taken in the investment in ICT and written in the form of a strategy document. The results demonstrated that the majority of the organisations (65%) do not have a documented ICT strategy while 30% mentioned that they do have a documented

ICT strategy (in the form of a written strategy report). Those organisations that do not have a documented ICT strategy indicated that their ICT vision is based on following the technological developments and advancements, while making ICT investments in parallel with their business (strategic) needs. In contrast, the actions and ICT investments of their competitors' has no influence on any of the organisations that have an undocumented ICT strategy. On the other hand, 5% of the interviewees mentioned that their organisation does not have any form of an ICT strategy.

The next question explored the role of the organisations' ICT strategy in the context of the organisations' overall business strategy. In response, 76% of the organisations mentioned that their ICT strategy is either value adding or a critical part of their overall business strategy, while 24% pointed out that their ICT strategy only supports their overall business strategy.

The sixth question investigated who engages in the formulation of the ICT strategy. More than half of the respondents (60%) mentioned that the organisations' ICT strategy is formulated by their central/core ICT department to align with the operational needs, which is dependent on the feedback from various departments. On the other hand, 33% pointed out that their central/core ICT department alone formulates the organisational ICT strategy (without input from other departments), and 7% stated that individual departments are responsible for formulating their own ICT strategy.

ICT Investment

The following group of questions focused on understanding the reasoning behind ICT investments and investments related to ICT R&D and training. The first question investigated the strategic reasoning behind the investments in ICT. In response, 42% stated that their organisation invest in ICT to reduce the cost of the processes, 39% indicated that ICT investments are made to add value to the current form of processes, while only a small percentage (19%) mentioned that their organisation invest on ICT to gain strategic advantage. In contrast, none of the respondents indicated that their ICT investments are made to avoid losing strategic advantage.

The following question asked if the organisations measure the Return-on-Investment (ROI) for their ICT expenditures. 45% of the respondents mentioned that they measure ROI, however only a limited number (15%) undertake this regularly, while 30% calculate ROI when needed. On the other hand, 30% expressed that they do not calculate ROI as they do not have a reliable method for ROI calculation for ICT investments in construction. A quarter of the respondents (25%) do not perceive ROI as an important indicator for determining their ICT investment policy, thus they do not calculate it.

The next question in this group explored the organisations' focus on investments on software and information systems development. In response, 5% of the interviewees indicated that their focus is on developing in-house software and IS, and in contrast 35% mentioned that they only outsource software development. More than half of the interviewees (55%) stated that their organisation implement a mix-and-match approach where some parts of their IS is developed in-house, while the development of some components is outsourced.

The following two questions investigated the organisations' perspective on ICT related research and development (R&D) investments. The first question was with regard to the organisations' focus on R&D activities. 47% of the interviewees mentioned that their organisation has never thought of investing on R&D. On the other hand, 48% stated that they have considered investing on R&D efforts, but only 37% actually recognise R&D as a part of their organisational vision. A small percentage of the organisations (5%) have joined an R&D effort initiated by an ICT organisation. The next question queried the organisations' willingness to participate in a national or European research project. 61% of the respondents indicated that their organisation may be interested in getting involved in a research project related to ICT. On the other hand, 39% mentioned that their organisation have no interest in joining such projects.

The next set of questions focused on whether organisations invest on ICT training along with the reasoning for investing on training activities. In response to the first question, 80% of the organisations stated that they invest on ICT training, while 20% make no investment at all. However, interviewees mentioned that even when a separate budget is not dedicated to ICT training (i.e. as 20% mentioned that they do not invest on ICT training); this does not necessarily mean that training is not provided for their employees.

The second question explored the reasoning behind the investment on ICT training. 36% indicated that ICT training is necessary to facilitate the business processes, while 25% mentioned ICT training has a strategic importance to win work. On the other hand, 19% indicated that their organisation is investing on ICT training in order to have better human resources (HR), and 19% stated that their organisation is providing ICT training as ICT is a necessity in accomplishing several tasks in their business processes.

Role of ICT in Recruitment

The following question investigated the role of ICT knowledge in employing white-collar staff for the organisation. 61% of the respondents indicated that a high level of ICT knowledge plays an important role for getting better employment opportunities. 34% mentioned that their organisation only require a certain level of ICT knowledge, which will be necessary to complete their tasks. On the other hand, 5% mentioned no importance is given to level of ICT knowledge while employing white-collar staff.

Structure of ICT Departments

The following two questions focused on the ICT department of the organisation. In response,, 86% of the respondents indicated that their organisation has an ICT department, while 14% pointed out that their organisation does not have a department dedicated to ICT. The survey results showed that 56% of the ICT department consists of only support staff, and of the remaining 44%, the staff is responsible for strategy development, systems implementation along with providing support for solving ICT (hardware/software) related problems.

Barriers and Critical Success Factors to the Successful Implementation of ICT

The next question investigated the possible barriers to successfully managing ICT in the organisation. In this question the interviewees were given a set of 'possible' barriers to which they were requested to answer whether the given issue has been a barrier for the organisation. The results are summarised in Table 1. Problems related to network and communication infrastructure, inefficient use of software and processes that are not defined successfully are indicated as the biggest barriers to preventing the efficient implementation and management of ICT in the organisation. On the other hand, the organisations state that their senior management does not underestimate the role of ICT for their processes and also indicate that no problems are due to the lack of an ICT strategy. The majority of interviewees also pointed out that as their ICT strategy is driven by their business needs, the lack of business driven ICT strategy has therefore not been a barrier.

The following question explored the critical success factors in order to implement and manage an information system (IS) within the organisation. First, the interviewees were given a set of factors which might be critical and were requested to select whether the given factor is either, not important, moderately important or critical for the successful implementation and management of IS. The results are given in Table 2. Continuous training on ICT (55%) and support from software vendors (55%) were found as the most critical factors for successful IS implementation. On the other hand, 47% of the respondents mentioned that experience gained from previous IS implementations in the organisation plays an important role on the success of future IS implementations. Another issue that 37% of the organisations found as critical was the re-design of current processes. The interviewees pointed out that their organisations faced several difficulties due to ill-defined processes. Finally, investment on new technologies has been found as an important issue by the majority of the respondents, but only 25% found technology-focused investment critical for the success of an IS, as many organisations thought that their IS should be designed towards their business objectives.

Table 1: Barriers to the successful implementation of ICT

	Has not been a barrier for successful ICT implementation	Has been a barrier for successful ICT implementation but does/did not have a direct effect on our business processes	Has been a barrier for successful ICT implementation and has/had a direct negative effect on business processes
Problems in the physical network and communication infrastructure	20%	35%	45%
Problems related to hardware	40%	25%	35%
Problems related to data storage	50%	20%	30%
Problems related to data exchange	60%	30%	10%
Inabilities of the software	37%	37%	26%
Inefficient use of software	21%	37%	42%
Not well defined processes	47%	16%	37%
The lack of ICT strategy	83%	6%	11%
Lack of Business driven ICT strategy	88%	6%	6%
The view of management that underestimates the role of ICT	85%	5%	10%
The staff with insufficient ICT skills	50%	30%	20%

Table 2: CSF for the successful implementation and management of IS

	Not important	Moderately important	Critical
Continuous ICT training	5%	40%	55%
Investment on new ICT	0%	75%	25%
Support from software vendors	5%	40%	55%
Benchmarking with competitors	55%	30%	15%
Re-design of current processes	16%	47%	37%
The feedback from previous IS implementations that failed or successfully implemented	10%	45%	45%

Role of ICT through the Construction Lifecycle

The final question investigated the role of ICT for organisations in different phases and for different aspects of the construction lifecycle. In the beginning the interviewees were given a set of lifecycle phases and processes and requested to identify the role of ICT in terms of '*not needed, supporting or critical*' for the given lifecycle phases/processes. The results are given in Table 3. The majority of the respondents indicated that ICT has a supporting role for all lifecycle phases. On the other hand, 38% interviewees mentioned that ICT is vital during the feasibility phase (for feasibility studies and sketch design), 44% pointed out that ICT is vital for architectural design and structural analysis, and 31% mentioned that ICT is vital for supply chain coordination and management. In most of the lifecycle phases, only a minority of the respondents (6%) stated that they do not use ICT in support of their business processes, i.e. most of the major LSEs in Turkey do not underestimate the role of ICT in managing AEC projects.

Table 3: Role of ICT through the construction lifecycle

	ICT is not needed/ not used within the organisation	Currently ICT are supporting the process	ICT are vital for process (task) to function
Feasibility Studies Sketch Design	6%	56%	38%
Architectural Design and Structural Analysis	6%	50%	44%
Bidding	6%	67%	27%
To manage activities in Construction Site	0%	78%	22%
Supply Chain Management / Procurement	6%	63%	31%
Time/Cost Management	0%	68%	32%
Quality Management	0%	89%	11%
Facilities Management	13%	74%	13%

4. Analysis and Discussion

The results of the first two questions demonstrated that ICT is seen as a value adding resource as a part of an overall business strategy, for gaining competitive advantage and for wining work. For example, around 1/3 of the organisations viewed ICT as a critical resource for their competitive strategy and similarly 38% mentioned that ICT strategy is a critical element of their overall business strategy. In contrast, 40% viewed ICT as non-critical in winning work. These results suggest that the strategic role of ICT is not completely underestimated among the organisations. The fact that the role of ICT in winning work is not found critical is due to customers not usually requesting a well established ICT infrastructure as one of the main requirements in the bidding process.

Most of the organisations that participated in the interviews mentioned that they do not have a properly documented ICT strategy, while the organisations that have a documented ICT strategy developed this in the requirement for standardisation reasons (i.e. ISO 9001). The findings indicate that the organisational culture in terms of ICT has not reached a level of maturity where ICT activities are planned and managed with a properly documented strategy. The majority of the organisations have chosen to follow technological developments/advancements in order to make decisions for further investments on ICT. This approach can be seen as a technology-oriented/driven approach for forming a strategy. However, the organisations are not aware of the bigger (industry) picture while formulating their strategy, as most of them are not driven by their competitors' actions and investments. The survey results highlight that business needs/objectives play an important role in forming ICT strategies. However, the organisations also follow an approach towards implementing the latest technologies possible to accomplish their business objectives.

The results indicate that in most of the organisations there is a well balance (of contribution) between ICT department and other departments of the organisation in forming the organisational ICT strategy. This well balanced contribution is necessary for the development of a successful strategy, and the results indicated that the organisational culture is mature enough in this manner.

The majority of the organisations invest in ICT either to reduce costs or add value to the current form of processes, i.e. ICT investments are not made for strategic reasons (gaining competitive advantage) but are made for supporting the processes. As previously explained, the findings indicated that the organisations do not completely underestimate the strategic role of ICT, but this has not been reflected in the organisational investments. This result raises the question if organisations recognise the strategic importance of ICT investments then why are they not investing in this manner?

The findings of the interviews showed that although not practiced as a regular activity, calculating ROI for ICT expenditures is quite evident (45%), which is an indicator that ICT investments is recognised as of critical importance in terms of the business.

The majority of organisations (90%) outsource IS development, but 55% also carry out in-house development to mainly align IS into their business needs. The organisational view in regard to this issue is towards developing and implementing systems on an 'as-needed' basis, and issues such as major changes in processes are not considered.

While half of the organisations have never considered investing in ICT related R&D, the findings of the survey indicate the willingness of 61% of organisations to participate in such activities. This raises the question of how many of these organisations would actually become involved in a research and technology development project/initiative without the recognition of a major industry-wide necessity.

In parallel with the results of a previous survey [1], training on ICT appeared as an important aspect of the overall organisational strategy. The reasoning behind ICT training was various but the main focus was towards facilitating business processes through the better use of technology.

Most of the organisations have an ICT department. However, the ICT departments are mostly composed of support staff rather than of staff responsible for strategy development and systems implementation. In contrast to the willingness of middle level management to join R&D projects, this result indicates that senior management still views ICT as a supporting resource.

The greatest barriers related to successfully implementing and managing ICT were identified as infrastructure problems and inefficient use of software. The infrastructure problems indicated are mainly related to telecommunications, e.g. low bandwidth in communications and internet access, while the inefficient use of software is mainly due to the lack of support from software vendors in Turkey. On the other hand, the importance given to ICT training and support from software vendors appeared as the most critical factors for successfully implementing ICT. The interviewees thought that ICT training acts as a road from failure to success, in parallel they also believe that without the support from software vendors a successful ICT implementation cannot be accomplished. In fact, the authors disagree with this industrial point of view, and believe that the success in ICT implementations should never heavily depend on external factors. In response to final question, the majority of interviewees mentioned the role of ICT as ‘supportive’ in different phases of the construction lifecycle; this indicates that (similar to the role of ICT from organisational point of view) ICT is also not seen as a strategic resource (by the majority of respondents) from the construction lifecycle management perspective.

5. Conclusion

There is a shift towards the recognition of the strategic importance of ICT in terms of value adding in winning work and achieving strategic competitive advantage, as opposed to simply supporting and facilitating business processes. However, although there is recognition of the strategic importance of ICT, the focus of investments in ICT is very much towards business process improvement rather than achieving strategic competitive advantage. This poses further research into exploring this gap between the ‘strategic thinking’ and the actual ‘process-focused practice’. Furthermore, the development of a well formulated and documented ICT strategy is not common practice. In such cases, the strategy is driven by business needs by focusing on technological advancements/developments, while the investments of competitors are of no concern, i.e. pointing towards an internally focused nature to investment. Organisational ICT strategy is being developed by a core/central ICT group/department, which in the main is still driven by operational business processes. However, there is evidence that some ICT departments are influencing the ICT strategic direction of their organisation.

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Although not a regular activity, measuring the return on ICT investment is quite evident and further demonstrates the valuing of the critical importance of ICT investment to the business. In addition, it is the issue of the lack of a reliable method that is preventing many organisations from measuring the return/impact of their investments rather than any undervaluing of their investments. While on the other hand, measuring the return on ICT investments is still perceived by some as having no importance on their ICT strategic planning.

ICT-related R&D is still not perceived an important strategic activity by the construction industry and therefore receives very little attention and investment. Although interestingly, there is significant interest in possibly becoming involved in ICT construction related research. This raises a further question at what level of involvement would encourage their engagement?

ICT training is evidently important in terms of investment, which in the main is towards delivering the ICT strategy, i.e. business process improvement facilitated by technology. However, where the strategic importance of ICT on the business is not recognised/undervalued, the activity of training and the associated budget is not encompassed as part of the overall investment in ICT.

In terms of the successful implementation and management of ICT, the main barriers identified are predominantly technological and process related rather than associated to people and strategy. In terms of the critical success factors, these are very much aligned with the barriers in that continuous training policy, learning from previous implementation efforts, and the re-design-engineering of currently ill-defined processes were identified. Interestingly, benchmarking against other competitor organisations was not identified as important, which further substantiates the internally focused nature of organisations in their ICT strategy and investments.

Finally, overall ICT is having a supporting role throughout the lifecycle of a facility/project. However, ICT is perceived vital particularly during the design phases along with the management of time/cost and the supply chain. The role of ICT is in the main valued in the management of AEC projects in Turkey.

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Appendix 1

List of Interviewees

Organisation	Contact Person	Position
Guris Insaat	Handan YUCEL	IT Manager
KC Group Yapı	Bedir AKSAN	IT Manager
Tepe Insaat	Ferhat BOLUKBAS	IT Manager
Nurol Holding	Emine ONGUN	IT Manager
Metis Insaat	Secimer TEZ	MIS Manager
MNG Holding	Murat KASABOGLU	IT Manager
Akfen Holding	Sinan OZKAN	IT Manager
Mesa Mesken Sanayi	Semra CANKIRILI	IT Manager
Gama Holding	Mehmet BESEN	IT Manager
Akturk Yapi Endustrisi	Timucin DIKMEN	IT Supervisor
Koray Yapi Endustrisi	Dr. Vehbi TOSUN	IT Manager
Tekfen Insaat	Cem AKTAS	IT Manager
Eston Yapi	Kutay SEYYALIOGLU	Planning Engineer
Sinpas Yapi Endustrisi	Taner AKKAS	ERP Specialist
Alarko Taahhut Grubu	Osman ISHAKOGLU	Planning Manager
STFA Insaat Grubu	Ali AVCAR	System Administrator
Soyak Holding	Murat TANATAR	IT Coordinator
Yuksel Proje	Sükrü BAYKAN	IT Manager
Limak Holding	Ersun GULBAS	IT Manager
Dolsar Muhendislik	Ali Onur KUYUCAK	Head of IT Division
Borova Yapi Endustrisi	Murat YAMAN	IT Manager

A Decision Support Model for Best Value IT Procurement for Construction Organizations

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Abstract

IT knowledge has become increasingly essential to the success of today's construction and will become more so in the future. Ineffective IT exploitation and poor procurement practices in construction organizations often create obstacles in reaping the full potential of IT investments. This paper presents a Decision Support Model for procurement of IT for construction organizations, which uses a value-based framework drawn from value engineering. It enables the identification of best value IT procurement options for various IT solutions and requirements. The model is developed using object oriented modeling techniques providing greater flexibility in future modification and expansion. The model is implemented as a decision support system and tested using real life cases from the construction industry. An expert evaluation carried out positively verified the concept and the usability of the system. The decision support model creates a knowledge repository for IT procurement and opens the opportunity to further enhance of aspects of IT procurement. The research was carried out in Sri Lanka using the construction industry as the forum for development of the system.

Keywords: Information Technology Procurement, Value engineering, Construction industry, Procurement model, IT solutions, Decision Support System

1. Background

Rapid evolution and spread of Information Technology (IT) during last few decades has increased usage of IT in every category of business. IT can no longer be viewed as an enhancement to traditional business procedures but rather as an innovative agent that enables new and different alternatives to organizing, administrating and operating business enterprises [1]. IT knowledge has become increasingly essential to the success of today's construction engineers and managers and will become more so in the future [2]. Lack of effective IT exploitation methods in construction organizations often creates difficulty in justifying future expansion and use of IT innovations. The task of identifying best IT products, procurement approaches, costs and benefits are some reasons behind that. This problem is global and drawbacks are experienced in all types of enterprises [3]. There is only limited capital available and an IT investment must compete with other demands on capital. Companies must recognize the full benefits of an IT project which can only be achieved as a part of an overall business strategy [4]. A recent article by the Central Unit of Procurement in the UK (2003) [5] states; everybody benefits from fast, effective and transparency in procurement. It reduces supplier's cost, enables the organizations to fulfil commitments faster and more effectively and gives better value for the client's money. These underline the necessity of having a systematic approach to procurement of IT.

A survey on the usage of IT in the construction industry of Sri Lanka revealed that there is organization wide poor utilization of IT [6]. This demands the introduction of a tool to evaluate and prescribe procurement approaches and provides feedback on their probable successes or failures. In most cases, although IT investment achieves business requirements, it may not provide value for money. Simply it may not increase client satisfaction nor reduce expenditure on procurement approaches. This research hypothesizes the use of Value engineering (VE) as an appropriate methodology for providing a solution for the problem of selecting best value IT procurement option. Value engineering is an organized approach in providing necessary functions at lowest cost [7]; [8] (VE is considered synonymous to value management in this paper).

The aim of this study on IT procurement is to investigate challenges associated with and develop a decision support model for construction organizations to assist in IT procurement which is capable of increasing customer satisfaction while removing unnecessary expenditure on IT procurement through the incorporation of value engineering principles.

2. Research methodology

A comprehensive survey of the construction organizations provided a detailed account of the current status of IT procurement and the extent of usage VE in the construction industry. The findings of the survey confirmed the need for a new approach to assist IT procurement in construction organizations while expert opinion favored the development of a DSS. The approach was to review previous theoretical considerations and current industry practices and to synthesize a new approach for IT procurement. It was modeled using a value based framework drawn from value engineering. The conceptual model was then further developed using object oriented modeling techniques allowing the users to make an intelligent and informed decision on the procurement route. The model was tested with real life IT procurement scenarios and evaluated using domain experts. The evaluated model was then implemented to as a Decision Support System (DSS) prototype with the intension of providing a user-friendly guide for IT procurement in construction organizations.

3. Survey of the construction industry of Sri Lanka

A comprehensive survey of industry was conducted to establish current status in terms of use of value engineering and methods of IT procurement. The survey also served as a method to establish the need for greater guidance in IT procurement for construction organizations.

Construction organizations in Sri Lanka are primarily represented by construction contractors and consultants. The survey sample selected included over 90% of representatives of contractors and consultants. This included all the large-scale construction organizations as those represent organizations capable of significant investments in IT. Survey sample size was restricted to 100 organizations comprising of 20 consultant organizations, 60 contracting organizations (selected from among M1, M2, M3 grades and foreign contractors) and 20 IT providers. Construction Contractors in Sri Lanka are classified in to 7 grades (M1 to M7), where M1 represents the largest organisations and M7 represents the smallest. The survey was carried out by visiting the organizations and getting the person responsible for IT procurement to fill the survey responses within an interview session. This way the researchers managed to achieve a 100% response rate.

3.1 Main Findings of Survey

Following are the main findings of the survey. These are analyzed under two headings: VE related and IT Procurement related findings.

3.1.1 Use of Value engineering in the Construction Industry of Sri Lanka

Most construction organizations consider value engineering as a relatively new concept. The only reported significant application of value engineering was in the construction of the World Trade Centre (Colombo) [9]. The survey identified the following as key factors contributing to poor usage of VE [9]:

- Greater fragmentation of the industry.
- Lesser collaboration and project approach among professionals.
- Less knowledge about benefits of value engineering among clients, developers etc.
- Unavailability of standards or guide for value engineering in Sri Lanka.
- No statutory requirement or encouragement to use VE in the public sector construction projects.

3.1.2 IT Procurement Methods used in Industry

The Sri Lankan construction industry is IT backward and is no different to construction industries of most other developing countries [6]. However, Methananda [6] found that the Sri Lankan construction industry has identified the potential of IT to a reasonable degree and that it has resulted in a trend of greater investment in IT. Current practices regarding IT procurement in construction organizations reveal the following [10]:

- 97% of organizations consider IT as a strategy to improve organizational performance.

- 75% of organizations hardly adhere to any rules and regulations for procurement of IT. Only 10% of government organizations even adhere to the "Guidelines on Government Tender Procedure (1997) for procurement of material and equipment including IT".

- Only 3% had licensed software. This is in fact violation of international copyright laws.

- 20% of organizations adopted a strategic plan for development of IT within their organizations. They tend to find finances as and when the need arises rather than pre-plan.

- Approaches available for IT Procurement include: Consulting services, Off-the-shelf IT supply and maintenance, Systems supply & installation and Systems Engineering. These options were used with different methods of payment: direct purchase, hire or leasing.

- Although organizations were conscious of the value of investments, there is no evidence of use of VE techniques to evaluate IT procurement.

In addition, the survey also revealed some factors within the industry that contribute to the problems associated with IT procurement:

- Unavailability of adequate resources (finance and technical) to invest on IT.

- Poor standard of after sales services provided by the IT providers.

- Difficulty of identifying the best IT products and systems in the open market, and inability to assess suitability of such products for the organization.

- Poor regulation of the IT sector and non-availability of industry standards, independent information and customer protection.

The major causes of concern in procurement of IT were the poor levels of knowledge of professionals, unavailability of a procurement guide, and difficulty of identifying best products. All these factors underlines the need for greater guidance for IT procurement to assist professionals in the construction industry. This research aims to address some of these issues through the development of a model for IT procurement.

4. The decision support model

The main function of the model is to facilitate its users in intelligent and informed decision making on available procurement routes for the procurement of IT. It provides guidance on how to procure IT solutions. This approach was adopted as various companies have various IT requirements based on size, activities and nature of their business. The IT solutions identified shall relate with the business and consequently play a part in and be integrated with construction activities. The model is designed for senior management, particularly those without adequate knowledge of IT procurement but responsible for selection and procurement of IT. It provides a ranked list of best-valued procurement methods with details of procedures and associated merits and demerits.

Development of the DSS for IT procurement consisted of phases for design and implementation. The Design phase was again considered in two stages as conceptual modeling and information modeling. Conceptual model illustrates the principles of the IT procurement model while information model deals with the contents of it. The model was evaluated for its contents to ensure its accuracy and validity of data through industry based case studies. The evaluated model was then implemented as a DSS providing greater user friendliness and was tested with actual data for its accuracy and workability. Finally, an expert evaluation was conducted to verify the validity of the research and the model.

4.1 The Conceptual model for Best Value IT Procurement

IT requirements identified by organizations and existing IT procurement options are considered in the value engineering process to identify best-valued procurement options, which will match procurement options to IT requirements. This facilitated the incorporation of new IT procurement options, procurement requirements and opportunity to address problems identified in current practice (Figure 1 1).

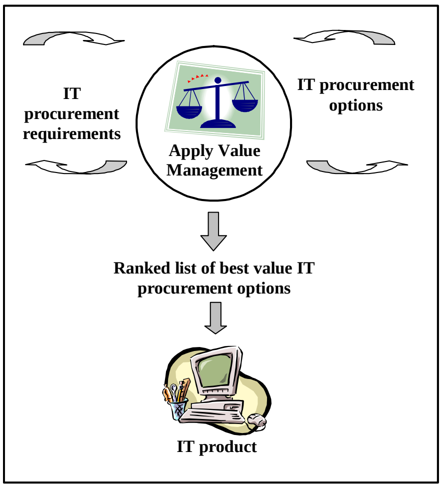

Figure 1: The Conceptual Model for IT procurement

The model assumes that IT solutions already identified have satisfied functional, financial and technical requirements of an organization. Requirements are diverse and difficult to define, highly sensitive to changing business objectives, organizational politics, and capacity of end users and are subjected to rapid technological changes over time.

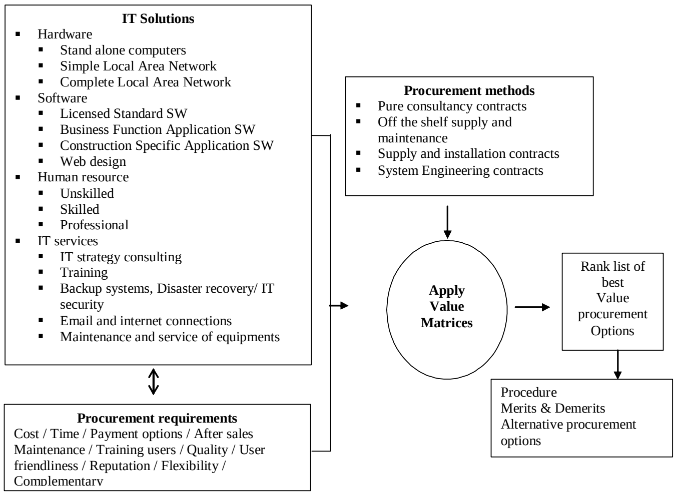

Figure 2: The Detailed Design of the Conceptual Model

Figure 2 illustrates the detailed design of the conceptual model for IT procurement. IT requirements are the inputs for the model while a ranked list of best valued procurement options are the output of the model. In addition the model knowledge base consists of all available procurement and payment options procurement procedures, their merits and demerits and alternative procurement options. The model uses value matrices as a useful technique to match and compare competing alternatives to identify the best-valued procurement routes relevant to the identified IT solutions. It initially weighs evaluated criteria according to their relative importance and then scores alternatives based on weighted criteria to determine those that are optimal. IT procurement requirements are scored against procurement options to determine the ranked list of best-value procurement options for the identified IT solutions. An example of application of value matrices to identify IT procurement route is illustrated in section 4.2.1

The model provides for the adoption of experience gained from building procurement as alternatives learned from the construction industry. This will enable to device new procurement methods for IT procurement based on the experience of building procurement. There are various theoretical models developed for selection of procurement methods for construction by various researchers [11]; [12]. These models can be adopted to provide alternative options as a further development of this IT procurement model. The conversion of this conceptual model to a workable object oriented information model is explained in detail in the next section.

4.2 The Object Oriented Information model

Information modeling is the logical representation of information identified at previous designs. Simply, it defines procedures, which must be followed, and data required to achieve user requirements. There are two main techniques of information modeling, viz: structured approach and object oriented approach [13]. The object oriented approach was used to develop the information model as it was developed to mimic a more natural way of defining systems than that is offered by the structured approach. This method provides greater flexibility and reusability, furnishing a components based programming framework [14]; [15]. The Unified Modeling Language (ULM) standard notations were used to express the content of the information model generated [16].

The object-oriented model for IT procurement is illustrated below in Figure 3.

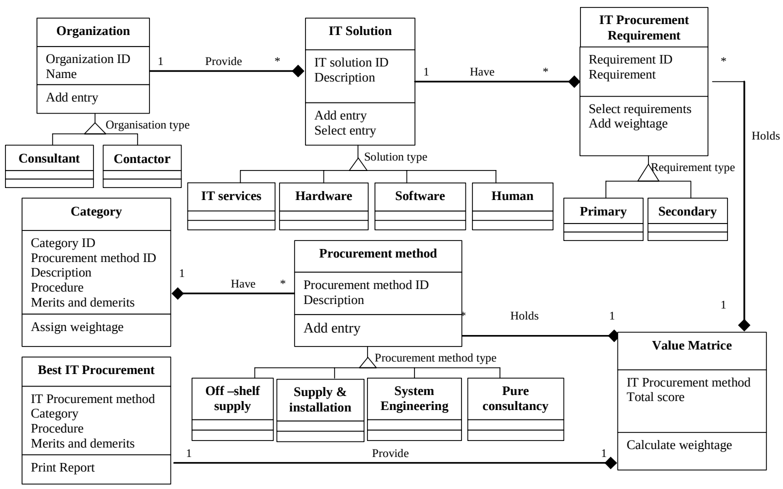

Figure 3: Object oriented model for IT procurement

The object model represents entities and their relationships. It consists of seven classes as: Organization class (containing organization. ID and name fields), IT solution class (containing IT solution ID and description), IT procurement requirement classes (containing requirement ID and requirement), Procurement method class (containing procurement method ID and description), category classes (which contains category ID, procurement ID, description, procedure and merits and demerits), Value matrices class (containing IT procurement ID and total score), best valued IT procurement class (which contains procurement description, category, procedure and merits and demerits) and their relationships. The methods “Add Entry”, “Select Entry”, “Print Report” and “Calculate Weightage” are the tasks carried out by the system. The inheritance (labeled “organization type”, “solution type” etc.) shows the categories or types belong to each class.

4.2.1 Use of Value Matrices

A value matrix is a tool that can be used to analyze complex situations when decision-making becomes hard and laborious task because of multiple variables and varying degree of influences by different factors. This method requires weighing of evaluation criteria according to their relative importance and scoring alternatives on the basis of weighted criteria to determine those that are optimal. An example value matrix for a selected IT solution (purchasing stand-alone computers) is illustrated below. (Out of fifteen IT solutions – refer figure 2)

Table 1 Weightage used for IT Procurement requirements

Procurement Requirement	Time	Cost	Payment options	After sales services	Maintenance	Quality	Reputation	Flexibility	Complementary
Code	T	C	PO	AS	M	Q	R	F	CO
Weightage	10	10	7	9	9	10	8	5	3

Application of points based on the level of satisfaction of procurement requirements (identified in Table 1 above) are given below.

Table 2 Degree of Satisfaction Points Scale

Level of Satisfaction	Non-satisfied	Poor	Average	Good	Complete satisfaction
Points	0	1	3	4	5

Table 3: Alternative analysis matrices

	T	C	PO	AS	M	Q	R	F	CO	Total	Rank
	10	10	6	10	10	10	8	5	3		
P1	5	3	1	3	3	3	3	5	1		
	50	30	6	30	30	30	24	25	3	228	3
P2	5	3	3	3	3	3	3	3	3		
	50	30	18	30	30	30	24	15	9	236	2
P3	5	5	5	5	5	5	5	1	3		
	50	50	30	50	50	50	40	5	9	334	1

Alternative procurement options;
P1 – Direct purchase (Off the shelf supply and maintenance contracts)

P2 – Through nomination (Off the shelf supply and maintenance contracts)

P3 – Calling quotation (Off the shelf supply and maintenance contracts)

The above example illustrates the use of value matrices for an identified IT solution for purchasing stand-alone computers. Initially weightage is assigned to each IT procurement requirement according to its relative importance (code denotes shorten form for IT procurement requirements). In this example cost, time, quality, and maintenance and after sales services are considered as critical factors.

At the alternative analysis matrix weighted IT procurement requirements are scored against alternative IT procurement options identified to determine a ranked list of best valued procurement options for the IT solutions identified. Application of points for each alternative is based on above criteria, which represent state of satisfaction of procurement requirements among selected alternatives where zero represents non-satisfaction and 5 points represents full satisfaction of requirements.

4.3 Decision Support System Developments

DSS development based on evaluated model consisted of three main phases: Database development, system interface development and system testing. The databases use a structure of a relational model as it provides the ability for end users to create and change records in the database in a user-friendly manner [17]. Microsoft™ Access 2000 was used to create the relational databases. Relationships among entities of the DSS were illustrated at object model in section 4.2.

System interfaces were developed using Java programming language (Beans IDE 3.6), which incorporates certain features such as polymorphism and inheritance, illustrated at object model for IT procurement. Java development environment offers benefits such as faster development, reusability, increased quality, modular architecture, better mapping of problem domain and client/ server applications [18]; [19].

4.4 Model and System Evaluation

The first stage of evaluation involved the evaluation on the model. It was then followed up by an expert evaluation using five industry experts on IT and value engineering.

4.4.1 Results of model evaluation

Model evaluation was aimed at verifying contents of model with industry practice. Thirty case studies were carried using large-scale construction and non-construction organizations within the Colombo metropolitan area. Model derived results were compared with the actual procurements occurred. The results indicated the existence of considerable variations in the selection of best-valued IT procurement options compared with the industry practice. Following summarizes the comparison.

Out of fifteen, only seven IT solutions (stand-alone computers, simple LAN, standard licensed software, web design, unskilled, skilled and professionals) represent similar results to the model derived best-valued IT procurement options. However, order of ranking of best-valued procurement options differs in most cases except in purchasing stand-alone computers and standard licensed software. Rest of IT solutions represents completely different results. This is significant as it means that industry has not been using best value procurement options.

From the model evaluation it was clear that model performance was different to the industry practice. Where differences exist, further evaluation proved that model performance was acceptable over industry practice. This was then verified using domain experts. The verification and expert evaluation process is explained in detail in the next section.

4.4.2 Results of expert evaluation

Expert evaluation was carried out as a series of semi-structured interviews, demonstrations and discussions as such methods provide openness to an interviewee to express genuine opinion, feeling at ease. It concluded that the model assists the initial decision making process and is specifically useful for less IT literate personal to procure IT in construction organizations. In addition facilitation of basic concepts of IT procurement highlighted as a shortcoming of this model. Also as the suggestions for improvement highlighted that it should be expanded to other industries and need to be flexible to accommodate future expansions.

The views expressed by the experts were considered in detail in the final phase of modification of the DSS. Following are some of the responses to the expert opinion.

- Model was designed, evaluated and developed based on results obtained by surveys and case studies obtained from construction organizations. Therefore, model is more suitable for construction organizations. However, the methodology and the conceptual model will be valid for implementation in any industry.

- Extension of the research to other industries and new areas was not incorporated due to time and resource restrictions of this research.

5. Conclusions

Organizations are continuously pressurized through evolving and demanding markets to increase productivity more than ever before. Increasing productivity has become a key to remain competitive. IT provides a means to attain greater productivity and competitive advantage to most enterprises. As a result, organizations tend to invest on IT. Although organizations have recognized adequate IT solutions to prevailing problems, identification of an appropriate approach for procurement of IT that achieves best value remains a barrier. The construction industry is not an exception to this. However, due to fragmentation and complex nature of the construction industry IT procurement has taken back stage in modern construction organizations resulting in unsatisfactory selection of IT procurement options. Through a comprehensive construction industry survey, Perera et.al, [9] identifies the adverse effects of poor IT procurement and consequent hesitation in investment on IT. This places emphasis on the need for formal guidance to assist in the decision-making process. The aim of this research was focused at the development of a IT Procurement model and implement it as a Decision Support System for construction industry organizations.

The approach was to identify and review industry practices and synthesize it with theoretical considerations. The technique of value matrices was used to identify best value procurement route. The data extracted from industry surveys and case studies were then modeled using object oriented techniques allowing users to make intelligent and informed decisions on available procurement routes. The model designed was also tested with real life IT procurement scenarios and then subjected to an expert evaluation to identify necessary improvements. Finally, the evaluated model was successfully enhanced into a Decision Support System to provide a user-friendly guide for IT procurement in construction organizations. The system and expert evaluations clearly revealed the superiority of the model and its greater industry relevance.

IT procurement model (and DSS) was designed to help understand procedures, merits and demerits of prevailing procurement methods for which IT investment can be directed. It is modeled using object oriented development methodology, developed using a relational database system and operates in a menu driven mode. Microsoft Access for databases and Java (Net Beans IDE 3.6) for system interfaces were used as development tools for the DSS.

The research makes a significant contribution in developing a knowledge base for IT procurement that facilitates the selection of best valued IT procurement option. The model serves as a knowledge repository and its object oriented nature allows it to be expanded to incorporate procurement experiences from the construction industry and to be further developed as a generic model for IT procurement. The research addressed the key issue of providing a value based framework for evaluating and selecting IT procurement options.

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Knowledge-based Material Cost Control for Building Construction Project using Expert System Approach

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Abstract

Poor project monitoring and control process has been identified as one of the main reasons for construction projects not achieving project cost objectives. Other factors contribute to this condition include: lack of documentation on project lessons learned, not optimum in adopting information technology, and a long process in making decisions. Documentation of lessons learned corrective actions can help project team in identifying various project risks. It is an important feedback in the effort to achieve better project performances, to prevent occurrences of specific risks or to prepare responses to such risks. This paper discusses the development of knowledge-based corrective actions related to controlling project material cost, which includes identifying the impacts, the causes and corrective actions. A survey on various high rise building projects was selected as the research method, and structured interviews with experts on such projects was used as data collecting method. Probability matrix, statistic and simulation were used to analyse the data, and expert system was used to develop decision support system based on cost control theory and practices. The results of the research show that there are four cost performance indicators, fifty eight impacts with fifty seven causes of risks for developing knowledge based lessons learned corrective action which provides about one hundred and fourteen corrective actions

Keywords: Knowledge base, cost control, lessons learned

1. Introduction

Construction industry is highly competitive industry. To win a construction projects, many construction companies have to work with small profit margin. Many construction companies fail to get profit from their projects because of their lack of capability in developing strategy that based on effective management system [1]. This condition typically caused by limited capabilities of project personnel, which resulted in ineffective project control. For that reason, the focus of project control in most developing countries is in project cost rather than time and quality [2]. In developing countries such as Indonesia, construction project failures are caused by [3]:

- Poor monitoring and control
- Lack of documentation on project lessons learned
- Not adaptive to information technology development
- Delayed and mistakes in decision making

There are also constraints that are faced by construction companies which are caused by internal as well as external factors. These factors are considered as sources of risk that potentially resulted in cost overrun [4]. Cost overrun in construction projects in Indonesia is typically caused by poor weather condition forecast, increased material cost due to inflation, increased labour cost, and lack or project experience [5]. A good coordination among project stakeholders using a good control system tool is needed in order to achieve required project performances [6].

There are several variables that need to be controlled in order to control project cost, which include: labours, materials, equipment, subcontract and field overhead [7, 8]. Sufficient data, particularly in material costs, is required to have effective monitoring and evaluation process. To support this, a good control system tools is needed.

Improvement in construction process is required in order to have a better quality performance management. This improvement should consider factors that directly influence the quality of construction process, particularly those that are related to documenting lessons learned, management techniques and technology used [9]. Many cost control techniques using software project management system have been developed and used to support project cost control process. However, is yet to provide optimum solution, in particular to support anticipating cost overrun. Therefore, a development of a decision support system tools using an expert system approach for corrective action in controlling project cost would be very beneficial, which in the end could improve quality performance management.

Base on the above problems description, the purpose of this paper is to discuss the development of a decision support system for project material cost control based on expert system approach as well as cost control theory and practices. To develop such system, it starts with identification of source of risks that cause cost overrun, then continued with the identification of appropriate lessons learned corrective actions.

2. Research method

To achieve the research aim, the following approach has been adopted:

- Secondary data collection was based on completed project report. Primary data was collected using questionnaire surveys and structured interview to different experts and experience project personnel.

- Data was analysed using Delphi method, risk assessment techniques, and statistical analyses. These analyses have provided various knowledge that were stored in knowledge based system. Risk analysis was used to assess related risk level for specified source of risks. Correlation analysis was used to identify various sources of risks, which have been assessed to have negative correlation with project cost performance. The Delphi method was used to select recommended corrective actions based on the specific source of risks. Regression analysis was then used to perform simulation which assessed the relation between the selected corrective actions and project cost performance. This process has resulted in preliminary conclusions which were used as input for the succeeding steps.

- Using an inference engine, a knowledge structure was then developed and converted into computer language.

- The knowledge based system was further developed using a scenario decision flow diagram, which considered various conditions that are related to decision making process. This scenario was used as the basis for developing subsequent decision flow diagrams. Dependency diagram and logic diagram were used in developing the knowledge structure.

- The validation of expert system application was done to compare the results with the opinion of experts.

3. Research results

3.1 Relationship between costs overrun indicators with events and causes in project cost control

Knowledgebase for project cost control process are based on relationships between cost overrun indicators with events and causes. In the initial stage of the research, these relationships were grouped into related project cost components. Table 1 shows the number of knowledgebase indicators as well as their related events and causes.

Project material cost has four indicators, which are purchasing cost, transportation cost, storage cost and excess (waste) material cost [10, 11, 12, 13]. Survey and interview with construction experts have identified 58 events that influence these cost overrun indicators. The four cost overrun indicators and their fifty eight events makeup 225 relationships. The numbers of events that influence each cost indicators are as follows:

- Purchasing cost 57 events (98%)

- Transportation cost, 57 events (98%)

- Storage cost 54 events (93%)
- Excess (waste) material cost 57 events (98%)

Table 1 Number of Knowledgebase Cost Overrun Indicators, Event and Causes

Project cost component	Cost overrun indicators	# Event	# Causes
Equipment	5	67	52
Materials	4	58	57
Manpower	4	48	70
Subcontractor	4	31	48
Overhead	4	52	43
Total	21	256	270

Literature survey and expert interviews have identified 57 causes of project material cost overrun, which can be grouped into ten as follows: planning & scheduling (12.3%); organization & key personnel (15.8%); purchasing (12.3%); transportation (7%); QA/QC (1.8%); storage (10.5%); usage (12.3%); change order (7%); monitoring & control (10.5%); and external factors (10.5%).

The 58 events and 57 causes make up complex relationships. The results of the analysis indicated that there are eleven events and their related causes which influence the cost overrun the most. Table 2 lists the eleven dominant events and their related causes.

Table 2 - The dominant events and related causes in project material cost overrun indicators

Event	Causes	
1. Delay in project completion	- planning & scheduling related - purchasing related - usage - monitoring & control	- organisation & key personnel - transportation related - change order - external factors
2. Material shortage during construction	- planning & scheduling related - storage	- transportation related - usage
3. increased material purchasing cost	- planning & scheduling related - usage - transportation related	- purchasing related - QA/QC
4. reworks	- planning & scheduling related - purchasing related - usage - monitoring & control	- organisation & key personnel - QA/QC - change order - external factors
5. excess materials	- planning & scheduling related - transportation related - usage	- purchasing related - storage - external factors
6. delay in procurement	- organisation & key personnel	- purchasing related

7. mistake in work execution	- organisation & key personnel - monitoring & control	- change order
8. delay in work	- purchasing related - QA/QC - usage - monitoring & control	- transportation related - storage - change order
9. increased material procurement cost	- purchasing related - storage - change order	- transportation related - usage
10. delay in delivering material to site	- purchasing related - external factors	- transportation related
11. increased damaged materials	- storage - change order	- usage - external factors

Further assessment using qualitative risk analysis has provided information on the complexity of the relationship between cost overrun indicators and events, as well as between events and their causes. Cost overrun on project materials which is caused by change order, for example, has 11 sources of risks.

The sources of risks that cause the most events on material cost overrun are purchasing and material usage. Eight events that have the most influence on material cost overrun, which are related to purchasing are:

- Project delay which is caused mostly by schedule variance and materials are purchased not in accordance to specifications & requirements,
- Increased material costs which is caused mostly by delay in purchasing and poor strategy in selecting sellers
- Change orders and excess materials which are mostly due to materials that are purchased not in accordance to specifications & requirements
- Delay in material procurement which is caused mostly by shortage in the market, change in materials sources that are related to project location, delay in payment, and delay in purchasing
- Delay in project works execution which is mostly due to shortage of materials in the market, change in materials sources that are related to project location, delay in payment, and delay in purchasing
- Increased procurement cost which is caused mostly by shortage of supply in the market
- Delay in delivery of materials to project site which is mostly due to poor strategy in selecting sellers

Seven events that have the most influence on material cost overrun which are related to material usage are:

- Delay in project completion which is mostly due to repairs or reworks
- Shortage of materials during construction which is caused mostly by excess materials onsite, reworks and inefficient works
- Reworks which are mostly caused by mistakes in material use
- Excess materials that are mostly caused by inefficient usage and materials movements of materials on site, poor understanding of site characteristics, insufficient equipment for mobilisation, and mistakes in materials usage.
- Delay in works execution which is due mostly to poor understanding of site characteristics and insufficient equipment for mobilisation
- Increase in procurement cost which is caused mostly by inefficient usage and materials movements of materials on site, reworks, mistakes in materials usage, poor understanding of site characteristics, insufficient equipment for mobilisation, and mistakes in materials usage.
- Increase in defective/damage materials which are caused by inefficient materials movements of materials on site, poor understanding of site characteristics, insufficient equipment for mobilisation, and mistakes in materials usage

The cost overruns indicators that are influenced by the above events are purchasing costs, storage costs, and excess material cost.

The main objective of material cost control is to have required materials as scheduled. It is an important and integrated part of materials management. The important steps in implementing materials control are planning, executing, monitoring, analysing performance, evaluating variance and developing necessary corrective actions [14]. There is a need to plan the necessary corrective actions to anticipate the events that can cause material cost overruns.

3.2 Relationship between cost overran indicators with event, causes and corrective actions in project cost control

The second stage of the research is aimed to identify appropriate lessons-learned corrective actions related to sources and events of the cost overrun as discussed in the previous section. This part of the research provides relationship patterns for: indicators-event; event-causes; and causes-corrective actions. Table 3 shows the grouping of these relationships.

Table 3 Number of knowledge base groups for Project Cost Control

Project cost Component	#indicators	#events	#causes	#corrective
Equipment	5	67	52	104
Materials	4	58	57	114
Manpower	4	48	70	149
Subcontractor	4	31	48	94
Overhead	4	52	43	120
Total	21	256	270	581

For project cost materials overruns, there are 114 recommended corrective actions that are related to the 58 events and their 57 causes. Good understanding and experiences are needed to provide recommended corrective actions that are appropriate for a particular cause of cost overrun.

The relationship of indicator-event, event-causes, and causes-corrective actions can be summarised as shown in Figure1. It is a complex network which requires a decision making tools that can identify the most appropriate corrective action for any cost overrun problem.

Figure 1 shows the integration of the relationships between indicator-event, event-causes and causes-corrective actions. The first level, which is the highest level of the network, is the four cost overrun indicators: purchasing cost, transportation cost, storage cost, and excess (waste) material cost. The second level is the events, the third level is the causes, and the fourth, which is the lowest level of the network, is the corrective actions.

An example of the relationship as follows: there is a cost overrun on purchasing cost (I1) as a result of the event number three (E3). This event is caused by the causes number twenty one (C21). To rectify this problem, the corrective actions number two and five (CA2 & CA5) are recommended to be performed. The interesting thing here is that by performing CA2 & CA5, they do not only solve the I1 problem but may also solve, for example, I2 (transportation cost) and I3 (storage cost). This is possible because, for example, C21 is also related to I2 and I3. These relationships make a complex network which requires a computer application to provide effective problem identification and decision making in selecting appropriate corrective actions.

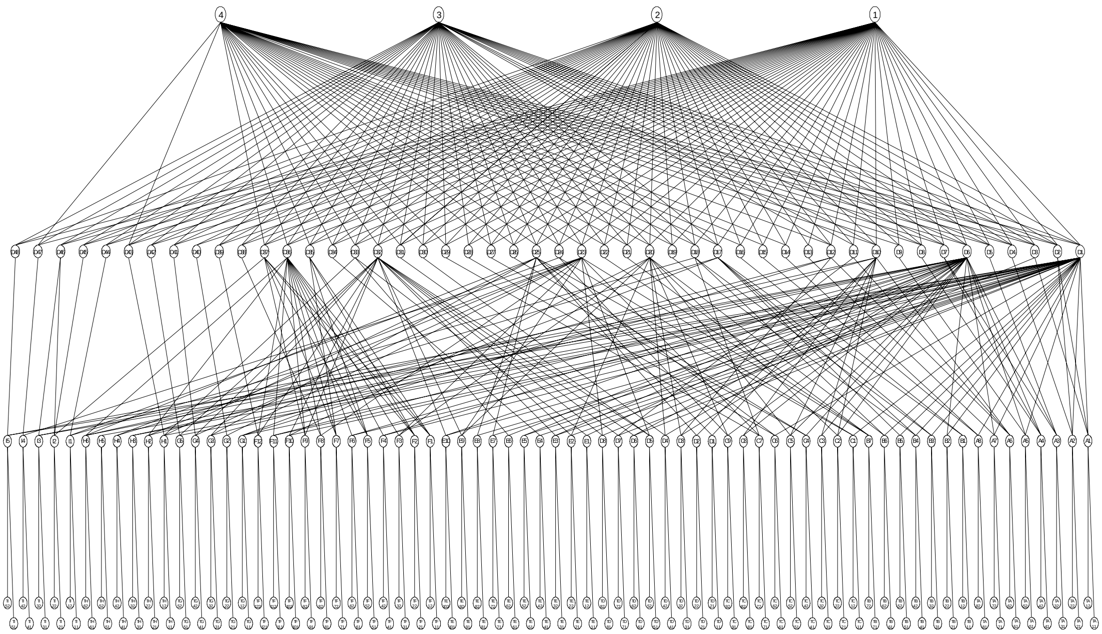

Figure 1 Relationship pattern indicators-event-causes-corrective action in Project Material cost control

From the 114 recommended corrective actions for project materials cost control, almost 90% of them tend to be preventive in nature. They are more likely lessons-learned corrective actions as they are used to prevent the similar events from happening. As an illustration, in planning & scheduling related events, materials are purchased way before they are needed which is caused by inaccuracy in materials scheduling. The recommended corrective action is for supervisor to review planning document before works execution. Another example: delay in decision (organisation & key personnel related events), which is caused by lack of support from head office, the recommended corrective action is to apply appropriate procedure.

3.3 Decision Support System Program

The use of decision support system (DSS) in selecting corrective actions can improve the effectiveness and efficiency in getting recommended corrective actions that lead to better project cost performances. The DSS developed in this research follows the algorithm as shown in Figure2.

The program starts with an introduction that explains what the program is all about and instructions to use the program. The second sub-model defines the project information, such as project type, contract type and contract value. The third sub-model consists of two modes of process, i.e. lessons learned mode and DSS mode. The fourth sub-model provides report of the process results. C++ has been used in developing the program.

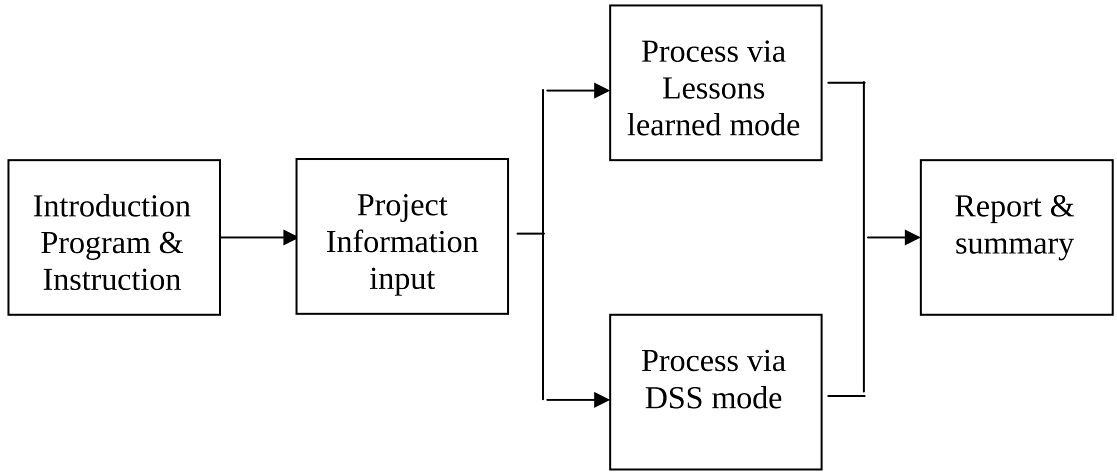

Figure 2 Algorithm for DSS Program

The validation of the program was done by conducting several trials to construction experts. These experts were asked to assess the program and the results it provides. The assessment used in the validation include: completeness of knowledgebase system, speed, user friendliness, accuracy of the results, and level of application. Most of the experts involved in the validation gave good assessments for the program. They also suggested that an improvement in design can make the program more attractive.

4. Conclusions

The paper discusses the development of a decision support system for project material cost control based on expert system approach, cost control theory and practices. In the first step of the development four cost overrun indicators have been identified. Those indicators are purchasing, transportation, storage and excess material costs. The four cost-overrun indicators have fifty eight events and fifty seven causes. To rectify these costs overrun, one hundred and fourteen corrective actions have been recommended by high-rise building construction project experts.

Relationships between cost overruns-events and events-causes are complex. The combinations of these relationships require effective and efficient corrective actions that can lead to improve project cost performances. It is very significant to document those relationships as part of project cost control system. Those relationships make up a basis for a good knowledgebase to select corrective actions The use of DSS program can support the selection of effective and efficient corrective actions.

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Virtualisation of disaster recovery centres

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Abstract

Governments, NGOs and International organisations must work together and contribute towards strategic disaster recovery planning process of countries [9]. Emergency management plans should be in place and tested fully well ahead of any adverse situations. Quantification of probable risks and preparedness can save time, costs and most valuably, lives in the disaster response and recovery effort. ICT system infrastructures play a significant role [15] in connecting various experts at disaster recovery centres around the world in a tactical environment. Virtualisation [8] of disaster recovery centres can provide high availability and efficient system deployment strategy for any emergency management plan. This paper proposes a systematic virtualised infrastructure and associated tools for the operation of disaster recovery centres by capitalising the state-of-the-art for leveraging its use.

Keywords: Disaster recovery centres, Virtual Data Services, Virtualisation technology, ICT infrastructure

1. Introduction

Finding a sustainable solution for facing disasters

Eliminating disasters cannot be achieved under most circumstances. Therefore efficient warning systems and preparedness at all levels must be established to minimise the aftermath. Based on the damage to the existing communication infrastructure the recovery process could be an overwhelming task. Due to collapse communication centres, antennas, power and mobile networks, transportation infrastructures, etc. recovery teams may not be able to reach the helpless. People could not survive without adequate basic needs for more than a few days or hours based on their health condition. It is clear that for recovery teams the time is the most important factor for reaching individuals affected. This is with the assumption that the recovery teams can accommodate all the necessary equipment, food, etc. in time when they reach individuals for salvation. Due to a number of reasons adequate quantities of such materials may not be able to be transported where required. With the experience of recent disasters around the world governments, organisations and researchers are aggressively seeking solutions for various aspects involved to find more sustainable solutions for facing future disasters.

Researchers are concentrating on finding the most appropriate solutions for various matters that are associated with disasters; natural or manmade. Firstly it is important to provide sufficient lead time as well as appropriate guidance based on the expected impact from the disaster in concern so that people and rescue teams take adequate precautions to minimise damage. This can be achieved by audible warnings [10], visual extrapolation of impending disaster, etc. after the disaster has been detected by the equipment and sensory devices and experts have completed the primary risk analysis of perhaps the inevitable. Such warning signals generated by the devices can be received by the disaster recovery centres through satellite networks or through global mobile network base stations via dedicated emergency channels established for such communications. Secondly after the disaster, it is vital to locate the affected people /communities for providing the required emergency assistance. Although many could assume that people can communicate for requesting emergency rescue services based on the level of disaster and the inadequate sophistication of available communication infrastructures this may not be possible. Vice versa, rescue teams and authorities (local or international) may not be able to locate or reach helpless people within an acceptable time frame. Inefficiencies of global diplomatic protocols [9] also may have an adverse effect on this matter. Standard mobile handsets are not designed to utilise the satellite communication network directly therefore they should communicate to a nearest base station and establish a connection for reaching other destinations. Lack of functioning mobile communication towers, base stations and telecommunication networks can isolate people under disaster conditions. Similarly lack of power networks can jeopardise reaching people through radio, TV, etc receives for information dissemination or provision of related advice. Specialised /switchable satellite networks that can reach ordinary mobile handsets, ample of portable GIS handsets to access detail imagery of the disaster area and globally funded automated disaster detection and recovery infrastructure armed with specialised teams that can reach any part of the world without a delay (E.g. political barriers) are some sustainable solutions for solving these matters. Finally provision of disaster relief during the most difficult period and thereafter continuing support until the civilisation recovers from the tragedy needs to be thought ahead and acted upon spontaneously until an adequate momentum of recovery to a reasonable expectation can be achieved. With the assumption that some local authorities have access to satellite phones and organisational specific wireless communication hubs it would be possible to create ad-hoc networks for people to make emergency communication via these hubs [1]. While current generation mobile handsets are capable of switching between up to four bands to accommodate various continental standards the future mobile handsets can be designed with the capability of switching into such universally accepted emergency bands via ad-hock networks.

This paper proposes a Virtualised [8] Disaster Recovery Centre (VDRC) that could be mobilised into the danger zone to assist the field workers and experts. The infrastructure proposed is built on the state-of-the-art services available to maximise their use. Recent knowledge created by European projects, Federal Emergency Management Agency (FEMA) [6] of the United States as well as research and industry contributions from experimental virtual emergency operations centre established by Telematics Lab at Simon Fraser University [7], SAR Technology [11], SAHANA Project initiated by the Sri Lankan Boxing Day tsunami [15][16], etc. drive defining the proposed infrastructure. While staff from the VDRC directly advise teams (ground, water, air based or tactical analysers) on recovery process, it captures information for mass delivery to the external parties and other VDRC's for constructive analysis. Experts around the world and staff from other centres can lively assist many scattered recovery teams with more informed manner from information received through VDRCs of the live condition. The writing is divided into three sections to expand the virtualised disaster recovery centre infrastructure proposed for emergency situations which follows onto a brief in further development works.

- Design of a system architecture for robust deployment
- Establishment of a broadband wireless communication and/or satellite system
- Provision of software services required for assisting the field workers through virtualised disaster recovery centres
- Further developments of the implementation strategy

2. Design of a system architecture for robust deployment

There are many ongoing global and continental initiatives with established infrastructures for Earth Observation (EO) focussed of meteorology, security, strategic incident management, etc. applications. World Meteorological Organisation (WMO) realised the inadequacies of the Global Telecommunication System (GTS) and its inability to address global issues and concerns in the early part of this decade. It promoted the requirement of countries within every continent to work together to collate and capture necessary EO data with a mutual effort for satisfying such matters. The definition of Future WMO Information System (FWIS) was created with the focus to disseminate the requirement of a single coordinated effort at an international level by the WMO in 2003.

The demonstration of Virtual Global Information Systems Centre (V-GISC) was considered a successful attempt to establish this definition using the SIMDAT technology. SIMDAT European Project has developed required protocols, knowledge and common infrastructure for the collection and sharing of distributed meteorological data among five dispersed organisations as a demonstrator [12]. The national weather services of France, Germany and the UK, the European Centre for Medium-Range Weather Forecasts (ECMWF) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) have been working together for this invaluable outcome. The inefficiencies, incompatibilities and redundancies of the previously developed multitude of ICT infrastructures of many countries are now possible to streamline by adhering this outcome; V-GISC that will be at production level by 2008. Capitalising on these and other findings figure 1 describes the virtual data service architecture of VDRC.

Each VDRC is to be linked with other VDRCs and similar data provisioning centres via Dedicated Data Communication Infrastructure (DDCI) as briefed previously. Services are created based on the local and external resources from various sites. As figured some Global Services / Resources (GS/R) are directly linked with the related local resources while others linked to resources from other centres. The centres responsible for the provision of services are also in charge for altering the portal service for corresponding services, managing and maintaining of data gathering and cleaning process related to service provision, synchronisation of catalogue updates to other centres, etc. The resource pool is labelled as Virtual Data Services (VDS) in the figure. This VDS architecture is common for all the VDRCs and the services available are accessible via the Virtual Global Portal (VGP) by its users. The experts who advise planning and recovery teams, data and resource managers and VDRC staff are among the users of this infrastructure. Construction of the portal and its operation is detailed later.

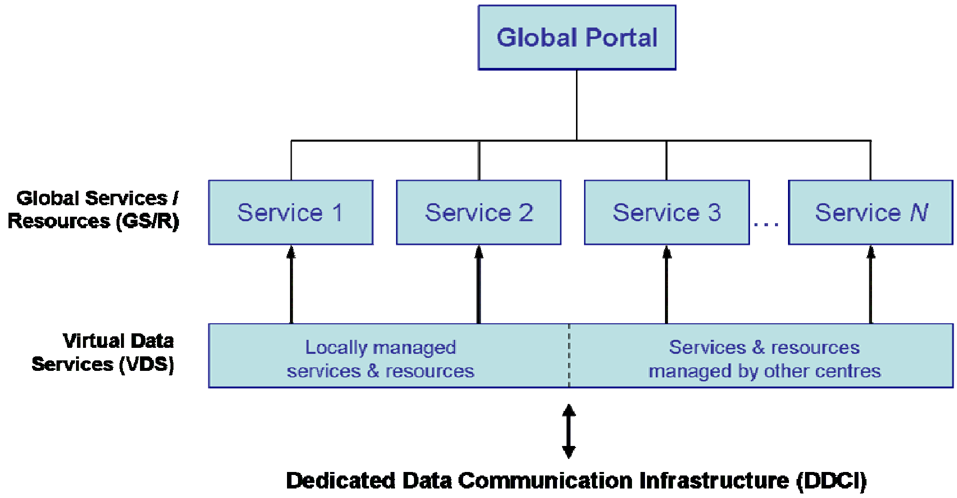

Figure 1: Virtual data services architecture

Centralisation of databases is not considered appropriate due to the sheer size of each database involved. Different VDRCs are responsible managing and maintaining of the related database resources and appropriate services based on the centre resources. However it is noted that very large databases hosted at multiple of distance sites may give adversary effect on user interrogation of services. A synchronised version of a distributed data catalogue, a synchronised global portal service and the local replication of necessary resources are used to provide prompt services to users. Figure 2 details components of proposed architecture.

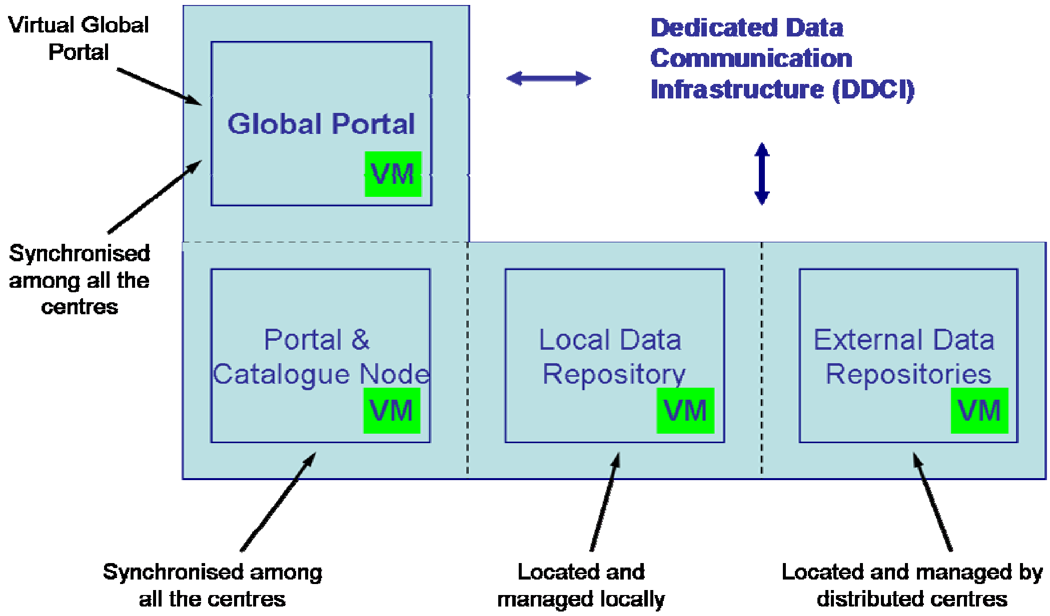

Figure 2: Component synchronisation and virtualisation

The portal and catalogue services are fully synchronised with other sites while some data repositories held locally and others dispersed within distributed centres. More importantly Virtual Machine (VM) architecture is employed to virtualise the complete disaster recovery centre infrastructure for achieving the necessary characteristics and robustness [8]. This is noted in the figure and expanded view of these components is to follow.

Virtual Global Portal

Users interrogate services via the virtual global portal. The service providers may alter this portal as needed and the synchronisation offer users with the same look and feel, streamlined functionality regardless of users' location. User authentication, security and access rights are controlled with the virtual DMZ engaged. As a first point of reference user queries and searchers are to be carried out among the synchronised catalogue VM. The system is to fetch necessary data items from the Local DR and/or External DR for displaying it to the user. Data communication within and among VDRCs are achieved by use of virtual networking where relevant. Some of this functionality is not detailed here due to lack of space.

Virtual Data Services

VDS is comprised of two parts; local data repository and external data repository. In the most circumstances data gathering process is linked with very specialise technological infrastructures that may be very expensive and somewhat complex to discuss here. Each VDRC is focussed of gathering some specialised disaster and recovery related data based on the equipment and expertise it hold. Colleted and cleaned data are saved in the data repositories (Local DR) where suitable services are created for sharing and utilisation purpose. While cataloguing of data and services available is managed within each centre the catalogue is synchronised among all the VDRCs for efficient access to services offered for their distributed users. Partial or full replication of some data repositories at the local level (Local DR) is also considered for providing the efficient service. This is very important if an External DR become unavailable for some reason such as loss of communication with that particular centre. Under this situation such

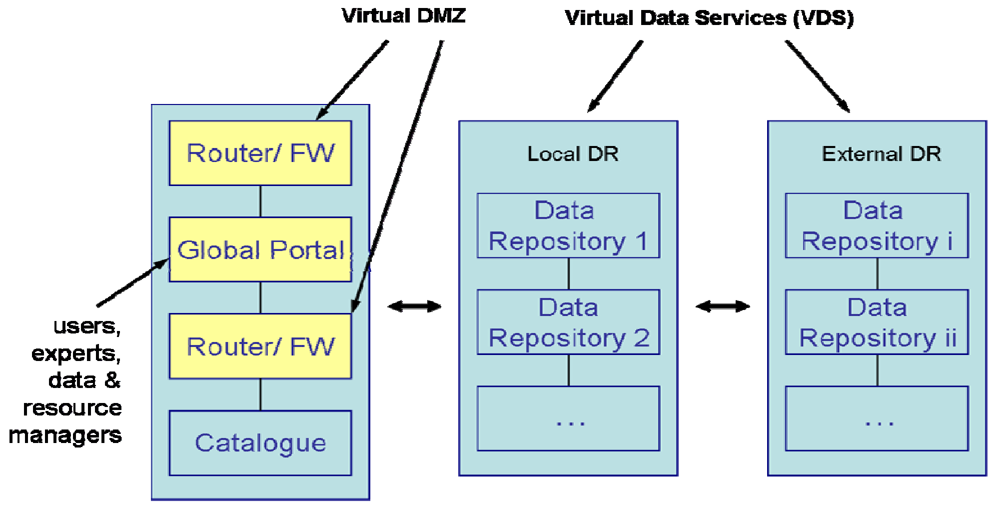

Figure 3: Virtual global portal linking VDS

Local DR could become available even for other centres. However maintenance of such data repositories could impinge on the available bandwidth adversely as replicated repositories are required to be kept current. The Virtual Global Portal links the VDS for providing services available to VDRC users as in figure 3 above. Many Local DRs are hosted and maintained as needed for efficient operation. The External DR in the figure is the consolidated view of the other data repositories available from many VDRCs.

3. Establishment of a broadband wireless communication and/or satellite system

There are many satellite based global broadcast systems (E.g. GEONETCast, EUMETCast) available for receiving the necessary data for disaster recovery process. The area of coverage may be important in some situations where the service may not be available globally. GEONETCast global data exchange program as introduced in November 2006 combines effort of FengyunCast (Asia-Pacific), GEONETCast Americas and EUMETCast (Europe-Africa) by provisioning interoperability between services offered to global communities for various applications. This is a continuing effort inspired by the 10 year implementation plan that was put forward and endorsed at the third Earth Observation Summit held in Brussels in February 2005 to create a Global Earth Observation System of Systems (GEOSS) as an essential step to undertake by a global community of nationals and intergovernmental, international and regional organisations. Dealing with disasters is high in the agenda of creating GEOSS.

> 'Disaster losses can be reduced through observations relating to hazards such as: wildland fires; volcanic eruptions; earthquakes; tsunamis; subsidence; landslides; avalanches; ice; floods; extreme weather; and pollution events. GEOSS implementation will bring a more timely dissemination of information through better coordinated systems for monitoring, predicting, risk assessment, early warning, mitigating, and responding to hazards at local, national, regional, and global levels.' [14]

NOAA Satellite and Information Service provides the user community of environmental satellite data and various products. These include analyses, blended products from polar orbiting and geostationary satellites, and interpretive services. The products and services are distributed to a diverse user community for a broad range of environmental applications [13]. This Satellite Services Division maintains an operational satellite data distribution network providing user access to real-time or near real-time environmental data and information that are suitable for disaster recovery activities.

EUMETCast is a product of EUMETSAT's Broadcast System for Environmental Data that is a multi-service dissemination system based on standard Digital Video Broadcast (DVB) technology. EUMETCast uses commercial telecommunication geostationary satellites to multicast data files and other products to a wide user community and it is the EUMETSAT contribution to GEONETCast [4]. EUMETSAT website, www.eumetsat.int provides the technical documents with details on reception station setup, programs and tools required, etc. for receiving the data from broadcast [3]. The establishment of broadband wireless communication infrastructure for VDRC is based on these and similar services offered by various global organisations.

4. Provision of software services required for assisting the field workers through virtualised disaster recovery centres

Provision of software services (GS/R) to operate the VDRC is partly based on the local and external data resources (VDS) the centres are willing to create and maintain for collaborative use. On the other part these software services must be capable of assisting the field workers carrying out their effort to engage with the disaster situation for helping the helpless. It should be noted that these services should also maintain the well-being of all the field workers and analysts involved for reaching and saving the helpless in a time critical manner.

The system architecture described in the section 2 requires the software environment to be virtualised using a suitable Virtualisation Technology (VT) [8]. The software available via SIMDAT European Project is suitable for virtualisation and provides some of the functionalities described here. This binary repository is available through the European Centre for Medium-Range Weather Forecasts website [2]. Federal Emergency Management Agency recently released IRIS V2.0 software [6] suitable for incident management applications. The National Incident Management System - Incident Resource Inventory System (NIMS-IRIS) software is designed for assisting the emergency response communities. The current version provides a basic database management tool for community's to manage 120 typed resources, which is suitable for sharing among other VDRCs by establishing as a parent host within one of the identified VDRCs. Future system functionality is expected to assist in placing and mobilising resource requests, GPS tracking of resources, and resource recovery. Since FEMA’s incident management focus is extensive; to capture different kinds of disasters, to support the recovery effort in a streamlined coherent facilitation within a large continent and nevertheless be able to secure ample resources for such developmental work than any other agency this tool captures, integrates and facilitates many disaster incident management situations. The vision for providing this tool at no cost for a wider community use is documented by FEMA as below.

> ‘The National Incident Management System provides a systematic, proactive approach guiding departments and agencies at all levels of government, the private sector, and nongovernmental organisations to work seamlessly to prepare for, prevent, respond to, recover from, and mitigate the effects of incidents, regardless of cause, size, location, or complexity, in order to reduce the loss of life, property, and harm to the environment. [5]

'Incident Commander Pro' Software developed by SAR Technology for Search, Rescue and Emergency Response is built upon the NIMS Incident Command System and provides a comprehensive set of Command, Operations, Planning and Logistic functions to manage every type of emergency response mission. It has features that are tightly integrated and tested by field workers to provide a fast and flexible response to every aspect of the recovery mission [11]. Versions of this software are available from http://sartechnology.ca, SAR Technology repositories for downloading.

5. Further developments

The components described in figures 2 and 3 were considered for integrating into a unique single VM infrastructure with the focus of targeting a simplified evaluation of the VDRC technology. Hence VGP, VDS and Catalogue node services are integrated to achieve an efficient decentralisation [2] of these services among many VDRCs with ease. The VMs in operation at VDRCs are connected securely for automated repository and catalogue updates. While each centre manages their own user base and related access policies within the node the single sign on allows users to access other centres based on the negotiations between VDRCs. Therefore with the engagement of an appropriate networking technology to connect VDRCs the users are able to receive required information via the VGP through the established VDS. The integration of this infrastructure with the other software services described in section 4 that also operates within VM environments are to be considered for establishing a baseline infrastructure for the future VDRCs. The results of such work, improvements to the system architecture and updates of the global communication infrastructure will be published in the future.

6. Conclusion

The proposed system, infrastructure and software tools that are described in this paper takes the disaster recovery process another step forward under different circumstances. It is envisaged to pilot this proposal for refining the baseline architecture suitable for ad-hock deployment in the near future. The VDRC infrastructure described which combines the above features while supporting an innovative capacity for dynamic integration of such tools within the given volatile environment. The VT allows the ability to mix and match variety of softwares and systems together that facilitate the disaster recovery effort. While the recovery communities and organisations may not have adequate resources to develop their own tools, softwares and infrastructures for this purpose it becomes very important to move with the latest global developments and capitalise on the state-of-the-art.

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Introduction of a model for pre-qualification of contractors based on the Fuzzy Topsis method

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Abstract

The aim of this paper is to introduce a model for pre-qualification of contractors in construction projects. In the recent years huge funds has been wasted due to the inappropriate selection of contractors for the construction projects. So, the appropriate selection of the qualified contractors is one of the most important strategies in such projects. However the nature of such decision making is sophisticated. Several quantitative and qualitative factors can be employed in the assessment procedure. The assessment of Iran construction codes shows that the most important criteria in construction contractors pre-qualification are experience, quality & safety, current projects, resources and company repetitions. In the present paper the language terms will be used in contractors' evaluation. These language terms are including triangular and trapezoidal fuzzy numbers. After that, a multi criteria decision making system based on the fuzzy set theory is introduced in order to clarifying the ranks of the contractors due to their qualification. In the proposed method, after determining the fuzzy weight of each criterion using Buckley method, the fuzzy topsis method is used for ranking the contractors due to their qualification. Finally the proposed model is assessed using a numerical example and sensitivity analysis has been done.

Keywords: Pre-qualification, Fuzzy Topsis method, Fuzzy Set, Multi Criteria Decision Making

1. Introduction

Contractors play a significant role in construction projects. So it can be concluded that the contractor selection is the most important decision made by the project owners. The contractor selection process has significant risks for the project owners; consequently they try to reduce these risks [1].

In the recent years, several problems encountered in the construction projects which cause wasting of huge funds. The collected statistics shows that near 10% of these problems is due to the low qualification of construction contractors [2]. Hence, introducing a procedure to solve

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such problems has its place in the owners' point of view. Firstly, the contractor selection was based on the lowest proposed price which causes some problems during the project performance. To solve the mentioned problem, the owners need a filter to prevent unqualified contractors to participate in the tender [3]. In the present paper a fuzzy method will be introduced to determine the qualification level of each contractor. After determining the fuzzy weights of criteria, the closeness coefficient for each contractor will be obtained and finally based on the owner idea limited number of qualified contractors will be invited to participate in the tender. Applying the mentioned method, assures the owner certain on the contractor's qualification and the breakage risk of the projects becomes lower.

2. Literature Review

The tender competition has a long history in the U.S.A. Hatush shows that this system has been employed in New York State since 1847. The main employment of this method was in highways and bridges tenders [4].

The main idea of this method was that awarding the tender with the minimum price, saves the public sector from the corruption and other unacceptable events. The initial demand for this system was to make owners certain on the project utilization and benefit with the minimum construction costs.

Some changes has made in this system during years. A division for proposal acceptability selection and the public tend to control the tender winner's capability has been added to the system. There were some improving elements including preparation of a list of qualified contractors and other factors in this area. Although the main idea has been remained unchanged since 19th century, but all countries do not accept the minimum price as the contract awarded [5].

Few countries including Italy, Portugal and Peru have chosen a system in which the best proposal is not necessarily the minimum financial proposal. The main philosophy used in this system is that the best proposal is the most acceptable one, not the one with the minimum price. The most acceptable proposal is near to the average price of received proposals [6].

This kind of tender's procedure has some disadvantages which influences its efficiency. Although this procedure saves the project from any political, financial and public pressures, as the decision making parameter is the proposed price it may cause some problems in time, quality and safety of project. So the multi parametric tender system has been proposed which considers other intervening parameters more than the construction costs. In the new system it is believed that the project can be completed with the highest quality if the contractor has an appropriate combination of all parameters. So the multi parametric procedure has been used in prequalification of contractors. This problem has been used in different cases by researchers. Diekmann used the multi properties applications method in a case study about contractor selection and evaluation in Cost-Plus contracts [7]. Nguyen used the fuzzy set theory in contractors evaluation based on some decision making parameters [8].

The most important person performing lots of activities in this field is J. S. Russel. Russel and his colleagues prepared a program named Qualifier-1 in 1990 which was produced from a linear model of weight factors created by the user. This program calculates the weight ratio of each contractor and each contractor's rank. Due to the systematic nature, this program is an appropriate device available for users to produce their own model considering the specific conditions. He also produced the Qualifier-2 software which is a model based on expert systems to select the appropriate proposal [9].

3. Fuzzy Set Theory

Fuzzy set theory, to treat fuzziness in data, was proposed by Zadeh in 1965. In Fuzzy set theory the membership grade can be taken as a value intermediate between 0 and 1 although in the normal case of set theory membership the grade can be taken only as 0 or 1.The function of the membership grade is called its "membership function" in Fuzzy theory. The membership function will be defined by the user in consideration of the fuzziness. In remote sensing it is often not easy to delineate the boundary between two different classes. In such cases as unclear defined class boundaries, Fuzzy set theory can be usefully applied, in a qualitative sense [10].

For the initial familiarization with fuzzy set theory some essential concepts and definitions should be mentioned. [11]

3.1. Definition of fuzzy sets: it is assumed that X is the classic set of possible space and its members are shown by x. Membership in a fuzzy subset of X is shown by μ_A identification function from X to [0,1], so that:

$\tilde{A} = \{(x, \mu_{\tilde{A}}(x)) \mid x \in X\}$	(1)

3.2. Definition: the $\tilde{A}$ fuzzy set will be convex if and only if for each x_1 and x_2 members of X:

$\mu_{\tilde{A}}(\lambda x_1 + (1-\lambda)x_2) \geq Min(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2))$	(2)

3.3. Definition: the $\tilde{A}$ fuzzy set will be normal if and only if there is one x_i member of X for which we will have:

$\mu(x_i) = 1$	(3)

3.4. Definition: the $\tilde{A}$ fuzzy set which has been defined in the $\tilde{X}$ universal set will be named $\tilde{A}$ fuzzy number.

3.5. Definition: the cutting section set from the $\widetilde{A}$ fuzzy set is a non-fuzzy subset of X and is defined as following:

$A = \{x \mid \mu_{\widetilde{A}}(x) \geq \alpha, x \in A\}$	(4)

3.6. Definition: A trapezoidal and triangular fuzzy number $\widetilde{A}$ are shown as $\widetilde{A} = (a_1, a_2, a_3, a_4)$ and $\widetilde{A} = (a_1, a_2, a_3)$.Their shapes come below:

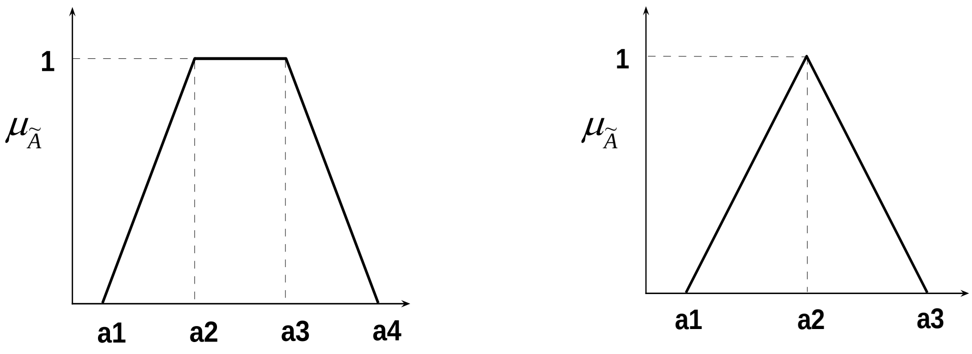

Figure1. Trapezoidal and triangular Fuzzy Numbers

If $\widetilde{A}=(a_1,b_1,c_1,d_1)$ and $\widetilde{B}=(a_2,b_2,c_2,d_2)$ then:

$\widetilde{A} + \widetilde{B} = (a_1 + a_2, b_1 + b_2, c_1 + c_2, d_1 + d_2)$	(5)
$\widetilde{A} - \widetilde{B} = (a_1 - d_2, b_1 - c_2, c_1 - b_2, d_1 - a_2)$	(6)

$r \otimes \widetilde{A} = (ra_1, rb_1, rc_1, rd_1)$	(7)
$\widetilde{A} \otimes \widetilde{B} = (a_1.a_2, b_1.b_2, c_1.c_2, d_1.d_2)$	(8)

3.7. Definition: The distance of two $\widetilde{A} = (a_1, b_1, c_1, d_1)$ and $\widetilde{B} = (a_2, b_2, c_2, d_2)$ fuzzy numbers is equal to:

$d(\widetilde{A},\widetilde{B}) = \sqrt{\frac{1}{4}\left[(a_1-a_2)^2+(b_1-b_2)^2+(c_1-c_2)^2+(d_1-d_2)^2\right]}$	(9)

4. The Proposed Model for Prequalification Based on the Fuzzy Topsis Method

The proposed model diagram for prequalification of contractors is indicated in Figure 2.

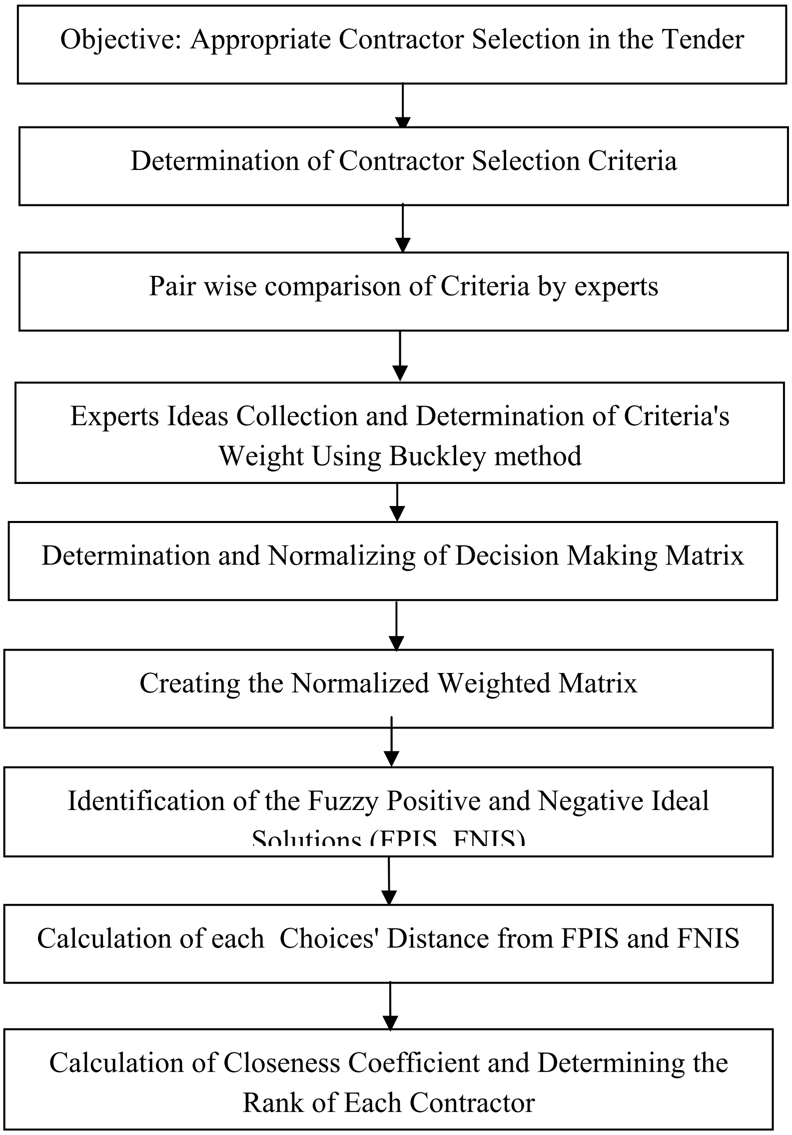

Figure 2: Proposed diagram for contractors' Pre-qualification model.

The model preparation steps are as follows:

Step 1: after careful assessment of Iranian construction codes and standards and assessing several owners' objectives, the main criteria for prequalification of contractors are mentioned below:

C1: Experience
C2: Financial Stability
C3: Company Repetitions
C4: Quality
C5: Current Projects
C6: Resources
C7: Company Management
C8: Company Technology

Step 2: To determine the weight of each criterion, the mentioned criteria were compared by experts. By application of Buckley method, the weight of each criterion will be determined considering the created pair wise comparison matrix. In this method some fuzzy numbers are used to compare the criteria priority. Figure 3 shows these numbers [12].

- Equal priority or importance: $(1,1,1,1)$
- Poor priority or importance: $(\frac{2}{3},1,1,\frac{3}{2})$
- Average priority or importance: $(\frac{3}{2},2,2,\frac{5}{2})$
- Strong priority or importance: $(\frac{5}{2},3,3,\frac{7}{2})$
- Absolute priority or importance: $(\frac{7}{2},4,4,\frac{9}{2})$

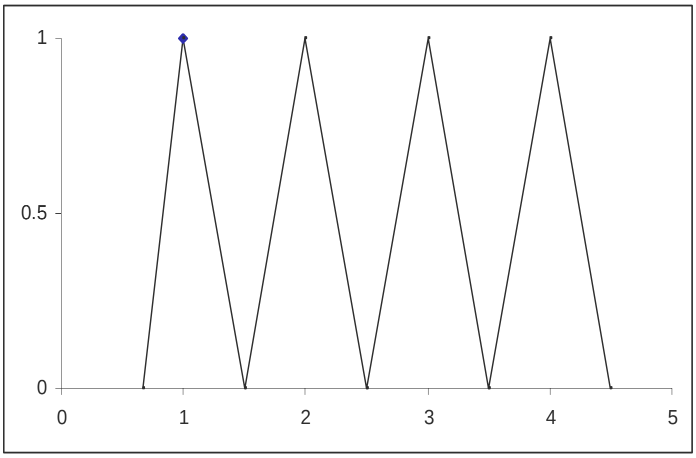

Figure 3: Fuzzy Numbers to Compare Criteria

Step 3: After completing the pair wise comparisons of criteria by experts and creating the pair wise comparison matrix, considering Buckley method the geometrical average of each line of pair wise comparison matrix will be determined using the following equation:

$$\tilde{z}_i = (\tilde{a}_{i1}.\tilde{a}_{i2}.\dots.\tilde{a}_{in}) \quad (10)$$

Then the fuzzy weight is determined by application of following equation:

$\widetilde{w}_i = \dfrac{\widetilde{z}_i}{\widetilde{z}_1 + \widetilde{z}_2 + \cdots + \widetilde{z}_n}$	(11)

If the number of decision makers were equal to k, and by using the mentioned method for each criterion a fuzzy weight has been obtained, then the total weight will be obtained as comes below:

If the weight of the J^{th} criterion for each of decision makers was as mentioned beneath:

$w_j = (w_{jl1}, w_{jl2}, w_{jl3}, w_{jl4}) \quad l = 1,2,\cdots,k$	(12)

Then the total weight will be calculated using following equations:

$w_{j1} = \dfrac{1}{k}\sum_{l=1}^{k} w_{jl1} \quad l = 1,2,\cdots,k$	(13)
$w_{j2} = \dfrac{1}{k}\sum_{l=1}^{k} w_{jl2} \quad l = 1,2,\cdots,k$	(14)
$w_{j3} = \dfrac{1}{k}\sum_{l=1}^{k} w_{jl3} \quad l = 1,2,\cdots,k$	(15)
$w_{j4} = \dfrac{1}{k}\sum_{l=1}^{k} w_{jl4} \quad l = 1,2,\cdots,k$	(16)

Step 4: Considering the ideas of experts assessing the contractors, for each criterion a quality manner is specified and finally the decision making matrix will be determined and then, using the following equations it will be normalized:

For indexes with positive aspect:

$\widetilde{n}_{ij} = \left(\dfrac{a_{ijl}}{a_{jr}^{\max}}, \dfrac{a_{ijm1}}{a_{jr}^{\max}}, \dfrac{a_{ijm2}}{a_{jr}^{\max}}, \dfrac{a_{ijr}}{a_{jr}^{\max}} \right)$	(17)

For indexes with negative aspect:

$$\tilde{n}_{ij} = \left(\frac{a_{jl}^{\min}}{a_{ijr}}, \frac{a_{jl}^{\min}}{a_{ijm2}}, \frac{a_{jl}^{\min}}{a_{ijm1}}, \frac{a_{jl}^{\min}}{a_{ijl}} \right) \tag{18}$$

Finally, after normalizing, the following decision making matrix will be obtained:

$$\tilde{N} = (\tilde{n}_{ij})_{m\times n} = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} x_1 & x_2 & \cdots & x_n \end{array} \\ \begin{pmatrix} \tilde{n}_{11} & \tilde{n}_{12} & \cdots & \tilde{n}_{1n} \\ \tilde{n}_{21} & \tilde{n}_{22} & \cdots & \tilde{n}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{n}_{m1} & \tilde{n}_{m2} & & \tilde{n}_{mn} \end{pmatrix} \end{array} \tag{19}$$

Step 5: in this step, having the weights of criteria and the normal matrix, the normalized weighted matrix will be obtained using following equations:

$$\tilde{V} = [\tilde{\upsilon}_{ij}]_{m\times n} \qquad i = 1,2,\ldots,m \qquad j = 1,2,\ldots,n \tag{20}$$

$$\tilde{\upsilon}_{ij} = \tilde{n}_{ij} . \tilde{w}_j \tag{21}$$

$$\tilde{V} = [\tilde{\upsilon}_{ij}]_{m\times n} = \begin{pmatrix} \tilde{\upsilon}_{11} & \tilde{\upsilon}_{12} & \cdots & \tilde{\upsilon}_{1n} \\ \tilde{\upsilon}_{21} & \tilde{\upsilon}_{22} & \cdots & \tilde{\upsilon}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{\upsilon}_{m1} & \tilde{\upsilon}_{m1} & & \tilde{\upsilon}_{mn} \end{pmatrix} = \begin{pmatrix} \tilde{w}_1 . \tilde{\upsilon}_{11} & \tilde{w}_2 . \tilde{\upsilon}_{12} & \cdots & \tilde{w}_n . \tilde{\upsilon}_{1n} \\ \tilde{w}_1 . \tilde{\upsilon}_{21} & \tilde{w}_2 . \tilde{\upsilon}_{22} & \cdots & \tilde{w}_n . \tilde{\upsilon}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{w}_1 . \tilde{\upsilon}_{m1} & \tilde{w}_2 . \tilde{\upsilon}_{m1} & & \tilde{w}_n . \tilde{\upsilon}_{mn} \end{pmatrix} \tag{22}$$

Step 6: Identifying the fuzzy positive and negative ideal solutions by following equations:

$$A^* = \{ \tilde{\upsilon}_1^*, \tilde{\upsilon}_2^*, \ldots, \tilde{\upsilon}_n^* \} = \{ (\max_i \tilde{\upsilon}_{ij} \mid j \in J_1), (\min_i \tilde{\upsilon}_{ij} \mid j \in J_2) \quad \mid i = 1,2,\ldots,m \} \tag{23}$$

$$A = \{ \tilde{\upsilon}_1, \tilde{\upsilon}_2, \ldots, \tilde{\upsilon}_n \} = \{ (\min_i \tilde{\upsilon}_{ij} \mid j \in J_1), (\max_i \tilde{\upsilon}_{ij} \mid j \in J_2) \quad \mid i = 1,2,\ldots,m \} \tag{24}$$

Step 7: Calculation of choices' distance from the fuzzy positive and negative ideal solutions. These distances will be specified using following equations:

$d_i^* = \sum_{j=1}^{n} d_\upsilon\left(\tilde{\upsilon}_{ij}, \tilde{\upsilon}_j^*\right) \quad i = 1,2,\dots,m$	(25)
$d_i^- = \sum_{j=1}^{n} d_\upsilon\left(\tilde{\upsilon}_{ij}, \tilde{\upsilon}_j^-\right) \quad i = 1,2,\dots,m$	(26)

Step 8: The qualification degree of each contractor is determined by applying closeness coefficient (Cc) as below:

$cc_i = \dfrac{d_i^-}{d_i^- + d_i^*}$	(27)

5. Numerical Example

To evaluate the proposed model a case study was conducted. This study was performed in a real construction project in Iran. The owner of the project is Iranian ministry of road and transportation and 7 companies participated in the tender which shown as A to G. Firstly, by distributing the questionnaires among experts and apply of mentioned method the weight of each criterion has been specified as presented in Table 1.

Table 1: Fuzzy Weights of Criteria

Pre-qualification criteria	**Fuzzy weights of criteria**
C1	(0/12 ,0/19 ,0/19 ,0/28)
C2	(0/07, 0/12 ,0/12 ,0/16)
C3	(0/08 ,0/14 ,0/14 ,0/22)
C4	(0/07 ,0/1 ,0/1 ,0/16)
C5	(0/07 ,0/12 ,0/12 ,0/20)
C6	(0/08 ,0/13 ,0/13 ,0/22)

C7	(0/1 ,0/14 ,0/14 ,0/22)
C8	(0/05 ,0/08 ,0/08 ,0/12)

After that in order to rank the contractors the language terms will be used. For this reason the triangular and trapezoidal fuzzy numbers are applied. Their fuzzy numbers are mentioned below [12]:

- Very good or very important: (VG/VI), fuzzy number: $(0/8, 0/9, 1, 1)$
- Good or Important (G/V), fuzzy number: $(0/6, 0/7, 0/8, 0/9)$
- Above Average (AA), fuzzy number: $(0/5, 0/6, 0/7, 0/8)$
- Average (A), fuzzy number: $(0/4, 0/5, 0/5, 0/6)$
- Below Average (BA), fuzzy number: $(0/2, 0/3, 0/4, 0/5)$
- Poor or low importance (P/LI), fuzzy number: $(0/1, 0/2, 0/3, 0/4)$
- Very poor or very low importance (VP/VL), fuzzy number: $(0, 0, 0/1, 0/2)$

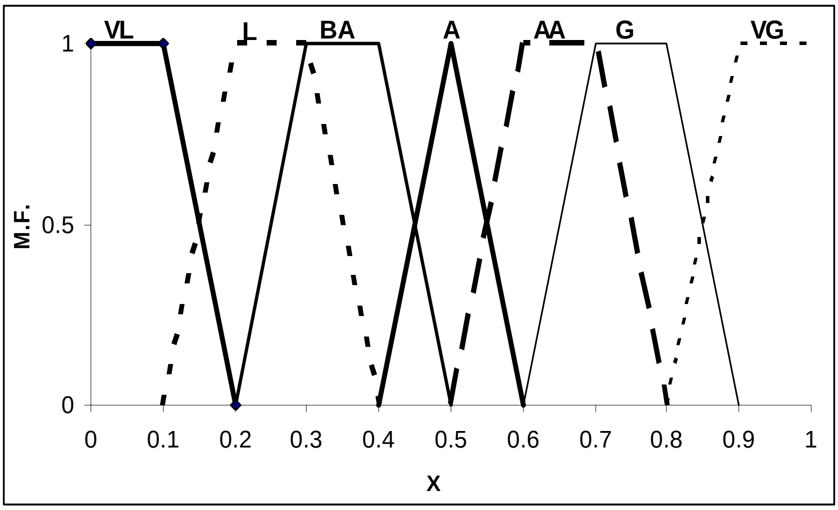

Figure 4: Fuzzy Numbers for each criterion

After determining the language terms and criteria' weight It can be assigned an especial manner for each criterion of each contractor. Considering the experts' ideas for each criterion and each contractor a language term has been assigned which is shown in Table 2.

Table 2: Assigned Language Terms

Criteria	C1	C2	C3	C4	C5	C6	C7	C8
A	G	A	VG	VG	L	G	G	AA
B	A	BA	BA	G	A	VP	BA	P
C	A	P	G	BA	H	AA	G	A
D	AA	BA	G	G	A	A	G	A
E	G	BA	BA	VG	AA	A	AA	A
F	VG	P	VP	G	VH	BA	G	VG
G	A	VP	P	G	VL	BA	G	VP

After locating the equivalent fuzzy of language terms in the above matrix, the decision making matrix will be obtained.

In the next step, by normalizing the decision making matrix using the aforementioned method, the normal matrix will be obtained. This matrix has been shown in Table 3 for the first four criteria. In the next step, by multiplying the criteria' weight by the normal matrix, the normal weighted matrix will be obtained which is shown for the first four criteria in Table 4. After determining the normal weighted matrix, the positive and negative fuzzy ideals will be obtained for each criterion. These values are shown in Table 5.

Table 3: Normalized Matrix

	C1	C2	C3	C4
A	(0/6 , 0/7 , 0/8 , 0/9)	(0/7 ,0/8 ,0/8 ,1)	(0/8 ,0/9 ,1 ,1)	(0/8 ,0/9 , 1, 1)
B	(0/4 ,0/5 ,0/5 ,0/6)	(0/3 ,0/5 ,0/7 ,0/8)	(0/2 ,0/3 ,0/4 0/5)	(0/6 , 0/7 , 0/8 , 0/9)
C	(0/4 ,0/5 ,0/5 ,0/6)	(0/3 ,0/5 ,0/7 ,0/8)	(0/6 , 0/7 , 0/8 , 0/9)	(0/2 ,0/3 ,0/4 0/5)
D	(0/5 ,0/6 ,0/7 ,0/8)	(0/3 ,0/5 ,0/7 ,0/8)	(0/6 , 0/7 , 0/8 , 0/9)	(0/6 , 0/7 , 0/8 , 0/9)
E	(0/6 , 0/7 , 0/8 , 0/9)	(0/6 , 0/7 , 0/8 , 0/9)	(0/6 , 0/7 , 0/8 , 0/9)	(0/6 , 0/7 , 0/8 , 0/9)

F	(0/8 ,0/9 , 1, 1)	(0/2 ,0/3 ,0/5 ,0/7)	(0, 0 ,0/1, 0/2)	(0/6 , 0/7 , 0/8 , 0/9)
G	(0/4 ,0/5 ,0/5 ,0/6)	(0 , 0 ,0/2, 0/3)	(0/1 , 0/2 , 0/3 , 0/4)	(0/6 , 0/7 , 0/8 , 0/9)

Table 4: Weighted Normal Matrix

	C1	**C2**	**C3**	**C4**
A	(0/07 ,0/13 ,0/15 ,0/25)	(0/05 ,0/1 ,0/1 ,0/16)	(0/06 ,0/13 ,0/14 ,0/22)	(0/06 ,0/09 ,0/1 ,0/16)
B	(0/05 , 0/1 ,0/1 ,0/17)	(0/02 ,0/06 ,0/08 ,0/13)	(0/02 ,0/04 ,0/06 ,0/11)	(0/04 ,0/07 ,0/08 ,0/14)
C	(0/05 ,0/1 ,0/1 ,0/17)	(0/01,0/04 ,0/06 ,0/11)	(0/05 ,0/1 ,0/11 ,0/2)	(0/01 ,0/03 ,0/04 , 0/08)
D	(0/06 ,0/11 ,0/13 ,0/22)	(0/02 ,0/06 ,0/08 ,0/13)	(0/05 ,0/1 ,0/11 ,0/2)	(0/04 ,0/07 ,0/08 ,0/14)
E	(0/07 ,0/13 ,0/15 ,0/25)	(0/02 ,0/06 ,0/08,0/13)	(0/02 ,0/04 ,0/06 ,0/11)	(0/06 ,0/09 ,0/1 ,0/16)
F	(0/1 ,0/17 ,0/19 ,0/28)	(0/01 ,0/04 ,0/06 ,0/11)	(0 ,0 ,0/01 ,0/04)	(0/04 ,0/07 ,0/08 ,0/14)
G	(0/05 ,0/1 ,0/1 ,0/17)	(0, 0 ,0/02 ,0/05)	(0/01 ,0/03 ,0/04 ,0/09)	(0/04 ,0/07 ,0/08 ,0/14)

Table 5: Fuzzy positive and negative ideal solutions for each criterion

	C1	**C2**	**C3**	**C4**
FPIS	(0/1 , 0/17 ,0/19 ,0/28)	(0/05 , 0/1 ,0/1 ,0/16)	(0/06 ,0/13 ,0/14 ,0/22)	(0/06 ,0/09 ,0/1 ,0/16)
FNIS	(0/05 ,0/1 ,0/1 ,0/17)	(0, 0 ,0/02 ,0/05)	(0, 0, 0/01 ,0/04)	(0/01 ,0/03 ,0/04 ,0/08)

Table 5 (Continue): Fuzzy positive and negative ideal solutions for each criterion

	C5	**C6**	**C7**	**C8**
FPIS	(0/05 ,0/1 ,0/1 ,0/16)	(0/05 ,0/1 ,0/12 ,0/22)	(0/07 ,0/11 ,0/12 ,0/22)	(0/03 ,0/05 ,0/06 ,0/4)
FNIS	(0/07 ,0/12 ,0/12 ,0/2)	(0 ,0 ,0/01 ,0/05)	(0/02 ,0/05 ,0/06 ,0/12)	(0, 0, 0/01 , 0/1)

In the next step, having FPIS and FNIS for each criterion, for each contractor the distances form the mentioned boundaries will be calculated. After that the summation of these distances is determined and finally the closeness coefficient for each criterion is calculated. Table 6 shows the closeness coefficients for each contractor. Finally after grading the contractors based on these coefficients, the sensitivity of this kind of grading to each criterion's weight should be investigated. To achieve this goal the sensitivity analysis will be done in the following section.

Table 6: Closeness Coefficients for Contractors

CONTRACTOR	A	B	C	D	E	F	G
Cc	0/79	0/275	0/55	0/61	0/59	0/69	0/22

6. Sensitivity Analysis

For evaluating the effect of criterion's weight on the closeness coefficients and contractor's ranking the weights of criteria will be changed .Figures 5, 6 and 7 shows the effect of changing weight of first three criteria on the contractor's ranking.

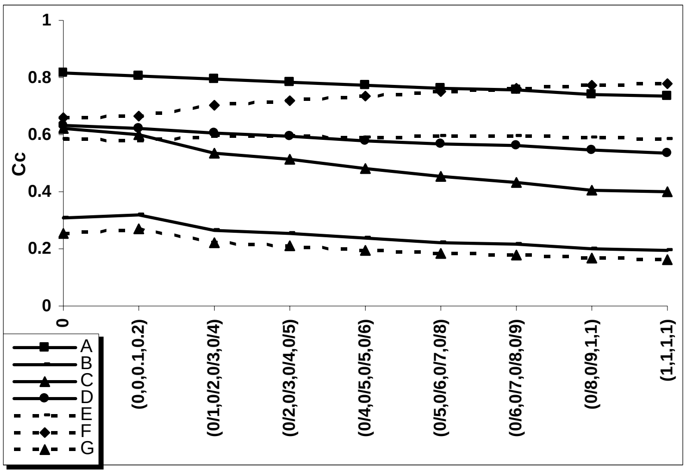

Figure 5: Experience Criterion – Fuzzy Topsis

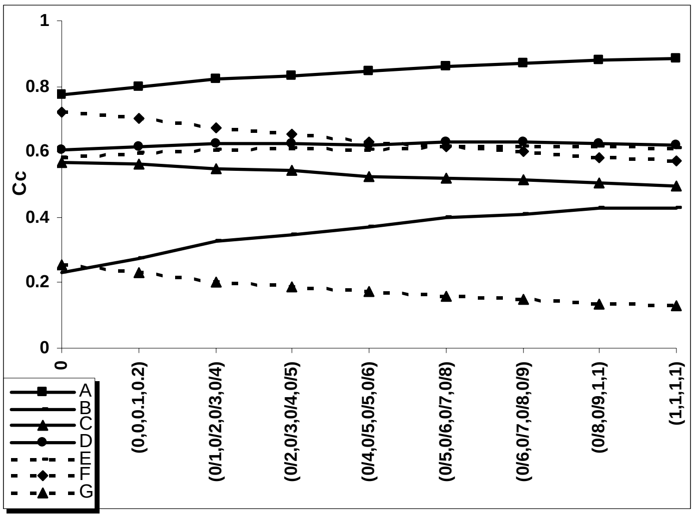

Figure 6: Financial Stability – Fuzzy Topsis

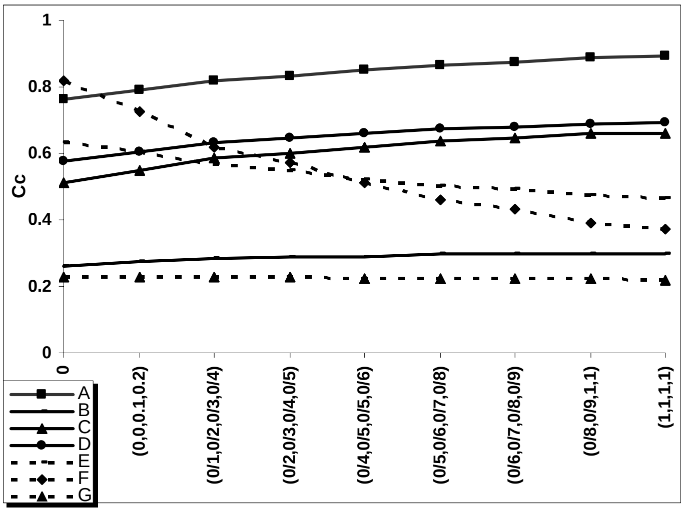

Figure 7: Company Repetitions – Fuzzy Topsis

7. Conclusion

In the present paper by introducing a fuzzy decision making method for prequalification of the contractors considering the appropriate criteria, the contractors were pre-qualified sensitivity analysis done on the model. The presented model is valuable and useful for owners plan to qualify the contractors. Considering the sensitivity results shown in the charts the following conclusions can be obtained:

- The contractor's ranking by means of Fuzzy Topsis method is too sensitive to criterion's weights. So determining the relative weight of each criterion has a significant importance in this method.

- The presented method is not appropriate for careful decision makers accepting low risks in their decisions.

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Knowledge value perceptions in Thailand: an interpretive case study

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Abstract

The paper aims to explore the knowledge value creation capability and maturity of a high-tech organisation in Thailand. The research adopts an interpretive stance and employs a survey and a case study approach involving multiple data collection methods. The paper is based on one of the author's personal expertise and involvement in the selected case study organisation for over a decade. The results indicate that (a) the selected organisation has demonstrated its readiness to migrate to a value creation culture underpinned by knowledge sharing and creation practices, (b) the distinctive collective characteristic of Thai culture engenders a strong human and social sense of community, which in turn promotes knowledge-friendly practices, and (c) a knowledge culture requires essential socio-organisational ingredients, including trust, confidence, motivation, continuous learning. This empirical study provides a foundation to further the research to: (a) explore the role of knowledge management systems in promoting value creation, and (b) investigate the key distinctive features of Thai culture which underpin and influence knowledge management perceptions and practices of Thai employees.

Keywords: Knowledge management, Value creation, Interpretive case study, Information Systems, Thailand

1. Introduction

The increasing popularity of knowledge management (KM) has been reinforced by the quest for innovation and value creation [1, 2]. Because of this, it is perceived that the future of KM tends to focus on value creation [3]. Value creation, as reported in Rezgui [4], is grounded in the appropriate combination of human networks [5], social capital [6], intellectual capital [7], and technology assets [8], facilitated by a culture of change [9]. In fact, the concept of Community of Practice (CoP) [5] was introduced as an effective social activity to share tacit knowledge. This had the effect of promoting and nurturing *human networks* which in turn motivate people to share and create knowledge. In this context, the *social capital* of an organisation emerges as an essential ingredient to help employees develop trust, respect, and understanding of others. Because of its (*social capital*) emphasis on collectivism and co-operation rather than individualism, distributed community members will be more inclined to connect and use electronic networks when they are motivated to share knowledge [6]. KM environments may foster social capital by offering virtual spaces for interaction, providing the context and history of interaction, and offering a motivational element (e.g. reward) to encourage people to share knowledge with each other [6]. The intellectual capital of an organisation encompasses organisational learning, innovation, skills, competencies, expertise and capabilities [10]. Liebowitz and Suen [7] suggest a strong and positive relationship between the value creation capability and Intellectual Capital of an organisation, pointing to factors such as training, R&D investment, employee satisfaction, and relationships development. Focusing on technology, the majority of KM initiatives involve, to a lesser or greater degree, information technology (IT) [11]. Alavi and Leidner [8] suggest that technology, including knowledge management systems (KMS), is an essential asset to sustain value creation. The use of technology in the context of KM has traditionally focussed on three common applications: (a) the coding and sharing of best practices, (b) the creation of corporate knowledge directories, and (c) the creation of knowledge networks. Lastly, change management plays an increasingly important role in sustaining “leading edge” competitiveness for organisations in times of rapid change and increased competition [9, 12, 13], and the future has only two predictable features – ‘change and resistance to change’ and the very survival of organisations will depend upon their ability not only to adapt to, but also to master these challenges.

KM solutions, including environments supporting information exchange, knowledge sharing and integration, and virtual communities, present a high and promising potential for developing countries [14]. However, very few articles have reported KM implementations and strategies in third world/developing countries, including South East Asia. Harris [15] argues that ICT adoption and deployment in South East Asian developing countries (Thailand, Malaysia, Philippines) are much effective than other developing countries (e.g. Pakistan and Bangladesh). Thailand, perceived as a new Asian Tiger economy [16], is successfully transforming itself into a knowledge-based economy. This confirms the perceived value of knowledge in Thailand and its crucial role in promoting a knowledge-based economy.

The aims of the paper are to (a) investigate overall KM practices and (b) explore value creation capabilities in a Thai Hi-Tech organisation, covering technical, cultural, and organisational aspects. The paper is organised into five main sections. Following this introduction, the paper presents the research methodology employed in this study, which involves a survey and a case study approach. This is followed by a brief overview of KM practices trends in Thailand that have emerged from the survey. A description of the case study data collection procedures and results is then given. The results are then discussed in the context of the research. Finally, the paper is summarised and various conclusions are drawn.

2. Research methodology

The research context used for the investigation is a case study, BETA (a pseudonym), a Thai Hi-Tech Research and Development (R&D) organisation which conducts research in Information Technology. A case study approach is well suited to Information Systems research [17]. It is widely used in qualitative information systems studies and can be applied in positivism and anti-positivism investigations [18, 19]. The case study aims to provide in-depth analysis of the selected organisation (BETA) for which KM is perceived as essential. The selected research units involve a number of knowledge-intensive production departments, which comprise several high-profile research teams. The two following research questions form the focus of the research:

- Have employees from BETA adopted a culture of knowledge sharing and creation across their organisation?

- What kind of perceived value is created out of existing knowledge practices across the organisation?

An interpretive stance is adopted as one of the researchers has worked in the organisation for over a decade. Indeed, the researcher has, over the years, acquired substantial personal knowledge of the organisation's culture and work environment.

The case study involves the use of five instruments: survey questionnaires, interview, process mapping, direct observation, and documentation. These instruments are employed in sequence from conducting a statistically analysed case study survey questionnaire then following up with in-depth interviews, observation and process mapping to better understand and interpret the results [20-22]. Therefore, the case study employs a combination of methods embodying quantitative and qualitative paradigms [23, 24]. There are two main reasons for supplementing quantitative with qualitative data: (a) to develop contextual richness that is valuable in model building, and (b) to improve internal validity and interpretation of quantitative findings through triangulation [25]. Data triangulation is chosen to analyse data collected from multiple sources, and corroborate qualitative with quantitative results [26].

3. Survey of Thai knowledge practices: key findings

Prior to conducting a case study approach, the researchers have surveyed 28 organisations, selected using the stratified random sampling technique, to build an overall understanding of KM practices in Thailand [27]. The main findings of the survey indicate that Thai organisations use information technology as a strategic instrument to address their communication and collaboration needs. Groupware has been identified as a common technology used by a limited number of leading organisations to create shared workplaces to support team work over space and time, and facilitate knowledge sharing. The results suggest that traditional face-to-face methods of interaction, such as formal and informal meetings, are essential in sharing experiences and tacit knowledge. These are complemented with virtual means through groupware functions, including e-mail, and telephone. Thai people expect reward for sharing and creating knowledge. While there is a distinct preference for monetary reward, Thai employees do also value recognition and praise. Overall, most Thai organisations attempt to increase their employees' awareness of the importance of knowledge, and various means are employed to motivate them to share, create, and use knowledge. The survey indicates a strong willingness of Thai organisations to adopt knowledge-friendly practices and become part of knowledge networks. From a socio-cultural perspective, the survey has identified the distinctive collective nature of Thai society underpinned by trust and strong social relationships. Overall, the following key findings have emerged: (a) there is an established knowledge sharing culture supported by a corporate KM strategy, amongst high-tech organisations, as well as a preparedness for change to migrate to a knowledge creation culture; (b) a number of Thai international organisations exhibit ad-hoc knowledge sharing practices as well as a growing awareness about the value of knowledge sharing and what can be termed as intangible assets; (c) there is a clear lack of any knowledge-oriented practice within ministry and departments of public sectors.

4. Case study data collection procedures and results

BETA was founded over 20 years ago. It employs more than 600 people, a majority of which is highly educated and works in R&D production departments. It has initially acted as a research supplier to Thai industry for over a decade. Following an increasing demand for R&D, BETA has transformed itself from a supply-driven to a demand-driven organisation. This demand-focused strategy has helped BETA address and meet the needs of Thai organisations more effectively. In the late nineties, the management initiated a large KM programme. In the first stage, a groupware (KMS) was deployed and adopted to help staff collaborate more effectively while promoting knowledge-friendly practices. Also, physical and virtual social spaces have been provided for sharing knowledge. Later, the management deployed a knowledge repository system to encourage staff codify tacit knowledge and experience into a re-usable form. A number of incentives have been introduced, including monetary rewards and recognition to motivate people share and create knowledge. This section provides an overview of the case study data collection procedures as well as a summary of key findings from each collected data source (survey questionnaire, interview and observation, and process mapping).

4.1 Survey questionnaire

One hundred and thirty anonymous survey questionnaires were sent to the R&D production departments. Seventy one completed questionnaires were returned and analysed, representing a response rate of 55%. The analysis is structured into four parts: work environment and teamwork, KM, requirements for ICT support, and barriers. The survey involves both open-ended and scaled-response questions.

In terms of work environment and teamwork, the results indicate that more than 95% of the respondents work in a team and almost 60% are involved in more than one team at a time. A majority of respondents perceive their teamwork culture as bureaucratic but promotes employees' participation. Virtual and face-to-face means (including E-mail, telephone, formal and informal meetings) are used to communicate within and across teams. Employees have raised a number of factors that inhibit team working, including: (a) lack of effective communication, (b) lack of contribution, and (c) conflicting cultures (or co-existence of several school of thoughts) reflected in working procedures (staff have been educated in various parts of the world).

In terms of KM practices, over 90% of the respondents rely on knowledge to carry out their tasks and processes. More than 60% of the respondents describe "knowledge" as the fact of knowing and understanding through experience and study, and materialises as objects to be stored, shared and maintained. Over 75% of the respondents express a preference in sharing knowledge in informal (traditional face-to-face) as opposed to virtual contexts supported by technology. This is perceived by a majority of respondents as a generalisable knowledge-sharing pattern. An interesting proportion (more than 75%) of the respondents exhibits a positive attitude to knowledge sharing as they perceive that knowledge sharing within and across organisations is very important in work. Simple knowledge sharing methods, such as storing knowledge items on the corporate intranet, represent some of the important needs expressed by the respondents, as opposed to any other methods involving extensive or advanced use of technology. However, some respondents have expressed strong concerns about sharing their knowledge arguing about confidentiality implications. Rewards, including in the form of staff development and empowerment, recognition, and financial incentives, have been suggested as effective factors that can contribute to improve staff level of motivation to share knowledge.

In terms of ICT usage, the results show that the respondents use computers mainly for (a) office automation purposes (including word-processing), (b) groupware-related needs (e-mail and some limited form of workflow support), and (c) web access. The survey indicates that 70% of the respondents often use groupware to support collaboration for intra-organisational purposes. Most respondents have expressed a preference to access information, knowledge, and services over the web, including access to document management functionality, e-learning and e-training systems to support self-learning over space and time. The introduction of solutions supporting ubiquitous access to information and knowledge resources has been appreciated by most respondents.

Finally, the gathered data helped identify barriers preventing employees to share / create knowledge in their organisation. These include: non-supportive organisational structure, lack of personal incentives, Intellectual Property Rights (IPR) concerns, reluctance to contribute (due to the fear to loose one's expert status), software limitations, and hardware / software prohibitive cost. A majority of respondents have also raised concerns about the management push to use open source software (e.g. OpenOffice word processor) motivated by software cost reductions. They feel that this constitutes a real barrier to personal and organisational development as ICT gradually play an important role in BETA's business processes.

4.2 Interview and direct observation

Twelve interviewees (including heads, sub-heads, and staff) drawn from four production departments, an IT department, and a KM department have been interviewed. These were complemented by direct observation. The analysis of the gathered data involved (a) producing interview transcripts, (b) generating pattern codes, and (c) drawing a checklist matrix [28].

Overall, interviewees are satisfied with their KM initiatives and the strong support they receive from their executives. This results in an increasing KM awareness and interest in the organisation, reflected in the effective use of existing in-house knowledge services. There is a strong belief that in-house knowledge repositories do provide great value for the organisation, in particular in the context of staff loss (although when an employee quits the organisation, his / her knowledge is not lost as it is already documented and stored in the system, and can therefore be used as best practice by other staff). Moreover, the interviewees believe in the self-development potential of in-house knowledge repositories. They suggest that employees should be encouraged to share knowledge within the organisation, and should be less concerned about inhibiting factors such as IPR and confidentiality issues. However, they do feel that these concerns are legitimate when knowledge is exposed externally.

Formal and on-the-job training, and learning from documentation are interviewees' preferred methods, respectively, to promote knowledge sharing. Knowledge sharing approaches in informal contexts such as discussion forums and coffee breaks are highly valued. They argue that these methods not only bridge the barrier between staff and managers, but also help staff practice their presentation skills, given the cultural reluctance of Thai people (due to a shy behavioural nature) to speak in public.

Interviewees have described their organisational structure as flat and participatory. This, in their opinion, has helped minimise teamwork problems. Employees tend to communicate with one another using informal face-to-face means. This promotes, as argued above, good relationship building between employees and managers. Although the prevailing participatory culture provides a strong working team spirit, potential problems may occur due to the desire of employees to be seen as being helpful by getting involved in several tasks, even when these can be achieved by one employee. Promoting appropriate teamwork environment and atmosphere help staff reduce their shyness and fears by encouraging them to contribute effectively through constructive comments to managers or team leaders. Interviewees have also mentioned a cultural problem where employees seem to have more respect for older employees regardless of their work performance and job status. This becomes an issue when a young manager is appointed. They have noted that this is non-changeable feature of Thai culture.

Reward systems have recently been introduced to motivate staff to share and create knowledge. The rewards offered include monetary rewards, promotion, recognition, and praise. They have noted that monetary reward and salary revision seem to be slightly resisted in the form they are currently implemented. One interviewee argues that monetary reward should be granted on an annual basis in the form of a special bonus. This is motivated by the fact that a salary revision has a permanent and definite effect (and is carried over in subsequent years) even when no further knowledge-friendly practices are demonstrated. Some categories of staff, including administrators, feel that this reward system is unfair and not suited to their jobs, as they do not involve a great deal of knowledge-friendly activities. Interviewees feel that this can be addressed through staff training and education.

In terms of technology adoption, interviewees reported that a minority of employees still resist the introduction of new IT systems to support teamwork and enhance organisational processes. This results in data redundancy and an unnecessary increase in helpdesk workload. In particular, this minority has complained about open source software that has recently been introduced, arguing that these are more difficult to use than similar commercial solutions. However, they follow these open source policies although such policies seem to generate resentment to anyone who disagrees. This is because they want to avoid any risks, conflicts, and unexpected problems such as punishment.

In terms of perceived limitations and barriers to KM, interviewees have raised several issues, including, financial implications, lack of adapted human resources, and limited knowledge of IT.

4.3 Process mapping

Process mapping is defined as a visual aid for picturing work processes which illustrate how inputs, outputs and tasks are linked [29]. Process maps do provide a clearer understanding of the business context than text [30] and are extensively used in re-engineering projects [31]. The purpose of process mapping in this research is to identify existing knowledge-related practices and structures across targeted departments. The resulting process maps, expressed in IDEF0 [32], were analysed and interpreted based on the data gathered from interview and observation.

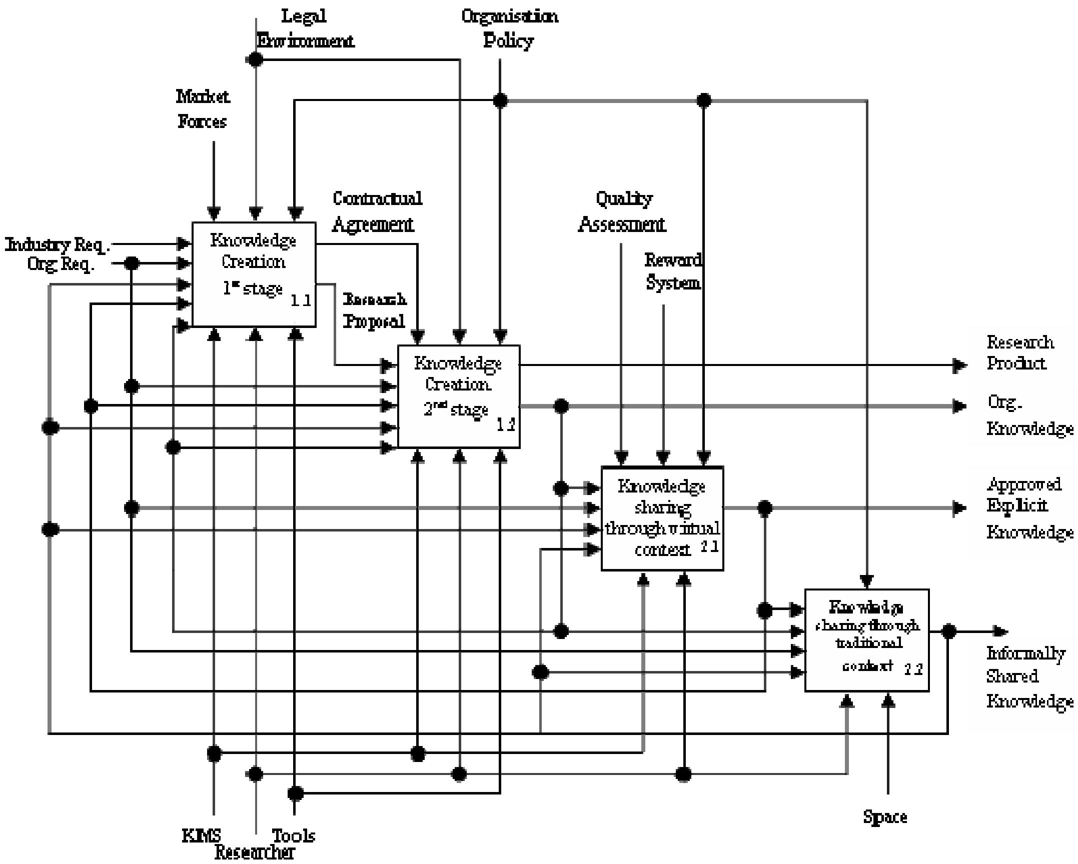

Figure 1: Process of Knowledge Sharing and Creation in BETA.

Figure 1 shows that industrial needs or market forces drive research in BETA, as it strives to be a “demand-driven” organisation. It helped identify two knowledge creation stages: *the 1st Stage* involves knowledge creation in the context of the commissioned research to support the development of a research proposal / brief, while the *2nd Stage* involves fulfilling the research proposal by producing research outputs, hence creating new knowledge. It also helped identify two knowledge sharing patterns: *Knowledge Sharing through Virtual Context*, which involves the process of knowledge sharing within virtual spaces through groupware using knowledge repository systems; whereas *Knowledge Sharing through Traditional Context* involves the process of knowledge sharing in physical contexts such as face-to-face formal or informal meetings. Researchers can share project / research knowledge through an internal and informal forum that all members of the department can attend. The forum aims to practice both research and presentation skills. Moreover, knowledge can be shared through dedicated project meetings that only project members are allowed to attend and discuss within the project team. During or after the research, the researchers are required to produce documents related to the ongoing or completed research, such as technical reports, papers, patents, and prototypes, and to upload these to the organisational knowledge repository system (BETA's Knowledge Management System). This is the mechanism used to acquire and store knowledge and also to claim rewards (monetary reward or promotion). The reward system was initiated based on the organisation policy to motivate employees to share and create knowledge. All documents uploaded to the system have to pass a quality assessment approved by a dedicated committee.

5. Discussion

Data gathered from these multiple qualitative and quantitative sources are triangulated to address the two research questions that form the basis of this investigation, supported by existing western as well as eastern (including Thai) literature.

Starting with the first research question, gathered primary sources of evidence confirm that a knowledge sharing and creation culture is in place in BETA. The results indicate an overall good awareness of, and cultural receptivity to, KM changes introduced in BETA over recent years. The authors argue in the context of the research that to promote KM, an organisation needs to meet four broad KM objectives [33] mentioned earlier in the paper: (a) creating knowledge repositories, (b) improving knowledge access, (c) enhancing cultural support for knowledge use, and (d) managing knowledge as an asset. The gathered data suggest that the introduction of a knowledge repository system has been welcomed, as the system promotes documenting and archiving of best practices across the organisation. In fact, the coding and sharing of best practice is one of the common initiatives employed to initiate organisational KM [8], and knowledge sharing can take place only once a corporate knowledge repository is made widely accessible to staff [34]. These have helped improve knowledge connectivity, access, and transfer across BETA. The research also confirms the role of information technology in general, in facilitating knowledge sharing and creation, as reported elsewhere [33, 35]. Moreover, the research has identified the role of Thai culture and values in the adoption and deployment of KM practices. This corroborates findings related to the adoption of IT in similar contexts [36]. Building a casual environment adapted to Thai culture, such as informal forums and personal connections, leads to positive KM practices [37], as trust and social relationships form the foundation of Thai society [36]. Also, the research acknowledges the impact of the change initiatives introduced by BETA over the years to increase staff KM awareness. This is exemplified by the introduction of reward systems to encourage people to contribute to KM activities, and establish an environment conducive to more effective knowledge practices, facilitated by the provision of physical and virtual spaces to share knowledge and help build knowledge communities. The change process involved (a) building awareness and cultural receptivity to knowledge, (b) changing behaviour relating to knowledge perception and practices, and (c) improving the KM process.

Overall, the gathered evidence suggests that BETA has achieved the four [33] KM objectives and has developed a true knowledge sharing and creation culture. This can help answer the second research question (What kind of perceived value is created out of existing knowledge practices across the organisation?). The four key value creation assets identified previously including human networks, social capital, intellectual capital, technology assets, and change processes [3] are used to support the discussion.

The gathered evidence shows that formal and informal communication using face-to-face (including scheduled meetings) and virtual (synchronous / asynchronous) means (e.g. telephone and e-mail) are perceived as effective to promote knowledge sharing and creation. As such, the research acknowledges the pivotal and strategic role that human networks play in promoting KM in the particular context of the collective characteristic of Thai culture, as reported in related literature [36, 38]. This has resulted in increased awareness, knowledge quality, and business intelligence which have triggered a value added dimension that did not exist prior to initiating the change processes. Human networks are facilitated and nurtured by providing informal forums that can be assimilated to communities of practice. These are complemented with virtual spaces to share knowledge (including sensitive information) protected by a role access control system. The collective characteristic of Thai society is exemplified by the dimension given to team working. However, it has been shown that human networks can only be effective if the social conditions that underpin collaboration are met (including trust). This emphasises the role that social capital plays in creating organisational value underpinned by strong human networks. A participatory culture helped employees develop trust, respect, and understanding for others at different levels in BETA. This, as reported in Kayworth and Leidner [39] and Soliman and Youssef [40], contributes to improving employees' overall satisfaction and job effectiveness.

The results confirm the usefulness of KMS to store best practices, and indicate a good enthusiasm for learning by doing, formal training or learning from documentation, facilitated by the wide introduction of technology. Knowledge is now perceived as a real asset, and gathered data highlight the importance of the ability to access internal and external knowledge. Hence, concerns raised by staff in terms of IPR and confidentiality issues. The level of awareness that exist amongst staff in relation to the power and politics of knowledge has developed remarkably over the years. This emphasises the positive perception and appreciation of BETA's corporate intellectual capital and direct influence on KM practices. In this context, the introduction of KMS (through knowledge repositories and dedicated groupware services) has been welcomed, as the system encourages staff to store and share best practices. Collaboration through groupware is overall highly valued, and is described as important to nurture knowledge sharing, as confirmed in related literature [41]. The incremental development and introduction of technology seem to have worked, as an acute sense of knowledge value is gradually emerging.

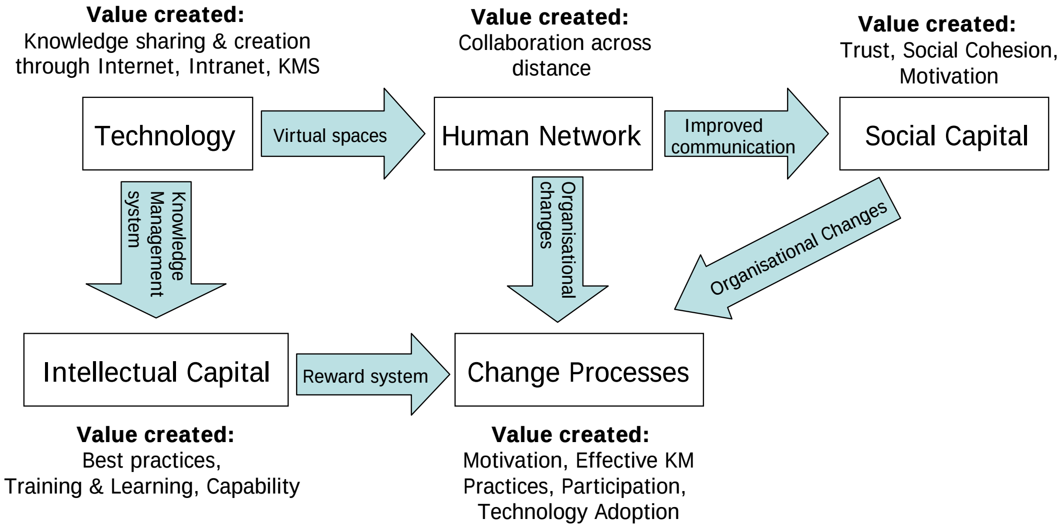

Figure 2: Factors to Sustain Value Creation in BETA

Thus, as illustrated in Figure 2, the value creation 'equation' in BETA is grounded in human networks underpinned by strong social structures facilitated by technology. Socio-cultural factors, including trust and confidentiality must be blended successfully toward the shared KM vision. Therefore, the migration path to value creation is grounded in human and cultural elements and is an exercise in change, which requires new mechanisms to enable participation and communication. The research reveals that the management have tried to adopt reward systems to motivate employees to share and create knowledge, and the employees have responded positively to the introduction of monetary and non-monetary rewards. There is a strong awareness amongst executive staff that managing the change process should not be overlooked to sustain this knowledge sharing and creation culture.

6. Conclusion

The research has investigated the KM capabilities in BETA, a Thai Hi-Tech organisation. It has also explored the perception about the value that is created out of knowledge. The results indicate that (a) BETA has demonstrated its readiness to migrate to a value creation culture underpinned by knowledge sharing and creation practices, (b) the distinctive collective characteristic of Thai culture engenders strong human and social networks, which in turn promote knowledge-friendly practices, and (c) a knowledge culture requires essential socio-organisational ingredients, including trust, confidence, motivation, continuous learning. BETA, as any other knowledge-based organisation, needs all of its employees to adopt a culture that promotes the virtues of knowledge sharing and creation. The culture of a company is the set of values, norms and attitudes shared amongst the members of the organisation. A knowledge-based culture requires a number of essential attributes, including:

- A culture of confidence and trust in which people are willing to share the information and knowledge they have.

- A culture that recognises that much knowledge is tacit and nurtured in social networks. This recognition places an emphasis on promoting open dialogues between staff so they can develop social links that can promote shared understandings.

- The support for human networks where members continuously strive to increase their shared understanding of their collective tasks and to seek continuous improvements in their practice.

The research confirms that Thai employees are full of perceptive insights into creating value out of knowledge and KM practices. Human networks, social capital, intellectual capital, and change process emerge as essential conditions to enable value creation. Focusing on social capital, the research identifies the collective capabilities derived from social networks facilitated by a supportive Thai culture. The higher the level of social capital, the more distributed communities are stimulated to connect and share knowledge [6]. Social capital can be applied to create value for organisations and end-users [42]. It has been shown that end-users in BETA are organised into teams with a strong social community dimension. Moreover, members of these teams and communities will be more inclined to use adapted KMS when they are (a) motivated to share knowledge with others, (b) able to share knowledge, and (c) have the opportunity to share knowledge. KMS that embed social awareness can play an important role in addressing these requirements, and promote social capital within and across teams.

Clearly more empirical research is needed to explore the role of KMS in promoting value creation in Thailand. A potential research avenue is to measure KM performance in organisations. It is hoped that the paper will stimulate this debate and trigger further research.

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Dynamic management models for simulation of construction company development

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Abstract

This paper presents models that are used for the prediction of the development of construction sector companies. These models are used for teaching management in the Czech Technical University. The models are based on the system dynamics method. The process of the model development and the usage is described in the paper. The first model describes the behaviour of the complex system representing the future development of a residential building market. The main subsystem is the stock of houses under development and stock of finished houses. The simulation program for hypothesis testing has been developed. The output parameters can be investigated from the investor, developer, construction company point of views. The second model calculates the amount of finished work in the projects that depend on the resources used in the project. It is an important issue nowadays in states with fast growth of the construction sector where a large worker shortage exists. The topic of the paper is more the description of the model development and learning process than a detailed description of the problem situations.

Keywords: System dynamics model, Dynamic behaviour, Housing market trends, Learning process

1. Introduction

1.1 Construction industry trends

We can observe in the Czech Republic the fast development of a construction industry production, see Figure 1. This industry comprises of 2355 companies with more than 20 employees that completed in the half year 2007 the construction works of 55.6 billion CZK (3 billion US$). It was more by 28.7 % than in the half year 2006 [1].

The changes in the economic environment caused important problems: construction companies suffer from worker shortage and from material shortage (e.g. bricks, thermal insulation materials). This development evoked new issues concerning the management methods in the companies as well as new tasks for the teaching processes in the universities. Project management and resources management subjects deal with the above described problems. This paper is focused on the presentation of system dynamics models that help to understand the dynamic behaviour of the systems reflecting real problems.

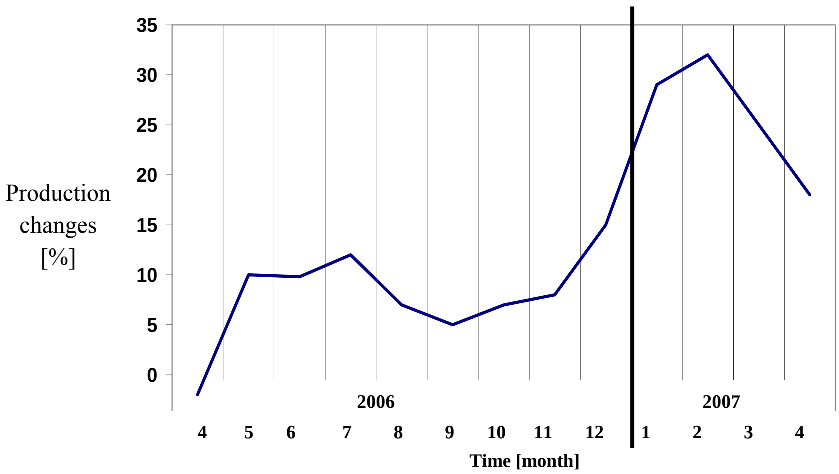

Figure 1: Construction industry production development in the Czech Republic (annual changes for certain month in current prices for year 2000)

1.2 System dynamics methodology

The models are based on system dynamics. System dynamics method allows us to understand the dynamic behavior of the complex system [2]. This method can be used for the simulation of any system - hard as well as soft systems. Most applications are focused on socio-economic systems at the company level.

The main elements of the models are the stocks that represent the level of the parameter (e.g. amount of the water in the tank, the number of existing buildings, account balance, number of workers) and the flows that influence the level of the stock (e.g. financial flows, building construction flow). An example of the model is depicted in Figure 2. Auxiliary elements are connections and converters that ensure information transfers and the calculation of the secondary parameters [3]. The elements create loops in the systems, see Figure 3. The existence of the back-loops considerably influences the dynamic behaviour of the investigated system [4].

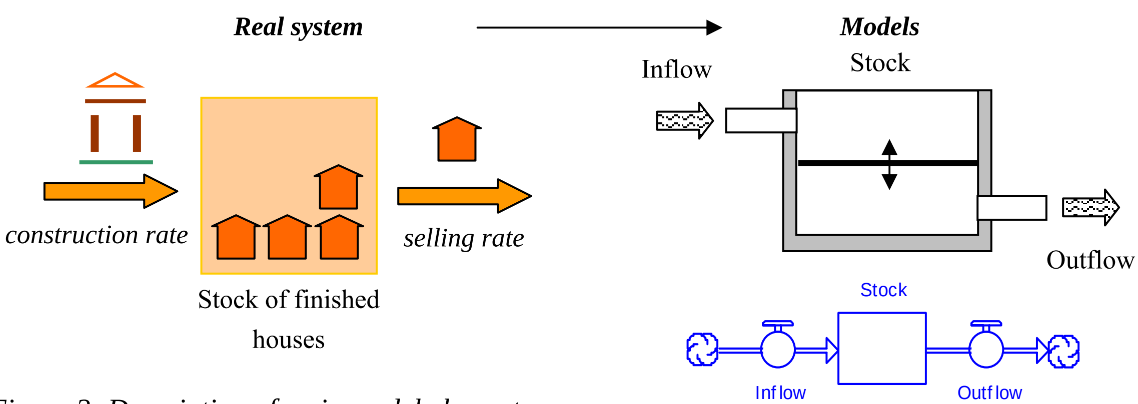

Figure 2: Description of main model elements

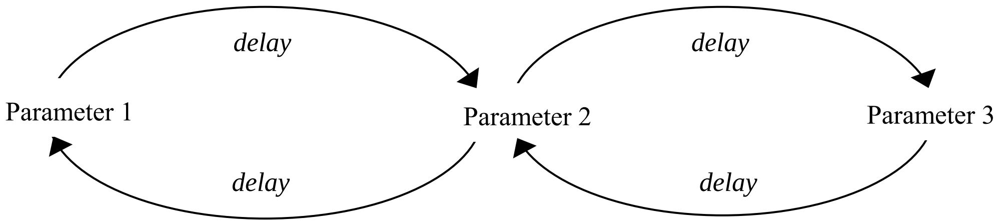

Figure 3: Causal loops in system

The equation that describes the stock changes for all kinds of parameters is Equation 1.

$$d\,(Stock)\,/\,dt = Inflow\,(t) - Outflow\,(t) \tag{1}$$

1.3 Teaching system dynamics

System dynamics models are used at the Czech Technical University, Faculty of Civil Engineering in subjects concerning management of the construction companies. There are different kinds of problem solving using system dynamics:

- From understanding system behaviour to the model - using ready-made system dynamics games, e.g. Beer game and deriving model for observed behaviour

- From the model to the proposal of the requested changes - using models for the design of input parameters or model structures with the goal to obtain the requested values of the output parameters

- Development of model for certain problem situation – understanding the dynamic behaviour and the development of the model

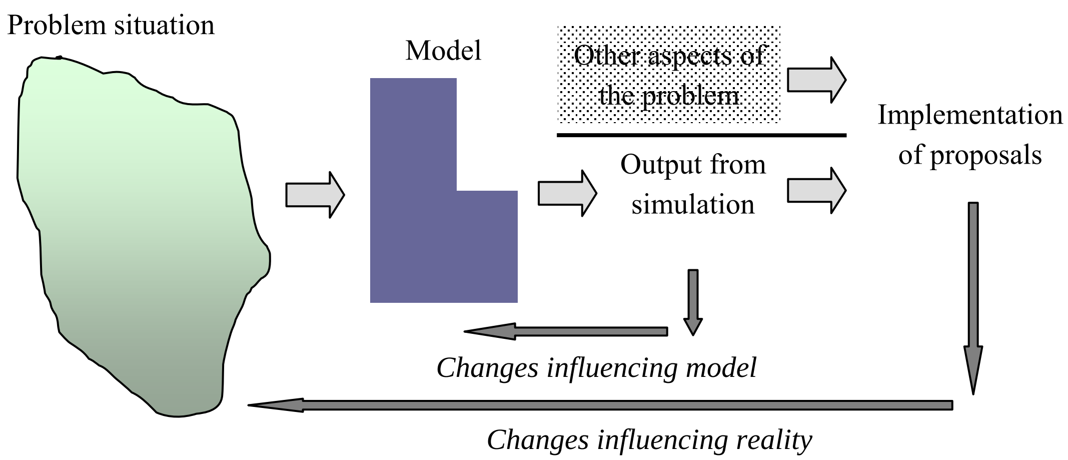

Figure 4: Relationship between problem situation and model

The students can practise all the described kind of problem solving. The whole process of the model design includes the steps of model construction, hypothesis development, hypothesis testing and conclusion writing. The students are trained to choose the relevant elements that have important influence on the behaviour of the real system and to consider also other aspects of the problem, see Figure 4.

2. Examples of models

The examples of two models developed for finding the desired parameters in the system are presented. Both models have been developed in the simulation program Stella [3].

2.1 Residential building market

The main subsystem is the stock of houses under development and stock of finished houses in a certain region. The starting rate is influenced by the efforts of the developers for new project launching. The number of finished houses depends on the capacity of building construction companies and on the demand for new houses.

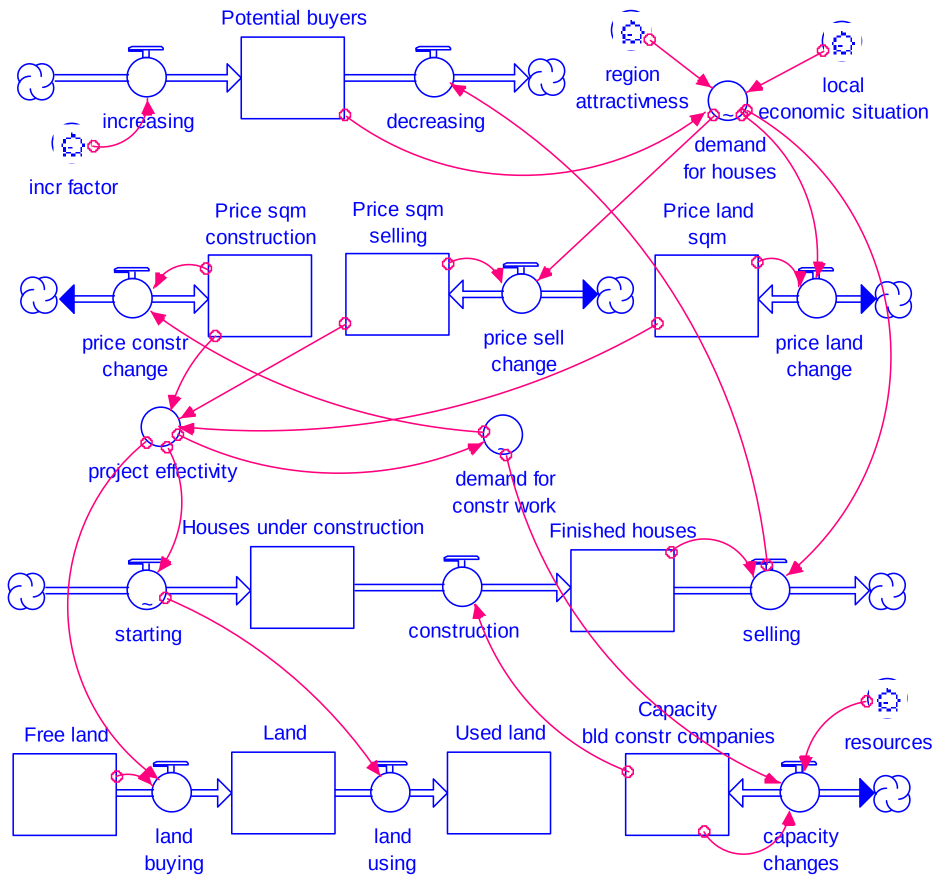

Figure 5: System dynamics model – residential buildings market

The objective of the class is to find the output parameters (finished houses during the next ten years) for actual input values and consequently to perform sensitivity analysis with goal to find the combination of input parameters that can ensure the growth of the market. The resultant values are shown in Figure 6.

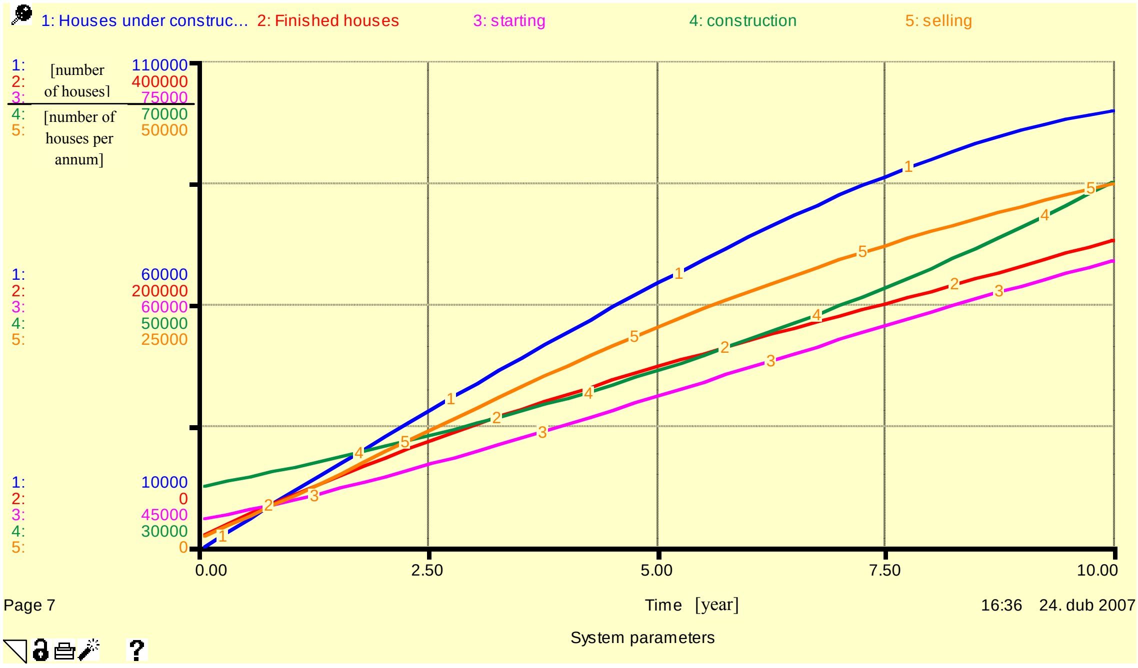

Figure 6: Output parameter values

2.2 Resources in project management

This model deals with the problem of project management. Students investigate the influence of the amount of the workers, their productivity and improvement time (Figure 7).

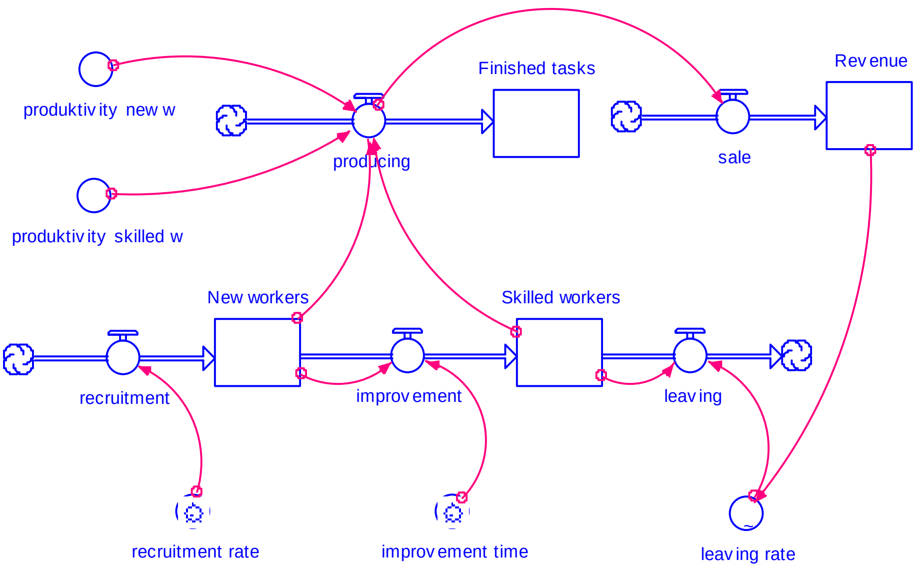

Figure 7: System dynamics model – project management

The main output parameter is *Finished tasks*. It is the amount of the accomplished tasks in the project during a time period. The model is suitable for all project-oriented companies but in this case the investigation is focused on solving problem of the key parameter - workers. The first stage is the presentation of the model as a simple line graph *recruitment – New workers – improvement – Skilled workers* and consequently other elements are added to the model. Students try to find the recruitment rate and the improvement time for the increase of the finished task and revenue. They also have possibility to design an improved structure of the model e.g. to introduce the element *cost of labour force*. The final recommendation is based on the simulated outputs together with the consideration of other influences.

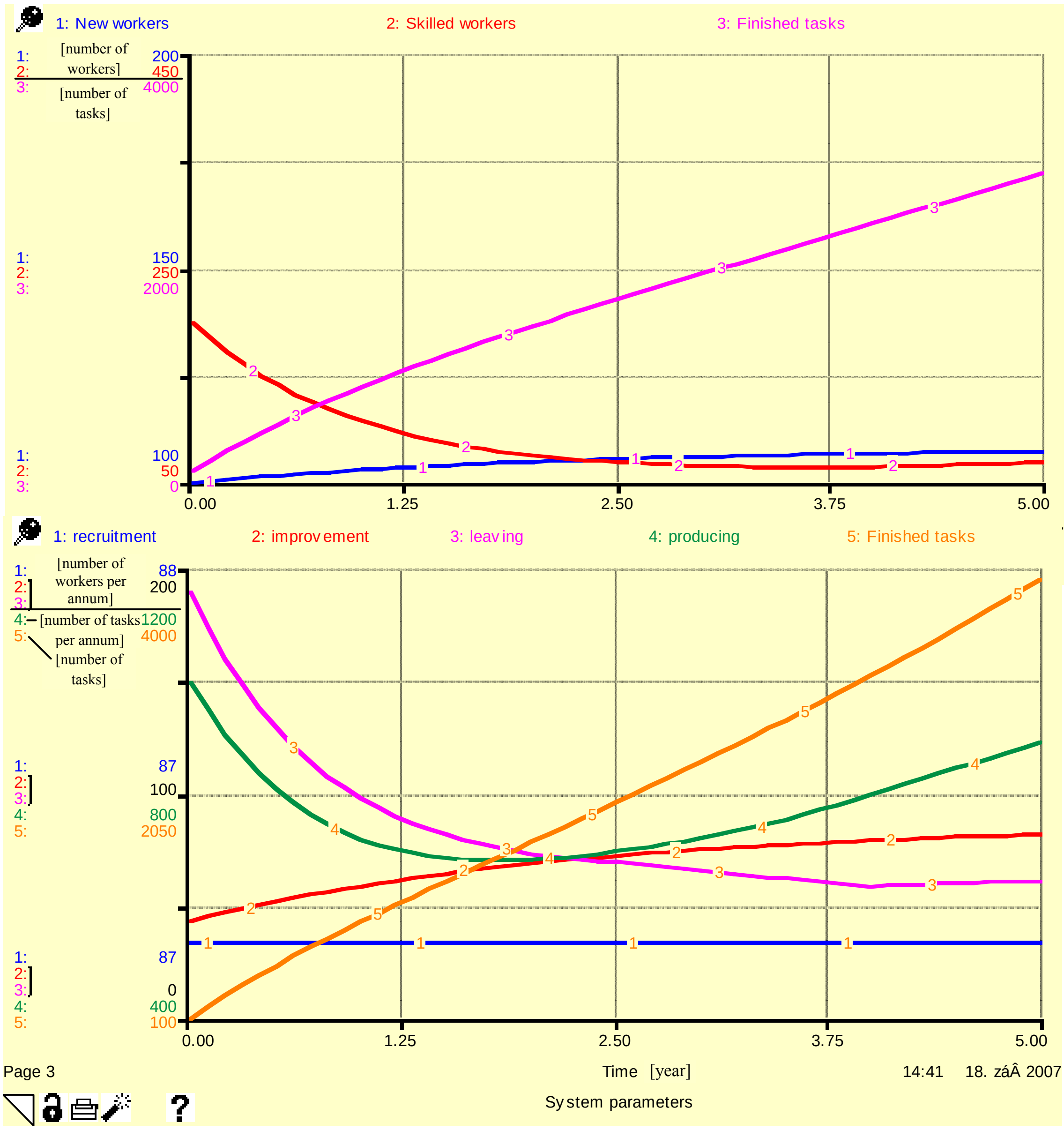

Figure 8: Output parameter values- initial values, Recruitment rate 47.0, Improvement time 2.3

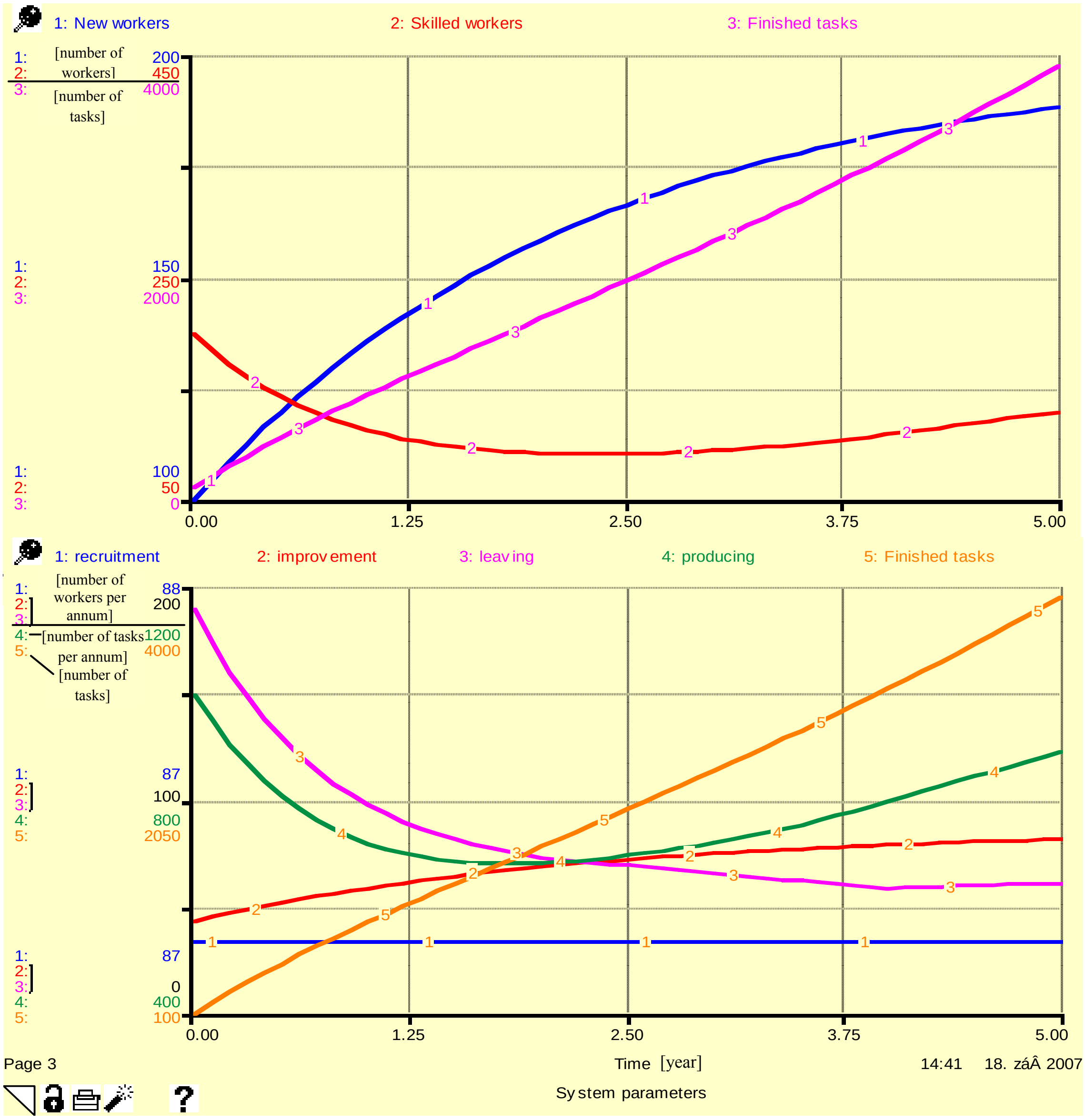

Figure 9: Output parameter values – improved values, Recruitment rate 87.0, Improvement time 2.3

Students write in the end of classes a document including their understanding of the problem situation, the goals of the simulation (what they wanted to obtain from the simulation) and their proposals for improving the problem.

The process of knowledge gathering and proposal making explained by means of system dynamics elements is described in Figure 10.

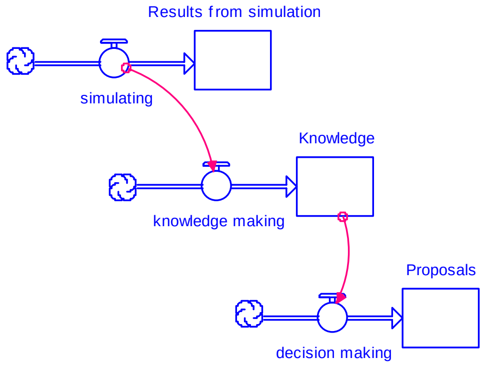

Figure 10: Process of knowledge and proposals development

3. Conclusions

Two models regarding the market prediction and the project management were presented. The usage of system dynamics models improves the learning process. The experiments in real world are very expensive and can caused serious problems in companies. The problem also is the impossibility to train all students in existing companies in the building sector.

The simulation in the virtual world brings new experiences for students. They can practise decision making without any apprehension. The students like to perform experiments in ready-made models and also to design their own models for a defined problem situation. Another advantage of using computer models is the possibility to compress time because students or any model designer can obtain many outputs in a very short time. The learning outcome is therefore very significant.

Next research will be focused on the development of the models that describe the problems in the building material supply. The discrepancies in the supply chain strongly influence the production of the companies in the construction industry.

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Author Index

Building Resilience brings together contributions to the CIB W89 Building Education and Research Conference that was held at Kandalama in Sri Lanka on 11th – 15th February 2008. It includes approximately 160 executive summaries by scholars from around the world.

The content of the papers reflects the research interests of several working commissions and task groups that operate within CIB, the International Council for Research and Innovation in Building and Construction, which is the world's foremost organisation for construction researchers and practitioners. The CIB working commissions and task groups are W098 (Building Education and Research), W113 (Law and Dispute Resolution), W116 (Smart and Sustainable Built Environment), TG53 (Postgraduate Research Training in Building and Construction), and TG63 (Disasters and the Built Environment). A major cross-commission and task group theme of the conference was to promote built environment related education and research to address the complex and global problems associated with anticipating and responding to unexpected events that damage or destroy an infrastructure project.

The conference was held in conjunction with the EURASIA project (European and Asian Infrastructure Advantage), a three year International research initiative funded under the EU's Asia-Link Programme. The project is working to improve capacity in training, teaching and research activities required for the creation and long-term management of public and commercial facilities and infrastructure. The project comprises partner Institutions from the UK (University of Salford), Estonia (Tallinn Institute of Technology), Lithuania (Vilnius Gediminas Technical University), and Sri Lanka (University of Moratuwa and University of Ruhuna).

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