KNOWLEDGE GAPS IN THE CONSTRUCTION INDUSTRY TO INCREASE SOCIETAL RESILIENCE TO DISASTERS

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ABSTRACT

There is a growing recognition that those responsible for the built environment have a vital role to play in developing societal resilience to disasters. If construction researchers and practitioners are to be able to contribute to reduce risk through resilient buildings, spaces and places, it is important that capacity is developed for modern design, planning, construction and maintenance that are inclusive, inter-disciplinary, and integrative. In order to address this challenge, an EU funded research project entitled CADRE (Collaborative Action towards Disaster Resilience Education) is identifying knowledge gaps and developing an innovative professional doctoral programme (DProf). The project seeks to integrate professional and academic knowledge in the construction industry to develop societal resilience to disasters. Through the development of an innovative and timely curricular and learning material, the project seeks to update the knowledge and skills of construction professionals in the industry.

Before developing the proposed DProf programme, it is important to identify the knowledge gaps in the construction industry. This paper is an account of a study to identify gaps in the knowledgebase of construction professionals that are undermining their ability to contribute to the development of a more disaster resilient society. Capturing knowledge gaps involved identifying the needs of various stakeholder groups associated with disaster resilience and management, as well as current and emerging skills that are applicable to construction professionals and would contribute to enhanced societal resilience to disasters. In parallel, an extensive policy analysis was conducted to capture the emerging policy level needs. The primary and secondary data generated a long list of needs and skills. Finally, the identified needs and skills were combined 'like-for-like' to produce thirteen broad knowledge gaps and associated sub-themes. The paper provides an extensive analysis of the knowledge gaps identified through this process.

Key words: Construction; disaster resilience; knowledge gaps; professional doctorates

BACKGROUND

The past decade has seen a concentration of disaster events causing major social, economic and financial impacts. Seven of the ten most costly disasters since 1980 have occurred in the last decade (Munich Re, 2015). This increasing trend of disaster losses is due in part to the unprecedented rate of urban growth, increasing dependence on complex infrastructure and changes in climate that are increasing exposure to anthropogenic and natural hazards (IPCC, 2014).

In order to tackle these increasing losses, the Sendai framework for disaster risk reduction 2015–2030 (UNISDR, 2015a), endorsed by 187 UN states in 2015, promotes disaster risk reduction practices that are multi-hazard and multisectoral, inclusive and accessible in order to be efficient and effective. The Framework also identifies: "a need for the private sector to work more closely with other stakeholders and to create opportunities for collaboration, and for businesses to integrate disaster risk into their management practices"; and, "a need to promote the incorporation of disaster risk knowledge, including disaster prevention, mitigation, preparedness, response, recovery and rehabilitation, in formal and professional education and training".

As a process, building disaster resilience involves supporting the capacity of individuals, communities and states to adapt through assets and resources relevant to their context (Manyena, 2006). There has been growing recognition that the construction industry and associated built environment professions are a vital component of this capacity, which needs to be deployed before and after a hazard visits a community. Effective mitigation and preparedness can greatly reduce the threat posed by hazards of all types. The post-disaster response can impact the loss of life, while timely reconstruction can minimise the broader economic and social damage that may otherwise result.

This paper is an account of a study to identify gaps in the knowledgebase of construction professionals that are undermining their ability to contribute to the development of a more disaster resilient society. This study is part of an EU funded research project, CADRE (Collaborative Action towards Disaster Resilience Education – www.disaster-resilience.net/cadre), that is seeking to develop innovative and timely professional education that will update the knowledge and skills of construction professionals in the industry, and enable them to contribute more effectively to disaster resilience building efforts.

ROLE OF THE CONSTRUCTION SECTOR

The environments with which people interact most directly are often products of human initiated processes. The importance of this built environment to the society it serves is best demonstrated by its characteristics, of which Bartuska (2007) identifies four that are inter-related. First, it is extensive and provides the context for all human endeavours. More specifically, it is everything humanly created, modified, or constructed, humanly made, arranged, or maintained. Second, it is the creation of human minds and the result of human purposes; it is intended to serve human needs, wants, and values. Third, much of it is created to help us deal with, and to protect us from, the overall environment, to mediate or change this environment for our comfort and well-being. Last, is that every component of the built environment is defined and shaped by context; each and all of the individual elements contribute either positively or negatively to the overall quality of environments.

The economic scale, size and impact of the built environment are significant. In the UK, construction is one of the largest sectors of the economy. It contributes almost £90 billion to the UK economy (or 6.7%) in value added, comprises over 280,000 businesses covering some 2.93 million jobs, which is equivalent to about 10% of total UK employment (Department for Business Innovation & Skills, 2013). It generates about 9% of gross domestic product (GDP) in the European Union and provides 18 million direct jobs. The European Union's internal market offers international partners access to more than 500 million people and approximately EUR 13 trillion in GDP (Internal Market, Industry, Entrepreneurship and SMEs Directorate, 2016). As a major consumer of services and intermediate products such as raw materials, chemicals or electrical equipment, construction impacts many other economic sectors.

From these characteristics, Haigh and Amaratunga (2010) identify several important consequences for the development of more disaster resilient societies. The vital role of the built environment in serving human endeavours means that when elements of it are damaged or destroyed, the ability of society to function – economically and socially – is severely disrupted. Disasters have the ability to severely interrupt economic growth and hinder a person's ability to emerge from poverty. The protective characteristics of the built environment offer an important means by which humanity can reduce the risk posed by hazards, thereby preventing a disaster. Conversely, post-disaster, the loss of critical buildings and infrastructure can greatly increase a community's vulnerability to hazards in the future. Finally, the individual and local nature of the built environment, shaped by context, restricts our ability to apply generic solutions.

In recognition of the built environment's importance to a society, there have been growing calls for greater engagement of the construction industry in disaster resilience building efforts. Hecker et al. (2000), Prieto (2002), Godschalk (2003), Liso et al. (2003), Lorch (2005), Aldunate et al. (2006), Haigh et al. (2006), Rees (2009), Haigh and Amaratunga (2010) and Bosher and Dainty (2011) have all indicated a need for greater integration of disaster resilience concepts into the education of construction professionals.

Supporting this view, one of the construction sector's key professional bodies, the Royal Institute of Chartered Surveyors (2015), called recently for, "a massive rethink around how we build up skills across our sector to meet the challenges we're facing and how we ensure economic viability for land and real estate firms while delivering on social needs and managing finite resources."

The scope of this contribution to resilience building efforts would appear to be considerable. Witt et al (2014) mapped, "the many and varied disaster resilience roles of construction professionals identified in the literature", to the disaster management cycle. They noted that each of the roles identified also reflected a corresponding need for construction education and research inputs.

CONTEXT OF THE STUDY

The consequences outlined above serve to underline and support the growing recognition that those responsible for the built environment have a vital role to play in developing societal resilience to disasters. It has also revealed the perceived challenges to deal with in developing a more resilient built environment. There is a dire need for construction industry and its professionals to adopt disaster resilience concepts and practices incorporating the multi-dimensional nature of the problem.

To this effect, the CADRE research team conducted a detailed study to capture labour market requirements for disaster resilience, and its interface with the construction industry and its professionals. The initial investigation aimed at capturing current and emerging skills for built environment professionals that could contribute to enhancing societal resilience to disasters across the property cycle (appraisal, brief, concept, development, design, tender, construct, operate and maintain), the needs of key stakeholders (local and national government, the community, NGOs, INGOs and other international agencies, academia and research organisations, and the private sector) involved in disaster resilience and management and across five dimensions of resilience (Social, Economic, Institutional, Environmental, Technological). This framework (Malalgoda et al, 2016) was developed through an extensive consultation process with project partners and was refined with the emerging literature findings and with the opinion of stakeholders who were interviewed to capture the labour market demands in construction industry to increase societal resilience to disasters.

There is growing recognition that those responsible for the built environment have a vital role to play in developing societal resilience to disasters. If construction researchers and practitioners are to be able to contribute to reduce risk through resilient buildings, spaces and places, it is important that capacity is developed for modern design, planning, construction and maintenance that are inclusive, inter-disciplinary, and integrative. This provided the basis for the identification of this multi dimensional framework combining construction life cycle, key stakeholders and the elements of resilience. This further supports the view that resilience need to be created and embedded through the products and processes of the built environment. In this context, the importance of a community's built environment – the processes and physical products of human creation that enable society to function economically and socially – was examined in the context of broader societal resilience. The study also considered the relative importance of the end product and the process used to create it. To what extent should those responsible for the planning, design and management of the built environment focus upon the elements of resilience? The starting point is that as society becomes more complex, resilient communities tend to be those which are well coordinated and share common values and beliefs and a sense of interconnectedness

METHODOLOGY

A broad range of practitioners from Europe and Asia involved with five stakeholder groups were interviewed: local and national government (20), academia (21), NGOs (12), community (15) and private sector (19). The aim was to understand gaps in the knowledgebase of construction professionals to contribute to the development of a more disaster resilient society. In total, 87 qualitative semi structured interviews were conducted with a view of better understanding the needs of the stakeholder groups, and the current and emerging skills, applicable to construction professionals. All interviews were voice recorded, transcribed and thematically coded using NVivo data analysis software. The interviews generated a long list of needs and skills with respect to the property lifecycle stages under the respective dimensions of resilience. Finally, the identified needs and skills were combined 'like-for-like' to produce a broader level of knowledge gaps.

In addition to semi-structured interviews, a desk review of key policies related to disaster resilience was carried out to reinforce the gaps yielded from the primary data: the Sustainable Development Goals (UN, 2015); the Sendai framework for Disaster Risk Reduction (2015-2030) (UNISDR, 2015a); the Paris 2015 climate change agreement (COP21, 2015); and UNISDR's 10 Essentials for making cities resilient (UNISDR, 2015b).

The findings were then validated using focus group discussions that were conducted as part of two organised stakeholder workshops.These involved a total of 25 respondents. The next section presents the knowledge gaps identified through this process.

KNOWLEDGE GAPS

Analysis of primary and secondary data revealed 13 knowledge gaps and a number of associated sub-themes, as shown in Table 1. Almost all of the stakeholders were in agreement about the key knowledge gaps, with the exception of 'ethics and human rights', which was only identified by private sector stakeholders. However, due to the importance placed on human rights in the Sendai Framework, it was considered as one of the key areas.

Among others, the imporatnce of governance, legal frameworks and compliance were strongly highlighted by many interviewees. Interviewees also highlighted the importance of greater engagement of the construction industry in developing and implementing building codes and land-use regulations in disaster resilience building efforts. Both primary and secondary data revealed a gap in the knowledgebase of the construction professionals in this context, especially at the planning, design and construction phases of the property cycle. Similarly, many interviewees highlighted the role construction professionals can play in developing resilient technologies, engineering and infrastructure, and highlighted a gap in this area. This is applicable for all phases of the property cycle, however interviewees extended particular emphasis to the 'use stage', and outlined the importance of strengthening and retrofitting vulnerable infrastructure.

While recognising the importance of a multi-stakeholder approach in disaster resilience and management, interviewees emphasised the importance of soft skills such as team working, communication and leadership while highlighting the need for alliances, partnerships and interdisciplinary working. All stakeholders equally acknowledged the gap in this area and highlighted the importance of promoting a multi-stakeholder approach and interdisciplinary working. Another key gap identified in the study was about the business continuity management (BCM). Although all stakeholders emphasised the importance of BCM, community and private sector stakeholders were more concerned about it. In terms of the construction industry's role, interviewees outlined the importance of effective supply chain management in order to ensure uninterrupted services during disaster times.

The construction industry's role in multi-hazard risk assessment, disaster response, contracts and procurement, and, post disaster management were equally highlighted by all stakeholder groups. Another key area was knowledge management. Within knowledge management, data and information management were particularly highlighted by the interviewees, along with related areas such as big data, analytical skills, standardisation and integration of data, and performance metrics, which emerged from the secondary data. Furthermore, all stakeholders agreed on the importance of indigenous knowledge and cultural intelligence in planning, designing and constructing houses for disaster affected people. Interviewees from Asia in particular highlighted about the abandoned post-tsunami housing in Sri Lanka due to a lack of social and cultural awareness at the planning and designing stage.

In terms of innovative financial mechanisms, all stakeholders emphasised the importance of risk transfer mechanisms such as insurance. Stakeholders attached to academia particularly highlighted the gaps related to affordable and cost effective designs, and cost benefit analysis, while private sector stakeholders highlighted the importance of investment appraisals at the planning stage. However, areas such as public-private partnerships and economic loss of disasters did not emerge from the interviews. These areas were cross cutting areas of the Sendai Framework and as a result, they were included under innovative financing mechanisms. Only the government stakeholders highlighted the importance of sustainability and resilience. However all stakeholders emphasised the importance of environmental impact assessment and management.

Table 1: Knowledge gaps

No	**Key knowledge gaps**	**Sub themes**
1	Governance, legal frameworks and compliance	8. Building codes, regulations and planning 9. Urban planning and land-use 10. Health & safety 11. Principles of accountability and transparency 12. Inclusive economic planning 13. Changing practice and policies
2	Business continuity management	J. Supply chain management
3	Disaster response	- Emergency and temporary shelters - Evacuation - Damage assessment - Temporary services
4	Contracts and procurement	• Supply chain management • Dispute resolution • Community wide engagement
5	Resilience technologies, engineering and infrastructure	q. Capacity and adequacy of critical infrastructure r. Strengthen / retrofit the vulnerable infrastructure s. Infrastructure interdependencies t. Clean and environmentally sound

		technologies and processes • Automation & standardisation • Project complexity • Climate change adaptation technologies
6	Knowledge management	• Data and information management • Communication • Big data analytical skills • Standardisation and integration of data • Performance metrics
7	Social and cultural awareness	• Cultural intelligence • Indigenous knowledge
8	Sustainability and resilience	• Environmental impact assessment and management • Sustainable design principles • Waste production and pollution of land water and air • Sustainable retrofitting • Debris management
9	Ethics and human rights	• Reflecting social demographics • Social responsibility
10	Innovative financing mechanisms	• Budgeting and estimating • Investment appraisals and cost benefit analysis • Economic loss of disasters • Affordable and cost effective design and usage • Claims and insurance • Public-private partnership (PPP)
11	Multi stakeholder approach, inclusion and empowerment	• Team working – collaboration and cross professional working • Soft skills of communication • Community empowerment • Leadership and people management • Disaster awareness • Alliances and partnerships • Interdisciplinary working • Change management
12	Post disaster project management	• Time management • Human resource management • Leadership and people management • Process and quality management • Materials and resource management

13	Understanding disaster risks	• Vulnerability, risk and exposure mapping • Multi hazard risk assessment

CONCLUSIONS AND WAY FORWARD

There have been growing calls for greater engagement of the construction industry in disaster resilience building efforts. This paper investigates the gaps in the knowledgebase of construction professionals that are undermining their ability to contribute to the development of a more disaster resilient society. This paper reports the findings of 87 stakeholder interviews which were supplemented by a comprehensive analysis of key policies related to disaster resilience and management. The primary and secondary data revealed thirteen key knowledge gaps and a number of associated sub-themes. This study is part of an EU funded research project, CADRE (Collaborative Action towards Disaster Resilience Education), that is seeking to develop an innovative professional doctorate for disaster resilience in the built environment. The knowledge gaps identified in this phase of the study will inform the next phase of the research, to develop a professional doctorate programme that can update the knowledge and skills of construction professionals in the industry.

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REFERENCES

Aldunate, R., Ochoa, S., Peña-Mora, F. and Nussbaum, M. (2006) Robust Mobile Ad Hoc Space for Collaboration to Support Disaster Relief Efforts Involving Critical Physical Infrastructure. ASCE Journal of Computing in Civil Engineering, January/February 2006, 13-20.

Bosher, L. and Dainty, A. (2011) Disaster risk reduction and 'built-in' resilience: towards overarching principles for construction practice. Disasters, 35(1): 1−18.

COP21 (2015) United Nations conference on climate change. [online] Available at: < http://www.cop21.gouv.fr/en/why-2c/ > [Accessed 22 October 2015].

Department for Business Innovation & Skills (2013) UK Construction: An economic analysis of the sector, July 2013.

Godschalk, G. (2003) Urban Hazard Mitigation: Creating Resilient Cities. ASCE Natural Hazards Review, August 2003, 136-143.

Haigh, R. and Amaratunga, D. (2010) An integrative review of the built environment discipline's role in the development of society's resilience to disasters. International Journal of Disaster Resilience in the Built Environment, 1(1), 11-24.
Haigh, R., Amaratunga, D. and K. Kerimanginaye, K. (2006) An Exploration of the Construction Industry's Role in Disaster Preparedness, Response and Recovery. The construction and building research conference of the Royal Institution of Chartered Surveyors University College London, 7-8 September 2006. London, United Kingdom.
Hecker, E., Irwin, W., Cottrell, D. and Bruzewicz, A. (2000) Strategies for improving response and recovery in the future. ASCE Natural Hazards Review, August 2000, 161-170.
Internal Market, Industry, Entrepreneurship and SMEs Directorate (2016) The European construction sector: a global partner, European Union.
IPCC (2014) Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
Liso, K., Aadahl, G., Eriksen, S. and Alfsen, K. (2003) Preparing for climate change impacts in Norway's built environment. Building Research
& Information, 31(3-4), 200-209.
Lorch, R. (2005) What lessons must be learned from the tsunami? Building Research & Information, 33(3), 209-211.
Malalgoda, C., Amaratunga, D., Keraminiyage, K. and Haigh, R. (2016) Knowledge gaps in the construction industry to increase societal resilience: a local and national government perspective. In: Achour, N. (Ed.). CIB World Building Congress 2016 (volume V) – Advancing products and services, 30 May – 2 June 2016, Tampere, Finland.
Manyena, S. B. (2006) The concept of resilience revisited. Disasters, 30(4), 433-450. DOI: http://dx.doi.org/10.1111/j.0361-
3666.2006.00331.x.
Munich Re (2015) Loss Events Worldwide 2014: 10 Costliest Events, Annual Statistics, Geo Risk Research, NatCatSERVICE.
Prieto, R. (2002) The 3Rs: Lessons learned from September 11th. Address to the Royal Academy of Engineering, 28th October 2002.
Rees, W. (2009) The ecological crisis and self-delusion: implications for the building sector. Building Research & Information, 37(3), 300-311.
RICS (2015) Our changing world: let's be ready, London: RICS.
UN (2015) Sustainable development goals. [online] Available at: < http://www.un.org/sustainabledevelopment/sustainable-development- goals/ > [Accessed 22 October 2015].
UNISDR (2015a) Sendai framework for disaster risk reduction 2015–
2030. Geneva: UNISDR.
UNISDR (2015b) Making cities resilient – my city is getting ready. [online] Available at: <

http://www.unisdr.org/campaign/resilientcities/home/index >
[Accessed 22 October 2015].

Witt, E., Sharma, K. and Lill, I. (2014) Mapping construction industry roles to the disaster management cycle, In the Proceedings of the 4th International Conference on Building Resilience, Building Resilience 2014, 8-10 September 2014, Salford Quays, United Kingdom, Procedia Economics and Finance 18 (2014) 103 – 110.