# 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.

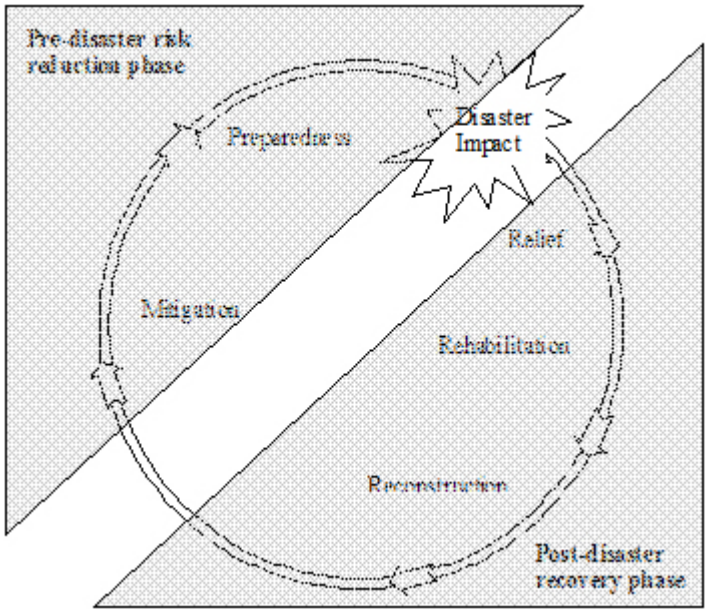


*Figure 1: Disaster management cycle by RICS (2006)*

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.

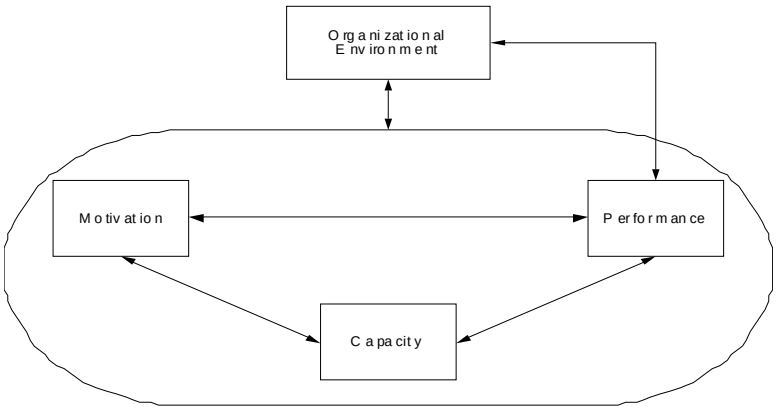


*Figure 2: Relationship between organisational environment, performance, motivation and capacity.*

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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