Capacity building for post disaster construction and demolition waste management

A case of Sri Lanka

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Received 1 September 2014
Revised 20 April 2015
2 November 2015
16 November 2015
Accepted 18 November 2015

Abstract

Purpose – The purpose of this paper is to present a theoretical framework for capacity building in post disaster construction and demolition (C&D) waste management at a national level to address the identified capacity gaps in managing disaster waste resulting from natural hazards.

Design/methodology/approach – Data were gathered through pilot interviews, case studies and expert opinion surveys representing government, non-government and other sector organisations involved in post disaster waste management.

Findings – The study revealed unavailability of a single point of responsibility and provision for disaster waste in existing policies and capacity constraints in prevailing peace time solid waste management practices which were identified as major capacity gaps. Establishment of a regulatory body and enforceable rules and regulations with necessary levels of capacities was identified and presented in a theoretical framework comprising of seven identified areas for capacity building in post disaster waste management.

Research limitations/implications – This study is limited to disaster C&D waste as debris generated from totally or partially damaged buildings and infrastructure as a direct impact of natural hazards or from demolished buildings and infrastructure at rehabilitation or early recovery stages. Waste generated during reconstruction phase of post disaster management cycle is not considered as disaster C&D waste for purposes of this study.

Originality/value – The research enabled analysis of existing capacities and presents approaches for capacity building for identified gaps in post disaster C&D waste management to attain sustainable post disaster waste management for future resilience.

Keywords Capacity building, Disaster waste, C&D, Post disaster

Paper type Research paper

1. Introduction[1]

Disasters with devastating impacts occur in the world at an increased frequency (Shakuf, 2007). Impacts of disasters have both human and environmental dimensions. Casualties including people being killed, injured and misplaced are major human impacts while property damage, collapsed buildings, infrastructure and crop destruction are some major environmental impacts including psychosocial impacts

Disaster Prevention and Management
Vol. 25 No. 2, 2016
pp. 137-153
Emerald Group Publishing Limited
0965-3562
DOI 10.1108/DPM-09-2014-0172

(Shaw, 2006). The US Federal Emergency Management Agency (FEMA) and Environment Protection Agency (EPA) identified physical damages that create enormous amounts of demolition waste through destruction of buildings and infrastructure as a grave consequence of disasters (United States Environmental Protection Agency (EPA), 2008; United States Federal Emergency Management Agency (FEMA), 2007). Brown *et al.* (2011a) and Shibata *et al.* (2012) revealed that construction and demolition (C&D) waste was the major component in most cases of disaster waste, such as in the Fukushima earthquake and tsunami in 2011, the Haiti earthquake in 2010, Hurricane Katrina in 2005 and the Indian Ocean tsunami in 2004. Pike (2007) concluded that approximately 55 per cent of the FEMA's federal disaster spending was directed towards immediate relief including waste removal such as in the case of post Hurricane Katrina in year 2005. United Nations Environmental Programme (UNEP) (2005), USEPA (2008) and Brown *et al.* (2011a) justify such enormous expenditure due to overwhelming impacts on existing solid waste management facilities that compel communities to use disposal options that are otherwise not acceptable. Further, Basnayake *et al.* (2005) stated more adverse effects caused by disaster waste on water quality, air quality, flora and fauna, visual impacts and socio economy, specifically highlighting the aftermath of the Indian Ocean tsunami in 2004. Within this context, disaster waste emerges as a critical issue in responding to a disaster closely intertwined with environment. Brown *et al.* (2011a) indicated that disaster debris impacts not only public and environmental health but also rescue and emergency services, provision of lifeline supports and social and economic recovery of affected areas. Thus, management of waste created by disasters has become an increasingly important issue to be addressed in responding to a disaster (Thummarukudy, 2012).

According to Pilapitiya *et al.* (2006) waste management and disposal is a significant weakness noted internationally when responding to disasters. The European Commission Progress Report on post tsunami Rehabilitation and Reconstruction Programme in year 2006 identified waste management as a key issue of environmental rehabilitation to be addressed at the post emergency relief stage (European Commission (EC), 2006). Brown *et al.* (2011a) revealed a number of gaps in existing legislation, organisational structures and funding mechanisms related to disaster waste management. Thus, emerges the importance of designing early stage strategies for disaster waste management with predefined disaster waste management procedures, adequate capacities of local areas, identified recyclable material and disposing sites for sustainable disaster waste management (Baycan and Petersen, 2002; Baycan, 2004; Basnayake *et al.*, 2005; United Nations Development Programme (UNDP), 2006; Ekici *et al.*, 2009; Moe, 2010; Brown *et al.*, 2011a).Further, it has been emphasised that these strategies need to be anchored to strategic-level disaster waste management policies with flexibility for further development to ensure continuity and sustainability (Baycan and Petersen, 2002; Joint UNEP/OCHA Environment Unit (JEU), 2010). In this context, this paper aims to present a theoretical framework for capacity building in post disaster C&D waste management to attain sustainable post disaster C&D waste management for future resilience. The next section of the paper presents the brief overview on post disaster waste management.

2. Post disaster waste management: C&D waste

The EPA of USA identified soil and sediments, building rubble, vegetation, personal effects, hazardous material, mixed domestic and clinical waste and human and animal remains that pose a risk to human health as several items of waste generated in most post disaster circumstances (EPA, 2008). In addition, it includes waste from relief

operations, damaged boats, cars, buses, bicycles, unexploded ordnance (e.g. landmines), waste from disaster settlements and camps, pesticides, fertilisers and healthcare waste (JEU, 2010). The type of waste generated mostly depends on the type of disaster and impacted built environment (FEMA, 2007; EPA, 2008). Hurricanes, tsunamis and floods create most typical debris streams, such as vegetation and household waste, while earthquakes, wildfires and ice storms mostly create specific items such as building rubble (C&D) and household hazardous waste (FEMA, 2007). Brown *et al.* (2011a) identified another form of waste indirectly generated in post disaster circumstances due to excessive donations such as healthcare waste, rotten food and emergency relief food packing.

Brown *et al.* (2011a) defined disaster debris to comprise of largely inert buildings (C&D waste) and vegetative material generated by a disaster and classified it as the largest component of urban disaster waste and a common type of waste generated in all types of disasters. Specifically, when contaminated with toxic substances such as lead, asbestos, arsenic, gypsum and organic pollutants it becomes hazardous (FEMA, 2007). Further, Kourmpanis *et al.* (2008) said that it is a priority waste stream that needs effective management due to non-degradable components that lead to environmental degradation and health problems.

Figure 1 illustrates the relationship between disaster C&D waste and post disaster management cycle.

As illustrated in Figure 1, the pre-disaster C&D waste management phase consists of measures to control disaster waste generation such as building regulations and codes. The post disaster C&D waste management phase includes collecting, transporting, processing and disposing of waste generated by disasters, partial

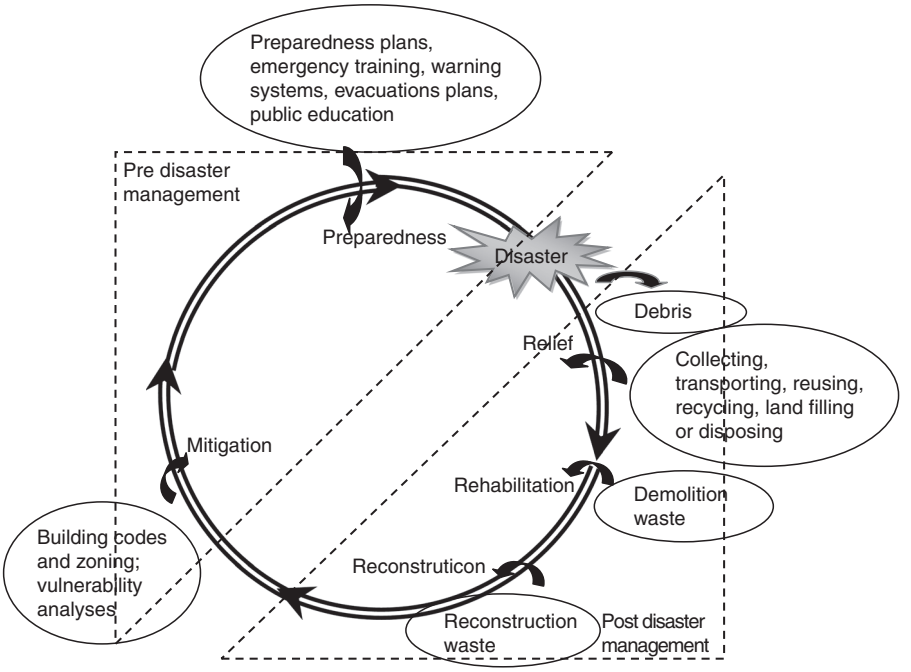

Figure 1.
Relationship between disaster C&D waste and post disaster management cycle

demolitions and reconstruction during relief, rehabilitation and reconstruction phase of disaster waste management cycle (Karunasena *et al.*, 2009; Karunasena, 2011). For this study, the researcher limited disaster C&D waste to being debris generated from totally or partially damaged buildings and infrastructure as a direct impact of disasters or from demolished buildings and infrastructure in rehabilitation or early recovery stages. Waste generated in reconstruction phase of post disaster management cycle is not considered as disaster C&D waste for this study as mostly it is "clean" and uncontaminated. Having identified the scope of study, the next section discusses the research methodology adopted to gather primary data for development of the theoretical framework with approaches to enhance capacities of national-level entities for post disaster C&D waste management.

3. Research methodology

Data collection was mainly conducted in four phases, as illustrated in Figure 2.

As illustrated in Figure 2, phase one – secondary data were collected through a comprehensive literature review to establish the importance of capacity building in post disaster C&D waste management.

The second phase mainly focused on preliminary investigations on the current status of post disaster C&D waste management in Sri Lanka. Pilot interviews were conducted due to inadequacy of information revealed by the literature review on post disaster C&D waste management processes in Sri Lanka. Most of literature revealed information on improper management of disaster waste with consequential challenges and issues during the Indian Ocean tsunami in 2004 (Srinivas and Nakagawa, 2007; Basnayake *et al.*, 2005). Basnayake *et al.* (2005) cited adverse effects caused by improper disaster waste management on water quality, air quality, flora and fauna, visual impacts and socio economy. Secondary findings revealed that there is a significant gap

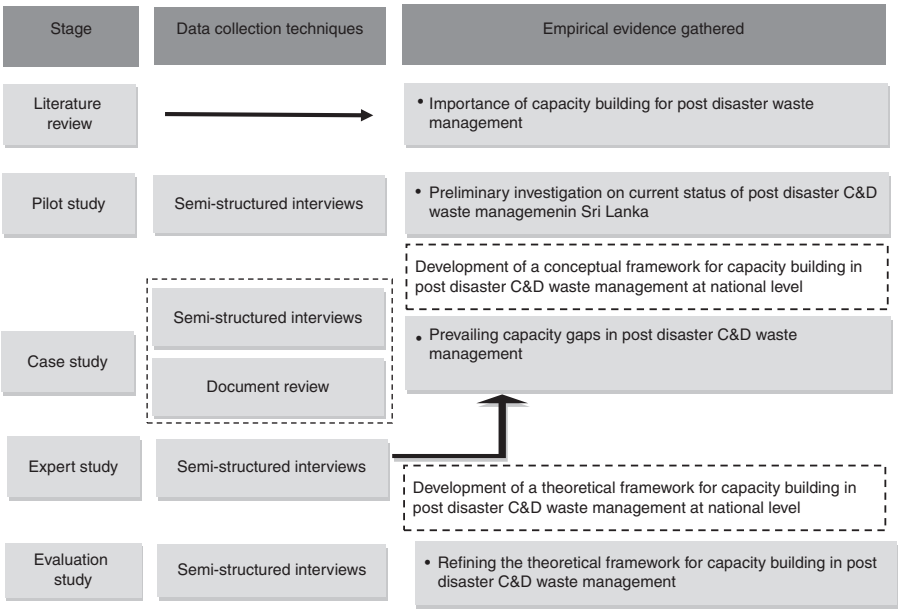

Figure 2.
Research methodology adopted

in information on existing practices on post disaster waste management specific to C&D waste. Thus, five pilot semi-structured interviews were conducted covering both national and local-level entities involved in disaster management as well as peace time solid waste management. Based on findings of literature review and pilot interviews, a conceptual model was proposed, as shown in Figure 3.

The third phase involved identification of capacity gaps of the seven identified areas (refer to Figure 3) in post disaster C&D waste management at national level. A case study approach was used to explore existing capacities and to identify capacity gaps as it facilitated in-depth analysis of seven identified areas. Three case studies were selected as government, non-government and other sectors representing key stakeholders involved in post disaster C&D waste management as shown in Table I.

Within three case studies fifteen semi-structured interviews were conducted with professionals experienced in post disaster waste management, representing entities of government, non-government and other sectors at national level. The case study findings were further verified by conducting six expert interviews. Expert views were gathered to verify capacity gaps and factors affecting capacity building identified in each area through case studies.

The fourth phase involved development of a theoretical framework by further enhancing the proposed conceptual framework incorporating case study and expert verified findings. Finally, three expert interviews were conducted to elicit experts' opinions on proposed theoretical framework for capacity building in C&D waste management at national level.

Semi-structured interviews were adopted as the main mode of data collection at all phases as it provided opportunities to respondents to express opinions

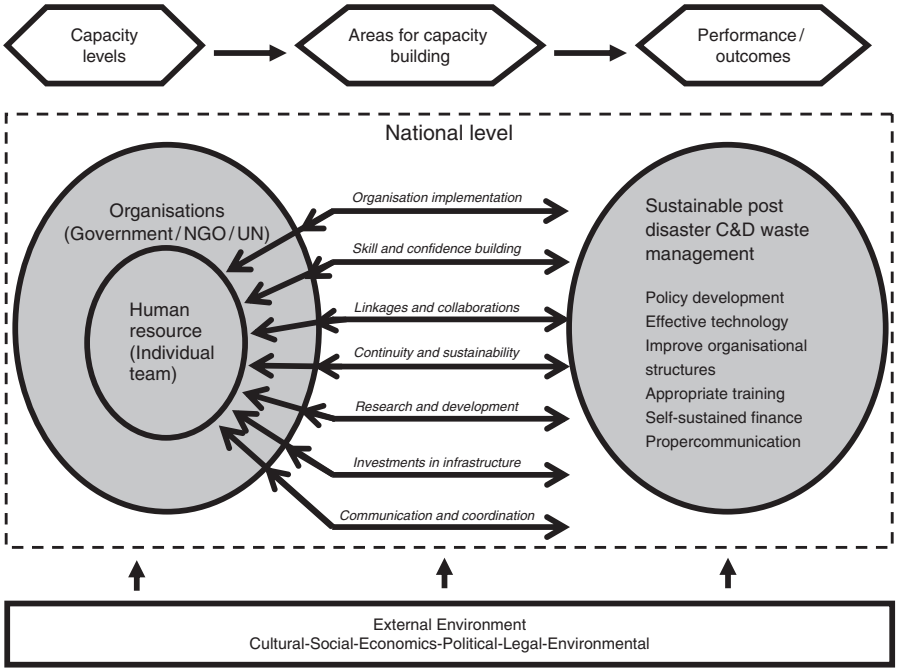

Figure 3. Conceptual framework

Case	Interviews	Entity	Designation
Government	7	Disaster Management Centre (DMC)	Director-Mitigation and Technology
		Ministry of Environment and Natural Resources (MENR)	Assistant Environment Manager
		Ministry of Resettlements and Disaster Relief Services	Development Assistant – Disaster Management
		Central Environmental Authority (CEA)	Assistant Director – Waste Management
		Coast Conservation Department (CCD)	Senior Engineer – Research and Design
		Marine Pollution Prevention Authority (MPPA)	Assistant Manager – Operations
		Ministry of Nation Building and Infrastructure Development	Additional Secretary – Planning and Development
Non-government	4	Sarvodaya Shramadana Movement	Manager-Community Disaster Management Centre
		Asian Disaster Preparedness Centre (ADPC)	Programme Coordinator
		International Union for Conservation of Nature (IUCN)	Programme Coordinator
		Practical Action	Project Manager –Disaster Risk Reduction
Other	4	United Nations' Development Programme (UNDP)	National Programme Officer
		International Federation of Red Cross and Red Crescent Societies	Disaster Management Coordinator – ICRC National Coordinator – Sri Lanka Red Cross

Table I.
Profile of the case interviews

without interruptions. In addition, documentary reviews were conducted to further clarify data gathered through semi-structured interviews at the case study stage. Details of previously conducted programmes and projects were specifically gathered through documents such as annual reports, year progress reports, etc.

The cross-case analysis technique was used as a suitable data analysis technique as the research contained three case studies. Code-based content analysis and cognitive mapping techniques were used to analyse each individual case based on seven themes mapping the identified areas. NVivo (Version 7) was used to assist data analysis process as it facilitated both content analysis and cognitive mapping. Next section provides a brief explanation of conceptual framework developed for capacity building in post disaster C&D waste management.

4. Conceptual framework for capacity building in post disaster C&D waste management

Figure 3 illustrates the conceptual framework developed for post disaster C&D waste management encompassing capacity building in the following characteristics:

(1) two levels of capacity building (human and organisational) linking to the third level (institutional and legal framework) of capacity development;

(2) dynamic and continuous process leading to improved effectiveness, efficiency and sustainability; and

(3) influenced by the external environment.

The existing literature strongly advocates that capacity building should take place at human resource and organisational levels. Human resource development (individual and team) addresses issues pertaining to skills and access to information, knowledge and training, providing for effective performance of national entities. Organisational development focuses on issues pertaining to structures, processes and procedures within organisations and maintenance of relationships with other organisations and sectors. Development of these two capacity levels eventually facilitates establishment of statutorily enforceable rules and regulations for post disaster C&D waste management (institutional and legal development). Although the two levels target different interventions they should not be considered in isolation as capacity development of one level may cause a synergistic or detrimental effect on the other (Low *et al.*, 2001; LaFond *et al.*, 2002; United Nations Educational, Scientific and Cultural Organization (UNESCO), 2006). As illustrated in Figure 3, seven areas of activities and processes contribute towards capacity building in national entities in disaster waste management, as graphically presented by arrows in the diagram. The arrows cut across structural levels indicating that activities and interventions may occur within and across structural levels. Arrow heads point at both directions suggesting that areas of each structural level can impact on another. Thus, the conceptual framework provides a structure by which capacities related to post disaster C&D waste management can be enhanced. It should, however, be noted that external factors such as cultural, social, economical, political, legal and environmental factors can also affect the proposed framework.

5. Research findings

The research findings from the case studies and expert interviews, along with an analytical framework, are disscused under three sub headings, as follows.

5.1 Capacity gaps in post disaster C&D waste management in Sri Lanka

Capacity gaps were identified and verified through case studies and expert interviews, as summarised in Table II.

As illustrated in Table II, the unavailability of formal procedures for preparation, conducting, monitoring and evaluation of training and awareness programmes is a major capacity gap as evidenced by a lesser number of programmes conducted on soft skills development as against many programmes on technical skills development at local authority level. The limited number of awareness programmes conducted for general public is another example. Lesser opportunities for personal development such as training, workshops and scholarships and inadequate strategies to retain valuable human resources are identified as other main capacity gaps prevalent in skills and confidence building.

Unavailability of a single point of responsibility at national level for post disaster waste management and absence of provision for disaster waste management in existing policies are major capacity gaps of organisation implementation. Inefficiencies and ineffectiveness of prevailing peace time solid waste management practices, policies and responsible authorities' is another capacity gap that impacts on disaster waste management. Examples are; absence of waste management practices such as segregation, reuse and recycling, lack of proper prior assessment of waste removal procedures and inadequate facilities for hazardous waste processing. During the Indian

Area	Capacity gaps
Skills and confidence building (Focuses on education and training of human resources (individual and team) to improve their ability to perform work functions)	Few opportunities for personal development – training/workshops
	Unavailability of formal procedures for preparation, conducting, monitoring and evaluation of training and awareness programmes
	Unavailability of strategies to retain valuable human resources
Organisational implementation (Focuses on improving organisational contributions for effective post disaster C&D waste management)	Unavailability of provisions for disaster waste management in existing policies
	Unavailability of single point of responsibility at national level for post disaster waste management
	Inefficiency and ineffectiveness of prevailing peace time solid waste management practices, policies and responsible authorities
	Non-revision of existing waste management systems/procedures par with new requirements
	Overlapping functions among institutions
Linkages and collaborations (Focuses on building partnerships and collaborations as means of building capacities by exchanges of skills, practice knowledge, resources, etc.)	Unavailability of formal procedures to establish linkages and collaborations to build capacities with expertise
	Availability of projects with complete proposals without implementation to build capacities
	Reduced active participation of NGOs and INGOs
Continuity and sustainability (Focuses on maintenance and continuity of acquired skills, knowledge, etc.)	Less consideration of incorporation of sustainable concepts into disaster waste management practices
	Ambiguities in prevailing solid waste management practices, policies and with responsible authorities
	Unavailability of formal procedures for monitoring and evaluation of implemented projects
Investment in infrastructure (Focuses on investing in infrastructure to enable smooth and effective post disaster C&D waste management)	Ambiguities in government rules and regulations on fund raising and procurement
	Less consideration for environmental protection
Research and development (Focuses on developing research capacity)	Reduced interest in research and development – government sector
	Inadequate opportunities for collaborative research programmes
	Inadequate transfer/sharing of knowledge and technical know-how
Communication and coordination (Focuses on enhancing communication and coordination capacities)	Non suitability of uniformity of prevailing centralised framework at emergency situations
	Inadequate efficiency and effectiveness of existing systems
Others (Focuses on capacity gaps and approaches identified, other than those mentioned above)	Vacuum between relief and early rehabilitation
	Policy issues, such as enforceability and less focus on disaster C&D
	Lack of awareness about peoples' needs when implementing new programs

Table II.
Capacity gaps in post disaster C&D waste management

Ocean tsunami 2004, disaster C&D waste was not recycled and reused to its optimum capacity in Sri Lanka, but was disposed of in landfills. Non-revision, retraining or monitoring of existing solid waste management systems at frequent intervals further aggravates these issues.

Unavailability of formal procedures to establish linkages and collaborations is a major capacity gap impacting on transparency and accountability. Example, risk assessments conducted during post-Indian Ocean tsunami period revealed that most disaster waste management programmes conducted at local authority level with the collaboration of NGOs, regularly fall short of current best practices due to lack of readily available advice, practical procedures and resources. It was revealed that projects with complete proposals and documentation exist without proper implementation. There is also a noted reduction in active participation of NGOs and iNGOs when compared to the period immediately after the Indian Ocean tsunami in 2004.

As mentioned, insufficiencies of prevailing peace time solid waste management practices, policies and also, responsible authorities and absence of formal procedures for monitoring and evaluation of implemented projects exist as capacity gaps impacting on continuity and sustainability of post disaster waste management in Sri Lanka. Example, lack of a pre-planned framework or rules and regulations which are statutorily enforceable and mandatory. This was evidenced in waste removal programmes implemented in Sri Lanka, along with the occurrence of the Indian Ocean tsunami in 2004, revealing that many failures incurred due to lack of enforceable legislations (Basnayake *et al.*, 2005; Martin, 2007; EC, 2006; UNEP, 2005). Less consideration at national level for incorporation of sustainable concepts into disaster management practices, including disaster waste management is also a prevailing capacity gap of this area. Example, many guidelines and projects initiated to achieve sustainability excluding disaster waste such as guidelines on establishing a National Sustainable Development Strategies (NSDS) and a special unit for sustainability called "*Haritha Lanka*" by Ministry of Environment and Natural Resources (MENR) (2007) and establishment of Green Building Council of Sri Lanka in 2010.

Inadequacies in rules and regulations on fund raising and procurement procedures are major capacity gaps impacting on investments in infrastructure in government sector entities. Example, findings revealed that many institutes have no authority to train people or issue permits to earn money. Less consideration on environmental protection and conservation by donors is another capacity gap.

There is inadequate interest in the area of research and development, particularly in the government sector. This is further aggravated by traditional government practices that do not facilitate new approaches in the long run. Inadequate opportunities for collaborative research programmes and lack of transferring and sharing of knowledge and technical know-how are also prevalent as capacity gaps in R&D.

Identified capacity gaps of communication and coordination include tight, formal approaches established for communication and coordination during emergency situations, uniformity of prevailing centralised framework, lack of efficiency and effectiveness and less transparency and accountability of established communication and coordination systems. A lesson learned after the Indian Ocean tsunami is that better coordination and information flow among environmental authorities, NGOs and disaster management authorities could have avoided several pitfalls such as improper waste management practices, unequal distribution of donations, etc.

Along with capacity gaps identified within aforementioned seven areas, findings further revealed capacity gaps influencing post disaster waste management in a

general context. An example is the vacuum between relief and early rehabilitation which leave disaster waste unattended. Lack of awareness of peoples' needs when implementing new programmes is also identified as a prevailing capacity gap. A study conducted on disaster waste management after the Samoan tsunami in 2009 by Brown *et al.* (2011c), revealed similar capacity gaps, such as unavailability of responsible authorities, lesser synergy among ministries, lack of strategy for coordination, unavailability of disaster funds and formal procedures to monitor funds.

In this context, the next section presents a proposed theoretical framework, which was developed for capacity building in post disaster C&D waste management to address the above-mentioned capacity gaps.

5.2 Proposed theoretical framework for capacity building

As illustrated in Figure 4, the proposed theoretical framework for capacity building in post disaster C&D waste management was developed based on research findings. Though it appears different to the conceptual model, it was based on same key concepts, inter-relationships and boundaries on which the conceptual framework was also developed (refer to Figure 3). Compared to the conceptual framework, proposed theoretical framework comprises of proposed approaches which can enhance capacities to overcome above-mentioned capacity gaps in post disaster C&D waste management processes in Sri Lanka, at national level.

Skills and confidence building. As illustrated in Figure 4, it is important to provide more opportunities for career development of responsible persons with local and international exposure to enhance capacities of officials at strategic level. Parallel to this, providing opportunities for self-training through field activities, specifically in disaster waste management which eventually provide real exposure than workshops and seminars is also important. It is proposed to provide incentives to attract and retain staff such as life insurance/pension schemes and sufficient grants for career development, especially for government employees due to high risk in disaster waste management. Specifically, significant difference need to be visible in provided incentives than those provided to general employees. To avoid repetition or duplication of programmes and unethical practices, establish formal procedures to prepare, conduct, monitor and evaluate local and foreign programmes under responsible authorities. Example, implement a national-level project to build technical support, assigning Disaster Management Centre (DMC) with responsibility for training and building awareness aligned with master plans at strategic level. These would eventually align capacity development with economic development of the country. Additionally, introduce monitoring and evaluation methods such as beneficiary evaluations, statistical and non-statistical measures and progress reports. Sharing and disseminating knowledge among respective parties can enhance personal interests on interactive working such as collaborative projects. Further, enhancement of soft skills is proposed as an approach to eliminate traditional bureaucratic red tape. Gupta and Sharma (2006) pointed out that good governance and social capital are important elements to ensure equitable recovery processes, as well as to ensure appropriate capacity building for marginalised and highly vulnerable communities. Thus, promote training and development programmes focusing on native and sustainable approaches giving consideration to new aspects such as good governance, livelihood development and resilience emphasising on environmental protection and conservation. Development of an expert knowledge database consisting of experience of experts

Figure 4.
Theoretical framework for post disaster C&D waste management

on disaster waste management comprising of technical information on safe waste handling, disposal options, facilities, regulations and contact information of those involved in disaster waste management, similar to a decision support tool such as the EPA's Suite of Disaster Debris Management and Disposal in the USA (Thorneloe *et al.*, 2007) is also vital.

Organisational implementation. It is necessary to incorporate disaster waste management into existing peace time solid waste management practices and policies to reinforce disaster waste management guidelines prepared specifically for developing countries with little or no existing infrastructure and expertise. Example, expansion of

existing peace time solid waste management practices such as "zoning" and "seven-step processes" is proposed to promote sharing of resources and collaborations among local authorities minimising the effects of inadequate resources, specifically during disasters. As mentioned, establishment of enforceable rules and regulations on disaster waste, as well as peace time solid waste management is necessary for long-term sustainability. Restructuring of institutional processes allocating specific functions with a single point of responsibility is also a key approach to improve institutional structures for better disaster waste management. This will overcome the non-functioning of important and necessary committees on disaster waste management and duplication of capacity building programmes. Example, preparation of lawfully enforceable provisions with clearly defined responsibilities and functions of each institution involved in disaster management is one such approach. These changes need to be incorporated into activities of entities as modes of mitigation, adaptation and recovery. In parallel, increasing collections of recyclable items, providing incentives for recyclers and mobilising peoples' support for recycling would also help future resilience. Enhancing existing procedures to facilitate quick and easy payment of compensation to affected parties from polluters, together with an effective spot fining system are suggested to enhance accountability of all parties in waste management.

Linkages and collaborations. Developing formal and transparent procedures to establish linkages and collaborations with local and international entities is an important approach. An example is to produce reports on benefits gained through established linkages and collaborations. This would enhance transparency and accountability of linkages leading to greater commitment of parties. Gupta and Sharma (2006) indicated networking among governments, NGOs, academia and communities as being crucial for informed decisions and improved practices, based on lessons learnt. As mentioned, enhancing capacities of government entities to promote interactive working, especially at local levels would lead to effective and efficient outcomes from partnerships since a government plays the leading role in many linkages and collaborations. Also, promoting diversification to build new relationships and collaborations among entities would increase linkages. Example, collaboration among government and non-government entities help avoid duplication of programmes, ensuring continuity of actions that evolve from projects.

Continuity and sustainability. Apart from creating awareness among the general public and training officials on sustainable, environmental-friendly and culturally supportive techniques on disaster waste management it is also suggested to create awareness on how to convert waste into profitable resources in the long run. An example is promoting composting and recycling together, as a holistic approach when initiating projects. Further, it is important to change rules and regulations to facilitate sustainability such as establishing formal procedures for monitoring and evaluation of implemented projects to avoid duplication of work and illegal projects with increased government intervention at regular intervals. Further, it is recommended to introduce procedures to obtain prior permission for projects on such aspects as quality, operational maintenance and environmental impacts to ensure continuity and sustainability. Additionally, at the end of a project, a certificate can be issued on achievement of sustainability standards.

Investments in infrastructure. The establishment of formal, transparent and accountable procedures for project selection and evaluation is important to improve investments in infrastructure, increasing confidence among investors. An example is to share financial reports at the end of a project among all parties, creating awareness

among investors on avenues available to make waste a profitable business while providing incentives. In addition, enhancing capacities of staff to obtain funds through project proposals and implementing policies, rules and regulations that facilitate self-financing are important steps for the government sector.

Research and development. The establishment of a transparent system to provide opportunities for career development, such as foreign training, workshops and scholarships is important to enhance research and development capacities. This is especially relevant to ignite and enhance interest on research and development within government entities. It can further be improved by allocation of sufficient funds for staff development and grant of promotions based on research performances. Examples are publications presented at recognised conferences, symposiums and papers published in academic journals. Establish resource centres with data on new developments and adequate facilities. Conducting awareness programmes to develop a research culture in government entities, changing attitudes and traditional practices is also important. Documentation of project outcomes for future reference and organisation of open discussion forums to share research interests at regular intervals would also enhance research and development.

Communication and coordination. The appointment of responsible persons at each level of communication and coordination process is necessary to enhance transparency and accountability in existing systems. Provision of adequate resources and new technologies such as wireless and online communication facilities can improve effectiveness and efficiency of existing systems. Through decentralisation of existing rules and regulations it is possible to minimise adverse effects of inadequate implementation powers of the DMC.

In addition to above suggested approaches within seven identified areas of capacity building, experts propose to design a framework on disaster C&D waste management through district coordinating committees and providing adequate provisions for disaster waste management when preparing urban development plans.

5.3 Updated theoretical framework for capacity building

The evaluation of proposed theoretical framework (refer Figure 4) was conducted based on opinions of experts gathered through interviews. Three experts were selected based on their expertise in post disaster waste management, specialising in C&D waste representing all stakeholders in disaster management. Two out of three experts were selected from DMC and Central Environment Authority, as they represent key government entities involved in disaster management and environmental protection, being responsible for development of related national policies. The other was selected from the Ministry of Local Government and Provincial Councils, being responsible for development of local authority-level policies. Semi-structured interviews were conducted with prior oral demonstrations of the proposed theoretical framework to obtain expert opinion on practicability of proposed approaches and suggestions for further improvement.

In respect of skills and confidence building, it was revealed that though opportunities for career development exist, generally they are not provided to the most suitable persons. Furthermore, introduction of a document entitled "National Competency Standard for Municipal Solid Waste Operation" in to National Vocational Qualifications level, to enhance capacities of technical-level persons in peace time solid waste management, was revealed.

All experts agree that national and local-level policies, rules and regulations need to be revised to include disaster waste management as prevailing rules do not address disaster debris. They further agree on necessity to restructure institutional practices as local authorities are incapacitated to handle disaster waste generated during national calamities. Experts proposed the formation of a national contingency plan on disaster waste management in collaboration with other entities, vesting a single point of responsibility in the DMC. They further proposed establishment of National Steering Committees on disaster waste management with all key players. They further suggested addressing disaster C&D waste separately as it provides an opportunity to impose a fee at disposal. Experts are of the opinion that prevailing rules and regulations are sufficiently enforceable, with inadequate implementation.

All experts said that linkages are maintained within institutional policies allowing limited opportunities for partnerships with NGOs and iNGOs. Active participation of NGOs and iNGOs are comparatively less than the post-Indian Ocean tsunami period. It is agreed that interactive working with government entities need to be promoted within prevailing rules and regulations. Experts also proposed introduction of a result-based management system to enhance interactive working.

Experts unanimously agree that as most projects are funded by the Government Treasury, there is less consideration for continuity and sustainability at national level. However, experts mentioned that organisations promote continuity and sustainability as most programmes are conducted at local levels introducing strategies such as holistic approaches and charging of service fees. Further, experts are of opinion that evaluation mechanisms of environmental impacts such as EIA, IEA or strategic environment assessments do not adequately consider continuity and sustainability.

In respect of investments in infrastructure, all agreed on the necessity of enhancing capacities to write proper research proposals. Due to lack of formal procedures on project evaluation, projects are difficult to implement. However, experts revealed the existence of their own evaluation procedures for local authority-level projects.

The experts said that at their relevant entities, priority is given to externally conducted research as they do not possess centres with adequate resources for research. These experts said that though open discussion forums are proposed, they are not successful due to the culture of participants who defend their own work, without sharing.

The experts agree with decentralisation of existing systems for more effective communications and coordination, while conceding that it is impossible to appoint responsible persons at each local authority due to the large numbers involved and lack of responsible persons at local levels. To overcome this, one expert suggested amending the Disaster Management Act, facilitating direct coordination with local authorities. According to experts, apart from a few local authorities, many do not have officers responsible for waste management. However, one expert mentioned that his entity appointed responsible persons at both levels of central and provincial government control.

In respect of general suggestions, experts commended such concepts as zoning and seven steps. Though there are provisions for waste management in urban development plans and development of standards enforceable by law is currently done by addressing needs from the bottom, disaster waste has not been considered in any one of them.

Accordingly, experts' evaluation of proposed theoretical framework suggested that most approaches already in execution for peace time C&D waste management needs to incorporate disaster C&D waste to enhance capacity building appropriately for future resilience.

6. Conclusions

The entire world is facing frequent and severe disasters. In a disaster, generation of waste is unavoidable and critical as it differs from a normal situation in terms of quantity and composition. Thus, improper waste management is a major environmental issue in any post disaster scenario, specifically when it is contaminated with toxic substances leading to environmental degradation and health problems. Therefore, measures to control waste generation and management of waste are needed for proper disaster waste management, being an important aspect of disaster management. This study investigated disaster waste management and prevailing challenges in Sri Lanka. Capacity building was identified as vital for post disaster waste management in Sri Lanka due to visible capacity gaps. Thus, this study proposed a theoretical framework for capacity building in post disaster waste management with a special emphasis on C&D waste at national-level entities.

Capacity gaps affecting capacity building in post disaster C&D waste management were presented within seven identified areas of: skills and confidence building, organisational implementation, continuity and sustainability, investments in infrastructure, research and development, communication and coordination and linkages and collaborations. Capacity gaps such as fewer opportunities for career development, unawareness, lack of incentives were identified at individual level while unavailability of formal procedures for preparation, monitoring and evaluation of programmes/projects, policy issues such as unenforceability, inadequate government support and unavailability of institutional arrangements were identified at entity level, in respect of aforementioned seven areas. The proposed theoretical framework for capability building in disaster C&D waste management was presented, with suggested approaches to overcome identified capacity gaps. The proposed framework could assist national entities involved in disaster waste management to focus on specific capacity building processes based on their institutional priorities. It contains evaluated approaches to enhance capacities, providing flexibility to initiate capacity building at different levels such as individual, team, programme, project, entity or network of entities and in different contexts than disaster waste management. It guides national entities involved in post disaster C&D waste management to enhance their capacities for effective and efficient processes and further assist them in necessary areas of other waste streams as well.

Note

1. This paper is an extension of *Capacity Gaps in Post Disaster Waste Management: Case Study in Sri Lanka* published in *Disaster Risk Reduction* in 2015, pages 403-415 and is based on some research undertaken in part completion of the first author's PhD.

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Further reading

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