Inspiring Sri-LankAn reNewal and Development – Phase II (ISLAND – II)

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Authors:
Mrs Krisanthi Seneviratne
Dr Chaminda Pathirage
Professor Dilanthi Amaratunga
Dr Richard Haigh

Centre for Disaster Resilience
School of the Built Environment
4th Floor, Maxwell Building
The University of Salford
Salford M5 4WT
Tel: 0161 295 4600
www.disaster-resilience.salford.ac.uk

School of the Built Environment **Education Trust, Royal Institution of Chartered Surveyors (RICS)**

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Executive Summary

Frequency and extent of natural disasters are increasing on a global scale. Natural disasters claim many human lives and damage a great deal of property. The urgent need to reduce disaster risk and develop a resilient community capable of recovering from disasters is of increasing concern in many countries. Knowledge management can play a vital role through ensuring the availability and accessibility of accurate and reliable disaster risk information when required and through effective lesson learning. 'ISLAND-II' (Inspiring Sri- LankAn reNewal and Development – Phase II) research project set out to identify key disaster knowledge factors pertaining to disaster management and incorporate appropriate knowledge and good practices relating to different types of disasters. The research was conducted according to four Work Packages (WPs): WP1- Test the Effectiveness of the Existing Knowledge Base; WP2- Identification of Key Knowledge Variables within the Disaster Management Cycle; WP3- Population and Expansion of Knowledge Base with more Case Studies; and WP4- Disseminate Research and Identify Future Research Directions. A review of existing literature, expert interviews and focus group discussions were used to deliver research outputs.

Disaster knowledge factors are classified into several categories based on their characteristics: Technological, Social, Environmental, Legal, Economical, Operational/Managerial, Institutional and Political. These factors are common for all types of disasters and across three phases of disaster cycle; mitigation/preparedness, relief/recovery and reconstruction/rehabilitation. Social factors have a very high influence level in managing disasters successfully. Technological, operational/ managerial, economic, social, legal and environmental factors seem to have direct influence over the disaster management cycle, while the influence of institutional and political factors seemed indirect and it is through other factors identified. The mitigation/preparedness phase seemed influenced by almost all the disaster knowledge factors. Among key challenges, the lack of detection and warning systems, the need for effective education, training and awareness raising programmes, the need for regular updating of disaster related laws, lack of funds for economic planning measures, poor planning, poor communication, poor leadership, and poor institutional arrangement were highlighted. Peoples' attitudes and perceptions hinder their involvement in disaster management; hence, in order to manage disasters successfully it is important to overcome these attitudes and perceptions.

About this Report

This document represents the final report for 'ISLAND - II' (Inspiring Sri-LankAn reNewal and Development Phase II- Project No. 383), a research project led by the University of Salford's School of the Built Environment. The project was partly funded by the Royal Institution of Chartered Surveyors (RICS) Education Trust and this report has been produced in partial fulfilment of the RICS's requirements. This report presents an overview of the project: the background and rationale; the project aim and objectives; the research methodology and project evaluation; a summary of activities undertaken, including a literature survey on disaster management and disaster knowledge management, development of knowledge factors, evaluation of the existing web portal, and collation of case material on good practices.

This final report has been written by the project's research team and it is produced for RICS in fulfilling the project's reporting requirements. If you require any further details, please contact the principal investigators:

Dr Chaminda Pathirage
C.P.Pathirage@salford.ac.uk
School of the Built Environment, 4th Floor, Maxwell Building, University of Salford, Salford, M5 4WT, UK

Professor Dilanthi Amaratunga
R.D.G.Amaratunga@salford.ac.uk
School of the Built Environment, 4th Floor, Maxwell Building, University of Salford, Salford, M5 4WT, UK

1 Introduction and Rationale

Billions of people in more than 100 countries are periodically exposed to at least one natural disaster (Moe *et al.*, 2007) and there are around 30 identified natural disasters worldwide (Deshmukh *et al.*, 2008). There is evidence that the frequency and extent of natural disasters are increasing on a global scale (Warren, 2010a). For instance, in the decade 1900-1909, natural disasters occurred 73 times, but in the period 2000-2005 the number of occurrences rose to 2,788 (Kusumasari *et al.*, 2010). This increase is as a result of more frequent disasters; the growth of global populations located in increasingly vulnerable areas; and continued environmental degradation (Deshmukh *et al.*, 2008).

Natural disasters claim many human lives and damage a great deal of property (Louhisuo *et al.*, 2007). During the previous century, over a thousand earthquakes have occurred in seventy countries worldwide, taking the lives of 1.53 million people and leaving behind great financial loss (Kusumasari *et al.*, 2010). In December 2004, a massive earthquake of magnitude 9.0 struck the coastal area of northern Sumatra in Indonesia and this triggered the tsunami that affected Indonesia, Thailand, Sri Lanka, India, the Maldives, Bangladesh, Malaysia, Myanmar and Somalia. It is identified as one of the deadliest and costliest disasters in history (Hansen, 2005; Oloruntoba, 2005), having caused an estimated US$ 9.9 billion worth of damage (Koria, 2009). The death toll is estimated to be between 200,000 and 300,000 (Poisson *et al.*, 2009). Hurricane Katrina was another large natural disaster which caused extensive human suffering and physical damage (Koria, 2009). According to Welsh and Higgins (2009) Hurricane Katrina left about 1,500 people dead and estimated US$ 81 billion worth of damage. Haiti was struck by an earthquake measuring 7.0 on the Richter scale on 12 January 2010. This is considered as the strongest earthquake in more than two centuries to have rocked the Caribbean nation. According to officials and witnesses, it caused dozens of buildings to collapse, and huge damage to infrastructure in the impoverished and crowded capital of Port-au-Prince (Cordoba and Luchnow, 2010). Three million people were affected by this earthquake and up to 250,000 died (Ozel *et al.*, 2011). The Tohoku earthquake and subsequent tsunami of 11 March 2011 caused huge loss of life and property. According to the Japanese National Police Agency, 11,438 people died and 16,493 people were missing as of 6.00 pm on March 30, 2011 (HuaDong *et al.*, 2011).

As communities worldwide have been facing an increasing frequency and variety of disasters (Oloruntoba, 2005; Kovacs and Spens, 2007; Moe *et al.*, 2007; Bayrak, 2009) , the urgent need to reduce disaster risk (Moe *et al.*, 2007) and develop a resilient community capable of recovering from disasters (Rotimi *et al.*, 2009) is of increasing concern in many countries. Disaster management efforts aim to reduce or avoid the potential losses from hazards, assure prompt and appropriate assistance to victims of disaster, and achieve rapid and effective recovery (Warfield, 2004).

In this context, knowledge management can play a vital role through ensuring the availability and accessibility of accurate and reliable disaster risk information when required and through effective lesson learning (Seneviratne *et al.*, 2010). Despite this, knowledge on disaster management strategies appears fragmented, emphasising a perceived gap in information sharing and coordination (Mohanty *et al.*, 2006; Seneviratne *et al.*, 2010). Accordingly, the knowledge and experiences of disaster practitioners remain in the individual or institutional domain. As an example, a case study conducted in Sri Lanka, revealed that many organisations have not been able to capture, retain and/or re-use the learning from similar operations except through the tacit knowledge of the individuals that have worked in various operations (Koria, 2009). Furthermore the UK Higher Education Disaster Relief Report (University of Gloucestershire, 2007) highlighted the lack of mechanisms at a national level in the UK to link the expertise, skills and knowledge that resides in higher education, with that of the practitioners working in humanitarian agencies. Therefore the lack of effective information and knowledge sharing, and knowledge creation on disaster management strategies can be identified as one of the major reasons behind the unsatisfactory performance levels of current disaster management practices.

In view of this identified need to share knowledge relating to disaster management strategies, the School of the Built Environment, at the University of Salford, undertook the research project 'ISLAND' (Inspiring Sri- LankAn reNewal and Development) in 2006, partly funded by the RICS Education Trust. The research aimed to increase the effectiveness of disaster management by facilitating the sharing of appropriate knowledge and good practices in land, property and construction. Due to the broad scope of disaster-management related activities, this initial research focused on creating a knowledge base on the post-tsunami response, with specific reference to case material in Sri Lanka. In this context, Sri Lanka provided a good base for data collection due to its experiences associated with the Indian Ocean Tsunami in 2004. ISLAND commenced with thorough and comprehensive literature and field surveys, visiting the subject areas of disaster management, post-disaster reconstruction and rehabilitation within the built environment. The findings of this phase resulted in the production of several academic papers and presentations made at international events such as the CIB World Building Congress 2007, held in Cape Town, South Africa, and at the RICS COBRA 2006 conference, held in London, UK. Accordingly, the development of a knowledge base with case materials relating to post-tsunami disaster mitigation measures was completed; however during the process, the necessity to concentrate on different phases of the disaster mitigation cycle was emphasised.

In this context, the 'ISLAND-II' (Inspiring Sri- LankAn reNewal and Development – Phase II) research project aimed to further extend the scope of ISLAND, by incorporating appropriate knowledge and good practices relating to different types of disasters, and by considering three phases within the disaster management cycle. These phases were, namely: *Preparation* in the form of planning, training and equipping to protect critical infrastructure and facilities, and mitigate when disasters do happen*; Response* by taking planned and improvised actions to restore critical infrastructure and facilities when a disaster occurs; and, *Recovery* by way of restoring communities to normal or, more precisely, creating a "new normal" through the development and reconstruction of facilities and infrastructure. Further the ISLAND-II project specifically focused on natural disasters, such as floods, tsunami, earthquakes, hurricanes etc.

2 Aim and Objectives

ISLAND-II set out to identify key disaster knowledge factors pertaining to disaster management, by evaluating the existing knowledge base and expanding the knowledge base to include good practice case studies associated with managing the different types of disasters, and by considering three phases within the disaster management cycle: mitigation/preparedness, relief/recovery and reconstruction/rehabilitation. In order to achieve this aim, the following objectives were identified:

- To evaluate and test the effectiveness of the existing knowledge base/infrastructure, for sharing and disseminating good practices relating to disasters;
- To identify key disaster knowledge factors within the disaster management cycle and map them against the disaster management cycle;
- To develop case materials associated with the above key disaster knowledge factors relating to different types of disasters, and further develop the existing ISLAND knowledge base by incorporating new case materials.

3 Methodology

The research was conducted according to four Work Packages (WPs). Details of WP specific aim, description and specific deliverables are provided within the WP outline.

Work Package 1: Test the Effectiveness of the Existing Knowledge Base

Aim: WP1 aimed to test the functionalities of the already developed infrastructure in accommodating disaster management components associated with preparation, response and recovery. Specifically, mechanisms were developed to extract and disseminate explicit knowledge from information gathered throughout the project life cycle. This provided the necessary base for the knowledge dissemination exercise within the proposed project, be it internal to an organisation or accessible worldwide as the database could be hosted centrally. A tested and updated dynamic web portal was the front end of this database, providing the search and update facilities to ensure enhanced user friendliness and self expansion.

Summary of tasks undertaken:

- Evaluate portal: Evaluation of the portal developed within ISLAND was used to refine its usage within ISLAND-II. As part of this activity, a selected group of users were invited to complete a survey in evaluating its user friendliness and accessibility, as well as its value for information and knowledge dissemination.
- Update web portal: These evaluations were used to provide an overall evaluation of the portal, which was used as the basis for further updates as part of ISLAND-II.
- Manage web portal: Once operational, an ISLAND-II researcher was responsible for managing the database and associated web portal. This included ongoing technical maintenance for the server, support for contributors and users, and periodic updates and improvements based on continuous evaluation.

Deliverables from WP1 include: Dynamic web portal and database.

Work Package 2: Identification of Key Knowledge Variables within the Disaster Management Cycle

Aim: WP2 aimed to identify key knowledge factors for effective disaster management. Knowledge can be categorised as explicit, tacit or implicit knowledge. Within a disaster management context, knowledge management is all about getting the right knowledge, in the right place, at the right time. As a strategic approach to achieve disaster management objectives, knowledge management will play a valuable role in leveraging existing knowledge and converting new knowledge into action through the knowledge management cycle. In essence, the knowledge organisation and human knowledge conversion process can bring a comprehensive foundation to the common operating picture, interoperability, intelligence, training and acquisitions.

Summary of tasks undertaken:

- Data collection: This work package was delivered based on interviews with experts who are involved in the disaster management process. In addition, published literature on good practices and lessons learned relating to disaster management were re-visited with a view to identifying key knowledge themes/factors.
- Identification of knowledge factors within the disaster management cycle: A focus group was used to further refine the identified knowledge factors within the disaster management cycle, identify appropriate sources of disaster management knowledge and establish what constitutes a disaster management body of knowledge. This was organised as part of the Disaster Resilience Conference, which took place in Sri Lanka. Data analysis: NVivo, Decision Explorer, were used to analyse the data gathered through various means in arriving at a refined set of key knowledge factors.

Deliverables from WP2 include: A knowledge map highlighting key variables relating to the disaster management cycle, academic journal and conference publications.

Work Package 3: Population and Expansion of Knowledge Base with more Case Studies

Aim: WP3 aimed to populate the expanded knowledge base with a range of materials related to the three phases of the disaster management cycle (preparation, response and recovery). Funding and professional bodies, and relevant research groups were identified and invited to contribute with materials to the knowledge base, including:

- Disaster recovery strategies, their effectiveness, drawbacks and current good practices; the level of community involvement;
- Details on short term relief and its benefits;
- Plans for long term developments including the consultation process between the government and the local community, and plans for physical and economic development;
- Knowledge on planning and building settlements that respond to community needs whilst providing a more secure environment.

Summary of tasks undertaken:

- Data Collection: Links to relevant websites and information sources were indentified and highlighted on the portal.
- Populate knowledge base: The project's researcher collated and uploaded information by making the knowledge base updatable through the proposed framework, it was also made self-expanding, self-updating and self-sustaining.

Deliverables from WP3 include: Populated knowledge base with additional case materials. Also a session to demonstrate the functionality of the website and other findings was organised as part of a Disaster Resilience conference.

Work Package 4: Disseminate Research and Identify Future Research Directions

Aim: WP4 aimed to disseminate the research outputs and identify future research directions. The research web portal formed the focal point for the research dissemination strategy. However, the project also used and integrated other appropriate dissemination mechanisms. VERBER, a state of the art collaborative research tool which was developed as a part of the EURASIA project (http://www.eurasia.buhu.salford.ac.uk) was used to promote the portal, and where appropriate create synergy. VERBER also has an interactive web front end, powered by a relational database, and therefore the two technologies work in harmony. It was used extensively to administer the questionnaire for this project. A range of academic publications, industry reports and prestigious international conferences on relevant themes were targeted as a means of promoting the portal and disseminating the case material to a wider audience.

Summary of tasks undertaken:

- Identify new research directions: The review of published materials and expert interviews (as part of WP 2) to identify gaps in the current knowledge base and opportunities for further research.
- Academic publications: The academic team was responsible for the dissemination of research findings through publication in academic journals and conferences. All publications and conference presentations acknowledged the financial assistance of the RICS Education Trust.
- Final project report: The project final report details the project outputs based on material gathered and collated during the project. The report also identifies future research directions.

Deliverables from WP3 include: Final project report; academic journal papers and conference papers; conference and other presentations.

4 Project Evaluation

This section summarises the outputs of major activities undertaken during the project;

- A review of existing literature; disasters, disaster management and the disaster management cycle (section 4.1.1); knowledge management and disaster knowledge management (section 4.1.2); and disaster knowledge factors (section 4.1.3)
- Interview and focus group findings on disaster knowledge factors; profile of the interviewees (section 4.2.1); influence level of disaster knowledge factors in managing disasters (section 4.2.2); how disaster knowledge factors influence the disaster management cycle (section 4.2.3); and challenges (section 4.2.4)
- An evaluation of the effectiveness of the existing knowledge base (section 4.3)
- Population of the knowledge base with more studies (section 4.4)
- Publications based on the project (Section 5.1, 5.2 and 5.3)

4.1 Literature review

4.1.1 Disaster management

Moe *et al.* (2007, pp. 787) define a disaster as ‘‘a situation which overwhelms local capacity, necessitating a request to the national and international level for external assistance, or is recognised by a multilateral agency or by at least two sources, such as national, regional or international assistance groups and the media’’. Disaster is derived from the Greek meaning, ‘bad star’ (Konoorayar, 2006). Disasters are classified in various ways. The Emergency Disasters Database classified disasters as natural or technological. The United Nations (2006 cited in Moe *et al.*, 2007) further classified natural disasters into three categories: hydro-meteorological disasters (floods, wave surges, storms droughts, forest fire and extreme temperature), geophysical disasters (earthquakes, tsunamis and volcanic eruptions) and biological disasters (epidemics and insect infestations). Technological disasters consist of industrial accidents, transport accidents and miscellaneous accidents.

Disaster management is an integrated process of planning, organising, coordinating and implementing measures that are needed for effectively dealing with its impact on people. This includes prevention, mitigation, capacity building, preparedness, response, assessment, rescue and rehabilitation (Deshmukh *et al.*, 2008). According to Warfield (2004), disaster management efforts aim to reduce or avoid the potential losses from hazards, promote prompt and appropriate assistance to victims of disaster, and seek to achieve rapid and effective recovery.

The disaster management cycle illustrates the ongoing process by which various stakeholders in a society plan for and reduce the impact of disasters, react during and immediately following a disaster, and take steps to recover from the impact (Clerveaux *et al.*, 2010). Phases in natural disaster management are frequently identified using different terms, but give similar insights. Figure 1 shows the disaster management spiral, which illustrates the two main phases of disaster management: pre-disaster risk reduction and post disaster recovery.

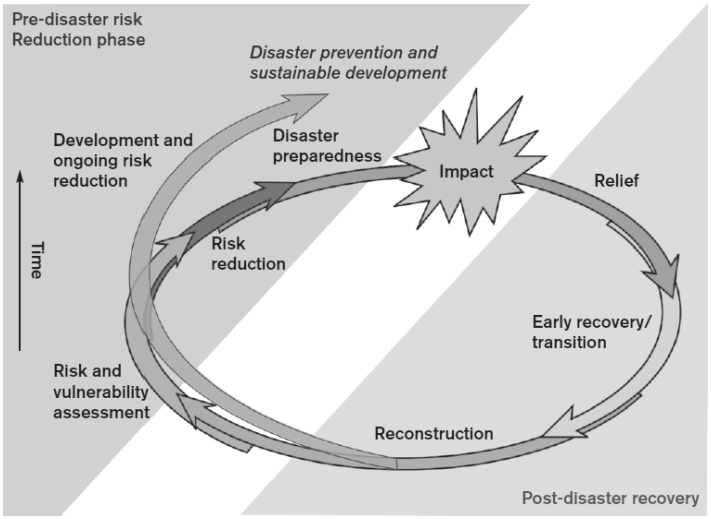


Figure 1: The risk management and response spiral

Source: RICS, 2009

Risk and vulnerability assessment involves identifying the nature and magnitude of current and future risks from hazards to people, infrastructure and buildings (RICS, 2009; McEntire, 2010). Through vulnerability analysis it is possible to identify which public and private buildings should be reinforced or relocated and which buildings are likely to contain large numbers of trapped survivors. For example, it would be unrealistic to prevent or limit building and occupation of the coastal environment and reinforce every building within a tsunami flood hazard zone due to the economic costs involved. Also it would not always be possible to construct large and hard engineered coastal barriers such as breakwaters, walls and revetments. Therefore, detailed information on which buildings, structures and group of people are vulnerable to tsunami impacts helps to develop cost effective mitigation measures. *Mitigation or risk reduction* activities include structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards (Atmanand, 2003). *Preparedness* deals with the activities and measures taken in advance to ensure an effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations (Atmanand, 2003; Moe *et al.*, 2007).

The provision of assistance or intervention during or after a disaster to meet the life preservation and basic subsistence needs of those people affected is made during the *relief phase* (Moe *et al.*, 2007). Relief activities include medical attention, body identification, clearing away rubble, debris, providing transport access, survival requirements, water purification kits, cooking utensils, foods, safe areas, relocation, shelter and general living and psychological support (Perry, 2007). The *transition phase* involves community surveys, needs assessment, land survey, and acquisition and provision of transitional shelters (RICS, 2009). Care and maintenance of transitional shelters is required until permanent housing construction is provided. *Reconstruction* refers to the rebuilding of the damaged living conditions of the stricken community with the aim of long term sustainability (Moe *et al.*, 2007). The commencement of the recovery phase begins with the restoration of essential buildings and infrastructure facilities destroyed in the disaster, and rehabilitation to assist the victims in returning to their pre-disaster livelihood (Pheng *et al.*, 2006) or until the community's capacity for self-help has been restored (Rotimi *et al.*, 2009). Recovery is usually identified as slow, expensive and complex in terms of its coordination and management (Koria, 2009). However it may present an opportunity for improvement in the functioning of the community, so that the risk from future events can be reduced while the community becomes more resilient (Rotimi *et al.*, 2009).

The activities of vulnerability assessment, mitigation and preparedness are conducted as a proactive approach while the activities conducted after the disasters are called a reactive approach. The lack of a proactive approach to disaster management can result in more damage and a higher level of proactive behaviour is required for successful disaster management (Moe and Pathranarakul, 2006). However, some natural disasters (droughts, floods and volcanic eruptions) are slow-onset and provide a lead-time for a proactive approach, while others (flash floods, earthquakes, tsunamis and cyclones) provide little or no lead-time for proactive measures (Moe and Pathranarakul, 2006). Therefore an integrated approach which includes both proactive and reactive strategies is important for managing disasters successfully.

4.1.2 Disaster knowledge management

Mohanty *et al.* (2006) define knowledge as "the fact or condition of knowing something with a considerable degree of familiarity through experience, association or contact''. Three forms of knowledge are identified: explicit, tacit and implicit. Explicit knowledge is that which is stated in detail and is termed as codified or formal knowledge (Tatham and Spens, 2011). Explicit knowledge can be accessed by anyone, for example, books, pictures, or recording clips. According to Nonaka *et al.,* (2000), tacit knowledge represents knowledge based on the experience of individuals, expressed in human actions in the form of evaluation, attitudes, points of view, commitments and motivation. Tacit knowledge is lost with the person who possesses it. Implicit knowledge is that which could be expressed, but has not been (Mohanty *et al.*, 2006). In other words implicit knowledge is that body of knowledge which exists without being stated.

Knowledge management is a process by which knowledge is created, shared and utilized (Deshmukh *et al.*, 2008). According to Tatham and Spens (2011), knowledge management is generally seen as a strategy to collect, store and retrieve knowledge in a systematic way, and then distribute the results to those who need it in a timely manner (Tatham and Spens, 2011). In simple terms, knowledge management is all about providing the right knowledge, in the right place, at the right time. However, it should be borne in mind that knowledge management systems can only provide decision support and it is the people in emergency situations that deal with the actual emergency or disaster. As a result, exact actions and responsibilities of individuals cannot be predetermined due to some unforeseen events occurring during the disaster (Otim, 2006).

Though there is no way of neutralizing all of the negative impacts resulting from disasters, efforts can be made in order to reduce their consequences. Knowledge on disaster management strategies, together with good practices and lessons learned can undoubtedly support this effort through well-informed mitigative measures and preparedness planning. The RICS (2009) emphasises the feeding back of recovery experience to inform the disaster management process in order to reduce future risks and improve the resilience of vulnerable communities. According to Moe *et al.* (2007) it is essential for practitioners in the disaster management field to be innovative and learn from lessons in order to adopt best practices throughout the disaster management cycle. Practitioners in disaster management should improve their skills and increase their level of knowledge, which requires investments in systems, databases and network structures so as to build a culture of learning from previous lessons and the adoption of best practices (Moe *et al.*, 2007).

Despite this, knowledge on disaster management strategies appears fragmented, emphasising a perceived gap in information coordination and sharing (Seneviratne *et al.*, 2010; Mohanty *et al.*, 2006). Accordingly, the knowledge and experiences of disaster practitioners remain in individual or institutional domains. According to UNESCO (2005), while abundant knowledge about risk and vulnerability to hazards exists, its access and utilization at the community, national, regional and international levels, to empower or protect, is yet to reach its full potential. Kaklauskas *et al.* (2009) indicate that in the countries affected by the Asian tsunami, the lack of knowledge management is apparent. By

reinforcing this fact, Koria (2009), finds that in Sri Lanka, organisations have not been able to capture, retain and/or re-use the learning from similar operations except through the tacit knowledge of individuals that have worked in various operations. This resulted in re-inventing the wheel in terms of setting up and managing the construction programmes and projects within the tsunami recovery operation (Koria, 2009). According to Pourezzat *et al.* (2010), disaster response is dynamic and therefore decision makers need to receive updated information on the current emergency situation. Disaster response is also time-sensitive, with little allowance for a delay in decision making and response operations. Therefore, any problem or delay in data collection, access, usage, and dissemination has a negative impact on the quality of decisions and hence, the quality of disaster response (Pourezzat *et al.*, 2010).

The lack of effective information and knowledge sharing, and knowledge creation on disaster management strategies can thereby be identified as one of major reasons behind the unsatisfactory performance levels of current disaster management practices. All these highlight the importance of embracing knowledge management within the context of disaster management.

4.1.3 Disaster knowledge factors

WP 2 of this study aimed to identify key disaster knowledge factors in managing disasters successfully through capturing good practices and lessons learned, and to map them against the disaster management cycle. This section provides the literature findings on disaster knowledge factors to be considered in managing disasters successfully. Identified factors are classified into several categories based on their characteristics: Technological, Social, Environmental, Legal, Economical, Operational/Managerial, Institutional and Political. These factors are common for all types of disasters and across three phases; mitigation/ preparedness, relief/recovery and reconstruction/rehabilitation.

Technological factors

This includes aspects relating to or involving the application of scientific advances including any tool, technique, product, process and method benefiting disaster management. Information and communication technology, and other scientific advances are applicable to the mitigation of natural hazards (WCDR, 2005 cited in Oloruntoba, 2005), which consequently helps to save lives and property while reducing the loss of livelihoods (UNDP, 2005 cited in Oloruntoba, 2005). Under this main category, three sub-categories are identified: warning systems, communication systems and structural measures.

Warning systems

Though it might be difficult to predict an earthquake, it is possible to predict a tsunami and warn people in its path in order to move them to a safer location. The Sumatra earthquake and subsequent tsunami in 2004 exposed the lack of a tsunami early warning system in the Indian Ocean (Camilleri, 2006; Moe and Pathranarakul, 2006). Therefore it is not only recommended to set up an Indian Ocean tsunami early warning system, but also to integrate it with Pacific Ocean tsunami early warning systems. For the total coverage of the world a similar early warning system should be set up in the Mediterranean and the Atlantic (Oloruntoba, 2005). Further it emphasized that a warning should be as inclusive as possible to raise the awareness amongst public officials in the region and globally (Oloruntoba, 2005). In other words warning systems should be integrated with communication, education and awareness raising of the population (Rodriguez *et al.*, 2006). The Pacific Ocean tsunami early warning system was reported to have had knowledge about the earthquake of Sumatra which triggered the 2004 tsunami and only selectively communicated a warning which would otherwise have reduced the loss of lives (Martin, 2004 cited in Oloruntoba, 2005). Reasons for the failure to issue warnings about the Indian Ocean tsunami are found as slow or non-existent flows of information. Said *et al*. (2011) assert that having an appropriate infrastructure such as early warning system in place does not guarantee the masses will respond accordingly to a disaster unless they are aware of the tsunami risk and what the

warning is for. The high death toll that occurred has been attributed to the absence of an Indian Ocean early warning system similar to that which exists in the Pacific Ocean and a lack of knowledge about tsunamis (Kurita *et al.*, 2006). People learned that nature is a powerful force, but also that a simple warning system could have saved many lives (McEntire, 2010).

Communication systems

The media is able to fulfil the strategic role of information distribution, mass communications and the education of people on how to evacuate, locate and relocate (Oloruntoba, 2005). Mass communication systems such as the use of emergency public sirens and warning broadcasts using radios, televisions and print media should be put in place. Public presentations, notices and pamphlets, signs and posters too have been used to communicate mitigation and protective measures.

Geographic information systems and remote sensing tools have been suggested to enable effective logistics management among organisations during relief (Moe and Pathranarakul, 2006). Communication between stakeholders is vital for successful reconstruction. Therefore, an effective communication mechanism should be established among key stakeholders (Moe and Pathranarakul, 2006). Computer networks and decision support systems can enhance disaster communication during the reconstruction stage (Ozceylan and Coskun, 2008).

Structural measures

The strengthening of buildings and infrastructure exposed to hazards via engineering design and construction practices come under this sub-category. As Allotey *et al.* (2010) emphasise, effective application of science and engineering principles in the development of the built environment has reduced the risks faced by earthquake-threatened cities of the developed world. The design of houses and buildings in coastal areas which could withstand a tsunami is important. For example, engineers and researchers could design a $40m^2$ house for the coastal areas of Sri Lanka that they believe could withstand a tsunami, which would cost between $1,000 and $1,500 at 2005 prices (Hansen, 2005). It is simply designed with gaps between walls that will enable water to flow through the structure without destroying it. Designers suggest that these houses would be approximately five times stronger than a conventional house of the same size.

The presence of protective structures can also reduce the vulnerability of people and structures. Studies have shown that $1 spent on prevention can save $40 of damage (Pheng *et al.*, 2006). Flood defences (dams, levees) and sea walls are considered as physical preventive measures while raised roads, resilient infrastructure, raised platforms with latrines and drinking water, resilient water supply systems such as boreholes and building design with escape roads, are considered as physical coping measures (DFID, 2005). For example, 40% of Japan's 28,000km coastline is protected by massive concrete seawalls (Harrison, 2011), though they proved ineffective during the 2011 tsunami disaster.

Social factors

This category includes the aspects relating to human society and its members in managing disasters: initiatives to increase the population's level of education, increase employment opportunity, reduce poverty, enhance the role and participation in decision making, including women that would support preparations for future disasters (Rodriguez *et al.*, 2006).

Awareness of disaster impact is necessary in inculcating into the citizen's culture of disaster preparedness, prevention and mitigation. Therefore, both formal and informal approaches to disaster education are advocated. Public information and enlightenment campaigns in print and electronic media, and through community-based organisations (e.g. women and youth associations, neighbourhood organizations, market/trade and religious organizations) should

be vigorously pursued. Also, disaster management studies should be incorporated into the educational curriculum at all levels, with an emphasis on disaster vulnerability reduction. This will, among other benefits, produce the qualified professionals, policy makers and managers required to meet the human resources needed for disaster management organisations, and enhance the capacity of agencies to formulate the right policies needed for effective vulnerability reduction strategies (Ibem, 2011). Lack of awareness and knowledge regarding tsunamis was apparent among the community members and government officials in Sri Lanka (Rodriguez *et al.*, 2006). As the lack of knowledge increases the vulnerability of people, strengthening communities against disasters is effective to reduce damage (Shiwaku and Shaw, 2008). On a global scale, it is natural disasters that have the most significant and most diverse effect on human beings (Ocal and Topkaya, 2011). A culture of safety and resilience requires people's awareness and understanding, which in turn leads to actions for reducing risk and vulnerability to disasters (UNESCO, 2005). Education for disaster risk reduction is an interactive process of mutual learning among people and institutions. Promotion of awareness among children not only represents future investment in disaster loss-reduction, but in addition, children are recognised as an important link of risk information between schools and households (Clerveaux *et al.*, 2010). It encompasses far more than formal education at schools and universities. Indigenous information and experience, training and the use of technology and media, all contribute means to manage valuable knowledge on disaster risk for the benefit of citizens, professionals, organizations, community stakeholders and policymakers (UNESCO, 2005).

Clerveaux *et al.* (2010), claim that although it is almost impossible to fully recoup the damage caused by a disaster, it is possible to minimise the potential risks among people. The challenge however is in the design of educational tools that can effectively transfer and transmit knowledge across a broad spectrum of social groups (Clerveaux *et al.*, 2010). A study conducted in Sri Lanka revealed that approximately 94 percent of residents had never heard about tsunamis before the disaster that took place in 2004 (Kurita *et al.*, 2006). Furthermore, most residents indicated that damage in the affected area could have been reduced, had they known more about tsunamis. Many people consider disaster education in the schools to be the most effective. Education is considered to be a key tool for the development of coastal communities' resilience (Morin *et al.*, 2008).

Education involves the enhancement and use of indigenous knowledge for protecting people, habitat, livelihoods, and cultural heritage from natural hazards. Educational practices can be conducted through direct learning, information technology, staff training, electronic and printed media and other innovative actions to facilitate and manage and transfer of knowledge and information to citizens, professionals, organisations, community stakeholders and policy makers (Kaklauskas *et al.*, 2009). Preparation through education is accepted as less costly than learning through tragedy (Kaklauskas *et al.*, 2009). According to UN/ISDR, awareness about risks and dangers needs to start in early education before the ability to address them becomes part of growing civic and professional responsibilities as people mature (2004 cited in Shiwaku and Shaw, 2008). Therefore, the value of education of school children cannot be underestimated and it indirectly raises the awareness of communities (Sonak *et al.*, 2008).

Differing needs in the various affected countries, coupled with differing socio-economic and cultural conditions need to be considered during relief and reconstruction (Oloruntoba, 2005). It is necessary to consider the short and long term demographic and socio-economic implications of affected regions and how they impact the population in general and women in particular. Some of these points are:

- More children have been orphaned.
- Traditional gender roles are being challenged by disasters.
- Women are affected differently by the tsunami, causing more deaths, sexual abuse in refugee settings, and the impact of the role as an economic provider (Oxfam, 2005; Rodriguez *et al.*, 2006; Sonak *et al.*, 2008). Following the high death rate of women, men are facing the challenge of raising and educating their children,

therefore issues related to land tenure, property rights, economic sustainability of widows and primarily patriarchal societies must be addressed (Rodriguez *et al.*, 2006).

Environmental factors

Aspects relating to the natural environment in managing disasters are considered here. Natural barriers such as sand dunes, coral reefs, and mangroves can provide protection from a tsunami as they can reduce the flow velocity. As an example, in Sri Lanka, Yala and Bundala National Parks were protected due to these natural barriers. The mangroves' complicated root systems help to bind the shore together and shield against destructive waves (Sonak *et al.*, 2008), the absence of which is a factor that determines vulnerability to coastal hazards. Therefore it is necessary to emphasize the importance of maintaining the protective features of the natural environment such as sand dunes, forests and vegetated areas (Arya *et al.*, 2006; Bosher *et al.*, 2007). Re-forestation of watersheds helps to minimise the effects of droughts.

Disasters create tonnes of waste, comprising hazardous waste, vegetation, soil, sediment, demolition debris and municipal waste. This waste poses a threat to human health, ground water supplies and the marine environment (Sonak *et al.*, 2008). As an example, the volume of disaster waste from the 2010 Haiti Earthquake was estimated at 20 to 25 million cubic yards (Moelloer, 2010). Management of waste created by natural hazards is important, with a need for clear guidelines. It is important to explore ways of recycling and reusing of debris, and the need for proper sewerage systems and cost-effective sewerage treatment plants is emphasized. Rehabilitation of saline soils needs to be performed through assessment and monitoring operations by trained staff. Development of a proper and adequate drainage system is also critical to minimise the harm to the ground. Remediation of ground water supplies that have been polluted is likely to take several years. Therefore it is necessary to provide drinking water for affected people to avoid the risks of diseases (Sonak *et al.*, 2008).

Legal factors

These include aspects relating to law, accepted rules, and regulations for managing disasters. Various regulations that apply to routine construction provide for the safe development of infrastructure, capital improvements and land use, ensuring preservation and environmental protection (Wilkinson *et al.*, 2006). Accordingly if the regulation processes are well formulated, they should not only be an effective means of reducing vulnerability to disasters, but also a means of facilitating reconstruction projects. As an example, legislative and policy factors are found as a major determinant of resource availability in post conflict reconstruction (Chang *et al.*, 2010). According to Moe and Pathranarakul (2006), disaster management supportive laws and regulations must be established and enforced so as to create an enabling environment. These laws and regulations can be enacted based on hazard and vulnerability assessment (Pheng *et al.*, 2006). It is claimed that much of the existing legislation was not drafted to cope with an emergency situation and was not developed to operate under the conditions that will inevitably prevail in the aftermath of a disaster (Rotimi *et al.*, 2009). The process of attaining building consent is identified as a bottleneck which hinders the achievement of reconstruction objectives.

On the other hand, poor construction quality is found to be a major reason for a higher level of destruction and deaths in developing countries. This could be as a result of a lack of building codes, weak enforcement of construction standards and corrupt procurement practices (Pheng *et al.*, 2006). Therefore laws relating to these areas should be strengthened and enforced. New Zealand is well known as having adopted stricter building codes on earthquakes, though the recent earthquake in Christchurch resulted in some damage to buildings.

Economic factors

Economic factors can be classified into two areas: long term economic planning measures and financial aspects. Economic planning measures include aspects relating to production, distribution, and consumption of goods and services in a society. Aspects relating to money and management of monetary assets are covered under the financial sub-category.

Economic planning measures

Destruction of infrastructure during a disaster directly affects the economy of a country. Papathoma *et al.* (2003) claim that destruction of property and engineered structures, and coastal infrastructure had resulted in countries experiencing major losses due to economic and business interruption. Therefore the design of roads, railways, pipelines and cables need careful location planning to reduce the risk of widespread failure (Bosher *et al.*, 2007). As good practice, providers of energy in hurricane-prone areas can put their connections underground to minimise the risk of power shortages (Longo, 2005 cited in Kovacs and Spens, 2007). Incentives such as tax breaks could be offered for resilient building designs. Incentives can also be used to attract qualified disaster management professionals to manage large and complex projects successfully (Koria, 2009). Insurance of properties against disasters must be made compulsory as an initiative to survive after disasters (Atmanand, 2003). Thomas and Leichenko (2011), claim that in many industrialised countries, flood insurance, much like earthquake insurance, is provided by the state. This will indirectly improve the quality of construction as insurance companies will insist on certain minimum standards being met. Introducing appropriate crops, breeds of livestock and drought resistant practices can also reduce agricultural losses due to disasters (Jayaraj, 2007).

Financial

The lack of funds for long term reconstruction after short term relief operations is another frequently cited problem (RICS, 2006). Authorities should also endeavour to invest in measures that reduce the impact of disasters. As an example, Curry (2011) contends that it is vital for countries to make the financial investment to create a culture of preparedness, to help lessen property damage from natural disasters. Donors are known to make financial pledges which are not fulfilled (Oloruntoba, 2005). Particularly when subsequent disasters occur, financial resources, personnel and political attention may soon be moved to other disasters. In addition, donor administration and financial policies are usually not suited for rapid release of funds for disaster response and can cause delays in reconstruction work.

Operational/managerial factors

This category includes factors relating to the planning, coordination and management of disaster related activities.

Participants' lack of skills and knowledge in disaster risk management initiatives is identified as a major issue of reconstruction. For example, the Sri Lankan government is not adequately prepared for managing natural disasters, as it is not considered as a disaster-prone country. A major disaster like the 2004 tsunami was definitely not anticipated. Thus, there was inadequate information management when the disaster struck, as well as coordination problems during the relief and rehabilitation phases after the disaster. Although officials did their best to perform their duties, the lack of experience and the lack of a disaster management system kept them from achieving productive results (Kurita *et al.*, 2006). For cost effective mitigation measures to be developed and applied, detailed information must be made available, including those buildings, infrastructural works and groups of people who are particularly vulnerable to hazards. Managing complex, large and demanding types of projects require competent and experienced staff; these are often found to be lacking in disaster reconstruction projects which may lead to unsuccessful project delivery (Koria, 2009). Therefore, reconstruction demands project management competencies, and networking with international partners is suggested as one way of achieving these. Inadequate planning and resources will inevitably hamper the reconstruction. Rotimi *et al.* (2009) indicate that the effectiveness of the reconstruction

process will depend on how much planning has been carried out and which contingencies are provided for in preparing for the disaster. For instance, common protocols and industry standard project management and planning tools have not been widely used in Sri Lanka (Koria, 2009). Therefore late starts, delays in delivery and inflation lead to cost overruns of reconstruction projects.

Challenges of logistics and access to affected areas are found to cause bottlenecks in aid flows. Disaster logistics include people, expertise and technology. The field of humanitarian logistics is relatively new and it is different from business logistics due to various characteristics: disaster relief operations are carried out in an environment with destabilised infrastructures ranging from a lack of electricity supplies to limited transport infrastructure. As most disasters are unpredictable, the demand for goods is also unpredictable (Kovacs and Spens, 2007), although the basic principles of business logistics can be applied to humanitarian logistics. The generation of risk information and its timely and effective communication to stakeholders of disaster management is the essence of strategies for hazard/disaster loss reduction. However, the latter is a major challenge for disaster managers, especially in an increasingly globalised world, characterised by higher levels of multiculturalism, as more and more people migrate to locations outside their cultural zones (Martin, 2003 cited Cleveaux, *et al.,* 2010). Coordination of recovery is usually accepted as slow, expensive and complex (Koria, 2009). The extent of effective collaboration and coordination between national authorities, local actors and international actors appear to be insufficient to achieve effective planning, damage assessment and public information management (Oloruntoba, 2005). Coordination should be considered at different levels including international, national, regional, organisational and project (Moe and Pathranarakul, 2006).

After a disaster, information is the most valuable and often most elusive asset (Paul *et al.*, 2006). Information is vital for early warning, planning, rehabilitation and reconstruction. Lack of information complicates the efficient management of catastrophes and makes the decision making process a difficult task (Puras and Iglesias, 2009). Sobel and Leeson (2007) found that the inability to overcome the information problem is the root cause of a government's failure to manage natural disaster relief effectively. Therefore, an effective information management system is important. For example, swift access to building plans and schematics of key services in the event of fires and floods would benefit the operational level of emergency management (Bosher *et al.*, 2007). During reconstruction, timely, accurate, and useful operational information must be disseminated amongst responding organisations for effective coordination (Oloruntoba, 2005). Another important aspect considered under this theme is community engagement. Local groups should be given the opportunity to engage in the decision making process and local skills should be utilised (Oloruntoba, 2005; Moe and Pathranarakul, 2006). If the relocation efforts are to be successful, it should involve the local communities in the decision making process (Rodriguez *et al.*, 2006). Koria (2009) also emphasized the importance of stakeholder participation and ownership of projects during reconstruction. Further, it should be appreciated that local participation in recovery efforts includes the distribution of relief aid and cleaning up of debris.

Institutional factors

This includes aspects relating to an organisation founded and dedicated to disaster management and related activities.

An effective institutional arrangement is essential for managing disasters successfully. While a principal responsible unit must be specified, other units should be identified at various levels including provincial, district and village level. Unclear lines of authorities coupled with slow decision making processes, cause delays in activities (Moe and Pathranarakul, 2006). These units should be fully authorised and empowered for disaster management, and should have developed a disaster management master plan.

Though warning systems may facilitate the saving of lives, they are not useful in minimising damage to property and infrastructure. Development of land use plans and regulations to direct new development away from known hazard locations, relocate existing developments to safer areas and maintain protective features of the natural environment, should be performed by the relevant institutions. However, these policies should be created with a wider consultation to make them effective and consistent. As an example, the 200m coastal buffer zone introduced in Sri Lanka after the tsunami disaster was later revised to a significantly lesser zone as a result of creating it without geomorphologic consideration (Koria, 2009). Further issues such as land acquisition, community acceptance and impact on livelihoods were neglected by the institutions that were responsible for reconstruction. For example some communities were relocated to a region where they would be impacted by floods and some fishermen and their families relocated to high-rise apartments which were unsuitable for their way of life. Furthermore, it is essential to plan the coastal zone developments of harbours, buildings and other infrastructure with coastal zone management strategies whilst restoring coastal ecosystems to enhance the level of resilience (Srinivas and Nakagawa, 2008). Institutions must develop necessary building codes informed by these risks.

Professional institutions need to carry out training programmes and disaster management courses to enhance capacity and disseminate knowledge on disaster risk management initiatives. For example it is found that the pre-construction phase is considered as the most critical phase for integrating disaster risk management into the construction; hence, designers, civil engineers, structural engineers, specialist contractors, engineering consultants and developers should be actively involved (Bosher *et al.*, 2007). Further it is identified that the stakeholders involved in the preliminary phase should consider what materials to use, where to build and what to build. It is emphasized that there is a need to develop accreditation schemes and training programmes relating to disaster management efforts (Koria, 2009).

The strengthening of networks among disaster experts across sectors and between regions is needed (Kaklauskas *et al.*, 2009). This is supported by Mohanty *et al.* (2006) who argued that linkages among all agencies working on disaster management need to be strengthened in order to derive the regional best practices and coping mechanisms. In order to enhance the information sharing and management of the knowledge generated in these institutions, it is essential to closely knit together these organisations/institutions. A network of these institutions will create a common platform and enable its stakeholders and people to capture, organise, share and reuse the knowledge generated in the area of disaster management. Education on disaster management should be institutionalised and a curriculum should be developed to include disaster management modules to educate school children and university students. Further educational programmes can be introduced to carry out research in the field. Designing and constructing a resilient built environment demands an in-depth knowledge of avoiding the effects of hazards; therefore research should support finding how disaster risk reduction can effectively be mainstreamed into construction (Bosher *et al.*, 2007).

Political factors

These include aspects relating to politics, parties or politicians in the context of disaster management. The political situation in a region may not be supportive of immediate distribution of relief materials or long term reconstruction and the safety and security of the disaster management practitioners can be affected (Oloruntoba, 2005). Deeply rooted political unrest complicated relief and reconstruction in Sri Lanka and Indonesia (Paul *et al.*, 2006). For example, due to a lack of access and ongoing civil war, all recovery work in the north of Sri Lanka was stopped (EC, 2007 cited in Koria, 2009). Rodriguez *et al.* (2006) indicated that the conflict between the government and the Liberation Tigers of Tamil Eelam generated a variety of concerns regarding how aid was distributed. Maditinos and Vassiliadis (2011), affirm the political commitment for a more effective management of mega fires in the USA. Provision of adequate budget, the adoption of proactive rather than reactive responses, the amendment of conflicting policies and legislations and the definition of clear

responsibilities for fire management are among the highlighted political commitments (Maditinos and Vassiliadis, 2011).

4.2 Interview findings on disasters knowledge factors

Discussions and findings presented in this section are based on interviews with disaster management experts and focus group sessions organised as part of the International Conference on Building Resilience: Interdisciplinary approaches to disaster risk reduction, and the development of sustainable communities and cities that took place in Sri Lanka. Interviews focused on identifying key knowledge factors and understanding their contribution within the disaster management cycle. Specifically, the level of influence of disaster knowledge factors in managing disasters; how these disaster knowledge factors influence the disaster management cycle; and challenges were identified during interviews and focus group session.

4.2.1 Profile of the interviewees

In total, five experts were interviewed using a semi-structured interview guideline (refer to Appendix 1 for interview guidelines). Table 1 shows the profile of the experts interviewed for this study.

Table 1: Profile of the experts

Interviewee Profile	Interviewee A	Interviewee B	Interviewee C	Interviewee D	Interviewee E
Age range	41-50	31-40	31-40	31-40	31-40
Gender	Male	Male	Male	Male	Male
Experience in dealing with disaster issues	4	7 (Research)	4	4	4 (Research)
Types of disasters dealt with	Flood Railway	Tsunami Hurricane	Hurricane Outbreaks	Flood	Earthquakes
Disaster related training programmes undergone	Literal training in CPD workshops	-	-	First aid Coordination	Simulation

4.2.2 Influence level of disaster knowledge factors in managing disasters successfully

Interviewees were asked to rank the Influence level of disaster knowledge factors on managing disasters successfully. A scale of very low to very high was used to measure the level of influence of disaster knowledge factors in managing disasters and the results are summarised in Table 2.

Table 2: Influence level of disaster knowledge factors in managing disasters

Disaster knowledge factors	Level of influence marked by each interviewee				
	Interviewee A	Interviewee B	Interviewee C	Interviewee D	Interviewee E
Technological factors	H	VH	VH	VH	VH
Social factors	VH	VH	VH	VH	VH
Environmental factors	H/ VH	N	H	VH	H
Legal factors	H	H	VH	H	VH

Economic factors	VH	H	VH	VH	H
Operational/ managerial factors	VH	H	VH	VH	H
Institutional factors	VH	H	VH	VH	VH
Political factors	H	VH	VL	N	VH

VL=Very Low, L=Low, N=Neither, H=High, VH=Very High

Influence level of technological factors

A significant number of respondents agreed that the influence level of technological factors in managing disasters successfully is 'very high'. They argued that the role of technology spans from preparedness to reconstruction by covering the whole spectrum of the disaster cycle. At any part of the disaster management cycle there is a high level of technological involvement. As an example, in the preparedness stage, most of the measures that countries take to avoid disasters are technology based. These include early detection systems, warning systems and building dams. Furthermore, in the immediate relief stage, speed is of the essence to save the lives of people being affected. This is often referred to as the 'golden hour' and it is essential to rely on appropriate technology. For example, in the 2005 Kashmir earthquake, the government only realised the scale of the disaster after a day and by that time, most of the people were already dead or injured. Consequently, the speed of communication is absolutely critical and technology plays a vital role in facilitating this. However, the need to contextualise and match when applying technology was also emphasised. It is quite important to match a particular technology to a particular type of disaster to find out how successful it might be. For example, the technology that tackles fire risk effectively, may be very different from that which will address flood risk. Similarly, the technology that is relevant in large scale disasters may not be applicable to small scale disasters.

Influence level of social factors

All the respondents agreed that the influence level of social factors in managing disasters is 'very high'. They argued that the end results of managing disasters will have to be useful to the community and if disaster professionals are not taking them seriously, then there is little point in doing disaster management in the first instance. Eventually the technology is just going to give the information, but it would be human beings that need to react in most cases. Human beings must interact closely with each other in order to react and respond to disasters. As an example, if people are trained about a particular issue, it increases their awareness and they will be more ready to appreciate what they need to do to reduce the consequences, to understand how to deal with such issues if it does happen, and they will be more robust to get over it. Hence, social factors were given a very high ranking by the respondents. However, it is highlighted that the fact that the extent to which they influence is not the same, as there may be subtleties in these social factors and each one does not act in the same way. As an example, the level of impact of education on managing disasters may not be the same as with training.

Influence level of environmental factors

Some of the respondents agreed that the influence level of environmental factors is at least 'high'. However, they argued that while natural factors can sometimes prevent disasters, in certain circumstances they promote disasters. For example Rathnapura district in Sri Lanka gets flooded due to its natural position. It is also at the south west face of the hill country which is exposed to heavy rain and in addition, several rivers flow through Rathnapura, particularly the Kalu Ganga, which is the fastest river in Sri Lanka. Therefore, Rathnapura is affected by all these natural factors and positioning. On the other hand, Yala and Bundala

national parks and some of the areas of Hambanthota district in Sri Lanka were protected from the tsunami due to the natural vegetation and mangroves. Therefore, though environmental factors were ranked as very high/high, respondents emphasised the fact that the answer is contingent upon the context. While people can benefit from natural environmental factors in managing disasters, there are instances where people do not have access to natural protection.

Influence level of legal factors

Legal factors were ranked as 'high' by the majority of respondents. As laws make people legally binding or things compulsory to follow, laws tend to safeguard everybody's interest and larger communities. Therefore, respondents considered legal factors as having high influence in managing disasters successfully. Despite this, some also noted that laws do not seem to impact certain human behaviours, such as bribery and corruption, and these behaviours appear to be more powerful and accepted in certain communities. Therefore, though the influence of legal factors looks high and straightforward on paper, in reality there is likely to be a limit to the extent to which legal structures and frameworks could influence, as the issue is socially embedded, contextual and multifaceted.

Influence level of economic factors

The majority of respondents agreed that the influence level of economic planning measures and financial factors in managing disasters successfully is 'very high'. Long term economic planning and finance have an influence on the measures or the strategies to build resilient communities, or to take preventive measures. In that sense, even though a country might have clear strategies for disaster management, if communities are not equipped with proper economic planning and finance, then there will be limited resources to get strategies implemented. Agricultural planning measures would ensure that there is no famine or calamities in times of crisis. Furthermore, in large urban models, all these economic measures, including financial, agricultural, infrastructure management, are very much interlinked. Infrastructure is one of the key facets affected during a disaster and how much money individually stands on safeguarding these infrastructures from potential vulnerabilities is important as these are the primary economic and financial instruments of a country.

Influence level of operational/management factors

The majority of respondents rated the influence level of operational/management factors as 'very high'. They viewed these factors as basic needs when it comes to any management process, which are equally important in a disaster management context. Respondents further described these factors - which included communication, decision making, level of information, quality of information, timeliness of information, cost of information, the absorptive capacity, leadership skills, coordination and competencies, as softer interpersonal skills that are very much needed in doing things effectively.

Influence level of institutional factors

A majority of respondents agreed that the influence level of institutional factors in managing disasters successfully is 'very high'. The reason for that choice is due to the fact that institutional factors cover the implementation aspect of the other factors. Institutional factors have strong connections with legal factors, training, planning and management.

Influence level of political factors

Respondents gave wide ranging rankings for the influence level of political factors in managing disasters successfully. Respondents who ranked the influence level as 'very high' argued that in order to implement and plan financial strategies and economic strategies relating to disaster management, there should be political backing and will. Respondents who ranked it as 'neither' tended to argue that depending on the particular political system

and view, they might take very different approaches in the way the disaster management is governed, but the effectiveness of disaster management will be more significantly determined by institutional arrangements, the legal framework and the operational plans. Legal, institutional and social factors to some extent have politics embedded in them. Though one respondent argued that the influence level is variable, they also noted the importance of local politics, especially when accessing affected communities. In addition, if there is a local community where people are mainly from a particular area, politics will be heavily charged and influenced by how decisions are made, resources are allocated, and statutes or legislations are enforced. For example, as a number of communities in America were affected by the BP oil spill, the President of America suggested that the country would institute new laws if it became a disaster. Such a response was likely influenced by political considerations.

Summary

In summary, when asked to identify the influence level of disaster knowledge factors in managing disasters successfully, respondents ranked most of the factors at least as 'high'. All interviewees agreed that the influence level of social factors in managing disasters successfully is 'very high'. A significant number of them agreed that the influence level of technological and institutional factors is also 'very high'. The influence level of economic and operational/managerial factors was rated as 'very high' by the majority of respondents; however not to the extent of technological and institutional factors. A majority of them again rated the influence level of legal factors as 'high'. It was difficult to conclude the respondents' rating on environmental and political factors. However, though some of the respondents rated the influence of them as neither or as very low, in their subsequent explanations they gave some examples highlighting the importance of them. The level of influence based on respondents' views is graphically represented in Figure 2.

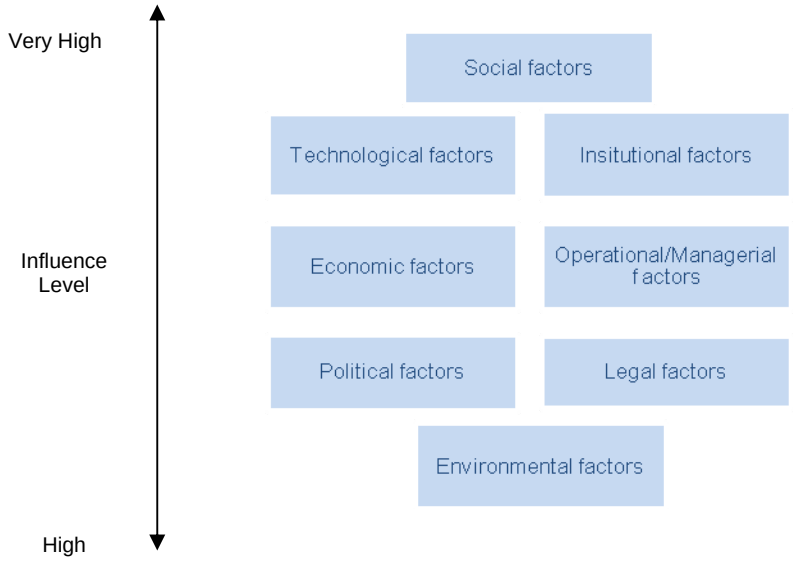


Figure 2: The level of influence based on respondents' views

4.2.3 How disaster knowledge factors influence the disaster management cycle

This section presents the findings on how disaster knowledge factors influence different phases of the disaster management cycle, including the mitigation/preparedness, immediate relief and reconstruction.

Influence of technological factors in different phases of the disaster management cycle

Most respondents agreed that technology plays a major role in almost all phases of a disaster. But technologies that could be used during the immediate relief stage are quite different from the technologies that could be used during long term recovery and the preparedness stages.

A technological focus in the immediate relief stage is very much on transport as a means to get to places very quickly and to recover people effectively and efficiently through ground vehicles to helicopters. In addition, sensing technology supports gathering of real time data on the scale of the disaster, what has being destroyed, and what is being left through satellite images. As this real time data supports much of the subsequent decision making on resource planning and allocation, it can have a big impact on the disaster management cycle. During long term recovery and preparedness, technology tends to be used to enhance the resilience of communities and safeguard existing communities. Effective methods of reconstruction or product modelling play a major role during long term reconstruction. In addition, product modelling helps to analyse the strength of the buildings after a disaster and to remodel better. As perceived by respondents, the maximum impact of technology is likely seen during the preparedness stage as this stage allows maximum time to plan for technologies to improve the resilience of communities to face further disasters. Most of the measures that a country takes to avoid disasters in the preparedness stage are technology based.

However, the usefulness or ability to make an impact will depend on numerous factors, including the key parties in the disaster management cycle, who uses the technology, competencies that they have on the use of that technology, and the environment in which it is being used. Therefore, technological factors are integrated with operational/ managerial factors and social factors through institutions. While these interview findings tend to support the literature findings, the interviews were also helpful in clearly identifying and establishing the links between technological factors and other factors.

Influence of social factors in different phases of the disaster management cycle

One of the key success factors of disaster management is to what extent humans are part of disaster management or to what extent disaster management is connected with the day to day lives and the operations of a society. Whether a society as a whole is well aware of the impending disaster but is also ready to take up and live with it, is considered as a key success factor. For example though Japan is a country which is prone to frequent earthquakes, it is considered as one of the world's most resilient countries because it is embedded into peoples' lives and people have a level of preparedness and resilience, despite the recent tsunami devastation. As found in the literature, disaster related training, education and awareness raising are helpful to enhance peoples' preparedness and resilience to disasters.

When it comes to immediate relief and reconstruction, the extent of peoples' network can either help or hinder the operation. If it is a society that helps each other, it can tremendously improve the ability of the social network to withstand the effect of the disaster. For example, a respondent perceived that the Sri Lankan culture, which is based on helping each other, seems to have helped Sri Lanka to overcome certain effects of the tsunami.

Influence of environmental factors in different phases of the disaster management cycle

As natural factors can sometimes prevent or promote disasters, the influence of natural factors on the disaster management cycle can be identified as follows.

When environmental factors have an effect in preventing disasters, measures should be taken to ameliorate and protect such natural factors. For example, planting trees may be

used to prevent landslides, or planting of shelterbelts and mangroves along coastal areas may be used to minimise the effects from waves. On the other hand if there are already natural barriers in place, measures should be taken to protect them. For instance, if mangroves and vegetation are already present in coastal areas, necessary planning measures should be taken to avoid any interventions that damage those barriers. When natural factors promote disasters, careful consideration, through building and town planning, should be given as to whether people should be allowed to live in those areas. If people are allowed to live there, then the necessary man-made barriers should be used to minimise the possible effects. For example in the Netherlands, protective walls are built around the sea as the Netherlands lies below the sea level.

The influence of environmental factors can be clearly identified during the mitigation/ preparedness phase of the disaster management cycle. The interview findings suggest that natural environmental factors can promote or prevent disasters. Also it is clear from the findings that, when natural factors promote disasters, the built environment has a big role to play in minimising any negative effects. In addition, institutions are responsible for developing necessary planning and regulations to enhance and protect the existing natural barriers and to minimise the damage to the structures and people when natural factors promote disasters.

Influence of the legal factors in different phases of the disaster management cycle

Most respondents felt that the highest impact of legal measures or legal factors is at the prevention and mitigation stages. As disaster management policies have a high possibility of being very effective at the prevention and mitigation stages, there should be legal backing to support these policies. In other words, the law can help to implement some of the disaster mitigation measures by incorporating them into codes, standards, and statutes.

In addition, emergency regulations and laws related to civic duties might influence when responding to a disaster during the immediate relief stage. As an example, when hurricane Katrina hit New Orleans, a state of emergency was declared in that part of America. This was partly because of human unrest. The other reason was to give central government the power to use the resources of other states. Because America has a very strong state governmental system, one state or even the federal government or central government cannot intervene straight away and use resources allocated to one state. By declaring a state of emergency it gave central government the power to use the resources of other states, though they were heavily criticised for the slow response.

Influence of the economic factors in different phases of the disaster management cycle

As disasters can affect a country's wealth generation mechanism, economic planning measures are accepted as very important. The focus of economic planning measures in the mitigation/ preparedness stages is on protecting the country's wealth generation mechanism and looking for alternatives during the reconstruction stage.

For example most of the South Asian countries rely heavily on agricultural production; therefore, a proper disaster risk assessment should be carried out in those areas to know the risks, mainly from floods, affecting the production and take actions to prevent them during the disaster mitigation stage. Similarly, risk assessments should be carried out to assess the risk to infrastructure facilities. During the disaster recovery/ reconstruction stage, actions should be taken to recover/ reconstruct damaged infrastructure and alternatives for such infrastructure can be identified. For instance, if a country has only got one international airport and seaport, any disruption on them due to a disaster could be crucial. Therefore, there is a need to build a secondary airport and seaport to minimise the effects of future disasters on country's economy.

With regard to financial factors, respondents highlighted the importance of financial management in the immediate relief stage as it may have filtered out the impact on other

stages. However, a few emphasized the aspects of rigid policies and financial allocations throughout the disaster management cycle that may hinder efforts.

Influence of operational/managerial factors in different phases of the disaster management cycle

It was highlighted that most operational/ managerial factors are interconnected and these factors remain important throughout the disaster management system. It was widely agreed that the management of technology is very important and therefore there is a strong link between technological factors and managerial/ operational factors. In addition, operational/ managerial factors are linked with institutional factors as institutions are responsible for enhancing disaster related competencies and skills.

Influence of the institutional factors in different phases of the disaster management cycle

It was felt that the role of the institutional factors or the role of institutions remained the same throughout the disaster management cycle. One reason given was that institutions tend to safeguard the implementation of all the other factors. Therefore, institutions are looking at those factors at different times, yet dealing with the same issue.

Influence of the political factors in different phases of the disaster management cycle

As politics is an art of influencing others, factors like legal, institutional, social and operational/ management factors have politics embedded in them. Politics have some implications not necessarily on disasters, but on the way institutions are formed, the way operations and things are managed, and the way the law is formed. Therefore, the level at which political factors affect disaster management will depend on how it affects the institutional arrangement, the legal framework and the operational/ managerial aspects. The implications of political factors on disaster management appeared to be indirect through institutional, legal, social and operational/managerial aspects.

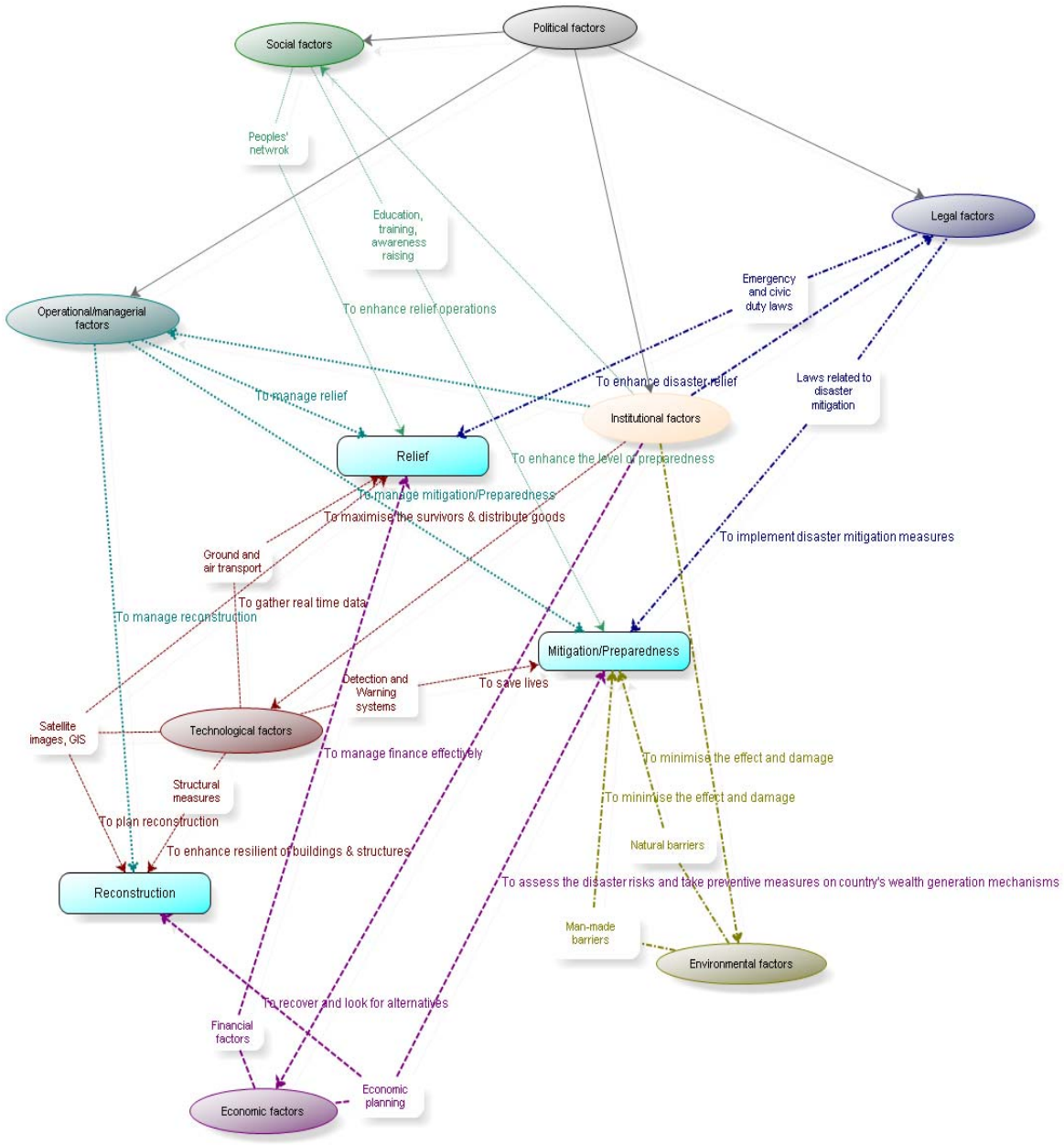
Summary

Figure 3 shows how disaster knowledge success factors are linked with different phases of the disaster management cycle. It also illustrates the links within different disaster knowledge factors themselves. It is clear from the above findings and discussion that technological, operational/managerial, economic, social, legal and environmental factors have direct influence over the disaster management cycle, while the influence of institutional factors is indirect and it is through other factors identified. The influence of political factors is also indirect and it influences through institutional, operational/managerial, and social and legal factors.

In terms of influence on disaster knowledge factors in different phases of disaster management, the influence of operational/managerial factors appeared throughout the disaster management cycle. Influence of institutional factors was identified within all other factors including technology, social, environmental, legal, economic and operational/ managerial. Influence of political factors was noticed as indirect through institutional, operational/managerial, legal and social factors. While implications of technological and economic factors were also evident in all three phases of the disaster management cycle in different ways, the influence of legal and social factors were most noticeable in the mitigation/preparedness phase. Environmental factors also appeared to influence during the mitigation/preparedness phase. Hence the mitigation/preparedness phase is influenced by almost all the factors discussed. The relief phase is mostly influenced by technological, social, legal, economic, operational/managerial, institutional and political factors. The long

term reconstruction phase is mainly influenced by technological, economical, operational/managerial, institutional and political factors.

A summary of these influences is shown in Table 3.



Oval shapes – disaster knowledge factors
Rectangular shapes – phases of the disaster management cycle
Lines and arrows – links
Please refer to the middle of the lines to the relevant text.

Figure 3: Influence of disaster knowledge factors on different phases of the disaster management cycle

4.2.4 Challenges

Experts identified a number of challenges related to disaster knowledge factors. These challenges are described below. Challenges recognise those areas which are lacking and need to be improved further in order to meet future disasters successfully.

Technological factors

In relation to technological factors, the need for cost effective and proactive technologies is highlighted by the respondents. Respondents identified communication as one of the areas that needs technological support. As an example, they elaborated the experiences of the Kashmir earthquake, which highlighted the importance of speed of communication as many people had died by the time the government realised the scale of the disaster and started the relief operations. Also proper use of the technology and having the necessary skills was recognised as highly important by the respondents. Effective technology will not cause a positive impact unless the people who use them have the required competency and knowledge. Respondents stressed that the key issue related to this aspect is lack of training. Knowing the strengths and weaknesses of the technology was another factor identified during the interviews. In addition, respondents identified a gap in the implementation of technology. They indicated that political institutions or bureaucratic structures hamper the uptake of technology. The need to address the social, political, institutional and behavioural barriers in the implementation of the required technology was highlighted during the interviews. The effective use of technology to create networks among communities and across networks between the policy makers and the communities was noted by the respondents as an area that is lacking and that needs further improvement.

Social factors

Interviewees indicated that people need to be educated and trained properly to engage in the overall disaster management cycle. Accordingly, people should be made aware of any potential disasters and their collective responsibility in preventing or minimising the effects of disasters. Respondents felt that these would help to make preparedness part of their lives or enhance their culture of preparedness. As an example, they pointed out that even though vulnerability is increased in many third world countries due to unsafe power lines and closed running sewers and water lines, the aggravating effects of these are not known by many of the people of these countries. Respondents highlighted that the success of training depends on several factors, including the knowledge of the person who delivers the training, the environment in which the training is delivered, the level of resources needed to support the training and the absorptive capacity of the people who receive training. Therefore, a thorough understanding of the context was emphasized by them. For instance it was highlighted by the respondents that there are certain training programmes where people cannot understand the terminologies or where the experts spend only a limited time with people rather than providing properly structured training.

Issues related to people's attitudes and perceptions were the next challenge identified by the respondents. Respondents admitted that, as civilians of a country, people should know their strengths and weaknesses and anticipate certain disasters. Respondents were of the view that while some people believe disasters can be prevented, some people do not learn lessons from previous disasters as they struggle for life which takes their focus away. For example, one respondent stated that even after the 2005 earthquake in Kashmir, people have started constructing their houses in hilly places where there are massive power lines running above the land. According to the respondent, in some countries behavioural structure has taken over the legal structure through bribery and corruption. Therefore, these socially embedded issues need to be addressed for successful implementation of laws.

Respondents agreed that social factors should be given thorough consideration throughout the disaster management cycle. However, social factors are of less concern during the long term reconstruction and preparedness/mitigation phases and much more attention is paid

during the relief stage. Accordingly, people's needs and requirements are not considered in long term reconstruction. As an example, they highlighted the fact that many resettlement programmes do not consider people's livelihood needs. In order to minimise these effects the detachment between policy makers and the affected community should be minimised. Building networks among people and between people and policy makers was viewed as vital if this challenge is to be addressed.

Environmental factors

It is reported that similar scales of hazards cause different effects in different countries due to different environmental factors, different population densities and different planning and building regulation standards. A thorough understanding of the environmental factors and their influence is needed by policy makers, professionals and communities. A broader understanding of the forces of nature and the forces of environment is proposed to be highly important by the respondents. Further it was acknowledged that the Indian Ocean is the least studied Ocean which led to huge devastation by the 2004 tsunami. A possible reason for this might be that the countries around the Indian Ocean are less economically developed. Finally the respondents indicated that building planning and regulations should be based on proper vulnerability analysis of the environment. When environmental factors promote disasters, town planning and building regulations should be developed in such a way to minimise the risks from disasters to people, infrastructure and building. As an example, directing new developments away from known hazard locations could be done through land use plans and regulations.

Legal factors

Implementation of the law was identified as a major shortcoming by most of the respondents. The laws which do not address the humanitarian aspect of disaster management have become unsuccessful and ineffective. For instance the 200m buffer zone which was regulated after the 2004 tsunami in Sri Lanka was unsuccessful as it did not take into consideration the livelihood needs of the affected community. As a result, the fishing community re-constructed their houses within the buffer zone in order to safeguard their livelihood needs. Within a disaster context, it is highly unlikely that laws can be developed which cover every aspect of disasters, as communities sometimes face new circumstances which they have not encountered before. It is also contended that disaster related laws should be updated regularly.

Economical factors

Economic planning measures: Risk assessment or vulnerability analysis of a country's wealth generation mechanism is accepted as a more prominent part of long term economic planning by the respondents. However, it was found that a lack of investment hampers this process. For example, though many developing countries' infrastructure facilities are instrumental to communities, governments do not invest enough in them. As a result the impact could be magnified if a disaster strikes. Therefore interviewees suggested that the vulnerability assessment of a country's wealth generation mechanism should be an integral part of the country's financial model. At the same time they argued that long term reconstruction should focus on both recovering the damaged infrastructure and looking for alternatives, rather than focusing only on repairing the existing facilities.

Financial aspect: As the relief stage attracts more funding, the management of finance during the relief stage was considered as vitally important by the respondents. Rigid policies in handling money hinder rapid decision making in the aftermath of disasters. Therefore, respondents highlighted the need for more flexible systems which allow fluid decision making. They also highlighted that the reconstruction and preparedness/mitigation phases tend to attract less finance. One reason given by respondents was that disaster management does not get priority in the allocation of finance. However as proactive approaches to disaster management could bring much benefit, they felt investments in the

reconstruction and preparedness/mitigation phases should be prioritised. Financial mismanagement is another issue experienced during the reconstruction stage. Respondents indicated that the disconnection between investment or insurance companies and the public sector has prevented the public sector learning from insurance companies on how to manage finance effectively. As respondents stated, the accountability of post disaster reconstruction should be improved, yet not adhering to the conventional financial accounting systems, as conventional financing accounting systems are developed on the basis that there are very well defined requirements and outputs. Nonetheless, in a disaster situation things are not certain and it needs a much more flexible accounting system.

Operational/managerial factors

Experts argued that improvement is needed in the decision making process of disaster management. Parties to the decision making process, speed of the decision making and innovativeness of decisions are some of the areas considered by the respondents. Community participation in the decision making process is highly promoted in the disaster context as it helps to identify their real needs. Slow decision making is identified as a main reason for delay in reconstruction work. As an example, despite the urgency, it is reported that most government institutions still follow the traditional tendering system by giving priority to the lowest bid. As every disaster brings some uniqueness, the role of innovative decision making is highlighted.

As viewed by the respondents, reasons for some failures in disaster management were down to the quality of leadership. Choosing the correct leadership style is one aspect which needs more attention. Respondents described that the participatory style of leadership may be appropriate for certain contexts while the autocratic style may convenient for certain contexts. While participative leaders seek to involve other stakeholders in the decision making process, altercative leaders' decision making is non participative Also the communication among affected communities and between the affected communities and policy makers should be enhanced. In order to avoid receiving inappropriate relief goods, the process of collecting goods should be driven by the requirements. For instance, the Disaster Emergency Committee (DEC) which operates in the UK sends money in a disaster emergency instead of goods which may be not appropriate or useful. Moreover, providing the required training and necessary resources including financial, time and manpower were identified as essentials in managing the disasters successfully by the respondents. Though people have the knowledge and know the best practices in managing disasters, transfer of knowledge to the right person at the right time is identified as lacking and training could facilitate this transfer of knowledge. A considerable gap exists between what is known and what is done in practice. Another area which needs attention is developing a common vocabulary that could bring together various disciplines in the disaster management field. As an example, terminologies used by engineers are different from GIS specialists or public officials and this may hamper the communication between them. Similarly there are various tools used in different sectors, yet those tools are not inter-communicating. For instance GIS maps and drawings may not be used in vulnerability analysis as information cannot be exchanged between tools. Therefore, knowledge based standardisation tools that could link different organisations and platforms need to be developed.

Institutional factors

Interviewees claimed that proper institutional formation and integration are vitally important in managing disasters successfully. Institutional formation refers to the establishment of required institutions, and resourcing and improving these institutions. Integration is concerned with identification and establishment of links between the established institutions. Hence they indicated that the capacity of these institutions need be reviewed and empowered according to the needs, and particularly the disaster related knowledge and skills, which need to be improved. In addition a centralised institution which monitors and oversees all the other institutions needs to be formed. For example once hurricane Katrina hit New Orleans, for a couple of weeks it was not known who should respond, the state of Luciana or the federal government.

Political factors

Studies on political expectations in the context of disaster management are recommended to minimise the mismatches between political agendas and disaster management agendas. Most importantly it is highlighted that the long term perspectives of disaster management should not be dominated by the short term political perspectives.

Table 3: A summary of the influence and challenges of disaster knowledge factors

Disaster Knowledge Factors	*Influence*	*Challenges*
Technological	– *Detection and warning systems to save lives and minimise the effects* – *Satellite images and GIS to gather real time data of the disaster impact and plan reconstruction* – *Ground and air transport to maximise the survivors and distribute goods and services* – *Structural measures to enhance the resilience of built structures*	– *The need for proactive technologies* – *Poor communication* – *Lack of necessary skills for proper use of technology* – *Gaps in implementation of technology* – *The need for effective use of technology to create networks among communities and between communities and policy makers*
Social	– *Social networks to enhance relief and reconstruction* – *Education, training and awareness raising to enhance culture of preparedness*	– *The need for effective education, training and awareness raising programmes to enhance culture of preparedness* – *Addressing the issues related to peoples' attitudes and perceptions* – *Lack of consideration of social factors during long term reconstruction and mitigation/preparedness phase*
Environmental	– *Natural barriers to minimise the effect and damages* – *Man-made structures to minimise the effect and damages*	– *Lack of understanding of the environmental related factors*
Legal	– *To implement disaster mitigation measures* – *To enhance relief operations through emergency and civic duty laws*	– *Challenges related to implementation of laws* – *Lack of consideration of social factors when making laws* – *The need for regular updating*
Economic	*Long term economic planning* – *To minimise the effect of disasters through taking necessary mitigative measures on country's wealth generation mechanism* – *To enhance the recovery through insurance* *Financial* – *An essential resource to effective management of disasters*	*Long term economic planning* – *Lack of investment on risk and vulnerability assessment of country's wealth generation mechanism* – *Long term recovery is only focused on reconstruction of damaged infrastructure. Looking for alternatives is neglected* *Financial* – *Poor management of finance* – *Rigid policies* – *Lack of funds for reconstruction and*

		mitigation/preparedness – *Not learning from investment or insurance companies* – *Financial mismanagement and poor accountability*
Operational/Managerial	– *Essential to effective management of disasters*	– *Poor decision making* – *Poor communication* – *Participatory approach to decision making* – *Aspects related to leadership* – *Poor humanitarian logistics management* – *Lack of knowledge management*
Institutional	– *To develop and implement necessary building codes* – *To develop and provide necessary education, training and awareness raising programmes* – *To develop and implement necessary planning and building regulations* – *To conduct risk and vulnerability studies on country's wealth generation mechanism and take necessary mitigative measures*	– *The need for proper institutional formation and integration* – *The need for a centralised institution to overlook and monitor all other institutions*
Political	– *Positive influence on decision making, allocation of resources and implementation of laws*	– *The need for studies on political expectations in context of disaster management* – *Domination of short-term political perspectives over long term perspectives of disaster management*

A summary of identified challenges are shown in Table 3. Respondents viewed the detection and warning systems and resilient built structures as key influences of technological factors. While detection and warning systems help to save lives, resilient built structures support to minimise the effects of disasters. With regard to the social factors, respondents indicated that technology can provide only the information and it would be the human beings who would have to react to disasters. Hence they highlighted the influence of education, training and awareness raising to enhance the level of preparedness. The influence of existing natural environmental barriers is highly recognised by all respondents. Support of legal factors to implement disaster mitigation measures is also highlighted by the respondents. In terms of economic factors, influence of long term economic planning measures was stressed by the respondents. In addition they viewed the financial, operational/managerial and institutional factors as essentials to manage disasters.

Among key challenges, the lack of detection and warning systems, the need for effective education, training and awareness raising programmes, the need for regular updating of disaster related laws, lack of funds for economic planning measures, poor planning, poor communication, poor leadership, lack of knowledge management and poor institutional arrangement were highlighted by most of the respondents. These clearly show that most of the challenges are related to operational/managerial factors. In order to enhance the management of disasters, these challenges need to be addressed.

4.3 Questionnaire survey on evaluating the existing web portal

A selected group of users were invited to complete a web-based questionnaire survey to evaluate the existing knowledge base. They were selected from stakeholders representing disaster management related institutes, members of the academic community, CIB TG 63: disaster and built environment members etc. While 20 users were invited to participate in the survey, 14 of them responded to the questionnaire (refer to Appendix 2).

Respondents' awareness on ISLAND website is shown in Figure 4. A majority of respondents either had not visited the ISLAND website or had less than 5 visits at the time the survey was administered. In view of enhancing the awareness, ISLAND website functionalities were demonstrated during the presentation session as part of the Disaster Resilience Conference, which took place in Sri Lanka.

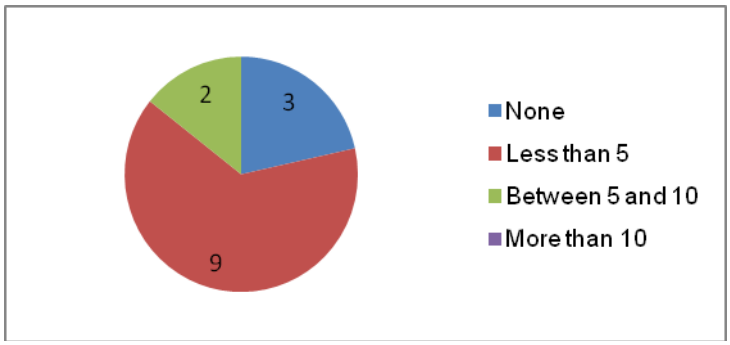


Figure 4: Number of times the participants visited the ISLAND website

Respondents' opinion about the ISLAND website is shown in Figure 5 below.

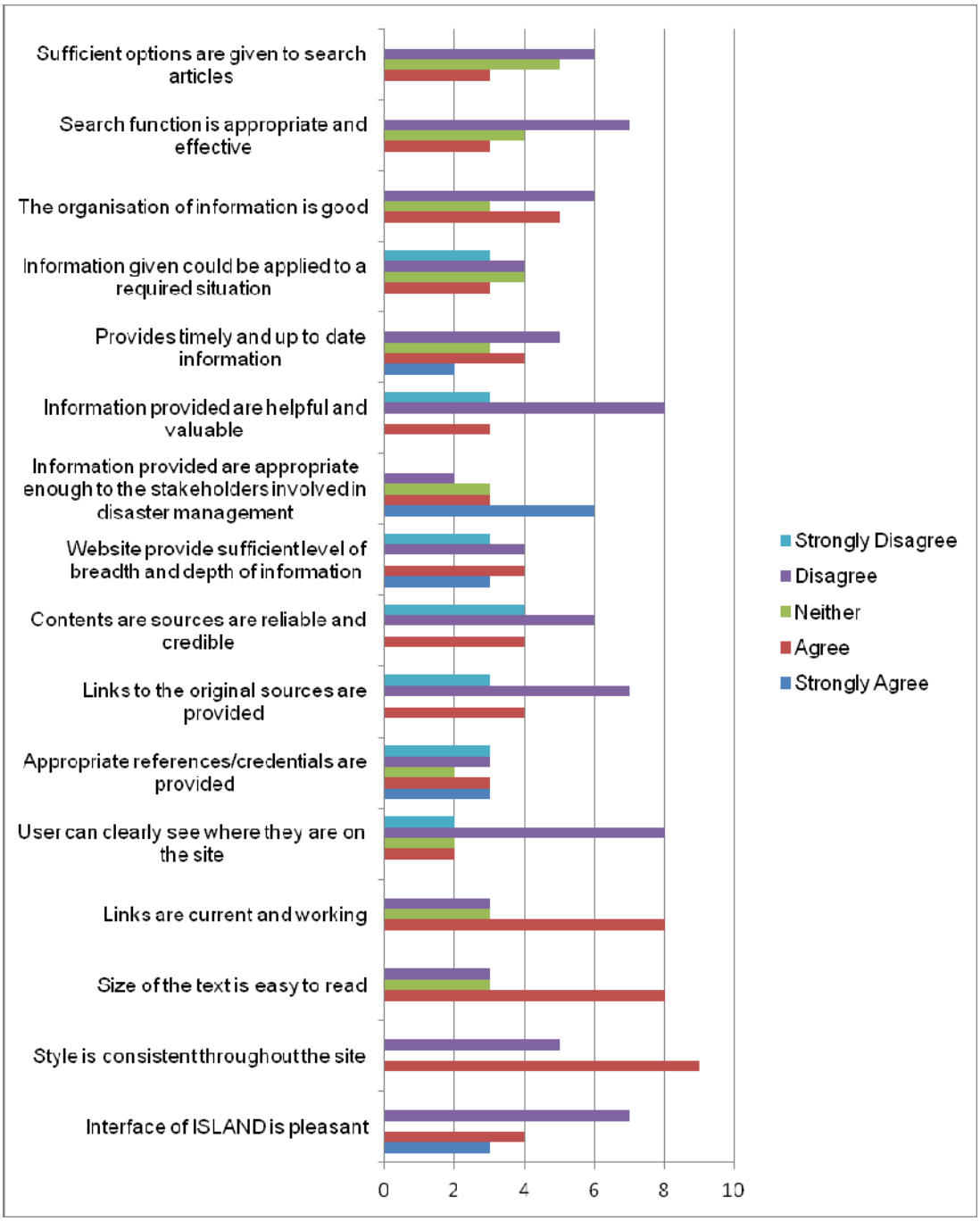


Figure 5: Respondents' opinion about the ISLAND website

The analysis of the above results is shown in Table 4 below.

Table 4: Analysis of the Respondents' opinion about the ISLAND website

Questions about the ISLAND website	Responses					Value of responses
	Strongly Agree (2)	Agree (1)	Neither (0)	Disagree (-1)	Strongly Disagree (-2)	
Interface of ISLAND is pleasant	3	4	0	7	0	0.214286
Style is consistent throughout the site	0	9	0	5	0	0.285714
Size of the text is easy to read	0	8	3	3	0	0.357143
Links are current and working	0	8	3	3	0	0.357143
User can clearly see where they are on the site	0	2	2	8	2	-0.71429
Appropriate references/credentials are provided	3	3	2	3	3	0
Links to the original sources are provided	0	4	0	7	3	-0.64286
Contents and sources are reliable and credible	0	4	0	6	4	-0.71429
Website provide sufficient level of breadth and depth of information	3	4	0	4	3	0
Information provided are appropriate enough to the stakeholders involved in disaster management	6	3	3	2	0	0.928571
Information provided are helpful and valuable	0	3	0	8	3	-0.78571
Provides timely and up to date information	2	4	3	5	0	0.214286
Information given could be applied to a required situation	0	3	4	4	3	-0.50000
The organisation of information is good	0	5	3	6	0	-0.07143
Search function is appropriate and effective	0	3	4	7	0	-0.28571
Sufficient options are given to search articles	0	3	5	6	0	-0.21429

According to Table 4, respondents negatively rated aspects relating to: navigation, links to the original sources, credibility of sources, organisation of the information and the effectiveness of the search function. Therefore, necessary measures were taken to address these aspects to enhance the effectiveness of the ISLAND website. Specifically, the knowledge base was further expanded and populated with additional case material to enhance the usefulness of information.

4.4 Population of knowledge base with more case materials

The knowledge base was originally created as part of the ISLAND project, addressing several themes of disaster management based on published case materials collected on the Asian tsunami disaster of 2004, particularly cases from the Sri Lankan context. Case materials are organised into type of disaster, phase, country, source, research methodology followed, scope and access to the study which is stored in a MySQL database using a PHP-Database interface. With the usage of SQL query, simple and advance searchers are provided to retrieve and view data. During this phase, the knowledge base is further expanded and populated with more case materials collated on different knowledge factors identified as part of ISLAND II.

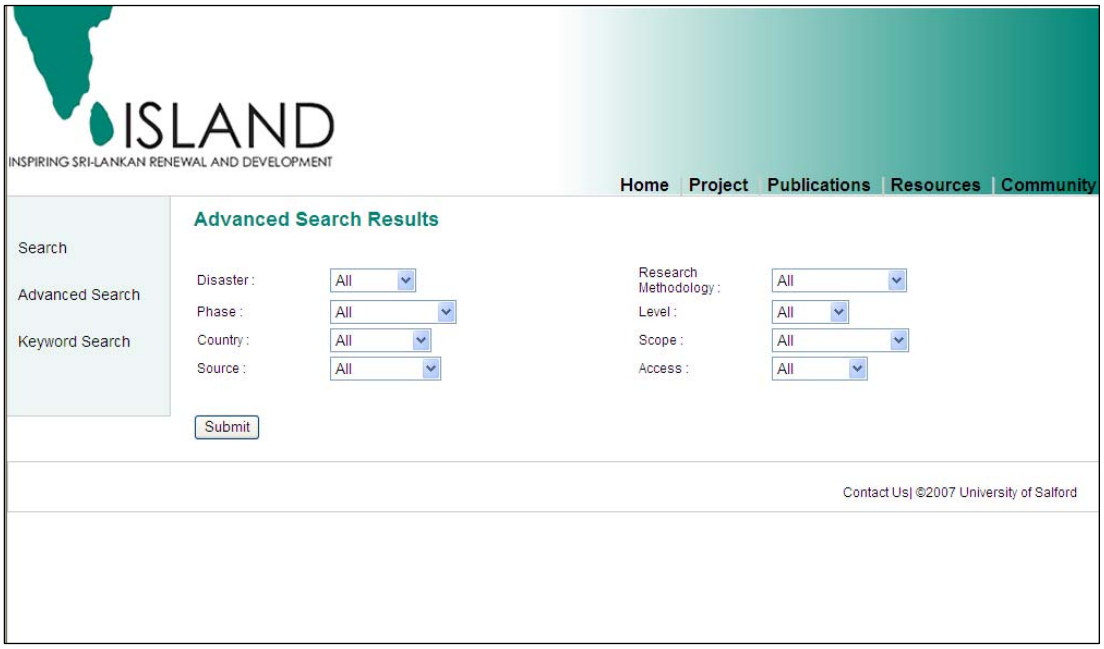


Figure 6: ISLAND Project Website- Advanced Search

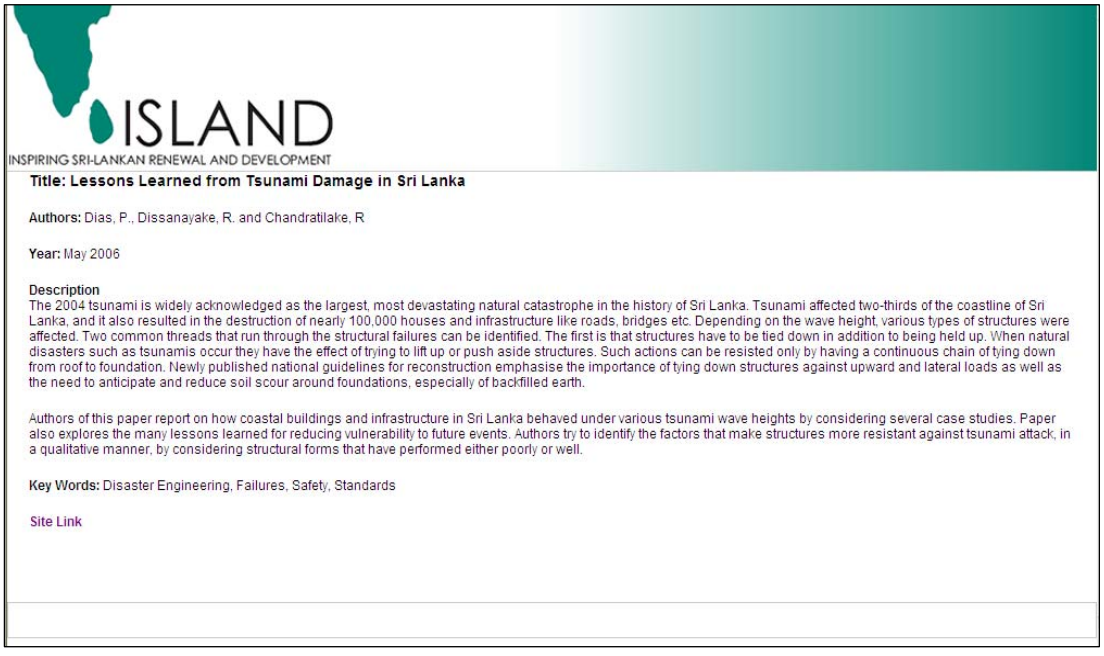


Figure 7: ISLAND project Website- Article Description

5 Dissemination

The following summarises the dissemination activities of the project.

5.1 Journal publications

- Seneviratne, K., Baldrty, D. & Pathirage, C. (2010) Disaster knowledge factors in managing disasters successfully, International Journal of Strategic Property Management, Vol 14, pp.374–388 (This was based on the paper published in the proceedings of the CIB World Congress 2010)
- A paper was submitted to the International Journal of Disaster Resilience in the Built Environment- awaiting review. This was based on the paper published in the proceedings of the COBRA conference 2010.
- There will be at least 2 further journal papers based on the final findings of the project, which will be submitted for consideration of :
    - Disasters Journal
    - Disaster Prevention and Management Journal

5.2 International conference publications & presentations

- Pathirage, C., Seneviratne, K., Amaratunga, D.,& Haigh, R. (2011). Managing Disaster knowledge: Identification of Knowledge Factors and challenges. In the proceedings of International Conference on Structural, Engineering, Construction and Management (ICSECM), Kandy, Sri Lanka, December 2011. It highlighted the identification of disaster knowledge factors in managing disasters successfully and challenges based on literature and expert interviews.

- Seneviratne, K., Pathirage, C., Amaratunga, D. & Haigh, R. (2011), Disaster knowledge factors: benefits and challenges, in the proceedings of International conference on BUILDING RESILIENCE 2011: Interdisciplinary approaches to disaster risk reduction, and the development of sustainable communities and cities, July 2011, Sri Lanka. It highlighted the benefits and challenges of disaster knowledge factors in managing disasters.

- Seneviratne, K., Amaratunga, D., Haigh, R. & Pathirage, C. (2010). Disaster knowledge factors: preliminary findings. In the proceedings of the Royal Institution of Chartered Surveyors (RICS) Construction, Building and Real Estate International Research Conference (COBRA), Université Paris-Dauphine in Paris, France, September 2010. It highlighted the disaster knowledge factors based on a comprehensive literature review.

- Seneviratne, K., Amaratunga, D., Haigh, R. & Pathirage, C. (2010). Disaster knowledge factors: preliminary findings. In the proceedings of the Royal Institution of Chartered Surveyors (RICS) Construction, Building and Real Estate International Research Conference (COBRA), Université Paris-Dauphine in Paris, France, September 2010. It highlighted the influence level of disaster knowledge factors in managing disasters successfully and how these factors influence the disaster management cycle based on the expert interviews.

- A poster was presented and published in the College of Science and Technology Research Showcase event in June 2011, UK. This poster highlighted the benefits and challenges of disaster knowledge factors in managing disasters.

5.3 Report

- Final project report: identification of key disaster knowledge success factors within the disaster management cycle and challenges.

6 Outcomes and the way forward

A number of important findings were elicited from the ISLAND II project. The findings highlighted the very high influence level of social factors in managing disasters successfully. Further, influence of technological and institutional factors are considered to be high. Though these findings are based on a limited number of experts, future research can focus on these identified areas and examine how the challenges identified could be overcome. Technological, operational/managerial, economic, social, legal and environmental factors had direct influence over the disaster management cycle, while the influence of institutional and political factors seemed indirect and it is through other factors identified. Further, the mitigation/preparedness phase seemed influenced by almost all the factors discussed. These findings could be further verified by selecting a larger expert sample. Findings highlighted the importance of education and training of people in managing disasters successfully. However peoples' attitudes and perceptions hinder their involvement in disaster management. As an example some people believe that disasters are an act of god which cannot be prevented, some are not involved due to their economic hardship. Also some people put the blame on others and refrain from contributing to managing disasters. Furthermore, bribery and corruption have taken over the legal structure. Hence, in order to manage disasters successfully it is important to overcome these attitudes and perceptions. Therefore, future research could be conducted to study how these attitudes and perceptions could be changed to manage disasters successfully.

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Appendices

Appendix 1

Inspiring Sri-Lankan reNewal and Development - Phase II

Knowledge Success Factors in Disaster Management

Interview Guideline

The research project entitled 'Inspiring Sri-Lankan reNewal and Development-Phase II' (ISLAND-II) aims to enhance the effectiveness of disaster management efforts by sharing, and disseminating knowledge and good practice relating to the built environment. The study is jointly sponsored by The Royal Institution of Chartered Surveyors (RICS) and the School of the Built Environment.

This study aims to cover the Work Package 2 (WP2) of the ISLAND - II project, which focuses on identifying key knowledge factors for effective sharing and dissemination of good practice based on interviews with experts in the disaster management process.

The interview guideline consists of two sections.

Section A: Participant's Background Information

Section B: Interview Questions
- Part I : Technological Factors
- Part II : Social Factors
- Part III : Environmental Factors
- Part IV : Legal Factors
- Part V : Economical Factors
- Part VI : Functional Factors
- Part VII : Institutional Factors
- Part VIII: Political Factors

Outcomes of these interviews will be used to produce a knowledge map highlighting key factors relating to the disaster management cycle.

Please answer the questions based on your experience and knowledge of disaster management.

Details of the Researcher:

Krisanthi Seneviratne
School of the Built Environment
4th Floor, Maxwell Building
University of Salford
Salford M5 4WT
UK

E-mail: T.K.K.Seneviratne@pgr.salford.ac.uk
Tel: +44 (0)161 295 7995
Fax: +44 (0)161 295 5011

Section A: Participant's Background Information

Name (Optional): ----------

Age in years: ☐ 20-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ above 60

Gender: ☐ Male ☐ Female

Current Job title/Designation: ----------

Organisation/Institution: ----------

Experience in dealing with disaster related issues (in years): ----------

Types of disasters you have dealt with (if any): ----------

Disaster related training programmes you have undergone (if any): ----------

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Section B: Interview Questions

This study focuses on managing different types of disasters by considering the three phases within the disaster management cycle; mitigation/preparedness, relief and reconstruction/rehabilitation.

Part I: Technological Factors

This includes aspects relating to, or involving the application of scientific advances including any tool, technique, product, process and method to benefit disaster management. Technological factors basically include the detection systems, communication systems, structural measures etc.

1. In your opinion how do you rank the influence level of technological factors in managing disasters successfully?

- 2	Very Low	- 1	Low	0	Neither	1	High	2	Very High

2. How do you think the way it influences change throughout the disaster management cycle?

3. How did you find the benefits of technology in managing disasters successfully?

4. What are the areas which need to be addressed?

Part II: Social Factors

This includes aspects relating to human society and its members in managing disasters. Social factors basically include community training, education etc.

5. In your opinion how do you rank the influence level of social factors in managing disasters successfully?

- 2	Very Low	- 1	Low	0	Neither	1	High	2	Very High

6. How do you think the way it influences change throughout the disaster management cycle?

7. How did you find the benefits of social factors in managing disasters successfully?

8. What are the areas which need to be addressed?

Part III: Environmental Factors

This includes aspects relating to the surroundings in managing disasters. Environmental factors basically include natural preventive measures, coping measures etc.

9. In your opinion how do you rank the influence level of environmental factors in managing disasters successfully?

- 2	Very Low	- 1	Low	0	Neither	1	High	2	Very High

10. How do you think the way it influences change throughout the disaster management cycle?

11. How did you find the benefits of environmental factors in managing disasters successfully?

12. What are the areas which need to be addressed?

Part IV: Legal Factors

This includes aspects relating to law, accepted rules, regulations in managing disasters.

13. In your opinion how do you rank the influence level of legal factors in managing disasters successfully?

- 2	Very Low	- 1	Low	0	Neither	1	High	2	Very High

14. How do you think the way it influences change throughout the disaster management cycle?

15. How did you find the benefits of legal factors in managing disasters successfully?

16. What are the areas which need to be addressed?

Part V: Economical Factors

Economical factors can be classified into two as long term economic planning measures and financial aspects.

a. Economic Planning Measures

This includes aspects relating to production, distribution and consumption of goods and services in a society. Economic planning measures basically include agricultural measures, economic incentives, economic penalties, provision of high priority to protect services network etc.

17. In your opinion how do you rank the influence level of economic planning measures in managing disasters successfully?

- 2	Very Low	- 1	Low	0	Neither	1	High	2	Very High

18. How do you think the way it influences change throughout the disaster management cycle?

19. How did you find the benefits of economic planning measures in managing disasters successfully?

20. What are the areas which need to be addressed?

b. Financial

This includes aspects relating to money and management of monitory assets. Financial matters include lack of funds, rigid policies, mismanagement of funds etc.

21. In your opinion how do you rank the influence level of finance in managing disasters successfully?

- 2	Very Low	- 1	Low	0	Neither	1	High	2	Very High

22. How do you think the way it influences change throughout the disaster management cycle?

23. How did you find the benefits of financial in managing disasters successfully?

24. What are the areas which need to be addressed?

Part VI: Operational/Managerial Factors

This includes aspects relating to the act of getting people together to accomplish desired goals and aspects relating to a process or series of actions for achieving a result. Operational/Managerial factors include leadership, competencies, communication, coordination, decision making, information management, logistics management etc.

25. In your opinion how do you rank the influence level of operational/managerial factors in managing disasters successfully?

- 2	Very Low	- 1	Low	0	Neither	1	High	2	Very High

26. How do you think the way it influences change throughout the disaster management cycle?

27. How did you find the benefits of operational/managerial factors in managing disasters successfully?

28. What are the areas which need to be addressed?

Part VII: Institutional Factors

This includes aspects relating to an organisation founded and dedicated to disaster management and related activities. Institutional factors include institutional arrangements, zoning, building codes, standards, national plans, training, education etc.

29. In your opinion how do you rank the influence level of institutional factors in managing disasters successfully?

- 2	Very Low	- 1	Low	0	Neither	1	High	2	Very High

30. How do you think the way it influences change throughout the disaster management cycle?

31. How did you find the benefits of institutional factors in disaster management process?

32. What are the areas which need to be addressed?

Part VIII: Political Factors

This includes aspects related to politics or parties or politicians in the context of disaster management.

33. In your opinion how do you rank the influence level of operational factors in managing disasters successfully?

- 2	Very Low	- 1	Low	0	Neither	1	High	2	Very High

34. How do you think the way it influences change throughout the disaster management cycle?

35. How did you find the benefits of political factors in managing disasters successfully?

36. What are the areas which need to be addressed?

Thank you

Appendix 2

ISLAND - Web Evaluation Questionnaire

Questionnaire Guideline

This study aims to cover the Work Package 1 (WP1) of Inspiring Sri Lankan renewal and Development – Phase II (ISLAND –II) research project. WP1 focuses on testing the effectiveness of the already developed ISLAND Website (http://veber.buhu.salford.ac.uk/island/index.php), as part of ISLAND phase I research project, in accommodating disaster management components associated with preparation, response and recovery. These evaluations will be used to provide an overall evaluation of the knowledge base, which will be used as the basis for further updates as part of ISLAND – II.

As part of this activity, a selected group of users including stakeholders representing disaster management related institutes, members of the academic community, CIB TG 63: disaster and built environment members etc will be invited to complete this web evaluation questionnaire, in evaluating its user friendliness and accessibility, as well as its value for knowledge themes/variables information and knowledge dissemination.

Please complete this questionnaire by using your experience in using the ISLAND website.

Questionnaire

Part I: Participant's Background Information

Name (optional): ----------

Current Job title/Designation: ----------

Experience: ----------

Part II: Participant's Awareness on ISLAND website

How many times have you visited the ISLAND website before?

- ☐ None
- ☐ Less than 3
- ☐ Less than 5
- ☐ More than 5
- ☐ More than 10

If 'None', please visit the website before you answer the following questions.

Part III: Questions about the ISLAND website

Please indicate your reply by checking the relevant responses for each of the statements below

SA	Strongly Agree	A	Agree	N	Neither	D	Disagree	SD	Strongly Disagree

1	General Questions about the ISLAND website	SA	A	N	D	SD
1.1	Interface of ISLAND is pleasant					
1.2	Style is consistant throughout the site					
1.3	Size of the text is easy to read					
1.4	Links are current and working					
1.5	User can clearly see where they are on the site					

2	Contents of the ISLAND website	SA	A	N	D	SD
2.1	The organisation of the information on the ISLAND website is clear					
2.2	It is easy for you to find information in ISLAND					
2.3	Information is timely and up to date					
2.4	Information is sufficient					

3. Overall, how do you rate ISLAND as a knowledge base on post-tsunami response in Sri Lanka?

   ☐ Excellent
   ☐ Good
   ☐ Neither good nor bad
   ☐ Weak
   ☐ Poor

4. Please list three(3) things that you like about ISLAND

   1. ----------
   2. ----------
   3. ----------

5. Please list three(3) things that you don't like about ISLAND

   1. ----------
   2. ----------
   3. ----------

6. Please list three (3) suggestions to improve ISLAND
    1. ----------
    2. ----------
    3. ----------

Appendix 3

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DISASTER KNOWLEDGE FACTORS IN MANAGING DISASTERS SUCCESSFULLY

Krisanthi SENEVIRATNE [1] ✉, David BALDRY [2] and Chaminda PATHIRAGE [3]

[1] *School of the Built Environment, The University of Salford, Maxwell Building, Salford, M5 4WT, UK*
E-mail: T.K.K.S.Seneviratne@edu.salford.ac.uk
[2] *School of the Built Environment, The University of Salford, UK*
E-mail: D.Baldry@salford.ac.uk
[3] *School of the Built Environment, The University of Salford, UK*
E-mail: C.P.Pathirage@salford.ac.uk

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ABSTRACT. The number of reported natural disasters has increased steadily over the past century and risen very sharply during the past decade. These bring about the loss of lives, property, employment and damage to the physical infrastructure and the environment. Disaster management efforts aim to reduce or avoid the potential losses from hazards, assure prompt and appropriate assistance to victims of disaster, and achieve rapid and effective recovery. While knowledge management can enhance the process of disaster management, there is a perceived gap in information coordination and sharing within the context of disaster management. Identifying key success factors will be an enabler to manage the disasters successfully. In this context, this study aim to identify and map key knowledge success factors for managing disasters successfully through capturing the good practices and lessons learned. The objective of this paper is to present the literature findings on factors which support successful disaster management. Accordingly the identified factors were classified into eight main categories as technological, social, legal, environmental, economical, functional, institutional and political.

KEYWORDS: Disasters; Disaster management; Knowledge management; Disaster knowledge success factors

1. INTRODUCTION

Billions of people in more than 100 countries are periodically exposed to at least one natural disaster (Moe et al., 2007) and there are around 30 identified natural disasters worldwide (Deshmukh et al., 2008). Each disaster has devastating impacts on human life, economy and environment. For example, in a quarter of the century since 1967, floods affected 30 percent of 2.8 billion people who suffered from weather-related disasters (Bayrak, 2009). There is evidence that the frequency and extent of natural disasters are increasing on a global scale (Warren, 2010a). In the decade 1900-1909, natural disasters occurred 73 times, but in the period 2000-2005 the number of occurrences rose to 2,788 (Kusumasari et al., 2010). Furthermore, though 80 percent of tsunamis occur in Pacific Ocean (Kong, 2004 cited in Camilleri, 2006), it is now identified that most other regions are prone to tsunamis. The Indian region is subject to increased seis-

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mic activity and the Mediterranean region too is active with earthquakes and volcanoes and some of these can generate tsunamis (Camilleri, 2006).

Natural disasters claim many human lives and damage a great deal of property (Louhisuo et al., 2007). On December 2004, a massive earthquake of magnitude 9.0 struck the coastal area of northern Sumatra in Indonesia and this triggered the tsunami that affected Indonesia, Thailand, Sri Lanka, India, Maldives, Bangladesh, Malaysia, Myanmar and Somalia (Pheng et al., 2006; Sonak et al., 2008; Srinivas and Nakagawa, 2008; Wijetunga, 2010). It is identified as one of the deadliest and costliest disasters in history (Hansen, 2005; Oloruntoba, 2005; Rodriguez et al., 2006; Morin et al., 2008) which caused an estimated US$ 9.9 billion worth of damages (Koria, 2009). The death toll is estimated to be between 200,000 and 300,000 (Poisson et al., 2009). Hurricane Katrina was another large natural disaster which caused extensive human suffering and physical damage (Koria, 2009). During the previous century, over a thousand earthquakes have occurred in seventy countries worldwide, taking the lives of 1.53 million people and leaving behind great financial loss (Valizadeh and Elmi, 2010). Haiti earthquake and Pakistan floods in 2010 record the latest deadliest disasters. The total cost of natural disasters in 2008 was US$ 181 billion (Warren, 2010b).

Less economically developed countries are prone to higher proportion of disasters and attendant deaths due to their inability to plan for and react effectively to the many disasters which face them, lack of infrastructure and emergency services, the high population densities of unplanned settlements and low economic capacities to withstand the impacts (Atmanand, 2003; Oloruntoba, 2005; Rodriguez et al., 2006; Louhisuo et al., 2007; Moe et al., 2007; Srinivas and Nakagawa, 2008). As an example, the most recent 7.0 magnitude earthquake which struck Haiti on 12 January 2010 is considered as the strongest earthquake in more than two centuries rocked the Caribbean nation. According to the officials and witnesses, it caused dozens of buildings to collapse, huge damage to infrastructure in the impoverished and crowded capital of Port-au-Prince (Cordoba and Luchnow, 2010). Authorities had estimated a total of 200,000 deaths and up to 3 million people are estimated to need aid following this earthquake (Carroll, 2010).

With the increased frequency and extent of natural disasters, there is an increase in the numbers of deaths, the numbers of people affected by disasters and their devastating impacts on human life, economy and environment (Bayrak, 2009). As worldwide communities have been facing an increasing frequency and variety of disasters which can cause direct and indirect effects (Haigh and Amaratunga 2010; Oloruntoba, 2005; Kovacs and Spens, 2007; Moe et al., 2007) the urgent need to reduce disaster risk (Moe et al., 2007) and develop a resilient community capable of recovering from disasters (Rotimi et al., 2009) is of increasing concern in many countries.

Therefore efforts need to be made in order to reduce their impacts. In this context knowledge management can play a vital role through ensuring the availability and accessibility of accurate and reliable disaster risk information when required and through effective lesson learning. Despite this it is observed that a perceived gap in knowledge management exists within the context of disaster management (Mohanty et al., 2006; Otim, 2006). This research aims to identify and map key success factors in managing disasters through good practices and lessons learned and to enhance the knowledge of disaster management. With regard to this study, this paper presents the literature findings on factors which support successful disaster management.

2. DISASTER MANAGEMENT

Moe et al. (2007, pp. 787) define a disaster as " a situation which overwhelms local capacity, necessitating a request to the national and international level for external assistance, or is recognised by a multilateral agency or by at least two sources, such as national, regional or international assistance groups and the media". Disaster is derived from Greek meaning, 'bad star' (Konoorayar, 2006). Disasters are classified in various ways. The Emergency Disasters Database classified disasters as natural or technological. Accordingly, technological disasters consist of industrial accidents, transport accidents and miscellaneous accidents. The United Nations (UN, 2006 cited in Moe et al., 2007) further classified natural disasters into three as hydro-meteorological disasters (floods, wave surges, storms droughts, forest fire and extreme temperature), geophysical disasters (earthquakes, tsunamis and volcanic eruptions) and biological disasters (epidemics and insect infestations).

Disaster management efforts aim to reduce or avoid the potential losses from hazards, promote prompt and appropriate assistance to victims of disaster, and seek to achieve rapid and effective recovery (Warfield, 2004). Phases in natural disaster management are identified in different terms which give similar insights. Figure 1 shows the disaster management spiral which illustrates the two main phases of disaster management as pre-disaster risk reduction and post disaster recovery.

Accordingly, risk and vulnerability assessment involves identifying the nature and magnitude of current and future risks from hazards to people, infrastructure and buildings (RICS et al., 2009; McEntire, 2010). Through vulnerability analysis it is possible to identify which public and private buildings should be reinforced or relocated and which buildings are likely to contain large numbers of trapped survivors. It would be unrealistic to prevent or limit building and occupation of the coastal environment and reinforce every building within the tsunami flood hazard zone due to the economic costs.

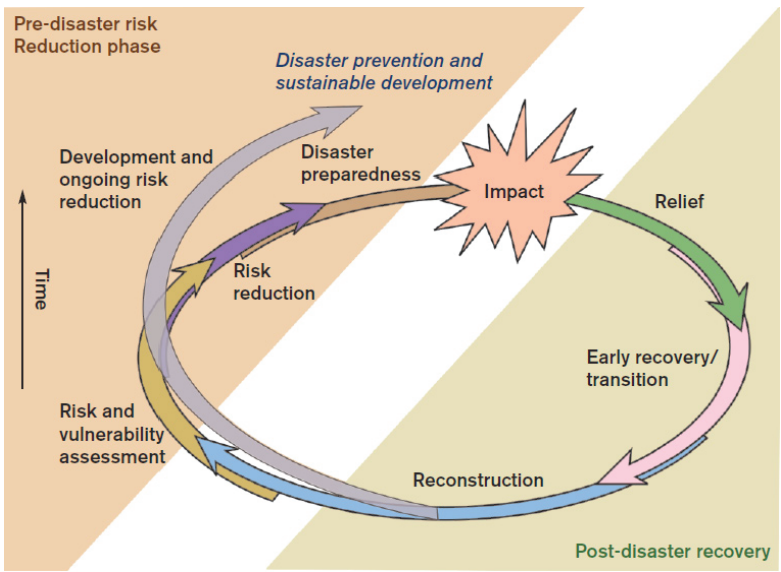

Figure 1. The risk management and response spiral
Source: RICS et al., 2009

Also it would not always possible to construct large and hard engineered coastal barriers such as breakwaters, walls and revetments. Therefore detailed information on which buildings, structures and group of people are vulnerable to tsunami impacts helps to develop cost effective mitigation measures. Mitigation or risk reduction activities include structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards (Atmanand, 2003; Bosher et al., 2007; Moe et al., 2007; RICS et al., 2009). Preparedness deals with the activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations (Atmanand, 2003; Moe et al., 2007).

Provision of assistance or intervention during or after a disaster to meet the life preservation and basic subsistence needs of those people affected is made during the relief phase (Moe et al., 2007). Relief activities include medical attention, body identification, clearing away rubble, debris, providing transport access, providing survival requirements, water purification kits, cooking utensils, foods, safe areas, relocation, shelter and general living and psychological support (Perry, 2007). Transition phase involves the activities of community surveys, needs assessment, land survey and acquisition and provision of transitional shelter (RICS et al., 2009). Care and maintenance of transitional shelter is required till permanent housing construction is provided. Reconstruction refers to the rebuilding of damaged living conditions of the stricken community with the aim of long term sustainability (Moe et al., 2007). The commencement of the recovery phase begins with the restoration of essential buildings and infrastructure services destroyed in the disaster and rehabilitation to assist the victims in returning to their pre-disaster livelihood (Pheng et al., 2006) or until the community's capacity for self-help has been restored (Rotimi et al., 2009). Recovery is usually identified as slow, expensive and complex in terms of coordination and management (Koria, 2009). However it may present an opportunity for improvement in the functioning of the community, so that risk from future events can be reduced while the community becomes more resilient (Rotimi et al., 2009).

Activities of vulnerability assessment, mitigation and preparedness are conducted as a proactive approach while the activities conducted after the disasters are called a reactive approach. Lack of a proactive approach to disaster management can result in more damage and higher level of a proactive behaviour is required for successful disaster management (Moe and Pathranarakul, 2006). However some natural disasters (droughts, floods and volcanic eruptions) are slow-onset and provide a lead-time for a proactive approach, while others (flash floods, earthquakes, tsunamis and cyclones) provide little or no lead-time for proactive measures (Moe and Pathranarakul, 2006). Therefore an integrated approach which includes both proactive and reactive strategies is important for managing disasters successfully.

3. KNOWLEDGE MANAGEMENT IN CONTEXT OF DISASTER MANAGEMENT

Mohanty et al. (2006) define knowledge as "the fact or condition of knowing something with a considerable degree of familiarity through experience, association or contact". Basically three forms of knowledge are identified as explicit, tacit and implicit. Explicit knowledge is that which is stated in detail and is termed as codified or formal knowledge. Tacit knowledge is that which is understood, implied and exists without being stated. It is housed in the human brain. Implicit knowledge is that

which could be expressed, but has not been. Knowledge management is all about providing the right knowledge, in the right place, at the right time. From organisations perspective, knowledge management is about applying the collective knowledge of the entire workforce to achieve specific organizational goals. It is about facilitating the process by which knowledge is created, shared and utilised.

Though there is no way of neutralizing all negative impacts resulting from disasters, efforts can be made in order to reduce their consequences. Knowledge on disaster management strategies, together with good practices and lessons learned, can undoubtedly support this effort through well-informed mitigative measures and preparedness planning. RICS et al. (2009) emphasize the feeding back of recovery experience to inform the disaster management process to reduce the future risks and improve the resilience of vulnerable communities. According to Moe et al. (2007) it is essential for practitioners in the disaster management field to be innovative and learn from lessons in order to adopt best practices throughout the disaster management cycle. Practitioners in disaster management should improve their skills and increase their level of knowledge, which requires investments in systems, databases and network structures so as to build a culture of learning from previous lessons and the adoption of best practices (Moe et al., 2007).

Despite this, knowledge on disaster management strategies appears fragmented, emphasising a perceived gap in information coordination and sharing (Mohanty et al., 2006). Accordingly, the knowledge and experiences of disaster practitioners are remain in individual or institutional domains. As an example, a case study conducted in Sri Lanka, revealed that organisations have not been able to capture, retain and/or re-use the learning from similar operations except through the tacit knowledge of individuals that have worked in various operations (Koria, 2009). Therefore the experiences, approaches and adopted modalities for disaster management remain with individuals as tacit knowledge. This resulted in re-inventing the wheel in terms of setting up and managing the construction programmes and projects within the tsunami recovery operation. This requires not only a great amount of work to establish but also result in a lack of incremental learning which constrained the strategic decision making. As Mohanty et al. (2006) point out, though information about disaster management has been available from various domains from decades, millions of people are still severely affected by disasters every year due to lack of adequate coping mechanisms as a result of un-coordinated information not being transformed into the life saving knowledge for the communities at risk. Kaklauskas et al. (2009) indicates that in the countries affected by Asian tsunami the lack of knowledge management is apparent. Therefore the lack of effective information and knowledge sharing, and knowledge creation on disaster management strategies can thereby be identified as one of major reasons behind the unsatisfactory performance levels of current disaster management practices.

4. METHODOLOGY

Identification of key success factors within the disaster management cycle will be delivered based on interviews with experts who are involved in the disaster management process, supported by an extensive questionnaire survey. This paper is based on a comprehensive literature survey and review carried out, with special focus on Asian Tsunami and case examples from Sri Lanka, to identify the factors which support successful disaster management. As a result of this detailed literature synthesis, a list of success factors within the disaster management cycle is identified and provided in succeeding section.

5. SUCCESS FACTORS IN DISASTER KNOWLEDGE MANAGEMENT

Success factors are truly important matters that must be considered for the performance of an operation. In the context of disaster knowledge management, success factors can be defined as; circumstances, facts, or influences that are input into the knowledge of disaster management and can directly or indirectly affect the outcomes of disaster management. This study aims to identify key disaster knowledge factors for managing disasters successfully through capturing the good practices and lessons learned and to map them against the disaster management cycle. It is currently underway and this section provides the literature findings on factors to be considered in managing disasters successfully. Identified factors are classified into several categories as; Technological, Social, Environmental, Legal, Economical, Functional, Institutional and Political based on their characteristics. These factors are common for all types of disasters and considered the three phases; mitigation/preparedness, relief/recovery and reconstruction/rehabilitation, by covering many countries affected.

5.1. Technological factors

This includes aspects relating to or involving the application of scientific advances including any tool, technique, product, process and method to benefit disaster management. Information and communication technology and other scientific advances are applicable to the mitigation of natural hazards (WCDR, 2005 cited in Oloruntoba, 2005) which consequently helps to save lives and property while reducing the loss of livelihoods (UNDP, 2005 cited in Oloruntoba, 2005). Under this main category, three sub-categories are identified as warning systems, communication systems and structural measures.

Warning systems

Though it might be impossible to predict an earthquake it is possible to predict a tsunami and warn people in its path in order to move them to a safer location. The Indian Ocean tsunami of 2004 made people aware of the lack of a tsunami early warning system (Camilleri, 2006; Moe and Pathranarakul, 2006). Therefore it is not only recommended to set up an Indian Ocean tsunami early warning system, but also to integrate it with Pacific Ocean tsunami early warning systems. For the total coverage of the world a similar early warning system should be set up in the Mediterranean and the Atlantic (Oloruntoba, 2005). Further it emphasized that a warning should be as inclusive as possible to raise the awareness amongst public officials in the region and globally (Oloruntoba, 2005). In other words warning systems should be integrated with communication, education and awareness raising of the population (Rodriguez et al., 2006). As an example, The Pacific Ocean tsunami early warning system was reported to have had knowledge about the earthquake of Sumatra which triggered the 2004 tsunami and only selectively communicated a warning which would otherwise have reduced the loss of lives (Martin, 2004 cited in Oloruntoba, 2005). Reasons for the failure to warn at the Indian Ocean tsunami are found as slow or non-existent flows of information.

Communication systems

The media is able to fulfil the strategic roll of information distribution, mass communications and the education of people on how to evacuate, locate and relocate (Oloruntoba, 2005). Mass communication systems such as the use of emergency public sirens and warning broadcasts using radios, televisions and print media should be put in place. Public presentations, notices and pamphlets, sign and posters too have been used to communicate mitigation and protective measures.

Geographic information systems and remote sensing tools are proposed to use for effective logistics management among organisations during relief (Moe and Pathranarakul, 2006). Communication between stakeholders is vital important for successful reconstruction. Therefore effective communication mechanism should be established among key stakeholders (Moe and Pathranarakul, 2006). Computer networks and decision support systems can enhance the disaster communication during reconstruction (Ozceylan and Coskun, 2008).

Structural measures

Strengthening of buildings and infrastructure exposed to hazards via engineering design and construction practices come under this sub-category. According to Allotey et al. (2010) effective application of science and engineering principles to the development of the built environment has reduced the risks faced by earthquake-threatened cities of the developed world. Designing of houses and buildings in coastal areas which could withstand a tsunami is important. For example, engineers and researchers could design a 40 m^2 house for the coastal areas of Sri Lanka that they believe could withstand a tsunami and which would cost between $1,000 to $1,500 at 2005 prices (Hansen, 2005). It is simply designed with gaps between walls that will enable water to flow through the structure without destroying it. Designers suggest that these houses would be approximately five times stronger than a conventional house of the same size.

Presence of protective structures could reduce the vulnerability of people and structures. Studies have shown that $1 spent on prevention can save $40 of damage (Pheng et al., 2006). Flood defences (dams, levees) and sea walls are considered as physical preventive measures while raised roads, resilient infrastructure, raised platforms with latrines and drinking water, resilient water supply systems such as boreholes and building design with escape roads are considered as physical coping measures (DFID, 2005).

5.2. Social factors

This category includes the aspects relating to human society and its members in managing disasters Initiatives to increase the population's level of education, increase employment opportunity, reduce poverty, enhance the role and participation in decision making including women that would support preparations for future disasters (Rodriguez et al., 2006).

Lack of awareness and knowledge regarding tsunamis was apparent among the community members and government officials in Sri Lanka (Rodriguez et al., 2006). As lack of knowledge increases the vulnerability of people, strengthening communities against disasters is effective to reduce damage (Shiwaku and Shaw, 2008). Education is considered to be a key tool for the development of coastal communities' resilience (Morin et al., 2008). Education involves the enhancement and use of indigenous knowledge for protecting people, habitat, livelihoods, and cultural heritage from natural hazards. Educational practices can be conducted through direct learning, information technology, staff training, electronic and print media and other innovative actions to facilitate and manage and transfer of knowledge and information to citizens, professionals, organisations, community stakeholders and policy makers (Kaklauskas et al., 2009). Preparation through education is accepted as less costly than learning through tragedy (Kaklauskas et al., 2009). According to UN/ISDR, awareness about risks and dangers need to start in early education before abilities to address them can become part of growing civic and professional responsibilities as people mature (UN/ISDR, 2004 cited in Shiwaku and Shaw, 2008). Therefore the value of education of school children cannot be underestimated and it indirectly raises the awareness of communities (Sonak et al., 2008).

While there should be effective early warning systems, it must also make public officials and populace aware of evacuation plans (Olo-

runtoba, 2005; Rodriguez et al., 2006). These will support the promotion of a culture of preparedness.

The tsunami swept away the tourism resorts and fishing industry (Moe and Pathranarakul, 2006). Rehabilitation of the fisheries sector is essential and can be done through the provision of equipment and restoration of infrastructure facilities. Apart from that it is important to diversify the livelihood opportunities for improved management of natural resources.

Differing needs in the various affected countries, coupled with differing socio-economic and cultural conditions, need to be considered during relief and reconstruction (Oloruntoba, 2005). It is necessary to consider short and long term demographic and socio-economic implications of affected regions and how they impact the population in general and women in particular. Some of these points are:

- More children have orphaned.
- Traditional gender roles are being challenged by disasters.
- Women are differently affected by the tsunami, causing more deaths, sexual abuse in refugee settings, impact of role as an economic provider (Oxfam, 2005; Rodriguez et al., 2006; Sonak et al., 2008). following the high death rate of women, men are facing the challenge of raising and educating their children, therefore issues related to land tenure, property rights, economic sustainability of widows and primarily patriarchal societies must be addressed (Rodriguez et al., 2006).

5.3. Environmental factors

Aspects relating to the natural environment in managing disasters are considered here. Natural barriers such as sand dunes, coral reefs, mangroves, can provide protection from tsunami as they can reduce the flow velocity. As an example, in Sri Lanka, Yala and Bundala National Parks were protected due to these natural barriers. The mangroves' complicated root systems help to bind the shore together and shield against destructive waves (Sonak et al., 2008) the absence of which is a factor that determine vulnerability to coastal hazards. Therefore it is necessary to emphasize the importance of maintaining the protective features of the natural environment such as sand dunes, forests and vegetated areas (Arya et al., 2006; Bosher et al., 2007). Re-forestation of watersheds helps to minimise the effects of droughts.

The tsunami created tonnes of waste, comprising hazardous waste, vegetation, soil, sediment, demolition debris and municipal waste. These wastes pose threats to human health, ground water supplies and the marine environment (Sonak et al., 2008). Management of waste created by natural hazards is highly important and highlights the need for clear guidelines. It is important to explore ways of recycling and reusing of debris, and the need for proper sewerage systems and cost-effective sewerage treatment plants is emphasized.

Rehabilitation of saline soils needs to be performed through assessment and monitoring operations by trained staff. Development of a proper and adequate drainage system is also critical to minimise the harm to the ground.

Remediation of ground water supplies that have been polluted is likely to take several years. Therefore it is necessary to provide drinking water for affected people to avoid the risks of diseases (Sonak et al., 2008).

5.4. Legal factors

These include aspects relating to law, accepted rules, and regulations for managing disasters. The various regulations that apply to routine construction provide for the safe development of infrastructure, capital improvements and land use, ensuring preservation and environmental protection (Wilkinson et al., 2006). Accordingly if the regulation proc-

esses are well formulated they should not only to be an effective means of reducing vulnerability to disasters, but also a means of facilitating reconstruction projects. As an example, legislative and policy factors are found as a major determinant of resource availability in post conflict reconstruction (Chang et al., 2010). According to Moe and Pathranarakul (2006), disaster management supporting laws and regulations must be established and enforced so as to create an enabling environment so that suitable laws and regulations can be enacted based on professional hazard and vulnerability assessment (Pheng et al., 2006). However it is claimed that much of the existing legislation was not drafted to cope with an emergency situation and was not developed to operate under the conditions that will inevitably prevail in the aftermath of a disaster (Rotimi et al., 2009). The process of attaining building consent is identified as a bottleneck which hinders the achievement of reconstruction objectives.

On the other hand, poor construction quality is found to be a major reason for a higher level of destruction and deaths in developing countries. This could be as a result of lax building codes, weak enforcement of construction standards and corrupt procurement practices (Pheng et al., 2006). Therefore laws relating to these areas should be strengthened and enforced.

5.5. Economic factors

Economic factors can be classified into two: long term economic planning measures and financial. Economic planning measures include aspects relating to production, distribution and consumption of goods and services in a society. Aspects relating to money and management of monetary assets are covered under the financial sub-category.

Economic planning measures

1. Destruction of infrastructure during a disaster directly affects the economy of a country. As an example the fisheries sector, agricultural sector, livestock, tourism and micro-enterprises were dramatically affected by the Asian tsunami. Therefore the design of roads, railways, pipelines and cables needs careful location planning to reduce the risk of widespread failure (Bosher et al., 2007). Providers of energy in hurricane-prone areas can put their connections underground to minimise the risk of power shortages (Longo, 2005 cited in Kovacs and Spens, 2007).
2. Incentives such as tax breaks could include for resilient building design. Incentives can even be used to attract qualified professionals to manage large and complex projects successfully (Koria, 2009).
3. Insurance of properties against disasters must be made compulsory as an initiative to survive after disasters (Atmanand, 2003). This will indirectly improve the quality of construction as insurance companies will insist on certain minimum standards being met.
4. Introducing appropriate crops, breeds of livestock and drought resistant practices can reduce the agricultural losses due to disasters (Jayaraj, 2007).

Financial

Donors are known to make financial pledges which are not fulfilled (Oloruntoba, 2005). Lack of funds for long term reconstruction in excess of short term relief operations is another issue of reconstruction (RICS, 2006; Koria, 2009). Apart from that they should endeavour to invest in measures that reduce the impact of disasters. Donor administration and financial policies are usually not suited for rapid release of funds for disaster response and can cause delays in reconstruction.

5.6. Functional factors

Functional factors can be classified as technical and operational. Technical aspects

include factors relating to the skills and competence needed to accomplish desired works. Operational aspects include factors relating to a process or series of actions for achieving a result.

Technical

Participants lack of skills and knowledge in disaster risk management initiatives is identified as a major issue of reconstruction. For cost effective mitigation measures to be developed and applied, detailed information should be available on which buildings, infrastructural works and groups of people are particularly vulnerable to hazards. For these to be achieved, vulnerability assessments should be carried out.

Managing complex, large and demanding type of projects requires competent and experienced staffs, which are often found to be lacking in disaster reconstruction projects which may lead to unsuccessful project delivery (Koria, 2009). Therefore reconstruction demands project management competencies, and networking with international partners is suggested as one way of achieving these.

Inadequate planning and resources will inevitably hamper the reconstruction. Rotimi et al. (2009) indicate that the effectiveness of the reconstruction process will depend on how much planning has been carried out and which contingencies are provided for in preparing for the disaster. For instance, common protocols and industry standard project management and planning tools have not been widely used in Sri Lanka (Koria, 2009). Therefore late starts, delays in delivery and inflation lead to cost overruns of reconstruction projects.

Operational

Challenges of logistics and access are found to cause bottlenecks in aid flows. Disaster logistics include people, expertise and technology. The field of humanitarian logistics is relatively new and it is different from business logistics due to various characteristics: disaster relief operations are carried out in an environment with destabilised infrastructures ranging from a lack of electricity supplies to limited transport infrastructure. As most disasters are unpredictable, the demand for goods is also unpredictable (Kovacs and Spens, 2007), although the basic principles of business logistics can be applied to humanitarian logistics.

Coordination of recovery is usually accepted as slow, expensive and complex (Koria, 2009). The extent of effective collaboration and coordination between national authorities, local actors and international actors appear to be insufficient to achieve effective planning, damage assessment and public information management (Oloruntoba, 2005). Coordination should be considered at different levels including international, national, regional, organisational and project level (Moe and Pathranarakul, 2006).

Local groups should be engaged in decision making and local skills should be utilised (Oloruntoba, 2005; Moe and Pathranarakul, 2006). If the relocation efforts are to be succeeded, it should involve the communities in the decision making process (Rodriguez et al., 2006). It is claimed that recognition was not effective so that some important groups were entirely excluded in Sri Lanka (Koria, 2009). Further it should be appreciated that local participation in recovery efforts include the distribution of relief aid and cleaning up of debris.

After a disaster, information is the most valuable and often most elusive asset (Paul et al., 2006). Information is vital for early warning, planning, rehabilitation and reconstruction. Lack of information complicates the efficient management of catastrophes and makes the decision making process a difficult task (Puras and Iglesias, 2009). Sobel and Leeson (2007) found that the inability to overcome the information problem is the root cause of a government's failure to manage natural disaster relief effectively. Therefore an effective information management system is important.

For example, swift access to building plans and schematics of key services in the event of fires and floods would benefit the operational level of emergency management (Bosher et al., 2007). During reconstruction timely, accurate, and useful operational information must be disseminated amongst responding organisations for effective coordination (Oloruntoba, 2005).

5.7. Institutional factors

This includes aspects relating to an organisation founded and dedicated to disaster management and related activities.

An effective institutional arrangement is essential for managing disasters successfully. While a principal responsible unit must be specified, other units should be specified at various levels including provincial, district and village level. Unclear line of authorities, coupled with a slow decision making process caused delays in activities (Moe and Pathranarakul, 2006). These units should be fully authorised for disaster management and have developed a disaster management master plan.

Though warning systems may facilitate the saving of lives, they are not useful in minimising damage to property and infrastructure. Therefore development of land use plans and regulations is necessary to direct new development away from known hazard locations, relocate existing developments to safer areas and maintain protective features of the natural environment. However these policies should be created with wider consultation to make them effective and consistent. As an example, the 200 m coastal buffer zone was later revised to a significantly less wide zone as a result of creating it without geomorphologic consideration (Koria, 2009). Further the issues of land acquisition, community acceptance and impact on livelihoods were neglected. For example some communities were planned to relate to a region where they would be impacted by floods and some fishermen and their families were planned to be relocated to high-rise apartment type housing which is not conceivable to them. It is essential to plan the coastal zone developments of harbours, buildings and other infrastructure with coastal zone management strategies whilst restoring coastal ecosystems to enhance the level of resilience (Srinivas and Nakagawa, 2008). Necessary building codes must be developed which are informed by these risks.

Lack of appropriate technical and managerial expertise and knowledge of participants is widely acknowledged (Koria, 2009). Professional institutions need to carry out training programmes and disaster management courses to disseminate the knowledge about disaster risk management initiatives and of which stages these must be addressed, including their roles and responsibilities. For example it is found that the pre-construction phase emerges as the most critical phase for integrating disaster risk management into the construction and designers, civil engineers, structural engineers, specialist contractors, engineering consultants and developers should be involved (Bosher et al., 2007). Further it is identified that the stakeholders involved in the preliminary phase should consider what materials to use, where to build and what to build. It is emphasized there is a need to develop an accreditation scheme and a training programme for the context of recovery work (Koria, 2009).

The strengthening of networks among disaster experts, managers and planners across sectors and between regions is needed (Kaklauskas et al., 2009). This is supported by Mohanty et al. (2006) and indicated that linkages among all agencies working on disaster management need to be strengthened in order to derive the regional best practices and coping mechanisms. In order to enhance the information sharing and management of the knowledge generated in these institutions, it is highly essential to closely knit together

the organisations/institutions. The network of these institutions will create a common platform and enable its stakeholders and people to capture, organise, share and reuse the knowledge generated in the area of disaster management. Education on disaster management should be institutionalised and a curriculum should be developed to include disaster management modules to educate school children and university students. Further educational programmes can be introduced to carry out research in the field. Designing and constructing a resilient built environment demands an in-depth knowledge on avoiding the effects of hazards and therefore research should be done on how disaster risk reduction can be effectively mainstreamed into construction (Bosher et al., 2007).

5.8. Political factors

These include aspects related to politics or parties or politicians in the context of disaster management. The political situation in a region may not be supportive of immediate distribution of relief materials or longer term reconstruction and the safety and security of the relief workers may be affected (Oloruntoba, 2005).

Deep rooted political unrest complicated relief and reconstruction in Sri Lanka and Indonesia (Paul et al., 2006). For example, due to lack of access all recovery work in the north of Sri Lanka was stopped (EC, 2007 cited in Koria, 2009). Rodriguez et al. (2006) indicated that the conflict between the government and the Liberation Tigers of Tamil Eelam generated a variety of concerns regarding how aid was distributed.

The volatile stakeholder map and conflicting internal political agendas too contributed to additional delays in reconstruction (Koria, 2009). In some cases, internal political agendas superseded the technical agenda in Sri Lanka (Koria, 2009).

6. SUMMARY

This study has identified a list of factors to be considered in disaster management and classified them into several categories based on their characteristics. It is clear from the literature review that most factors are identified within one or more phases of the disaster management cycle. As an example, communication comes under mitigation, preparedness, relief and reconstruction. Some of other factors as well follow this pattern and these factors may be critical for some particular phase or phases and general for other phases. At the same time it will depend upon the type of disaster and country.

The need for disaster risk reduction is widely acknowledged against the increasing frequency and variety of disasters which can cause direct and indirect effects. In this context, knowledge of disaster management strategies, together with recognised good practices and lessons learned, can undoubtedly support this effort through well-informed mitigative measures and preparedness planning. In this context, this research aims to identify key success factors for managing disasters and maps them against the disaster management cycle. This paper identified and categorised factors which must be considered for successful disaster management through a comprehensive literature survey. Major categories derived are; technological, social, legal, environmental, economical, functional, institutional and political. Identified factors were classified into these main categories based on their characteristics.

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SANTRAUKA

INFORMACIJOS APIE NELAIMES VEIKSNIAI, LEIDŽIANTYS SĖKMINGAI VALDYTI NELAIMES

Krisanthi SENEVIRATNE, David BALDRY, Chaminda PATHIRAGE

Pastarąjį amžių pranešimų apie stichines nelaimes nuolat daugėjo, o pastarąjį dešimtmetį ypač. Per nelaimes žūsta žmonės, prarandama nuosavybė ir darbo vietos, suniokojama fizinė infrastruktūra ir aplinka. Valdant nelaimes siekiama sumažinti arba išvengti potencialių nuostolių dėl pavojų, užtikrinti greitą ir tinkamą pagalbą nelaimės aukoms, viską greitai bei efektyviai atkurti. Nors žinių vadyba nelaimių valdymo procesui gali padėti, nelaimių valdymo kontekste pastebima spraga tarp informacijos koordinavimo ir dalijimosi ja. Nustačius pagrindinius sėkmės veiksnius, tai leis sėkmingai valdyti nelaimes. Šiame kontekste tyrimu siekiama nustatyti ir surūšiuoti pagrindinius žinių sėkmės veiksnius, leidžiančius sėkmingai valdyti nelaimes, užfiksuojant gerąją patirtį ir išmoktas pamokas. Šio darbo tikslas – pateikti literatūros išvadas apie veiksnius, kurie prisideda prie sėkmingo nelaimių valdymo. Nustatyti veiksniai atitinkamai suklasifikuoti į aštuonias pagrindines kategorijas: technologiniai, socialiniai, teisiniai, aplinkos, ekonominiai, funkciniai, instituciniai ir politiniai.