Knowledge Management for Disaster Resilience: Identification of Key Success Factors

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Abstract

The number of reported 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 aims 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, disaster management cycle, knowledge management, success factors

1. Background

Billions of people in more than 100 countries are periodically exposed to at least one of natural disasters (Moe *et al.*, 2007). Sri Lanka is prone to different kinds of natural disasters including floods, cyclones, landslides, droughts and coastal erosion. Recorded earthquakes over the past 400 years were relatively small magnitudes and not caused significant damage (Jayawardane, 2006). Nevertheless with a new tectonic boundary formed below Sri Lanka, it is now not possible to exclude any future damages. Further, Sri Lanka has recently been identified as a tsunami prone area. Disasters cause huge impact on people, property and environment. On December 2004, a massive earthquake of magnitude 9.0 struck the coastal area of northern Sumatra in Indonesia and this triggered 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). 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). For example 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). Haiti earthquake counts as the latest deadliest earthquake.

A higher proportion of disasters and deaths occur in developing world due to their inability to plan for and react effectively to the many disasters which face them, high population densities of unplanned settlements and low economic capacities to withstand the impacts (Atmanand, 2003, Oloruntoba, 2005, Rodriguez *et al.*, 2006, 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 need aid from this earthquake (Carroll, 2010). At least 1.8 million people live within the area and according to the geophysicists a strong earthquake in such a populated area could really cause substantial damage (Cordoba and Luchnow, 2010).

As worldwide communities have been facing an increasing frequency and variety of disasters which can cause direct and indirect effects (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) are of increasing concern in many countries. As an example, though 80% of tsunamis occur in Pacific Ocean (Kong, 2004 cited Camilleri, 2006), it is now identified that most of other regions as well are prone to tsunamis; Indian region is subjected to increased seismic activity and Mediterranean region too active with earthquakes and volcanoes, and some of these can generate tsunamis (Camilleri, 2006).

Therefore, efforts should 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 a perceived gap in knowledge management within the context of disaster management. In

this context, this research aims to identify and map key success factors in managing disasters through good practices and lessons learned, and to enhance the knowledge management on disaster. This paper presents the literature findings on factors which support successful disaster management.

Paper comprised with 7 sections: Section 1 is the background; Section 2 provides an introduction to disaster management followed by the section 3 which identifies the role of knowledge management in the context of disaster management; Section 4 briefly introduces the adopted research methodology; Section 5 provides the literature findings on factors to be considered in managing disasters successfully followed by the discussion under section 6; Summary is provided at the end of the paper.

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. Emergency Disasters Database in 2006 classified disasters as natural or technological (Moe *et al.*, 2007). Accordingly, technological disasters consist of industrial accidents, transport accidents and miscellaneous accidents. United Nations (2006 cited 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, assure prompt and appropriate assistance to victims of disaster, and 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.

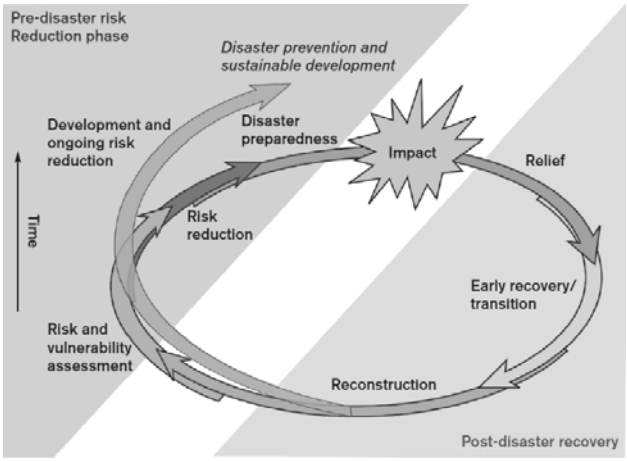

Figure 1: The risk management and response spiral (Source: RICS, 2009)

Accordingly, risk and vulnerability assessment involves identifying the nature and magnitude of current and future risks from hazards to people, infrastructure and buildings (RICS , 2009). According to Papathoma *et al.* (2003) and Moe and Pathranarakul (2006), tsunami vulnerability analysis is fundamental to effective disaster planning as it is not possible to develop or implement sensible mitigative measures without a meaningful analysis. This process is based on a review of both technical features of hazards such as their location, intensity frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capacities of the risk scenario (Moe and Pathranarakul, 2006). 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. Also it would not 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 measure 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, 2009). Preparedness dealing with the activities an 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 ad acquisition and provision of transitional shelter (RICS, 2009). Care and maintenance of transitional shelter is required till permanent housing construction. 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 known 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 proactive approach while the activities conduct after the disasters are called reactive approach. Lack of proactive approach to disaster management caused more damage and it is encouraged more proactive activities for successful disaster management (Moe and Pathranarakul, 2006). However, some natural disasters (droughts, floods and volcanic eruptions) are slow-onset and provide lead-time for proactive

approach, while others (flash floods, 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 getting the right knowledge, in the right place, at the right time. In organisational 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 resulted from disasters, efforts can be made in order to reduce their impacts. In this context, 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 (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 members in the disaster management be innovative and learned from lessons in order to adopt best practices throughout the disaster management cycle. Members in disaster management should improve their skills and increase their level of knowledge. For these to achieve it is necessary to do the investments in systems, databases and network structures so as to build a culture of learning from previous lessons and adopting 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 remaining in individual or institutional domain. As an example, a case study conducted in Sri Lanka revealed that the organisations have not been able to capture, retain and/or re-sue 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 a tacit knowledge. This resulted the re-inventing the wheel in terms of setting up and managing the construction programmes and projects within the tsunami operation. This requires not only a great amount of work to set things up but also results a lack of incremental learning which constraint the strategic decision making. As Mohanty *et al.* (2006) point out, though information about disaster management are available at various domains from decades, millions of people are getting severely affected by disasters every year due to lack of adequate coping mechanisms, as result of lying information at one place and not getting transformed into the life saving knowledge for the communities at risk. Kaklauskas *et al.* (2009) indicate 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 disaster management process and supported by an extensive questionnaire survey. Currently, several interviews are being conducted with several experts in Sri Lanka from Ministry of Disaster Management and Human Rights, Disaster Management Centre, Red Cross, UNHABITAT, World Bank in Sri Lanka, UNDP etc. This will be followed by an extensive web-based questionnaire survey to supplement the findings of expert interviews.

This paper is based on a comprehensive literature survey and review carried out to identify the factors which support successful disaster management. As an outcome of this detailed literature synthesis, a list of success factors within the disaster management cycle is identified and explained in section 5 below.

5. Success factors in disaster knowledge management

Success factors are truly important matters that must be considered for the successfulness of an operation. In context of disaster knowledge management, success factors can be defined as, circumstances, facts or influences that are input into knowledge of disaster management and can directly or indirectly affect the outcomes of disaster management. This study aims at identifying key knowledge factors for managing disasters successfully and to map them against the disaster management cycle. It is currently underway and this section is provided with the literature findings on knowledge success factors. In doing so, disaster knowledge management success factors are classified into eight categories as, Technological, Social, Environmental, Legal, Economical, Functional, Institutional and Political based on their characteristics. Factors identified 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 Oloruntoba, 2005) which consequently helps to save lives and property while reducing the loss of livelihoods (UNDP, 2005 cited Oloruntoba, 2005). Under this main category, three sub-categories are identified as warning systems, communication systems and structural measures.

Warning systems

Though it is 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. Recent Indian Ocean tsunami is made people aware of the lack of 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 is emphasized the fact that 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, Pacific Ocean tsunami early warning system was reported to have had knowledge about the earthquake of Sumatra which triggered 2004 tsunami and have selectively communicated warning which could otherwise have reduced the loss of lives (Martin, 2004 cited Oloruntoba, 2005). Reasons for the failure to warn Indian Ocean tsunami are found as slow or non-existent flows of information.

Communication systems

Media should 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. Designing of houses and buildings in coastal areas which could withstand a tsunami is important. For example, Engineers and researchers designed a 40 m2 house for the coastal areas of Sri Lanka that they believe could withstand a tsunami and which is cost between $1,000 to $1,500 (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, increasing employment opportunity, reducing poverty, enhancing the role and participation in decision making including women would support preparing 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 coastal communities' resilience's development (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 management 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 (2004 cited Shiwaku and Shaw, 2008). Therefore education of school children cannot be underestimated and it indirectly supports to raise the awareness of communities (Sonak *et al.*, 2008). While there should be effective early warning systems, it must also make aware public officials and populace regarding evacuation plans (Oloruntoba, 2005, Rodriguez *et al.*, 2006). These will support to promote a culture of preparedness.

Tsunami swept away the tourism spots and fishing industry (Moe and Pathranarakul, 2006). Rehabilitation of fisheries sector is essential which 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 required 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. More children have orphaned and 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). Against high death 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 surrounding in managing disasters are considered here. Natural barriers like sand dunes, coral reefs, mangroves had provided 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. As mangroves' complicated root systems help to bind the shore together and shield against destructive waves (Sonak *et al.*, 2008) absence of these is a factor that determine vulnerability to coastal hazards. Therefore it is highlighted 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.

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 marine environment (Sonak *et al.*, 2008). Management of waste created by natural hazards is highly important and it is highlighted the need for clear guidelines. It is important to explore the ways of recycling and reusing of debris. It is emphasized the need for proper sewerage systems and cost-effective sewerage treatment plants.

Rehabilitation of saline soils needs to be performed through assessment and monitoring operations by a 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 required to provide drinking water for affected people to avoid the risks of diseases (Sonak *et al.*, 2008).

5.4 Legal factors

This includes aspects relating to law, accepted rules, regulations in 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 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, legislation 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 and suitable laws and regulations can enact 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 getting building consent is identified as a bottleneck which hinders the achievement of reconstruction objectives.

On the other hand, poor construction quality is found as a major reason for higher proportion of destruction and deaths in developing countries. This could be caused by 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 Economical factors

Economical factors can be classified into two as 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 monitory assets are covered under financial sub-category.

Economic planning measures

Destruction of infrastructure during a disaster directly affects the economy of a country. As an example Fisheries sector, agricultural sector, livestock, tourism and micro-enterprises were dramatically affected by tsunami. Therefore the design of roads, railways, pipelines and cable 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 power shortages (Longo, 2005 cited Kovacs and Spens, 2007).

Incentives such as tax breaks could include for resilient building design. Incentives can even use to attract qualified professionals to manage large and complex projects successfully (Koria, 2009).

Insurance of properties against disasters must be made compulsory an initiative to survive after disasters (Atmanand, 2003). This will indirectly ensure the quality of construction as insurance companies will insists on certain minimum standards being met.

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 fund for reconstruction over 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 administrative and financial policies are usually not suited for rapid release of fund for disaster response and cause delays in reconstruction.

5.6 Functional factors

Functional factors can be classified into two as technical and operational. Technical aspect includes factors relating to the skills and competence needed to accomplish desired works. Operational aspect includes 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, it

should available detailed information on which buildings, infrastructural works and groups of people are particularly vulnerable to hazards. For these to achieve, vulnerability assessments should be carried out.

Managing complex, large and demanding type of projects need adequate and experienced staff, which is found to be lacking in disaster reconstruction projects which lead to unsuccessful project delivery (Koria, 2009). Therefore reconstruction demands project management competencies. Networking with international partners is suggested as a way of achieving the necessary competencies. Inadequate planning and resources hampered 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 what 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 the reconstruction projects.

Operational

Challenges of logistics and access are caused 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 and as most disasters are unpredictable, the demand for goods also unpredictable (Kovacs and Spens, 2007). But it is stated that 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 appears 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 used 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 decision making process (Rodriguez *et al.*, 2006). It is claimed that the beneficiary identification was not robust and some important groups have been entirely excluded in Sri Lanka (Koria, 2009). Further it should appreciate the local participation in recovery efforts including the distribution of relief aid and cleaning up 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 government's failure to manage natural disaster relief effectively. Therefore 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 principal responsible unit must be specified, other units should be specified at various levels including provincial, district and village level. As unclear line of authorities coupled with slow decision process had caused delays in activities (Moe and Pathranarakul, 2006), these units should be fully authorised for disaster management. It 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. 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. No construction zones, vulnerable zones, evacuation routes and evacuation sites must have identified and mapped informed by the critical task of risk identification and vulnerability assessment. 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 it was neglected the issues of land acquisition, community acceptance and impact on livelihoods. For example some communities were proposed to relate to a region where they would be impacted by floods and some fishermen and their families were proposed relocate to high-rise apartment type housing which is not conceivable to them. These caused relocation unsuccessful. It is essential to plan the coastal zone developments of harbours, buildings and other infrastructure with coastal zone management and restoring coastal ecosystems for enhance the resilience (Srinivas and Nakagawa, 2008). Necessary building codes must be developed 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 which stages these must be addressed including their roles and responsibilities. For example it is found that 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 the need to develop an accreditation scheme and a training programme for the context of recovery work (Koria, 2009).

Strengthen 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 the linkages among all agencies working on disaster management need to be strengthen 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 the organisations/institutions and moreover people. 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. Curriculum should be redeveloped to include disaster management modules to educate school children and university students. Further scholar programs can be introduced to carry out various researches 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). Research on resilient materials and practices too highly appreciated.

5.8 Political factors

This includes aspects related to politics or parties or politicians in context of disaster management. Political situation in a region may not be supportive to immediate distribution of relief materials or longer term reconstruction and safety and security of the relief workers may be affected (Oloruntoba, 2005). Deep rooted political unrest complicated the 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 the Sri Lanka was stopped (EC, 2007 cited Koria, 2009). Rodriguez *et al.* (2006) indicate 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. Discussion

Study 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 of factors identified are applicable within one or more phases of the disaster management cycle. As an example, communication factor is identified within mitigation, preparedness, relief and reconstruction phases of the disaster management. Some of other factors too follow this pattern. However these factors may be critical for a particular phase or phases and can be general for other phases. At the same time it will depend upon the type of disaster and country. All these aspects are expected to be covered through primary data collection as part of the study.

7. Summary

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 on disaster management strategies together with good practices and lessons learned can undoubtedly support this effort through well-informed mitigative measures and preparedness planning. This research aims to identify key success factors for managing disasters successfully and map them against the disaster management cycle. This paper identified and categorised factors which need to be considered in successful disaster management practices 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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