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Original Citation

Malalgoda, Chamindi, Amaratunga, Dilanthi and Haigh, Richard (2014) Challenges in Creating a Disaster Resilient Built Environment. *Procedia Economics and Finance*, 18. pp. 736-744. ISSN 2212-5671

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4th International Conference on Building Resilience, Building Resilience 2014, 8-10 September
2014, Salford Quays, United Kingdom

Challenges in creating a disaster resilient built environment

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Abstract

With the increase in occurrences of high impact disasters, the concept of risk reduction and resilience is widely recognised. Recent disasters have highlighted the exposure of urban cities to natural disasters and emphasised the need of making cities resilient to disasters. Built environment plays an important role in every city and need to be functional and operational at a time of a disaster and is expected to provide protection to people and other facilities. However, recent disasters have highlighted the vulnerability of the built assets to natural disasters and therefore it is very much important to focus on creating a disaster resilient built environment within cities. However the process of making a disaster resilient built environment is a complex process where many challenges are involved. Accordingly the paper aims at exploring the challenges involved in building a disaster resilient built environment. Paper discusses the findings of some expert interviews and three case studies which have been conducted in Sri Lanka by selecting three cities which are potentially vulnerable to threats posed by natural hazards. The empirical evidence revealed, lack of regulatory frameworks; unplanned cities and urbanisation; old building stocks and at risk infrastructure; unauthorised structures; institutional arrangements; inadequate capacities of municipal councils; lack of funding; inadequacy of qualified human resources; and corruption and unlawful activities as major challenges for creating a disaster resilient built environment within Sri Lankan cities. The paper proposes a set of recommendations to address these prevailing concerns and to build a more resilient built environment within cities.

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Selection and/or peer-reviewed under responsibility of the Centre for Disaster Resilience, School of the Built Environment, University of Salford.

Keywords: Disaster resilience; built environment; cities; natural disasters; urbanisation

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1. Introduction

Disasters, either natural or manmade, cause a significant impact to the entire world. The occurrences of natural disasters have increased sharply worldwide causing damage, loss and disruption to lives, built and social assets, and economy. Over the past few years, a series of widespread disasters hit several parts of the globe, which challenged the existing risk reduction, and management that was in place. Indian Ocean tsunami in 2004, hurricane Katrina in 2005, Haiti earthquake in 2010, New Zealand earthquake in 2010, Japan earthquake and tsunami in 2011, Typhoon Haiyan in 2013 are some of the major catastrophic disasters over the past decade, which caused devastating and long-term impacts to the affected countries and the entire nation. Japan's earthquake and tsunami in 2011 was one of the most costly natural disasters, which caused a loss of hundreds of billions of dollars (AFP, 2012). Meeting the cost related to natural disasters has increased from US\$ 50 billion a year in the 1980s to US\$200 billion a year in the last decade (Georgieva, 2014). As such it is apparent that the annual losses of disasters are staggering. As such, natural disasters are considered to be a major threat to the entire world and have become a global concern. Recent literature highlighted the vulnerabilities of cities and the need of making cities resilient to threats posed by natural disasters (UN-ISDR, 2010; Godschalk, 2003; Albritto, 2012; Dubbeling et al., 2009; Kreimer et al., 2003). It is therefore important to prioritise investment in cities in order to mitigate the impacts of disasters in the short term and to reduce risks in the future (Dubbeling et al., 2009). Built environment play an important role in every city and when moving towards sustainable urbanisation and safer cities, it is of paramount importance to develop the built environment with an effective degree of resilience, in order to withstand and adapt to the threats of disasters (Bosher, 2008). In this context, the paper aims to explore the challenges in achieving a disaster resilient built environment within cities and to provide recommendations as to how these challenges could be overcome.

The paper presents a synthesis of literature related to disasters, disaster resilience, cities and their risk of disasters, and, the need of attaining a disaster resilient built environment. Data gathered from some expert interviews and three case studies in the context of Sri Lanka, has been used to support the research arguments derived from the literature review. Sri Lanka is increasingly susceptible to various natural disasters and requires a coordinated approach in attaining disaster resilience in all development activities. As a developing country which is prone to natural disasters caused by floods, cyclones, landslides, droughts, coastal erosions and also to low-frequency and high impact events like tsunamis, Sri Lanka is vulnerable to disasters and is in great need of disaster resilient cities. As such three case studies were conducted selecting three cities which have been severely affected by various disasters and are vulnerable to potential disasters. The data were gathered through semi-structured interviews with the local and other government officials, policy makers, industry practitioners and experts who are engaged in the respective areas of study. In addition, ten (10) expert interviews were conducted with the experts who are extensively engaged in disaster management and built environment related disciplines to validate the case study findings. The interview data were analysed and based on the findings the authors have drawn conclusions on the challenges associated in achieving a disaster resilient built environment within Sri Lankan cities and have recommend the ways of overcoming such challenges.

2. Disasters, disaster resilience and cities

In historical times disasters were seen as 'acts of god' with the assumption that nothing could be done to avoid their occurrences (Voogd, 2004). Later with the development of secularism and science disasters were increasingly seen as 'acts of nature' and in the late 20th century the view has shifted again to be considered as an 'act of society'. Today disasters are largely seen as an 'act of society' or an 'act of human beings'. O'Keefe et al. (1976) argued that disasters were neither an 'act of god' nor an 'act of science' but a consequence of vulnerabilities. As such the disaster impact has a direct or indirect link to the actions of human beings (Voogd, 2004) and the disaster impact can be reduced by effective disaster management. Thus a disaster can be identified as a social event created by human behaviors where the propensity is dependent upon the interplay between humans and their use of the physical and social world (Neil, 1986). As such it can be argued that disasters stem from the social system and not necessarily from the event itself (Quarantelli and Perry, 2005).

Accordingly, natural disasters will inevitably continue to occur, however by understanding the concept of resilience and the factors that lead to it, vulnerabilities could be minimised and resilience could be increased

(Kapucu et al., 2013). As such the concept of resilience is now widely adopted across academic and policy debates as a way of reducing society's vulnerability to threats posed by natural and human induced hazards (Haigh and Amaratunga, 2010). The original notion of the term resilience comes from a Latin word meaning 'jump back' or 'bounce back' (Manyena et al., 2011). The authors have further explained the term 'resilience' in the disaster context. In the disaster context, they explained resilience as the ability of people to recover within the shortest possible time with minimal or no assistance. Manyena (2006) further argued that the limitations of the 'bounce back' notion as returning to the original position may mean a return to vulnerability and to the conditions that caused the disaster. Therefore it is necessary to strengthen existing structures and institutions to resist disasters and thus resilience can be viewed as a 'bounce forward' strategy following a disaster (Manyena, 2006). As such, resilience can be viewed as "the intrinsic capacity of a system, community or society predisposed to a shock or stress to 'bounce forward' and adapt in order to survive by changing its non-essential attributes and rebuilding itself" (Manyena et al., 2011). In summary resilience can be defined as the "ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including the preservation and restoration of its essential basic structures and functions" (UN-ISDR, 2007). Accordingly the notion of resilience suggests a more proactive approach to disaster risk reduction.

As a result of the rapid urbanisation, cities are becoming extremely vulnerable to threats posed by natural hazards (Malalgoda et al., 2013a). The urban population exceeded the rural for the first time in 2008 and by 2050 it is predicted that the urbanisation will rise to 70% (Albrito, 2012). As a result of rapid urbanisation, cities face many challenges. The major challenges for cities include, increased density which put pressure on land and services, settlements in hazard prone areas, lack of capacities and unclear mandates for DRR at local levels, weak local governance, inadequate water resource management, decline of eco systems, decaying infrastructure and unsafe building stocks, uncoordinated emergency services and adverse effects of climate change (UN-ISDR, 2012). On the other hand, a city can be seen as, an engine of economic growth, an integrated system which links consumption and production, a source of livelihood, a stock of accumulated assets, and, a political and cultural arena (Pelling, 2012). As such the impacts of natural disasters to cities can be worse than in other environments (Wamsler, 2006; Malalgoda et al., 2013a). Thus, when a disaster happens in one city, the impact will not be limited to that city but would have an impact on the whole country and the entire nation. For an example, the tsunami which hit Japan in March 2011 triggered a series of events, culminating in the shutdown of the Fukushima nuclear reactor, which affected the steady power supply and functioning of transportation infrastructure, industrial facilities and exports, causing major disruptions in the global supply chain (PWC, 2013). Thus, it is of paramount importance to focus on building disaster resilient cities. A city or an urban area could be identified as a "set of infrastructures, other structures, and buildings that create an environment to serve a population living within a relatively small and confined geographic area" (Kreimer et al., 2003). Accordingly, the built environment is a core component of every city and therefore when moving towards resilient cities it is important to develop the city's built environment with an effective degree of resilience which can withstand at a time of a disaster. The next section therefore discusses the literature on disaster resilient built environment.

3. Disaster resilient built environment

Bosher (2008) suggest a resilient built environment as where the "built environment is designed, located, built, operated and maintained in a way that maximises the ability of built assets, associated support systems (physical and institutional) and the people that reside or work within the built assets, to withstand, recover, and mitigate for, the impacts of extreme natural and human induced hazards". Moreover, built environment required to play an effective role in protecting the people from natural and man-made disasters (UN ESCAP and AIT, 2012). Accordingly critical facilities and infrastructure systems need to be operational and functional during and after the hazard event (McAllister, 2013). As such it is important to design, develop, operate and maintain the built assets in a city in such a way that it can withstand at a time of a disaster and be able to protect the functioning of the city, its people and other associated physical and social systems. Inadequate structural capacity of the built environment has been identified as one of the major reason of extensive damage from natural disasters (Mannakkara and Wilkinson, 2013). Adding to that, insufficient consideration of coastal risks, non-disaster resistant building designs and constructions in disaster prone areas, inaccurate assessment of hazards, lack of consideration of climate change

effects, incompatibilities between structural designs and hazard levels, lack of consideration of risks in town planning, neglected building codes and regulations, illegal occupancy in high risk lands have been identified as factors which increase the risk of disasters (Mannakkara and Wilkinson, 2013). As such it is important to reduce the risk by use of hazard resilient designs, specifications, construction methods, materials and technologies; and construction of protective infrastructure and also by protecting critical infrastructure available (Haigh and Amaratunga, 2011). Despite the growing importance of the role of the built environment professionals in disaster resilience, there appear to be some resistance of policy makers and built environment professionals to incorporate such resilience measures due to cost constraints (Dainty and Boshier, 2008). As such it is important to address these issues at the policy level and to assign sufficient budgets for DRR activities in achieving a safer built environment. The next sections present the findings of the empirical data collected through expert interviews and case studies.

4. Challenges to achieving a disaster resilience built environment in cities

Empirical evidence discovered number of barriers in creating a disaster resilient built environment within urban cities of Sri Lanka. The main challenges identified are discussed below.

4.1. Lack of regulatory frameworks

Empirical evidence revealed that the existing regulatory frameworks on planning, design and construction does not adequately look into disaster impacts and resilience. Nevertheless, number of initiatives was taken at the central level to design hazard and risk maps, disaster resilience planning and construction guidelines and set back zones. Also it has now being started to issue a landslide clearance for construction in landslide prone areas which could be identified as a good practice in building a disaster resilient built environment. However, many of these initiatives have not been mainstreamed into building planning and approval process of the local governments and as a result the awareness on these new initiatives was somewhat low with the local level staffs who are actually engaged in the building approval process. On the other hand, some of the cities do not have an urban development plan to regulate urban planning and often disaster resilient aspects have not been adequately considered when preparing urban development plans. Further, some people do not get their building plans approved prior to construction, all of which have adversely affected the process of creating a resilient built environment within cities.

4.2. Unplanned cities and urbanisation

Most of the cities in the country are unplanned and also a rapid urbanisation is undergoing at present. As a result most of the drainage systems and protective and servicing infrastructure are not sufficient to serve the increasing population and also many dwelling houses and other buildings are built without adequate consideration of disaster risks and vulnerabilities. More recently the country was severely affected by floods and landslides and the impact was aggregated due to poor design and construction activities in the country. Some of the major reasons behind the increased impacts of flooding and landslips are, filling of agricultural lands, paddy fields and other low-lying areas; obstructing the natural rain water drainages for the construction of houses and other structures; widening of roads in mountainous areas without adequate consideration for the stability of the embankments; and, construction of highways blocking natural waterways, without adequate drainage structures. Most of the cities now have development plans which are developed by the country's Urban Development Authority. However, as most of the cities at present are unplanned it has become a complicated procedure for regulating the development based on the development plan due to ownership issues, land acquisitions and relocation requirements. These processes are time consuming where more time is required in settling the disputes and litigation matters.

4.3. Old building stocks and at risk infrastructure

Number of old building stocks and infrastructure are visible in many cities which were designed without adequate consideration to disaster impacts and resilience. Replacing these old building stocks and at risk infrastructure requires substantial funds. Sri Lanka being a developing country, it is difficult for the country to

allocate funding for these matters as they have so many other priorities to consider. Also, poor maintenance of the existing infrastructure aggravate the risk of disasters where, inadequate cleaning and maintenance of canals and other natural and man-made rainwater drainage systems has been identified as one of the reasons for recent flooding in the country.

4.4. Unauthorised structures

Lot of unauthorised structures and temporary buildings are visible in coastal areas and in cities which are poorly built without basic infrastructure and other facilities. These urban slums are extremely vulnerable to disasters and the country is finding it difficult to relocate these people. These people have been in these areas for many years and their livelihood and income earning avenues are based on the surrounding area. Therefore relocating these people has become a challenge.

4.5. Institutional arrangements

In Sri Lanka, there are a number of governmental organisations responsible for the design, development, operation and maintenance of the built environment. As such, urban planning in Sri Lanka functions in close collaboration with various agencies under different government ministries. Each of these agencies has a specific role in the process of planning, designing and approval of housing and infrastructure. Accordingly, all these departments are responsible for initiating disaster risk reduction and contribute to building safer cities. In addition, further collaboration is required with DMC and technical agencies responsible for producing information related to natural hazards. All these indicate that there is a system in place to create a disaster resilient built environment in Sri Lanka. However it is witnessed that the current system demonstrates a number of drawbacks such as lack of well-defined roles and responsibilities; overlapping of responsibilities; lack of coordination among organisations; and, lack of leadership, team work, political will and commitment. On the other hand, due to the involvement of the large number of stakeholders and organisations, the process has become complex and complicated and a prolonged time is taken to resolve any issue.

4.6. Inadequate capacities of municipal councils

Municipal councils are the premier form of local governments which are based at the most urban cities of the country. They are the primary agency in the country for providing planning approval for new buildings, alterations and extensions to existing buildings, and changing the use of buildings and land use and issuing certificates of conformity to ensure the construction complies with the approved plan. Thus, municipal councils are required to play an inevitable role in creating a resilient built environment within cities. However, the empirical evidence revealed that municipalities in Sri Lanka are facing a number of challenges in their contribution to making a resilient built environment within cities. The main issues that have emerged are legal framework; lack of adequate tools, techniques and guidelines; human resource and funding constraints; lack of focus; coordination; managing the long term process; dependence on central government; irregular occurrences of disasters; community engagement; leadership and organisational culture; and corruption and political interference (Malalgoda et al., 2013b).

4.7. Lack of funding

Disaster resilient built environment is all about ensuring that built assets are capable of withstanding at a time of a hazard event. It requires relocating existing vulnerable structures; enforcing resilient building codes and standards; use of hazard resilient designs, specifications, construction methods, materials and technologies; protecting critical infrastructure in the city and constructing protective infrastructure; sustainable urban planning; and land use practices (Haigh and Amaratunga, 2011; Godschalk, 2003; Malalgoda et al., 2013b). All these invariably require a considerable amount of funding for satisfactory completion. Findings revealed that the funding restrictions act as a major barrier in developing disaster resilient built environment in cities. The resilient practices discussed requires substantial amount of funding and, Sri Lanka being a developing country, allocation of funds for such projects is

problematic. On the other hand municipal councils do not have a separate budget allocation for DRR activities and therefore finding funds for such work is difficult. Moreover, due to irregular occurrences of the disasters, the financial difficulties do not encourage people to include these risk reduction measures into practice.

4.8. Inadequacy of qualified human resources

Qualified staff knowledgeable on DRR is limited especially at the local level and as a result some of the resilient measures are overlooked. Local governments are the primary agency in the country for issuing development permits for buildings and lands and issuing certificates of conformity to ensure that the constructions carried out complies with the approved plans. In doing so, all disaster risks and vulnerabilities need to be considered before issuing development permits and the certificate of conformity. However without the adequate number of qualified staff, knowledgeable on DRR, it is difficult to build a resilient built environment and to effectively monitor the development activities carried out in the city.

4.9. Corruption and unlawful activities

Corruption and unlawful activities are quite common in the construction sector and as a result planning regulations and approval systems are sometimes overruled due to various reasons such as political pressure and bribery. Ad hoc construction and land use decisions further aggravate the situation and adversely affect the efforts of building a safer built environment.

5. Overcoming challenges

In moving towards a disaster resilient built environment, it is important that all the challenges discussed in the previous section are addressed effectively. In addressing the challenges, participation of all relevant stakeholders, government or otherwise and the support of the community is highly appreciated. Based on the empirical evidence, the paper proposes number of recommendations for overcoming the existing barriers. Table 1 highlights the proposed recommendations.

Table 1. Suggestions to overcome the challenges for resilient built environment

No	Challenges	Recommendations for overcoming the challenges
1	Lack of regulatory frameworks	<p>Enforce DRR building codes; planning, designing and construction guidelines; hazard and risk maps; and set back zones and mainstream into existing regulations</p> <p>Mainstream DRR into urban development plans</p> <p>Raise awareness among local level employees who are engaged in providing building permits of the new regulations initiated at the central level</p> <p>Organise educational and training programmes for local level staff on the disaster resilience planning, designing, construction and operational practices</p> <p>Establish a dedicated team within the municipal councils to supervise and monitor all development activities of the city</p> <p>Monitor all housing construction activities at specified intervals to ensure that the constructions are in accordance with the approved plans</p> <p>Impose strict rules on land fillings</p>
2	Unplanned cities and urbanisation	<p>Prepare and enforce development plans for all cities</p> <p>Develop and promote sub urban/ residential areas for habitation</p> <p>Promote businesses and industries in sub urban/ rural areas</p> <p>Relocate urban vulnerable groups to safer lands</p> <p>Organise community awareness programmes to educate community on urban risks and vulnerabilities</p> <p>Design, develop and maintain rain water drainage systems</p>

3	Old building stocks and at risk infrastructure	Identify the structures which are at risk Allocate funding to repair, maintain or demolish Establish systems for regular maintenance of canals and other natural and man-made rainwater drainage systems
4	Unauthorised structures	Identify all unauthorised structures in the city Procedures to be laid down on how to deal with the unauthorised structures Take steps to relocate these structures to a safer lands Educate the people on the disaster risks and vulnerabilities
5	Institutional arrangements	Identify the roles and responsibilities of each stakeholder Establish proper communication links between stakeholders Mechanisms for sharing of good practices and resources between cities and organisations Build leadership and facilitate team working Make processes simple and user friendly
6	Inadequate capacities of municipal councils	Amend policies related to disaster management and establishment of municipal councils in order to make them responsible for creating a disaster resilient built environment within their cities. Policies to address the funding, human and other resource needs and support required for municipalities Integrate all relevant development plans, risk maps, disaster resilient planning, construction and operation guidelines and resilient land use practices into existing planning regulations Establish proper monitoring and control mechanisms to ensure the compliance with the regulations Raise awareness of council officials on disaster risks and resilient practices by way of organising educational programmes such as seminars and workshops. Involve municipal officials in national level decision making with regard to their local areas Establish proper communication channels to exchange decision and information related to city resilience
7	Lack of funding	Increase the DRR budget allocation Allocate funds to local governments for DRR Effectively manage the funding received from donor agencies Establish proper systems within the municipal councils to collect taxes and other revenue
8	Inadequacy of qualified human resources	Budget allocations to recruit qualified staff Pooling of staff between different tasks and organisations Training and educational programmes for existing staff Build leadership
9	Corruption	Strict rules and procedures to control corruption

6. Conclusions

Empirical evidence revealed that the Sri Lankan cities face number of challenges in achieving a disaster resilient built environment. Some of the challenges identified are, lack of regulatory frameworks to regulate disaster resilient development, such as resilient building codes, planning regulations and risk maps; unplanned cities and urbanisation; old building stocks and at risk infrastructure; unauthorised structures; institutional arrangements; inadequate capacities of municipal councils; lack of funding; inadequacy of qualified human resources; and corruption and unlawful activities. The paper therefore suggests some recommendations to overcome these challenges. The main recommendations captured are mainstreaming DRR into all existing planning regulations and urban development plans; develop procedures to regulate and monitor all development activities carried out in the city; making the planning approval process simple and user friendly; education and training programmes to local staff who are engaged in local development activities; raise awareness of the community on the need of adhering to DRR practices in all their planning and construction; promote sub-urban cities; relocate vulnerable structures to safer lands; allocate funding to maintain, repair or reconstruct old building stocks and at risk infrastructure;

implement strict procedures to deal with unauthorised structures; revisiting the institutional arrangements in place and defining the roles and responsibilities of each stakeholder; empowering local governments to make their city's built environment resilient to disasters; increasing DRR budget allocations; and strict rules and procedures to control unlawful activities happening in planning and construction.

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