A Systematic Review on Disaster Resilience Knowledge for Built Environment Professionals

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Abstract

The frequency and magnitude of disasters are on the rise due to the increased urban growth rate, increased dependency on complex infrastructural facilities and climatic changes. The Built Environment (BE) professionals engage in enhancing the disaster management (DM) process. Thus, BE professionals shall possess an enhanced knowledge and skills on improving disaster resilience (DR). This study investigated the value of acquiring DR knowledge for BE professionals through a systematic literature review. The systematic review incorporated PRISMA guidelines in achieving the main objective of investigating the importance of acquiring DR knowledge for BE professionals. Hence, this study focused on DR, impact of disasters on BE, role of stakeholders in DM, role of BE professionals in improving DR and the importance of acquiring DR knowledge by BE professionals. The study revealed that the disasters shall be controlled through adhering appropriate structural and human-induced strategies. The key stakeholders of DM process are the community, local and national government, NGOs, international agencies, academia, research organisations and private sector. The knowledge on disaster risk is essential to be included into the formal and professional education, and training in enhancing DM. Continuous skills and knowledge development of BE professionals on DR shall answer most of the disaster related issues.

Keywords
Disasters, Built environment professionals, Disaster resilience knowledge

1. Introduction

During the past decade there can be seen an unprecedented increased intensity of disasters (Perera et al. 2018). These disasters cause major social and economic impacts (Warren 2010). The increased urban growth rate, increased dependency on complex infrastructural facilities and climatic changes that are increasing exposure to hazards are the factors encountered for the identified tremendous increment in disasters (Amaratunga et al. 2018). Effective DM strategies are vital to be adhered in order to eradicate or reach a minimal level of potential disaster impacts (Nia and Kulatunga 2017).

Built assets can never be believed to be totally resistant, due to the changing nature shown by natural and man-made threats (Bosher and Dainty 2010). Further, disaster reconstruction is possessing many peculiar features when compared to normal construction process (Thayaparan et al. 2015). According to Thayaparan et al. (2014), BE professionals are having the capacity to engage in disaster situations and also, they have achieved a recognition on this regard. Effective response of professionals is challenged by the inadequate knowledge on disaster response and reconstruction process (Bilau et al. 2018). Siriwardena et al. (2013) has declared the urging requirement of proper education and training on DM, and Advancing Skill Creation to Enhance Transformation [ASCENT] (2019) has

emphasised the use of improved Research and Innovation (R&I) capacity on DM field as successful modes to enhance the DR knowledge. However, the importance of acquiring DR knowledge by BE professionals is not evident within current research literature. In this context, the overall objective of this paper is to investigate the importance of acquiring DR knowledge for BE professionals. Accordingly, the paper focused on DR, impact of disasters on BE, role of stakeholders in DM, role of BE professionals in improving DR and the importance of acquiring DR knowledge by BE professionals.

2. Research Method

Research methodology embodies the steps followed in the research from the research problem formulation to the final conclusion deriving (Akhidime 2017). This study undertook a systematic literature review, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, in answering the research question, "what is the significance of acquiring DR knowledge for BE professionals?". A systematic literature review is a tool, which enables the summarisation of available evidence accurately and reliably (Liberati et al. 2009). Thus, use of systematic literature review in this research enabled the drawing together of all known knowledge on the study area, and Grant and Booth (2009) identified it as a perceived strength of a systematic literature review. This section outlines the process followed in conducting a systematic literature review using PRISMA.

2.1 PRISMA

PRISMA guidelines encompasses of sub-items such as eligibility criteria, information sources, searching strategies, process for study selection, outcomes, and synthesis of data. Three main advantages as attainable through PRISMA guidelines as availability of a well formulated research question which shall enables the systematic literature search, early defined inclusion and exclusion criteria, and providing the possibility to examine a comparatively large database in a defined time period (Shaffril et al. 2018). This method enables the rigorous literature search on importance of acquiring DR knowledge by BE professionals.

2.2 Resources

The review incorporated three main databases namely Scopus, Science Direct and Emerald Insight. Scopus is said to be the largest abstract and citation database with peer reviewed literature. Science Direct and Emerald Insight also contain large collection of articles related to many disciplines. Most specifically, these three databases possess a large collection of articles related to built environment and disaster resilience, and are considered to be robust in nature. Thus, the study has incorporated these three databases in conducting the literature search.

2.3 Eligibility and exclusion criteria

The process of literature search incorporated several inclusion and exclusion criterion, in order to collect the contemporary and relevant research articles to address the objective. Initially, in order to keep the outdated knowledge aside, only the articles published since 2009 onwards were included in the search. The focus was further emphasised on research-based articles, hence the books and books chapters were excluded. As such, peer reviewed journals, conference proceedings and research reports were used as the main sources of knowledge using which the objective of investigating the importance of acquiring disaster resilience knowledge for built environment professionals have been achieved.

Non-English articles were excluded due to lack of ability to translate, understanding and interpret foreign language. Unpublished articles were also excluded due to limited reliability. Finally, the article that have access only to the 'abstracts' were removed, as they were not considered sufficient for an extensive review of literature. Table 1 illustrates the adopted inclusion and exclusion criteria for the selection of relevant research articles.

Table 1: Inclusion and exclusion criteria

Criterion	Eligibility (inclusion)	Exclusion
Time line	Articles published since 2009	Articles published prior to 2009
Type of literature	Journals, conference proceedings, reports	Books and book chapters, unpublished articles
Language usage	English publications	Non-English publications
Length of article	Full papers	Abstract only

2.4 Systematic review process

As per PRISMA flow diagram, the process of systematic review consists of four main stages as identification, screening, eligibility and included as shown in Figure 1. Under the first stage, keywords were identified. Identifying the correct combination of keyword is an important activity in the systematic review process. No selection of properly related keywords to the objective, will result in a poor review of literature. As such, the research has selected three keywords such as “Built Environment Professionals”, “Disaster” and “Knowledge” which would completely cover the objective of this research. Further, based on previous studies, similar words for the selected keywords were included to maximise the search results. Table 2 depicts the combination of the keywords used in each database.

Table 2: Literature search strategy

Database	Search term
Scopus	("knowledge" or "education" or "training") AND ("disaster" or "disaster management" or "disaster resilience" or " disaster resilient") AND ("built environment" or "construction professionals")
Science Direct	(("education" OR "knowledge" OR "training") AND ("disaster" OR "disaster management" OR "disaster resilience" OR “disaster resilient”) AND (“built environment professionals” OR "construction professionals"))
Emerald Insight	(("education" OR "knowledge" OR "training") AND ("disaster" OR "disaster management" OR "disaster resilience" OR "disaster resilient") AND ("built environment professionals" OR "construction professionals"))

As illustrated in Figure 1, at the initial stage 104, 89 and 117 records were identified through Scopus, Science Direct and Emerald Insight respectively. Additionally, articles that the authors considered relevant, but were not automatically generated through the systematic search were manually added as supplementary materials. As such, 3 reports published by United Nations Office for Disaster Risk Reduction (UNDRR) and 1 journal paper which describes the BE related details were manually incorporated.

As the second stage, the screening of the articles was conducted in order to derive the suitable articles from the identified articles. Firstly, duplicate items were identified and removed with the help of Mendeley database software. The total of 314 articles were cut down to 305, after removing the duplicates. Then, remaining articles were screened considering the established inclusion and exclusion criteria as per Table 1. As a result of that process, 270 articles were selected to assess for eligibility. Those full articles were examined thoroughly and articles which are not related to BE discipline and DM were removed. As such, the 27 articles included in this systematic literature review were the eligible literature that was used to achieve the objective of this research. No meta-analysis was conducted due to the insufficiency of statistical data in the field of this research and within the selected articles. Thus, the current systematic literature review is said to be a qualitative systematic review.

The above process is clearly illustrated in Figure 1, where 27 articles which were published between 2009 and 2020 became eligible to be used in the systematic literature review for this paper. This resulted in a huge reduction of articles from 314 to 27. Thus, the selected articles were directly related to BE, disasters, DR and knowledge improvement.

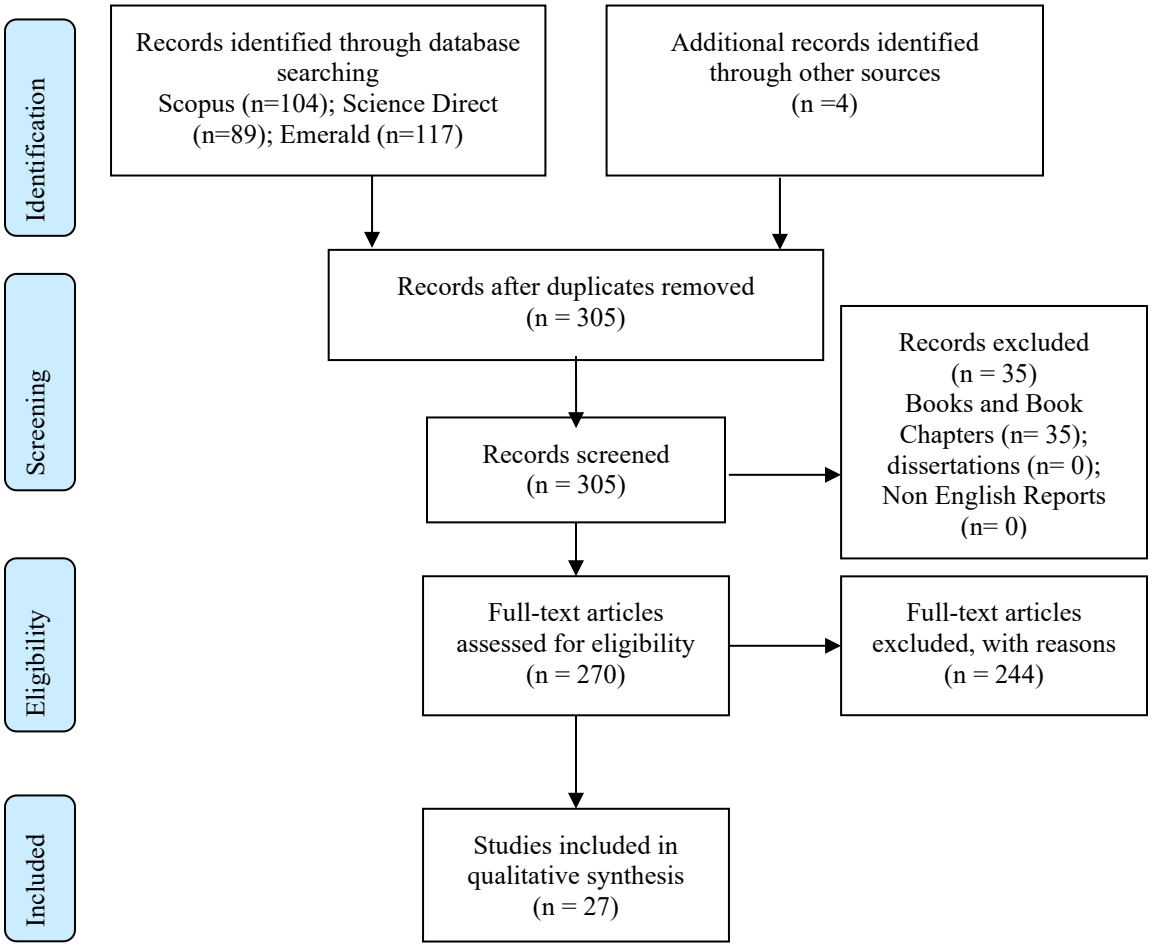

Figure 1: Study selection flow diagram
(Adapted from Moher et al. 2009.)

2.5 Data extraction and analysis

Having carried out all four the stages of systematic review process, the extracted articles were more concentrated towards the area of study. The complete set of articles were downloaded and, the qualitative data were collected from each article, first by reading the abstract, and then by reading the whole article. This was to ensure an in-depth search of literature. As a results of the analysis, the appropriate main themes and the sub-themes were derived from the review of literature.

2.6 Limitations

Other than the available advantages, systematic literature reviews have several in-born limitations (Ortiz-Martínez et al. 2019). In this literature search use of limited number of databases, selection of keywords for the literature search, incorporated inclusion and exclusion criterion were based on the personal preference, which can act as limitations.

However, as the research adopts a qualitative approach the value laden component of the authors can play a part in the selection of literature for systematic review.

3. Discussion

Following section descriptively describes the importance of achieving DR knowledge for BE professionals by paying special attention role of stakeholders in DM, impact of disaster on BE and role of BE discipline in improving the DR.

3.1 Disaster resilience (DR)

Disaster are under two main categories, natural or human-induced (Malalgoda et al. 2014). These disasters are said to be exceptional events (Amaratunga and Haigh 2010), which cause social, economic and physical damages on the society (Thayaparan et al. 2015). Level of disaster impact on the society mainly depends on the vulnerability level of community on a particular disastrous situation (Izquierdo-Horna and Kahhat 2020). Also, according to Haigh and Amaratunga (2010), disasters are obvious in developed, developed, developing and newly industrialized countries. More importantly, it is revealed that the disaster impacts highly work on developing countries due to the factors such as high population growth, poverty, and lack of skills on planning and implementation of development procedures (Amaratunga and Haigh 2010). According to Ibem (2011), as poor community is highly exposed to any hazard and they possess a minimum level of adaptation those events, their vulnerability to disasters is comparatively high when compared with rest of the society. Therefore, there can be seen a link between disasters and poverty of the society (Bosher and Dainty 2010).

In far history, it was believed that impacts resulting from hydrological and geological disasters are “Gods’ acts”, and the only remedy to manage those impacts is to under-take post-disaster rehabilitation efforts (Ibem, 2011). Izquierdo-Horna and Kahhat (2020) argued that ultimate loss can be minimised by taking necessary structural and human-related factors into account. According to the authors, incorporating resilience measures also shall ensure the minimised loss from disasters.

As per United Nations Office for Disaster Risk Reduction [UNDRR] (2005), globally, there is an increasing concern towards disaster risk, where by the disaster risk rises-up when the hazards get contaminated with the social, economic, physical and environmental vulnerabilities. The organisations shows only a gradual adaptation of DRM concept into their organisation since the beginning of 20th century (Bosher and Dainty 2010). UNDRR (2009) defined DRM as “the systematic process of using administrative directives, organisations and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster”. There prevailed a high concern on investigating the relationship among DRM, DRR and DM. (Alabi et al. 2017). Hopefully, UNDRR (2009) asserted DM and DRR as the sub-sectors of DRM, and Figure 2 depicts the relationship among DRM, DRR and DM.

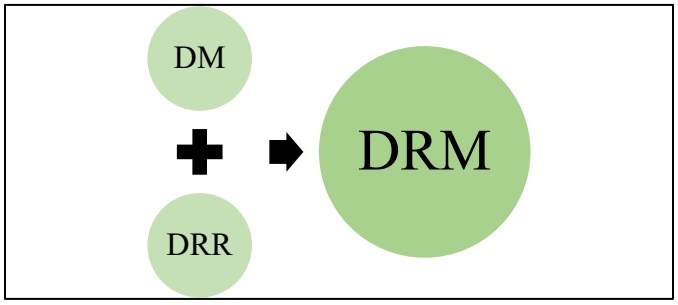

Figure 2: Components of DRM

Wherever in the world, the practice of DM is the same as all the people are exerting effort to control over the environment (Amaratunga and Haigh 2010). Increased frequency of natural disasters resulted in making DRR a “must do” (Palliyaguru et al. 2013). DRR is defined as “the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to 11 hazards,

lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events" (UNDRR 2009). Even amidst the acceptance of the importance of DRR and increased capacity to disaster response, disasters, DM and DRR are still continued to be a global challenge (UNDRR 2005).

The concept of resilience is practiced across many disciplines such as ecology, psychology and infrastructure (Pascua and Chang-Richards 2018). Further, the author declared the wide incorporation of the term 'resilience' in DRR. Penaloza, Saurin and Formoso (2020) defined the term 'resilience' as "the ability of a system to adjust its functioning prior to, during, or following events, and thereby sustain required operations under both expected and unexpected conditions". UNDRR emphasised that the resilience of a certain community depends on the ability of a certain community to withstand the impacts of a disaster.

Additionally, Haigh and Amaratunga (2010) declared that the term 'resilience' can be used in reducing the societal susceptibility to impacts of natural, human originated and technical hazards. More importantly, the concept of 'resistance' is widely accounted at the pre- disaster mitigation stage (Bosher and Dainty 2010). When resilience is achieved, countries and communities receive the capability to maintain their day today living condition without any shock or stress, or adapt any of the alterations resulted due to disasters (UNDRR 2005).

As per UNDRR (2005), though there is a lack of accord on the definition of resilience, there prevails several similarities among the varied concepts of resilience, such as;

- the ability to anticipate and prevent potentially disruptive events;
- the ability to maintain a certain level of functionality during disruptive events
- the ability to recover quickly from the negative impacts of disruptive events and
- the ability to adapt to the changes brought about by disruptive events.

3.2 Impact of disasters on BE

The term, 'BE' emerged in the 1980s, and it came into widespread usage by 1990s (Bartuska 2007). The concept of BE defines the outcomes of human oriented construction activities, which takes into account any physical alteration or modification to the natural environment (Adeniyi et al. 2019). Apart from the afore-mentioned fact, Amaratunge et al. (2018) highlighted that the people are maintaining most of the direct interacts with the environments which are produced through human initiated processes, namely BE.

Needs of both current and future generations are required to be satisfied, and that can be fulfilled through sustainable measures (Adeniyi et al. 2019). According to the authors, one way of making current and future generation satisfaction is protecting both natural and BE. Thus, BE is an integral part of the society. Based on the characteristics of BE, Bartuska (2007) defined BE as "Everything humanly made, arranged or maintained, to fulfil human needs, wants and values, to mediate the overall environment, with results that affect the environmental context".

According to Amaratunga et al. (2018) and Bartuska (2007), four interrelated characteristics are possessed by a BE. Those characteristics are mentioned as follows:

- Extensive: BE provides context for all human endeavours.
  Every component of BE is constructed, modified or maintained by humans.
- Creation of human minds and the result of human purposes:
  Through BE it is intended to serve the needs and wants, and values of humans
- BE is created to help us deal with, and to protect us from the overall environment, and to mediate or change this environment for our comfort and well-being.
- Every component of BE is defined and shaped by context: All the elements of BE contributes to the quality of environment either positively or negatively

Components of BE are based upon the human needs and actions, and in some situations human actions are grand resulting quality life experience and in some situations human actions are short-sighted resulting comfortable life experience (Bartuska 2007). Accordingly, buildings, roads, bridges, landscaped areas, parks and automobiles are parts of BE (Bartuska 2007; Thayaparan et al. 2015).

The BE is undergoing an escalated frequency of threats due to climatic changes, and it gets severely affected by the impacts of a disaster, resulting a wiped out the development and investments of a certain country for years (Bosher and Dainty 2010). Further, during the post-disaster stage, most of the indirect economic losses are said to be construction-related losses (Esfahani and Shahandashti 2020). Rapid development of BE sector has become a major reason for the increased human faults, and it ultimately it paves the way to man-made disasters (Alabi et al. 2017). It is revealed that the persistent desire to engage in constructions has set path to many disasters (Bosher and Dainty 2010). Further, the authors declared that the mortality rate due to disasters are reducible through early warning systems, since it ensures early movement from disaster prone area to a safer area. However, as BE properties cannot be moved entirely, early warning systems are less effective. In addition to the ideas presented by most of the authors, Palliyaguru et al. (2013) raised the fact that the disasters enable many development windows such as physical, social, economic, political and environmental through reconstruction of housing and infrastructural facilities.

When considering resilience of BE, design, engineering and construction are the most influencing factors that create impacts on the resilience of BE (Bosher and Dainty 2010). Process of building DR involves in enhancing the capacity of individuals and communities to adapt through assets relevant to their context (Amaratunga et al. 2018). Construction sector has defined the resilience concept by considering the ability of BE to cope with two types of disaster, natural and man-made (Penaloza et al. 2020).

3.3 Role of stakeholders in DM

A human-oriented approach is an essential factor in tracking the interconnection between disasters and vulnerability (Izquierdo-Horna and Kahhat 2020). Also, when considering the nature of disasters, causes and their impacts, a multi-sectoral approach is required to accomplish risk reduction with increased resilience (Haigh and Amaratunga 2010). In process of accomplishing risk reduction with increased resilience, the requirement of stakeholders is very significant (Perera et al. 2017). Even though recent disasters have made the duty of stakeholders more complex by increasing the degree of uncertainty, it is the duty of stakeholders to increase the community resilience through proactive disaster risk consideration (Haigh and Amaratunga 2010).

As per Sendai Framework for Disaster Risk Reduction 2015-2030, in order to understand the disaster risk, it is required to "promote and improve dialogue and cooperation among scientific and technological communities, other relevant stakeholders and policymakers in order to facilitate a science policy interface for effective decision-making in disaster risk management". Thus, DM has to be multi-disciplinary in nature.

As DM is a complex process, it requires tremendous efforts from various stakeholders, and they can be classified as follows (Perera et al. 2017; Amaratunga et al. 2018);

01. Community
02. Local and national government
03. NGOs
04. International agencies
05. Academia
06. Research organisations
07. Private sector: All private sector organisations such as construction service providing companies, contractors, professional bodies, clients, small and medium sized enterprises (SMEs) are included under this 'Private sector' category.

Stakeholders with the capacity of engaging in DM processes are having a responsibility to improve their capacity to prepare, mitigate, respond and recover (Thayaparan et al. 2014). According to the authors, the threat imposed by the hazards can be greatly minimised by adopting proper preparation and mitigation initiatives, and effective post disaster response can result in reduced impact of disasters, minimised economic and social damage. Moreover, the stakeholders of BE are having a greater responsibility to enhance the DR in the society (Amaratunga et al. 2018). Most significantly, when activities demand participation of several parties, they shall work collaboratively by considering various expectations and desires possessed by them (Perera et al. 2017).

The term 'BE professionals' is said to be a broad term (Bhattacharya-Mis et al. 2018), and engaged BE professionals in DRR differs from disaster to disaster. For instance, the authors stated that building surveyors, insurance experts,

valuation surveyors, property managers, facility managers, project managers and property investment surveyors are the BE professionals engaged in flood risk reduction and resilience construction.

3.4 Role of BE professionals in improving the DR

Most of the emergency situations are not said to be unexpected, but those are stemming due to the interactions between the BE, the physical environment and the vulnerable community (Bosher and Dainty 2010). More often, disaster situations indicate a risk for life and properties (Alabi et al. 2017). Thus, the authors stated that it is required to manage the adversarial impacts caused by disasters on BE.

There prevails a great enthusiasm among research community to investigate the key roles and responsibilities of BE professionals in DM (Perera et al. 2018). Most probably hazards are becoming more prominent in upcoming years. Thus, the professionals engaged in planning, designing and constructing the BE are having a great responsibility to encounter the threats as core part of their professional activities (Bosher and Dainty 2010). Accordingly, Perera et al. (2017) has emphasised the importance of adopting and implementing DRR strategies for resilience by BE professionals. Strong and effectively connected construction industry professional groups possess a higher degree of resilience in order to cope with risks (Penaloza et al. 2020).

BE is severely damaged by the disasters (Thayaparan 2010). Accordingly, 'Built-in-resilience' is said to be a key constituent of DRR (Bosher and Dainty 2010). So, the authors emphasised that the designing, locating, building, operating and maintaining of a resilient BE should be done in a way that it enhances the ability of built assets and the built asset occupants to withstand, recover and mitigate from the impacts of extreme hazardous situations. Further, the resilience is required to be embedded through products and processes of the BE (Amaratunga et al. 2018). Being BE professionals, it is their responsibility to consider the risk possessed by a customer, and make their customer aware and provide appropriate advice on physical, environmental and technical due attentiveness (Bhattacharya-Mis et al. 2018).

Adopting disaster preventing strategies in building design and construction should be highly encouraged, and it must be noted that this strategy is capable of providing only a partial solution, as it is required to consider the whole life cycle of a building (Mohamed et al. 2019). Thus, the authors asserted the involvement of stakeholders such as architects, contractors, facilities managers and building occupants in handling the whole life cycle of a building. Most significantly Amaratunga et al. (2018) highlighted the fact that, in order to reduce the disaster risk and strengthen the resilience, it is required to pay an early attention and engage the most appropriate expert on addressing the building and infrastructure related problems.

Construction industry professionals and the associated BE professionals have achieved a prominent place in DM as they can assert the required capacity to DM (Thayaparan et al. 2014). Also it is revealed that BE professionals shall play a vital role in DM as BE is expected to withstand the disasters and even it is required to contribute in rebuilding efforts where necessary (Thayaparan et al. 2015).

Also by considering the severe damage caused by disasters on BE and construction industry, it is expected that BE professionals shall engage in a predominant role in DM (Amaratunga et al. 2018). Thus, the authors emphasised the importance of engaging in DRR, response and recovery initiatives by the BE professionals. Most specifically, when considering the higher probability of BE getting damaged by the all types of disasters, they are having a responsibility to engage in activities such as cleaning, salvaging, reconstruction and rehabilitation (Thayaparan et al. 2015).

Haigh and Amaratunga (2010) declared that the BE and the construction industry professionals are shall play a vital role in improving the societal resilience. No surprisingly, civil infrastructure sector is playing a vital role in the society by providing a tremendous contribution to the country's' economy and increasing the resilience of the society (Pascua and Chang-Richards 2018). According to the authors, the infrastructure is required to be resilient due to the increased dependency of society on infrastructural facilities such as power, water, telecommunication and transportation, and if it is possible to maintain a continuous functionality of those most critical infrastructure facilities after a disaster and recover quickly, a more resilient society is easily achievable.

3.5 Importance of acquiring DR knowledge by BE professionals

Knowledge exchange can be defined as "a process of generating, sharing and/or using knowledge through various methods appropriate to the context, purpose and participants involved" (Hendriks and Opdyke 2020). The education and training for the BE professionals are structured in order to provide necessary knowledge and competencies which are essential in performing their professional roles (Bhattacharya-Mis et al. 2018). Further the authors asserted that globally, BE education composes of technical expertise, rigorous knowledge on standards relevant to BE discipline and guidance.

Sendai Framework for Disaster Risk Reduction, which is developed with the aim of overcoming the disaster impacts over the next fifteen years (2015-2030), established the significance of incorporating knowledge on disaster risk into formal education, professional education and training (UNDRR 2015). Further, Thayaparan et al. (2015) emphasised effective education, awareness programmes and trainings as essential initiatives in DM. Authors declared that disaster risk knowledge shall comprise of knowledge on disaster prevention, mitigation, preparedness, response, recovery and rehabilitation. Well informed and motivated community towards a resilience culture is attainable through collection, compilation and dissemination of appropriate knowledge on hazards, and ultimately will assist in management of disaster occurrences (UNDRR 2005).

For instance, Vanciu-Rău et al. (2020) emphasised that at times of disasters like earthquakes, when the risk faced by population and infrastructure is too high, it is required to implement various actions parallely, such as ensuring the enhanced knowledge on disaster event, vulnerability reduction of assets, making assets less exposed, and minimise the resultant side effects of the respective disaster event. Bhattacharya-Mis et al. (2018) identified sustainability and climatic change as emerging elements of BE, and also the flood risk and DM through property adaptation will emerge as a growing theme due to the higher demand for competent professionals made by increased flooding frequency.

Following a disaster, the construction industry undergoes many challenges in answering "how the disaster occurred?" and "what possible actions shall be taken in preventing a disaster of similar nature?" (Mohamed et al. 2019). Therefore, the construction industry professionals are having an urging need of engaging in continuous skills and knowledge enhancement (Thayaparan et al. 2015).

According to Amaratunga et al. (2018), it is vital to engage in continuous skill development, due to the peculiar nature and requirements of post-disaster reconstruction. Moreover, in addition to the peculiar nature and requirements of post-disaster reconstruction, Thayaparan et al. (2015) highlighted that continuous skill development has become a key requisite for BE professionals when considering the complex nature of disasters and the requirement of incorporating DRR efforts into development activities. For instance, Amaratunga et al. (2018) highlighted that issues arising due to the use of traditional building-up processes by architects, which results in increased degree of uncertainty, shall be addressed through knowledge improvement of BE professionals as a strategy. Also, designing and construction of a resilient BE is possible only with an in-depth knowledge and an understanding on avoiding the disaster impacts (Bosher and Dainty 2010). Further, the prevailing infinite changing behavioral pattern of the people and the environment emphasises the need of in-depth understanding and knowledge on designing and building-up of a resilient BE (Amaratunga and Haigh 2010).

4. Conclusions

Disasters are exceptional events that are on rise during the past decade, and cause major economic, social and physical damages on the developed, developing and newly industrialised countries. It is believed that resultant impacts of disasters shall be controlled through adhering appropriate structural and human-induced strategies. Even though the disaster risk is heightening due to the contamination of hazards with social, economic, physical and environmental vulnerabilities, organisations depict only a gradual adaptation of DRM concept into their entities. Design, engineering and construction are the major influencers of a resilient BE. Most importantly, disaster and vulnerability interconnection will be successfully tracked with a human-oriented approach. Community, local and national government, NGOs, International agencies, academia, research organisations and private sector are the key stakeholders of DM process, who shall engage in DRR with improved resilience by demonstrating the multi-disciplinary nature of DM. Acquiring the service of the most appropriate professional is highly recommended in addressing the construction related issues. BE professionals shall adopt disaster preventing strategies at stages of the

whole life cycle of a building. Design and construction of a BE with resilient features is achievable only if professionals are possessing an in-depth knowledge and understanding on avoidance of disaster impacts. The knowledge on disaster risk is essential to be included into the formal and professional education, and training in enhancing the management of disaster occurrences. It is vital for the BE professionals to improve their knowledge on ways and means of getting rid of future disasters. Moreover, knowledge and skill development in DR shall pave the way for BE professionals to identify the peculiar nature of post disaster reconstruction, requirements of post disaster reconstruction, complex nature of disasters and the importance of incorporating DRR measures into the construction related activities. Engagement in continuous skills and knowledge development of BE professionals on DM shall answer most of the disaster related issues. Even though it is important to conduct this study by aiming all the disciplines, this study was limited only for the BE discipline. This study shall be further extended to identify the barriers in integrating DR into the higher education curriculum in the BE disciplines in Sri Lanka and to identify effective ways for incorporating DM knowledge within the higher education curriculum on the BE disciplines in Sri Lanka.

Acknowledgements

The authors would like to acknowledge the financial assistance provided by the University of Moratuwa, Sri Lanka for the publication at the conference.

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