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Mainstreaming building code practice and risk management principles towards disaster risk reduction

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ABSTRACT

Global disaster impacts on the built environment have triggered the call for an operational disaster risk reduction (DRR). The application of building code requirements has shown an acceptable means of minimizing disaster impacts, as it prevents buildings from total collapse and may require an extra drive to boost its capacity to reduce disaster impacts. This study used an integrative literature review method to investigate the synergy between building codes and disaster risk reduction and develop a concept of mainstreaming risk mitigation strategies into building codes. The study findings demonstrate how building code applications could reduce disaster impacts by integrating building code requirements into disaster risk reduction principles and risk management principles. Findings in the study show the necessity of creating a robust link between the disaster risk reduction principles and the building code beyond the construction industry to achieve a safe human-built environment. The study developed a concept of mainstreaming building code and risk management principles into disaster risk reduction. This paper concludes by encouraging the full participation of all stakeholders to harness the full potential of mainstreaming building code practice and risk management principles into disaster risk reduction.

1 INTRODUCTION

Disasters arising from natural and human-made hazards constitute a threat to human lives and property. The rising number of deaths and loss of valued properties globally has triggered the campaign of disaster risk reduction (DRR). Both the United Nations (UN) and other non-government and government organizations have made efforts toward providing solutions in reducing the destructive nature of the disaster, which is the primary purpose of disaster risk reduction. Initially, emergency preparedness and disaster humanitarian relief materials dominated the discussion on disaster risk reduction. However, recently attention has been shifted to searching for reliable mitigation plans and measures (Bosher and Dainty, 2011), that will help to reduce catastrophic disaster impacts in the built environment. Accordingly, the UN recognises the building code as a vehicle to achieve disaster risk reduction (UNISDR, 2015b). Many leading international and local agencies have started addressing implementation and compliance with building code as a global priority to accomplish disaster risk reduction (USAID, 2016, Moullier and Krimgold, 2015, JICA, 2017). After the 1994 Northridge earthquake in Los Angeles, the less destruction experienced in the built environment was attributed to severe adherence to the building code regulations (Petak and Elahi, 2000). Also, GNS (2010) reported that strict implementation of the building code resulted in minimal impact on the built environment during the New Zealand Darfield earthquake in 2010. In comparison, the 2010 Haiti earthquake caused colossal destruction because of non-adherence and enforcement to the building code requirements (Lindell, 2010). However, building code application as a resilient measure to disaster is lacking in many nations such as Nepal and Bangladesh (Ahmed et al., 2018).

The building code is viewed as a competent measure to protect lives, properties, and the built environment generally against a disaster of any kind. However, disasters like an earthquake have claimed many lives even in countries where there is an existing building code (Ahmed et al., 2018, Dixit Amod and Esteban Leon, 2009, Nwadike et al., 2019b). This shows that having building regulation is one of the first steps but not the only action plan needed to reduce the impact of a disaster in the built environment. Building code aims to bridge the gap of achieving disaster risk-reduced built environment, as the effect of disaster continues to increase in the built environment due to global climate change (Wei et al., 2021). Other significant steps needed to achieve a safe built environment following a disaster like an earthquake are regular building code updates, design implementation, enforcement, compliance, and integrating building code into risk management principles and disaster management phases in pursuing a disaster reduced environment.

This study is focused on investigating the interaction between building code and disaster risk reduction and developing a concept of mainstreaming risk mitigation strategies into building code. The integrative literature review method was used to study how to mainstream risk mitigation strategies into building code. The findings from this study demonstrate insightful measures of reducing the impacts of disaster in the built environment.

2 DISASTER RISK REDUCTION

In the quest to reduce the impact of the disaster in the built environment, the United Nation set-up the Hyogo Framework for Action (HFA), from 2005 to 2015. This framework concentrated on the plan of actions that would systematically reduce vulnerability and hazard risks (UNISDR, 2015b), and disaster losses (Bosher and Chmutina, 2017), in the built environment. HFA opened the global doors in the right direction towards adopting and improving DRR, although modifications needed to be made to enhance the roles of DRR in safeguarding developments in the environment (Bosher and Chmutina, 2017). However, Hyogo blueprint framework for disaster risk reduction was successful for the purpose it was established (Stanganelli, 2018). The HFA provided a global podium, where the international communities affirm their support to engage fully in disaster risk reduction as a nation.

Disasters have continued to cause loss of lives and economic value by disrupting human activities with emphasis on the built environment (UNDRR, 2019). Disaster like an earthquake has caused about 58% of the total death in the built environment between 2000 to 2019, making earthquakes the main disaster source of death (UNDRR, 2019).

The persistent occurrence of disasters like earthquakes proved that more strategic plans are needed to focus on tackling the disaster risk drivers (Assembly, 2015), to achieve the build back better principles in post-disaster recovery and reconstruction (Mannakkara et al., 2014). The approach towards handling disaster risk reduction has changed over the period by redirecting disaster-related issues, as shown in figure 1. There is increasing recognition by stakeholders that DRR can only be achieved by reducing the factors that turn hazards into catastrophic disaster. Hence, Chagutah (2009) noted that a change from responding to disaster to preventing and preparing for the disaster is the fundamental principle.

In 2015, another framework was established called Sendai Framework for Disaster Risk Reduction, and this framework is expected to run from 2015 to 2030. This framework gives preference to building code and land use development, emphasizing implementation as a key element of disaster risk reduction (Moullier and Krimgold, 2015). These illustrate the effort put in place to ensure a safe built environment. Attention was given to emergency preparedness and disaster relief materials; however, focus on disaster risk reduction recently shifted to finding reliable mitigation plans and measures to reduce the underlying risks, rather than managing disaster (Bosher and Dainty, 2011, Moullier and Krimgold, 2015), as shown in Figure 1.

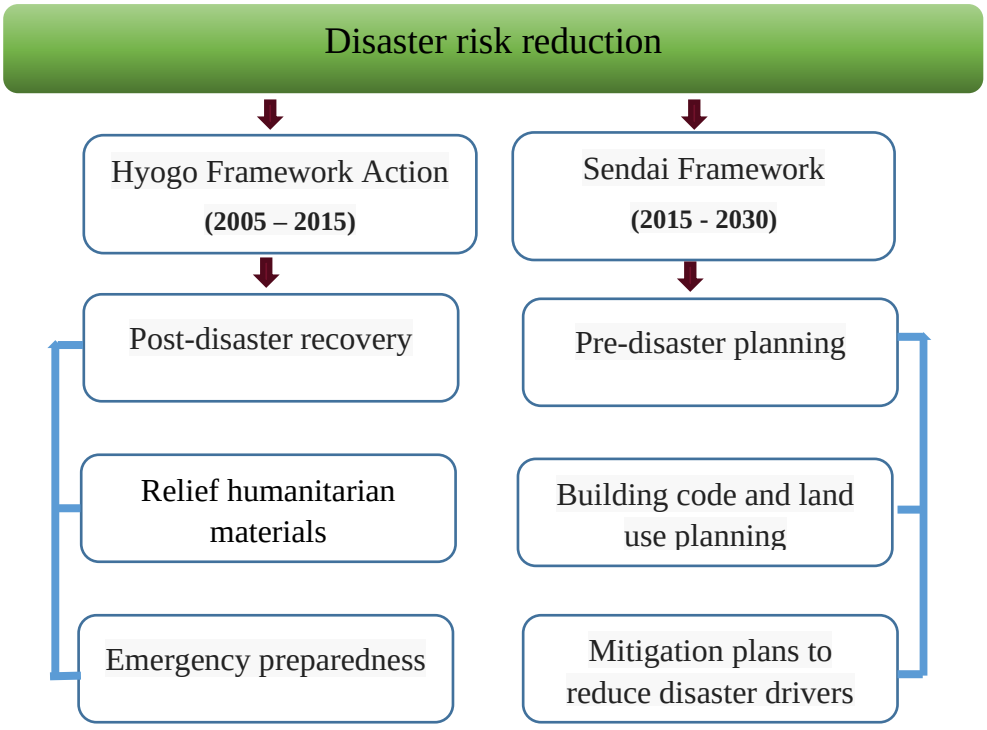

Figure 1: Shift in disaster risk reduction approach

The use of building regulation as an essential strategy to mitigate the impact of a disaster has been neglected over the years (Moullier and Krimgold, 2015), but has recently gained attention (Maki and Hayashi, 2000, UNISDR, 2015a). Disaster risk reduction is the primary objective of any building code (Walker and Musulin, 2015), to protect the loss of lives and properties before, during, and after any extreme loading conditions such

as an earthquake (Nwadike et al., 2019a). Integrating disaster risk reduction into building regulation has faced some challenges, especially its implementation in the construction industry (Ingirige, 2016, Malalgoda et al., 2011). However, construction professionals must be compassionate to reduce the impact of disaster through proactive measures (Bosher and Chmutina, 2017). Hamelin and Hauke (2005) stressed that a comprehensive understanding of the construction practitioners in designing a resilient structure is vital to mitigate the impacts of a hazard turning into a disaster.

3 RESEARCH METHOD

This study used an integrative literature review approach to investigate the interaction between building code and disaster risk reduction to develop a concept of mainstreaming risk mitigation strategies into building code to reduce disaster impact in the built environment. An integrative literature review allows for critique, thorough review, and synthesizing of existing literature on a topic to generate new knowledge perspectives and frameworks on the topic under consideration (Torraco, 2016). This type of review was selected as it contributes to the theory of knowledge and allows the newly generated knowledge to be practically applicable (Whittemore and Knafl, 2005). Also, this method is used to identify research gaps for future research, build a bridge between existing knowledge and new perspectives, and generate a theoretical or conceptual framework (Russell, 2005).

4 BUILDING CODE IN DISASTER RISK REDUCTION

Following the increase in the destructive nature of disaster, loss of lives, and valued financial assets (Botzen et al., 2020), a call to mitigate, protect, and reduce the impact of the disaster in the built environment has received more attention, unlike in the past. Since earthquake causes the most number of death due to the collapse of buildings during and after any seismic loading, building code has been seen as a crucial tool in disaster risk reduction (UNDRR, 2019, Ahmed et al., 2018, Dixit Amod and Esteban Leon, 2009). The collapse of the eight-story building called Rana Plaza in 2013 in Bangladesh claimed more than 1,134 lives and injured about 2,500 people (Dutia and Erol, 2018, BHRRC, 2013). Poor compliance with the building code in practice is principally responsible for turning tolerable magnitude of earthquakes into catastrophic disaster, with reference to Haiti and New Zealand 7.0 magnitude earthquake (Ambraseys and Bilham, 2011). Building code sets out the minimum standard that must be adhered to in designing and constructing buildings to ensure the protection of lives, properties, and the surrounding environment (Nwadike and Wilkinson, 2021b). Building code aims to achieve disaster risk-reduced environment; however, effective strategic regulations should be in place to support building code as a tool in reducing disaster. The building code undergoes a continuous maintenance process of revision that should not be interrupted at any stage to achieve a disaster reduced safe environment, as shown in Figure 2.

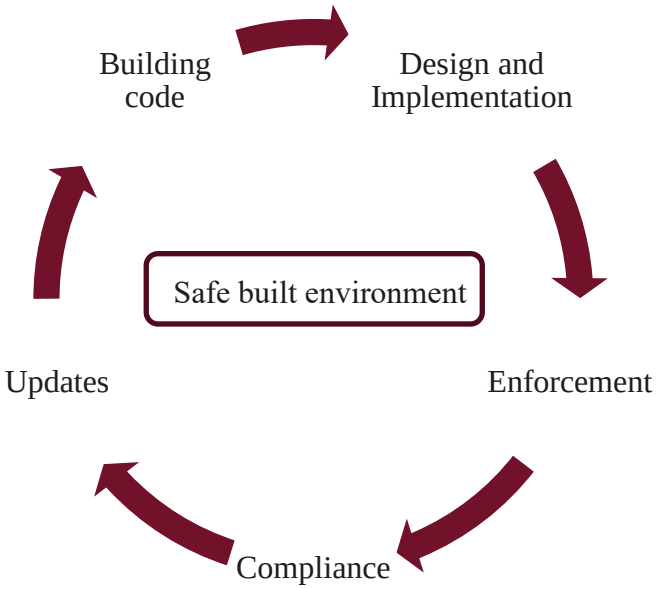

Figure 2: Continuous building code process

The maintenance process of building standards is the backbone of building safe construction and post-disaster reconstruction and recovery. Moullier and Krimgold (2015) stated that the method of building code development and amendment determines the feasibility of the code as an active tool for disaster risk reduction. The building code maintenance process takes a top-bottom approach, meaning that the central authority institutionalises the building standard, which is adopted, practiced, and enforced at all levels.

The policymakers, governments at all levels, private sectors, and donor-driven entities should collaborate towards reducing disaster risk by making building code a top priority. Furthermore, integration of building code into DRR, regular updates of building code, implementation, compliance, and enforcement are imperative in reaching a safe built environment.

Integrating building code into Disaster risk reduction requires the construction practitioners to have a disaster risk reduction mindset in designing, constructing and inspection of construction works. Understanding the principles of disaster risk reduction will encourage the building professionals to see disaster risk reduction strategy as a culture rather than a burden to their duties. Proactive involvement of building industry personnel to view DRR as a core part of their professional activities in efficient planning, designing, and construction will help to reduce retrofitting operation measures in the built environment (Bosher and Chmutina, 2017).

As noted by Armstrong et al. (2017), having the wrong mindset could be costly and constrain the use of the innovative approach in applying building code into DRR. There is a missing vacuum between the building code and disaster risk reduction action plans (Ahmed et al., 2018, Dixit Amod and Esteban Leon, 2009). The integration can be achieved by identifying the various areas where there are missing gaps between building code and risk management principles and integrating the identified gaps into disaster risk reduction. Mainstreaming building code, risk management principles into DRR requires some set of processes, which includes problem identification, action plans, action needed to achieve a safe built environment, as shown in Figure 3.

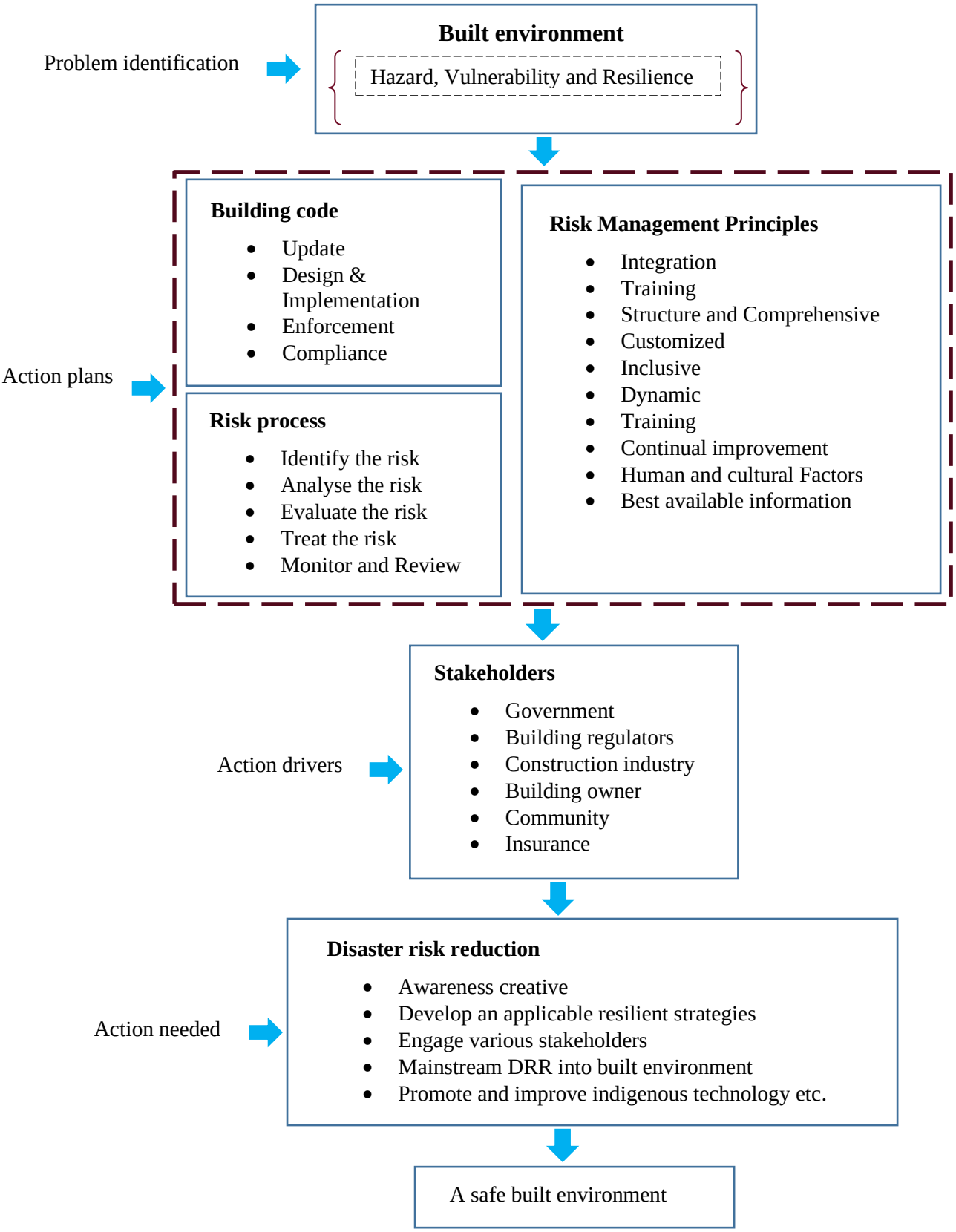

Figure 3: Mainstreaming building code and risk management principles into DRR

The accomplishment of Figure 3 guidelines requires the active involvement of different stakeholders that are willing and ready to take responsibility at all times. The duty and roles of the various stakeholders should be outlined and recognised within the corridors of the division of labour. This step will enhance a coordinated active driver of DRR in the built environment. The "Action plans" and Action needed" are the mitigating tools that help to mainstream DRR through effective implementation of building code requirements and risk management principles in achieving a robust human environment. The "Action needed" stage compliments both the building regulation and risk principles in accomplishing the DRR strategies and frameworks to reduce hazard vulnerability and increase resilience.

5 LACK OF COMPLIANCE AND POOR BUILDING REGULATION ADMINISTRATION

Many countries have adopted building code as a measure to have a safe, resilient structure, but its application to disaster risk reduction is missing (Ahmed et al., 2018). Lack of compliance truncates the primary aim of building code and can lead to disaster (Nwadike et al., 2019b). Non-adherence to building code compliance signifies that natural hazards are not always required for disaster to occur (Ahmed et al., 2018). Some of the building collapses result from compliance deficiency during construction and maintenance (Ahmed et al., 2018, Menum and Mistry, 2001, Mistry et al., 2001). The weakness in administering building regulation paved the way to non-compliance. Even in some developed countries, compliance with the building code is usually not compulsory (Ahmed et al., 2018, Thiruppugazh, 2008). Enforcement and compliance to building code have encountered many challenges as listed in (Ahmed et al., 2018, Johnson, 2011, Koroluk, 2016, Moullier and Krimgold, 2015, Yates, 2002). However, effective integration of disaster risk reduction into building code requires efficient enforcement of building code to achieve compliance by the building agencies. An adequate number of technical staff with in-depth knowledge of building regulation at all levels, incentives to ensure compliance adherence and breaking down the compliance procedures to the local construction artisans is essential in building code application. Integration can be enhanced through partnership between the construction industry, government at all levels, non-governmental organisations in charge of DRR and other involved stakeholders for smooth building code and DDR mainstreaming process. Furthermore, attaining the goals of DRR and compliance with the building regulation should be viewed beyond enforcement of building standards to involving socio-cultural activities of communities to appreciate the benefits of having a resilient structure willingly (Huisman et al., 2006).

6 DEFICIENCY IN AWARENESS CREATION AND TRAINING IN THE BUILDING INDUSTRY

Maximising the strength of building standards in mitigating disaster in the built environment demands the inclusiveness of building regulation and disaster risk reduction strategies. These entails the incorporation of risk management principles into building code application, as shown in Figure 4.

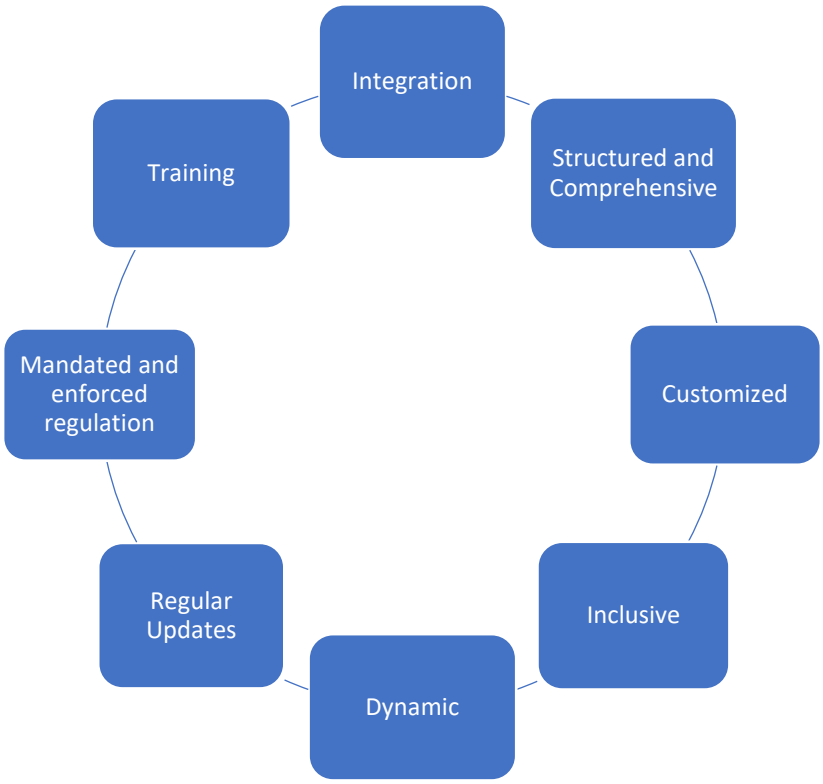

Figure 4: Modified risk management principles and building code interaction

In reducing disaster, building standards should be made interactive with the Sendai framework and risk management principles. The risk management principles help the regulation to be mutually inclusiveness in implementation, so the Sendai framework sets out the required guidelines to achieve a disaster-reduced built atmosphere (Hutchins, 2018, UNISDRR, 2015).

Customising building code to a particular geographical location or country could help to handle and reduce the impacts of hazard turning into disaster. When building regulations are not made to be country-specific, it may cause confusion in implementation and compliance (Bosher and Dainty, 2011). Countries that borrow building code from developed countries may find it difficult to cope, especially in low-income countries, and could strongly depend on imported building materials and skills (Moullier and Krimgold, 2015). These may create an unpleasant atmosphere for local materials and technologies in the construction market. A structured and comprehensive approach sets a platform for robustness and self-explanatory building code in achieving a disaster resilient environment. The comprehensive master plan to mitigate disaster is recommended to be integrated into each national building standard to enhance efficient pre-disaster planning. Also, building code should have the capacity to serve as a guiding tool to control and address the activities of disaster risk reduction strategies both in the private and public sectors. Hence, the ability of building code to reduce disaster could be deeply dependent on how often the code and the associated documents are reviewed, enforced, implemented, complied and the culture of disaster risk reduction mindset among the construction practitioners (Nwadike and Wilkinson, 2020, Nwadike and Wilkinson, 2021a, Nwadike and Wilkinson, 2022).

Many countries have introduced building standards with less or no enforcement, with some nations have their building code not enacted into law, hence, not legally bounding document (Bosher, 2014). This means that anyone can choose not to adhere to the building regulation during planning, designing, construction and operational stages. The exhaustive master plan, policy framework and code enforcement strategies for disaster risk mitigation through the use of building code should be developed to be country-specific. These can be

accomplished through a comprehensive approach that will include all stakeholders to strengthen the connection between climatic change, development, and disaster risk reduction in the built environment through the principles listed in Figure 4. The adopted interaction between the modified risk management principles (Hutchins, 2018), and the building code lays a strong foundation to accomplish risk mitigation, as illustrated in Figure 4. One Build Back Better principle requires a regular amendment and active legal framework in building standard adoption (Iglesias et al., 2009, Mora and Keipi, 2006). This legal framework create an avenue where the stakeholder's responsibilities are well defined, and enforcement of the regulation can be fully administered in the building industry, where the practitioners could be held accountable. Mainstreaming disaster risk reduction needs proactive approaches in training and transferring knowledge on how to use building code to alleviate the impact of a disaster in the built environment. This will give an opportunity to share experiences gained from previous disasters and various ways to attenuate the vulnerabilities of disaster in the built environment. The training initiative would help equip the regulatory bodies, the construction industry, disaster facilitators, the communities, the government, the private and donor-driven sectors on the importance of disaster risk reduction. All the parties involved should be enlightened about adopting an inclusive risk reduced building code and practice (Ikeda et al., 2008, Reddy, 2000). It is the sole responsibility of the building code regulatory bodies to run in collaboration with the disaster facilitators to create a working mechanism and instrument to ensure a purposeful training exercise among the stakeholders. Local technologies and creativity should be dynamically accommodated, strengthened, and promoted in mainstreaming building standards. This practice encourages the participation of all stakeholders, including the local people, in planning, implementation, design, enforcement, and compliance. However, some building standards may not recognise the local technologies, making the participation of the locals more difficult.

In many low-income countries, there is a lack of technical experts to cross-check and monitor the building plans and actual construction against the technical requirements stipulated in the regulation (Iglesias et al., 2009). Even when there are technical staff, corruption and lack of professional knowledge become a hurdle that needs to be crossed in the discharge of their duty. Ambraseys and Bilham (2011) opined that corruption destabilises the efforts of building an effective regulatory framework to create a robust environment in the construction sector. Furthermore, Moullier and Krimgold (2015) believe that corruption leads to the collapse of the building code implementation and enforcement system.

7 CONCLUSION

This study investigated the synergy between building code and disaster risk reduction and developed a concept of mainstreaming risk mitigation strategies into building code. The study employed an integrative literature review method to achieve the purpose of the study on how to mainstream risk mitigation strategies into building code.

The United Nation recognises disaster risk reduction as an essential issue, and this is established by their commitment to forming frameworks, such as Hyogo and Sendai with the aim of reducing the impact of a disaster. The HFA provided a global podium, where the international communities affirm their support to engage fully in disaster risk reduction as a nation. The study shows that there are increasing recognition by stakeholders that DRR can only be achieved by reducing the factors that turn hazards into a catastrophic disaster. The study identified that the HFA primarily centered on post disaster recovery coupled with emergency preparedness and humanitarian relief materials. Accordingly, the Sendai framework scheduled to run from 2015 to 2030 focused on pre-disaster planning, aimed at involving building code in disaster mitigation strategies.

The study established the need to create a robust link of using the building code beyond the normal conventional use in construction to mitigate the impact of a disaster in the built environment. Also, the study findings demonstrate that integrating building code requirements into disaster risk reduction and risk

management principles are possible and can be handled for a better outcome. Although applying the building code requirements are needed in reducing disaster impacts, the building code maintenance should be made continuous without any form of interruption in design and implementation, enforcement, compliance and regular updates.

The significance of this study shows that there is an urgent need to activate smooth active interaction between building standards, risk management principles, and DRR policies. The study findings stressed the importance of cultivating a DRR mindset within the construction industry, especially among the building code users. Furthermore, there is a need to customise building code to be country specific, as this could help proficient risk mitigation strategies at all levels. By aiming to reduce the impact of a disaster, hazard awareness should be used to educate the people on the importance of adhering to building code practice with emphasis at the grassroots level. The study concludes that there are benefits to all the stakeholders, especially to the host communities in incorporating risk management strategies and disaster risk reduction principles into building code and other associated documents. Also, the study encouraged the full participation of all stakeholders, irrespective of their diverse interests, to harness the full potential of mainstreaming building code practice and risk management principles into disaster risk reduction. As a limitation, this study used an integrative literature review approach to investigate how to mainstream disaster risk reduction principles and risk management into building code requirements. Future studies should consider using primary data collection methods to revisit the study objectives.

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