Enhancing Disaster Resilience: Overview of Resilient Housing

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Abstract
One of the main concerns in disaster risk reduction strategy related to housing is the implementation of the disaster resilience concept for rebuilding housing after a disaster. The disaster resilience approach for reconstruction is often used to address this issue but its implementation poses significant challenges in vulnerable areas. It has been observed that the current trends show that researchers have recognized the importance of providing communities with resilient housing that can withstand the impact of disasters. However, the recent works of literature lack an overview of the latest trends and advancements in resilient housing practices specifically during the development of housing project phases. Therefore, this study aims to provide an inclusive understanding of the fundamental phases of resilient housing practices that can enhance disaster preparedness in the housing sector. By using a systematic literature review, this study identified the fundamental phases of resilient housing practices in resilient settlements under five dimensions of resilience phases; hazard assessment, hazard identification, mitigative adaptation, preparedness planning, and recovery planning. This paper provides a comprehensive approach to combining the various stages of resilient housing with the concept of disaster resilience, ensuring that both current and future developments are equipped to withstand potential disasters. By prioritizing the resilience concept in housing and taking proactive measures to address the impact of disaster on vulnerable communities, this approach is expected to create more sustainable and resilient communities.
Keywords: Resilient Housing, Built Environment, Disaster Risk Reduction, Disaster Resilience.

Introduction

Disaster resilience is defined as the ability of a community or a system to prepare for, respond to, recover from, and adapt, to the impacts of disasters (Sou, 2019; Taeby & Zhang, 2019). It involves minimizing the loss of lives, assets, and livelihoods while enhancing the capacity to withstand and bounce back from the adverse effects of disasters. It has been suggested that resilience is more than just returning to pre-disaster status; it is also analyzing past disasters for rebuilding to be better prepared for future disaster events(Jayakody et al., 2022; Vahanvati et al., 2023).

The introduction of the concept of resilience into the housing sector has become an urgent need in the development of the performance of the housing system, to continue to meet the housing needs in the housing market through a set of that increase their resilience to risk (Mesquita & Kós, 2017). Building housing to a standard that is less vulnerable to future hazards can contribute to reducing disaster risks in the long term (Hamideh et al., 2021). 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 a time of disaster and be able to protect the functioning of the city, its people, and other associated physical and social systems (Amaratunga et al., 2018).

Previous research has established and documented evidence that many of the strategies that have been adopted around the globe in developing the methods of resilience construction differ depending on the regional context, specific climatic conditions, and materials available such as wind-resistant construction(Simmons, 2021), flood-resistant design(FEMA, 2015) and multi-hazard resistant new construction or reconstruction (Dhulipala, 2021). The proper materials and construction techniques are crucial for protecting both the property and the living beings in and around structures during disasters (Shama & Motlak, 2020).

In the literature of resilient housing, the importance of resilience concepts and strategies to the building structure has been debated as the concept is challenging because it is necessary to understand the evolutionary resilience components used in complex but rigid systems (Dissanayake et al., 2021). Debates continue about the best strategies in the process of developing resilient housing in resilient settlements. However, based on our extensive literature review in this study, we have not come across a single study that has focused on describing the latest research trends and advancement in resilient housing practices specifically in the stages of developing and constructing resilient housing. This gap is particularly noteworthy given the critical role that resilient housing can play in safeguarding communities against disaster.

Therefore, this paper brings a unique paradigm in developing a more resilient and sustainable infrastructure that can withstand the adverse impacts of disasters by establishing a comprehensive synthesis that covers various dimensions within the stages of developing resilient housing. By integrating recent development in resilience concept, this research aims to provide a comprehensive understanding of the fundamental phases of resilient housing practices that can enhance disaster preparedness in the housing sector.

Method
Search Strategy

This study employed a modified PRISMA-guided research and review technique, with pre-specified inclusion and exclusion criteria, terms definitions, and documentation of selection decisions as recommended by (Mirzaei et al., 2019; Ricci et al., 2019) which consists of four steps; identification, screening, eligibility, and inclusion. This method enables us to

identify any gaps in the current knowledge and provide a comprehensive summary of the latest findings. In addition, this approach capable of giving a historical overview of a particular subject, and a highly effective technique to cover more ground (Ummihusna & Zairul, 2022).

Data sources and searches

First, the identification step is conducted using the selected database. Numerous databases collection is common among researchers such as Scopus, Emerald, and Science Direct. On top of that, the Scopus database has been chosen as the referral source as it has been recognized and widely used in the academic field because the key elements in the Scopus database such as its multidisciplinary and broad coverage of academic literature from different regions with high citation publications offer reliable material in managing the review (Hassan et al., 2022).

Eligibility criteria and study selection

To answer the research questions, the selected keyword "resilient housing" was entered into the Scopus search engine. The second step is screening where the subject filters were applied. The time frame in this study is limited between January 2018 to July 2023 to select the most recent and pertinent research. The source type is restricted to journals and articles must have been published in a peer-reviewed publication in English language. Each article's full text was examined to exclude those not genuinely connected to resilient housing used in disaster preparedness. This data was retrieved on 18th July 2023 (see Figure 1).

Table 1
Search terms and review criteria

Search terms	
Housing; residential building, dwelling	
Disaster; resilience, climate change, sustainability, sustainable development, disaster management, vulnerability	
Inclusion criteria	**Exclusion criteria**
- TITLE-ABS-KEY (resilient AND housing) AND PUBYEAR > 2018 AND PUBYEAR < 2024 AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SUBJAREA , "ENGI") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ENVI")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (EXACTKEYWORD , "Housing") OR LIMIT-TO (EXACTKEYWORD , "Resilience") OR LIMIT-TO (EXACTKEYWORD , "Climate Change") OR LIMIT-TO (EXACTKEYWORD , "Sustainable Development") OR LIMIT-TO (EXACTKEYWORD , "Sustainability") OR LIMIT-TO (EXACTKEYWORD , "Disasters") OR LIMIT-TO (EXACTKEYWORD , "Architectural Design") OR LIMIT-TO (EXACTKEYWORD , "Residential Building") OR LIMIT-TO (EXACTKEYWORD , "Disaster Management") OR LIMIT-TO (EXACTKEYWORD , "Vulnerability"))	- Not related to resilient housing and disasters context - Not available in English - Conference papers, master's and doctoral dissertations, textbooks, and unpublished working papers were excluded, as academics and practitioners alike most often use journals to acquire information and disseminate new findings.

Included

A total of 166 articles were identified from the literature search, after title and abstract reviews, 78 were considered for full examination based on inclusion criteria. A manual search through references of the 78 chosen articles revealed an additional after the screening of documents had been completed, 33 documents of resilient housing articles focusing on disaster preparedness remained in the final database.
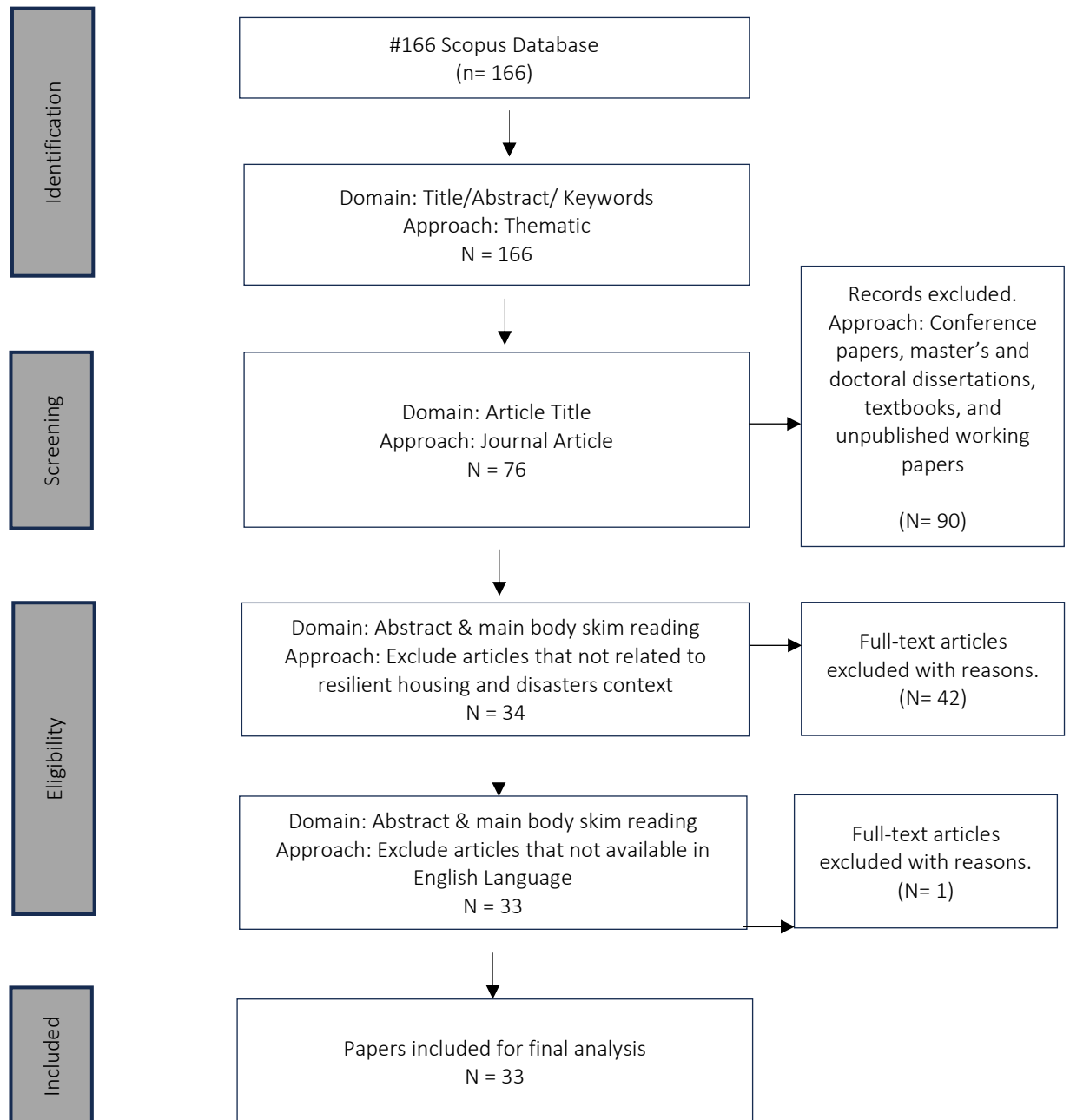

Figure 1. Flow diagram of the search strategy.

Table 2
Literature search by included criteria.

Categories	
Include key principles and concepts of resilient housing practices.	Shi et al (2022) Dhulipala (2021) Sen et al (2021b) Sou (2019)
Include existing strategies and technologies used in resilient housing.	Tuan Hai & Kim Hoang (2023) Amada et al (2022 Haque et al (2022) Harun-Or-Rashid et al (2022) Pinto et al (2022) Kim & Jeon (2020) Kumar et al (2020)
Include challenges and barriers in implementing resilient housing practices.	Putri et al (2023) Shokry et al (2022) Alba-Rodríguez et al (2021) Bienvenido-Huertas et al(2021) Tleuken et al (2021) Zune et al (2020)
Include best practices and lessons learned from previous resilient housing projects.	Adegun & Olusoga (2020) Hugo (2021) Kasprzyk et al (2022) Hanbashi et al (2023) Sánchez-García et al (2019)
Include potential future directions and innovations in resilient housing practices.	Equere et al (2020) Cacique & Ou (2022) Uidhir et al (2020) Navas-Martín et al (2022) Segal et al (2022) Bigurra-Alzati et al (2021) Waly et al (2021) Adhikari et al (2020) Wang & Tsavdaridis (2022)

Table 3

Matrix of literature review summaries

Authors and Year	Type of Study			Housing Development Stages						Resilient Phases				
	Quantitative	Qualitative	Mixed Method	Concept design	Developed Design	Technical Design	Preconstruction	Construction	Handover and Inuse	Hazard Identification	Hazard Assessment	Mitigative adaptation	Preparedness Planning	Recovery Planning
Hanbashi et al (2023)	X				X	X					X		X	X
Putri et al (2023)		X		X	X					X			X	X
Tuan Hai & Kim Hoang (2023)		X						X	X				X	X
Amada et al (2022)	X			X	X								X	X
Cacique & Ou (2022)		X		X								X	X	
Harun Rashid et al (2022)	X			X	X	X	X			X	X			
Haque et al (2022)		X		X	X					X	X			
Kasprzyk et al (2022)			X						X	X	X	X	X	X
Navas-Martín et al (2022)	X								X				X	X
Pinto et al (2022)	X				X	X							X	X
Shi et al. (2022)			X	X	X					X	X	X	X	X
Shokry et al (2022)			X	X	X					X			X	X
Segal et al. (2022)			X	X	X					X	X			
Wang & Tsavdaridis (2022)			X	X		X				X	X			
Alba-Rodríguez et al (2021)			X	X	X					X	X			X
Bienvenido-Huertas et al (2021)			X	X	X				X	X	X			
Bigurra-Alzati et al (2021)	X			X	X					X	X	X	X	
Hugo (2021)		X							X	X	X	X		
Dhulipala (2021)	X			X	X								X	X

Sen et al (2021b)	X								X		X	X	X
Tleuken et al (2021)	X								X		X	X	
Waly et al (2021)		X							X			X	X
Adhikari et al (2020)	X		X	X					X	X			X
Equere et al (2020)	X								X			X	X
Kim & Jeon (2020)	X			X	X	X	X		X	X			
Kumar et al (2020)	X		X	X							X	X	X
Uidhir et al (2020)	X		X	X							X	X	X
Zune et al (2020)	X		X	X					X	X			
Sánchez-García et al (2019)		X							X			X	X
Sou (2019)		X							X			X	X

Findings

The findings of this paper highlight the significance of five dimensions of resilient housing practices that are critical in achieving resilience. These findings are derived from a systematic literature review and provide insights into key stages involved in developing and implementing resilient housing strategies. The five identified dimensions of resilience phases shown in Figure 2 as follow:

1. Hazard assessment: This phase involves evaluating potential hazards and risks that particular settlement might face. It encompasses understanding the type of disaster such as heat wave, earth that could impact the area, assessing their likelihood and potential consequences and identifying vulnerable areas or populations within the settlement.

2. Hazard Identification : Once hazards are assessed, this phase involves the detailed identification of specific threats and vulnerabilities within the settlement. It seeks to pinpoint critical infrastructures, housing structures and community assets that are at risk. This phase may also involve analyzing historical data, conducting vulnerability assessment and identifying the potential triggers of disaster events.

3. Mitigative adaptation : In this phase, strategies are formulated to adapt and enhance the resilience of housing and settlements against identified hazards. Mitigation adaptation involves implementing measures to reduce vulnerabilities, enhance structural integrity and improve community preparedness.

4. Preparedness planning : This phase involves creating comprehensive strategies, protocols and action plans to ensure that communities and housing structures are well prepared to respond effectively in the event of a disaster.

5. Recovery planning: This phase involves formulating strategies to facilitate a swift and organized recovery process. It includes coordinating relief efforts, restoring essential services, rebuilding damaged housing and infrastructure and supporting affected communities in their recovery journey.
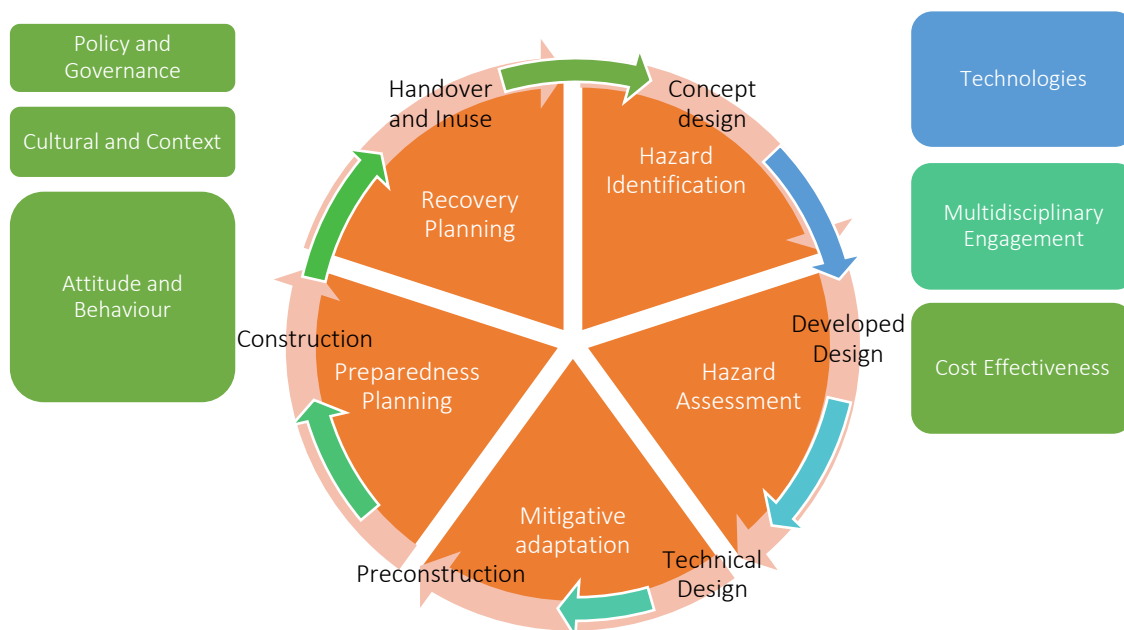
Figure 2. Integrated framework of disaster resilience phases in resilient housing

Discussion

Through a systematic literature review, this study aimed to gain insights into the foundational phases of resilient housing practices within resilient settlements. By synthesizing existing research, the study identified five dimensions of resilience phases that are integral components of resilient housing strategies. Enhancing disaster resilience in housing and settlements requires a comprehensive framework that includes hazard assessment, identification, mitigative adaptation, preparedness planning, and recovery planning. The discussion of this paper elaborates on the implications, significance and potential applications of the findings obtained through the systematic literature review as shown in table 4.

Table 4
Implications, significance and potential applications of the integrated framework of disaster resilience phases in resilient housing

Themes	Implications/Significance/Potential
Integration of resilience dimensions	This study found that the identified dimensions of resilience phases are interconnected and collectively contribute to a comprehensive approach to resilient housing practices. It discover recent advancement in the use of latest technology such as BEV, PV, ZH through modelling, simulation and prediction of future disaster risk into resilient housing strategies. The recent strategies and technologies used in resilient housing can be categorized under technology theme such as the use of energy efficiency and off-grid capabilities as suggested by (Kumar et al., 2020; Amada et al., 2022). The use of durable and sustainable materials was highlighted by Pinto et al (2022) where implementing resilient and durable materials can withstand

	extreme weather conditions and resist damage up to a certain level. Using modular construction techniques to expedite the assembling process of resilient housing has been studied by (Haque et al., 2022).
Adaptation and Contextualization	The importance of tailoring the resilient housing strategies to match the specific challenges and opportunities are unique to each community. This covers empowering social resilience by promoting cohesion and mutual support is highlighted by Tuan Hai & Kim Hoang, (2023) where local communities shall be involved during the planning and design process to tailor the resilient housing requirements. The implementation of resilient housing can be tough due to a variety of constraints such as technical aspects where there are no technical instructions or manuals on the maintenance and repair of individual houses in general, or the project houses in particular Tuan Hai & Kim Hoang (2023). Collaboration across disciplines is required for resilient housing, including design, engineering, urban planning, and social sciences (Shokry et al., 2022).
Preparedness as a Proactive strategy	Previous studies by Jayakody et al (2022) highlight the importance of four important measures in the theoretical framework; described as the abilities of survivability, reconfigurability, adaptability, and learnability while indicating a set of strategies to help the housing sector and built environment practitioners to manage and mitigate extreme weather effects during planning, design, construction, and occupancy phase. Another studied by Sen et al (2021a) suggested that resilience mainly depends on two key attributes such as reliability and recovery. Meanwhile, one interesting finding of this paper underscores the importance of a proactive approach and multi-dimensional approach to resilience, starting with a thorough understanding of potential hazard assessment and identification. Subsequently, the integration of mitigation adaptation strategies bolsters the structural and functional resilience of housing and infrastructure, helping communities withstand the impacts of disasters.
Challenges in implementation	The implementation of resilient housing can be tough due to a variety of constraints such as technical aspects where there are no technical instructions or manuals on the maintenance and repair of individual houses in general, or the project houses in particular (Hai & Hoang, 2023). Collaboration across disciplines is required for resilient housing, including design, engineering, urban planning, and social sciences (Shokry et al., 2022). It can be difficult to ensure efficient communication and cooperation among different disciplines. (Putri et al., 2023) suggested that a

	significant barrier can be a scarcity of experienced individuals educated in robust design and construction. In addition, inadequate regulations and incentives at the local, regional, and national levels can prevent the widespread adoption of resilient housing methods (Alba-Rodríguez et al., 2021).
Future Research Directions	The effectiveness of specific interventions such as zero energy housing, case studies that showcase successful implementation or comparative studies across different regions is needed for further investigation.

Conclusion

The main conclusions drawn from the review indicate that having a plan that integrates different aspects, involving the community, and utilizing advanced technologies are essential in creating durable housing solutions. Various successful initiatives across different contexts highlight the importance of collaboration between governments, non-governmental organizations, and private entities in achieving goals of disaster resilience. In short, given the increasing frequency and severity of disasters in the world today, it is not just a choice, but a necessity for communities to prioritize resilient housing practices.

It is imperative to recognize that although this study provides valuable insights, it is not without its constraints. Therefore, it is vital to take into account these limitations while interpreting the findings. For one, the data used in this research is of a secondary nature, which means that relevant studies, initiatives, and practices that pertain to resilient housing may have been unintentionally excluded from the chosen databases. Additionally, the absence of primary data-gathering methods, such as interviews, may have restricted the scope of comprehension and firsthand perspectives from individuals involved in implementing resilient housing strategies.

Despite these limitations, this study serves as an elementary framework for understanding the significance of resilient housing practices in enhancing disaster resilience. It is crucial to view this research as a launching point for further exploration and examination of the subject matter to obtain a more comprehensive understanding.

Acknowledgement

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