A SYSTEMATIC REVIEW OF THE MITIGATING FACTORS FOR EMERGENCY RESPONSE IN FACILITIES

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Abstract
This study aims to identify effective practices and strategies that improve preparedness and response capabilities by examining the factors contributing to mitigating challenges in emergency response. A comprehensive literature review was adopted to analyse current trends, case studies, and expert opinions regarding global emergency response infrastructure. The review synthesised existing research and case studies and provided insights into practical experiences and perspectives from diverse operational contexts. The research highlights 11 factors categorised into 7 key factors that contribute significantly to mitigating challenges in emergency response. These factors include community engagement and capacity building, policy and governance, technological integration, collaboration and coordination, cultural and social integration, science and knowledge integration, outsourcing, and local initiative. The study highlights the importance of addressing potential biases in interview responses and the challenge of extrapolating results across different contexts to improve global emergency response results. This study provides valuable insights for facility managers, policymakers, emergency management agencies, and practitioners to implement targeted interventions to strengthen mitigating factors, such as communication infrastructure and community-centered approaches. This study provides empirical evidence and practical insights on effective emergency response strategies, emphasising the importance of proactive measures and integrated approaches for enhanced preparedness and response capacities.

Keywords
Emergency Response, Mitigating Factors, Disaster Risk Reduction, Natural Disaster, Resilience.

1 Introduction

Global environmental catastrophes underscore the necessity of comprehending locals' responses to new challenges as they frequently grapple with the decision to remain or relocate (Swapan and Sadeque 2021). Unpredictable disasters threaten human life and property safety, making assessing and responding to building damage challenging due to time-consuming design processes (Zheng *et al.* 2021). Disaster management operations require extensive information and resource allocation, requiring coordinators to efficiently assign rescue teams to high-survivor probability sites despite informal decision-making processes and a lack of reliable information (Chaudhuri and Bose 2020). In 2018, built environments were hit hard by natural and artificial disasters, resulting in 3,655 fatalities and $25.6 billion in property losses (Zhu and Li 2021).

The importance of planning and scheduling for emergencies to enhance critical infrastructure resilience (Jia *et al.* 2023). US natural disasters, like Hurricane Katrina in 2005 and 2017, have caused significant economic, social, and environmental losses, causing over $105 billion in damage and loss (Olanrewaju *et al.* 2020). A disaster, according to the International Federation of Red Cross (IFRC), is an abrupt, catastrophic event that significantly disrupts a community or society and causes significant losses that are beyond its control (Erbeyo˘glu and Bilge 2020). Preparedness planning is crucial for natural disasters like earthquakes, involving locating distribution centres, allocating supplies, and determining inventory to reduce casualties and expedite relief efforts (Ghasemi and Khalili-Damghani 2021). The US provided over $63 billion in short-term disaster assistance from 2007 to 2016, primarily for restoring basic living conditions, but its impact on socially vulnerable populations remains unclear (Drakes *et al.* 2021). Efficient planning and allocation of aid and rescue efforts in natural disasters can save thousands of lives and cause significant human and economic losses (Adriano *et al.* 2021). The successful disaster management process necessitates timely and precise data access on the extent of damage and the impact of the disaster, including prevention, mitigation, preparedness, response, and recovery (Pi *et al.* 2020).

Earthquakes, floods, hurricanes, avalanches, and tsunamis cause significant casualties and property losses worldwide, with the 2010 Yushu earthquake in China causing over $124 billion in direct losses (Sun *et al.* 2021; Félix *et al.* 2020). 2017 was a devastating year with numerous natural disasters, including the Sierra Leone floods, Hurricane Harvey, Hurricane Irma, Hurricane Maria, significant earthquakes in Mexico, and over 500 deaths in Iran (Sabbaghtorkan *et al.* 2020). Strategic pre-disaster mitigation activities enhance public self-help, disaster mitigation effectiveness, and government emergency management, raise risk awareness, and increase participation in disaster governance initiatives (Cai *et al.* 2023).

Community planning and public awareness are crucial in minimising asset loss, deaths, and injuries during natural disasters, thus enhancing the effectiveness of response and relief operations (Ghasemi and Khalili-Damghani 2021). In some fields, research has been done. For example, Kalogiannidis et al. (2022) used school systems as a center for risk and disaster management: a case study of Greece. The resilience solution to climate disasters: recursive and contested relations with equity and justice-based transformations in the Global South is the subject of Ajibade's (2022) research. Al-Wathinani *et al.* (2023) research on driving sustainable disaster risk reduction (DRR): a rapid review of the policies and strategies in Saudi Arabia. However, studies have not explored the mitigating factor to emergency

response infrastructure. Thus, a paradigm that can direct the creation of contemporary emergency response infrastructure in Sub-Saharan Africa is required.

2 The mitigating factors for emergency response in facilities

2.1 Emergency Response

Accidents, social security crises, public health emergencies, and natural disasters are examples of emergencies that occur occasionally and pose serious threats to national security, safety, and property rights (Wang *et al.* 2022). Response refers to emergency measures taken during and after a disaster, primarily aimed at rescuing victims and meeting the immediate needs of survivors (Dwarakanath *et al.* 2021). Emergency response involves mobilising people and supplies to damaged infrastructure, including public buildings, transit systems, telecommunication networks, and power systems designed for natural disasters (Gilmore and DuRant, 2021; Dwarakanath *et al.* 2021).

2.2 Facotrs for Mitigating Emergency Response

The factors necessitating modernised emergency response infrastructure are provided in this section. Eleven mitigation factors are presented.

2.2.1 Community Engagement and Capacity Building

The initiative established community action groups for high-risk groups, organised capacity-building workshops, and increased community involvement, leading to more volunteers tackling community risks (Perera *et al.* 2020). The initiative involves establishing community-based early warning systems, training local communities in disaster preparedness and response, and encouraging citizen participation in emergency planning and decision-making (Anguelovski *et al.* 2014; Pelling 2012). The Saudi Arabian government enhances community involvement in disaster management by providing resources, training, and authority to local disaster management committees (Al-Wathinani *et al.* 2023). Effective institutional management in democratic governance is considered crucial for DRR through public involvement (Tanesab 2020). However, because of unawareness, uncertainty about the role, and infrequent awareness programs, community-level interest in response to natural hazards is always very minimal (Perera *et al.* 2020). Local hazards and vulnerability can be understood better when insights into proper strategies are availed by the community members themselves (Al-Wathinani *et al.* 2023). Training programs enhance emergency responders, strengthen management, and promote collaboration (Pelling 2012). Community support is vital but faces challenges in socially fragmented areas (Al-Wathinani *et al*. 2023). Empowering citizens through resources, training, and funding is key (Ajibade 2022). Civil Society Organizations bridge social gaps in DRR as directed by the European Commission in 2020 (Perera *et al.* 2020; Merz *et al.* 2020).

2.2.2 Technological Innovation

Integrating Artificial Intelligence (AI), Internet of Things (IoT), and Geographic Information System (GIS) in real-time monitoring, emergency alert development, and drone use for aerial surveillance and disaster assessment (Pelling 2012). Computer-assisted dispatch systems are gaining popularity in emergency infrastructures, with local governments and third-party platforms promoting their value in ensuring community safety (Gilmore and DuRant 2021). The digital revolution has transformed communication, enabling a hyperconnected society using IoT, big data, AI, and urban analytics, empowering cities to adapt to their unique characteristics (Myeong *et al.* 2021). Call-takers and dispatchers use a suite of operations, including autonomic number identification and location identifier systems. These systems help to assess a caller's location, classify the situation, and coordinate with dispatchers to provide necessary resources (Gilmore and DuRant 2021). Nimbus CAD, eclipse

analytics, and radius mapping are cloud-based tools that aid operators in tactical mapping, dynamic arrival times, and enhanced telemetrics, providing historical and real-time insights and future data analysis for operational efficiency (Gilmore and DuRant 2021).

2.2.3 Policy Reforms

Ineffective building by-laws and inadequate land use planning hinder the implementation of disaster resilience regulations and standards in infrastructure development, especially in developing countries (Abdul and Yu 2020). Local governments should improve building codes, infrastructure, early warning systems, public awareness, and disaster risk management so they can enhance emergency response, inform policy, and contribute to a safer, more resilient future (Al-Wathinani *et al.* 2023; Gilmore and DuRant 2021). South Korea has been implementing technology-driven smart city initiatives since the 2000s, focusing on construction, connecting, and enhancement stages, with the U-City Act in 2008 aiming to improve quality of life (Myeong *et al.* 2021). Planning is essential for identifying vulnerabilities and utilizing tools such as building codes, urban planning, land use planning, development and risk management plans, and others to reduce risk and increase resilience (Bello *et al.* 2021). Smartopia Gimpo, a sustainable smart city, partnered with the private sector to develop an ICT-based platform, addressing challenges like unclear stakeholder relationships (Myeong *et al.* 2021). The pillar advocates for mandatory building codes for essential infrastructure like food storage, health, education, water, energy, and telecommunications to enhance societal and economic operations (Bello *et al.* 2021). Most countries lack DRR material in teachers' education, but postsecondary education should include such materials to effectively educate students (Kalogiannidis *et al.* 2022). The school curriculum's insufficient inclusion of disaster risk awareness and inadequate implementation of emergency plans in developed countries further hinder public awareness (Perera *et al.* 2020). Local government can enhance disaster risk management through transparent, accountable public finance mechanisms, independent monitoring, and on-ground reconstruction inspections (Deen 2015).

2.2.4 Collaboration and Coordination

Stakeholder collaboration combines the private sector, academia, and local authorities to promote nature-based solutions and climate change adaptation, fostering joint projects and knowledge exchanges (Wamsler *et al.* 2020). The 2008 Koshi Flood response was ill-coordinated due to a lack of a transboundary framework for disaster management, highlighting the need for localised solutions to disasters (Nepal *et al.* 2018). Disaster management policy has evolved from a state-centric approach to a cooperative governance network framework, incorporating ideas from governments transitioning from interactive command-and-control to cooperative governance (Nawang *et al.* 2024). The strategy shifts from silos-based to intersectoral work, focusing on consistent, longitudinal integration of climate change adaptation and nature-based remedies, with internal cooperation as the driving force (Wamsler *et al.* 2020). The success of disaster risk management initiatives relies heavily on the government's institutional and policy framework, which includes creating roles, legal provisions, and strategies (Nepal *et al.* 2018).

2.2.5 Strategic Citizen Involvement

The strategy aims to increase public awareness and prevent protests by involving citizens in planning processes, addressing issues like limited interest in greening and objections to tree protection (Wamsler *et al.* 2020).

2.2.6 Outsourcing

The strategy involves providing information and advisory services to stakeholders to implement nature-based solutions and climate change adaptation, often outsourced to citizens or property owners (Wamsler *et al.* 2020).

2.2.7 Concealed science-policy integration

This strategy promotes nature-based solutions and climate change adaptation in planning regulations, aiming to increase pressure on staff and policymakers and create small changes through individual champions (Wamsler *et al.* 2020).

2.2.8 Cultural and Social Integration

Social practices develop various competencies, expertise, and readiness in responding to emergencies at the personal, family, and community levels. Community-based organizations are also the most relevant during disaster response and reflect public trust in collective efforts. Government institutions also contribute to social trust, especially when the service delivery mechanism is effective during crises (Aslam *et al.* 2021). Early warning systems and disaster management require trust, and this particular aspect creates a diversified role of public response through awareness programs, volunteer programs, and interactions with vulnerable groups. This view has been supported by Aslam *et al.* (2021) as well as Liu and Mehta (2021). Effective disaster risk reduction (DRR) relies on clear communication between authorities and communities, enabling better risk identification, response planning, and learning from past events (Liu and Mehta 2021).

Cultural and religious practices shape norms and interactions that influence emergency response strategies. The role of faith-based and cultural organizations in disaster management is a key measure of the effectiveness of local approaches (Aslam *et al*. 2021). Religious institutions serve as valuable partners in disaster awareness and relief, providing safe spaces for vulnerable populations and reinforcing the role of faith in disaster resilience. Engaging religious institutions in disaster planning ensures broader community involvement and strengthens adaptive capacity across different disaster phases (Aslam *et al.* 2021). A summary of the factors can be found in Table 1.

Table 1. Factors for sustainability and long-term emergency response infrastructure

Main Factors	**Sub Factors**	**Source**
Community Engagement and Capacity Building	Community Engagement	Al-Wathinani *et al.* (2023), Perera *et al.* (2020), Pelling (2012), and Tanesab (2020)
	Capacity Building of Communities	Al-Wathinani *et al.* (2023), Perera *et al.* (2020), Pelling (2012), Aslam *et al.* (2021), and Ajibade (2022)
Policy and Governance	Creating Policy Reforms	Gilmore and DuRant (2021), Abdul & Yu (2020), Al-Wathinani *et al.* (2023), Myeong *et al.* (2021), Perera *et al.* (2020, Anguelovski *et al.* (2014), Bello *et al.* (2021) and Kalogiannidis *et al.* (2022)
	Strategic Citizen Involvement	Wamsler *et al.* (2020)
Technological Integration	Provision of Technology	Merz *et al.* (2020), Myeong *et al.* (2021), and Gilmore and DuRant, (2021)
	Targeted Stakeholders' Collaboration	Wamsler *et al.* (2020), Nawang *et al.* (2024), Nepal *et al.* (2018).

Collaboration and Coordination	Alteration of Internal Cooperation Structures	Wamsler *et al.* (2020), Nepal *et al.* (2018)
Cultural and Social Integration	Enhancement of Social Practices	Aslam *et al.* (2021), Zhou *et al.* (2024), Deen (2015), Pelling (2012), Ajibade (2022), Bello *et al.* (2021), Kalogiannidis *et al.* (2022), Nepal *et al.* (2018), Liu and Mehta, (2021), Nawang *et al.* (2024).
	Enhancement of Cultural and Religious Norms	Aslam *et al.* (2021), Liu and Mehta, (2021).
Science and Knowledge Integration	Concealed Science Policy Integration	Wamsler *et al.* (2020)
Outsourcing and Local Initiative	Outsourcing of Neighborhood Disaster Management Teams	Wamsler *et al.* (2020)

2.3 Theories underpinning the study

Systems and Resilience theories underpin the study and are relevant for addressing the mitigation factors. The theory of systems, which emphasizes interconnectedness, feedback loops, and overall system behaviour, describes how infrastructure components interact and react to disturbances. It helps create resilient, adaptable infrastructure emergency response systems (Bonaretti and Piccoli 2018; Chen *et al.* 2017). Integrating AI, IoT, and GIS systems in real-time monitoring, emergency alert development, and drone use for aerial surveillance and disaster assessment is a result of system theory and its application. Resilience Theory: Resilient infrastructure anticipates, absorbs, and recovers from disruptions. It promotes redundancy, diversification, and adaptive strategies to reduce the impact of crises (Carlson *et al*. 2012; Son *et al.* 2020).

3 Methodology

This study examines the effectiveness of emergency response through a systematic literature review, using an organised methodology to identify mitigating factors (Ismagilova *et al.* 2022) and the selection and analysis of pertinent academic literature from a range of fields and geographical settings (Sharifi 2021). A systematic search was conducted for pertinent studies using electronic databases, including Scopus, Web of Science, and Google Scholar. Combinations of terms like "emergency response," "disaster management," "developing countries," "challenges," "barriers," and "mitigating factors" were among the keywords. Research on factors influencing emergency response, especially in Global South nations, was accepted regardless of the nature of the disaster or the specific emergency (McClymont *et al*. 2020).

The study's objectives were evaluated by screening the titles and abstracts of the retrieved articles. The study assessed full-text publications that met the criteria for investigating factors affecting emergency response in Global South nations (Sharifi 2021). The study analysed the selected 30 articles relevant to the study area out of 150 articles through a keyword search using a qualitative thematic approach to identify recurring themes and patterns in emergency response mitigation strategies. Additional consideration was given to articles in full that met the requirements for addressing problems with emergency response. Studies that did not explicitly address emergency infrastructure concerns were excluded. Research that only examined developed nations or was vague about elements important to emergency response was omitted and relevant studies were selected, identifying facilitators or barriers to efficient emergency response (Castañer and Oliveira 2020). The data was categorised into thematic areas such as governance, infrastructure, socioeconomic factors, cultural considerations, and the effectiveness of international aid (Sharifi 2021). Mitigating factors were examined to find recurring themes and patterns among the Global South's nations (Hajjaji *et al*. 2021). The results summarise the

mitigating factors found, how those factors affect emergency response plans, and recommendations for policy and practice.

4 Findings and Discussion

The findings highlight the importance of understanding the region's unique socio-economic and cultural contexts in enhancing resilience and preparedness in emergency management strategies. The study identifies seven primary categories of factors significantly impacting emergency response operations globally, emphasising the need for multifaceted approaches, as shown in Figure 1.

Accountability and ownership are key to emergency response at the level of local communities, which enhance preparedness of people (Al-Wathinani *et al.* 2023; Perera *et al.* 2020). In turn, this helps in developing better communication between the authorities and residents, while focusing on local needs (Anguelovski *et al.* 2014). Grassroots participation is also driving innovative responses in the Global South, where formal structures might be weak, according to Pelling (2012). The participatory approach empowers marginalised groups through having their voices heard (Tanesab 2020). Capacity building enhances skills and resources (Ajibade 2022). Training, workshops, and simulations equip communities for emergencies (Anguelovski *et al.* 2014). Investing in local capacity fosters self-sufficiency and rapid emergency response (Perera *et al.* 2020; Pelling 2012).

Developing a structured framework for emergency response requires strong policies (Bello *et al.* 2021; Kalogiannidis *et al.* 2022). Policy changes must consider the unique vulnerabilities of the Global South, including socioeconomic inequality and environmental issues (Gilmore and DuRant 2021; Al-Wathinani *et al.* 2023). Sustainable development principles, such as redistributing funds, improving infrastructure, and reducing disaster risk, should be prioritised in effective policies for long-term resilience (Myeong *et al.* 2021; Perera *et al.* 2020). Active citizen participation in emergency management planning ensures efficient plans, improves compliance and implementation, and increases local contexts in policy-making (Wamsler *et al.* 2020). Technologies like mobile tools and early warning systems improve emergency response efficiency. Drones aid disaster assessment, relief delivery, and rescues, utilizing sensors and IoT for real-time data (Merz *et al*. 2020; Myeong *et al.* 2021). However, infrastructure inequalities limit technology's benefits, requiring adaptability (Gilmore and DuRant 2021). According to Wang *et al*. (2025), AI, IoT, blockchain, and big data enhance risk perception and response in disaster management, particularly in China. Munawar *et al.* (2022) present an AI-driven flood warning system that will improve disaster response for aged care facilities.

A coordinated emergency response requires collaboration among public and private sectors, NGOs, and community organizations (Wamsler *et al.* 2020). Targeted efforts reduce duplication, enhance resource sharing, and improve response capacity (Nawang *et al.* 2024). Clearly defined roles facilitate efficient interventions (Nepal *et al.* 2018). Social networks foster resilience through resource sharing and emotional support (Aslam *et al.,* 2021; Zhou *et al.* 2024). Community-based initiatives strengthen preparedness and social cohesion. According to Kalogiannidis *et al.* (2022) and Liu & Mehta (2021) cultural and religious norms influence community perceptions and responses. Policymakers need scientific knowledge for informed decisions, but data access and skepticism pose challenges. Bridging science and policy improves emergency planning (Wamsler *et al*. 2020). Outsourcing disaster management enhances local response by leveraging external expertise while empowering communities. Utilising local resources fosters collective responsibility in disaster relief (Wamsler *et al*. 2020).

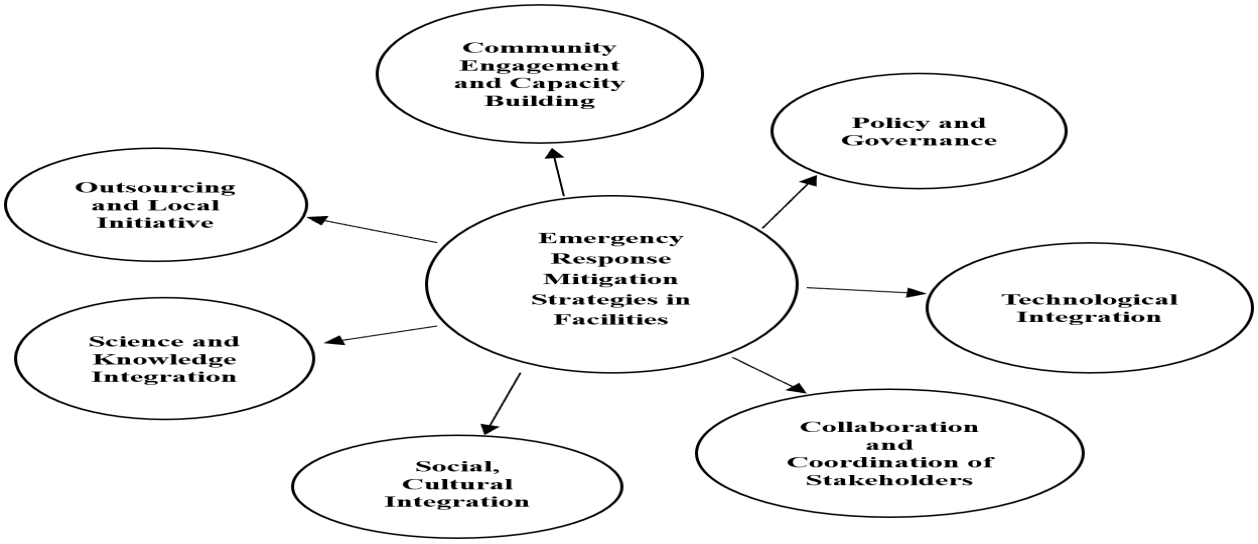

Figure 1: Conceptualised Emergency Response Mitigation Strategies in Facilities. Author's Construct (2025).

5 Conclusions and Further Research

The literature review on a broad scale covers the complexity of emergency response and the integrated strategies needed for building resilient communities on the globe. Key priorities include policy and governance, integration of technology, cooperation, cultural or societal considerations, scientific knowledge, outsourcing, and local initiatives. Ways to tackle the factors include concentrated policies, investments, and collaboration that can reduce disaster impacts protecting life, and infrastructure. A proactive and integrated methodology will enhance social resilience against very frequent and complex disasters. These factors fill the complex nature and disaster mitigation gap by holistically addressing more resilient communities capable of effectively navigating the challenges posed by disasters and emergencies and providing a roadmap for improving emergency response frameworks, ultimately contributing to enhanced safety and resilience in vulnerable regions.

Mitigation factors in emergency response infrastructure enhance disaster management knowledge, provide empirical evidence, and inform future policies. Facility managers, emergency planners, and policymakers should adopt emergency response mitigation strategies in facilities to enhance emergency response management and resilience in the built environment. The study recommends further research using quantitative and qualitative data to evaluate the study's mitigation factors for emergency response in facilities.

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