

Responding to Environmental Changes through Resilient Urban Design: Insights from Iraq

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Abstract

This article systematically explores the realm of Resilient Urban Design (RUD) as a proactive approach to addressing emerging environmental challenges.

The paper commences with a detailed background of the environmental challenges anticipated in the near future and accentuates the necessity of RUD. Through a comprehensive literature review, the theoretical framework and significance of RUD are discussed, along with an analysis of prominent strategies and practices hitherto employed. A meticulous analysis and evaluation of previous research reveals points of agreement and disagreement among various scholars, identifying the gaps in current knowledge, particularly concerning the implementation and evaluation of RUD strategies in diverse urban contexts. Observations on the effectiveness of RUD strategies are discussed, underlining the critical role they play in mitigating and adapting to environmental challenges.

The paper concludes by drawing key inferences from the literature and suggesting a roadmap for future research. Recommendations include advocating for empirical assessments, fostering interdisciplinary approaches, addressing policy implementation hurdles, and emphasizing community-centric research. It underscores the pivotal role of resilient urban design in orchestrating a sustainable, resilient, and livable urban future amidst escalating environmental adversities.

Keywords: Resilient, Environmental Changes, Urban Sustainability, Adaptive Urban Planning, Climate Change Adaptation.

Introduction

The rapidly transforming global landscape has ushered cities into a new epoch characterized by dynamic environmental changes. These changes, largely driven by anthropogenic activities, present an array of challenges including climate change, natural disasters, and resource depletion. The imperative to safeguard urban spaces against such unforeseeable adversities has never been more pronounced. Urban areas, with their dense populations and significant infrastructural setups, are particularly susceptible to the detrimental impacts of environmental changes, thereby necessitating a paradigm shift in urban design and planning.

Resilient Urban Design emerges as a pivotal approach in this context, offering a scaffold for urban areas to not only withstand but to adapt and thrive amidst these evolving challenges. It embodies a proactive rather than a reactive approach to urban planning by integrating adaptability and flexibility into the fabric of urban spaces. This encompasses a broad spectrum of strategies ranging from sustainable resource management to the incorporation of green spaces, and innovative infrastructure solutions. The objective is to foster urban areas that are not only sustainable but are capable of responding to and recovering from adversities, ensuring the long-term well-being and security of their inhabitants.

This paper aims to explore the corpus of knowledge surrounding Resilient Urban Design as a means to address future environmental challenges. The objectives are manifold:

- To elucidate the theoretical framework underpinning Resilient Urban Design, delineating its core principles and significance.
- To review and evaluate the prevailing strategies and practices within Resilient Urban Design, assessing their efficacy in addressing environmental challenges.
- To analyze and critique the existing body of literature, identifying gaps in knowledge and areas for further inquiry.
- To examine real-world case studies where Resilient Urban Design principles have been employed, analyzing the outcomes and drawing insights for future initiatives.

By undertaking a comprehensive review of the existing literature, this article endeavors to contribute to the broader discourse on urban resilience, providing a robust foundation for future research, policy formulation, and practical implementations in the realm of urban design and planning.

Research Methodology

The methodology for this research on Resilient Urban Design (RUD) involves a comprehensive literature survey and the analysis of case studies, including insights from the specific case study area of Iraq.

Literature Survey

- The literature survey encompasses an extensive review of existing academic and professional work in the field of Resilient Urban Design. This includes a deep dive into the theoretical framework of RUD, highlighting its concept, significance, and core principles.
- The research critically analyzes and evaluates prevailing strategies and practices within RUD, assessing their efficacy in addressing environmental challenges.
- Identified gaps in existing literature are scrutinized to pinpoint areas requiring further investigation, particularly in the implementation and evaluation of RUD strategies in diverse urban contexts.

1. RUD Case Studies:

- The research examines real-world case studies where RUD principles have been employed. These cases are chosen to represent a diverse application of resilience strategies to confront environmental challenges.
- Notable examples include cities like Rotterdam, Christchurch, Medellin, Singapore, New York City, Copenhagen, Tokyo, Melbourne, Bangkok, and Toronto. Each of these cities demonstrates unique approaches to RUD in response to specific environmental and urban challenges.
- These cases collectively illustrate the global endeavor towards resilient urbanism underpinned by core RUD principles like adaptability, redundancy, diversity, and community engagement.

2. The Case Study Area (Insights from Iraq):

- The specific case study area focused on in this research is Baghdad, Iraq. The selection of Baghdad is driven by its unique urban and environmental challenges, including legislative changes affecting land use, urban expansion, slum encroachment, and orchard uprooting.
- The research explores how the principles of RUD can be applied to Baghdad's context, addressing issues like urban sprawl, population growth, and weak urban planning laws.
- Specific strategies discussed for Baghdad include sustainable urban planning and heritage preservation, highlighting how these approaches can contribute to enhanced cultural resilience and sustainable development in the face of conflict aftermath and rapid urban changes.
- The case study of Baghdad serves as a concrete example of applying RUD in a challenging urban environment, offering insights into the adaptability and effectiveness of RUD strategies in the context of Iraq.

This research methodology combines a thorough literature survey with the analysis of global case studies and a focused examination of Baghdad, Iraq, to explore the application and effectiveness of Resilient Urban Design in urban environments facing environmental changes and challenges.

Literature review

1. Resilient Urban Design (RUD):

Concept and Significance: Resilient Urban Design is seen as a systemic and comprehensive response to the complex environmental challenges facing urban areas. The literature emphasizes the importance of integrating resilience principles into urban planning to understand urban systems and their inherent vulnerabilities, focusing on design strategies that adapt to ongoing changes (Ahern, 2011; Desouza & Flanery, 2013; Godschalk, 2003; Holling, 1973; Meerow et al., 2016; Vale, 2014).

2. Core Principles of Resilient Urban Design:

- Adaptability and Flexibility: Focusing on developing urban systems capable of evolving in response to changing conditions (Coaffee, 2013; Davoudi et al., 2012; Pickett et al., 2004).
- Redundancy and Diversity: Supporting diversity in urban infrastructure and providing alternative routes for essential services during disruptions (Ahern, 2011; Fouda & ElKhazendar, 2023).
- Participatory Design and Community Engagement: Enhancing community collaboration to create resilient solutions that reflect the needs and aspirations of local communities (Arnstein, 2019; Chelleri et al., 2015; Woods-Ballard et al., 2007).

3. Existing Strategies and Practices:

- Green and Blue Infrastructure: Managing stormwater and enhancing urban biodiversity (Foster et al., 2011; Meerow & Newell, 2017; Tzoulas et al., 2007).
- Adaptive Design: Developing urban systems that are adaptable to environmental changes (Ahern, 2011; Chelleri et al., 2015).
- Strength and Redundancy: Creating strong urban systems with alternative pathways or backup systems in case of failures (Fouda & ElKhazendar, 2023).
- Community Engagement: Integrating communities into urban planning and decision-making processes to enhance urban resilience (Arnstein, 2019).
- Disaster Risk Reduction (DRR): Integrating disaster risk reduction strategies into urban design (Godschalk, 2003).
- Policies and Regulatory Frameworks: Developing effective policies and frameworks to support resilient urban design (Coaffee, 2013).
- Technological Innovations: Using advanced technology for better monitoring, analysis, and management of urban systems in the face of environmental changes (Desouza & Flanery, 2013).

4. Critique and Identified Gaps:

- The need for stronger empirical evidence to assess the effectiveness of RUD strategies and methodologies.
- Challenges in equitably distributing the benefits of resilience and engaging marginalized communities in RUD processes (Cutter et al., 2008; Pickett et al., 2004; Shi et al., 2016).

5. Points of Agreement and Disagreement:

- There is a consensus on the necessity of a multidisciplinary approach in RUD to address environmental challenges.
- Differences in prioritizing and implementing strategies, such as the contrast between security-focused and ecosystem-centric views (Ahern, 2011; Coaffee, 2013; Tzoulas et al., 2007).

The research concludes that Resilient Urban Design is a fundamental paradigm in addressing the environmental challenges of urban areas, indicating the need for further research to deepen understanding and improve the application of RUD strategies.

Theoretical Framework of Resilient Urban Design

Concept and Significance of Resilient Urban Design

The concept of resilience has been progressively embraced within urban design discourse, reflecting a growing recognition of the complex challenges posed by environmental changes to urban areas (Meerow et al., 2016; Vale, 2014). Resilient Urban Design (RUD) emerges at the nexus of resilience theory and urban design practice, championing a systemic, integrative approach to planning and designing urban environments capable of absorbing shocks and stresses while maintaining functionality (Ahern, 2011; Desouza & Flanery, 2013).

The significance of Resilient Urban Design is underscored by its ability to address the multi-faceted nature of environmental challenges confronting urban areas. Foster (2011) posits that the integration of resilience principles within urban design fosters a holistic understanding of urban systems and their inherent vulnerabilities. Moreover, RUD encourages a proactive stance towards urban planning, advocating anticipatory design strategies that can adapt to changing circumstances over time (Godschalk, 2003; Holling, 1973).

Core Principles of Resilient Urban Design

The exigency for urban areas to withstand and adeptly respond to the ongoing and anticipated adversities of environmental alterations necessitates an enlightened approach to urban design. Resilient Urban Design (RUD) emerges as a paradigm fostering urban resilience through design principles that cater to the dynamic and multifaceted nature of urban ecosystems. This section delineates the cardinal principles underpinning Resilient Urban Design, illuminating how these principles contribute to fostering urban resilience against a backdrop of environmental, social, and economic vicissitudes. The discussion encapsulates three seminal principles: Adaptability and Flexibility, Redundancy and Diversity, and Participatory Design and Community Engagement, each elucidated with theoretical underpinnings and empirical exemplars from the extant literature.

1. **Adaptability and Flexibility:** Central to RUD is the notion of adaptability and flexibility, enabling urban systems to evolve in response to changing conditions (Coaffee, 2013; Davoudi et al., 2012). This encompasses design strategies that accommodate dynamic environmental, social, and economic contexts, ensuring the urban fabric remains viable amidst uncertainties (Pickett et al., 2004).
2. **Redundancy and Diversity:** RUD advocates for redundancy and diversity in urban systems to ensure continued functionality during adversities (Ahern, 2011). This includes a diversified urban infrastructure and the provision of alternative pathways for essential services during disruptions (Fouda & ElKhazendar, 2023).
3. **Participatory Design and Community Engagement:** Community engagement is identified as a cornerstone of RUD, facilitating the co-creation of resilient solutions

that reflect the nuanced needs and aspirations of local communities (Chelleri et al., 2015; Woods-Ballard et al., 2007). Participatory design processes foster a sense of ownership and empowerment among urban inhabitants, promoting long-term resilience (Arnstein, 2019).

Existing Strategies and Practices

A rich body of literature explores various strategies and practices embodying the principles of RUD. For instance, the incorporation of green and blue infrastructure to manage stormwater and enhance urban biodiversity is well-documented (Foster et al., 2011; Tzoulas et al., 2007). Similarly, the design of flexible urban spaces that can accommodate a range of functions and adapt to changing needs over time is gaining traction within RUD discourse (Roggema, 2016). Innovative urban planning frameworks such as “Living with Water” and “Sponge Cities” represent a shift towards embracing environmental challenges as opportunities for enhancing urban resilience (Ma et al., 2023; Meerow & Newell, 2017).

Critique and Identified Gaps

While Resilient Urban Design holds promise, critical examinations reveal gaps and challenges. For instance, Pickett et al. (2013) argue that the application of resilience theory within urban design remains in nascent stages, with a need for more robust methodologies to assess and enhance urban resilience. Additionally, the equitable distribution of resilience benefits and the engagement of marginalized communities within RUD processes are identified as areas warranting further investigation (Cutter et al., 2008; Shi et al., 2016).

In conclusion, Resilient Urban Design represents a vital paradigm in addressing the environmental challenges of urban areas. Through a critical examination of existing literature, this article elucidates the core principles, strategies, and critiques associated with RUD, setting the stage for further exploration and application in the quest for more resilient urban futures.

Strategies of Resilient Urban Design in Addressing Environmental Changes

The notion of resilient urban design emerges as a significant approach to cushion urban areas against the adverse impacts of environmental changes (Desouza & Flanery, 2013; Meerow et al., 2016). This section reviews the most prominent strategies and practices in resilient urban design employed to address the challenges posed by environmental changes.

- **Green Infrastructure:** Green Infrastructure (GI) has been acknowledged as a vital strategy in promoting urban resilience. It encompasses the integration of green spaces and water systems within urban planning to enhance stormwater management, reduce heat island effects, and foster biodiversity (Foster et al., 2011; Tzoulas et al., 2007). The multifunctional nature of GI offers a diversified strategy in promoting urban resilience against a range of environmental challenges (Meerow & Newell, 2017).
- **Adaptive Design:** Adaptive design strategies are hinged on the flexibility and ability to adjust to changing environmental conditions. The idea is to create urban systems that can evolve over time to respond to emergent environmental challenges (Ahern, 2011; Chelleri et al., 2015). This strategy emphasizes the importance of flexibility in urban design to ensure sustained resilience.
- **Robustness and Redundancy:** The principle of robustness focuses on creating strong, durable urban systems, while redundancy ensures alternative pathways or backup systems in case of failures (Fouda & ElKhazendar, 2023). Both strategies aim at enhancing the capability of urban systems to withstand and recover from various environmental adversities.
- **Community Engagement:** Engaging communities in urban planning and decision-making processes is a key strategy in fostering urban resilience. Community engagement harnesses local knowledge and fosters collective responsibility in addressing environmental challenges (Arnstein, 2019; Shi et al., 2016). Moreover, it promotes social cohesion and resilience in the face of environmental uncertainties.

- **Disaster Risk Reduction (DRR):** Incorporating disaster risk reduction strategies within urban design is fundamental in anticipating, preparing for, and recovering from disasters. This includes the development and enforcement of building codes, land-use planning, and other regulatory measures that mitigate disaster risks (Godschalk, 2003).
- **Policy and Regulatory Frameworks:** Effective policies and regulatory frameworks are crucial in guiding and promoting resilient urban design. They provide the necessary guidelines, standards, and incentives required to integrate resilience into urban planning and development (Coaffee, 2013).
- **Technological Innovations:** The role of technological innovations in promoting resilient urban design cannot be overstated. Innovative technologies provide tools for better monitoring, analysis, and management of urban systems in the face of environmental changes (Desouza & Flanery, 2013).

The reviewed strategies underline the multidimensional and interdisciplinary nature of resilient urban design. A holistic approach, integrating various strategies, is imperative in addressing the complex and interconnected challenges posed by future environmental changes.

Analysis and Evaluation of Previous Research

The exploration of the concept of resilient urban design has brought forth a range of perspectives and methodologies by various researchers. There's a general agreement among scholars such as Ahern (2011), Chelleri et al. (2015), and Meerow et al. (2016) on the indispensable role of resilient urban design in mitigating and adapting to environmental changes. They underline the importance of multifunctional green infrastructure, community engagement, and integrated planning to achieve urban resilience.

Points of Agreement and Disagreement

The consensus is evident on the necessity of a multidisciplinary approach to resilient urban design that encompasses ecological, social, and economic dimensions. Desouza & Flanery (2013), Foster et al. (2011), and Meerow & Newell (2017) highlight the importance of integrating green infrastructure and nature-based solutions in urban planning to counter environmental challenges. However, the extent to which these strategies should be prioritized and implemented has bred some disagreements. For instance, Coaffee (2013) argues for a more security-centered approach to resilience, emphasizing preparedness and response to crises, which contrasts with the ecosystem-centric view of Ahern (2011) and Tzoulas et al. (2007).

Moreover, the role of community participation in resilient urban design has been underscored by many, but the level and form of engagement are debated. Arnstein's (2019) classic ladder of citizen participation is often referenced, yet the practicality and effectiveness of high levels of public involvement are questioned by some researchers, echoing concerns regarding the capacity and willingness of communities to engage in resilience-building actions.

Shortcomings and Knowledge Gaps

Current research portrays a robust theoretical foundation of resilient urban design, but there's a palpable need for more empirical evidence to validate the proposed strategies and methodologies. The spatial-temporal dynamics of urban resilience are not well-understood, and a clear framework for measuring resilience is lacking, as pointed out by Chelleri et al. (2015) and Godschalk (2003).

Moreover, there's a notable gap in research regarding the cost-effectiveness and long-term sustainability of various resilient urban design strategies. The socioeconomic implications and equity considerations of these strategies are often underexplored, leaving a crucial area of research unattended.

Lastly, the translational gap between academic research and practical implementation is significant. Bridging this gap, as suggested by Shi et al. (2016), by fostering a better understanding and collaboration between academia, policy-makers, and practitioners, is

essential for advancing resilient urban design that effectively addresses future environmental changes and challenges, Table 1.

Table 1: Shortcomings and knowledge gaps

Source: Author

Knowledge Gap Area	Gap Description	Impact on Research and Application	Proposed Future Research
Empirical Evidence	Lack of studies empirically evaluating resilient urban design strategies.	Hinders deep understanding of the effectiveness and cost of resilient urban design strategies.	Conduct empirical studies to evaluate resilient urban design strategies in diverse contexts.
Spatial and Temporal Dynamics	Insufficient understanding of resilience dynamics at the urban level over time.	Hinders effective application and long-term sustainability of resilient urban design solutions.	Explore spatial and temporal dynamics of urban resilience and the impact of resilient urban design strategies.
Cost-Effectiveness Assessment	Lack of analyses evaluating the cost-effectiveness of resilient urban design strategies.	Hinders efficient resource allocation and identification of cost-effective strategies.	Conduct cost-effectiveness analyses for different resilient urban design strategies.
Achieving Equity and Inclusivity	Lack of research discussing challenges and opportunities related to achieving social equity and inclusivity in resilient urban design.	May lead to perpetuating social and economic disparities and inequity.	Explore mechanisms for integrating equity and inclusivity in resilient urban design strategies.

RUD Case Studies

In reviewing the application of Resilient Urban Design (RUD) principles across various urban settings, several exemplary cases emerge, demonstrating a diverse application of resilience strategies to confront environmental challenges, Table 2.

- 1- Rotterdam, Netherlands: Renowned for its innovative water management strategies, Rotterdam's urban design embodies adaptability. The city's floating pavilions and water plazas are prime examples of design solutions responding to rising sea levels (Rijke et al., 2012).
- 2- Christchurch, New Zealand: Post-earthquake reconstruction efforts encapsulated the essence of redundancy and diversity, through the incorporation of flexible public spaces and diversified transportation networks (Vallance & Carlton, 2015).
- 3- Medellin, Colombia: By fostering community engagement, the city transformed its urban fabric, reducing crime and enhancing livability through participatory design processes in upgrading informal settlements (Brown-Luthango, 2013).
- 4- Singapore: With its meticulous planning, Singapore's water management, and green building initiatives epitomize a harmonized approach towards urban resilience, addressing both current and future environmental challenges (Neo, 2016).
- 5- New York City, USA: Post Hurricane Sandy, the city adopted a comprehensive resilience framework, developing coastal protections and redesigning public spaces to accommodate floodwaters (Rosenzweig & Solecki, 2014).

- 6- Copenhagen, Denmark: Cloudburst Management Plan exemplifies a holistic approach to climate adaptation, integrating green infrastructure to manage stormwater and enhance urban biodiversity (City of Copenhagen, 2011).
- 7- Tokyo, Japan: Earthquake-resilient urban design is a focal point, with stringent building codes and innovative engineering solutions like base isolation and energy-absorbing structures (Ikeda et al., 2019).
- 8- Melbourne, Australia: Resilience planning here incorporates heat management strategies within urban design to mitigate urban heat island effects and enhance public health (Norton et al., 2015).
- 9- Bangkok, Thailand: Facing frequent flooding, the city is exploring resilient urban design strategies such as elevated buildings and permeable surface installations to enhance flood resilience (Schipper & Pelling, 2006).
- 10- Toronto, Canada: Engaging in long-term urban resilience planning, the city's focus on green infrastructure and stormwater management portrays a commitment to confronting climate-related challenges (Toronto Environment Office, 2008).

Table 1: RUD case study

Source: Author

City	Strategy Employed	Impact Achieved	Future Research Directions
Rotterdam, Netherlands	Advanced water management and green spaces	Enhanced city resilience against flooding and improved urban life quality	Opportunities for further research on long-term maintenance and community engagement
New York, USA	Redesign of public spaces and improved green infrastructure	Reduced environmental stress and improved resource efficiency	Knowledge gap in quantifying the cumulative benefits over time
Copenhagen, Denmark	Improved transportation systems and sustainable urban planning	Reduced carbon emissions and improved pedestrian experience	Need for studies on integration with existing urban fabric
Singapore	Water-sensitive urban design and improved green infrastructure	Improved water sustainability and mitigation of climate change impacts	Opportunities for research on biodiversity enhancement
Mexico City, Mexico	Building reuse programs and renovation	Reduced waste and improved energy efficiency	Understanding barriers to broader adoption needed
Melbourne, Australia	Green infrastructure and improved transport systems	Improved air quality and reduced congestion	Need for holistic assessment of environmental and social benefits
Freetown, Sierra Leone	Community-centric urban planning	Improved urban services and empowered local communities	Research on long-term community engagement and sustainability needed
Karachi, Pakistan	Improved sanitation systems and waste management	Improved public health and reduced pollution	Understanding socio-economic challenges for implementation

London, UK	Improved transport and energy infrastructure	Reduced carbon emissions and improved urban mobility	Knowledge gap in assessing long-term resilience and adaptability
Bogota, Colombia	Efficient public transportation systems and green spaces	Improved air quality and sustainable transport options	Need for research on integration and acceptance in different socio-economic contexts

These cases collectively illustrate a global endeavor towards resilient urbanism, underpinned by the core principles of adaptability, redundancy, diversity, and community engagement. The geographical and contextual diversity across these examples emphasizes the flexibility and applicability of RUD principles in addressing environmental challenges within distinct urban scenarios.

The aforementioned examples also shed light on the collaborative essence of RUD, involving multiple stakeholders – government bodies, communities, and private sector entities. The evaluation of these practical cases aligns with the earlier discussions in this article, affirming the pertinence of Resilient Urban Design in navigating environmental uncertainties. The broad spectrum of strategies embodied across these cities echoes the rich discourse reviewed earlier, illuminating the path towards more resilient urban futures.

The Case Study Area

The study area comprises the spatial boundaries of Baghdad, the capital city of the Republic of Iraq, and the central administrative province of Baghdad, including Akbar City, covering an area of 4.6 square kilometers. Baghdad, ranking as the second-largest city in the Arab world after Cairo and in western Asia after Tehran, serves as the central hub for economic, administrative, and educational activities in the country (Santos-Reyes, 2010). The selection of the study area was driven by several factors:

- **Legislative Changes:** The passage of successive laws distributing agricultural lands, transforming them into residential or other uses, and granting building permits without considering the basic design or nature of land use.
- **Urban Expansion:** The significant expansion of the urban area of Baghdad at the expense of surrounding agricultural land.
- **Slum Encroachment:** The encroachment of slums into Baghdad and irregular expansion onto nearby agricultural lands, driven by factors such as increasing immigration due to general security conditions in Iraq, economic challenges, and employment searches.
- **Orchard Uprooting:** The widespread uprooting of thousands of orchards in Baghdad, containing numerous palm and citrus trees, posing a serious threat to the environmental landscape and contributing to the desertification of the surrounding environment (Santos-Reyes, 2010).

Urban Sprawl Toward Agricultural Lands Within Baghdad is Influenced by Several Factors:

- **Population Growth:** The dramatic increase in the population of Baghdad in recent decades, reaching 7,055,000 people in 2021 (Ministry of Housing, 2021), has resulted in severe overcrowding, especially in the city center. This rapid growth generates increased demand for land, leading to rising land values and encouraging encroachment on agricultural lands due to their lower cost compared to residential lands.
- **Weak Laws and Regulations:** Various laws have impacted the urban planning of Baghdad, facilitating the city's expansion at the expense of agricultural lands. Resolution No. 117 of 2000 allows for the conversion of agricultural lands to non-

agricultural uses, especially for the military and police. Decisions by the Supreme Committee for Basic Design have also contributed to changes in land use, particularly for housing needs (Malalgoda et al., 2013).

- **Poor Urban Planning:** The spatial distribution of land uses, characterized by horizontal orientations favoring urban sprawl over agricultural lands, has resulted in urban sprawl issues in Iraqi cities, including Baghdad. The city's large size, expansion in different directions, and non-compliance with basic designs and structural plans have created an imbalance between the city and its services (Alkinani et al., 2022).

Resilient Urban Design to the Impact on Baghdad:

The concept of Resilient Urban Design (RUD) holds significant relevance in understanding and addressing the challenges faced by Baghdad. The factors influencing urban sprawl in the city, as discussed earlier, underscore the critical need for adopting resilient strategies.

- **Adaptability and Flexibility:** RUD emphasizes adaptability and flexibility, allowing urban systems to evolve in response to changing conditions. In Baghdad's case, where legislative changes, population growth, and weak laws contribute to urban sprawl, resilient strategies must be adaptable to evolving circumstances. Design approaches that accommodate dynamic changes in land use and urban expansion align with the core principles of RUD (Alkinani et al., 2022).
- **Redundancy and Diversity:** RUD advocates for redundancy and diversity in urban systems. In the context of Baghdad, where slum encroachment and orchard uprooting pose threats to environmental stability, adopting diversified urban infrastructure and alternative pathways for essential services becomes crucial. This aligns with RUD principles of ensuring continued functionality during adversities (Alkinani et al., 2022).
- **Participatory Design and Community Engagement:** Community engagement, a cornerstone of RUD, can play a pivotal role in Baghdad's case. The city's challenges, including population growth and poor urban planning, necessitate the co-creation of resilient solutions with local communities. Participatory design processes, as advocated by RUD, foster a sense of ownership and empowerment among urban inhabitants (Alkinani et al., 2022).

In summary, adopting Resilient Urban Design principles in Baghdad's urban planning can help mitigate the adverse impacts of urban sprawl. The adaptability, diversity, and community engagement aspects of RUD can contribute to developing sustainable and resilient solutions tailored to the specific challenges faced by the city.

Table 3: RUD Insights from Iraq (Baghdad)

Source: Author

City	Strategy Employed	Impact Achieved	Future Research Directions
Baghdad, Iraq	Sustainable urban planning and heritage preservation	Enhanced cultural resilience and sustainable development	Challenges related to conflict aftermath and displaced populations. Research needed on post-conflict resilient urban reconstruction and social cohesion.
	Adoption of Resilient Urban Design (RUD)	Enhanced resilience to rapid population growth and unplanned urban sprawl	Investigate the effectiveness of RUD in mitigating environmental challenges specific to Baghdad. Explore community perceptions and involvement in RUD implementation. Assess the long-term adaptability and sustainability of RUD strategies in the local context.

Discussion

This article delves profoundly into the existing literature concerning Resilient Urban Design (RUD) with a focal point on addressing forthcoming environmental challenges and changes. It scrutinizes the theoretical underpinning of RUD and examines a myriad of strategies lauded for their potential in combating environmental adversities. Moreover, an analytical endeavor identifies prevailing knowledge gaps, casting a spotlight on areas requiring further academic and practical attention.

A salient insight derived from the literature survey is the critical role RUD plays in urban regions aspiring for adaptability and longevity amidst escalating environmental uncertainties. Core principles of RUD, including adaptability, sustainability, and inclusivity, manifest as crucial threads in the urban resilience fabric. Additionally, the review accentuates a variety of strategies such as green infrastructure, adaptive reuse of buildings, and urban morphology optimization as promising avenues to ensure urban vicinities remain tenable and vibrant against environmental exigencies.

The discussion is enriched by exemplary case studies from diverse cities like Rotterdam, New York City, Copenhagen, and others, demonstrating the practical application and effectiveness of RUD strategies in countering environmental challenges. For instance, Rotterdam and Singapore's innovative water management strategies exemplify resilience against floods and rising sea levels, while Christchurch and New York City's redesigning of public spaces and transportation networks showcase enhanced resilience post-natural disasters. These cases underscore the diverse methodologies in which RUD principles have been operationalized to address environmental challenges across different urban landscapes.

Observations on the effectiveness of these strategies reveal a broad scholarly consensus regarding their potential in alleviating adverse environmental impacts. For instance, green infrastructure is praised for its dual function in augmenting urban biodiversity and managing stormwater runoff. Similarly, adaptive reuse of buildings embodies a sustainable approach towards urban development by minimizing resource consumption and waste generation. Nonetheless, the disparities in geographical, social, and economic contexts across varied urban settings call for a nuanced understanding and application of these strategies, ensuring alignment with local circumstances and capacities.

On a contrasting note, the analysis pinpoints several domains where current research falls short. Among them, the deficiency of empirical evidence assessing the efficacy and cost-effectiveness of RUD strategies is a notable gap. This lacuna impedes the capability to form definitive conclusions regarding the most effective and efficient strategies for nurturing urban resilience. Similarly, the minimal attention towards the spatial and temporal dynamics of resilience at the urban level, along with challenges tied to achieving equity and inclusivity, unfolds a rich avenue for future research endeavors.

The discourse accentuates the significance of Resilient Urban Design as a mechanism for both responding to and anticipating environmental challenges on the horizon. It propels the discussion forward, underlining the need for an expanded research scope to deepen the understanding and refine the application of RUD strategies. By bridging the identified knowledge gaps, the academic and practitioner communities can architect a more robust, nuanced, and holistic approach to urban resilience, better equipped to traverse the uncertain environmental future.

The analytical insights emanating from this review aim to stimulate further research, foster informed policy dialogues, and guide practical interventions in the realm of Resilient Urban Design, thus contributing towards a more resilient urban fabric poised to weather the environmental vicissitudes of the future.

Conclusions and Recommendations

Conclusions

The comprehensive literature survey conducted herein reveals the cardinal significance of Resilient Urban Design (RUD) in grappling with the escalating environmental challenges. This study has unfolded several key findings through the survey.

- 1- **Integral Framework:** Resilient Urban Design stands as a seminal framework empowering city to endure, adapt to, and recuperate from diverse environmental adversities. The practical embodiments of RUD strategies as demonstrated through various case studies such as Rotterdam's water management system and New York City's redesigning of public spaces provide compelling evidence of its indispensable role in urban sustainability and resilience.
- 2- **Multifaceted Strategies:** The explored literature delineates a myriad of strategies, encompassing both traditional and avant-garde approaches, pivotal for bolstering urban resilience. These span across green infrastructure, sustainable mobility, mixed-use development, and community engagement, among others, with each holding promise in addressing environmental exigencies as illustrated through the diverse case studies discussed.
- 3- **Knowledge Gaps:** Despite a robust body of research, discernible knowledge gaps and inconsistencies remain, especially concerning the implementation and evaluation of RUD strategies in varied urban contexts. The disparities in the effectiveness of these strategies across different geographical, social, and economic settings necessitate a more nuanced examination.

Recommendations

In the light of the findings and the discerned gaps in the extant body of knowledge, several forward-looking recommendations for future research in the domain of Resilient Urban Design are posited:

- 1- **Empirical Assessments:** Prospective research endeavors should embark on rigorous empirical assessments to appraise the efficacy and applicability of various RUD strategies across disparate urban settings. The empirical grounding will provide a better understanding of how these strategies perform in different contexts, an insight enriched by the exemplary case studies discussed herein.
- 2- **Interdisciplinary Approaches:** Fostering interdisciplinary research, intertwining insights from urban planning, environmental science, social science, and other germane fields, can significantly bolster the comprehension and solution ideation in RUD.
- 3- **Policy Implementation:** Research directed towards elucidating the challenges and opportunities of policy implementation regarding RUD is pivotal to ensuring the successful transmutation of theoretical frameworks into pragmatic urban resilience strategies.
- 4- **Community-Centric Research:** Delving into community perception, involvement, and the social ramifications of RUD will yield a more holistic understanding, a requisite for crafting inclusive and effective urban resilience strategies.
- 5- **Exemplary Case Studies:** Integrating and analyzing exemplary case studies in future research can unveil practical insights and foster a deeper understanding of how RUD principles are operationalized across diverse urban landscapes.

These recommendations aspire to engender a progressive trajectory of research, which is quintessential for unlocking the potential of Resilient Urban Design in heralding sustainable, resilient, and livable urban futures amidst proliferating environmental challenges. By bridging the identified knowledge gaps, there is a potent opportunity to further refine and optimize RUD strategies, fostering a more resilient urban fabric capable of navigating the environmental vicissitudes of the future.

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