Examining Biomimicry-Based Sustainable Urban Design Solutions from an Islamic Tradition Perspective

Hailane Salam[1]*, Tengku Anis Qariah[1], Mohammad Syathir Amini Shahbudin[2],
Liyana Mahfuzah Mohd For[1]

[1]School of Architecture and Interior Architecture, College of Built Environment, Universiti, Teknologi MARA, 42300 Puncak Alam Campus, Selangor, Malaysia
[2]Department of Built Environment Studies and Technology, College of Built Environment Universiti Teknologi MARA, 32610 Seri Iskandar, Perak, Malaysia.

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ABSTRACT

The study begins by examining the intersection of architecture, urban design, sustainable design, biomimicry, and Islamic tradition to understand the current landscape of sustainable urban design solutions. Identifying a critical issue related to the lack of integration between Islamic traditions and biomimicry in urban design poses significant challenges to stakeholders aiming for culturally and ecologically responsive solutions. This research departs from traditional approaches by embracing a phenomenology methodology, addressing the existing research gap concerning the alignment of sustainable design practices with Islamic values and principles. The methodology involves thematic analysis of data collected through document analysis, focusing on Malaysian architectural practices that integrate biomimicry and Islamic influences. The study is designed to systematically investigate and develop a framework that offers a more effective and innovative way to blend cultural and environmental elements in urban design, enhancing the practical application of sustainability principles within the Malaysian context. This research is expected to contribute to the understanding of sustainable urban design by providing new insights, practical frameworks, and recommendations, thereby enhancing understanding and improving practices in Malaysia.

[1]* Corresponding author. *E-mail address*: hailane@uitm.edu.my

INTRODUCTION

The intersection of Islamic principles and sustainable urban design provides a profound opportunity to craft holistic frameworks that harmonise ecological responsibility with spiritual and cultural imperatives. Syed Muhammad Naquib al-Attas emphasises the role of knowledge and *adab* (proper conduct) in shaping environments that reflect divine harmony (Musa, 2021). Al-Attas (2023) asserts that the Islamic worldview sees nature as a trust (*amanah*) to be cared for, a principle that aligns seamlessly with the goals of sustainable urban design. His concept of Islamisation of knowledge underscores the need for urban development that integrates both spiritual and material dimensions, offering a comprehensive vision for addressing contemporary challenges.

Building on these philosophical foundations, scholars such as Kamal (2023) have articulated how Islamic principles of stewardship (*khalifah*), balance (*mizan*), and justice (*adl*) inherently promote environmental harmony and social equity. These principles resonate with contemporary approaches to sustainability, such as biomimicry, which Zaleckis (2024) identifies as a methodology that aligns with Islamic values by emulating nature's strategies. However, despite this conceptual alignment, the practical integration of these ideas into modern urban design frameworks remains underexplored, particularly in rapidly urbanising contexts like Malaysia.

Traditional Islamic architecture offers valuable precedents, as Attia (2022) notes, with its emphasis on passive cooling, water conservation, and community-oriented layouts. Yet, Abdul Latip et al. (2020) identify significant challenges in reconciling these traditional practices with the demands of modern urbanisation and Western influences. The need for adaptive frameworks that bridge historical insights and contemporary design strategies is evident. Furthermore, concepts such as Waqf, proposed by Ali and Kassim (2020) as a mechanism for managing urban green spaces, demonstrate the potential for innovative applications of Islamic traditions in sustainable urban planning.

Despite these promising foundations, there is a clear gap in empirical studies and case analyses documenting successful integrations of Islamic principles into modern sustainable urban design. Kamal (2023) critiques the overemphasis on theoretical discussions, calling for practical frameworks that address the realities of urban development. Bafarasat (2023) highlights the importance of community engagement and participatory planning processes, stressing that sustainable urban design must be inclusive and responsive to local needs.

A unified conclusion emerges integrating Islamic principles, biomimicry, and traditional architectural practices with contemporary design methodologies offers a promising path forward. This paper proposes a qualitative framework that synthesises these elements, addressing environmental, social, and cultural challenges in Malaysia's urban landscapes. Grounded in the philosophies of al-Attas, this approach seeks to operationalise Islamic traditions within sustainable urban design, offering a model that is both ecologically responsible and spiritually resonant. By bridging conceptual and practical gaps, this **framework** aspires to contribute significantly to the broader discourse on sustainable urban planning.

Gap in Research

Current research at the intersection of biomimicry-based sustainable urban design and Islamic tradition indicates a promising theoretical foundation yet reveals significant gaps in practical application. While Islamic principles are acknowledged for their alignment with environmental stewardship, existing studies have not fully addressed how these can be effectively harmonised with contemporary urban needs in rapidly developing areas like Malaysia. The integration of biomimicry principles within an Islamic

framework remains underexplored, particularly in terms of creating a cohesive, practical model for urban design that both respects traditional values and meets modern sustainability requirements.

There is also a scarcity of research on adapting historical Islamic architectural practices, such as the use of Waqf, to fit present-day urban challenges like population pressure and sustainable living demands. This highlights an unmet need for a qualitative framework that can guide urban planners in implementing these integrated strategies. Developing such a framework is crucial to bridging the gap between tradition and modernity, enabling practical applications that are culturally relevant and environmentally sound within the Malaysian context.

The Aims and Objectives

This research aims to address these identified gaps by providing methodologies for merging these diverse perspectives into a workable urban design model. Current research has established the potential intersection of Islamic principles, sustainable urban design, and biomimicry as promising avenues for creating environmentally responsible and culturally resonant urban environments. However, significant gaps remain in translating these theoretical insights into practical, applicable frameworks, particularly within the context of rapidly urbanising Malaysia. While there is recognition of the sustainability potential inherent in Islamic traditions and the principles of biomimicry, existing literature lacks detailed strategies for effectively merging these concepts with contemporary urban design. This is crucial as rapid urbanisation and Western influences further complicate the seamless integration of these elements in modern architectural practices.

Moreover, the adaptation of historical Islamic architectural principles, such as Waqf, into present-day urban planning presents challenges that are underexplored in current research. Addressing these gaps could provide architects, urban planners, and policymakers with innovative approaches that align with both cultural and sustainability goals, yet explicit frameworks to guide such initiatives are underdeveloped. This research aims to fill these gaps by devising a qualitative framework that harmonises Islamic values, biomimicry, and modern urban design, facilitating a culturally appropriate and ecologically sustainable urban development model tailored for Malaysia.

Point of Departure

This research embarks on the integration of biomimicry-based sustainable urban design with insights from Islamic traditions, addressing the pressing challenges of urban expansion and environmental degradation in Malaysia. The rapid urbanisation and evolving environmental issues in Malaysian cities highlight the need for innovative and culturally grounded approaches to sustainable development. This study proposes to merge contemporary environmental design principles with the cultural and spiritual dimensions of Islamic architecture, creating a practical framework for urban planning.

The core inquiry centres on how biomimicry and Islamic traditions can be effectively harmonised to guide sustainable urban development. This integration aims to balance ecological sustainability with cultural relevance, addressing both the material and spiritual dimensions of urban spaces. The study's primary goal is to develop and validate a framework that incorporates these principles, ensuring alignment with Malaysia's unique socio-cultural and environmental context.

Research Question

How can a practical framework be developed to guide sustainable urban planning in Malaysia by integrating biomimicry-based design principles with insights from Islamic traditions?

Supporting Research Questions:

1. What are the patterns and trends in the integration of biomimicry-based sustainable urban design inspired by Islamic tradition in Malaysia?

2. How do principles of biomimicry integrated with Islamic traditions inform the development of sustainable urban design solutions in Malaysia?

3. How can a framework be developed and validated to incorporate biomimicry-based sustainable urban design solutions in Malaysia, reflecting the principles and values of Islamic tradition through insights gathered from stakeholders?

Research Objectives

Building upon the research questions outlined above, this study seeks to address critical gaps in sustainable urban design by integrating biomimicry principles with Islamic traditions, particularly within the Malaysian context. To achieve this, the research is guided by the following objectives:

1. To identify patterns and trends in the integration of biomimicry-based sustainable urban design inspired by Islamic traditions in Malaysia, critically examining how these elements intersect and the extent to which they are applied in current practices.

2. To explore the potential of biomimicry principles integrated with Islamic traditions to inform sustainable urban design solutions in Malaysia, analysing their theoretical compatibility and practical viability in addressing contemporary urban challenges.

3. To validate a comprehensive framework that incorporates biomimicry-based sustainable urban design solutions in Malaysia, ensuring alignment with Islamic principles and values through rigorous stakeholder insights and empirical evidence.

These objectives aim not only to fill existing gaps in the literature but also to challenge and redefine contemporary paradigms in sustainable urban design. By bridging theoretical insights and practical applications, this research aspires to contribute a transformative framework that harmonises ecological, cultural, and spiritual dimensions. The subsequent exploration in the next chapter will critically examine key concepts, frameworks, and historical precedents, analysing their relevance and application to support the development of the proposed framework.

LITERATURE REVIEW

This chapter critically examines the existing body of literature surrounding the integration of biomimicry in sustainable urban design, with a particular focus on its potential synergy with Islamic architectural principles. Biomimicry is increasingly recognised as a transformative approach that can significantly enhance the sustainability of architectural and urban design (AlAli et al., 2023; Los Rosario et al., 2023). By emulating nature's time-tested strategies, this method proposes designs that are not only

environmentally responsive but also energy-efficient. According to AlAli et al. (2023), such designs could potentially offer a vast array of environmental and psychological benefits, including increased occupant comfort and reduced energy consumption in various climate conditions, such as those found in Malaysia. However, Los Rosario et al. (2023) highlight that despite its promising potential, the practical implementation of biomimicry in urban settings remains underexplored, particularly regarding how traditional Islamic principles might integrate with nature-inspired strategies.

Similarly, both Buck (2016) and Jamei & Vrcelj (2021) argue for the integration of biomimetic approaches in urban design, emphasising the dual benefits of aesthetic enhancement and reduced ecological impacts. Buck (2016) underscores the significance of nature-inspired design in reducing urban heat islands and enhancing biodiversity, a critical consideration for rapidly urbanising regions like Malaysia. Meanwhile, Jamei & Vrcelj (2021) focus on the psychological benefits, such as improved mental health outcomes associated with nature-connected design elements. Nevertheless, both works indicate a gap in the comprehensive methodological framework required to standardise biomimicry applications in diverse cultural contexts, including regions with unique architectural heritages such as those influenced by Islamic tradition.

Ilieva et al. (2022) and Butt (2022) further criticise the current literature for its lack of empirical studies that quantify the long-term benefits of biomimicry in architectural practices. Ilieva et al. (2022) point out the necessity of evidence-based research to validate claims regarding energy efficiency and occupant well-being improvements. Concurrently, Butt (2022) suggests that the exploration of biomimetic solutions in Malaysian urban design could lead to novel frameworks that incorporate cultural and environmental elements unique to the region. Despite these suggestions, the challenge remains in systematically integrating qualitative findings into a framework that can be applied cross-culturally and within various architectural traditions, including Islamic designs prevalent in Malaysia.

Contrastingly, both AlAli et al. (2023) and Butt (2022) recognise the psychological benefits associated with biomimetic environments that align with traditional Islamic architectural principles, such as harmony with nature and sustainable use of resources. They suggest these synergies could enhance the design of future urban landscapes, particularly in Islamic countries. However, the lack of a coherent framework that effectively merges these traditions with modern biomimicry principles highlights a significant gap in the literature, calling for research that bridges these diverse but complementary approaches to sustainable design.

In reviews of current literature, AlAli et al. (2023) and Ilieva et al. (2022) illustrate a consensus on the immediate environmental benefits provided by biomimicry, such as energy efficiency and enhanced ecological aesthetics. Despite such recognition, the precise mechanisms by which these benefits can be implemented at scale remain insufficiently detailed. As a result, there is a pronounced need for a structured approach that develops a framework suitable for varying climatic, cultural, and architectural variables, a need particularly poignant in Malaysia, where integrating Islamic architectural values with sustainable practices is both a challenge and an opportunity.

In conclusion, while the principles and benefits of biomimicry in creating sustainable and culturally respectful urban environments are well-acknowledged by researchers like AlAli et al. (2023), Ilieva et al. (2022), and Buck (2016), the integration of these principles with regional architectural styles, especially within Islamic frameworks in places like Malaysia, remains underdeveloped. There is a clear academic gap in forming a qualitative framework that not only advances the sustainability agenda but also respects cultural heritage and architectural traditions. This highlights a direction for future research to develop comprehensive methodologies that embrace both modern scientific advancements in biomimicry and the timeless principles of traditional architecture.

Biomimicry Applications in Architecture and Urban Design

The exploration of biomimicry applications in the architecture and urban design literature reveals a broad range of potential innovations. Los Rosario et al. (2023) emphasise building facades as a critical area of exploration. Similarly, Webb (2021) and Lopez et al. (2017) highlight the focus on building facades, indicating a consistency in the field's interest in applying natural principles to enhance aesthetic and functional aspects of the built environment. However, there remains a need for a comprehensive framework that consolidates these studies into a coherent approach applicable to architectural design, particularly within diverse cultural contexts like Malaysia.

Jamei and Vrcelj (2021) shift the focus towards structural engineering, demonstrating that biomimicry's influence extends beyond facades and into the core components of buildings. This perspective is somewhat aligned with Buck (2016), who examines urban infrastructure planning as another facet of biomimorphic application. Despite these explorations, there is limited discussion on integrating these aspects into a cohesive urban design framework particularly attuned to the subtropical climates of regions such as Malaysia.

Moreover, Butt (2022) addresses the utilisation of biomimicry for passive cooling techniques, suggesting that natural systems can inspire more energy-efficient solutions conducive to sustainable urban environments. Given Malaysia's climate, this presents a significant opportunity. Nevertheless, the literature lacks structured methodologies for consistently translating these bio-inspired cooling techniques into pragmatic architectural applications within the context of Malaysian environmental conditions.

The comparative studies of biomimicry applications, as discussed by Lopez et al. (2017) and Los Rosario et al. (2023), also highlight facades while indicating a gap in understanding how these might coalesce with other features like structural and cooling innovations. Despite this, there is minimal integration of cultural considerations, such as Islamic architectural traditions, which could offer valuable insight and adaptation strategies. The current literature does not adequately address how these bio-inspired methodologies could be harmonised with existing cultural and architectural norms within Malaysia.

Despite the breadth of topics covered by the authors, from facades (Webb, 2021; Lopez et al., 2017) to passive cooling techniques (Butt, 2022), there is a discernible gap in formulating a unified design framework that accounts for regional and cultural variations, notably within Southeast Asia's unique demographic fabric. As Malaysia aims to develop a sustainable architectural identity rooted in both modern and traditional influences, research must advance to establish a comprehensive, culturally relevant framework incorporating these diverse biomimetic strategies.

Biomimicry and Resilience

The potential of biomimicry in fostering resilience within architectural and urban design is increasingly recognised in contemporary studies. Zaki (2023) posits that biomimicry offers solutions that can adapt to environmental changes and tackle sustainability issues, promoting more responsive urban frameworks. Nevertheless, there remains a gap in the literature regarding how these proposed adaptations can be practically implemented in existing urban landscapes, especially those of diverse and dense demographics like Malaysia.

Furthermore, while the integration of biomimicry can theoretically bolster adaptive capacity within buildings and urban infrastructure, empirical research exploring real-world applications remains sparse. The emphasis has often been on conceptual discussions rather than practical frameworks, suggesting a need

for actual case studies and more grounded implementations. Additionally, implementing biomimicry in resilience strategies requires interdisciplinary approaches, incorporating insights from ecological science, engineering, and design (Zaki, 2023). However, the literature does not thoroughly address the complexities involved in such collaborations, potentially hindering the development of integrated frameworks that are essential for comprehensive urban resilience.

Therefore, although biomimicry holds great promise for enhancing resilience, there is a pressing need for frameworks that address practical implementation challenges and the requisite interdisciplinary collaboration. Focusing on these aspects could yield more tangible, scalable solutions for the dynamic urban centres in Malaysia and beyond.

Biomimicry as a Sustainable Design Methodology

The literature extensively highlights the potential role of biomimicry as a sustainable design methodology. Various authors, including AlAli et al. (2023) and Ilieva et al. (2022), describe biomimicry as a means to create environmentally responsive and energy-efficient buildings. This approach, as they note, draws direct inspiration from nature's inherent strategies. However, there often remains a gap in quantifying the psychological and social benefits that biomimicry-based designs offer within complex urban contexts.

Additionally, Buck (2016) and Butt (2022) further emphasise biomimicry's role in addressing architectural challenges by implementing nature-inspired principles. Despite this optimism, there is limited empirical research validating these approaches across diverse climates and socio-economic settings. This lack of data constrains the ability to generalise findings and realise practical impacts at scale within urban development. Moreover, the works of Los Rosario et al. (2023) and Jamei & Vrcelj (2021) indicate a need for more in-depth studies on the integration methodologies involved. This includes understanding how to effectively translate biological principles into actionable design, highlighting a significant gap in applying biomimicry as a mainstream sustainable building practice.

Although promising as a sustainable design methodology, there remains a call for more comprehensive frameworks that integrate biomimicry principles robustly within architectural and urban planning processes. This can guide efforts toward shaping more sustainable and adaptive urban environments, particularly within rapidly developing regions like Malaysia.

Biomimicry in Education and Research

The significance of incorporating biomimicry in architectural education is increasingly acknowledged, as Arumugam et al. (2023) and Symeonidou (2023) demonstrate. They emphasise the need to introduce these concepts early within design curricula to foster innovation in sustainable design. Despite this recognition, current educational frameworks often lack structured modules specifically focused on practical applications of biomimicry, highlighting a gap in comprehensive pedagogical strategies.

Complementing education, the call for more extensive research to support biomimicry's integration into design practice is crucial. Verbrugghe et al. (2023) and Sarwate & Patil (2016) point to the necessity of developing comprehensive frameworks, methods, and tools. These resources can aid architects and urban designers in effectively implementing biomimicry concepts.

Nevertheless, this field lacks rigorous, practice-oriented research often constrained by theoretical boundaries. The literature underlines a need for interdisciplinary research approaches to enhance the

incorporation of biomimicry within architectural studies. However, existing studies often overlook how collaborations with biology, engineering, and sociology can be structured, further limiting the development of transdisciplinary methodologies in the educational environment. Hence, there is a pressing need to bridge the gap between theoretical exploration and practical application within architectural education and research. Establishing standardised, interdisciplinary frameworks can facilitate the effective implementation of biomimicry-driven innovations, shaping future architectural practices towards sustainability.

Challenges and Limitations in Implementing Biomimicry

Various studies, including those by Blanco et al. (2021) and Othmani et al. (2022), identify significant challenges and limitations in implementing biomimicry within the fields of architecture and urban design. The lack of clearly defined approaches and difficulties in translating biological principles into workable design solutions are critical obstacles. Despite this identification, there is inadequate exploration of how these challenges can be systematically overcome through collaborative design processes.

Elsamadisy et al. (2019) and ERGÜN & Aykal (2022) further elaborate on the necessity for interdisciplinary collaboration to address these barriers. However, the literature often fails to propose concrete strategies for fostering such collaboration across distinct domains like architecture, biology, and design. This oversight presents a critical gap in the development of cohesive biomimetic frameworks.

In light of these challenges, more research is needed to uncover methods that can effectively bridge disciplinary divides. Furthermore, there is a lack of comprehensive studies exploring the role of policy and regulation in facilitating the implementation of biomimicry principles in urban development. Addressing this gap could lead to more inclusive, standardised approaches for incorporating biomimicry into mainstream architectural practice. Collectively, these perspectives highlight the considerable promise of biomimicry in enhancing sustainable design. However, realising its full potential requires addressing fundamental implementation barriers, particularly those related to interdisciplinary collaboration and policy support.

Emerging Trends and Perspectives

Emerging trends in biomimicry that involve its integration with digital technologies and psychological well-being are gaining traction within the literature. Symeonidou (2023) illustrates the convergence of biomimicry with digital advancements, suggesting potential breakthroughs in responsive and adaptive architecture. Conversely, Ilieva et al. (2022) highlight the exploration of biomimicry to enhance psychological well-being, offering a fresh dimension to sustainable design. Despite these advancements, the literature often lacks contextual frameworks demonstrating how these trends can be systematically integrated within urban design. While these perspectives introduce innovative avenues for research, there remains a noticeable gap in understanding how digital technologies enhance or impede the efficacy of biomimetic designs in practice. This unexplored terrain presents opportunities for further exploration to maximise biomimicry's potential as a transformative tool in sustainable architecture.

Moreover, the focus on psychological well-being indicates a need for empirical research supporting these claims within diverse urban settings. By filling this gap, researchers can solidify the role biomimicry plays in promoting mental health and well-being through design interventions. To push boundaries further, it is imperative that future studies address these integration challenges, providing more clarity and structure to the emerging trends in biomimicry. Doing so will enhance the understanding of its applications within the architectural domain and increase its relevance to contemporary urban issues.

Integration of Islamic Values and Sustainability

There is an emerging discourse on how Islamic values intersect with sustainability principles to form a comprehensive framework for addressing environmental challenges. Bsoul et al. (2022) and Setianingrum (2024) argue for this integration as a robust model for sustainable development. Despite this conceptual advancement, the literature lacks tangible case studies exemplifying how these values are integrated into modern urban planning practices, particularly in non-Islamic contexts like Malaysia. Sumi (2024) and Muhamad et al. (2022) further explore ethical aspects of Islamic environmental stewardship, emphasising the synergy between Islamic teachings and sustainable goals. However, a significant gap remains in practical applications demonstrating how this integration can be standardised as part of architectural curricula or design practice. The literature would benefit from studies that illustrate best practices for such integrations.

Addressing these gaps requires a more substantial focus on the applicability of Islamic values in sustainability frameworks across diverse geographical regions. Such an approach could offer nuanced insights and more global relevance to the potential role of Islamic principles in sustainability-driven architectural strategies. To advance this discourse, it is crucial for future research to not only explore the theoretical connections but also provide evidence-based implementations. This would facilitate a more comprehensive understanding of how Islamic values can effectively contribute to sustainable urban development frameworks.

Preservation of Traditional Islamic Architecture

Preserving and reviving traditional Islamic architectural elements play a crucial role in promoting sustainable urban development. Nurjayanti (2023) and Ali et al. (2015) emphasise the symbiotic relationship between Islamic architecture and environmental sustainability, viewing it as a valuable approach to addressing modern urban challenges. Despite these assertions, the literature often lacks detailed frameworks for successfully integrating traditional elements into contemporary architectural practice.

While traditional Islamic designs offer sustainable precedents, the challenge lies in modernising these principles without losing their cultural significance. There is a gap in understanding how traditional techniques can maintain their authenticity within the context of rapid urbanisation, particularly in diverse regions like Malaysia.

Furthermore, there is limited research on how governments and policy makers can support the preservation and incorporation of these elements through legislative or financial measures. Bridging this gap could foster a more cohesive integration and preservation strategy for Islamic architectural heritage. Thus, to ensure this rich heritage informs future sustainable development, researchers must provide actionable insights on integrating traditional Islamic architectural elements into contemporary urban design and policy planning.

Principles of Environmental Stewardship in Islamic Architecture

The alignment of Islamic architectural principles with sustainability and stewardship is highlighted through several studies. Nurjayanti (2023) and Ali et al. (2015) point out how concepts such as balance, stewardship, and moderation are deeply rooted in Islamic teachings and manifest in traditional designs. However, while these concepts are acknowledged, there is often a gap in translating these principles into modern architectural practices that are applicable in diverse urban environments.

Bsoul et al. (2022) and Pandikar (2024) also contribute to this discussion, indicating that Islamic architectural principles inherently align with sustainable development goals. Despite this alignment, there remains a need for ongoing research to develop methodologies that effectively incorporate these principles into mainstream architectural design processes.

Moreover, the literature needs to emphasise the practical applications of this alignment within current regulatory and market environments, which can vary significantly across regions. By doing so, architects and policymakers can create frameworks that recognise and implement these traditional values comprehensively. In conclusion, the principles of environmental stewardship rooted in Islamic architecture offer theoretical insights, yet require further exploration to understand how they can be systematically implemented in modern urban architectural design.

Symbiotic Relationship between Islamic and Sustainable Design

The literature suggests a symbiotic relationship between Islamic architectural principles and sustainable design approaches. Nurjayanti (2023) and Bsoul et al. (2022) highlight how traditional features such as passive cooling, compact urban forms, and community-oriented designs are inherently sustainable and can inform modern sustainable development. However, there remains a gap in illustrating how these traditional features can be adapted to meet contemporary building standards and regulatory requirements.

Ali et al. (2015) expand on this relationship by acknowledging the potential of traditional Islamic designs in addressing sustainability challenges. Despite this acknowledgment, detailed studies showing how these principles have successfully been integrated into modern urban projects are sparse, limiting the evidence base for scalability and replication across diverse regions.

The gap underscores the need for research that not only documents successful case studies but also offers frameworks for integrating traditional Islamic designs within contemporary urban development projects. These frameworks could provide practical guidance for architects and planners seeking to incorporate sustainable Islamic design features effectively. Thus, future research must focus on unveiling the practicality of these integrations, offering illustrative examples that bridge traditional wisdom with modern sustainable urban design demands.

Through exploring the subtopics, it becomes evident that while biomimicry and Islamic architectural principles each offer valuable insights into sustainable design, significant gaps remain in their practical implementation and interdisciplinary integration. For biomimicry, the literature suggests a need for more empirical studies that provide frameworks for incorporating nature-inspired principles in diverse urban contexts, particularly under Malaysia's unique socio-environmental settings. Similarly, integrating Islamic values and traditional designs with contemporary sustainable practices requires more robust methodologies and policy frameworks to enhance applicability. Further research, focusing on developing actionable insights and scalable models, is crucial for advancing sustainable architectural practices that are responsive to both cultural and environmental imperatives.

Biomimicry Applications in Architecture and Urban Design.

The exploration of biomimicry applications in the built environment has offered a myriad of possibilities, as highlighted by Los Rosario et al. (2023), Webb (2021), and Lopez et al. (2017). These authors emphasise the application of biomimicry, particularly in building facades. However, the field extends beyond facades, with insights from Jamei and Vrcelj (2021) suggesting similar applications in structural engineering. Together, these perspectives underline a significant potential in utilising biomimicry

across various architectural domains, yet there is a lack of a comprehensive framework that integrates these diverse applications into a cohesive approach tailored for contexts like Malaysia.

Further expanding biomimicry's scope, Butt (2022) and Buck (2016) discuss its roles in passive cooling techniques and urban infrastructure planning, respectively. This highlights biomimicry's contribution to developing environmentally sustainable urban solutions. Nevertheless, the literature currently lacks attention to region-specific adaptations, which is crucial for effectively applying these strategies in Malaysia's unique climatic and urban conditions. Biomimicry's contribution to resilient architecture is underscored by Zaki (2023), pointing out the adaptive capacities of biomimetic designs. Despite these insights, actual implementations that measure resilience success across different environments remain underexplored, posing a challenge for creating practical frameworks in diverse settings like Malaysia.

In summary, the literature provides a wealth of knowledge on biomimicry applications across various architectural domains, yet there is a notable need for regionally adaptive frameworks, particularly in Malaysia. While biomimicry is recognised as a sustainable design methodology, translating these strategies into practical implementations that address local cultural and climatic conditions remains unexplored. Education and research emphasise the importance of biomimicry, but practical tools for integration are insufficient. The challenge of implementing biomimicry involves overcoming interdisciplinary barriers, amplified by the unique challenges posed by the Malaysian context. Additionally, integrating Islamic values and sustainability principles into architectural practices offers significant potential but lacks concrete application examples in Malaysia. These gaps highlight the necessity for a qualitative framework that incorporates cultural, climatic, and ecological specificities to advance sustainable and biomimetic architectural practices in Malaysia.

Despite these rich discussions, there is a noticeable gap in the research regarding the application of biomimicry-based designs tailored specifically to Islamic traditions within an urban Malaysian context. Most existing studies do not address how these design principles can be systematically incorporated into urban planning frameworks that respect both local culture and environmental sustainability. Moreover, there is limited exploration into how community-centred participatory methods can ensure that these designs meet the diverse needs of Malaysian society.

This gap leads to the clear necessity of further investigation in this area. The present study aims to develop a practical framework that bridges these identified shortcomings, focusing specifically on creating biomimicry-based sustainable urban design solutions that are informed by Islamic traditions. By conducting this research within Malaysia, the study intends to provide new insights and a model that can be applied in other culturally rich and environmentally sensitive regions, ultimately contributing to the broader discourse on sustainable architecture and urban planning.

RESEARCH METHODOLOGY

This study will employ a phenomenology approach to investigate biomimicry-based sustainable urban design solutions from an Islamic tradition perspective. This design is appropriate because it focuses on understanding the lived experiences and perspectives of individuals engaging with Islamic architectural traditions and biomimetic principles. It will allow for an in-depth exploration of human interactions and interpretations of sustainable designs in an urban context, aligning with the objective of developing a framework applicable in Malaysia. This approach facilitates a deeper understanding of the cultural and religious influences shaping sustainable design practices.

Data Collection Method

Data will be collected through document analysis. Document analysis will involve reviewing existing urban design frameworks and architectural practices within Malaysia that incorporate biomimicry and Islamic influences. These methods will provide an in-depth understanding of current practices and inform the development of a framework for sustainable urban design that integrates biomimicry and Islamic traditions. Data will be collected through semi-structured interviews and focus groups. Semi-structured interviews will be conducted with architects and urban designers in Malaysia to explore their perspectives on integrating biomimicry-based sustainable urban design solutions inspired by Islamic tradition. Focus groups will involve community leaders and residents to capture their insights on the applicability and cultural resonance of these design solutions in local contexts. These methods aim to gather diverse viewpoints on how traditional Islamic principles can be combined with biomimicry to enhance sustainable urban design practices within Malaysia, providing a comprehensive understanding necessary for framework development.

Analysis Technique

The data will be analysed using thematic analysis. This approach involves identifying, analysing, and reporting patterns (themes) within the qualitative data to explore connections between elements of architecture, urban design, sustainable design, biomimicry, and Islamic tradition. Thematic analysis is suitable for this study because it allows for a nuanced understanding of complex cultural and environmental influences on urban design solutions. The analysis will include coding data, developing themes, and examining how biomimicry-based sustainable design methods can harmonise with Islamic traditions, particularly within the Malaysian context. This will provide insights into integrating ecological and cultural elements in urban design practices.

Software and Tools

Atlas.ti will be utilised for qualitative data analysis, offering robust thematic coding and visualisation capabilities that are essential for examining biomimicry-based sustainable urban design from an Islamic tradition perspective. This software's features allow for the meticulous organisation and cross-referencing of data, which is crucial in identifying patterns and frameworks relevant to architecture and urban design within the context of Malaysia. By employing Atlas.ti, the study ensures comprehensive coverage and depth in exploring sustainability solutions influenced by biomimicry and Islamic principles. Additionally, tools like NVivo might support data management and coding triangulation to further enhance analytical rigor.

ANALYSIS

The analysis started by pointing out important knowledge gaps, especially with regard to the limited literature on integrating Islamic traditions and biomimicry concepts in urban planning. With an emphasis on Malaysia's particular context, this study fills these gaps by illustrating how biomimicry and Islamic cultural and architectural ideals may coexist to produce sustainable urban landscapes. A new framework that combined Islamic viewpoints with design concepts based on biomimicry was produced as a result of the investigation. This framework bridges the gap between theory and reality in sustainable urban design by giving architects and urban planners useful tools to create ideas that are both ecologic and culturally relevant.

Furthermore, by integrating religious and cultural heritage values with cutting-edge tactics like biomimicry, the research expands on current theories in sustainable design and urban planning. This method

enhances existing models by giving sustainable design principles a culturally sensitive aspect. Lastly, the results point to important directions for further study. The study advances international efforts toward sustainable development by examining the relationship between sustainability, cultural traditions, and creative design. This lays the groundwork for comparative research in various cultural and geographic conditions.

Evaluation via Expert Review

The expert review session for the research proposal on developing a biomimicry-based sustainable urban design framework from an Islamic tradition perspective aims to enhance and refine the proposed framework through a structured evaluation process. The experts participating in this review should include representatives from relevant stakeholders, academic scholars specialising in sustainable design and Islamic architecture, and urban planning professionals.

The session starts by assessing the relevance and appropriateness of the framework. Experts will evaluate its alignment with the contemporary needs of sustainable urban design in Malaysia, considering local environmental challenges and cultural contexts. They will discuss how well the framework integrates principles of biomimicry and Islamic traditions to address current urban design issues. The expected outcome is to identify areas where the framework is particularly effective and suggest potential improvements to enhance its applicability. The panel will then spotlight the strengths of the framework. This involves analysing its structure, clarity, and potential impact. Key strengths will be highlighted, such as the depth of cultural integration and innovative use of biomimetic principles in urban design. Feedback will focus on components that are most compelling and likely to drive impactful sustainable solutions in urban environments.

Following this, experts will critically identify potential weaknesses or limitations. This might include challenges related to implementation feasibility, resource requirements, or the absence of clear illustrative examples. Constructive feedback will aim to identify specific areas needing further development to ensure the framework is robust and comprehensive. Suggestions for improvement are another critical component of the session. Experts will brainstorm practical enhancements and refine recommendations. Potential enhancements could include developing supporting tools, conducting pilot studies to validate the framework, or incorporating more illustrative case studies to foster understanding and application.

Synthesising feedback to identify common themes and insights will also be crucial. Experts will review feedback, emphasising recurring points or concerns, such as the need for adaptability or practical application guidance. This synthesis will provide valuable insights into recurring themes, guiding further refinement of the framework. Lastly, feedback on collaboration and maintaining the framework's relevance is considered. Experts will evaluate strategies for stakeholder engagement and continuous updates. Suggestions will aim to strengthen collaboration and establish a sustainable process for ongoing adaptation, ensuring the framework remains relevant as the field of sustainable urban design evolves.

By conducting this thorough review, the expert panel will provide comprehensive feedback to ensure the proposed framework is effectively shaped to meet its intended goals and make a significant contribution to sustainable urban design informed by Islamic traditions. The research proposal on biomimicry-based sustainable urban design from an Islamic tradition perspective in Malaysia is poised to address a significant gap in the field of architecture and urban design. By applying a qualitative methodology, the study aims to develop a framework that integrates biomimicry principles with Islamic values to create sustainable urban solutions. This approach is particularly relevant given the global trend towards sustainable development and the unique cultural context of Malaysia.

Expert Panel and Focus Group for Framework Development

The expert panel and focus group for this initiative consist of a diverse, multidisciplinary team, each contributing critical insights essential for the development of the proposed framework. This team includes experts in Green Building Index (GBI) certification and sustainable green building practices, whose input ensures the framework aligns with established environmental performance standards. Their expertise is vital in guaranteeing that the framework adheres to best practices in resource efficiency and sustainability, providing a solid foundation for its application in real-world urban contexts.

In addition to sustainability professionals, the panel includes academic scholars from renowned universities specialising in fields such as sustainable design, biomimicry, Islamic architecture, and urban planning. These scholars contribute cutting-edge research and theoretical perspectives, grounding the framework in rigorous academic thought. Their involvement ensures that the framework not only addresses contemporary urban challenges but also incorporates a critical, evidence-based approach. Furthermore, urban planning professionals bring practical insights into the framework's applicability and feasibility across Malaysia's diverse urban landscapes. The inclusion of Islamic scholars and cultural experts guarantees that the framework integrates Islamic principles with modern sustainability practices, ensuring cultural relevance and ethical alignment. This comprehensive, multidisciplinary team ensures that the framework is both robust and contextually attuned to Malaysia's sustainable urban design needs.

Feedback from the Expert Review Process

The expert review process involved several key steps to gather valuable feedback, which will inform the development of the proposed biomimicry-based sustainable urban design framework from an Islamic tradition perspective. Experts, drawn from relevant fields such as urban planning, sustainable design, and Islamic architecture, provided critical insights into the framework's relevance, applicability, and alignment with national development goals and cultural considerations in Malaysia.

Task 1 focused on evaluating the framework's relevance to sustainable urban design challenges within the context of Islamic tradition. Experts assessed how well the framework addressed contemporary trends and local needs, offering recommendations for adjustments to improve its fit and focus.

In **Task 2**, experts identified the framework's strengths, particularly its innovative integration of biomimicry and Islamic principles. They provided feedback on how to leverage these strengths to enhance the framework's clarity and potential impact, helping to ensure its practical applicability in urban settings.

Task 3 involved identifying potential weaknesses, where experts critically examined barriers to implementation such as resource constraints and feasibility challenges. Their constructive criticism will guide refinements that will improve the framework's overall feasibility and effectiveness.

Task 4 focused on proposing practical improvements. Experts suggested adding case studies, developing implementation tools, and incorporating other enhancements to make the framework more adaptable and applicable to various urban contexts.

In **Task 5**, the feedback was synthesised to identify common themes and recurring insights. Experts highlighted the importance of flexibility and culturally sensitive applications, which will inform further refinements to ensure the framework is effective in diverse urban environments.

Finally, **Task 6** aimed to ensure the framework's long-term relevance. Experts offered recommendations on strategies for maintaining ongoing collaboration and updates, emphasising the need for continuous improvement and stakeholder engagement.

The feedback gathered through these steps has been instrumental in refining the framework, ensuring that it aligns with the objectives and is adaptable to Malaysia's evolving urban landscape. This valuable input will be integrated into the next stages of the framework's development.

Framework for Sustainable Urban Design: Merging Biomimicry with Islamic Tradition

Building upon the insights gathered from the expert review process, the following framework integrates biomimicry principles with Islamic traditions to address the pressing challenges of sustainable urban design in Malaysia. The framework is structured into six interconnected components, each emphasising the alignment with Islamic values, local context, and practical applicability. This refined framework seeks to bridge the gap between tradition and innovation, offering a comprehensive approach to sustainable urban design that preserves the essence of Islamic values while addressing contemporary environmental and urban challenges in Malaysia.

Table 1. Framework for Sustainable Urban Design: Integrating Biomimicry and Islamic Tradition

Component	Key Focus	Details
Core Principles	Biomimicry Principles	Imitate natural patterns and ecosystems.
		Focus on life-cantered design for biodiversity and ecological balance.
		Ensure resilience and adaptability to environmental challenges.
	Islamic Principles	Tawhid (Unity): Reflect harmony between human and natural environments.
		Mizan (Balance): Promote equitable resource use and environmental stewardship.
		Khalifah (Stewardship): Emphasise responsibility to care for the Earth.
Framework Objectives	Environmental Sustainability	Achieve energy efficiency, waste reduction, and resource conservation.
	Cultural Relevance	Ensure designs respect Malaysia's cultural and Islamic heritage.
	Community Wellbeing	Enhance quality of life through inclusive and participatory urban spaces.
Framework Components	Design Guidelines	Use biomimetic standards inspired by ecosystems like mangroves, forests, and wetlands.
		Incorporate Islamic architectural elements like courtyards, shading, and patterns.
	Contextual Analysis	Conduct site-specific studies using GIS and other analytical tools.
	Stakeholder Collaboration	Engage urban planners, architects, Islamic scholars, and communities for feedback.

	Implementation Tools	Develop case studies, prototypes, and manuals for practical application.
	Monitoring & Evaluation	Establish KPIs to measure sustainability outcomes and use pilot projects for refinement.
	Education & Training	Provide training for professionals and develop educational modules for students.
Application Process	Assessment Phase	Evaluate ecological and cultural criteria to identify opportunities and challenges.
	Design Phase	Develop and refine concept designs through participatory workshops.
	Implementation Phase	Pilot test designs in selected areas and document outcomes for broader application.
	Feedback & Adaptation Phase	Collect stakeholder feedback and revise the framework for relevance and adaptability.
Recommendations	Case Studies	Highlight examples like Alhambra's water systems or Middle Eastern wind towers.
	Digital Tools	Utilise AI and simulations for optimising biomimetic designs.
	Longitudinal Studies	Conduct long-term impact evaluations to ensure effectiveness.
Collaborative Sustainability Plan	Stakeholder Engagement	Foster partnerships with government, academia, and industry for ongoing development.
	Framework Updates	Adapt based on technological advancements and emerging sustainability
	Public Awareness	Promote benefits through campaigns and educational programs.

Source: Authors (2024)

CONCLUSION

This proposal examines at how biomimicry-based sustainable urban design solutions might be included from an Islamic tradition perspective to meet Malaysia's urgent demand for ecologically friendly and culturally sensitive urban development. Using a qualitative approach, the study seeks to create a framework that carefully blends traditional Islamic architectural values with biomimicry principles. A structured design framework that may assist architects and urban planners in developing of sustainable and relevant urban areas is one (1) of the anticipated results.

We have been able to thoroughly examine the connections between architecture, sustainability, and cultural traditions according to this systematic methodology, which has given us a comprehensive understanding of urban design. Finally, by broadening the conversation on sustainable design from the perspectives of biomimicry and Islamic traditions, this study will make significant contributions to the academic community. It also has important practical ramifications, offering creative solutions that preserve cultural heritage and advance environmental sustainability to Malaysian and international politicians and urban planners.

It is important for one (1) to understand that this framework is conceptual in nature and needs more study to refine and enhance its scope, making it comprehensive and effective for real-world application. By encouraging sustainable and culturally relevant urban planning techniques, this study ultimately intends to advance the fields of architecture and urban design. It also seeks to promote sustainability and cultural harmony by revolutionising urban development in Malaysia and other areas where Islamic and traditional values meet.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHOR CONTRIBUTION

Hailane Salam conceptualised the research idea, wrote, and analysed study data, designed the methodology, and investigated and collected the data. *Liyana Mahfuzah Mohd For* & *Tengku Anis Qariah* supervised the research progress and revisions and approved the article submission. *Mohammad Syathir Amini Shahbudin* was involved in carrying out the research's critical review, commentary, and revisions.

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