



EXPLORING THE KEY FACTORS DRIVING THE ADOPTION OF BIOPHILIC DESIGN IN AFFORDABLE ENVIRONMENTS: PERSPECTIVES FROM EXPERTS AND DESIGNERS

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Abstract

Financial constraints and developers' and designers' ignorance of the advantages of biophilic design, among other creative and sustainable design approaches, frequently impede its implementation. This study aims to evaluate the factors that influence the implementation of biophilic design in a low-cost context through the views of experts and designers. Biophilic design, which integrates elements of nature into the built environment, is increasingly recognised as essential for enhancing user well-being. In this context, this study is significant because it supports efforts to promote sustainable and environmentally friendly design, especially in developments that are limited by financial resources. The main objective of this study is to identify and analyse the factors that influence the implementation of biophilic design in low-cost settings. This study involves nine experts who are within the fields of architecture, green technology, sustainable design, and interior design. A qualitative approach was employed through in-depth interviews, utilising thematic analysis to identify themes related to biophilic design, including designers' awareness and knowledge regarding its implementation in low-cost settings. Although this study provides valuable insights, it has several limitations, including a small sample size and a restricted geographic focus. The main findings show that awareness of the benefits of biophilic design, support from authorities, and financial constraints are the main factors influencing its implementation. While the implementation of biophilic design in low-cost housing and the opinions of professionals like architects and designers are still understudied, prior research has concentrated more on commercial buildings and user perspectives. This study closes this gap by evaluating important aspects of low-cost housing from an expert perspective while accounting for design, policy, and cost. The implications of this study highlight the necessity of enhancing awareness and education regarding biophilic design, as well as advocating for policies that foster innovation in a cost-effective manner. Consequently, this study not only sheds light on the challenges encountered in the implementation of biophilic design but also presents recommendations to encourage more sustainable practices within the framework of sustainable development.

Keywords: Biophilic design, Low-Cost settings, Influencing factors, Residents' well-being, Sustainable development

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INTRODUCTION

Biophilic design refers to an architectural approach that incorporates natural elements into built environments to strengthen human connections with nature. In a context where development is increasingly constrained by financial resources, the implementation of biophilic design in low-cost settings is becoming more pertinent. Although many studies show the benefits of biophilic design in improving the well-being and quality of life of users, there are certain constraints that prevent its implementation in low-cost settings. In this study, the term "Low-Cost Settings" refers to affordable housing such as the People's Housing Project (PPR) and the Malaysian Civil Servants Housing (PPAM), which are created for low and middle-income groups (B40 and M40) in urban areas in Malaysia.

Financial constraints are often a major obstacle to adopting innovative and sustainable design strategies. In addition, the lack of awareness and understanding of the advantages of biophilic design among developers and designers also contributes to this issue. Therefore, this study aims to investigate the factors that influence the implementation of biophilic design in a low-cost context through the views of experts and designers.

Through a qualitative approach, this study will gather insights from industry experts and experienced designers, such as professionals with technical and practical competence, in assessing the use of biophilic design, especially in the context of affordable housing; this includes architects and interior designers. Their opinions are crucial in ensuring that the ideas created are workable, compliant with the law, and affordable. Through analysing the findings obtained, this study hopes to provide a deeper insight into the challenges and opportunities that exist in the implementation of biophilic design in low-cost settings. Biophilic design is increasingly recognised for improving psychological well-being.

Although biophilic design has been widely discussed within the broader sustainability and green building literature, its application in affordable housing remains limited. Previous studies concentrate primarily on energy performance and environmental efficiency, with minimal attention to psychological outcomes such as stress recovery. This study advances existing knowledge by repositioning biophilic design as a human-centred, low-cost strategy that addresses the mental well-being of residents. By analysing residents' preferences, demographic influences, affordability constraints and expert insights, this research develops a comprehensive guidance model that fills a significant gap in current sustainable housing research.

However, previous studies have focused on commercial buildings while implementation in low-cost settings has been underexplored. In addition, the views of experts such as architects and designers who are directly involved in the implementation of design have received little attention because existing studies

have focused more on the user perspective. This study fills the gap by assessing key factors from an expert perspective in the context of affordable housing, taking into account costs, policies and design strategies. Finally, the results of this study are expected to contribute to the development of more effective policies and strategies to promote biophilic design in low-cost settings, while improving community well-being.

LITERATURE REVIEW

Definition and Concept of Biophilic Design

Biophilic Design refers to an architectural approach that integrates natural elements into the built environment to strengthen the relationship between humans and nature (Kellert, 2008). This concept is rooted in the idea that interaction with nature can emphasise the emotional attachment (Wilson, 2018) improve psychological well-being, reduce stress, and increase productivity (Browning et al., 2014). In the context of sustainable development, biophilic design also supports efforts to create more comfortable, pleasant, and healthy spaces. There is the importance of biophilic implementation in design, which contributes to the well-being of the population, increased productivity, ecosystem diversity and sustainable development.

Studies show that within minutes, exposure to biophilic design elements in an indoor environment can significantly reduce stress and anxiety, and physiological effects are immediately observed (Yin et al., 2020). Studies show that elements of nature, such as natural light, plants, and views outside, can improve mood, reduce stress, and improve mental health. Factors like thermal conditions, lighting, noise, layout, and biophilic design affect office workers' stress levels, highlighting the need for stress-free workspaces (Awada et al., 2023). Plants offer emotional and mental health benefits, reducing anxiety, improving attention, boosting memory retention, and increasing happiness (Hall & Knuth, 2019). These findings affirm that biophilic design contributes meaningfully to mental restoration and stress recovery in built environments.

Benefits of Biophilic Design in a Low-Cost Settings

Two benefits from biophilic design in a low-cost setting are a response to the well-being of users and society, and economic and social benefits in low-cost projects. Biophilic design incorporates natural elements into buildings, enhancing mental and physical well-being. It reduces stress and anxiety, creating a more pleasant environment that promotes better mental health; integrating plants and sunlight can lower physical health issues such as high blood pressure and encourage physical activity. Such spaces also boost creativity and productivity, especially at work, fostering social interaction and strengthening community

bonds. Ultimately, biophilic design improves quality of life, making people feel more connected and at ease in their surroundings (Kellert & Calabrese, 2015)

Biophilic design enhances user well-being and offers significant economic benefits for development projects. Several buildings in Malaysia use a biophilic approach that includes natural elements such as natural lighting, green spaces, and natural ventilation to reduce energy consumption, an example is the Pertubuhan Arkitek Malaysia (PAM) building. Ibrahim et al. (2021), through studies, prove that the use of biophilic elements in buildings can reduce operating costs and, at the same time, increase employee productivity. Notably, incorporating natural elements reduces operating costs through lower lighting and heating needs, while increasing property values and attracting buyers. This design approach is appealing for sustainable projects, often drawing investment and incentives from authorities. Additionally, using local materials supports the local economy, creates jobs, and boosts small businesses. Over time, biophilic design fosters a better living environment within an urban sprawl, enhances the area's appeal, and raises community awareness about environmental preservation. (Browning et al., 2014)

Factors Influencing the Implementation of Biophilic Design

Awareness and Knowledge Gap (Designer and Developer)

Factors influencing the implementation of biophilic design include: developer and designer awareness and knowledge, cost and budget, access to information, government support, and perceptions of health and well-being benefits. Awareness and knowledge of biophilic design among developers and designers is essential to integrate natural elements in their projects. Lack of knowledge on how to implement this design with a limited budget causes this concept to be often overlooked in the construction industry (Clark-Havron, 2023). This is probably due to the lack of knowledge about biophilic design practices, where it is known as a new design practice and the lack of accessibility of information related to this practice. There is a misconception that biophilic design requires high costs, which causes hesitation in its implementation. Sadick et al. (2023b) in their study stated that architects and building sustainability consultants influenced design decisions, yet very limited studies were found on their point of view about the direct nature integration (DNI) adoption barriers. This statement has been denied by Lei et al. (2022), whereby their study states that designers were well versed with this design approach and have adapted biophilic design attributes in design practices. Moreover, raising awareness through training and seminars can help developers and designers understand the benefits of biophilic design, including improved mental and physical well-being, and encourage them to prioritise spaces that support human relationships with nature. Awareness in making decisions to integrate biophilic design elements into buildings provides

many benefits, especially to green technology supporters, property owners, building designers and architects (Bartczak et al., 2013). If the information and knowledge about this practice and its implementation are more widespread and understood, this practice will be easier for the public to access (Clark-Havron, 2023).

Financial and Resource Constraints

Cost remains one of the primary barriers to adopting biophilic design in low-cost projects. Tight budgets, expensive organic materials, and maintenance costs deter the developers (Nguyen, 2023; Shamsi et al., 2023). Even though early integration can reduce costs in the long run, the perception of inefficiency persists. Studies by Larsson and Krishnaraj, (2023) indicate that while biophilic homes offer long-term benefits, they are often perceived as unaffordable. Government incentives and clearer communication of long-term savings could improve adoption. However, integrating biophilic elements during the pre-construction phase can provide benefits such as seamless installation, aesthetic value at no additional cost, and reduced labour and material costs. Most biophilic elements require high costs due to the involvement in the maintenance of natural elements, other than expensive organic materials (Shamsi et al., 2023). These facts are supported by (Larsson & Krishnaraj, 2023) through their study, which shows that biophilic design can give many benefits to residents and society that have been found to be severely unaffordable. In conclusion, biophilic design can benefit residents and communities, but is often considered inefficient. Sharp price increases force developers to find alternatives that may sacrifice quality. Lack of government incentives and understanding of the benefits of biophilic design make its implementation difficult. Structured incentives can increase developers' confidence to integrate biophilic design while considering profitability (Saka et al., 2021). Financial risk due to the uncertainty of demand for space that integrates biophilic elements puts pressure on developers. Although government incentives aim to stimulate growth (Bramayusa & Adi, 2024), a lack of consumer confidence in the price of biophilic homes makes sales difficult. Developers need to convince buyers of the long-term benefits of this design, especially in maintenance costs. Summatively, the government has an important role in dealing with financial problems for the implementation of this design.

Authorities Support

Government policies and incentives play an important role in promoting biophilic design by providing guidelines and financial incentives such as tax deductions. Although there are financial risks due to demand uncertainty, government policies can mitigate these challenges. Studies show that financial incentives and legal obligations are common ways to support green infrastructure (Liberalesso

et al., 2020). Javed et al. (2020) identified high costs and a lack of experienced contractors as risks in green building projects, suggesting financial incentives. Tambe et al. (2023) suggested incentives in the building permit approval process to increase resource efficiency, while Deborah Aanuoluwa Soyombo (2024) suggested mandatory building codes, financial incentives, and procurement policies as effective means for encouraging sustainable practices. Malaysia is making progress in the development of green roofs, but much remains to be done to promote their widespread adoption. Overall, government intervention is important to drive sustainable construction practices and improve an environmentally friendly built environment. Authorities' support through incentives, policies, and guidelines will not be effective without public awareness. Community environmental awareness is still low due to a lack of formal education (Wiradimadja et al., 2023). Education programs can raise awareness and encourage sustainable practices (Tadesse, 2024), emphasising the importance of government support and private sector collaboration. In Malaysia, in 2018, there was a positive relationship between awareness levels and the efficiency of green building practices, highlighting the importance of education and government support (Sabar et al., 2018). This shows that environmental awareness is on a good path to be developed over time.

Experts' Insight: Challenges and Opportunities

Biophilic design offers benefits but faces challenges in a low-cost context, including high material costs, limited space, lack of awareness, and obstacles from regulations and planning policies. Other obstacles such as green retrofits and housing market issues, also make implementation difficult (Adabre et al., 2020). The use of renewable materials to reduce embodied emissions often requires increased investment costs (Schneider-Marin & Arendt, 2024). However, new incentives and policies are needed to overcome economic barriers and promote sustainable construction practices (Schneider-Marin & Arendt, 2024). The implementation of biophilic design faces challenges in limited spaces, especially in dense cities. In Dubai, residents showed high acceptance of green strategies such as balcony control and rooftop gardens (Shakhshir & Sheta, 2023). In Australia, low-cost biophilic design increases biodiversity (de Souza et al., 2023). Researchers suggest creating shared spaces in various building typologies to promote healthy living (Tracada & Sorensen Allacci, 2023). There is a lack of awareness about biophilic design and green buildings among developers and architects. Studies in Turkey revealed that technical knowledge about pro-environmental practices in the business domain is a stronger predictor of pro-environmental behaviour than general environmental awareness (Acar & Yalçın, 2019). In Pakistan, the most critical barrier to green building adoption was identified as a lack of awareness about its importance and advantages (Azeem et

al., 2020). Researchers suggest seminars, mandatory green building codes, and financial incentives to increase awareness (Azeem et al., 2020; Sabar et al., 2018). There are opportunities to leverage innovations in environmentally friendly materials, education, and community collaboration to reduce the cost of biophilic design. Government policies need to be revised to support the implementation of these designs, which can bring great benefits to society if the challenges can be overcome.

Table 1 summarises key findings from previous studies related to the challenges and opportunities. This synthesis highlights several gaps, which this study aims to address.

Table 1: Summary of Key Findings from Previous Studies

Author(s)	Challenges Identified	Opportunities / Recommendations
(Adabre et al., 2020)	High material cost, limited space, lack of awareness, policy barriers	Recognition of green retrofits and design incentives is needed
(Schneider-Marín & Arendt, 2024).	Renewable materials increase initial investment cost	Propose new policies and incentives to address economic barriers
(Shakhshir & Sheta, 2023)	Limited urban space in dense cities	Residents support green strategies like rooftop gardens and balconies
(de Souza et al., 2023)	Low-cost implementation may be seen as limiting	Can enhance urban biodiversity through biophilic strategies
(Tracada & Sorensen Allacci, 2023).	Challenges in promoting health through shared space	Promote shared biophilic spaces in varied building types
(Acar & Yalçın, 2019)	Lack of technical knowledge on environmental practices	Technical knowledge is key to promoting sustainable behavior
(Azeem et al., 2020).	Lack of awareness on green building benefits	Suggest seminars, mandatory codes, and incentives
(Azeem et al., 2020; Sabar et al., 2018)	Low public awareness of green design practices	Improving awareness boosts implementation efficiency

Strategies for Improving Implementation

Increasing awareness and education about biophilic design is essential for its widespread implementation. Education and training programs, including courses for architects and the public, need to be expanded (Adua et al., 2024); only 10% of colleges teach passive heating and cooling systems. Interdisciplinary collaboration and public awareness campaigns through social media and community events are also important to convey biophilic benefits (A. O et al., 2023), including their effects on mental and physical health. Higher awareness will increase the demand for projects that integrate biophilic elements, making the implementation of this concept more relevant and effective.

Implications for the Future of Biophilic Design

The future of biophilic design carries important implications for architecture, urban planning, and well-being. With increasing awareness of environmental and health impacts, integrating natural elements into the built environment can enhance human connection with nature, improve mental health, and increase productivity. Advances in technology and sustainable materials will facilitate innovative designs that are aesthetically appealing and environmentally friendly. Additionally, in the face of ongoing urbanisation, biophilic design can help overcome issues such as urban heat and loss of biodiversity, creating healthier and more sustainable communities.

While biophilic design has been widely recognised for its psychological, environmental, and economic benefits, its application in low-cost housing settings remains underexplored. Existing studies have predominantly focused on commercial or high-end residential contexts, often neglecting the realities and constraints of budget-limited environments. Moreover, limited attention has been given to expert perspectives, particularly those of designers, architects, and built environment professionals who play a key role in the feasibility of implementation. This study addresses these gaps by assessing the factors that influence biophilic design adoption in low-cost housing through the lens of experts, aiming to inform more inclusive and practical design strategies.

RESEARCH METHODOLOGY

Semi-Structured Interview

This study employed a qualitative approach using semi-structured interviews that were conducted online, each lasting 45 to 60 minutes. Nine (9) architectural experts with backgrounds in green, sustainable, and biophilic design were interviewed. Questions were developed through a literature review, allowing flexibility for in-depth discussion. This method is effective for keeping the conversation focused while enabling the interviewer to guide the discussion as needed (Islam & Aldaihani, 2021). Key points for the questions are outlined below:

Table 2: Questions Procedures and Guide

Procedures	Questions Guide
Introduction Questions	Knowledge and awareness about biophilic design in building design
Focus Questions	Factors that affect the effectiveness of the application of biophilic design in the interior design of housing Key design strategies and challenges in the implementation of biophilic design in low-cost setting

Procedures	Questions Guide
Concluding Questions	Open question about future recommendation for biophilic design widely used in the field of design in Malaysia.

In conclusion, the primary objective of this interview session is to support the goals of this study, which are to explore the strategies and challenges encountered by design practitioners in Malaysia regarding the implementation of biophilic design. Additionally, the session aims to identify the key factors that influence the effectiveness of biophilic design in practice.

Expert Selection

Since biophilic design is a relatively new design approach in Malaysia, no expert in this field has been identified in Malaysia. In the absence of experts who are directly labelled under biophilic design, this study selected professionals such as architects, interior designers, and sustainability consultants who actively incorporate nature-based design principles into their work. Their expertise was deemed relevant based on their direct involvement in low-cost housing development and environmental design decisions (Welch & Patton, 1992). Therefore, this interview takes the approach of interviewing experts in the field of green building design and sustainable design, since biophilic design is identified as one of the design approaches that is closely related to this design approach. Meanwhile, interior designers and architects were interviewed since they are the key people who prepare the design brief for each project, which is formed through understanding the end user's needs and experience in the field of construction. Practitioners are close to the end user, and biophilic design is a design approach that touches the heart of the end user, and is not just a standard practice. Interdisciplinary knowledge is required to form biophilic design guidelines, where information and in-depth knowledge about biophilic design is obtained to link design strategies with the benefits (Zhong et al., 2022). According to Creswell and Creswell, (2018) conducting approximately 3 to 10 interviews is sufficient for phenomenological research.

Despite its restricted geographical focus, this study offers useful theoretical and technical viewpoints by concentrating on professional insights from various disciplines. The expert opinions add to a greater understanding of biophilic design concepts, which helps inform future practical applications and advances, even though it excludes input from all stakeholders, such as the inhabitants or users.

Table 3: Interviewee Key Profiles

Item	R1	R2	R3	R4	R5	R6	R7	R8	R9
Interviewee Position	Managing Director /Green Design Expert	Architect /Interior Designer	Architect	Project Manager / Sustainability Architect	Architect/ Head of Department	Architect	Principle Architect/ Managing Director	Architect	Architect Ecologist Planner
Professional title	Ts	n/a	n/a	n/a	Ar	n/a	Ar	n/a	Dr
Organisation	Consultant	Consultant	Consultant	Consultant	Developer	Consultant	Consultant	Developer	Consultant
Experience In industry (Years)	>10	>10	>15	>10	>10	>10	>30	>10	>40
Experience in biophilic/ sustainable/ green design	Sustainability Green	n/a	Sustainability Green	Sustainability	Sustainability	n/a	Sustainability Green	Sustainability Green	Sustainability Green

This research complied with institutional ethical standards. Approval was granted by the UiTM Research Ethics Committee according to CH Good Clinical Practice Guidelines, Malaysian Good Clinical Practice Guidelines, and the Declaration of Helsinki. Participants were fully informed of the study purpose, procedures, confidentiality measures, and their right to withdraw at any time. All participants provided written informed consent before taking part in the survey and interviews.

DATA ANALYSIS

Data analysis for in-depth interviews has several procedures. Based on Creswell and Creswell, (2018), before reaching the data analysis stages, it starts with data collection, data recording, data analysis, interpretation, validity, reliability and writing a qualitative report. Figure 1 shows the data analysis procedures:

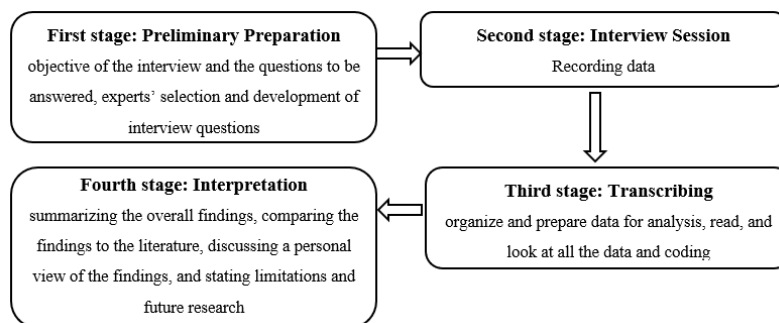


Figure 1: Data Analysis Procedures

Data Collection

Data were collected through semi-structured interviews with experts in the fields of architecture, design, and planning. Purposive sampling was used to ensure that the expertise of the respondents was relevant to the research topic. Interview questions focused on the challenges and opportunities in implementing biophilic design.

Data Recording

With the consent of the interviewees, all interviews were audio recorded, accompanied by field notes. After that, these recordings were thoroughly transcribed for study.

Data Analysis

Data were analysed using thematic analysis methods. Transcripts were reviewed and read repeatedly, coded, and key themes were identified based on expert views.

Data Interpretation

Results are interpreted by contrasting new themes with those of earlier research, especially those pertaining to affordable housing.

Validity and Reliability

Cross-checking findings with existing literature

RESULTS AND DISCUSSION

Based on interviews with nine experts, the key challenges include: (1) awareness and knowledge among developers and designers, (2) financial and resource constraints, and (3) support from authorities through guidelines and policies.

Challenge 1: Developer and Designer knowledge and awareness

Referring to the content analysis of the interview session conducted, all 9 experts believe that biophilic design is known and realised by experts involved in green design, however, their opinions regarding the understanding of developers and designers are different according to their respective approaches.

The lack of knowledge about biophilic design may be because it is still new in Malaysia, causing a gap in understanding between designers and end users. – R1, R6

The fact that designers lack of knowledge to implement this design approach is due to them not being able to balance between design strategies and design

requirements. This is because at the worldwide level and Malaysia itself, it has its own design and cost standards – R2

As a designer, we only applied biophilic design concept by client request. If not, we will go with a standard design, due to cost implementation even, we clearly aware of the advantages of biophilic design – R3

The consultant's role is to convince the developer in the use of this design approach. Awareness is also necessary from the top down. developers well versed with this concept, but in the end, everything turned to dollars and cents. but it is picking up. they are exploring biophilic design and passive design. That is a high-rise building, but it going to be a long journey in Malaysia – R4

The issue is not about developer and designer lack of knowledge or awareness, an issue is there is no enforcement from the government, so this design approach not compulsory – R5

For me, it is not about new design approach, designers have practiced similar designs all this time. it is something very natural. It is something natural that humans need. Now, it has a name – R7

It is about the awareness and the issues. It is not about the adaptation – R8

Certainly, designer need to consider and aware about beneficial influences of vegetation on humans – R9

Literature highlights some of the main reasons why biophilic design is less used, whereby the main reason being the developers' and designers' lack of knowledge. The main concern is a lack of knowledge about the implementation of biophilic design with a limited budget (Clark-Havron, 2023). New design practice and the lack of accessibility of information related to this practice are also highlighted as factors. It appears that both the literature and the findings converge on similar concerns regarding the issues at hand. Several new challenges are highlighted, particularly the relationship between the government's role and the developer's role in promoting the expansion of this approach; this aspect is currently gaining traction in Malaysia.

Challenge 2: Financial and Resource Constraints

Based on the content analysis of the interview session, the second question is more focused on the challenges of implementing biophilic design in low-cost

settings. Every interviewee expressed almost the same opinion that financial constraint is the main influence concerning implementation.

...we need to balance all of this in terms of the capital expenditure and the operating expenditure. the challenge is to find the balance, between design and cost because of financial constraint – R1

Cost constraint is the main subject, but if we can strategize this design into nice to have, must have and which can be implemented later, cost is not the main constraint. The main constraint is the design requirement and the residents' understanding of the biophilic itself – R2

Green or biophilic implementation itself is indeed costly, and it has not yet been used for low-cost houses in Malaysia, however, it goes back to the design strategy itself despite the high cost of implementation – R3

In the Malaysian industry, particularly in green building design, the focus is often on active design, while passive design is frequently overlooked. However, it is essential to prioritize passive design first. If biophilic design is considered at the beginning of the design stage, it does not necessarily lead to high implementation costs – R4

In the context of low cost, you will not be able to get all the elements in one housing unit due to the high cost of implementation and maintenance – R5

The cost of construction and the cost of the house is beyond our control as a designer, but we can control the design strategy from causing the cost to skyrocket – R6

To provide comfortable home units at the same time low cost, government must do not mind to invest their money. We cannot balance between implementation costs and including all the benefits of biophilic at one time – R7

....it is not about cost. It is how you design your space; you just integrate it as part of your design – R8, R9

Most of interviewees agree that as a designer, seeing cost as an obstacle is unnecessary. The effectiveness of implementation is based on the design strategy for the implementation of biophilic elements in housing (R2, R3, R6, R8, R9). Apart from that, a focus on passive design is necessary to make this adaptation design approach a success method to not lead to high-cost implementation (R4). Apart from the cost, there is an interviewer who

highlighted the role of government in providing investment for this design to be used well in Malaysia (R7). Designers consider cost to be the main issue, but this can be overcome through a design strategy. Moreover, the government plays a role in providing incentives related to the implementation of green and biophilic design strategies. Implementation at the start of the design phase to prevent cost increases (R1) and classifying the biophilic characteristics as common or unusual for low-cost implementation (R2) are two of the design solutions that are recommended. Furthermore, according to R8 and R9, the way the space is constructed is a design strategy, and this parameter can be broken down in the design without raising the price.

Challenge 3: Authorities Support and Initiatives

Referring to the content analysis of the last question, all the interviewees agreed that the government's support in providing incentives can help this approach to be widely used in Malaysia.

For first group of biophilic design such as natural lighting, view of nature and natural ventilation, government already enforced it in policies and guidelines namely GBI. that one is all green building parameters – R1

If the government can enforce the universal design act, they also need to look at biophilic design, where the benefits are broader – R2

Designers will only adapt the minimum requirements enforced by government and authorities, so focused guideline is required – R3

Enforcement by government indeed with a focus on passive design first. Also, the government now offers some sort of green building initiatives, namely tax allowance, so that buyers are more confident to invest their money to buy green housing units – R4

Government giving incentives to developers during MCO, lead to reducing development charges, and developer can tolerate with affordable housing scheme. Government should impose green technology incentives so that win-win situation between government and buyer can be develop – R5

Government should enforce biophilic design through green building index so that we as a designer can adopt this design approach without any cost barrier – R6

Despite of incentives, government should initiate more affordable housing scheme, and need to manage it well to give an opportunity especially B40 income

level persons. Government also needs to give an education to public about this scheme – R7

Authority supports comes along with design strategies itself even there is no guidelines for biophilic design. We called it design principle – R8

In line with the literature review, the analysis shows that the government or authorities play an important role in encouraging biophilic design to be widely implemented in Malaysia. Among the recommendations are improving policies, creating a guideline focusing on biophilic design and incentives for buyers (Liberalesso et al., 2020). Another highlighted factor is public awareness, whereby the government needs to educate buyers to promote the implementation of biophilic design.

The literature and findings of this study converge on a key issue, i.e., the lack of knowledge among developers and designers regarding the implementation of biophilic design, particularly in low-cost housing contexts. A significant concern identified is the perception that biophilic design is too costly to implement within a limited budget (Clark-Havron, 2023). This is echoed by the designers in the study, who acknowledge cost as a barrier but suggest that it can be mitigated through strategic design solutions. By integrating biophilic elements early in the design phase, such as classifying features as either common or uncommon for low-cost projects, designers can minimise additional expenses. Additionally, according to experts (R8 and R9), the construction approach itself can be a flexible design strategy that does not necessarily increase costs, indicating that thoughtful planning can address financial constraints without compromising biophilic principles.

In line with the literature, the study highlights the importance of the government's role in promoting biophilic design. Policy improvements and the creation of biophilic design guidelines, along with incentives for developers and buyers, are crucial in encouraging wider adoption in Malaysia (Liberalesso et al., 2020). Public awareness is another critical factor, as government initiatives that are aimed at educating buyers and stakeholders about the benefits of biophilic design can help drive its acceptance and implementation. These combined efforts, through better policy, design strategies, and public engagement, can support the integration of biophilic design in affordable housing, making it a more feasible and attractive option for both developers and residents.

The study outlines the key factors that hinder the adoption of biophilic design in low-cost housing, with the primary issue being the ignorance of developers and designers regarding how to implement it economically. Designers believe that early design integration and calculated decisions, including categorising biophilic features as common or uncommon, will address cost-

related challenges. The government plays a crucial role in promoting biophilic design by proposing policy changes, establishing biophilic design guidelines, and providing incentives for developers and buyers. Additionally, campaigns aimed at raising public awareness are essential for further promoting biophilic design.

By highlighting how economic considerations, which are frequently viewed as the main obstacle, can be resolved through thoughtful design decisions, the study offers fresh perspectives on the viability of integrating biophilic design in affordable housing. This includes including biophilic features early in the design process and categorising them as typical or more cost-effective choices for low-cost housing. Furthermore, the study emphasises how important it is for the government to support biophilic design through incentives, policies, and public awareness campaigns. This will help to create an environment that is conducive to incorporating biophilic principles into affordable housing projects. Despite these findings, there is a significant gap in practical knowledge regarding how biophilic design can be applied specifically in low-cost housing in the Malaysian context. Although the study indicates that biophilic design has the potential to enhance well-being, little is known about how people interact with biophilic design elements in low-cost housing, especially regarding the advantages and difficulties they perceive. Additionally, although design solutions are suggested, there are not many thorough case studies or actual instances of low-cost biophilic housing projects that have been successful. To improve implementation tactics and guarantee wider adoption in the future, there is a deficit in both real-world applications and residents' input.

CONCLUSION

This study identified several factors influencing the implementation of biophilic design in Malaysia's construction sector, focusing on three main challenges: knowledge and awareness among developers and designers, financial constraints, and the need for governmental support and initiatives. Biophilic design is relatively new in Malaysia, which has led to hesitance among developers and designers who view it as costly. To foster collaboration between these two groups, it is crucial to strengthen their relationship, thereby ensuring that biophilic design can be implemented in a cost-effective manner. Designers often view cost as a significant barrier; however, effective design strategies can mitigate this issue. The government can play a crucial role by providing incentives for green and biophilic design implementation, making it more financially viable. By allocating funding for developments that incorporate green technologies, the government can facilitate the creation of comfortable housing that ensures mental health. Additionally, improving policies and establishing guidelines focused on biophilic design can encourage its implementation. The government should also promote public awareness and education regarding

affordable housing schemes, helping the public to understand the advantages of biophilic design. In conclusion, the successful implementation of biophilic design in low-cost housing requires collaboration among the government, the designers, and the public.

This study recognizes various methodological constraints. First, the expert and designer sample was relatively small ($n=9$), which limits the ability to generalize the findings across the broader professional population. Although the participants provided in-depth and informed perspectives, their views may not fully capture the diversity of opinions among practitioners in other regions or sectors of the built environment industry. Second, the study's limited geographic scope further limited the results' external validity. As a result, the particular professional and local context in which the study was carried out should be taken into account when interpreting the results. To improve the model's generalizability, future studies using a broader and more geographically diverse pool of experts and designers are advised.

This collective effort will contribute to sustainable development goals, particularly SDG 3 (Good Health and Mental Wellbeing) and SDG 11 (Sustainable Cities and Communities), and align with the KPKT's vision for sustainable, affordable housing. While this study offers valuable insights, it faces limitations such as a small sample size and a restricted geographical focus. Future research should investigate the perspectives of designers and developers regarding the implementation of design strategies in low-cost settings to effectively address cost barriers.

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Author 1 and 3 contributed to the conceptual framework development, provided academic guidance, and secured publication funding. *Author 2* was responsible for conducting the literature review, designing the research methodology, collecting and analyzing the data, and drafting the manuscript. All authors reviewed and approved the final version of the article.

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