



THE IMPACT OF BIOPHILIC DESIGN ON RESIDENT WELL-BEING IN MALAYSIA

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Abstract

Biophilic design that integrates natural elements into the built environment is recognized to enhance human well-being and support sustainable development. However, the application of biophilic principles in low-cost housing in Malaysia is still limited, due to financial constraints and a lack of awareness and understanding among residents and stakeholders. This study aims to investigate the key factors of biophilic design in low-cost housing projects in Malaysia, focusing on the level of knowledge and awareness of residents. The study also assesses the potential impact of these design elements on the well-being of residents and their contribution to the Sustainable Development Goals (SDGs), particularly in the aspects of health and sustainable communities. A quantitative approach was used through a structured questionnaire distributed online (Google Form). The survey involved residents of public housing projects such as PPR in Negeri Sembilan and Melaka and PPAM in Putrajaya. The 229 Google Form was analyzed to assess the level of awareness, identify valued design factors, and understand perceptions of the benefits of biophilic design. The study findings show that although residents appreciate natural elements in residential spaces, the level of awareness of biophilic design principles is still low. This study highlights the importance of integrating biophilic elements into low-cost housing designs to improve residents' well-being and support environmental sustainability. This study also suggests the need for educational and policy programs to raise awareness and encourage the adoption of biophilic design in future housing developments. Further research is recommended involving larger sample sizes and expert perspectives for a more comprehensive understanding.

Keywords: Biophilic Design, Low-Cost Housing, Resident Knowledge, Sustainable Development Goal (SDG), Urban Well-being

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INTRODUCTION

Living in dense urban areas is often associated with high psychological stress, especially among low-income communities who are exposed to less conducive residential environments. Environmental stressors such as congestion, noise pollution, lack of green space, and high population density have been shown to contribute to negative impacts on the mental health and well-being of urban residents (Mouratidis, 2021). Meanwhile, low-income communities, especially in low-cost housing areas, the majority do not have access to natural elements that can contribute to natural stress recovery. Referring to previous studies, in this context, the biophilic design approach offers the potential as a cost-effective strategy to improve the indoor environment of the home and support the mental well-being of residents. Biophilic design that integrates natural elements such as natural light, good ventilation, views towards greenery, and the use of natural materials has been shown to be able to reduce stress levels, improve mood, and promote mental recovery (Kellert, 2018; Pouso et al., 2021). Therefore, strategically applying biophilic design principles in low-cost housing can be an effective intervention in addressing the pressures of living in urban areas, while improving the quality of life of low-income communities.

Sustainable Development Goal (SDG) has become central to the global agenda, to ensure safe and affordable housing. In this regard, the application of biophilic design in low-cost houses can help achieve these goals. Residents' knowledge and awareness of these design principles is important, as it affect how they interact with their environment. However, studies on residents' knowledge and awareness of biophilic design in the context of low-cost housing in Malaysia are still limited, particularly in urban settings (Bahauddin et al., 2021). Residents of low-income housing should receive special attention because their living conditions frequently negatively affect their well-being. Although individuals are not well-informed about biophilic design, it can enhance their surroundings.

Low-cost housing, globally and in Malaysia, often faces challenges such as overcrowding, poor indoor environmental quality, poor indoor air quality, limited access to natural resources, and a lack of aesthetic appeal (Amerio et al., 2020; Singh et al., 2019). These issues, including poor lighting and ventilation, can have a detrimental effect on the residents' physical and emotional health, causing tension and discontent. By enhancing the environment and the health of the occupants, biophilic design, which incorporates natural features such as plants and natural light, offers a potential remedy. Despite its advantages being in line with the Sustainable Development Goals (SDGs), biophilic design in low-cost housing is not widely known or used, especially when it comes to how it affects the quality of life of its occupants. Despite the demonstrated advantages of biophilic design, such as reduced stress and enhanced mental health, its use in low-cost housing is still restricted, and residents are not sufficiently aware of its benefits. This disparity matters because biophilic integration has the potential to

elevate living conditions and advance sustainable development priorities. Closing the theory–practice gap is thus essential, as biophilic design an approach that embeds natural elements within built environments supports occupants' well-being and strengthens residents' overall quality of life.

The literature that is currently available on biophilic design in housing and planning mostly focuses on descriptive awareness levels rather than actionable frameworks or implementation dynamics. By offering an empirically supported guiding model that connects biophilic design features to stress recovery results and low-cost housing realities, our work closes that gap and advances the field in a more significant and useful way.

By employing a quantitative survey as the methodology, this study will involve residents from various low-cost housing projects in Malaysia. The findings of this study are expected to provide valuable insight into the relationship between biophilic design and the well-being of residents, as well as support efforts in achieving sustainable development goals in this country. Therefore, this study has the potential to be a guide in the development of more sustainable and quality housing.

LITERATURE REVIEW

Advantages of Biophilic Design in Housing

Biophilic design integrates natural elements into built environments to enhance human well-being and foster connections with nature. It encompasses various principles, including the incorporation of natural elements, adaptive features, and social strategies in residential buildings (Shakhshir & Sheta, 2023). It involves principles such as incorporating adaptive features and creating inclusive spaces, promoting restorative activities for diverse occupants (Tracada & Sorensen Allacci, 2023). Related to "green" architecture, it emphasises sustainability and eco-friendly practices (Merenkov et al., 2019). However, current policies often fail to achieve universal well-being and true sustainability. A design-based approach that enhances public spaces and ecological foundations may be necessary to address these issues and create genuinely sustainable urban environments (Birkeland, 2018). Collectively, these principles redefine and expand the application of biophilic design across various contexts.

Biophilic design in architecture combines nature and innovation to create sustainable, energy-efficient buildings that enhance well-being. This approach necessitates interdisciplinary collaboration and strong research frameworks for effectiveness (O et al., 2023). Studies have evaluated occupant satisfaction with biophilic features in residential buildings and proposed strategies to strengthen the human-nature connection (Shakhshir & Sheta, 2023). Researchers develop multidisciplinary tools to evaluate designs that support healthy living behaviours in various building typologies (Tracada & Sorensen Allacci, 2023). Furthermore, sustainable development principles are applied in

mountain regions to balance natural and built environments, serving as models for similar challenges elsewhere.

Advantages of Biophilic Design in Housing

Biophilic design in housing offers many advantages, including increased occupant satisfaction, energy efficiency, and improved well-being. Biophilic design and green exercise have significant benefits for the occupants' mental and physical well-being. Green exercise, which combines physical activity with natural environments, offers multifaceted psychological, hormonal, and neuroimmunology benefits, contributing to sustainable health and improved quality of life (Durusoy & Mutuş, 2021). Studies show high acceptance of biophilic features such as indoor gardens and vertical farming (Shakhshir & Sheta, 2023). Nature-inspired design enhances sustainability by incorporating natural elements, generating energy-efficient homes, and promoting social well-being (O et al., 2023). Integrating biomimetic design into housing policies can improve resource and energy conservation (Tambe et al., 2023). Additionally, active design for healthy living encourages social interaction and restorative activities, supporting the physical and psychological well-being of occupants of various ages and abilities (Tracada & Sorensen Allacci, 2023). These findings underscore the value of integrating biophilic elements and promoting well-being initiatives in residential.

Low-Cost Housing Design in Malaysia

Biophilic design involves building components, elements, and systems. Components include foundations, walls, floors, and roofs, while elements refer to physical parts such as doors and windows. Building systems include electrical, mechanical, and security. There are two design approaches: active, which uses mechanical devices, and passive, which relies on building design to maximise energy and reduce reliance on mechanical systems (Sharif Bala et al., 2023). Using biophilic and passive design strategies, the four main strategies include incorporating natural elements, maximising natural ventilation, using natural lighting, and promoting biodiversity for well-being.

Several design factors involving and related to building design and services need to be considered in indoor housing. Notably, through previous studies, 11 factors have been identified, namely, Natural light (Kellert, 2008), View of Nature (Ulrich, 1984), Indoor plants and green walls (Lohr et al., 1996), Water Features (Browning et al., 2014), Natural Materials and Textures (Kellert & Calabrese, 2015), Colours and patterns (Kaplan & Kaplan, 1989), Thermal Comfort and air quality (Shakhshir & Sheta, 2023), Acoustic Comfort (Alvarsson et al., 2010) and, Refuge and Pattern and sensory variability (Ahmed & Shukur, 2022). Based on Ibrahim and Al-Chaderchi, (2022) there are different approaches

to the studies of the aspects that contribute to sustainability in several publications and authors.

Low-cost housing in Malaysia faces challenges despite government initiatives that are aimed at alleviating the affordable housing crisis. Key issues include high construction costs, financial constraints for developers, and insufficient enforcement (Syed Jamaludin et al., 2020; Teoh et al., 2018). Factors such as taxes, location, and urbanisation further drive-up prices (Mohd Thas Thaker & Ariff, 2020). Meanwhile, programs such as the 1Malaysia concept support low-income groups, stakeholders recommend adopting alternative construction methods, using local materials, and fostering public-private partnerships to improve affordable housing projects.

The development of low-cost housing faces challenges such as quality, accessibility, and high initial costs for sustainable practices. Financial constraints and lack of design expertise hinder the integration of affordability and sustainability (Adetola Adewale Akinsulire et al., 2024; Syed Jamaludin et al., 2020). Compromises often arise in design, construction quality, and access to amenities due to rapid urbanisation (Hasan et al., 2018). However, policy innovations such as green building standards and public-private partnerships offer potential solutions, emphasising the need for economic, socio-cultural, and environmental sustainability (Agarwal et al., 2021).

The design of low-cost housing is shaped by local culture, climate, and economic factors. Incorporating traditional elements and passive solar systems can enhance sustainability, however, challenges such as cheap energy and limited access to sustainable materials exist (Al-Haroun, 2021). Inclusionary housing policies and adaptive reuse of buildings can address shortages while preserving local identity (Jamelle, 2021). Quality function deployment methods help prioritise customer needs, emphasising cost-effective materials and flexible designs (Salim & Alabdouli, 2022). Government support through incentives and policy-making is vital for promoting sustainable, affordable housing solutions.

Case Study of Biophilic Housing in Malaysia

In Malaysia, factors influencing house-buying decisions include income, location, and government incentives, with variation among income groups (Zulkifli & Ismail, 2023). There is a positive relationship between awareness levels and green building practices in Malaysia, with government support being crucial to increase awareness (Sabar et al., 2018). According to Syed Jamaludin et al. (2020), a lack of commitment from stakeholders is the key challenge in developing affordable and sustainable housing in Malaysia despite financial constraints. These studies highlight the importance of sustainable and biophilic design in housing, as well as the challenges in implementing such practices in developing countries like Malaysia.

Residents' Knowledge and Awareness

Recent studies emphasise the importance of biophilic and sustainable design in residential buildings, with a focus on the knowledge and perceptions of stakeholders. Although residents appreciate the conservation and biophilic elements, with high acceptance of adaptive balconies and interior gardens, awareness of certain programs is still low (Shakhshir & Sheta, 2023; Ureta et al., 2021). Factors such as environmental concerns, marketing, and government incentives influence the acceptance of green buildings (Durdyev & Tokbolat, 2022), but cost remains a major obstacle, even if the residents are willing to invest in energy improvements (Vassiliades et al., 2023).

To promote adoption, experts suggest financial incentives, better communication, and stakeholder-oriented strategies. Incorporating biophilic design can enhance the occupant's experience and guide future development. In areas such as Dubai, residents value biophilic features such as roof gardens (Shakhshir & Sheta, 2023) but awareness of certain urban planning measures is low in places such as Bangkok and Bangladesh.

Residents' awareness of biophilic design is influenced by various factors. Satisfaction with biophilic features varies by building type (Shakhshir & Sheta, 2023). In Malaysia, greater awareness correlates with effective green building practices (Sabar et al., 2018). However, socio-economic barriers, particularly costs, hinder the adoption of bioclimatic strategies (Vassiliades et al., 2023). While government support and education can help overcome cost challenges, a participatory approach with multiple stakeholders can improve integrated decisions (Eker et al., 2018). Resident knowledge is essential in creating energy-efficient homes, and benefits mental health.

Implications for Sustainable Development Goal (SDG)

The relationship between biophilic design and the Sustainable Development Goals (SDGs) encompasses green innovation, climate change mitigation, and sustainable forestry practices. Green innovation in SMEs significantly impacts community development and environmental activities, bolstered by government support (Ullah et al., 2023). Climate change actions can offer co-benefits and trade-offs with the SDGs, necessitating a deep understanding of these interactions for effective policies (Cohen et al., 2021). The SDGs aim to address global challenges such as poverty and health, with connections between SDG 4, SDG 11, and SDG 9. Biomimetic architecture offers insights for designing housing that promotes energy efficiency, waste management, and occupant well-being (Tambe et al., 2023). Participatory system dynamics modelling reveals that investments in communal spaces positively impact the adoption of energy-efficiency measures and resident well-being (Eker et al., 2018). In response to challenges posed by the COVID-19 pandemic, recommendations for healthy and sustainable housing include incorporating visible green spaces, flexible living

areas, and sustainable architecture principles (D'alessandro et al., 2020). These findings underscore the importance of integrating nature-inspired elements and communal spaces in housing design to enhance community well-being and promote sustainable living environments.

Based on the literature review, there is a lack of adoption of biophilic design in low-cost housing, particularly in Malaysia, due to financial constraints and lack of expertise. There is a need for more practical guidance models, taking into account cost-effective biophilic elements. Population awareness of biophilic design is also still low, and this affects its acceptance in low-cost housing. Further research is needed to understand the impact of this design on mental and physical well-being, as well as how it supports the Sustainable Development Goals (SDGs), especially SDG 3 and SDG 11.

RESEARCH METHODOLOGY

This study conducts a quantitative survey. Data is collected through the distribution of a questionnaire in Google Form. This questionnaire was produced through the findings found in the previous stage, whereby 11 factors are identified that can be considered in biophilic design in housing. 11 factors that have been identified, namely, Natural light (Kellert, 2008), View of Nature (Ulrich, 1984), Indoor plants and green walls (Lohr et al., 1996), Water Features (Browning et al., 2014), Natural Materials and Textures (Kellert & Calabrese, 2015), Colours and patterns (Kaplan & Kaplan, 1989), Thermal Comfort and air quality (Shakhshir & Sheta, 2023), Acoustic Comfort (Alvarsson et al., 2010) and, Refuge and Pattern and sensory variability (Ahmed & Shukur, 2022).

The open questions are to enable the respondents to share their thoughts about biophilic design before closed-ended questions are used to validate the results from the open questions that have been given (Creswell & Creswell, 2018). This survey includes PPR residents from Negeri Sembilan and Melaka, while PPAM is designated for residents in Putrajaya. These three areas are classified as having the highest urban population percentages according to the Department of Statistics Malaysia (DOSM) in 2022: Putrajaya at 100%, Melaka at 90.9%, and Negeri Sembilan at 69.3% (Perdana et al., n.d.) The other criterion is household income, which falls within the low range and is insufficient for homeownership based on the national median house price of RM 293,000.00. Melaka has been identified as one of the states with relatively unaffordable housing, while Negeri Sembilan has been categorised as very unaffordable for homeownership (Ismail et al., 2019). A total of 229 responses were collected from respondents. This questionnaire uses a self-administered and an on-site distribution method. This combination method can reduce measurement error and at the same time speed up the response rate. This research applies Roscoe's guidelines and utilizes a sample size ranging from 100 to 200 for data analysis. It includes considerations

for sampling and sample size by estimating a response rate plan and distributing questionnaires accordingly to ensure an adequate sample size. The Likert scale employed for this survey is a binary yes/no format. This questionnaire uses self-administered and on-site distribution method. This combination method can reduce measurement error and at the same time speed up the response rate. The questionnaire distribution period is for 1 month starting from the beginning of July 2024 until the beginning of August 2024. On site survey also uses the same google form.

Although the study obtained responses from a relatively large sample of 229 residents, the analytical depth is limited by the use of a binary Yes/No response scale. While this dichotomous format allowed for straightforward interpretation and clear categorisation of residents' perceptions, it restricted the ability to capture more nuanced variations in attitudes, strength of agreement, or underlying motivations. The absence of intermediate response options may have oversimplified residents' actual experiences and preferences, thus constraining the potential for deeper statistical or inferential analysis. Future studies should consider employing multi-point Likert scales in order to derive richer, more granular insights into residents' perceptions and behavioural tendencies.

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.

ANALYSIS AND DISCUSSION

Respondent Demographics

Residences Location

The demographic profile consists of 229 participants, with 21.8% (50 individuals) answering the Google Form in English and 78.2% (179 individuals) in the Malay language. Regarding their residence, 48.9% (112 individuals) live in PPAM (Perumahan Penjawat Awam) in Putrajaya, 30.6% (70 individuals) in PPR (Program Perumahan Rakyat) in Negeri Sembilan, and 20.5% (47 individuals) in PPR in Melaka. By revealing the number of residences based on location, the respondents' sample size was descriptively described.

Table 1: Residents Locations

Demographic Profile	n	%
live at		
PPAM (Perumahan Penjawat Awam) in Putrajaya	112	48.9
PPR (Program Perumahan Rakyat) in Negeri Sembilan	70	30.6
PPR (Program Perumahan Rakyat) in Melaka	47	20.5

Source: Authors' Analysis, 2024

SocioEconomics

Employment status reveals that 44.1% (101 individuals) are employed, 23.1% (53 individuals) are unemployed, 12.2% (28 individuals) are retired, and 20.5% (47 individuals) are students. Regarding income, 75.5% (173 individuals) fall into the B40 category (earning less than 6k), 21.0% (48 individuals) are in the M40 category (earning 6k to 10k), and 3.5% (8 individuals) are in the T20 category (earning above 10k). Household sizes vary, with 3.1% (7 individuals) having 1 member, 11.4% (26 individuals) having 2 members, 20.1% (46 individuals) having 3 members, 25.3% (58 individuals) having 4 members, and 40.2% (92 individuals) having more than 4 members.

Table 2: Employment Status, Income Level and Household

Demographic Profile	n	%
employment status		
Employed	101	44.1
Unemployed	53	23.1
Retired	28	12.2
Students	47	20.5
income		
B40 (<6k)	173	75.5
M40 (6k – 10k)	48	21.0
T20 (>10k)	8	3.5
household		
1	7	3.1
2	26	11.4
3	46	20.1
4	58	25.3
More than 4	92	40.2

Source: Authors' Analysis, 2024

This data shows that the highest household in affordable housing is more than 4 persons per house based on a sample size (n=92), and they consist of employed persons classified within the income category B40 with a monthly income of <6k.

Further analysis on the biophilic design factors that can be considered in indoor housing is through the residents' perspectives, which focus on knowledge and awareness.

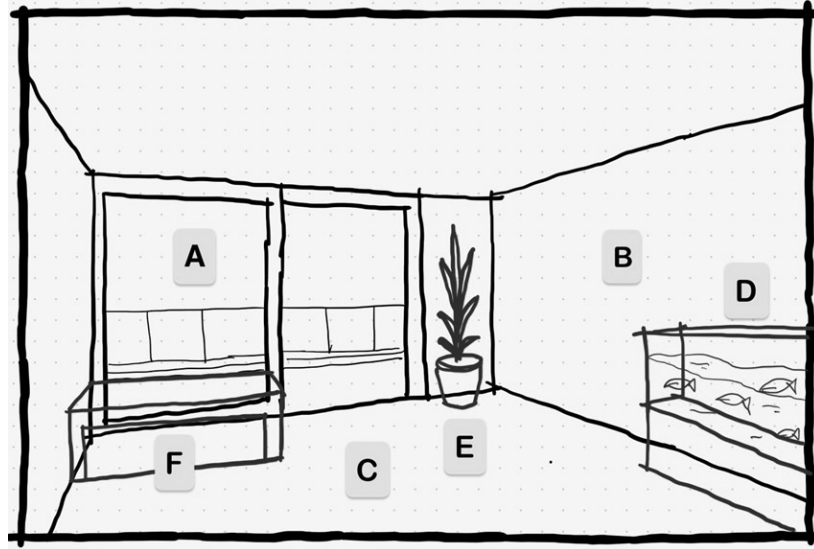


Figure 1: Spaces Illustration for Questionnaire

Table 3: Analysis on Residents Knowledge and Awareness

Item	Mean	Std. Deviation
A1. Natural Light: Are you aware of the benefits of natural light from A on your well-being?	1.1135	0.31794
A2. View of Nature: Do you know that having a view of nature through A can reduce stress?	1.2227	0.41697
A3. Natural Ventilation: Are you familiar with the advantages of natural ventilation that get through from A in giving you comfort feeling in the house?	1.2183	0.41402
A4. Material Texture: Did you aware that by looking at the nature materials (eg : wood and stone) that apply on B and C can improve your emotional condition? ?	1.2661	0.44291
A5. Colour and Patterns: Are you aware that natural colours and patterns (eg: botanical and animal pattern) that apply on B can create a calming and aesthetically pleasing environment?	1.2500	0.43397
A6. Thermal & Air Control: Do you understand the importance of balanced heat gained and losses to maintain the body's core temperature for a healthy indoor environment?	1.2412	0.42877
A7. Acoustic Comfort: Are you aware of the impact of natural materials and design such as wood, stone, and bamboo on reducing noise pollution indoors?	1.2807	0.45033
A8. Water Features: Do you know that indoor water features such as D can enhance relaxation and stress recovery?	1.2996	0.45908
A9. Indoor Landscape: Are you familiar with the benefits of having indoor plants and green spaces like E?	1.3100	0.46352
A10. Refuge and Prospects: Do you know that designing cozy window seating as F to provides views of the surrounding areas can enhance feelings of security and well-being?	1.2807	0.45033

Item	Mean	Std. Deviation
A11. Sensory Variability: Are you aware of the importance of textures such as wood and stone and scents of aromatic plants in creating a stimulating indoor environment?	1.2096	0.40792
	1.2448	0.42598

Source: Authors' Analysis, 2024

Through this analysis, it can be identified that of the 11 biophilic design factors listed, several of them can be implemented in the context of low-cost housing. The results of interviews and surveys show that residents have a good level of awareness of the benefits of indoor landscaping, in line with the findings of Shakhshir and Sheta (2023) who reported residents' satisfaction with biophilic elements such as adaptive balconies and indoor gardens. In addition, residents also showed an understanding of the benefits of water features, refuge and prospects, acoustic comfort, natural materials and textures, and the use of color and pattern in improving their psychological and emotional well-being (Ahmed & Shukur, 2022; Browning et al., 2014; Kaplan & Kaplan, 1989; Shakhshir & Sheta, 2023)

However, the implementation of some elements such as water features faces physical constraints, especially in terms of limited space in low-cost houses. As an alternative, some residents choose to place small aquariums as a source of tranquility and the element of water in their homes. This shows that despite design constraints, residents' creativity and awareness allow them to adapt biophilic elements in an appropriate and effective way (Durusoy & Mutuş, 2021).

At the same time, this study also revealed that there are four design factors that are poorly understood or not paid attention to by residents, namely indoor temperature and ventilation control, view of nature, natural ventilation, and sensory variability. The lack of awareness of these factors may be due to the lack of information or direct experience about them, especially elements that are not in their daily line of sight (Kellert, 2008; Lohr et al., 1996; Ulrich, 1984). These findings indicate that residents' level of awareness of biophilic design is greatly influenced by its visibility and accessibility in residential spaces (Ureta et al., 2021; Vassiliades et al., 2023)

The order of design factors identified in this study based on residents' knowledge and awareness can be used as an initial guide in developing a model for implementing biophilic design in low-cost housing. However, this order should be re-evaluated in terms of its suitability for implementation according to needs, physical space, and financial capabilities in the actual context of affordable housing (Syed Jamaludin et al., 2020; Tambe et al., 2023). Adapting this order can strengthen the effectiveness of the design in achieving the main goal of improving well-being and reducing stress among residents (Tracada & Sorensen Allacci, 2023).

CONCLUSION

This study has been able to identify residents' knowledge and awareness of the presence of biophilic design in their housing. The eleven design factors identified were acknowledged by residents; however, due to cost constraints that resulted in low-cost housing design standards, some design factors were less recognised. Among the various factors contributing to residents' unawareness is a lack of knowledge regarding biophilic design in their homes. They do not realise that these factors can positively influence their mental health and improve their well-being. The residents' socioeconomic status also contributes to their lack of awareness. Notably, the B40 group is obliged to buy a house based on their income level. Due to a lack of input and awareness regarding the implementation of biophilic design, they tend to focus solely on the existing features of the house, believing that this is all they are entitled to, without attempting to adapt biophilic design principles to their own preferences. This mindset contributes to the reason why biophilic design is often associated with being unaffordable. The implementation of biophilic design is very important to help achieve the Sustainable Development Goal (SDG). The limitation of the study is a certain sample size, which does not represent the entire population of low-cost housing in Malaysia. The recommendation for future work is a study related to how this biophilic design factor can be implemented in low-cost housing with a low-cost setting so as not to affect the price of the house, so that this biophilic benefit can be savoured by low-income residents. Further research is strongly encouraged involving larger sample sizes and perspectives from experts in various fields such as environmental psychology, architectural design, and cost estimators. This approach will allow for a deeper and more comprehensive understanding of the effectiveness of biophilic design elements in the context of low-cost housing. Overall, this study strengthens the planning and housing literature by moving beyond descriptive awareness studies to the development of a guiding model based on empirical analysis. This study explains how biophilic elements can be practically integrated into low-cost housing while enhancing occupant stress relief, thus contributing new approaches to theory and practice.

Furthermore, the involvement of experts can help identify real challenges on the ground and formulate more practical and interdisciplinary recommendations. This is important to ensure that the guidance model developed is truly relevant, applicable, and has a positive impact on the well-being of residents holistically.

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AUTHOR CONTRIBUTIONS

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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