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The Application of Green Elements in Bungalow Residential Projects

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ABSTRACT

Energy usage is the main culprit in multiple environmental problems. Usage of energy in residential sectors has contributed significantly to the primary energy consumption. Almost one million metric tonnes of carbon dioxide (CO^2) can be reduced by applying green building elements in constructing, operating, and designing residential structures. Integrating green building elements as sustainable strategies can help to consume less energy and water while lowering carbon emissions. Extensive application of green building elements can uplift the detrimental impacts of development towards the environment. Thus, this study aims to investigate the green building elements suitable for bungalow residential projects in Malaysia. The achieve the aim of this study, three (3) objectives are utilised which are to identify green elements appropriate for residential bungalow developments, to determine green elements that work best for bungalow projects, and to analyse the barriers in applying the green elements in bungalow residential projects. The method for data collection administered in this study is semi-structured interviews with property developers that have involved in bungalow residential projects. The data collected has highlighted green building elements such as energy efficiency, waste management, and indoor environmental quality as crucial foundations for environmentally responsible and sustainable designs. The combination of these elements is necessary and effective to reduce energy usage and CO^2 emissions for bungalow residential building projects.

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INTRODUCTION

Green building standards are frequently overlooked, especially when applied to residential buildings, presumably due to financial considerations. This leads to why most residents opt to install air-conditioning and mechanical ventilation systems that will consume more electricity and produce carbon emissions to achieve comfortable indoor air quality. Elias & Chong (2015) also stated that green development has become the new global objective that promises the sustainability of the human way of living. The surrounding environment must also be protected from any harm from the intensive development required to pursue economic progress. The construction sector plays a significant role in raising the Malaysians' standard of living by producing more green buildings in Malaysia.

The world believes that green buildings bring potential solutions to this catastrophic energy crisis. Several sources have provided definitions of green buildings as a technique for making the most of resources while considering how the building would affect the environment and people's health. This is described over the span of a building's life cycle, which includes planning, designing, constructing, operating, maintaining, renovating, and demolishing. Empirically, it has been demonstrated that using green construction techniques and integrating different green envelope elements effectively reduces energy use, especially in nations with hot climates like Malaysia (Alaidroos & Krarti, 2015; Olanrewaju et al., 2021). According to Elias & Chong (2015), green development is crucial for developing nations such as Malaysia, as well as for developed countries such as the United States. According to Aldhshan et al. (2021) and Farabi et al. (2019), energy consumption is the main culprit behind various environmental problems such as global warming, greenhouse gasses, air pollution and climate changes. The ability of a building to achieve long-term sustainability through energy efficiency is one of the requirements for green residential construction (Olanrewaju et al., 2021). It can be accomplished by applying green technology applications such as recycled materials, solar systems, and rainwater collection. Therefore, this study aims to investigate the green building elements suitable for bungalow residential projects in Malaysia.

LITERATURE REVIEW

The definition of 'Green Building' is said to be evolving and can be simplified as buildings that have features and qualities using sustainable practices which consume less energy, produce less pollution and environmentally friendly (Ching & Shapiro, 2021; Ismail et. al, 2015). Green building is the process of designing and constructing buildings using resources and environmentally conscious methods at every stage of a building's life cycle. According to Jackson (2022), a building to be considered as a green building will have to have elements of green building which can be called as green building components. The green building components include materials used during construction and operation, which can have benefits for the environment and the people occupying the space (Jackson, 2022).

Green Building Initiatives in Malaysia

The growing emphasis on environmental issues have encouraged the green building practices in the Malaysian construction sector. Razman et al. (2023) elaborated that this scenario has captured the attention of construction professionals and government agencies, thus, persuading the stakeholders to incorporate environmental concerns into operations. Align with this effort, the Ministry of Economic Affairs has revised the Eleventh Malaysia Plan 2016 to 2020, which emphasised several important areas, including promoting environmental sustainability through green growth. The goal of green growth efforts is to ensure that natural resources will be available to both current and future generations. It also seeks to improve environmental quality by reducing greenhouse gas (GHG) emissions for increased well-being.

One of the main outcomes of the Eleventh Malaysia Plan (2016-2020) is The Green Technology Master Plan (GTMP). The GTMP aims to integrate sustainable practices into the construction sector recognising

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green growth as a key driver of national development in Malaysia (Ministry of Energy, Green Technology and Water Malaysia (KeTTHA), 2017). According to CIDB (2023), the Malaysian government strives to intensify their green growth efforts by promoting green building investment and demand through implementing policies such as the Green Building Index (GBI) certification system and the Green Technology Financing Scheme. Green tax incentives are also offered to encourage stakeholders to take part in uplifting sustainable development as one of the green growth efforts (CIDB, 2023). Moreover, Razman et al. (2023) added that the Malaysian government has developed several green building rating tool and construction policies after the success of GBI such as the Malaysian Carbon Reduction and Environmental Sustainability Tool (MyCREST), Green Real Estate (GreenRE), Green Performance Assessment System (GreenPASS) and Penarafan Hijau Jabatan Kerja Raya (PHJKR).

Green Building Index (GBI) Residential New Construction (GBI-RNC)

The Green Building Index (GBI) organisation, a division of Pertubuhan Arkitek Malaysia (PAM) and the Association of Certified Engineers (ACEM) has introduced the Green Building Index (GBI) as the nation's local green building rating system in May 2009 (Makmor et al. 2015). The GBI rating tool offers property developers and building owners the chance to design and build environmentally friendly, sustainable structures that provide a healthier indoor environment, better accessibility to public transportation, the adoption of recycling and greenery for their projects, and help minimise the environmental impact of construction. The Green Building Index - Residential New Construction (GBI-RNC) is intended to assess a new constructed residence in Malaysia's tropical climate (Aldhshan et al., 2021; Elias & Chong, 2015; Chua & Aziz, 2024). Table 1 shows the GBI assessment criteria entailing six (6) criteria for new residential projects and GBI ratings.

Table 1. Green Building Index Assessment Criteria for Residential New Construction and GBI Rating

Green Elements	Maximum Points	GBI Rating	Points
Energy Efficiency (EE)	23	Platinum	86 to 100 points
Indoor Environmental Quality (EQ)	12	Gold	76 to 85 points
Sustainable Site Planning & Management (SM)	33	Silver	66 to 75 points
Material and Resources (MR)	12	Certified	50 to 65 points
Water Efficiency (WE)	12		
Innovation (IN)	8		

Source: GBI-RNC (2014)

Based on the GBI-RNC criteria, green elements integration in a new residential building shall comprise of initiatives to reduce the energy consumption of the building. According to Mazli & Fauzi (2022), designing the house to include day lighting, ventilation, heat reduction can be applied to reduce the usage of energy for lights and air-conditioner. Furthermore, usage of solar photovoltaic (PV) technology to supply the electrical energy without environmental pollution is relatively suitable in Malaysia due to the high solar energy (Aldhshan et al., 2021). Water efficiency by using rainwater harvesting can allow to save the usage of water in the residential building. This can be attained by installing green roof to the new residential buildings (Aldhshan et al., 2021; Mazli & Fauzi, 2022). Moreover, usage of five stars energy efficiency appliances in the building can also help to induce the innovation used for the residential building (Mazli & Fauzi, 2022).

Barriers to Apply Green Elements in Residential Projects

Malaysia's high energy consumption and potential to double its energy demand in the next seven (7) years make green buildings more expensive than conventional structures (Aldhshan et al., 2021). The construction sector is likely to encounter obstacles when implementing green building practices (Yee et al.,

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2023). The barriers can be categorised into five (5) categories which are economic concerns, market demand and attitude, government engagement, technology and training, and awareness (Chan et al., 2017; Yee et al., 2023).

The first barrier to apply green elements in residential development is economic concerns. In comparison to conventional buildings, the cost of a sustainable building in residential will be higher due to the high cost of green materials (Kibert, 2016; Kumar & Agrawal, 2022). Companies with limited financial resources will struggle to execute sustainable construction. A further problem affecting the construction industry is the motivation for builders to use green building techniques (Mustaffa et al., 2021). Normally, green practices will be integrated if it receives financial incentives. Thus, causing the construction sector to be profit-driven and reluctant to adopt sustainable building practices (Ha et al., 2020).

Next, the attitude of the stakeholder where it can be seen in older generation where they are unwilling to learn new techniques and new technologies. Using the traditional way is favourable which results in pollution and is not environmentally friendly (Khoo, 2016). Additionally, the client's preparedness to embrace the trend without considering financial gain will guarantee the implementation of green elements in the project (Kibert, 2012). Market demand in the construction industry entices the market supply of green technologies. The market's willingness to invest in the development of green buildings is influenced by public and client attitudes (Ha et al., 2020).

Government engagement in the form of financial and non-financial incentives, building laws, and policies should also be the primary driver of green building construction and development, as these measures have a direct impact on the application of green building practices (Qian & Chan, 2010). However, some governments' disregard for this problem and failure to lead the green building industry by providing incentives or financial support inhibits the usage of green building technologies (Chan et al., 2009). The building industry will not be concerned about environmental issues if the government fails to comprehend them or how important it is to use green practices. This is because there will not be any rules or legislation enforcing the usage of green practices on the property (Ha et al., 2020).

Since the idea of green building has just gained popularity in Malaysia, new materials and construction techniques are required. It is challenging for developers, contractors, and subcontractors to obtain all the materials and technology needed for the construction of green buildings, nevertheless, because these resources are still in short supply (Corbett, 2007; Kumar & Agrawal, 2022). Before being used, any new use of materials should be examined to ascertain its capabilities. To get the most accurate outcome, the latest materials and technologies should be assessed, and their performance should be compared to a comparable product. Some unforeseen issues with the green construction concept, materials, and technologies create barriers (Ha et al., 2020; Mustafa et al., 2021).

The advancement of green building is being halted by ignorance and need for more understanding (Mustafa et al., 2021). According to Wright & Wilton (2012), a thorough interview was conducted, and the results indicate that senior management's ignorance and insensitivity will have an impact on the construction company's desire to include green practices in its projects. The study demonstrates that, despite their concern for environmental issues, top management needs to truly grasp sustainable development. In addition, the construction company will have to deal with the issue of its employees' lack of technological literacy, which makes it difficult for them to manage and control green technology. The implementation of sustainable development will be hampered by this (Wright & Wilton, 2012; Kumar & Agrawal, 2022).

Ha et al. (2020) also stated that people's motivation to consider sustainable development is also a barrier to implementing sustainable development. Construction businesses will be less motivated to explore sustainable development if they do not obtain incentives and support for energy-efficient construction projects. Small and medium-sized businesses that lack sufficient cash and do not receive any incentives or grants cannot achieve sustainable development. According to Hopkins (2016), there are fewer possibilities and rewards in higher education, leading to fewer people with advanced degrees understanding new technology. Furthermore, a lack of infrastructure will reduce construction businesses' incentive to

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participate in sustainable development (Horhota et al., 2014). There is no driving force to push the realisation of green building without incentives; hence, the implementation of sustainable development will fail (Ha et al., 2020).

METHODOLOGY

Qualitative research is the method used in this research. This method was selected over the quantitative method due to a great deal of flexibility (Mwita, 2022). It enables the researcher to see and pinpoint additional problems not initially considered or covered during the study's conception phase. Semi-structured interviews were conducted to collect data in this study. The research focused on developers that have involved in green bungalow residential projects in Klang Valley. Due to the scarcity of green residential development focusing on bungalow projects in Klang Valley, this research has successfully interviewed four (4) developers for the purpose of data collection. The data collection was sufficient as it has reached the saturation point.

ANALYSIS AND FINDINGS

The data collection covered four (4) primary areas which are the types of green elements that are suitable to be applied in bungalow projects based on the bungalow house developer's perspectives, the application of green elements from the bungalow developer's previous projects, barriers to apply green elements from developer's perspectives and opinions and recommendations from the participants. Table 2 provided the list of codes for green elements included in the interview.

Table 2. List of Codes for Green Elements

No.	Green Elements	Code
1.	Energy Efficiency	GE
2.	Greenery	GG
3.	Water Efficiency	GW
4.	Sustainable Construction	GS
5.	Waste Management	GM
6.	Indoor Environmental Quality	GI
7.	Public Transportation	GP

Adapted from: *Life Science Journal* (2013)

Green Elements Commonly Applied in Bungalow Developments

The majority of the participants agreed that Waste Management (GM) and Indoor Environment Quality (GI) are the most crucial green elements to be applied in residential projects. Participant 2 explained that waste management on-site is primarily the responsibility of the contractor's decision and planning unless the Contract Document specifies a Standard of Operation for waste management that the employed contractor must adhere to. It also depends on the site bank, which is a location allocated and designated for material stockpiling or storage. Other than that, GI mainly describes the state of the environment inside buildings and is influenced by several variables. Participant 2 elaborated the variables such as lighting, acoustics, air quality, and temperature that have an impact on the occupants' comfort, health, and well-being. Noise control is also included the GI element.

Participant 1 explained that reducing unwanted noise from external sources, particularly in urban areas, HVAC systems, and other building operations, improves comfort. Soundproofing materials and architectural factors, such as keeping noisy equipment away from occupied areas, can be beneficial. Aside from that, proper acoustic design, which includes the use of sound-absorbing materials and reducing reverberation, can contribute to a comfortable auditory experience.

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The next element is water efficiency (GW), which include water-saving appliances and water-efficient fittings. Participant 3 stated that the developers are not responsible for appliances and fittings, especially in designing bungalow buildings. Nevertheless, they highly advise users to opt for any alternatives available to maximise water efficiency, such as installing dual-flush toilets, which are currently very common in residential and commercial buildings. Following GW, Energy Efficiency (GE) is the commonly used green element and in residential buildings. Apart from reducing the use of energy and maximising renewable energy, GE also reduce the need for heating, cooling, and lighting by using energy-efficient design principles, including appropriate building orientation, insulation, and window placement. The participants have collectively agreed that the theme of the project influence the incorporation of green elements on the bungalow units. Moreover, site location including the land's topography, street access, and neighbour placement also contribute to the decisions. Participant 2 stated that energy-efficient appliances are rare in buildings since most units have basic electrical wiring for air conditioning, lights, and ceiling fans. This is because most owners are more inclined to decide the appliances they prefer to use.

The remaining three (3) green elements are sustainable construction (GS), greenery (GG) and public transportation (GP). Participant 1 discussed that GS, GG and GP have more considerable initial costs due to the requirement for specialised materials, technologies, and design knowledge. Developers and investors may hesitate to invest in these initial costs unless there are apparent short-term financial benefits. Participant 4 added that while GS and GG frequently result in lower operational costs and energy savings, these long-term advantages are occasionally neglected in favour of current budget restrictions.

Elements Application in the Developer's Previous Projects

The second section of the semi-structured interview included the motivations that encourage the developers in applying green elements and the common green elements adopted in bungalow house developments. Most of the participants collectively agreed that their motivation for the application of green features was to raise awareness of climate change, establish a precedent in the building sector, and obtain GBI points or the green building certificate. Participant 1 elaborated that obtaining green building certifications, awards, and incentives is more about enhancing the reputation of the company.

Proper natural ventilation is one of the common green components that they have used in their previous projects. Participant 2 emphasises that a window that allows for natural airflow is a must in a space aside from a space intended for storage. In addition, materials that limit solar heat intake are installed in walls and roofs. Participants 1 and 4 recommended that residential buildings employ weather-tolerant and cost-effective building materials to cope with Malaysia's intense heat. Other than that, there is extensive landscaping on the premises. Participant 3 stated that their bungalow development frequently includes significant landscaping for many reasons, including aesthetic, practical, and environmental factors. Bungalows are typically one-story buildings, as opposed to multi-story homes. The single-story form promotes a horizontal orientation and a closer relationship with the surrounding landscape. Participant 4 responded that well-kept and planned landscaping can increase the property's value. This proves that extensive landscaping not only improves the homeowner's enjoyment but also contributes to the bungalow's market value.

Barriers in Applying Green Elements

This section of the interview aimed to uncover the challenges and restrictions that developers faced when incorporating green elements into their projects. The implementation of green aspects is hindered by some factors, including a lack of awareness from industry players, minimal incentives from the government, and high cost as a first basis. Participant 3 highlighted that energy-efficient technology, environmentally friendly materials, and eco-friendly behaviours are examples of green features that can be implemented; however, they involve higher initial costs. Private enterprises could be reluctant to undertake these investments without financial incentives, particularly if the immediate return on investment is uncertain. The implementation of green elements is hampered by a variety of causes, ranging from a lack of knowledge

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among industrial players to insufficient government incentives and high initial costs. Participant 3 added that green features could be featured by its energy-efficient technology, environmentally friendly materials, and eco-friendly behaviours, but they come with a higher initial cost. Private firms may be hesitant to make these investments without financial incentives, especially if the immediate return on investment is questionable.

The implementation of green elements is hampered by a variety of causes, ranging from a lack of knowledge among industrial players to insufficient government incentives and high initial costs. Participant 3 added that green features can be featured by its energy-efficient technology, environmentally friendly materials, and eco-friendly behaviours, but they come with a larger initial cost. Without financial incentives, private firms may be hesitant to make these investments, especially if the immediate return on investment is questionable.

Recommendations on Applying Green Elements

The last section of the interview included recommendations from the participants related to the application of green elements in bungalow residential projects. Participant 1 stated that as they managed to face the challenges and opportunities of urban development in an ever-changing setting, a compelling vision for a sustainable and ecologically conscientious future emerged. Participant 1 hoped that all developers will thoughtfully consider solar panels and include them in future property development. Participant 1 added that developers and homeowners stand to gain much from this thoughtful incorporation of solar technology, which might usher in a new era of responsible and progressive urban development.

Participant 2 emphasised that profit and reputation are the only factors a private business organisation takes into account when making decisions. Therefore, it may be possible to enhance the use of green elements in Malaysian bungalow residential developments by offering incentives, rewarding the developer, and mandating green aspects from the authorities. Participant 2 focuses on profit as the main factor feeling private company organisations and stresses the dominating economic reasons behind them. Participant 2 added that reputation is a crucial component for private companies, where the idea of being environmentally conscious can become a powerful motivator since it builds client loyalty and trust. Hence, incentives are a useful tactic to encourage private developers to incorporate sustainable features. Apart from that, Participant 2 elaborated that developers may be more likely to invest in green technologies if environmentally conscious enterprises are highlighted and rewarded, not just for the financial benefits but also for the prestige that comes with sound recognition. Finally, regulations can provide fairness by requiring developers to adhere to environmentally friendly techniques, regardless of their financial interests.

Participant 3 opined that bungalows will continue to be the preferred option for clients in the future if their needs are fulfilled. Before the house keys are handed over, we also give homeowners instructions on how to maintain their property's green features. Thus, participant 3 mentioned that the best way to increase the use of green elements in bungalow residential projects is to make sure the chosen contractor is knowledgeable about them so that each project can meet the standards for green elements. Participant 3 stated that spreading the word to all Malaysians about the importance of these green elements in the future. Participant 3 highlights that the more extensive campaigning will bring a change in culture which can be achieved by educating the public about the value of green elements.

Participant 4 stated that it is imperative that local authorities consider encouraging environmentally friendly practices through public awareness campaigns, green building certification incentives, and the implementation of legislation that fosters sustainable construction and cost-effective technologies. Participant 4 emphasises the importance of local government, describing them as influential figures with the ability to promote eco-friendly behaviour. Participant 4 elaborated that the local governments can lay the foundation for public support and involvement in green programmes by raising awareness. Other than that, incentives can take the form of monetary gains or expedited approval procedures. Such encouragement provides substantial advantages for developers who invest in and adhere to green construction requirements.

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Furthermore, Participant 4 mentioned that the demand for laws that promote sustainable building emphasises the necessity of a legal system that actively encourages and requires ecologically beneficial behaviour. For developers, legislation can establish precise requirements, benchmarks, and guidelines that guarantee the incorporation of sustainability into construction methods.

CONCLUSION

Malaysia's high energy consumption is the main drive to incorporate green elements in the developments especially in residential projects. The primary challenges to green building development include greater upfront expenditures, a lack of education among professionals, and high consumer expenses. Therefore, this research aims to investigate the green building elements suitable for bungalow residential projects in Malaysia. Qualitative method was utilised and data from four (4) participants with extensive experience developing bungalow buildings were analysed. From the data collected, waste management, water efficiency, energy efficiency, and indoor environmental quality were the most suitable green elements to be incorporated in bungalow residential projects. Nonetheless, green elements such as energy efficiency, greenery, waste management, and indoor environmental quality have been implemented in few prior bungalow projects. Moreover, multiple obstacles to implement green elements were analysed including insufficient government funding, a deficiency of comprehension among industrial participants, and financial limitations. To overcome these barriers, it is imperative to promote sustainable practices through public awareness, government intervention, incentives inclusion and implementation through legislation. In conclusion, green elements can be further incorporated in new bungalow residential as some elements have already being incorporated in few prior projects such as energy efficiency, waste management, and indoor environmental quality. This serve as an important foundation for developers to be more ecologically responsible and sustainable in practice.

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AUTHORS' CONTRIBUTIONS STATEMENT

The authors confirm contribution to the paper as follows: study conception and design: S. N. Mohamad Zahid, N. A. Ahmad Bari; data collection: S. N. Mohamad Zahid; analysis and interpretation of results: S. N. Mohamad Zahid, N. A. Ahmad Bari, M. Makmor; draft manuscript preparation: M. Makmor, S. N. Mohamad Zahid. All authors reviewed the results and approved the final version of the manuscript.

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