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The Inclusion of Smart Technology Criteria into Malaysian Green Residential Assessment Tools

JUN KIT NG[1], Farhana Mohd Zaini[2]

Abstract

Residential sector is ranked as the most significant energy consumer, and the contributes to adverse environmental effects. A high level of energy consumption with high levels of embodied carbon dioxide (CO2) leads to an increase in CO2 emissions. As the existing Malaysia green building assessment tools was lack of smart technology criteria. Utilizing smart technology may able to cut down the daily utility's consumption as an alternative to conventional home has the potential to decrease CO2 emissions. A smart technology may ably reduce a home energy and water consumption up to 40% compared with a conventional home. The smart technology application is getting popular in the green housing especially in residential building construction due to its more efficient, lowering utilities cost and environment-friendly. Hence, the primary objective of this study was to identify the existing criteria in evaluating green residential. This research employed a mixed methods approach via a comparative analysis and quantitative approach, involving questionnaire surveys directed at Green Building Index Facilitators in Malaysia, and the collection of secondary data from sources such as articles, journals, and the websites of smart technology to complement it. The findings indicated that there were nine significant elements towards smart technology criteria in the construction industry, and investigated the acceptance of smart technology criteria in green residential. However, the smart technology promotes a lot of benefit to make a home greener and sustainability.

Keywords: *Green Residential, Sustainable Residential, Green Housing, Developing Countries, Green Building, Smart Technology.*

Introduction

Construction industry has been termed as one of the greatest contributors to environmental degradation since construction industry use lots of resources in construction process and emit pollutants. The Malaysian residential sector consumption of electricity comprised a little more than a quarter (27.3%) of the total national electricity consumption in 2023. Which contributes to a massive amount of carbon dioxide CO 2 emissions, making the country heavily dependent on fossil fuels, in particular coal (43%) and natural gas (37%) (TNB, 2023; EMBER, 2024). Such high demand lifestyle contributes to climate change, resource depletion and urban heat island effect and this fact makes sustainable housing solutions not only desirable but also necessary. Based on GreenRE (2024), the fundamentals of green residential area are energy and water efficiency, indoor environmental quality, carbon reduction, and green innovation, and these are meant to reduce the load on the environment, which is intended to enhance the quality of life. Although green assessment systems such as Green Building Index (GBI) and GreenRE have been established well, existing evaluation tools however do not outline certain requirements on smart technologies and which are turning out to be more important in optimizing sustainable home performance. The smart technology is also not applied, which translates into the missed possibility of using automated energy monitoring, real-time water management, and intelligent climate controls that will minimise the use of energy and water by 30 to 40% and drastically increase the efficiency of operations (Stopps & Touchie, 2021; Smart Energy International, 2020).

[1] INTI INTERNATIONAL UNIVERSITY
[2] INTI INTERNATIONAL UNIVERSITY

The use of smart technology in separate residential buildings provides great opportunities to transform the sustainability prospective with the help of smart thermostats, sensors, sockets, home automation, and energy management applications (Chakraborty et al., 2023; Min Li et al., 2018). These systems allow to control and optimize household energy and water consumption in real-time, which directly leads to the reduction of their carbon footprint due to the savings in operational costs. Also, new technologies of smart house automation, auto lights, smart security system, and smart inventions do not only facilitate safety and comfort but can fit the United Nations Sustainable Development Goals (SDGs), such as SDG 7 (Clean Energy), SDG 11 (Sustainable Cities, and Communities), and SDG 13 (Climate Action).

The use of smart technology in green housing has caught the pace of growth in the international markets and is gradually taking root in the Malaysian construction industry in the last few years. Nevertheless, the absence of common criteria of smart technology in Malaysia green building evaluation tools depicts a research gap. To ensure comprehensive, future-proof performance of green buildings through use of sustainability rating systems, it is crucial to incorporate smart technology within these systems (Khoja and Danylenko, 2024). Therefore, this study aimed to evaluate the inclusion of smart technology criteria into the Malaysian green residential assessment tools. Specifically, the study will address the following research objectives:

1. To identify the existing criteria in evaluating green residential.
2. To study the smart technology indicator in evaluating green residential.
3. To investigate the acceptance of the smart technology criteria in green residential.

Literature Review

Green Housing in Malaysia

Green housing is increasingly becoming a suitable solution to environmental degradation that results due to rapid urbanization and over consumption of the available resources in the Malaysian construction sector. Green housing can also be called green residential or eco-friendly housing and it is characterized as a housing which embraces environmentally sustainable behaviours and technologies to lower down energy consumption, save water and energy intensive effects on the environment. It improves the life experience with a maximized indoor air quality and a minimized exposure by pollution of sustainable materials and smart building systems (Iberdola, 2024; Dimitroulopoulou et al., 2023). Green housing is very important in driving green development due to efficiency in resources and low-carbon construction. Khoshnava et al. (2020) determine that taking up green building materials greatly limits adverse effects on the environment and the health of people. In addition, Elnaklah et al. (2021) observed that green housing facilitates both ecological and economic sustainability because it does not overuse non-renewable resources. These will satisfy the international environmental objectives and will be beneficial in the long run both in cost savings and environmental conservation.

Green housing in Malaysia is implemented by an existing rating system or rather, it is done according to Green Building Index (GBI) and GreenRE. First local green rating tool, GBI was introduced in 2009, whereas GreenRE was initiated in 2013 by REHDA to respond to the needs of the private developers. The two systems evaluate structures according to six primary categories such as energy efficiency, water efficiency, indoor environmental quality, sustainable site planning, material and resources, and innovation (GBI, 2024; GreenRE, 2024). The tools were developed keeping in mind the tropical environment and the cultural setting of Malaysia with an aim of revolutionizing the building process in the country to sustainable building. Nonetheless these initiatives have not been very successful to the point of widespread use of green housing in Malaysia as compared to other developed countries. High cost of initial constructions, inadequate levels of awareness among the populace and absence of financial stimulation are some factors that impede the growth of the market. Nevertheless, green initiatives have been squarely supported by the Malaysian government. Datuk Sr Mohd Zaid Zakaria as Chief Executive of CIDB has affirmed that soon the use of green building will become a requirement in all construction works and sustainable construction is no longer a favor (Kaur, 2024).

Green housing has a number of advantages as seen in various ways. It minimizes the consumption of energy and water in the environment, as well as carbon emissions. On a social basis, it offers healthier living conditions by increasing good indoor air quality and the use of toxic free materials. In economic terms, it saves continuously due to the reduction in utility bills and repairs expenses. Thus,

green housing does not only imply an ethical choice of the environmentally friendly option but also represents an effective measure to attend the needs of the continuously increasing urban population of Malaysia trying to find efficient and environmentally sound housing solutions.

Importance of Green Housing in Sustainable Development

Green housing is important in attaining sustainable development characterized by consumption of less resources and better quality of the environment. According to Mustaffa et al. (2021), there is a possibility that green housing in Malaysia may halve the amount of energy consumption, which minimizes the carbon emission levels and reduces the potential burden on the environment caused by residential consumption. Woon et al. (2023) further stated that these designs also facilitate 25 percent reduction of water used. These initiatives are also sustainable in the sense that they save homeowners who would be saving on utility expenses in the long-term. Green housing implementation is quite beneficial in three folds which include economic, environmental, and social. Green homes are also economically beneficial due to the fact that they can reduce/save the energy cost up to one-third (Ahmad et al., 2024) and 10-15 percent hike in the resale value (Chuweni et al., 2024). They additionally employ long-lasting materials that reduce the maintenance expenses (Patil et al., 2020). Green housing supports and promotes sustainable industries through job creation and growth, and innovation (Ogunmakinde et al., 2020). Green buildings generate as much as 40 percent fewer carbon emissions because of increased energy efficiency (Mariotti, 2023). Such characteristics as green roofs assist in cooling the city and reducing the need to cool the offices (Hamid et al., 2023), whereas landscaped surfaces contribute to the health of an urban ecosystem and biodiversity (Leong et al., 2024). Sustainably, green housing will play a part in enhancing safer living conditions by lowering air pollution levels and improving indoor air conditions, which allow the physical and mental states to improve (Zahid et al., 2024). The culture of sustainability is also being implemented in society through campaigns and green way of life activities (Sukereman et al., 2024). Moreover, the concept of green housing is becoming more inclusive, where much effort is put to ensure the beneficial availability of sustainable housing to low-income populations, such as the B40 in Malaysia (Ramli et al., 2024). The significance of green housing is illustrated in Table 1.

Table 1: Importance of Green Housing in the Sustainable Development

Category	Element	Source
Economic	Cost savings in utility fees	(Azis, 2021; Ahmad et al., 2024)
	Higer market value	(Chuweni et al., 2024)
	Reduce maintance cost	(Patil et al., 2020)
	Increase investment in sustainable construction	(Ogunamakinde et al., 2020)
Environmental	Reduction in carbon emissions	(Mariotti, 2023)
Social	Reduce urban heat Energy efficiency improvements Biodiversity preservation Improve better living standards and better health Community awareness and behavioral change Social inclusivity in housing option	(Hamid et al., 2023) (Fauzi & Ismail, 2024) (Leong et al., 2024) (Zahid et al., 2024) (Sukereman et al., 2024) (Ramli et al., 2024)

Smart Technologies Integration

The idea of smart technology as a complement to green housing is gaining value in the hopes to maximize resource use and enhance conveniences at residence. Some of the most important technologies include smart thermostats that enable one to control the indoor temperatures using automation and remotely. This kind of system is effective in ensuring economy in the usage of energy since it varies the indoor environment depending on the patterns of occupancy and weather conditions. Stopps and Touchie (2021) assert that with the right use of the thermostats one can reduce the energy so much by ensuring less cooling or heating when the building is not occupied. Another difference

highlighted in the study by Kam et al. (2023) is that the devices allow reducing electricity bills without sacrificing the comfort of occupants.

While, the other significant system is on smart lighting that one can incorporate motion sensors as well as occupancy sensors to automatically switch off lights and appliances when not in use. According to Widartha et al. (2024), this technology is capable of eradicating the wastage of energy during idle times, whereas Lo Verso and Pellegrino (2019) observed that automatic lighting systems that have the switch off feature can mitigate energy consumption by 60 per cent. Other than lighting and the climate control, smart energy management systems are also useful in monitoring real time electricity consumption. These systems give feed-back of the usage by day through profiles, and home owners can monitor the usage. Tuomela et al. (2021) and Gill (2025) realized that smart energy systems have the potential to help decrease monthly electricity usage by as much as 30 percent. In the same way, the smart water meters encourage sustainable water consumption by monitoring in real-time water consumption, behavioral activities and leak identification. Daminato et al. (2021) mentioned that more conscious usages of water were the results of smart water meter usage, and Msamadya et al. (2023) explained that the overall consumption of water was reported to diminish by 10%. These systems do not only save resources but also develop the more responsible behavior among residents because of increased awareness of the consumption habits and they are in line with the objectives of the environment.Smart sensors can also help to maintain the environmentally good status as they also monitor the temperatures, amount of humidity, and light in order to automatically adjust the systems to the best levels of comfortable and least consuming environments.

According to Chakraborty et al. (2023), these sensors can make a house adjust itself based on the comfort of occupants and on energy-reduction goals. All these technologies are present in centralized smart home systems that enable users to control the appliances and utilities using the combined platforms. Pohl et al. (2021) and Min Li et al. (2018) state that this kind of integration can encourage automation, effortslessness in control, and efficiency. An example of a smart socket is that which can limit loss of electricity in standby mode due to time scheduling. Ma et al. (2018) and ELORBANY et al. (2021) research proved that smart sockets could reduce electricity use by a maximum of 10 percent by programming on/off smart connections with devices. Home appliances such as air conditioners, washing machines, refrigerators that are mostly IoT-enable are also another critical contribution. Such smart gadgets optimize energy consumption, since they operate according to the patterns of users, as well as peak hours. Chakraborty et al. (2023) found that apart from enhancing the functionality, the use of IoT technology also minimized unnecessary energy consumption.

Lastly, intelligent security systems like smart locks, motion sensors and surveillance cameras have a similar benefit to making the home more secure, as the energy expenses are also minimised. These systems are automated and at times when the house is not occupied; there are options that turn off other non-essential systems that aid a more efficient and conscious household. To sum it up, the implementation of green homes that have smart technologies will contribute to the environmentally friendly, more reasonable, and safer-tomorrow residential conditions.

Table 2: Smart Technology Integration

Element	Source
Smart Thermostats	(Stopps and Touchie, 2021; Kam et al., 2023)
Automated Lighting and appliance controls	(Lo Verso and Pellegrino, 2019; Widartha et al., 2024)
Smart Energy Management Systems	(Tuomela et al., 2021; Gill, 2025)
Smart Water Meter	(Daminato et al., 2021; Msamadya et al., 2023)
Smart Sensor	(Chakraboraty et al., 2023)
Smart Home Systems	(Min Li et al., 2018; Pohl et al., 2021)
Smart Socket	Min Li et al., 2018; Ma et al. 2018; ELORBANY et al., 2021
Smart Appliances	Chakraboraty et al., 2023
Smart Security System	Chakraboraty et al., 2023

Methodology

The research method for this study applies mix methods, it involved the comparative analysis and questionnaire surveys that was conducted among the green building facilitators throughout Malaysia.

A list of green building facilitators was obtained from the Green Building Index (GBI) database. The purpose of the questionnaire was to obtain the responses on the inclusion of smart technology in the Malaysian green building assessment tools. Following the delivery of the questionnaire throughout email and WhatsApp application, follow up reminder were sent out to all respondents to increase the respond rate. Due to the time constraint with only three (3) weeks to spare in distributing the questionnaire survey to the respondents, only 51 or 59.03% of the green building facilitators responded. This result is acceptable as it has achieved the minimum response rate. This was proven from a similar study done by (Lam et al., 2024) who obtained response rate of 50%.

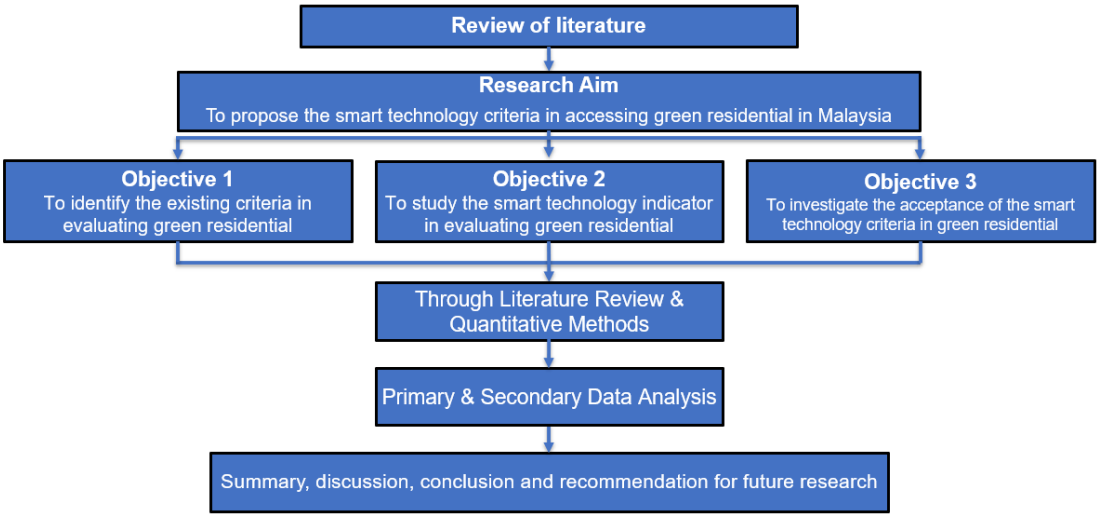

Figure 1: Research Design

Result & Discussion

Response Rate and Timeline

86 green building facilitators were invited to participate in the quantitative questionnaire, 51 agreed to participate and responds the questionnaire, registering a 59.30% of positive response rate. This fairly large participation rate indicates a high level of involvement and interest in the respondents, which reinforces the validity and credibility of the quantitative information collected.

Systematic Literature Review

12 articles that have been identified in this studies. The articles review encompassed studies from 2018 to 2025. It indicates a growing academic and practical interest in the integration of smart technologies into residential environments.

Table 3: Result of Systematic Literature Review

Title	Authors	Year	Smart Technology Indicators
Residential Smart Thermostat Use: An Exploration of Thermostat Programming, Environmental Attitudes, And the Influence of Smart Controls on Energy Savings	Stopps, H. and Touchie, M.F.	2021	Smart Thermostats
A Study on The Adoption of Smart Home Technologies Among the Homeowners in Malaysia	Kam et al	2023	Smart Thermostats
Energy Saving Generated Through Automatic Lighting Control Systems According to the Estimation Method of the Standard EN 15193-1	Lo Verso, V.R.M. and Pellegrino, A.	2019	Smart Lighting System
Advancing Smart Lighting: A Developmental Approach to Energy Efficiency Through Brightness Adjustment Strategies.	Widartha, V.P., Ra, I., Lee, S.-Y. and Kim, C.-S	2024	Smart Lighting System

Impacts Of Home Energy Management Systems on Electricity Consumption	Tuomela, S., de Castro Tomé, M., Iivari, N. and Svento, R	2021	Smart Energy Management System
How Home Automation Is Revolutionizing Energy Efficiency for Homeowners	Gill, K	2025	Smart Energy Management System
The Impact of Smart Meters on Residential Water Consumption: Evidence from a Natural Experiment in the Canary Islands	Daminato, C., Diaz-Farina, E., Filippini, M. and Padrón-Fumero, N	2021	Smart Water Meter
Estimated Impacts of Smart Water Meter Implementation on Domestic Hot Water Consumption and Related Greenhouse Gas Emissions from Case Studies	Msamadya, S., Jin Chul Joo, Jung Min Lee, Lee, S., Kim, S., Hyeon Woo Go and Seul Gi Lee	2023	Smart Water Meter
Smart Home System: A Comprehensive Review	Chakraborty, A., Islam, M., Shahriyar, F., Islam, S., Zaman, H.U. and Hasan, M	2023	Smart Sensor
Smart Home: Architecture, Technologies and Systems	Li, M., Gu, W., Chen, W., He, Y., Wu, Y. and Zhang, Y	2018	Smart Home Systems
Environmental saving potentials of a smart home system from a life cycle perspective: How green is the smart home?	Pohl, J., Frick, V., Hoefner, A., Santarius, T. and Finkbeiner, M	2021	Smart Home Systems
Smart Home: Architecture, Technologies and Systems	Li, M., Gu, W., Chen, W., He, Y., Wu, Y. and Zhang, Y	2018	Smart Socket
Development of an Energy-Efficient Smart Socket Based on STM32F103	Ma, M., Huang, B., Wang, B., Chen, J. and Liao, L	2018	Smart Socket
A Smart Plug Equipped with IoT Technologies for Energy Management of Electrical Appliances	ELORBANY, K., BAYILMIŞ, C. and BALTA, S	2021	Smart Socket
Smart Home System: A Comprehensive Review	Chakraborty, A., Islam, M., Shahriyar, F., Islam, S., Zaman, H.U. and Hasan, M	2023	Smart Appliances
Smart Home System: A Comprehensive Review	Chakraborty, A., Islam, M., Shahriyar, F., Islam, S., Zaman, H.U. and Hasan, M	2023	Smart Security System

Demographic

Tables 4 describes the demographic profile of 51 respondents from green building index facilitators. Most of the respondents are from different designations, with Mechanical & Electrical Engineering being the most common field of participants, followed by Architect, Civil & Structural Engineer and Others. In addition, the respondents mainly comprise of more than 10 years' experience (60.80%), followed by 5 – 10 years (31.44%) and less than 5 years (7.8%), which represents a deep experience in green building certification. Moreover, most of the respondents were having less than 5 projects GBI certification project (56.90%), followed by 5 – 10 projects (35.30%) and more than 10 projects (7.80%). This robust demographic composition clearly lays a good foundation to discuss the Likert scale responses in this study.

Table 4: Demographic background of Green Building Facilitators

Parameter	Category	Number of facilitators	Percentage of suppliers (%)
Designation	Mechanical & electrical engineers	26	51
	Architect	15	29.4
	Civil & structural engineer	5	9.8
	others	5	9.8
Year of experience	<5 years	4	7.80
	≥5≥10 years	16	31.4
	>10 years	31	60.8
No. of certification projects involves	<5 projects	29	56.9
	≥5≥10 projects	18	35.3
	>10 projects	4	7.80

The Need for Smart Technology Criteria in Evaluating Green Residential

This was followed by the Part B of the questionnaire which was concerned with the identification of the pertinent smart technology indicators contributing to the assessment of green residential buildings in Malaysia. The respondents were requested to give their responses on a five-point Likert scale against a number of features of smart technology. The Index Method was an unidimensional and non-comparative psychometric scaling instrument applied in the analysis to measure the extent of agreement with every smart feature. The index scores of various indicators were found to be high with a range of the scores between 4.48 and 3.38 as observed in Table 5 hence agreement was high. Among the top-rated features were smart thermostats, auto lighting, energy monitoring systems and smart appliances. This shows that more interest is being taken by the industry in using smart systems during the evaluation of the green residential projects.

These questions were looking to the evaluation of acceptance criteria of smart technologies among construction persons and other stakeholders within the green building industry in part C of the questionnaire. The data was analyzed similarly like in Part B using the Index Method. The findings as per Table 5 indicated that majority of the respondents supported the response positively with regard to inclusion of smart technology in green housing assessments. The highest index score was 4.44 and the lowest 3.33 indicating a general average of moderate to high level of acceptance. The simplest issues (i.e. energy efficiency, water-saving and real-time monitoring) were at the top of the scale. The results of these research findings show that professionals in the construction industry acknowledge the importance of smart technologies in the improvement of sites towards sustainability outcomes and endorse its formal adoption towards green assessment plans.

Table 5: The Need for Smart Technology Criteria in Evaluating Green Residential

Parameter	Category	Number of facilitators	Percentage of suppliers (%)
Are the existing criteria in the green building ratings tools are adequate in measuring a green residential	Strongly disagree	0	0
	Disagree	2	3.90
	Neither agree nor disagree	16	31.4
	Agree	30	58.8
	Strongly agree	3	5.90
Smart technologies should be included to the existing evaluation tool	Strongly disagree	0	0
	Disagree	2	3.90
	Neither agree nor disagree	14	27.5
	Agree	24	47.1
	Strongly agree	11	21.6

Most of the green residential in Malaysia comprise the smart technology elements for example Smart Thermostat, Smart Lighting System, Smart Meter System etc.	Strongly disagree	0	0
	Disagree	8	15.7
	Neither agree nor disagree	7	13.7
	Agree	33	64.7
	Strongly agree	3	5.90

Acceptance of Smart Technology Criteria in Green Residential

The findings indicate that smart thermostats, smart lighting, and energy management systems were the most influential indicators, as they recorded a score of over 4.0. This implies that in green housing, it is important to enhance automation and control in real-time. Other indicators, such as smart sockets and smart water meters, obtained relatively modest but at the same time above the level of 3.3, which also means positive review. The standard deviations of 0.693 to 1.081 indicate the consistency of the responses with quite a small divergence of the level of agreement among the professionals.

Conversely, summarises the criteria acceptance level of smart technology by three major themes as energy efficiency, water conservation, and comfort and automation. The indicator used to measure the energy-efficient operations got the highest index score of 4.44 and features relating to automation and data monitoring followed. These results suggest that the specialists do not only realise the technical benefits of smart systems but also do not exclaim their incorporation in national green assessment tools. With further construction industry technology to become more digitalized, and with the ideas behind living smart homes, this information gives value to the ability of the policy to become improved, and that the smart technologies ideas can be added into the green building certification systems in Malaysia.

Table 6: Acceptance of Smart Technology Criteria in Green Residential

Elements	Mean	SD	5	4	3	2	1	Ranking
Smart Water Meters	4.235	0.840	0	3	4	22	22	1
Smart Energy Management Systems	4.196	0.715	1	0	3	31	16	2
Smart Lighting System	4.157	0.801	1	0	7	25	18	3
Smart Thermostats	3.961	0.685	1	0	7	35	8	4
Smart Appliances	3.941	0.639	0	1	9	33	8	5
Smart Socket	3.863	0.758	0	3	10	29	9	6
Smart Sensor	3.510	0.724	0	3	23	21	4	7
Smart Home Systems (SHS)	3.353	0.762	0	5	27	15	4	8
Smart Security System / Smart Lock	3.176	0.856	0	12	21	15	3	9

It can be concluded that GBI facilitators emphasize to a large degree the smart water meters (M=4.235) that add resolute value to the green residential and user experience of their residential, or in other words, their perceived importance. The smart energy management systems (M=4.196) is considered highly perceived as facilitators appreciate the well energy management may contribute to the environment nature. Smart lighting system (M=4.157), smart thermostats (M=3.961), and smart appliances (M=3.941) also appeared as important to green residential, which suggests that physical comfort and smart interactions of green spaces are acknowledged. Moreover, others smart appliances such as smart socket (M=3.863), smart sensor (M=3.510), smart home systems (M=3.353) and smart security system (M=3.176) for a green residential.

Conclusion & Recommendation

Key Findings for Objective 1: To identify the existing criteria in evaluating green residential.

The objective 1 had been successfully achieved via a comparative document analysis on existing green building assessment tools between the Green Building Index (GBI) and GreenRE. The study found and highlighted that both of the assessment tools currently evaluate green residential buildings, focusing on 6 main criteria. These are energy efficiency, water conservation, indoor environmental quality, green and sustainable renovation, environmental landscaping and biodiversity; location and site selection and waste management. Notably, both GBI and GreenRE frameworks lacked explicit criteria related to smart technologies. This confirms the presence of a significant gap in the existing evaluation assessment tools and supports the need to improve the criteria to include smart technology criteria.

Key Findings for Objective 2: To study the smart technology indicator in evaluating green residential.

This objective is also successfully achieved through a systematic literature review. The research had successfully identified multiple smart technology indicators that are related and beneficial to green residential development to become greener and more sustainable. The smart technologies indicators are smart water meter, smart energy management systems, smart lighting system, smart thermostats, smart appliances, smart sockets, smart sensor, smart home systems (SHS) and smart security system / smart lock. These smart technologies had been proven by the researchers with details information and data in the studies. These technologies may reduce a home's energy and water consumption and enhance comfort.

Key Findings for Objective 3: To investigate the acceptance of the smart technology criteria in green residential

For objective 3, it had been successfully achieved via a quantitative survey, which was conducted among 86 certified green building facilitators on the GBI official website. The survey successfully collected 51 valid responses, which is a 59.03% response rate. In the survey, the majority of the respondents agreed that smart technologies should be included a part of the green residential assessment tools. The data shows that over 70% of the green building facilitators strongly supported the inclusion of smart technologies. This indicates that the industry is willing to adopt smart technologies as part of future green building strategies. The result also highlighted the ranking for each smart technologies as smart water meter (1), smart energy management systems (2), smart lighting system (3), smart thermostats (4), smart appliances (5), smart sockets (6), smart sensor (7), smart home systems (SHS) (8) and smart security system / smart lock (9). Among these smart technologies, the top three were smart water meter, smart energy management systems and smart lighting systems. These technologies may reduce a home's energy and water consumption and enhance comfort.

Conclusion

The introduction of smart technology is becoming one of the most important provisions of green housing in Malaysia, as it is driving resource optimisation, environmental-friendliness and easy lifestyle. Despite the fact that the idea of smart homes is beginning to receive some coverage, only a little is being implemented particularly on residential buildings that are green. The paper has been researched to determine the incorporation of smart features of technology in Malaysian green residential housing. The surveyed people were the relevant industry professionals and people who have experience in making sustainable housing development. A questionnaire survey was done on them. The paper specifically focused on the adoption and efficiency of some smart technologies used in facilitating green building goals. The analysis of the average results has also revealed 9 important smart technology features offering significant contribution to green housing namely; 1) Smart water meters (4.235), 2) Smart energy managment system (4.196), 3) Smart lighting system (4.157), 4) Smart thermostats (3.961), 5) Smart appliances (3.941), 6) Smart sockets (3.863), 7) Smart sensor (3.510) and 8) smart home system (3.353) and 9) Smart security system (3.176). These technological products will facilitate vital sustainability operations, which carry part of responsibilities, including energy and water consumption reduction, leak detection, appliance optimization, and better indoor comfort. The findings indicate that the combination of the technologies in green assessment can be the new wave of enhancing green performance and the user experience of green homes in Malaysia. In a nutshell, policy makers, developers and departments of certifications like GBI, GreenRE can find useful information in this research and accommodate the inclusion of smart technology requirements in their criteria sets. The smart systems used in the green housing norms can aid the sustainability of Malaysia through SDG 7, SDG 11, and SDG 13 in the long-run. Moreover, cooperation among the technology providers, housing developers and government agencies should be encouraged to foster innovation, overcome the blend in the marketplace, and spread the image of smart green living. Because the current study is concentrated on the Malaysian situation, the further research may investigate the acceptance and use of smart technology in green housing in other developing countries to evaluate the scaling and adjustment in other socio-economic settings.

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