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Contributing Factors on the Effectiveness of Green Building Using the GBI Tool: A Case Study of Putrajaya Energy Commission Building

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Abstract

The concept of a green building refers to a planned, constructed, operated, maintained, or reused structure to protect occupant health, enhance occupant productivity, conserve natural resources, and minimise environmental impact. This study aims to investigate the contributing factors that contribute to the effectiveness of sustainable green buildings in Malaysia concerning the green building index (GBI) tool. This proposed model is based on the dependent variable, the effectiveness of green building and the independent variables namely, property management, government supervision, incremental costs, and environmental protection awareness. A quantitative survey was done on 320 staff of the Putrajaya Energy Commission Building. The results show that government supervision, incremental cost, and property management have a significant positive moderate relationship while environmental protection awareness has a very strong relationship with the effectiveness of green building. Therefore, these strategies can serve as a roadmap for construction industry stakeholders, enabling them to construct improved versions of green buildings that align with sustainable principles and practices.

Keywords: factors, effectiveness, green building, GBI tool

1.0 INTRODUCTION

In its broadest sense, the notion of "green building" refers to the planning, designing, building, running, maintaining, or reusing of structures (Hussein et al., 2017) to safeguard occupant health, boost worker productivity, make prudent use of natural resources, and lessen their negative effects on the environment. Incorporating sustainability into the building industry led to the development of the idea of "green building". Green buildings are defined by the Environmental Protection Agency (EPA) as those that are constructed with environmentally responsible methods (EPA, 2016).

In the United Nation's 2030 Agenda for Sustainable Development, businesses and nations are invited to explore opportunities that combine social, economic, and environmental sustainability through 17 wide-ranging Sustainable Development Goals (SDGs). The SDGs seek to separate economic growth from the causes of poverty, inequality, and climate change (World Green Building Council, n.d.). Green buildings, often called sustainable or high-performance buildings, are thus designed to protect the environment by using water, energy, and other resources as efficiently as possible.

The phrase "green building" is ambiguous, but it usually refers to structures that have received certification from green building assessment tools like Singapore's Green Mark, Australia's Green Star, BREEAM (UK), Kingdom of Saudi Arabia's SAGRS, GRIHA (India), and LEED (USA) (Ahmed et al., 2016). Buildings that comply with specific standards and regulations are assessed using green building assessment tools, frequently voluntarily (Yousif et al., 2023).

In Malaysia, the Green Building Index (GBI) assessment is used as a standard measurement to certify green buildings which can reduce damages and impacts on the environment, increase building value and benefit society (Ha et al., 2023a). To inspire and drive people to push the limits of sustainability, they reward and honour organisations and businesses that construct and run greener buildings, hence, the stakeholders and the public become more conscious of environmental challenges and their obligation to future generations.

Since people are becoming more concerned about the environment and how it affects the world in which we live, green buildings are rapidly gaining popularity. Green building practices can help mitigate the effects of global warming by reducing carbon emissions and natural resource consumption (Ha et al., 2023a). In addition, less natural resource is exploited in the building sector when green technology is used (Simpeh & Smallwood, 2018).

The GBI criteria are relevant to the success of green buildings, and these will be the elements determining the efficacy of green buildings in Malaysia (Abdullah et al., 2015; Ha et al., 2023a; Hussein et al., 2017). Nonetheless, the number of green buildings in Malaysia is low due to a variety of issues facing the construction sector. As a result, the growth of green buildings in Malaysia is still occurring at a lower rate compared to the total number of buildings in Malaysia (Ha et al., 2023b).

Green rating tools are designed to consider both the short- and long-term implications (Pandey, 2018). Many long-term impact factors are integrated into the physical layout and design of the building, including thermal comfort design, daylighting, air-change effectiveness, QLASSIC construction standards, and material selection. These qualities typically stay with the building forever because they were included in the original specs and design of the structure. Annual gains can be made from their energy and environmental advantages.

Contrarily, short-term impact criteria are typically not built into the structure and, as such, are unlikely to guarantee future energy efficiency and environmental benefits for the building (Pandey, 2018). This distinction is crucial. From the perspective of building maintenance and environmental protection, these criteria are unquestionably important. Nevertheless, the overall energy-efficiency aims of the building are not addressed, for instance, while they are crucial during the development phase, worker facilities and construction waste management do not affect the building's ability to remain "green" throughout its operational period.

These days, buildings are typically between thirty and fifty years old. Thus, the building's long-term characteristics are what will ultimately determine whether it stays green and energy-efficient during its useful life, and the building's "green" designation will only be maintained because of these long-term features. Consequently, most developers could opt for the simple route by meeting the GBI framework's short-term impact requirements to receive a green grade. Thus, especially in terms of energy efficiency, green buildings will not be able to last for very long.

According to Pandey (2018), 80% of the green-rated buildings have a solid share of short-term impact criteria while the important long-term impact criteria are achieved by less than 20%. Buildings with a Platinum rating are the only ones that will satisfy the long-term impact requirements, which will reduce the building's efficacy as a green building.

Furthermore, although there is a performance gap where energy consumption is still considerable, the benefits of certified green buildings should be fully realised as they currently stand. To boost resource efficiency and lessen its impact on the environment and people, Malaysia needs more Gold or Platinum building structures.

While the global count of environmentally friendly buildings has surged over the past century, the Malaysian construction industry is reportedly lagging in adopting sustainable green buildings (Ha et al., 2023b). To boost green building development in Malaysia, it is necessary to determine the elements that can enhance the efficacy of green buildings in the country. This could help governing bodies compare the factors that lead to the development of green buildings. Thus, the goal of this study is to investigate the contributing factors that contribute to the effectiveness of sustainable green buildings in Malaysia.

2.0 LITERATURE REVIEW

2.1. Green Building Rating Systems

A sustainable structure that is advantageous to the environment, society, and economy is referred to as a "green building." Nowadays, most construction projects are pushed and encouraged to be green buildings. Every nation has a system in place for certifying buildings as green. Based on their unique cultures, climates, and geographic significance (Abdulaali et al., 2020), numerous green building rating systems are being introduced worldwide, such as CASBEE (Comprehensive Assessment System for Built Environmental Efficiency) in Japan, BREEAM (BRE Environmental Assessment Method) in the United Kingdom, Leadership in Energy and Environment Design (LEED) in the United States, Green Rating for Integrated Habitat Assessment (GRIHA) in India, BEAM in Hong Kong, Green Star and Green Mark in Singapore, Green Building Index (GBI) in Malaysia, and so on (Ahmed et al., 2016; Ha et al., 2023a; Yousif et al., 2023).

Green building rating systems play a very important role in reducing current and future energy demands. There are similarities and differences regarding green building evaluation criteria among countries. Table 1 shows the comparison of assessment methods in selected countries. The evaluation criteria of different green building grading systems were compared in the study by Shan and Hwang (2018), and seven criteria are commonly utilised. Sustainable site, land, and outdoor environments; innovation in design; material and resource efficiency; energy efficiency; interior environment quality; and water efficiency are some of these requirements. Most rating systems employ a 100-point or greater point system to assess buildings, each assigning a different number of points (Pandey, 2018). The representation points will be granted if the prerequisite has been satisfied. The building rating and the adopted green building rating tool's categorisation will be reflected in the total points earned.

Today, there are two main obstacles facing the building construction sector globally (Pandey, 2018). First is the use of energy from conventional sources, which is becoming more and more costly. The second category comprises the potential environmental harm that buildings may cause during construction and maintenance (Ha et al., 2023a). These harms may include contamination of the air, water, and soil; emissions of greenhouse gases; and harm to nearby plants and other natural ecosystems. Nonetheless, there is a growing awareness that green design can assist builders in addressing these two issues.

Table 1. The Green Building Assessment Criteria (Ali & Al Nsairat, 2009).

Name Country Year	**BREEAM UK 1990**	**LEED USA 1996**	**GREEN STAR Australia 2003**	**GREEN MARK Singapore 2005**	**Green Building Index Malaysia 2009**
Assessment Criteria	1. Management 2. Health & Comfort 3. Energy 4. Transportation 5. Water Consumption 6. Materials 7. Land Use 8. Ecology 9. Pollution	1. Sustainable Site 2. Water Efficiency 3. Energy & Atmosphere 4. Materials & Resources 5. Indoor Environment al Quality 6. Innovation & Design / Construction Process	1. Management 2. Transport 3. Ecology 4. Emissions 5. Water 6. Energy 7. Materials 8. Indoor Environmental Quality 9. Innovation	1. Energy Efficiency 2. Water Efficiency 3. Environmental Protection 4. Indoor Environmental Quality 5. Other Green Features	1. Energy Efficiency (EE) 2. Indoor Environmental Quality (IEQ) 3. Sustainable Site Planning & Management (SM) 4. Materials & Resources (MR) 5. Water Efficiency (WE) 6. Innovation (IN)

2.2. Malaysia Green Building Index

In 2009, the Malaysian Institute of Architects (PAM) and the Association of Consulting Engineers Malaysia (ACEM) developed the Green Building Index (GBI), propelled by the need to take care of the environment (Ha et al., 2023a; Pandey, 2018, Shafiei et al., 2017). The GBI is aimed at leading the building industry to become more eco-friendly in their practices. To certify green buildings—which can lessen environmental harm and consequences, boost building value, and benefit society—the GBI assessment is utilised as a standard measurement. It makes the public and stakeholders more conscious of environmental challenges and their duty to future generations.

Building owners, architects, engineers, and developers are among the key stakeholders who have benefited from GBI and the Malaysian Green Building Council's successful efforts to raise awareness of the value of green buildings. GBI Sdn Bhd (GSB), a business founded especially by PAM and ACEM, is where building owners, developers, and consultants in Malaysia can apply for a GBI assessment (Shafiei et al., 2017). Additionally, the applicants may designate GBI as the facilitator to receive expert assessment services.

A building's eligibility for certification as a green building is determined by evaluating its design according to six primary sustainability criteria (Ha et al., 2023), which are energy efficiency (EE), indoor environmental quality (IEQ), sustainable site planning and management (SM), material and resource (MR), water efficiency (WE), and innovation (WE). In addition, buildings can be divided into seven groups: township, industrial new construction (INC), industrial existing building (IEB), residential new construction (RNC), non-residential new construction (NRNC), residential existing building (NREB), and interiors (ID) (Abdulaali et al., 2020; Pandey, 2018).

The GBI rating classification is displayed in Table 2. Green buildings are rated as platinum, gold, silver, or certified based on the points earned from a 100-point scale that includes those six criteria. A structure cannot be classified as a green building if it has a score of less than 50. To generate the required number of credit points, each of the six criteria is further broken down into the relevant sub-sections.

Table 2. GBI Rating Classification (Ha et al., 2023a)

Points	GBI Rating
86 – 100 points	Platinum
76 – 85 points	Gold
66 – 75 points	Silver
50 – 65 points	Certified

2.2.1. Energy Efficiency (EE)

According to Fan et al. (2020), efforts to achieve low energy consumption can also be attained by using renewable energy sources including unique designs and innovative features, utilising building orientation to reduce direct sunlight, or installing photovoltaic (PV) panels for renewable energy generation. Optimising building orientation to receive more natural daylight while absorbing less solar radiation is one factor to consider when trying to increase energy efficiency. Marhani and Muksain (2018) discovered in their research that a green building project will result in 36% lower energy consumption than a conventional project. For instance, using natural daylight as an energy source in a green building could lessen the need for artificial lighting, which would cut down on the amount of power used.

2.2.2. Indoor Environment Quality (EQ)

A green building needs to function exceptionally well in terms of air quality, lighting, visual comfort, and acoustic comfort when it comes to the indoor environment quality component. Passive design strategies, which focus primarily on the design phase, and active design strategies, which prioritise the installation of mechanical elements, can both benefit from the incorporation of an energy-efficient plan. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) states in section 62.1 that the building must fulfil the minimum requirements of ventilation rate to reduce the possibility of harmful health impacts by defining minimum ventilation rates and indoor air quality that will be acceptable to human occupiers (Li, 2019). However, according to Zhang et al. (2011), the implementation of green construction projects has resulted in a comparatively high cost for the appliances and equipment needed for natural ventilation and air conditioning.

2.2.3. Sustainable Site Planning and Management (SM)

To reduce the negative effects on the surrounding surroundings, a site planner should consider appropriate sustainable site planning when designing green structures. Nizarudin et al. (2010) and Abdulaali et al. (2020) state that every project development needs to adhere to local government requirements and submit a structural plan for the proposed location. In certain circumstances, such as those involving green space, redevelopment of an existing building or site may result in less exploitation of the natural environment (Algburi et al., 2016).

2.2.4. Material and Resources (MR)

When establishing the material and resource criteria for a green building project, waste management, recycled and repurposed materials, and sustainable materials must be taken into consideration. Debris or building trash can be kept out of landfills by using construction waste management. Reducing, reusing, and recycling are so essential to minimising a building's environmental impact (Algburi et al., 2016). To cut down on material waste, a designated location on the property should be made available for the storage of non-hazardous, recyclable objects. Environmentally friendly materials will also guarantee minimal building maintenance without compromising the project's quality.

2.2.5. Water Efficiency (WE)

The GBI has implemented a rainwater harvesting system to reuse rainwater and greywater, which means that all household waste is strongly pushed for recycling for building consumption or irrigation (Ha et al., 2023a). Recycling, according to Algburi et al. (2016), is the act of retrieving water that was previously intended to be disposed of, cleaning and purifying it, and then using it again for drinking purposes. Reusing household waste for eco-friendly water efficiency techniques, such as water recycling, is advantageous.

2.2.6. Innovation (IN*)*

Every green construction project would be subject to a distinct innovation standard (Marhani and Muksain, 2018). Adopting the Industrialised Building System (IBS), which can decrease labour requirements, shorten building times, and improve site quality, is one of the creative ideas. In addition, Building Information Modelling (BIM), sometimes referred to as the n-dimensional model, can be used in green construction projects since it can create a 3-D model, display the model, identify conflicts, predict costs and schedules, and even show sustainability (Manzoor et al., 2021).

2.3. Contributing Factors on the Effectiveness of Green Building Development

The adoption of green building standards in the construction industry has been the subject of numerous prior studies. In China, for example, Wang et al. (2018) investigated and assessed the factors influencing the implementation of green construction standards. Green technology, awareness and attitude, policies and regulations, and market and economics were identified to be the six elements that influenced adoption. To further explore the variables driving the expansion of green building in the South African construction sector, Simpeh and Smallwood (2015) carried out a study along a similar line. Inadequate cost data for green buildings and a lack of incentives to promote green construction are two main reasons limiting the expansion of green buildings, according to their research. In addition, Hwang et al. (2017) studied the variables influencing productivity in Singaporean green building construction projects. They distinguished and grouped the variables into five groups: project, labour, management, technical, and external factors.

Abdul-Rahim et al. (2020) look into the underlying structure brought on by the latent elements and the reasons impacting Malaysia's non-adoption of green building criteria. The component connected to public awareness and behaviour is ranked highest among the other factor categories, per the data. This was due to stakeholders' opinions and attitudes regarding green practices in the construction sector, which impeded the implementation of green building criteria in Malaysia. Most of them had preconceived notions about how adopting green construction practices would affect their ability to make money and were predisposed in favour of it. Apart from that, the economic-related linked factor is the second-highest factor grouping (Abdul-Rahim et al., 2020). Since it addressed the main concern of businesses, which was the cost element, it was also an important factor grouping that acted as the catalyst for encouraging construction players to embrace sustainable building. The cost and rate of return on investment of each respective implementation therefore became critical to the success of creating green building guidelines (Abdul-Rahim et al., 2020).

To achieve the intended results, Ding et al. (2018) emphasised the importance of considering both the initial and operational stages of green building implementation. Huang et al. (2018) assert that to guarantee that green buildings fulfil their design criteria and operational objectives, efficient government oversight and administration are critical. Subsidy-based incentive programs and regional economic fundamentals promoted the development of green buildings, according to research by Darko et al. (2017) and Algburi et al. (2016). The utilisation of distinctive and superior imported materials in the construction of green buildings results in higher initial investment, but over time, life cycle costs are frequently decreased (Ding et al., 2018). Furthermore, increased development expenditures for incorporating cutting-edge designs, materials, and technology might enhance the efficacy of green buildings (Halim, 2012; Azizi et al., 2018).

According to Aghili et al. (2016), a comprehensive set of practices that include sustainable procurement, operation, resource management, and maintenance are among the significant contributions to the efficiency of green buildings. Property managers need to be proficient in green management techniques, as noted by Jaafar and Salleh (2016). A sense of ownership and accountability can be fostered among tenants through participation in management practices, which further boosts the efficiency of green buildings (Razali et al., 2015). While there is a growing number of green buildings, most are only certified at the lowest level because of inadequate training in green practices (Algburi et al., 2016), and environmentally friendly consumption behaviours are not always translated (Sabar et al., 2018). It is crucial to raise building occupants' understanding of environmental issues since their perspectives have a direct impact on how much energy, water, and resources a green building can save (Huang et al., 2018). As mentioned by Abdullah et al. (2015) and Abu al-Rejal et al. (2017), the Green Building Index (GBI) is used to evaluate the efficacy of green buildings.

3.0 METHODOLOGY

This study employed a quantitative methodology. The research approach for this study consisted of three steps. Initially, data was gathered from the literature to determine, using GBI tools, the elements that contribute to the efficacy of green buildings. The factors were then utilised as the foundation for creating the questionnaire. The employees of the Putrajaya Energy Commission Green Building were the study's target demographic since they are the primary stakeholders in enhancing the building's efficiency. Since roughly 320 people are working at the Putrajaya Energy Commission Green Building overall, 175 respondents were chosen at random for the study's group sample (Krejcie and Morgan, 1970).

Demographic data, contributing variables, and the efficacy of green buildings make up the survey questionnaire's framework. Likert scale items covering contributing causes and the effectiveness of green buildings are included in the questionnaires, with responses ranging from Strongly Disagree (1) to Strongly Agree (5).

Utilising SPSS, data analysis was conducted to assess respondents' feedback and perform various statistical analyses, including multiple regression, inferential statistics, Pearson's correlation, and demographic analysis of questionnaire respondents. Descriptive statistics provided an overview of the features of the data, whereas inferential statistics expanded the results to encompass broader groups. The relationship between contributing components and the effectiveness of green buildings was evaluated using Pearson's correlation. The impact of each predictor on the dependent variable was ascertained by multiple regression.

4.0 ANALYSIS AND RESULTS

4.1. Demographic Profile

Based on their gender, age, years of service, and department at the Putrajaya Energy Commission Building, the survey participants were divided into groups. Table 3 provides further details regarding the respondents' distribution.

Table 3. Distribution of Respondents (n = 175)

Item	Description	Number of Participants	Percentage (%)
Age	< 25 years old	42	24
	26 – 30 years old	8	4.6
	31 – 35 years old	10	5.7
	36 – 40 years old	21	12.0
	41 – 45 years old	23	13.1
	46 – 50 years old	14	8.0
	51 – 55 years old	14	8.0
	> 55 years old	43	24.6
Gender	Male	98	56.0
	Female	77	44.0
Years of Service	0 – 5 years	48	27.4
	6 – 10 years	34	19.4
	11 – 15 years	40	22.9
	Above 15 years	53	30.3
Department	Industry Operation	20	11.4
	Safety Regulation	21	12.0
	Enforcement and Regional Operations	17	9.7
	Strategic Planning and Communication	30	17.1
	Corporate Services	16	9.1
	Economic Regulation	14	8.0
	Industry Planning and Development	18	10.3
	Other	16	9.1

4.2. Mean Score Analysis

The purpose of mean score analysis in a quantitative study is to rank the relative relevance of components. Several writers' earlier research also employed mean score analysis (Pallant & Manual, 2007). The mean score analysis for this study is displayed in Table 4.

Table 4. Mean Score Analysis of Respondents.

Contributing factors on the effectiveness of green building at Putrajaya Energy Commission Building	Mean Value	Level
Independent Variables		
Government supervision	3.75	High
Incremental cost	4.00	High
Property management	3.98	High
Awareness of environmental protection	3.27	Moderate
Dependent Variables		
Energy Efficiency	3.94	High
Water Efficiency	3.97	High
Indoor Environmental Quality	3.30	Moderate
Sustainable Site Planning and Management	3.01	Moderate
Materials and Resources	3.27	Moderate
Innovation	3.97	High
Average Mean (Effectiveness of Green Building)	**3.58**	**Moderate**

Table 4 displays the total mean level for the contributing elements. The highest factor influencing the efficacy of green building was incremental cost, with a mean of 4.00. Table 4 further demonstrates how the Putrajaya Energy Commission Building's green building efficacy is evaluated using GBI tools. Water efficiency and innovation rank highest, with a corresponding mean of 3.97. The Putrajaya Energy Commission Building's overall mean score for the effectiveness of its green building is 3.58, which is considered moderate.

4.3. The Regression Test among Independent Variables (Government supervision, Incremental Cost, Property management, Awareness of Environmental Protection) and Dependent Variable (Effectiveness of Putrajaya Energy Commission Building)

Multiple linear regression (MLR) is a method used to model the linear relationship between a dependent variable and one or more independent variables. The dependent variable is sometimes called the predictand, and the independent variables are the predictors. MRA to identify the significant contributing variables (government supervision, incremental cost, property management, and environmental protection awareness) that significantly affect the effectiveness of the Putrajaya Energy Commission Building. Analysis of Variance (ANOVA) shows that factors identified by this analysis together significantly related to the dependent variable.

This means that the factors identified in this analysis are significantly related to the effectiveness of the Putrajaya Energy Commission Building (refer to Table 5). If there is a change in the factors, there will be a change in the effectiveness of the Putrajaya Energy Commission Building. Table 5 shows the individual factors' relationship with the dependent variable of the regression model. It shows that all impact factors such as awareness of environmental protection (51.600); property management (5.376), incremental cost (-2.244) and government supervision (2.394) are significantly related to the effectiveness of the Putrajaya Energy Commission Building.

Table 5. The Regression Test among IVs and DV.

IV	*DV (Effectiveness of Putrajaya Energy Commission Building)*							
	Coefficients (β) [a]				*Annova* [b]		*Model Summary*	
	B	Beta	t	Sig	F	Sig	R	R^2
(Constant)	0.016		0.226	.821	970.049	.000[b]	0.979	0.958
Government supervision	0.065	0.058	2.394	.018				
Incremental cost	-0.047	-0.051	-2.244	.026				
Property management	0.108	0.118	5.376	.000				
Awareness of environmental protection	0.866	0.925	51.600	.000				
a. Predictors: (Constant), government supervision, incremental cost, property management, and awareness of environmental protection								
b. Dependent Variable: Effectiveness of Putrajaya Energy Commission Building								

The multiple regression now is as follows:

In this study, multiple regression models initially are expected as below.

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \varepsilon$$

Where,

β_0 is the y-intercept
y is the effectiveness of the Green Putrajaya Energy Commission Building.
β_1, β_2, β_3, β_4, are the respective coefficient for the predictors
x_1 is government supervision
x_2 is incremental cost
x_3 is property management
x_4 is awareness of environmental protection

Eventually, the multiple regression model is as follows:

In this study, multiple regression models initially are expected as below

$$y = 0.058x_1 - 0.051x_2 + 0.118x_3 + 0.925x_4 + \varepsilon$$

This indicates for every unit increase in the effectiveness of the Putrajaya Energy Commission Building there will be an increase of 0.058 units of government supervision, a decrease of 0.051 units of incremental cost, an increase of 0.118 units of property management and an increase of 0.925 unit of awareness of environmental protection. In other words, government supervision contributes an increase of 5.8%, incremental cost contributes a reduction of 5.1%, property management contributes an increase of 11.8% and awareness of environmental protection contributes an increase of 92.5% towards the effectiveness of Putrajaya Energy Commission Building.

4.4. Pearson's Correlation Coefficient

The Pearson Product-Moment Correlation Coefficient is a measure of the linear correlation (dependence) between two variables X and Y, giving a value between +1 and −1 inclusive, where 1 is a total positive correlation, 0 is no correlation, and −1 is a total negative correlation. It is widely used in the sciences as a measure of the degree of linear dependence between two variables. It was developed by Karl Pearson from a related idea introduced by Francis Galton in the 1880s. Pearson's correlation coefficient is defined between two random variables equal to their variance divided by the standard deviation (refer to Table 6).

Table 6. Correlation Pearson Coefficient Test between Variables (EGB, GS, IC, PM, and AEP).

Independent Variables (IV)	Dependent Variable (DV) (Effectiveness of Green Building (EGB)	
Government Supervision (GS)	Pearson Correlation Sig. (2-tailed)	0.539** 0.000
Incremental Cost (IC)	Pearson Correlation Sig. (2-tailed)	0.415** 0.000
Property Management (PM)	Pearson Correlation Sig. (2-tailed)	0.421** 0.000
Awareness of Environmental Protection (AEP)	Pearson Correlation Sig. (2-tailed)	0.971** 0.000

***Correlation is significant at 0.01 (2-tailed).*

5.0 DISCUSSION

5.1. Contributing Factors

The building's effectiveness was shown to be significantly influenced by government oversight, which is consistent with the government's role in encouraging and regulating green building techniques (Darko et al., 2017). The efforts of the Malaysian government to enact laws supporting energy efficiency goals highlight the significance of governmental backing for green building initiatives (Maghsoudi Nia et al., 2022). Thus, strengthening the partnership between the government and the building sector is essential to improving the Putrajaya Energy Commission Building's efficiency.

Another significant influence was found to be incremental cost. The belief that including green building elements in a construction project can result in higher initial expenses but lower overall prices underscores the economic aspects of sustainable building practices (Jaffar et al., 2022). Despite the widespread misconception that using green building practices will cost more upfront, this study suggests that addressing these concerns can improve the overall effectiveness of the building. These strategies include careful planning, precise cost-benefit analysis, and raising awareness of the long-term advantages.

The significance of property management procedures in guaranteeing the efficacy of the Putrajaya Energy Commission Building was also emphasised. According to Aghili et al. (2016), efficient property management is essential to preserving the environmental performance and functionality of green buildings. The durability and sustainability of green building features are largely dependent on property management personnel's commitment to green practices, system monitoring, and adequate maintenance. This emphasises how important it is to maintain a commitment to property management techniques that support the building's green goals.

The study revealed that employees had a moderate understanding of environmental protection, which is indicative of the continuous difficulty in encouraging sustainable behaviours and practices among stakeholders (Hussein, 2016). Since green development is still a relatively new idea, increasing organizational understanding and encouraging public participation are crucial to its effective application. The efficacy of the building can be increased by teaching building occupants, the public, and end users about the advantages of green building practices and environmental preservation. This can encourage more responsible behaviour.

5.2. Effectiveness of Putrajaya Energy Commission Building

The research evaluated the effectiveness of the Putrajaya Energy Commission Building using the Green Building Index (GBI) tool across various categories. The findings indicate a mixed level of effectiveness across different dimensions, revealing areas of strengths and opportunities for improvement.

Energy efficiency emerged as a strong point, reflecting the building's focus on reducing energy consumption and promoting energy-conscious behaviours. The integration of energy-saving technologies and sustainable design strategies further contributed to the building's success in this category. Water efficiency was also a notable area of achievement, showcasing the incorporation of water-saving fixtures and rainwater harvesting systems that contributed to the building's ability to reduce water consumption and minimize wastage. However, the study identified room for improvement in ensuring water quality for reuse, suggesting the need for stricter monitoring and maintenance of water management systems.

Indoor environmental quality (IEQ) received a moderate rating, suggesting the need for further improvement in this area. Implementing strategies to optimize temperature and humidity control, air quality management, and acoustic treatments can contribute to a more favourable IEQ for occupants. Sustainable site planning and management exhibited a moderate level of performance. The study emphasized the importance of selecting suitable locations with access to public transportation and preserving green spaces.

Materials and resources management also showed potential for improvement. While the building scored well in using eco-friendly construction materials, efforts to reduce construction waste and incorporate recycled materials were identified as areas that need attention. Innovation emerged as a strong point, indicating the building's incorporation of cutting-edge technologies and sustainable practices. The use of renewable energy systems, advanced insulation materials, and smart building automation systems demonstrated the building's commitment to innovation.

5.3. Relationship between Influencing Factors and Effectiveness

The evaluation of relationships between influencing factors and effectiveness revealed significant insights. Government supervision, as a factor, demonstrated a moderate positive relationship with effectiveness. This highlights the importance of government involvement in fostering sustainable construction practices and enforcing regulations that align with green building objectives.

The relationship between incremental cost and effectiveness is more complex, showing a moderate negative correlation. This suggests that while higher costs may be perceived as a hindrance, addressing cost concerns through proper financial planning, education, and accurate evaluation can mitigate this negative perception and enhance the overall effectiveness of green building projects.

Property management exhibited a moderate positive relationship with effectiveness. This emphasizes the pivotal role of property management practices in maintaining the building's environmental performance, operational efficiency, and overall effectiveness. By prioritizing green management practices, property management contributes significantly to the building's success.

The relationship between environmental protection awareness and effectiveness was found to be very strong and positive. This underscores the critical role of environmental awareness in promoting sustainable behaviours, fostering stakeholder engagement, and driving the overall effectiveness of green building initiatives. Building occupants, stakeholders, and the public need to be well-informed and engaged to maximize the positive impact of green building practices.

5.4. Strategies to Improve the Effectiveness of Green Buildings

To enhance the effectiveness of green buildings using the Green Building Index (GBI) tool, a set of strategies has been developed across various dimensions (Refer to Table 7):

Table 7. Strategies to improve the effectiveness of green buildings.

Energy Efficiency	- Implement energy-saving technologies such as high-efficiency HVAC systems, LED lighting, and smart energy management systems. - Incorporate passive design strategies like natural ventilation, daylighting, and shading devices to reduce reliance on artificial lighting and cooling systems. - Integrate renewable energy sources like solar panels to generate clean energy on-site. - Government supervision should enforce stricter building codes and standards emphasizing energy-saving measures and renewable energy integration.
Water Efficiency	- Install water-saving fixtures, rainwater harvesting systems, and greywater recycling systems to reduce reliance on potable water sources. - Incorporate drought-tolerant plants and efficient irrigation systems in landscaping design. - Engage and educate stakeholders, especially occupants, through water conservation programs and consumption monitoring.
Indoor Environmental Quality	- Optimize natural ventilation, control indoor air pollutants, and promote access to natural light. - Regular maintenance and inspections for proper ventilation systems and low-emitting materials. - Incorporate acoustic design principles to reduce noise pollution. - Effective property management practices are vital for maintaining and improving IEQ.
Material and Resources	- Utilize sustainable and locally sourced materials and implement recycling and waste management practices. - Adopt construction methods that reduce material consumption. - Select materials with low embodied energy and high recycled content. - Implement modular construction and adaptive reuse of existing structures.
Sustainable Site Planning and Management	- Select sites with access to public transportation and preserve green spaces. - Implement efficient storm water management systems and pedestrian-friendly designs. - Promote public transportation and infrastructure for cycling and walking. - Government regulations can incentivize brownfield redevelopment.
Innovation	- Integrate cutting-edge technologies like renewable energy systems and smart building automation. - Explore alternative energy sources and innovative construction techniques. - Use occupancy sensors and data analytics for optimized resource management.

Aspects of the GBI tool that are addressed by these strategies include resource conservation, lower operating costs, enhanced occupant health and well-being, sustainable sourcing, and less environmental effect. Stakeholders can make a positive impact on the built environment, improve the efficacy of green building initiatives, and promote sustainability by putting these techniques into practice.

6.0 CONCLUSION

In conclusion, property management, government supervision, incremental costs, and environmental protection awareness all support the efficacy of green building. Stakeholders may contribute to the cause of sustainable construction and create a built environment that is more resilient and ecologically sensitive by understanding and utilizing these characteristics. Furthermore, three key factors—government supervision, incremental cost, and property management—have a strong positive moderate association with the efficacy of green building. A noteworthy and robust correlation exists between the efficacy of green building and the awareness of environmental protection. The relationship's significance indicates that, by considering the influencing elements while deciding whether to amend the current regulations or apply new tactics, the efficacy of green building can still be improved. This study has the potential to greatly benefit the construction industry by providing insightful analysis and suggested approaches to improve the performance of upcoming green building projects that make use of the Green Building Index (GBI) tool. Stakeholders in the construction sector can use these techniques as a guide to build better green buildings that adhere to sustainable concepts and practices.

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