The Energy Efficiency Awareness for Selangor Office Buildings

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Abstract

The adoption of Energy Efficiency (EE) is now imperative rather than optional for every industry or sector, particularly in developing countries like Malaysia. The building sectors, responsible for consuming up to 40% of the world's energy, 12% of water, and contributing 40% of landfill waste, play a significant role in this global issue. The high cost of energy and the pressing concerns of global warming compel governments to develop numerous alternative initiatives. Thus, this study aims to identify energy efficiency practices implemented in office building according to the Green Building Index (GBI) and to analyse the level awareness of energy efficiency practices on occupants in office building in Selangor. The survey method via questionnaire was applied and distributed to the occupants in three office building in Selangor. The sample size that was used is S=168. The questionnaire consists of three (3) sections on respondents' demographics, energy efficiency practices implemented and level awareness of energy efficiency practices on occupants in office building. A descriptive analysis and mean score method have been used for data analysis by using Statistical Package for Social Science (SPSS) version 27. Overall analysis revealed that occupants in the three-office building were mostly agreed that the energy efficiency practices were implemented in their office building and aware about the energy efficiency practices in office building. Therefore, a study on full assessment under GBI criteria is needed to measure the energy efficiency practices were implemented for the existing office building for future research purposed.

1. Introduction

The global warming issues are affecting the whole world in recent years as the average temperature of the Earth had increased as compared to the 19th century. Solutions are required to face the challenges particularly on climate change and sustainable economic development. Construction sector as one of the major parts of this problem, which consumed about 40% of the world's energy; where 12% of these energies consumed is water and also directed 40% of the waste to landfill (Baharom et al., 2012).

Malaysia's carbon emissions were 7.9 metric tonnes per capita as of 2011, with buildings and the built environment contributed significantly to greenhouse gas emissions (World Bank, 2016). Research indicates that buildings account for approximately 33% of global energy consumption (IEA, 2013). Consequently, it is crucial to promote the construction, operation, and maintenance of buildings that minimise energy usage. To achieve a

40% reduction in carbon emissions per person from the 2005 level by 2020, various measures have been implemented in the energy, building, transportation, and waste management industries. (Smith et al., 2020).

2. Previous Studies on Green Building in Malaysia

Prior to 2011, the early literature on the development of green buildings in Malaysia concentrated on defining the idea of green building evaluation methodology. During this time period, research was mostly focused on particular aspects of establishing green building evaluation tools such as criteria, sub-criteria, weightage, certification procedure (Gou et al., 2013). Between 2011 and 2015, additional analytically based studies that provided information on the attitudes and problems faced by Malaysian building stakeholders when designing green buildings were added to the research environment. The research discussed the important parties' responsibilities in promoting the adoption of green construction, including the government and developers (Helgeson & Lippiatt, 2009). The steps Malaysia is taking to encourage the construction of green buildings have been detailed. They have identified potential components that might aid in overcoming difficulties and obstructions to the adoption of green practices (Fellows & Liu, 2021). They have identified potential components that might aid in removing obstacles and stumbling blocks to the adoption of green practices.

2.1 Energy Efficiency (EE)

The Malaysian government has played an important role in stressing the importance of energy efficiency (EE). This has been accomplished over the past three decades by adopting several energy efficiency efforts encompassing incentives, education and subsidiaries (Algburi & Faieza, 2016). It is important to note that energy efficiency is not noticed as a critical concern that need to be spotlighted by engineers. The energy efficiency performance also required to minimize the energy usage in the building and lead to reduction of emissions gases.

The use of auto sensor-controlled lighting and motion sensors for lighting zoning is suggested in the lighting phase (Algburi & Faieza, 2016). Moreover, as to improve the light switching flexibility, individual controls need to be employed. Marhani & Muksain, (2018) affirmed that by implementing the building integrated photovoltaic as the building envelope and reducing the usage of air conditioning can lead to energy efficiency. The separate sub-metering for energy usage more than 100 kVA is requires, as well as adopting the Energy Management System to monitor and analyze energy usage in the building. Thus, the sustainable maintenance must be ensuring that energy system will beyond the 12 months of Defects and Liability period by implementing the Energy Monitoring Committee (EMC) and providing maintenance office together with services team from one to three months before operational completion (Liew, 2012).

In a simple word, energy efficiency means using less energy to perform the same work. As example, whenever you change your electrical equipment with the more energy efficiency equipment, the output is still the same but the energy used for energy efficiency equipment is less. Therefore, GBI have made a guideline to increase the energy efficiency which is design and performance, commissioning and as well as monitoring, improvement and maintenance. The details of assessment criteria of GBI on energy efficiency of NREB is shown in Table 1.

Table 1: The details of assessment criteria on energy efficiency (GBI, 2011).

Design and Performance		
EE1	Minimum Energy Efficiency Performance	2
EE2	Lighting Zoning	3
EE3	Electrical Sub-metering	2
EE4	Renewable Energy	5
EE5	Advanced or Improved Energy Efficiency Performance – BEI	15
Commissioning		

EE6	Enhanced or Re-commissioning	4
EE7	On-going Post Occupancy Commissioning	2
Monitoring, Improvement and Maintenance		
EE8	Energy Efficiency Monitoring and Improvement	2
EE9	Sustainable Maintenance	3

2.2 Level of Awareness in Green Building Practices

The development of sustainable construction is being limited by the lack of awareness and knowledge. A study demonstrates that the desire of the construction company to incorporate sustainable building in the projects would be negatively impacted if top management does not have the necessary knowledge and understanding. The lack of public awareness is cited as a fundamental impediment to the adoption of green construction schemes (Ibrahim & Raji, 2018). A study showed that one of the most significant impediments to the development of green buildings in the country is a lack of public awareness (Lim et al., 2018). According to the findings of the research, top management does not have a strong understanding of sustainable development, despite the fact that they are concerned about environmental concerns (Wright & Wilton, 2012). Awareness informs the public, the building design team, stakeholders, and the construction team on the operation and maintenance of the building's green elements (Zigenfus, 2008). It may be used to educate the public and the construction project team about the importance of green building by utilizing green building certification systems from around the world. Not only that, the study was also highlights that developer awareness in Malaysia is still low-moderate (Nordin et al., 2017). Many parties should be aware of the importance of healthy living and environmental stewardship. The awareness should be raised and pressure applied to the design team and corporations to perform sustainable operations when sustainable businesses are developed, the influence on demand for green buildings will improve (Yudelson, 2012). Green building development is limited due to the lack of awareness and education (Yee et al., 2020).

3. Methodology

The present study adopted the questionnaire survey method.

3.1 Data Collection

Primary and secondary procedures are two categories of data collection techniques that are essential for research. The survey question, the type of data, and the resources available all influence the data collection method selection. While secondary data is obtained from sources like books, journals, and articles, primary data is obtained via methods like questionnaires and interviews. Journals, articles, books, and other secondary data sources are used by the researcher to pinpoint the attitudes and practices that lead to risky behavior on building sites. Several risky behaviors and key elements that employees frequently engage in on building sites were utilized to generate primary data, which is then employed to assist and accomplish Goals 1 and 2 through the usage of a questionnaire.

3.2 Questionnaire

Well-designed questions are crucial for obtaining positive responses from respondents. The study consists of three main parts: Part A, which focuses on demographic information; Part B, which examine the energy efficiency practices implemented in office building; and Part C, which identifies the level awareness of energy efficiency practices on occupants in office building according to the Green Building Index. The questionnaire format includes a start page outlining the study's objectives, format, and sequence, and a questionnaire describing the study's objectives and sequence.

3.3 Sample size of questionnaire

Sample size refers to the number of observations or participants included in a study or survey. It is crucial to make sure that the number of samples is not too small to avoid risk of inadequate or too large to avoid unworthwhile data as the size of the sample affects the reliability of the study. There are many approaches to determine the total sample size in the specified population (Department of Statistics Malaysia, 2015.This research study only focused on three office building in Selangor. For easier orientation, the following table 3.2 will be used to determine the sample size for a specific population. Thus, based on Whitehouse (2020), the sample size that will be used in this study is will be, S=162 and N=280 is sufficient to represent the sample size.

3.4 Pilot study

The pilot study was carried out before the final version of the questionnaire draft was approved. Its aim was to ensure that all of the questions and instructions are clear, and to assess the suitability of the question before distribution process occur. The response rate required for adequate precision in data collection has been set at around 10 –15 in order to carry out the pilot study which expert in the field of study should be involved in the pilot study. A pilot study can be used to assess the dependability and validity of a questionnaire. Cronbach's Alpa is a common method for testing the instrument's internal reliability; if the value is greater than 0.60, the instrument is considered internally consistent. In other word, when the value is close to 0, the responses are not very reliable, but when it is close to 1, they are quite reliable.

3.5 Descriptive Analysis

After the data has been collected, Statistical Packages for Social Sciences (SPSS) software is used to analyze it. As this was a quantitative study, the data gathered was analyzed statistically. For the interview the answers from respondent were summarized depends on the questions. In this research questionnaire the formula that have been used to obtain mean score is as follows:

$$\text{Mean score} = \frac{\sum R}{N}$$

where;
R = Total Mean Score of each scale (5point likert scale)
N = total number of respondents

4. Results and Discussion

This chapter provides a detailed explanation of the results obtained from collecting data through questionnaires distributed to 168 respondents at three office building. The data was analyzed statistically using Microsoft Excel and SPSS version 27. The results are visually represented through various graphical formats, including bar charts, pie charts, tables, and numerical score.

4.1 Respondent Demographic

Demographic sections in the survey questionnaire were to investigate the characteristics of a population. It covers respondents' group of age, occupation status and education level as stated in Table 2. It shows that the survey was mostly participated by age group of 20-29. Aside from that, the majority of the respondents were employed and quite well educated.

Table 2: Respondent's demographic background

Variables		Percentage (%)
Age	< 20 years old	3.0
	21 - 30 years old	66.1
	31 - 40 years old	29.2
	> 50 years old	1.8
Company Name	Ansactech	10.7

	TIME dotCom	64.3
	Shanghai Mitsubishi	25.0
Academic Qualification	Diploma	6.5
	Degree	85.7
	Master	7.7
Position	Admin	6.5
	Technician	5.4
	Manager	3.6
	Engineer	41.1
	Other	43.5
Year in Work Experience	Less than 5 years	50.6
	6 to 10 years	30.4
	11 to 15 years	10.7
	15 to 20 years	5.4
	More than 20 years	3.0
Work Department	Administration	4.8
	Central Sale & Application	1.8
	Branch Sale & Service	4.2
	Service (Laboratory)	1.2
	Service (Site and Flow)	1.8
	Project	14.3
	Maintenance	10.1
	Network Operation	47.6
	Business Operation	14.3
Understanding in Green Building Concept	I fully understand the Green Building concept.	14.3
	I understand the Green Building concept.	82.1
	I do not understand the Green Building concept.	3.6

4.2 Energy efficiency practices implemented in office buildings according to the Green Building Index (GBI).

In part B questionnaire, 15 items related to system of energy efficiency practices implemented in office building have been asked to measure the energy efficiency in the office building. The questions are divided into three parts which are design and performance, commissioning and monitoring, improvement & maintenance.

(i)Design and performance

The office building's energy efficiency performance and design were observed with regard to six items. Table 3 displays the average score for the implementation of energy efficiency strategies in an office building. The highest management system is establishing minimum energy efficiency enhancing the efficiency of energy usage in office buildings., with an average mean score of 4.01, as the initial investments may be required to meet or exceed minimum energy efficiency standards, the long-term cost reduction is significant. Properly designed and maintained systems extend the lifespan of equipment and reduce the frequency of repairs.

The second highest is upgrading the traditional energy and lightning system or flexible lighting controls to optimize energy savings with an average mean score 3.99, as traditional energy and lighting systems may lack the precision and adaptability of modern technologies. Upgrading to flexible lighting controls allows for better energy management, reducing unnecessary consumption and optimizing usage based on real-time needs

Lastly, the lowest energy efficiency implemented is provide auto-sensor controlled lighting in conjunction with the daylighting strategy for all perimeter zones and daylit areas with an average mean score is 3.71. It is because some building operators may worry about the ongoing maintenance requirements of sensor-controlled systems. Concerns about reliability, potential malfunctions, and the need for specialized technical support could contribute to a reluctance to adopt such systems. To overcome these barriers, it is crucial to emphasize the long-term cost savings, energy efficiency benefits, and occupant comfort improvements associated with sensor-controlled lighting. Education, pilot projects, and financial incentives can also encourage building owners and managers to adopt this technology and contribute to the overall energy efficiency of office buildings

Table 3: Mean Score on Design and Performance

No	System of energy efficiency practices implemented in office building						Total Respondents, N	Mean
	Items	1	2	3	4	5		
1	Establish minimum energy efficiency enhancing the efficiency of energy usage in office buildings.	0	0	29	108	31	168	4.01
2	Provide an Energy Management Controlsystem where Air-conditioned space.	0	1	31	109	27	168	3.96
3	Upgrading the traditional energy andlightning system or flexible lighting controls to optimize energy savings.	0	0	41	87	40	168	3.99
4	Provide auto-sensor controlled lighting in conjunction with the daylighting strategy for all perimeter zones and daylit areas.	0	2	69	73	24	168	3.71
5	Provide sub-metering for all energy used.	0	1	43	102	22	168	3.86
6	Encourage the use of renewable energy.	0	1	44	79	44	168	3.99

(ii) Commissioning

The energy efficiency measurement of the completed office building encompassed four elements. Table 4 displays the mean rating value for the commissioning of the energy efficiency system in office buildings. The highest management system is following the completion of fit-out modifications, perform current ongoing post-occupancy establishing for all occupied areas, with an average mean score of 4.08, as by assessing the ongoing performance of modified spaces allows for financial optimization. It establishes a feedback loop that supports continuous improvement and contributes to creating a workspace that enhances both productivity and well-being. The second highest is implementing enhancements to ensure efficient repair, operation, and maintenance of the building's primary energy-consuming systems in order to maximise energy efficiency with the mean score 4.06 as in Malaysia have regulations and standards in place to promote energy efficiency and environmental conservation. Implementing enhancements ensures compliance with these regulations, helping the office building avoid potential fines and legal consequences.

Overall, modifying the building management plan as required to accurately incorporate any alterations in the occupancy timeline, appliance operating time table, system parameters, and lighting levels with a mean score of 3.71 as there may be resistance among building management staff to adopt new practices or modify existing plans. This resistance could be due to concerns about the learning curve associated with new technologies or changes in established routines. To address these challenges, there needs to be a concerted effort to raise awareness about the benefits of regularly updating building management plans. Additionally, providing training and support for building management staff, investing in modern building management systems, and aligning with sustainability goals can encourage the adoption of proactive management strategies in office buildings.

Table 4: Mean Score on Commissioning

No	System of energy efficiency practices implemented in office building						Total Respon ts, N	Mean
	Items	1	2	3	4	5		
7	Implementing enhancements to ensure efficient repair, operation, and maintenance of the building's primary energy-consuming systems in order to maximise energy efficiency.	0	1	18	119	30	168	4.06
8	Conduct training sessions for management personnel to enhance their knowledge and expertise in various aspects of sustainable building operations, encompassing energy efficiency, as well as the maintenance and operation of building equipment and systems.	0	2	20	117	29	168	4.03
9	Modifying the building management plan as required to accurately incorporate any alterations in the occupancy timeline, appliance operating time table, system parameters, and lighting levels.	0	2	26	107	33	168	4.02
10	Following the completion of fit-out modifications, perform current ongoing post-occupancy establishing for all occupied areas.	0	0	24	107	37	168	4.08

(iii) Monitoring, Improvement and Maintenance

Measuring monitoring, improving and maintaining system energy efficiency in an office building involves five items. The mean score for monitoring, improving, and maintaining the energy efficiency of systems in office buildings is presented in Table 5. The highest management system is utilising Energy Star certified appliances and equipment is sufficient., with an average mean score of 4.33, as by consuming less energy, they contribute to environmental conservation, lowering the office building's carbon footprint and aligning with sustainability goals. Compliance with regulations and standards related to energy efficiency is facilitated, safeguarding the business from potential fines or penalties. Adopting Energy Star products is also a demonstration of corporate social responsibility, enhancing the company's reputation and appealing to environmentally conscious stakeholders. The lowest management system is giving verifiable evidence of a formally recorded strategy for maintaining and budgeting for repairs and preventive maintenance for a minimum of three years, with an average score of 3.99, as limited financial resources may hinder the implementation of a comprehensive maintenance strategy. Some organizations may prioritize immediate needs over long-term planning due to tight budgets.

Table 5: Mean Score on Monitoring, Improvement and Maintenance

No	System of energy efficiency practices implemented in office building							Total Respondents, N	Mean
	Items	1	2	3	4	5		
11	Implemented an Energy Management System (EMS) (or employed a specialised Energy Monitoring Team) to oversee and assess energy usage, including the monitoring of sub-meters.	0	0	19	117	32	168	4.08
12	Ensure that the energy-related systems of the building will consistently function as intended through appropriate and sustainable maintenance.	0	0	30	108	30	168	4.00
13	Give verifiable evidence of a formally recorded strategy for maintaining and budgeting for repairs and preventive maintenance for a minimum of three years.	0	1	28	111	28	168	3.99
14	Implementing enhancements to optimise the building's primary energy consumption by incorporating state-of-the-art systems or technologies.	0	0	19	112	37	168	4.11
15	Utilising Energy Star certified appliances and equipment is sufficient.	0	0	7	98	63	168	4.33

4.3 Awareness of respondents regarding energy efficiency practices among occupants in office buildings.

Table 5: Mean Score on awareness of energy efficiency practices on occupants in office building.

No	Level awareness of energy efficiency practices on occupants in office building							Total Respondents, N	Mean
	Items	1	2	3	4	5		
C1	I use the knowledge I've gained about energy management to run the building's everyday operations.	0	0	29	108	31	168	4.01
C2	Before I leave the office, I make sure to turn off all of the appliances.	0	1	31	109	27	168	3.96
C3	I consistently ensure that lights are switched off and prefer to utilise natural light whenever it is sufficient.	0	0	41	87	40	168	3.99

C4	The energy-saving awareness briefing facilitated my progress in conserving energy.	0	2	69	73	24	168	3.71
C5	Energy management guidance on energy usage can enhance the energy utilisation performance of buildings.	0	1	43	102	22	168	3.86
C6	Green building could improve occupants' ability to achieve optimal energy efficiency.	0	1	44	79	44	168	3.99
C7	Workplace provides awareness notices emphasising the significance of conserving electricity and water.	0	1	18	119	30	168	4.06
C8	The training I received on energy management made it easier for me to save energy.	0	2	20	117	29	168	4.03
C9	Energy efficiency can minimise expenses, cut emissions, and reduce energy use.	0	2	26	107	33	168	4.02

The table 4.6 above displays the mean values for each of the part C questions that were distributed by the researcher. These values were calculated using SPSS. Objective 2 is regarding analyzing the level of awareness of energy efficiency practices on occupants in green office building. The provided inquiries concern energy training, techniques for energy mindfulness, and recommendations for facility management.

The results indicate that Item C7 produces the highest mean value, implying that management of buildings should provide awareness notices emphasising the significance of conserving electricity and water. The mean score for the query in question is 4.06. The findings indicated that conservation efforts lead to lower electricity and water consumption, resulting in reduced utility bills for the office building. This translates into immediate cost savings, contributing to overall financial efficiency. By emphasizing the significance of conserving electricity and water through awareness notices, an office building not only contributes to immediate cost savings but also aligns with broader environmental and sustainability objectives. It engages employees in responsible practices and fosters a workplace culture that values resource conservation.

The second highest is in the item C8, with and average index 4.03 state that the training the received-on energy management made it easier for me to save energy. It shows that employees who receive energy management training are more likely to adopt energy-saving habits in their daily activities. Simple behavioral changes, such as turning off lights and equipment when not in use, can make a significant difference. It leads to cost savings, environmental benefits, and the creation of a workplace culture that values responsible resource management.

The lowest mean score in item C4, with and average mean score 3.71 state that the energy-saving awareness briefing facilitated my progress in conserving energy. It is because limited budget for training and awareness programs may be a significant barrier. Some building operators may prioritize other immediate needs over investing in energy-saving initiatives, especially if they perceive them as additional costs. Additionally, creating a comprehensive and well-communicated strategy for energy-saving awareness, incorporating incentives, and leveraging technology can enhance the effectiveness of such initiatives in office buildings.

5. Conclusion

On the whole, the degree of consciousness regarding the adoption of energy-efficient measures in office buildings in Selangor is of paramount significance for the promotion of environmental sustainability and economic factors. The results of this study emphasise the urgent requirement for increased knowledge among stakeholders, such as building owners, occupiers, and policymakers, to adopt and execute energy-efficient techniques. The findings indicate that although there is a certain degree of consciousness, there is scope for enhancing the education and involvement of important stakeholders. Heightened consciousness can result in the implementation of energy-efficient technology, practices, and regulations, ultimately resulting in less energy usage, decreased operational expenses, and a beneficial effect on the environment. Collaboration across organisations, government authorities, and other stakeholders is crucial in creating and executing comprehensive awareness programmes. These programmes should not only emphasise the advantages of energy efficiency but also offer concrete instructions and incentives to promote wider adoption.

Acknowledgement

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