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DETERMINANTS OF DRIVING FACTORS IN PRACTICING ENERGY EFFICIENCY IN MALAYSIAN PUBLIC UNIVERSITY BUILDINGS

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Abstract

Energy is the main element in building operations. It is crucial to ensure that the operation and services in that building can be carried out effectively. Naturally, energy is produced from fossil fuels. In Malaysia, the overall energy demand rises at an average annual rate of 6.3 per cent due to the expected higher growth in Growth Domestic Product (GDP). However, high energy consumption will cause the buildings to release more Carbon Dioxide (CO2) which results in greenhouse gas (GHG) emissions. Therefore, it is vital for all buildings to practice energy efficiency (EE) to ensure that the buildings consume minimum energy and produce maximum output during operation. Thus, this research aimed to determine the driving factors that facilitate the implementation of EE in public university buildings. A quantitative approach via a questionnaire survey was adopted. A purposive sampling technique was used which listed 69 respondents who were directly involved in building maintenance and energy efficiency as respondents. The data were analysed using the Statistical Package for Social Science (SPSS) version 25 quantitative software. The results reveal that seven factors were identified as barriers in the implementation of EE in public university buildings. In relation to that, ten driving factors to facilitate the implementation of EE in Public University buildings were found to overcome barriers in the practice of EE of a building. The findings of this research might benefit practitioners in promoting EE practices to achieve cost reduction through low energy usage.

Keywords: *barriers, driving factors, energy, energy efficiency, public universities.*

1.0 INTRODUCTION

Energy is the main element in the operational period of a building. A rise in the world's energy demand rose by 39 percent between 1990 and 2008 and by 40 percent between 2007 and 2030 (Mohd Salleh et al., 2016). This shows that energy is a crucial aspect to a building in ensuring that the operation or services in that building can operate efficiently. Usually, the energy produced from fossil fuels will go through several processes to be generated. High energy consumption will cause the building to release Carbon Dioxide (CO2) which results in greenhouse gas (GHG) emissions. Energy usage in buildings was found to contribute up to 40 percent of the total world consumptions (Mohd Salleh et al., 2016).

In the construction industry, energy efficiency (EE) is very crucial and is becoming more important as global anthropogenic CO2 emissions need to be significantly reduced (IPCC, 2007). According to the United Nations Environment Programme (UNEP) (2007), 30 percent to 40 percent of all primary energy is used in buildings worldwide. EE can be practiced in a building to ensure that the building consumes minimum energy and produces maximum output during operation. However, to execute EE in one building is not an easy task and many factors such as building material and design, environmental suitability, and payback period need to be considered to ensure that these tasks are achieved.

Generally, buildings that practice EE have more advantages such as increasing energy-saving for the building, and enhancing safe environment and air quality. United State Congress

Office of Technology Assessment (1993) mentioned that EE provides high potential for customer and service savings, shareholder profits, enhanced manufacturing production, increased international competitiveness and reduced impacts on the environment. It is in-line with the WWF European (2005) which stated that EE is now viewed as one of the most cost-effective ways for society to boost energy protection from greenhouse gas and other contaminants.

Abd Rahman et al. (2019) indicated that Malaysia is one of the prominent energy consumers in Asia. Thus, it is important to practice EE in a building because it can conserve limited resources such as fossil fuels. In Malaysia, EE and renewable energy are identical in terms of sharing the same goals of reducing energy demand, controlling the use of natural fossil fuels, and protecting the environment from harmful emissions (Abd Rahman et al., 2019).

Even though EE in buildings has been practiced for several years, there are many barriers in practicing EE in a building. This has been expressed by Soares et al. (2015), that reduction of energy consumption in buildings depends on the awareness of the users about the energy consumption. Therefore, users' awareness on EE is very crucial because it will indirectly become an obstacle in implementing EE in a building. Thus, to ensure that EE can be implemented in all buildings, factors that drive towards improving EE implementation are essential.

2.0 ISSUES OF ENERGY CONSUMPTION IN MALAYSIA

In Malaysia, the construction sector has become one of the main sources of economy. Due to that, many buildings have been constructed especially in strategic areas and this will cause a high consumption of energy from year to year. The overall energy demand in Malaysia is expected to rise at an average annual rate of 6.3 per cent between 2005 and 2010 due to expected higher growth in GDP (Kementerian Tenaga Air dan Komunikasi Malaysia et al., 2014). Besides, the excessive consumption of energy will cause the building to release more Carbon Dioxide (CO2) and become harmful to the environment and public's health (Stavins & Jaffe, 1994). Even though numerous researches have been conducted concerning EE in the construction industry, the issues on the implementation of EE in the industry are continuously debated. The issues include the following:

2.1 Lack of Implementation in EE

Due to an increase in energy demand, conventional buildings did not take into account the application of energy efficiency in a building. As Abd Rahman et al. (2019) mentioned, Malaysia's final energy consumption rose from 13 million toes in 1990 to an approximately 41 million toes in 2010, reflecting an average annual growth rate of 6 percent. Malaysia had shown no improvement in energy consumption and conservation. This shows that the majority of the conventional buildings were built for their functional purposes without considering EE.

Mohd Salleh et al. (2016) mentioned that it was not an easy task to implement EE. Implementing EE in a building was considered difficult because it required high initial cost, expertise and suitable material during the construction. Thus, conventional contract buildings gave less emphasis on EE implementation. In fact, these buildings used alarmingly high energy consumption in daily operations. Therefore, these buildings should also implement EE to reduce the environmental impact. Increased demand for energy in buildings could be reduced by improving the implementation of EE.

2.2 Lack of Awareness in Implementation of EE

Usually, buildings that have a high consumption of energy in industrial fields are the manufacturing premises. Other than that, educational premises also have high daily energy consumption. Sorrell et al. (2004) mentioned that universities were 60 percent more energy-intensive than commercialoffices and more than twice as power-intensive as production facilities. This led to the high cost during the buildings' operation. By choosing the right method and strategy, the problem of high energy consumption of the buildings could be reduced (Mohd

Salleh et al., 2016). Consequently, a need to determine the driving factors in order to implement energy efficiency in Public Universities is crucial to reduce energy usage and save the environment.

3.0 METHODOLOGY

A quantitative method via questionnaire survey was conducted. This corresponded with professionals and experts that were involved in managing EE in building operations. The questionnaire survey was distributed to the building operators involved in managing EE in public universities. It involved 69 building operators selected through purposive sampling techniques within thirteen Universiti Teknologi MARA (UiTM) branches. The building operators were selected based on their responsibility in carrying out and handling all maintenance activities of the buildings. The data obtained from this questionnaire survey were analysed using descriptive analysis employing the Statistical Package for Social Sciences (SPSS) version 25.

4.0 RESULT AND DISCUSSIONS

Table 1 presented the mean and standard deviation for the questionnaire survey. Most of the variables indicated that the respondents agreed with all the variables. There were ten (10) variables that had been determined in order to identify the driving factors that facilitate the implementation of EE in public universities. The average mean of the data collected was 4.55. This shows that most of the respondents agreed with all the statements of driving factors that facilitate the implementation of energy efficiency.

Besides, all variables show a score mean above 4.0. The lowest standard deviation as presented in Table 1 was 0.479 that is for the statement “Sufficient technology to be implemented in a building” which also had the highest mean score of 4.66. This is followed by the highest standard deviation 0.772 which was for the statement “People with real ambition and desire to implement energy efficiency” and this variable presented the lowest mean score of 4.34.

Table 1: Mean and standard deviation for driving factors that facilitate the implementation of energy efficiency in public universities

ITEM	STATEMENTS OF DRIVING FACTORS	MEAN	STANDARD DEVIATION	RANKING
1.	Cost reduction due to lowered use of energy.	4.56	0.501	3
2.	Various benefits can be gained by implementing energy efficiency in a building.	4.54	0.503	4
3.	Increase the energy prices (electric bill) during the operation period by monitoring or limiting the energy usage of the building.	4.54	0.503	4
4.	Long term strategy (energy efficiency) for long term benefit.	4.58	0.499	2
5.	People with real ambition and desire to implement energy efficiency.	4.34	0.772	5
6.	Practicing energy efficiency to improve the working conditions.	4.58	0.499	2
7.	Adoption of an environmental management system in implementing energy efficiency in a building.	4.54	0.503	4
8.	Reducing environmental impacts through reduction of Carbon Dioxide (CO2) emission.	4.58	0.499	2
9.	The sufficiency and availability of information will encourage practicing energy efficiency.	4.58	0.499	2
10.	Sufficient technology to be implemented in a building.	4.66	0.479	1
	AVERAGE MEAN	**4.55**	**0.526**	

There are many driving factors that encourage universities to implement EE. Based on the result, the highest mean score for driving factors in implementing energy efficiency was “Sufficient technology to be implemented in a building” (4.66). The result indicated that sufficient technology was the main factor that facilitated Public Universities to implement EE. Technology must be improved from time to time to fulfill the requirement of the consumer. According to Thollander and Ottoson (2008), sufficient technology such as turbines could facilitate the implementation of EE because the payback periods are short-term. Universities can also implement water harvesting, solar panels, and other technologies. However, technology adoption in universities needs high investment because the cost consideration of skilled labour, material, and expertise is high. In addition, this finding contradicted with Lawrence et al. (2019) which mentioned that the main factor in implementing EE was the availability and sufficiency of information. It is due to the importance of available information sources as an effective way to facilitate the implementation of EE.

Furthermore, the result obtained states that four variables had the same score mean of 4.58. These variables are, “long term strategy (energy efficiency) for long term benefit”, “practicing energy efficiency to improve the working conditions”, “reducing environmental impacts through reduction of Carbon Dioxide (CO2) emission”, and “sufficiency and availability of information would encourage practicing energy efficiency”. The results indicate that long term strategy was one of the main driving factors as implementing EE in a building garners many profits and benefits. The maintenance cost could also be reduced as compared to a conventional building. According to Rohdin and Thollander (2006), long term strategy could be a driving force in resolving strict control of investment and these driving factors usually take effects in a long-term period.

Meanwhile, practicing EE could ‘improve working conditions’ and simultaneously ‘reduce environmental impact’. These two variables are related because EE produced energy by

maintaining the maximum output. For example, by using the efficient machine in a building, the emission of carbon dioxide could be reduced. Then, higher air quality can be maintained and the impact on the surrounding can be reduced. This is supported by Apeaning and Thollander (2013) which mentioned that environmental surroundings and the internal building would be more guaranteed. Buildings that implemented EE would produce energy without bringing high risk to the environment due to the reduction of carbon dioxide in the air. Universities that wished for a title of 'green building' would focus more on this driving factor. In addition, the sufficiency and availability of information is also one of the driving factors most frequently selected by the respondents. This factor is important because insufficient information would make someone uninterested to implement EE. By knowing EE, people could understand the benefit, outcome and profit of implementing EE. However, it was contradicted by Thollander and Ottosson (2008) who argue that the information was not the major factor that facilitated the implementation of EE in buildings.

Besides that, another one of the top-five driving factors is "cost reduction due to lowered use of energy" with a mean score of 4.56. Cost reduction attracted many building owners to implement EE. This is because the operational cost could be reduced. Most conventional buildings would spend a high amount of money during the operational period due to the high production of electricity. According to Thollander and Ottosson (2008), cost reduction was the most important driving factor because more profits could be gained rather than spending high costs in the operation period. This was supported by Lawrence et al. (2019) which identified cost reduction from the lowered use of energy as the main driver that facilitated the implementation of EE.

Furthermore, it was also clarified that "various benefits could be gained by implementing EE in a building", "increasing the energy prices (electric bill) during operation period by monitoring or limiting the energy usage of the building" and "adoption of the environmental management system in implementing EE in a building" have a mean score of 4.54 and were fourth in the ranked. By implementing EE, various benefits could be gained such as cutting the operational cost, gaining more profit, reducing environmental pollution, and others. Moreover, increasing the electric bill was one of the driving factors to implement EE. This is because the building owners are unwilling to spend high electric costs especially during the operational period. So they intend to implement energy efficiency to have lower costs during the operational period and focus for more profit. This is supported by Thollander and Ottosson (2008) who stated that increasing the energy prices was one of the most influential factors to force building owners in applying EE. Moreover, the adoption of an environmental management system was one of the driving forces in implementing EE. In universities, the environmental management system could be adopted at offices, labs and other facility rooms. This system could control negative impacts such as air pollution and the emission of other harmful gases. According to Rohdin and Thollander (2006), the environmental management system was one of the driving forces and it played a significant role in promoting the adoption of technologies and practices.

Other than that, the lowest mean score is 4.34 which is "people with real ambition and desire to implement EE". This driving force is from within oneself and is considered 'real ambition' and this factor will not be easily influenced by other people or the surrounding. People with real ambition want to gain many benefits and profit from their building. In addition, some people actually care about the environment and health so this encouraged them to implement energy efficiency in building. According to Rohdin and Thollander (2006) and Rohdin et al. (2007), there were several people who succeeded in adopting energy efficiency because of their ambitious driving force.

5.0 CONCLUSION

In conclusion, controlling the Greenhouse Gas (GHG) emission is crucial to ensure that the environment can be sustained and maintained in good condition. There are many driving factors that facilitate EE in public universities. Based on the research, the implementation of sufficient technology in a building would attract the building owners to become the major factor in implementing and executing EE in their buildings. The other factors are; long term benefit that would be gained by implementing EE; sufficient information, and reduction of Carbon

Dioxide (CO2) emission. Reduction of cost during the operation period is also one of the driving factors in implementing EE. Most building owners that implemented EE could reduce the operation cost besides the consumption of energy with the same output that the conventional method produces. This research has also identified that people with real ambition and desire was the smallest factor in implementing EE due to the subjective notions that depend on the people's behavior. The implementation of EE should be viewed as the most important factor in reducing the environmental impact. It could be attained by determining factors that facilitate practitioners in implementing EE. Thus, it can be concluded that by determining the driving factors, it could encourage the university buildings operators to practice and implement EE effectively.

REFERENCES

Abd Rahman, N. A., Kamaruzzaman, S. N., & Akashah, F. W. (2019) Scenario and Strategy towards Energy Efficiency in Malaysia: A Review, MATEC Web of Conferences, 266, p. 02012. doi: 10.1051/matecconf/201926602012.

Apeaning, R. W. & Thollander, P. (2013). Barriers to and driving forces for industrial energy efficiency improvements in African industries - A case study of Ghana's largest industrial area. Journal of Cleaner Production, 53, pp. 204–213. doi: 10.1016/j.jclepro.2013.04.003.

IPCC (2007) Climate Change 2007: Impacts, Adaptaion and Vulnerability. Available at: https://www.ipcc.ch/site/assets/uploads/2018/03/ar4_wg2_full_report.pdf.

Kementerian Tenaga Air dan Komunikasi Malaysia, et al. (2014) Achieving Industrial Energy Efficiency in Malaysia. Available at: http://www.my.undp.org/content/malaysia/en/home/library/environment_energy/EEPub_Industrial EnergyEfficiency.html.

Lawrence, A. et al. (2019). Drivers, barriers and success factors for energy management in the Swedish pulp and paper industry. Journal of Cleaner Production, 223, pp. 67–82. doi: 10.1016/j.jclepro.2019.03.143.

Mohd Salleh, M. N., Kandar, M. Z. & Md Sakip, S. R. (2016). Benchmarking for Energy Efficiency on School Buildings Design: A Review. Procedia - Social and Behavioral Sciences, 222, pp. 211–218. doi: 10.1016/j.sbspro.2016.05.149.

Rohdin, P. & Thollander, P. (2006). Barriers to and driving forces for energy efficiency in the non-energy intensive manufacturing industry in Sweden. Energy, 31(12), pp. 1836–1844. doi: 10.1016/j.energy.2005.10.010.

Rohdin, P., Thollander, P. & Solding, P. (2007). Barriers to and drivers for energy efficiency in the Swedish foundry industry. Energy Policy, 35(1), pp. 672–677. doi: 10.1016/j.enpol.2006.01.010.

Soares, N. et al. (2015). Energy efficiency of higher education buildings: A case study. International Journal of Sustainability in Higher Education, 16(5), pp. 669–691. doi: 10.1108/IJSHE-11-2013-0147.

Sorrell, S. et al. (2004). The economics of energy efficiency: Barriers to Cost-Effective Investment. The Economics of Energy Efficiency, 14(1), pp. 186–192.

Stavins, R. N. & Jaffe, A. B. (1994). The energy-efficiency gap What does it mean?. Energy Policy, 22(10), pp. 804–810. doi: 10.1016/0301-4215(94)90138-4.

Thollander, P. & Ottosson, M. (2008). An energy efficient Swedish pulp and paper industry - Exploring barriers to and driving forces for cost-effective energy efficiency investments. Energy Efficiency, 1(1), pp. 21–34. doi: 10.1007/s12053-007-9001-7.

U.S. Congress Office of Technology Assessment (1993) Energy Efficiency: Challenges and Opportunities for Electric Utilities (September). Available at: http://ota.fas.org/reports/9323.pdf.

United Nations Environment Programme (UNEP) (2007) Buildings and Climate Change: Status, Challenges and Opportunities. United Nations Environment Programme (UNEP), Paris. Available at: https://pdfs.semanticscholar.org/8da6/7d13e4841b680d213497073fee9a0aaf1eb5.pdf?_ga=2.253734539.302808089.1600475568-770942749.1600475568.

WWF European (2005) The Energy Efficiency Business Coalition. Available at: http://www.climatesolver.org/sites/default/files/energyefficiencychallengefinal.pdf

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Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

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Setuju.

27.1.2023

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