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INTELLIGENT BUILDING SYSTEM: A STUDY ON EVALUATION OF INFLUENCING FACTORS FOR SUSTAINABLE DEVELOPMENT IN PRIVATE UNIVERSITIES IN KLANG VALLEY

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Abstract- This project is carried out to study the evaluation of influencing factors for sustainable development with intelligent building systems in private universities in Klang Valley. An intelligent building system can be defined as a building automation system that is integrated into the physical plant and building facilities and linked with the corporate systems to ensure the building management system can be brought up to date on the building operating cost, and energy efficiencies of the building. Questionnaire surveys were distributed to collect the data. Descriptive analyses were used to analyse the data using Statistical Package for Social Science (SPSS). The study showed that the main barriers to implementing Intelligence Building System (IBS) were the high initial cost. The benefits of using IBS were reduced waste, pollution, and environmental degradation. The potential chances in implementing IBS were using sustainable building materials, and recycling and reuse of materials. The ways to deal with these issues are to learn, understand, and accept, then apply the intelligent building system in the campus and try to keep up with the latest technology and innovation to increase the quality of life and productivity of the people like lecturers, students, admin staffs who are using the campus every day.

Keywords -Intelligence Building System (IBS); sustainable development; energy saving; cost efficient; green building; construction technology

1. Introduction

First and foremost, the ecosystem is evolving rapidly nowadays, issues regarding the uses of energy efficiency primarily became the rights and obligations of the supplier of a good and

building material recognized by industry experts from SPIE Group, (Kuo et al., 2016). Intelligent building systems play a significant role which intelligent building system can provide a responsive, effective as well as a supportive environment in a building for achieve its business objectives (McCormick et al., 2017). Other functions like data management of the building, and the facilities operation inside the building will also gain benefits from the intelligent building systems (Omar, 2018).

Furthermore, the intelligent building system operates depending only on one internet protocol network, the intelligent building system is connecting all building services in the building such as the intercom lighting system, biometrics recognition, the building management, the elevator in the building, visitor management, closed-circuit television, and access control to achieve the space optimization, energy efficiency of the building. This is because the intelligent building system is designed to be a system that can provide occupants with automatic control of conditions of the interior environment in a building that mainly focuses to recognize significant savings with low cost and reduce energy utilization, (Chasta et al., 2016).

An intelligent building system required four core elements to achieve the best performance, and the function of the intelligent building system such as management, system, services and, structure, as long as these four core elements perform and bond well together, the intelligent building system will automatically perform efficiently without the intervention of occupation of the building.

Sustainable building applies many different techniques including active techniques and passive techniques to increase the ability of the building to generate energy and reduce the energy needs of the building. Wide use of recycled materials, and solar panels can help reduce pollution, and wastage as well as ensure the high efficiency of using energy and resources, it can also protect occupants' health in the building and improving productivity at the same time. Hence, this study was focusing on evaluating the influencing factors in practising sustainable practices on private university campuses.

2. Literature Review

First and foremost, according to (Mattern et al., 2010), one of the methods to carry out the data collection for the three objectives in this study such as potential barriers to sustainable building development by implementing the intelligent building system in the private university campus in Klang Valley, the benefits of the intelligent building system that may

contribute to the sustainability of private university campus in Klang Valley, as well as the potential implementation of the intelligent building system in the private university campus in Klang Valley is with the extensive literature review as it is a systematic way for assembling as well as combining all the research to form a firm and strong foundation in supporting the findings.

2.1 Identification of the barriers to the sustainable building development of private university campuses in Klang Valley.

Firstly, the application of the intelligent building system to the university campus is a system to reveal the suitability as well as the effectiveness of the advanced technologies used and the technologies that using currently (De Angelis et al., 2015). There are various sustainability systems developed for intelligent buildings such as university campuses, such as BREEAM in Britain, LEED in the USA, and multinational GBTOOL (McFarlane & Söderström, 2017).

Considering the environmental and energy factors of the building, sustainable buildings surely will be the trend in the future around the world. Therefore, sustainability assessment, and research for the intelligent building combined with high-tech information technology is very important (M. Yu & Jiang, 2020). Other measures of building quality include the design quality indicator and the many rating tools available such as BREEAM, leadership in energy and environmental design (LEED), Green Star, Comprehensive Assessment System for Built Environment Efficiency, Sustainable Built Environment Tool and others (Yu et al., 2012). Without a doubt, the intelligent building system is invented at the right time to provide a building sustainability solution for the building, (Li et al., 2016).

2.2 The benefits of the intelligent building system that may contribute to the sustainability of the private university campus in Klang Valley.

The implementation of the intelligent building system able to improve the building efficiency as well as the safety of the building, this is because the intelligent building system operates by using the concept of automation on various kinds of equipment in the building to improve the work efficiency, this system is operated by using the method of a modern network that can perform, interact, analysis, as well as the use of all resources. For instance, sensor technologies can detect the connection or activities between the occupants and the things in the building. Normally the sensor technologies installed in a smart building are for monitoring, collecting data as well as transmitting the data by using the network transmission

technology in a building, and this is the main reason that the intelligent building system also known as the advanced integrated management method being used for building, (Yu & Jiang, 2020).

2.3 The potential implementation of an intelligent building system in the private university in Klang Valley.

It is an open secret that building automation has become common gradually in the world along with the improvement of the intelligent building system that is according to the habit of use by users (Bagozzi, 2017). In this literature review, the usage of intelligent building systems that can affect the sustainability of the university campus will be discussed.

Furthermore, the intelligent building system consists of various storage devices such as batteries, and water tanks, and the schedulable loads such as heating, ventilation, and air conditioning system in the building as well as the room thermal loads are controlled by opening the windows in the room, (Xu et al., 2012). The usage of the intelligent building system can also be discussed, especially the usage of the Internet of Things on the university campus as the main system to access any data that are available on the university campus. The Internet of Things plays a significant role in the intelligent building system with which location determination can be accomplished. The concept of the Internet of Things can be described as each object can access each other anywhere as well as any time and it allowed the object to communicate and identify their location, (Turgut et al., 2016).

2. Methodology

150 Questionnaire surveys were disseminated among private university occupants. The 113 data collected were then analysed using descriptive analysis through Statistical Package for Social Science (SPSS). The targeted respondents were the academician from engineering and building background. Building facility department from private universities were among the respondents involved. The papers covered the evaluation of influencing factors for sustainable development with intelligent building systems among private universities in Klang Valley.

3. Research Findings

The total quantity of responses has been analysed and interpreted into a table that is stating all the barriers to sustainable building development by implementing an intelligent building

system (IBS) in a private university in Klang Valley with the descending order of the mean score from high to low reading like in Table 1.

Table 1. Mean score table for barriers to sustainable building development of private university in Klang Valley

Factors	Mean Score
1. High initial cost of implementing IBS	3.84
2. Inadequate demonstration of projects of IBS	3.76
3. Lack of experience in IBS	3.75
4. Lack of understanding of IBS	3.72
5. Lack of professional training for IBS	3.66
6. Lack of technology supply in IBS	3.62
7. Lack of incentive in IBS	3.6
8. Social and psychological barriers	3.57
9. Reluctant to replace the uses of traditional technologies	3.41
10. Lack of interest in IBS by investor	3.40

Table 2. Result of reliability test for barriers of sustainable building development of private university in Klang Valley

Cronbach's Alpha	N of Items
0.904	10

Table 3. Mean score table for benefits of intelligent building systems that may contribute to the sustainability of the private university campus in Klang Valley

Factors	Mean Score
1. Reducing waste, pollution and environmental degradation	3.93
2. Superior building management	3.91
3. Predictive maintenance on the building facilities	3.83
4. Improve building efficiency	3.76
5. Increase productivity	3.76
6. Enhance facility operation	3.74
7. Minimise daily operation cost	3.72
8. More efficient audits	3.71
9. Concept to achieve nearly net zero energy building	3.69
10. Lower consumption of building energy	3.64

Table 4. Result of reliability test for benefits of intelligent building system that may contribute to the sustainability of private university campus in Klang Valley

Cronbach's Alpha	N of Items
0.913	10

Table 5. Mean score table for potential implementation of intelligent building system in the private university campus in Klang Valley

Factors	Mean Score
1. Uses of sustainable building material, recycling and reuse materials	4.02
2. Usus of environmentally friendly resources	3.90
3. Uses of internet of things	3.84
4. Uses of innovative technologies	3.83
5. Reuse of water	3.83
6. Uses of supervisory control and data acquisition system	3.83
7. Minimise daily operation cost	3.83
8. Uses of solar energy	3.79
9. Uses of cloud system	3.69
10. Uses of natural ventilation	3.64

Table 6. Result of reliability test for potential implementation of intelligent building system in the private university campus in Klang Valley

Cronbach's Alpha	N of Items
0.907	10

3.1 Critical Analysis based on mean score and reliability test.

Based on the **Table 1**, the respondents agree with the finding through questionnaires in this study as it shows all the mean score of the barriers to sustainable building development average of more than 3.00 while **Table 2** showed the reliability test for barriers of sustainable building development in the private university campus in Klang Valley. In this case, based on the result it shows that there is a huge difference between the high initial cost of implementing the intelligent building system and the lack of interest in the intelligent building system by the investor as these two barriers have a mean score of 3.84 and 3.40 respectively.

The difference between the mean score between these two barriers is 0.44. The reason for the high initial cost of implementing the intelligent building system ranked at the top of the

table may because that people acknowledge that new technologies require a higher initial cost to acquire the features in the building, one of the examples would be the initial cost of the green building, the sustainable building normally requires a higher initial cost to implement the system (Kuo et al., 2016). Thus, relatively the initial capital required to invest in the intelligent building system in a building is also considered high. In other words, it also means that the respondents most agree on this is the barrier to sustainable building development in Klang Valley.

Conversely, the lack of interest in intelligent building systems ranked last with the lowest mean score of 3.40 in the table above. It may due to the intelligent building systems are being promoted, and started implementing in some the buildings like campuses, airports, and some commercial buildings located in other developed countries, it is considered a new technology that is not popular and not trending in Klang Valley, and this is the main reason that the investors are lack of interest on the intelligent building systems even when the investors have adequate of capital to invest on this intelligent building system in the building that used to operate daily activities, therefore that based on the respondents answer collected from the questionnaires distributed, respondents do agree on the lack of interest on the intelligent building system as one of the barriers of the sustainable development in Klang Valley but with the lowest mean score among the others barriers listed out in the table.

Based on the mean score in **Table 3** for the benefits of the intelligent building system that may contribute to the sustainability of the private university campus in Klang Valley, it is clearly shown that reducing waste, pollution, and environmental degradation has the highest mean score with 3.93 in the table while the lowest mean score in the table is only 3.64 for the lower consumption of building energy while **Table 4** mentioned about the reliability test for benefits of intelligent building system that may contribute to the sustainability of private university campus in Klang Valley. The contrast of the mean score of these two benefits is 0.29 and the reason for reducing waste, pollution, and environmental degradation is the most agreed benefit of the intelligent building system that may contribute to the sustainability of the private university campus in Klang Valley may due to the concept of sustainable building is mainly promoting the uses of the material with lower embodied environmental impact as well as minimize the ecological burdens at the same time, and it can be done easily because if compared to the lower consumption of the building energy and the result was compared with finding by Li, R. Y. (2016) .

Based on **Table 5** for potential implementation of an intelligent building system in the private

university campus in Klang Valley, the data and information collected from the questionnaires filled by the respondents show that the potential implementation of an intelligent building system in the private university campus in Klang Valley that is most agreed by the respondents is the uses of sustainable building material, recycling and reuse materials with a highest mean score of 4.02. **Table 6** showed the result of reliability test for potential implementation of intelligent building system in the private university campus in Klang Valley. Compared to the uses of natural ventilation which has the lowest mean score of 3.64, the difference between these two potential implementations of intelligent building systems is 0.38 and it may be due to the use of sustainable building material, recycling, and reuse material is more achievable. This is because, the uses of sustainable building materials are including bamboo, recycled plastic, ashcrete, and timbercrete bricks as the building materials. The materials are sustainable as well as can reduce the transportation emission during delivery to the construction site, however, the use of natural ventilation is not that effective if using the natural glazing in a private university in Klang Valley.

4. Conclusion

To put it into a nutshell, this research aimed to study potentially further enhance the sustainability practice of the private university campus in Klang Valley by implementing the intelligent building system. Based on the quantitative analysis of the 3 main points are achieved which are the barriers to the sustainable building development of private university campuses in Klang Valley, the benefits of the intelligent building system that may contribute to the sustainability of the private university campus in Klang Valley, and the propose of the potential implementation of the intelligent building system in a private university in Klang Valley. It can be concluded that the first objective, the barriers that occur is the key reason for setting back the level of development and restricting the quality of life in a private university in Klang Valley concurrently. The ways to deal with these issues are to learn, understand, and accept (Omar, 2018), then apply the intelligent building system in the campus and try to keep up with the latest technology and innovation to increase the quality of life and productivity of the people like lecturers, admin staffs who are using the campus every day.

The intelligent building system can benefit the user in the private university in Klang Valley as it can take care of the comfort, safety, and health of the occupants by applying an

intelligent building system in the private university campus in Klang Valley. It also proved by applying the intelligent building system in the private university in Klang Valley, can help to gain positive impacts for the building and occupants as well as meet the requirement of the concept of sustainable building at the same time.

5. Recommendation

For having a better understanding of the implications of these results, future studies could address which aspect of sustainability to focus on and study the impact of implementing the intelligent building system toward the sustainable development goals in private universities in Klang Valley. This is due to the intelligent building systems will become an inevitable technology and trend in the future. Thus, awareness toward the intelligent building system has to be raised, whether is by organizing events to promote the intelligent building system. For example, in promoting intelligent building systems in exhibition like international construction week, a company like GFM Services is one of the participants in the industry construction week event to promote and raise awareness about the services provided like facility management.

In short, the concept of the smart home and its intelligent building system must be developed in a proper and official platform so that it can be noticed by the social. Further studies may include the examination of the sustainability in the private university campus in Klang Valley to analyse the energy efficiency before and after implementing the intelligent building system whether it achieves the original goal of implementing the intelligent building system which according to (Mayer et al., 2017), minimizes the operating goal, improve the building facility, reducing waste, pollution and environmental degradation and the like.

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