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Energy Management Practice: A Case Study of University Utara Malaysia Main Administrative Building

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Over the past few years, the cost of operations and maintenance of buildings on public university campuses have increased and among the issues that need to be promptly addressed are those related to energy efficiency within the campus. Although the university management is aware of this issue, there are challenges that have never been taken into account in energy management activities within the university campus. Therefore, this paper aims to examine the energy efficiency program as well as identify the challenges that the energy committee is currently facing. The approach is a case study from which data was collected through observations, interviews, and documentation research about the overall program and all the challenges faced during the energy management program carried out at the campus of Universiti Utara Malaysia (UUM). The findings of the study show that top management commitment, budget allocation, employee involvement, and awareness are key issues that challenge the sustainability and effectiveness of energy efficiency programs at UUM campus. The implementation of energy efficiency programs on campus at public universities in the future should take into account the

challenges and difficulties faced by the energy management committee.

Key words: *Building Energy Index, Building Energy Efficiency, Energy Audit, Energy Management.*

Introduction

High energy consumption in government office buildings, especially on public university campuses, has been gaining more attention, particularly from energy research experts and relevant agencies as well as academics. New developments in the existing public university campus also contribute to the high cost of energy consumption every year. However, the calculation of the consumption of electricity is not dependent on consumption rates but on the total energy used in a building which is divided by the gross floor area of the building in square meters. This method is called Building Energy Index (BEI) which is calculated as kWh/ m^2/ year and measures the total energy used in a building for one year (Tahir, Nawi & Rajemi, 2015; Mokhtar Azizi, Wilkinson, & Fassman, 2014; Tahir, Jamaludin, Nawi, Baluch, & Mohtar, 2017; Anwar, 2018). The development and growth of higher-education institutions to accommodate the growing number of local as well as international students is also in line with the country's economic growth (Ahmad, Hassan, Abdullah, Rahman, Majid, & Bandi, 2012). Further it is believed that the government needs to be sensitive to this positive development which at the same time can also affect the annual budgets of the education sector if no serious and proactive efforts are taken to respond to this scenario.

Since the Energy Commission of Malaysia states that for any installation used, worked, or operated by a private installation licensee with a total net electrical energy generation equal to or exceeding 3,000,000 kWh over any period of six consecutive months, an Electrical Energy Manager must be appointed to conduct energy audit activities (Jalal & Bodger, 2009; Caifen, Hailun & Rongrong 2018). All electrical works in relation to the Energy Services provided by the Registered Energy Service Company must be performed by competent persons in accordance with the Electricity Supply Act 1990 and the Electricity Supply Regulations 1994 (Suruhanjaya Tenaga Malaysia, 2008). Therefore, in this case, Universiti Utara Malaysia (UUM) campus recorded a total electricity consumption exceeding 3,000,000 kWh over six consecutive months based on the billing history data obtained, and follow-up actions must be taken in accordance with the instructions issued under the act.

Literature Review

The need for energy efficiency in a building is due to the increased operating and maintenance costs as well as the ever-increasing cost of energy (Bamgbade, Kamaruddeen, Nawi, Yusoff, & Bin, 2018). At present, energy efficiency in buildings is seen as an approach to make the operation of a building more efficient and effective and avoid electricity wastage without any control or solution. To achieve the objectives of energy efficiency, it is important to understand what is meant by energy efficiency. Gillingham, Newell and Palmer (2009) describe energy efficiency as the energy services provided per unit of energy input into the production of desired energy services such as heating, lighting, and motion. Energy efficiency is a way of managing and restraining the increase in energy consumption. Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input (International Energy Agency, 2015). This definition is in line with government initiatives to tackle the problem of energy inefficiency in government buildings, particularly during the current economic downturn. In fact, the electricity distribution in Malaysian office buildings consist of air-conditioning load with the highest percentage (58%), lighting (20%), office equipment (19%) and others (3%) (Energy Information Unit, 2014).

Air-conditioning load in Malaysian office building recorded higher energy consumption due to Malaysia's climate which is categorized as a tropical rainforest climate**,** being hot and humid throughout the year. The climate is indeed the main cause of high usage of air-conditioners, considering that the daytime temperature can reach up to 32 degrees Celsius in the dry season. However several other factors also contribute to the high energy consumption, such as lighting and office equipment, or energy inefficient.

Therefore, in this case, Universiti Utara Malaysia (UUM) is no exception to the need to be more prudent in managing expenses including the operation and maintenance of Heating, Ventilation, and Air Conditioning system (HVAC), followed by lighting and office equipment. Office structures are frequently referred to as internal-load-dominated structures because of the fact that a very large portion of the energy use is in response to the high temperature pick-up from building occupants, lights, and electrical supplies. Additionally, cooling is required not just because of the climate, but to reduce the heat-load from all equipment used within the offices. Elevators can also be significant energy users in multi-story buildings. Other areas for energy use in an office include office cafeterias, auditoriums, and security systems.

The UUM campus is more exposed to the daily sun and the campus infrastructure requires a huge amount of electricity consumption to run lifts, office equipment, and air conditioning in buildings, which consume more energy in the operation stage similar to other office buildings

in Malaysia (Tahir, Nawi & Rajemi, 2015; Bülbül, 2018). Air conditioning has become a necessity, especially in commercial and office buildings where the energy consumed by HVAC can exceed more than 50% of the total energy consumption of a building (Chua, Chou, Yang, & Yan, 2013; Chianese, 2018).

Background of the Building

Figure 1. Chancellery building

The campus buildings consist of the Chancellery, Sultanah Bahiyah Library, the Islamic Center Complex (including Sultan Badlishah Mosque), the Mu'adzam Shah Grand Hall, the Tan Sri Othman Hall, the Sports Complex, the Varsity Mall, the Budi Siswa building and the Convention Complex. However, for the purpose of this case study, the Chancellery building (Figure 1 above) was chosen as the main focus area to facilitate discussions and analysis of findings. Based on meter readings, it is clear from the initial findings that UUM electrical energy consumption (kWh) by buildings from January 2017 until September 2017, the new Libraries building and Chancellery shows the highest energy consumption. This is followed by other buildings such as Faculty of Cognitive Science and Education and the old Library. In fact, there are over 30 buildings that can be measured but this will take a longer period of time and involve additional costs. Hence, the selection of Chancellery buildings as the object of this study is due to the fact that of four buildings that recorded high energy consumption, only the Chancellery building is fully occupied throughout the year and is an administrative building.

As an iconic main office building, it has been used as administration office and located in the prime area of the UUM campus, where energy plays an important role in its daily operation. The building is a six storey building and its operation hours are from 7.45am to 5.30pm. The building operation involves a huge amount of electricity consumption to operate HVAC system. The Chancellery building uses energy in the form of electricity to activate building

operations, especially to run lifts, office equipment, and air conditioning as part of Mechanical and Electrical (M&E) systems in building, which consume more energy in the operation stage. Therefore, the objectives of this study are to determine the features that need to be taken into account when assessing energy efficiency in buildings.

Objectives of the Study

Through preliminary studies, discussions from observations and data obtained, the key objectives of this study are to identify energy efficiency problems and best practices that can be implemented. The objectives are to identify the total energy consumption based on the previous and current data of the Chancellery building and to investigate the current performance (Building Energy Index) of energy management in Chancellery building in order to improve its energy management practice in favour of energy efficiency.

Research Methodology

The research methodology is based on the methods used to collect information via a real case study pertaining to energy consumption in the office building. To meet the objectives of this study, the data will be collected through simple interviews, observations, and documentation. The analysis of the study, the understanding of the literature reviewed, and the analysis of the data obtained will lead to the presentation of initial requirements for an effective energy management system. Several processes involve and focus on management practices and some others on technical aspects as required by the senior officer in order to facilitate the process of improving energy use in this campus, especially in the Chancellery building.

Implementation of Energy Efficiency Programs

Throughout 2017, the Energy Management Committee, which was established in UUM with the cooperation of various units from the Department of Development and Maintenance (JPP), lecturers, and energy managers has taken various initiatives to ensure that the use of electricity around the campus meets the requirements of the Energy Commission (ST). Taking into account the perspectives of various parties consisting of academics, energy managers, and M&E equipment suppliers, the following are among the key steps taken to address these issues including the selection of low-cost and no-cost practice (Tahir, Nawi, & Ibrahim, 2016; Suruhanjaya Tenaga, 2014) to achieve energy efficiency in the building:

a) Establishing of awareness of energy management aspects among university staff with the support of university management and the establishment of an Energy Management Committee to strengthen this awareness;

b) Setting the "On" and "Off" timetable for the chiller in certain buildings;
c) Installing, implementing and assembling a new chiller in the Chancellery building;
d) Utilizing natural ventilation and natural lighting, and applying high volume low speed fans (HVLS);
e) Retrofitting from fluorescent tubes (T8) to (T5) and LED tubes, replacing street light with LED fittings, retrofitting from compound light to Induction Lamp fittings, replacing Metal Halide High Bay fittings with Induction Lamp Fittings, and flood light system from Metal Halide fittings with LED/ Induction Lamp fittings.

Result and Discussion

There are interesting findings related to the level of energy use in the Chancellery building. The air conditioning system, lighting system, and office equipment are the main operations of energy used in this building (Zandi and Haseeb, 2019). For the purpose of an energy management program, the data of electricity consumption in the building was obtained through the collection of monthly electricity bills from the year 2012 to 2016 (Jabarullah et al., 2019). In early 2012, there was a slight increase in energy usage in February, followed by a sudden decrease in the next month (March) before rising again from April to September. In fact semester breaks are usually from mid-January to mid-February, with a week off in April and a two-month semester break at the end of June until September, however there was not any significant change to the pattern of energy usage. The rate of electricity consumption decreases in October with a total consumption recorded as 66,111 kWh before returning to a rather ordinary usage of 150,889 kWh in November and 163,961kWh in December 2012 with the total energy consumption for the year 2012 as 1,691,961 kWh.

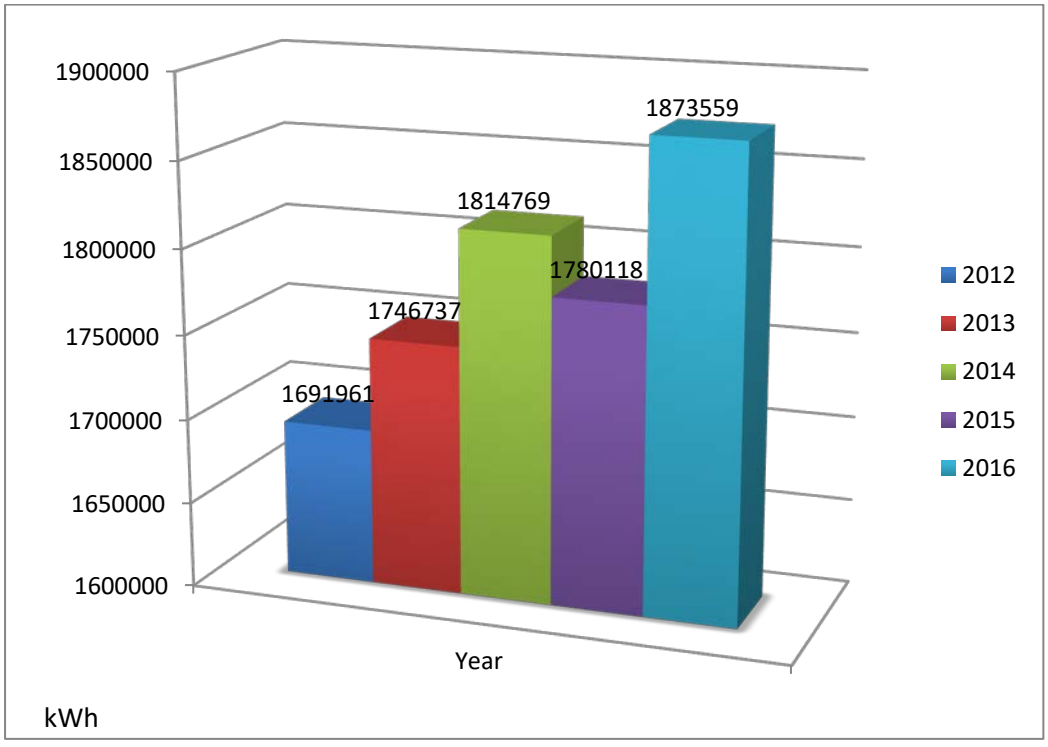
Concerning 2013, the energy consumption was relatively low early in the year but began to increase in February and March before it decreased again in April and May. In June, the energy consumption recorded the second lowest consumption of the year, probably due to the long semester break at UUM campus. Successively, the energy consumption in the Chancellery experienced ups and downs until November when it recorded the second highest energy usage after March with 198.985 kWh. Total energy consumption in the year increased to 1,746,737 kWh.

In 2014, two peaks of high energy consumption occurred in March with a record of 193,034 kWh and in October with 235,234 kWh. However, the energy consumption in the other months is much lower and not exceeding 150,000 kWh per month. The high energy consumption in March and October can be attributed to the influx of new students and seniors

in mid-January and September, which may involve high data throughput, especially involving the office of the Registrar and Bursar located in the Chancellery building.

Regarding 2015, the data show that in March, October, and November there was a significant increase in energy consumption, similar to the previous year. This may be due to the registration of new students and former students. The total energy consumption throughout the year was only 1,780,118 kWh. In 2016, the rate of energy consumption at the beginning of the semester showed a significant decrease compared to the previous three years. October records show the highest energy consumption of the year as the previous years, but the number is lower than in 2015 and 2014 with a total of 139,656 kWh. However, the total energy consumption for the year 2016 was still very high with 1,873,559 kWh. Figure 3 below shows yearly usage comparison from 2012 to 2016 where it is evident that there is a significant increase over the years.

Figure 3. Yearly usage comparison from 2012 until 2016



There were varieties of electric density load and those were all dependant largely on functional and aesthetic requirements and the operating hours. There were also other minor electrical appliances, such as the audio / visual and office equipment noted in use. Based on the monthly electricity consumption history, the energy consumption (kWh) of Chancellery

buildings was very high throughout the 12-months periods because the buildings were occupied throughout the year. In fact, the difference in level of energy consumption in certain months as described in the previous paragraph is due to academic sessions and semester breaks.

The electrical system for the buildings is distributed to the use of lighting, plug loads and others while an artificial lighting system is used to illuminate interior office space and external areas such corridor and building façade. Basically, there are two parameters that are used to evaluate the lighting efficiency namely lighting power density and luminance level. Overall, electricity usage of the Chancellery building is very uneven throughout the year (Hussain, Salem, Rashid, & Kamarudin, 2019).

Conclusion

In conclusion, this study aimed at producing a strategic model for energy-efficient operation and management for effective building maintenance and operation in Malaysian office buildings. Overall, the Chancellery building at UUM campus in Sintok, which is the main administrative office at the university, has very high energy consumption which has increased yearly from 2012 to 2016, except for in 2015 when there was a slight decline. This building that houses several main offices such as Vice-Chancellor's Office, Office of the Deputy Vice-Chancellor, the Registrar's Department as well as the Treasury Department and has a total gross floor area of 8,983m2 and annual energy consumption in 2016 was 1,873,559 kWh/ m^2/ year. Based on the building performance evaluation done by this case study, the BEI recorded is 208.57 kWh/ m^2/ year which isw very high compared to the current standard in Malaysia of 136 kWh/ m^2/ year (MS 1525: 2007). As this is a major administrative building in a higher education campus, it is a finding of this study that the university management must take immediate action in identifying factors that have caused high energy consumption for the past five years and address energy efficiency into the future.

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