



Barriers, Challenges and Opportunities for Energy Management Program: A Case Study of Universiti Utara Malaysia

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ARTICLE INFO

ABSTRACT

Article history:

Received 5 June 2019

Received in revised form 14 July 2019

Accepted 2 August 2019

Available online 28 August 2019

Over the last few years, the cost of operations and maintenance of buildings on public university campuses has increased and among issues that should be promptly addressed are related to energy efficiency within the campus. While university management is aware of this issue, however, there are barriers and challenges that have never been taken into account in energy management activities within the university campus. Therefore, this paper examines the energy efficiency program as well as to identify the barriers, challenges and opportunities for energy management program at the university level. The research approach is a case study from which data were collected through observations, interviews and documentation with the overall program and all the obstacles faced during the energy management program carried out at the campus of Universiti Utara Malaysia (UUM). Through the findings of the study, top management commitment, budget allocation, employee involvement and awareness are the key issues that challenged the sustainability and effectiveness of energy efficiency programs at UUM campus. Implementation of energy efficiency programs within the campus of public universities in the future should take into account the challenges and difficulties faced by the energy management committee.

Keywords:

Energy management; building energy index; energy efficiency; energy audit

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1. Introduction

Operation and maintenance within an office building is the process of sustaining the good performance of a building based on the established standards and requirements. There are many related activities that are capable of maintaining the building's performance and improving the efficiency of the use of equipment and systems that have been used so far. To meet these requirements, operational activities that involve optimizing energy efficient as well as other operation strategies must be one of the priorities in building management aspects. This is followed by a set of maintenance activities that monitor and maintain important equipment in the building to minimize damage, failure from functioning and this procedure is to avoid excess operating costs if not properly maintained.

As one of the most important systems in the operation of a building; Heating, Ventilating and Air-conditioning (HVAC) systems and equipment are most linked to daily activities in the operation and maintenance of buildings besides electrical, plumbing and other technical matters. In addition, a comprehensive review of building energy performance and recommendations for improvement is very important and should be emphasized in the decision-making process. This decision will be more significant if it is based on a comprehensive assessment of financial analysis that measures savings against all the investment for more efficient energy use in buildings within the university campus.

Therefore, it is important for university campuses in Malaysia to emphasize the importance of energy-saving aspects, especially in academic buildings and administrative offices as all public universities in Malaysia are highly dependent on funds from the government [17]. In fact, the trend of electricity consumption in the campus is increasing every year as a result of inefficient use of energy in buildings on the campus. It is time for public universities in Malaysia to identify challenges and constraints that may be a major factor in issues related to energy efficiency within the building. As one of the top public universities in Malaysia, Universiti Utara Malaysia (UUM) in Kedah is no exception in ensuring that its office buildings are energy efficient and thus contributing to the sustainability of development within the university campus.

1.1 Campus Background

The UUM main campus is on a 1,061 hectare site located in the small town of Sintok, Kedah was established on 16 February 1984 (Figure 1). This green campus is 48 km north of Alor Setar and 10 km south of the Bukit Kayu Hitam, close to Malaysia- Thailand border, which involves the development cost of RM580 million began its operations in 1990. Some administrative buildings among the earliest buildings that have been built here are the Chancellery, the Sultanah Bahiyah Library, the Sultan Badlishah Mosque and Islamic Center, the Mu'adzam Shah Hall, the Varsity Mall, the Convention Complex and the building that houses the Academic Colleges.

Officially all the office buildings operate from 7.45 am to 5.00 pm daily from Sunday to Thursday except holidays. Most of these old buildings have been built since 26 years ago by applying technology of construction and design criteria at the time. Generally, the old buildings in UUM campus are less emphasizing the type of building materials with energy efficiency features and no characteristics of passive design that directly takes advantage of the climate to maintain a comfortable temperature range in the building.

The electrical system for the buildings in the UUM campus is distributed to the use of lightings, plug loads and others while 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.

There are many large buildings on this campus, for example, the Chancellery is one of the largest buildings that house several main offices such as Vice-Chancellor's Office, Office of the Deputy Vice-Chancellor, Registrar's Department, Treasury Department, Department of Student Affairs and the UUM Gallery. The lowest level of the building is mostly devoted to maintenance, services and electrical aspects. There is a maintenance room, loading room, electrical substation, main switch room, private automatic branch exchange (PABX) room, main distribution frame (MDF) room, intermediate distribution frame (IDF) room, battery room, A/C plant room, various types of stores and also a printing room. Most of these functions rooms are also available in other major buildings such as libraries, academic buildings and other administrative and operational offices.



Fig. 1. The aerial view of Universiti Utara Malaysia main Campus

1.2 The Energy Efficiency Aspect in the Campus Environment

At present, energy management in buildings is seen as an approach to make the operation of a building into a more efficient, effective and avoid electricity wastage. To achieve the objectives of energy efficiency, it is important to understand what is meant by energy efficiency. Gillingham *et al.*, [6] 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. By managing and restraining the growth in energy consumption, energy consumption in buildings is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input [8]. This definition is in line with government initiatives to handle the issue of energy inefficiency in government buildings, particularly during the economic downturn. Figure 2 shows that electricity distribution in Malaysian office buildings consists of air-conditioning load with the highest percentage (58%), lighting (20%), office equipment (19%) and others (3%).

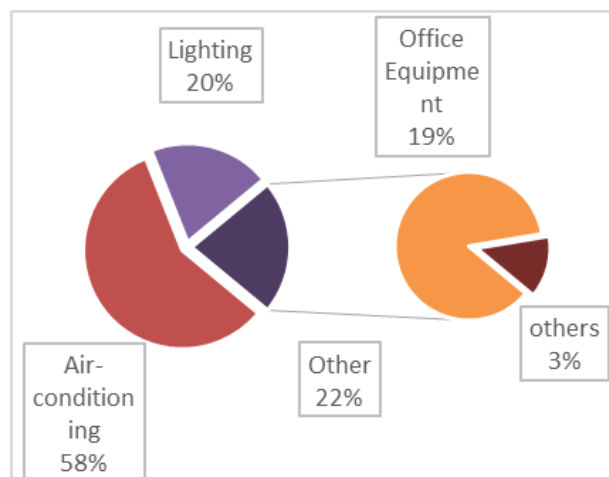


Fig. 2. Typical electricity usage in office buildings in Malaysia (adapted from Suruhanjaya Tenaga, 2014)

Air-conditioning load in Malaysian office building recorded higher energy consumption due to Malaysia's climate is categorized as a tropical rainforest climate, being hot and humid throughout the year. This is the factor as the main cause of higher usage of air-conditioners at UUM main campus, considering the daytime temperature can reach up to 32 degrees Celsius in the dry season. But

several other factors also contribute to high energy consumption such as lighting and office equipment, if not properly maintained.

In terms of energy efficiency aspects at the UUM campus, it is clear that there is a problem in terms of energy efficiency around the campus. Therefore, as determined by the Energy Commission, the UUM management should appoint an Electrical Energy Manager to conduct energy audit work. In fact, 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. Based on the billing history data obtained, the total energy use of the Universiti Utara Malaysia (UUM) campus is apparently over 3,000,000 kWh over a period of six consecutive months in 2016. Since the regulation states that 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.

Previous studies found that applying energy efficiency measures could reduce energy consumption significantly by using the existing technologies, equipment and building systems [5,9, 12,19-24] as well as planning and design of energy-efficient landscapes [7]. Therefore, action is needed if economic, social and environmental sustainability is to be achieved [2,10,13]. Indeed, all the project process with the right decisions made on energy efficiency in the operational and maintenance stage would have significant impact on the overall construction project.

2. Research Methodology

The methodology for this study is conducted systematically with the appropriate analysis methods to be practiced in energy management and based on the case study. Case study is one method that can be used in social science research in addition to experiments, surveys, histories, and the analysis of archival information [18]. A case study is a specific field research method where field studies are investigations of phenomena as they occur without any significant intervention of the researcher [4]. As noted by Yin [18] the case study is an empirical enquiry that rises out of the need to understand complex phenomena, within a real-life context, by undertaking in-depth data collection involving multiple sources of information. In this research, case study will be used to investigate participants' opinion and preference. For example, in this study, case study have been conducted at the UUM main campus, mainly focus on inspection, survey and analysis of energy usage to obtain basic information and data for the whole year. It involves preliminary audit, a brief review of utility bills and other operating data and a walkthrough to become familiar with the building operation; this type of audit usually covers major problem areas. In this study, utility bills are collected for four years to evaluate energy usage profiles. In-depth interviews with the experts who are highly experienced in the building operation and facilities management have been conducted in order to get a better understanding of major energy consuming systems.

3. Results and Findings

Details of 18 energy efficiency key practices covered responses that related to the energy efficiency in the office building to achieve its goals and objectives. The data collected for energy management practices is based on 47 energy management key practices that has adopted by Choong *et al.*, [3] and according to data obtained from the results of the study. Based on that, only 18 issues were identified based on the scope of the study and used as the main focus for observations, interviews and documentation from which data were collected.

3.1 Documentation

Some more information were used made of datasets and documentation related to energy consumption for the whole building on campus. The use of documentation as a source of data gathered from SCADA system and data from energy audit activities to evaluate the buildings performance throughout the year.

3.1.1 Building performance evaluation

According to Schlueter and Thesseling [14] building performance is defined differently among professionals and researchers, whereas he describes building performance as related to energy consumption in the building. Therefore, this study defines building performance relates to the overall energy consumption throughout the year. Building performance in this study is measured by using mathematical calculation models is based on Building Energy Index (BEI) [16]. In fact, BEI is used for comparing energy use in buildings and usually expressed as kWh/ m²/ year which measure the total energy used in a building for one year in kilowatts hours divided by the gross floor area of the building in square meters [1, 15]. The index is used based on the normalizing factor to compare building energy consumption for the whole year. The formula is shown as below.

Calculation for Building Energy Index (BEI): (1)
$$\text{BEI} = \frac{\text{Total Energy Used (kWh/year)}}{\text{Gross Floor Area (m}^2\text{)}}$$

As reference, MS 1525:2007 Standard indicates that any building which implements energy efficient measures can be achieved the BEI of 136 kWh/ m²/ year. According to Aun [1] based on the energy audit results show majority of Malaysia office buildings had the BEI in the range of 200 to 250 kWh/ m²/ year. For BEI calculations as described above, for example, the Chancellery building of UUM has the BEI in the range of 180 to 210 kWh / m² / year (2014-2016). Since this building is the main office building in the campus, it is fully utilized during the BEI calculation. While the building may also be affected by the semester break and involves matters related to students, however based on the observations made, the Chancellery building was not involved student activities such as in academic buildings such as at faculty buildings, libraries or student activity centre. Figure 3 below shows the trend of energy consumption at UUM campus from 2014 to 2017.

Through the graphs shown in Figure 3, it is clear that electricity consumption in 2017 has decreased substantially compared to 2014. In general, if according to the trend of monthly energy consumption shows in January-February and July-August are less than in the other months. This is because during those months, it is a mid-semester break and final semester break for undergraduate students at UUM. In terms of monthly electricity consumption in UUM, the average has decreased gradually compared to previous years and data in 2017 had recorded the lowest average monthly electricity consumption in UUM since 2014. This noticeable difference is the result of energy management activities and energy audits conducted at the UUM main campus since mid-2016 until this study was conducted.

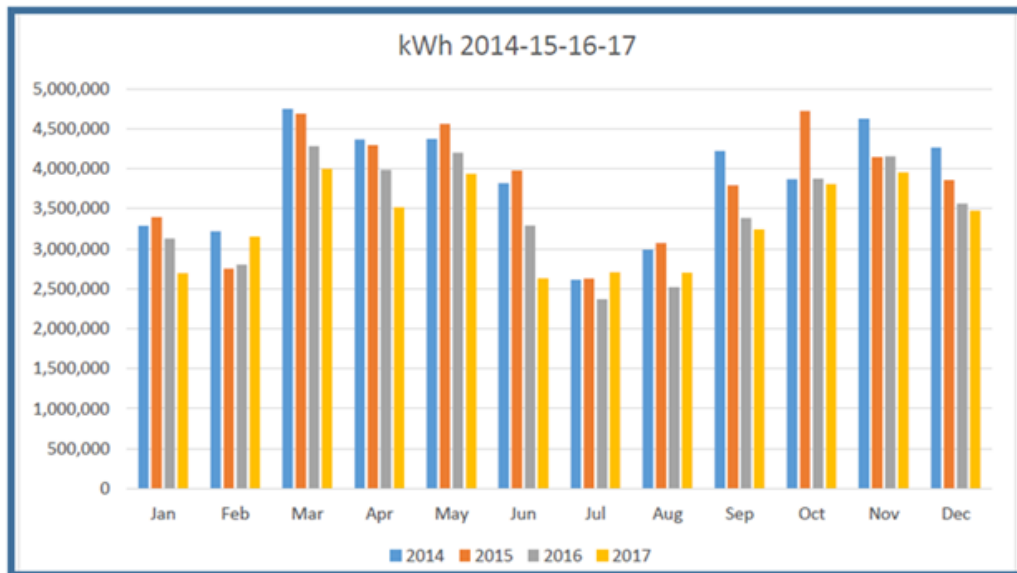


Fig. 3. Trends in electricity consumption from January 2014 to December 2017

Table 1 below shows that monthly average electricity consumption (kWh) in 2014 was 3,866,254 kWh and decreased to 3,318,288 kWh in 2017. Based on these improvements, the year 2017 has also recorded the lowest monthly average electricity consumption (kWh) compared to previous years with 9 out of 12 months of electricity consumption in 2017 is lower compare to the same period over the last 3 years.

Table 1

Monthly average electricity consumption (kWh) from 2014 to 2017

Year	2014	2015	2016	2017
Monthly Average Electricity Consumption (kWh)	3,866,254	3,823,738	3,461,486	3,318,288

3.1.2 Documentation

Data from simple observation used in this study are presented in Table 2.

Table 2

Summary of observation on key issues and practices of energy efficiency (UUM Main Campus)

Key Issues of energy efficiency	Observation of practices
All-level employee involvement	Only some department are involved in energy management programs
Budget allocation	There is indeed a huge budget allocated for the purchase of new assets, especially involving equipment that uses old technology and is no longer efficient in terms of usage and operating costs
Developing a strategy plan	Strategy implementation is more into a short-term program and has not yet taken into account the SWOT analysis in particular to achieve long-term objectives.
Gaining top management commitment	Top management provides a huge budget allocation for the purchase of new equipment especially involving HVAC. However, there is no active commitment and top management is not involved in the implementation of the program
Improving energy efficiency electrical appliance system	Improve energy efficiency of a certain electrical appliance only.
Promoting awareness	Less efforts to increase consumer awareness (staff) through methods such as campaigns and posters as well as stickers to remind about energy saving

3.2 Interview

The formal interview has been conducted with the experts who are highly experienced in the building operation and facilities management. The interview provided more insight and understanding on the key issues. Key issues were discussed and selection of key quotes are presented.

3.2.1 Selection of interviewees

This study was carried out by listing some of the main criteria that must be in the process of selecting the interviewee by focusing on UUM campus in Sintok, Kedah. First, the interviewee should have at least 10 years working experience involving several completed projects, building operation as well as facilities management. Secondly, interviewee must possess the required qualifications, knowledge and skills relevant to the study and this is important in order to ensure that the interviewee have the competency, particularly in the work discipline, to discuss every issue in the interview session. For the study, interviewees represent different field job, such as Senior Electrical Engineer, Mechanical Engineer, Assistant Mechanical Engineer and Chargeman in order to generate different opinions during the interview session. It was decided that the names of the interviewees in this study would not be disclosed due to issues of confidentiality and anonymity. Instead the job position will be used to identify the interviewee. The list of the interviewees is shown in Table 3.

Table 3
General profile of interviewees

No.	Position held	Experience	Gender
1	Senior Electrical Engineer	28 years	Male
2	Mechanical Engineer	12 years	Male
3	Assistant Mechanical Engineer	25 years	Male
4	Chargeman	22 years	Male

3.2.2 Analysis and discussion of findings from the interview

As has been highlighted in the previous sections, the aims of the interview session are to collect more data, to aid and improve the current literature review relating to the effective energy efficiency practices. All the findings will be used as reference and guidance in determining energy efficiency practices in the office building which may be the challenges that will be faced and need to be addressed urgently in ensuring energy management activities achieve their goals as best they can. The findings of the interview are discussed in the next section.

3.3 All-level Employee Involvement

Involvement in energy efficiency programs such as energy management activities should involve all levels of staff, including the top management, by providing support and encouragement and not limited to some specific departments or divisions only. In a personal interview with the Assistant Mechanical Engineer, he emphasizes the importance of involving all parties from the management and administration of the organization, as he stated that, "The management should involves together, not just the lower level of employees participate in energy management program but at the same time, the top management is not aware of the issues especially the wastage of energy. We

have to work together on this issue” (Assistant Mechanical Engineer, personal interview, March 5, 2017).

3.4 Budget Allocation

Operating expenses usually involve a very high cost and not except for the operation of an office building. To implement energy efficiency programs in an office building, a special budget is required and must be sufficient. Overall, according to the Senior Electrical Engineer (personal interview, March 14, 2017) with 28 years experiences, the top management usually has no budget allocation or does not giving priority to ongoing efforts towards achieving energy-efficient buildings as he mentioned that; "We could not replace some major equipment because we do not have a fund to get new equipment with modern technology. Generally, there will be problems in terms of budget allocation” (Senior Electrical Engineer, personal interview, March 14, 2017).

This statement was supported by the Mechanical Engineer as stated in personal interview March 5, 2017, that there should be a special budget available for the improvement and efficiency of energy usage by some major equipment or application of certain systems. He stated that, "When you want to implement energy management programs, then we need a budget, there is a need to replace equipment to replace chillers, cooling towers, new systems and so on. So when we change that, we have to allocate some of the budget” (Mechanical Engineer, personal interview, March 5, 2017).

There are interviewees who have stated that to buy new energy-efficient equipment is very important but it certainly involves a very high cost and no special allocation. According to the Assistant Mechanical Engineer (personal interview, March 5, 2017), "The budget problem may be that it is due to the installation of new equipment and new technologies that involve high costs. The budget for electricity savings is likely to take the overall budget for the organization. Top management gives us permission to install new equipment, and if they have facilities and provisions, I think there is no problem at all”.

The statement is supported by the Chargeman (personal interview, February 26, 2017), especially when there is a proposal from the supplier. He stated that "Issues or challenges are costly to buy energy-efficient equipment. Sometimes there are some of suppliers coming up for recommendations for new equipment or related energy efficiency activities, but stunted because of no feedback from top management. Usually, considerations are there, but because suppliers need to spend their own budget first then there may be cost constraints”.

Indeed, all the interviewees agreed that there was a shortage of budget or no budget that could be allocated to energy efficiency implementation in current government office building

3.5 Establishing an Energy Policy

According to Khattak *et al.*, [10] an improvement not only needed to be focus on the technical but also towards the many polices dimensions. Indeed, there are several good examples of energy efficient activities that can be implemented, but everything is still dependent on the commitment of top management to make it a policy that should be adhered to. Energy policy is not limited to incentives or legislation from the government and its agencies as stated by the Mechanical Engineer in personal interview March 5, 2017, "Top management is closely related to the policy in the organization. If top management does not commit to prioritizing implementation of energy management program, it will eventually become constraints for us to implement such programs in any office building."

From this discussion, energy efficiency policies and programs will not only help drive the implementation of projects or activities that can minimize or reduce energy usage. The government, through its agencies also has established energy efficiency standards for certain appliances and office equipment that may require products adhere to a certain maximum allowable energy usage. Educating employees, can also be included as a policy on attitude and behavior as well as the tendency to use energy more efficiently and followed by energy-efficient practices representing an important element of a government's efforts to encourage a more energy efficient society and the benefits it could provide to the end user.

3.6 Improving Energy Efficiency Electrical Appliance System

Various efforts have been undertaken to improve the energy efficiency of the widely used electrical equipment inside the office building. Inefficient electrical appliances will be costly if not properly maintained or without any additional device that can determine their level of use as stated by the Senior Electrical Engineer personal interview, March 14, 2017, "Most of these LED technologies reduce the amount of energy consumption to only half, but in terms of output is much the same as conventional lighting technology. While usually the problem is most of the equipment is not working properly and less energy efficient and excessive energy consumption". - Senior Electrical Engineer.

3.7 Promoting Awareness

Awareness of energy efficiency is much discussed in terms of overall energy management. Active involvement from top management is very important to ensure that its employees are aware of the importance of achieving energy efficiency objectives within the office building rather than just a command from the top.

According to the Senior Electrical Engineer in personal interview, March 14, 2017, the level of awareness in Malaysia is still below than expected although there are efforts towards energy efficiency, yet still inadequate because there is no guidance and encouragement and he suggested some improvement that can be implemented as he stated that, "In Malaysia, awareness of energy efficiency is still not seen as one of the requirements to be followed. Among the energy-related activities that can be done is by organizing some awareness campaigns and providing some rewards, then it will increase the awareness among the end user or employees".

Among the activities in the energy awareness campaign are to create energy awareness programs in each department, friendly reminders via e-mail, energy reminder stickers attached to walls or electrical equipment, reward programs through energy saving, awareness posters and more. It is agreed by Mechanical Engineer (personal interview, March 5, 2017) who also thinks that with energy saving, many benefits can be obtained, especially for improvements in building operations and using approaches that do not involve high costs. According to him, employees may be exposed to a comprehensive, cost-effective and cost-effective measure, particularly when dealing with daily routines within the office building. Low-cost and no-cost measures as suggested such as performing monthly maintenance of heating and cooling equipment, turn off lights when not in use, using natural daylight if appropriate, remove unnecessary lamps in over lit areas, activate sleep settings on all computers, while turn off all hardware and peripherals when not in use. For HVAC, regularly change or clean the filters every month to prevent equipment inefficient, low air quality and improper cost of use.

4. Issues and Challenges of Energy Efficiency in Office Building

Other issues and challenges are based on findings and summarized as follows.

- i. Budget allocation is because of the purchase of HVAC equipment which is very expensive and it has been used for over 20 years. In contrast, there is no specific budget specifically for energy efficiency activities. The top management usually has no budget allocation or does not giving priority to ongoing efforts towards achieving energy-efficient buildings.
- ii. Top management does not prioritize the implementation of energy management programs in the organization as a main agenda, it will eventually become constraints to implement the program, especially when it comes to getting strategic cooperation, budget allocation, energy-awareness activities and consultations from experts in energy management.
- iii. Staff engagement in energy efficiency programs is only from certain departments and does not involve the entire staff in this building.
- iv. Energy managers are only needed after finding that the amount of energy used is very high in the campus. The energy manager's services are for the general audit stage and provide advice on energy management.
- v. Awareness is relatively low and staffs were still not aware of issues related to energy efficiency. Therefore, active involvement from the management is very crucial to ensure that its employees are aware of energy efficiency in the office building. Although there are efforts towards energy efficiency, yet still inadequate because there is no guidance and encouragement from the management.
- vi. There are situations where most of the old equipment is not working properly and less energy efficient which causes excessive energy consumption in the day-to-day operations of the building. This makes the problem more challenging as they need to identify such equipment that may be inefficient and waste energy if used continuously. The main issues and challenges of energy efficiency at UUM are represented by Figure 4.

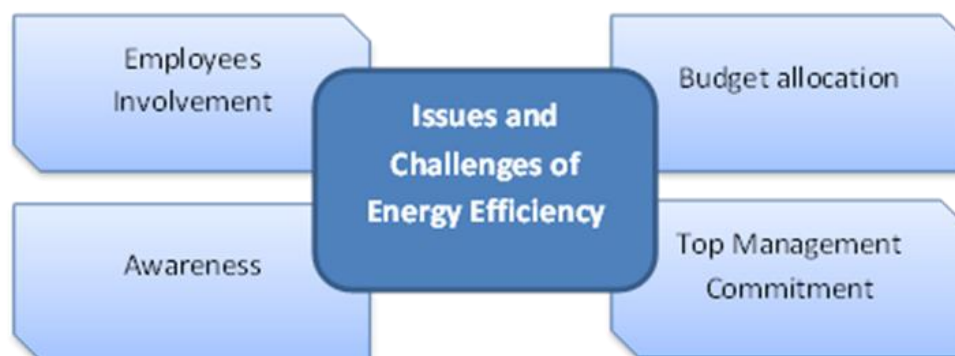


Fig. 4. Main issues and challenges of energy management at UUM main campus

5. Conclusions

Energy inefficiency issues in office buildings on university campuses in Malaysia should be given serious attention as it is crucial to promote less energy consumption and to reduce energy consumption significantly. Most past studies have focused on solving the energy inefficient based on the same method of using the available technology, technique, methods or specific measures without the involvement and understanding of the whole organization, top management and employees. There is still a lack of studies focusing on the real case studies of energy efficiency practices at the

government office building and less awareness towards the importance of energy efficiency among all level of employees. However, the current energy management program has succeeded in improving the energy efficiency level in the building that has been identified, but has not been able to deal with the issue of energy efficiency over the long term by involving a comprehensive participation of all parties especially in the government office building. Most of the methods used especially when the energy audit is carried out, are more than just technical aspects and involve the purchase of equipment to facilitate the building operation and maintenance.

This research has highlighted that the energy management faces considerable challenges in its efforts toward energy efficient building. This study has identified the sources and nature of these challenges highlighted that energy management programs are very crucial because they involve attitudes and habits of building occupants such as management staff and employees. They should see the energy management committee and team fully involved and participating. This, will not only raise awareness and provide exposure to them, but will also make them practicing energy efficiency program effectively. Indirectly, this will ensure that the committee and energy management teams are adequately prepared to face any challenges that will prevent them from working in a comprehensive manner. They will learn something from every issue and challenge that comes with, and learn to deal with the problem in groups and share new knowledge and best practices.

Overall, this study has contributed to the body of knowledge by identifying the various factors that influence the energy efficiency of the office building. This contribution is made through the development of the case study at the university campus in Malaysia. Results from the case study also highlight several main factors influencing the implementation of energy management program. This research further contributes to theory identifying the key issues that affect energy efficiency in the office building. This study also contributes to the industry on how the potential of energy management can be expanded extensively and is not limited to experts and academics who are engaged in energy management. Based on the energy management practices found in the case study, it is clear that not all energy efficiency activities are appropriate and effective. In fact, the involvement of employees or the public is also important and this may give an idea to the industry to improve their energy efficiency programs.

The process of energy audit at the office building could be adjusted according to the findings of the study. Therefore, it is important for the management of government office building to establish an energy management committee to achieve energy efficient building within a specific period of time. This energy management committee will be the information channel, implementer and monitor the energy efficiency aspects of the building in a more organized and systematic manner.

Acknowledgement

This work is financed by the Fundamental Research Grant Scheme (SO Code: 14169) provided by the Ministry of Higher Education Malaysia.

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