Faculty of Mechanical Engineering

ANALYSIS OF ENERGY USAGE IN PUSAT PERSATUAN PELAJAR

Ibrahim Hamad Mohamed Najem

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IBRAHIM HAMAD MOHAMED NAJEM

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DECLARATION

I declared that this thesis entitled “analysis of energy usage in Pusat Persatuan Pelajar” is the result of my own research except as cited in the references. The project has not been accepted for any degree and not concurrently submitted in candidature of any other degree.

Signature : ……...……

Name : IBRAHIM HAMAD MOHAMED NAJEM

Date : ……...……

APPROVAL

I hereby declare that I have read this project and in my opinion this thesis is sufficient in terms of scope and quality as a partial fulfilment of Master of Mechanical Engineering (Energy Engineering).

Signature	:	……..
Supervisor Name	:	DR. NAZRI BIN MD DAUD
Date	:	……

DEDICATION

This project is dedicated to:

The sake of Allah, my Creator and my Master, my great teacher and messenger, Mohammed (May Allah bless and grant him), who taught us the purpose of life. My parents, for their endless love, support and encouragement along my life. My dearest wife, who leads me through the valley of darkness with the light of hope and support. My beloved brothers and sisters. My beloved kids: Hamad, and Hala, whom I cannot force myself to stop loving. To all my family, the symbol of love and giving. My friends who encourage and support me. All the people in my life who touch my heart.

I dedicate this research.

ABSTRACT

Energy analysis is important in resolving energy consuming modality, due to observing how the energy utilized has shifted with time in the building and how the arrangement elements interrelate with each other. In this case study, a preliminary energy audit is done on the existing indoor parameters. The study was conducted at Pusat Persatuan Pelajar (PPP), Universiti Teknikal Malaysia (UTeM). The project is aimed at comparing the lighting index between PPP building and the current Malaysian standard (Malaysian Standard 1525:2014). This undertaking is also aimed at evaluating and analyzing energy used in the PPP building. To calculate the electricity consumption and lighting, physical indoor data was collected through a clamp meter and lux meter on three floors in the PPP building. The air-conditioning system in the selected rooms was left for one hour before starting the measurements. The lighting data was collected between 10 am to 12 pm and again 2 pm to 4 pm with a gap of 20 minutes for each reading. The results show indicated that the energy consumption of the air-conditioning system was 11157.76 kWh and costing RM 4072.58 per month. From lighting system analysis, the energy consumption was 6600.16 kWh and costing RM 2409.05 per month. The project also studies the current lighting system and a proposed energy retrofit to save energy usage. After proposing retrofit plan, the energy consumption can be saved 18931 kWh per month and RM 1105.57 per month. The difference of power consumption for a month March in 2017 between the measurements and electricity bill analysis is about 5%. Since the difference is too small, therefore, it can be concluded that the obtained the Building Energy Index (BEI) value in the project is reliable. Most of the lighting levels in every audited zone exceed Malaysian Standard MS 1525:2014. In addition, the Building Energy Index (BEI) for all the building is 233.67kWh/m²/year and for each level is 77.89 kWh/m²/year. The best BEI exercise and recommended by Malaysian Standard is 135kWh/m²/year.

ABSTRAK

Analisis tenaga adalah penting untuk menyelesaikan kaedah penjimatan tenaga, discbableen peralihan penggunaan tenaga terhadap masa di dalam bangunary dan bagaimana elemen tersebut saling berkait. Dalam kajian kes ini, audit tenaga awal dilakukan terhadap parameter dalaman yang sedia ada. Kajian ini dijalankan di Pusat Persatuan Pelajar (PPP), Universiti Teknikal Malaysia (UTeM). Projek ini bertujuan untuk membandingkan indeks pencahayaan di antara bangunan PPP dan piawaian Malaysia (Malaysian Standard 1525: 2014). Usaha ini juga bertujuan untuk menilai dan menganalisis penggunaan tenaga di bangunan ppp. Untuk mengira penggunaan elektrik dan pencahayaan, data dalaman secara fizikal dikumpulkan melalui clamp meter dan lux meter di tiga tingkat di bangunan PPP. Sistem penyaman udara di bilik alat yang dipilih dibiarkan selama satu jam sebelum memulakan pengukuran. Data pencahayaan dikumpulkan antara jam10 pagi hingga 12 malam dan sekali lagi pada jam 2 petang hingga 4 petang dengan selang 20 minit dalam setiap bacaan. Keputusan untuk projek ini, menunjukkan bahawa penggunaan tenaga sistem penyaman udara adalah 11157.76 kWh dan menelan kos RM 4072.58 sebulan. Dari analisis sistem pencahayaan, penggunaan tenaga adalah 6600.16 kWh dan kos RM 2409.05 sebulan. Projek ini juga mengkaji sistem pencahayaan dan, retrofit tenaga yang dicadangkan bagi menjimatkan penggunan tenaga. Selepas pelan 'retrofit" dicadangkan, penggunaan tenaga dan caj elektrik dapat dikurangkan sebanyak 18931.96 kWj sebulan dan RM 1105.57 sebulan. Perbezaan penggunaan tenaga antara pengukuran dan analisis bil elektrik adalah dalam anggaran 5%. Oleh kerana perbezaannya adalah terlalu kecil, ianya, dapat disimpulkan bahwa nilai di samping itu (BEI) yang diperoleh dalam projek ini dapat disahkan. Kebanyakan tahap pencahayaan di setiap zon yang telah diaudit melebihi Standard Malaysia MS 1525: 2014. Di samping itu, BEI untuk semua bangunan adalah 233.67kWh / m² / tahun dan bagi setiap peringkat adalah 77.89 kWh / m² / tahun. Nilai BEI terbaik dan disyorkan oleh Malaysian Standard ialah 135kWh / m² / tahun.

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CHAPTER 1

INTRODUCTION

1.1 Background

The research of the building energy request has turned into a theme of absolute significance, on the account of the huge increment of attention for energy sustainability, which has grown vastly after the spread of the EPB European Directive (Commission, 2002). Considering the consistent increment of fuel costs, dangers of an unnatural weather change, ramifications of carbon emissions from conventional energizes, there is a developing attention for enhancing energy efficiency. The important components in guaranteeing a building's efficiency is energy administration and observing. Energy observing is an energy efficiency procedure in view of the standard administration aphorism expressing that "you cannot improve what you cannot measure". It implies the necessity of measurements and data organization (Sretenovic, 2013). One of the hardest problems to achieve energy efficiency is to reduce the cost of building energy when energy costs will be considered as part of the General overhead. Therefore, building energy auditing is one of the approaches reviewed and implemented to reduce energy costs. Energy audit of the Faculty aims to identify and evaluate where a building that uses energy consumption and identify energy-saving opportunities (Tee et al., 2006).

Energy audit is an important method or a systematic process of energy evaluation to reduce energy consumption by identifying electrical energy efficient measures (EEMs). It applies certain methods of analysis to evaluate the records of energy utilized in order to

develop those measures (EEMs) in buildings (Thumann, 2007). In addition, there are several types of energy audit. The best way to determine the appropriate type of energy audit is energy consumption Index Facilities or buildings. At the global level, the building took 40% of total energy consumption and the extra energy is used for heating, ventilating and air conditioning (HVAC) (Ahmadzadehtalatapeh, 2014). Generally, in buildings more than 50% of the energy used by HVAC systems, especially in hot areas (Yau, 2008). A study conducted in UTeM (2015) established an energy utilization profile of electrical devices in terms of kWh consumption, cost and the operating hours, such as air – conditioning, lights and other electrical equipment. It was concluded that a large amount of energy was consumed for the purpose of air – conditioning and lighting systems, having high potential of energy saving. Therefore, EEMs were developed and implemented to reduce energy utilization and the cost for the lighting and air – conditioning systems.

The management of an organization should fully cooperate and acknowledge the importance of an audit since it‟s impossible to perform an audit without the involvement of the top management and the entire staff (Bhawarkar and Kamdi, 2011).

A new and even existing building must comply with Malaysia Standard policies which are required to meet MS 1525:2014 while undergoing the design, construction, operation and maintenance. Energy is mostly consumed by air – conditioning systems in offices, educational premises, commercial buildings and homes to provide comfort to the occupants. In this manner, Department of Standard Malaysia (DSM) distributed Code of Practice for Energy Efficiency and Use of Renewable Energy for Non-Residential Building, its purpose is mainly for outline installation. It is also requiring to minimize the usage of energy without compromising the design, the function of the building, the comfort or the

productivity of the residents (Malaysian Standard, 2014). Therefore, with the matters mentioned above, it is important to find effective ways to build optimal operation level and meet the best energy saving options.

1.2 Introduction

As a building type, instructions on a building require our consideration: a cathedral would have had many years on it, earliest being built in the nineteenth century, Office buildings however were booming towards the twentieth century, the training buildings is to the 21st century. These are the types of buildings that represent the two projects and technology, the soul and culture of our age and enthusiasm for the scholarly and monetary assets among the largest in our community. Unfortunately, in the education building this user requires many natural resources. For example, education building usually takes 5 to 10 times more energy for every square from doing office building (Gropp et al., 1996), and some of the education building can take as much as 100 times the energy structures of the institution or commercial use have the same size. The challenge for Architects, engineers, and other building experts to outline and build them up and then we have the generation of advanced education with energy efficiency, exporter of renewable energy source and economic development hone at the top of the priority list. What's more, to do it while keeping up and building up the contemporary reality, level of rest, health, and security. As mentioned before, lighting and air – conditioning systems consume the most energy in a building. Approximately 25% of the total energy is consumed by the lighting system. This energy is wasted due to the irresponsible behavior of staffs that failed to switch off the lights before they leave their premise of work. The management could install efficiently designed lightings with quality lights to reduce energy waste (Muhamad et al., 2010). On the other hand, air – conditioning consumes approximately 56% of the total energy, hence, it is the

highest energy utilized in a building. Energy waste occurs when the air – conditioning systems are not switched off accordingly when it is not needed and the behavior of staff that leave the doors and windows space open. An improvised system control of equipment losses be achieved by using an efficient air – conditioning system (Hua et al., 2011).

Energy administration is the way to control and diminish a buildings energy consumption, which empowers building proprietors to:

- Reduce costs; this has become increasingly important because of the rising cost of energy.
- Reducing carbon emissions and environmental damage that causes them; and related tax implications of the cost of carbon, each organization may be interested in reducing the carbon impression to advance a green picture, and supportable. It goes without saying that the ground of advancing such pictures is regularly useful for the main issue, particularly for pedagogical organizations.
- Reduce the risk; more energy using a number of buildings, the greater the risk that any increase in the price of energy or lack of serious supply can affect the function. With the management of each organization can reduce this risk by reducing demand for energy and control it so that it can be predicted (Sretenovic, 2013).

To monitor and control energy consumption, to collect sufficient data is the main problem. The advanced way in dealing with the manual information gathering was reviewing meters once the youthfulness of each week, or each month. This is a huge burden, and information week to week or month to month is not nearly as great information turns out to be effective and more natural from the approach now. A more advanced approach, frame-

work data gathering is interesting. Metering interim measurements and recording energy consumption within a short time intermittently, for example, like clockwork, 30 minutes or hour. The detailed energy consumption data Interval makes it possible to see the entire pattern of energy and to view an example of the overall fitness that is hard to see in general. For example, there is simply no chance that meter readings week by week or month to month can show how much energy is used at various hours of the day, or on various days of the week. Thus, energy utilizes more itemized reading and makes it less demanding to locate the normal waste in the building. It is additionally imperative to have the correct and solid measured information. In the event that a piece of a building is rented to different clients, there is a need for calculating energy utility bills for each rented. There is expanded attention for information blunder investigation and creating techniques that can call attention to conceivable meters breakdown. Additionally, without right measured information it is not conceivable to observe and confirm advantages of applying energy saving measures. Realizing the model helps the use of energy in the presence of the building design, it is able to provide useful information about the use of power is most likely for a similar building. Additionally, these models can be utilized to foresee energy use in various conditions, indicate effects of conceivable energy savings measures and help in finding ideal method for decreasing energy costs (Sretenovic, 2013).

1.3 Malaysian Standards

Malaysia is a country of accreditation and standardization bodies. Basic capabilities of the Department of Standards is to promote and advance models, institutionalization and Declaration as a tool to boost the country's economy, increase the productivity of industry and improvement, medical and wellness opened edge, secure shopping, promote exchange

and global household and grew up in the universal connection measures and institutionalization (Halim and Man, 2006).

The Malaysian Code of Practice on Energy Efficiency and Use of Renewable Energy For Non-Residential Building (MS 1525:2007) went for advancing energy efficiency of buildings has been attempting to promote a general consciousness in energy-conscious plan and operational practice (Standard Malaysia, 2007). Department of Standards Malaysia has proposed requiring that the building envelope design buildings non-residential new air-conditioned rooms to meet the needs of the State of the interior design.

1.4 Energy Index

A very commonly used metric for building energy performance is the energy use index (EUI), defined as the energy consumption per unit conditioned floor area. In the U.S., this metric is expressed in Btu per square foot, and it is the metric used by the widely accepted Energy Star Portfolio Manager. Experience with Energy Star has found that this one-parameter system is appealing to the affected industries. Benchmarking using this index helps building owners and managers to decrease energy consumption. There is a wide fluctuation between the energy utilize per square meter of various buildings of a similar sort in a similar nation or even a similar city. The most widely recognized practice is to utilize a determinant which is somehow identified with the offices gave by the building. For instance, the general energy consuming of a building is typically shown by the yearly building energy consuming per net floor area (GFA), communicated in kWh/m²/annum. Somebody may contend that the utilization of GFA might be deceiving if a few buildings contain a great deal of non-air-conditioned areas and have altogether different capacities and hours of operation. Along these lines, it has additionally been recommended that the

execution file may be communicated in consuming per air-conditioned area, every hour o operation, per determine function and per determine functional activity within the facility (Orlando and Hayes, 1978).

1.5 Problem Statement

Energy is an essential factor for the accomplishment of all economies in the prompt and long-haul future. Since the energy emergency of 1970 s, individuals expected to decide how much energy buildings were utilizing and to recognize how that energy utilize could be decreased. This would effectively affect building architects, administrators, and proprietors. It is clear that electrical energy utilized in buildings continues to increase and will continue to grow in demand, gleaned by the advanced technology used in electrical equipment (Singh et al., 2012). An energy audit is essential to achieve an optimal energy performance by reducing the energy wastes and improving the efficiency of air – conditioning and lighting systems. Basic assessment and propelled contemplate is required keeping in mind the end goal to give measures in accomplishing ideal building energy efficiency.

Building energy analysis examines the ways actual energy consumption is currently used in the facility, in the case of a completed and occupied building; it identifies some alternatives to reduce current energy usage. Implementation of energy analysis is practically used to analyze the energy consumption pattern and monitoring on how the energy used varies with time in the building. UTeM‚s energy policy was introduced in 2015. One of the policy matters is to reduce power consumption by 20% within 2015 to 2020. The aim of this project is to support UTeM‟s energy policy. There were a few energy analyses previously in the UTeM‟s Pusat Persatuan Pelajar *(PPP)*.

1.6 Research Objectives

At present, there are a variety of energy-saving methods. The impact of energy conservation, viability of the operation, acceptance by the end user and the payback of the investment cycle to consider when choosing appropriate energy-saving methods. The effectiveness of the same method used in the different building types will be affected by variables such as climate, habits of residents, HVAC system, enclosure properties, geometric properties, etc., and therefore, the final decision varies greatly. Researchers need to invest time and money with the thoroughness of the properties for building and different methods. There is no quick way to policy makers and engineers to make broad judgments about the appropriate energy-saving methods. Regarding the previous study, most of the research done abroad was aimed at specific zones of a country's climate, and various applied certain energy-saving methods are usually limited to one building. These specific study objectives below:

- To compare the lighting index between the Pusat Persatuan Pelajar (PPP) building and the standard building which follows MS1525:2014.
- To evaluate and analyze energy use in Pusat Persatuan Pelajar (PPP).

1.7 Scope of the Study

The scope of this study is to evaluate the electrical energy consumption in an academic building, using the practical experiment method to measure the Indoor Environmental Quality parameter. It is also very important to have correct and reliable measured data, by using the important physical parameters that may influence the system performance and collect gross sections area of the building. Collected information of the electricity bill of

buildings, and analyze energy use to evaluating the current energy consumption. Determine the relationship between energy consumption with the indoor condition.

1.8 Significant of the Study

With energy utilization developing quickly around the globe, building energy preservation is turning into a great concern, particularly for larger business buildings. Along these lines, it is essential to create proper strategies for energy utilize evaluation of business buildings.

The aim of this study is to analyse energy consumption at Pusat Persatuan Pelajar (PPP), utilizing the reverse approach, measured data for electro and heating consuming is utilized. Gathered data of buildings, and electro and heating consuming is utilized to make a model. Making model energy consuming helps before the building plans; it can give valuable data about the most likely energy consuming for buildings that are comparable, or prophesy energy consuming in various conditions. Additionally, these models can be utilized to indicate effects of potential energy provision funds measures and help in finding ideal method for lessening energy costs. It is likewise essential to have right and dependable measured information. On the off chance that a piece of a building is rented to different clients, there is need for computing bills for each inhabitant. There is expanded attention for information blunder investigation and creating strategies that can bring up potential meters glitch. Additionally, without right measured information it is not potential to observe and demonstrate advantages of applying energy saving measures for expanding energy efficiency.

1.9 Summary of the Study

Building energy analysis examines the ways actual energy consumption is currently used in the facility, in the case of a completed and occupied building and to identify some alternatives to reduce current energy usage. Implementation of energy analysis is practically used to analyse energy consumption pattern and monitoring on how the energy used varies with time in the building. UTeM,s energy policy was introduced in 2015. One of the policy matters is to reduce power consumption about 20% within 2015 to 2020.

When an electricity bill is collected from office and the physical characteristics of the academy building is measured, the actual situation of the indoor environment concerning energy consumption in the building, and light level transmitted will be known. After that, the historical energy data was essential to be investigated in order to assess the monthly energy consumption pattern, and Conduct a comparison in lighting index between the real building and a building in which is built for MS1525:2014. Then, the measurement of the total power consumption for a month in 2017 compared with same a month in electricity bill. Next, the Building energy index BEI will be calculated and compared with Malaysian Standard. The reason will be understood if the result of the building energy index BEI increases or decrease. Finally, the potential energy savings will be suggested for the academic building. Thus, the consumption of electrical energy will be decreased and many benefits will be obtained such as, economic benefits, environmental benefits, and health benefits.

Chapter 1 contains the introduction and the overview of this project, the problem statement of this project, the objectives of the project, the scopes of the project, Significance of the Study and Summary of the Study. Chapter 2 contains all the literature