UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A STUDY ON ENERGY EFFICIENCY FOR LIGHTING IN SMALL SCALE ROOM USING LUMEN METHOD

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Mechanical Engineering Technology (Maintenance) (Hons.)

by

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I hereby, declared this report entitled "A Study on Energy Efficiency for Lighting in Small Scale Room using Lumen Method" is the result of my own research except as cited in references.

Signature	:	……
Author's Name	:	Muhammad Faeez Bin Mohamed Hariri
Date	:	9th December 2015

APPROVAL

This report is submitted to the Faculty of Engineering Technology of University Teknikal Malaysia Melaka (UTeM) as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Bachelor's Degree of Mechanical Engineering Technology (Maintenance Technology)) (Hons.). The number of the supervisory is as follow:

……..

(Project Supervisor)

ABSTRAK

Ke arah tahun 2020, permintaan tenaga akan menjadi lebih besar di Malaysia, menurut standard MS1525, sebuah bangunan indeks tenaga disyorkan di Malaysia adalah hampir 135kWh / m² / tahun. Walau bagaimanapun, hampir semua bangunan tidak memenuhi piawaian. Kajian ini adalah terutamanya mengenai menyiasat kecekapan tenaga di Universiti Teknikal Malaysia Melaka (UTeM) secara khusus dalam Fakulti Teknologi Kejuruteraan (FTK) dan Fakulti Kejuruteraan Mekanikal (FKM). Objektif kajian ini adalah untuk mengenal pasti kegunaan berlebihan lampu dan tahap cahaya. Skop yang ada di FTK dan bangunan FKM dengan menggunakan kaedah lumen. Kemudian, kaedah yang akan digunakan bermula dengan melakukan beberapa kajian dan soal selidik kepada pengguna, mengumpul data, mengira data dan analisis untuk penggunaan tenaga dan penambahbaikan. Hasil kajian telah menunjukkan pengiraan tahap pencahayaan bilik kuliah 9 di Fakulti Kejuruteraan Mekanikal (FKM) adalah berlebihan iaitu sekitar 73 kaki lilin. Tahap pencahayaan terbaik untuk ini bilik kelas atau kuliah hanya boleh menjadi sekitar 20-50 kaki lilin sahaja. Ia menunjukkan kecekapan tenaga yang lebih baik dengan melihat pada tahap cahaya lampu boleh dikurangkan berdasarkan pengiraan. Akhir sekali, di hujung hari, kajian ini diharapkan akan menunjukkan pengurangan dalam penggunaan elektrik terutama boleh menyebabkan penjimatan dalam penggunaan dan perbelanjaan untuk UTeM.

ABSTRACT

Towards year 2020, energy demand will become more massive in Malaysia. According to MS1525 standard, a recommended building energy index in Malaysia is almost 135kWh/m²/yr. However, almost all of the buildings do not meet the standard. This study is mainly about investigating the energy efficiency at Universiti Teknikal Malaysia Melaka (UTeM) specifically in Faculty of Technology Engineering (FTK) and Faculty of Mechanical Engineering (FKM). The objective of the study is to identify the excessive uses of lamp and light level. The scope is in the FTK and FKM building by using lumen method. Then, the methods that will be use start with doing some survey and questionnaire to the user, collect data, calculate data and lastly analysis for improvement energy consumption. The result indicates the calculation of lighting level for lecture room 9 at Faculty of Mechanical Engineering (FKM) is excessive which around 73 foot-candle. The best lighting level for this class or lecture room could only be around 20-50 foot-candle only. It shown better energy efficiency by look at the light level of lamp can be reducing based on calculation. Lastly, at the ends of the day, the study hopefully will show a reduction in the electricity consumption especially could result in savings in utilization and associated expenditure for UTeM.

DEDICATION

To my beloved family,

My supervisor,

My Panel,

and to all my friends,

Thanks for all support and idea.

ACKNOWLEDGEMENT

First I would like to express my grateful to ALLAH S.W.T. as for the blessing given that I can complete my final year project. In preparing this paper, I have been involved with many people in helping me to complete this project.

I am grateful and would like to express my sincere gratitude to my supervisor, Mr. Mohamed Saiful Firdaus Bin Hussin for the preliminary ideas, invaluable guidance, continuous encouragement and continuous support in making this research possible. I appreciate his consistent support from the beginning till the end of this project. Thanks to all my supervisor mates and staff of the Mechanical Engineering Technology Department of Universiti Teknikal Malaysia Melaka and development department who helped me in many ways during the project.

I acknowledge my sincere gratitude to my family for their love, dream and sacrifice throughout my life. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to attain my goals. Special thanks should be given to my friends. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this final year project.

The next category is those who help me to grow further and influence in my project are my colleagues who always help me in order to finish this project. I really appreciate the idea and information given.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

UTeM	–	University Technical Malaysia Melaka
FTK	-	Faculty of Technology Engineering (FTK)
FKM	-	Faculty of Mechanical Engineering (FKM)
FHE	-	Further and higher education
MOHE	-	Ministry of Higher Education
FPTT	-	Faculty of Technology Management and Technopreneurship
ZW	–	Zettawatt (10^21 watt)
OECD	-	Organization for Economic Cooperation and Development
CFL	-	Compact fluorescent lamps
GDP	-	Gross Domestic Product
LUX	-	The SI unit of illuminance, equal to one lumen per square meter
NFPA	-	National Fire Protection Association

CHAPTER 1
INTRODUCTION

1.1 Energy Consumption Overview

Energy consumption is the consumption of energy or power used by all of human civilization. The pattern of energy consumption actually differs for an industry, buildings and sites where it also depends on the duration and nature of the period of occupation. Usually, a building that demands high usage has high energy consumption. Eventually, energy efficiency measures should be carried out in order to improve overall building performance (Bassi et al., 2009). Energy saving can increase competitiveness for industry, through the cost reduction, economic growth and environmental issues (Ozolina & Rosˇa, 2012).

Electricity is used for running air-conditioning plant, lighting and other equipment in the building include university. Lighting consumption depends on the purpose of the building, use of daylight, illumination levels for certain areas and the hours of usage (Musa et al., 2012). This means that the energy consumed in the buildings is mainly related to cooling and lighting, and high costs are incurred if the energy is not managed well. Electricity has many functions and, in addition to high-grade energy, it is required in the transportation of low-grade energy, for instance, in air-conditioning through a ducting system using a fan. The grade of energy used in a

building is determined by the load or equipment that been use. So that, when more demands by the load, the grade will be higher.

Presently, further and higher education (FHE) around the world is a growing sector, with student numbers increasing by 44% over the past ten years (Ozolina & Rosˇa, 2012). This means that the energy consumption of colleges and universities is also growing (Ozolina & Rosˇa, 2012). Establishments are under constant pressure to provide optimum learning facilities on a limited budget so it makes sense to look at the way energy is used in order to release much needed additional funds for curricular resources. Implementing a few simple techniques can reduce energy consumption. It will also boost the environmental credentials of a college or university, which could influence the number and caliber of students attracted and retained.

The energy consumption increases with population growth, increasing demand for building services and comfort levels, and time spent inside buildings (Ozolina & Rosˇa, 2012). Lighting has the potential to improve energy saving in buildings (Boyano et al., 2013). In fact, the energy use in buildings is reflected by the energy consumption in residential and commercial sectors (Ozolina & Rosˇa, 2012), and energy efficiency in buildings has become a primary objective for energy policy at regional, national and international levels. The increase in the number of commercial buildings and residential area development projects has a great impact to the national development but it also increases the energy demand.

Eventually, university buildings are high consumers of energy in the category of commercial buildings (Najihah et al., 2013). According to Hoballah (2009), almost no country in the world can hope to achieve energy consumption reduction targets without including building sector. The building industry is one of the big resource users of energy consumption (Melchert, 2007). The industry sector was the highest user of electricity with its share of 43.6% of the total consumption and followed by commercial

sector with its share 34.1% in 2012 (Choong et al., 2009). In Malaysia, the Ministry of Higher Education (MOHE) spends more than ten million ringgit annually on the expensive electricity bills (Choong et al., 2009).

MOHE has urged all education centers to save energy for expensive monthly electricity bill which had become the concerns for many parties (Choong et al., 2012). A survey done has shown the energy consumption in Universiti Teknologi Malaysia and International Islamic University Malaysia has led to more than ten million ringgit annually due to increment of students' population almost every year (Choong et al., 2012).

Table 1.1: Annual electric bill UTeM (Hassan, 2012)

Year	Total (RM)
2007	2,341,804.00
2008	3,181,141.00
2009	6,238,546.00
2010	7,700,956.00
2011	8,154, 463.00

Most organizations (including UTeM) use more energy than necessary and energy savings of up to 25% are able to be achieved. The smart user, management and maintenance actually capable to affects savings without involving minimum cost. UTeM spent an average of RM 675,000 per month to electricity bills, which is around RM 8.1 million per year since 2007 as shown in Figure 1.1. If energy consumption can be reduce

about 20% which is around RM 1.6 million by an implementation of good energy management, the annual electric bill of course will be reduce. Below is the Table 1.1 shown the annual electric bill for University Technical Malaysia Melaka (UTeM) (Hassan, 2012).

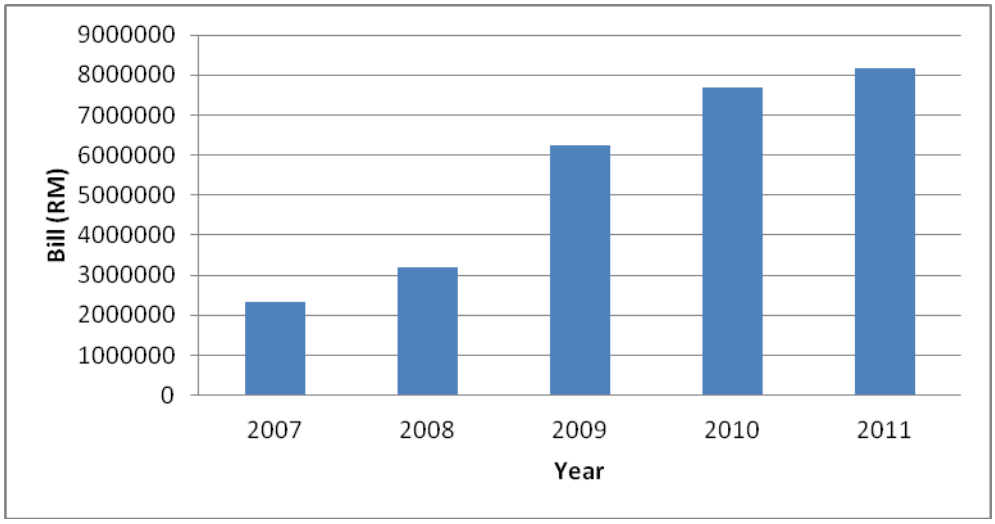

Figure 1.1: Bar chart annual electric bill UTeM (Hassan, 2012)

1.2 Problem Statement

Energy consumption at colleges and universities is always growing through the time together with increases of student numbers (Piper, 1999). Especially at University Technical Malaysia Melaka (UTeM) an academic precinct is widespread and consists of a large number of buildings of different functions and consumption patterns. The rapid growth of UTeM leads increase of electrical energy usage. It is expected that UTeM soon will expand six greater in just several years ahead.

The most common problem is energy consumption to the building. The demands will increase due to high requirement. The common factors which affect energy consumption in domestic, commercial and industrial sectors include the number of air-

conditioners and electrical appliances in use, temperature, occupancy rate, occupant behavior, and size of buildings (Piper, 1999). Energy consumption increases when more air conditioners are turned on and more electrical devices are in use (Piper, 1999).

According to the research by Hassan (2012) from Faculty of Technology Management and Technopreneurship (FPTT) & Faculty of Mechanical Engineering (FKM), state that trend of annual bill UTeM always increase. The overall cost for electric bill UTeM in the 2011 is about RM 8,154, 463.00. So that, if this annual bill can be reduce, the funds can be saved for research and other areas that are more in need.

Energy audits are carried out to understand the energy performance of buildings and facilities so that areas with potential for energy savings can be identified (Jayamaha, 2007). Energy audits are commonly classified as preliminary or walk-through audits and comprehensive or detailed audits, each differentiated by the level of detail involved and the depth of analysis undertaken (Beggs, 2009.). Preliminary energy audits focus mainly on the gathering and analysis of historical data such as utility bills and invoices, a walk-through of the facility under consideration to familiarize with the facility operation and identify evident areas with energy inefficiency, taking meter readings as well as simple interviews with site operating personnel (Gard, 2007.). Detailed energy audits normally involve conducting of in-depth measurements and data inventory, possibly with the aid of energy simulation computer software, thus consuming more time.

For that reason, a study on energy efficiency of energy consumption focus on lighting at Faculty of Technology Engineering (FTK) and Faculty of Mechanical Engineering (FKM) using lumen method by conducting a preliminary or walk-through energy audit. A better understanding of the energy consumption pattern will lead to easier identification of more viable and cost-effective energy measures, thus reducing operating costs in the long run. Factors that contribute to energy consumption such as

electrical appliances which is lighting will be investigated to determine their effects on energy consumption.

1.3 Objective

Based on the problem statement stated above, the objectives of this study are stated below:

i. To identify the excessive uses of lamp and lighting level in the small scale room.

ii. To propose energy management that could result in savings in utilization and associated expenditure.

1.4 Scope

In order to reach the objectives, a few scopes have been stated below:

i. Identifying the excessive uses of lamp and lighting level in the FTK and FKM building by using lumen method.

ii. Proposing energy management focus on lighting system that could result in savings in utilization and associated expenditure at FTK and FKM.

CHAPTER 2
LITERATURE REVIEW

2.1 Energy Consumption by Global Perspective

Energy is usually a simple desire for distinct purposes in industrial facilities around the globe including in college or university building. Huge amount of energy required for countries together with more rapidly financial progress. Energy can be as a result a crucial element with regard to financial competition along with work. On the other hand, world-wide people along with power desires are generally improved hand-in-hand. This particular matter has to be tackled by the global local community in order to get over almost any shortage of energy sources sometime soon.

Entire world marketed power usage is actually estimated to improve simply by 33% by 2010 to 2030. Total world power consumption utilize rose by 82, 919 ZW within 1980 to 116, 614 ZW within 2000 after which is actually required to reach 198, 654 ZW within 2030 as shown in Figure 2.1 (U.S Energy Information, 2009). The most rapid growth in energy demand from 2006 to 2030 is projected for nations outside the Organization especially for Economic Cooperation and Development (non-OECD nations).

In late decades, OECD nations have been on the move from manufacturing economies to serve economies. Absolute non-OECD power utilization was expanded by

73% contrasted with a 15% expansion in power use among the OECD nations (U.S Energy Information, 2009). The states devours 25% of the world's energy consumption. On the other hand, the hugest development of power utilization is at present occurring in China, which has been developing at 5.5% every year (U.S Energy Information, 2009).

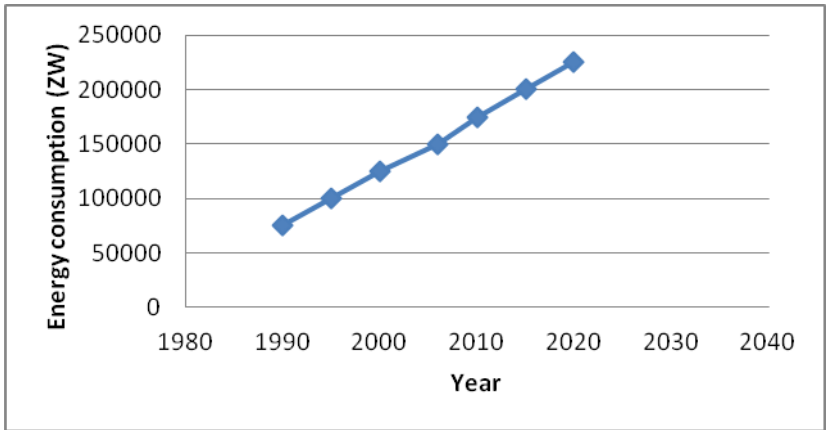

Figure 2.1: World marketed energy consumption (U.S Energy Information, 2009)

Electricity is consumed within the industrial sector by the diverse group involving industries including producing, agriculture, mining, and construction and for a wide range of activities, such seeing that processing and construction. Over the next 25 years, worldwide industrial strength consumption is projected growing from 51, 275 ZW throughout 2006 to 71, 961 ZW throughout 2030 by an average of 1. 4% annually in (Figure 2.2) (U.S Energy Information, 2009).

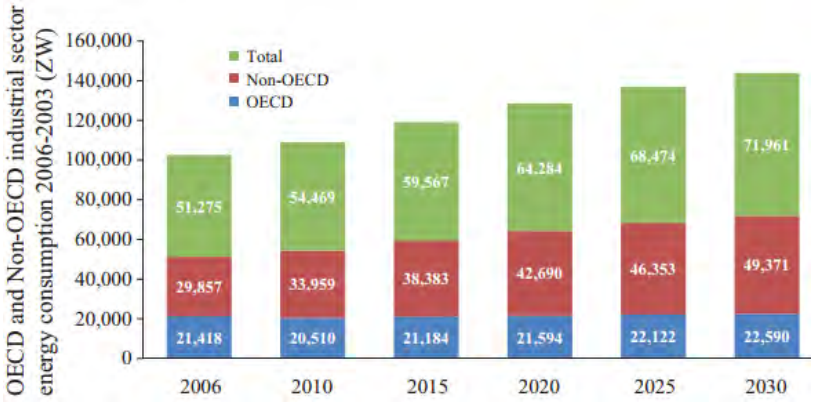

Figure 2.2: Energy consumption OECD and non-OECD industrial sector (U.S Energy Information, 2009)

2.2 Importance of Energy Efficiency in Industry

Industrial development throughout the world will result with more energy use and definitely will lead to additional concentration of greenhouse gases for instance carbon dioxide (CO_2) and also other emissions such because sulfur dioxide (SO_2), nitrogen oxide (NO_x) as well as carbon monoxide (CO) which in turn all have disastrous consequences for earth's climate including rising temperature, drought, surges, famine and monetary chaos. (Mahlia, 2002). The actual Intergovernmental Panel about Climate Change (IPCC) described that continued emissions will bring about a temperature improves of between 1.4˚c to 5.8˚c in the period from 1990 to help 2100.

Moreover, The Department of energy (The United States of America) highlighted that, global carbon emissions are rising greater than 2% per season and by 2015 could possibly be more than 50% earlier mentioned 1997 level, all of which because of improving energy demand and inefficient way of energy use. (Mahmoud et al., 2009). Energy efficiency inside the industrial sector begun to be considered one of the primary functions in this 1970s. After that, the world possesses trimmed its energy budget by utilizing higher efficiencies, while still growing monetarily, and has realized the importance of protecting surroundings.

In the industry sector, large plants together with high energy consumption tackled the issue by retrofitting method plants and features. Other industrial sectors resorted to investments with the shortest possible payback including heat recovery as well as reduction of loss (Petrecca, 1992). Furthermore, energy efficiency can be improved by three different approaches as follow:

- Energy savings by management.
- Energy saving by technologies.

- Energy saving by policies/regulations.

2.3 Energy Management

Energy management could be the strategy of getting together with energy demand when and where it really is needed. This can be carried out by adjusting along with optimizing energy utilizing systems and procedures so that you can reduce energy demands per unit involving output while holding constant or decreasing total costs involving producing the productivity from these techniques (US Bureau of Energy Efficiency, 2010). Energy management started to be considered one of the many functions of industrial management from the 1970s as the effect of the rising price of electricity and reports in regards to the approaching exhaustion connected with world energy resources (Petrecca, 1992).

These days, the role of energy management has greatly expanded in market sectors. Top management on the company participates throughout planning various power management projects regularly. The annual reports of the numerous companies should mention information of energy resource efficiency activities and various achievements because of the company regarding power conservation projects. To be effective, energy management programs will include four main pieces (Kannan et al., 2003). To begin with, analysis of previous data, then power audit and accounting, follow by executive analysis and investments proposals based on feasibility studies not only that personnel training in addition to information.

2.3.1 Objectives of Energy Management

The objectives of energy management are: To reduce energy costs/waste without affecting production and quality and also to minimize environmental side effects (US Bureau of Energy Efficiency, 2010).