UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS OF THE INFLUENCE FACTORS IN MODELLING THE ENERGY USE IN FACTORY 1, FTK USING STEPWISE MULTIPLE REGRESSION

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

By

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

…….

(Nor Hafizah binti Hussin)

ABSTRAK

Pada masa kini, masyarakat sangat memikirkan tentang tenaga dan penjimatan tenaga dalam bangunan. Antara faktor yang mempengaruhi penggunaan tenaga di Makmal 1, Fakulti Teknologi Kejuruteraan (FTK) adalah penggunaan penghawa dingin, peralatan makmal, suhu, lampu, dan lain-lain merupakan penyumbang kepada jumlah penggunaan elektrik di dalam bangunan. Oleh itu, kajian ini bertumpu kepada audit tenaga sistem untuk mengetahui faktor yang manakah lebih banyak menyumbang kepada jumlah penggunaan elektrik yang paling banyak di Makmal 1, Fakulti Teknologi Kejuruteraan (FTK). Di dalam kajian ini, bacaan kilowatt meter (kWh) di ambil pada hari Isnin hingga Ahad selama 60 hari. Pengambilan data diambil sekali dalam sehari. Matlamatnya untuk mengetahui hubungan diantara faktor yang mempengaruhi penggunaan tenaga dan bacaan kilowatt meter (kWh). Dengan menggunakan kaedah pekali korelasi untuk membina hubungan diantara faktor yang mempengaruhi penggunaan tenaga dengan bacaan kilowatt meter (kWh) sama ada positif atau negative korelasi. Seterusnya menganalisis data untuk mengetahui factor yang mempengaruhi penggunaan tenaga manakah lebih tinggi. Akhirnya, menggunakan factor yang lebih tinggi ini sebagai model faktor yang mempengaruhi penggunaan tenaga di Makmal 1, Fakulti Teknologi Kejuruteraan (FTK).

ABSTRACT

Nowadays, people are more concerned about energy consumption and conservations in building. The factors that affect energy consumption in Factory 1, Faculty of Engineering Technology UTeM) are used of air-conditioner, laboratory equipment, temperature, lighting and other which contributes the higher amount of electricity usage in a building. Thus, this study focused more on energy audit of lighting system at Factory 1, Faculty of Engineering Technology UTeM. In this analysis, the kilowatt meter (kWh) reading is taken on Monday to Sunday for sixty day. The data are taken once for every day. The aim is to know the relationship between the factor of energy consumption and the kilowatt meter (kWh) reading. By using the correlation coefficient to develop between the factor of energy consumption with kilowatt meter (kWh) reading which is positive or negative correlation. Next, analyze data to determine most factor of energy consumption. Finally, used the most factor of energy consumption to model the energy use in Factory 1, FTK using stepwise multiple regressions.

DEDICATION

To my beloved parents

My mother

Rosnani Binti Abdul Rahman

My Father

Ishak Bin Sahari

Siblings

Muhammad Imran Bin Ishak

Rashidah Binti Ishak

Muhammad Ammar Binti Ishak

Noor Atikah Binti Ishak

Khidhir Bin Ishak

For the prayers, support and encouragement.

Thank you very much.

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LIST ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

°C	-	Celsius
EUI	-	Energy use intensity
FTK	-	Faculty of Engineering Technology
HVAC	-	Heating, ventilation and air conditioning
JTKE	-	Department of Electrical Engineering Technology
JTKEK	-	Department of Electronic & Computer Engineering
JTKM	-	Department of Mechanical Engineering Technology
JTKP	-	Department of Manufacturing Engineering Technology
kW	-	Kilowatt
kWh	-	Kilowatt hour
UTeM	-	Universiti Teknikal Malaysia Melaka
W	-	Watt
Ω	-	Ohm

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter will describes the background of the project which explains about the energy efficiency, considered which factor affecting the energy used in FTK and multiple regressions. The objectives also included in this chapter. Then, the problem statement will be discussed. Finally, the result of the data collection in 60 days will be published in the last chapter. The structure of this report briefly describes the project as well as to ensure better visualization of the whole project.

1.1 Project Background

Energy efficiency is essential for some reasons which can reduce the cost of operation and management of electrical energy efficiently. This means that significant cost savings can be achieved by enhancing energy efficiency by constantly improving the equipment. In addition, lighting conditions are essential for each building as it can produce the perfect lighting for each room (Lu et al., 2010).

Although, the influence factors of the energy use such as equipments, temperatures, environments, occupants, lighting, air-conditioner and other based on the journal can be considered as the main factors affecting the energy in Factory 1, FTK. A successful energy management plan must start with energy accounting to

record and track the progress of energy efficiency programs. This paper have been discussed and only focus on the Factory 1, Faculty of Engineering Technology, UTeM which have several number of laboratories inside the Factory 1. There are 38 laboratories in Factory 1, FTK including 4 departments which is Department of Electrical Engineering Technology (JTKE) have 6 laboratories, Department of Electronic & Computer Engineering Technology (JTKEK) have 9 laboratories, Department of Manufacturing Engineering Technology (JTKP) have 14 laboratories, Department of Mechanical Engineering Technology (JTKM) have 5 laboratories and the rest are lecture room.

It is conducted for the purpose of identifying and analyzing the factors influencing the use of energy at the Factory 1, Faculty of Engineering Technology, UTeM which is the practice of energy efficiency programs at UTeM. The view of Factory 1, Faculty of Engineering Technology, UTeM is shown in Figure 1.1

Figure 1.1: The view of Factory 1, Faculty of Engineering Technology, UTeM

Data collection with kilowatt meter reading (kWh) has been done based on the influence factor of energy consumption and analyzing data to the most influential factors of energy used by using stepwise multiple regressions. Multiple regressions are an easy to follow regression (bi-variation). The purpose of multiple regression is to enable a researcher to assess the relationship between a dependent (predicted) variables and some independent variables (predictors). Finally, the result of multiple regression is the development of a regression equations (the most appropriate line) between dependent variables and some independent variables (Jane et al. n.d.).

In this analysis, the relationship between the factors developed and the result of multiple regressions is the development of a regression equation representing the use of energy use in Factory 1, FTK. Therefore, this project will analyze the factors affecting the electricity demand in Factory 1 and then develop the correlation which is the relationship between the factor and reading of kilowatts meter (kWh) by using correlation coefficient. Finally, to determine the most influencing factors of energy use by using the stepwise multiple regression and using the most influential factors to model energy use in the Factory 1, FTK.

1.2 Objectives

The main goals of this project is to determine the influence factors in modelling the energy used in Factory 1, FTK using stepwise multiple regression analysis.

The objectives of this analysis as follows:

1. To determine the influence factors of the energy used in Factory 1, FTK.
2. To develop the relationship between the factors and the kilowatt meter reading (kWh) using correlation coefficient.
3. To model the most influence factors of energy used in the Factory 1, FTK using stepwise multiple regressions.

1.3 Problem Statement

1.3.1 High electricity bill

The high electricity bill caused by the high energy consumption. Energy consumption depends on the usage of the energy which is lightings, laboratory equipments and other, where this factor can lead to high electricity bill. For example, fluorescent lamp that is currently used in lab is one of the high energy consuming lamps.

1.3.2 High energy consumption

Nowadays, energy consumption in Factory 1, FTK is a worrisome issue. The use of light even without occupant are one of the concern especially when there is no lab session. This condition leads to high energy consumption and high electricity bill.

1.4 Work Scope

This analysis will focus on factors affecting the use of energy at Factory 1, Technology Campus (FTK) using a stepwise multiple regressions. To analyze this situation, some models will be developed in the regression models. In FTK, there are several factors that influence the energy usage of temperatures, lightings, occupants and equipments. Using these factors, we will use the most influential factor selecting by analyzing the relationship between factor and reading of kilowatt meter (kWh). This project is divided by phase; in Phase 1, collecting kilowatt meters readings based on the influence factors of energy consumption. Phase 2 uses the correlation coefficient to develop the relationship between factor and reading kilowatt meters (kWh). Finally, Phase 3 uses Multiple Regression in this session of energy consumption model at Factory 1, FTK.

In phase 1, the work is done by taking a kilowatt meter reading and every factor of energy use in Factory 1, FTK. Kilowatt meters are taken 5 pm o'clock on Monday to Sunday include holiday for sixty days. Then the data is taken once for every day. The goal is to determine the relationship between factor and reading of kilowatt meters using correlation coefficients. Additionally, it also compares whether electrical readings are high or energy saving. Then, determine the most influential factor using stepwise multiple regressions.

In phase 2, the task is done by analyzing data using correlation coefficient to establish correlation which the relationship between factor and kilowatt meter reading (kWh) reading and correlation coefficient value will be used to determine the most influence between the factor and kWh reading. Then by using the result, we designed a scatter plot to show their relationship.

In Phase 3, the model of energy used in Factory 1, FTK is obtained by using Stepwise Multiple Regression where this method will select the most influencing factors to be incorporated into the model.

In addition, based on the past journal, we compare other factors of energy use in this analysis. For example, the energy consumption factor in this analysis is the temperatures, lightings, occupants and equipments, the equipment is higher using electricity consumption in the kilowatt meter readings compare to other factors of energy consumption, so the equipment is used factor influencing the model to model energy consumption in Factory 1, FTK.

1.5 Expected outcome

Data Collection for five day.

Day & Date	Actual Reading (kWh) in 1 hours	Lightings				Equipment					Occupants	Temperature
		Laboratory/Surau/Corridor	Quantity	Power (kW)	Total power (kw)	Laboratory	Type of Equipment	Power(kW)	Quantity	Total power (kW)		
		Corridor	502	0.036	18.072	Industrial Engineering & Quality Control	PC ARENA Simulation Software	0.18	10	1.8	20	29.5
		Surau	10	0.036	0.36	PLM Catia Studio	PC CATIA	0.18	20	3.6	20	
		5 laboratory use	350	0.036	12.6	Advanced Machining	CNC 5-Axis Milling Machine	39.95	1	39.95	2	
			862		31.032	Advanced Manufacturing & Studio CNC	EDM-Wire Cut	9.35	1	9.35	2	
Monday	8					Rapid Prototyping Laboratory & DFX Studio	Liquid Based Layer Manufacturing(large)	3.6	1	3.6	2	
18/4/2017							PC (HP Z620 workstation)	0.18	30	5.4	30	
							Projector	0.22	1	0.22		
								53.66		63.92	76	
		Corridor	502	0.036	18.072	Rapid Prototyping Laboratory &DFX Studio	PC (HP Z620 workstation)	0.18	30	5.4	30	32.5
		Surau	10	0.036	0.36	PLM Catia Studio	PC CATIA	0.18	30	5.4	30	
Tuesday		5 laboratory use	350	0.036	12.6	Industrial Engineering & Quality Control	Lecture Class	0	0	0	30	
19/4/2017	5		862		31.032	Programming Computer Laboratory 2	PC	0.18	20	3.6	30	
						SCL 2	Lecture class	0	0	0	30	
								0.54		14.4	150	
		Corridor	502	0.036	18.072	Pneumatic & Hydraulic	PC	0.18	10	1.8	20	28
		Surau	10	0.036	0.36		Pneumatic training set	3.73	2	7.46	8	
		4 laboratory use	280	0.036	10.08	PLM Catia Studio	PC CATIA	0.18	30	5.4	30	
Wednesday	6		792		28.512	Advanced Manufacturing & Studio CNC	EDM-Wire Cut	9.35	1	9.35	3	
20/4/2017						Advanced Machining	CNC Lathe	17.85	1	17.85	3	
							CNC Milling	14.45	1	14.45	3	
								45.74		56.31	67	
		Corridor	502	0.036	18.072	MACHINE MAINTENANCE LABORATORY	Pump and Valve System Trainer	4.3	1	4.3	10	28.5
		Surau	10	0.036	0.36		Compressor	2.2	1	2.2	10	
		5 laboratory use	350	0.036	12.6	DIAGNOSTIC & MACHINE VIBRATION	BASIC PUMP TRAINING SYSTEMS	0.9	3	2.7	15	
Thursday	7		862		31.032	Advanced Machining Laboratoty	CNC 9-Axis Mill/Turn Machine	51	1	51	5	
21/4/2017						SCL 2	Lecture class	0	0	0	30	
						HVAC Industrial Technology Laboratory	Lecture class	0	0	0	30	
								58.4		60.2	100	
		Corridor	502	0.036	18.072	Rapid Prototyping Laboratory & DFX Studio	PC (HP Z620 workstation)	0.18	30	5.4	30	30
		Surau	10	0.036	0.36	Advanced Forming Technology Laboratory	CNC Press Brake	11	1	11	3	
Friday		3 laboratory use	210	0.036	7.56	Plastics Technology Laboratory	Injection Molding Machine	1	1	1	2	
22/4/2017	5		722		25.992		Blow Molding Machine	9	1	9	2	
								21.18		26.4	37	

Table 1.5: Pre reading of influence factors the energy use in factory 1, FTK.

Based on previous reading (pre-reading) result, Monday has the highest watts for equipment, 63.92 kW and watts for lighting, 31.032 kW then the total kilowatt meter (kWh) reads 8 kWh. On Tuesday, having the lowest watts for equipment, 14.4 kW and watts for lighting, 31.032 kW then the total kilowatt meter (kWh) reads 5 kWh. Thus, on Monday watts for equipment is highest than Tuesday but the watts for lighting Tuesday and Monday are the same. Thats mean that on Tuesday the equipment did not use more than Monday for having a class lecture as the occupants were over 150 people.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will clarify about the influence factors of the energy use that related to the project. There are a few cases of influence factors which are temperatures, lightings, occupants and equipments in laboratory at Factory 1, FTK. The literature review for analysis of the influence factors is incorporated. When doing this project, this chapter is important part as reference source. From the past journals, reference books and websites is a sources which Factory 1, Faculty of Technology Electrical (FTK) is related the influence factors of the energy used.

2.1 Energy Consumption

In Malaysia, energy consumption has expanded dramatically. By optimizing the efficiency, it may also be decreased some energy consumption in an electrical system. The main contribution of energy consumption was from residential and industrial. In 2009, total energy consumption for business and accounted 13% for residential sector and 48% of electricity consumption in Malaysia. In this way, building energy consumption presents a significant part of the last numbers utilized by business and residential sectors. Energy performance of building's segment which is contrasted with some chose countries and evaluated to be measured. The primary use which is lighting and air conditioning are two the of electricity in each sector and

type of buildings all through the country and records for around 60% of national electricity consumption. For new local clients, the most of users connected are low-income earners, with low consumption, and little or no experience in the use of electricity. Energy consumption of a business building talks about the consumption standard of non-sustainable assets. Therefore, by directing a analysis on the energy consumption and the equipment load in the building is gathered for the analysis. To put forward there are few stages to improve energy efficiency.

2.2 Energy Efficiency

In according to (Review 2015) 76% of electricity use for the buildings sector accounts and 40% of all U. S. primary energy use and associated greenhouse gas (GHG) emissions, making it basic to reduce energy consumption in buildings in order to meet national energy and environmental challenges and to reduce costs to building owners and occupants. Opportunities for improved efficiency are tremendous. By 2030, building energy could be cut over 20% using technologies known to be cost effective today and by over 35% if look into objectives are mect? Much higher savings are technically possible.

To provide occupants with a comfortable, safe, and attractive living and work environment, should consider improving the performance of a complex system designed. This requires superior architecture and engineering designs, quality construction practices, and intelligent operation of the structures. Operations will be increasingly encompassing integration with sophisticated electric utility grids.

The total building energy, the main areas of energy use in buildings are heating, ventilation, and air conditioning is 35% then, lighting is 11% and the major appliances which is water heating, refrigerators and freezers, dryers is 18% with the balance is 36% electronics. In each case there is an opportunity to improve the performance of system components for examples improve the efficiency of lighting

devices and improve their way of control as a part of integrated building systems for example sensors that adjust light levels to occupancy and daylight.

2.3 The Influence Factors of energy use.

2.3.1 HVAC

According to (Anon 2008), HVAC stands for Heating, Ventilation and Air Conditioning (Cooling) system maintains a building's comfortable indoor climate through . This system greatly influences energy use in buildings. Without heating, cooling and ventilation systems there will be no energy consumption in the building, as it relief entirely on external conditions. There is an inverse correlation between the building efficiency and the need for HVAC systems that highly efficient building envelopes reduce the need for heating and cooling systems. Intelligent designed buildings also can reduce or even avoid the need for heating and cooling and reduce the need for ventilation.

2.3.2 Equipments

In 6% all building energy use computers and other electronic devices(Review 2015). Stated from 9 am to 6pm, is a present time or during other peak-periods (Chris et al., 2006). At Factory 1, FTK this is the time that students, workers, lecturers and other present at. During this time, electric appliances are widely used for work and classes such as computers, electric motors, projectors and other processes work smoothly to ensure learning and teaching.