UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MODELLING AND FORECASTING THE ELECTRICITY DEMAND IN ADMINISTRATION BUILDING AT TECHNOLOGY CAMPUS UTeM BY USING STATISTICAL ANALYSIS

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

by

NORSURIANA BINTI SHAMSUDDIN
B071310289
910703-06-5672

FACULTY OF ENGINEERING TECHNOLOGY
2016

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK **MODELLING AND FORECASTING THE ELECTRICITY DEMAND IN ADMINISTRATION BUILDING AT TECHNOLOGY CAMPUS UTeM BY USING STATISTICAL ANALYSIS**

SESI PENGAJIAN: **2016/2017 Semester 1**

Saya **NORSURIANA BINTI SHAMSUDDIN**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	TIDAK TERHAD	

Disahkan oleh:

_____ _____

Alamat Tetap:

No. 185 Blok 2 Felda Keratong 6,

26700 Muadzam Shah,

Pahang.

Cop Rasmi:

Tarikh: _____

Tarikh: _____

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled "Modelling and Forecasting the Electricity Demand in Administration Building at Technology Campus UTeM by Using Statistical Analysis" is the results of my own research except as cited in references.

Signature : **…….....**

Name : **NORSURIANA BINTI SHAMSUDDIN**

Date : **…….....**

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Industrial Automation & Robotics) (Hons.). The member of the supervisory is as follow:

…….

(PN. NOR HAFIZAH BINTI HUSSIN)

ABSTRAK

Dalam kertas ini, satu elemen penting dalam perancangan sumber utiliti elektrik adalah ramalan penggunaan elektrik tahunan bagi jangka masa pendek. Kajian ini merangkumi pendekatan untuk menentukan model permintaan elektrik dan ramalan penggunaan elektrik pada masa hadapan dengan menggunakan ARIMA bagi Bangunan Pentadbiran di Kampus Teknologi Universiti Teknikal Malaysia Melaka (UTeM). Proses kajian adalah untuk memilih model yang terbaik dengan menggunakan analisis statistik dan mengujinya dengan menggunakan data dari meter kilowatt untuk memahami ketepatan data dan penggunaan elektrik di Bangunan Pentadbiran Kampus Teknologi UTeM. Selepas memperolehi model yang terbaik, ramalan permintaan elektrik akan dilaksanakan. Model terbaik telah dipilih dengan menggunakan nilai terendah *Akaike's Information Criterion* (AIC) dan hasilnya adalah untuk Bangunan Pentadbiran Fakulti Teknologi Kejuruteraan (FTK) adalah model ARIMA (1,1,1) manakala bagi Bangunan Pentadbiran di Fakulti Kejuruteraan Mekanikal (FKM) adalah model ARIMA (2,1,2). Senario ini dibangunkan dengan cara bagaimana pembolehubah akan ditukar dalam masa yang berikut. Model ini menghasilkan keputusan yang sangat memuaskan dan purata penggunaan elektrik untuk 20 hari akan datang diperolehi.

ABSTRACT

In this paper, an essential element of electric utility resource planning is forecasting the annual electricity consumption for the short term. This study includes an approach to determine the model of electricity demand and forecast future electricity consumption, by using ARIMA for Administration Building at Technology Campus Universiti Teknikal Malaysia Melaka (UTeM). The process of study is to select the best model using statistical analysis and testing it by using data from kilowatt meter to understand its accuracy. After obtaining the most reliable model, forecasting the electricity demand is performed. The best model was selected using lowest value of Akaike's Information Criterion (AIC) and the result is for Administration Building in Faculty of Engineering Technology (FTK) is model ARIMA (1,1,1) while for Administration Building in Faculty of Mechanical Engineering (FKM) is model ARIMA (2,1,2). The scenario is developed by means of how the variable is going to be changed in the following time. The model yields very satisfactory result and the range of electricity consumption in 20 days ahead are obtained.

DEDICATION

A special appreciation, I dedicate this thesis to my father Shamsuddin Bin Salleh, my mother Che Yam Binti Che Hussain and all.

ACKNOWLEDGEMENT

Alhamdulillah, I would like to thanks to Allah S.W.T, the Most Merciful, and all praises to Allah for His blessing in completing this thesis. Special appreciation to my supervisor, Pn. Nor Hafizah Binti Hussin for supervised and guiding me throughout the experimental and thesis works.

I would like to express my appreciation to my co-supervisor, Pn Siti Nur Suhaila Binti Mirin, all the technicians and maintenances that help towards my study. Sincere thanks to my beloved family and friends for their moral support and kindness. I also would like to acknowledge the support of the Faculty of Engineering Technology (FTK), Universiti Teknikal Malaysia Melaka (UTeM). Unforgotten to those who directly or indirectly contributed in this research.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

STLF	-	Short-Term Load Forecasting
MTLF	-	Medium-Term Load Forecasting
LTLF	-	Long-Term Lad Forecasting
ARIMA	-	Autoregressive Integrated Moving Average
UTeM	-	Universiti Teknikal Malaysia Melaka
FTK	-	Faculty of Engineering Technology
FKM	-	Faculty of Mechanical Engineering
ISO	-	Independent System Operators
KWh	-	Kilowatt per Hour
GWh	-	Gigawatt per Hour
TNB	-	Tenaga NAsional Berhad
SESB	-	Sabah Electricity Sdn Bhd
ICPT	-	Imbalance Cost Pass-Through
AR	-	Autoregressive
ARMA	-	Autoregressive Moving Average
ANN	-	Artificial Neural Network
ACF	-	Autocorrelation Function
PACF	-	Partial Autocorrelation Function
AIC	-	Akaike's Information Criterion
MSE	-	Mean Square Error
RMSE	-	Root Mean Square Error
MAPE	-	Mean Absolute Percentage Error

CHAPTER 1
INTRODUCTION

1.0 INTRODUCTION

Forecasting electricity demand is a key undertaking for the arranging of power system and effective operation. Electricity demand forecasting is concerned with the expectation of hourly, day by day, week by week and yearly estimations of the peak demand and system demand. Forecast have three categorized that is short-term load forecasting (STLF), medium-term load forecasting (MTLF), and long-term load forecasting (LTLF) depending upon a time horizon.

1.1 PROJECT BACKGROUND

Monetary development in a nation that is firmly related with the availability of the energy. In socio-economic development, power is the most adaptable type of energy that is one of the essential infrastructure input. Demand for power has been becoming consistently due to increased commercialization and industrialization. Since power can't be put away and there is a large variation in supply and demand, by the accurate forecast electricity demand is crucial. This allows strategy makers to devise for financially savvy venture, working of existing and new power plants to provide enough electricity to take care without bounds power demand and its varieties.

Load forecasting assists electric utilities to settle on vital choices, including the choice to purchase and produce electric power, load exchanging, and infrastructure development. The subject of load determining has been around for quite a long time to predict or estimate future demand.

This some portion of research work is essential to determine the model of electricity demand for Administration Building at Technology Campus Universiti Teknikal Malaysia Melaka (UTeM) using statistical analysis. The best model will be selected to forecast the future electric demand. Autoregressive Integrated Moving Average (ARIMA) model is used to select the best model. Time series forecasting is an essential region in which observations and figures of similar factors were gathered and analyzed to build up a model that describes the fundamental relationship. One of the time-series model that is the most imperative and generally utilized model is the autoregressive integrated moving average (ARIMA). ARIMA model's popularity is because of its measurable also known in Box-Jenkins technique in the model building process. The ARIMA model is very adaptable in that they can represent some kind of time series.

Time series forecasting technique is developed and is generally used to forecast future demand. A time series for the most part contain a mainstream incline, occasional varieties, patterned developments and unpredictable components. Time series forecasting is a procedure that predict what will happen in future if the pattern don't change. Univariate analysis of time-series variables merges with historical data pertaining to building model that describe the behavior of these variables (time series) and permits to make attractive figure for what's to come. To make predictions more substantial and delicate to different factors that impact yearly power demand, forecast by statistical time series analysis is required. At the end of this project, I'm expecting to modelling the data using ARIMA and forecasting the electricity demand in Administration Building at Technology Campus UTeM. The best model that selected by using statistical analysis able help users to use to forecast the future electric demand.

1.2 OBJECTIVES

This project is a study to modelling and forecasting the electricity demand in Administration Building at Technology Campus Universiti Teknikal Malaysia Melaka (UTeM) by using statistical analysis. Data on kilowatt meter will be taken every Monday until Friday to complete this project. The objectives of this project are as follows,

1. To study electricity demand for Administration Building at Technology Campus Universiti Teknikal Malaysia Melaka (UTeM)

2. To select the best model using statistical analysis.

3. To forecast the future electricity load demand.

1.3 PROBLEM STATEMENT

Power assumes an increasingly important part in our lives and in the economy that encourages us. The main objective when creating electricity regulators of the electricity market is to reduce electricity costs through competition. Power demand forecast is considered as one of the basic variables for economic operation of power system load forecasting accurately holds the potential for huge saving for electric utility partnerships. The most extreme saving can be accomplished when the load forecast is utilized to control the operations and the aftereffect of such unit duty and fuel allocation, financial dispatch and on-line network analysis. Be that as it may, this situation can't be accomplished without the full cooperation of power demand.

Nowadays, we know that the Administration Building at Faculty of Mechanical Engineering (FKM) & Faculty of Engineering Technology (FTK) is currently undergoing upgrading of electricity saving by reducing the opening of the air conditioner operates 15 hours/day to 10 hours/day. Electricity consumption for too long also can cause environmental impact towards of global warming. Since we demand more power, we should avoid from increasing harm to our surroundings by using energy efficiently and to get power from the cleanest source accessible.

1.4 PROJECT SCOPE

In this project, the first thing to focus is to study electricity demand in the Administration Building at Technology Campus. Data on kilowatt meter will be taken every day for at the Administration Building to find out how many users have been using electricity every day. The data will be taken the same time every day for 60 days. After completing the data collection, the next process in this project is to model the electricity load demand in Technology Campus.

The second thing to focus is to select the best model. The best model will be selected using statistical analysis. The project has been trying to predict the short-term power demand for Administration Building Campus Technology in Universiti Teknikal Malaysia, Melaka, a developing country that lies between 2°11'45.60" latitudes (northern) and between 102°14'25.8" longitude (east), type tropical atmosphere with temperature variety between 24°- 32° Celsius consistently and normal yearly of 3540mm, by using multivariate time series so that all the key variables that influence the nation's power demand can be considered.

Time series forecasting is a critical territory in which observation and forecast of similar variables were gathered and analyzed to build up a model that describes the fundamental relationship. Autoregressive integrated moving average (ARIMA) model is a standout among the most popular in linear time series forecasting in most recent three decades. This project is concerned with the short-term load forecasting (STLF) in power system operations. Throughout this project, the term "short" time imagining hour forecast command. The basic quantity of interest in STLF is usually amount of load per hour integrated system. Finally, after the best model has been selected, the electricity load demand will forecast for the future.

CHAPTER 2
LITERATURE REVIEW

2.0 INTRODUCTION

In chapter two, the literature review is a content of a logical, which incorporates current learning including substantive discoveries, and commitments to the hypothesis of a specific subject. This chapter consists of market that demands the electrical load, type of load forecasting, short-term price forecasts, long term price forecasts, medium-term price forecasts, factors of load demand, electricity rates, and statistic review for load demand such as AR, ARMA, ARIMA, ANN and ARAR.

2.1 MARKET OF ELECTRICITY LOAD DEMAND

Development of the electricity market is based on the premise that electrical energy can be considered as a commodity. In addition, this assumption cannot be denied; Electrical energy is well differentiated that can be traded in large quantities because it is easily measured. If the industrial, residential and commercial users pay a flat rate for each kilowatt hour of electricity consumed, they are insulated from the price of electricity and their sport to be affected only by cyclical demand their activities (Kirschen D.S, 2003). Nowadays, many Independent System Operators (ISO) has developed DR Programs with a view to changing consumer demand superpower. In addition, some ISO promotes the likelihood of total demand through

commercializing substances to accomplish a base level of state demand for consumer participation. The problem now is how to track spending, most effective way to reach the minimum change in the level of demand for energy comply with the reduction in short-term market with quick response (Guillamon A, et al, 2009).

Energy is the establishment that backings the improvement of socio-economic of a nation. Sustainable advancement is impractical without sustainable sources of energy and improvement is unrealistic without energy. Subsequently making arrangement for future energy demand is essential. Different nations may have different methodologies in arranging their future energy demand. In additional, future energy demand is constantly impacted by different factors for example energy approach is not population growth, energy prices, economic growth and the use of innovative advances (Tan C.S, et al, 2016). At the worldwide level, the most central relationship in GDP stay hearty, more individual with more income implies that the creation and use of energy will increase as appeared in Figure 2.1.

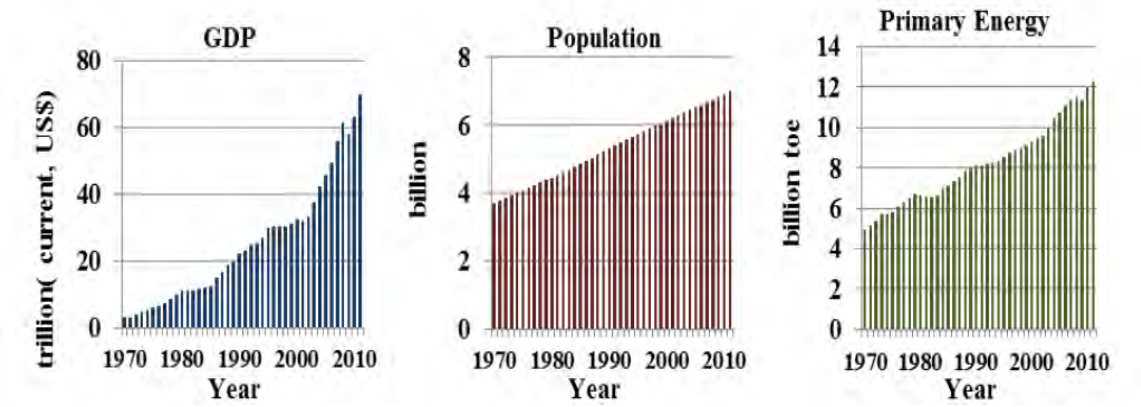

Figure 2.1: Relationship between economic activity (GDP), population, and primary energy demand between 1970 until 2010 (source: *electricity energy outlook in Malaysia*, Tan C.S, et al, 2016)

Electricity is the primary information and requirements for improvement, automation, financial development and modernization. Therefore, worldwide interest for power is increasing quickly and this concern is tended to globally to fill the demand for power for world's future. Figure 2.2 demonstrates the power demand of the world market. World demand for power expanded from 145 billion MW in 2007 to 218 billion MW in 2035 (i.e. an increments of 49 %) (Hasanuzzaman. M., et al, 2012).

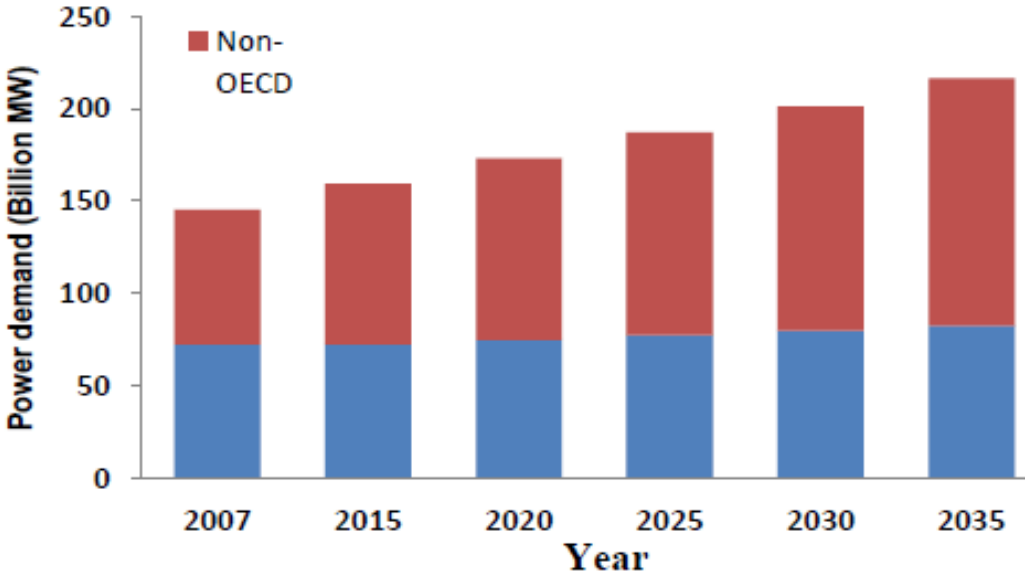

Figure 2.2: World Marketed Power Demand (source: energy situation in Malaysia: presents and its future, Rahim N.A, et al, 2012)

Industrial sector uses more than 33% of aggregate world energy consumption. It additionally predicts that the share of electricity utilization in this sector will increment later on. Load demand increases because of expended economic activity and equipment in the industrial sector. Along these lines, it is an essential undertaking to analyze and forecast electricity consumption in the industrial sector for the future. Malaysia is one of rapid economic development and the industrialized nations. Figure 2.3 represent the general power demand in Malaysia. Because of fast industrialization, the general power

demand from 1990 to 2009 in Malaysia expanded roughly three times from 1990 to 2009 (NEBM, 2009).

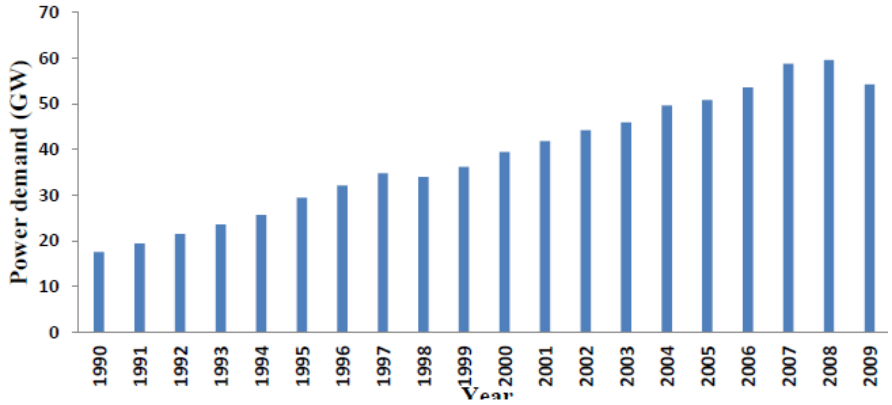

Figure 2.3: Overall Power Demand in Malaysia (source: energy situation in Malaysia: presents and its future, Rahim N.A, 2012)

The one of the significant energy consumers in Malaysia is industrial sector. Industrial power demand in 1990-2009 is shown in Figure 2.4. The rate of increase of power demand of the industrial sector is much higher than the overall rate of growing demand in Malaysia between 1990 and 2009 (NEBM, 2009).

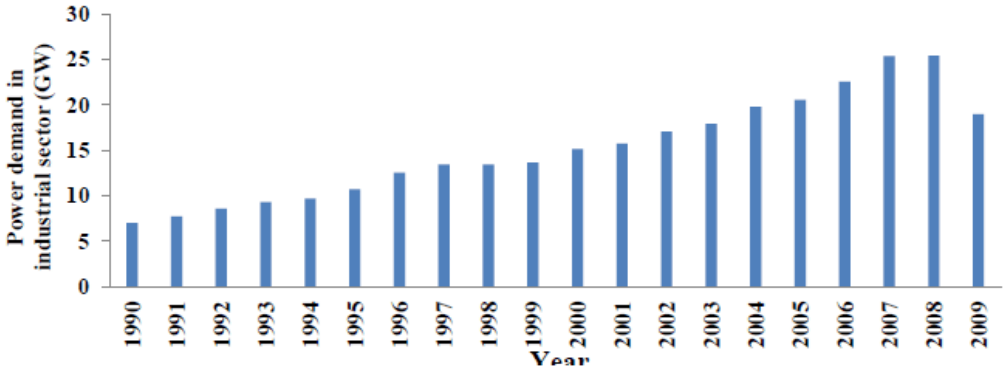

Figure 2.4: Power Demand in Industrial Sector in Malaysia (source: energy situation in Malaysia: presents and its future, Rahim N.A, 2012)