CENTRALIZED AIR CONDITIONING SYSTEM COEFFICIENT OF PERFORMANCE OF OFFICE BUILDING

SHAHRULDIN BIN OTHMAN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CENTRALIZED AIR CONDITIONING SYSTEM COEFFICIENT OF PERFORMANCE OF OFFICE BUILDING

SHAHRULDIN BIN OTHMAN

**A report submitted
in fulfilment of the requirements for the degree of
Bachelor of Mechanical Engineering (BMCG)**

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2020

SUPERVISOR'S DECLARATION

I declared that this project entitled "Centralized Air Conditioning System Coefficient of Performance of Office Building" is the result of my own work except as cited in references.

Signature   : ....

Name   : ....

Date   : ....

DECLARATION

I hereby declared that I have read this project report and in my opinion this report is

sufficient in terms of scope and quality for the award of the degree of Bachelor of

Mechanical Engineering (Maintenance)

Signature   : ....

Name   : ....

Date   : ....

DEDICATION

I would like to devote my thesis to my beloved parents and siblings who have

given me constant support, love, motivation, and day-and-night prayers in

completing this project.

ABSTRACT

The general aim is to study the pattern of energy consumption of a building by relying on the Internet of Thing (IoT) method available and the effect of Coefficient of Performance (COP) to energy consumption. According to the literature review, the heating ventilation air conditioning (HVAC) system in a building contribute to almost 60 percent of energy consumption usage in a building. Growing concern over the HCAV system effect has initiated the pursuing energy-efficient in Universiti Teknikal Malaysia Melaka (UTeM) with energy policies implementation. The result of energy consumption has been obtained for six (6) month to identify the pattern and the maximum demand usage. The highest energy consumption recorded in November 2019 is 110808.59 kWh with maximum demand 357.33 kW while for the highest maximum demand is recorded in September with 368.06 kW at 89313.75 kWh energy consumption. The coefficient of performance (COP) in the chiller shows the maximum in 22/8/2019 at 4.7 with energy consumption of 3733 kWh. On top of that, for the highest energy consumption is on 22/8/2019 with 4878.87 kWh of energy consumption. Besides, the increment of 1.6 COP can save 23.49 percent of the energy consumption of the building. The study concludes that the Internet of Thing (IoT) method achieved the desired state in collecting and presenting the pattern of the energy consumption at the building. Finally, the relationship has been resolute where the coefficient of performance (COP) of the chiller is inversely proportional to the energy consumption. Hence, the research confirms that the coefficient of performance (COP) affect energy consumption significantly as concluded.

ABSTRAK

Tujuan utama kajian adalah untuk mengkaji corak penggunaan tenaga bangunan dengan bergantung pada kaedah Internet (IoT) Perkara yang ada dan keupayaan pekali prestasi (COP) dalam mempengaruhi penggunaan tenaga. Menurut tinjauan kajian, sistem penghawa dingin pengudaraan pemanasan (HVAC) di sesebuah bangunan menyumbang hampir 60 peratus penggunaan tenaga di sesebuah bangunan. Keprihatinan yang semakin meningkat terhadap kesan sistem penghawa dingin pengudaraan pemanasan (HVAC) telah menyuntik usaha penjimatan tenaga di Universiti Teknikal Malaysia Melaka (UTeM) dengan perlaksanaan dasar tenaga. Hasil penggunaan tenaga telah diperoleh selama enam (6) bulan untuk mengenal pasti pola dan penggunaan permintaan maksimum. Penggunaan tenaga tertinggi yang dicatatkan pada bulan November 2019 adalah 110808.59 kWh dengan permintaan maksimum 357.33 kW sementara untuk permintaan maksimum tertinggi pula dicatatkan pada bulan September dengan 368.06 kW pada 89313.75 kWh penggunaan tenaga. Pekali prestasi (COP) dalam penyejuk udara menunjukkan maksimum pada 22/8/2019 iaitu 4.7 dengan penggunaan tenaga 3733 kWh. Selain itu, untuk penggunaan tenaga tertinggi adalah pada 22/8/2019 dengan 4878.87 kWh penggunaan tenaga. Selain itu, kenaikan 1.6 COP dapat menjimatkan 23.49 peratus penggunaan tenaga bangunan Kajian ini menyimpulkan bahawa kaedah internet perkara (IoT) mencapai keadaan yang diinginkan dalam mengumpulkan dan menyajikan corak penggunaan tenaga di bangunan. Akhir sekali, hubungan pekali prestasi (COP) penyejuk berbanding adalah berkadar songsang dengan penggunaan tenaga telah dapat dibuktikan. Oleh itu, penyelidikan ini dapat mengesahkan bahawa pekali prestasi (COP) sangat mempengaruhi penggunaan tenaga seperti yang disimpulkan.

ACKNOWLEDGEMENTS

First and foremost, I would like to take this opportunity to express my sincere acknowledgement to my supervisor Associate Professor Dr Musthafah Bin Mohd Tahir from the Faculty of Manufacturing Engineering Universiti Teknikal Malaysia Melaka (UTeM) for her essential supervision, support, and encouragement towards the completion of this project report.

I would also like to express my greatest gratitude to Pn Mawarni, and all staff from Office of Occupational Safety and Environmental Sustainability Universiti Teknikal Malaysia Melaka (UTeM) for their contribution for helping me to obtain the required data of energy consumption.

Mainly, I would also like to express my deepest gratitude to the technician from the Development Office Universiti Teknikal Malaysia Melaka (UTeM) for their assistance and efforts to set the device and equipment at chiller room to get the data.

Special thanks to all my peers, especially Muhammad Al Junaidi, my beloved mother and father and siblings, for their moral support in completing this degree. Lastly, thank you to everyone who had been to the crucial parts of the realization of this project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

LIST OF FIGURES

LIST OF ABBREVIATION

AHU   - Air Handling Unit

CHWS   - Chilled Water Supply

CHWR   - Chilled Water Return

CO2   - Carbon Dioxide

CoP   - Coefficient of Performance

CSE   - Centre of Sustainability and Environment

DP   - Dew Point

FCU   - Fan Coil Unit

GDP   - Gross Domestic Product

GFA   - Gross Floor Area

GGP   - Government Green Procurement

GHG   - Green House Gas

HVAC   - Heating Ventilation and Air-Conditioning

IAQ   - Indoor Air Quality

IoT   - Internet of Things

IU   - Induction Unit

KUTKM   - Kolej Universiti Teknikal Kebangsaan Malaysia

MSB   - Main Switch Board

PKA   - Pusat Kelestarian Alam Sekitar

RH   - Relative Humidity

TNB   - Tenaga Nasional Berhad

UTeM   - Universiti Teknikal Malaysia Melaka

WB   - Temperature of Wet Bulb

LIST OF SYMBOLS

Q - Chilled Water Flow Rate (m^3/s)

C_p - Specific Heat Water (4/18 kJ/kg.K)

ΔT - Temperature Different (K)

%   - Percent

LIST OF UNITS

kW   - Kilowatt

kWr   - Total Rejected Heat Load

kWe   - Total Electric Load

kWh   - Kilowatt Hour

°C   - Temperature

m^3/hr   - Flow rate

CHAPTER 1

INTRODUCTION

1.0   Project Background

Earth's natural capital is diminishing as a consequence of population growth and increased wealth due to constant and unregulated anthropic resource consumption. An asset such as raw materials, biomass, fuels, and water is drained at a level that exceeds the ability of the planet to replenish them. Higher pollution levels, Green House Gasses (GHG) emissions, waste generation and land degradation, are among the significant impacts of the increased resource consumption (Dixit, M. K., 2013). There are a lot of studies that characterize the relationship between energy consumption and the environment, economic growth, and the environment. The extensive use of natural resources would increase the level of emissions of carbon dioxide (CO_2) that degrade the environment (Banday et al., 2019).

To resolve the phenomenon, Malaysia's government is aware of its position in formulating its national energy management policies which are either environmentally sensitive or energy resource sustainability (Azlina et al., 2012). Sustainability is becoming a key element in achieving green development. Malaysia needs to develop the right policies and regulatory frameworks to expedite these sustainable projects. Hence, Malaysia has also moved to the energy efficiency route by initiating its 2030 sustainability goal of reducing 25% of gross electricity usage from the construction sector, whereas committing to minimize up to 40% of CO_2 emissions per Gross Domestic Product (GDP) by 2020 (SURUHANJAYA TENAGA ENERGY COMMISSION, 2017).

1

The overall energy efficiency of institutional buildings is mostly determined by its existing systems and components, in particular, the mechanical system, the lighting system and the building envelope. For mechanical components that mainly consists of Heating Ventilation and Air Conditioning (HVAC) system, they are known as the most energy-consuming equipment in a building. So, an appropriate HVAC system ranges and services can achieve 25% savings and give indoor comfort as well. There are two possible methods to be used, namely as passive and active methods, to reduce HVAC power. The passive method involves replacing windows, enhancing natural ventilation, and increasing airtightness. While for the active method, it involves boiler upgrade and enhancement, installation of variable frequency drives, and programmable system thermostat (Abidin et al., 2017)

Electricity production is responsible for the massive contributions of Green House Gas (GHG) emission levels in Malaysia. (Babatunde et al., 2018). Regarding this dimension, Universiti Teknikal Malaysia Melaka (UTeM) has been embroiled in decreasing their electricity consumption gradually. One of the main initiatives is the introduction of the Energy Audit Conditional Grant Program, which aims at raising awareness, offering financing aid, attracting financial institutions and building capacity for audited building and energy service companies through a 3-year program from 2016 to 2018 (Hafiz et al., 2018). The load apportions in a building play the leading role of a contributor to electric usage.

1.1 Problem Statement

University Teknikal Malaysia Melaka (UTeM) is one of a well-known university in Malaysia which focus on the engineering courses with several campuses, office, and buildings. For this whole field, electrical energy consumption is quite rigid in comparison with the vast area of coverage of energy demand. The energy consumption for the entire UTeM is very critical which had burst into 1,727,495 kilowatts hour in October 2018 which the maximum among the five (5) months from July to December 2018 to make the energy management is critically important to be implemented (Centre of Sustainability and Environment UTeM, 2018). For several years back, the Internet of Things (IoT) has been remarkably used to monitor, collect, and record the data of energy consumption as a replacement to the ancient manual ways which quite vague and misleading. Water consumption, where peoples most likely did not realize that consumables of water need electricity. The process of extracting raw water to be daily consumed and the distribution of water from places to places somehow need an electrically operated machine to work.

Lastly, the problem is about maintaining the building's air conditioning at top performance to maintain the building's ambient temperature while holding the temperature for staff and students to comply. The allocation of the load between the electrical equipment in the building must be aimed at minimizing the total demand for electricity in the same way as reducing the use of energy consumption.

1.2   Objectives

Regarding the Control Movement Order, which started on 18 March 2020, I have some difficulty in collecting the chiller data at Chancellary as all the experiment will be conducted have to be stop and postponed in future. Because of this pandemic issues, my supervisor and I had discussed to change the location and objective of my research from Chancellery building to Laman Hikmah building.

The objectives of this project are as follow:

1. To analyze the Laman Hikmah UTeM building energy consumption using Internet of Things (IOT) energy management method.

2. To analyze the effect of Coefficient of Performance (COP) to energy consumption.

1.3   Scope of Work

1. This analysis focus on the energy consumption in Laman Hikmah buildings.

2. Analyzing how the air conditioning (Chiller) Coefficient of Performance (COP) affect the energy consumption using Internet of Thing (IoT) method.

1.4   Organization of Report

This report consists of three (3) chapters which explained in the related field study in this project. In chapter 1, the introduction will focus on the description of the introduction of this study onto this project. Besides, it also contains the problem statement, the scope of work, and objective of work for this project. In chapter 2, the literature review will focus on the study of the related issues in this project. From the literature review, the problem occurred, and the outcomes of the project in term of analysis and data improvement will be cover in detailed.

Furthermore, in chapter 3, the methodology shows the device and equipment used and how the data is obtained from the set-up experiment to achieve the stated objectives. Next, chapter 4 will focus on the analysis of the collected data and discussion on the reason why it occurs. Finally, in the last chapter, will conclude all the outcome of the result obtained and state the conclusion and recommendation on future work.

5