UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS OF WIND SPEED DATA AND WIND ENERGY POTENTIAL IN MELAKA USING WEIBULL DISTRIBUTION

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

AINUN NAJIHA BINTI GHAZALLI

B071510262

950706-04-5462

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY

2018

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: Analysis of wind speed data and wind energy potential in Melaka using Weibull distribution

Sesi Pengajian: 2018/2019

Saya **AINUN NAJIHA BINTI GHAZALLI** 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 (X)

☐ 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

Yang benar,

.....

AINUN NAJIHA BINTI GHAZALLI

Alamat Tetap:

NO 818-2, Lorong Imam Hj Adam, Kg Ayer Molek, 75460, Melaka.

Tarikh:

Disahkan oleh penyelia:

.....

PN.NOR HAFIZAH BINTI HUSSIN

Cop Rasmi Penyelia

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

DECLARATION

I hereby, declared this report entitled Analysis of wind speed data and wind energy potential in Melaka using Weibull distribution is the results of my own research except as cited in references.

Signature: ……

Author : AINUN NAJIHA BINTI GHAZALLI

Date:

APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (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:

Signature: …….

Supervisor : PN.NOR HAFIZAH BINTI HUSSIN

ABSTRAK

Tenaga digunakan untuk memudahkan kerja harian and keselesaan semua. Terdapat pelbagai jenis, contohnya tenaga solar, biomass, hydro dan lain- lain. Walaupun terdapat pelbagai jenis tenaga tetapi tenaga yang diperlukan sebenarnya ialah tenaga yang bersih dan boleh diperbaharui. Oleh yang demikian, satu idea telah tercetus untuk mebuat kajian tentang analisa statistikal tentang ciri-ciri tenaga angin dan keupayaan tenaga angin menggunakan taburan Weibull. Kajian ini dilakukan kerana tenaga pada masa ini semakin berkurang kerana populasi yang semakin meningkat. Kajian ini bertujuan untuk mengetahui samada tenaga angin sesuai untuk dibina di Melaka dan menghalang perkara yang tidak diingini dari berlaku pada masa hadapan. Terdapat tiga objektif untuk kajian ini iaitu untuk mengetahui ciri-ciri angin dan keupayaan angin, untuk menganalisa ciri angin di Melaka menggunakan Weibull distribution, untuk menentukan keupayaan angin menggunakan aplikasi Minitab. Cara yang akan digunakan dalam kajian ini ialah kaedah grafik, hasilnya di nilai melalui parameter "c" dan "k" iaitu bentuk dan skala taburan Weibull. Kesimpulannnya, Melaka mempunyai potensi untuk mendirikan tenaga angin berskala kecil di dalamnya.

ABSTRACT

The energy is used to make our daily life easier and comfort. There are many types of energy such as solar, biomass, hydro and etc. Even though, there are many types of energy but what the world needed most is actually renewable energy which is clean and can be renew. Thus from this statement, one idea is produced to make a research about statistical analysis of wind energy characteristics and wind energy in Melaka using Weibull distribution. This research is due to nowadays the energy is become more limited as increase the population, to find out if wind energy is suitable to develop in Melaka and to prevent bad scenarios from happening in the future. These research has three objectives which are to study the wind characteristics and wind energy potential, to analyze the energy characteristics in Melaka using Weibull Distribution and to determine the wind energy potential using Minitab software. The method that will used for this research graphical method, the results are evaluate through c and k parameter which is shape and scale of Weibull distribution In conclusions, Melaka has the potential to develop small scale of wind energy farm in it.

DEDICATION

I would like to dedicate this research to my beloved supervisor, Madam Nor Hafizah Binti Hussin who give extra knowledge to assist me in this research, and also thanks my beloved parents for supporting me in this project.

ACKNOWLEDGEMENTS

I am highly indebted to Madam Nor Hafizah Binti Hussin for her guidance and constant supervision as well as for providing necessary information regarding the project and also for her support in completing this research. I would like to express my gratitude towards my parents, family members, and friend for their kind co-operation and encouragement which help me in completion of this research. My thanks and appreciations also go to my colleague who are willingly helped me out with their abilities

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

v	-	Speed of wind
k	-	Shape parameter
c	-	Scale parameter
CO_2	-	Carbon dioxide
P	-	Power
ρ	-	Density of air (1.25 kg / m^3)
C_p	-	Power coefficient
A	-	Rotor swept area
U	-	Wind speed
F(v)	-	Probability of occurrence
σ	-	Standard deviation
Ƭ	-	Gamma function
E_{pf}	-	Energy pattern factor
Mtoe	-	Million Tons of Oil Equivalent
m	-	metre
W/m^2	-	Watts per metre square
kWh/m^2	-	Kilowatts hours per metre square
m/s	-	Metre per second
MW	-	Megawatts
kW	-	Kilowatts

LIST OF ABBREVIATIONS

PCA	Principal Component Analysis
EWEA	European Wind Energy Association
EML	Empirical Method of Lysen
PDM	Power Density Method
SDM	Standard Deviation Method
WECS	Wind Energy Conversion System
AGL	Above Ground Level
WAsP	Wind Atlas Analysis and Application Program
RMSE	Root Mean Square Error
LiDAR	Light Detection and Ranging
PSO	Particle Swarm Optimization
BRNER	Brazilian Northeast Region
PA	Paris Agreement
GHG	Greenhouse Gas
COP	Conference of Parties
NRE	Minister of Water, Land and Natural Resources
AD-Value	Anderson-Darling goodness-fit-statistic

CHAPTER 1

INTRODUCTION

1.1 Background

In this day, energy is very important in this era of technology. The energy commonly used to make our daily life easier and comfort. There are many types of energy such as solar, biomass, hydro and etc. Although there are many types of energy, the energy that nationwide main focused is fossil fuels. However, in long time the fossil fuels give bad effect to the world such as greenhouse effect and global warming. This is because the fossil fuels release carbon dioxide when it burns. One of fossil fuel example is coal. As the coal burns, it release most carbon dioxide and sulphur dioxide which then cause breathing problems to human and acid rain. Soon, this fossil fuels will be run out as it limited and non-renewable.

Thus, it is important to find other renewable energy which has less emissions or none. Wind energy is suitable to be considered due to zero emissions and renewable energy. Nowadays, energy demand is increasing along with the population, therefore, renewable energy is considered great alternatives since air is clean energy source. As a matter of fact, wind energy is mainly used in two sector which is electricity generation and water pumping.

1.2 Project Objective

Development Statistical Analysis of Wind Energy Characteristics and Wind Energy Potential in Melaka using Weibull Distribution based on objectives such as the following:

i. To study the wind characteristics and wind energy potential.
ii. To analyse the energy characteristics in Melaka using Weibull Distribution.
iii. To determine the wind energy potential using Minitab software.

1.3 Problem Statement

Nowadays, energy such as fossil fuels, coal become more and more limited. A great deal of demand need to be fulfilled as it important in daily life. In any cases, if the energy runs out, this will causes chaos as most of the technology right now is still using the same energy such as fossil fuels for example transportation. Along these lines, this project help to identify the wind characteristics and which area that has most high wind energy potential in Melaka using Weibull Distribution. As for Melaka which is known as City of Green technology, this project help to analyses data to know if it suitable for develop wind energy in certain area in Melaka.

Aside from that, there are still some energy cannot be renew or obtain by free such as fossil fuels. Years by years, energy demand of mankind increasing with no doubt since the globalization. The part need to take concern of that too much use of fossil fuel will release a great amount of greenhouse gases. These gasses will give effect to global temperature to increase which led other bad scenarios such as hurricane, extinction of

species and etc. As a matter of fact, the ice in north poles to melts and then causes the water sea level increases and this is dangerous to all mankind. To keep the bad scenarios from repeating, the other type of energy which is wind energy need to be considered for use in the future. With this project, it help this issue from continuing become worse.

1.4 Scope of Project

The project scopes are recorded to guarantee the project is conducted along the time provided during this final year project. The focus of this task is to study the wind characteristics and wind energy potential. To study this, the data is taken at Melaka Meteorological station and analyses it by using Weibull Distribution. The data that taken is then process into Minitab software.

The wind energy characteristics and wind potential previous data and current data is compared with other studies to seek the best way to determining the wind energy potential and the wind energy characteristics. The wind energy characteristic such that the wind speed density and wind direction which both have big difference as it compare between regions in close proximity. The wind potential mostly is study by using three parameter probability density function where v is speed of wind, k is shape parameter and c is the scale parameter.

The Weibull Distribution is famous as it has ability to fit the data from diverse field, ranging from life data to weather data or observation made in biology or in engineering sciences and etc. It is normally used to analyses the wind speed distribution at the location wanted for certain period. Weibull distribution also have connections with other

probability distributions. One of method that is important in determining *k* and *c* is power density method.

In this study, the data is analyses by Minitab software. As results, the potential location for wind energy field will be able to identify. The software is statistical software which helps in easier to key in the input data, and it also can identify the trend and pattern which then gives out result to the current issues. Minitab is widely used as it quick and has easy solution for the level of analysis data which needed most especially for Six Sigma projects.

1.5 Project Structure

In order to fully understand the flow of the project, the outline is provided.

a) Chapter 1:

This chapter is about introduction to the project. It is concentrate on the outline of the project, which is project objectives, the problem statement, project scopes and the project structure.

b) Chapter 2:

The background of project is explain in this chapter. The focused on this part is about method, theory that have been explained by other researchers. This chapter likewise contains the meaning of term that will be use.

c) Chapter 3:

This section is about the methodology. This chapter will explain about the procedures that have taken throughout the project. This chapter also will brief about the method that will be use and the project flow.

d) Chapter 4:

This section is about the result and discussion. This section will clarify about result of the project and the analysis that has been done. This chapter will discuss about the overall of the project.

e) Chapter 5:

This section is about conclusion and recommendations. This part will explain what can be conclude by the end of project. This chapter will discuss end of the experiment.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The carbon dioxide emissions in Malaysia have been rise around 1980's due to usage of energy. Unfortunately, Malaysia is one of fastest growing rates of carbon dioxide (CO2). In 1980, as much of 26.330 million metric tons of CO_2 was released in Malaysia. In 2011, it raised to 195.701 million metric of tons.

Around 1990, the government of Malaysia have accomplish wind assessment studies. Yet, these previous studies and demonstrations meet with dead end as it cannot justify the reliability of utilising wind energy in Malaysia. This is due the data most collected at meteorological station which unsuitable to decide which area suitable for wind energy stations. Hendry said that wind are more commercialization compare to others such as hydroelectric, solar, wave and etc. (Harbone P et al., 2009). In order to build up the wind farm, the assessment of wind energy potential is necessary for nationwide. Next, it is follow by completing assessment in reassuring locations. These assessment is very crucial before installing wind energy farm. (Xydis G, 2009)

2.2 Wind Energy

Wind power is gain through a process conversion of wind energy into electricity. This process involving the wind turbines, the wind will blows the blades of wind turbine. The blades is connected to a hub which mounted with a turning shaft. The shaft will undergo