CONCEPTUAL DESIGN OF GRAVITATIONAL FORCE TURBINE FOR ROOF TOP APPLICATION

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DECLARATION

I declare that this project report entitled “Conceptual Design of Gravitational Force Turbine for Roof Top Application” is the results of my own work except as cited in the references.

Signature : ……

Name : JEREMIAH CAMILLUS

Date : ……..

APPROVAL

I hereby declare 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 degree of Bachelor of Mechanical Engineering.

Signature	:	……
Name of Supervisor	:	Dr. Ernie binti Mat Tokit
Date	:	……..

DEDICATION

This report is dedicated to both my mother and father for supporting me from the first step of my journey in having a bachelor's degree until the end. Also not forgetting the rest of my family for their never endless support and advice to go through everything. Other than that, to all my friends that had helps me through all the semester. A thousand appreciations are also given to my supervisor for always helping me back and forth to complete this final year report.

ABSTRACT

Nowadays, fuel energy is becoming more expensive as the fuel energy is decreasing day by day. A hydropower can be an economical alternative source of energy without the need to purchase a fuel. The energy to power a hydropower can be harnessed in many ways such as water energy. Therefore, this study introduces and creates a conceptual design of vortex gravitational force turbine for rooftop application and as well as to improve the current mechanism which will help in generating more electricity. The objective of this study is to create a new conceptual design of gravitational force turbine for rooftop application as well as to provide complete analysis of turbine in terms of deformation, safety factor and the strength. The design process of this product is started with a survey among civilians. Through the data obtained from the survey, a House of Quality has been produced to convert the customer requirements into the engineering characteristics. This includes the angle of inlet opening, angle of pre-rotational plate, number of fans, material and safety that is converted from the customer requirement which is produce more power, long lasting, not easily damage and safety. Then, a Product Design Specification is produced in order to be used as a project target specification that must be met. Furthermore, a Morphological Chart is used to obtain some conceptual design whereas the final designs are selected through the Pugh method and Weighted Decision Matrix. Through the morphological chart, the component is identified as angle of inlet opening, angle of pre-rotational plate, the number of fans and material. The Pugh method and Weighted Decision Matrix determines the best product ideas after the comprehensive design generation process is carried out and the conceptual design 3 is chosen as the best conceptual design. After the 3D final design is produced using Catia V5, some analysis and simulation has been carried out by using ANSYS 2021 R1 in order to obtain the workability and functionality of the design. Next, a simulation using ANSYS 2021 R1 is used for structural analysis. The maximum deformation, maximum stress and safety factor are predicted to be less than 0.02 m, less than 4.43×10^7 Pa and more than 2 respectively.

ABSTRAK

Pada masa ini, tenaga bahan bakar menjadi lebih mahal kerana tenaga bahan bakar semakin berkurang dari hari ke hari. Tenaga hidro boleh menjadi sumber tenaga alternatif yang ekonomik tanpa perlu membeli bahan bakar. Tenaga untuk menghidupkan tenaga hidro dapat dimanfaatkan dengan pelbagai cara seperti tenaga air. Oleh itu, kajian ini memperkenalkan dan membuat reka bentuk konseptual turbin daya graviti pusaran untuk aplikasi di atas bumbung dan juga untuk meningkatkan mekanisme semasa yang akan membantu menghasilkan lebih banyak elektrik. Objektif kajian ini adalah untuk membuat reka bentuk konsep baru turbin gaya graviti untuk aplikasi di atas bumbung serta memberikan analisis lengkap turbin dari segi ubah bentuk, faktor keselamatan dan kekuatan. Proses reka bentuk produk ini dimulakan dengan tinjauan di kalangan orang awam. Melalui data yang diperoleh dari survei tersebut, sebuah House of Quality telah dihasilkan untuk mengubah keperluan pelanggan menjadi ciri teknik. Ini merangkumi sudut bukaan masuk, sudut plat pra-putaran, jumlah kipas, bahan dan keselamatan yang ditukar dari keperluan pelanggan yang menghasilkan lebih banyak kuasa, tahan lama, tidak mudah rosak dan keselamatan. Kemudian, Spesifikasi Reka Bentuk Produk dihasilkan agar dapat digunakan sebagai spesifikasi sasaran projek yang mesti dipenuhi. Selanjutnya, Carta Morfologi digunakan untuk mendapatkan beberapa reka bentuk konseptual sedangkan reka bentuk akhir dipilih melalui kaedah Pugh dan Matriks Keputusan Berat. Melalui carta morfologi, komponen tersebut dikenalpasti sebagai sudut bukaan masuk, sudut plat pra-putaran, bilangan kipas dan bahan. Kaedah Pugh dan Matriks Keputusan Berat menentukan idea produk terbaik setelah proses penjanaan reka bentuk menyeluruh dijalankan dan reka bentuk konsep 3 dipilih sebagai reka bentuk konsep terbaik. Setelah reka bentuk akhir 3D dihasilkan menggunakan Catia V5, beberapa analisis dan simulasi telah dilakukan dengan menggunakan ANSYS 2021 R1 untuk mendapatkan kebolehkerjaan dan fungsi reka bentuk. Seterusnya, simulasi menggunakan ANSYS 2021 R1 digunakan untuk analisis struktur. Deformasi maksimum, tekanan maksimum dan faktor keselamatan diramalkan kurang dari 0.02 m, kurang dari 4.43 x 10^7 Pa dan lebih dari 2 masing-masing.

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LIST OF ABBREVIATIONS

HOQ	-	House of Quality
FEA	-	Finite Element Analysis
PDS	-	Product Design Specification
CAD	-	Computer Aided Design
QFD	-	Quality Function Deployment
ABS	-	Acrylonitrile Butadiene Styrene

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

In this era of globalization, the amount of energy used has been increasing due to the increase of houses, buildings and a lot of industrial factories. Replenishable energy which is collected energy from any replenishable energy such as the sun, wind, rain, tides, waves and geothermal heat is becoming the fastest growing energy type as the world is switching from fossil fuels to various types of renewable resources. Renewable resources can be viewed as one of the element or factors for the country's growth in economy as renewable resources implementation can protect the energy being supply and can be the alternatives in alleviating the global warming dilemma by reducing the use of fossil fuels which can benefit the environment and is sustainable as stated by (Mohd Chachuli, Mat, Ludin, & Sopian, 2021).

Hydropower is one of type of renewable energy which uses a water to generate an electricity. There are many types of water sources that can be used to generate electricity such as water sources from the river, rainwater harvesting and rainwater that fall on the rooftop of a house. These water resources are renewable since the water will be renew when there is a rainfall, so the resources are almost always there and it is a free energy that can be use. Hydropower, of all renewable energy resources, is an appealing and viable alternative

to generate power and is becoming very famous around the world due to its variety of benefits that comes with it as stated by (Nautiyal & Goel, 2020).

There are many types of turbines that was used for hydropower to generate electricity, such as Pelton wheel turbine, Turgo turbine, Crossflow turbine and Propeller turbine. The turbine work when the turbine's blade being pushed by the force of the falling water which will then causes the turbine to spin. In order for the turbine to function, it will need a water source and one of the sources that can be use would be the water source from the river since the river water is a free source that can easily be obtained to generate power. Other than that, rainwater can also be used as an initiative for water energy since it is a free energy. The rainwater that falls on a rooftop can be used to power this turbine rather than letting it go to waste.

Vortex gravitational force turbine is also another type of turbine which can be used to generate electricity. The vortex gravitational turbine is typically employed near rivers or streams, where water is channelled through a circular vertical pool known as a reservoir with a small aperture at the bottom. When the water flowing due to the gravity, an artificial vortex is created and is responsible for the production of electricity as stated by (Ullah, et al., 2019).

The purpose of this study is to create a conceptual design of gravitational force turbine for rooftop application to generate hydroelectric from the rainwater.

1.2 PROBLEM STATEMENT

Nowadays, fuel energy is becoming more expensive as the fuel energy is decreasing day by day. A hydropower can be an economical alternative source of energy without the need to purchase a fuel. The energy to power a hydropower can be harnessed in many ways such as water energy. Rain water is also considered as a free water source energy. The rain water that fall on the roof top of a house can be used to generate energy through a vortex gravitational force turbine rather than letting the rain water go to waste. The vortex gravitational force turbine is a great alternative as it can generate energy power at low head and low flow rate. Therefore, this study introduces and creates a conceptual design of vortex gravitational force turbine for rooftop application and as well as to improve the current mechanism which will help in generating more electricity.

1.3 OBJECTIVE

The objective of this projects are as follows:

i. To create a new conceptual design of gravitational force turbine for rooftop application.
ii. To provide complete analysis of turbine in terms of deformation, safety factor and the strength.

1.4 SCOPE OF RESEARCH

The scope of this project is:

2 The Finite Element Analysis using ANSYS simulation.

3 The study only focus on the conceptual design of a gravitational force turbine.

1.5 GENERAL METHODOLOGY

A systematic project planning needs to be carried out in order for the project to be successful. In this section, a flow chart is used to ensure the project flow will run smoothly without any problem. Flowchart is used by arranging all the entire process for the project accordingly in order to achieve the objective of this project. The action that are required to be done to achieve the objectives of the study are briefly discussed in the section below:

1. Literature Review

   Any findings from the journals, articles, books and papers are collected to be reviewed as a study material.

2. Conceptual Design

   By using the methods of Morphological Chart, House of Quality, and PUGH Method to choose the ideal design.

3. CAD Drawing

   Draw a new gravitational force turbine design for rooftop application using CATIA V5R21 software.

4. FEA Analysis

   The design that had been drawn is transferred to ANSYS software for FEA analysis.

5. Analysis of Findings

   An investigation will be done for the analysis result that comply with the required new design.

6. Report Writing

   A written report will be created at the end session to show all the finding and the result that was obtained from the whole study.

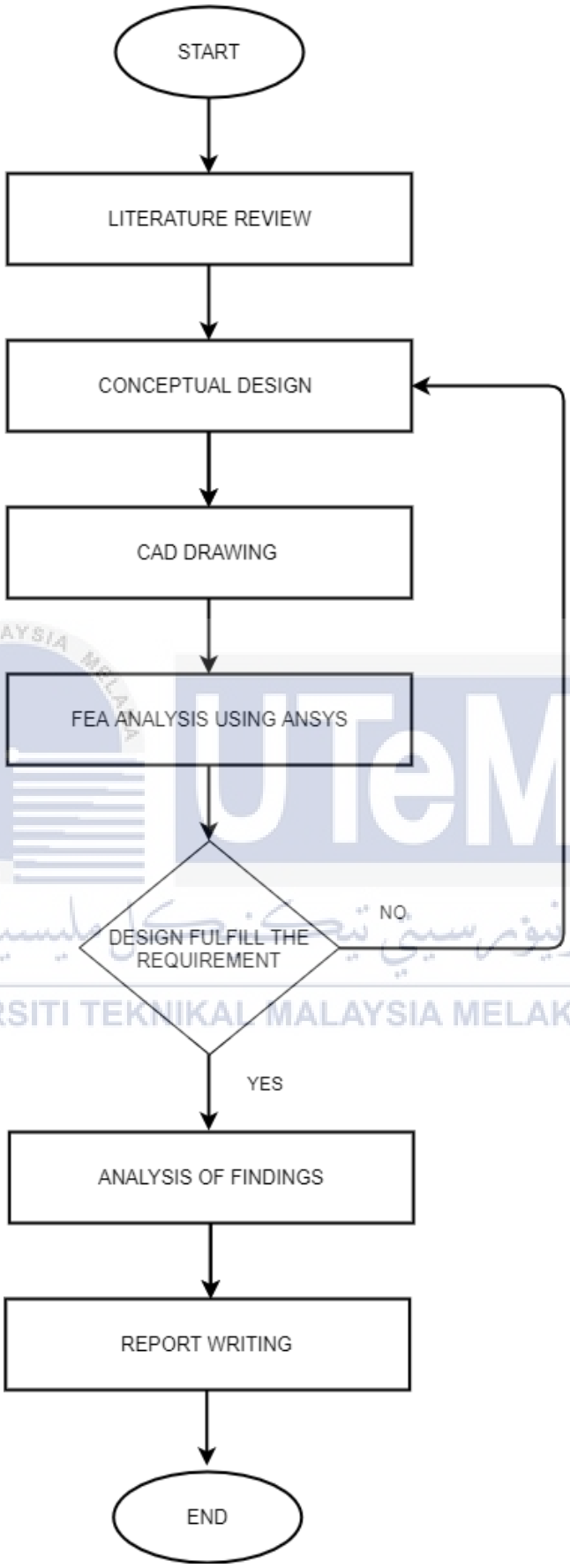

Figure 1.1: Flowchart for FYP.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will discuss the previous research and study that has been done that are related to the conceptual design of gravitational force turbine for rooftop application. To complete this study, relevant information, knowledge and results that was obtained from sources such as articles and journal reports will be used as a parameter. This chapter will briefly summarize the past research about the application of conceptual design, the analysis used and the current gravitational force turbine.

2.2 MORPHOLOGICAL CHART

A morphological chart is a method that was used to produce ideas in a scientific systematic way. According to (Dragomir, Banyai, Dragomir, Popescu, & Criste, 2016), the use of morphological charts in the generation of design concepts is distinguished by reliability such as a wide number of restricted data and time-limited designs and the potential to yield prior results where the morphological chart comprise of a table layout which merge the coveted functions of the product with the potential answer for each list in as much detail

as possible of its future technical characteristics or specifications. By using morphological chart, the solution means for each of the sub-function can be defined and merged to create a possible coherent conceptual design or operating structure. The Figure 2.1 shows the smart table morphological chart that was done by the researcher.

	Solutions				
Functions	Charging socket for laptop	Computer integrated	Printer	Scanner	Lamp
	Motion tracking device	Keyboard integrated	Speakers	Video projector	Clock
Shape	Cubic	Plan "L" type	Plan "I"	Plan "T"	Plan "U"
Materials	Wood	PAL	Plastics	Glass	Metal

Figure 2.1: Smart Table Morphological Chart.

Nowadays, the morphological chart method has been widely used during concept generation which also supported by (Zeiler, 2018) where the morphological charts method are essentially instruments for information retrieval and are not limited to strictly technological challenges, but can also be used in the production of management systems and in other fields. Thus, the morphological chart can be mainly used to explore a new concept and types of solution which also has a lot of advantages in terms of communication and for group work.

2.3 HOUSE OF QUALITY (HOQ)

A House of Quality (HOQ) function is to establish a relationship between the needs of the customer on the basis of the product and all of the performance criteria and functions