DESIGNING AN INNOVATIVE MANUAL WASHING MACHINE

WONG HWEI JEN

A report submitted
in fulfilment of the requirements for the degree of
Bachelor of Mechanical Engineering (with Honours)

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2018

DECLARATION

I declare that this thesis entitled “Designing an Innovative Manual Washing Machine” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :……

Name :……

Date :……

APPROVAL

I hereby declare that I have read this thesis 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 (with Honours).

Signature :……

Supervisor Name :……

Date :……

DEDICATION

To my beloved mother and father.

ABSTRACT

In an era where sustainability and environment are emphasized, manual washing machine has recurred to meet the requirement of human to take care of the ecosystem. However, there are plenty of defects on the manual washing machines in the market. Therefore, an innovative manual washing machine, Benri-Wash is designed to overcome the problems of existing manual washing machines. The design process is as follows. Firstly, problems occurred in the existing manual washing machines are determined in the first place before designing Benri-Wash. Secondly, background research related to components of manual washing machine is done. Thirdly, specifications of Benri-Wash and needs of customers are identified by using Quality Function Deployment and Product Design Specification. Fourthly, five alternative concepts were generated by combining options from Morphological chart. Next, the concepts are then evaluated using Pugh Concept Selection. Then, parametric design is conducted on components of Benri-Wash. Next, detail design of Benri-Wash are generated into engineering drawing form using CATIA V5R20. Analysis and Simulation of Benri-Wash are then carried out to determine factor of safety.

ABSTRAK

Dalam era di mana kelestarian dan alam sekitar ditekankan, mesin basuh manual telah diulang-ulang untuk memenuhi kehendak manusia untuk menjaga ekosistem. Walau bagaimanapun, terdapat banyak kekurangan pada mesin basuh manual di pasaran. Oleh itu, mesin basuh manual yang inovatif, Benri-Wash direka untuk mengatasi masalah mesin basuh manual yang sedia ada. Proses reka bentuk untul Benri-Wash adalah seperti berikut. Pertama, masalah yang berlaku dalam mesin basuh manual yang sedia ada dipastikan terlebih dahulu sebelum proses mereka bentuk Benri-Wash dijalankan. Kedua, penyelidikan tentang latar belakang yang berkaitan dengan komponen mesin basuh manual akan dilakukan. Ketiga, spesifikasi Benri-Wash dan keperluan pelanggan dikenalpasti dengan menggunakan Penyebaran Kualiti Fungsi dan Spesifikasi Product Reka Bentuk. Keempat, lima konsep alternatif dihasilkan dengan menggabungkan pilihan dari carta Morfologi. Seterusnya, konsep-konsep tersebut akan dinilai dengan menggunakan Pemilihan Konsep Pugh. Kemudian, parametrik reka bentuk dilakukan pada komponen Benri-Wash. CATIA digunakan untuk menjana bentuk lukisan kejuruteraan bagi reka bentuk terperinci Benri-Wash. Faktor keselamatan Benri-Wash akan dianalisis dan disimulasikan bagi menentukan tahap keselamatan reka bentuk tersebut.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my deepest gratitude to whom have provided me assistance while conducting this thesis especially my supervisor, Dr Mohd Asri bin Yusuff, who unconditionally guided and supported me not just in the process of this thesis, but in my study life in UTeM.

In addition, I would like to acknowledge Prof. Madya Ir. Dr. Abdul Talib bin Din and En. Mohd Nazim bin Abdul Rahman who are both presentation and report examiners with much appreciation for evaluating my thesis and giving advices in designing a product.

Furthermore, much appreciation to Faculty of Mechanical Engineering (FKM) of Universiti Teknikal Malaysia Melaka (UTeM) for providing the opportunity to conduct and complete this thesis by providing courses that is adopted in this thesis.

Last but not least, a deepest thanks to my adored family and friends who have supported and encouraged me to complete this thesis and pursuing study in UTeM.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBEREVATIONS

ABS	Acrylonitrile Butadiene Styrene
BOM	Bill of Material
CAD	Computer Aided Design
CATIA	Computer Aided Three Dimensional Interactive Application
CRs	Customer Requirements
ECs	Engineering Characteristics
FEA	Finite Element Analysis
HOQ	House of Quality
PDS	Product Design Specification
PM	Pugh Matrix
QFD	Quality Function Deployment
RM	Ringgit Malaysia

LIST OF SYMBOL

d	=	Diameter
L	=	Length
t	=	Thickness
F	=	Force
M	=	Moment
θ	=	Number of turns spring can deliver
D_c	=	Diameter of case
D_a	=	Diameter of arbor

CHAPTER 1

INTRODUCTION

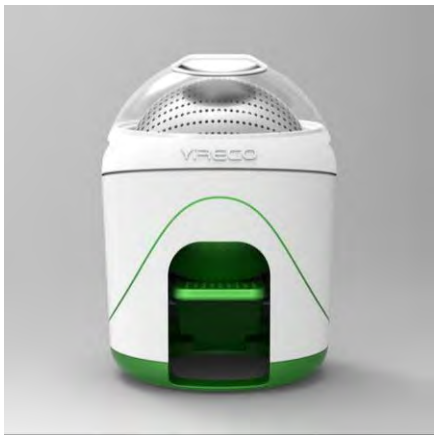
1.1 BACKGROUND OF STUDY

Technology has replaced the traditional method of doing laundry with the invention of electrical washing machine. Christina Sterbenz described that the invention of electrical washing machine is a revolution to the world (Sterbenz, 2014). As compared to the traditional washing method, an electrical washing machine allows laundry to be done effectively and reduces burden of users that are packed with busy lifestyle (Easy Appliance Parts, n.d.). The process of doing laundry using an electrical washing machine is far more convenient and simple where all users have to do is pop their dirty clothes into the washing machine and push the start button. Then, they can relax or spend the free time to do some other jobs while the washing machine is doing their laundry. However, everything has its pros and cons.

Recently, going green is a trend that is getting popular and it is very important for the world to carry out go green and water-saving practices in order to protect and save the Earth from global warming. As seen in the data of DaftLogic, a typical electrical washing machine can consume 500Watts per hour (DaftLogic, n.d.). Besides that, a significant amount of water which is 15% to 40% of total water consumption of an average home of four members is used to do the laundry. A minimum approximation of 53 litres of water is used by a new and high efficiency washing machine (homewaterworks, n.d.). If the washing

machine operates one complete cycle per day for 30 days, the total water consumption per month will be 1590 litres which is a massive household water usage. This shows that a typical electrical washing machine needs a high dosage of water to operate which will increase the amount of wastewater generated. In addition, there are circumstances where consumers will do their laundry using the electrical washing machine even though there is only a small load of laundry to be done. This is due to they have relied on the washing machine to do the laundry. Eventually, this will cause water wastage as it does not require that massive amount of water for that small load of laundry to be done. Therefore, manual washing machine is created to achieve the target of reducing carbon footprint and water-saving.

There are a few types of manual washing machine in the market. They are generally divided into two types which are hand-operated and foot-operated manual washing machine. Figure 1.1(a) shows WonderWash which is a hand-operated manual washing machine whereas Figure 1.1(b) shows Drumi which is a foot-operated manual washing machine. Although they have enhanced convenience to public, there are still some improvements that can be done on the existing manual washing machines. Therefore, Benri-Wash, an innovative and sustainable manual washing machine is designed to overcome the problems occurred in the existing manual washing machines.



(a) (b)

Figure 1.1 (a) WonderWash and (b) Drumi

(Source: Yirego, n.d.)

1.2 PROBLEM STATEMENT

Although existing manual washing machines can effectively reduce household electricity bill and wastage of water, there are still some cons. First, users could not multitask while doing their laundry as they have to be there with the manual washing machine for the entire washing process. Secondly, hand-operated manual washing machine can easily causes fatigue especially for senior citizens to operate the machine with hand for a long period. Thirdly, manual washing machine in the market has high cost causing low income family that could not afford an electrical washing machine could not afford the manual washing machine in the market as well.

Besides that, manual washing machines in the market are not sustainable. Parts such as pedal of foot-operated manual washing machine can easily spoilt due to focused pressure point by repeating the process of exerting force on the pedal. Failure of the product may cause severe injury to user. Therefore it is important to ensure the sustainability of the product before proceeding to manufacturing stage.

1.3 OBJECTIVE

The objectives of this project are as follows:

1. To design an innovative manual washing machine.
2. To investigate factor of safety of designed product.

1.4 SCOPE OF PROJECT

This project focuses on the design of an innovative manual washing machine that can solve the problems of manual washing machines that are available in the market. Main considerations of this project are structure, working mechanism, material, and manufacture cost of the product. Aspects such as fabricating the product and estimating the marketing price are not included in this project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In order to design Benri-Wash, research and studies on components and mechanisms of existing manual washing machine are carried out. Besides that, early invention of manual washing machine is discussed in this chapter. Mechanisms applied in existing manual washing machine are used to generate ideas on designing Benri-Wash. Different types of transmission system found in existing manual washing machine are elaborated and their advantage and disadvantage are discussed.

2.2 HISTORY OF MANUAL WASHING MACHINE

As far back as man understood that apparel was a fundamental need, man too understood the need to keep their garments clean, regardless of sterile purposes or simply for reusing the clothes (Washing Machine and Combo History, n.d.). In order to overcome the difficulty to wash clothes with bare hands, hand-powered mechanical washing machines came into existence in early 1800s after the invention of scrub board. The first hand-powered washing machine that uses a drum was patented in 1851 by James King which is an American. Then, in 1858, the rotary washing machine was patented by Hamilton Smith. Later in 1896, the Sears, Roebuck and Co. offered the first hand crank washing machine (Bellis, 2017).

In the primary stage, rubbing the clothes is the method used by mechanical washing machines to clean clothes. Later, the mechanical washing machines moves the clothes through water to clean them (M.Marton, 2017). An example of 19th century Metropolitan washing machine is shown in Figure 2.1.

Figure 2.1 19th century Metropolitan washing machine

(Source: Washing Machine, 2017)

2.3 MANUAL WASHING MACHINE TRANSMISSION MECHANISM

Manual washing machines require human power to rotate the drum in order to remove dirt from clothes. In order to successfully operate a manual washing machine, transmission mechanism plays an important role as it is the system which transmits kinetic energy from human to the machine. Belt, chain, gear and single slider-crank transmission mechanism are discussed in this section.

2.3.1 Belt Transmission Mechanism

Belt transmission mechanism is popular among existing manual washing machines. This mechanism transmits kinetic energy from human to machine directly. The diameter of