UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND FABRICATION ECO FRIENDLY 3D PRINTED BICYCLE CUP HOLDER

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BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PRODUCT DESIGN) WITH HONOURS

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Faculty of Mechanical and Manufacturing Engineering Technology

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A thesis submitted
in fulfilment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Product Design) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

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2023

DECLARATION

I declare that this Choose an item. entitled “Design and Fabrication Eco Friendly 3D Printed Bicycle Cup Holder” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : *Nur Amira Zulaikha Binti Mohd Supian*

Date : 20/01/2023

APPROVAL

I hereby declare that I have checked this thesis and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Product Design) with Honours.

Signature : 

Supervisor Name : *Dr. Mastura Binti Mohammad Taha*

Date : 20/01/2023

DEDICATION

Firstly, I would like to express my gratitude to Almighty Allah for His kind blessing for giving me a healthy body and mind to finish this project. Next, I would like to express my sincere appreciation to Universiti Teknikal Malaysia Melaka (UTeM) for giving me opportunity to do my Final Year Project (FYP) here. I wish to give my special gratitude to my personal supervisor Dr. Mastura Binti Mohammad Taha, for the help and cooperation during my project period here and guide me until I completed my research study.

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Lastly, thank you so much to my beloved family, especially my father, Mohd Supian Bin Idris and my mother, Harlina Binti A.Rahim for the kind, understanding and moral support to finish my Final Year Project. Not forget to all my friends, thank you for all the support and sharing knowledge especially Muhammad Hamizan Bin Zainal, Muhammad Fikri Bin Roslan, and Muhamad Syaqir Ehzan Bin Muhamad Zahurin, my partner that I always collaborate with them and share input of information together to finish this research study.

ABSTRACT

Holding onto a water bottle while pedalling is a major hassle for cyclists. thus, this cup holder for bicycles is a must-have for each cyclist. The increasing environmental concerns over plastic waste calls for more sustainable alternatives in product design. This study aims to address this issue by identifying and designing a universal bicycle cup holder using natural fibre materials and 3D printing method which is both eco-friendly and suitable for all types of bicycles to reduce reliance on disposable plastic cup holders. The Quality Function Deployment (QFD) method is used to create a bicycle cup holder that meets customer requirements. This is a technical element that assists in gathering consumer feedback and translating the respondent's needs. The current method for evaluating client demands in product design does not effectively consider all aspects of customer needs and preferences. This study aims to address this issue by implementing an integrated Quality Function Deployment (QFD) approach, which utilizes a combination of tools to connect client needs to the product development process and create a feedback loop. Additionally, a survey questionnaire is used in this study as a preliminary research method to gather information about customer needs, expectations, and preferences early in the project to ensure the design of the product aligns with customer requirements. This integrated approach aims to improve the alignment of product design with customer needs and preferences and increase customer satisfaction. The House of Quality (HOQ) is the method's principal tool, where all of this data will be kept. Through HOQ, Concept 3 (Clip Bicycle Cup Holder) was chosen as the concept with the most relevant interest. In the meantime, this approach meets the majority of client needs, including reasonable price, durability, lightweight, desired style, and appropriate materials. On a final note, the project aims to design a bicycle cup holder that meets customer requirements by using an integrated Quality Function Deployment (QFD) method, with Fused Deposition Modelling (FDM) 3D printing technology to create an environmentally friendly and sustainable prototype. The integrated QFD approach prioritizes customer feedback and uses the House of Quality to evaluate design alternatives, resulting in the selection of concept 3 as the optimal solution.

ABSTRAK

Memegang botol air semasa mengayuh adalah kerumitan utama bagi penunggang basikal. Oleh itu, pemegang cawan untuk basikal ini mesti ada untuk setiap penunggang basikal. Kebimbangan alam sekitar yang semakin meningkat terhadap sisa plastik memerlukan alternatif yang lebih mampan dalam reka bentuk produk. Kajian ini bertujuan untuk menangani isu ini dengan mengenal pasti dan mereka bentuk pemegang cawan basikal universal menggunakan bahan gentian asli dan kaedah cetakan 3D yang mesra alam dan sesuai untuk semua jenis basikal bagi mengurangkan pergantungan kepada pemegang cawan plastik pakai buang. Kaedah Quality Function Deployment (QFD) digunakan untuk mencipta pemegang cawan basikal yang memenuhi keperluan pelanggan. Ini adalah elemen teknikal yang membantu dalam mengumpul maklum balas pengguna dan menterjemah keperluan responden. Kaedah semasa untuk menilai permintaan pelanggan dalam reka bentuk produk tidak mempertimbangkan dengan berkesan semua aspek keperluan dan pilihan pelanggan. Kajian ini bertujuan untuk menangani isu ini dengan melaksanakan pendekatan Quality Function Deployment (QFD) bersepadu, yang menggunakan gabungan alatan untuk menghubungkan keperluan pelanggan kepada proses pembangunan produk dan mencipta gelung maklum balas. Selain itu, soal selidik tinjauan digunakan dalam kajian ini sebagai kaedah penyelidikan awal untuk mengumpul maklumat tentang keperluan, jangkaan dan keutamaan pelanggan pada awal projek untuk memastikan reka bentuk produk sejajar dengan keperluan pelanggan. Pendekatan bersepadu ini bertujuan untuk menambah baik penjajaran reka bentuk produk dengan keperluan dan pilihan pelanggan serta meningkatkan kepuasan pelanggan. Rumah Kualiti (HOQ) ialah alat utama kaedah, di mana semua data ini akan disimpan. Melalui HOQ, Concept 3 (Clip Bicycle Cup Holder) dipilih sebagai konsep yang paling relevan. Sementara itu, pendekatan ini memenuhi sebahagian besar keperluan pelanggan, termasuk harga yang berpatutan, ketahanan, ringan, gaya yang diingini dan bahan yang sesuai. Pada nota akhir, projek ini bertujuan untuk mereka bentuk pemegang cawan basikal yang memenuhi keperluan pelanggan dengan menggunakan kaedah Quality Function Deployment (QFD) bersepadu, dengan teknologi cetakan 3D Fused Deposition Modeling (FDM) untuk mencipta prototaip yang mesra alam dan mampan. Pendekatan QFD bersepadu mengutamakan maklum balas pelanggan dan menggunakan House of Quality untuk menilai alternatif reka bentuk, menghasilkan pemilihan konsep 3 sebagai penyelesaian optimum.

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Last but not least, from the bottom of my heart a gratitude to my beloved family, especially my father, Mohd Supian Bin Idris and my mother, Harlina Binti A.Rahim for the kind, understanding and moral support to finish my Final Year Project. Not forget to all my friend, thank you for all the support and sharing knowledge especially Muhammad Hamizan Bin Zainal, Muhammad Fikri Bin Roslan, and Muhamad Syaqir Ehzan Bin Muhamad Zahurin, my partner that I always collaborate with them and share input of information together to finish this research study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

CNC	-	Computer Numerical Controller
QFD	-	Quality Function Development
FDM	-	Fused Deposition Modelling
TRIZ	-	Theory of Inventive Problem Solving
CWQC	-	Company Wide Quality Control
GOAL	-	Growth Opportunity Alliance of Lawrence
ABS	-	Acrylonitrile Butadiene Styrene
REBA	-	Rapid Entire Body Assessment
CAD	-	Computer Aided Design
STL	-	Standard Triangle Language
IFR	-	Ideal Final Result
ASI	-	American Supplier Institute
VOC	-	Volatile Organic Compound
QPC	-	Quality Productive Centre
PLA	-	Polylactic Acid
IPA	-	Isopropyl Alcohol
HOQ	-	House of Quality

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of 3D Printing

The Hideo Kodama of the Nagoya Municipal Industrial Research Institute invented the first 3D printing manufacturing equipment when he invented two additive processes for generating 3D models. Hideo Kodama's early work in laser cured resin rapid prototyping, which built on Ralf Baker's work in the 1920s for manufacturing ornamental things, was completed in 1981. (Patent US423647A). His invention was further improved over the next three decades after the launch of stereolithography in 1984. Chuck Hull of 3D Systems invented the first 3D printer, which used the stereolithography technology, in 1987. Following that, selective laser sintering and selective laser melting were developed, among other things. Other expensive 3D printing systems were developed in the 1990s and 2000s, but as their patents expired in 2009, their prices dropped dramatically, allowing more individuals to use the technology.

3D printing is one of the technologies in Additive Manufacturing (AM), is the technique of creating three-dimensional solid items from a computer file. 3D printed part are made using additive manufacturing methods. In an additive process, an object is constructed by laying down consecutive layers of material until the product is complete. Each of these layers can be considered as a gently sliced cross-section of the item. Subtractive manufacturing, which involves cutting or hollowing out a piece of metal or plastic with a milling machine, is the opposite of 3D printing. When compared to traditional production methods, 3Dprinting allows you to create complicated shapes with less material.

The length of time it takes to print a part is determined by several factors, including the part's size and the printing settings. When determining printing time, consider the quality of the finished product, as higher quality items take longer to make. 3D printing can take anything from a few minutes to several hours or days, depending on the pace, resolution, and volume of material used.

3D printing, also known as additive manufacturing, has been utilized to develop successful commercial technology in the manufacturing, medical, industrial, and sociocultural sectors (e.g., Cultural Heritage). In the humanitarian and development sector, 3D printing has recently been used to create a variety of medical supplies, prosthesis, parts, and repairs. At the tooling end of the manufacturing spectrum, additive manufacturing was initially used. Rapid prototyping, for example, was one of the first additive versions, with the goal of reducing the time and cost of manufacturing prototypes of novel components and devices, which was previously done primarily with subtractive toolroom processes like Computer Numerical Controller (CNC) milling, turning, and precision grinding. In the 2010s, additive manufacturing became much more common in the industrial industry.

1.2 Problem Statement

Based on the background, most development companies in Malaysia create new products based on their own designs. It is possible that they are not using proper product creation methods. Designers have several methods for improving and selling their goods. One of these is Quality Function Development (QFD). Here are some problem statements of the product:

- Many bicycle riders face difficulties in carrying drinks while cycling as they do not have a cup holder. This can be uncomfortable, impede control of the bike, cause spills and accidents and make it hard to stay hydrated.

- Environmental-friendly bicycle cup holders may be in limited supply because the market for these products is small, the materials and production processes can be costly, manufacturers may not invest in them until there is more demand, and the concept of environmental-friendliness is broad so some manufacturers may only consider some aspects and no other.

1.3 Research Objective

From the problem statement explained above, several objective need to be completed at the end of this project. The main objectives of this project are:

a) To design the 3D printer eco-friendly bicycle cup holder.

b) To fabricate the eco-friendly bicycle cup holder using Fused Deposition Modelling (FDM).

1.4 Scope of Research

In this section, the scope of this project is to discuss the production of environmentally friendly products that make bicycle cup holders useful to those who use them. The bicycle cup holder's purpose is to allow cyclists of all ages to bike while carryingwater or coffee. This bicycle cup holder should also be made of high-quality, long-lasting materials so that it can be used every day without fear of harm.

From this project, we need to know how to meet customer needs and solve all problems related to bicycle cup holders. Furthermore, one of the areas that need attention is the implementation of quality and design planning tools to improve the design process.

Additionally, producers must pay a lot of attention to environmentally friendly products. This is because environmentally friendly materials are used in far too few products in Malaysia. Therefore, whether the design is complex or simple, the design of the bicycle cup holder should be considered when creating the product.

1.5 Summary

This chapter gives a general outline of the project's background and objectives. Furthermore, the problem statement and scope of the study are being clarified to restrict the scope of this planning process. The literature review and information required to perform the entire analysis are covered in the following chapters.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will discuss the Design and Fabrication of Eco-Friendly 3D Printed Bicycle Cup Holder and provide a review of previous research as well as existing products that have been developed using reference sources and guidelines such as journals, the internet, article writing, blogs, and scientific studies. The purpose is to acquire a better graspof the project's design, conception, and any other information that can help improve or develop the product. Others have built and innovated projects that differ from the original inventors' and designers in terms of concept and design. This chapter also contains details about the research that was conducted in conjunction with this project.

2.2 Bicycle Cup Holder

2.2.1 Definition of Bicycle Cup Holder

The current invention pertains to cup holders in general, and specifically to cup holders that attach to the handlebars of a bicycle, motorcycle, or other vehicle. A basic handlebar-mounted cup holder consists of a bracket for mounting to the handlebars and a cup-holder component that is designed to hold a cup firmly. The piece that holds the cup is usually cylindrical and may include a bottom for further stability.

A standard cup holder’s cylindrical component is normally rigid and non-adjustable. The variety of cup sizes that can be retained by the cup holder is limited by such designs. Also, even when no cup is being carried, the section that holds the cup is constantly visible

and exposed. This function may be unappealing to customers who want to improve the cup holder's appearance and aerodynamics while it is not in use.

2.2.2 Product Features Analysis of Bicycle Cup Holder

Product feature analysis is a specific piece of functionality that has a corresponding benefit or set of benefits for the consumer. These product attributes assist in learning more about a specific product. This part can explain the objective of each section on the product to the user. The feature analysis of the product is shown in figure 2.1, which has four parts that are necessary to make the product look stable and enable it to fulfil its function as a bicycle cup holder. For the first part, it high grade foam insert. It helps users to accommodatehot or cold water while cycling. The second part is polished stainless steel. It allows consumers to save money because the product produced is durable and maximum lustre for a neater appearance. Then, attach the metal handlebars. With a corrosion -proof coatingwith a rubber grip, it makes the product stronger when cycling in extreme places. Lastly, stainless hardware. It facilitates the user with a quite easy installation without the need for tools that can be installed anywhere.

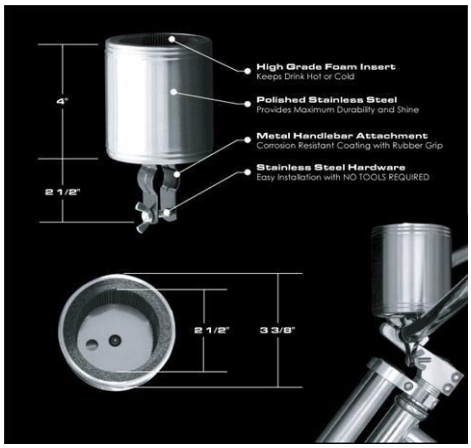

Figure 2.1 Features Analysis of Bicycle Cup Holder

2.2.3 Specification Analysis of Bicycle Cup Holder

Table 2.1 Environmentally or Eco-Friendly Bicycle Cup Holder

No	Product	Description
1	 Figure 2.2 Bicycle Coffee Cup Holder Source: https://www.walmart.com/ip/ **Brand:** Walmart **Item Type:** Bicycle Cup Holder **Material:** Aluminum Alloy and Eco Friendly **Colour:** Black, Red, Pink, Blue, White **Dimension:** 5.12 x 4.33 x 0.79 inches	**High Quality** • Our bicycle coffee cup holder is composed of a high-quality aluminium alloy combined with environmentally friendly PC, making it extremely strong and long-lasting. It has a strong grip on the handlebar. **Hand Free** • Our bicycle coffee cup holder is made of a high-quality aluminum alloy and eco-friendly PC, making it exceptionally sturdy and long-lasting. On the handlebar, it provides a firm grip. Suitable for different types and sizes of cups. **Portable** • This sturdy and durable bicycle cup holder makes carrying a variety of handle less cups, such as coffee, tea, water, and hot chocolate mugs, a breeze. **Easy To Use** • Place cups in the bicycle coffee cup holder quickly and simply or remove the water cup from the bike. This cup holder is designed to accept cups with a diameter of up to 8cm without handles and does not fit normal water bottles. The diameter is adjustable and fits handlebars with a diameter of 22.2mm- 31.8mm.