UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND DEVELOPMENT OF SMART HOME POST BOX

LAILI BINTI AHMAD SIDIK
B091910190

BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY WITH HONOURS

2023

Faculty of Mechanical and Manufacturing Engineering Technology

DESIGN AND DEVELOPMENT OF SMART HOME POST BOX

Laili Binti Ahmad Sidik

Bachelor of Manufacturing Engineering Technology with Honours

2023

DESIGN AND DEVELOPMENT OF SMART HOME POST BOX

LAILI BINTI AHMAD SIDIK

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this Choose an item. entitled “Design And Development Of Smart Home Post Box” 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 : Laili Binti Ahmad Sidik

Date : 11.01.2023

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 with Honours.

Signature : Kamarul Amir Mohamed

Supervisor Name : Ts. Dr. Kamarul Bin Amir Mohamed

Date : 11 Jan 2023

DEDICATION

Every challenging work, needs self efforts, as well as guidannce of elders especially those who were very close to our heart. My humble effort I dedicated to my biggest supporter, my sweet, caring, loving parents,

Mr. Ahmad Sidik Bin Tarmidi & Mrs. Saniyah Binti Marwan

Whose affection, love, encouragement and prays of day and night make me able to get success and honor. Not to forget my beloved siblings,

Ainul Majid and Laila

for being helpful and supportive towards this journey, from start till end of this study.

And finally, I would proudly dedicated to my future life-sharing partner,

Muhamad Fuad

for expressing abundance of opinion and informative idea towards this thesis study.

ABSTRACT

E-commerce is an internet retailer that is open 24 hours a day. In this day of largely going online, many people have access to the internet both at work and at home. As a consequence, people discover that shopping online is really convenient. Their online purchase will subsequently be delivered to their house or preferred address. The problem that is causing the project's implementation may be observed from the perspective of courier services and clients. In order to provide the greatest services and ensure that the client's package is delivered securely, the courier will contact the customer when it is time to deliver the parcel. However, if they wish to deliver the item but there is no receiver there, they will have to return the parcel back to their hub for parcel dumping, or the courier man would leave the parcel outside the house at the recipient's request. On the customer's side, they will confront the issue of the item going missing after being delivered due to theft, or the parcel being damaged due to severe weather. The availability of this house post box might help to alleviate the problem. The goal of this study is to learn about user preferences for the design and features of a residential post box. Aside from that, its objective is to create a Smart Home Post Box depending on the questionnaire supplied. Another goal is to create a post box for use on most residential property. A set of questions is created to collect data and user preferences for the design solution. According to the results of a Google form poll, the majority of respondents agreed that installing a post box in each property will reduce the problems that couriers and buyers experience. In terms of design, the questionnaire offers a few contemporary market designs that have been offered in the questionnaire. The largest proportion of all designs based on each component will be developed into morphological charts, sketches, 3D drawings, and structural analysis before manufacture. Design 4 was chosen to be developed because it meets more safety requirements than the other designs. Aside from that, the mechanism for the receiving door and slot takes up less space and is less complicated than in Designs 2 and 3. The actuator was chosen compared to spring because it had a superior criterion in concept alternatives when evaluated using Pugh's Matrix.

ABSTRAK

E-dagang adalah kedai dalam talian yang tersedia 24 jam sehari. Pada hari ini sebahagian besarnya pergi dalam talian, ramai orang mempunyai akses kepada internet di tempat kerja dan di rumah. Dengan itu, orang mendapati bahawa membeli-belah dalam talian sangat mudah. Pembelian dalam talian mereka kemudiannya akan dihantar ke rumah atau alamat pilihan mereka. Masalah yang menyebabkan pelaksanaan projek ini dapat dilihat dari perspektif perkhidmatan kurier dan pelanggan. Untuk memberikan perkhidmatan terbaik dan memastikan bungkusan pelanggan dihantar dengan selamat, kurier akan menghubungi pelanggan apabila tiba masanya untuk menghantar bungkusan. Walau bagaimanapun, jika mereka ingin menghantar barang tetapi tidak ada penerima di sana, mereka perlu mengembalikan bungkusan itu ke hab mereka, maka terjadinya lambakan bungkusan, atau lelaki kurier akan meninggalkan bungkusan itu di luar rumah atas permintaan penerima. Di pihak pelanggan, mereka akan menghadapi isu barang yang hilang selepas dihantar kerana kecurian, atau bungkusan itu rosak akibat cuaca yang teruk. Ketersediaan home post box ini dapat membantu mengurangkan masalah tersebut. Matlamat kajian ini adalah untuk mengetahui tentang pilihan pengguna untuk reka bentuk dan ciri-ciri peti pos kediaman. Selain itu, objektifnya adalah untuk mewujudkan Smart Home Post Box bergantung kepada soal selidik yang dibuat. Matlamat lain adalah untuk membuat peti pos untuk digunakan pada kebanyakan kediaman. Satu set soalan dibuat untuk mengumpul data dan pilihan pengguna untuk penyelesaian reka bentuk. Menurut hasil tinjauan borang Google, majoriti responden bersetuju bahawa memasang peti pos di setiap rumah akan mengurangkan masalah yang dialami oleh kurier dan pembeli. Dari segi reka bentuk, soal selidik menawarkan beberapa reka bentuk pasaran kontemporari yang telah ditawarkan dalam soal selidik. Bahagian terbesar semua reka bentuk berdasarkan setiap komponen akan dibangunkan menjadi carta morfologi, lakaran, lukisan 3D, dan analisis struktur sebelum pembuatan. Reka bentuk 4 dipilih untuk dibangunkan kerana ia memenuhi lebih banyak keperluan keselamatan daripada reka bentuk lain. Selain itu, mekanisme untuk pintu penerimaan dan slot mengambil ruang yang kurang dan kurang rumit daripada dalam Reka Bentuk 2 dan 3. Aktuator dipilih berbanding spring kerana ia mempunyai kriteria unggul dalam alternatif konsep apabila dinilai menggunakan Pugh's Matrix.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to the and Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform. Thank you also to the Malaysian Ministry of Higher Education (MOHE) for the financial assistance.

My utmost appreciation goes to my main supervisor, Ts. Dr. Kamarul Bin Amir Mohamed, Faculty of Engineering Technology, Universiti Teknikal Malaysia Melaka (UTeM) for all his support, advice and inspiration. His constant patience for guiding and providing priceless insights will forever be remembered.

Last but not least, from the bottom of my heart a gratitude to my supportive friend, Nor Azureen, Muhammad Firdaus, Aliah Afifah, and Nor Nazira for their encouragements and who have been the pillar of strength in all my endeavors. My eternal love also to all my college, for their patience and understanding. Finally, thank you to all the individual(s) who had provided me the assistance, support and inspiration to embark on my study.

TABLE OF CONTENTS

PAGE

DECLARATION

APPROVAL

DEDICATION

ABSTRACT **i**

ABSTRAK **ii**

ACKNOWLEDGEMENTS **iii**

TABLE OF CONTENTS **iv**

LIST OF TABLES **vii**

LIST OF FIGURES **viii**

LIST OF SYMBOLS AND ABBREVIATIONS **xi**

LIST OF APPENDICES **xii**

CHAPTER 1 INTRODUCTION **1**
1.1 Background 1
1.2 Problem Statement 2
1.3 Research Objective 3
1.4 Scope of Research 4
1.5 Report Outline 4

CHAPTER 2 LITERATURE REVIEW **6**
2.1 Introduction 6
2.2 Internet of Things (IoT) 6
2.2.1 General Device 7
2.2.2 Sensing Devices 7
2.2.3 RFID Security System 9
2.3 History of Post Box 9
2.4 Parcel Delivery 11
2.4.1 List of Courier Services in Malaysia 12
2.4.2 Statistic of Postal Delivery by Pos Malaysia 14
2.4.3 Type of Package 15
2.5 Home Property in Malaysia 18
2.5.1 Types of Home Property 18
2.5.2 Gate of home property in Malaysia 20
2.6 Part Component 25
2.6.1 Box Casing 25

2.6.2 Inner Part 29
2.7 Structure Analysis 36
2.7.1 Finite Element Analysis 36
2.8 Summary of Literature Review 38

CHAPTER 3 METHODOLOGY 41
3.1 Introduction 41
3.2 Planning of Study 41
3.3 Phase I Study and Research 43
3.3.1 Study Current Product in Market 43
3.3.2 Problem Statement 44
3.3.3 Part Identification 44
3.3.4 Review Product in Current Market 45
3.4 Phase II Design 45
3.4.1 Construct Questionnaire 45
3.4.2 Distribute Questionnaire 46
3.4.3 Obtaining Product Information 47
3.4.4 Analyze The Data 47
3.4.5 Categorized Customer Demand 47
3.5 Phase III Development 48
3.5.1 Morphological Chart 48
3.5.2 Solidwork 3D Drawing 48
3.5.3 Analysis Simulation (Solidwork) 49
3.5.4 Fabrication 49
3.5.5 Product Functionality 49

CHAPTER 4 RESULTS AND DISCUSSION 51
4.1 Introduction 51
4.2 User Requirement Preliminary Survey 51
4.3 Analysis of Questionnaire 52
4.3.1 Section I – Respondent Background 52
4.3.2 Section II – Shopping Experience 55
4.3.3 Section III – Design Selection 60
4.4 Design and Development of Smart Home Post Box 64
4.4.1 Morphological Chart 64
4.4.2 Concept Sketch 66
4.4.3 Hanging idea 71
4.4.4 Method to hold the box 75
4.5 Pugh's Matrix 78
4.6 House of Quality (HOQ) 79
4.7 Technical Drawing 80
4.8 Solidwork Analysis 81
4.8.1 Simulation for post box 81
4.8.2 Simulation for other parts 83
4.8.3 Simulation for trolley 88
4.9 Electronic part 90
4.9.1 Component used 90
4.9.2 Coding for the process 93

4.10 Prototype 95
4.11 Summary 97

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS 98
5.1 Conclusion 98
5.2 Recommendations 99

REFERENCES 100

APPENDICES 105

LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1	Types and Uses of Sensors	7
Table 2.2	Top 10 Courier Services in Malaysia 2020	12
Table 2.3	Postal Delivery by Average Number and Percentage in year 2017 - 2020	14
Table 2.4	Number Of Postal Delivery Each Box In Year 2017 - 2020	15
Table 2.5	Type of Package	16
Table 2.6	Type Of Home Property In Malaysia	19
Table 2.7	Type Of Gate	24
Table 2.8	Example Of Current Market Post Box	25
Table 2.9	Types Of Post Box Materials And Its Characteristics	28
Table 2.10	Types Of Electric Motor	30
Table 2.11	Different Between Induction Motor And Synchronous Motor	32
Table 2.12	Basic Winding Types To Identify Types Of DC Motor	33
Table 2.13	The Advantage and Disadvantage of Finite Element Analysis	37
Table 2.14	Summary of Literature Review	38
Table 4.1	Morphological Chart	65
Table 4.2	Pugh's Matrix	78
Table 4.3	Electronic Component Used	91

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1.1	Example of Home Post Box	2
Figure 1.2	Example Of Current Situation In Home Property	3
Figure 2.1	Britain's Oldest Red Postbox	11
Figure 2.2	Small 'C' Size Wall Box by WT Allen (post 1881)	11
Figure 2.3	Postal Delivery In Year 2020 By Pos Malaysia.	15
Figure 2.4	Gate Design 1	21
Figure 2.5	Gate Design 2	21
Figure 2.6	Gate Design 3	22
Figure 2.7	Gate Dimension	23
Figure 3.1	Framework of Study	42
Figure 3.2	Framework of Product Development in Phase I	43
Figure 3.3	Framework of Product Development in Phase II	45
Figure 3.4	Front Page Of Google Form Survey	46
Figure 3.5	Framework of Product Development in Phase III	48
Figure 4.1	Percentage Of Respondent Gender	52
Figure 4.2	Percentage Of Respondent Age	53
Figure 4.3	Percentage Of Respondent Occupation	54
Figure 4.4	Percentage Of Respondent's Home Property	54
Figure 4.5	Percentage Of How Frequent Respondent Buying Products Online	55
Figure 4.6	Percentage Of How Frequent Respondent Receiving Parcel By Themselves	56

Figure 4.7 Percentage Of Maximum Parcel Received For A Day 57

Figure 4.8 Percentage Of Preferences On Receiving Parcel 57

Figure 4.9 Percentage Of Missing Parcel Experience 58

Figure 4.10 Percentage Of Opinion If Post Box Would Improve Missing Parcel Problem 59

Figure 4.11 Percentage Of Having A Secure Smart Home Post Box 59

Figure 4.12 Percentage Of Preferred Top Part Of Post Box Design 60

Figure 4.13 Percentage Of Preferences On Receiving Space Post Box Design 61

Figure 4.14 Percentage Of Preferred Design For Collection Spot 62

Figure 4.15 Percentage Of Preferred Location To Place The Box 62

Figure 4.16 Percentage Of Preferred Holder Opener Design 63

Figure 4.17 Design 1 Sketching 67

Figure 4.18 Design 2 Sketching 68

Figure 4.19 Design 3 Sketching 69

Figure 4.20 Design 4 Sketching 70

Figure 4.21 Post Box Hanging Idea 71

Figure 4.22 Hanging Issue On Property Fence Design 1 72

Figure 4.23 Hanging Issue On Property Fence Design 2 73

Figure 4.24 Hanging Issue On Property Fence Design 3 74

Figure 4.25 Example Of Top Part Of Fence 75

Figure 4.26 Hanging Issue On Property Fence Design 4 76

Figure 4.27 Sketching Real Situation Using Trolley 77

Figure 4.28 House of Quality 79

Figure 4.29 Technical Drawing Post Box 80

Figure 4.30 Technical Drawing Trolley 80

Figure 4.31 Post Box Stress Analysis 81

Figure 4.32 Post Box Displacement Analysis 82

Figure 4.33 Post Box Factor Of Safety Analysis 83

Figure 4.34 Analysis For Receiving Door 84

Figure 4.35 Analysis For Receiving Slot 85

Figure 4.36 Analysis For Hinge 86

Figure 4.37 Analysis For Platform 87

Figure 4.38 Trolley Stress Analysis 88

Figure 4.39 Trolley Displacement Analysis 89

Figure 4.40 Trolley Factor Of Safety Analysis 90

Figure 4.41 Hardware Connection 92

Figure 4.42 Hardware Connecting Using Circuito Software 93

Figure 4.43 Coding Part 1 94

Figure 4.44 Coding Part 2 94

Figure 4.45 Prototype of Home Post Box 95

Figure 4.46 Prototype of Home Post Box (Opened) 96

Figure 4.47 Prototype of Trolley 96

LIST OF SYMBOLS AND ABBREVIATIONS

cm	-	Centimeter
h	-	Height
w	-	Wide
d	-	Deep
No.	-	Number
mm	-	Milimeter
etc	-	Et cetera
	-	

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
APPENDIX A	Preliminary Survey	105
APPENDIX B	Gantt Chart PSM 1	110
APPENDIX C	Gantt Chart PSM 2	112
APPENDIX E	Sketching	114
APPENDIX F	Turnitin Result	118

CHAPTER 1

INTRODUCTION

1.1 Background

People's lifestyles have changed in recent years. Going to crowded markets makes people feel uncomfortable and time consuming (Sunitha & Gnanadhas, 2014). As a result, E-Shopping is a blessing because it saves a great deal of time. Consumers buy goods, services, and other items directly from sellers through the Internet without the need of an intermediary provider. Online stores are typically open 24 hours a day, and many consumers have access to the internet both at work and at home. As a result, shopping online is incredibly convenient for them.

As online shopping available 24 hours a day, platform users can purchase their desired item at any time. When a courier delivers a delivery to a user, a common problem occurs when the user purchases too many items and has too many packages to be delivered, but there is no one at home to accept them. Some couriers will simply leave the package near the house or in the garage area, by toss it away. This is why the parcel post box was created. If the item is fragile, it can reduce the chances of the package being damaged, lost, or shattered.

A parcel post box is a mail box that accepts packages. Its purpose is to accept and store delivered packages in a safe container. The parcels can only be retrieved by someone who has a key because of the way they are designed (Sam Ellis, 2021). The package will be secured in the box once the delivery person has dropped it in, and no one will be able to

remove it. To ensure that no one can break into a parcel drop box, it is normally made entirely of sturdy metal. Figure 1.1 below shows the example of Home Post Box in market.

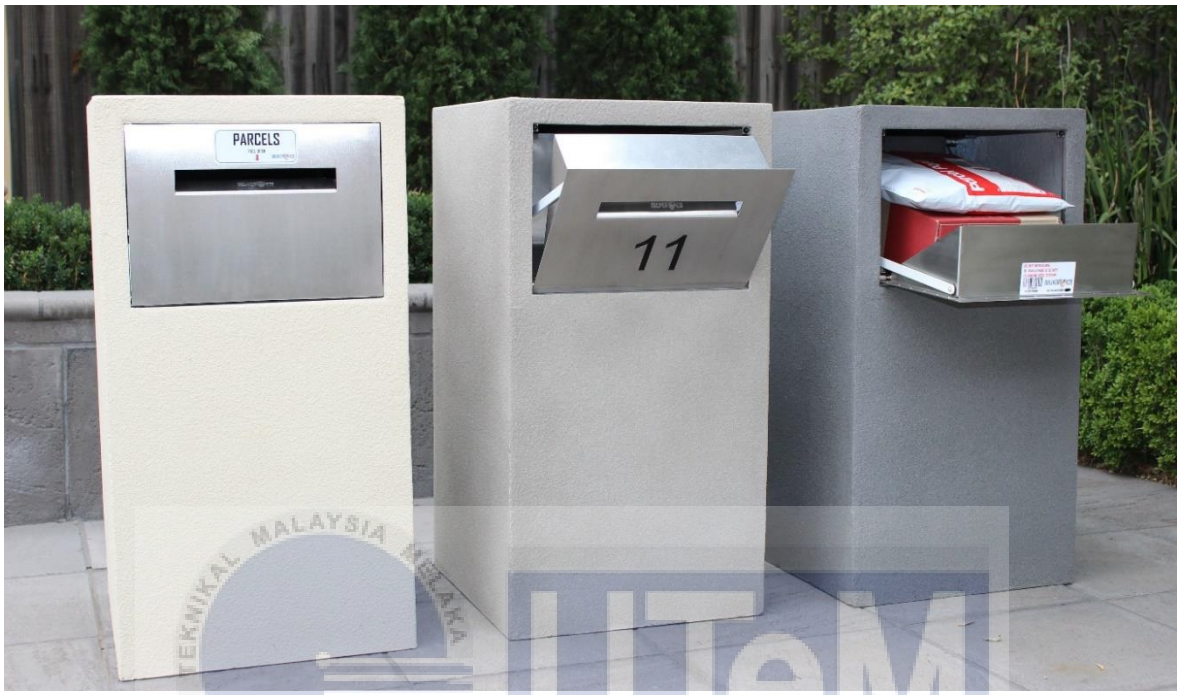

Figure 1.1 Example of Home Post Box

1.2 Problem Statement

With the rise in popularity of e-commerce, the number of shipments dispatched is continuously increasing. This fact implies a big opportunity for the logistics and postal services industry. Currently, the postal sector is confronted with the problem of recipients who have limited of time to accept delivery by courier or postman, therefore packages are left at the post office or other contact delivery places (Turská & Madleňáková, 2019).

Other than recepient is not available at home during the delivery, some people also a bit lazy to receive the parcel even they at home because sometimes in a day, the delivery might come twice or trice a day depends on the person's shopping pattern. Sometimes, the parcel is left outside the house, or the receiver themself prepare a simple box for the courier

to put the parcel. This method will somehow increase the issue of missing parcel even in the tracking provided stated that the parcel is already being delivered. Other than that, the parcel also will damage if the parcel if delivered during rainy days. Figure 1.2 shows the example of current situation in home property that use basket to put their parcel if they not at home.

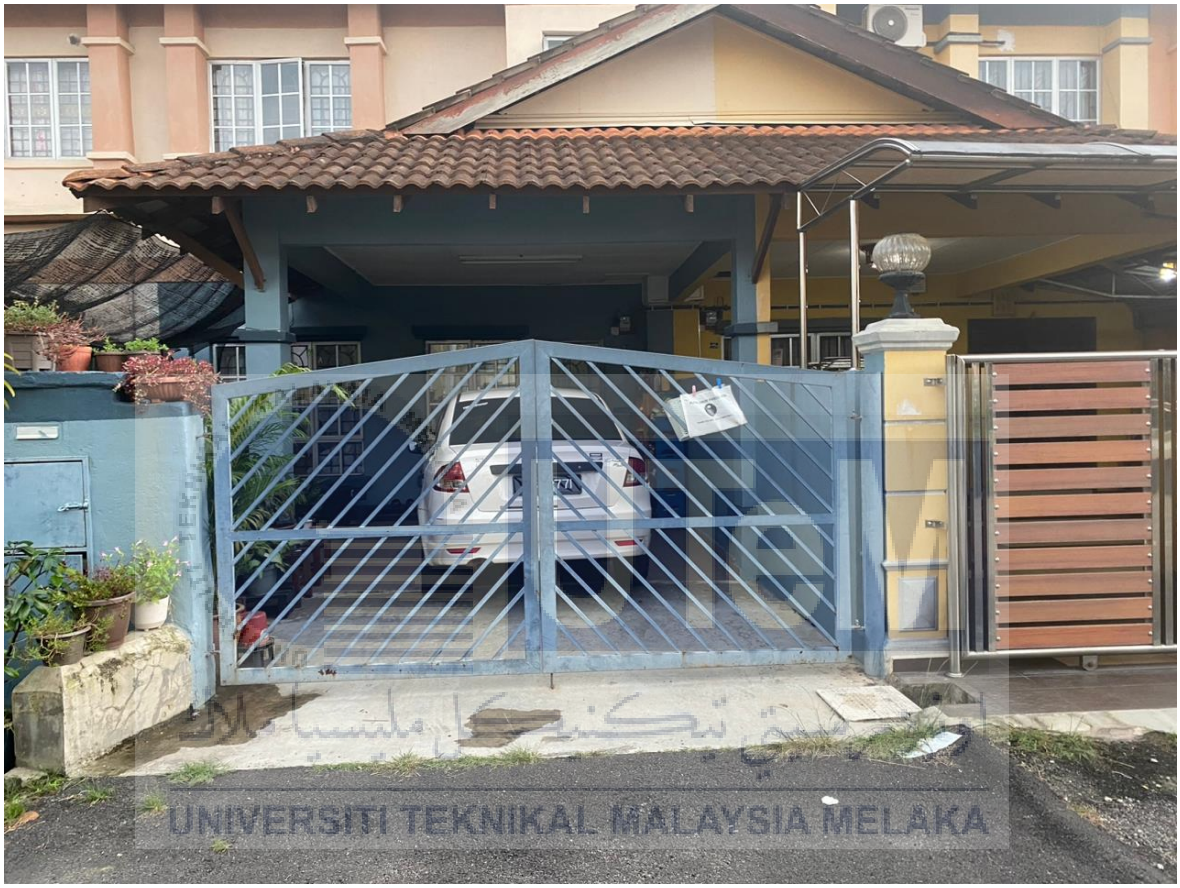

Figure 1.2 Example Of Current Situation In Home Property

1.3 Research Objective

There are three objective to be achived, which is :

a) To study user preferences towards the product design and characteristic of a home post box.

b) To design Smart Home Post Box based on questionnaire provided.

c) To develop a post box for the use of most home property.

1.4 Scope of Research

The scope of this project is to focus on the needs of home post box in most home property in this era of majority people prefer to buy or shopping their things online. This survey will be carried out on respondents. To complete the project, a simple questionnaire was needed and created in order to investigate customer experience in online shopping and also their preferences in the design of home post box. For the development, this project also conducted a research on the characteristics of a home post box. However, the main focus of this project is to minimize the issue related on deliverying parcel from courier man to receiver, such as missing parcel problem.

1.5 Report Outline

This research proposal is separated into five chapters. The project background, literature review, methodology, result, and project summary are all included in one thesis report. Chapter 1 reviewed the project background, problem statement, research objective, research scope, report outline, and summary. This chapter is essential in conveying the project's history and purpose.

Chapter 2 covers on the literature study about home post box, the material used on the outer casing of the box. Other than that, this chapter includes study on where the position of smart home post box suitable to be located based on variety of home property and types of gate in Malaysia. Besides, the size of smart home post box will be studied based on the majority size of parcel from courier. Basically, Chapter 2 will cover more on the product knowledge.

Chapter 3 which is Methodology explain on how to get the data from the research study. Other than that, it is also describes the project flow for Smart Home Post Box from

the beginning of project, until the final product is produced. In chapter 3, it is divided into 3 phase. Phase I is a study on the background product, while Phase II focuses on the design, and Phase III is about how to develop the Smart Home Post Box.

Chapter 4 represent the results and analysis which have been made on the development of Smart Home Post Box. In this chapter, the result is obtained from the response collected in the questionnaire. While the analysis can be found in terms of few aspect. Among them are the analysis of the outer frame structure, how to select the design of the product by using morphological chart, analysis on the automation of the product.

Chapter 5 finally concludes the improvement that have been made, the difference between current product in the market, and the improved product based on the customer requirement collected from survey. This chapter also includes the study objective achievement and provides suggestion for future innovation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter makes an attempt to evaluate the relevant literature and research on the Smart Home Post Box, which is conducted in this study. Encyclopaedias, articles, journals, is few of the sources used in this chapter as a reference. This chapter first discusses the history of the home post box, as well as the innovations in the home post box from its inception to the most recent form on the market. Followed by types of home post box, component used in the development of Smart Home Post Box, the design in the current market and etc. This chapter will also cover the integration of IoT into the system, which allows sensors and smart devices to monitor a network of physical items.

2.2 Internet of Things (IoT)

In a fast-changing world, technology has acted to improve people's lives. This involves the use of the Internet of Things (IoT). IoT is also known as ambient Technologies or Embedded Systems, is a worldwide system of IP-connected computer networks, sensors, actuators, machines, and gadgets that connect the physical and virtual worlds (Pawan Kumar, n.d.). It is a new paradigm that consists of a continuum of uniquely addressable things connecting with one another to build a global dynamic network. The Auto-ID Center at MIT, the development community of the Radio-Frequency Identification (RFID) standard, is credited with the invention of IoT (Borgia, 2014). In a context of IoT devices, it is can be classified into General Devices and Sensing Devices.