WISE SHOPPING WITH RADIO FREQUENCY IDENTIFICATION (RFID) BASED SMART TROLLEY SYSTEM

BY

LEE MENG XIAN

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF INFORMATION TECHNOLOGY (HONS)

COMMUNICATIONS AND NETWWORKING

Faculty of Information and Communication Technology

(Perak Campus)

MAY 2018

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DECLARATION OF ORIGINALITY

I declare that this report entitled "**WISE SHOPPING WITH RADIO FREQUENCY IDENTIFICATION (RFID) BASED SMART TROLLEY SYSTEM**" is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

Signature   :   _____

Name   :   _____

Date   :   _____

ACKNOWLEDGEMENTS

I would like to express my sincere thanks and appreciation to my supervisors, Dr Robithoh Annur who has given me this bright opportunity to engage in Radio Frequency Identification (RFID) project. It is my first step to develop a smart device with the use of RFID technology. A million thanks to you.

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ABSTRACT

Nowadays, shopping market rely on barcode technology for their groceries. This technology is outdated and less effective because it require line of sight technology during scanning where the barcode tags must be oriented in a specific direction. Besides that, shopping market provide a simple trolley for their customer where this trolley only used for carrying the groceries. This leads to a significant problem during a low fare price happens in shopping market. This is because during those periods, customer will spend more on groceries until over budgeting. They will not noticing this issues until they pay for groceries. As a result, this shopping experience is less effective and consuming times for the customer during shopping.

The proposed system in this project will use RFID technology for all the groceries. This way, the system is more effective in term of scanning because the tags can be oriented in any direction. Besides that, the system request user to enter a budget amount before start for shopping. When over budget detected, this system will provide some options to overcome it. This system will attach on the trolley where the scanner will scan each of the entries for the grocery. Furthermore, a database system will designed to store all the information for the products and the RFID tag values. Finally, a web application is design for the user and admin to manage the product from the database. The aim of this project is to allow user to have an interactive experience during shopping for groceries where it reduce the risk for user to encounter over budget issues.

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LISTS OF ABBREVIATIONS

RFID	Radio Frequency Identification
Etc.	Et cetera
LCD	Liquid-crystal Display
LF	Low Frequency
HF	High Frequency
UHF	Ultra High Frequency
MHz	Megahertz
GHz	Gigahertz
IR	Infrared
GUI	Graphical User Interface
EEPROM	Electrically Erasable Programmable Read-Only Memory
LAMP	Linux, Apache, MySQL, PHP
OS	Operating System
SPI	Serial Peripheral Interface
IoT	Internet of Things

CHAPTER 1 – INTRODUCTION

1.1 Motivation and Problem Statement

Shopping for groceries cannot separated with our daily life. During the low fair prices or special festival, customer will always spend more for the groceries than the usual times. However, sometimes they will encounter some over budget issues due to the special sales in the shopping market. These issues happen frequently because they did not calculate the total cost for the groceries each time they add the grocery into the shopping trolley. Due to this situation, they will miss out some of the groceries they plan before start for shopping. As a result, this issue is getting serious whenever they focus only on those discounted groceries. Hence, an effective solution has to be implement for shopping trolley in order to overcome this issue. According to (Koert van Ittersum, 2013), real-time spending feedback will influence the way of shopping. Thus, by using the real-time spending feedback during shopping for groceries, shoppers able to monitoring how much they spend. Therefore, this system manage to minimize the risk from overspending happen during shopping for groceries.

Besides that, almost every shopping market is still using the old traditional barcode system. This system requires workers to scan one by one for the groceries. This is because it requires the grocery to orient in a specific direction during scanning. As a result, this will definitely reduce the shopping experience for the customer during the discounted seasons because it takes more times on scanning. In this project, a RFID based smart shopping trolley system that will features a real-time feedback at the end of the project. The reason of using RFID technology instead of barcode technology is because barcode technology requires line of sight for identify whereas RFID uses radio waves where it was more effective. Furthermore, this barcode has some constraint issues such as durability whereas RFID tags are more durable and safer. With the use of RFID technology on smart trolley, workers can reduce their workload as they scanning multiple items at once. Thus, the shopping experience can be improve even there is a special sales happen.

The motivation of this project was to allow the user to have a wise shopping experience with the use of real-time feedback system and RFID technology.

1.2 Project Objective

1. **To develop an over budget detection system for smart trolley to reduce the risk for over budget during shopping for groceries.**

   - Every user might have a different budget plan before going shopping for groceries. Therefore, this system will requesting user to enter a budget amount in order to proceed for shopping. Afterwards, user can scan the product by using the RFID scanner that build on top of the smart trolley. Besides, with the real time feedback system build along with the scanner, user can always know how much they spend and how much does the budget left. When over budget detected, this system will alert user first then provide some options to overcome the issue.

2. **Design a shopping list web application for user to interact with smart trolley system.**

   - The web application develop for this system is to allow user to create a shopping list before going shopping for groceries. Once user create their own shopping list, smart trolley system will synchronize the list. Then, each time user enter the product into the cart that also matching with the shopping list, the product from the shopping list will be remove or highlighted.

1.3 Project Scope

This project aims to develop an over budget detection system on the shopping trolley. In order to solve the problem stated, user has to enter a budget amount before start using the system. A real-time feedback system will be develop on top of the shopping trolley where it allow user to monitor how much they spend during shopping. Besides, this shopping trolley also capable to scan each of the product user put inside the trolley by using a RFID scanner. Each time they put the groceries inside the trolley, the LCD display will display the information of the item and price. Furthermore, the processing tools used in this project is microcomputer Raspberry Pi 3 with a connected RFID module. The RFID module is used to scan the RFID tag from the products while Raspberry Pi will processing the information and retrieve the data from the database. After the data retrieved, the information will display on the 16x2 LCD where it connected to Raspberry Pi. When over budget detected by the system, an alert sound will notify the user and they can start to select different options to overcome the issue. Finally, this smart trolley system targeted to all customer in the shopping market.

1.5 Proposed Approach

In this project, we are going to develop an interactive smart trolley system by using RFID modules. This system not only allow user to use the real-time spending feedback with budget detection system on the trolley but also manage to interact it with the web application. Before using the smart trolley system for shopping, user can create their shopping list on the web application. Then, during using the smart trolley system, user require entering their account in order to synchronize their shopping lists. This idea of the system provide a simple and interactive way for user during shopping for groceries. By using this system, they would not miss out what they plan to buy and under their budget amount.

1.6 Report Organization

This report consists of six chapters in total. The first chapter introduce the concept of the project, the problem and motivation for working on a project, project scopes and objectives. In the second chapter, four different types of RFID based smart trolley projects are reviewed and compared with the proposed solution. Their functionalities and design features are examined. This chapter also includes some background information related to the project.

In chapter three, the system design has explains in details. Instruction to set up the system and the database are describe in this chapter. Chapter 4 explains the methodology and tools used in this project and timeline for this project. Chapter 5 explains in details on the implementation and testing for the project.

Final chapter concludes the project and explain the possible future improvements on the finished system.

CHAPTER 2 – LITERATURE REVIEW

2.1 Review of Technology

In this following chapter, the technology used to implement for this smart trolley system can be accomplish by different technologies. Meanwhile, a few examples of smart trolley system that related to this project had reviewed.

2.1.1 Radio Frequency Identification (RFID)

Radio Frequency Identification is a type of wireless communication technology used to capture data that linked to different attributes of entities carrying RFID tags. The data accumulate process will be carry out by exchanging the radio-frequency electromagnetic waves between RFID transponder and interrogator. (Chetouane, 2015) Fundamentally, RFID system is form by two parts; transponder (tag) and interrogator (reader). (Finkenzeller, 2010)

Tags are categorize into three types namely passive, active and semi-passive. Passive tag does not require power sources. However, the antenna on the passive tag is important to connecting the reader because the magnetic or electromagnetic field of the reader will supply all the power for operating the tags. Meanwhile, active tags have their own energy supply. This own resources is use to supply the voltage for the chip. Then, the magnetic and electromagnetic field received by the interrogator will not require. Furthermore, the inner battery of active tags can used to transmit through a longer distance and higher data rates. Other than that, the semi passive tag is a type of passive tag that contains the features of active tags. This semi-passive tag has internal power source that used to supply power for the chips. But the difference between semi-passive tags and passive tags is that the semi-passive tag has a greater range and have the ability to monitor sensor input that are not appear within a radio frequency field. (Finkenzeller, 2010)

There are three different types of transmission frequencies in the RFID technology; LF (30 – 300 kHz), HF (3 – 30 MHz) and UHF (300MHz-3GHz). (Finkenzeller, 2010) These frequencies define the resistance to interference and other performance. Hence, different frequencies are use on different RFID tags. On the other hands, RFID reader used to extract the information received

from the signal of the tags to the hosts. The core components for the reader is the antenna. This is because the radiation or reception of electromagnetic waves has been to a large degree optimize for selected frequency ranges. (Finkenzeller, 2010) Traditionally, antennas are select by their bean width. As a result, it can induces scattered waves in different directions and guarantee a bigger reader zone coverage. (Chetouane, 2015)

2.1.2 Barcode

Barcode is a pattern of bars and spaces with different width where it represent the digits, letters or other symbols. This technology can be used for identify a product price or name. In the past, this technology is a useful recognizable tool that provides precise support for sophisticated management systems. (Singh & Sharma, 2015) Traditionally, barcode tag stores the data in the width and space on the printed lines. Then, these lines and spaces can be design in different thickness and different combination. Furthermore, this technology contains two unique pattern for identify the start and end or start and stop character in a barcode symbol. As a result, the digits and punctuation symbol can be determine by different widths of black bars and white space. The function of the barcode scanner is to extract the information optically from the barcode. During the process for retrieving the data from a barcode, the intensity of reflected light from the dark bars will be less than the white spaces. As a result, the reflected light converted into an electronical signal. Then, the decoder from the scanner converted this data into character data that represented of the barcode.

2.1.3 Comparison between RFID and Barcode technology

The idea behind this project can be accomplish by different technologies. In order to build a reliability application that has to meet to our scope of the project, we have choosing carefully in different technologies such as RFID and Barcode. We compare each of the technology in different perspective. As a result, RFID became our first choice to be use in this project.

Traditionally, shopping mall tends to use barcode system for the groceries and inventory tracking. In this project, we use RFID to replace barcode because RFID can improve the effectiveness while

reducing the time for scanning. Furthermore, the biggest differences between these two technologies are barcode technology uses light as the transmission media while RFID uses radio waves. (Yewatkar, et al., 2016) Table below show the differences between RFID and barcode technology.

	RFID	Barcode
Speed of scanning	Fast. Scan multiple items at once.	Slow. Scan one by one.
Require line of sight	No. Tag can oriented in different direction during scanning.	Yes. Items require oriented in specific position during scanning.
Human Capital	No. Automated.	Yes. Require workers scan each of the tags.
Read/Write Capabilities	Yes.	Read only.
Durability	High. Internally attach and able to scan in a harsh environment.	Low. Unreadable when the tag damaged or stained.
Security	High. Hard to copy or modify.	Low. Easy to replicate or modify

Table 2-1 Comparison between RFID and Barcode System (Yewatkar, et al., 2016)

2.1.4 Real-time Feedback

According to (Koert van Ittersum, 2013) research, he conducts 3 test on real-time spending feedback. The result showing a diverging impact on spending if a person is constrained by the budget. This paper has emphasize that the user will be under control once they set up a budget amount during spending on certain items. Besides that, Du and Kamakura (2008) conduct a research related to the uses of budget money. This research has conclude that budget shoppers will spend their budget to maximize the utility. Hence, this research imply that budget shoppers are actually underspend on their budget. They are constructing a safety margin into their shopping to limit the danger of overspending on their financial plans. Nevertheless, real-time spending feedback does helping consumers by reducing their spending uncertainty, thus allowing them to

spend more of their budget without the risk of exceeding the budget. (Lynch & Ariely, 2000) However, there are some limitation throughout these papers. For example, real-time feedback could also reduce the spending for non-budget shoppers.

2.2 Review of Existing Technology

2.2.1 RFID Based Wireless Intelligent Cart Using ARM7 (Suraj.S, Vishal Guruprasad, Udayagiri R Pranava, Preetham S Nag, 2016)

Suraj.S, Vishal Guruprasad, Udayagiri R Pranava and Preetham S Nag have conduct a project to build an intelligent cart using ARM7 and RFID technology. They have explore an automatic identification by using RFID that help to benefits the quality of service provided by the retailers. Besides, they use modernized equipment for shopping cart that will help to reduce the time at the billing counter. This system will implemented in each of the shopping cart where it will attach with a RFID reader. All the items will be equipped with a unique RFID tags. Therefore, when the customer put the desired products in the trolley, the RFID tag will scan by the reader and the product name and prices will display on the LCD screen. Furthermore, this system manage to calculate the total cost automatically. Besides, ZigBee module will be use to transfer the billing data to the counter computer. This system also included an IR sensor that used for detecting a select light wavelength in the infrared spectrum. In addition, this sensor is aims to counting the total items in the trolley.
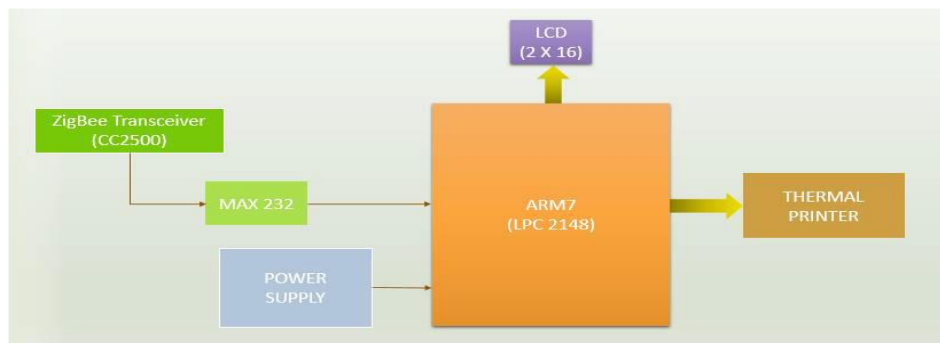

Figure 2-1 Transmitter Block Diagram of RFID based Wireless Intelligent Cart Using ARM7 (Suraj.S, et al., 2016)

From the block diagram above, thermal printer provided on the trolley. This equipment will printed a total billing for the customer once finishing shopping. Apart from that, ZigBee technology is use to controlling and monitoring applications.

As a result, the advantages of this system does help the customer to reduce the waiting time at the counter for their billing payment. All their purchases will be transfer to the central billing system by using ZigBee; therefore, they can pay their bills through credit/debit cards as well. Thus, this system proposed is time-effective for the user. Other than that, there are some limitations in this system. For example, latency time of the communication between the devices and the server. Besides, ZigBee can easily intercepted during transmitted data whenever the operating frequency is same.

2.2.2 Developing a Multitasking Shopping Trolley Based On RFID Technology (Satish Kamble, Sachin Meshram, Rahul Thokal, Roshan Gakre, 2014)

Another system proposed by Kamble, Meshram, Thokal and Gakre in 2014 had focused on the scalability, affordable, and multitasking shopping trolley system. In this system, it consists of three mains part. Firstly, Server Communication component (SCC) maintained the connectivity between the cart and server. This component offers a more security way during transferring the data between the cart and the server. For example, when customer finish shopping, the purchasing list will be transfer under a secure method to shopping list database. User Interface and display component (UIDC) provide a user-friendly interface for customer to review the status of the items in the trolley. Whereas Automatic billing component (ABC) handles the billing where associates with SCC components. All of these components have to working together in order to perform some associated task.

The advantages in this project is to increase the speed of purchasing during shopping. With the use of RFID based security system, user does not need to wait longer in the shopping mall during purchasing for groceries. Moreover, this system had create a database web management by using .net framework. Hence, the user can easily login into the database to view for their purchases. This will help them to improve the efficiently during shopping because they would not need to

verify each of the items separately. Furthermore, the RFID technology is much effective compare to barcode as barcode technology is slow and less effective.

There are some limitations in this system. Firstly, reliability is one of the issues for this system. Malfunction happens if one of the components stop services. For example, if the server communications component is stop functioning, this system will also stop functioning because most of the components are rely on each other in this system.

2.2.3 Automated Shopping Trolley for Super Market Billing System (S.Sainath, K.Surender, V.Vikram Arvind, 2014)

In 2014, Sainath, Surender and Vikram Arvind has proposed a smart trolley system which integrated Raspberry Pi, Embedded Chip with two barcode scanner and battery kit to allow user to self-checkout at the shopping market. This system exploited barcode technology for billing products where the customer can be self-scan the product using the barcode scanner on the shopping trolley. Meanwhile, barcode values are preloaded into database and coded application can access these values using wireless network. After that, all of the product details will be sending to the server at the checkout counter where user able to pay instantly at the counter. Furthermore, there is a keypad in this system whereby allow user to changes the amount of the product due to wrongful entries. A smart devices with a GUI based android application will be attached on the trolley where it uses for communicate between the server and the android application.
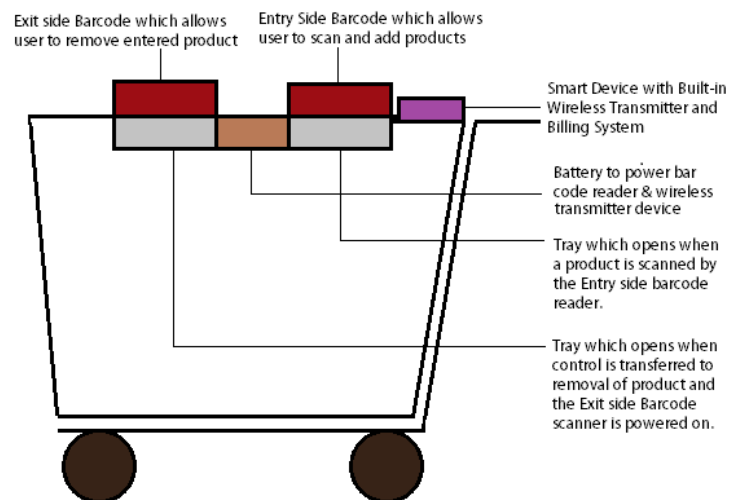
Figure 2-2 Visual Diagram of Automated Smart Trolley for Super Market Billing System (S.Sainath, et al., 2014)

With the use of barcode scanner in this system, it helps user to self-checkout while increasing productivity time. Besides, this system also benefits to the management section because it can reduce the work force and the expenses incurred by the management.

There are some disadvantages in this system. It would be costly to implement this system on a large scale. Therefore, it would be difficult for a small-scale vendor to use this costly system. Besides that, this system require constant battery for the scanner. Without power source, this system will stop working.

2.2.4 Smart Shopping Cart with Automation Billing System through RFID and Bluetooth (Prateek Aryan, Prof. Priya Pise, Sandip Tamhane, Rakesh Patil, Kaustubh Pittulwar, 2014)

Another smart shopping cart system proposed by Aryan, Rise, Tamhane, Patil and Pittulwar has focuses on the automation billing system through RFID and Bluetooth. There are two major perspectives in this system. RFID technology was used to identify products automatically within specifies ranges and proceed to the billing system. Bluetooth used for communication between cart and mobile devices. Once the RFID tags being scan by the scanner, the product information will sent to EEPROM. After that, this data will sent to central billing system through Bluetooth. The central billing system will immediately collect the data and start calculate the total amount for that particular cart. Furthermore, each time the product being scan, the data will sent to the user's mobile device via Bluetooth. Besides that, this system included a special features where the data stored over the cloud and encrypted using Attribute Encryption Algorithm.
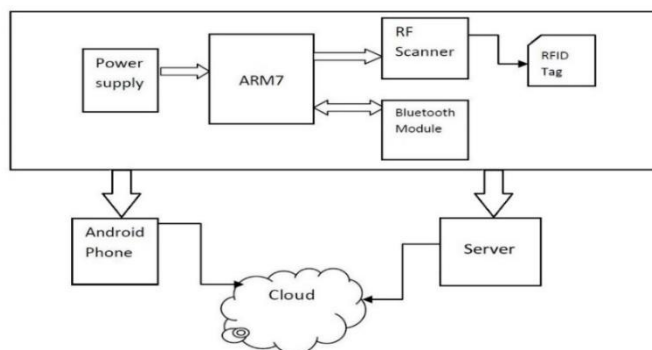
Figure 2-3 System Architecture of Smart Shopping Cart with Automation Billing System through RFID and Bluetooth (Aryan, et al., 2014)

One of the advantages in this system is the shopping cart has the ability to calculate the total bills automatically and display the total prices on the mobile devices. This feature makes it easy for the customer to know how much they spend for shopping. With the integration between RFID and Bluetooth, it makes the system more intelligent and easy to use.

There is some limitation in this system where this author should not expect each of the user has a smart phone during shopping. Without smartphone, this system will be less effective where user difficult to review what they had buy during shopping. Besides that, Bluetooth can have connectivity and range issues. Malfunction will happen if the user did not have a minimum distance between the cart and the mobile device.

2.2.5 Comparison between Existing Applications

Features	2.2.1	2.2.2	2.2.3	2.2.4	Proposed Application
Technology Used	RFID, ZigBee	RFID	Barcode	RFID, Bluetooth	RFID
Hardware Used	ARM7, ZigBee Transceiver, Thermal Printer, LCD(2x16), IR Sensor, RFID reader, Keypad	RFID reader, Antenna, LCD Screen, Microcontroller	Raspberry Pi, Barcode Reader, WIFI Adapter, 4 Inch LCD Screen, 100V Battery Kit	ARM7, RFID reader, Bluetooth module, Android phone, EEPROM	Raspberry Pi, RFID reader, Keypad, LCD screen, buzzer
Software/Language Used	Keil Software, Flash Magic	VB,Net, Embedded 'C'	Android 4.4 Kitkat, Eclipse Android	Product software	Raspbian OS, LAMP, Python Language

			SDK, Barcode Driver		
Databases	Yes	Yes	Yes	No	Yes
Cloud	No	No	No	Yes	No
Graphical User Interface	Information display on LCD	Information display on LCD	Information display on smart devices	Information display on mobile device	Information display on LCD
Cost	Low	Low	High	High	Low
Power Consumption	High	Low	High	High	Moderate

Table 2-2 Comparison between existing works

2.3 Critical Remarks of previous works

In the previous review, four existing smart trolley systems were review. For the first existing work, "RFID Based Wireless Intelligent Cart Using ARM7", it was a modernized system. Several technology had been use in this system. The uniqueness for this system is the system include a thermal printer where it use for printing the billing for the user. Besides, ZigBee transmitter (CC2500) is a low-power application that use to control and monitor the whole application in this system. Both of these features make it unique compare to others previous works.

Strength	Weakness
• Reduce waiting time at billing counter. • Low Cost and easy to learn.	• Latency time of wireless communication with the server • Data easily be intercept by same frequency • Highly hardware requirement

Table 2-3 Critical Remarks Existing Work 1

In the next review, "Developing a Multitasking Shopping Trolley Based on RFID Technology", it focuses on scalability, affordable and multitasking for this smart trolley system. In this existing works, three components integrated into an embedded system in this smart trolley system. Besides, user can easily communicate the shopping cart information with a computer system where they can verify the purchases of items. Then, billing will automatically generate for them once they confirm for the purchase.

Strength	Weakness
• Improve the speed of purchases by using RFID • Easy to use	• Reliability issues between components.

Table 2-4 Critical Remarks Existing Work 2

For the next review "Automated Shopping Trolley for Super Market Billing System", it focuses on barcode technology where it allows user to self-checkout at the shopping market. The interesting part in this system is that it allows user to self-scan for the entire purchasing product by using barcode scanners on the trolley. Besides, it also provide a keypad for the user to change the amount of items due to wrongful entries. By using this system, it can benefits lots where it reduces the work force and reduces all the expenses incurred by the management.

Strength	Weakness
• Improve productivity • More secure	• Connectivity and range issues • Require mobile phone

Table 2-5 Critical Remarks Existing Work 3

In the last reviews "Smart Shopping Cart with Automation Billing System through RFID and Bluetooth", it focuses the automation billing system based on RFID and Bluetooth. For this system, each time the product being scan, the data will send to the user's mobile device. User able to review the shopping list through the mobile device. The most interesting feature in this system is the data being stored over the cloud and it has encrypted using Attributed Encryption Algorithm. With this feature, the data is much safer compare to other previous works.

Strength	Weakness
• Reduce the expenses incurred by the management. • Improve satisfaction	• Expensive to implement in large scale. • Consume high power.

Table 2-6 Critical Remarks Existing Work 4

2.4 Summary

As a result, all of the existing works are unique and innovative especially the smart shopping cart with automation through RFID and Bluetooth. This system integrate shopping cart and mobile phone which makes more integrative between user compare to the other existing works. This system definitely will improve the overall shopping experience to a different level. This is because different information in the smart trolley such as product name, and product cost will be synchronize to user's mobile devices. However, the drawback for this system is connectivity and range issues. User require staying minimum distance between the mobile devices and the shopping cart. Furthermore, this system also require user equipped with a smartphone which capable with Bluetooth technology.

Compare with all of the reviews, the proposed smart trolley system is an enhancement of the current smart trolley system. Compare to all the existing works; they are focusing more to the billing system. For this propose system, it focuses more at the beginning of the application. The goals for this system is to provide user a smart budget system before they start shopping. This budget system will improve the shopping experience for all user. The requirement for the smart trolley system is relatively low compare to other smart trolley system. As a result, using this proposed system is much easier compare to existing work. User only need to enter a budget amount on the shopping trolley system before start shopping for groceries. Meanwhile, over budget detected during shopping, an alert sound will warns the user and user can select different options to overcome over budget. Below is the strength and weakness table of the proposed smart trolley system.

Strength	Weakness
• Fast and effectiveness system • Easy to use • Offer a new shopping experience • Consume less battery	• Highly hardware requirement • Require a good connectivity between server and the cart

Table 2-7 Summary Existing Work

CHAPTER 3 – SYSTEM DESIGN

3.1 System Design / Overview

In this chapter, we will look into the design of the entire project and techniques implement on this project. The system flow of the application will presented in this chapter and the description of the database will explained in this chapter as well.

3.2 System Flow
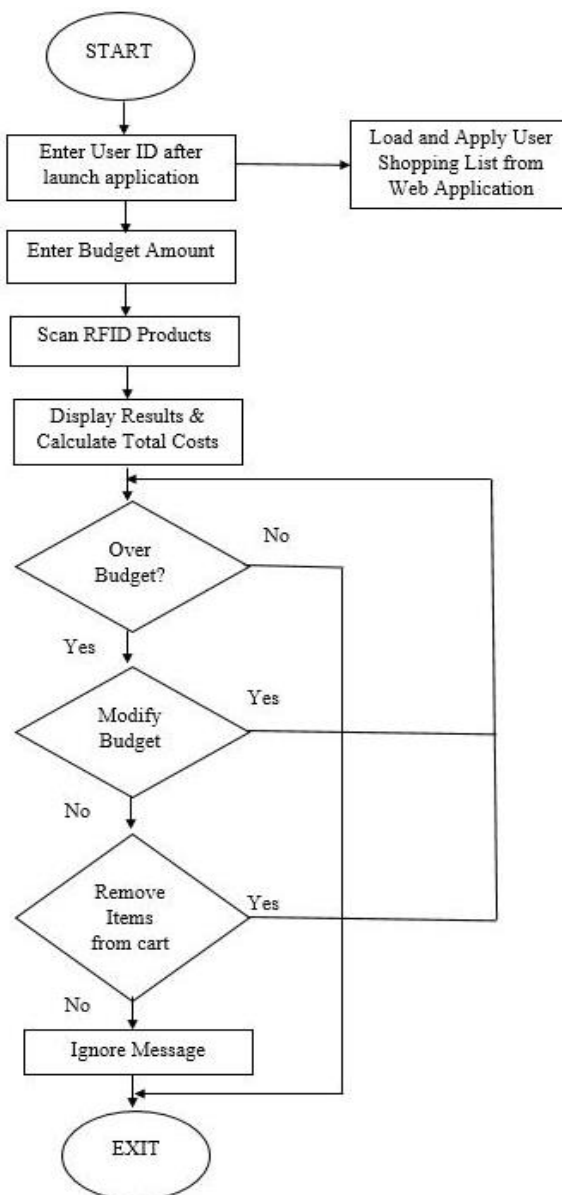
Figure 3-1 Overall System Flowchart

3.2.1 Load and Apply User Shopping List

From the Figure 3.1, after user launch the application, user require to enter their user id for the system. Then, the application will go to a process call as Load and Apply User Shopping List from Web Application. In this project, user can use the web application to create the shopping list before going to use the smart trolley system. The database use to store user shopping list is same for the entire system. The diagram below describe the flow of this process. This extra feature allow user either create or not create for the shopping list.
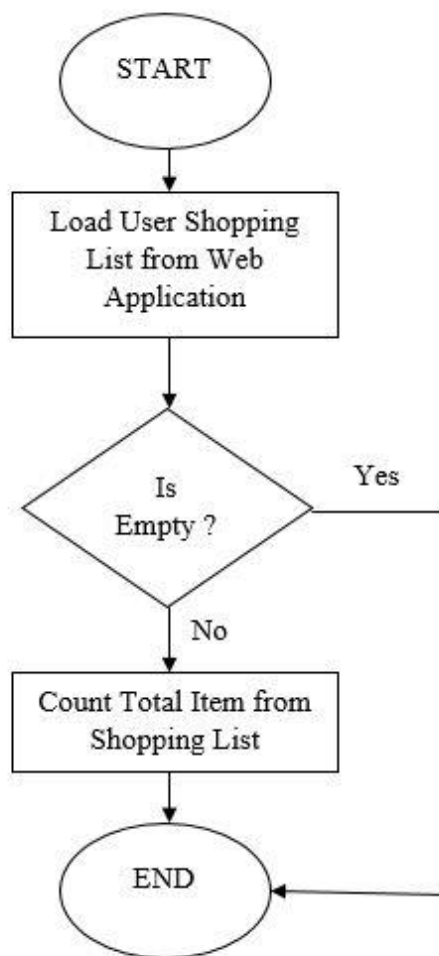
Figure 3-2 Load and Apply User Shopping List Flowchart

3.2.2 Admin Management
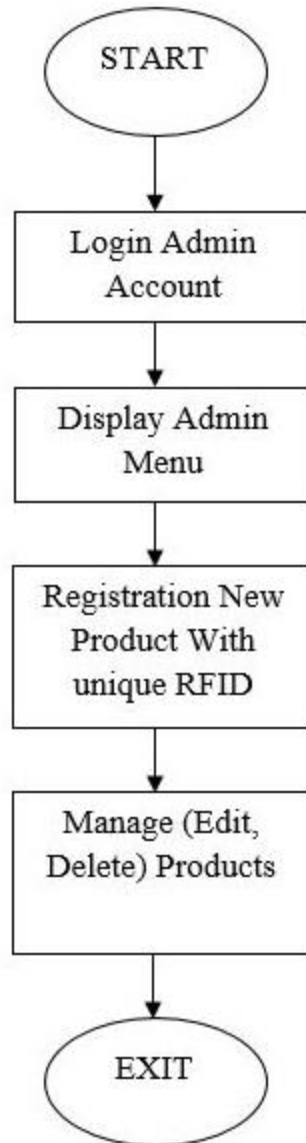
Figure 3-3 Admin Management Flowchart

From Figure 3-3, the admin management was design in PHP web application. This web application allow admin to assign the RFID tag values to the product. Before run the web application, the RFID tag values has to go through the read or write process. This process is used to check the validity of the RFID tag values. If the tag values is unused, the tag value will be automatically save into the database. After that, admin can start browse the website to manage the products with RFID tag values.

After login to the website, admin can select different options from the navigation bar. The first function is to allow admin to register new product with unique RFID values. Once the RFID value being assign to the product, the value will remove from the tag list. The next function allow admin to managing the products. This feature allow user to either edit the price of the products or delete the products from the database.

3.2.3 User Management
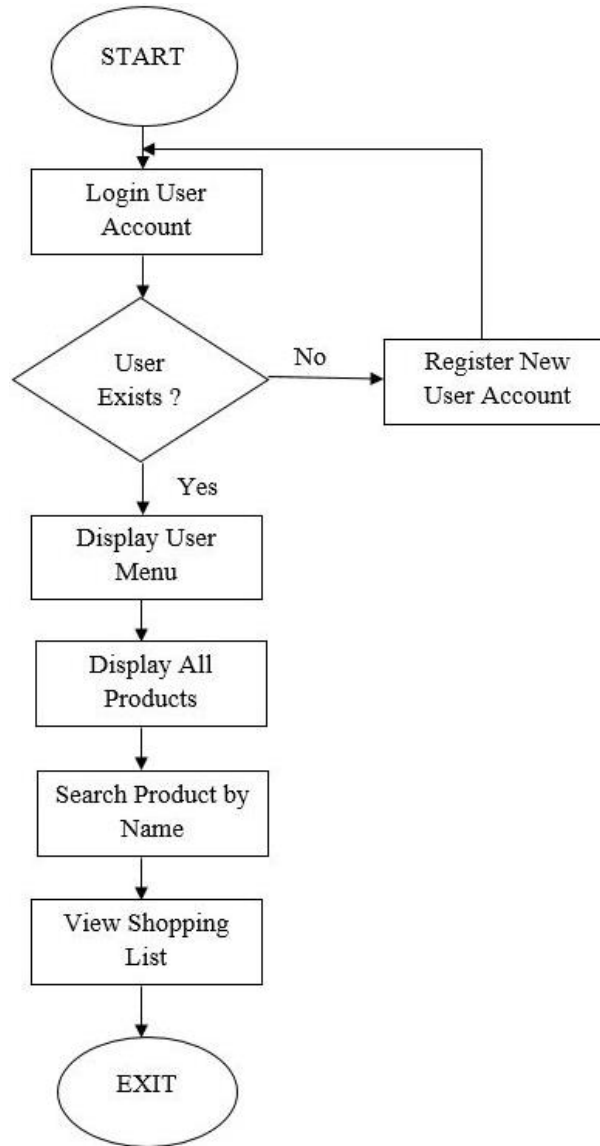
Figure 3-4 User Management Flowchart

From Figure 3-4, the user management was design in PHP web application. This web application allow user to create a shopping list before going to use the smart trolley system. In this web application, user can choose three different options before adding their desire product to the shopping list. To start using this user management web application, user has to login to their account. If user account does not exists, user require to registers their account from the website.

After login to the website, the first function for this website is to allow user to display all the products from the database. Next, user can search their wanted product by the product name in search product page. Besides, this application provide user a single click function to add the product to their shopping list. Lastly, user can always review their shopping list and managing the product at the shopping list page.

3.3 Database Design

Figure 3-5 Database Design

From the Figure 3.5, a database named 'shopping' created in this project. This database is used to store all the information including the RFID tag values for the products. In this database, there are

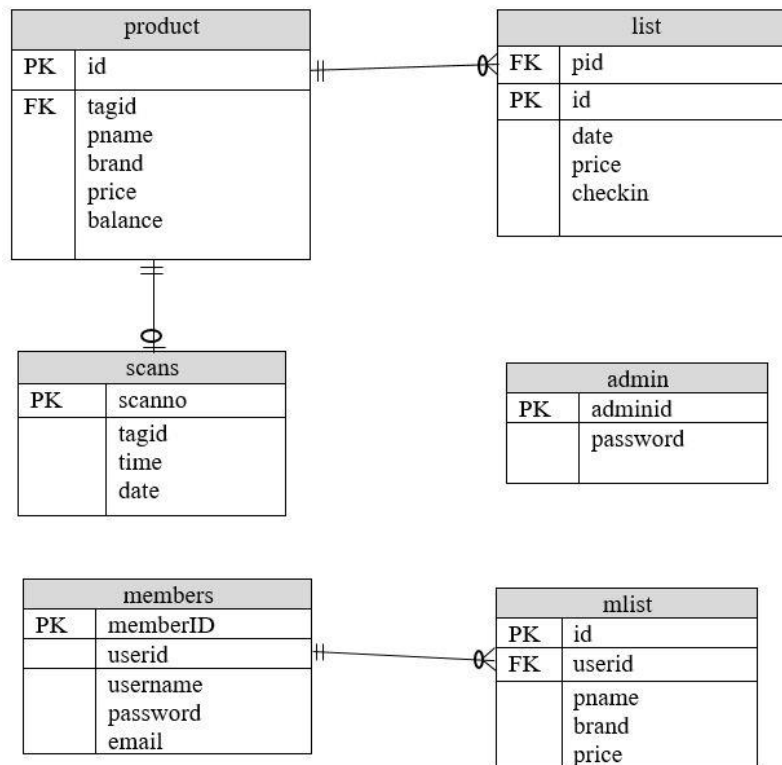six table created. For admin table, the adminid and password are the attributes in this table where it use for identify the database user. Next, the scanno, tagid, time and date has been create in the scans table. The purpose of this scans table is to insert the new RFID value after being scan. Then, each time the RFID tag value assign to product id, the tag value will be remove from this table. In product table, the attributes are id, tagid, pname, brand, price and balance. The product table is used to store all the information of the product in this project. Other than that, in list table, pid will be the foreign key to product id. The rest attributes in this table are id, date, price, and checkin. The uses for this table is to insert the product information where it located in shopping trolley only. In members table, the attributes are memberID, userid, username, password, and email. This table is used to store user information only. Lastly, the attributes for mlist table are id, userid, pname, brand and price. The userid are the foreign key in this table where it reference to members table's user id. This table is used to store the shopping list where associate with userid in the members table.

3.4 Schematic Diagram of the system
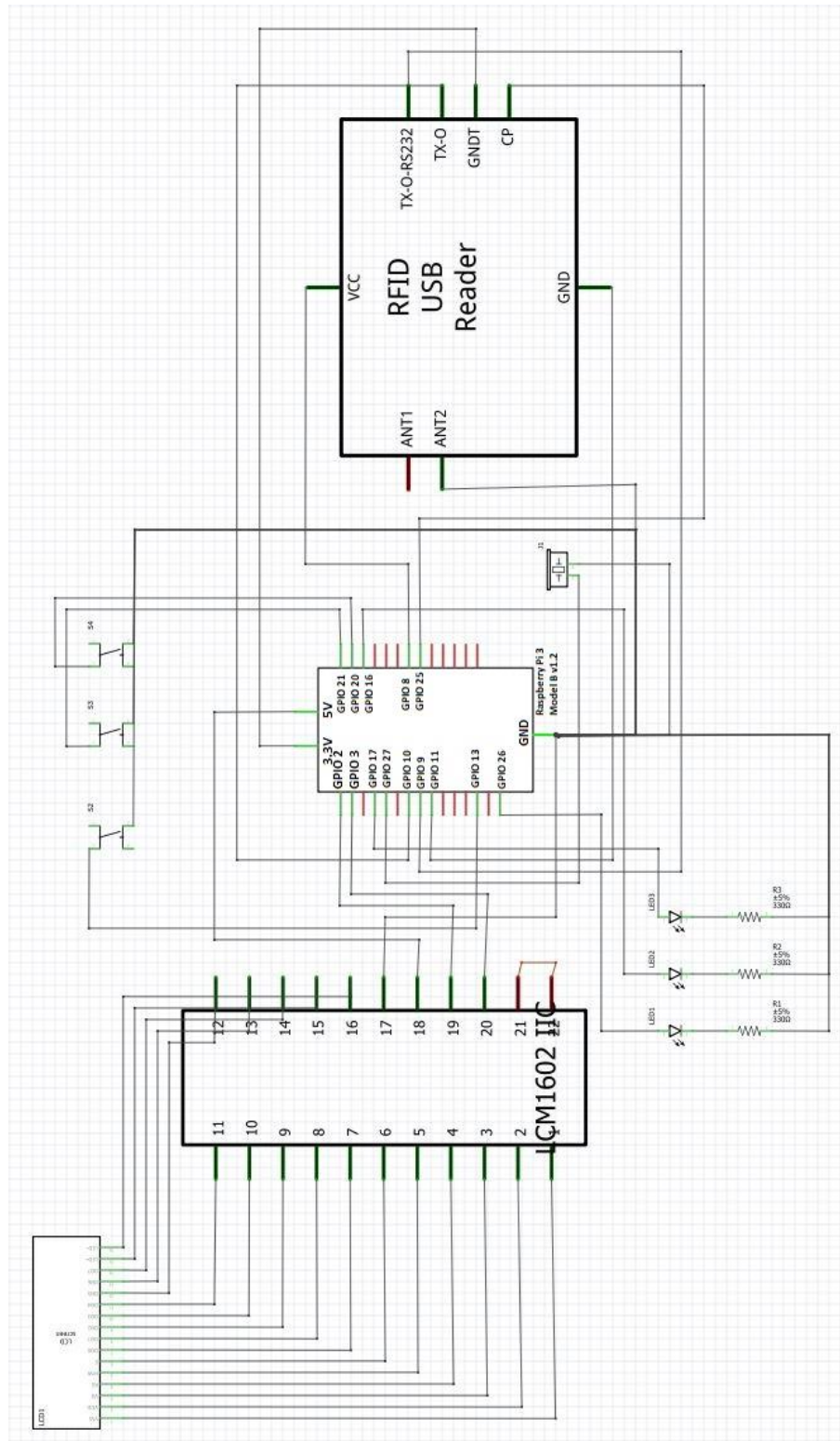
Figure 3-6 Schematic Diagram of Full System

Chapter 4 Methodology and Tools

4.1 Project Methodology

In this project, the system development methodology used is prototyping model. The reason for choosing this model is that it perform analysis phase, design phase and implementation phase concurrently. Thus, it will help the project to shorten the time for building a working prototype. By using the model, user can actually understand more on this system earlier instead of waiting for the final system to be complete. In results, this give the system designer a much clearer and understanding about the application for user during design phase. Besides, this model also allow any unclear requirements or possible errors to be detect in the early phase. Other than that, changes and additional requirements can be implement to this prototype model easily. Lastly, refinements will carry out repeatedly until a final product produced that meets all the requirements.

4.1.1 General Work Procedure

During the planning phase, the scope of the project is define. RFID technology will be our first choice to be use in this project. After that, the objective of the project had identified and determined. Then, project workflow and methods are produce respectively. Next, in the analysis and design phase, system requirement and hardware requirement are studied. In order to understand more about the smart trolley system, similar existing smart trolley projects are take into study and analysis. Based on the research, the system design and methods is propose to fits the project objective.

A working prototype is produce in the development phase. This prototype consists of two parts. First, a functional smart trolley system where it consists of RFID module. This module manage to perform read and write process of a RFID tag. Second, a functional web application develop to help admin and user to manage the products from the database. In this web application, admin manage to create, edit and delete the product. While user can use this web application to create their desire shopping list. Besides, this prototype will deliver to user for evaluation and testing. Then, the product will run through several testing to identify possible error before going to next phase. This process will repeatedly until all the requirements work perfectly on the prototype.

Lastly, in deployment phase, the final prototype is ready to turn to be the final product and will deliver to the user and provide maintenance support.

4.2 Development Tools

4.2.1 Software
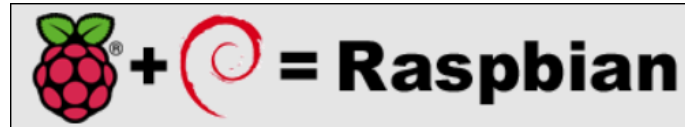
Figure 4-1 Raspbian OS logo (Raspbian, 2018)

1. Raspbian Operating System

Raspbian OS is a Debian Linux based operating system and is optimize to operative efficiently for the Raspberry Pi hardware. This operating system provide a set of programs and utilities that runs on a specific hardware. This Debian based operating system is very lightweight which makes it a perfect choice for Raspberry Pi.

2. Window 10 Operating System

Window 10 is a Microsoft operating system for most of the personal laptops, desktop, tablets devices. This operating system released in July 2015 as a follow-up to Window 8.

3. Python Language

Python language is a high-level, interpreted, interactive and object-oriented language. This programming language designed to be highly readable where it frequently uses English keywords. This language support variety of hardware platform due for its writability, error reduction and readability.

4. LAMP SERVER

LAMP SERVER known as Linux, Apache, MySQL and PHP, is an open source Web development platform. Each of the components has its own roles to the system; Linux as the Operating System, Apache as a Web server, MySQL as the relational database management system and PHP as the server-side scripting programming languages.

5. MobaXterm Software

MobaXterm is a graphical desktop sharing system that allow us to remote control from one computer to another computer. This software is use in this project to provide a remote connection between Raspberry Pi and laptop.

6. Fritzing Software

Fritzing is an open-source initiative tool where it used to design the schematic electronic hardware. This software is use for this project to design the initial hardware connection diagram before start working for the prototype.

4.2.2 Hardware Requirement

Figure 4-2 Raspberry Pi 3 Model B (element14, 2018)

1. Raspberry Pi 3 Model B

The Raspberry Pi 3 is the core component for this project. Although this device is tiny but it is capable to run multiple task at the same time. It also can perform almost all the functions that a Linux PC can.

2. Kingston 16GB MicroSD Card

This microSD card is used to store both operating system and basic programs for the Raspberry Pi 3. This capacity is enough to store all the require files for the entire project.

3. 2.5A, 5.1V Micro USB B Power Supply

Power supply is used for the Raspberry Pi 3 in this prototype demonstration.
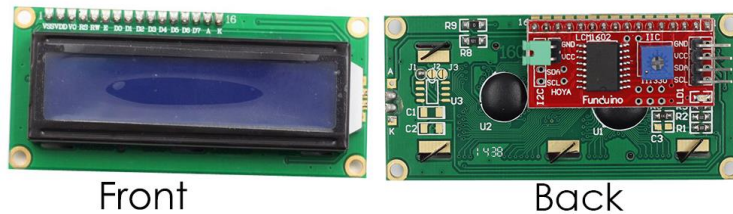
Figure 4-3 16X2 I2C Enabled LCD (SunFounder, 2018)

4. 16x2 I2C Enabled LCD screen

A 16cm * 2cm screen is used to display the information of the product for this project. The 16x2 I2C enabled LCD screen is connecting to Raspberry PI via 5V pin, Ground pin, SDA pin and SCL pin.

Figure 4-4 Mifare RC522 RFID Modules (SunFounder, 2018)

5. Mifare RC522 RFID Modules

The Mifare RC522 modules is used for this project to communicates with the RFID tags with the use of 13.56MHz electromagnetic field, then sends the data to Raspberry Pi through SPI communication.

Figure 4-5 RFID tags (SunFounder, 2018)

6. RFID Tags

A passive type of RFID tag is used for this project. The unique values of the RFID tag will be assign to selected product once it save into the database.

7. Other Components (Jumper Wire, Buzzer, Push Button, Breadboard)

Jumper wire is an electrical wire where it used to connect between the RFID modules and Raspberry Pi. Breadboard is a construction base for prototyping where it used to connect buzzer and raspberry pi to form a basic circuit. Buzzer is a beeper device that use for alert purposes in this project.

8. Personal Computer (Laptop)

Window based operating system laptop was used to run the Mobaxterm and Fritzing application. As the embedded device has the limited resource, some of the resource works will tested on Window OS before transfer to Raspberry Pi.

4.3 Project Milestone

Task	Project Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Data Collection	■	■												
Define project objective and scope			■											
Analysis for literature review				■	■									
Define technologies involved					■									
Determine system development model						■								
Determine system and functional requirements							■	■	■					
Outline system architecture										■				
Outline system flow										■				
Begin construct a basic functional prototype											■	■	■	
Presentation														■
Documentation	■	■	■	■	■	■	■	■	■	■				

Table 4-1 Gantt chart showing the project milestones (FYP1)

Task	Project Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Refining database	■	■												
Begin development of Web Interface			■	■	■									
Add different functionalities						■	■							
Finalizing the development and implementation of database and Web application								■	■					
Finalizing the functional requirement, system architecture and system flow									■					
Finalizing system for presentation										■	■			
System testing and performance												■		
Presentation														■
Documentation	■	■	■	■	■	■	■	■	■	■	■	■		

Table 4-2 Gantt chart showing the project milestones (FYP2)

4.4 Design Specification

4.4.1 System Architecture
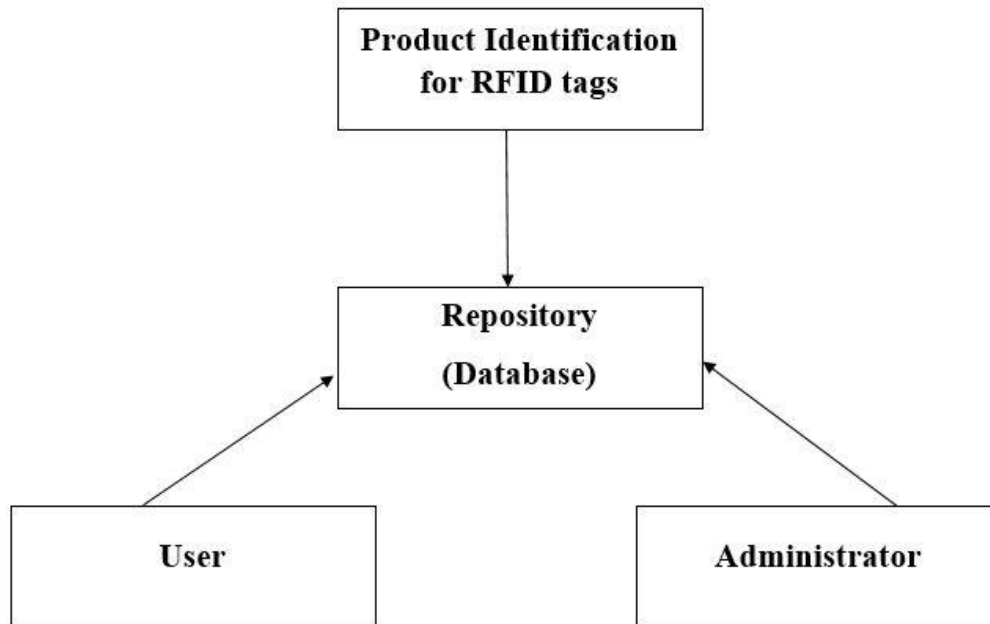
Figure 4-6 System Architecture of Full System

The architecture used for this smart trolley system is Repository architecture. The main reason of choosing this architecture is because the system is dealing with large amount of data and data sharing. Besides, there are many services require the information which is stored inside this system. For example, user require to login to the system to create their shopping list, view the shopping list history and manage the groceries from the shopping list. On the other hands, admin require to login into system to register new product with RFID tag values, editing the product or delete the product. Both of these examples require to connect in the same database. Besides that, all of the new RFID tags will be store in the same database before assigning to the products. Therefore, it is most appropriate to use this architecture pattern since all the data are stored in one place. Therefore, the data changes from the admin will updated instantly for the user. Hence, the data inconsistency can be avoids with this architecture.

4.5 Requirement Specification

Functional Requirements

- The program should be able to enter the user id.

- The program should be able to allow user to enter different budget amount.

- The program should be able to detect over budget when budget amount less than total cost of the groceries.

- The program should be able to allow user to use push button for select different options to solve over budget issues.

- The program should be able to scan the RFID tags and read the data from the database.

- The program should be able to scan the RFID tags and write the data to the database.

- The user should be able to select to become budget or non-budget user for the system.

- The user should be able to enter different budget amounts for the system.

- The user should be able to register a new account for the website.

- The user should be able to display all the products on the website.

- The user should be able to search the products by product name on the website.

- The user should be able to review their shopping list each time they add the product.

- The admin should be able to register new product with RFID tag value on the website.

- The admin should be able to edit or delete the products from the website.

Non-functional Requirements

- The program should be able display username and total items from user's shopping list.

- The program should be able to display budget amount on the LCD display.

- The program should be able to display product name and price on LCD display after being scan.

- The program should be able to display the deduct budget amount on LCD display after product entering shopping trolley.

- The program should be able to alert user when over budget detected.

- The program should be able to display options for user to choose when over budget issues happen.

- The LCD display on the system should display the product name and price in 3 seconds.

- The buzzer from the system should turn off when over budget not detected.

- The LCD display on the system should display message when push button entered.

- The program should written by Python language and PHP script.

4.6 Estimated Cost

Items	Final Year Project Development
Raspberry Pi 3 Model B	RM162.75
Kingston 16GB MicroSD Card	RM24.99
2.5A, 5.1V Micro USB B Power Supply	RM63.99
RFID RC522 Module	RM11.90
5 Pieces RFID Tag	RM7.50
Jumper Wires	RM4.90
Buzzer	RM0.70
Laptop	-
Window OS	-
Raspbian OS	-
LAMP Server	-
	RM276.73

Table 4-3 Estimation Cost for FYP Development

Based on the estimation, most of the items are hardware where it requires to purchase for developing the prototype. When it comes for developing the prototype, the Raspberry Pi 3 Model B, 16GB MicroSD card, power supply adapter, RFID modules, RFID tags, and some electronics components will cost total RM276.73. However, the cost of the items such as laptop, window OS, raspbian OS and LAMP server were not included in this table. This is because there have many types and different prices in the market where user able to choose any types they want to use. Therefore, there are no exact values for these categories.

CHAPTER 5: Implementation and Testing

5.1 Hardware Setup

1. Raspberry Pi 3

In this project, there are several hardware to be implement for the Raspberry Pi 3. RFID Module (Mifare RC522) was connected to raspberry pi 3 through GPIO pins to perform read and write function for the system. Next, the I2C 16x2 LCD display was also implement to raspberry pi 3 by connecting to two GPIO pins, one 5V pins and one ground pins. Next, this project also implement three LEDs and three push buttons where connected to the GPIO pin provided in the raspberry pi. The table below shows the details on the GPIO connection in this project.

GPIO Pins	Function
Ground	Connect to ground
GPIO 26	Control the output of red led
GPIO 16	Control the output of green led
GPIO 17	Control the output of yellow led
GPIO 20	Control the output of push button 01
GPIO 21	Control the output of push button 02
GPIO 13	Control the output of push button 03
GPIO 19	Control the output of buzzer
3.3V	Power input for Mifare RC522
GPIO 25	RST of Mifare RC522
GPIO 09 (SPI_MISO)	MISO of Mifare RC522
GPIO 10 (SPI_MOSI)	MOSI of Mifare RC522
GPIO 11 (SPI_CLK)	SCK of Mifare RC522
GPIO 08 (SPI_CE1_N)	SDA of Mifare RC522
5V	Power input for I2C 16x2 LCD Display
GPIO 02 (SDA)	SDA of I2C 16x2 LCD Display
GPIO 03 (SCL1)	SCL of I2C 16x2 LCD Display

Table 5-1 GPIO Connection of Full System

2. LED Setup

In this project, there are total three different colors of LEDs connected to raspberry pi. These LEDs are used to indicate the status of the system. Each LED is representing different status of the system. The purpose of these indicators is to allow user to identify the status of the full system. Below are the table to describe LEDs setup.

LED Status	Status Description
RED ON	The system is running and over budget detected.
RED OFF	The system is running and no over budget detected.
GREEN ON	The system is running and waiting for scanning.
GREEN OFF	The system is running and waiting user to enter user id.
YELLOW ON	The system is running and waiting for scanning product to remove from cart
YELLOW OFF	The system is running and waiting for scanning product to insert to cart.

Table 5-2 LEDs Setup of Full System

3. Push Button Setup

In this project, there are total three different push button connected to raspberry pi. Each push button is representing different solutions for overcome the over budget issues. Below are the table to describe push buttons setup.

Push Buttons	Functionality
01	To modify budget amount when over budget detected.
02	To remove items from the carts when over budget detected or during shopping for groceries.
03	To ignore the over budget message display on the LCD screen.

Table 5-3 Push Buttons Setup of Full System

4. Personal Laptop

In this project, a personal laptop is used to perform the remote connection for the raspberry pi. The reason of using this setup is that raspberry pi require a monitor screen for the display. Therefore,

remote connection can easily solve the issue. To use the remote connection, the laptop has to install MobaXterm software.

5.2 Software Setup

1. Raspbian OS on Raspberry Pi 3

Before setup LAMP server on Raspberry Pi 3, the Raspberry Pi should running the latest Raspbian OS. To install Raspbian on Raspberry Pi 3, download the installation zip files from the official website (https://www.raspberrypi.org/downloads/raspbian/). Besides, this installation also require Etcher software (https://etcher.io/#downloads) where it used to burn the Raspbian OS image file to the MicroSD card. Below is the step by step installing the Raspbian OS on Raspberry Pi 3.

1. Unzip the .img file (Raspbian OS) and remember the unzip location.
2. Install Etcher software and runs after finish installation.
3. Insert SD card into PC's card reader.
4. Select .img files on Etcher software and select the drive letter of the SD Card.
5. Click Flash button.
6. Once Etcher has finished, remove SD card from reader and insert to Raspberry Pi.
7. Turn On Raspberry Pi 3.

2. LAMP Server Installation on Raspberry Pi 3

Before start install the LAMP packages on Raspberry Pi 3, we need to update Raspbian OS first. Open terminal on Raspbian OS then enter following commands.

sudo apt-get update

sudo apt-get upgrade –y

Install Apache2

Once Raspbian has finished installing the updates, we can start install Apache2 and enable the mod_rewrite. Open terminal from Raspbian OS and enter following commands.

sudo apt-get install apache2 –y

sudo a2enmod rewrite

sudo service apache2 restart

When the install is finish, we need to change the setting on Apache2 to allow .htaccess overrides in the */var/www* directory. In the terminal, type *sudo nano /etc/apache2/apache2.conf* and change the *AllowOverride None* to *AllowOverride All*. After that, restart apache server by typing *sudo service apache2 restart* in the terminal.

To verify the installation, type *ifconfig eth0* in terminal on Raspbian OS. Then you can obtains the IP address for your Raspberry Pi 3 which shown *inet addr: 192.xxx.x.xxx* in the terminal. Then, open browser from the laptop and type *http://192.xxx.x.xxx* in the address bar and hit enter. You should able to see the following Apache2 Debian Default Page.

Install PHP

The next installation is installing PHP on Raspberry Pi 3. Open terminal on the Raspbian OS and type the following command.

sudo apt-get install php libapache2-mod-php –y

After finishing installing PHP on raspberry, we can start testing by create new PHP file in the following folders in Raspbian OS */var/www/html*. Type the following command in terminal to create a simple PHP script for testing purposes.

cd /var/www/html

sudo nano index.php

The PHP file will pops out and you can start edit it. For example: *<?php echo "Hello World"; ?>* in the php files. Hold Ctrl + O to save the file and then hold Ctrl + X to exit nano. After that, we

need to delete the default Apache2 Debian page and restart Apache with just two command on the terminal.

sudo rm index.html

sudo service apache2 restart

Finally, go back to your laptop browser and hit refresh button. You should see the output that came from your edit.

Install MySQL

Lastly, install the MySQL database engine by typing the following commands in the terminal.

sudo apt-get install mysql-server php-mysql –y

sudo service apache2 restart

In order to manage MySQL databases, you have to install phpMyAdmin by entering the following commands. (*sudo apt-get install phpmyadmin –y*)During installation of phpMyAdmin, you will be ask some question such as.

1. Choose [*] apache2 with Spacebar, hit Tab then Enter for the Automatic Configuration question.
2. Choose Yes for the dbconfig-config question.
3. Setup password for logging into the phpMyAdmin web interface.

To verify the installation, go back to laptop browser and enter the following address. (http://192.xxx.x.xxx/phpmyadmin/) You should see the standard phpMyAdmin login page.

3. MobaXterm Software Installation on Window Platform

MobaXterm is a graphical desktop sharing system that allow user to remote connection. To install this software, download the installation from its official websites (https://mobaxterm.mobatek.net/). After that, follow the instruction from the downloaded files and start the installation.

To perform the SSH connection between Raspberry Pi and laptop, obtains the IP address of the Raspberry Pi 3. After that, run MobaXterm in Window Platform and create SSH session. Enter the IP address of Raspberry Pi 3 in Remote Host *. Then enter 'pi' in specify username and 22 for the port. Finally start the connection; you will see the connection successful in the GUI. Then enter */etc/X11/Xsession* in the MobaXterm terminal. This command is use to display the Raspbian OS environment on Window.

5.3 User Interface

5.3.1 Smart Trolley System

Figure 5-1 Screenshot of User Verification and Total Items Count

After launch the application, user require to enter their user id for validation. If user is valid in this system, a welcome message (top) will display on the LCD screen. After the validation, the system will calculate the total item from the shopping list which store inside user accounts. A message will be show on the LCD display (below) for user to review the total items inside their shopping list. After that, the system will request user to enter a budget amount.
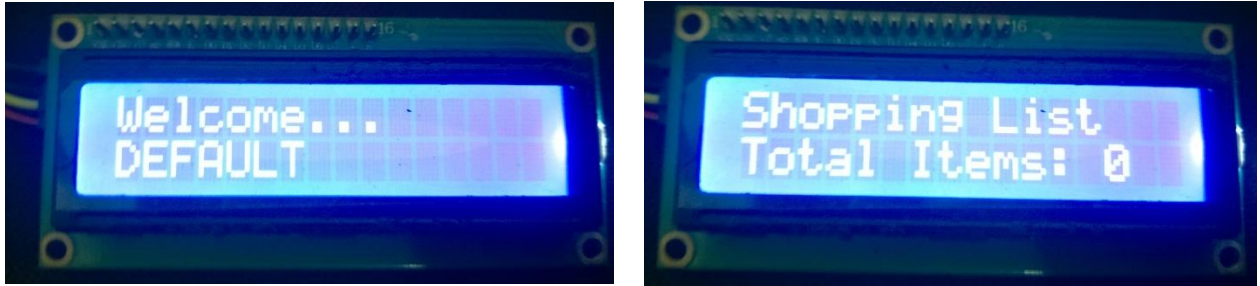
Figure 5-2 Screenshot of New User

If user still not register to the system, they can still using this system by skipping the validation part. A default user (left) will be automatically enter to the system. The shopping list for the default user will set as empty (right). Furthermore, the system also concern about non-budgeting user. Once finishing validate user, non-budget user just need to enter zero for the budget amount and the system will enter into non-budget mode where it only show how much they spend on the LCD screen.
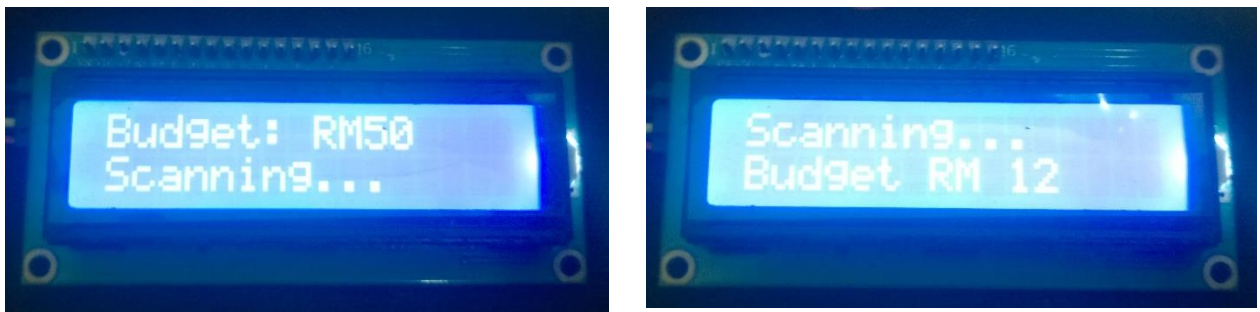
Figure 5-3 Screenshot of Review Budget

After user enter the budget amount, the LCD display will review the budget amount again for the user (left). Then, user can start shopping for the groceries by scanning the product with the RFID scanner. Each time they scans the items and put into the shopping trolley, the budget amount will minus the product price and showing the remains budget amount(right). In the meantime, the product name and price will be show after being scan on the LCD display as well.
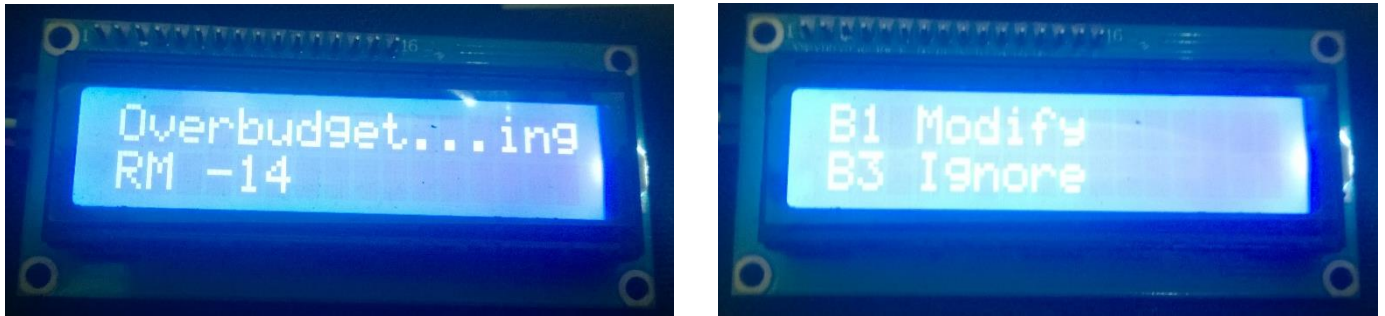
Figure 5-4 Screenshot of Over Budget Detected and Options for select

When the system detects over budget, it will immediately alert the user by the buzzer and the indicator. After that, a warning message (left) will be show on the LCD screen to let user know they are facing over budgeting. This process will continue where it allow user to choose some options to solve the issues. From the right screenshot, it consists of two options, firstly user can choose to modify the budget amount. For the third option, user can choose to ignore the over budget message. This features is includes to the system because sometimes user might only over spending few cents at the end of shopping and they do not want to either change the budget amount or remove the items from the cart. Therefore, this feature is to let them ignore the over budget message and go for the payment. Besides that, there are another option where user can remove selected items from the cart to overcome this over budget issues.

5.3.2 Admin Management
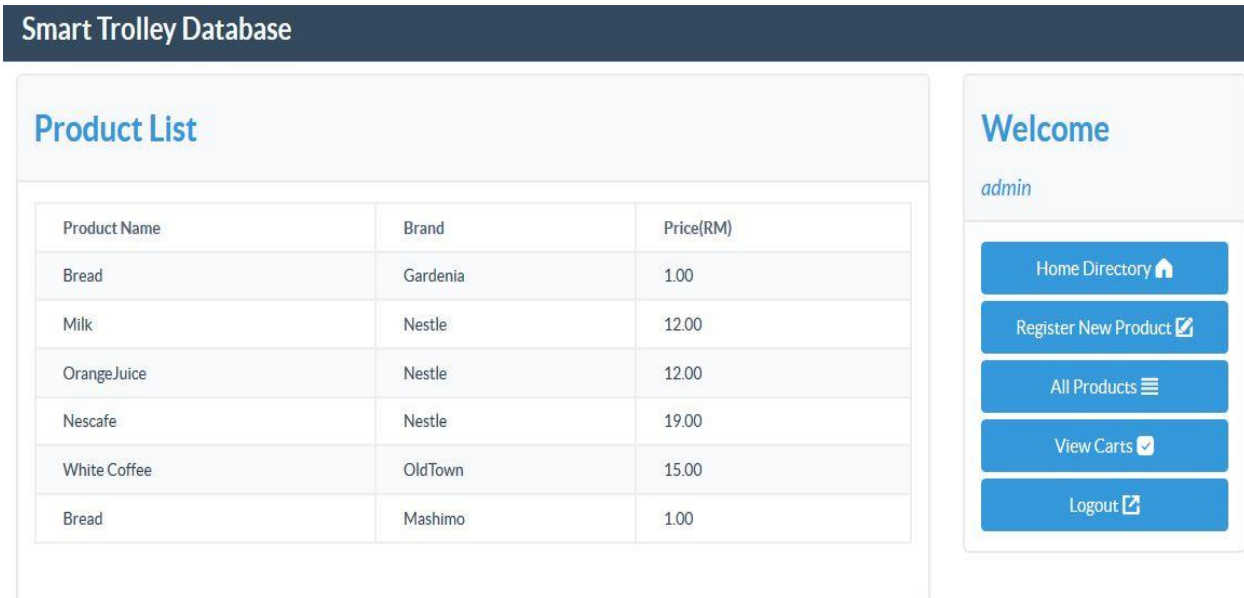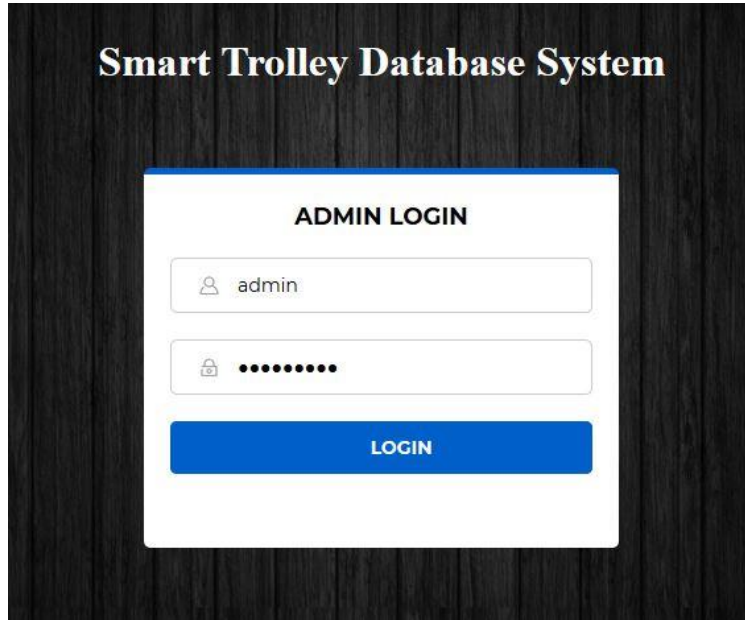
Figure 5-5 Screenshot of Login and Main Page (Admin)

From the Figure-5-5, the admin management was design in PHP web application. This admin management is use to allow them to manage the RFID tag values with the products. After a new RFID tag being scan by the reader, the tag values will be automatically save into database. Then, admin must login into this website (top) to go through the function of the website. As we can see from the screenshot (down), the main page of the website show an overview of the product information.

Figure 5-6 Screenshot of Registration New Product Page (Admin)

In this Register New Product page, all the product information requires to enter before submit to the database. Then, each time the RFID tag value being assign to a product, the tag value will automatically remove from the list. This is to ensure that there are no duplicate tag value being enter for another product.
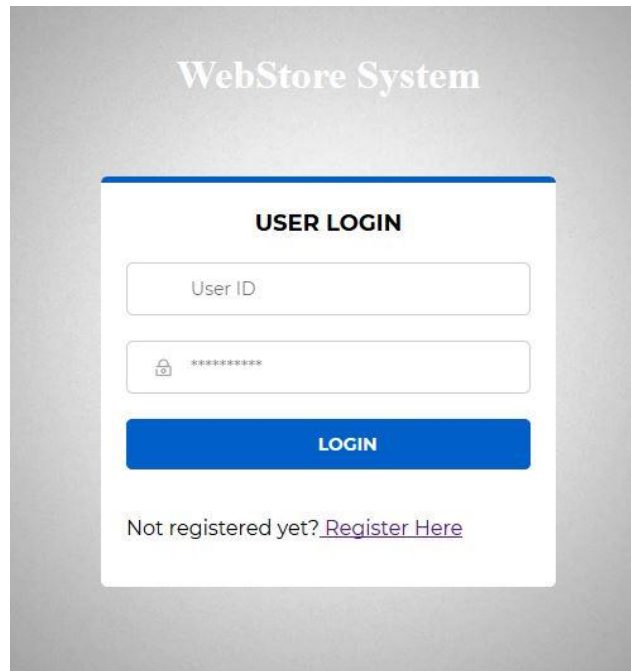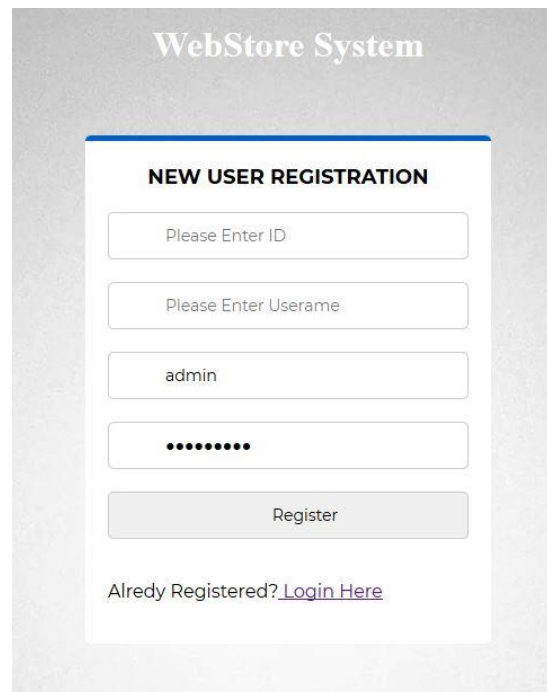
Figure 5-7 Screenshot of All Product Page (Admin)

In the All Product page, admin can always choose to edit or delete for the product. Each time they edit the price of the product, it will automatically synchronize to the user product page.

5.3.3 User Management

Figure 5-8 Screenshot of User Login Page

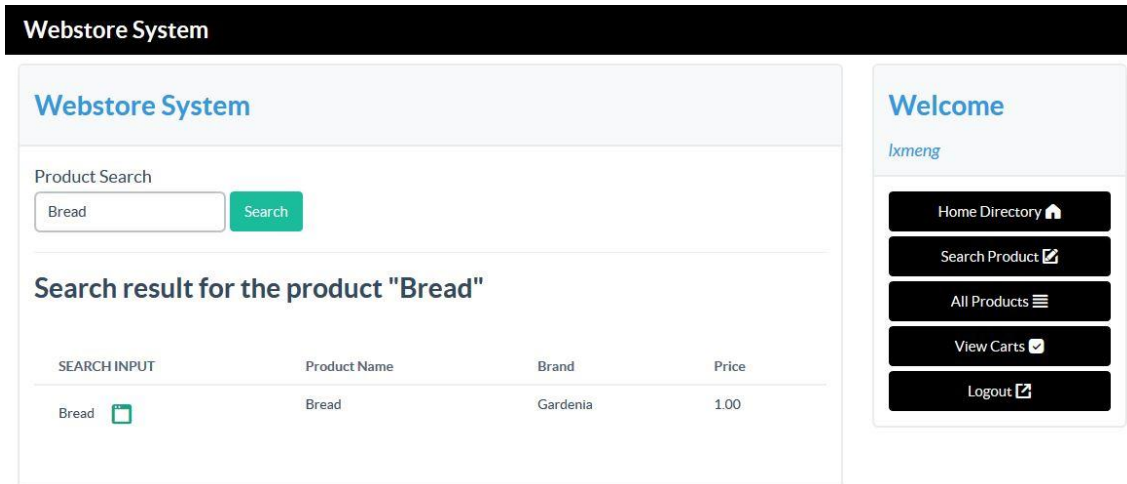*Figure 5-9 Screenshot of User Registration Page*

Figure 5-10 Screenshot of Search Product Page

From the figure above, the user management was design in PHP web application. This user management website allow user to create a shopping list before using the smart trolley system. From Figure-5-9, if user does not exist in this system, user require to register an account to the website by clicking Register Here link on the login page.

The first function for this website is to allow user search for the product. As we can see from the Figure 5-10, user just need to enter the product name for the search input. The result will return shortly and user can select to view the details of the product before adding to their shopping list.
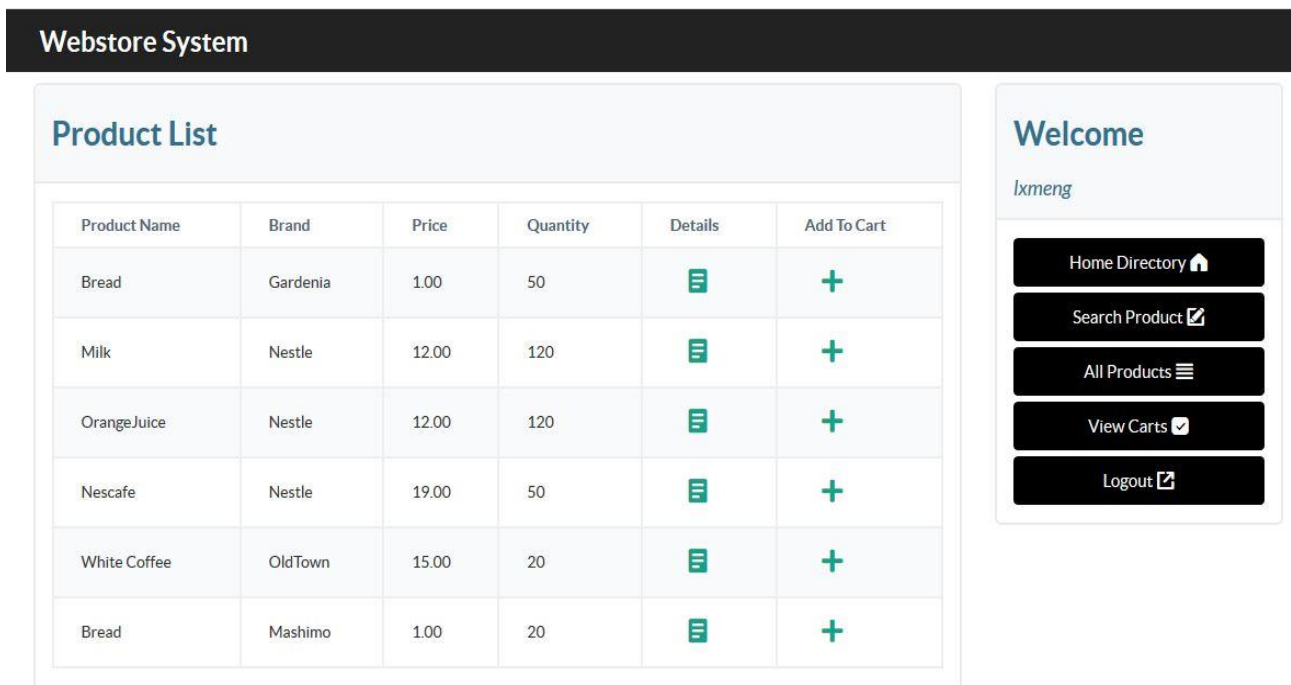

Figure 5-11 Screenshot of User Product Page

To create a shopping list before using the smart trolley system, user can adding the product from the All Product page. As we can see from the Figure-5-11, user can either to review the details of the product or add the product to their shopping list. If user decide to add the product to their shopping list, they just need to click the plus icon.
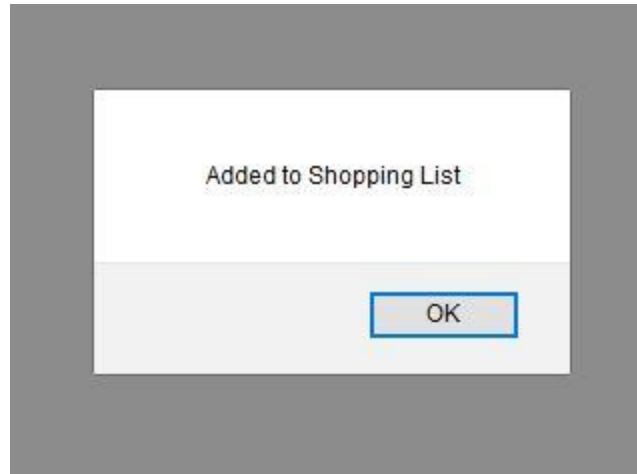

Figure 5-12 Screenshot of Product Added to Shopping List Message (Scenario)

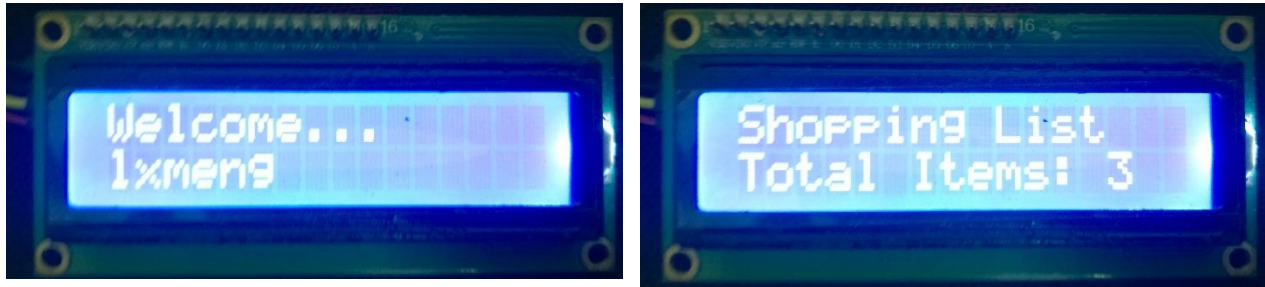After user adding the product to the shopping list, an alert message will pops out to notify user.

Figure 5-13 Screenshot of User Shopping List Page – Before (Scenario)

Figure 5-14 Screenshot of User Verification and Total Items Count (Scenario)

In the shopping list webpage from Figure 5-11, we can see that there are total three items in user shopping list before going for using smart trolley system. After user input their user id on the smart trolley system, the system will start validate the user and calculate the total items from their shopping list. As we can see from the Figure 5-14, the total items shown is matching with user shopping list.

Figure 5-15 Screenshot of Budget Condition and Product Scanning (Scenario)

After go through user validation, user can enter their desire budget amount and start shopping. As we can from the Figure 5-13, each time they scan the product and enter to the shopping trolley, the budget will minus the price of the product. After that, the remains budget will show in the following LCD screen.

Figure 5-16 Screenshot of User Shopping List Page – After (Scenario)

As we can see from the Figure 5-16, if the product they scan on the smart trolley is matching to their shopping list, the product from the shopping list will texted in red. With this feature, user can always check the list for buying and they would not miss out any groceries.

5.4 Project Challenges and Implementation Issues

During developing the project, there are some challenges. The very first challenges issue is that choosing a good range RFID module. Normally, standard shopping trolley is large sizes where it allow user to store groceries before going to payment. In this project, the RFID module we choose does not meet the initial expectation. This is because the RFID module used in this project targeted in short range purposes. However, this RFID module does provide us with consistency and reliability.

Besides that, there are some implementation issues during developing the prototype. The first implementation issues we encounter is choosing the right processing tools. Instead of using Adruino as the processing tool, we choose to use Raspberry Pi 3 Model B. This is because Raspberry Pi 3 is much more powerful than Adruino. Beside, Raspberry Pi able to carry our multiple program while Adruino only able to run one program at a time.

The next implementation issues is hosting a web server for this system. Since our project is not yet commercialise, we use Raspberry Pi as the web server for our prototype instead of paying every months or years for using the web services. Therefore, we choose to use apache as our web server in this project. As the project require database to store the information, we decided to use LAMP server on Raspberry Pi because LAMP contains everything we need in this project. By combining apache web server, PHP and MySQL database, we can create a simple and truly database driven and dynamic web site. Since Raspbian OS is a Linux based operating system, it would much easier for us to build a web server where it provide a rich functionality to support the users.

CHAPTER 6 – CONCLUSION

6.1 Conclusion

At the end of this project, a working prototype with basic functionalities was developed. In this prototype, the system able to detects over budget for the user when their budget plan is less than the total cost of items in the shopping trolley. Besides, the prototype system also allow user to select different options to overcome the over budget in order to continue shopping for the groceries. Moreover, a simple web application developed for the user and administrator to interact with prototype system.

This system help user to have a better and enjoyable shopping experience. The concept of this project is to allow user to enter any budget amount they want before start shopping for groceries. During shopping for groceries, they can always review how much they are spending with the real time feedback system. Therefore, this smart trolley system can greatly reduce the risk from having overspending situation even there is a festival or special discounts happen.

Undoubtedly, this project potentially show that IoT technology will be one of the strongest trend in the future.

6.2 Impact, Significance and Contribution

In this project, the real-time feedback system with RFID technology on the shopping trolley will provide user a wise shopping experience during shopping for groceries.

For a traditional trolley, they just function to carry all the groceries for the customer. Besides that, traditional shopping market still employs barcode technology for the groceries. This technology is less effective and less durability in today's modern world. For example, barcode tag will be unreadable by the reader if it is damage or stained. As a result, this traditional method should be change in order improve the shopping experience for the user during shopping.

In the proposed smart trolley application, it solved the issues mention above. This project has focusing more on setting up a budget before start shopping while each of the groceries are attached with the RFID tag. With the use of RFID technology, all of the groceries can be scans at once in seconds. In the future, RFID technology will be widely used in different field such as manufacturing sector or supply chain management. The growing number of these applications has proof that the capability of RFID system helps to achieve operational and reduce costs.

6.3 Future Work

Currently the web application design for the user are not convenient and less effective. To make user feels more comfortable and easier to use, mobile application should implement to this system. This is because nowadays everyone carry a smartphone when leaving for shopping; hence, it would much easier for user to use the mobile application to create the shopping list whenever possible. Besides that, mobile application can also include features such as notification for shopping list, daily sales of certain groceries or user preferences for the groceries.

Besides RFID module in this smart trolley system, the project can implement more sensor on the smart trolley. For example, adding IR sensor to alert user if they accidentally drop the product without scanning. This sensor manage to improve the reliability and consistency for the smart trolley.

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SunFounder, 2018. *Mifare RC522 RFID Module. [image].* [Online] Available at: https://www.sunfounder.com/rc522-card-read.html
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APPENDIX A-Weekly Report

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Year 3 Trimester 3	Study week no.: 2
Student Name & ID: Lee Meng Xian – 1507202	
Supervisor: Dr. Robithoh Anuur	
Project Title: Wise Shopping With Radio Frequency Identification (RFID) based Smart Trolley System	

1. WORK DONE

- Discussed the design of web application for user.
- Discussed the function to be use in this system

2. WORK TO BE DONE

- Refining project scope and objective
- Refining Databases
- Purchase new RFID module for the project

3. PROBLEMS ENCOUNTERED

- None

4. SELF EVALUATION OF THE PROGRESS

- Re-evaluated the project scope and objectives

_____   _____

Supervisor's signature   Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Year 3 Trimester 3	**Study week no.: 4**
Student Name & ID: Lee Meng Xian – 1507202	
Supervisor: Dr. Robithoh Anuur	
Project Title: Wise Shopping With Radio Frequency Identification (RFID) based Smart Trolley System	

1. WORK DONE

    – Finalise the database to be use on the web application.
    – Discussed the functionality of web application.

2. WORK TO BE DONE

    – Begin development of web application for user.
    – Begin development of new RFID module with the system.
    – Begin develop the functionality for the smart trolley system.

3. PROBLEMS ENCOUNTERED

    – Facing difficulties to connect new modules to the raspberry pi.

4. SELF EVALUATION OF THE PROGRESS

    – Progress schedule face some delays, but confident to finish develop the full system before deadline.

_____   _____

    Supervisor's signature   Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Year 3 Trimester 3	Study week no.: 6
Student Name & ID: Lee Meng Xian – 1507202	
Supervisor: Dr. Robithoh Anuur	
Project Title: Wise Shopping With Radio Frequency Identification (RFID) based Smart Trolley System	

1. WORK DONE

   – Finalise the functionality for smart trolley system on raspberry pi.
   – Designed simple login and register system on web application for user.

2. WORK TO BE DONE

   – Construct a schematic diagram for the full system
   – Insert additional function for the user web application.
   – Connect more components to the raspberry pi for alert purposes.

3. PROBLEMS ENCOUNTERED

   – Unable to implement new RFID module on raspberry pi.

4. SELF EVALUATION OF THE PROGRESS

   – Manage to follow the schedule of development after using back the previous RFID modules.

_____   _____
         Supervisor's signature   Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Year 3 Trimester 2	Study week no.: 9
Student Name & ID: Lee Meng Xian – 1507202	
Supervisor: Dr. Robithoh Anuur	
Project Title: Wise Shopping With Radio Frequency Identification (RFID) based Smart Trolley System	

1. WORK DONE

– Simple scenario has been carry out for the smart trolley system on raspberry pi.
– Estimate cost of development has been determined.
– User web application showing alert message after successful register new user.
– User web application showing confirmation message after items added to the shopping list.

2. WORK TO BE DONE

– Begin develop the function for interacting the user web application and raspberry pi.
– Draw out the architecture of the full system.
– Redefine flow chart for all functional modules of the system.

3. PROBLEMS ENCOUNTERED

– Bugs happens where no user id input in the smart trolley system.
– Bugs happens where user enter negative value for the budget amount.

4. SELF EVALUATION OF THE PROGRESS

– 50 percentage of report writing has complete, all the diagrams has been draw and implement to the report.
– Improved understanding on Python programming used in raspberry pi.

_____   _____

Supervisor's signature   Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Year 3 Trimester 3	Study week no.: 12
Student Name & ID: Lee Meng Xian – 1507202	
Supervisor: Dr. Robithoh Anuur	
Project Title: Wise Shopping With Radio Frequency Identification (RFID) based Smart Trolley System	

1. WORK DONE

 – System testing was carried out for the whole system.
 – User web application was finalized by adding shopping list function to the smart trolley system.
 – Complete the PHP and python code for the smart trolley system

2. WORK TO BE DONE

 – Finalize report
 – Check plagiarism for report in Turnitin website
 – Create poster for the project
 – Create power point slides for presentation

3. PROBLEMS ENCOUNTERED

 – Minor bug happens during testing the user web application.

4. SELF EVALUATION OF THE PROGRESS

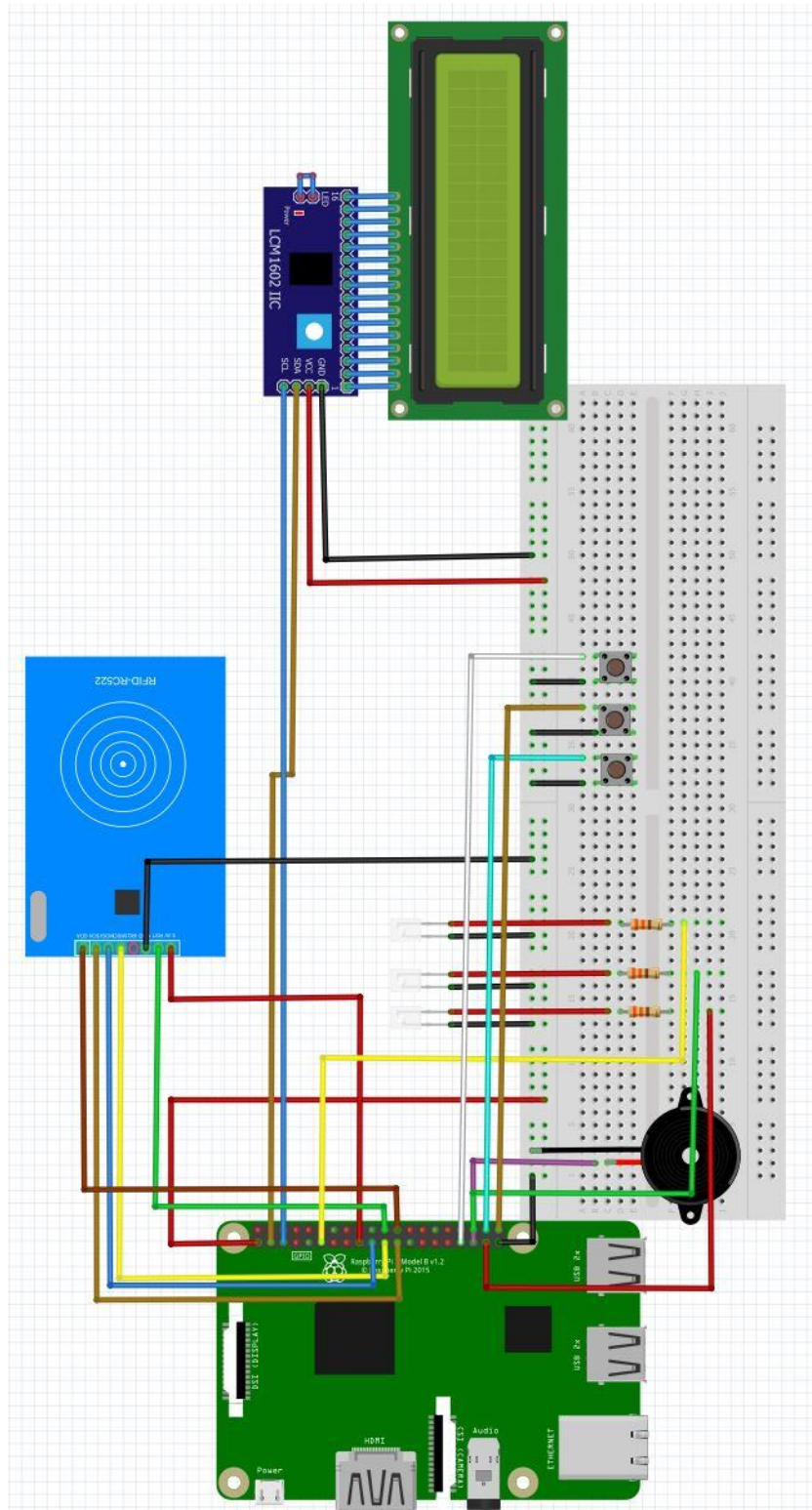 – Report writing finish fast due to good understanding on what have been done

_____   _____

Supervisor's signature   Student's signature

APPENDIX B-BLOCK DIAGRAM

APPENDIX C-POSTER

WISE SHOPPING WITH RADIO FREQUENCY IDENTIFICATION (RFID) BASED SMART TROLLEY SYSTEM
LEE MENG XIAN

UNIVERSITI TUNKU ABDUL RAHMAN

Introduction

Nowadays shopping market rely on barcode technology for their groceries. This technology is old and require line of sight technology during scanning where items has to oriented in a specific direction. Besides, during the times of festival or special discounts, customer will spend more on groceries until over budget happens. They will not noticing this issues until they come to the payment counter. As a result, a effective solution has to be implemented to overcome this issues.

Project Objectives

The major objective of this project is to develop an over budget detection system for the smart trolley where it use to reduce the risk for over budget during shopping for the groceries. Sub-goals include
- Provide real-time spending feedback system on the smart trolley
- Alert user when over budget detected.
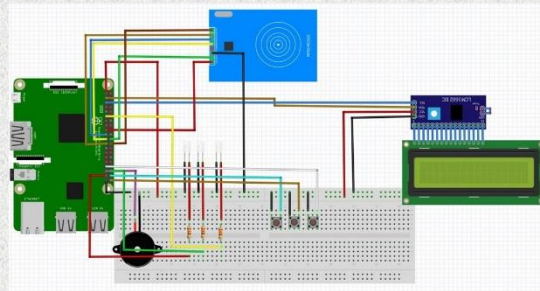- Provide options to solve the over budget issues

System Methodology

- Developed using Prototyping Model
- LAMP server setup on Raspberry Pi 3
- Python Language for hardware develop

Overall System Flowchart
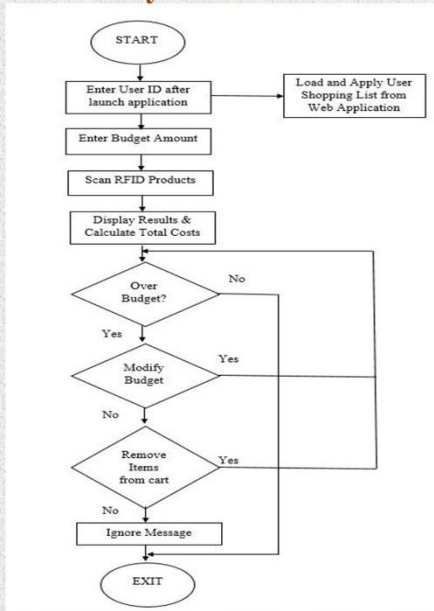
Results

If over budget detected, buzzer will alert the user whereas a red LED will turn on. An alert message will also display on the LCD screen. Then, user can use the push buttons to select options to overcome the issues.

If the product enter to trolley matching to the user shopping list, the shopping from user website will highlight the items in red text.

APPENDIX D

APPENDIX D-PLAGIARISM CHECK RESULT

Wise Shopping With Radio Frequency Identification (RFID) based Smart Trolley System

ORIGINALITY REPORT

10%	7%	3%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universiti Tunku Abdul Rahman Student Paper	2%
2	pchelp.ricmedia.com Internet Source	2%
3	journals.ama.org Internet Source	1%
4	Submitted to University of Huddersfield Student Paper	<1%
5	research.ijcaonline.org Internet Source	<1%
6	Submitted to Caledonian College of Engineering Student Paper	<1%
7	Ali, Zeeshan, and Reena Sonkusare. "RFID based Smart Shopping: An overview", 2014 International Conference on Advances in Communication and Computing Technologies (ICACACT 2014), 2014.	<1%

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	LEE MENG XIAN
ID Number(s)	1507202
Programme / Course	BACHELOR OF INFORMATION TECHNOLOGY (HONS) COMMUNICATION AND NETWORKING
Title of Final Year Project	Wise Shopping With Radio Frequency Identification (RFID) based Smart Trolley System

Similarity	**Supervisor's Comments (Compulsory if parameters of originality exceeds the limits approved by UTAR)**
Overall similarity index:_____ **%** **Similarity by source** Internet Sources: _____% Publications: _____ % Student Papers:_____ %	
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Parameters of originality required and limits approved by UTAR are as Follows: **(i) Overall similarity index is 20% and below, and** **(ii) Matching of individual sources listed must be less than 3% each, and** **(iii) Matching texts in continuous block must not exceed 8 words** *Note: Parameters (i) – (ii) shall exclude quotes, bibliography and text matches which are less than 8 words.*	

Note Supervisor/Candidate(s) is/are required to provide softcopy of full set of the originality report to Faculty/Institute

Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

_____   _____
Signature of Supervisor   Signature of Co-Supervisor

Name: _____   Name: _____

Date: _____   Date: _____

BIT (Hons) Communication and Networking
Faculty of Information and Communication Technology (Perak Campus), UTAR

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FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY
(KAMPAR CAMPUS)

CHECKLIST FOR FYP2 THESIS SUBMISSION

Student Id	1507202
Student Name	LEE MENG XIAN
Supervisor Name	Dr Robithoh Annur

TICK (√)	DOCUMENT ITEMS Your report must include all the items below. Put a tick on the left column after you have checked your report with respect to the corresponding item.
	Front Cover
	Signed Report Status Declaration Form
	Title Page
	Signed form of the Declaration of Originality
	Acknowledgement
	Abstract
	Table of Contents
	List of Figures (if applicable)
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	List of Symbols (if applicable)
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	Chapters / Content
	Bibliography (or References)
	All references in bibliography are cited in the thesis, especially in the chapter of literature review
	Appendices (if applicable)
	Poster
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*Include this form (checklist) in the thesis (Bind together as the last page)

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