CERTIFICATION OF APPROVAL

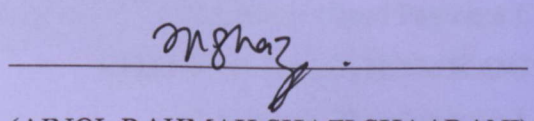
Self-checkout kiosk system with RFID-based payment module

by

Abdul Rahman Bin Abdul Hakim

A project dissertation submitted to the
Computer & Information Science Department
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
BACHELOR OF TECHNOLOGY (Hons)
(BUSINESS INFORMATION SYSTEM)

Approved by,



(AINOL RAHMAH SHAZI SHAARANI)
Lecturer,
Computer & Information Science Department.

UNIVERSITI TEKNOLOGI PETRONAS

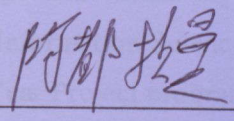
TRONOH, PERAK

January 2012

TABLE OF CONTENTS

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



ABDUL RAHMAN BIN ABDUL HAKIM

ACKNOWLEDGEMENTS

First, praise upon God for His bless and willingness, I managed to complete the project within the specified time frame. The special appreciation goes to my helpful supervisor, Miss Ainol Rahmah Shazi Shaarani for the undivided commitment and guidance she gave throughout the completion of this project. My grateful appreciation also goes to both Assoc. Prof. Dr. Wan Fatimah Wan Ahmad and Miss Elaine Chen Yoke Yie for their help in this project. Next, I would also like to acknowledge and extend my heartfelt gratitude to the staffs of Department of Computer & Information Science for their commitment and help in the management of our Final Year Project program especially to Madam Emelia Akashah and Madam Rozana Kasbon for their hard work in coordinating the program. Last but not least, my deepest gratitude to all my family members and friends for their constant support and motivation in completing this project to the end.

ABSTRACT

The Self-checkout kiosk system with RFID-based payment module (SCHECK) is to provide a convenient checkout alternative for customers in hypermarts to checkout their items. The system shall reduce the overall time taken for the whole checkout process and is specially addressed for the time-crunched individuals. The system will embodies the conventional checkout process in hypermarts while enhancing the convenience for customers and speed the overall process. The author, inspired by the capabilities and potential in RFID technology has decided to embed the technology into his project. SCHECK will use the RFID technology in its payment module in order to provide a speedy checkout experience for customers in hypermarts. In fact, through SCHECK, the author aspires to expose the Malaysian community to the RFID based payment card technology; e.g. Touch n Go card and leverage the utilization of the technology in the country through the retail industry. Lastly, this project will also act as a platform to study the implementation of RFID based payment card technology in Malaysia and its acceptance rate among the Malaysian community.

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND NOMENCLATURES

RFID	Radio Frequency Identification
SDLC	System Development Life Cycle
POS	Point of Sale
AVI	Automated Vehicle Identification
ATM	Automated Teller Machine
EFT	Electronic Fund Transfer
PIN	Personal Identification Number
DVD	Digital Video Disc
RAD	Rapid Application Development

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The Self-checkout kiosk system with RFID- based payment card module (SCHECK) for Hypermarts is a kiosk-based application system with RFID reader and barcode reader implementation. Basically, it allows the customers to perform goods self-checkout in hypermarts with the help of RFID-based payment cards. The project addresses the enormous potential that RFID-based payment card has in order to become the future main payment mode, and the possibility of reducing the overall time taken for customers' checkout process in hypermarts in Malaysia.

Over the past few decades, we have witnessed some of the incredible things that RFID technology has done in our lives; from transportation to education systems, parcel tracking to health monitoring. Undeniably, RFID is etching itself more and more into different aspects of our lives as the time goes by.

Technically, RFID utilizes the electromagnetic waves in transmitting and receiving data and information. RFID tags or transponders are able to communicate interchangeably with RFID readers to exchange data and information. This feature of RFID has made it possible for us to track the present of the tags from distant.

Hence, due to its capabilities in transmitting and receiving information wirelessly, RFID technology is ought to have a great potential in realizing the much anticipated ubiquitous computing technology; especially in the commercial industries. An example will be the introduction of the RFID based payment card to automate the fare collection process in public transport industry; e.g. trains and bus services. One famous successful example is the famous Octopus card in Hong Kong.

On the other hand, the self-checkout kiosk technology has been implemented in developed countries such as United Kingdom, United States of America, Japan and Korea since the late 20th century. The kiosks are designed to automate the overall

customer checkout process in Hypermarts; from scanning the items to making a payment using cash or cards at the kiosk.

This project will thus, provide a platform for the customers to checkout their purchases without the need of a cashier and cash. This is the need to cater the hectic lifestyle of the customers nowadays. With the busy schedule, people want everything to be done fast and conveniently, and that is solely the purpose of this project; to minimize the overall time taken for the entire checkout process in hypermarts.

With this kiosk around, people would have an alternative mechanism to checkout their items; hence, minimizing the issues of long queues in hypermarts while conveniently provides speed and control to the customers. Besides, customers will no longer need to bring plenty amount of cash whenever they shop for their groceries. They only need to bring the RFID-based payment card which can be used to pay for the groceries without worrying about the balance and small changes.

Lastly, from the hypermarts management's view, this kiosk will greatly reduce the cost that they need to invest in cashiers training and development program. In fact the implementation of these kiosks would have minimized the number of cashiers needed to operate the store.

1.2 Problem Statement

The overall checkout process in hypermarts is time consuming due to:

i. Long waiting in checkout queues

Hypermarts normally get overly crowded on weekend, especially when it's the pay-day week at the end of the month; hence, this explains the long waiting time in the long queues at the cashiers. Often, customers seem to get stuck in the checkout lines for a significant amount of time and this certainly is not favoured by any normal shoppers.

ii. Lengthy payment process

Adding to the predicament, the customers' overall checkout time is also affected by the speed of the payment processes. Currently in Malaysia, the customers have three options when it comes to paying their items in hypermarts; cash, credit cards and debit cards. However, the issue rises when these modes of payments contribute a significant amount of time to the overall checkout process; further stretching the customers' waiting time. This is true especially when they use their credit and debit cards; having to wait for the cashiers to validate the card, issues a receipt, and request for the customer's signature in order complete a particular transaction.

iii. Cashiers' Inefficiencies

The speed of the overall checkout processes ultimately relies on the cashiers' efficiency. Cashiers main responsibility is to ensure that the customers are happy with their services – which mean the checkout process must end up smoothly and conveniently as fast as possible. However, often cashiers services and performance are affected by their moods; which is normal in being a human. Nonetheless, swampy face and rude attitude could potentially wrecks down the cashiers' entire services to the customers - ends up with an unhappy customers whining as they leave the hypermarts.

1.3 Objectives & Scope of Study

The goal of this project is to address the lengthy checkout problems in hypermarts by introducing Self-checkout Kiosk System with RFID-based payment module. The objectives are as follow:

- Shorten the waiting lines in hypermarts by introducing an alternative checkout mechanism.
- Shorten the time taken for payment processes with RFID payment card module.
- To provide more purchase privacy & freedom to customers.

The project will cover the areas as follow:

- Study the feasibility of the project
- Understanding the payment mechanism of RFID-based payment card
- Understanding the processes involved during checkout in hypermarts
- Study the acceptance rate of RFID-based payment card among Malaysians
- Develop the system addressing the real need of customers in hypermarts
- Implementing the system and compiling the documentation

1.4 The Relevancy of the Project

This project will strive to provide the utmost convenient shopping experience to hypermarts customers especially those with high-demanding lifestyle where everything needs to be done in a quick and efficient manner. In fact, this system adds value to the overall checkout process in hypermarts by providing speed, convenient and purchase privacy to the customers.

Besides, the author realizes the big potential of RFID card to become the future "cashless" mode of payment and intends to use this project and the retail industry to leverage the usage of RFID-based payment cards in Malaysia.

1.2.1 Problem Identification

i. Hypermarts Customers WANT:

- Alternative checkout mechanism
- Speedier payment mechanism
- No-cash environment

ii. Hypermarts Management WANT:

- Cost reduction in the long run
- Improved customer satisfaction & retention

1.2.2 Significance of the project

If the RFID card based Self-checkout Kiosk System were to be implemented in hypermarts in Malaysia, it will serve as an alternative checkout mechanism for users who:

i. Time-crunched individuals; those who would like to spend as lesser time as possible queuing to pay for their items.

ii. Seeks for a more convenient way to checkout their items.

iii. Do not prefer to bring a large amount of cash and small changes around

Thus, by having an alternative method of checking out their goods, it can help to ease the long queues at peak times in hypermarts. In fact, the waiting time can be reduced significantly; considering Malaysians are embracing this project. Besides, by using RFID-based payment cards, it allows the customers to skip the wait for balance and small changes. The virtual money stored in the customers' cards will be deducted the exact amount of price of the items purchased. Hence, adding value to the checkout process; speedier and more convenient.

Last but not least, from the hypermarts point of view, this new system can be seen as one way to increase customer satisfaction, reduce the operating cost and to optimize the hypermarts' profit in the long run.

1.5 Feasibility of the Project within the Scope and Time Frame

The author has two semesters of his final year to realize this project, which is roughly eight to nine months of time frame. In the first half of the time frame, the author will focus on the following parts:

- Identifying the need for the system
- Clarifying the problem statement and scope of the project
- Understanding hypermarts business operations and RFID card payment mechanism
- Carry out research in order to understand the conceptual and technical design of the mechanisms involved
- Market analysis and redefining of the value proposition to customers and hypermarts as well as RFID payment card operator
- Come out with a the most feasible design and process flow for the system
- Redefining scope and functionalities of the system
- Acquiring hardware and relevant parts for the development of the system

While in the second half of the time frame, the author will focus on the following few parts:

- System development
- System testing and redefining
- System implementation

CHAPTER 2

LITERATURE REVIEW

2.1 The New Technological Hype: Self-checkout Kiosk

"The day is approaching when most of our common transactions may be information-rich, but first an extensive supporting infrastructure must be developed in three areas: devices, networking, and trust." Fichman and Cronin (2003).

Everything is moving fast these days; people are becoming more and more demanding than before. The hectic schedule and high demand lifestyle we are living in had turned us into a "Time-crunched" society; and inconvenience is simply intolerable these days.

A self-checkout kiosk is a computer-like device that provides people with self-service access to products and services. Similar to home or office PCs, self-checkout kiosk may provide Internet access for web surfing and email, tools for viewing multimedia files, and access to various software applications. However, unlike a regular computer, a kiosk typically performs only a few specific tasks. They are usually designed to be used by many different people, and is often optimized for remote control and management – without the need of permanent monitoring attendants. (Wirespring Technology, 2002).

We have seen a lot of industries have started to adopt the self-checkout mechanism to-date. Some popular examples are:

- *Automated Teller Machines (ATM)*

  The most infamous example, the banks' Automated Teller Machine (ATM) is definitely one thing we could not live without nowadays. It has been part of our daily lives that we no longer need a bank account book. All we need is a chip-based card to perform our transactions over the self-service ATM machines.

- *Automated airline check-in systems*

  Starting November 1st, 2010 ago, the infamous low-cost airline in Malaysia; AirAsia has begun to provide another check-in mechanism for its passengers; through the self-checkout kiosks that were made available in airports. According to its commercial regional head, Kathleen Tan, the new mechanism was intended to provide more convenient for the passengers as they will no longer have to turn up extra early in airport; queuing up to check-in over the counters; and this has in turn reduced the traffic congestion at the airport (Nambiar, 2010).

- *Interactive catalogs*:

  This type of catalogs kiosk can usually be found at major car or bikes showrooms; e.g: Mercedez Benz etc. The interactive catalogs kiosk provide information about the products or services of the particular company to the audience.

- *Recruiting kiosks*:

  Major companies take advantage of kiosk technology to do recruiting activities. Apart from displaying information about the company during convention or career carnival, recruiting kiosks can be more interactive in a way that applicants are able to submit their job applications there and then through the kiosk – guided and without the need to print their Vitaes!

The advantages of self-checkout kiosks hence are significant, and there are increasing number of companies that have started utilizing this technology to cater their customers' needs nowadays. In fact, there are a lot more industries out there that are still looking for opportunities to embrace the self-checkout mechanism in their businesses.

2.1.1 Anatomy of self-checkout kiosks

Self-checkout kiosk comes in many different shapes and sizes; depending on its purpose and the environment it is intended to be used in. Besides, they can also be very simple and take form of a regular PC while performing specified tasks and provides self service mechanisms to its users.

Although every kiosk are different to some extent, most of the kiosks needs the basic few elements to operates: a cabinet, CPU, a display device, additional peripherals for additional functionalities, and exterior signage. The display and interface peripherals can be as simple as a regular monitor, keyboard and mouse, or more exotic, like a large-screen plasma display and touchscreen. (Wirespring Firecast, 2002)

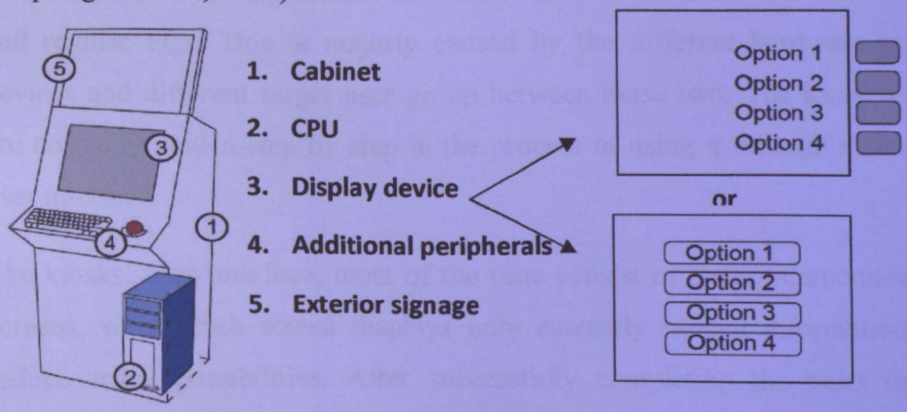


Figure 2.1 Basic components of a self-checkout kiosk

- **Hardware characteristics**

For self-checkout kiosks, that are usually located in public places, the use of keyboard and mouse as navigation and input mechanism is not feasible as they can be easily ripped off. Hence, to address this issue, touch-screen monitors and specialized embedded keyboards or buttons are used. Also, for security reasons, most of kiosks have cameras to monitor and record users actions. Besides, kiosks often is connected to Internet or at least via a network to its owner – for status report and paying services report etc.

For kiosks that provide paying services, they have credit card readers and cash-intake devices attached to aid the payment processes and the most important part of the kiosk is an uninterruptible power supply to allow the

kiosk to end its job in a regular way in case of a power shortage. Often, all the hardware is placed inside strong metal case, to protect them from weather and from being damaged by destructive-oriented users; and the metal case is usually coupled to the ground to make it difficult or nearly impossible to be transported. Additional hardware can be attached to kiosk for specific purposes; e.g: receipt printers, barcode scanners RFID readers etc. Kiosks that have any kind of material input or output, require periodic maintenance: refilling printers and receipt paper trays, etc. (Živanov, Rakić & Hajduković, 2008)

- **Software characteristics**

  There are also a few significant differences in software traits between kiosks and regular PCs. This is majorly caused by the different hardware input devices and different target user group between those two. The kiosk users are normally guided step by step in the process of using it through a simple user interface.

  The kiosks' user interface, most of the time consist of static interconnected screens, where each screen displays only currently needed information to reduce errors possibilities. After successfully completing the tasks on a particular screen, users are guided to the next. The user interface needs to be as simple as possible in order to be used by users with little or no technical knowledge.

  The kiosk screens are displayed in full screen format, hiding everything of underlying operating system. This is necessary because users must not interact with the kiosks' operating system directly. In most cases, screen elements are limited to buttons, labels, pictures and input fields. Hence, for interactions with users, kiosks normally use peripheral buttons or embedded keyboard (for touch screen display devices) as in Figure 2.1. In almost all cases, kiosks applications have no mouse-like navigations and only relies on touch screen inputs or buttons input to receive inputs from users. (Živanov, Rakić & Hajduković, 2008)

In term of operating system, most kiosks simply run on a desktop OS like Microsoft Windows, and use third party software to cover up any holes and add in kiosk specific features. Recently, though, there are some operating systems been designed and built solely to run on self-checkout kiosks developed by few companies. (Wirespring, 2002)

2.1.2 The Significant of Self-checkout Kiosks in Hypermarts

Technologies are replacing the manual and conventional mechanism everywhere nowadays. The same thing applies to retail industry; they are continuously looking for opportunities to automate the entire checkout process in their stores. The conventional checkout mechanism which has been practiced until today requires customers to bring their checkout items to the cashiers for scanning and payments. However, there have been several issues addressed by the public on the conventional checkout mechanism.

According to Beal (2009), the long waiting time in queues is the major bottleneck for customers shopping in hypermarts. Barbaro (2007) claims that the long lines can be hurtful to businesses especially retailers and can be a major turn off factor for customers; causing them to back away from it. Besides, not only the line can be a major turn off factor, the lengthy payment process possesses equal threat to hypermarts in this context.

Psychological research has shown that customers, most of the time perceived their waiting time to be far longer than it actually is. Maister (2005) came up with several theories on this matter. In one of his theory, he claims that customers perceive unoccupied time to be longer than occupied time. Hence, when one is doing nothing but waiting for the cashiers to process the customers in front of him, he will feel that his unoccupied waiting time to be longer than it actually is. This could be a major motivator for the customer to turn off and leave the hypermart without buying anything or can eventually leads to a surprisingly agonizing shopping experience for the customer.

The customers' turn off rate may lead to major losses to businesses. Hence, the hypermarts will need to come up with an alternative system which can reduce the waiting time in queues, simplify the payment process or method and eventually offer convenience and practicality to customers – Self Checkout kiosk.

Besides that, considering cashiers are human beings, there are certain limitations to what we are capable of. While most of us can learn basic things very fast, some just fall behind especially when it comes to dealing with other people and providing services. Thus, training and development program are required for cashiers in performing their jobs. This could only mean additional cost for the hypermarts in their operations. Not to mention that cashiers have emotions, and when they are on turmoil, their performances get affected; so as the service they provide to the customers. Inefficiencies of the cashiers is also one of the major contributing factor of customers turn off rate in hypermarts. Hence, by having the Self-checkout system, these subjective human factors can be rid off.

2.1.3 Self-checkout Kiosk in Hypermarts: Hype or Hope?

We have read about the existence of Self-checkout mechanisms in most of the developed countries in the world; United States, United Kingdom, Japan, Korea, Hong Kong, Taiwan etc. These Self-checkout kiosks serve as an alternative to the manual checkout lanes staffed by cashiers; they are intended to provide the customers a convenient and speedier checkout process.

The Self-checkout option however is not intended to cater for mothers with their hands full of bags and babies but it is meant for shoppers who want a quick and convenient checkout process; grab it and go style. The following figure shows the result of a survey carried out by a company in United States highlighting some of the key benefits provided by a Self-checkout kiosk:

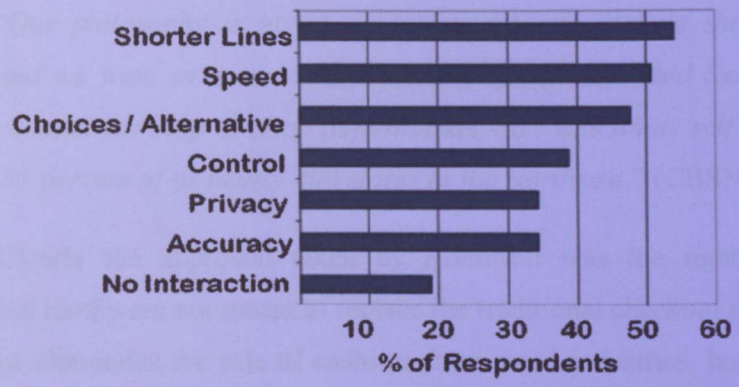


Figure 2.2 Response from customers on the key benefits of using Self-checkout kiosk in hypermarts (Massachusetts Institute of Technology, 2006)

Figure 2.1 shows a typical cash-based Self-checkout kiosk implemented in hypermarts nowadays. It comprises of a touch screen monitor to guide the customers throughout the checkout process, a basket stand, barcode reader, payment module, bagging area and a lane light. There are other models in the market which include automatic belts for ease of product arrangement bagging process for customers.

Figure 2.3 Example of a self checkout kiosk in hypermarts

Self-service checkout kiosks have been introduced for more than 10 years in commercial industry. The technology was first invented to provide more control, convenience and speed to the customers especially the time-crunched individuals. However, in reality the reactions from customers though, were mixed (CBSNews, 2011). Some favour the traditional cashiers staffed checkout lanes and some prefer to use the Self-checkout.

"Our philosophy is giving customers options. People shop in different ways and we want to accommodate their preferences," said Suzi Robinson, a spokeswoman for Stop & Shop Supermarket Co., which has self-serve lanes in about 85 percent of its nearly 400 stores in the Northeast." (CBSNews, 2011).

Clearly the approach taken by Robinson was the right choice; self-checkout kiosks are not meant to replace the traditional checkout mechanism and will not eliminates the role of cashiers from retail industries, but it exist as an alternative mechanism for those customers who don't prefer to linger around the checkout lanes doing nothing but waiting.

2.1.4 Self-checkout Kiosk: Challenges in Hypermarts context

Self-checkout kiosk is definitely not a flawless system on its own. Since its first introduction about a decade ago, reactions from people vary. Some people are embracing the new technology without a doubt, but some are still having issues with the new system. What seems to be the problem?

According to Grohol (2008), Winterman (2009), Mostue (2011) and Rogers (2011), the following are the few major problems with the current self-checkout kiosk in hypermarts.

i. Complex Procedure

Under normal occasion, the self-checkout kiosks are programmed with an anti-theft mechanism; in which some strict rules been imposed – which could only mean more confusion and freedom limitations to the customers. This indeed, is one of the major demotivator for customers to use the checkout kiosk.

ii. Payment Module

Most of the self-checkout kiosk we have seen to date supports multiple modes of payments; cash, credit cards etc – which sometimes leads to confusion and inconvenience of waiting for changes and the verification process of the cards.

iii. Purchase of products with restrictions

Some products have age restrictions imposed; alcohol, certain types of drugs etc. This has raised the attention of the public towards the probability of under-age kids or teenagers obtaining these restricted products via the self-checkout kiosk.

iv. Theft / Honesty issues

From the hypermarts' perspective, thefts have always been their major concern. With the lack of security features or theft-prevention system installed, the self-checkout kiosk is deemed as an easy way for the thieves to steal the items from the hypermarts. This though, is a very subjective issue and can be overcome by adjusting the business process to the usage model of that of self-checkout kiosk.

v. Kiosk Management issues

Due to the fact that kiosks are typically deployed at multiple locations that lack on-site technical support, crashed kiosks will be a major headache for hypermarts. The crashed kiosks displaying the "Blue Screen of Death" will remain unusable until a technician or trained employee arrives to reset the machine – which means loss of valuable resources for the hypermarts and could lead to customers' rejection on using the kiosks.

However, love it or hate it, according to Anand, (2011), the self-checkout mechanism is not leaving the retail scene anytime soon.

"Self-checkout suppliers ranked in $524.1 million worldwide in 2010, a 46 percent increase from 2007, according to technology research firm VDC Research Group, which projects growth of 84 percent over the next five years." – Anand, 2011.

Besides, with technology advancement, the self-checkout kiosk will continue to grow and dominate the industry while coming out with solutions to solve the challenges one by one as the time goes.

2.2 Radio Frequency Identification (RFID) in 21st Century

Radio Frequency Identification (RFID) technology has found itself a place in the spotlight of today's ubiquitous automatic identification environment. Starting as part of the effort to increase the efficiency of spotting allies air units in air combats during World War II in 1948, RFID has managed to strive its way into the fast pace global environment of the 21st century; from transportation systems to education systems, logistics tracking to healthcare monitoring; RFID has now becomes a very important aspect of our daily lives (Rida, Yang, and Tentzeris, 2010).

Technically, RFID transmits electromagnetic waves in sending and receiving data or information. An RFID system comprises of RFID tags or transponders, an RFID reader or writer, middleware, encoder and application software. According to Rida, Yang and Tentzeris (2010), RFID tags or transponders have greater data and information storing capacity compared to most of its rivals – Barcodes, Magnetic Stripes Cards and other Smartcards. The RFID tags communicate interchangeably with RFID readers or writers in exchanging data and information wirelessly without human interference. Weiss (2003), claims that most of the commonly found RFID tags in our daily lives are read only – only capable of transmitting data to be read by RFID readers, and those which are rewriteable are a bit costly compared to the first. In data transmission, the readers or writers will first send radio-frequency signals to the tag; which comprises of a chip and an antenna, requesting for access to the data it contained. The tag will then transmit the requested data contained in the chip to the readers through its antenna. However, in order to transform the data received into meaningful information, the readers or writers, often embedded along with encoders, will encode the data before transmitting it in digital form to the application software with the help of a middleware (Hossain and Prybutok, 2008).

In fact, this ability of RFID technology has in storing and transmitting data and information passively has captured the attention of the industry players. Its enormous potential in commercial industry has contributed to its wide usage in the industry to date. Some of the fields that has adopted RFID technology into their systems to date: Point of Sale (POS), Automated Vehicle Identification (AVI) systems, access control to buildings or rooms within buildings, livestock identification, asset tracking, pet

ownership identification, warehouse management and logistics, product tracking in a supply chain, product security, raw material tracking/parts movement within factories, library books check-in/check-out, railroad car tracking, luggage tracking at airports, and telemedicine (Panigraphy, Jena and Turuk, 2011) and its implementation is continuously growing with time. It is only a matter of time until we realize that RFID tags are everywhere in every corner of the world.

2.2.1 RFID in Commercial Industry

RFID technology is now moving into more sophisticated applications in our lives. One of the significant traits of RFID technology that helps in gaining the attention in the wireless automated identification field is its expendability and flexibility in supporting additional functions. Hence, scientists and researchers are continuously drawn into expanding the usability and practicality of RFID implementation in various industries in our daily lives.

The efforts have led to the commercialization of RFID technology in various industries we have known today; parcel tracking and detecting system in logistic industry, access control system in education, health and corporate world, and most definitely the most popular hit; contactless smart card for automated fare collection system in transportation and retail industries (Rida, Yang, and Tentzeris, 2010).

Generally, RFID hits the commercial industry in 1980s. It was not long after that it captured the industry's attention to its big potential, especially in the backend operations such as product tracking as part of the supply chain management strategies. Besides, the biggest and the famous convenient store in United States; Wal-Mart was one of the key players who adopted RFID technology in their supply chain early back then. Spreading its wings, RFID continue to hype in commercial industry in 1990's; leading to some of the greatest breakthroughs in the industry itself. Entering the 21st century, RFID continues to shine; its new potential been discovered as one of the way to make secure payment without involving cash.

2.3 Electronic Fund Transfer (EFT): Need for a Convenient Cashless Payment Method

Electronic Fund Transfer has been hype since the late 20th century. EFT is basically the electronic exchange of money or tokens for payment purposes through computer-based systems as oppose to using the conventional paper cash and coins. This field has long been penetrated by the banking entities and those credit suppliers; VISA and MasterCard and ought to have a big potential in realizing the "cashless future" dream. (Lamond, 1996)

Credit cards and Debit cards are two major well known Electronic Fund Transfer (EFT) methods in the market. However, according to McKeen et al (2003), one of the major drawbacks of credit cards or debit cards is the time consuming process it takes in performing a payment transaction. As been mentioned in the earlier part of this review, this is one of the major bottlenecks for customers in hypermarts especially for the time-crunched customers.

The authorization process involved in a credit card transaction is as shown in Figure 1 (Metzger, 2009). Basically, whenever the cashier swipe a customer's credit card in hypermarts, the credit card reader will need to first, authorize the card, then, communicate with the server back at the banks' end to validate the outstanding balance before they can proceed with the transaction. The time taken for the entire process will depend on the bandwidth of the network and the connection.

Adding to the hustle, the customers will need to enter their personal identification number (PIN) and put their initial on the receipt as consent and validation for the transaction. The overall credit card payment process is as shown in Figure 2.3 and 2.4. Besides, the fact that credit cards allow one to spend way over his average monthly income and the amount of interest applied has led to some major social and economic problems to date; bankruptcy among youngsters due to bad financial management, bad shopping habits etc.

A debit card, on the other hand, operates basically the same way with credit cards except for the part that they have certain limitation in term of the customers' maximum spending amount. The spending limit is determined by the amount of

money one has in the bank account linked to the debit card; thus, avoiding overspending. However, technical wise, its payment transaction process is basically similar with credit cards'; as time consuming as it can be, depending on the bandwidth and the speed of connection.

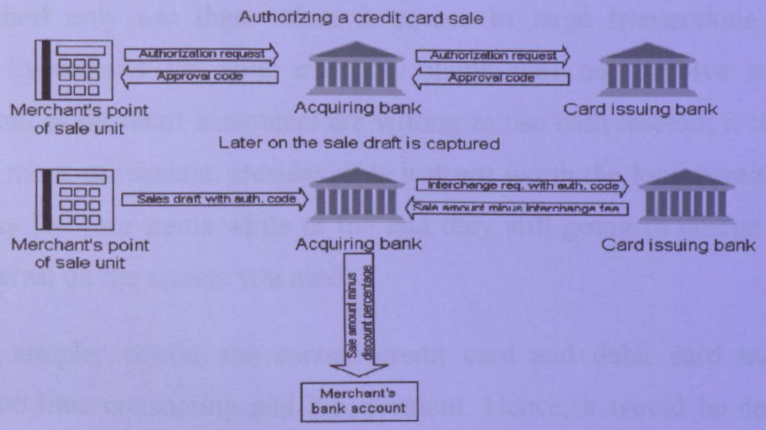


Figure 2.4 Overall payment process using credit cards (Lamond, 1996)

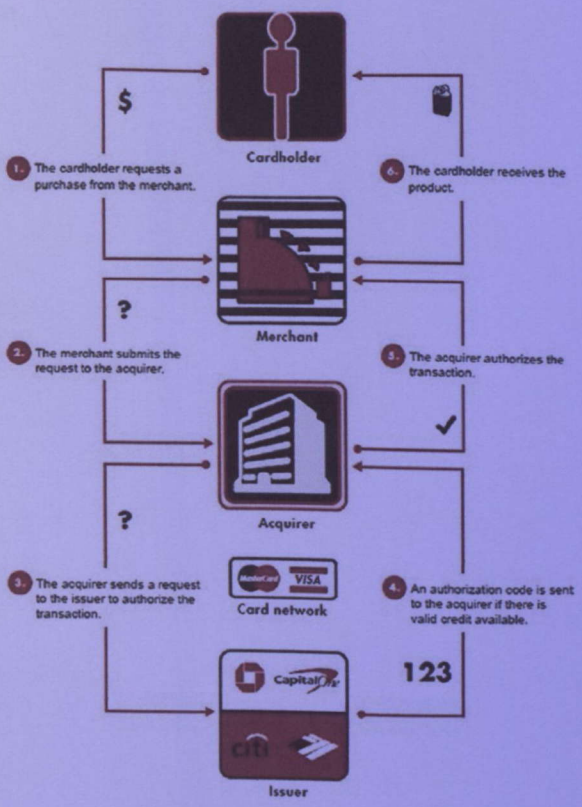


Figure 2.5 Credit cards transaction authorization process (Metzger, 2009)

In fact, despite its wide acceptance in the society, according to McKeen et al (2003), credit cards and debit cards are failing in terms of efficiency especially when it comes to small transactions. Most of the time, those people who embraced such payment method only use them when it comes to large transactions. Usually, shopping in hypermarts for your everyday items will not involve such large transactions and some smart customers are willing to use cash instead; it is indeed a lot faster and more convenient. Besides, it is just not worth the long waiting time to get you to pay for your items while in the end they still going to charge you with additional interest on the credits you used.

Thus, in simpler words, the current credit card and debit card transactions process are too time consuming and inconvenient. Hence, it would be desirable to implement a new simpler and convenient mechanism for customers to pay for their items without the need for cash and RFID technology is the next big thing the industry is looking into.

2.4 Realizing Cashless Future: RFID-based payment cards

People nowadays are getting more and more technology conscious. Most of the things in our lives nowadays involved the so called computing environment – using computer and technology to assist in daily processes. This has been one of the major motivator for businesses to adopt RFID into their systems. Realizing the big potential that RFID has, some of the companies began their venture into utilizing it in aiding payment processes; as one of the alternative Electronic Fund Transfer (EFT) method.

There are many RFID-based payment cards have been implemented across the nations to date; T-Money Card in SouthKorea, EZ-Link Card in Singapore, Touch n' Go Card in Malaysia, Octopus Card in Hong Kong, Oyster Card in London, Easy Card in Taiwan, EZ Tag in North Texas and Houston, FasTrak in California, Pikepass in Oklahoma, and SunPass in Florida (Hossain and Prybutok, 2008). Basically all these cards utilized the RFID's capability of sending and storing information wirelessly in their system.

Figure 2.6 Examples of RFID-based payment cards

i. Convenience; Short Transaction Processing Time and Wide Area of Coverage

These cards have managed to redefine the whole meaning of convenience for the customers. Ever since they exist, they allow the customers to pay for their goods and services wirelessly without the need for cash. These contactless, rechargeable smartcards have been implemented in various industries across the countries. For example, the famous Octopus Card in Hong Kong, which was first introduced in 1997 to ease the fare collection process in Hong Kong's public transportation industry, has captured almost the entire seven million Hong Kong residents market and in fact, there are now 10 millions

Octopus Cards circulated; which far exceed the entire Hong Kong's population (Chau and Poon, 2003 and Octopus, 2011).

The implementation of Octopus Card in Hong Kong was so successful that it has become part of the people daily lives. Octopus utilizes the RFID technology, a technology in offering the customers the ultimate convenience of simplifying fare collection mechanism and payment process for goods and services in Hong Kong. As to date, Octopus Cards not only can be used to pay for public transport fares, they can also be used to pay the mobile phone bills, rent DVDs, make orders and payments at cafes, purchase goods and items in 7eleven retail stores and pay for snacks and soft drinks etc through the Self-checkout kiosks provided (Octopus, 2011). The fact that the transaction processing time only takes less than one-third of a second, people are continuously drawn to the convenience Octopus gives; in fact, it has become a necessity for the residents and even the tourists whenever they want to visit Hong Kong (Hong Kong Travel, n.d.).

The Oyster cards in London on the other hand, focus on the convenience of the travellers. The cards have become the main cashless fee payment method for public transportations; metro, urban, trams, buses etc and London's holiday spots. Offering a high speed transaction time with claimed reader sensing proximity of approximately 8 centimetres away, Oyster cards have managed to capture the "Time-crunched" people in London. In addition, the discount offered for paying certain public transportations using the pay-as-you-go Oyster card scheme has made it the preferred payment mode for London community especially those who need to commute on everyday basis. (London Pass, 2011).

In Malaysia's context, we do have our own RFID-based payment card; Touch n' Go. First introduced in 1997, focusing on simplifying the tolls fare collection payments in highways and car parks, Touch n' Go Card has managed to spread its wings to cover other industries as to date; trains, monorails, LRTs, fast food restaurants, theme parks, cafes etc. (Touch n' Go, 2011) and the coverage is expanding fast as the time goes by. Touch n' Go

cards offer its customers the convenience of being in the fast lane. Customers are able to make payments for trains and buses fares, highway tolls etc conveniently just by swaying their cards - may even be inside wallets or purses, on the readers and the transaction takes place securely within a split second without the worry of small changes and balances.

ii. Transaction Security and Privacy

Apart from conveniently shorten the overall transaction process time, these cards offer a secure and private transaction process. The cards are not linked by any means to any bank accounts and operate based on the amount charged to the cards. In fact, most of the time, these cards are anonymous by default; not linked to any individuals profile in any country, making it transferable between users. Octopus and Touch n' Go cards for example can be easily bought over the counters or self-service kiosks without filling any application forms; the users are anonymous.

The transactions are safely governed by the compliance ISO/IEC 14443 standards for contact less smartcards. The cards will be able to interact with readers that have the "secret handshakes" with them; not readable by other types of RFID readers except the one it is programmed to. This, of course, can reduce the chances of fund stealing or robbery from one's card.

In simpler words, the current protocols are sufficient to provide necessary security and privacy to these RFID-based payment card users as to date. However, as the technology develops, there are needs to continuously revise the transaction protocols for RFID-based payments cards in order to ensure the security and privacy of the customers. In fact, there are already ideas and researches carried out in these areas to date; in improving the security and privacy level of RFID-based payment cards.

Blass, et al. (2009) suggested the idea of Private and Secure Payment (PSP) protocols to be used for RFID-based payment cards. The main idea is that the RFID-based payment cards will not physically store the coins but it receives instructions to generate a limited number of valid coins that can be validated

by the protocols installed from the reader side. This protocol enhances the security of the transaction by requiring the cards to send a "challenge" message to the reader and requires the reader to send the valid replies. If the messages match each other, the card will then carry out the transaction, however, if the message sent by the reader does not match the challenge message sent by the card, the authentication process is considered fail and transaction will not take place. This approach will definitely increase the overall security of payment or transactions over the RFID technology; however, there will be significant increase in the transaction process time while adopting this protocol.

In addition, Czeskis et al. (2008) proposed a standard solution to use multi-factor authentication for the RFID-based payment cards; for example, requesting for PIN or password or even biometric scan when making transaction. However, similar case to the previous, it will result in a significant increase in the time taken to perform a transaction.

2.4.1 RFID-based Credit and Debit cards

In order to provide more utilities to its customers, the credit and debit card providers with collaboration with the banking entities are looking into RFID technology. RFID technology is ought to be able to help to ease the current tedious payment process for credit and debit cards; applying what has been implemented in other RFID-based payment cards to shorten the payment process, except that these cards are linked to the customers' bank account; which however can bring a significant security threats to the customers.

Despite the whole cryptology method implemented in RFID-based cards, adversaries are still able to virtually rob the customers provided they have the proper RFID readers and encryption/decryption applications for such purposes. Hence, the security and privacy level for RFID-based credit and debit cards must be strong enough before they can introduce them to the market. In fact, research has started to look into these areas since the past few years according to O'Connor (2005).

- **People Acceptance**

According to Hossain and Prybutok (2008), customer acceptance of RFID technology especially as payment mode is a very sophisticated issue. The focus of the customer is mainly ranging from the usefulness of the RFID-based payment cards to its security and privacy issues. Hossain and Prybutok also mentioned that the result of one's behaviour is much likely motivated by his or her behavioural intention; which is in turn motivated by the customers' perception of the technology based on a given range of factors. Hence, the customers' intention to use RFID technology will determine whether or not they will embrace and accept the new technology in their transactions.

Based on Hossain and Prybutok's studies, the customers' intention to use the RFID-based payment cards can be laid based on its perceived privacy, perceived security, perceived regulations' influence, and perceived culture's influence from the customers' perception. Both the perceived privacy and perceived security will be further judged from two different dimensions resulting in four variables; importance of privacy, unwillingness to sacrifice privacy, importance of security, and unwillingness to sacrifice security as in the figure below:

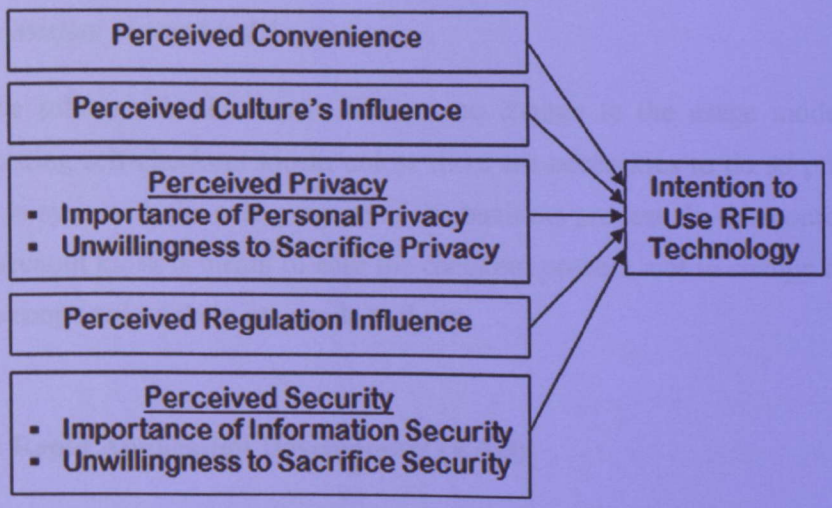


Figure 2.7 Factors influencing the customers' intention to use RFID-based payment cards (Hossain and Prybutok, 2008)

2.5 RFID-based Payment Card and Its Challenges

RFID technology is definitely one of the major contributor to the future cashless payment mechanism; with the simple ability to store and transmit data, RFID can conveniently ease the transactions in our daily lives, reducing the hustles and thus, buying us more time to spend for other activities in our ever demanding lifestyles.

As futuristic as it may sound, RFID-based payment cards are still prone to few problems it has to face as to date. According to Panigrahys, Skjena and Akturuk (2011), the following are the few major challenges that are relevant to RFID-based payment cards.

- **Technical Factors**

  i. **Sniffing**— RFID technology is indiscriminate, it allows the right readers to retrieve its information without the knowledge of the card holders. This could lead to some security issues due to the RFID reader technology abuse.

  ii. **Tracking**— This however is not relevant to anonymous RFID-based payment cards except if the owners take the decision to customize their cards and having it linked to any personal information which could be a huge threat for them; their locations will be able to be tracked every time s/he use the card.

  iii. **Spoofing/Cloning**— Adversaries are able to mimic any authentic RFID-based payment card by writing appropriately formatted data on another blank RFID tag. An adversary might have the proper reader to capture the overall payment process information so that s/he can replicate the "coins" to be used in his/her transactions.

  iv. **Replay Attacks**— Relay devices can intercept and retransmit RFID queries, which adversaries can use to abuse various RFID applications to retrieve anyone's information or reusing their coins in payment context.

CHAPTER 3

METHODOLOGY

3.1 System Development Life Cycle

System Development Life Cycle is basically a framework that describes the activities involved at every stage of a software development project. There are five stages involved in a software development project which are; Systems planning and Investigation, System Analysis, Systems Design, Systems Implementation (Programming, Testing and Documentation) and Systems Maintenance.

According to Czeskis et al. (2008), the development of any new technology should comply with the following factors, and this project is no exceptional:

i. *Backward Compatibility*

   The solution should not be based on assumptions of any future modifications of the current hypermarts business processes. The solution should be able to accommodate and improve the current and existing technology and processes.

ii. *Consistent Usage Model*

   The solution should require little or no change to the usage model of the existing self-checkout kiosk, unless there are necessities to do so provided it is in sync with the sole purpose of the business process. In this context, Self-checkout kiosk is meant to ease the checkout process, not to change or extend its scope unless there are needs to do so.

3.1.1 Rapid Application Development (RAD)

The Rapid Application Development model comprises of four major phases; Analysis and Quick Design, Prototype Cycle, Testing and Implementation as depicted by Figure 3.2. The author perceives that adopting

this model in developing the system will help him in completing the system within the time frame given.

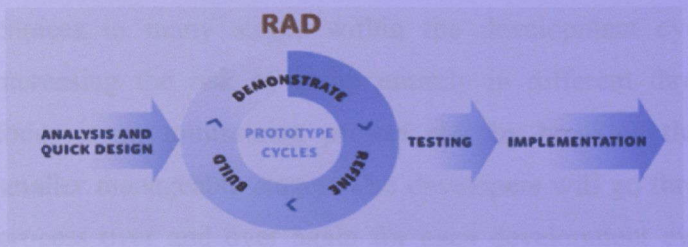


Figure 3.1 Overview of a RAD model

There are many advantages in adopting Rapid Application Development Model for the development of the system:

i. Speed and Quality

RAD promotes speed and quality in system development process, primarily through the use of iterative prototyping and active user involvement. In terms of speed, RAD allows an early initiation of the development stage even though the requirements and business objectives have yet to be defined and narrowed. Besides, the development of a working prototype concentrates on building the essential system elements from user perspective. Hence, the users will get the chance to test the system faster, allowing them to get a sense of a bit of everything they will get at the end of the development process.

ii. Flexibility

According to Purcell (n.d), RAD model allows a quick requirements gathering process and development of the system prototype. Feedbacks from the users will then be used as a platform for the developers to improve the quality of the system and gain a further insight into the business requirements as the development goes along. Besides, if there are any changes in techniques or business requirements deemed necessary to be included in the project, it can be embedded to the system before it is completed, before too many resources are wasted.

- **Risk Management**

  Flexibility, however, may cause the developer to be overwhelmed by choices in many stages within the development cycle; therefore, increasing the risk of going entirely in different direction. Hence, focus is on minimizing project risk by breaking the project into smaller manageable stages. The developers will go through the same process over and over again for each development cycle; collecting valuable information, feedbacks, and requirements as well as helping to regain focus as they go through the processes.

  Nonetheless, it may also leads to an uneven progress in the system development process, with high-risk areas being overly emphasized and the low-risk areas are being overlooked; hence, risk management is the main emphasis in this model (Linger et al, 2002).

- **Appropriateness**

  The author has only about 2 months to complete the system. Hence, by adopting RAD model, the author would be able to start of the development stage as early as the initial scope been defined; and the improvements can proceed along in the development stage. Besides, the author will also be able to produce prototypes, test them, and enhance from time to time until the complete working system is produced within the time frame. In this context, RAD model is highly relevant as the implementation is a priority compared to the functionalities; core functionalities are given priority.

3.2 Project Activities

The project activities starts with the planning and analysis and finally moves further into quick design & description of processes which explains the entire process in developing the prototypes and final deliverables of this project.

3.2.1 Problem Identification and Information Gathering

Speaking from this project's context, the author has managed to identify problem in the overall checkout process in hypermarts. The author realizes the opportunity to enhance customers' shopping experience in hypermarts by enhancing the convenience and speed of the entire checkout process.

The author has carried out a preliminary survey on a group of people; from different age groups, gender and geographical areas in order to spot and to be able to identify the real problem with the current existing checkout mechanism in hypermarts. Online questionnaires and interviews have been the main source of knowledge seeking method used by the author in this context.

i. Online questionnaires

Taking advantage of the technology, the author decided to use the free online questionnaire services on the internet to help him to reach a broader audience. The questionnaire comprises of 2 major clusters; Checkout Mechanism and Payment Modules. Each cluster mainly consist of several multiple choice questions, open ended (opinion-based) questions and a few likert-scale questions to ease the answering process by the audience. The questionnaire was designed in a way that every audience can only do it once and anonymously.

At the end of the day, the data gained from the questionnaires will be used by the author in deciding the direction of the project. Besides, the questionnaire is built in order to foresee the extent of perceived practicality of the system towards the Malaysian society nowadays;

given with their limited knowledge on RFID technology and lack of exposure towards self-checkout kiosk system.

- **Interviews**

  In addition, the author has also managed to reach some of the managers in the hypermarts to gain a general insight of their current checkout processes; from the minute cashiers scan the customers' items until the update of their inventory database. The author also has been exposed with some of the knowledge deemed necessary and relevant to this project such as the mechanism of the different payment modules available for customers during checkout, categorization of items, tagging of items as well as some customers service mechanisms; which include the introduction of discount or reward card and queue busters mechanism. Speaking from their experience, the managers surely shared some very useful knowledge and information with the author on the practicality and the potential of this project to be the future main checkout process.

  Apart from that, the author has also managed to conduct a phone interview on the managers in Touch n Go company; the only RFID-based payment card service provider in Malaysia. From this phone interview, the author has been exposed to the mechanism of a Touch n Go card, from the places it can be used, the reload and top up mechanism, transaction update mechanism and some error prevention mechanism. From the interview, the author foresees the potential of expanding the usability of the Touch n Go card into retail industries through this project; however, further communication with the company is needed for a deeper insight on their technical operations.

3.2.2 Information Analysis

With all the information gained, the author has done some analysis and has managed to define a clear objective and goal of this project as well as the scope of this project that will need to be covered as for its design and implementation.

In this context, the author has identified the main problem in the current checkout mechanism in the country is that it is too time consuming and not fast enough for the "time-crunched" people. Living in the technological era, people are becoming more and more impatient and "time-crunched" due to their busy lifestyles. Hence, the author foresees the opportunity to enhance customers' shopping experience in hypermarts by proposing the use of RFID-based payment card as payment module for the Self-checkout Kiosks.

Besides, from the hypermarts management's view, customers' satisfaction is very important. Their level of satisfaction while leaving the hypermarts can be a determinant whether or not they will make another visit to the store; retention level, thus, hypermarts will always strive towards satisfying and accommodate customers' needs during their visit.

"As a business, we want people to leave our stores with smiles and happy with the convenience we provided to them." - **Syed Mohd Hasri, HR Manager Tesco (M)**

However, in Malaysia, that is not always the case. Most of the time, we only have a single checkout option while checking out our items in hypermarts; thus, been restricted to use the traditional cashiers staffed checkout lanes. The problem with this traditional checkout mechanism is that sometimes it gets too crowded especially during the weekends and at the end of the month, hence, customers need to spend most of their time waiting for their turns in the checkout lanes. This can potentially decrease the customers' satisfaction and increase the customers' turnover rate; thus, cause losses to the hypermarts themselves.

Hence, the author has come up with the idea to have an alternative checkout mechanism for the customers in hypermarts; self-checkout kiosks using RFID-based payment card as payment module. The technology has not been new to the societies in developed countries such as United States and Hong Kong especially. Thus, the author believes that this technology holds the potential to revolutionize the whole checkout mechanisms we have in hypermarts in Malaysia.

3.2.3 Quick Design & Description of Process

The author has decided to implement the self checkout kiosk as an alternative checkout option for time-crunched customers in hypermarts; providing them with more convenience and speed. The self-checkout kiosk system will be built based on the current checkout process in hypermarts. It will hence, accommodate the following processes:

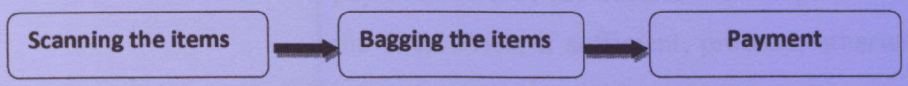


Figure 3.2 Conventional checkout processes in Hypermarts

In coming out with the proposed design and process flow of the entire system, the author will need to include all the processes above in ensuring a wholesome and complete coverage of the checkout process. Based on the information received through the survey and interviews, the following are the list of expected functions needs to be covered by the system:

Functions	**Description**
Barcode Data Retrieval	The system must be able to retrieve data and information of the items from barcode scanner, storing the data in variables.
Items Information Display	The system should be able to display the information of the individual item scanned along with its price.
Total Price Calculation	The system must update the total price of the whole items, each and every time a new item is scanned.
Items Summary Function	The system must be able to display the summary of the items scanned by the customers and the total price for checkout and confirmation purposes.

Checkout and Confirmation Function	The system must be able to store the Total Price of the customers' items in a variable and thus use this value to deduct the amount of "token" from the customers' RFID-based payment card.
RFID Payment Card Data Retrieval (Read)	The system must be able to read the initial amount of "token" available in the RFID payment card of the customers; compare it with the Total Price, if sufficient, proceed; otherwise, prompt error messages.
RFID Payment Card Data Update (Write)	Upon receiving valid "token" as payment confirmation, the system must be able to overwrite the existing data on customers RFID payment card and replace it with the current amount of "token" they have; the balance.
Receipt Generating Function	Upon successful update of RFID payment card data, receipt is then generated; containing the current date, checkout time, summary of items purchased and total price paid.
Inventory Database Update	Upon successful checkout, the system will need to be able to update the inventory database of the hypermarts.

Table 3.1 List of expected system functions and descriptions

The functionalities of the system will be revised and redefined as the author receives more technical information on the Touch n Go card as well as the hypermarts point of sales management system.

Besides, the author has also made some research on the functionalities and process flow of the current existing self-checkout kiosk in other countries in order to help him in deciding the best practical design and process flow for this

project. In fact, it is expected that the author will produce a series of proposed designs and process flows before finalizing it prior to the implementation. Until then, the proposed design is still open to changes; if there is any need to expand the scope or functionalities etc. The functions are classified according to their importance in the prioritized list of requirements below:

M - MUST have this	- Barcode data retrieval - Manual input of product code for products with no barcodes - Total price calculation - Items summary function - Checkout and confirmation function - RFID payment card data retrieval - RFID payment card data update / overwrite - Receipt generating and printing function - Bagging mechanism
S – SHOULD have this	- Display the information about the individual item - PIN or other payment verification method.
C - COULD have this if it does not give effect on anything else	- Camera; as part of security system - Discount/Reward card function for members - Attendant approval mechanism for controlled products and special events.
W – WONT have time for this but would like to in the future	- Theft prevention system - RFID labels scanning function

Table 1.2 Prioritized List of Requirements using the MoSCow approach

3.2.3.1 SCHECK System Framework

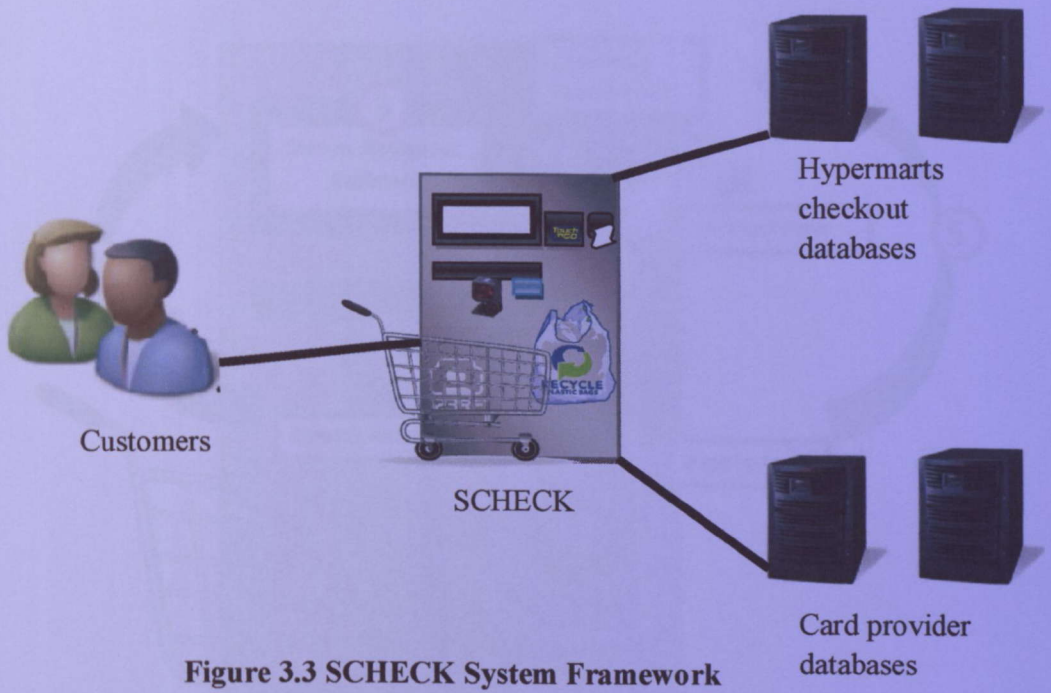


Figure 3.3 SCHECK System Framework

Based on the figure above, SCHECK will be connected to both the hypermart's checkout databases as well as the payment card service provider databases. Upon successful transactions or purchase, SCHECK will communicate with these databases to update the relevant information accordingly.

In this context, SCHECK will interchangeably retrieve and update customer's card balances and other information from the card provider databases. While on the other hand, SCHECK will record all the confirmed transactions or purchases in the hypermart's checkout databases. This information will then be used by the hypermart to monitor and manage their inventories as well as reference for accounts payable information; to get payments from the card providers etc.

3.2.3.2 SCHECK Proposed Physical Architecture & Physical Flow

1. User touch their RFID payment card
2. User scan the items using the barcode scanner
3. The information of the items projected on the screen
4. Bagging of items
5. Confirmation of total price and purchases and payment validation
6. Receipt printed

Figure 3.4 SCHECK System Physical Architecture & Physical Flow

3.2.3.3 SCHECK System Flowchart and System Model

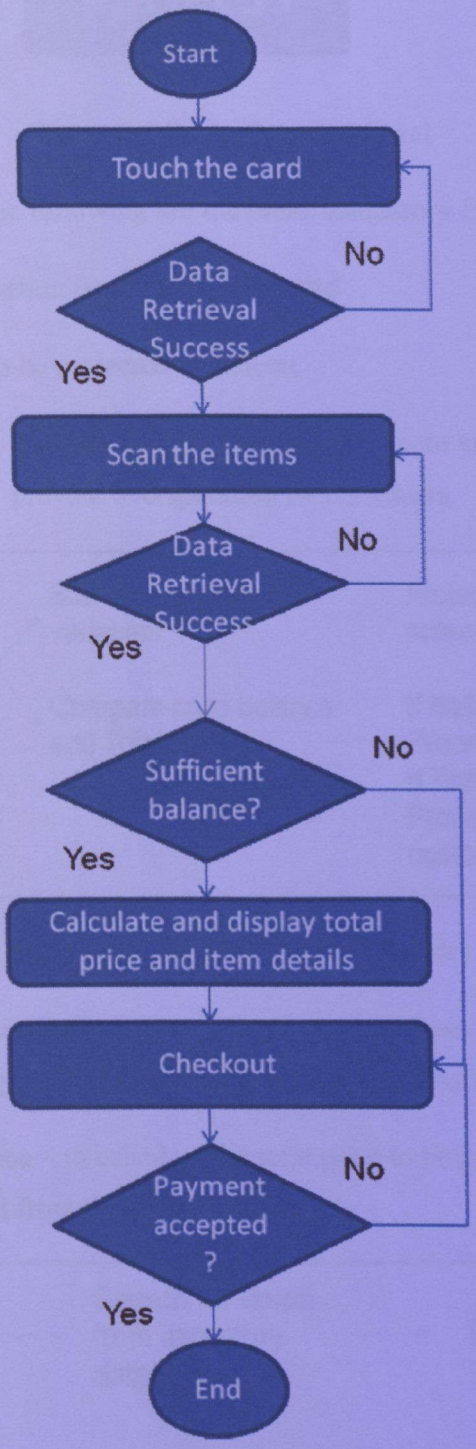


Figure 3.5 SCHECK System Flowcharts

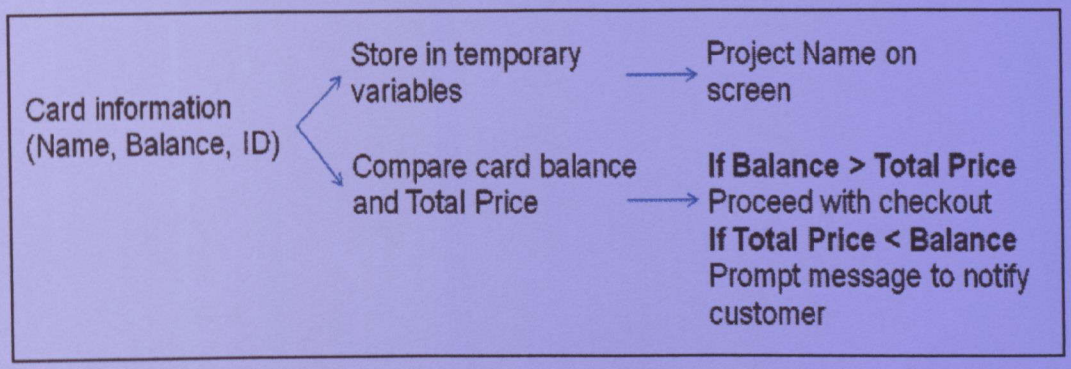
Figure 3.6 Basic System Model

In this project context, the following are the basic mandatory IPO model involved:

1. Capturing information from customers' card

    a. Name – to be projected on screen

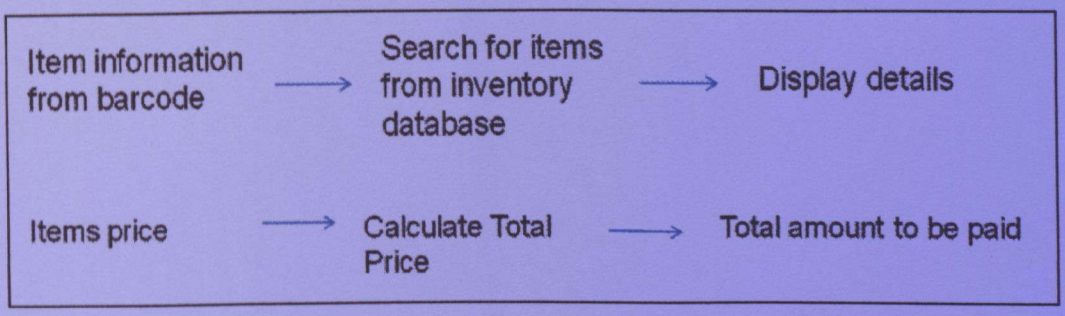
    b. Balance – to be used as parameter to compare against the total price to prevent overspending by customers.



2. Capturing Items information by scanning the barcodes

    a. Items Description – to help hypermarts to keep track of their inventory; inventory management and monitoring purposes.

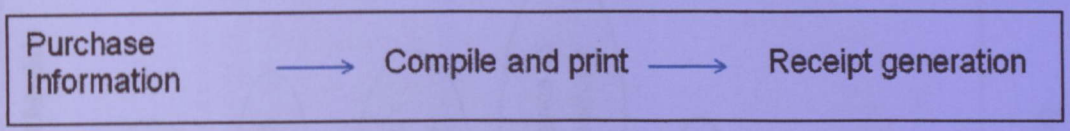
    b. Items Price – to calculate the total price to be paid by the customers; deducted from their card balance.



3. Capture purchase information for receipt generation

    a. Purchase information consists of Purchased Items Information, Total Price, Payment confirmation, Date and Time of purchase.

    b. Purchase Information will be used to generate receipts for customers and to update the hypermarts' checkout and inventory database.



3.2.3.4 SCHECK Use Case and Class Diagrams

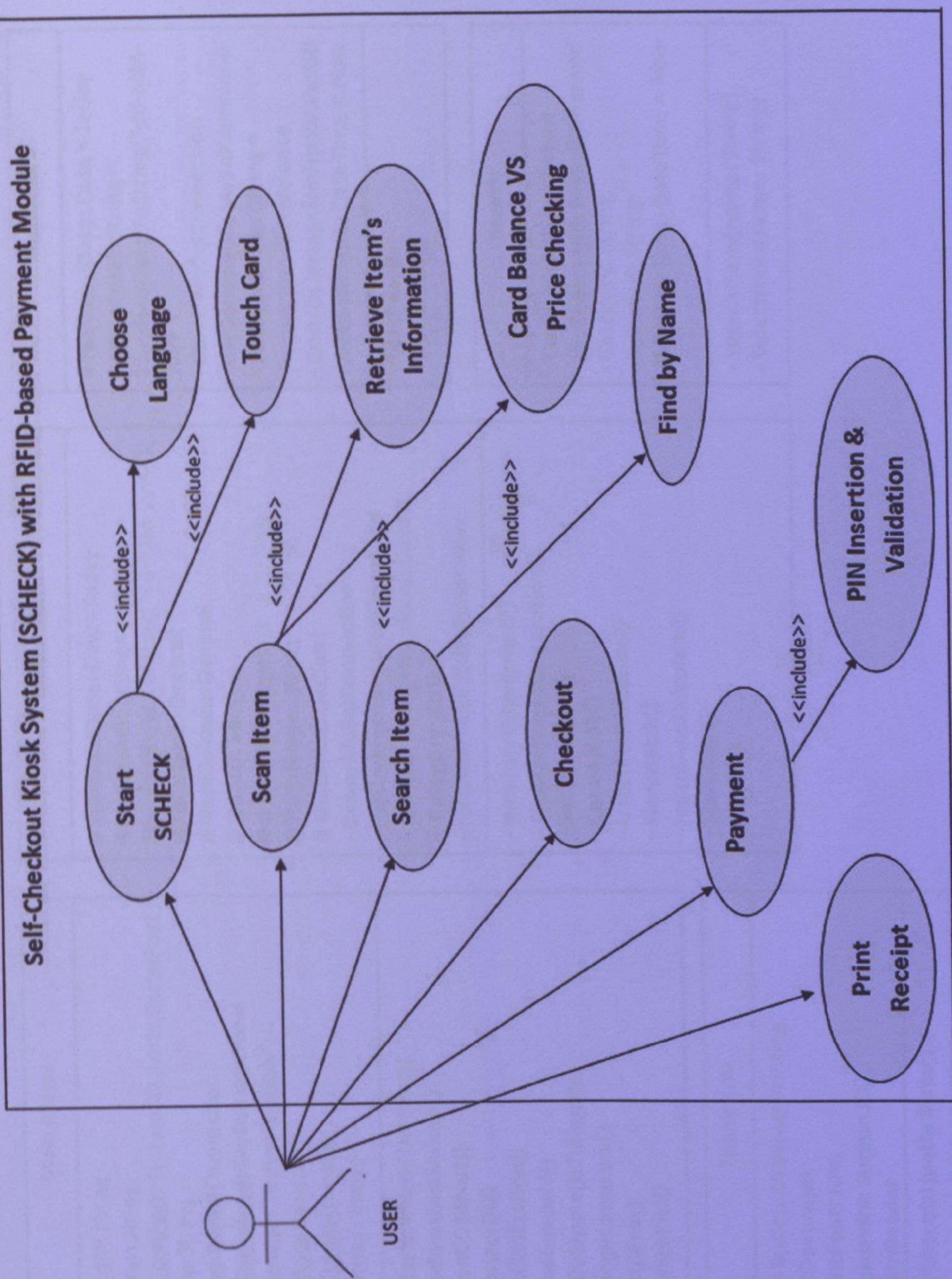


Figure 3.7 Use Case Diagrams for Self-Checkout Kiosk System (SCHECK)

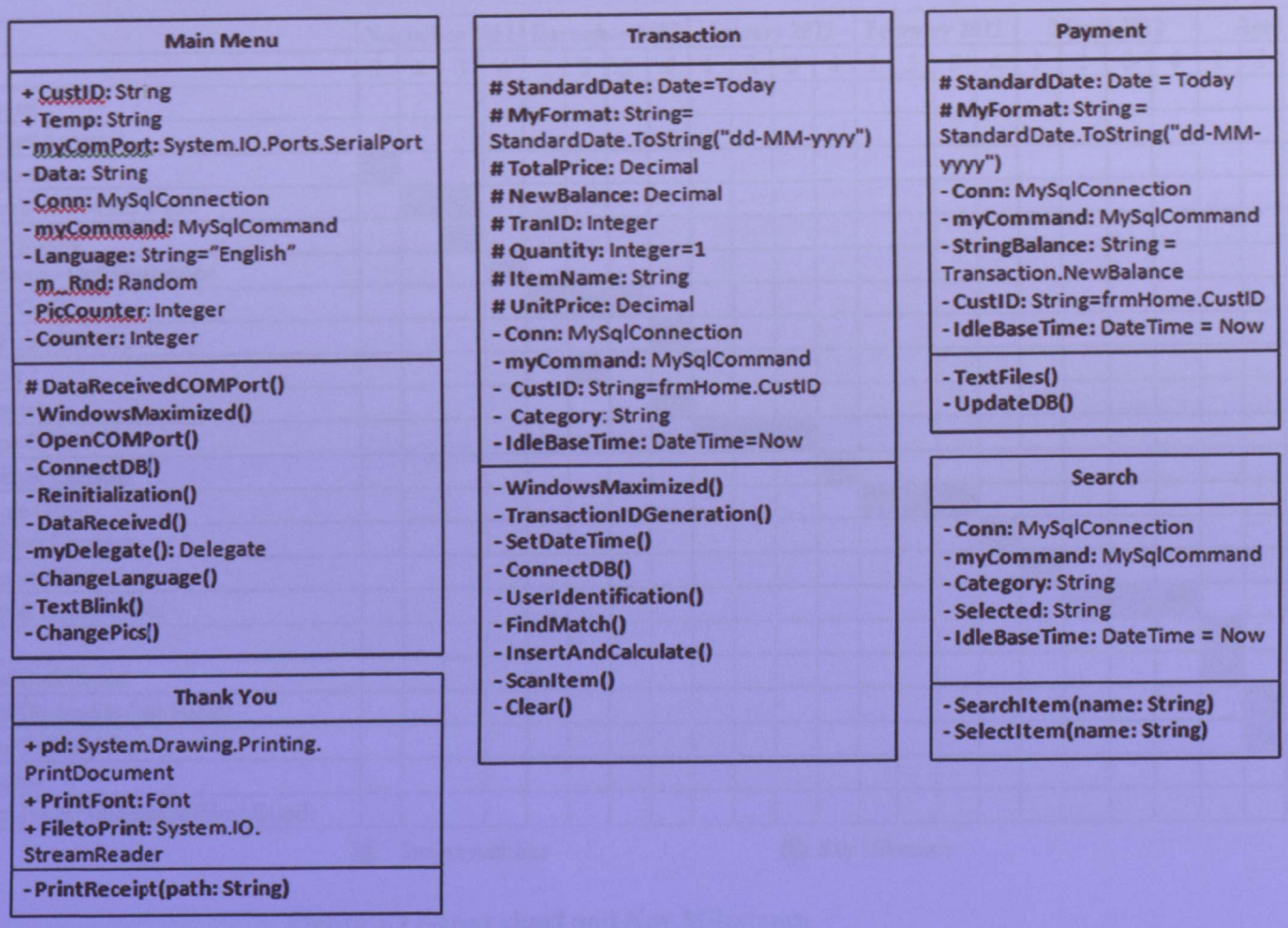


Figure 3.8 Class Diagram for Self-Checkout Kiosk System (SCHECK)

3.3 Project Gannt Chart & Key Milestones

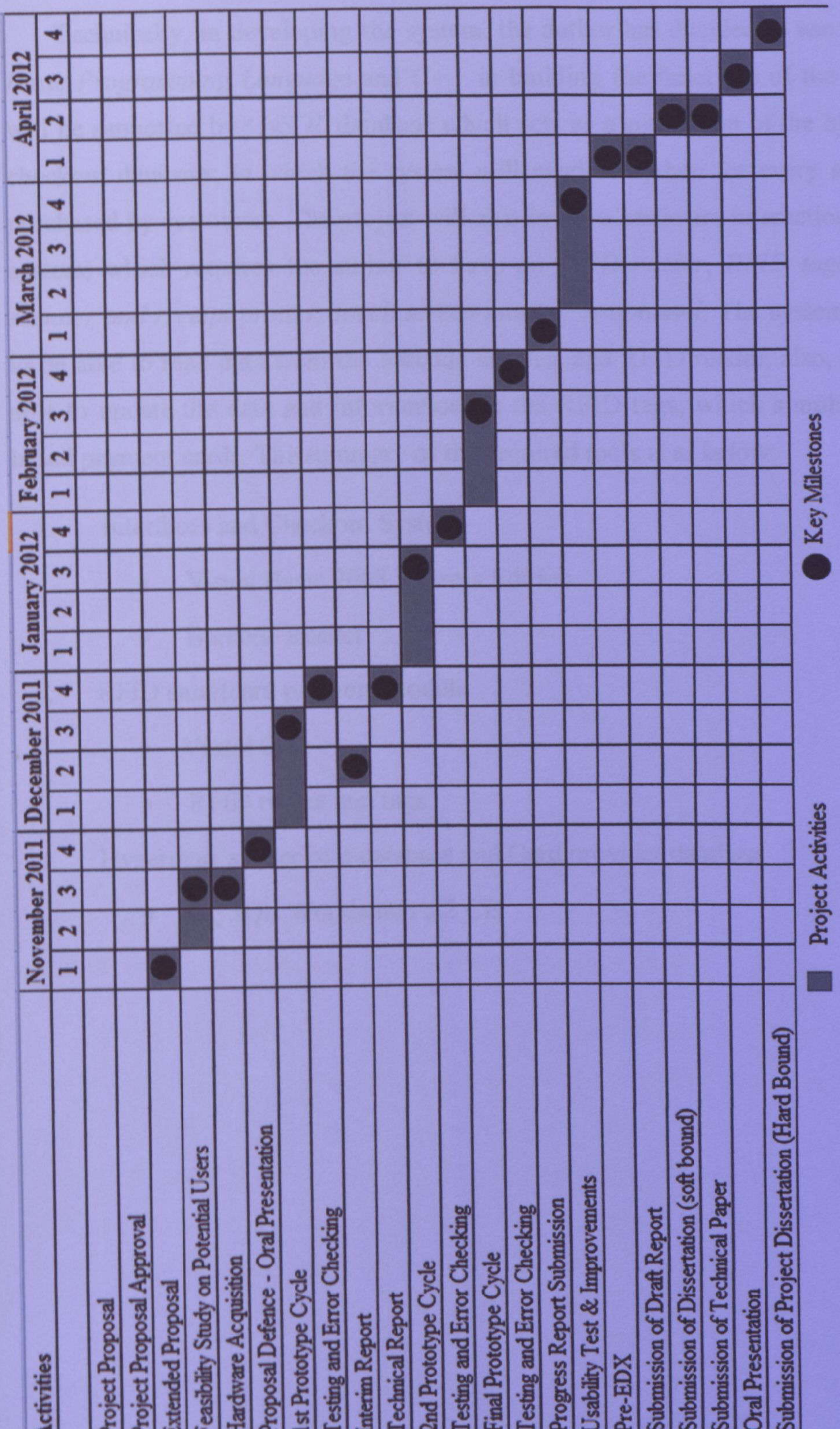


Figure 3.9 Gannt chart and Key Milestones

3.4 Tools Required

Technically, in developing the system, the author has decided to use the *Visual Basic Programming Language* and *C++* in building the functions of the system. It will be supported by *MySQL* database which acts as a simulation of the hypermarts' checkout database; in which the system will need to update for every single item purchased by customers. The project will also involve hardware interactions with the system; which requires the author to have an *RFID reader, RFID tags, barcode scanner and receipt printer; touch screen monitor is optional*. The system will need to be able to read data from the barcode scanner and RFID reader; also, need to be able to update the data and information on the RFID tags; which simulates RFID-based payment cards. The summary of the required tools is as below:

i. Interfaces and Checkout System
   - Visual Basic 2008 Express Edition
   - Barcode Reader

ii. RFID smartcard payment module
   - Visual C++
   - RFID reader and tags

iii. Hypermart's Checkout database and Card provider database
   - MySQL Workbench 5.2 CE

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Data Gathering and Analysis

The author has taken the initiative to conduct an online questionnaire, significantly targeting the university students and working young adults in Malaysia in order to see their opinions on this project. The significant of targeting these groups of people is due to the following factors:

i. They are more open to new technology and technology savvy

This group of people is more open towards new technology and is willing to try out the latest technology in the market. Hence, they have more exposure to the series of technology being introduced in the industries; Self-checkout machines such as ATM and RFID payment card such as Touch n Go card.

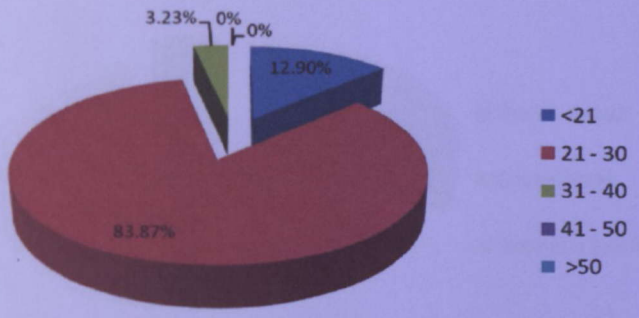
ii. Time-crunched

This group of people has the urge to spend as lesser time as possible to wait in the queues in hypermarts. They are busy with their workload on weekdays and have very limited time to spend with their family and waiting in queues in hypermarts during weekend is definitely not a favorable option for them.

The author took the advantage of the free online questionnaire generator and promotes the link through social networks such as twitter and facebook; specifically on the working group pages like LinkedIn Malaysia facebook page, JustMalaysian facebook page etc. Hence, this will help the author to reach the working group easily while gaining more insight and feedbacks from the industry people on the feasibility of this project in the country.

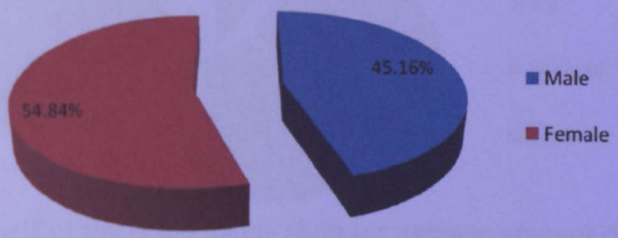
Hence, based on the 50 random samples on students and working young adults, below are the results based on the questions asked in the questionnaire.

1. Determine your age.



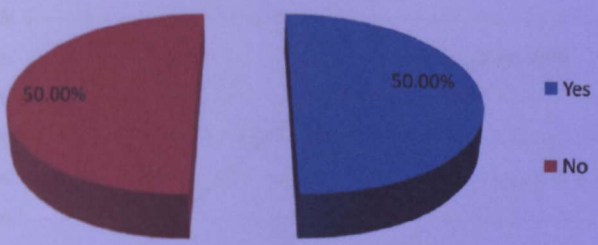
Analysis: Most of the respondents are the youngsters and the young adults between 21 to 30 years old. This young adults group is the best segment to target to be introduced with new technology; they are more technology literate and open towards changes and new ideas. They have the power to decide the future and shaped it according to their preferences.

2. Determine your gender.



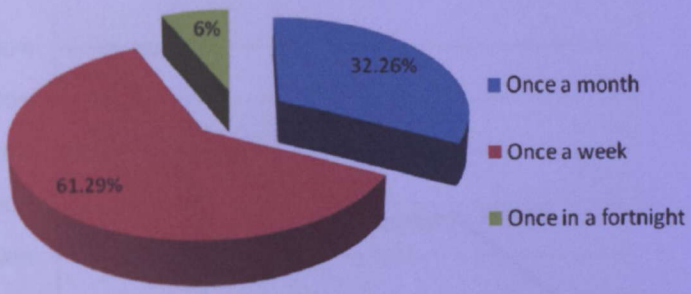
Analysis: The gender distribution among the respondents is fairly balanced. This will help to show a rightful data on gender preferences when it comes to checkout processes.

3. Are you currently working?



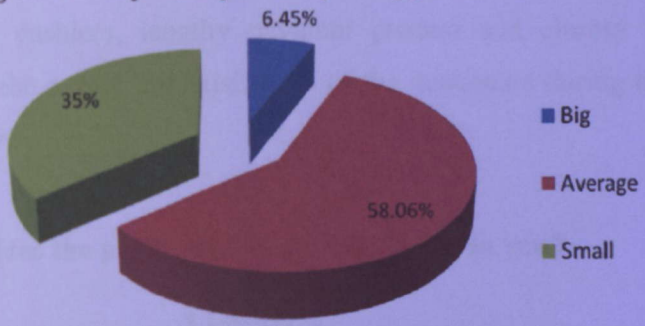
Analysis: Distribution among respondents who are currently working and not working is evenly distributed. Chances are, those who are not working are students, and those who are working came from those young executives.

4. How frequent do you shop in hypermarts? [on average]



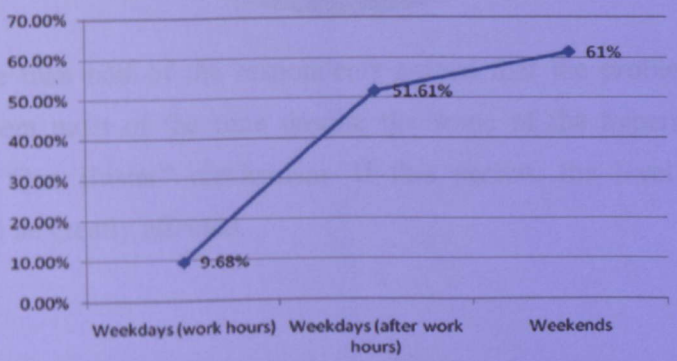
Analysis: More than half of the respondents shop in hypermarts once a week and about one third shop average once a month. This shows that the respondent prefer to visit the hypermarts on weekly basis rather than to buy for monthly stock at once.

5. Size of shopping cart every time you shop in hypermarts?



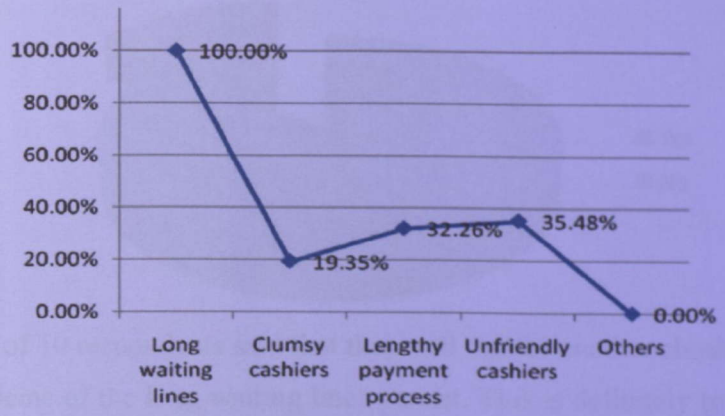
Analysis: More than half of the respondents shop for average amount of items when they shop in hypermarts. About one third only shop for few items and very few of them buy a large amount of items when shopping in hypermarts. The average and small size of shopping cart is most likely due to their weekly visit to the hypermarts.

6. When do you usually shop in hypermarts? [May choose more than one option]



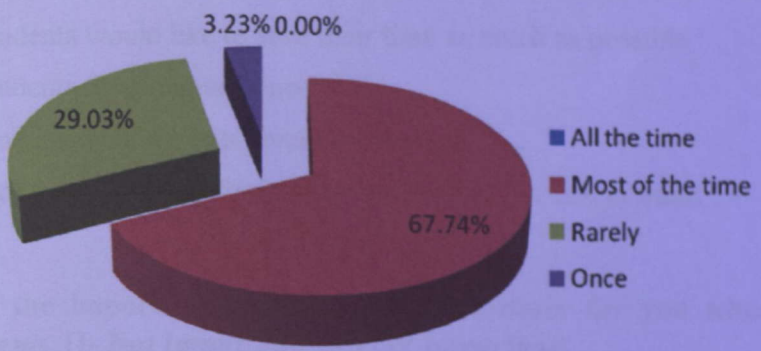
Analysis: Most of the respondents prefer to shop during weekends and weekdays after working hours. In fact, these 2 periods are considered the "peak" hours.

7. What are some of the problems you've faced when checking out your items at cashiers.



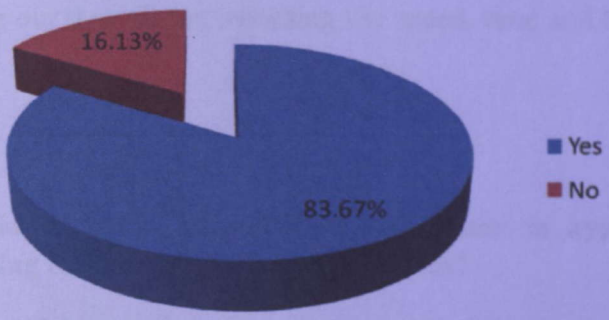
Analysis: The main problem faced by the respondents in hypermarts is the Long waiting lines when checking out their items; all of the respondents agreed that this is the major issue they faced when it comes to shopping in hypermarts. Other factors such as unfriendly cashiers, lengthy payment process and clumsy cashiers also contribute towards the overall dissatisfaction of the customers during their checkout process in hypermarts.

8. How frequent does the problem(s) in (7) happened on you?



Analysis: More than half of the respondents agreed that the problems mentioned happened to them most of the time despite the some of the hypermarts effort to introduce the "Que Buster" mechanism. If this persist, the level of customers satisfaction will be greatly affected.

9. If you were given a choice, would you opt for alternative checkout option?



Analysis: 8 out of 10 respondents said that they will opt for another checkout option should the problems of the long waiting lines persist. This is definitely true with the fact that most of the respondents are working young adults and they are the time-crunched individuals.

10. Please specify the reason(s) for (9).

Analysis: Overall, the reasons specified by the respondents to opt for alternative checkout mechanism are as follow:

i. The respondents hate waiting in lines
ii. The respondents would like to have a faster and speedy checkout process
iii. The respondents would like to save their time as much as possible
iv. The respondents favor convenience
v. The respondents would like to avoid the crowd
vi. The respondents would opt for it if their shopping cart size is small

11. Please rate the importance of the following criteria for you when you checkout your items. [1- Not Important, 5- Very Important]

	1	2	3	4	5
1. Speed of checkout	6.45%	3.23%	9.68%	32.26%	48.39%
2. Convenience (Ease of checkout)	9.68%	0%	9.68%	35.48%	45.16%
3. Freedom to control your items	9.68%	3.23%	22.58%	35.48%	29.03%

Analysis: More than half of the respondents perceive that speed, convenience and freedom to control their items during checkout are important for them. This shows

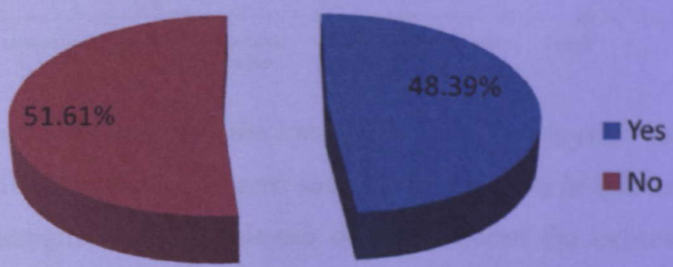
that most of the respondents would like to get in control over as much thing as possible while checking out their items; including the speed, time and the way they checkout their items.

12. What is your opinion on having self-checkout kiosks in hypermarts as alternative to the existing cashiers-staffed checkout lanes?

Analysis: The summary of the responds from the respondents on the idea of having self-checkout kiosks in hypermarts:

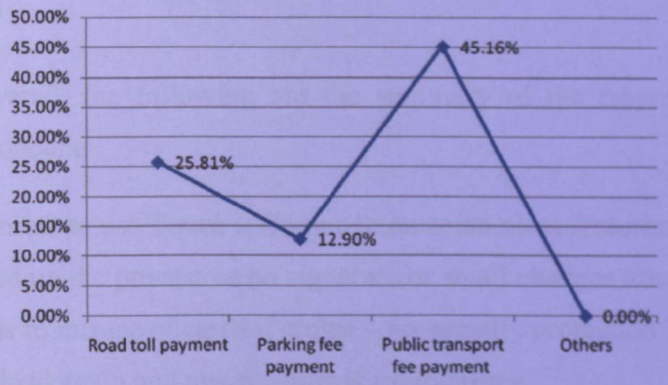
i. The system must be user friendly and easy to use
ii. The kiosk may be able to save their time
iii. The kiosk will lessen the time taken for waiting in queues
iv. For customers with big size shopping cart, it might be inconvenient
v. Customers do not prefer to bag their own items unless they are motivated by other reasons to do so
vi. Items theft might be a major problem
vii. Supervision from attendants might be needed – to assist the customers and to minimize theft cases
viii. Convenient for customers with small size of shopping cart

13. Do you own a Touch n Go card?



Analysis: Since the respondents came from different regions across the country, most of them are not exposed to the existence of Touch n Go card technology. Hence, more than half of the overall respondents do not own a Touch n Go card; most probably this group of people lives outside Klang valley in which Touch n Go uses is very limited.

14. (If answered Yes to 13) What do you usually use it for?



Analysis: Each and every one of the respondents who owned a Touch n Go card only uses the card for Road toll fee payment, Parking fee payment and Public transport fee payment. Not a single one of the respondents know any othes uses of Touch n Go card; this shows how limited the knowledge of the Malaysian community on the real uses of RFID based payment card such as Touch n Go.

15. (If answered No to 13) What are the reasons you're not using it?

Analysis: This shows how limited is the knowledge of the Malaysian community in the real uses of RFID based payment card such as Touch n Go in this nation. While some of our counterparts in East Malaysia do know about the existence of such technology, the limited infrastructure and uses becomes a barrier for them to enjoy the technology; so as most of the states in Malaysia outside Klang valley ; where all the infrastructure like monorails, trains and busses concentrated. Hence, there is a need to elevate and expand the uses of this technology in the Malaysian lifestyles; and shopping in hypermarts would be the best platform for the RFID-based card technology to gain such leverage that it needed.

16. What is your opinion on using Touch n Go card to pay for your items in hypermarts?

Analysis: Overall, the following are the summary of the responses received from the respondents:

i. It is convenient to use Touch n Go due to its contactless features
ii. It will speed up the process as no signature or small changes are involved
iii. Might leads to misuse of cards if stolen – no security protection
iv. Need to reload again and again which is troublesome
v. Very convenient for time-crunched individuals

Basically, the respondents are trapped in between the pros and cons of RFID based payment card such as Touch n Go. Issues like theft and misuse of the card is the major concern for using the card for shopping. However, such act beyond our control does not limit the uses and convenience offered by such technology.

The idea of using ATM card and debit card are more dangerous as the cards are directly linked to the individuals bank account, and if by any chances, it is stolen, the whole individual's assets will be gone as well. On the other hand, despite the troubles to need to reload again and again, RFID based payment card such as Touch n Go minimize the risk of losing the entire assets and allow the users to control the amount of assets they wish to store in the card – depending on their tolerance of risks.

4.2 Experimentation/Modeling

4.2.1 Database Design and Schematic Model

The database is one of the most important parts to this project. The design must resemble as close as possible, the real life hypermarts database design; in terms of the tables and fields included. The database schema for SCHECK is reflected in Figure 4.2. Throughout the design, the author has included several assumption deemed necessary to ensure the success of this project within the time frame. The assumptions are as follow:

i. The scale of the database has been minimized to fit the scenario of a single main branch of the hypermarts chain. Hence, the database contains tables and information about the items sold in the hypermarts as well as the registered customers (with their RFID card serial number as their CustID). In real life application, customers' database should be sided in one centralized database of the payment card service provider while the items and inventory database should be managed accordingly by the respective hypermarts branches.

ii. The Barcode number standards been used by the hypermarts chain is the EAN-13. EAN-13 encodes 12 digits of numeric data along with a trailing check digit, for a total of 13 digits of barcode data. Hence, all the items in the "Items" table should comply with the standards: 13 digits.

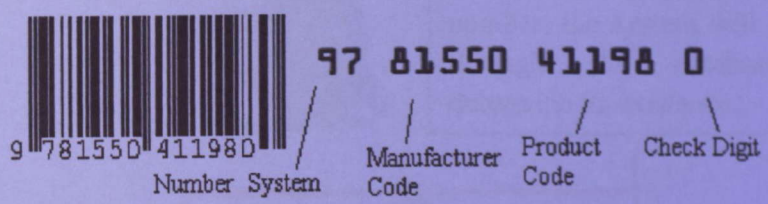


Figure 4.1 EAN-13 Barcode's elements

Hence, the author has managed to come up with a database schema as in Figure 4.2.

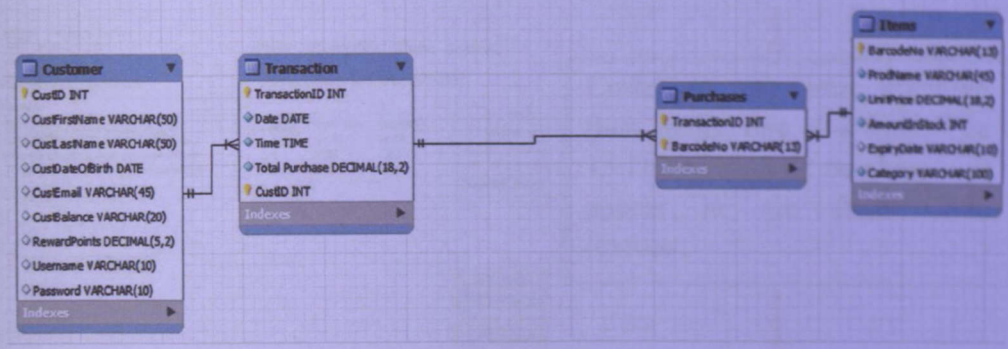


Figure 4.2 Database Schemas for SCHECK

4.2.2 SCHECK Storyboard

Customers are allowed to choose their preferred language. English is the default language.

To start using the system, the customers need to touch their RFID payment card on the reader.

Once the reader manages to read the Customers' card ID number, the system will search through the database to determine its existence.

OR

Record not found.

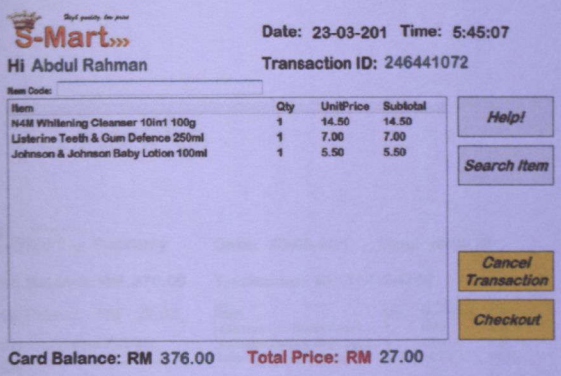
Display error message.

Kill session.

Record found.

Retrieve Name, Card balance & accumulated reward points.

Continue.



Customers can start scanning their items, one at a time. The 13 Digits barcode numbers will appear at the Item Code textbox.

At the same time, the system runs through a quick query in the database to search for information about the item scanned (using the barcode number as parameter)

OR

Record not found.

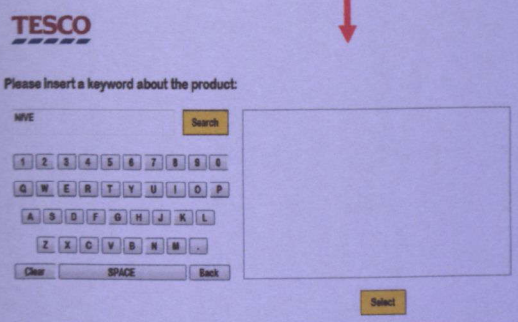
Display error message.

Record found.

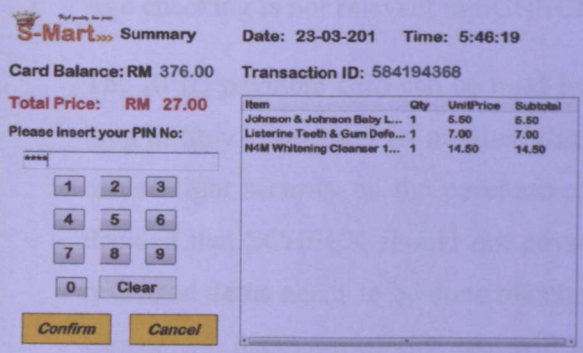
Retrieve Product Name & Unit Price.

Click **Lookout for Items**

Click **Checkout**

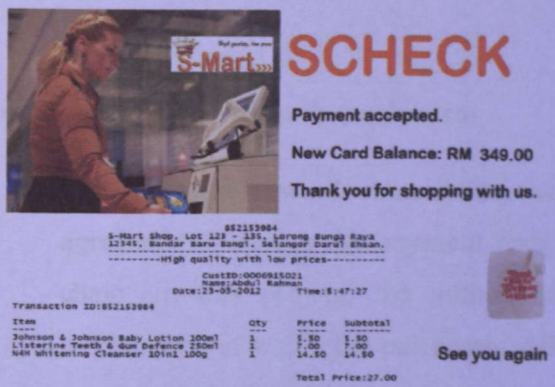


Insert a keyword and click "Search" Button. Select the appropriate item and hit the "Select" button.



Customers need to enter their PIN number and click "Confirm".

Details of the transaction (Transaction ID, CustID, Name, Items purchased, Date and Time) will be recorded in a text file as proof of transaction.



New Card Balance will be displayed.

Reward points calculated and saved.

Receipt is printed.

Session is killed and the application restarts.

4.3 Prototype Cycle

Throughout the two prototyping loops, the author has spotted few areas that need a "redirection" from the initial planning of SCHECK. The issues are as follow:

i. Age checking is not relevant in SCHECK – purchase of age-restricted items

The RFID payment card can be used by other individuals than the owner; as long as they know the PIN number, disregard of their age. Hence, in order to ensure tight security on the purchase of age-restricted items, the author has decided that SCHECK should not cover the said area. The purchase of age-restricted items needs to be done manually at the cashiers for legal purchases. Customers; disregard of any age, will not be able to checkout age-restricted items through SCHECK.

ii. Discount and rewards mechanism

Discount and rewards mechanism will only be featured based on the agreements between the payment card service provider and the hypermarts chain. In this project, the author decided to include the reward point mechanism, in which the customers will get reward points based on the total price they pay for each transaction.

iii. Database scale and implementation

As been discussed before, the author has decided to compress all the possible tables for SCHECK into one single database – disregard of its real-life practical approach. Hence, in this project, all the customers, items, transactions and purchases details will be stored and retrieved from one single MySQL database. However, should this project been taken into real life implementation, intensive research on the practical approach to design and place the databases should be conducted – where to store the tables etc.

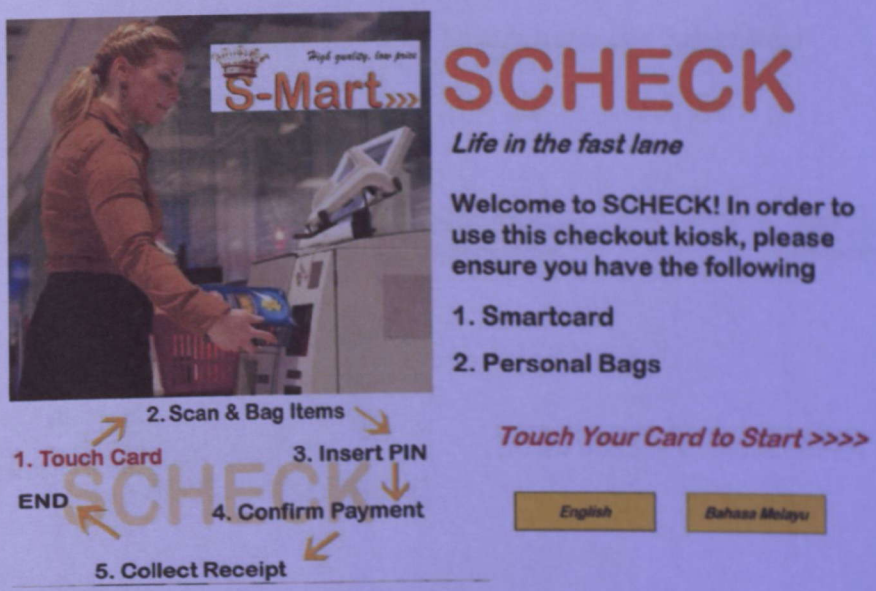
iv. Theft prevention mechanism

This is one of the major concerns in this project. Though this issue might not be big with the assumption that all the customers are ethical and won't perform any thefts or any misconduct while shopping, however, we need to consider the chances and possibilities. Hence, as extension to this project, further research on customers' theft issues as well as theft prevention mechanisms in hypermarts should be conducted. These researches will definitely help in providing more ground for this project to be employed in Malaysia as soon as possible. Given the limited time frame to work on this project, the author however, will not cover the mentioned areas. Those researches can be conducted as an extension for this project in the future – should opportunity prevails.

4.3.1 SCHECK Interfaces

i. Start Window

Functions: Change Language, Retrieve Data from RFID card

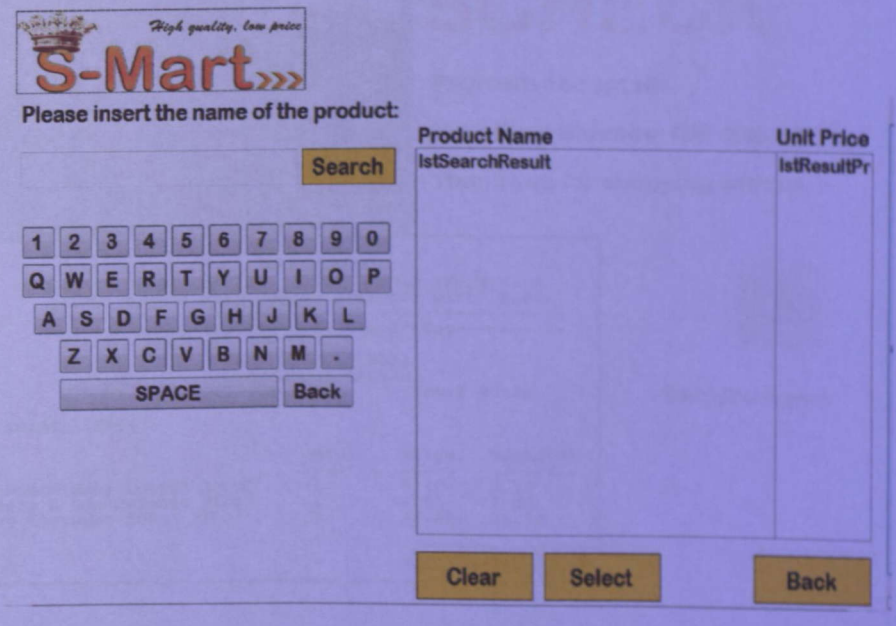


ii. Total Price Window

Functions: Scan Items' barcodes, Lookout for Items, Next Item, Remove Item, back to Main Menu and Checkout

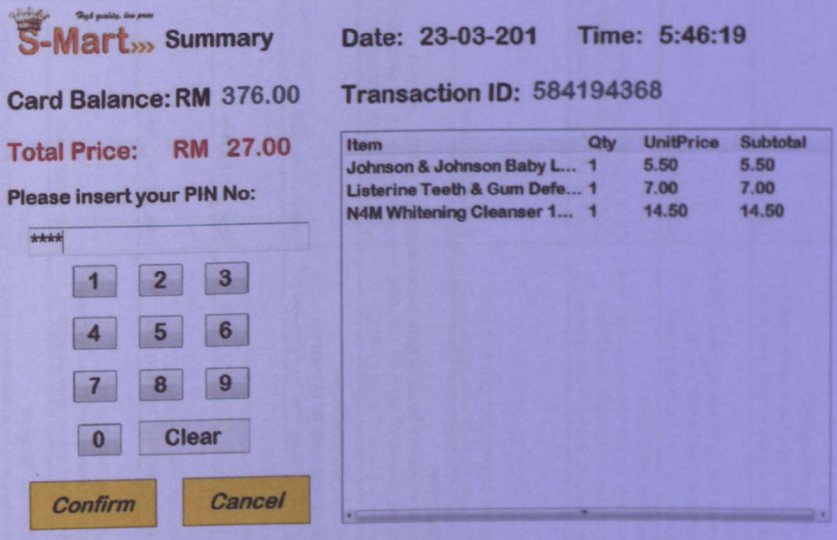
iii. Search Window

Functions: Insert keyword, Search Items and Select Item



iv. Payment Window

Functions: Insert PIN, back to Total Price window, Confirm transaction, update database, save transaction record to text files for record keeping



v. Thank You Window & Sample Receipt

Functions: Print Receipts, Restart application

SCHECK

Payment accepted.

New Card Balance: RM 349.00

Thank you for shopping with us.

852153984
S-Mart Shop, Lot 123 - 135, Lorong Bunga Raya
12345, Bandar Baru Bangi, Selangor Darul Ehsan.

---------High quality with low prices----------

CustID:0006915021
Name:Abdul Rahman
Date:23-03-2012 Time:5:47:27

Transaction ID:852153984

Item	Qty	Price	Subtotal
Johnson & Johnson Baby Lotion 100ml	1	5.50	5.50
Listerine Teeth & Gum Defence 250ml	1	7.00	7.00
N4M Whitening Cleanser 10in1 100g	1	14.50	14.50

Total Price:27.00

See you again

4.4 Findings

4.4.1 SCHECK Test Case Results

Table 4.1: Integration Test Plan for SCHECK

SI No	Test case name	Test Procedure	Pre-condition	Expected Result	Reference to Detailed Design/Spec Document	Results
1	Change_Language	Switch language from English to Malay or vice versa.	None	Change the language of the entire system based on the language chosen.	Main Menu Class	Pass
2	Windows_Maximized	Change the appearance of the User Interface to occupy the whole screen.	None	Full screen User Interface without any toolbars.	Main Menu Class, Transaction Class, Search Class, Payment Class & Thank You Class	Pass
3	SetDateTime	Retrieve date and time from local OS and display. To show ticking time, timer is used.	None	Current date and time displayed. Time is ticking as per seconds.	Main Menu Class, Transaction Class,	Pass
4	ChangePics & TextBlink	Change images or text colour/visibility every second the timer ticks.	None	Images that contains step by step instructions are displayed sequentially and the texts are blinking	Main Menu Class	Pass
5	Open_COMport	Specify BaudRate, Parity, PortName, Databits, Stopbits, Handshake , DtrEnable of the COM port and then open the port.	COM Port is available to use	COM Port is opened, allowing data transmission via the port.	Main Menu Class	Pass
6	DataReceived_COMport	Determine, organize and manage the data received from the COM Port.	COM Port is available to use	Data received from COM Port (RFID Reader) and is readable, usable and able to be manipulated.	Main Menu Class	Pass
7	UserIdentification	Retrieved ID from the RFID-based card and retrieve information from related databases about the user based on the ID.	COM Port is available to use	Cardholder's name and card balance is displayed and used as reference throughout the transaction.	Transaction Class	Pass
8	ConnectDB	Determine the correct path to connect to the correct database.	Database is available to use and database server is running	Connection to the specified mySQL Database is opened, allowing retrieval, manipulation and update of data stored in the database.	Main Menu Class, Transaction Class, Search Class, Payment Class & Thank You Class	Pass
9	TransactionIDGeneration	Generate random numbers to be used as transaction ID. Numbers range must be large enough to allow low possibilities of the same number to be used at a relatively close time gap.	None	Transaction ID is generated for a particular transaction. One at a time.	Transaction Class	Pass
10	Windows_OnIdle	Specify the idle time and constantly monitor user actions to record the user idle time.	None	Whenever the specified idle time is reached (no inputs from user), the system will kill the current session and display the main menu.	Main Menu Class, Transaction Class, Search Class, Payment Class & Thank You Class	Pass
11	ItemsData_Retrieval	Retrieve items information from the specified database based on the barcode number scanned.	Item's barcode must be scanned	Item's name, unit price and other information is retrieved from the database and displayed in the transaction summary.	Transaction Class	Pass
12	Insert&Calculate_ScannedItems	Insert the retrieved information about the item into the summary list and calculate the current total price of all the items scanned.	Item's barcode must be scanned	Items' information is displayed in the summary list and the current total price is updated accordingly.	Transaction Class	Pass

13	SummaryList_FindMatch	Concatenate the quantity of the same item scanned by users.	Item's barcode must be scanned	If the item has been scanned before, and is scanned again, only the quantity is updated. No need for new rows to be created in the summary list.	Transaction Class	Pass
14	RestrictedItems_SystemRefusal	Check the category of the specified item. If it falls within "restricted" category, SCHECK wont be able to process the item.	Item's barcode must be scanned	SCHECK will refuse to process restricted items. Users are instructed to checkout the items using the cashier-staffed checkout lanes for security and legal purposes.	Transaction Class, Search Class	Pass
15	ClearInfo	Clear the relevant textboxes.	None	The current contents in the specified textboxes is cleared. Textboxes left empty.	Transaction Class, Search Class, Payment Class	Pass
16	ItemsCheckout	Finalize on the total price of all the items scanned and display their details in a listview.	At least one item has been scanned	Direct user to payment confirmation page, displaying all the items s/he have scanned.	Transaction Class	Pass
17	Cancel_Transaction	Kill the current session, clear the contents stored in the buffer or variables and redirect to main menu.	A session has been started	Direct user to the main menu and clear all the contents in the buffer.	Transaction Class	Pass
18	Confirm_Transaction	Check whether the PIN entered by user matched with the one stored in the database. If it matches, transaction continues. Otherwise, error is prompted.	PIN No has been inserted and validated.	Direct user to the "Thank You" page and transaction is considered successful.	Payment Class	Pass
19	Update_Databases	Update the relevant tables in the databases with the updated information after a successful transaction.	Transaction is successful.	The relevant tables in the database is updated with the current information after the successful transaction. E.g. Item's quantity in stock, card balances	Payment Class	Pass
20	InsertDetails_TextFiles	Upon successful transaction, write the details of the transaction into a text file for future references.	Transaction is successful.	The details of the transaction is exported to the specified text files.	Payment Class	Pass
21	UserHelpManual	Display the relevant helpful guide for users references.	None	Users will be redirected to a page containing detailed instructions on the relevant actions to be performed by them.	Transaction Class	Pass
22	Receipt_Print	Print the details exported into the text files after a successful transaction.	Transaction is successful.	Receipt will be printed according to the format specified.	Thank You Class	Pass
23	Search_Keyword	Search the relevant databases for information on the items based on the keyword entered by the user.	Keyword is entered	Search results is prompted based on the relevancy to the keyword entered by the user.	Search Class	Pass
24	Search_Select	Import the details of the items selected by the user from the search results.	An item is selected	The details of the selected item will be imported to the current transaction window and total price will be updated accordingly.	Search Class	Pass

4.4.2 Snapshots of important codes

i. Full screen without toolbars

```
Private Sub WindowsMaximized()
    Me.FormBorderStyle = Windows.Forms.FormBorderStyle.None
    Me.WindowState = FormWindowState.Maximized
    Me.StartPosition = FormStartPosition.Manual
    Me.ControlBox = False
End Sub
```

ii. Reading data from RFID card through COM Port

```
Private Sub OpenCOMPort()
    If Not myComPort.IsOpen Then
        Try
            myComPort.BaudRate = 9600
            myComPort.PortName = "COM26"
            myComPort.Parity = IO.Ports.Parity.None
            myComPort.DataBits = 8
            myComPort.StopBits = IO.Ports.StopBits.One
            myComPort.Handshake = IO.Ports.Handshake.None
            myComPort.ReadTimeout = 3000
            myComPort.ReceivedBytesThreshold = 1
            myComPort.DtrEnable = True
            myComPort.Open()

        Catch ex As Exception
            MsgBox("Error Opening COM Port", MsgBoxStyle.Critical)
        End Try
    End If
End Sub

Private Sub DataReceived(ByVal sender As Object, ByVal e As System.IO.Ports.SerialDataReceivedEventArgs)
    TextBox1.Invoke(New myDelegate(AddressOf DataReceivedCOMport), New Object() {})
End Sub

Public Delegate Sub myDelegate()

Friend Sub DataReceivedCOMport()
    Data = Data + myComPort.ReadExisting()
    If Len(Data) = 12 Then
        TextBox1.Text = TextBox1.Text + Microsoft.VisualBasic.Mid(Data, 2, 11) & vbLf
        myComPort.DtrEnable = False
        CustID = TextBox1.Text.Substring(0, 10)
        TextBox1.Clear()
```

iii. Connecting to specified MySQL database

```
Private Sub ConnectDB()
    'Database Connection
    conn = New MySqlConnection()
    conn.ConnectionString = "server=localhost; database=database; user id=root; password=sasukear;"
End Sub
```

iv. On Idle, restart application

```
Private Sub Total_Price_Disposed(ByVal sender As Object, ByVal e As System.EventArgs) Handles Me.Disposed
    RemoveHandler Application.Idle, AddressOf OnIdle
End Sub
```

```
Private Sub OnIdle(ByVal s As Object, ByVal e As EventArgs)
    If Now > IdleBaseTime.AddMinutes(2) Then
        Me.Close()
        frmHome.Show()
    End If
End Sub
```

```
Private Sub TotalPrice_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
    IdleBaseTime = Now
    txtBarcode.Focus()
End Sub
```

```
Private Sub TotalPrice_MouseMove(ByVal sender As Object, ByVal e As System.Windows.Forms.MouseEventArgs) H
    IdleBaseTime = Now
    txtBarcode.Focus()
End Sub
```

v. Scan item's barcode and data retrieval

```
Friend Sub ScanItem(ByVal barcode As String)
    Try
        conn.Open()
        myCommand.Connection = conn
        myCommand.CommandText = ("SELECT i.ProdName FROM Items i WHERE i.BarcodeNo=" & barcode)
        ItemName = myCommand.ExecuteScalar().ToString
        myCommand.CommandText = ("SELECT i.UnitPrice FROM Items i WHERE i.BarcodeNo=" & barcode)
        UnitPrice = myCommand.ExecuteScalar().ToString
        myCommand.CommandText = ("SELECT i.Category FROM Items i WHERE i.BarcodeNo=" & barcode)
        Category = myCommand.ExecuteScalar().ToString
        If Category = "restricteditem" Then
            MessageBox.Show("Restricted Items are not allowed to be checkout using SCHECK, please
            conn.Close()
            Clear()
            txtBarcode.Focus()
        Else
            FindMatch()
            conn.Close()
        End If
    Catch ex As Exception
        speaker.Speak("Item is not recognized.")
        txtBarcode.Clear()
        txtBarcode.Focus()
        conn.Close()
    End Try
End Sub
```

vi. Receipt printing

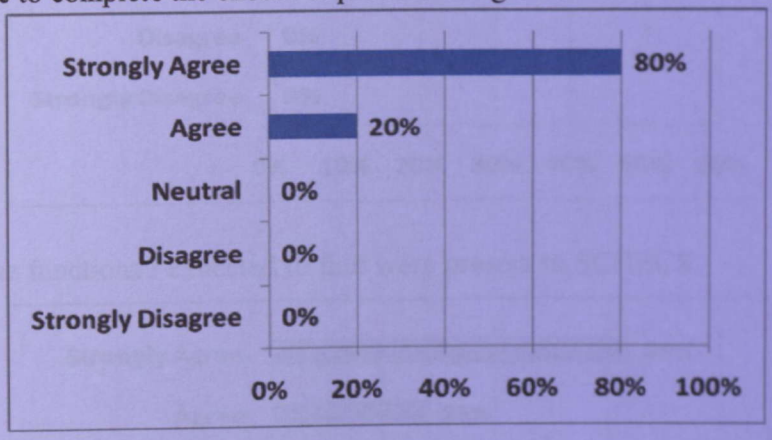
```
    Dim Path As String = "C:\Users\user\Desktop\SCHECK\Receipts\" & Payment.txtTransID.Text & ".txt"
    PrintReceipt(Path)

End Sub
```

```
Public Sub PrintReceipt(ByVal Filename As String)
    Dim piStart As New ProcessStartInfo
    With piStart
        .FileName = Filename
        .Verb = "print"
        .WindowStyle = ProcessWindowStyle.Hidden
    End With
    Process.Start(piStart)
End Sub
```

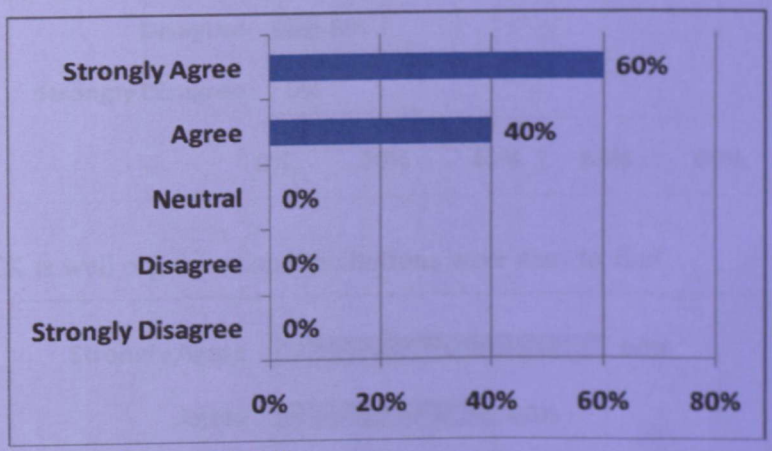
4.4.3 Post-development survey results / Usability Test

Based on the post-development survey conducted by the author to a group of targeted respoendents, below are the results gained:

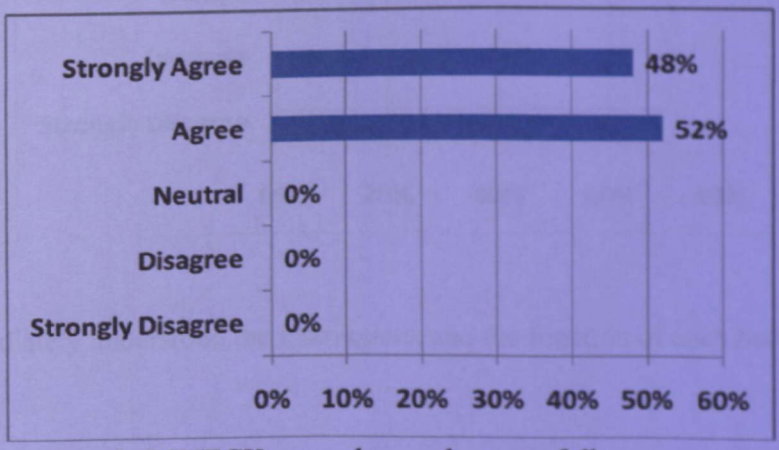
i. I am able to complete the checkout process using SCHECK without any help.



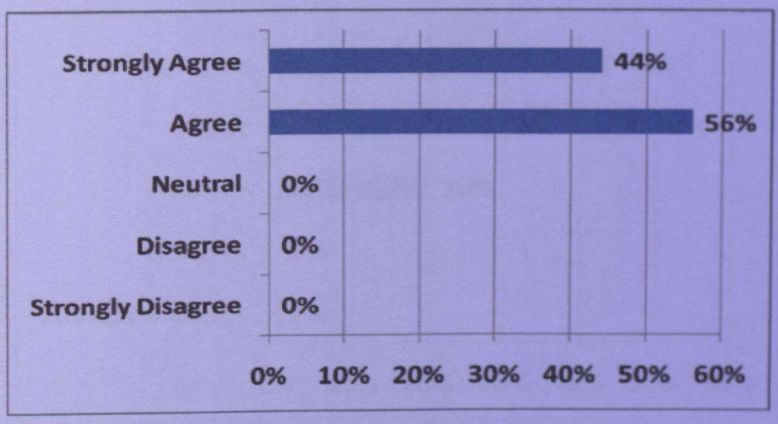
ii. I found that SCHECK prototype is easy to use.



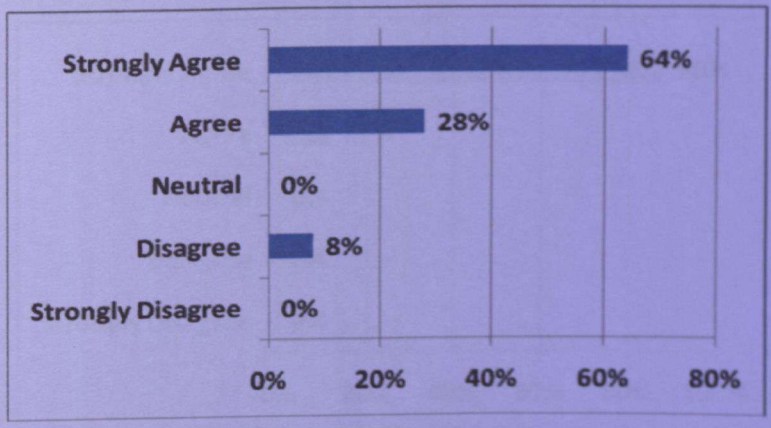
iii. SCHECK screen is user-friendly.



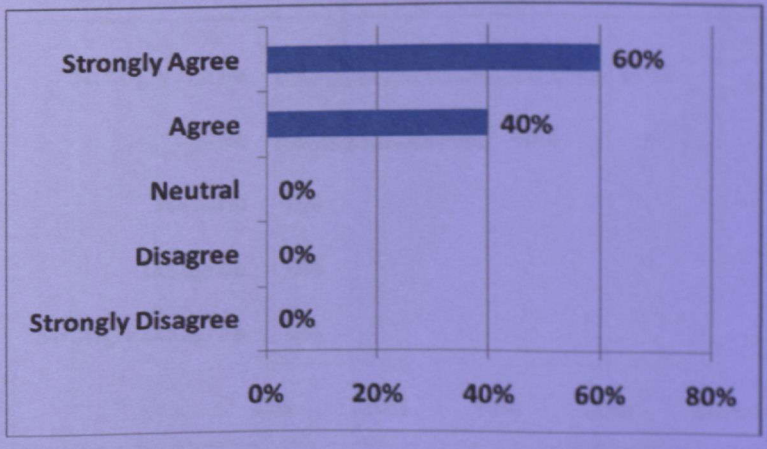
iv. The instructions in SCHECK were clear and easy to follow.



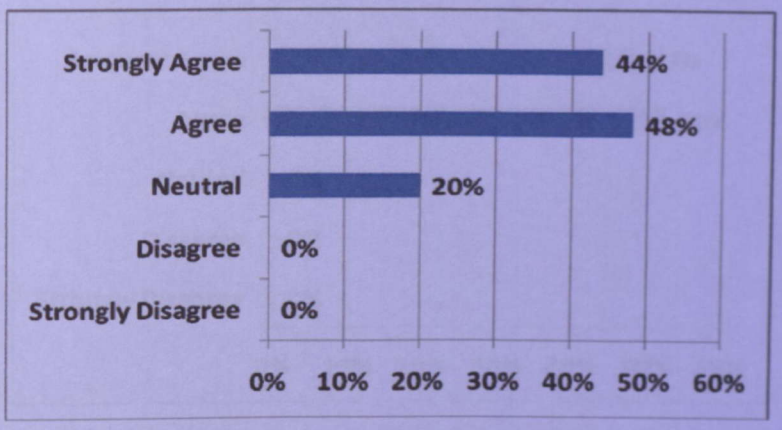
v. All of the functions I expected to find were present in SCHECK.



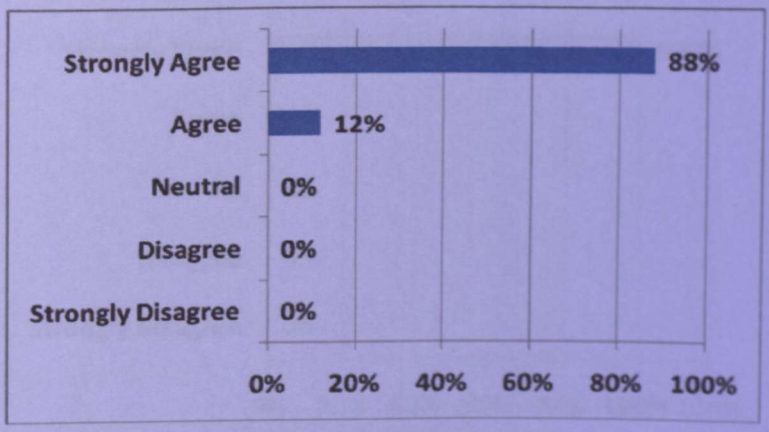
vi. SCHECK is well organized and the buttons were easy to find.



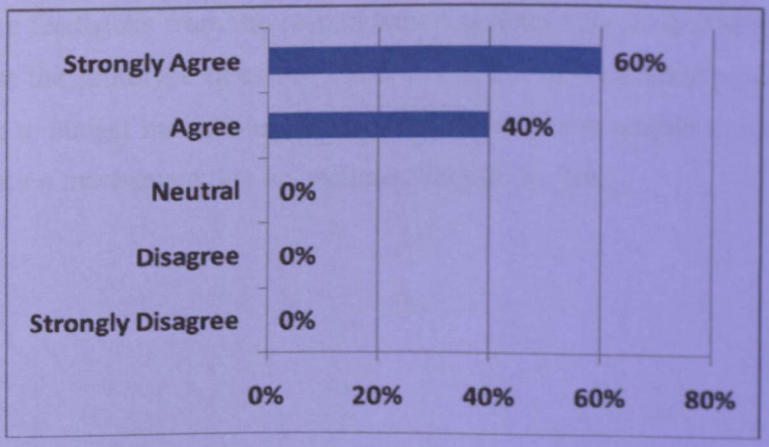
vii. I immediately understood the instructions and the function of each button.



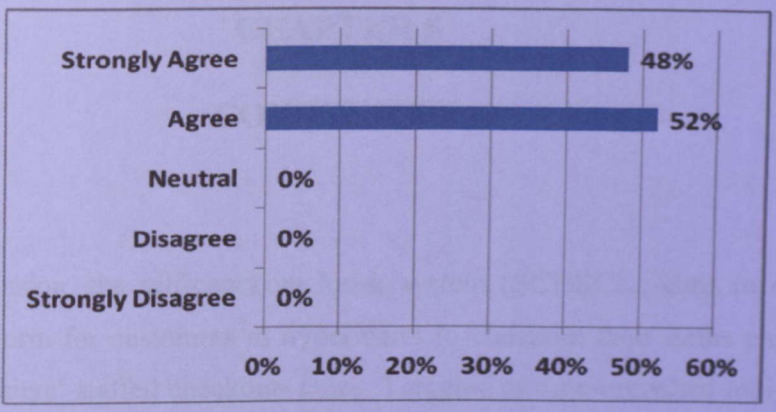
viii. I found navigating around SCHECK screen to be easy.



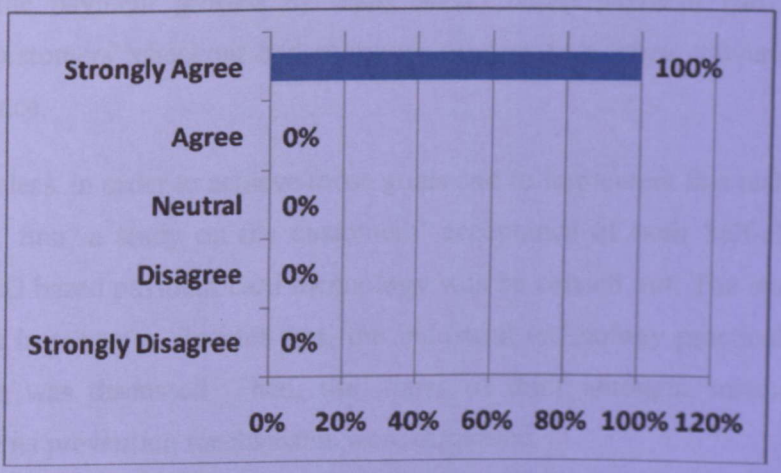
ix. If SCHECK were to be implemented in hypermarts, I will use it.



x. Checking out my items with SCHECK is relatively faster than the cashiers.



xi. SCHECK provides greater control for me to checkout my items.



In summary, the feedbacks from the respondents has been very encouraging except for the fact that the prototype does not cover a wholesome checkout process as it intended to due to budget limitations. In this case, the author is unable to implement the theft prevention mechanism that he aspires to include at first.

CHAPTER 5

CONCLUSION

In conclusion, the self-checkout kiosk system (SCHECK) aims to offer an alternative platform for customers in hypermarts to checkout their items parallel to the existing cashiers' staffed checkout- lanes. Targeted at time-crunched individuals, SCHECK will allow the customers to cut down the waiting time in checkout queues and simplify the payment process by using RFID based payment card, hence, elevating the customers' checkout and shopping process to a more convenient and speedy experience.

Nonetheless, in order to achieve those goals and to implement this technology in the country, first, a study on the customers' acceptance of both Self-checkout kiosks and RFID based payment card technology was be carried out. The study was conducted with hypermarts. Besides that, the industrial technology practicality and network design was discussed. Then, the issues of theft amongst customers in hypermarts and its prevention mechanisms were discussed.

In conclusion, SCHECK is a recommended solution for time-crunched individuals shopping at hypermarts who want the flexibility of choosing a faster goods-checkout mode. At the same time, it helps hypermart management reduce the length of checkout queues during peak hours. The use of RFID-based prepaid payment cards allow customers to control the spending because unlike with credit cards, they cannot spend money they do not have. The usage of this card also expands the potential customer base to include people from the lower income group who cannot afford credit cards to enjoy the flexibility SCHECK offers.

As a recommendation for future enhancements, SCHECK should support credit card payments and use RFID-reader to scan all the goods at one go once the customer takes the shopping cart through the checkout scanner. This will make the checkout process faster and add more value to the entire system implementation.

REFERENCES

1. Fichman, R.G., 2003. *Information-rich commerce at a crossroads: business and technology adoption requirements* [e-journal] Volume 46 (9), Available through: Communications of the ACM [Accessed 17 October 2011].

2. Beal, S.K., 2009. Helium: *Does self checkout at supermarkets save the consumer money?,* [online] Available at: <http://www.helium.com/items/1591569-does-self-checkout-at-the-supermarkets-save-the-consumer-money> [Accessed 24 October 2011].

3. Barbaro, M., 2007. Business: A Long Line for a Shorter Wait at the Supermarket. *The New York Times online*, [online] 23 June. Available at: <http://www.nytimes.com/2007/06/23/business/23checkout.html> [Accessed 24 October 2011].

4. Maister, D.H., 2005. General: *The Psychology of Waiting Lines,* [online] Available at: <http://davidmaister.com/articles/5/52/> [Accessed 25 October 2011].

5. Rida A., Yang, L. and Tentzeris, M., 2010. RFID-Enabled Sensor Design and Applications. Norwood: Canton Street.

6. Weiss, A., 2003. *Me and my shadow* [e-journal] Volume 7 (3) , Available through: Communications of the ACM [Accessed 19 October 2011].

7. Hossain, M. M. and Prybutok V. R., 2008. *Consumer Acceptance of RFID Technology: An Exploratory Study*, [pdf] Available at: <http://f2331.just.edu.tw/rfid/RFID%20papers/Consumer%20Acceptance%20of%20RFID%20Technology%20An%20Exploratory%20Study.pdf> [Accessed 1 October 2011].

8. Panigraphy, S. K., Jena, S. K. and Turuk, A.K., 2011. *Security in Bluetooth, RFID and wireless sensor networks* [e-journal] Proceedings of the 2011 International Conference on Communication, Computing & Security, Available through: Communications of the ACM [Accessed 19 October 2011].
9. McKeen, K.C., Richardson, Sunapy and Anthonyson, R. B., Intermec IP Corp., 2003. Automatic Payment System for a Plurality of Remote Merchants. U.S. Pat. 6,529,880.
10. Metzger, T., 2009. How credit card transactions work: *Interactive guide shows how merchants, banks process card purchases*, [online] Available at: <http://www.creditcards.com/credit-card-news/how-a-credit-card-is-processed-1275.php> [Accessed 25 October 2011].
11. Lamond, K., 1996. Credit Card Transactions: *Real World and Online*, [online] Available at: <http://virtualschool.edu/mon/ElectronicProperty/klamond/credit_card.htm> [Accessed 25 October 2011].
12. Chau P. Y. K. and Poon, S., 2003. *Octopus: An E-Cash Payment System Success Story* [e-journal] Volume 46 (9), Available through: Communications of the ACM [Accessed 14 October 2011].
13. Octopus, 2011. *Our Innovative Edge*. [online] Available at: <http://www.octopus.com.hk/about-us/our-innovative-edge/en/index.html> [Accessed 24 October 2011].
14. Hong Kong Travel, 2011. *Transportation : Octopus Card* [online] Available at: <http://hong-kong-travel.org/Octopus/> [Accessed 24 October 2011].
15. London Pass, 2011. *London Pass: How it Works?* [online] Available at: <http://www.londonpass.com/how-it-works/index.html> [Accessed 24 October 2011].
16. Touch n Go, 2011. *Touch n Go: Where To Use* [online] Available at: <http://www.touchngo.com.my/index.php?pg=products_tng_where_to_use> [Accessed 1 October 2011].

17. Blass, E. O., Kurmus, A., Molva, R. And Strufe, T., 2009. *PSP: Private and Secure Payment with RFID* [e-journal] Proceedings of the 8th ACM workshop on Privacy in the electronic society, Available through: Communications of the ACM [Accessed 19 October 2011].

18. Czeskis, A., Koscher, K., Smith, J. R. and Kohno, T., 2008. *RFIDs and secret handshakes: defending against ghost-and-leech attacks and unauthorized reads with context-aware communications,* [e-journal] Proceedings of the 15th ACM conference on Computer and communications security, Available through: Communications of the ACM [Accessed 17 October 2011].

19. O'Connor, M. C., 2005. RFID Journal: *RFID-Enabled Credit Cards Apt to Lead,* [online] Available at: <http://www.rfidjournal.com/article/view/1468> [Accessed 26 October 2011].

20. Merriam-webster, n.d. *Security definition*, [online] Available at: <http://www.merriam-webster.com/dictionary/security> [Accessed 26 October 2011].

21. Juels, A. and Weis, S. A., 2005. *Defining strong privacy for RFI,* [e-journal] Volume 13 (1), Available through: Communications of the ACM [Accessed 19 October 2011].

22. Massachusetts Institute of Technology, 2006. *Human-use Experience: Self-checkout kiosk* [online] Available at: <http://web.mit.edu/2.744/www/Project/Assignments/humanUse/lynette/index.html > [Accessed 21 October 2011].

23. The Associated Press, 2011. US: *Some supermarkets bagging self-checkout. CBSNews online.* , [online] 26 September. Available at: <http://www.cbsnews.com/2100-201_162-20111648.html?tag=contentMain;contentBody> [Accessed 26 October 2011].

24. Purcell, J. E., n.d. *Comparison of Software Development Lifecycle Methodologies*, [online] Global Information Assurance Certification Available at: <http://www.giac.org/cissp-papers/217.pdf> [Accessed 28 October 2011].

25. Linger, R. C., Lipson, H. F., McHugh, J., Mead, N. R. and Sledge, C. A., 2002. *Life-Cycle Models for Survivable Systems*, [pdf] Available at: <www.cert.org/archive/pdf/02tr026.pdf> [Accessed 28 October 2011].

26. Nambiar, P., 2010. Articles: Airasia Promotes Self Check-in, *New Straits Times* [online] 24 October Available at: <http://www.nst.com.my/nst/articles/6air/Article> [Accessed 1 November 2011].

27. Rogers, J., 2011. Business, The Future: Self-Checkout No More?, *TBD All Over Washington* [online] 26 September Available at: <http://www.tbd.com/blogs/market-report/2011/09/self-checkout-no-more--12954.html> [Accessed 1 November 2011].

28. Mostue, A., 2011. Morning Report: Grocers Take Back the Checkout Lane, *Marketplace* [online] 10 October Available at: <http://marketplace.publicradio.org/display/web/2011/10/10/am-grocers-take-back-the-checkout-lane/> [Accessed 1 November 2011].

29. Winterman, D., 2009. Magazine: The problem with self-service checkouts, *BBC News* [online] 9 December Available at: <http://news.bbc.co.uk/2/hi/8399963.stm> [Accessed 1 November 2011].

30. Grohol, J. M., 2008. Blog: Self-checkout: A Consumer's Rant, *PsychCentral* [online] Available at: <http://psychcentral.com/blog/archives/2008/11/07/self-checkout-a-consumers-rant/> [Accessed 1 November 2011].

31. Anand, A., 2011. Retail: Welcome valued customer ... to more self-checkouts, *msnbc.com* [online] 22 July Available at: <http://www.msnbc.msn.com/id/43729757/ns/business-retail/t/welcome-valued-customer-more-self-checkouts/#.Tq7h8fRT93E> [Accessed 1 November 2011].

32. Wirespring Technology, 2002. The Real World Benefits and Challenges of Interactive Kiosks. [pdf] Available at: <http://www.wirespring.com/pdf/kiosk_benefits_and_challenges.pdf> [Accessed 1 Feb 2012].

33. Živanov, Z., Rakić, P. and Hajduković, M., 2008. Using Code Generation Approach in Developing Kiosk Applications. [pdf] Available at: <http://www.doiserbia.nb.rs/img/doi/1820-0214/2008/1820-02140801041Z.pdf> [Accessed 30 Jan 2012].

- **Pre-development Survey**

Self-checkout kiosk with RFID based Smartcard payment module

Note:

To complete this survey, you must understand the following few terms used in this survey.

1. RFID based Smartcard : e.g: Touch n Go card (Malaysia), Oyster Card (UK), Octopus card (HK), EZ Link card (S'pore)

2. Checkout: an act where customers bring the items they are planning to buy to cashiers for payment and bagging.

3. Self-checkout: the idea of using machine/kiosk to checkout the items; self-service basis

1. **Determine your age.** *
   - ◯ A. <21
   - ◯ B. 21 - 30
   - ◯ C. 31 - 40
   - ◯ D. 41 - 50
   - ◯ E. >50

2. **Determine your gender.** *
   - ◯ A. Male
   - ◯ B. Female

3. **Are you currently working?** *
   - ◯ A. Yes
   - ◯ B. No

This part of survey revolves around your shopping experience in hypermarts

4. **How frequent do you shop in hypermarts? [on average]** *
   - ◯ A. Once a month
   - ◯ B. Once a week
   - ◯ C. Once in a fortnight

5. **Size of shopping cart everytime you shop in hypermarts?** *
   - ◯ A. Big (bought a lot of items)
   - ◯ B. Average (considerably moderate)
   - ◯ C. Small (bought only few items)

6. **When do you usually shop in hypermarts?** *
   - ☐ A. Weekdays (work hours)
   - ☐ B. Weekdays (after work hours)
   - ☐ C. Weekends

7. **What are some of the problems you've faced when checking out your items at cashiers.** *

- [ ] A. Long waiting lines
- [ ] B. Clumsy cashiers
- [ ] C. Lengthy payment process (wait for small changes etc)
- [ ] D. Unfriendly cashiers
- [ ] E. Others (Please specify):

8. **How frequent does the problem(s) in (7) happened on you?** *

- ○ A. All the time
- ○ B. Most of the time
- ○ C. Rarely
- ○ D. Once

9. **If you were given a choice, would you opt for alternative checkout option?** *

- ○ A. Yes
- ○ B. No

10. **Please specify the reason(s) for (9).** *

11. **Please rate the importance of the following criteria for you when you checkout your items.** *

1 - Not Important, 2 - Slightly Important, 3 - Average, 4 - Important, 5 - Very Important

	A. 1	B. 2	C. 3	D. 4	E. 5
1. Speed of checkout	○	○	○	○	○
2. Convenience (Ease of checkout)	○	○	○	○	○
3. Freedom to control your items	○	○	○	○	○

12. **What is your opinion on having self-checkout kiosks in hypermarts as alternative to the existing cashiers-staffed checkout lanes?** *

The following questions will revolve around RFID payment card implementation in Malaysia : Touch n Go card

13. **Do you own a Touch n Go card?** *

If you answer 'Yes' to this question, please proceed to question 14. If 'No' please proceed to question 15.

- ○ A. Yes
- ○ B. No

14. **What do you usually use it for?**

- [ ] A. Road toll payment
- [ ] B. Parking fee payment
- [ ] C. Public transport fee payment (ktm, monorail, busses etc)
- [ ] D. Others (please specify):

15. **What are the reasons you're not using it?**

- [ ] A. Limited uses
- [ ] B. Privacy concerns
- [ ] C. Security threat
- [ ] D. Not convenient enough
- [ ] E. Impracticality (too many people using it, makes the waiting lines too long)
- [ ] F. Others (please specify):

16. **What is your opinion on using Touch n Go card to pay for your items in hypermarts?** *

-End of survey- Thank you very much for your participation!

- **Post-development Survey**

Information on SCHECK

i. The objective of this questionnaire is to conduct a feasibility study on the use of RFID-based payment card as a payment module on self-checkout kiosk in hypermarts. The feedbacks from hypermarts' customers are important for further improvements on this project.

ii. SCHECK is a self-checkout kiosk system which uses RFID payment card module as its **only** payment mode. When using SCHECK, customers are able to freely scan the items they wish to purchase and bag them accordingly. In order to pay for the items, customers are required to use their RFID-based payment card; e.g. Touch n Go.

Terms & Jargons

i. *RFID payment card*: e.g: Touch n Go card (Malaysia), Oyster Card (UK), Octopus Card (Hong Kong), EZ-Link Card (S'pore)

ii. *Checkout*: An act where customers bring the items they are planning to buy to counters / point of sales for payments and bagging.

iii. *Self-checkout*: The idea to automate the checkout process and give freedom and control on checkout processes to the customers.

iv. *Conventional checkout mechanism*: Refers to the standard cashiers-staffed checkout lanes.

Instructions to fill in the survey

i. All questions labeled * are **mandatory**.

ii. Please **select** your answer based on the following:

1 – Strongly disagree
2 – Disagree
3 – Neutral
4 – Agree
5 – Strongly Agree

iii. You are **not allowed** to refer to any individuals other than the person in charge when answering the questions in this survey.

Questions

1. I am able to complete the checkout process using SCHECK without any help.

   1 **2** **3** **4** **5**

2. I found that SCHECK prototype is easy to use.

   1 **2** **3** **4** **5**

3. SCHECK screen is user-friendly.

   1 **2** **3** **4** **5**

4. The instructions in SCHECK were clear and easy to follow.

   1 **2** **3** **4** **5**

5. All of the functions I expected to find were present in SCHECK.

   1 **2** **3** **4** **5**

6. SCHECK is well organized and the buttons were easy to find.

   1 **2** **3** **4** **5**

7. I immediately understood the instructions and the function of each button.

   1 **2** **3** **4** **5**

8. I found navigating around SCHECK screen to be easy.

   1 **2** **3** **4** **5**

9. If SCHECK were to be implemented in hypermarts, I will use it.

   1 **2** **3** **4** **5**

10. Checking out my items with SCHECK is relatively faster than the cashiers.

    1 **2** **3** **4** **5**

11. SCHECK provides greater control for me to checkout my items.

    1 **2** **3** **4** **5**

12. Any additional comment on SCHECK?

    _____

    _____

    _____