RFID BASED FOOD EXPIRY NOTIFICATION BY USING AUTHENTICATION

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BORANG PENGESAHAN STATUS TESIS

JUDUL: RFID BASED FOOD EXPIRY NOTIFICATION BY USING AUTHENTICATION

SESI PENGAJIAN: 2016/2017

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RFID BASED FOOD EXPIRY NOTIFICATION BY USING AUTHENTICATION

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This report is submitted in partial fulfilment of the requirements for the

Bachelor of Computer Science (Computer Security)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2017

DECLARATION

I hereby declare that this project report entitled

RFID BASED FOOD EXPIRY NOTIFICATION BY USING AUTHENTICATION

is written by me and is my own effort and that no part has been plagiarized without citations.

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I hereby declare that I have read this project report and found this project report is sufficient in term of the scope and quality for the award of Bachelor of Computer Science (Computer Security) With Honours.

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DEDICATION

I dedicate this project to my beloved parents, siblings, supervisor, friends, and to myself..... I would not be here without each of them…..

ACKNOWLEDGEMENTS

Grateful to Allah Almighty for His blessings and grace I have been able to complete this project successfully. First of all, my special thanks to my beloved parents and siblings who have given me love, support and encourage me from the beginning until the end. Without the support and encouragement from them, I may not be able to finish this project. Next, I would like to express my gratitude towards my supervisor Dr.Zaheera Binti Zainal Abidin for the perfect explanation from the beginning until the process of completing this task and for giving me the confidence to carry out this project successfully.

Not to forget, I would like to thank Universiti Teknikal Malaysia Melaka for giving me the opportunity to produce this project. Last but not least, many thanks to all my friends who willing to share knowledge either directly or indirectly, providing ideas and guidance, advice, support and encourage me during the process of this project. Without them, I was not able to complete the project properly.

ABSTRACT

RFID based tracking food has been a latest trend in food industry. A high quality of food demands a high quality of assurance, safety and security in the food industry, which an innovation and technology are needed to fulfil the supply chain requirements. However, the existing technology unable to provide a solution for food safety. In fact, the problem of end-to-end traceability across supply-chain has been a challenge in security. The problem statement of this study are people tend to lose track of the amount of food ingredient in massive or huge size. Additionally, time consuming for searching the expired food products. Besides, the current devices used in tracking expiry food product has no security features in it. In fact, there is a lack of security element especially to cater the person who take control on the operation of the process, supply chain. In the new system, the methodology used is waterfall model. This model was chosen because it is really suitable for this project which each process need to be completed first before continues to another process. Thus, the objective of this project is to explore RFID and NFC technology used in tracking canned food expiry product. At the same time, to introduce the new system using the proposed security features. Therefore, this project assists in exploiting new areas of safety and security in food industry using RFID technology that overcome several problems for instance expiry food product. In addition, the project features is to design a new tracking system using or based on authentication which for the element of authentication at the staff site, to indicate the authority of food ownership. As a result, the implementation of this study provides a positive impact towards the safety and security in food quality. The significant contribution of this project was developed to design a tracking system that can detect the process food expiry with security features.

ABSTRAK

Makanan pengesahan berasaskan RFID telah menjadi trend terkini dalam industri makanan. Makanan yang berkualiti tinggi memerlukan jaminan kualiti dan keselamatan yang tinggi dalam industri makanan di mana satu inovasi dan teknologi diperlukan untuk memenuhi keperluan rantaian bekalan. Walau bagaimanapun, teknologi yang sedia ada tidak dapat memberi penyelesaian dari segi keselamatan. Malah, masalah pengesanan dari awal hingga akhir seluruh rantaian bekalan telah menjadi cabaran dari segi keselamatan. Kenyataan masalah kajian ini adalah orang lebih cenderung untuk kehilangan jejak jumlah produk makanan dalam kuantiti atau saiz yang besar. Tambahan, memakan masa untuk mencari produk makanan yang telah tamat tempoh. Selain itu, alatan semasa yang digunakan tidak mempunyai ciri-ciri keselamatan, malahan terdapat kekurangan unsur keselamatan terutemanya dari segi kawalan ke atas operasi rantaian bekalan. Malah, terdapat kekurangan elemen keselamatan terutama untuk menampung orang yang mengawal operasi proses, rantaian bekalan. Dalam sistem baru ini, kaedah yang digunakan adalah model air terjun. Model ini dipilih berdasarkan kesesuaian projek yang mana setiap proses perlu diselesaikan terlebih dahulu. Oleh itu, objektif projek ini adalah untuk meneroka RFID dan NFC teknologi yang digunakan dalam mengesan produk makanan dalam tin yang telah tamat tempoh. Pada masa yang sama, untuk memperkenalkan sistem baru dalam menggunakan ciri-ciri keselamatan. Oleh itu, projek ini membantu dalam mengeksploitasi bidang baru dari segi keselamatan dalam industri makanan dengan menggunakan teknologi RFID yang mengatasi beberapa masalah misalnya produk tamat tempoh. Sumbangan penting daripada projek ini adalah untuk mengesan makanan proses yang telah tamat tempoh dengan ciri-ciri keselamatan.

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CHAPTER 1

INTRODUCTION

1.1 Project Overview

A high quality of food demands a high quality of assurance, safety and security in the food industry, which an innovation and technology are needed to fulfil the supply chain requirements. However, the existing technology unable to provide a solution for food safety. In fact, the problem of end-to-end traceability across supply-chain has been a challenge in security. Therefore, this project assists in exploiting new areas of safety and security in food industry using RFID technology that overcome several problems for instance expiry date. As a result, the implementation of this study provides a positive impact towards the safety and security in food quality.

In the food industry, RFID can increase traceability and reduce spoilage, shrinkage and over-buying. RFID stands for Radio-Frequency Identification. The acronym refers to small electronic devices that consist of a small chip and an antenna. It provides a unique identifier for the object and just a bar code or magnetic strip must be scanned to get the information, the RFID device must be scanned to retrieve the identifying information. Current problem of RFID based systems is there is no data privacy features and there is some limitation to access the RFID devices for example

assuming the person have the same radar, they might have access to receive all the data capture and there is a limitation in the length which can make the connection slow.

In this project, the new tracking system with security features are developed by using RFID and NFC.

1.2 Problem Statement (PS)

The possibilities to keep track the amount of ingredient is very low. Thus, the time consuming to search for the expired food products also take too much time. In fact, there are several devices that had been used in tracking expiry food product has no security in it.

Table 1.1: Problem Statement

PS	**Problem Statement**
PS_1	Tend to lose track of the amount of food ingredient/material in massive or huge size.
PS_2	Time consuming for searching the expired food products.
PS_3	The current devices used in tracking expiry food product has no security features in it. In fact, there is a lack of security element especially to cater the person who take control on the operation of the process, supply chain.

1.3 Project Question (PQ)

Table 1.2: Project Question

PS	PQ	Project Question
PS_1	PQ_1	How to keep track of the amount of food ingredient/material in massive or huge size.
PS_2	PQ_2	How to reduce time consuming for searching the expired food products.
PS_3	PQ_3	How to implement a new tracking system in tracking expiry food product by using the proposed security features.

1.4 Project Objective (PO)

This project embarks on the following objectives which is to design a new tracking system with a security features by using RFID and NFC technology.

Table 1.3: Project Objective

PS	PO	Project Objective
PS_1	PO_1	To explore RFID and NFC technology used in tracking canned food expiry product.
PS_2	PO_2	To design a new tracking system using or based on authentication.
PS_3	PO_3	To introduce the new system using the proposed security features.

1.5 Project Scopes

In the food industry, the tracking systems that currently used do not have a security features which cannot secure all the data and the data can be stolen by unauthorized user. The scopes of this project are developing new canned food expiry date product tracking system with a security features by using RFID and NFC technology.

1.6 Project Contribution

This project is developed to design a tracking system that can detect the canned food expiry date product with security features.

Table 1.4: Project Contribution

PS	**PQ**	**PO**	**PC**	**Project Contribution**
PS_1	PQ_1	PO_1	PC_1	Improving the study of RFID and NFC technology
PS_2	PQ_2	PO_2	PC_2	Develop a new tracking system for canned food expiry product.
PS_3	PQ_3	PO_3	PC_3	Implement new tracking system with security features.

1.7 Thesis Organization

Chapter 1: Introduction

In this chapter, it include problem statement about the project and the object that this project need to achieve. This chapter also discussing regarding the scope of the project and the expected output. Overall, this chapter are covered about the background of the project.

Chapter 2: Literature Review

In this chapter, it thrive more on the explanation details of the project supported with any reading materials. Literature review, related based on previous project with other technique that can be used to implement in this project.

Chapter 3: Methodology

In this chapter, it explain all the method that are going to be used in this project which make the task for implementing and organizing the project become easier.

Chapter 4: Design

In this chapter, to discuss on the system architecture design and user interface. On the other hand, this chapter focus on analysis on the problem and requirement.

Chapter 5: Implementation

In this chapter, it briefly describe all the activity involved and what is the expected output that need to be achieved after completing this phase.

Chapter 6: Testing

In this chapter, to describe the activity involved in testing phase and that is testing strategy that are used to ensure that overall project results follow the expected output. This chapter explain more in the test design and plan.

Chapter 7: Conclusion

In this chapter, it conclude overall the project summarization and discuss on how the objective has been achieved, the strength and weakness of the project and what the contribution to this project.

1.8 Conclusion

As a conclusion, this project was design to enhance the current tracking system with proposed security features. This chapter help to understand the target that should be accomplish and the current problem facing before starting the project. Next chapter are focus on literature review which are covered about related work regarding the technology that need to be used.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This research conducted in a food manufacturing field. The case study involved a manufacturing company that has a number of manufacturing facilities across Malaysia and supplies food products in most states through a number of different sales and distribution line. There are a few roles involve in this studies which is customer, supplier, manufacturer, deliverer, warehouse staff and retailer. (Almuiet & Salim, 2013)

The current system which is most of the company still using manual system in checking the food expiry date. Therefore, a new autonomous tracking detection introduced such as barcode and QR code by (Tzoulis & Andreopoulou, 2013), RFID by (Yewatkar, Inamdar, Singh, Ayushya, & Bandal, 2016). Nowadays, most of manufacturing organization are using barcode on each item as a basic procedure of tracking and tagging system but manual intervention is still required in order to capturing data that is contained in the barcode. However, by using RFID it can be more efficient with a specific end goal to give precise data about the goods and it can have significant effect, especially in high-capacity and high-speed manufacturing

operations, where speed, accurateness, and appropriateness are critical for material and performance.

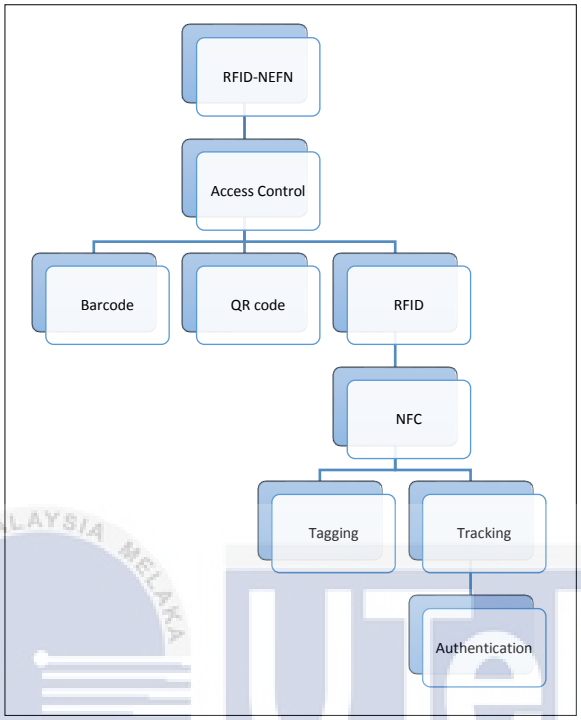

Figure 2.1: Theoretical Taxonomy of RFID

2.2 Information Security and Access Control

According to (Sutar, Kapratwar, Rayate, Birari, & Zalke, 2013), security provides a form of protection where a separation is formed between the assets and the threat, however information security basically ensures the confidentiality, integrity and availability of information. Besides that, in actual fact provides the necessary protection to information and supporting processes, systems and infrastructures from various forms of possible threats and vulnerabilities in both physical and logical access control. (Syed Ahmad, Mohd Ali, & Wan Adnan, 2012)

Access control is mainly classifying a person doing an exact business which authenticating them by observing at their identification, then giving that individual key

to access the entrance or computer. There are four access control models which is Mandatory Access Control (MAC), Role Based Access Control (RBAC), Discretionary Access Control (DAC) and Rule Based Access Control (RBAC or RB-RBAC). In access control there are three different types of authentication used in the security field such as password or PIN, a card key or smart card and biometric which is the most secure and convenient authentication tools. (Bhargava & Ochawar, 2013).

2.3 Barcode

Nowadays, the food industry is not the only industry that uses barcodes. Other industry that using barcode include healthcare, transportation, manufacturing and industrial. As explained by (Hashim, Ibrahim, Saad, Sakaguchi, & Zakaria, 2013), barcode is a visual representation of information in the form of bars and spaces on a surface which are designed with different widths and consist of numbers, characters and symbols such as dot, colon and others. Today barcode are widely used on books and at retail stores in order to keep track of the products available and easy checkout of the products.

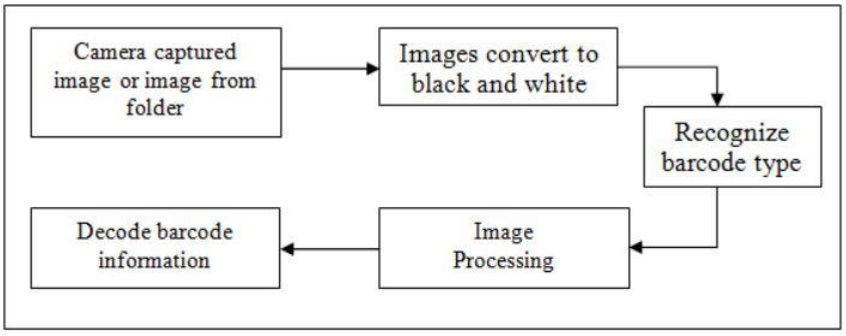

Figure 2.2: Barcode Process Diagram by (Hashim et al., 2013)

By using barcode scanners, it can help users keep track of inventory easily which can make time spent doing inventory checks are minimized and at the same time reduces rates of human error. In addition, some of the features can allow users to set up alerts for items that are out of stock so orders can be filled promptly.

The disadvantages of barcode scanners, it need a direct line of sight and need to be quite close to the barcode in order to be able to read. In addition, barcodes have no read or write capabilities which is they do not contain any added information such as expiry date and it only contain information about the manufacturer and product. They are very manual labour demanding as they must be scanned separately. Compare to RFID, barcodes have less security as they can be more easily reproduced or forged, it can easily damage which means if a barcode is ripped or damaged there is no way to scan the product. Barcode scanner is cheap, but in the long run it cost a lot of money for manually entering information.

2.4 QR code (Quick Response code)

QR code is a two-dimensional barcode that can be read via QR barcode reader or camera and it able to transmit data both in vertical and horizontal track, which is why it is named a 2D barcode. The most significant objective of using QR code is the traceability or monitoring the system. (Tzoulis & Andreopoulou, 2013)

As stated by (Dos Santos & Marins, 2015), one of the advantages of the QR Code is that it eliminated the need to type WEB addresses which it is only necessary to launch the application and point the cell phone at a QR Code for the additional content to be displayed in the reader or Web browser.

QR code have a problem which is people can easily duplicate and manipulate the accurate data, the physical spaces are the most vulnerable to spamming pointing to unsolicited content over the internet. (Razzak, 2012). However, the first kind malicious detected by Kaspersky lab which is the attack method used in the QR code was that

when a user scans the code, he is directed towards a website and then a malicious file downloads in the user's device without the knowledge of the user. (Narayanan, 2012)

Figure 2.3: Left is the correct version, Right is the spammed (Razzak, 2012)

2.5 Radio Frequency Identification (RFID)

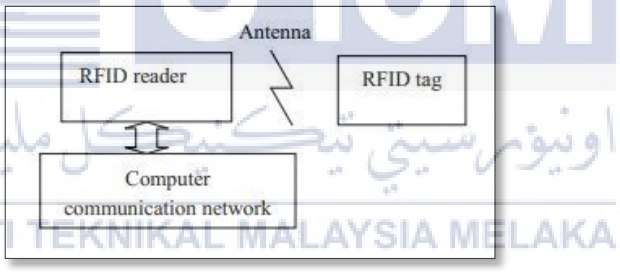

Figure 2.4: RFID Reader Block Diagram (Sun, 2012)

RFID consist of a tag attached to a product which classifies and tracks the product via radio waves besides these tags can carry up to 2000 bytes of records. As stated by (Ginters & Martin-Gutierrez, 2013), the basic components of an RFID systems are tag, scanner, antenna, writer, control equipment and software. However, people that are choosing RFID instead of barcode because it cannot be easily duplicated based on circuit based chip which represent unique identification number and address. There are a comparison between RFID and barcode as shown in Table below:

Table 2.1: Comparison of RFID and Barcode (Yewatkar et al., 2016)

	RFID	**Barcode**
Read Rate	-High throughput. -Multiple tags can be read simultaneously.	-Very low throughput. -Tags can only read one at a time.
Line of Sight	Not required	Required
Read/Write Capability	Ability to read, write modify and update.	Ability to read items and nothing else.
Durability	-High -Much better protected.	-Low -Easily damaged -Cannot be read if dirty or greasy.
Security	-High -Hard to replicate -Data can be encrypted	-Low -Much easier to reproduce or counterfeit.
Event Triggering	Can be used to trigger certain events.	Not capable.

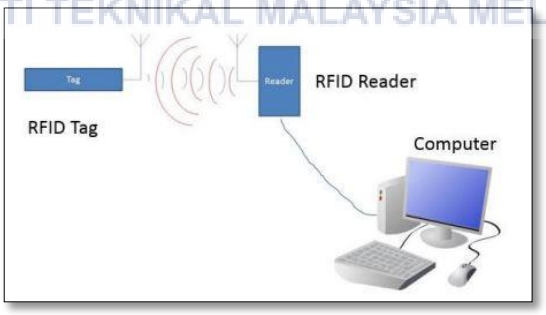

Figure 2.5: How RFID tag and reader works by (Yewatkar et al., 2016).

According to (Swedberg, 2016) Italian Food Company Barilla had launched an RFID-enabled product which exploring the use of both passive and active radio frequency identification technology to help track ingredients at the same time maintaining quality and food safety.

2.6 Critical Review of Current Problem and Justification

A major criticism of (Attaran, 2012) work is that Companies are preventing to keep critical products or items and supplies moving, manage inventory level effectively, maintain productivity, improve safety and security, meet confirmed or agreed requirements and keep emergency transport costs in check. This inconsistency may be due to improve inventory organisation at the retail store and together with the supply chain. However, (Sun, 2012) points out that The prime asset for an inventory system is an automatic identification technology system. One of the best examples is the Auto-ID based on RFID technology. This asset is on behalf of two reasons. First, the perceptibility provided by this technology allows a precise information of inventory level by removing the difference between inventory record and physical inventory. Second, RFID technology can avoid or decrease sources of errors. A reasonable approach to tackle this issue could be to decrease of labour costs, the popularisation of business processes and the saving of inventory inaccuracies.

It seems that (Wilson, Hainey, & Connolly, 2012) a study found that related change of high social concern and high contribution services such as services with banks as opposite to groceries stores have more impact on user's privacy issues when they use QR codes to access the business web sites. Taken together, these results suggest that privacy Issues when using QR code. (Williamson, Tsay, Kateeb, & Burton", 2013) describes sniffing or Eavesdropping, Spoofing, Cloning, Replay, Relay and Denial of Service Attacks are some of the security threats to RFID technology. One possible methods being used as countermeasures to the security threats presented against RFID technology.

(S. W. Park & Lee, 2013) holds the view that there are many kind of authentication technologies that are developed to protect personal information. However, if the NFC-based services are being used widely, the efficiency and payment information protection of these technologies must be ensured. Initial observations suggest that there may be a link between protection of a user and service provider in NFC-based. If (Alqarni, Alabdulhafith, & Sampalli, 2014) findings are accurate The authentication protocols between the tag and the back-end server are a crucial issue. Since the messages are transmitted by using radio waves through the air in RFID

systems and those protocols are still directly using the real tags' identity such as tag identifier and secret key in the authentication phase. For these reasons, RFID users can be affected by broadcasting the content of their RFID tags because any malicious RFID reader can track their location or obtain their identification and private information. The data reported here appear to support the assumption that solving RFID authentication issues that go a long way to persuade people that using these tags are not expose their secret data.

(Badra & Badra, 2016) recent research has suggest that There are many types of applications that can be run using NFC technology. The fact that the lower layer of NFC includes no communication security primitives makes this technology exposed to a wide range of vulnerabilities and attacks. A possible explanation for this might be that NFC security issues. However, all the previously mentioned methods suffer from some serious drawbacks. (Joseph & Joby, 2016) recent research view that Time taken for the valuable information to be extracted from the RFID data is too long and while the object moves within the distance of a RFID reader, it reads the tag attached on that object. It seems possible that these results are due to reading the same tag so the duplicated data or information has been generated.

Table 2.2: Summary of Critical Review

Author and Year	Description	Problems
(Attaran, 2012)	Companies are preventing to keep critical products or items and supplies moving, manage inventory level effectively, maintain productivity, improve safety and security, meet confirmed or agreed requirements and keep emergency transport costs in check.	To improve inventory organisation at the retail store and together with the supply chain.
(Sun, 2012)	The prime asset for an inventory system is an automatic identification technology system.	The decrease of labour costs, the popularisation of business processes and

	One of the best examples is the Auto-ID based on RFID technology. This asset is on behalf of two reasons. First, the perceptibility provided by this technology allows a precise information of inventory level by removing the difference between inventory record and physical inventory. Second, RFID technology can avoid or decrease sources of errors.	the saving of inventory inaccuracies.
(Wilson et al., 2012)	A study found that related change of high social concern and high contribution services such as services with banks as opposite to groceries stores have more impact on user's privacy issues when they use QR codes to access the business web sites.	Privacy Issues when using QR code.
(Williamson et al., 2013)	Sniffing or Eavesdropping, Spoofing, Cloning, Replay, Relay and Denial of Service Attacks are some of the security threats to RFID technology.	The methods being used as countermeasures to the security threats presented against RFID technology.
(S. W. Park & Lee, 2013)	There are many kind of authentication technologies that are developed to protect personal information. However, if the NFC-based services are being used widely, the efficiency and payment information protection of these technologies must be ensured.	Protection of a user and service provider in NFC-based.

(Alqarni et al., 2014)	The authentication protocols between the tag and the back-end server are a crucial issue. Since the messages are transmitted by using radio waves through the air in RFID systems and those protocols are still directly using the real tags' identity such as tag identifier and secret key in the authentication phase. For these reasons, RFID users can be affected by broadcasting the content of their RFID tags because any malicious RFID reader can track their location or obtain their identification and private information.	Solving RFID authentication issues that go a long way to persuade people by using these tags are not expose their secret data.
(Badra & Badra, 2016)	There are many types of applications that can be run using NFC technology. The fact that the lower layer of NFC includes no communication security primitives makes this technology exposed to a wide range of vulnerabilities and attacks.	NFC Security Issues.
(Joseph & Joby, 2016)	Time taken for the valuable information to be extracted from the RFID data is too long and while the object moves within the distance of a RFID reader, it reads the tag attached on that object.	Reading the same tag so the duplicated data or information has been generated.

2.7 Proposed Solutions/further project

Therefore, a new mechanism to be introduced in this project in order to avoid the above issues by using Authentication in Near Field Communication (NFC). Based on (Priporas, Stylos, & Fotiadis, 2017), respondents agree that human interactions with smart devices are increase, making people feel more confident as the technology becomes an inseparable part of human life.

2.7.1 Near Field Communication (NFC)

NFC is a descendant or an evolved form of Radio Frequency Identification (RFID) which involves tracking or identifying objects by a reader and through information stored on electronic tags. As claimed by (Mehmood, Hassannezhad, & Abbas, 2014), during recent years, mobile phones have become our ubiquitous friends and are perhaps the most common itinerant computing devices, playing an important role socially, emotionally and recreationally. The innovations in communication networks particularly mobile phones technology have made it prone for a broad range of applications. Nowadays, Near Field Communication (NFC) service, as one of the most recent technologies in telecommunication area, is going to be developed around the world through transformation from initial testing to full scale deployment.

As explain by (Mary & Connor, 2015), Near Field Communication (NFC) is a type of passive 13.56 MHz RFID technology that enables short-range wireless data transmissions at 4 centimetres (1.6 inches) or less and it lets consumers use NFC-enabled mobile devices to interact with RFID tags or other NFC-enabled devices and products.

The number of applications in which NFC technology is widely used including application which is new secure system should be proposed for managing security in complex mobile and variable conditions such as secure payment tools, access management and retailing industry among others. (León-Coca, Reina, Toral, Barrero, & Bessis, 2013).

Keeping smartphone secure is a very fundamental need considering the valuable data that may be found stored inside and users would loathe to waste even a few more seconds of their time to unlock a phone to that end besides, the entire process got a lot easier with the introduction of technologies like NFC while keeping the standards of security. (Jambusaria, Katwala, & Mistry, 2015)

Mentioned by (Persson & Håkansson, 2015), The focus of this research is general security specifications, which should serve as guidelines that cover most of the basic security requirements within the system which is an authorized user can just take their NFC device and hold it close to another NFC device and the information can be transmitted instantly. Starting with the initial connection to the system, which is done via NFC, the user are required to provide an identity. As stated by Dave Kolar, NFC was also chosen in a goal for optimal protection. (Prince, 2017).

According to (Swedberg, 2016) when a user taps his or her smartphone next to the tag, the reader captures that tag's unique ID number which is prompting the phone to access webpage. Although this technology is increasingly becoming mainstream, it still has issues that need to be addressed mainly regarding security concerns with Secure Element (SE) personalization, management, ownership and architecture that can be useable by attackers to interval the alteration of NFC within societies.

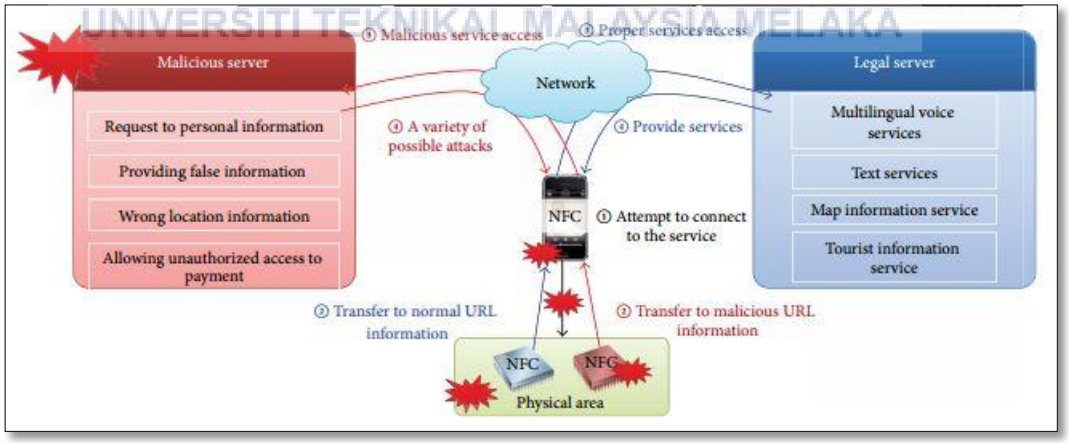

Figure 2.6: NFC attack (S. Park & Lee, 2016)

2.7.2 Authentication

Based on previous research and studied paper had been discuss by (Zavvari, Shakiba, Islam, Sundararajan, & Singh, 2013) the main problem with RFID system is the security problem because the communication between RFID components is wireless which is still demand a better solution for authentication and detection.

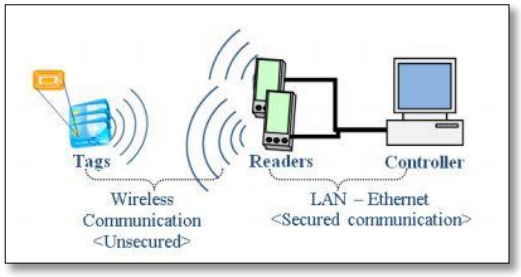

Figure 2.7: RFID system (Williamson et al., 2013)

Figure 2.8: The tags send and receive data from reader which is connected to a server (Zavvari et al., 2013)

In the NFC environment, security vulnerabilities have been found such as tag cloning, access of illegal tag and leaving authentication information on record through a disguised reader or a mobile device, because communication between tag and mobile devices occurs in a wireless environment. (Feng, Hwang, & Syu, 2016). Other than that, Man-In-The-Middle attack, replay and snatching of the authentication information in communication between a mobile device or a reader and a certification information in communication between a mobile device or a reader and a certification center server may also occur.

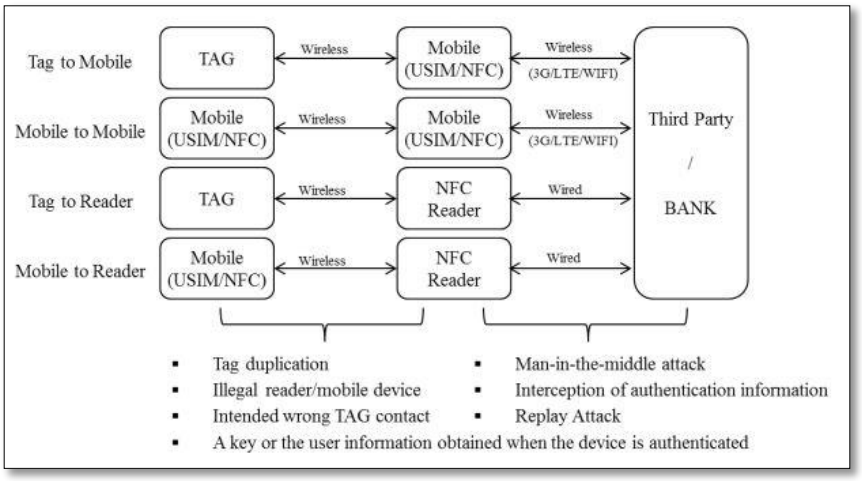

Figure 2.9: Security vulnerabilities by (Jung, 2015).

In order to solve these problems, our goal in this paper is to propose a lightweight authentication method and a secure way in response to these attacks.

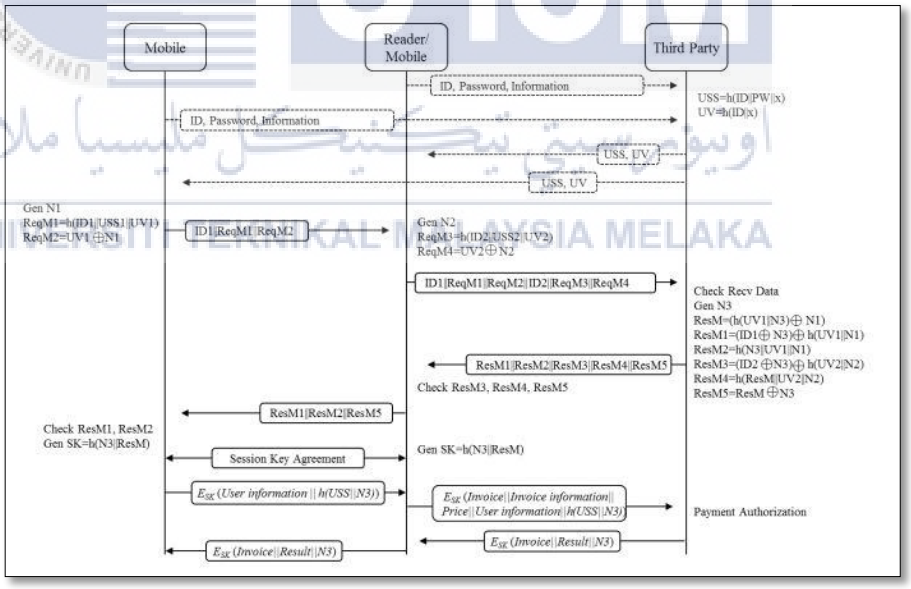

Figure 2.10: Proposed solution by (Jung, 2015)

2.8 Conclusion

In this chapter, it explained about the literature review on previous project that related to this project. RFID reader block diagram by Sun's has been used as a reference to this project. By using that diagram, this project is adding authentication element as a security features. The next chapter explained about the project methodology of the RFID and NFC project.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describe methodology that have been used in this project include project milestones and conclusion. This project involved studies and development of NFC technology to achieve the development of system. In previous chapter, the literature review has been done by collecting the data regarding RFID and NFC systems based on previous work.

3.2 Project Methodology

The project methodology is important to use as a guide to handle the project in right manner within a correct flows. The best methodology that had been used is waterfall model. The waterfall model derives its name due to cascading effect one phase to another. This model was chosen because it is really suitable for this project

which each process need to be completed first before continue to another process. This project methodology consists of six phases as shown in the diagram below:

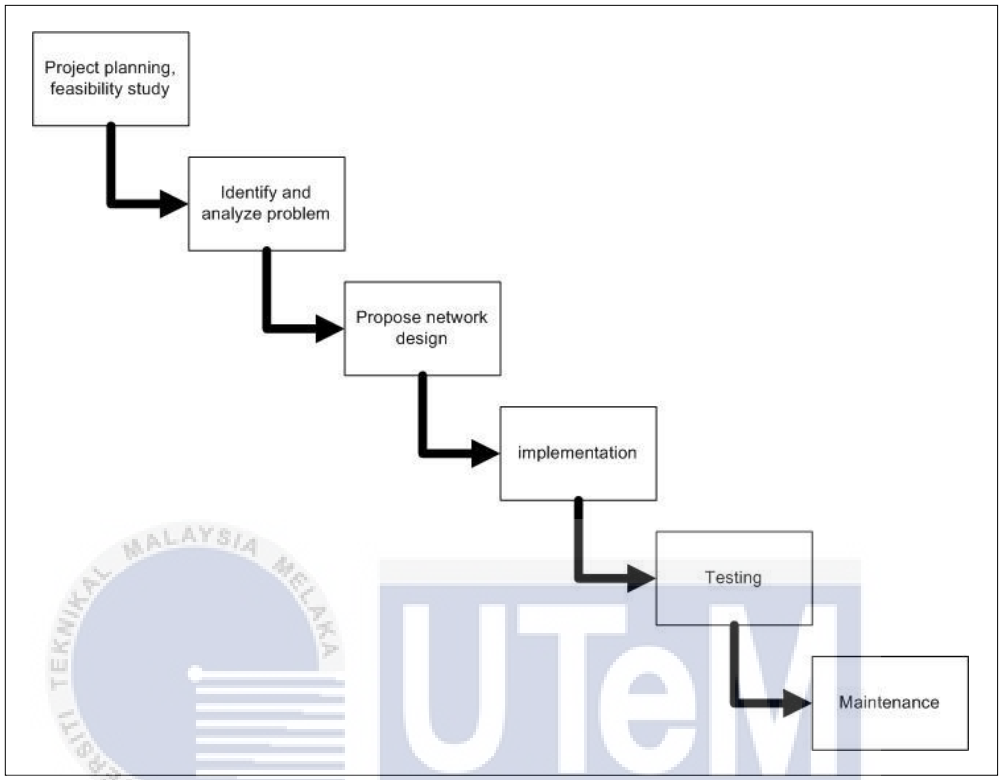

Figure 3.1: Implementation Cycle for the Waterfall Methodology

3.2.1 Project Planning, Feasibility Study

In the phase 1, the purpose of the project planning and feasibility study is to gathered all information and requirement such as where the objective project is determined, identify and know what type that current technology used in food industry and findings the suitable software and hardware that used to make the project run as expected. In this phase, before the project title is confirm, many research need to be done to find out the implementation project idea which is need to understand what is NFC, how it work and need to find out project requirement to fulfil the project needs. The software and hardware that are used in this project:

1. Hardware
    - Laptop or Personal Computer
    - NFC device
    - NFC tag

2. Software
    - C#
    - SQLite
    - Microsoft Visual Studio
    - Microsoft Office Visio
    - Microsoft Office Word

3.2.2 Identify and Analyse Problem

In the phase 2, identify and analyse problem is a process to collect data, identify the problem and recommending some suggestion for improving the existing system. This phase involve in gathering data, finding solution for overcome the limitation of the current system and identify the target users in developing NFC technology. The main objective of this phase is to find out the solution on what, who, when and how the system been and there is a certain technique used to gather data about this project.

3.2.3 Propose Network Design

In phase 3, there are something needed to designed based on the requirement and analysis such as architecture design, software and hardware selection. To show how the system work, user interface need to design and determine each application for each path of the system. This new design show the solution to the current network design problem. There are logical and physical design in this phase. All information regarding NFC and detection system are needed to be analyse in this phase which includes web-based interface and NFC reader.

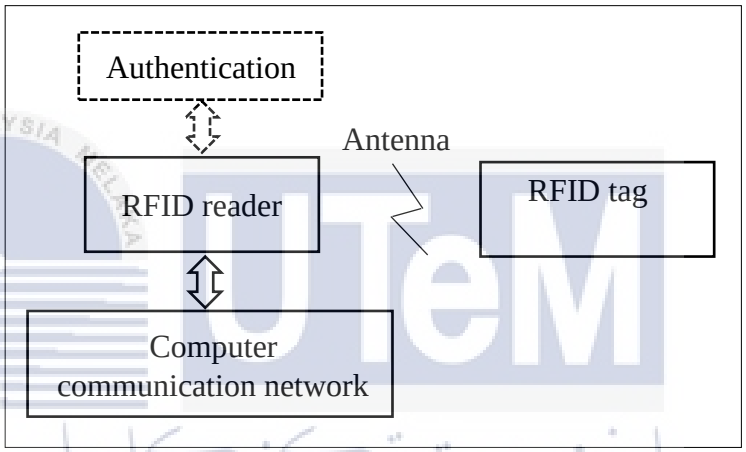

Figure 3.2: Proposed Network Design

3.2.4 Implementation

In phase 4, it show installation and configuration the development of systems that are using NFC completely conducted which is the real system that can be used by user. The hardware and software is required to fully functioning running the system also the database with security need to be setup. There are testing such as unit testing, integration testing, system testing and user acceptance testing need in this phase to ensure the system working completely. This system are using C# for web-based and while SQLite for the database.

3.2.5 Testing

In phase 5, unit testing, integration testing, system testing and user acceptance testing are conducted. All the units developed in the implementation phase are integrated into a system after being test by each unit to ensure the system are working completely.

3.2.6 Maintenance

In phase 6, the developers must ensure all the requirement statement are fulfils in the implemented. This phase dealing with any changes that needed by the project. All the record data are collected and with the collected results, it determine the effectiveness of the research application. There are several major advantages why the Waterfall Model is chosen:

- The requirement phase stated deciding how the project do after identify what the system do.
- The design phase encourage building the components after planning the system structure.
- The requirement analysis need to be better through documented and technical analysis which can make the project can easily understand and avoid the development from facing problem in the future. All of the documented requirement can helps in the future as a reference.

3.3 Project Schedule and Milestones

In this project, milestones has been design as one of the most useful ways of showing activities alongside time and what task to be completed next in this project. It show each activity for development of the system from the beginning of the date and the ends of the project time according to weeks which is from the first until last week of presentation.

Table 3.1: Project Milestones PSM 1

Week	Activity	Output
W1 13 – 17 February	Seek and decide on a project tile and developed a proposal	Supervisor is assigned Title is chosen Developed a proposal
	Submit completed proposal to supervisor for approval	Proposal submitted Project suggestion form
	Submit approved project title to PSM committees	Project suggestion form us submitted
W2 20 – 24 February	Correction of proposal	Received approved proposal form for correction
W3 27 February – 3 March	Begins with project	Chapter 1: Introduction
W4 6 – 10 March	Complete and submit Chapter 1 to supervisor for evaluation	Supervisor checked Chapter 1
W5 13 – 17 March	Begins studies on related work and previous research	Chapter 2: Literature Review
W6 20 – 24 March	Research and finding taxonomy on chapter 2	Progress report for Chapter 2
W7 27 – 31 March	Complete and submit chapter 2 to supervisor for evaluation	Supervisor checked Chapter 2

W8 3 – 7 April	Begins studies on previous research for methodology	Progress report on Chapter 3: Methodology
W9 10 – 14 April	Complete and submit chapter 3 to supervisor for evaluation	Supervisor checked Chapter 3
W10 17 – 21 April	Design the network and finding the tools for implementation	Chapter 4: Design
W11 24 – 28 April	Design the environment for implement on Chapter 4	Progress report for Chapter 4
W12 1 – 5 May	Complete and submit Chapter 4 to supervisor for evaluation	Supervisor checked Chapter 4
	Begins with the poster	Project poster is created
W13 8 – 12 May	Prepare PSM 1 Report	Supervisor checks the report
	Complete and submit poster to supervisor for evaluation	Supervisor approved and submit poster to ulearn
W14 15 – 19 May	Demonstration of project and make a slide presentation	Demonstration of project is evaluated and submit full report to supervisor.
W15 22 – 26 May	Final Presentation PSM 1	Final evaluation from supervisor and evaluator
W16 29 May – 2 June	Correction draft report based on comments from supervisor and evaluator during the final presentation session	Correction of PSM 1
W17 12 – 16 June	Submission of Chapter 1 until 4	Preparation for PSM 2

Table 3.2: Project Milestones PSM 2

Week	Activity	Output
W1 3 – 7 July	Setup the environment and implementation	Progress report for Chapter 5
W2 10 – 14 July	Complete and submit Chapter 5 to supervisor for evaluation	Supervisor check Chapter 5: Implementation
W3 17 – 21 July	Testing the result for Chapter 6	Progress report for Chapter 6
W4 24 – 28 July	Complete and submit chapter 6 to supervisor for evaluation	Supervisor checks Chapter 6: Testing
W5 31 July – 4 August	Conclusion for this project	Progress report for Chapter 7: Conclusion
W6 7 – 11 August	Complete and submit Chapter 7 to supervisor for evaluation	Supervisor checks Chapter 7
W7 14 – 18 August	Prepare PSM 2 report and demonstration of project also make a slide presentation	Demonstration of project is evaluated and submit full report to supervisor
W8 21 – 25 August	Final presentation PSM 2	Final evaluation from supervisor and evaluator

Table 3.3: Gantt chart

Task	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Submitting proposal																
2. Correction & Improvement of proposal																
3. Chapter 1 (Introduction)																
4. Chapter 2 (Literature Review)																
6. Chapter 3 (Methodology)																
7. Chapter 4 (Design)																
8. Progress Report & Project																
9. Project Demostration & Report																
10. Final Presentation																
11. Documentation																

3.4 Conclusion

As a conclusion, the project methodology which involves all 6 phases which are planning, analysis, design, testing, implementation and maintenance in this project have been identified. This all phases is very important to determine the overall success of developing the project.

CHAPTER 4

DESIGN

4.1 Introduction

In this chapter, the discussion of the project design are briefly explain regarding how to implement through problem analysis, system architecture and requirement analysis. This chapter focus on analysing the software and hardware requirement, also identifying the major problem of the current situation in order to have better understanding in analysis stage. The architecture of the network are created to make sure the project is carried out smoothly.

4.2 Problem Analysis

Problem analysis is the most clear requirement analysis where the user need to recognize the current system issues that need to enhance on system later.

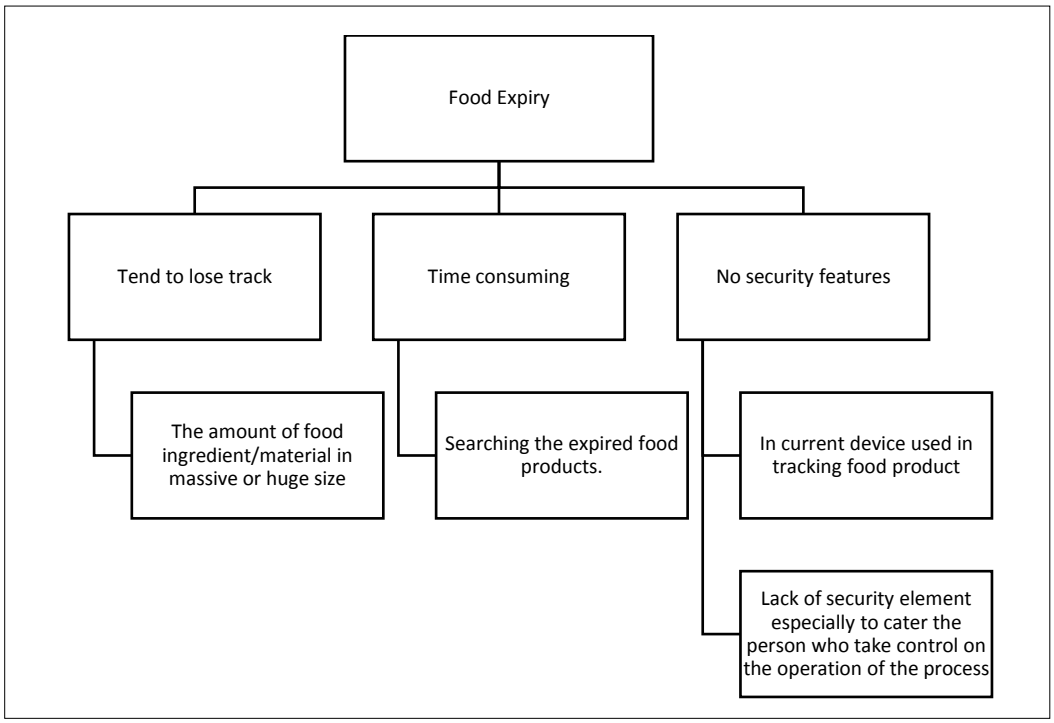

Figure 4.1: Root Cause Analysis

Based on the Figure 4.1, the problem of the current system is listed that the food expiry date checking is now carried out manually in many of food manufacturing company, this project aim to overcome the problem.

Firstly, this system is quite complicated when manual inspection had to be done. Current system tend to lose track of the amount of food ingredient/material in massive or huge size. The food barcode has become the medium of intermediate to facilitate the work done. In which, the staffs sometimes need to double check each of delivery item to the company.

Second, time consuming for searching the expired food products. Since the expiry date in each food product is different, staffs need to make an inspection on each food product. Therefore, this inspection need to be done to ensure that there are no left over expiry food that are used later on.

Lastly, the current devices used in tracking expiry food product has no security features in it. In fact, there is a lack of security element especially to cater the person who take control on the operation of the process, supply chain.

4.3 High Level Design

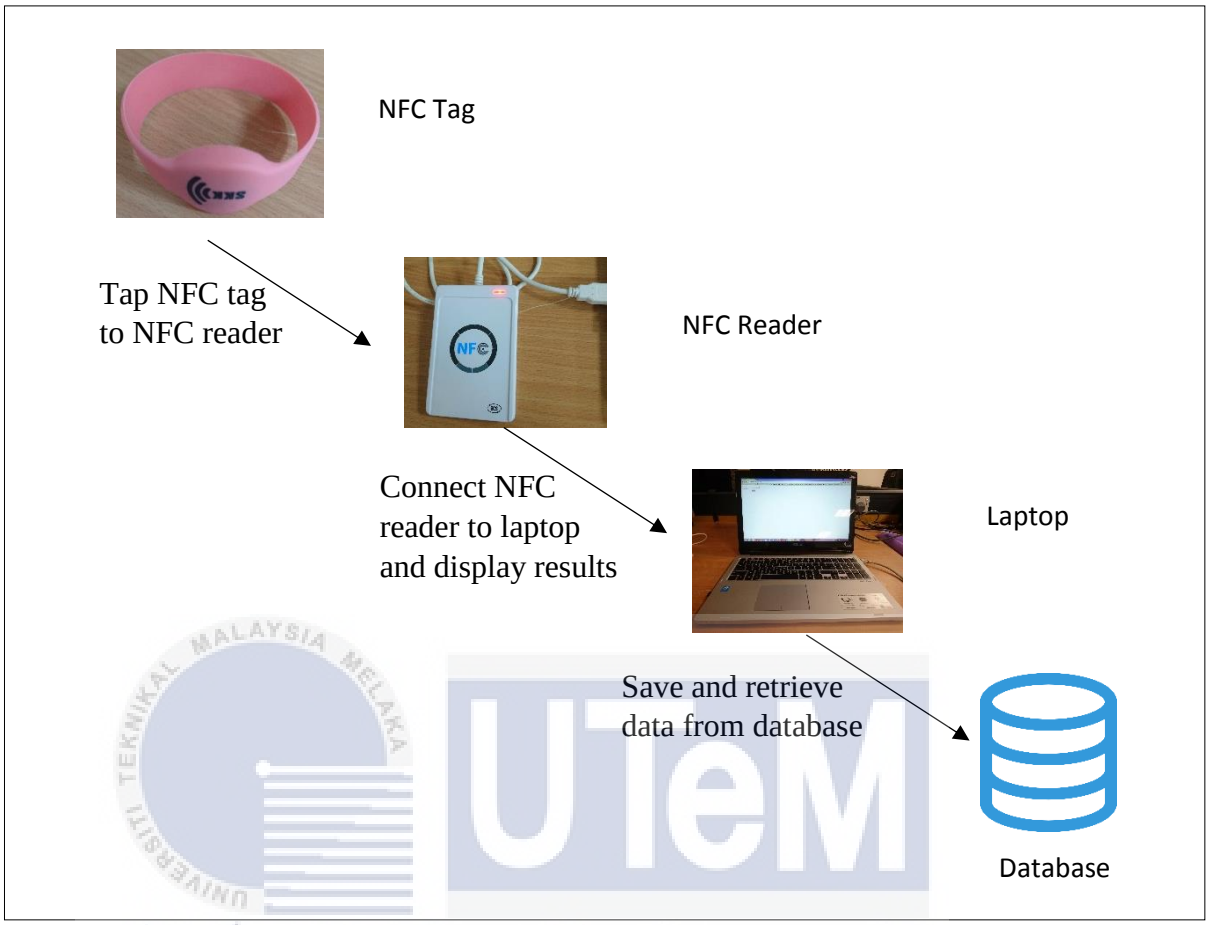

Figure 4.2: High-Level Design

4.3.1 System Architecture

System architecture is very important stage which show the designs need to be used for defining the system in a certain area which include users and server.

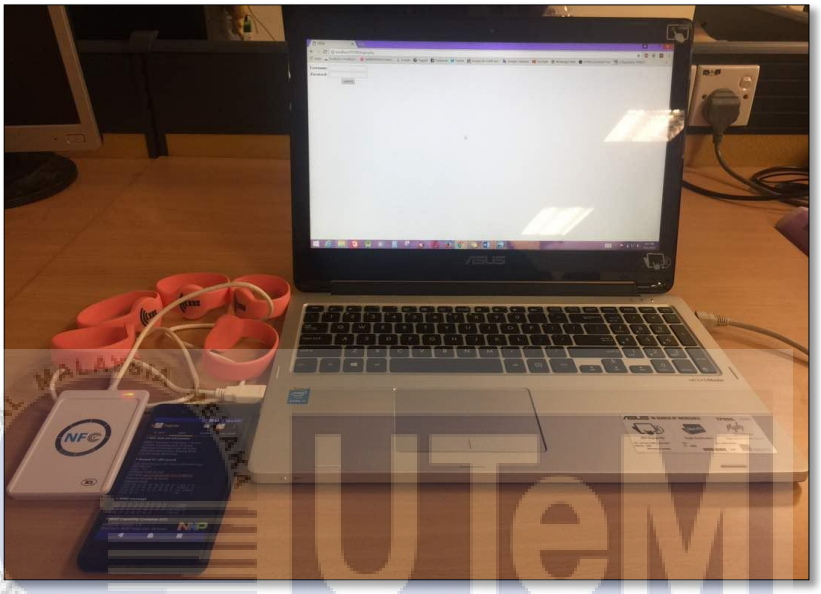

Figure 4.3: Architecture Design

Based on the figure 4.3, SQLite is responsible as a server to store all the details in database. The user device responsible to manage the application and the presentation of the system which include system interface for authorized user only, NFC tag is needed in the food product to tag the NFC reader because this detect all details that stored in database regarding the item.

4.3.2 User Interface Design

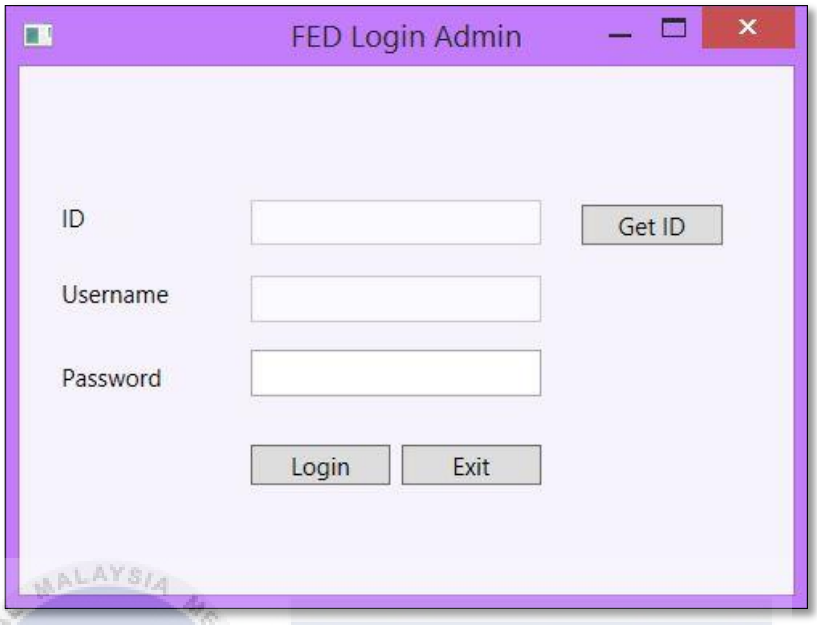

Figure 4.4: Authentication user interface

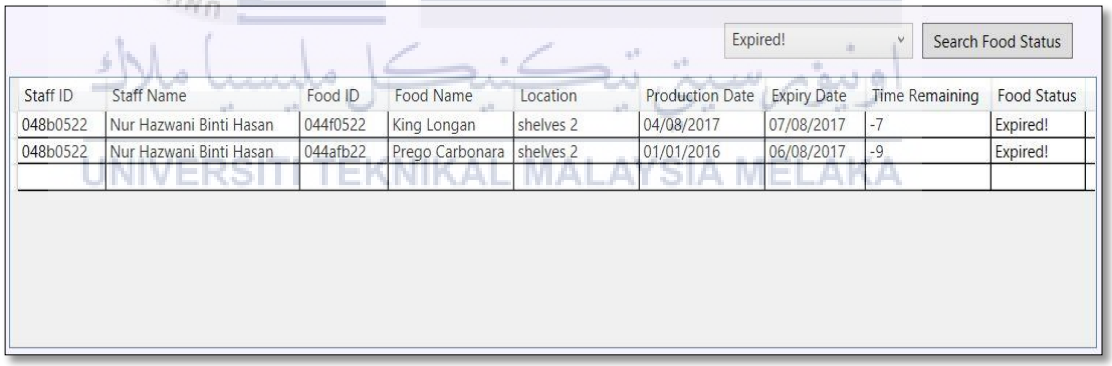

Figure 4.5: Search for expiry date product

4.3.3 Conceptual Design

Conceptual design concentrate on how the data in a table is identified with another data by using Entity Relationship Diagram (ERD) that has been develop for the system. Figure 4.6 below show the ERD of project system.

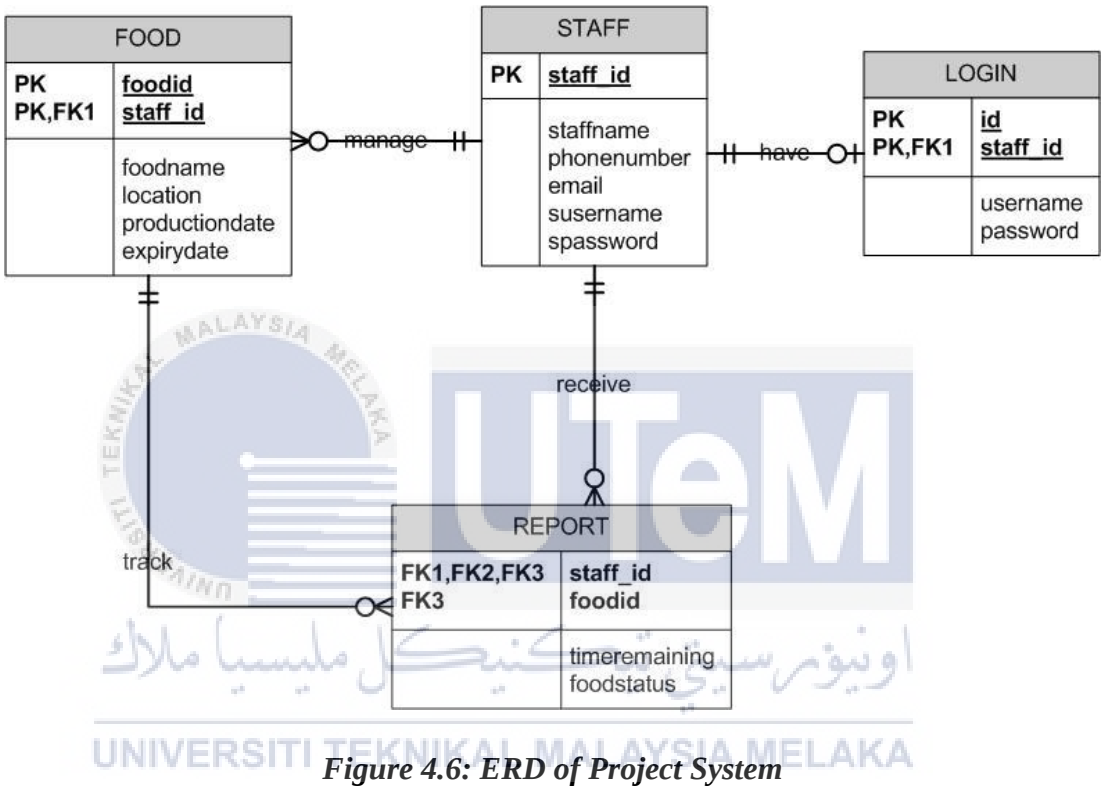

Figure 4.6: ERD of Project System

4.4 Requirement Analysis

This section explain the requirement need to be used in project that include NFC process and internal user process.

4.4.1 Data Requirement

The input of this product is NFC reader that has been configure that it can read NFC tag while the data from the reader store information in the database and it also display information that had been store in the web-based system interface. The data type, constraints and description of every data contained in the database table are expressed out as Data Dictionary. Other than that, only an authorized user can used this system. All of the table below show the data dictionary for login, staff, food and report.

4.4.1.1 Login

Table 4.1: Data Dictionary for Table Login

Filled	Data Type	Description
id	varchar	The user tag ID
username	varchar	The username based on staff number
password	varchar	All user are given password based on tag ID

4.4.1.2 Staff

Table 4.2: Data Dictionary for Table Staff

Filled	Data Type	Description
staff_id	varchar	The UID tag of the user
staffname	varchar	Name of the staff
phonenumber	varchar	Staff phone number
email	varchar	Staff email
susername	varchar	Staff number
spassword	varchar	Staff password

4.4.1.3 Food

Table 4.3: Data Dictionary for Table Food

Filled	Data Type	Description
foodid	varchar	The NFC tag UID for the food
foodname	varchar	foodname is for food name
location	varchar	The food location
ProductionDate	date	It show the food product production date
ExpiryDate	date	The food product expiry date

4.4.1.4 Report

Table 4.4: Data Dictionary for Table Notification

Filled	Data Type	Description
staff_id	varchar	The UID tag of the user
foodid	varchar	The NFC tag UID for the food
TimeRemaining	int	Show the time before expired
FoodStatus	varchar	Status show whether the product is expired or not.

4.4.3 Other Requirement

4.4.3.1 Software Requirement

Table 4.5: Software Requirement

Software/Tools	**Description**
C#	C# is an elegant and type-safe object oriented language that enables to build a variety of secure and robust applications
SQLite	SQLite is a database that are used to store all the information or data
Microsoft Visual Studio	Microsoft Visual Studio is used to write the C# script
Microsoft Visio	Microsoft Visio is used to draw the flow chart, Entity Relationship Diagram and other Diagram
Microsoft Word	Microsoft Word is used to write all the documentation for this project

4.4.3.2 Hardware Requirement

Table 4.6: Hardware Requirement

Hardware	**Description**
Personal Computer/Laptop	The Asus laptop is used to install all the software to develop the project. The particular of the laptop is as list as below: a) Operating System: Windows 8.1 b) Processor: Intel® Core™ i7-5500U CPU @ 2.40GHz c) RAM: 4.00GB d) System Type: 64-bit Operating System, x64-based processor.
NFC tag	NFC tags is used to retrieve food product details or staff information. Once the reader scan the tag, it display the food product details or staff information.
NFC device	ACR122U-A9 is used as a NFC reader

4.5 Detailed Design

This section explain about all the detailed of the design project that include NFC connection, web-based system and flow chart.

4.6 Conclusion

As a conclusion, this chapter mainly focus on designing which is the important stage after planning the project. Problem analysis and requirement analysis is covering as a part of developing the system. Other than that, this chapter includes all software and hardware requirement as a part that need to be implementing and testing. It also explains the network architecture design in details for the project that has been planned. This chapter are guide to the next phase which is implementation that involves analysis of the data collected.

CHAPTER 5

IMPLEMENTATION

5.1 Introduction

For this chapter, implementation of the project is discussed. In implementation phase, it focus on software development environment setup, software configuration management, implementation status and conclusion for this chapter. Software development environment setup, include diagram to present the environment architecture. Software configuration management, discuss on configuration environment setup and version control procedure. Implementation status, present the progress of each component for the project.

5.2 Project Development Environment Setup

This section describes the overall development environment of the project. The required operating system used in this environment setup is Windows platform. The hardware used by this project are NFC tag, NFC reader, laptop or personal computer. Server for this project is use to control all the data of the users and products. Users could access the server through the system. Laptop or personal computer allow the user to view the information needed by using the web GUI interface. NFC tag have unique identification which allow tag matching with information inside the database. Table 5.1 below shows overall environment.

Table 5 1: Implementation Environment

Implementation Environment	**Description**
System Operation Environment	• Windows 8.1 • Microsoft Visual Studio • NFC Reader ACR122U-A9 • NFC tag-wristband (able to match data with database)
Database Management System	• SQLite
Programming Language	• C#

5.2.1 Laptop or Personal Computer (PC) Environment Setup

This section describes all the things that related to laptop or personal computer. This project are using Laptop to run Microsoft Visual Studio shown in Figure 5.1 and SQLite database to store all user information and retrieve all food information shown in Figure 5.2 below.

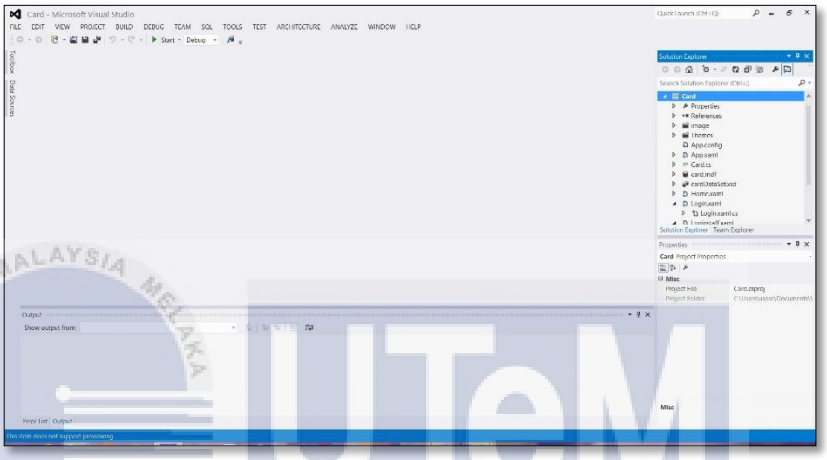

Figure 5.1: Microsoft Visual Studio 2012

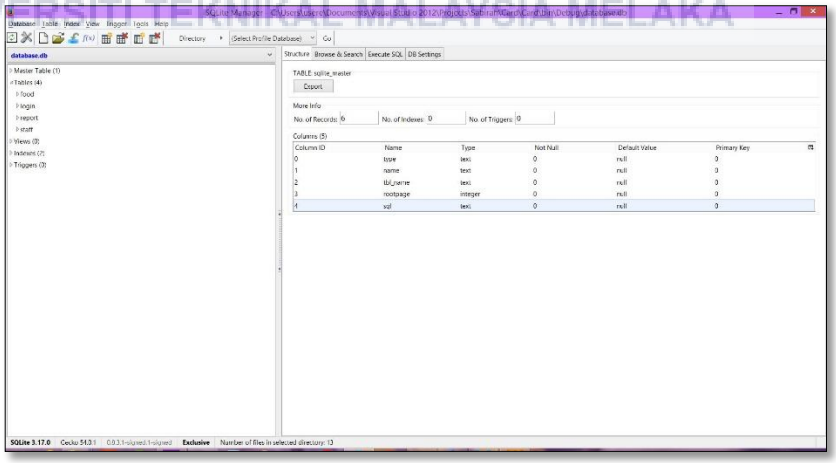

Figure 5.2: SQLite server database

5.2.2 NFC Reader and NFC Tag Environment Setup

This section describe how the NFC reader are setup and integrated with the system. The configuration needs to be done for matching the tag UID with database. The reader first need to be connected to the laptop or PC before it can be used by the system. Figure 5.3 and Figure 5.4 shows the reader and tag that are used in this system.

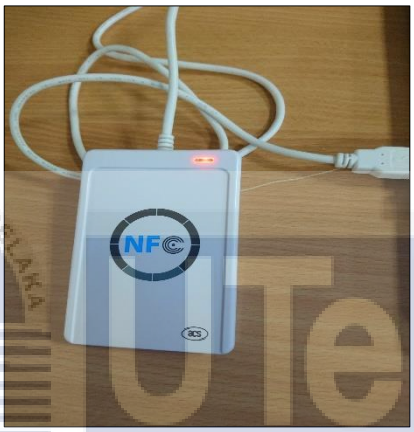

Figure 5.3: NFC Reader ACR122U-A9

Figure 5.4: NFC Tag (Wristband)

5.3 Project Configuration Management

Sub section 5.3.1 to 5.3.3 describes the overall configuration management for the project.

5.3.1 SQLite server Database Installation

Step 1: Go to "sourceforge.net/projects/sqlite-dotnet2/" to download SQLite framework.

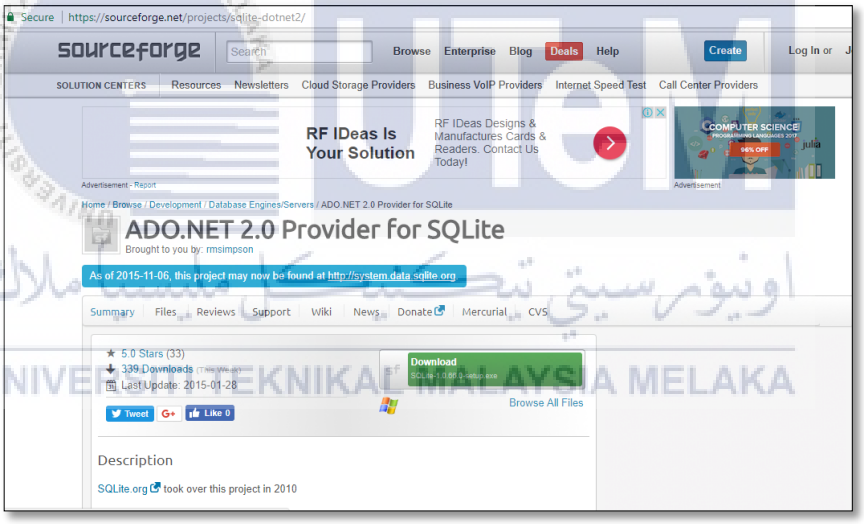

Figure 5.5: Download SQLite

Step 2: Run the SQLite setup

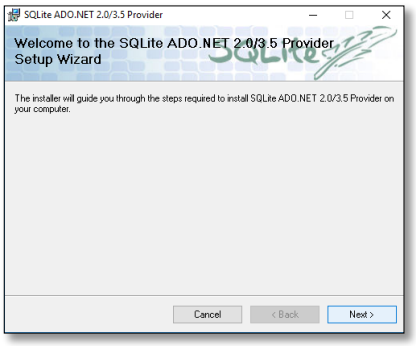

Figure 5.6: SQLite setup 1

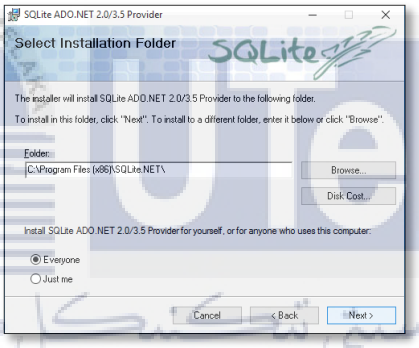

Figure 5.7: SQLite setup 2

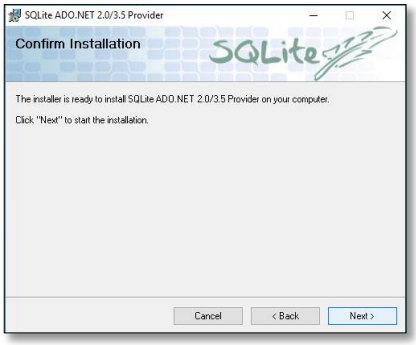

Figure 5.8: SQLite setup 3

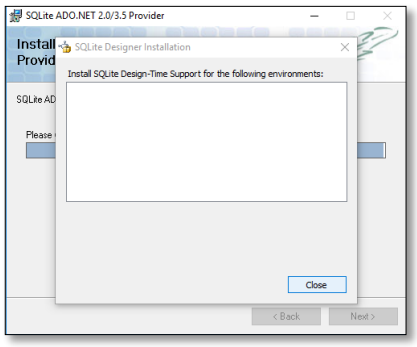

Figure 5.9: SQLite setup 4

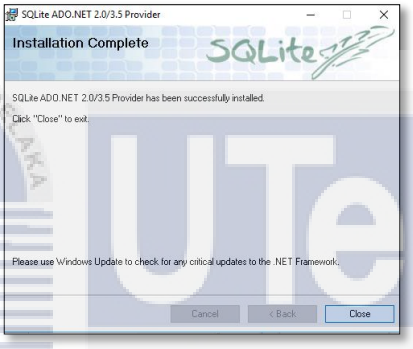

Figure 5.10: SQLite setup 5

Step 3: Open Microsoft Visual Studio, on Solution explorer section, right click on Card and choose add reference.

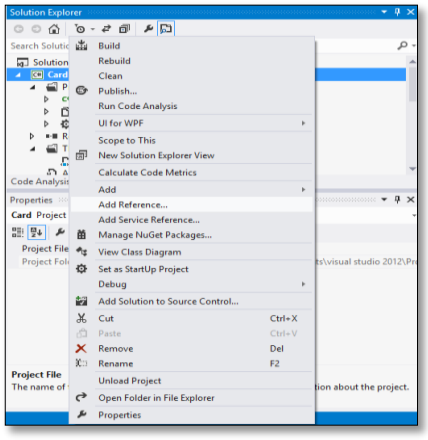

Figure 5.11: Insert Reference

Step 4: Search for the needed reference, choose and click ok.

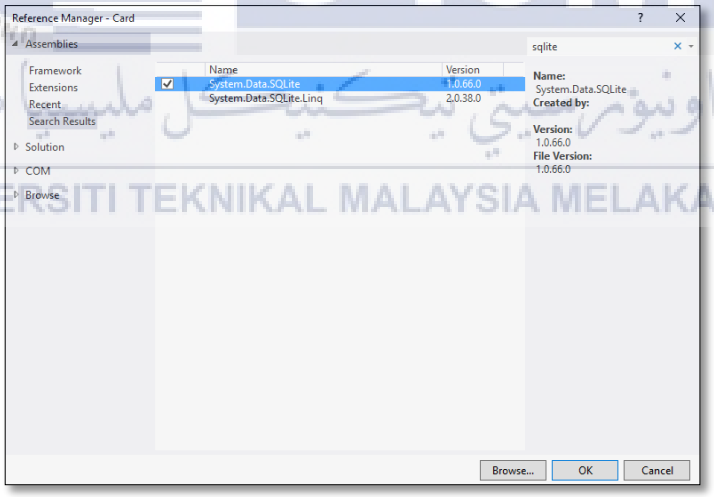

Figure 5.12: System Data SQLite

Step 5: Open Mozilla Firefox and add on SQLite Manager on the browser and create the database for the system.

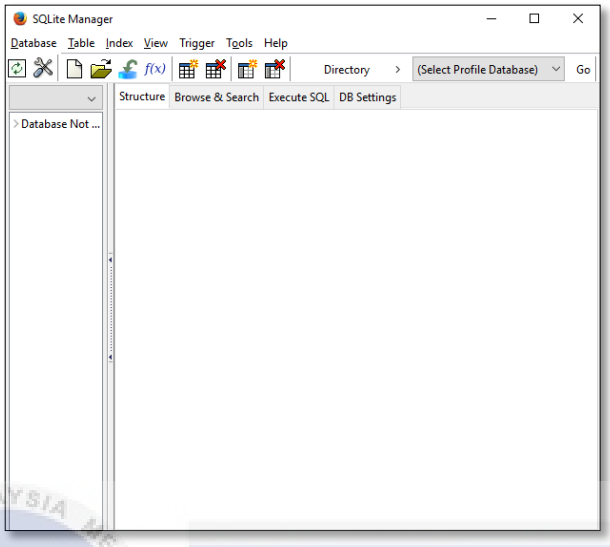

Figure 5.13: SQLite Manager

5.3.2 Integrated reader to system

Step 1: First, open the Microsoft Visual Studio. Add new item or project and choose Window (WPF) and write all of the code below

```
namespace Card
{
    /// <summary>
    /// Interaction logic for Login.xaml
    /// </summary>
    public partial class Login : Window
    {
        int retCode;
        int hCard;
        int hContext;
        int Protocol;
        public bool connActive = false;
        string readername = "ACS ACR122 0";      // change depending on reader
        public byte[] SendBuff = new byte[263];
        public byte[] RecvBuff = new byte[263];
        public int SendLen, RecvLen, nBytesRet, reqType, Aprotocol, dwProtocol, cbPciLength;
        public Card.SCARD_READERSTATE RdrState;
        public Card.SCARD_IO_REQUEST pioSendRequest;

        string dbConnectionString = @"Data Source=database.db;Version=3;";

        public Login()
        {
            InitializeComponent();
            SelectDevice();
            establishContext();
        }
```

Figure 5.14: Integrate reader to system 1


```
public void SelectDevice()
{
    List<string> availableReaders = this.ListReaders();
    this.RdrState = new Card.SCARD_READERSTATE();
    readername = availableReaders[0].ToString();//selecting first device
    this.RdrState.RdrName = readername;
}

public List<string> ListReaders()
{
    int ReaderCount = 0;
    List<string> AvailableReaderList = new List<string>();

    //Make sure a context has been established before
    //retrieving the list of smartcard readers.
    retCode = Card.SCardListReaders(hContext, null, null, ref ReaderCount);
    if (retCode != Card.SCARD_S_SUCCESS)
    {
        MessageBox.Show(Card.GetScardErrMsg(retCode));
        //connActive = false;
    }

    byte[] ReadersList = new byte[ReaderCount];

    //Get the list of reader present again but this time add sReaderGroup, retData as 2rd & 3rd parameter respectively.
    retCode = Card.SCardListReaders(hContext, null, ReadersList, ref ReaderCount);
    if (retCode != Card.SCARD_S_SUCCESS)
    {
        MessageBox.Show(Card.GetScardErrMsg(retCode));
    }
```

Figure 5.15: Integrate reader to system 2

```
    string rName = "";
    int indx = 0;
    if (ReaderCount > 0)
    {
        // Convert reader buffer to string
        while (ReadersList[indx] != 0)
        {

            while (ReadersList[indx] != 0)
            {
                rName = rName + (char)ReadersList[indx];
                indx = indx + 1;
            }

            //Add reader name to list
            AvailableReaderList.Add(rName);
            rName = "";
            indx = indx + 1;

        }
    }
    return AvailableReaderList;

}

internal void establishContext()
{
    retCode = Card.SCardEstablishContext(Card.SCARD_SCOPE_SYSTEM, 0, 0, ref hContext);
    if (retCode != Card.SCARD_S_SUCCESS)
    {
        MessageBox.Show("Check your device and please restart again", "Reader not connected", MessageBoxButton.OK, MessageBoxImage.Warning);
```

Figure 5.16: Integrate reader to system 3

```
            connActive = false;
            return;
        }
    }

    public bool connectCard()
    {
        connActive = true;

        retCode = Card.SCardConnect(hContext, readername, Card.SCARD_SHARE_SHARED,
                Card.SCARD_PROTOCOL_T0 | Card.SCARD_PROTOCOL_T1, ref hCard, ref Protocol);

        if (retCode != Card.SCARD_S_SUCCESS)
        {
            MessageBox.Show(Card.GetScardErrMsg(retCode), "Card not available", MessageBoxButton.OK, MessageBoxImage.Error);
            connActive = false;
            return false;
        }
        return true;
    }

    private string getcardUID()//only for mifare 1k cards
    {
        string cardUID = "";
        byte[] receivedUID = new byte[256];
        Card.SCARD_IO_REQUEST request = new Card.SCARD_IO_REQUEST();
        request.dwProtocol = Card.SCARD_PROTOCOL_T1;
        request.cbPciLength = System.Runtime.InteropServices.Marshal.SizeOf(typeof(Card.SCARD_IO_REQUEST));
        byte[] sendBytes = new byte[] { 0xFF, 0xCA, 0x00, 0x00, 0x00 }; //get UID command      for Mifare cards
        int outBytes = receivedUID.Length;
        int status = Card.SCardTransmit(hCard, ref request, ref sendBytes[0], sendBytes.Length, ref request, ref receivedUID[0], ref outBytes);
```

Figure 5.17: Integrate reader to system 4

```
private string getcardUID()//only for mifare 1k cards
{
    string cardUID = "";
    byte[] receivedUID = new byte[256];
    Card.SCARD_IO_REQUEST request = new Card.SCARD_IO_REQUEST();
    request.dwProtocol = Card.SCARD_PROTOCOL_T1;
    request.cbPciLength = System.Runtime.InteropServices.Marshal.SizeOf(typeof(Card.SCARD_IO_REQUEST));
    byte[] sendBytes = new byte[] { 0xFF, 0xCA, 0x00, 0x00, 0x00 }; //get UID command      for Mifare cards
    int outBytes = receivedUID.Length;
    int status = Card.SCardTransmit(hCard, ref request, ref sendBytes[0], sendBytes.Length, ref request, ref receivedUID[0], ref outBytes);

    if (status != Card.SCARD_S_SUCCESS)
    {
        cardUID = "Error";
    }
    else
    {
        cardUID = BitConverter.ToString(receivedUID.Take(4).ToArray()).Replace("-", string.Empty).ToLower();
    }

    return cardUID;
}

public void tutup()
{
    if (connActive)
    {
        retCode = Card.SCardDisconnect(hCard, Card.SCARD_UNPOWER_CARD);
    }
    //retCode = Card.SCardReleaseContext(hCard);
}
```

Figure 5.18: Integrate reader to system 5

5.3.3 Retrieve or matching tag with database

Step 1: To retrieve or matching tag with database first, connect system to database.


```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Data;
using System.Windows.Documents;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Media.Imaging;
using System.Windows.Navigation;
using System.Windows.Shapes;
using System.Data;
using System.Data.SqlClient;
using System.Configuration;
using System.Data.SQLite;
```

Figure 5.19: System Connection

```
namespace Card
{
    /// <summary>
    /// Interaction logic for Loginstaff.xaml
    /// </summary>
    public partial class Loginstaff : Window
    {

        int retCode;
        int hCard;
        int hContext;
        int Protocol;
        public bool connActive = false;
        string readername = "ACS ACR122 0";      // change depending on reader
        public byte[] SendBuff = new byte[263];
        public byte[] RecvBuff = new byte[263];
        public int SendLen, RecvLen, nBytesRet, reqType, Aprotocol, dwProtocol, cbPciLength;
        public Card.SCARD_READERSTATE RdrState;
        public Card.SCARD_IO_REQUEST pioSendRequest;

        string dbConnectionString = @"Data Source=database.db;Version=3;";

        public Loginstaff()
        {
            InitializeComponent();
            SelectDevice();
            establishContext();
        }
```

Figure 5.20: Database Connection

```
private void staff_id_TextChanged(object sender, TextChangedEventArgs e)
{
    SQLiteConnection sqliteCon = new SQLiteConnection(dbConnectionString);

    try
    {
        sqliteCon.Open();
        string Query = "select * from staff where staff_id = '" + staff_id.Text + "'";
        SQLiteCommand createCommand = new SQLiteCommand(Query, sqliteCon);
        createCommand.ExecuteNonQuery();
        SQLiteDataReader dr = createCommand.ExecuteReader();
        while (dr.Read())
        {


            string sstaffname = dr.GetString(1);
            string sphonenumber = dr.GetString(2);
            string semail = dr.GetString(3);
            string ssusername = dr.GetString(4);
            string sspassword = dr.GetString(5);

            staffname.Text = sstaffname;
            phonenumber.Text = sphonenumber;
            email.Text = semail;
            susername.Text = ssusername;
            spassword.Password = sspassword;
        }

        sqliteCon.Close();
    }

    catch (Exception ex)
    {
        MessageBox.Show(ex.Message);
    }
```

Figure 5.21: Retrieve data from database

5.4 Conclusion

As conclusion, this chapter discuss about the implementation of the project. The software development environment for the RFID based Food Expiry Date Notification by using Authentication show how the system process setup using software, hardware and network setup. Software configuration management described in details which software language and database is used for the system. Next chapter are going to discuss the testing and analysis of the project by using all the information gathered in this chapter.

CHAPTER 6

TESTING

6.1 Introduction

This chapter describe about the testing of the project. The process of testing is to find out the effective performance on how food expiry date using NFC reader as the main platform to cater the information. This testing has been done several times in order to make sure the reader detected well-functioning. In this project, when user are tapping the tag in the reader, first it shows staff information. Second the reader are getting the food information. All of the information that shown in the interface are going to save in the report. Based on the phase that has been discussed before, now it is time to do the testing that includes test plan, test strategy, text design and result and analysis.

6.2 Test Plan

These part explain about the basis for the testing of the system. It also covers testing activities and scope of the system.

6.2.1 Test Organization

In this testing phase, developer are testing the system. This process for developer to know how the system is working from the beginning phase until the end.

6.2.2 Test Environment

In design phase, the interface for user details is configured. Therefore user is able to view the interface via screen that is provided. The purpose of the test environment is to provide a structure for the testing activities. In this task, the test environment requirements are established and reviewed before implementation.

6.2.3 Test Schedule

This section describe how the testing are carries out by developer in a period of time. During the testing process, the system error and problems should be back to implementation phase. This is a continuous process cycle which is the system should be able to run successfully based on phase.

6.3 Test Strategy

This project use white-box testing strategy. The white-box is a testing technique that examines the program structure and derives test data from the program logic or code. Firstly, connect the NFC reader to the system. The main system for this project is to provide full information regarding food product expiry date and to display details of user that cater the information in interfaces. Card.sln file is the main C# script for the system. The developer runs the Card.sln to execute the system. The details of the staff are automatically displayed on the interface once the user tap the tag and it is detected by the NFC reader. After that, the food information are displayed once the wristband are detected by the NFC reader. All the information are saved on the database and displayed on the interface. The Figure 6.1 below show a project flow.

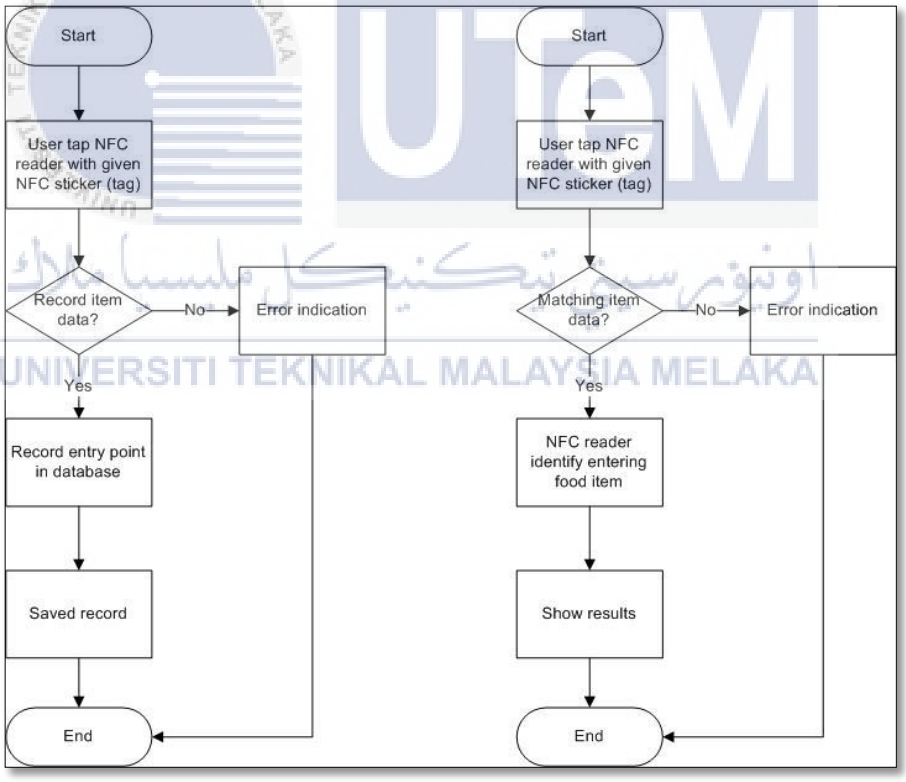

Figure 6.1: Project Flow Chart

6.4 Test Design

Test design is a part of the system testing where each test are carried out step by step in order to validate the system.

6.4.1 Test Description

The test cased are identified with the expected results by each module. This test covered separate part of the system such as NFC integration with system and database. All test descriptions are shown in the following tables:

Table 6 1: NFC integration with system testing

Test	NFC integration with system
Test purpose	To test the integration between NFC reader and tag with system
Test environment	In order to integrated NFC reader with system, there are some code need to be done using C# as stated in section 5.3.2 implementation.
Test setup	i. Run the system in Microsoft visual studio. ii. Connect device to the laptop or PC. iii. Tap NFC card to the reader to get the card UID.
Expected result	The output are shown in section 6.5.1.

Table 6.2: NFC integration with database testing

Test	NFC integration with database
Test purpose	To test the integration between NFC reader and tag with database
Test environment	In order to integrated NFC reader with database, there are some code and connection that need to be done using C# and SQLite as stated in section 5.3.3 implementation.
Test setup	i. Run the system in Microsoft visual studio. ii. Connect device to the laptop or PC. iii. Open the database SQLite using Mozilla Firefox iii. Tap NFC card to the reader to get the card UID and save data. iv. Refer to database and refresh to see inserted data.
Expected result	The output are shown in section 6.5.2.

Table 6.3: Overall system test

Test	RFID based Expiry Food Notification by using Authentication
Test purpose	To test the integration for overall system.
Test environment	In order to run this test, the full system configuration must be finish.
Test setup	Full procedure step-by-step for overall system setup please refer in section 5.3.2 and 5.3.3.
Expected result	The output are stated in section 6.5.3.

6.5 Result

6.5.1 NFC integration with system testing

The NFC integration with system testing need to be tested separately in order to ensure the correct functionality of the system. To start the testing process, the system need to be run. Figure 6.2 below show integration between the reader and the system is success because the system can detect the tag that had been touch.

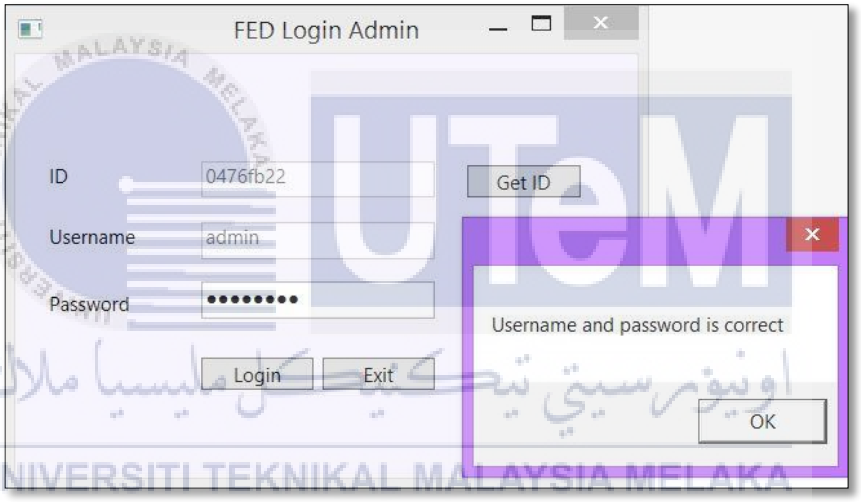

Figure 6.2: The result when the tag detected

6.5.2 NFC integration with database testing

In order to test the NFC integration with database, there are a few steps that need to be done. To start the testing process, the developer need to make sure there are a few line code to connect the system with the database. After that, the system need to be run. Figure 6.3 below show integration between the reader and the information in database is success because the system can display, delete and insert data once the tag is touch the reader.

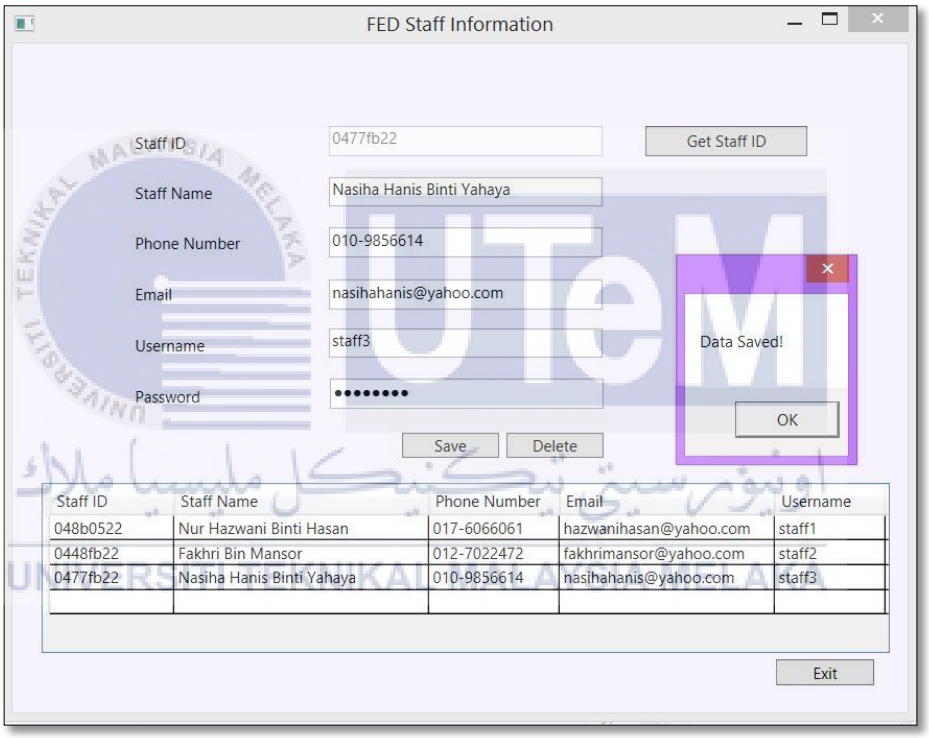

Figure 6.3: The result display on system

6.5.3 Test the Project

The overall project test need to be done by running the Card.sln file. The following figure below are showing overall system interface. Overall project test is success.

6.6 Conclusion

As the conclusion, the testing phase is conducted to test overall project functionality of the NFC reader and tag also integration between both devices with system and database. In the next chapter are focus on conclusion which covers project summarization, limitation and future works.

CHAPTER 7

CONCLUSION

7.1 Introduction

This chapter are focusing more on the project summarization. Besides, project summarization, project contribution, project limitation and future work also included in this chapter. Project summarization concludes that whether the project objective is fulfilled or not. Project contribution concludes on the new findings in this system development. Project limitation is some of the restrictions occur during the projects implementation and research. Finally, the future works state on how to improve the current development for gaining better results in the next projects.

7.2 Project Summarization

7.2.1 Project Objective

In this project, there are a few objective that had been identified which is:

i. To explore RFID and NFC technology used in tracking canned food expiry product. All background study regarding both technology had been done in literature review phase where all related details are referred such as Vitamix Adds RFID to Its Food Blenders by Prince, N 2017, Generation Z consumers' expectations of interactions in smart retailing: A future agenda by Priporas, Stylos, and Fotiadis 2017. Based on background study, it giving idea on how to develop the project. Many previous works have been identified and as the result, RFID based Food Expiry Notification by using Authentication can be done.

ii. To design a new tracking system using or based on authentication. The objective has been done. Once the NFC tag are tap in NFC reader, the user get information from database before the user able to use the tracking system.

iii. To introduce the new system using the proposed security features. The RFID based Food Expiry Notification by using Authentication has been tested thoroughly by following the test cases module as describe in previous module. The outcomes from overall system test shows that the interface and functionality of the system prototype is validates.

7.2.2 Project Weakness

The weaknesses of the RFID based Food Expiry Date Notification by using Authentication system are stated as below:

i. Only use default password for all user

This system only use default password that had been set by admin based on staff ID tag given.

ii. Cannot print full report data

The details of report that can be print are limited and the report only print based on system datagrid.

7.2.3 Project Strength

The strength of the RFID based Food Expiry Date Notification by using Authentication system are stated as below:

i. Security

The system have authentication which make the system secured and can be used by the registered staffs only.

ii. User friendly

This system is a user friendly because it provided GUI interface and is easy to use by users.

7.3 Project Contribution

This project was developed to improving the study of RFID and NFC technology which focus on how to enhance the usage of both technology. The main project contribution is to develop a new tracking system for canned food expiry product and implement new tracking system with security features. This system only required a NFC reader, NFC tag and laptop or PC.

7.4 Project Limitation

For the project limitation of RFID based Food Expiry Date Notification by using Authentication are stated as below:

i. NFC tag cannot be read automatically by the NFC reader.

User need to click the button first before the NFC tag UID can be read. It is not really suitable for those who need the fast and convenience system.

ii. One UID can be used by one product only.

The same product name should be able to use the same UID but with different date. User need to use a lot of tag with different UID which more spaces are needed to save the information.

iii. Required Microsoft Visual Studio and SQLite

The new user of this system need to have Microsoft visual studio 2012 and above to run the program and user need to install SQLite and a little bit configuration before being able to connect the system with database which require a lot of work.

7.5 Future Works

In order to improve the RFID based Food Expiry Date Notification by using Authentication system there are some suggestion as stated as below:

i. Authentication based on user level. In this project, authentication already been used but there are two login page. The suggestion for future work, it should have only one login page and all user are using the same login page the only different is they login using different level.

ii. Automatically get UID tag and save to database. The NFC reader should be able to automatically read NFC tag once the tag is tap to the reader. Suggestion for future work, once the NFC tag is detected by NFC reader, the data will be automatically read and save in the database.

iii. Automatically cater staff name and save to the report after staff login into the system. In this project, after staff login, they need to tap their tag again to get the information before retrieve food data. For future work, once staff login, they only need to tap food tag to get data and their name are automatically save in report.

iv. Every user can change their own password. In this project, staff is given a default password which based on their UID and they cannot change it. Suggestion of future work, all staffs can be able to change their own password which make the system more secured.

v. The notification icon can be pop up once the expired product detected. In this project, staff get the notification based on report which make it inconvenience. For future work, staff should be notify based on time remaining for the expiry product.

vi. Report can be print nicely and all the details are stated on the report. In this system not all information can be shown in the print report and the report only print based on datagrid in the system. Suggestion for future work, report should be able to print based on preference of the user.

vii. For future work, system should be able to use cloud or wireless which make it easier to be used by all the user.

7.6 Conclusion

As a conclusion, the project meets all the objective of the project which is listed in the chapter 1. The RFID based Food Expiry Date Notification by using Authentication which helps the users get the food expiry date easily and reduced the uses on paper to record food expiry information. All the information and data are stored into database which is more secure and easy to view by the users. The system is successfully solves all the problems on current food expiry system.

REFERENCE

Almuiet, M. Z., & Salim, J. (2013). Knowledge Flow in Supply Chain Manufacturing: Case Study in Food Manufacturing Firm. *Procedia Technology*, *11*(Iceei), 463–470. https://doi.org/10.1016/j.protcy.2013.12.216

Alqarni, A., Alabdulhafith, M., & Sampalli, S. (2014). A Proposed RFID Authentication Protocol based on Two Stages of Authentication. *Procedia Computer Science*, *37*, 503–510. https://doi.org/10.1016/j.procs.2014.08.075

Attaran, M. (2012). Critical success factors and challenges of implementing RFID in supply chain management. *Journal of Supply Chain and Operations Management*, *10*(1), 144–167. Retrieved from http://csupom.org/PUBLICATIONS/2012-1/JSCOM_2012-1-11.pdf

Badra, M., & Badra, R. B. (2016). A Lightweight Security Protocol for NFC-based Mobile Payments. *Procedia Computer Science*, *83*(Ant), 705–711. https://doi.org/10.1016/j.procs.2016.04.156

Bhargava, A., & Ochawar, R. S. (2013). Biometrics in Access Control System, *3*(2), 1–5.

Dos Santos, R. F., & Marins, F. A. S. (2015). Integrated model for reverse logistics management of electronic products and components. *Procedia Computer Science*, *55*(Itqm), 575–585. https://doi.org/10.1016/j.procs.2015.07.047

Feng, T., Hwang, M., & Syu, L. (2016). An Authentication Protocol for Lightweight NFC Mobile Sensors Payment, *27*(4), 723–732.

Ginters, E., & Martin-Gutierrez, J. (2013). Low cost augmented reality and RFID application for logistics items visualization. *Procedia Computer Science*, *26*(December), 3–13. https://doi.org/10.1016/j.procs.2013.12.002

Hashim, N. M. Z., Ibrahim, N. a, Saad, N. M., Sakaguchi, F., & Zakaria, Z. (2013). Barcode Recognition System. *International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)*, *2*(4), 278–283. Retrieved from http://www.ijettcs.org/Volume2Issue4/IJETTCS-2013-08-19-097.pdf

Jambusaria, U., Katwala, N., & Mistry, D. (2015). Secure smartphone unlocking

using NFC. *Procedia Computer Science*, *45*(C), 465–469. https://doi.org/10.1016/j.procs.2015.03.081

Joseph, S. A., & Joby, N. J. (2016). Analyzing RFID Tags in a Distributed Environment. *Procedia Technology*, *24*, 1483–1490. https://doi.org/10.1016/j.protcy.2016.05.073

Jung, M. S. (2015). A study on electronic-money technology using near field communication. *Symmetry*, *7*(1), 1–14. https://doi.org/10.3390/sym7010001

León-Coca, J. M., Reina, D. G., Toral, S. L., Barrero, F., & Bessis, N. (2013). Authentication systems using ID cards over NFC links: The Spanish experience using DNIe. *Procedia Computer Science*, *21*(0), 91–98. https://doi.org/10.1016/j.procs.2013.09.014

Mary, B., & Connor, C. O. (2015). New NFC Security Feature Tightens Controls on Tag Data New NFC Security Feature Tightens Controls on Tag Data, 1–2.

Mehmood, F., Hassannezhad, M., & Abbas, T. (2014). Analytical Investigation of Mobile NFC Adaption with SWOT-AHP Approach: A Case of Italian Telecom. *Procedia Technology*, *12*, 535–541. https://doi.org/10.1016/j.protcy.2013.12.526

Narayanan, A. S. (2012). QR Codes and Security Solutions. *International Journal of Computer Science and Telecommunications*, *3*(7), 1–4.

Park, S., & Lee, I. (2016). Mutual Authentication Scheme Based on Lattice for NFC-PCM Payment Service Environment.

Park, S. W., & Lee, I. Y. (2013). Efficient mcoupon authentication scheme for smart poster environments based on low-cost NFC. *International Journal of Security and Its Applications*, *7*(5), 131–138. https://doi.org/10.14257/ijsia.2013.7.5.11

Persson, M., & Håkansson, A. (2015). A communication protocol for different communication technologies in cyber-physical systems. *Procedia Computer Science*, *60*(1), 1697–1706. https://doi.org/10.1016/j.procs.2015.08.279

Prince, N. (2017). Vitamix Adds RFID to Its Food Blenders Vitamix Adds RFID to Its Food Blenders, 1–4.

Priporas, C.-V., Stylos, N., & Fotiadis, A. K. (2017). Generation Z consumers' expectations of interactions in smart retailing: A future agenda. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2017.01.058

Razzak, F. (2012). Spamming the Internet of Things: A possibility and its probable solution. *Procedia Computer Science*, *10*, 658–665. https://doi.org/10.1016/j.procs.2012.06.084

Sun, C. (2012). Application of RFID Technology for Logistics on Internet of Things. *AASRI Procedia*, *1*, 106–111. https://doi.org/10.1016/j.aasri.2012.06.019

Sutar, S., Kapratwar, K., Rayate, R., Birari, S., & Zalke, S. (2013). Door Access Control in an Intelligent Car, *4*(April), 1220–1225.

Swedberg, C. (2016). NFC Tags Take to the Slopes on Ski Jackets NFC Tags Take to the Slopes on Ski Jackets, 1–2.

Syed Ahmad, S., Mohd Ali, B., & Wan Adnan, W. A. (2012). Applications As Access Control Tools of Information Security. *International Journal of Innovative Computing, Information and Control*, *8*(11), 7983–7999.

Tzoulis, I., & Andreopoulou, Z. (2013). Emerging Traceability Technologies as a Tool for Quality Wood Trade. *Procedia Technology*, *8*(Haicta), 606–611. https://doi.org/10.1016/j.protcy.2013.11.087

Williamson, "Avery, Tsay, L.-S., Kateeb, I. A., & Burton", L. (2013). "Solutions for RFID Smart Tagged Card Security Vulnerabilities." *AASRI Procedia*, *4*, 282–287. https://doi.org/10.1016/j.aasri.2013.10.042

Wilson, A., Hainey, T., & Connolly, T. (2012). Evaluation of Computer Games Developed by Primary School Children to Gauge Understanding of Programming Concepts. *Proceedings of the European Conference on Games Based Learning*, *2013*, 549–558. https://doi.org/10.5171/2013.

Yewatkar, A., Inamdar, F., Singh, R., Ayushya, & Bandal, A. (2016). Smart Cart with Automatic Billing, Product Information, Product Recommendation Using RFID & Zigbee with Anti-Theft. *Procedia Computer Science*, *79*, 793–800. https://doi.org/10.1016/j.procs.2016.03.107

Zavvari, A., Shakiba, M., Islam, M. T., Sundararajan, E., & Singh, M. J. (2013).

Computational Cost Analysis on Securing RFID Protocols Conforming to EPC Class-1 Generation-2 Standard. *Procedia Technology*, *11*(0), 778–784. https://doi.org/10.1016/j.protcy.2013.12.258