Mobile Assets Monitoring using RFID for UTAR Hospital

By

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ABSTRACT

Most of the service sectors like hospitality, education, banking, and other service sectors were manually entering the data of assets into the database. Sometimes, it causes data errors and inaccuracies since there are human typing errors or overlooking the number of lines of assets. Recently, AI and IoT are the most convenient technologies and are very useful in all sectors, especially in the service sector. They help sectors produce the most profit and productivity through technology. Since RFID is more convenient to use to check and update the data of assets, it is suitable for use in an asset monitoring system.

The outcome of the project is a **mobile application for the asset monitoring system using RFID** for UTAR Hospital. The purpose of developing this mobile application is to **keep track of the real-time incoming assets of the hospital**. The assets will be labelled with RFID tags and registered using a mobile RFID reader, then the information of RFID tags will be uploaded to the server. In case of finding assets needed by hospital staff, they can immediately find the assets through the server and confirm the location of the asset.

Area of Study: Java Programming, Networking
Keywords: UTAR Hospital, Mobile Assets Monitoring, RFID, Frappe server, Assets tracking

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LIST OF ABBREVIATIONS

RFID	Radio-Frequency Identification
UTAR	Universiti Tunku Abdul Rahman
QR Code	Quick Respond Code

CHAPTER 1 INTRODUCTION

Introduction

In this chapter, we present the background, problem statement and motivation of this project, project objective and scope, expect contributions of this project and organization of the project.

Project Background

UTAR Hospital is a not-profit hospital that offers affordable and holistic healthcare services, including Western Medical & Medicine services and Traditional & Complementary Medicine (T&CM) services [1]. It provides clinical training for undergraduate, postgraduate, and medical education and allow them to do clinical research and development. On 1st August 2023, UTAR Hospital began their services and opened to public after receiving approval from Health Ministry of Malaysia [2].

Figure 1 Overview of UTAR Hospital [1]

Same as other hospital, UTAR Hospital also using a lot of assets every day. For instances, assets of hospital were included computer, light, steel etc. that cost quite expensive and precious for hospital. Since there were many person like doctor, nurse and patient work or make treatment in hospital, it may cause the assets easily disappear in somewhere or may stole by people for selling outside. Thus, the assets monitoring system by using Radio-Frequency Identification (RFID) is important to ensure that assets can be identify and track effectively.

1.1 Motivation and Problem Statement

Problem Statement

Nowadays, hospitality and healthcare sector still using manual ways to key in data of assets to record the available of the assets. Sometimes, the data might be different to the number of assets exists since there were human error that happen. For example, key in the wrong assets serial number or overlooking number of line of assets information that needed key in. It will cause the information in database not complete and confuse. Additionally, the application in the RFID mobile reader only come out with simple function like write, read, and kill RFID tags. Thus, it is not sufficiently to record or change the information of assets.

To using assets monitoring system, the RFID mobile reader is needed to store the information of the tags of assets into a database. However, the own application in the mobile reader only has the function of reading and write the information of RFID tags. Thus, when mobile reader scans the RFID tags of assets, it will not store the information of asset to the database. When the information of assets not stored in database, user needs RFID mobile reader to scan the RFID tags for getting information due to record manually in the PC. This action was quite unfriendly and inconvenience.

Another problem of the system is lacking assets monitoring function in the system. Due to the assets is smaller and easily misplaced in corner of a room, the assets easier to disappear and need to find one by one in different room. Moreover, there were no monitoring system to tracking the exact location of the assets. If there were many assets suddenly disappear or misplaced, this will cause worker wasting their time to find the assets and lead to loss of unnecessary cost for buying the assets. Thus, it will no efficiency for the hospital's worker.

Motivation

The main motivation of the project is **improving data accuracy of assets**. Manual entry of the data would result to wrong records of the assets and it will provide wrong information to staff when assets checking. With RFID technology, errors can minimize and improve assets management and maintenance since staff able to scan the tags stick on assets. This will help to reduce the amount of time and effort that hospital staff must spend in gathering information about assets and among other things, the information obtained will be accurate and reliable.

This project also needs to **enhance asset visibility**. There are often situations when one must search for a misplaced or a missing asset and due to the absence of the real-time tracking it might be lost or wasted. Therefore, through successful accomplishment of the project, it will assist in cutting the rate of lost assets as well as the time taken in searching for these items thereby increasing security of assets. This will also assist in generating information on assets usage and various ways that assets can be used.

To make the RFID mobile reader more usable and effective for asset management, the **application needed to be improved** so that it will allow storing of the assets' details directly into the database. It would help to cut out additional data entry and keep assets' data available and updated in real time, which would enhance the system's usability and productivity. Users could monitor the location and condition of actual assets that were imported, saved and tiled in the database; this would generate minimal time chasing physical assets. This would also help in increasing the accuracy and reliability of the asset information so that any information that is key can always be available.

1.2 Project Objective

The first objective of this project is to **improve the application feature of RFID mobile reader**. In original RFID mobile reader, the features only have read and write function that only display tag number after reading the tag. These two basic functions are not enough for hospital staff to having their daily checking. They need to manually enter and labelling each tags into computers and may have changes to entering wrong data. In this project, the application features in mobile reader will be improved by adding efficiency functions and increasing the working efficiency of hospital staff.

The second objective of this project is to **store and retrieve data from server.** When scanning RFID tags, only tag numbers will display on mobile reader and show to user. This situation is not convenience to staff in hospital that having their daily assets checking. They need to compare the tag number of RFID tags with the specific assets with piece of paper. Thus, the database in server is very important to allow the staff visualize the type of assets that specific to RFID tags in RFID mobile reader after scanning the tags. This will help them saving their time and saving cost of hospital on purchasing new assets.

The third objective of this project is to **keep track the real-time location of assets.** In hospital, the flow of people very complex due to hospital staff and patient or other people can go in and out hospital randomly. This situation will cause assets may steal by thief or hospital staff since the security in hospital not strictly prohibited. Additionally, some tiny assets may be ignored, and assets may be misplaced in other placed due to human error. As a result, the monitoring system is needed to keep track the real-time location of assets. This may be protected hospital assets avoiding stole by people and saving the hospital costs.

1.3 Project Scope

The first scope of this project is **developing a mobile application for the RFID mobile reader**. Since the application only has read and write function on the mobile application of RFID mobile reader, thus, an application needs to develop for adding more features for allow user to update the information of RFID tags of assets, store information to database and monitoring the asset's exact location.

The second scope of this project is **employing database with Frappe Server**. The online database employed will store information of asset after user scan the RFID tags of assets. Thus, it can decrease the workload of staff form entering data manually. The information of RFID tags of assets also will retrieve data from server and use in mobile application to avoid the incorrect information have been store to the server. This will prevent incomplete and incorrect information store in the server.

The third scope of this project is **employing a dashboard to monitor real-time assets data.** After storing the information into database, user need a user interface to showing the information of assets from database. Within this interface, user can directly review the data from the database, while other people with access also able directly review the real time data set.

1.4 Expected Contribution from the Project

The contribution on this project will **help UTAR Hospital to saving cost and staff time.** With the implementation of this project, hospital staff can effectively read all the information of RFID tags in few seconds. When scanning the tags, timestamp and location also will be recorded and showing in the application. Thus, when staff need to find the disappear assets, staff could know what the time and where can find the disappear assets. It also can help hospital to saving the cost on buying new assets.

The second contribution of the project is **improving data accuracy of assets**. Manual entry of the data would result to wrong records of the assets and it will provide wrong information to staff when assets checking. With RFID monitoring system, errors can minimize and improve assets management and maintenance since staff able to scan the tags stick on assets. This will help to reduce the amount of time and effort that hospital staff must spend in gathering information about assets and among other things, the information obtained will be accurate and reliable.

The third objective of this project is to **keep track the real-time location of assets.** In hospital, the flow of people very complex due to hospital staff and patient or other people can go in and out hospital randomly. This situation will cause assets may steal by thief or hospital staff since the security in hospital not strictly prohibited. As a result, the monitoring system could help to keep track the real-time location of assets. This may be protected hospital assets avoiding stole by people and saving the hospital costs.

1.5 Organization of the Project

The details of this project are shown in the following chapters. In chapter 2, some related systems' backgrounds are reviewed. Then the system methodology is present in chapter 3. In chapter 4, the system design will be presented. In chapter 5, the system implementation will be presented. For chapter 6, system evaluation and discussion will be presented. Last but not lease, the conclusion will be presented in chapter 7.

CHAPTER 2 LITERATURE REVIEW

2.1 Review of the Technologies

2.1.1 Hardware platform

In this project, the main hardware using is the RFID portable mobile reader and UHF RFID tags. Review had been done on RFID portable mobile reader is C72 UHF RFID mobile reader and UHF RFID tags.

Figure 2.1.1.1 C72 UHF RFID mobile reader [3]

Based on [3], C72 mobile reader is an Android-based rugged RFID reader renowned for its superior UHF RFID performance. Equipped with the embedded Impinj E710 / R2000 chip, reading distances of over 30 meters in outdoor settings is achievable. Optional barcode scanning also offer in this devices, an Octa-Core processor, and a robust 8000mAh battery, making it ideal for demanding applications such as asset management, retail, warehousing, apparel inventory, expressway tolling, fleet management, and finance. Thus, this mobile reader will provide efficiency read and write tags smoothly.

Figure 2.1.1.2 UHF RFID tags [4]

Based on [5], there are many RFID tags without batteries and powered only through electromagnetic waves. Unlike barcodes, RFID tags do not necessitate a direct line of sight to be read. To manage multiple tags within the read area, each tag utilizes an “Anti-Collision” algorithm that helps in determining their sequence of response. Read range of RFID varies extensively among different types of tags ranging from several inches to over 120 ft. The Integrated Circuit (IC) incorporated in the tag has four memory banks which are EPC, TID, User and Reserved memory banks respectively. Furthermore, the antennae for each of these tags are accoutered differently to optimize reactance.

2.1.2 Programming Language

The programming language use to develop mobile applications on this project is Java language.

Java language is an object-oriented programming language that everything we declare or initialize will in the form of object with the reference of [6]. Programmer will easily extend the project or model since it is based on Object model. Mobile applications in Java was very popular because it was cross-platform development especially on android applications. Whenever programmer or developer wants update applications, Java always have the high scalability to extend the applications based on different situations.

2.2 Review of the Existing System

2.2.1 RFID for Monitoring System

RFID is technology used radio waves to track and identify a certain object. This technology was widely adopted into every sector especially in healthcare sector and manufacturing sector.

Based on [7], some of the private hospital in Malaysia and hospital in China starting implemented RFID monitoring system in their hospital in year 2008. Basically, this monitoring system is implementing to prevent baby thieves and identify patients' information for safety purpose since the human traffic in hospital very high every day. The monitoring system also be using in the hospital high-value moveable asset since the price of the asset was expensive and it will very easy be misplace, lost and stolen. Based on [8], the impairment loss of asset and goodwill for the fourth quarter end of Dec 31, 2022, was about RM 305.9 million in China during the pandemic Covid-19.

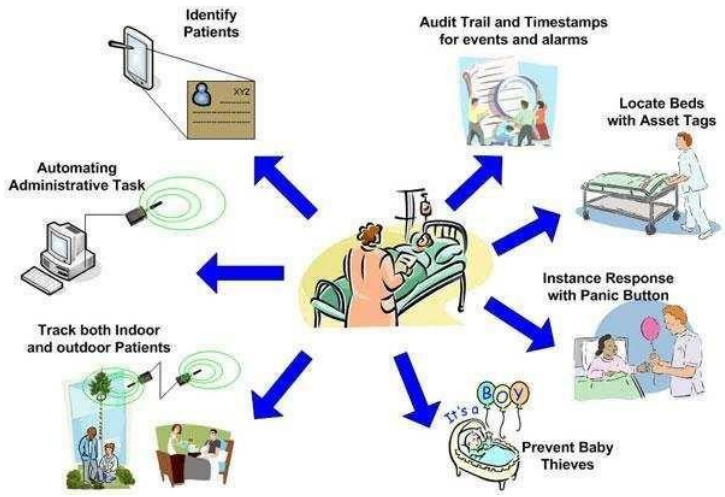

Figure 2.2.1.1 Reason using RFID Monitoring System [7]

RFID monitoring system have 4 main components like RFID tags, an antenna, RFID reader and computer database. This component was important to keep track the realtime location of the patients or assets of hospital. The asset or patient of hospital will be given a RFID tag with a unique ID number that contains their information. An

antenna will install in a place near to the RFID tags. RFID reader will wirelessly connect to the antenna and receive the signal RFID tags and receive the data stored in RFID tags. Then, the data will be send through the antenna to the database, thus it will be realtime tracking to the patient or asset.

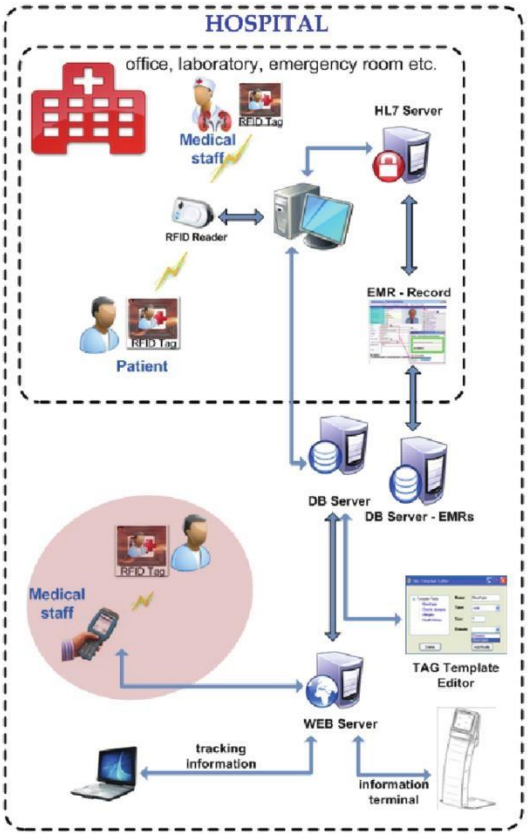

Figure 2.2.1.2 RFID Monitoring System Architecture [9]

There were some benefits using RFID monitoring system to keep track the assets for real-time. The advantages for using RFID monitoring system was efficiency and reduce cost through the automation. The data collection will be more convenience since it can be collected it wirelessly from the RFID reader and store it into the database. Additionally, it can reduce the loss of assets from stolen by theft. Within the RFID monitoring system, the cost of purchasing assets will be reduce.

2.2.2 Barcode for Monitoring System

Figure 2.2.2.1 Example of Barcode [10]

Barcode is ubiquitous in modern society that can be found in every product. Barcode is the data that is machinable read. The barcode is a parallel line with varying of lines used to entering the data. [10]

Based on [11], most of the e-commerce company like Lazada, Shopee in Malaysia, grocery shop, fashion retail shop also in logistics company will be using the barcode monitoring system to keep tracking their product. Barcode monitoring system is very convenience and efficiency to the staff without manually entering the data of product but using the barcode scanner to scan the barcode and store to the database. Most of the shop in shopping mall will be installing a warning machine to detect the theft from stolen the product. When a thief wants to steal a product, there have a machine to detect the barcode on the products and make the alarm warning. It can reduce the cost of losing from product.

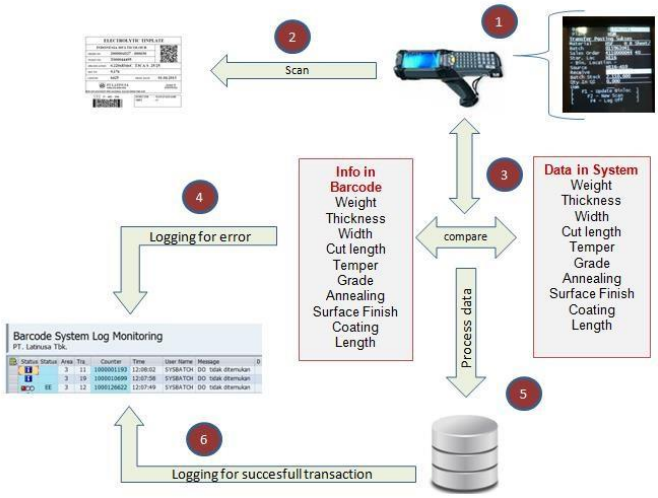

Figure 2.2.2.2 Barcode Monitoring System Architecture [12]

Based on [13], the barcode monitoring system need three main components like barcode scanner, barcode tags and computer with database. The barcode will store the data of products with unique ID number and stick with the products. Then, the barcode scanner will use an incandescent light bulb to shine the light. The barcode will absorb the light. The black line of barcode will absorb more light, while white line will absorb lesser light. The scanner will detect amount of light and convert to digital data. For example, the light barcode will be 1 and white code will be 0. After that, the binary code will be received and decode the data and store in the database.

Barcode monitoring system extremely similar with the RFID monitoring system. The major advantage of this technology is lower cost. Most of the barcode scanner can be purchase from the retail shop while barcode can be easily generated and print on the product. Another advantage for the barcode monitoring system is easily to store the information of data since all the information will store electronically on the computer rather than paper or plastic [14].

2.2.3 QR Code for Monitoring System

Figure 2.2.3.1 Example of QR Code on [15]

Quick Response Code (QR Code) is code that can be store significant amount of information compare with barcode. QR code is very popular use in e-wallet like Touch and Go e-wallet, WeChat Pay, Alipay etc. QR code very convenience and easy to generate since it can be scan by phone using the QR scanner from phone.

Based on [15], QR code also implement in healthcare sector since it was convenience to patient and public who need to use it. We know that most of the staff or professions in hospital smart in using smartphone, thus QR code become the solution of healthcare operation for reducing the cost and efficiency. Patient identity and information always the important and need to be secure for avoiding information stolen. Hospital at United States (US) provides the QR code allow staff or profession to keep track their healthcare journey. Additionally, assets monitoring also important to prevent the mismanagement of asset and jeopardize patient safety. Thus, the hospital asset will pair with QR Code for tracking the real-time location and convenience to use since it only need the QR scanner of the phone for checking.

Based on [16], QR Code Monitoring System, there only two main components needed that is a generated QR Code and a smart phone with QR Code Scanner. Data will be store in the unique QR Code. When we need to see the content of QR Code, we need to open the QR Scanner from the phone and scan the QR Code. Then, the database will be decoding the QR Code which is in binary form and sent the data back to smartphone and display to user.

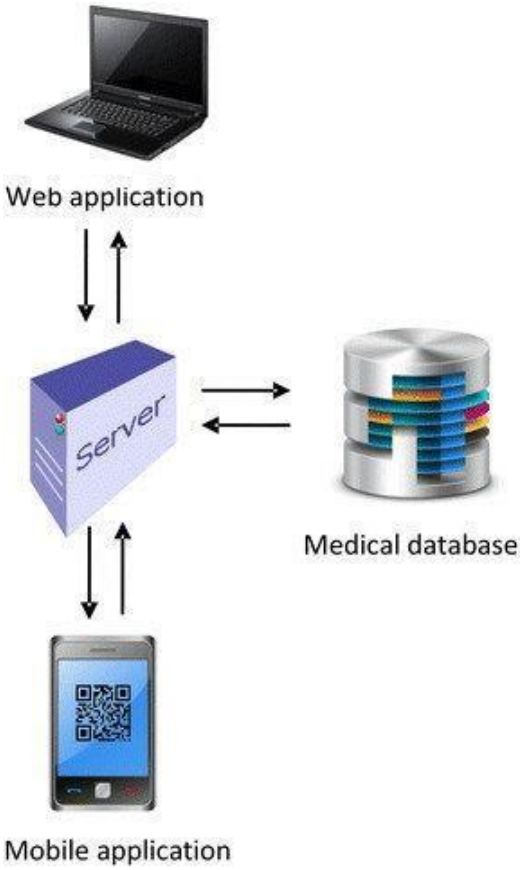

Figure 2.2.3.2 QR Code Monitoring System Architecture [17]

Most of the monitoring system will using the QR code monitoring system in different sector due to the convenience of the technology. The advantage of the QR code monitoring system was the system would be secure and protect the information of product or asset. When scanner scan the code, it will be decoding the QR code and then display the information of product or assets. Another advantages of QR code monitoring system would be ease for maintenance and repair. The QR code may easily to regenerated when the information consist it.

2.2.4 Comparison of Existing System

	QR Code for Monitoring System	**Barcode for Monitoring System**	**RFID for Monitoring System**
Reading Method	Scan using camera of smartphone or Code Scanner	Scan using a barcode scanner	Data transmit wirelessly to RFID reader
Technology Used	Two-Dimensional Barcode	Light reflection	Radio Waves
Data Storage	Few Bytes to Severa Kilobytes	Few Bytes to Severa Kilobytes	Few Bytes to Severa Kilobytes or more
Range and Interaction	Requires Close range between scanner and code	Requires Close range between scanner and code	Can be read from few centimeters until several meters
Cost and Complexity	Low cost and only need print on a paper	Cheaper, print unique code on asset	Expensive, RFID tags need specialized hardware for read and write
Speed	Low Speed	Fast Speed	High Speed
Security and Privacy	Can be easily replicated	Not Secure	Secure and data will be protected

Table 2.2.4.1 Comparison between QR Code, Barcode and RFID

Based on the table 2.2.4.1 and pervious work above, it was shown that the RFID is more preferring to using for the assets monitoring system for UTAR Hospital. RFID technology was very convenience to the hospital staff and help them to reduce their workload.

Chapter 3 SYSTEM METHODOLOGY

3.1 System Development Models

3.1.1 Waterfall Model

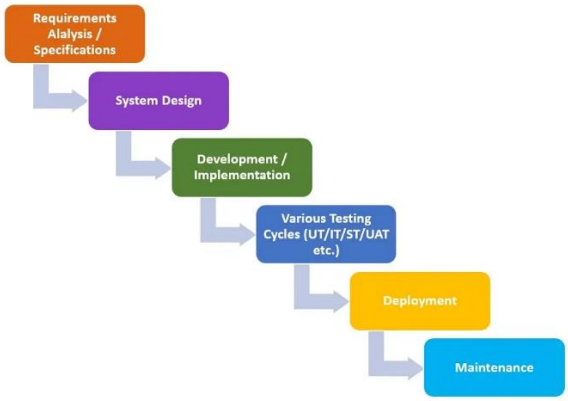

Figure 3.1.1 Example Waterfall Model [18]

Waterfall is a straight and rigid style of project management which shares its name with the notion of a waterfall. The various phases of the project are sequential that entails one stage to be completed before the other stage starts. This method focuses on the documentation of the requirements, the design as well as the features at the initial phase and with much attention to detail [18]. The methodology typically involves five main phases (Requirements, Design, Implementation, Testing & Deployment, Maintenance).

Advantages of Waterfall:

- **Structure and Predictability**: The detailed approach also means that project lasts are and costs are much easier to define.
- **Clear Documentation**: A push for a strong advance plan translates to well documented projects thus facilitating future reference in the case of maintenance.
- **Suitable for Specific Projects**: Pretty good for clearly outlined scopes, where the requirements are unlikely to change much, like construction of the infrastructures.

3.1.2 Agile Model

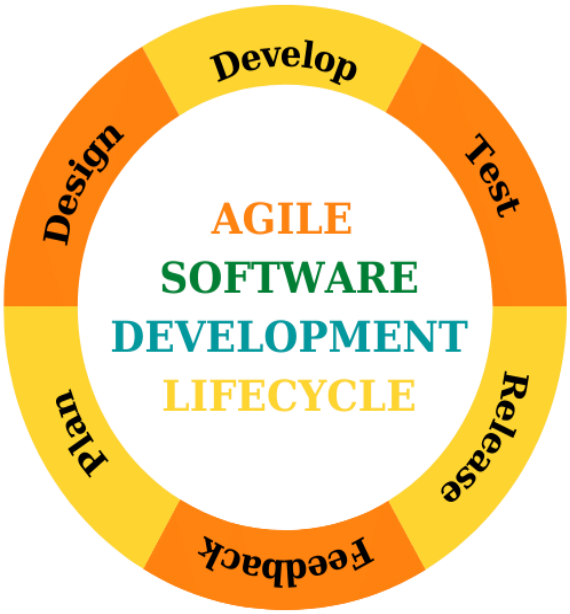

Figure 3.1.2 Example of Agile Model [19]

Agility is a method of managing projects based on their progressive improvements that are characterized by collaboration between multi stakeholders. It puts great value in adaptability, customers, and in small and frequent updates that would enhance productivity and the quality of the product. Although Agile is used primarily in software development, it can be implemented in any industry. Some of the principles include customer satisfaction, being open and receptive to change, delivering working software on a regular basis and practicing sustainability [20]. The methodology will involves six main phases (Plan, Design, Develop, Test, Release and Feedback).

Advantages of Agile:

- **Intermediate Feedback:** Convenience to developer for improving their project whenever receive feedback.
- **Time-Efficient:** It is well-suited for its time-efficient practices, which help in delivering software quickly and reducing time-to-market.
- **Frequent Changes:** It effectively manages and accommodates frequent changes in project requirements according to stakeholder convenience.

3.1.3 DevOps

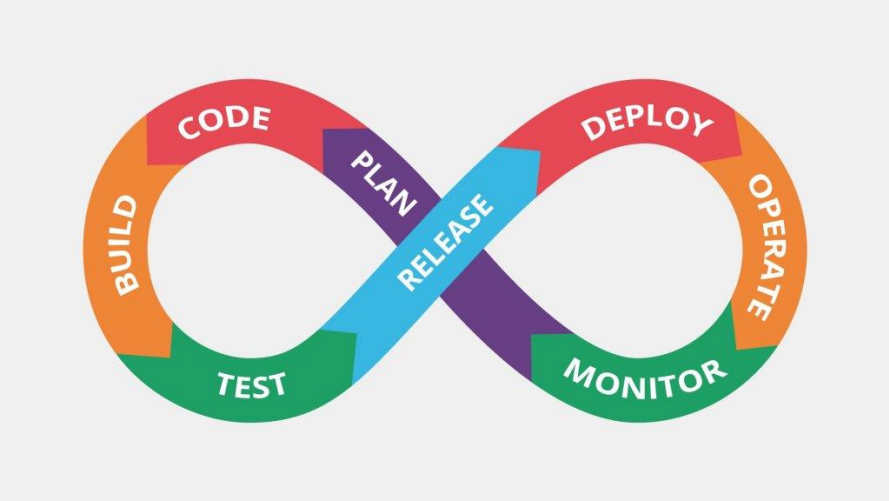

Figure 3.1.3 Example of DevOps Model [21]

DevOps is an approach to software development that focuses on the collaboration of the development and operations teams to improve what is known as the 'dev/ops divide'. It is based on the principles of continuous integration, continuous delivery and automation testing, which makes it possible to provide high frequency and stability of the software releases [22]. DevOps promotes a culture of collaboration and ownership with an emphasis on reducing the development cycle and increasing the software's quality and speed to market. This methodology will involves in eight phases (Plan, Code, Build, Test, Release, Deploy, Operate and Monitor).

Advantages of DevOps:

- **Faster and easier releases:** DevOps enables organizations to release improved and more frequent updates while reducing the risks involved.
- **Increased Efficiency:** Automation of repeated tasks like testing, deployment, and monitoring avoids manual errors and work on the more important activities.
- **Increased security:** It is to be noted that testing and monitoring are better implemented through DevOps practices.

3.1.4 Kanban

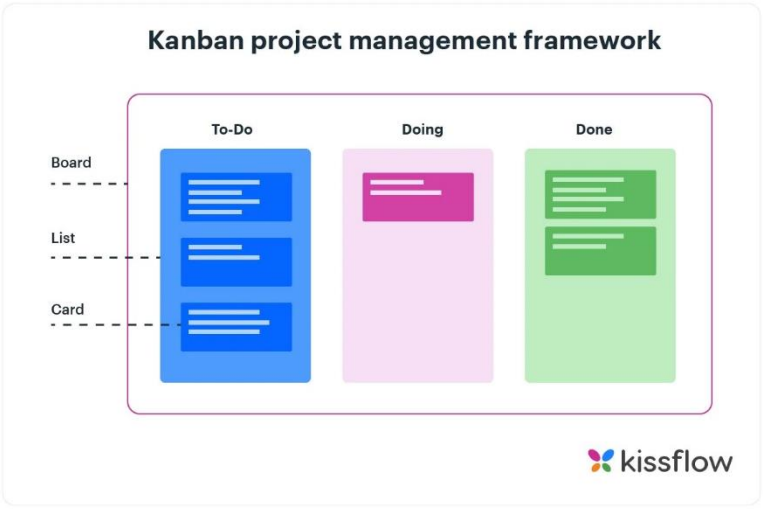

Figure 3.1.4 Example of Kanban Model [23]

Kanban is a work management model based on the visualization of work and managing that work as a process rather than a set of tasks. Starting with lean manufacturing, Kanban utilizes a board with columns that are labelled according to a process, for instance, To-Do, In-Progress, Done, among others, and with tasks represented by cards which move horizontally across the columns [23]. The Kanban principles are- creating a visual system, defining and bounding WIP, understanding flow dynamics, standardizing work, and continuously defining, measuring, and refining.

Advantages of Kanban:

- **Enhanced Flexibility:** Allows tasks to be added or to change their priority on the go. This makes it suited for environments with ever-changing requirements.
- **Continuous Improvement:** The work in progress is evidenced on the Kanban board and the flow metrics help a team notice areas of improvement or inefficiencies.
- **Increased Collaboration:** Promotes the level of openness within teams as all the processes are established on the board that is accessible to all members.

3.1.5 Selected Model

After review all the system development method, DevOps will suitable to be using in this project. In the initialize stage, plan and code should complete in this stage to prevent the project out of project scope and overtime. After having the scope and requirements, project team would start to build, test and release to achieve the best result in the projects. In the final stage, the project will deploy and monitor by developer to handling any issue on the project. This model is quite faster and easier to having update whenever getting the feedback. This model will be used in the lifecycle until the project ended.

3.2 Technology Requirement

3.2.1 Hardware

The hardware involved in this project is a laptop for developing mobile application and access the user interface for asset monitoring or assets tracking, RFID mobile reader will be used for reading the RFID tags and store data into database and RFID tags will be embedded, sewn or heat sealed for asset tracking .

Figure 3.2.1.1 Huawei Mate book 14 [24]

Description	Specifications
Model	Huawei Mate Book 14
Processor	AMD Ryzen 5 4600H
Operating System	Windows 11
Graphic	Radeon Graphics
Memory	16.0 GB
Storage	512 GB

Table 3.2.1.1 Specifications of laptop

Figure 3.2.1.2 Chainway C72 RFID mobile reader [3]

Description	Specifications
Model	Chainway C72 RFID mobile reader
Operating System	Android 8.1; Soti Mobile Control
Expansion	Support to 128 GB Micro SD card
RAM + ROM	3 GB + 32 GB / 4GB + 64 GB

Table 3.2.1.2 Specifications of Chainway C72

Type	embed	Stitch	Hot seal
Base Model Number	6F8991-001	6F8990-001	6F8992-001
Operating Frequency	860-960 MHz (worldwide)		
Chip Type	MONZA M5		
Memory	128-bit EPC		
Reading Distance	Up to 23 ft (7 m)		
Size	64 × 22 mm	64 × 28 mm	64 × 22 mm
Thickness	1.7 mm at module, 0.9 mm over rest of tag		
Mounting Method	Sew into pouch	Stitch onto fabric	Apply via heat-seal

Table 3.2.1.3 Specifications of RFID tags

3.2.2 Software

In the software part, the important software will be use is Android Studio. This software very powerful since it can support Java, Kotlin and other plugin programming languages for developing a complete mobile application.

For the database, Frappe server would be used as database to store and retrieve the assets information. In the other hand, Frappe server also provides interfaces that allow user to monitoring real-time locations of assets.

3.3 Functional Requirements

In this project, scanning function on RFID mobile reader was the most important function. Without the scanning function, RFID mobile reader cannot capture the PC number from RFID tags. In the developed application, scanning function involves auto and single scanning function. Auto scan will allow user to scan RFID tags as many as user wanted until user wanted to stop. Single scanning function allow user to scan one RFID tags one time.

After scanning the tags, user allow to upload data to database for recording the data. Thus, Frappe server was needed to store the information of RFID tags and the transaction of daily checking of assets for keep tracking the location of assets efficiency. Frappe server also needs to configure to allow application to have the authorization to log in to server.

User also needs monitoring system to keep tracking the location of assets. Users allow to design the interface in the frappe server to monitoring the records of assets. The record was very important when assets was disappear to allow users to trace back the assets efficiency.

3.4 Project Milestone

Task Description	Start Date	End Date	Week													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
FYP 1	**17/06/2024**	**20/09/2024**														
Project Analysis	**17/06/2024**	**28/07/2024**														
Determine Objective of Project	17/06/2024	30/06/2024														
Research project information	01/07/2024	07/07/2024														
Find documentation of hardware	08/07/2024	21/07/2024														
Design the flow of system	22/07/2024	28/07/2024														
Determine hardware and software used	22/07/2024	28/07/2024														
Project Development	**29/07/2024**	**25/08/2024**														
Get familiar with hardware	29/07/2024	04/08/2024														
Develop reading function	05/08/2024	18/08/2024														
Develop user interface	19/08/2024	25/08/2024														
Project Testing	**26/08/2024**	**20/09/2024**														
Test reading function in hardware	26/08/2024	08/09/2024														
Test user interface	09/09/2024	20/09/2024														

Table 3.4.1 Final Year Project 1 Milestone

Task Description	Start Date	End Date	Week													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
FYP 2	**10/02/2025**	**16/05/2025**														
Project Revising	**10/02/2025**	**30/03/2025**														
Review for FYP 1 process	10/02/2025	16/02/2025														
Redesign authentication	17/02/2025	23/02/2025														
Design login Page	24/02/2025	01/03/2025														
Improving all the function	02/03/2025	16/03/2025														
Improving application interface	16/03/2025	30/03/2025														
Project Testing	**31/03/2025**	**16/05/2025**														
Testing connection with server	31/03/2025	12/03/2025														
Testing all the improved function	12/02/2025	03/05/2025														
Testing all the possible error	04/05/2025	16/05/2025														

Table 3.4.2 Final Year Project 2 Milestone

3.5 Concluding Remarks

In this chapter, there have 4 system development methodology discussions which is Waterfall, Agile, DevOps and Kanban methodology. After the comparison of methodology, DevOps methodology is the most suitable methodology to use in this

project. Then, hardware and software also discuss in this chapter. Last, milestone of final year project 1 also been recorded in this chapter.

Chapter 4 STSTEM DESIGN

4.1 System Architecture

Figure 4.1 System Architecture

In this project system architecture, there are 4 main components involves in this system, which is RFID tags, RFID mobile reader, Frappe server and Pc.

First, RFID tags will stick on the assets and allow user to using RFID mobile reader to scan the tags. Then, the RFID mobile reader will display the information of RFID tags that retrieve from server on the application developed. When user need register RFID tags, the tags will be labelled and store the information to the server side.

On the PC side, user allow log in to the server interface to keep track the assets' real-time location. Users allow to design their user interface to showing the important information of assets on Frappe server interface.

4.2 Functional Model in System

Before the user start to use the application, the user will proceed to the login page. The user needs to key in their username and password for authentication checking. If the user does not pass the authentication check, user needs to enter again their correct username and password. For user success pass the authentication, user will proceed to the main page of the application.

There were two main functions in the system which is register tags and read tags function. As all the RFID tags needs to store information as a records, the application allow user to register RFID tags by labelling types and location of RFID tags. This function was very convenience and efficiency for user since they no need to key in the information of assets one by one into server. This will hep the user to saving their time and decrease the risk on information error.

Second main functions is read tags function. If the user needs their daily checking on the assets, the read function also very effectively to user that allow them to check the asset and application will display the information of RFID tags in a list form after scanning RFID tags. Thus, user no need to comparing the RFID tags and information of tags in a piece of paper.

After the read function, there have three sub functions, there is daily checking, remarks and dispose function. For the daily checking function, user will select all the information such as block, floor, location and department. Then, the user will submit one daily checking list to the server. Meanwhile, all the information of the RFID tags will updated to the server simultaneously. Daily checking function allows the nurse or staff in hospital for handle the assets checking every day. This action will increase their working efficiency and save a lot of time.

After the daily checking function is complete, it will proceed to remarks function. User will select the assets where the assets presence with the issue. After that, the user will enter the remarks that are needed based on the situation and submit them to the server. The RFID tag will change their status to remark assets. There will also save a record to the remark list in server. This remark's function allows the user to add the remarks to the specific assets if the assets consists of any physical issue. It will very useful to tracking all the problem assets and liable to deal with the asset.

Finally, the third sub function is the dispose function. Same with daily checking functions, user will allow to select the assets that need to be disposed of if the assets is really broken and can't be repair. The RFID tag will be marks as the pending dispose status and need confirm by the administrator, If the assets confirm to be dispose, it will been deleted from the assets list and exist in dispose list for future tracking.

4.3 System Flow

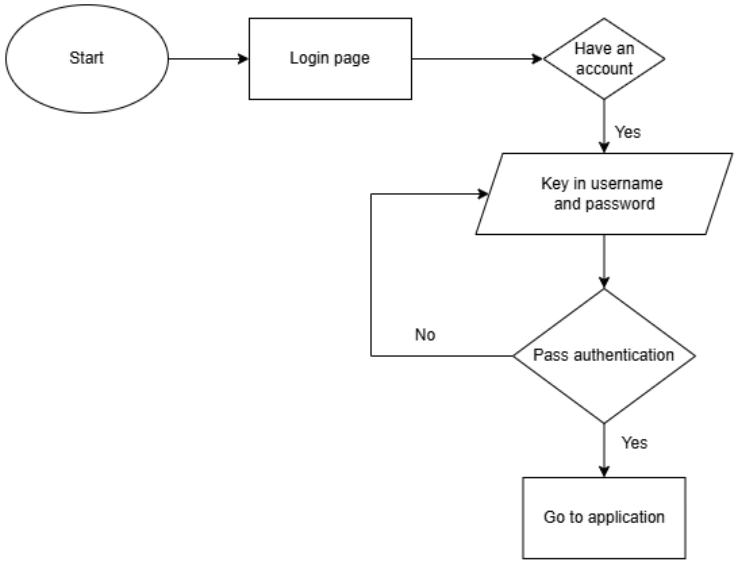

Figure 4.3.1 Login System Flow

Figure 4.3.1 shows the flow of the login page of the application. Before the user start to use the application, the user will proceed to the login page. For user did not consist of an account, user need to ask the IT department or administrator to create an new user account. If a user has the login account, the user needs to key in their username and password for authentication checking. If the user does not pass the authentication check, user may enter a wrong username and password. In this situation, users need to enter again their correct username and password. For user success pass the authentication, user will proceed to the main page of the application.

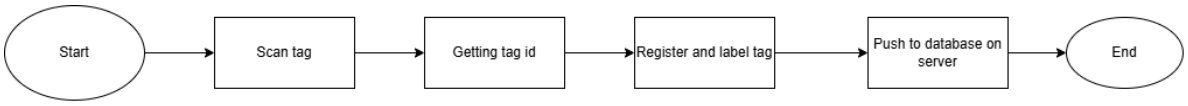

Figure 4.3.2 Register Function Flow

When the application starts, user allow to choose what function needs to be proceed for their purpose. If user choose register function, user will scan the tag which the tags haven't register and EPC number of tags will be showing in the mobile reader. The user will allow to label the RFID tags as a record and user will store the information to the database of the server.

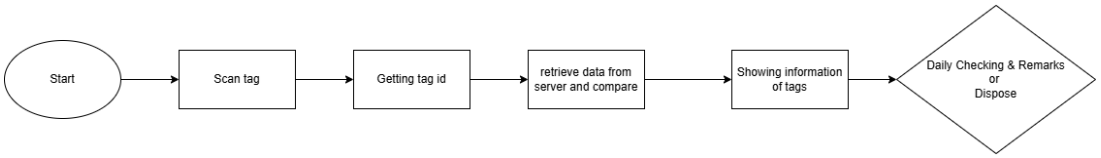

Figure 4.3.3 Read Function Flow

While user choose read tags function, user will allow to scan the RFID tags for checking purpose. When the scanning process is done, the application will retrieve data from server and compare the scanning RFID tags to show the information of RFID tags. Then, the information of RFID tags will be shown in mobile readers that allow user to proceed to daily checking purpose. After completing the information of RFID tags, user will choose daily checking & remarks or dispose function.

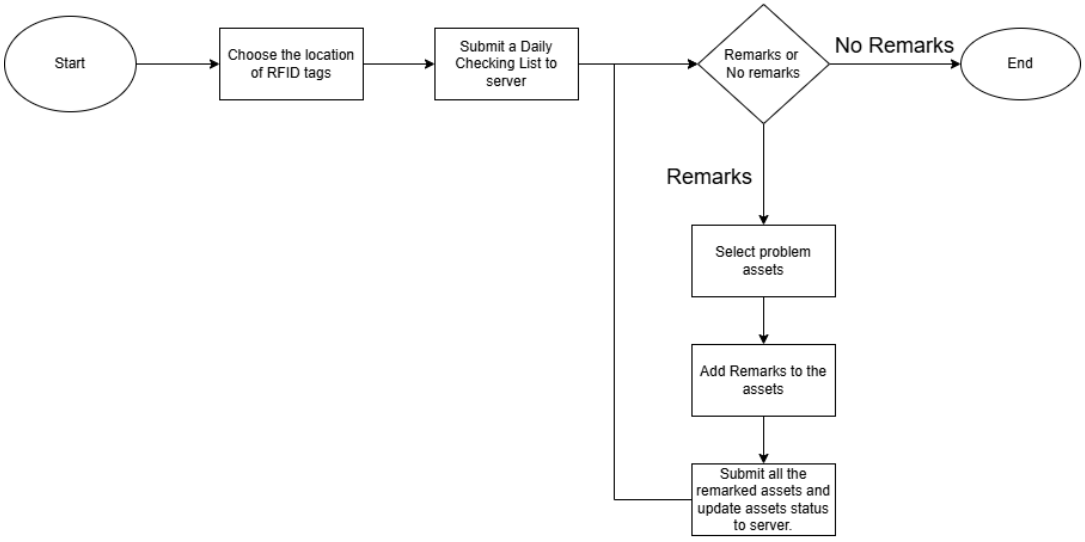

Figure 4.3.4 Daily Checking and Remarks Function Flow

While users choose daily checking & remarks function, it will proceed to the location labelling page. Users need to choose the correct details of location based on where the RFID tags were located. After choosing all the details, users will submit one daily checking list to the server. Meanwhile, users also will update all the location information of RFID tags which have been scanned to server. Then, users will proceed to remarks function. Users allow to choose RFID tags that have issue and add remarks for them. All the remarks will be saved as an record and upload to the server. Meanwhile, the status RFID tags also will be updated to pending remarks status.

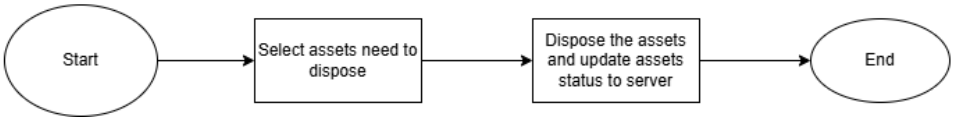

Figure 4.3.5 Dispose Function Flow

If user choose dispose function, user will allow to dispose the RFID tags that have been scanned. User will select all the RFID tags need to be dispose and submit to the server. All the dispose RFID tags will save as record and upload to server. Meanwhile, the status of RFID tags also will update to pending dispose status.

4.4 GUI Design

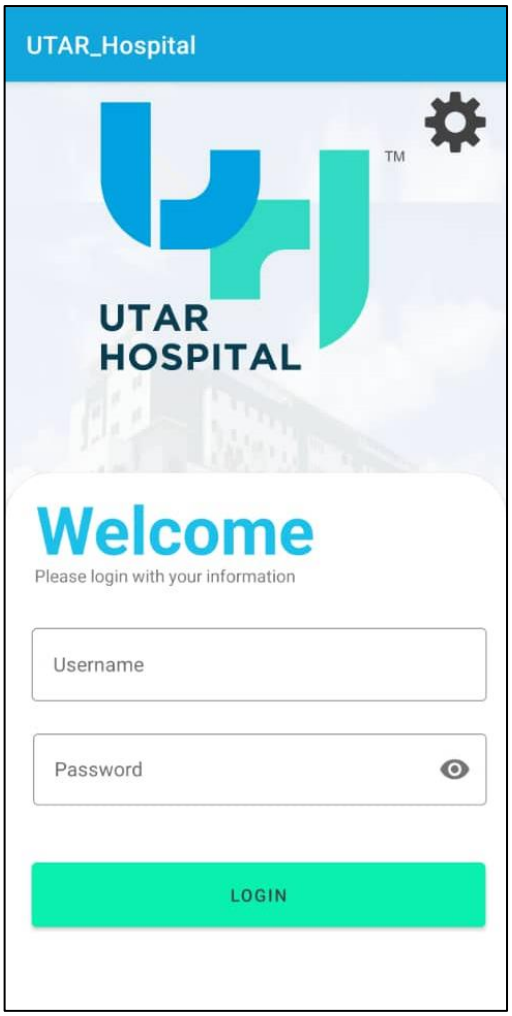

Figure 4.4.1 Login Page

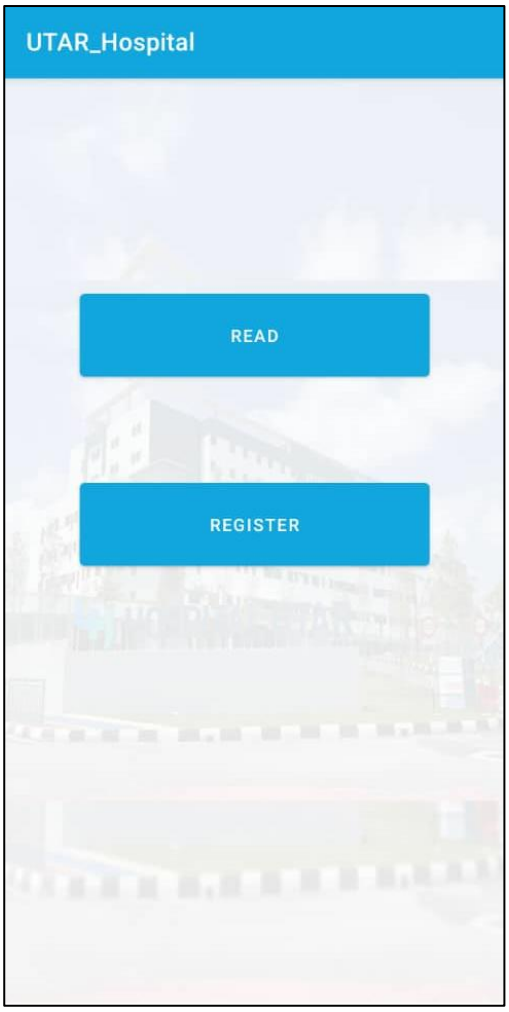

Figure 4.4.2 Main Page

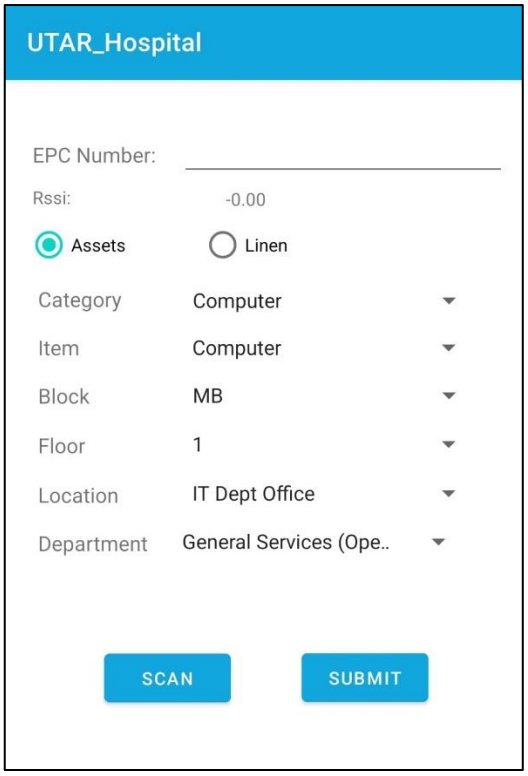

Figure 4.4.3 Register Page

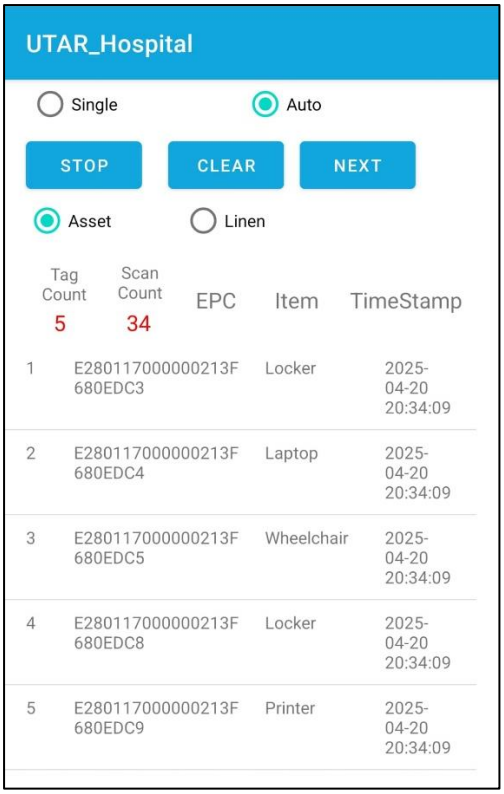

Figure 4.4.4 Read Page

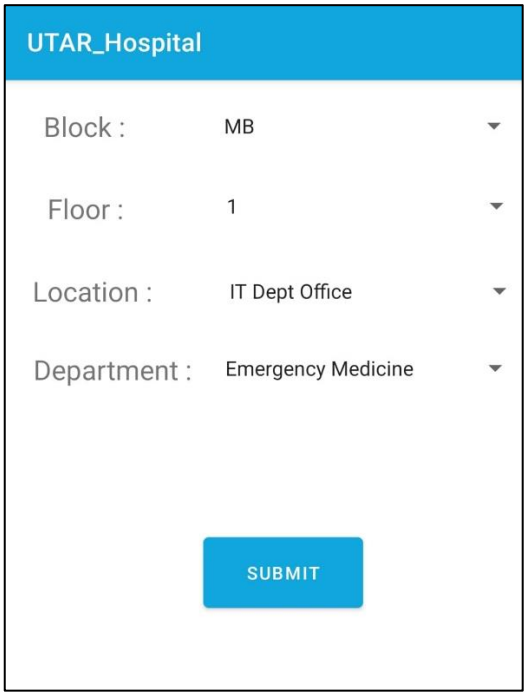

Figure 4.4.5 Daily Checking Page

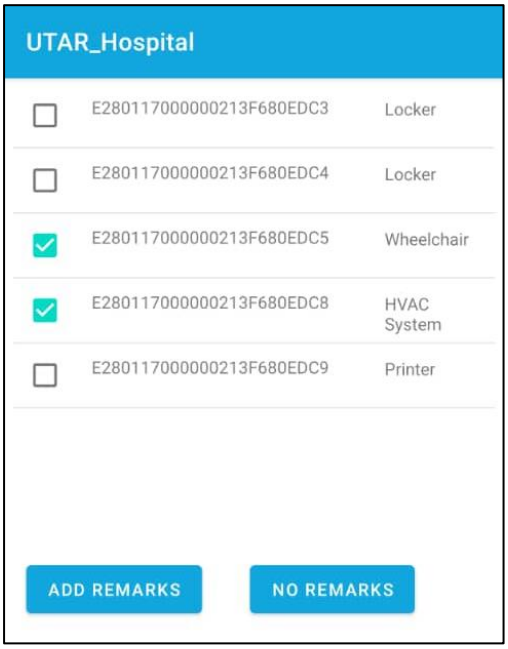

Figure 4.4.6 Remarks Page

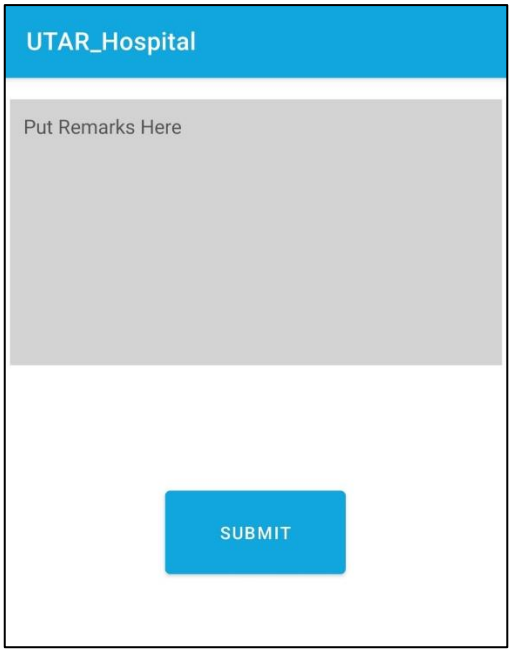

Figure 4.4.7 Add Remarks Page

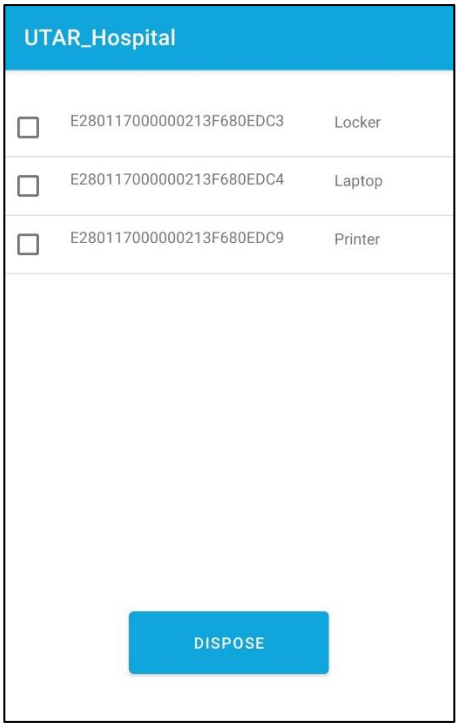

Figure 4.4.8 Dispose Page

4.5 Concluding Remarks

In this chapter, system architecture and system flow were discussed. The discussion of the system architecture and system flow showed the connection between the server and application. Discussion about system flow was showing to allow user have the concept on how to operate the application. Last, the GUI design of the application also showing in this chapter.

Chapter 5 SYSTEM IMPLEMENTATION

5.1 Hardware Setup

In hardware setup, there are three parts needed to prepare:

1. **Laptop**
2. **RFID Mobile Reader**
3. **RFID tags**

First hardware needed is laptop. In this project, laptop is provided a large distribution to handle all the data and database for user. Laptop needed to power on and the server in the laptop also need to run in laptop for allowing user to create, read, write and delete data from the server. Meanwhile, the laptop must connect to the hospital local network that allow the user to view the website page of the server.

Second hardware is RFID mobile reader. RFID mobile reader is the important hardware to allow user to complete the RFID tag scanning part. The RFID mobile reader needed to power on in a good condition. Meanwhile, the reader also need to connect to the hospital local network which the server connects to. Thus, the reader could connect to server to fetch, update and write data to the server. After the setup, the mobile application needs to install to reader via cable or download online. The first way is the reader will connect to the application develop software, Android Studio via a USB cable. Then, user can click run application on Android Studio in the laptop. The mobile application will be installed in RFID mobile reader and user can unplugged the USB cable. Second way is installed mobile application via online. Create an APK file and upload or commit to play store, then download the application and install in RFID mobile reader.

Third hardware is RFID tags. The tags must be sealed on the assets of the hospital to allow the user can scan the tags for getting the RFID tag's information. User need to confirm the RFID tags consist with all the information of the assets. If there were empty or wrong information, user need to use mobile application to register the assets information or change the information.

5.2 Software Setup

There was only one software use in the project is the mobile application that need to install in the RFID mobile reader. First, need to confirm that the mobile application did not consist of any bug and error that affect the mobile application. Then, After the setup, the mobile application have two ways to install to reader via cable or download online. The first way is the reader will connect to the application develop software, Android Studio via a USB cable. Second way is installed mobile application via online. Create an APK file and install in RFID mobile reader.

5.3 Setting and Configuration

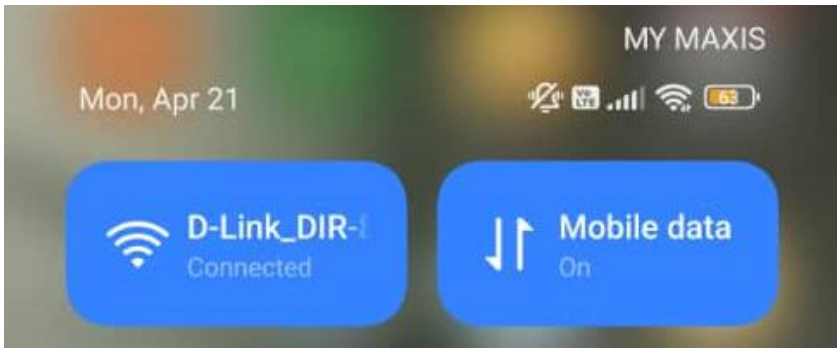

Figure 5.3.1 Wi-Fi connection

Since the application need to connect to the server, user need to connect the RFID mobile reader to the access point that connect to the server.

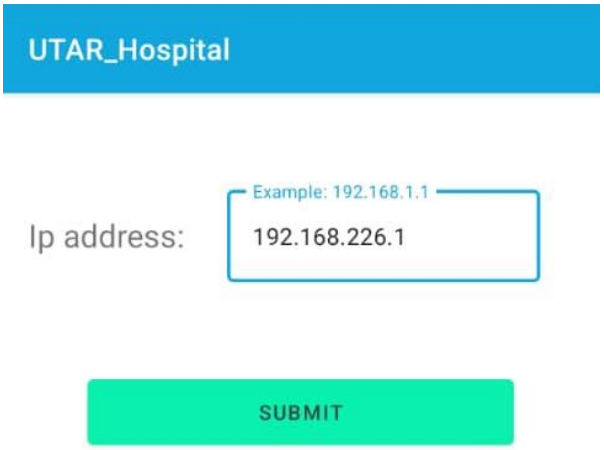

Figure 5.3.2 Setting Page

Then, user should go to the application and click the setting icon on the upper right icon of login page. After that, user should enter the correct IP address of the server and submit to check whether the IP address could access the server.

5.4 System Implementation

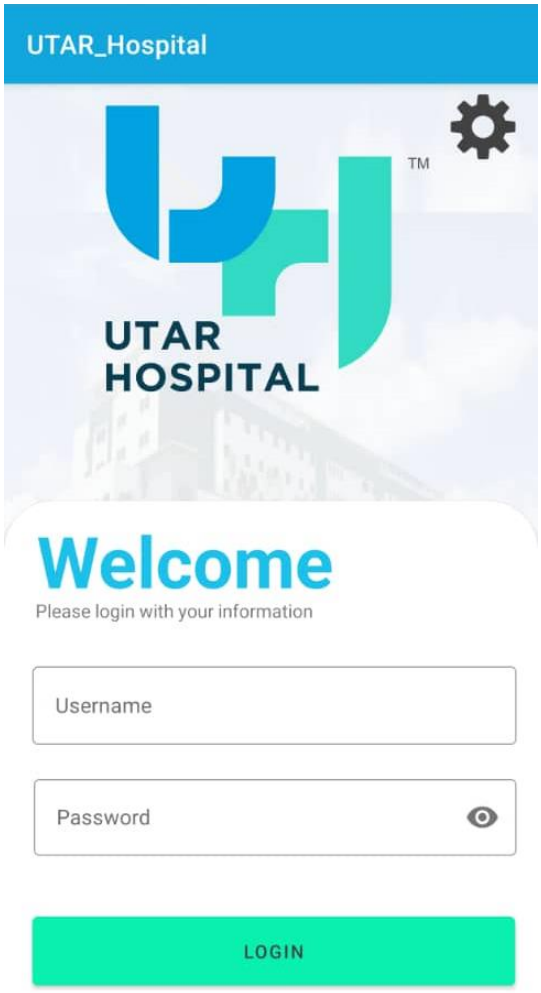

Figure 5.4.1 Login Page

After all the configuration, users need to enter their username and password to login to the application. If successful login, user will go to main page of application.

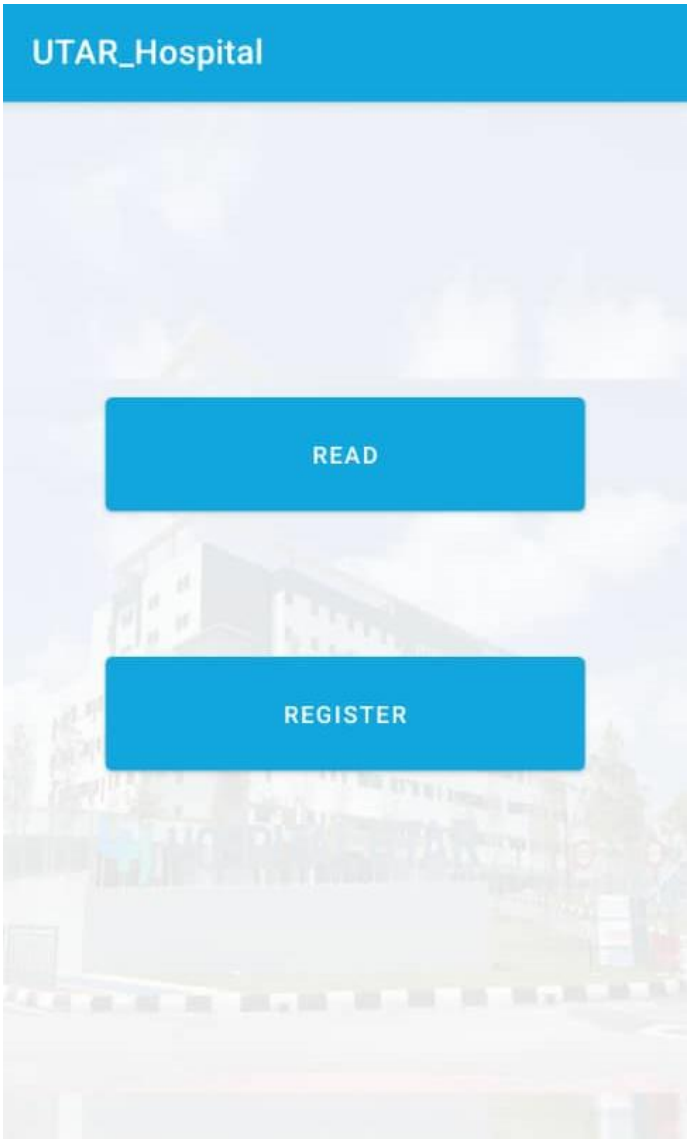

Figure 5.4.2 Main Page

If user login successful, it will show main page. User can choose either **Read** or **Register** to proceed.

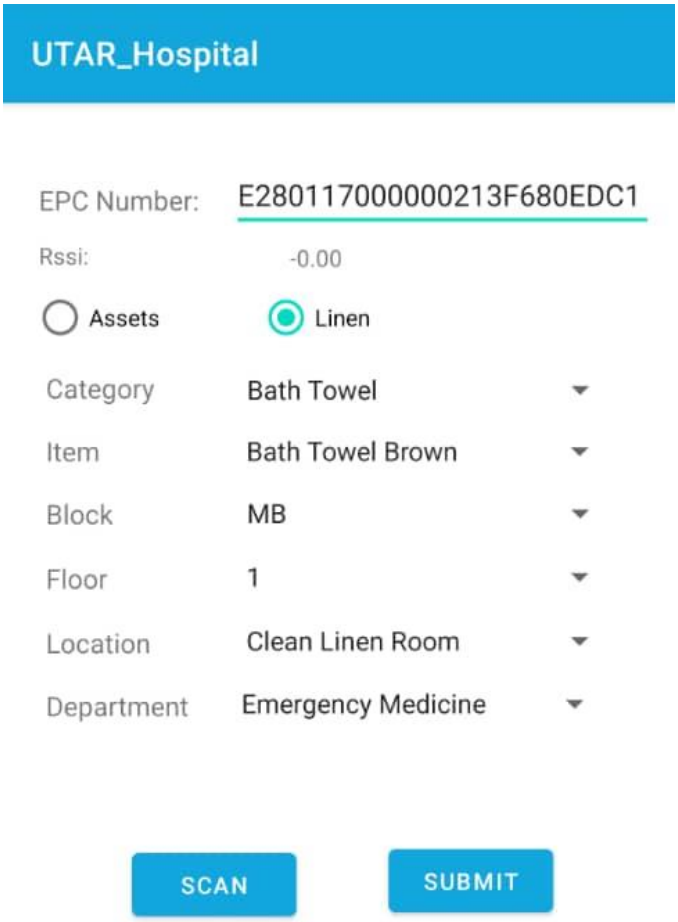

Figure 5.4.3 Register Page

When user choose to register, user will proceed to the Register page. Before press the scan button, user need to select whether the item register as asset or linen. Then, user need to scan the tag, and the tag EPC number will show same as the figure above. If the tag is registered before, it will not show the EPC number. After finish scanning, user should select all the correct information for the RFID tags for their labelling. After finishing all the step and confirm, user can press submit button to register the item and upload to the server.

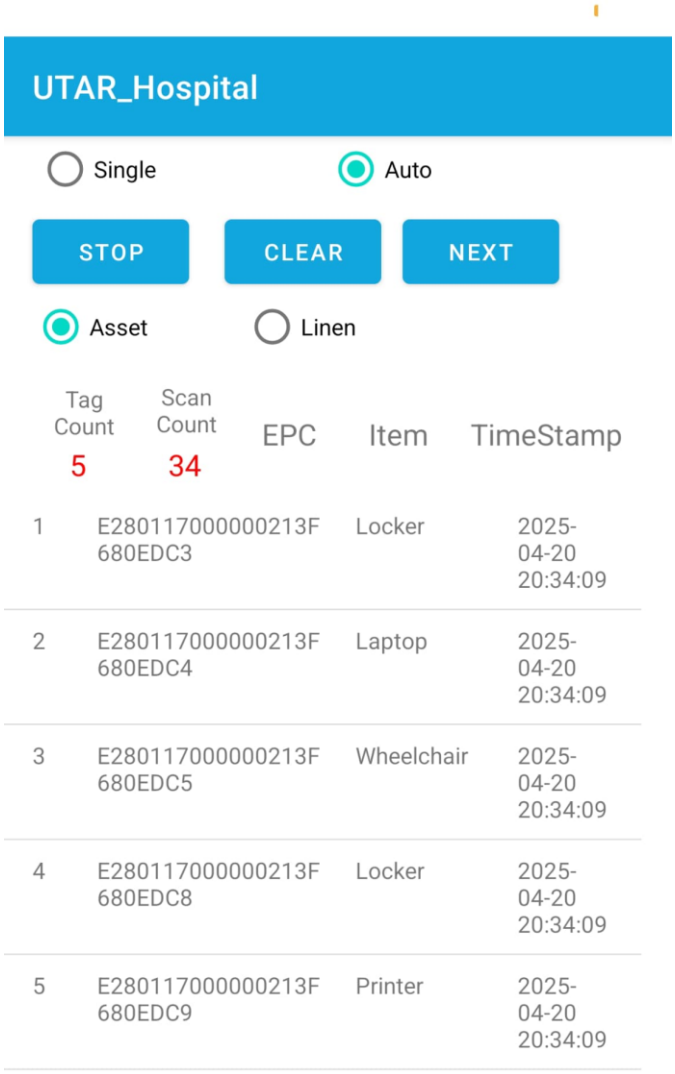

Figure 5.4.4 Read Page

If user select read Page, user will proceed to the read function. In this page, there have two group of radio Button. First group is single and auto button. User can select whether to use single or auto button. If select single button, when user click scan, it only scan one tag once a time. If select auto button, when user click scan, it will scan automatically until user click stop button to stop the action. This function will allow users flexible to choose based on their situation. The second group of radiao button is asset and linen button. Before start to scan, user need to select whether linen or asset need to be scan for the item. This is because the system need to retrieve data from the server and show the RFID tags information in the application.

After select all the radio button above, user can start to read the RFID tags information. If user choose the auto mode, it will perform the scan and stop button. User need to press scan button to scan the tag and press stop to stop the scan action.The scanning result will shown as list same as the figure above. The clear button is allow user to clear all the scanning result if user scan wrongly or need to reset the scan result. Last but not least is the next button. After complete the scanning and no any error, user can press next button to next step.

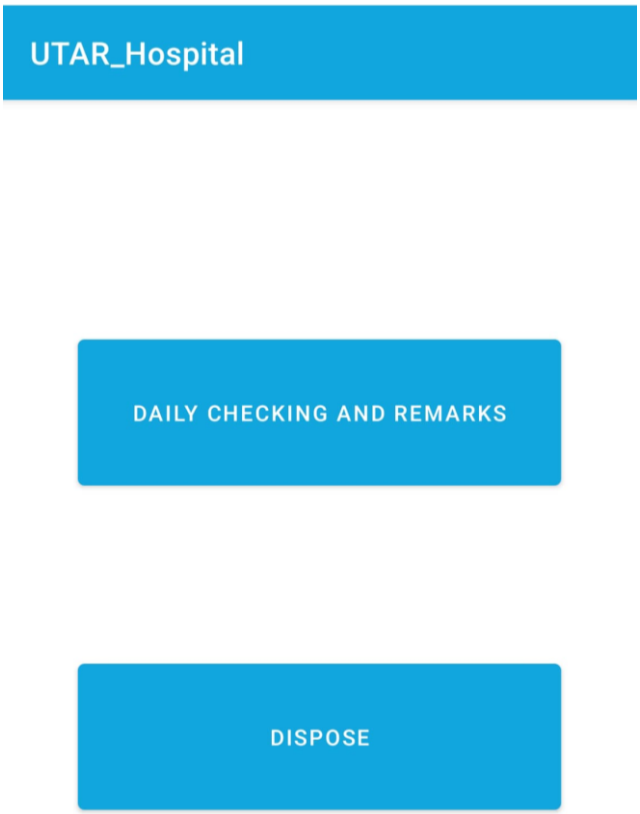

Figure 5.4.5 Select Page

Then, users need to proceed to Daily Checking and Remarks or Dispose.

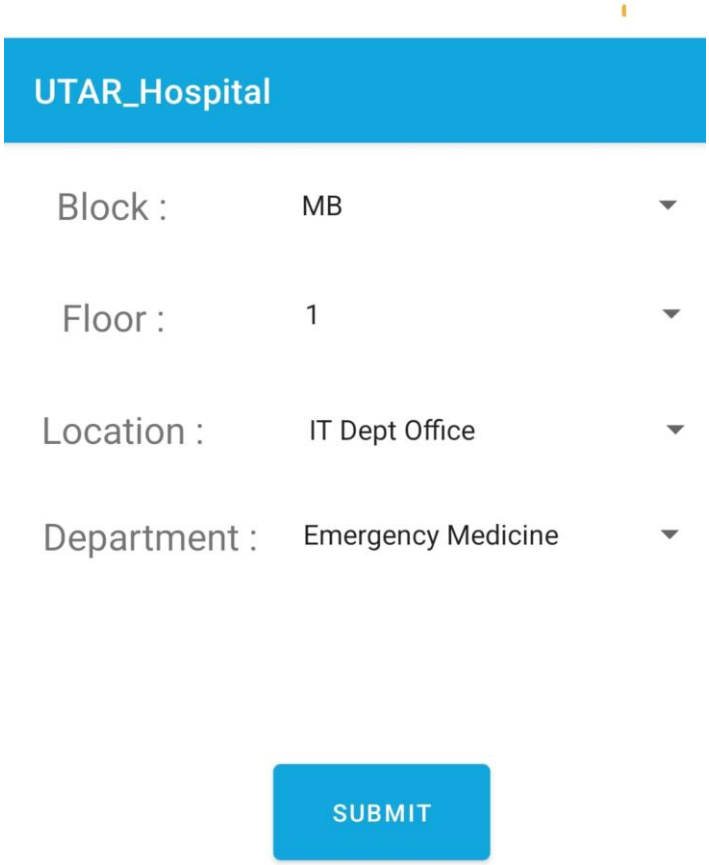

Figure 5.4.6 Daily Checking Page

If user select Daily Checking and Remarks, user will proceed to this page. Users need to select all correct information and press Submit button to submit to server.

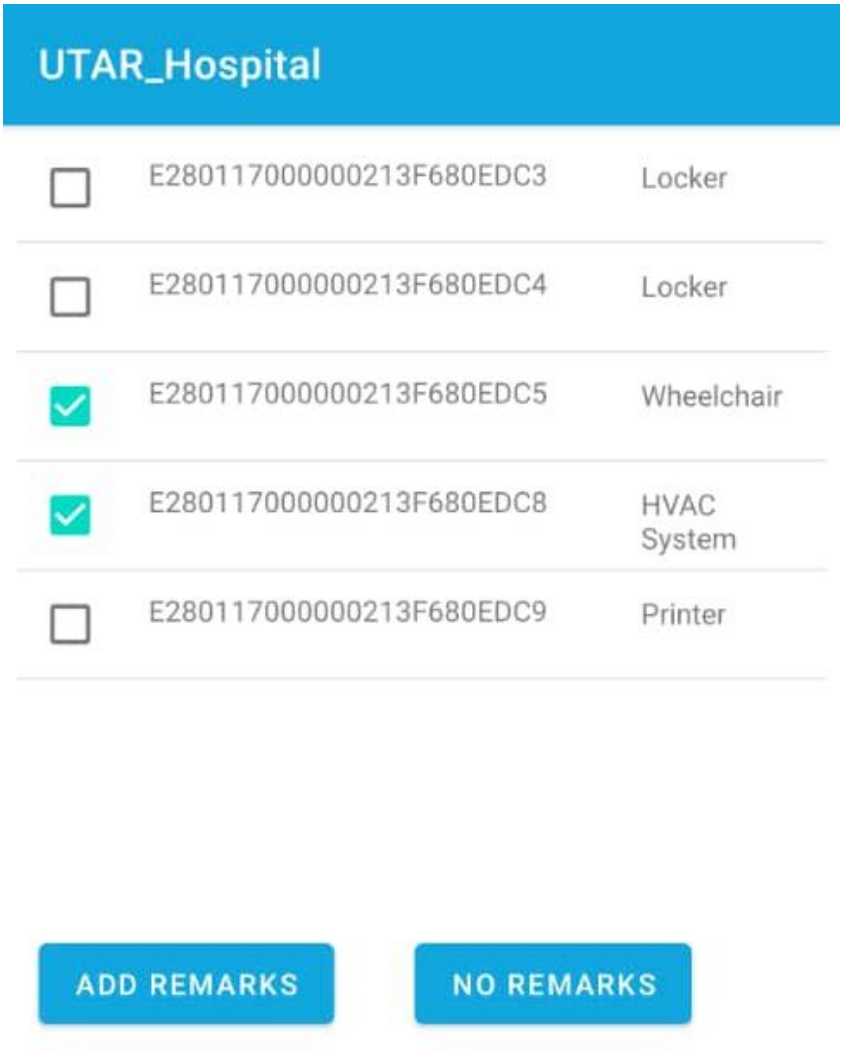

Figure 5.4.7 Remarks Page

After submitted, user now will proceed to Remark page. If there is no remark for asset or linen, user can just press No Remarks and finish the procedure. If asset or linen have problem and need to remark, user need to press Add Remarks to add remarks for the asset.

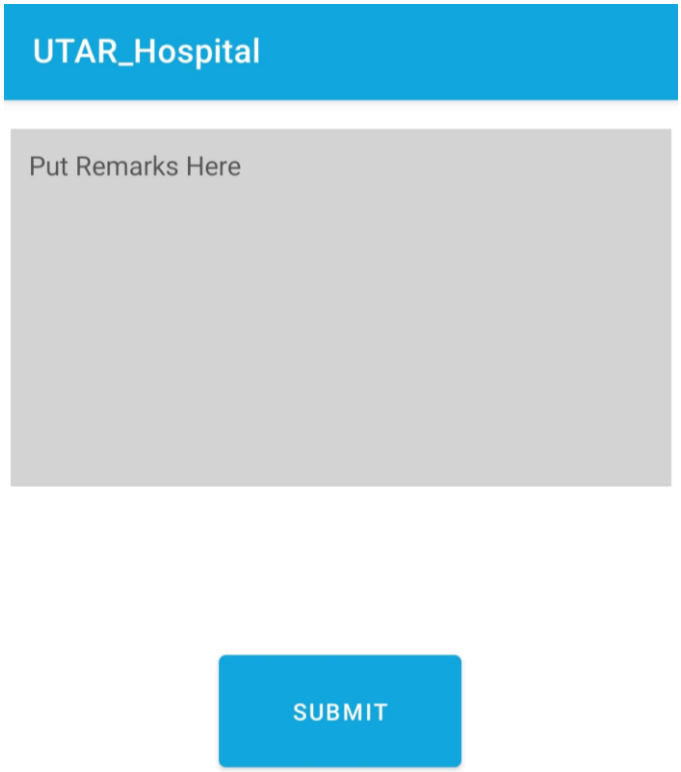

Figure 5.4.8 Add Remarks Page

Now, user can enter the remarks on the text box. After entering, press Submit button to submit the remarks to server.

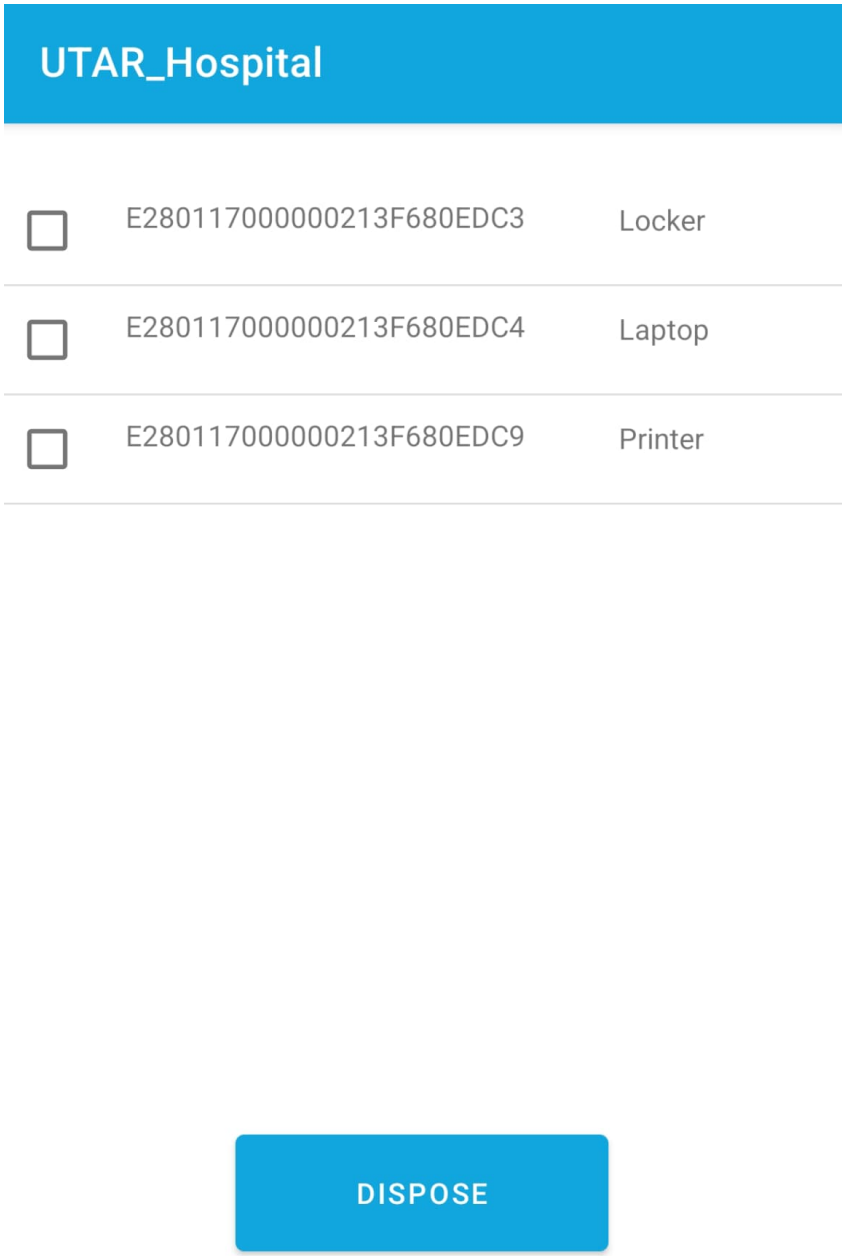

Figure 5.4.9 Dispose Page

If user select dispose after read page, user will proceed to Dispose page. In the dispose page, user can select whether which asset or linen that need to dispose. After select item, user need press Dispose button to dispose the asset or linen. The dispose asset or linen will submit and upload to the server.

5.5 Concluding Remark

In this chapter, hardware setup, software setup, setting and configuration and system implementation has been explained.

Chapter 6 SYSTEM EVALUATION AND DISCUSSION

6.1 System Testing and Performance Metrics

In this chapter, system testing and performance metrics are needed after the mobile application is developed. For the system testing, it can be performed to test all the mobile application's features working correctly without any bug. For the expected performance metrics, there are few performance metrics needed to measure such as:

1. Connection to server testing: The testing will test the system whether it could connect correctly to server for create, read, update and delete purpose.
2. Login feature: The testing will test the system whether the system could authenticate and authorize the user correctly based on their permission.
3. Scanning feature: The testing will test whether the scanning function can correctly scan the RFID tags and display the information on the application.
4. Response time: The metric measures the time of the system responds the information to the user.
5. Accuracy: The metric use to measure the accuracy of number of tags have count by mobile reader with number that have been recorded in the server.

6.2 Testing Setup and Result

1) Server Connection Testing

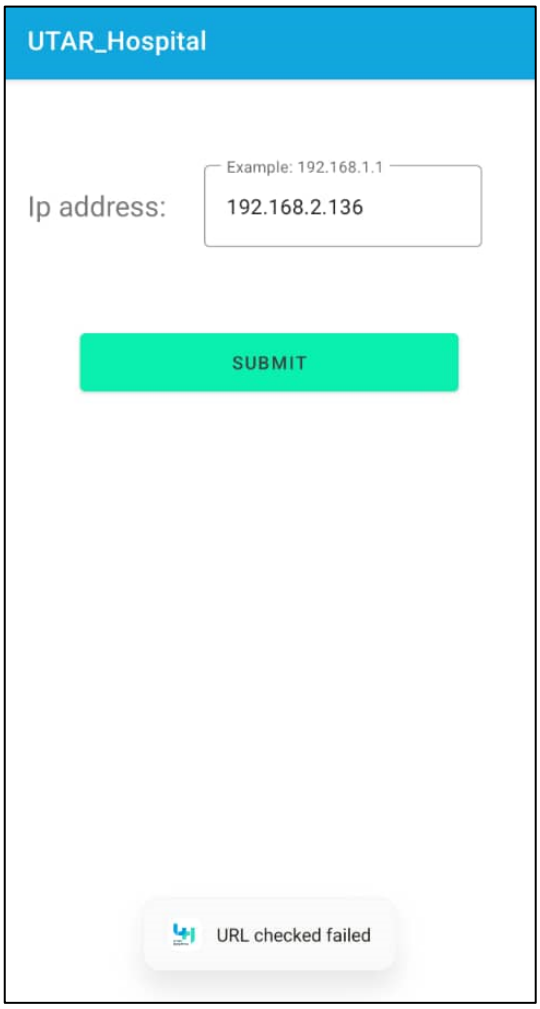

Figure 6.2.1 Ip address check failed

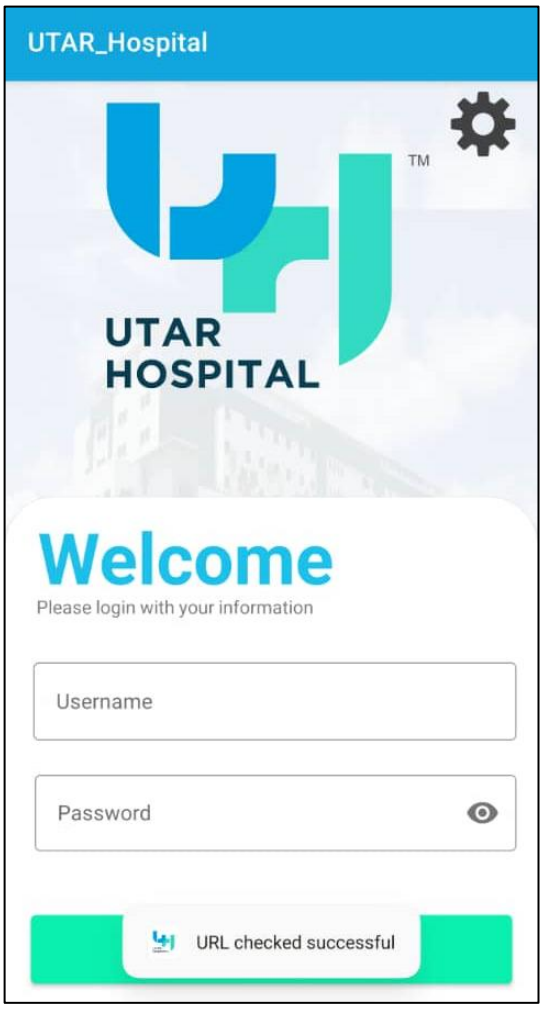

Figure 6.2.1 Ip address check success

In this project, the IP address that connect to the server is very important to make sure that our mobile application could connected to the server for read or write data to server. The URL & IP address checking testing for this application should ensure that checking function can be work as expected.

In this checking testing, when I close the server, the application is failed to connect to the server and replied with a check failed message. When the server is on, the application successfully connected to server, then the application success connects to server and replied with a check successful message.

2) Login Testing

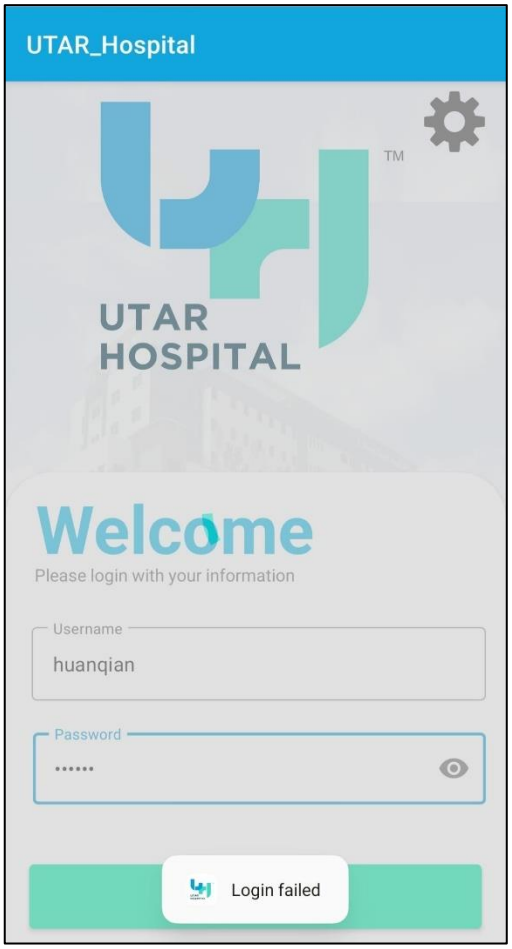

Figure 6.2.3 Invalid login

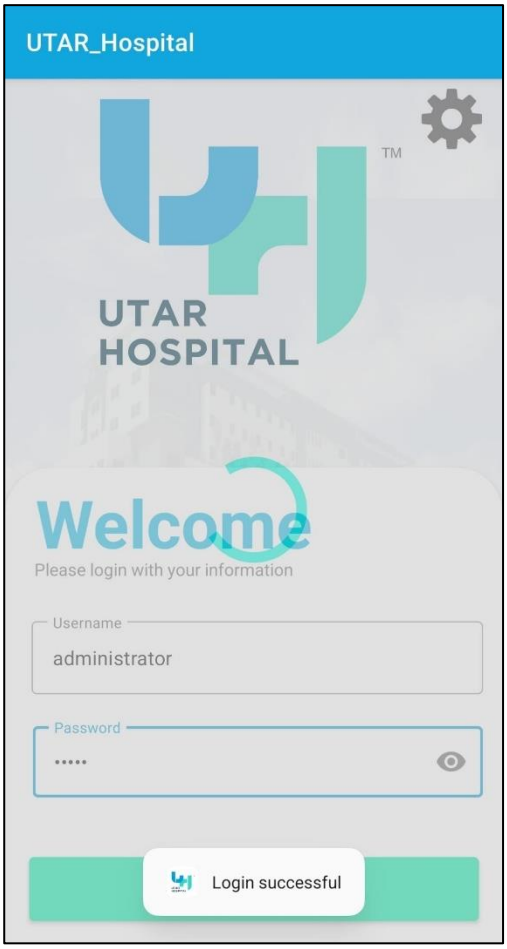

Figure 6.2.4 Valid Login

The login activity is important that allow the user authentication. The login testing is to make sure that the login activity is working normally and securely. The testing included verifying the user whether have the valid credential to login to the system and the system should rejected or accepted the login attempts.

In this testing, I have testing with the valid and invalid user account. When user is entering a wrong username or password, the system will rejected user to login to the system. If the username and password is correctly, the system will allow the user login to system.

3) Scanning

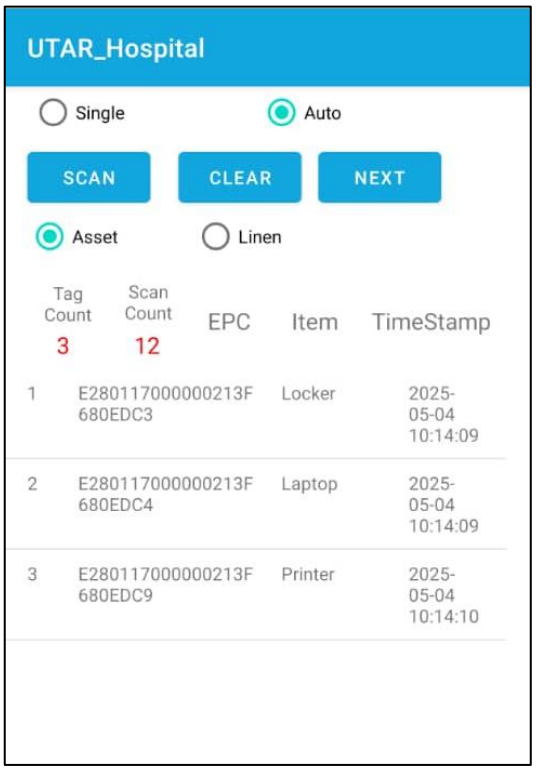

Figure 6.2.5 Read Scan

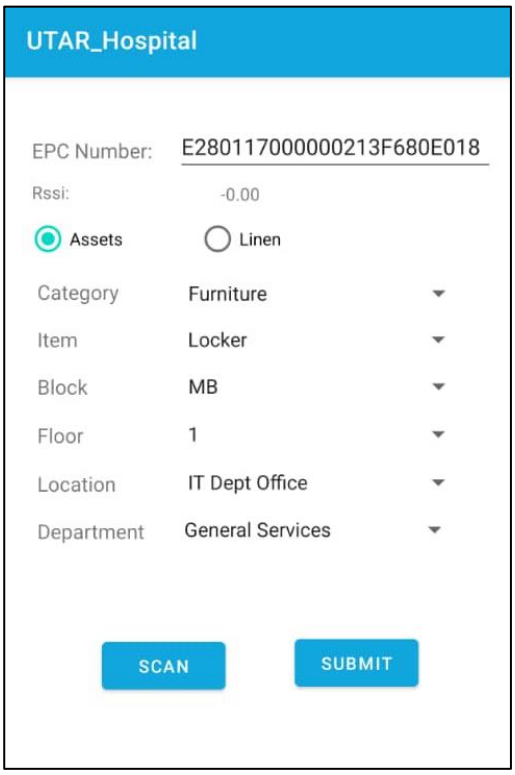

Figure 6.2.6 Register scan

The scanning function is the most important function in the system to allow user to scanning all the RFID tags. The scanning testing is including the rapid scanning as Figure 6.2.5 and single scan as Figure 6.2.6. For the rapid scanning is allow the RFID mobile reader continuous scanning the RFID tags until user trigger the stop button to stop the scanning. Single scan is only scanning one time once the user clicks the scan button.

In this testing, I have tested the scanning function in two way which is rapid scan and single scan. As shown in Figure 6.2.5, the rapid scan has shown that there have 3 RFID tags were scan by the reader, but the scan count is shown as 12. It means that the one RFID tags have been scan four times. In this case, I have filter out all the duplicate scanned RFID tags to avoid the duplication on server. As shown in Figure 6.2.6, the single scan will scan one time only to show the RFID tags. If the RFID tags are register on the server, it will not bee scan again and did not show the EPC number again.

4) Response time

Number of Category Data Fetch from Server	Number of Category Data Show	Time taken to finish (seconds)
1	1	1
1	1	1
1	1	1
1	1	1
1	1	1
3	3	2.5
3	3	2.5
3	3	2.5
3	3	2.5
3	3	2.5

Table 6.2.1 Response Time

In the project, the data in the server need to retrieve so that the system can display all the selection to the user to choose in the register page. The EPC number from the server also needs to be displayed to allow the system to compare the registered EPC number not to be register again. In this situation, there are many data need to be displayed on the application or use by the application. Thus, if the category of the data retrieved from the server is many, then the more time need to display all the information to the application.

5) Accuracy

Number of RFID tags	RFID tags have been scanned	RFID tags being updated in server
10	10	10
10	10	10
10	10	10
10	10	10
10	10	10

10	10	10
10	10	10
10	10	10
10	10	10
10	10	10

Table 6.2.2 Accuracy

For the above testing, it have shown that all the RFID tags that have been scanned are all updated to the server. As the result shown, the accuracy of the mobile reader and server are reliable.

6.3 Project Challenges

6.3.1 Connection mobile application with server

One of the challenges facing is the connection between the server and mobile application. Since the mobile application need to read and write data from the server, thus I need to find the method to undergoing the read and write function. However, since the frappe structure is complicated and only have one way to access to the server. Finally, I found a way that I can use the URL to POST and GET method to handle all the function since the server could run in port 80 (HTTP).

6.3.2 Data Filtering

Another challenge is to ensure that the data will not duplicate when scanning. This is very important since duplicate data will affect the data conflict to the server. In the end, data filtering had been developed to filter out the scanned RFID tags. Thus, when user using the system, it will very convenience and efficiency.

6.3.3 Network Performance

In this project, the mobile application is very rely on the server to handle all the POST and GET process for data retrieve and data updated. Therefore, the network performance is very important for all the function since if the network is down, all the function can’t be work properly. However, the network connection must be in the same local network to have the connection with the server. Meanwhile, if too many devices connect to the local network, the network performance of the network maybe slow and delay. It means that it may affect the system performance and the data accuracy.

6.4 Objectives Evaluation

The first objective of this project is to **improve the application feature of RFID mobile reader**. Since the RFID mobile reader only consists of write and read RFID tags, thus, a mobile application was developed to handle all the scanning, login and data updated functions. Additionally, the developed mobile application also could allow user to label and register RFID tags with correct information.

The second objective of this project is to **store and retrieve data from the server.** In this project, the system have the function to handle all the create, read, update and delete (CRUD) function due to the requirements. The user could handle the RFID tag's registration and could read the RFID tag's information in the system. The system also provide login activity to restrict all the irrelevant people to use the system. It will be more secure to protect all the RFID tags and hospital information.

The third objective of this project is to **keep track the real-time location of assets.** This system also provided the user a dashboard to keep track all the asset real time information. Dashboard also will provided different graph to allow user to customize their own dashboard.

6.5 Concluding Remarks

In this chapter, system testing and performance metrics, testing setup and result, project challenges and objective evaluation have been explained.

Chapter 7 CONCLUSION

Conclusion

The purpose of this project is to develop an RFID tag reading system that can run on the RFID mobile reader to create, read, update and delete data from Frappe server and display of tag EPC, number of reads and RSSI signal strength. Through the in-depth research and development process in Chapters 1 to 6, the system gradually moves from theoretical conception to practical application. At the beginning of the project, the development background and application status of RFID technology were clarified, and the technical foundation of system design was further laid. In addition, the functional requirements, non-functional requirements and user interface requirements of the system are analyzed and planned in detail, which provides a clear direction for the subsequent development phase.

The core function of the system is to realize the data exchange with the RFID reader through serial communication. This project is developed using Java language using Android Studio and integrates a variety of key libraries of the RFID mobile reader to ensure compatibility with hardware and communication stability. During the development process, the project solved several key technical difficulties, including connection between application and server, RFID tags labelling, real-time UI update of application, and memory resource management. The user interface allows users to easily view the results of each scan, including key information such as EPC values, cumulative reads, and RSSI values, and automatically update and record the data.

The test phase showed that the system had good read performance and user interaction experience. Field tests in a variety of environments have shown that the system is able to read multiple RFID tags stably and display the corresponding information accurately. In the case of moving labels, overlapping or unstable signals, the system still maintains a high recognition accuracy and response speed. In addition, the system design also considers the scalability of user needs, such as the subsequent access to the cloud database to synchronize the label information, or the analysis and display of historical data in combination with charts, so as to improve the practicability and intelligence of the system.

In summary, this project achieves the expected technical goals and verifies the feasibility and practicability of implementing an RFID reading system on Android devices. In the future, the work can be optimized and expanded in the direction of label classification management, data analysis, remote control, etc., to further improve the system performance and commercial application value.

Recommendations

Improve the stability and error handling ability of the system

During serial communication or data parsing, exceptions or packet loss may occasionally occur. It is recommended to enhance the error handling mechanism, such as adding functions such as disconnection reconnection, exception prompts, and error logging, to ensure the robustness and reliability of the system.

Optimized the multi-tag reading algorithm

The current system already supports multi-tag reading, but in environments with dense tags or severe signal interference, the recognition rate may be reduced. It is suggested that more efficient label filtering and sorting algorithms should be studied in the future to improve the performance of the system in complex scenarios.

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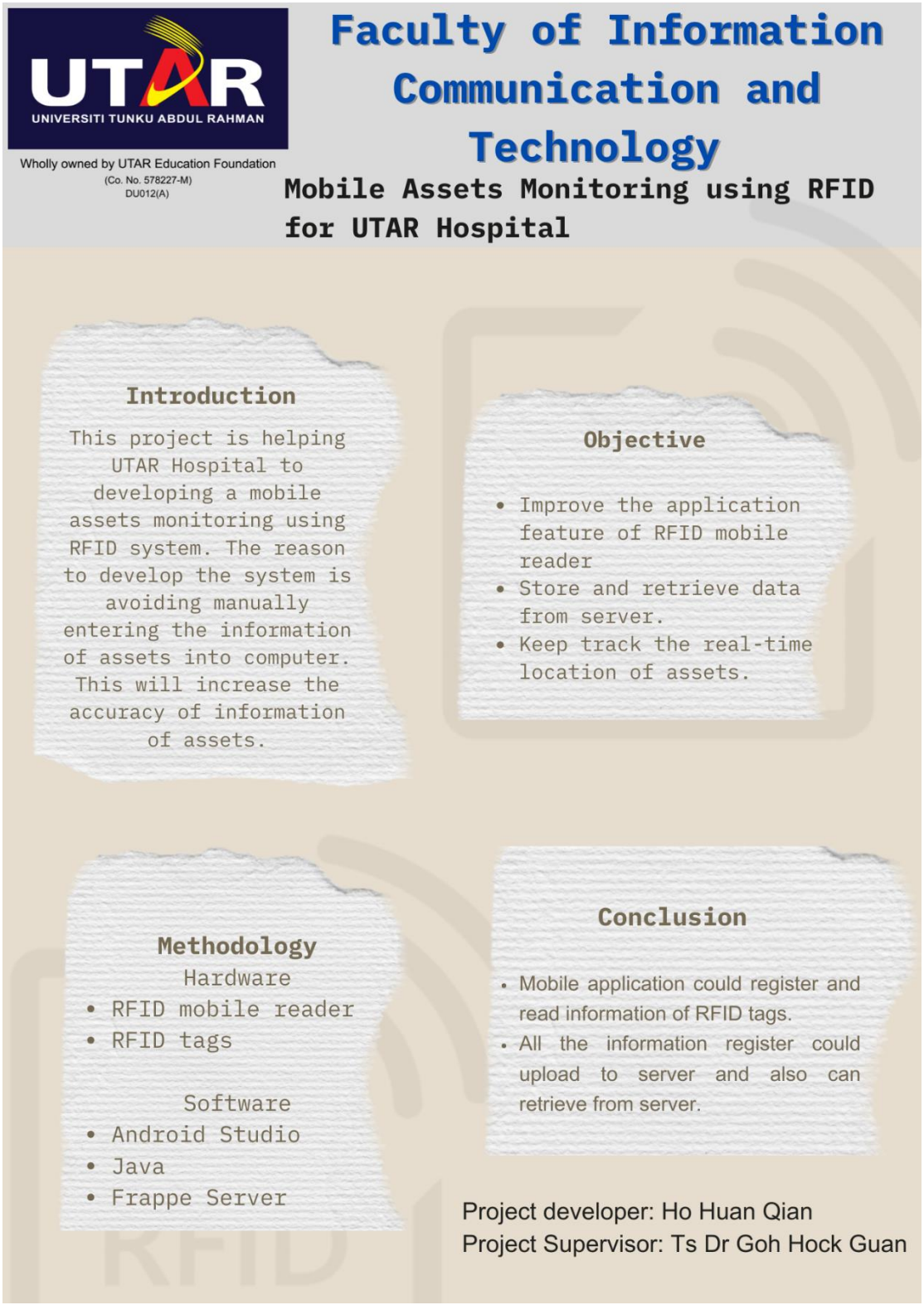
Poster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Mobile Assets Monitoring using RFID for UTAR Hospital
Introduction
This project is helping UTAR Hospital to developing a mobile assets monitoring using RFID system. The reason to develop the system is avoiding manually entering the information of assets into computer. This will increase the accuracy of information of assets.
Objective
Improve the application feature of RFID mobile reader
Store and retrieve data from server.
Keep track the real-time location of assets.
Methodology
Hardware
RFID mobile reader
RFID tags
Software
Android Studio
Java
Frappe Server
Conclusion
Mobile application could register and read information of RFID tags.
All the information register could upload to server and also can retrieve from server.
Project developer: Ho Huan Qian
Project Supervisor: Ts Dr Goh Hock Guan