



## **FACULTY OF ENGINEERING**

### **EPE3016 CAPSTONE PROJECT**

# **Pregnancy Guide to Traditional Chinese Medicine Using Near-Field Communication Technologies**

**TRIMESTER 2 SESSION 2018/2019**

**Declaration of originality:**

I declare that all sentences, results and data mentioned in this report are from my own work. All work derived from other authors have been listed in the references. I understand that failure to do this is considered plagiarism and will be penalized.

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## **ABSTRACT**

At present, women in pregnancy prefer using Traditional Chinese Medicine (TCM) to improve self-regulatory ability of body due to the perceptions that TCM offers lesser side effects as compared to modern medicines. Elderly tend to give advices on the usage of TCM to pregnant women without considering its compatibility on pregnancy. Hence, such phenomenon raises the issue of misconception about effects of TCM on pregnancy due to the influence of older generation. Consequently, danger may be brought to maternal and infant health due to the consumption of certain traditional medicine by pregnant women. This paper proposes a system to educate pregnant women or their family on the suitability of traditional medicines on pregnancy use. Videos showing uses, effects and precautions due to the consumption of different traditional medicines by mothers-to-be will be shown to visitors of maternal clinics or maternity wards in hospitals. This can be realized with the implementation of a system that involves the technology of Near-Field Communication (NFC), Raspberry Pi (RPi), Bluetooth Low Energy (BLE) and additionally an application on Android smartphone. An interactive booth with NFC tags will be set up by the clinic or maternity ward to allow the display of the videos. The videos can be displayed on either an NFC-enabled smartphone or an external display in the clinic. The Android application can be used separately to browse the effects of various traditional remedies. With the aid of this system, targeted users can easily acquire the knowledge of traditional remedies on pregnancy, which can guide pregnant women to make correct choices on traditional remedies. Thus, victims of adverse effects due to improper TCM intake during pregnancy will be reduced.

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## **CHAPTER 1 – INTRODUCTION**

### **1.1 Motivation to the project**

This project is motivated by the difficulty in obtaining traditional Chinese medicine (TCM) effects' information despite the increasing usage of TCM by people from all around the world. TCM is commonly used to regulate and improve humans' general health due to the perception that it brings fewer side effects. However, the sources of information for TCM effects are not easily found and, in most cases, not well-organized. Thus, some may have misunderstandings on the effects of consuming TCM.

### **1.2 Problem statement**

Across the years, traditional medicine (TM) is growing more popular in the treatment of diseases which emphasizes on boosting the resistance of body and the maintenance of health by people from all around the world. In 2014, World Health Organization estimated that around 80% of the world's population use TM for health care (Parasuraman, S., Thing, G. S., & Dhanaraj, S. A., 2014). Additionally, the saying that the consumption of TM is encouraged among pregnant women to promote smooth labor and to improve the health of fetus is well-known among elderly and often passed down from generation to generation. Thus, elderly tend to pressure their pregnant younger generations to take TM for their and their future babies' well-beings. In fact, up to 60% of pregnant women in Asian countries (Ahmed, M., Hwang, J. H., Choi, S., & Han, D., 2017), 58% in United Kingdom and Australia, 48% in Italy and Norway take TM (Kennedy, D. A., Lupattelli, A., Koren, G., & Nordeng, H., 2013). While in China, up to 90% of Chinese women who are pregnant take TCM, specifically (Chen, H. Q., Zou, S. H., Yang, J. B., Cai, J., Zhang, Y., & Wang, Z. L., 2015). Although that saying is true to a certain extent, there are exceptions to this general rule. Some TMs, particularly TCMs, are not suitable for mothers-to-be to consume as they may bring adverse effects to them and/ or their fetuses, such as miscarriages, birth defects and haemorrhage. The elderly may not be aware of this rule as they believe that the effects of TCMs apply the same on pregnancy. Therefore, pregnant younger generations may be misled by the elderly who are believed to be more experienced in pregnancy-related matters. This causes the issue of misconceptions about effects of TCM on pregnancy by pregnant women, due to the influence of elderly, to arise.

### **1.3 Scope of the project**

The scope of this project is narrowed down from TM to TCM. Since the identified problem revolves around and mainly affects pregnant women, our target users are pregnant women. Due to the same reason, the outcome of this project is to be implemented in maternity wards in hospitals and maternal clinics where mothers-to-be are to visit on a regular basis during their pregnancy for their pregnancy checkups. This is to ensure that pregnant women will be aware of and informed about the effects of TCM on pregnancy, preventing them from harming or losing their fetuses due to ignorance.

### **1.4 Objectives and Overall Project Description**

The objective of this project is to provide TCM information regarding its positive and negative effects on pregnancy to users on-the-go besides to have direct access to it instantly. It is to be designed for public use in order to expose the public, particularly the target users, to the possible misconceptions about effects of TCM on pregnancy which exists in the society. Once proper TCM knowledge is obtained, users can be clear about the effects of TCM on pregnancy, thus correcting their misunderstandings about this matter which they may not even realize of their existence. Moreover, the information provided can be used to verify the TCM information obtained from older generations as well as the users' own knowledge regarding this matter. As the negative effects of TCM and their improper or excessive usage can be avoided, pregnant women can give birth to healthier babies.

Near-Field Communication (NFC) technology will be utilized in the project together with an Android mobile application specific to this project. The mobile application will contain TCM information especially its effects on pregnant women and their fetuses. In addition to that, NFC tags, each containing a specific content, when scanned by the NFC reader embedded in the smartphone, will cause the TCM information in the application to be presented to the users in a specific form of display. Furthermore, the application will allow the control of video playing on the large screen in the maternity ward or maternal clinic. In short, by using the tailored mobile application, users can obtain the TCM information with or without the NFC tags, anywhere and anytime they wish.



## CHAPTER 2 – LITERATURE REVIEW

### 2.1 Introduction

Before designing and implementing this project, several researches were done to learn of the existing solutions which can be utilized to solve our problem, which was identified in **Section 1.2**. This is to keep up-to-date with the latest technologies that can be used to solve our problem. The chosen existing solutions proposed by other researchers deploy different technologies which will be analyzed in **Sections 2.2** to **2.5** later in this chapter. This will be followed by the analysis of the technologies, which will potentially be utilized to solve our problem later in this project, and their applications in **Section 2.6**.

### 2.2 NFC coupled with Speech Synthesizer

In the year 2011, Marja Harjumaa and her colleagues developed a system which involves the use of Near-Field Communication (NFC) tags and speech synthesizer to provide information regarding medicines to users who are primarily visually challenged elder. The medication instructions, in text form, were written to and stored in the NFC tags attached on the medicine packages. A specific software which includes the use of speech synthesizer is to be installed on the users' laptop. Also, an external NFC reader had to be connected to the laptop with the specific software installed. This is to allow the content of NFC tags, in text form, to be read when scanned on the reader, sent to the laptop, converted into speech by the speech synthesizer and read out to the users using the speaker of the laptop. In extension to that, external loudspeakers can be connected to the laptop to improve the sound quality of the medication instruction read out to users. The complete setup of this system and a demonstration of its usage are shown in **Figure 2.2.1** (Harjumaa, M., Isomursu, M., Muuraiskangas, S., & Konttila, A., 2011).



**Figure 2.2.1:** Complete setup of system and demonstration of its usage.

When this solution is applied to solve our problem, the NFC tags will be used to store information regarding the good and bad effects of TCM on pregnancy. Instead of medicine packages, the NFC tags will be attached on TCM packages. The setup and usage of the system will be the same. Hence, users can obtain TCM information regarding its uses and clear their misunderstandings about the effects of TCM on pregnancy.

### 2.3 Barcode in Drug Packaging

In the year 2014, C Bala Saravanan and P. Sarasu used barcode technology to provide drug information to the public in a timely manner in order to increase the awareness on side effects of drugs. Data matrix barcode which can store up to 2000 ASCII characters was chosen to be used in order to allow more information to be packed. A barcode is placed in each drug packaging to allow users to know the side effects of the purchased drugs and be informed of them (Saravanan, C. B., & Sarasu, P., 2014).

When a particular drug is to be purchased by a user in a drug store, the barcode in the drug packaging of that drug will be scanned using a barcode scanner. Then, the drug's information stored in the barcode will be read by the barcode scanner and sent to a system in the drug store. This system will collect and store the user's information such as names, active mobile phone number that can receive text messages and bill records as customers of the drug store. Once the required information is collected, a text message containing the purchased drug's information will be sent to the drug's purchaser via Message Send Protocol (MSP). The system architecture is depicted in **Figure 2.3.1**.

This solution can be deployed to solve our problem by substituting the drug information in the barcodes to TCM information on its effects on pregnancy. By making such change, the scanning of barcodes by users will cause them to receive mobile phone text messages containing the information of the purchased TCM's effects on pregnancy, thus clearing their misconceptions on the effects of TCM on pregnancy.



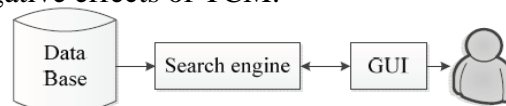
**Figure 2.3.1:** System architecture of the existing solution which uses barcode.

## 2.4 Drug Information Mobile Application

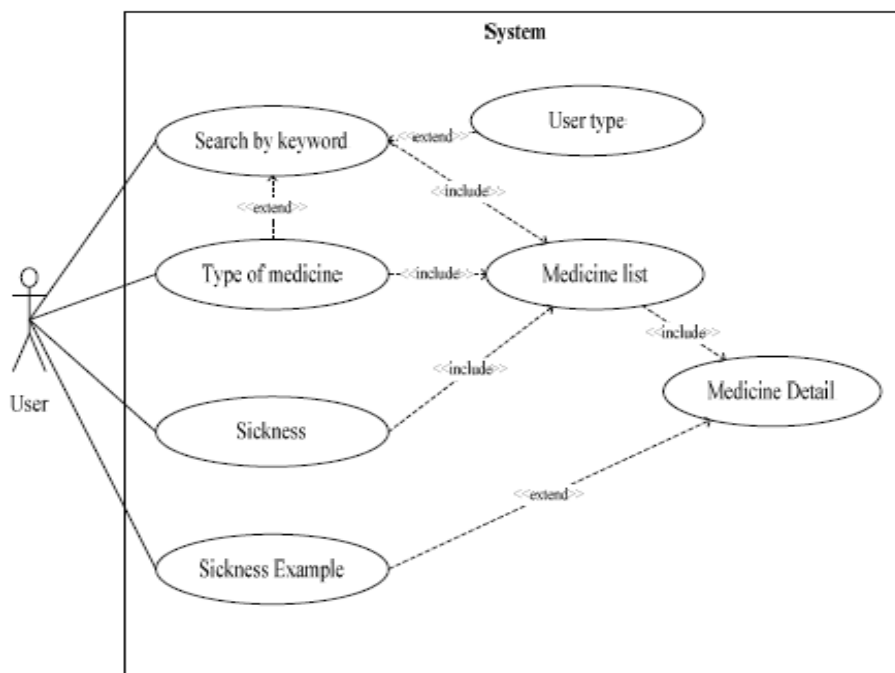
In the year 2017, Hathairat Ketmaneechairat et al. proposed a solution which uses an offline Android smartphone application to provide information about drugs, including the drug name, illnesses that it can cure and usage warnings (Ketmaneechairat, H., Jongsiriworachot, K., & Thangtoon, C., 2017).

All the medicine information in this system are stored in a database. The retrieval of specific information can only be done through a search engine, in which the retrieved information will be displayed on the graphical user interface (GUI), as demonstrated in **Figure 2.4.1**, to allow users to learn the information. Users can select a specific medicine to learn its details based on the medicine name, medicine type or the illness that it can cure. The selection can be done by using a keyword search or by browsing through the list of medicine or sickness available in the application, as shown in the use case diagram in **Figure 2.4.2**.

By changing the system to provide TCM information, this system can be used as a platform for users to obtain information regarding the effects of consuming a specific TCM, particularly on pregnancy. Thus, users can learn the possible side-effects that consuming a TCM can cause to the expectant mother as well as her fetus, correcting their possible misunderstandings on the negative effects of TCM.



**Figure 2.4.1:** Retrieval of information to be displayed to user.



**Figure 2.4.2:** Use case diagram of the system.

## 2.5 Analysis of the existing solutions

As time passes, technology advances, causing older technologies to be said to have limitations which were not discovered until the later technologies are able to overcome them.

The first existing solution, which utilizes both NFC and speech synthesizer, has to be set up every time before it can be used. This is done by connecting a laptop installed with the specific software to an external NFC reader and optionally external loudspeakers, electrically. Hence, the portability of system is limited and users will not be able to check TCM information on-the-spot wherever they are. Therefore, it would be less effective in achieving the objective mentioned in **Section 1.4**. Moreover, in our case, the target users have difficulties in moving around frequently. Thus, it is infeasible to implement this system to achieve the objective as it would increase their burden in moving around.

As for the second existing solution which utilizes barcode technology, lighting condition of the environment poses a limitation on this system. The barcode scanner may not be able to scan a barcode successfully in low light conditions. Also, if there is a sudden change in light settings, the same barcode may be scanned several times. The unstable barcode scanning decreases the efficiency of the system.

The third existing solution which involves a mobile application only provides indirect access to information. When applied in our case, it allows users to search for a specific TCM's details by typing the TCM name, TCM type or illness that it can treat in the search bar or by navigating through the application. As TCM are usually referred by their Chinese names, it is possible for users to input misspelled TCM name. Hence, if misspelling occurs when searching for a particular TCM's details, users may fail to search for the desired TCM's details as the search function will produce zero result. This reduces the efficiency of the system in solving our problem.

The limitations of all the existing solutions mentioned in this section are summarized in **Table 2.5.1** as shown below.

**Table 2.5.1:** Summarized limitations of related works.

| Related Work                            | Limitation                      |
|---|---------------------------------|
| (1) NFC coupled with Speech Synthesizer | Low portability                 |
| (2) Barcode in Drug Packaging           | Affected by lighting conditions |
| (3) Drug Information Mobile Application | Indirect access to information  |

## 2.6 Enabling technologies

NFC is a half-duplex protocol which allows wireless communications between a reader and a tag or between two readers within a short range of up to 10cm. The proximity in communication ensures that the reader device will only detect the NFC tag intended to be read, thus establishing a secure connection. The usage of its 13.56MHz operating frequency is different from that of other technologies such as Bluetooth and Wi-Fi, hence providing a higher safety level than the other technologies mentioned. The connection establishment of NFC is lower than 0.1 second, which makes NFC tag work almost instantly upon tapping it on the reader device. Hence, this fast link establishment causes NFC to not consume high power to operate.

As NFC readers are embedded in most of the existing smartphones in the market, the application of NFC in various systems grows more common due to its increased portability and widened market, thanks to the introduction of mobile applications. In the year 2014, NFC was used to transmit clinical parameters, which fits within the NFC data capacity, from the point-of-care to servers situated remotely in a healthcare mobile application introduced by Gabriele Rescio (Rescio, G., Leone, A., Montagna, G., & Siciliano, P., 2014). Besides that, NFC was also used in a mobile application which includes the reservation system of a university, as proposed by Lok Li Ching in 2017. This is due to the fact that it can be used to specifically allow one user to scan one NFC tag at a particular time, thus preventing double-booking. The access control accomplished by utilization of NFC technology can also improve the facility's security. Moreover, NFC was chosen instead of radio-frequency identification (RFID) as the cost for NFC technology is cheaper (Ching, L. L., Malim, N. H. A. H., Husin, M. H., & Singh, M. M., 2017). Furthermore, since NFC can function without needing batteries, it was used as an interface for sensor in a mobile application as proposed by Tore Leikanger in 2017. This eases the reading of a sensor value from a smartphone as the processing of data will be done by the cloud. The raw data read by the sensor will be pushed to the clouds to be processed and the processed sensor value will be pulled back by the device (Leikanger, T., Schuss, C., & Häkkinen, J., 2017).

## CHAPTER 3 – SYSTEM DESIGN

### 3.1 Introduction

In this chapter, the factors that are to be taken into account in the design of system and functions of main components in the proposed system will be discussed in **Section 3.2**. Next, the proposed system architecture will be discussed in depth in **Section 3.3**. Next, the front end graphical user interface (GUI) of the software in the proposed system and the back end logic part will be presented in a flowchart in **Section 3.4**.

### 3.2 Design Objectives and Considerations

Recall that the primary objective of developing this system, as stated in **Section 1.4**, is to provide information regarding the effects of traditional Chinese medicine (TCM) on pregnancy to users on-the-go as well as to have direct access to the information instantly. The information obtained can clear the possible misconceptions of the public, particularly expectant mothers, about the effects of TCM on pregnancy.

With the advancement of technology, it is common for people to be able to obtain information wherever they are, whenever they want. If pregnant women do not know the negative effects of taking certain TCM during pregnancy, they may consume the TCM regularly, thinking that it is good for them but actually harming their fetuses and themselves. By developing an Android smartphone application containing information about TCM effects on pregnancy, users can learn and verify their TCM knowledge anywhere, anytime. Hence, they can clear their misunderstandings on this topic and avoid the painful consequences that may occur.

In addition to that, different people have different preferences for the way information is represented. For instance, it is a common fact that some people prefer visuals while others prefer words. Thus, the mobile application should include information in the forms of texts, images, audios and videos to suit people of different preferences.

In the proposed system, the TCM informative videos can be played either on the users' smartphone or on the large screen in the maternity ward or maternal clinic to allow more people to obtain the TCM information provided in one go. Hence, a switch should be included in the mobile application to allow users to choose where to play the videos.

Users should also be able to control the playback of video playing on the screen without having to move towards it. This is because it is tiring and difficult for pregnant women to move frequently in order to control the video. Therefore, the mobile application should have a function to allow the control of video playback on the screen from a distance.

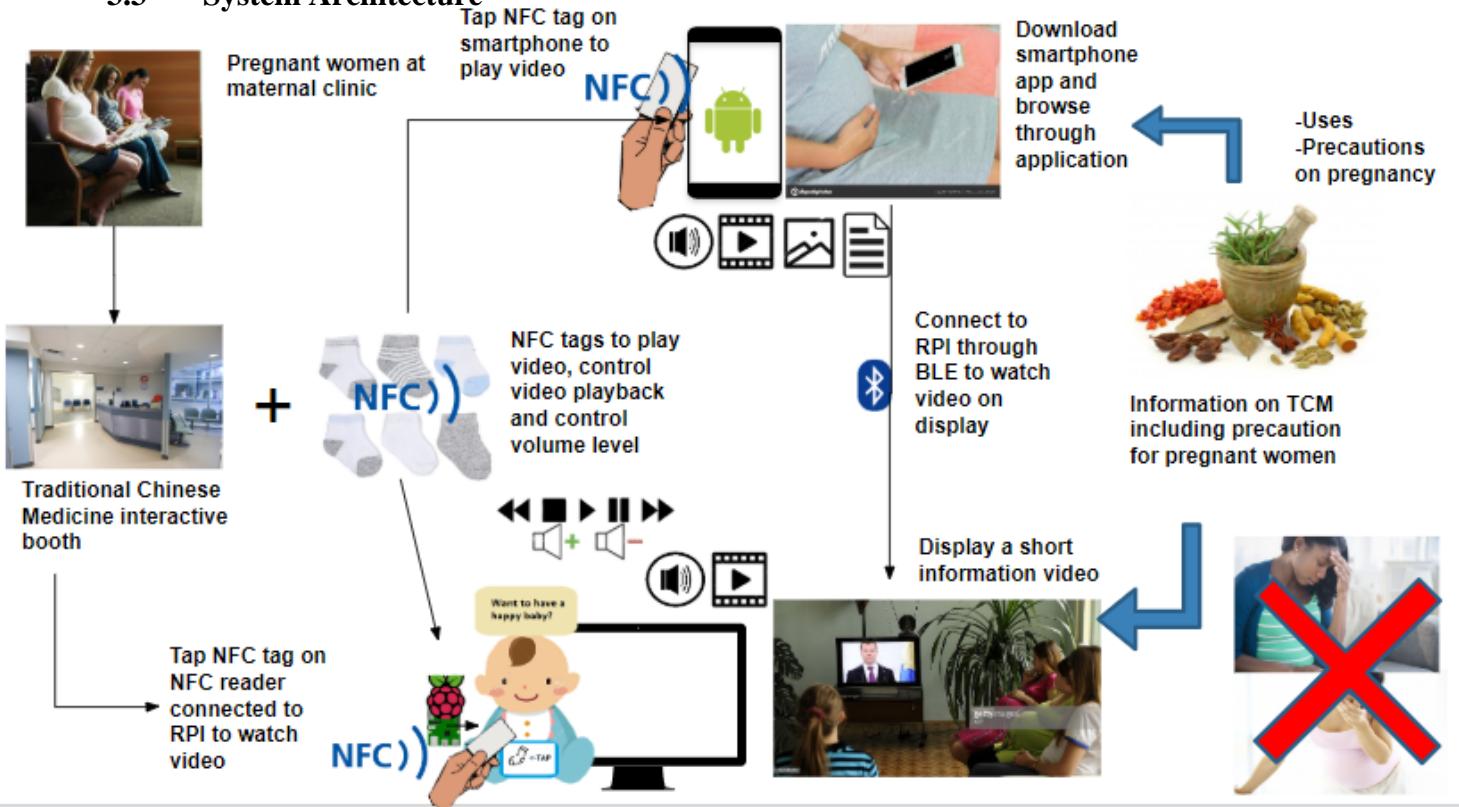
In the current time where time is money, the demand for fast, if not instant, access is increasing exponentially. Therefore, instant access to the TCM information in the form of video should be available to avoid users' frustrations in waiting for information to be displayed. This can be achieved by using Near-Field Communication (NFC) technology. Since an Android smartphone is involved in this project, NFC capability of the gadget can be utilised in the mobile application to allow users to have direct, instant access to the information in the application.

The design objectives and their descriptions are summarized in **Table 3.2.1**.

**Table 3.2.1:** Summarized design objectives and the ways to achieve them.

| <b>Design Objective</b>  | <b>Description</b>   |
|--|--|
| Provide information about TCM effects on pregnancy to users on-the-go    | Develop a mobile application which contains the TCM information                                |
| Different forms of information representation                            | Information can be represented in text, image, audio and video forms in the mobile application |
| Select where to play the TCM video                                       | Include a switch in the mobile application to select where to play the TCM video               |
| Control video playback on large screen without having to move towards it | Allow the mobile application to control video playback on large screen from a distance         |
| Allow instant access to TCM effects' information                         | Users can have instant access to TCM videos using NFC functionality of the mobile application  |

### 3.3 System Architecture



**Figure 3.3.1:** System architecture of the proposed system.

We propose to solve the problem identified in **Section 1.2** by having a system to provide information about effects of TCM on pregnancy. The system architecture of our proposed solution is as depicted in **Figure 3.3.1**. Since the target users are mothers-to-be, we plan to set up this system in special TCM interactive booths in maternity wards in hospitals and maternal clinics which the target users will frequent for pregnancy checkups.

In order to encourage the usage of the proposed system, instant access to the TCM information contained in the system can be achieved through the simple tapping mechanism of NFC technology which is convenient and easy to use. As visual and sound is better in attracting people's attention and keeping them focused, the short informative video of TCM is chosen to be the displayed through this "shortcut" access. Each NFC tag will store different data where each is associated to different functions including playing a specific TCM video and video playback control functions including play/ pause, stop, volume up and down, fast forward and rewind. The function of each NFC tag is notified to users by the image on the "baby sock" containing the NFC tag. The English name of the TCM will also be on the "baby sock" containing NFC tag to play a TCM's video as users may not recognize the TCM from its appearance in the image.



When users wish to learn a specific TCM's knowledge, they only need to retrieve the "baby sock" with that TCM's image and name, and tap the image on the "baby sock" onto the NFC reader connected to the Raspberry Pi (RPi). The reader will read the content of the NFC tag and send it to the RPi. Next, the RPi will run a Python program stored in it to check the NFC data with a set of values which are set programmatically. Then, the action which corresponds to the NFC data detected specified in the program will be performed by the RPi. These actions include playing a specific TCM's video on the external large screen connected to that RPi in the booth and controlling video playback of the video played by the RPi.

The RPi is used to store the short informative TCM videos containing TCM information about the appearance, alternative names, effects (or uses) and usage precautions on pregnancy due to its sufficiently large storage. It is also used to develop and run a Python program dedicated for functions in our proposed system. Other than that, it is used to connect other devices including an NFC reader, an external large screen and external speakers so that signals can be received from or sent to them. The Python program in RPi is coded such that a specific video file will be played or a specific video playback control function will be performed when the corresponding signal is received by the RPi when it is waiting for incoming signals. The signal can come directly from the tapping of an NFC tag on the NFC reader connected to the RPi, or from the mobile application through wireless connection. The external large screen connected to the RPi provides a broadcast service, allowing people to receive the TCM information provided in the videos in one go.

As most smartphones from all around the world use Android OS, an Android mobile application is developed for this proposed system. This application allows the same TCM videos, which are stored in the mobile application, to be played on NFC-enabled smartphones with the application installed when the corresponding NFC tag is scanned by the NFC reader embedded in the smartphone. Other than that, this application includes information in text and image forms to aid users in obtaining the TCM information directly, without having to watch the TCM videos. Hence, users can obtain the TCM information wherever they are, whenever they want, in the form which they prefer (text, image, audio, video).

As it is difficult and tiring for pregnant women to move around frequently, it is irrational to have them move back and forth to retrieve a "baby sock", tap it on the NFC reader connected to the RPi, and go back to their seats a distance from the large screen connected to the RPi to reduce the amount of radiations absorbed by their bodies which may

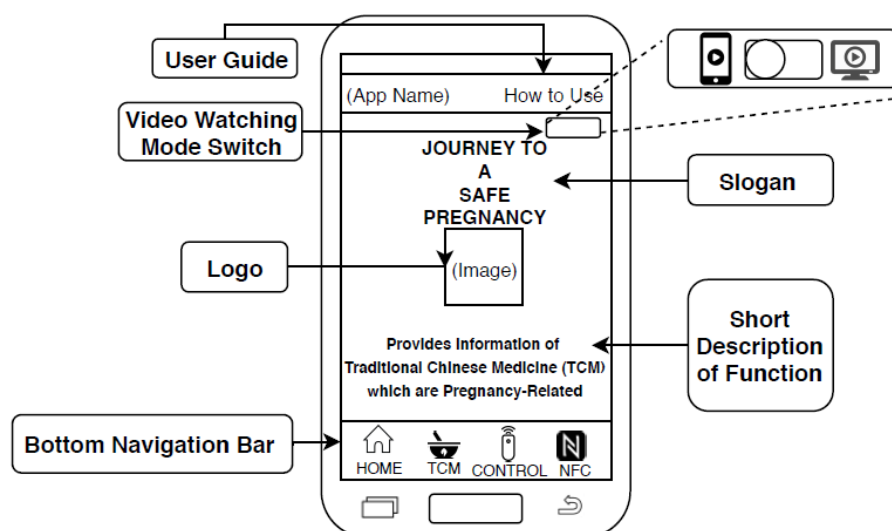
harm their fetuses. Although those videos can also be played on their smartphones, it would be more comfortable for them to watch the videos on the large screen readily available to them at the venue. Hence, we plan to implement a remote control function in the mobile application dedicated to our system. Bluetooth Low Energy (BLE) technology will be used to establish a connection between the users' smartphone with Bluetooth 4.0 or above's capability and the RPi in the interactive booth. With that, users can control the video playback and change the video playing on the large screen using the mobile application from their seats, a distance from the screen, comfortably. Since the TCM videos can be played either on users' smartphone or on the external screen, the mobile application will have a switch to allow user to select where to play the videos.

By using our system, users can be exposed to their hidden misconceptions about the effects of TCM on pregnancy, gain proper TCM knowledge and correct the said misconceptions. Hence, they can avoid the possible TCM negative effects on their fetuses and themselves, preventing tragedy from happening. Also, pregnant women can increase the chance to have a healthy baby.

### 3.4 Software System Design

#### 3.4.1 User interface of the NFC smartphone application

This application will have dark background with white and green as main colours to highlight the foreground components so that they can be seen clearly and are sharp to the eyes.



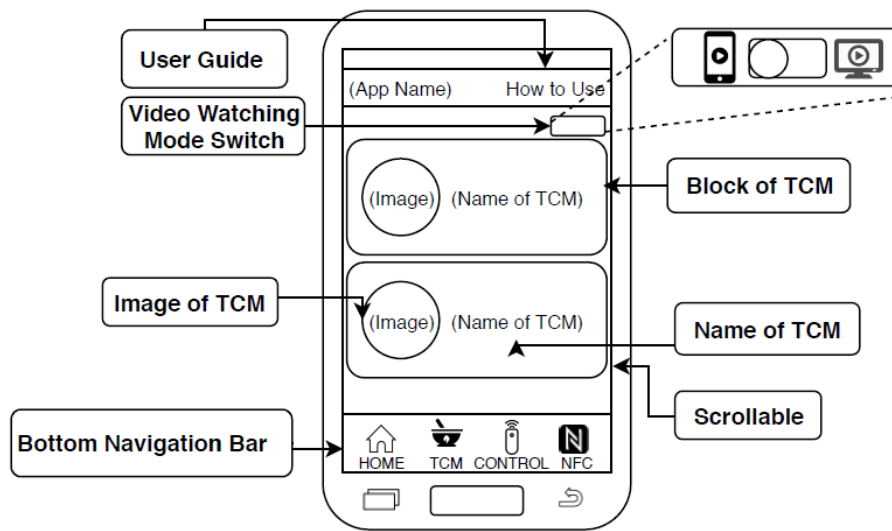
**Figure 3.4.1.1:** The home page of the proposed Android application.

The home fragment or home page, as shown in **Figure 3.4.1.1**, is the interface displayed when the application is launched by selecting the application icon. Its **slogan** and **logo** are placed at the center of the screen to decorate the interface in order to give users a visually attractive interface and attract them to use this application. Below them, this application's **short description of function** can inform users the general function of this mobile application, which is related to both TCM and pregnancy.

The “How to Use” is placed at the top right corner to allow users to understand that a simple **user guide** or manual will be shown to users when it is clicked. The user guide will include special features of this application which may be new to the users, such as NFC and BLE functionalities.

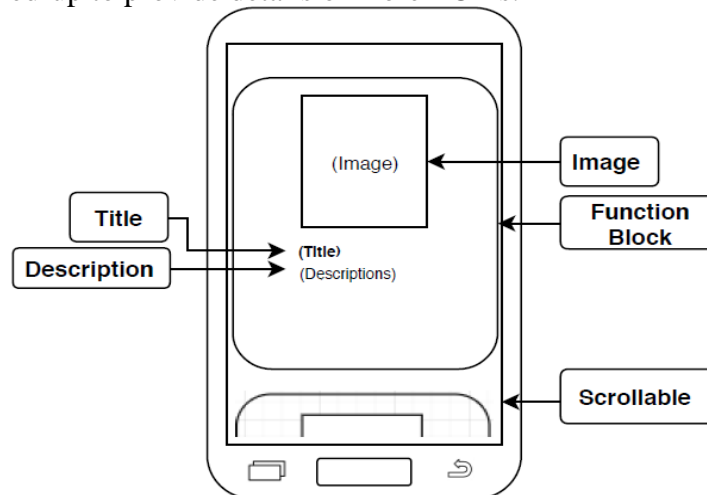
The choice of where the TCM videos will be played is based on the status of the **video watching mode switch**. If it is unchecked or swiped towards the smartphone icon on the left, the TCM videos will be played on the smartphone. On the contrary, if it is checked or swiped towards the television or monitor icon on the right, the TCM videos will be played on the external large screen in the TCM interactive booth, provided the BLE connection between the RPi and the smartphone was established prior to the signal being sent to play the video.

The **bottom navigation bar** at the bottom of the screen provides an easily understandable fast navigation control between interfaces. Icons and labels are available in the tabs to help users recognize the interface that will be displayed when a tab is selected. The selected tab will light up in green, and the corresponding fragment or interface will be displayed on screen. The “HOME” icon is present on the bar as it leads user to the home page which is displayed upon launching the application, giving users a first impression and a brief idea on the function of the application. The “TCM” icon leads users to the list of TCM where a specific TCM can be selected to learn its details. The “CONTROL” icon leads users to the control page which allows users to use the application as a remote control to control the video playbacks on the large screen in the interactive booth. As the proposed application enables NFC tags to be read by NFC-enabled smartphones, the “NFC” icon can introduce this feature to users who are new to NFC functionality on smartphone or provide convenience to enable or disable NFC.



**Figure 3.4.1.2:** The TCM list page in the proposed Android application.

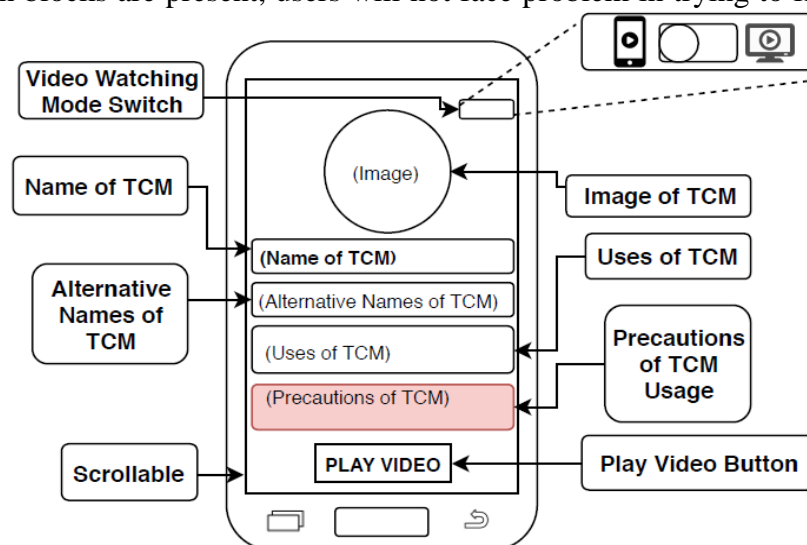
When the “TCM” icon on bottom navigation bar is selected, the TCM list fragment or TCM list page, as depicted in **Figure 3.4.1.2**, will be displayed. Here, each TCM will have its own **TCM block** containing its **image** and its common English **name** to ease users in differentiating TCMs and avoid confusions. The TCMs will be listed in alphabetical order according to their **names** to ease users in finding their desired TCM. The **image of TCM** can ease the search of a specific TCM based on its colour and appearance. This is useful when users only know the appearance of the TCM which they want to learn its details. Also, this interface is **scrollable**, simulating social media applications and web pages, to allow the application to be scaled-up to provide details of more TCMs.



**Figure 3.4.1.3:** The user guide page in the proposed Android application.

The user guide page, as shown in **Figure 3.4.1.3**, provides a simple guide on how to use the special features of this application. Each feature has its own **function block** which consists of an **image**, a **title** and **descriptions** to ease users in knowing the separation between functions so as to prevent confusion. An **image** is included in each function block to show the feature referred to, visually, while the **title** is the feature referred to, in text. These can help users understand the features. The **descriptions** provide details of a feature or

guidelines on how to use a specific function. As its content cannot be fitted into a static screen, this interface is **scrollable**, simulating social media applications and web pages. Since only a few function blocks are present, users will not face problem in trying to find a certain feature's guide.



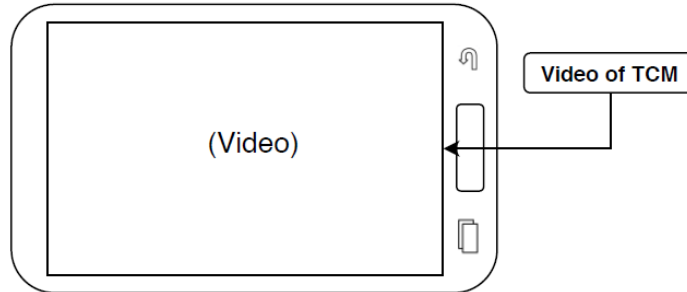
**Figure 3.4.1.4:** The selected TCM page in the proposed Android application.

When a TCM is selected from the TCM list, the TCM fragment or TCM page containing details of the selected TCM, as shown in **Figure 3.4.1.4**, will be displayed. The text on this interface will be displayed separately according to their categories to improve readability and to ease user in finding specific information. The title for each block will be bolded to indicate the property of the TCM in that block.

The TCM's **image** can help users recognize the TCM's appearance. Different users from different places and backgrounds may refer the same TCM with different names, hence some of the TCM's **alternative names** are provided to resolve any confusion that may arise due to this issue. The common Chinese name is included as TCM are usually referred to and more widely known by its Chinese name. The scientific name is also included for users to search for a specific TCM's details or to ease consultation of medical practitioners on the usage of the TCM by users. The **uses** of the TCM include the (positive) uses or effects of consuming the TCM. They will be presented in point forms to improve readability of contents. The **precautions** of taking the TCM include the negative effects and possible side-effects of consuming the TCM. The contents are presented in point forms to improve readability. The background colour for this block is chosen to be reddish pink as it is sharp to the eyes and will attract humans' attention and make them focus on it. Additionally, red indicates warning or danger.

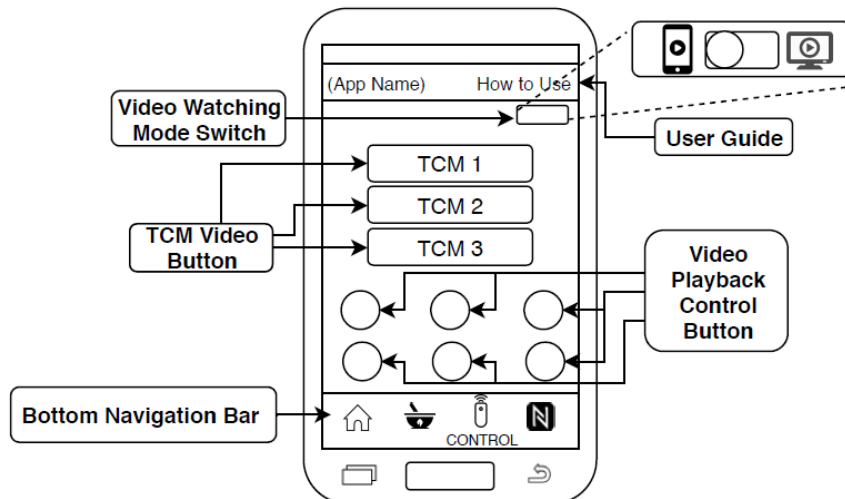
At the bottom of the **scrollable** page, there will be a **play video button** which allows the short informative video of the respective TCM to be played when clicked, either on the

smartphone itself or on the large screen in the interactive booth, depending on the video watching mode. The **video watching mode switch** will always be floating at the upper right corner to ease users to alter the video watching mode even at the bottom of the page, where the play video button is present.



**Figure 3.4.1.5:** The video playing page in the proposed Android application.

The video playing interface on the smartphone, as shown in **Figure 3.4.1.5**, will be used to play a TCM's video full screen in landscape to provide the largest view available on that device.



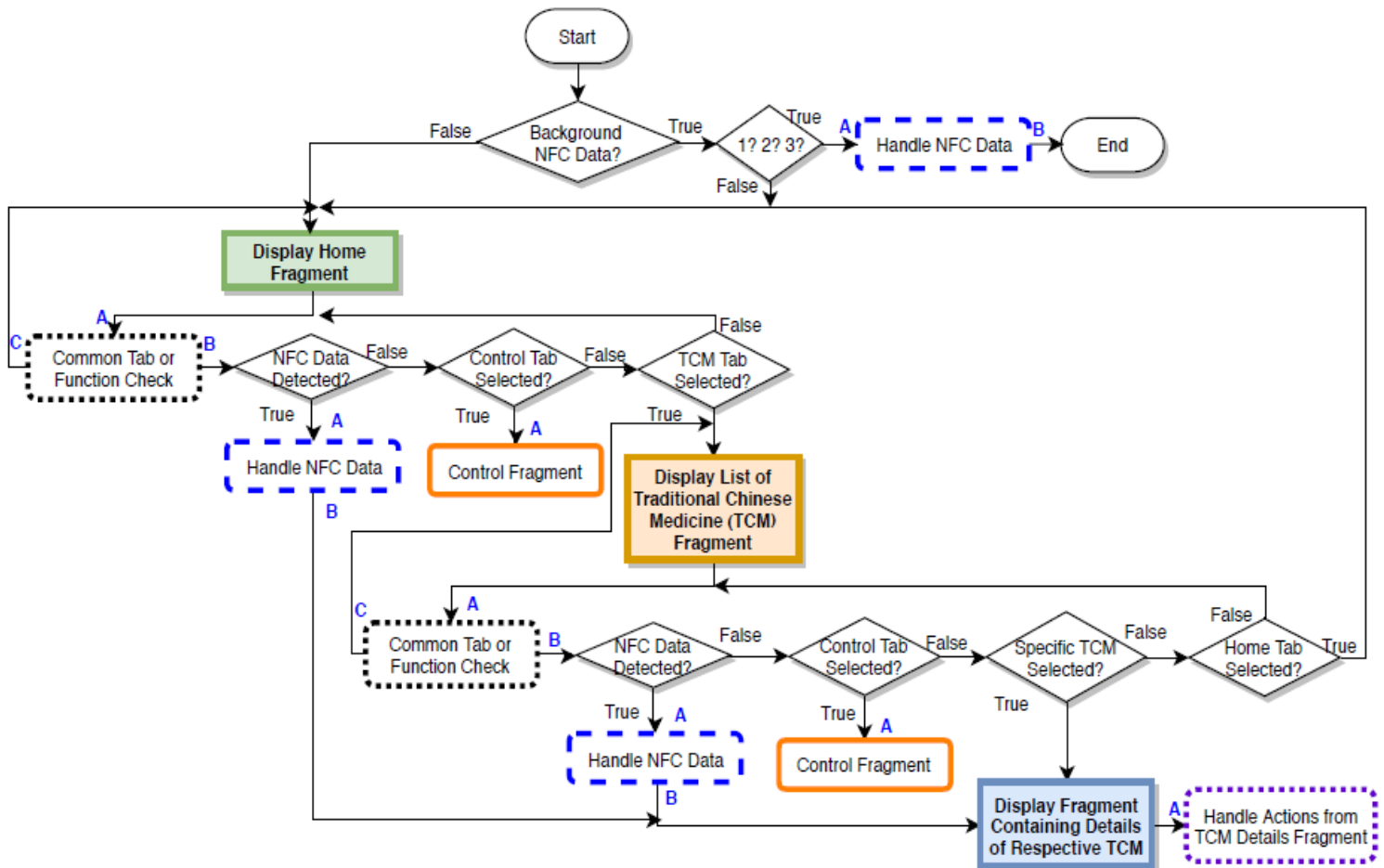
**Figure 3.4.1.6:** The control page in the proposed Android application.

The control page, as shown in **Figure 3.4.1.6**, allows the application to act like a remote control of the video playing on the external large screen in the interactive booth. This interface is only usable in external screen video watching mode (when the **video watching mode switch** is checked). If the smartphone is not connected to a recognized RPi in a TCM interactive booth, this interface will serve no purpose to the user.

Each **TCM video button** allows users to play the video of the TCM with its name displayed in the button, on the external screen. Each TCM with details contained in the application will have its corresponding button. On the other hand, the round **video playback control buttons** allow the video playing on the large screen to be controlled using the smartphone. The control functions include play/ pause, volume up and down, stop, fast

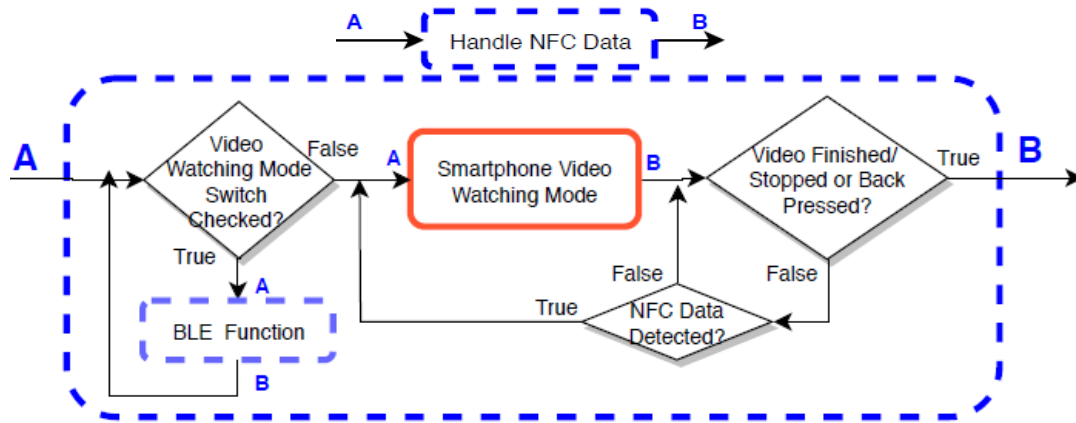
forward and rewind. The icon for each control function will be placed on the corresponding button to ease users in identifying the buttons' uses. The **video watching mode switch** in this interface eases users to change the video watching mode to external screen in case they forgot to change it before coming to this interface.

### 3.4.2 Flowchart of the NFC smartphone application

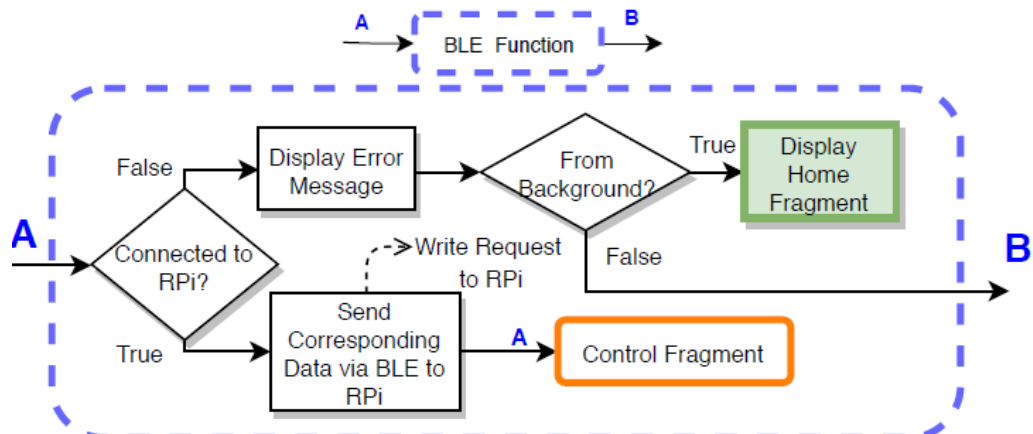


**Figure 3.4.2.1:** The main flowchart of proposed NFC smartphone application.

The main flowchart of the proposed NFC smartphone application is as shown in **Figure 3.4.2.1**. If NFC data detected from background dispatch is “1”, “2” or “3”, which is used to play a specific TCM video, the NFC data will be handled according to the logic in the “Handle NFC Data” block shown in **Figure 3.4.2.2**. If the NFC data detected from background dispatch is not for playing a video or no NFC data is detected from background dispatch, the home fragment will replace the frame layout in the only activity in this application to be displayed on the smartphone and be added to the fragment back stack.



**Figure 3.4.2.2:** The internal structure of “Handle NFC Data” block.

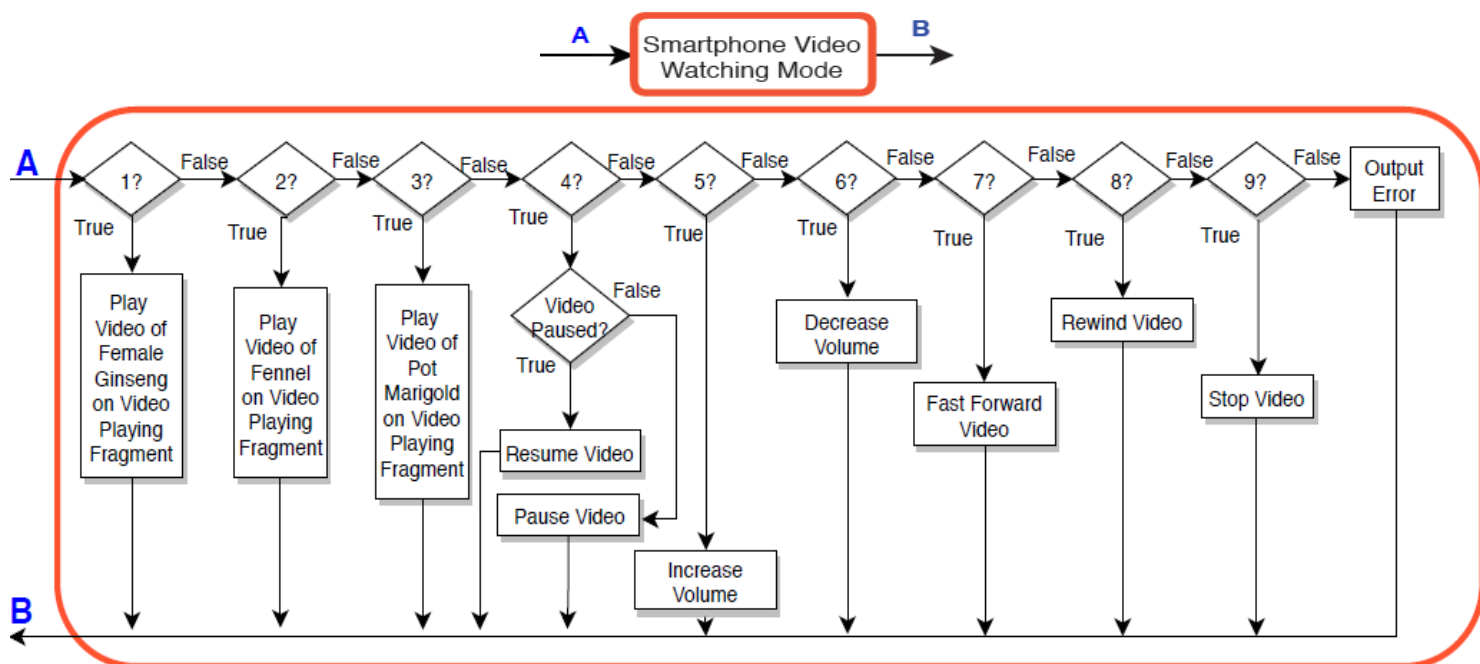


**Figure 3.4.2.3:** The internal structure of “BLE Function” block.

In the “Handle NFC Data” block shown in **Figure 3.4.2.2**, the status of the video watching mode switch will be checked. If it is checked, the application is on external screen video watching mode, meaning any video to be played from the mobile application will attempt to play on the external screen, and the logic in the “BLE Function” block, depicted in **Figure 3.4.2.3** will run. If “BLE Function” block is exited, the application will repeatedly check the status of video watching mode switch from the same interface. On the other hand, if the switch is unchecked, the application is on smartphone video watching mode and the actions each pre-determined unique NFC data is specified to carry out will be performed accordingly on the smartphone. These actions include playing a specific TCM video and video playback control functions as shown in the “Smartphone Video Watching Mode” block.

The detection and processing of NFC data are placed in the only activity in the program. Hence, while the activity is active, whenever NFC data of the matching type is detected, it will be processed according to the logic in “Handle NFC Data” block in **Figure 3.4.2.2**.

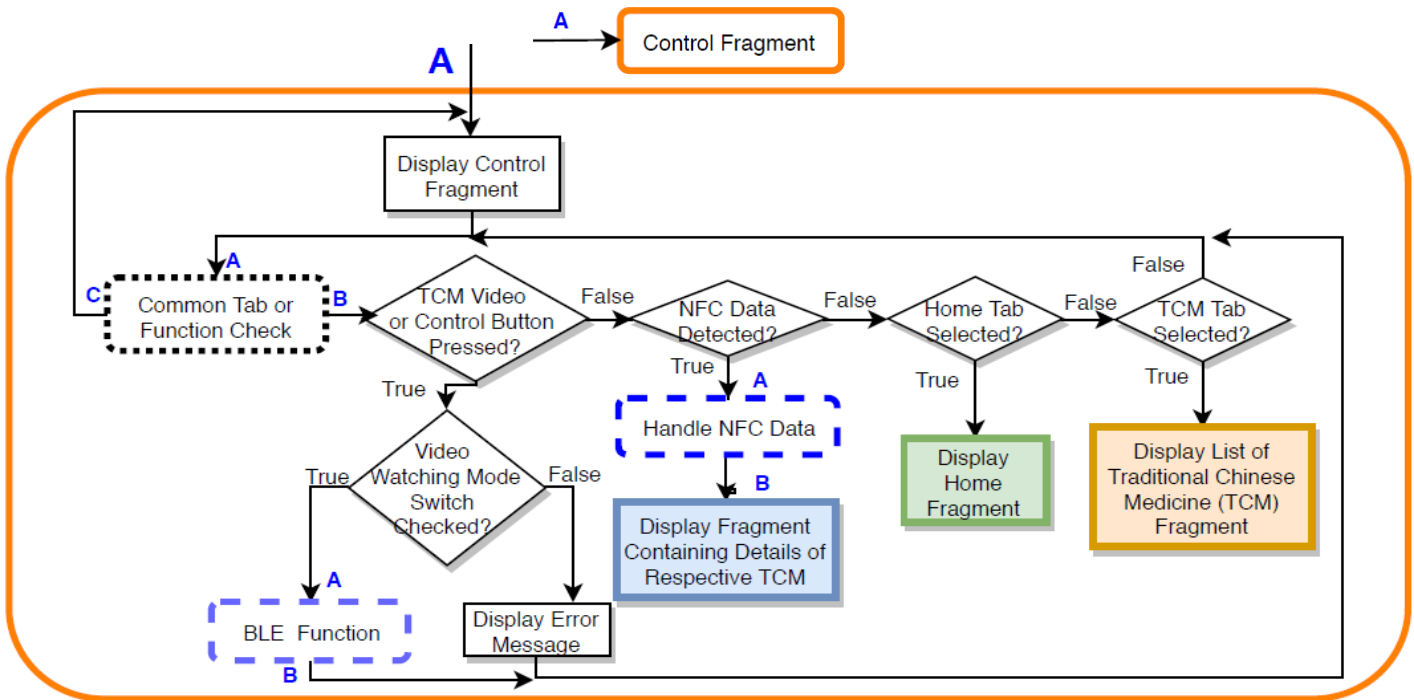




**Figure 3.4.2.4:** The internal structure of “Smartphone Video Watching Mode” block.

**Figure 3.4.2.4** depicts the internal structure of the “Smartphone Video Watching Mode” block. If the NFC data read is “1”, “2” or “3”, the video playing fragment will replace the current fragment to be displayed and be added to the fragment back stack. Then, the TCM videos of female ginseng, fennel or pot marigold will be played on the video playing fragment respectively, according to the content of NFC data. If NFC data read is a value from “4” to “9”, video playback control functions such as play or pause, increase and decrease volume, fast forward, rewind and stop will be performed on the video currently being played on the video playing fragment. However, if the NFC data contains other values, an error message will be displayed.

After exiting the “Smartphone Video Watching Mode” block, while a video is being played (activity is active), detection of NFC data will be carried out by the application. This continues until the video is finished, stopped or the default back button of the smartphone is pressed, where the “Handle NFC Data” block will be exited. Back to where it was left off in **Figure 3.4.2.1**, exiting “Handle NFC Data” block will cause the activity to be stopped.



**Figure 3.4.2.5:** The internal structure of “Control Fragment” block.

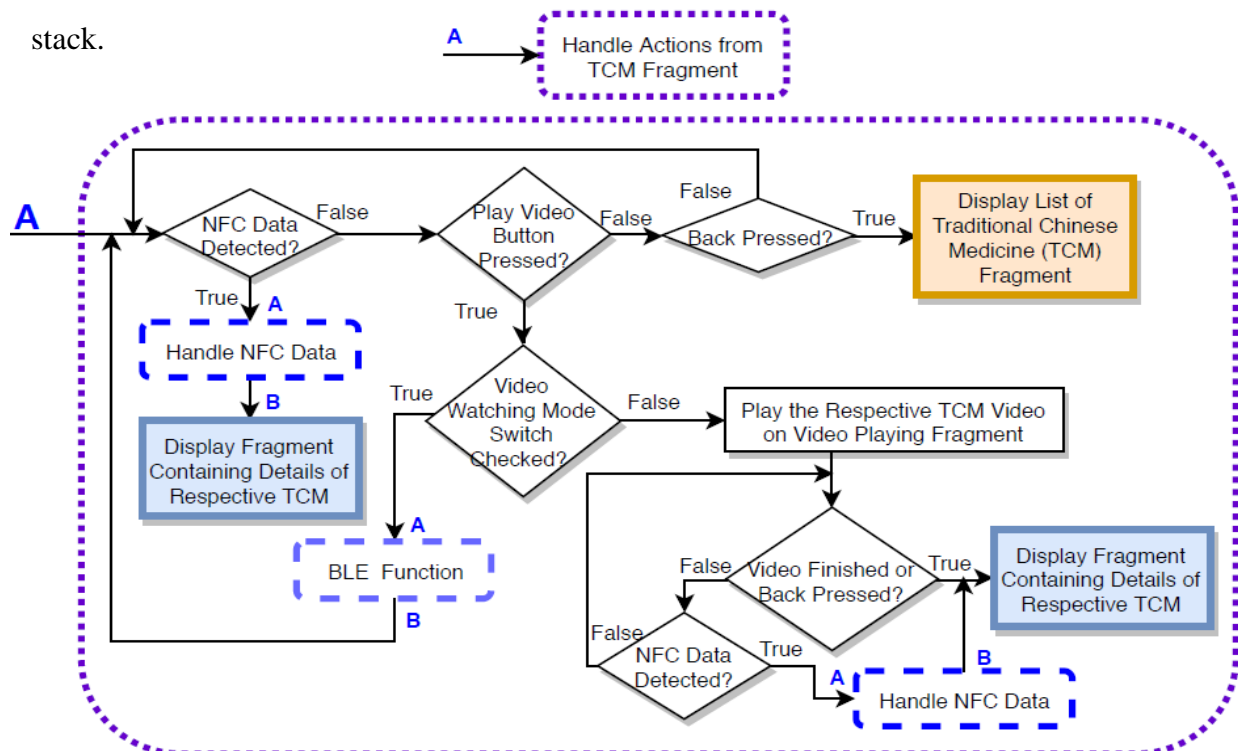
The “Control Fragment” block used in **Figures 3.4.2.1** and **3.4.2.3** has the internal structure illustrated in **Figure 3.4.2.5**. When entered, the control fragment will replace the previous fragment to be displayed on the smartphone and be added to the fragment back stack. Here, several actions can be done: (1) Any of the four actions specified in the “Common Tab or Function Check” block, depicted in **Figure 3.4.2.6**, as they are commonly used across the application. (2) If any of the TCM video or video playback control buttons in this fragment is pressed, the status of video watching mode switch will be checked. If it is checked, the logic follow that in the “Handle NFC Data” block depicted in **Figure 3.4.2.2**. However, if it is not checked, an error message will be displayed as this fragment is specially designed for external screen video watching mode to allow the mobile application to function as a remote control. (2) If NFC data is detected from foreground dispatch, the detected NFC data will be handled according to the logic in “Handle NFC Data” block. (3) If the home tab or TCM tab on the bottom navigation view is selected, the home fragment or TCM list fragment will replace the current fragment, which is control fragment, to be displayed and be added to the fragment back stack respectively. The logic that follows is shown in the main flowchart depicted in **Figure 3.4.2.1**.



to **Figure 3.4.2.5**, the control fragment will be displayed. If none of the conditions are satisfied, this block will be exited.

Back to the main flowchart in **Figure 3.4.2.1**, from home fragment: (1) If any of the actions in the “Common Tab or Function Check” block is performed, the logic in **Figure 3.4.2.6** will run. (2) If NFC data is detected from foreground dispatch, it will be processed accordingly. The exit of “Handle NFC Data” block will cause a TCM fragment containing details of TCM in the last played video to replace the video playing fragment to be displayed and it will be added to the fragment back stack. (2) If the control tab on the bottom navigation view is selected, the logic depicted in “Control Fragment” block, shown in **Figure 3.4.2.5**, will run. (3) If the TCM tab on the bottom navigation view is selected, the TCM list fragment will replace the current home fragment to be displayed, and it will be added to the fragment back stack.

From the TCM list fragment, actions (1), (2), (3) from home fragment can also be performed to get similar responses. Additionally, if a TCM is selected from the list, TCM fragment containing the details of the selected TCM in the form of text and image will replace the TCM list fragment to be displayed, and it will be added to the fragment back stack. From there, the logic will follow the “Handle Actions from TCM Details Fragment” block as shown in **Figure 3.4.2.7**. If the home tab on bottom navigation view is selected, the home fragment will replace the TCM list fragment to be displayed, and added to the fragment back stack.



**Figure 3.4.2.7:** The internal structure of “Handle Actions from TCM Fragment” block.

According to the internal structure of “Handle Actions from TCM Fragment” block illustrated in **Figure 3.4.2.7**, action (2) from home fragment also applies from TCM fragment. Moreover, if the play video button in TCM fragment is pressed, the status of video watching mode switch will be checked. The consequent actions or logic are similar to the case in “Handle NFC Data” block if the switch is checked. If the switch is unchecked, a video playing fragment will replace the current TCM fragment to be displayed, and it will be added to the fragment back stack. Then, the video of the TCM which details were loaded in the latest TCM fragment will be played on the video playing fragment. Until the video finish playing or the default back button of smartphone is pressed, any NFC data detected from foreground dispatch will be processed accordingly. If the video finished playing or the back button is pressed, the TCM fragment containing the details of TCM in the last played video will replace the video playing fragment to be displayed and this fragment will be added to the fragment back stack. From TCM fragment, if the smartphone’s default back button is pressed, the TCM list fragment will replace the current fragment, and be added to the fragment back stack.

## CHAPTER 4 – SYSTEM IMPLEMENTATION AND DISCUSSIONS

### 4.1 Introduction

In this chapter, the design of system explained in **Chapter 3** will be implemented. In **Section 4.2**, the results of system implementation will be shown through screen captures and given explanation on how it can solve the problem identified in **Section 1.2**. Then, in **Section 4.3**, the implemented system will be analyzed in terms of its impact on the society and users, and it will be compared with the related works in **Sections 2.2 to 2.4**. Next, the strengths and weaknesses of the developed system will be discussed in **Section 4.4**. Finally, suggestions on improvement of the implemented system will be included in **Section 4.5**.

### 4.2 Software System Implementation

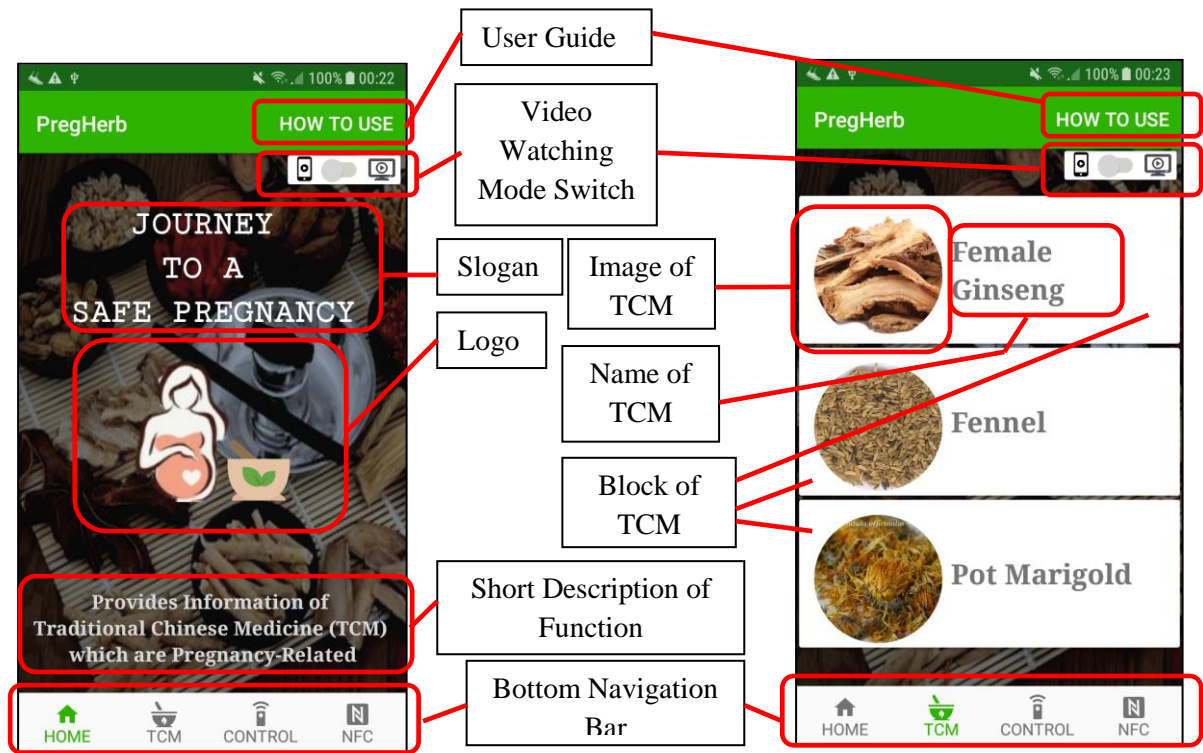
The development of the Near-Field Communication (NFC) smartphone application allows users to obtain and verify information regarding effects of traditional Chinese medicine (TCM) on pregnancy wherever they are, whenever they want, as long as they have access to their smartphones with the application installed. To ensure compatibility on Android smartphone, the mobile application is developed using Android Studio software. This application will store the TCM information as well as the short informative TCM video files that can be displayed to users.

Since the target users are pregnant women and this application will provide TCM, or Chinese herbal medicine, information to users, “PregHerb” is chosen as the name of the NFC smartphone application. Once PregHerb application is installed on an Android smartphone, it will be shown in the list of applications on the smartphone with the application icon and name as shown in **Figure 4.2.1**.



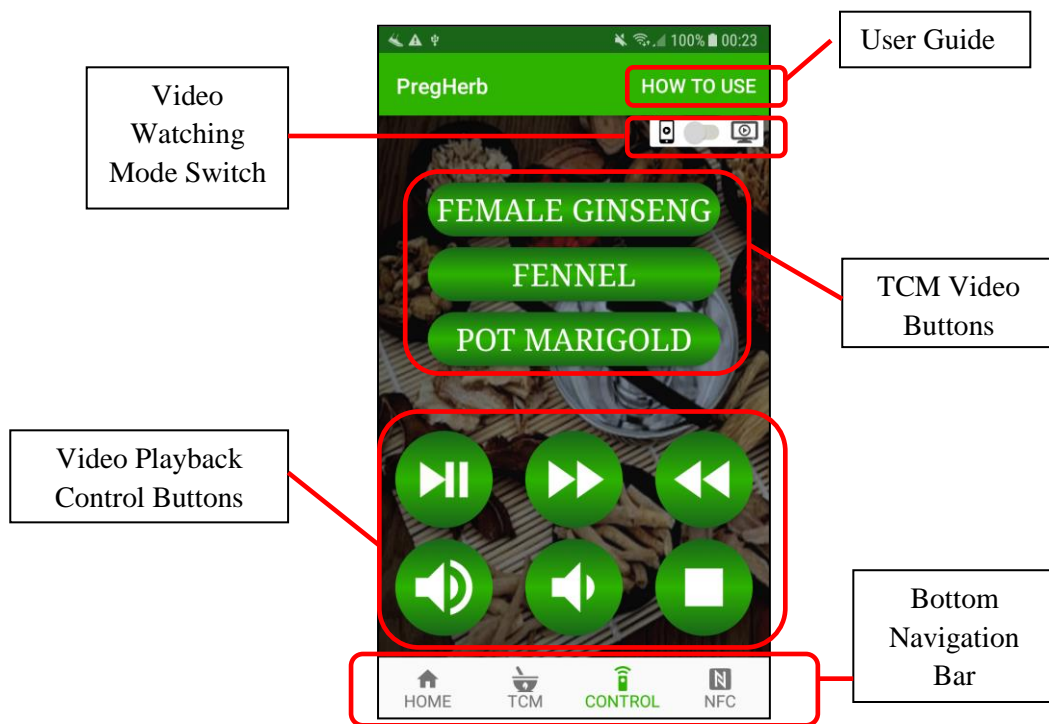
**Figure 4.2.1:** The application icon and name of implemented NFC smartphone application.





**Figure 4.2.2:** Home page of application.

**Figure 4.2.3:** TCM list page of application.



**Figure 4.2.4:** Control page of application.

**Figure 4.2.2** shows the home page, which is the main interface of PregHerb. It will be shown every time the application is started. Users can come to this interface by selecting “HOME” tab on the bottom navigation bar. Selecting different tabs on the bottom navigation bar will display different pages. Selecting “TCM” tab will display the TCM list page which contains the list of TCMs which information can be provided by this application, as shown in **Figure 4.2.3**. Next, the control fragment, depicted in **Figure 4.2.4**, is displayed when “CONTROL” tab is selected. It will also be displayed when the application is on external

screen video watching mode where signals will be sent to play a video on the external screen. “NFC” tab, when selected, will lead user to the NFC settings of the smartphone. This is to indirectly inform users of the application’s NFC functionality as not all users will view the user guide.

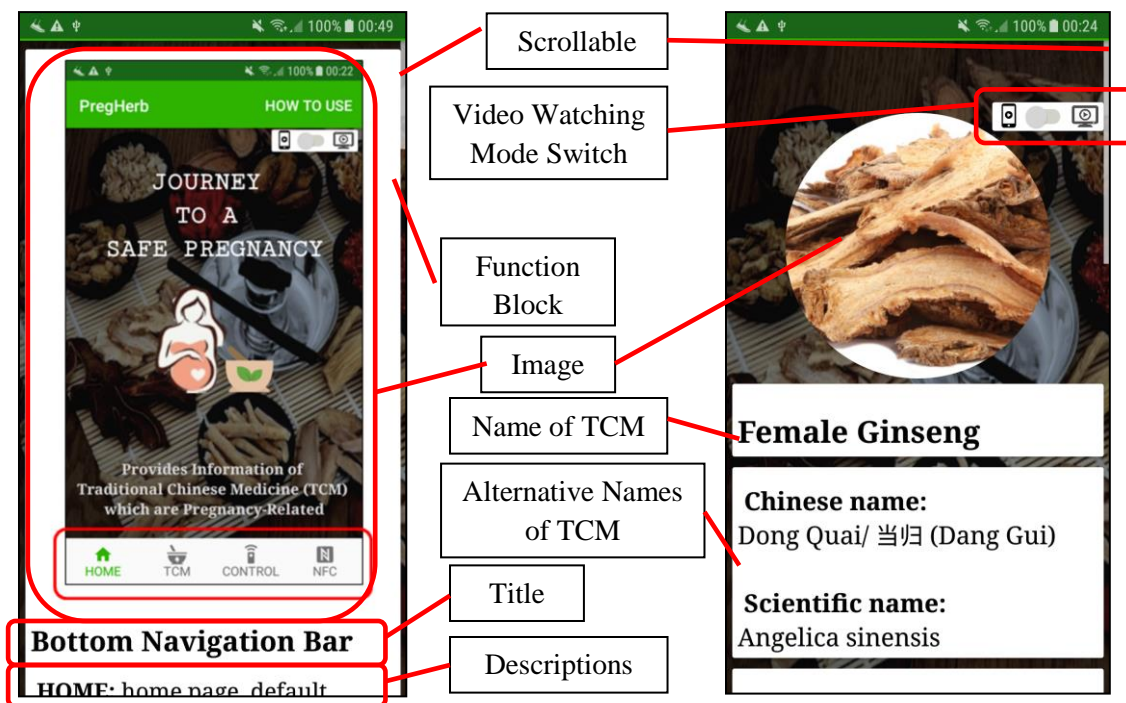


Figure 4.2.5: User guide page of application.

Figure 4.2.6: Top of TCM page of female ginseng of application.

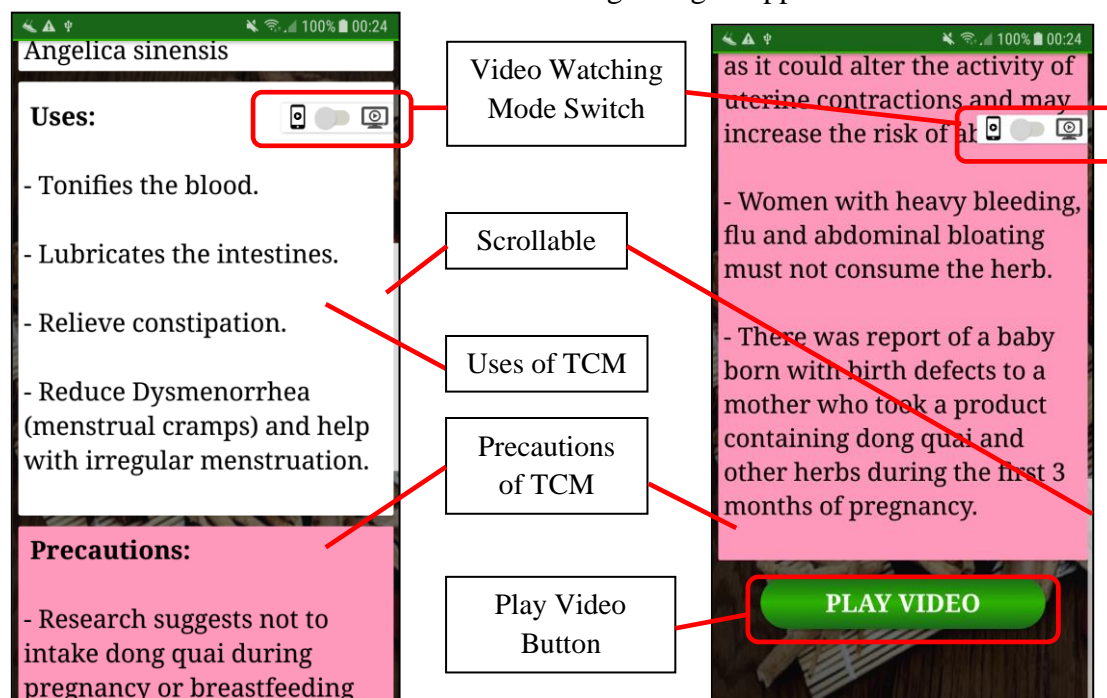


Figure 4.2.7: Middle of TCM page of female ginseng of application.

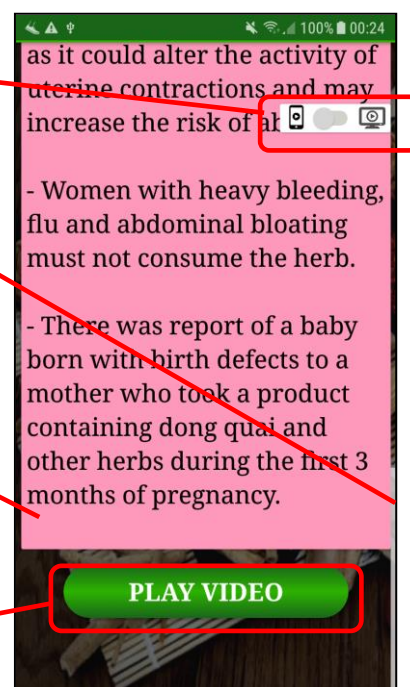
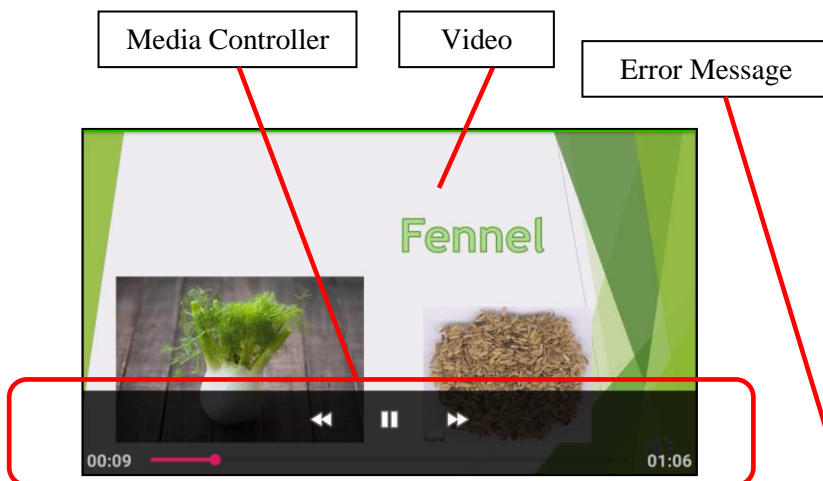


Figure 4.2.8: Bottom of TCM page of female ginseng of application.



From the home, TCM list or control page or interface depicted in **Figures 4.2.2, 4.2.3** and **4.2.4** respectively, the user guide page, as shown in **Figure 4.2.5**, can be displayed on screen by clicking the “How to Use” on the top right corner of the interfaces. From this interface, users can be notified of the special functions of PregHerb and the ways to use them. Hence, they can utilize the functions in PregHerb which provides convenience to them.

From the TCM list page shown in **Figure 4.2.3**, when a TCM is selected from the list, a TCM page loaded with the image, text details on the common English name, alternative names, uses and precautions of that TCM, and a play video button will be displayed. For instance, if female ginseng is selected from the TCM list, the TCM page displayed will be those illustrated in **Figures 4.2.6, 4.2.7** and **4.2.8**, when scrolled from top to bottom respectively. From this interface, users can know the positive and negative effects of taking a particular TCM during pregnancy. By obtaining the proper TCM knowledge, if there exists misconception(s) on this topic, such misconception(s) will be corrected.



**Figure 4.2.9:** Video playing page of application playing video of female ginseng.



**Figure 4.2.10:** Error message due to failure to establish BLE connection.

If the play video button in TCM page is pressed and the application is currently in smartphone video watching mode, the video playing page will be loaded with the video file of the TCM which its information was displayed in the TCM page, as depicted in **Figure 4.2.9**. This page will also be shown to users if the application is in smartphone video watching mode and NFC data responsible for playing a specific TCM video is detected, either from foreground or background dispatch. When a video is played on the smartphone,

its playback can be controlled using either NFC tags with the appropriate contents or media controller displayed on the screen. Therefore, users can obtain information regarding the appearance, names, effects and usage precautions of a particular TCM from the video of this application. However, if the application is in external screen video watching mode when the play video button is pressed, the control page shown in **Figure 4.2.4** will be displayed. From there, if any of the buttons in the control page is pressed while the application is in smartphone video watching mode, the error message shown in **Figure 4.2.10** will be displayed.

Therefore, through the implementation of the proposed system, users can obtain TCM information regarding its positive and negative effects on pregnancy, in the forms of text, image, audio and video. Some users may have misconceptions about the effects of TCM on pregnancy which they did not even realise until they obtain the proper TCM knowledge on the matter. Hence, our system is able to make them realise their hidden misconceptions about this matter and clear the said misconceptions. Thus, the number of pregnant women who fall victim to this problem and suffer the consequences can be reduced.

### **4.3 Preliminary Analysis of the system**

Through the usage of the implemented system, users can obtain the proper knowledge on TCM regarding its good and bad effects on pregnancy. When the target users, who are pregnant ladies, are introduced to this system in the maternity ward or maternal clinic which they frequent for pregnancy checkups, they can be exposed to, realize and correct their hidden misconceptions about the effects of TCM on pregnancy through the TCM information obtained. Hence, the issue of misconceptions about the effects of TCM on pregnancy can be tackled and the consequences of improper TCM consumption during pregnancy which fall on their fetuses and themselves can be avoided. Thus, healthier babies can be given birth to by the target users.

By using the NFC smartphone application, TCM information in the forms of text, image, audio and video can be obtained by users regardless of when and where they are, for as many times as they want. For instance, pregnant women can always check the effects of taking a particular TCM before purchasing or consuming the TCM, thus avoiding the possible negative effects of the TCM on their fetuses and themselves.

Moreover, users can learn the effects of a particular TCM on pregnancy instantly just by tapping the NFC tag containing the data responsible for playing that TCM's informative video on their NFC-enabled smartphones. As humans have different reading, listening and processing abilities, video playback control functions were included to allow users to learn the TCM knowledge at their own pace.

In maternity wards and maternal clinics with TCM interactive booths, once the smartphone is connected to the Raspberry Pi (RPi) through Bluetooth Low Energy (BLE), PregHerb can act as a remote control to allow users to control the video playing on the large screen connected to the RPi in the booth. This can be done using the control page in PregHerb or using the NFC tags prepared in the interactive booths. Hence, mothers-to-be can relax in their seats and enjoy the informative TCM videos without being exposed to the large amount of radiations emitted by the large screen at a very short distance.

The implemented system is expected to be better than the existing solutions discussed in **Chapter 2** in one way or another. In this case, the implemented system will be analyzed by checking whether it overcame the limitations of the related works discussed in **Section 2.5**. By incorporating a mobile application as an essential component, the implemented system was able to solve the low portability limitation of the first related work, NFC coupled with speech synthesizer. This is because mobile applications are designed to run on smartphones, and smartphones are light and highly portable as compared to laptops. Moreover, since smartphones can have embedded NFC readers, there is no need to connect an external NFC reader. Thus, the implemented system allows users to obtain TCM information regarding its effects on pregnancy on-the-go. Next, unlike the second related work, which is barcode in drug packaging, NFC technology utilized in the implemented system is unaffected by lighting conditions of the surrounding. Hence, problems like double scanning or insensitive scanning caused by lighting conditions will not arise in the implemented system. Furthermore, the use of NFC technology in the implemented system allows users to access the desired TCM information, in the form of videos, directly without having to input anything into the system. Hence, the problem faced in the drug information mobile application can be avoided. The impacts of the implemented system with the existing solutions are summarized in **Table 2.5.1**.

**Table 4.3.1:** Summarized impacts of implemented system with the existing solutions.

| <b>Related Work</b>                            | <b>Limitation of Related Work</b> | <b>The Implemented System Solving the Limitation of Related Work</b> |
|--|-----------------------------------|--|
| <b>(1)</b> NFC coupled with Speech Synthesizer | Low portability                   | Use mobile application as smartphones are light and portable         |
| <b>(2)</b> Barcode in Drug Packaging           | Affected by lighting conditions   | Include NFC technology which is unaffected by lighting conditions    |
| <b>(3)</b> Drug Information Mobile Application | Indirect access to information    | NFC technology allows direct access to information                   |

## **4.4 Strengths and Weaknesses of the system**

### **4.4.1 Strengths of the system**

The NFC smartphone application contains information regarding TCMs' positive and negative effects on pregnancy. It allows users to learn and verify their TCM knowledge anywhere, anytime, for unlimited amount of times. Since information is readily available in the system, user can save up the time to search and filter the TCM information retrieved from the internet or other sources.

Next, the use of NFC technology allows instant access to the TCM information essential to expectant mothers, which is ideal to the users. Thus, they would not be demotivated to use the system due to frustrations caused by the waiting time or difficulty in searching for the desired information.

Furthermore, the video playback control functions such as pause, fast forward and rewind can be performed on the TCM videos either using the media controller (smartphone video watching mode), the control page (external screen video watching mode) or using NFC tags with the corresponding data (both smartphone and external screen video watching modes). This allows users to learn the TCM information at their desired pace.

Moreover, the TCM details in the mobile application are in the forms of text, image, audio and video. Hence, users can learn the TCM knowledge in their preferred form. They can even obtain TCM information in several forms to better understand the good and bad effects of TCM on pregnancy.

#### 4.4.2 Weaknesses of the system

Once the system is scaled-up to contain information of more TCMs, the number of NFC tags will become unreasonably large. This is because, currently, one NFC tag is used to store an NFC data responsible for one specific action, either playing a specific TCM video or a video playback control function. If the same strategy is applied, it would take time for users to pinpoint the desired TCM's NFC tag, reducing the efficiency of the system.

In addition to that, once the NFC smartphone application holds information of more TCMs, it may cause inconvenience to users to search for a specific TCM. Although the TCMs are arranged according to alphabetical order, users still have to scroll through the list and identify the desired TCM in order to learn its details when they do not have access to the NFC tags.

For users who are familiar with TCM names which are not included in the application, it may be difficult for them to search for the desired TCM as they would have to remember the other name(s) of the TCM which may be unfamiliar to them. For instance, goji berry can be referred to as gei ji.

Also, the current NFC smartphone application is in English language only. People who are weak in English will not be able to utilize this mobile application to gain the proper TCM knowledge regarding its effects on pregnancy. Other than that, some may prefer to learn the TCM knowledge in Chinese language as most TCM information are represented in Chinese language and there could be words that loss their meanings in translation.

#### **4.5 Future work**

In the future, one NFC tag can be mapped to more than one specific action. The storage spaces of NFC tags are not fully utilized in the implemented system. By packing more than one data into each NFC tag where each data is responsible for one particular action, the total number of NFC tags required can be reduced significantly if the system contains information of a large number of TCM. This can also reduce the amount of money spent on purchasing NFC tags.

Since the TCM are arranged alphabetically, there can be a quick link to each alphabet, directing users to the first TCM which starts with that alphabet in the scrollable TCM list.

There can also be a search bar to allow users to search for TCM names and alternative names to access to a specific TCM without having to go through the list.

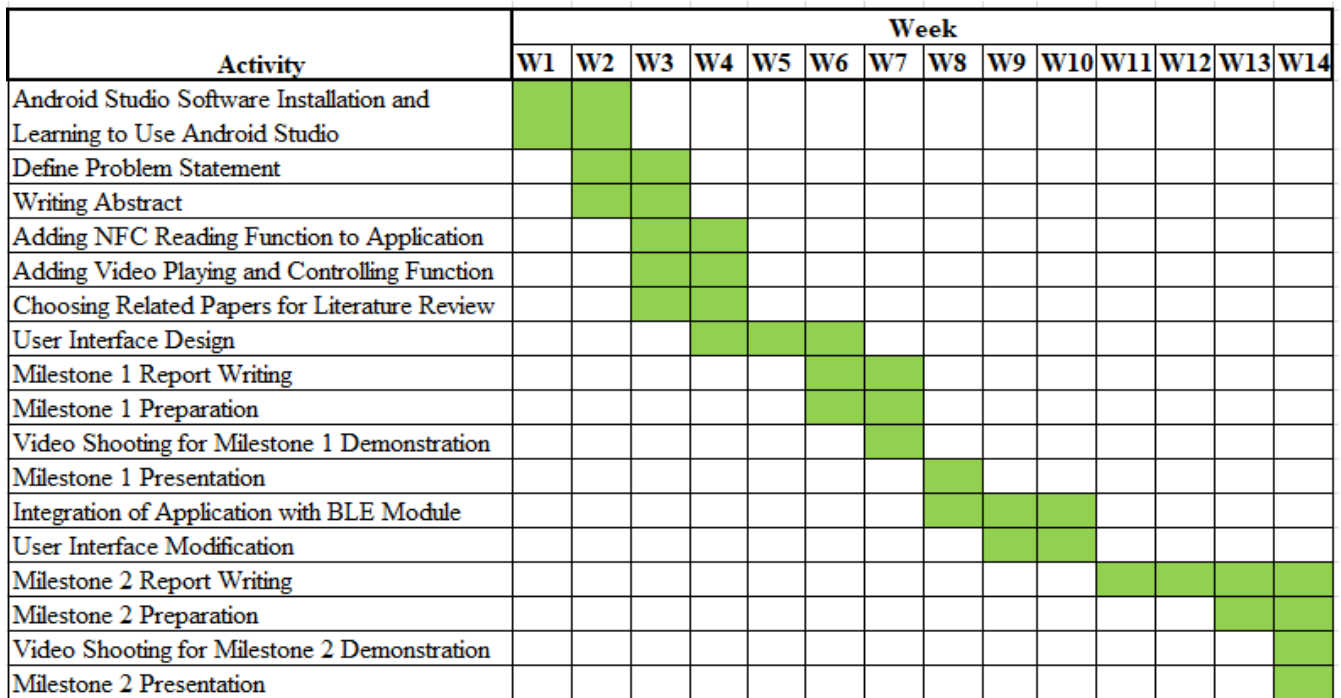
Other than that, the application can be modified to allow users to include remarks on each TCM. Once a remark is added to a TCM, it should be visible from the TCM list, perhaps in the form of a specific symbol to notify users that a remark has been added to a specific TCM. Also, users should be able to search for a particular remark which they have inserted to a TCM using the search bar. Hence, it is now possible for them to refer a TCM with a name which is not included in the application.

Furthermore, different languages, including English, Chinese and other languages which are more commonly used, should be used to represent the TCM information. Users should be able to choose the language that the application and TCM information will be represented. This should be included in the settings of the application which can be changed anytime the user wishes to do so.

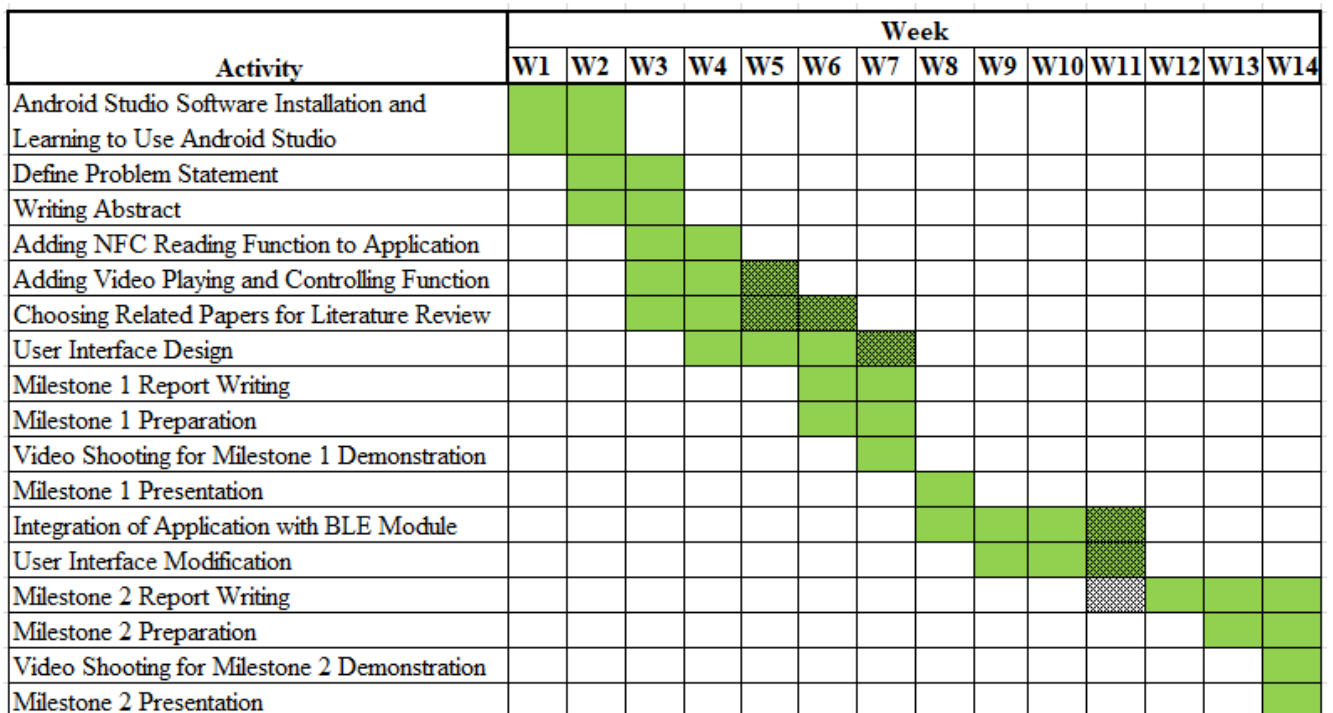
## CHAPTER 5 – PROJECT MANAGEMENT

### 5.1 Project Delivery and Time Management

A Gantt chart was used to schedule the time to be spent on each stage of the project in order to ensure continuous progress and the time constraint can be met. **Figures 5.1.1** and **5.1.2** show the planned and actual Gantt charts for the person in-charged of the development of Android application respectively.



**Figure 5.1.1:** Planned Gantt chart for person in-charged of Android application development.



**Figure 5.1.2:** Actual Gantt chart for person in-charged of Android application development.

The deviations of the actual Gantt chart from the planned Gantt chart are marked with the shaded boxes in **Figure 5.1.2**. Before achieving milestone 1, the changes made in order to play a video from NFC detected from background dispatch took a few days more than planned. Next, the research on related works for literature review took up a long time due to the attempt to find papers which are solving the exact problem identified in **Section 1.2**. Also, the limitations identified from most of the papers were not suitable as they were far beyond our level of expertise. This includes image processing, noise cancelling and 3D modeling. Moreover, the refining of user interface design took longer time than expected due to the feedbacks received from others. As for milestone 2, the modification of user interface which is interrelated with the integration of application with Bluetooth Low Energy (BLE) module also consumed longer time than planned due to the feedbacks on the user interface. Hence, this caused the delay to enter the report writing stage.

## **5.2 Project Budget Planning and Costs Management**

A research was done before purchasing the components and items required to build the prototype of this system to ensure that the budget of RM 300 will not be exceeded. The websites used to purchase the items online and their prices are shown in **Table 5.2.1**.

The components in **Table 5.2.1** were bought after ensuring they are of the lowest price among the online shopping websites, with some of them having discounted prices. The RPi and micro SD card were purchased to develop, store and run a program specific to this system in the TCM interactive booths. The NFC tags and external NFC reader allows NFC technology to be utilized in the system. The baby doll was bought to build the casing of the RPi to hide it from view. The jumper wires were to connect the RPi to the external NFC reader. Overall, the budget was not exceeded, with RM 286.80 spent and RM 13.20 left unused.





**Table 5.2.1:** List of purchased items and their prices.

| No.          | Components   | Proof        | Price (RM)      |
|--------------|--|--------------|-----------------|
| 1            | Raspberry Pi 3 Model B+<br><a href="https://bit.ly/2U0c6tV">https://bit.ly/2U0c6tV</a>   | Figure 5.2.1 | 125.13          |
| 2            | PN7120 NFC Controller SBC Kit for Arduino<br><a href="https://www.nxp.com/search?keyword=OM5577&amp;hdr=1&amp;subcf=Search%20Filter:%20All">https://www.nxp.com/search?keyword=OM5577&amp;hdr=1&amp;subcf=Search%20Filter:%20All</a> | Figure 5.2.2 | 101.95 (USD 25) |
| 3            | Samsung 32GB 95mb/s EVO Plus Class 10 Micro SD Card with Adapter<br><a href="https://bit.ly/2Isi0CI">https://bit.ly/2Isi0CI</a>  | Figure 5.2.3 | 16.60           |
| 4            | Arduino 40p Breadboard Dupont Jumper Wire (20cm) Female to Female<br><a href="https://bit.ly/2T94FTQ">https://bit.ly/2T94FTQ</a>   | Figure 5.2.4 | 3.00            |
| 5            | NFC Tag NTAG213 Sticker - 5 pieces<br><a href="https://bit.ly/2DQX3M0">https://bit.ly/2DQX3M0</a>  | Figure 5.2.5 | 15.00           |
| 6            | Reborn Baby Doll Soft Vinyl Silicone Lifelike Newborn Baby for Girl Gift<br><a href="https://bit.ly/2IoJGwW">https://bit.ly/2IoJGwW</a>  | Figure 5.2.6 | 25.13           |
| <b>TOTAL</b> |  |              | <b>286.81</b>   |


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| Image   | Product Name   | Model | Quantity  | Unit Price | Total    |
|---|--|-------|---|------------|----------|
|  | Raspberry Pi 3 Model B+ (Latest Version) + 1 Yr Warranty<br>Reward Points: 166 | E3635 | 1   | RM166.00   | RM166.00 |

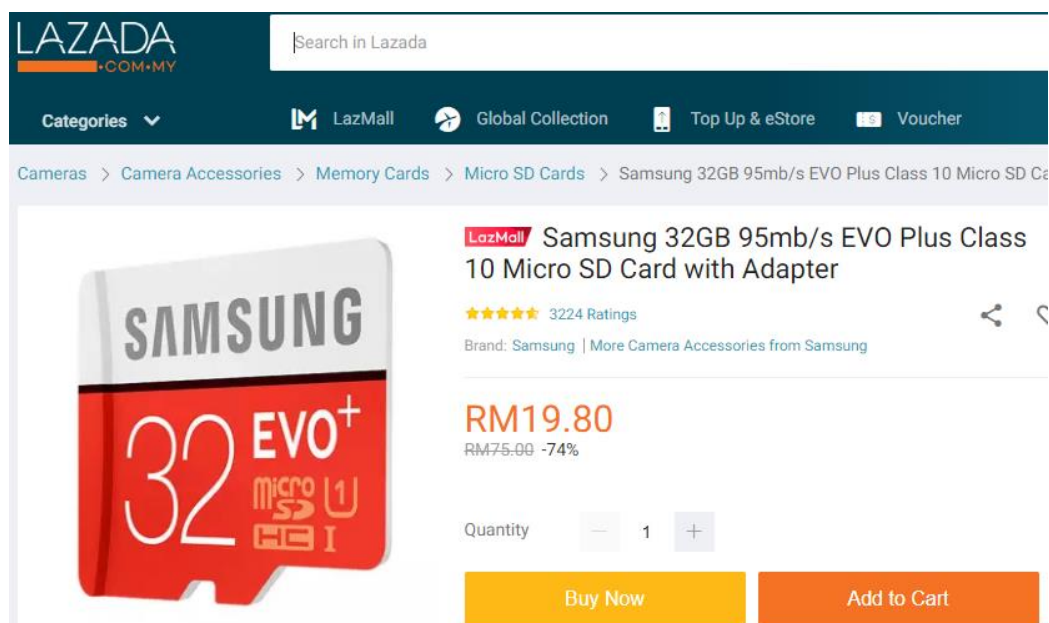
**Figure 5.2.1:** Raspberry Pi purchased from Autobotic website.

## Shopping Basket

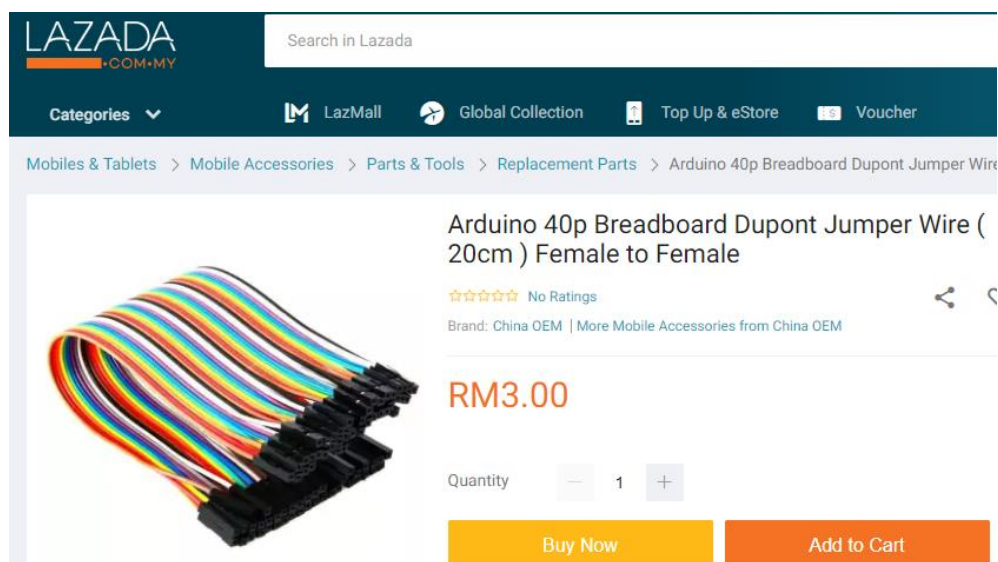
» Basket »Address & Project »Summary/Payment »Confirmation

| #   | Item  | Item Type | Availability | Quantity     | Unit Price (US\$) | Subtotal (US\$) | Remove      | Registration Number |
|---|---|-----------|--------------|--------------|-------------------|-----------------|-------------|---------------------|
| 1   | Ordered Part # : OM5577/PN7120ARDM<br>12NC: 935308904699<br>Part Description: - | Tool      | In stock     | <div>1</div> | US\$25.00         | US\$25.00       | <div></div> | -                   |
|   |   |           | Total (US\$) |              |                   | 25.00           |             |                     |
| (This amount does not include Tax, Shipping & Handling charges) |   |           |              |              |                   |                 |             |                     |

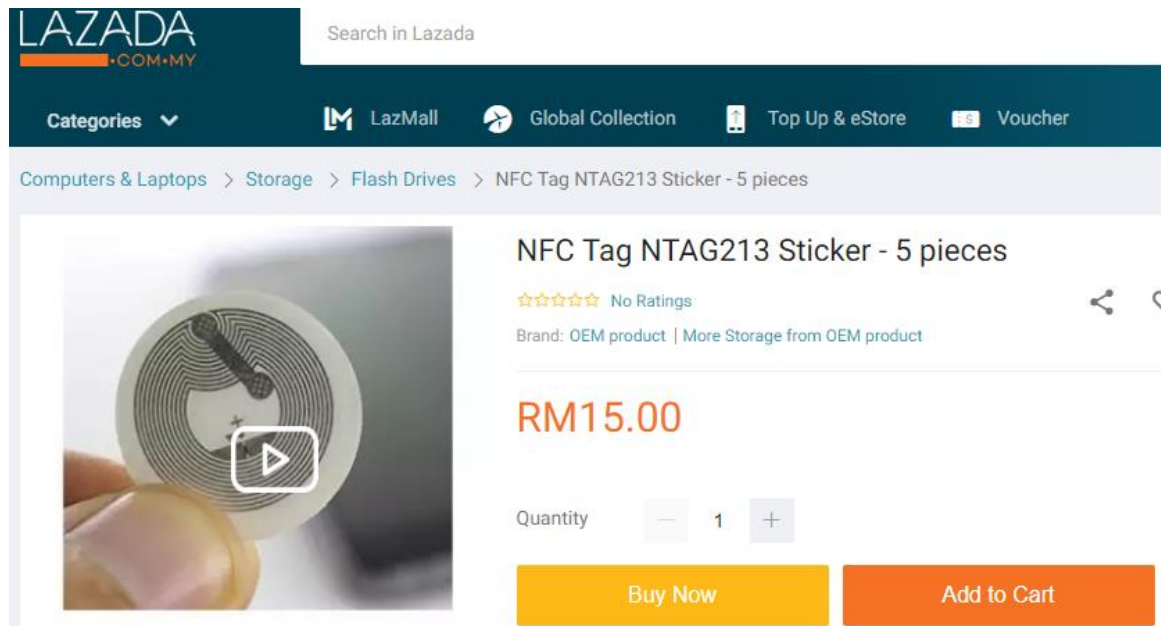
**Figure 5.2.2:** External NFC reader purchased from NXP website.



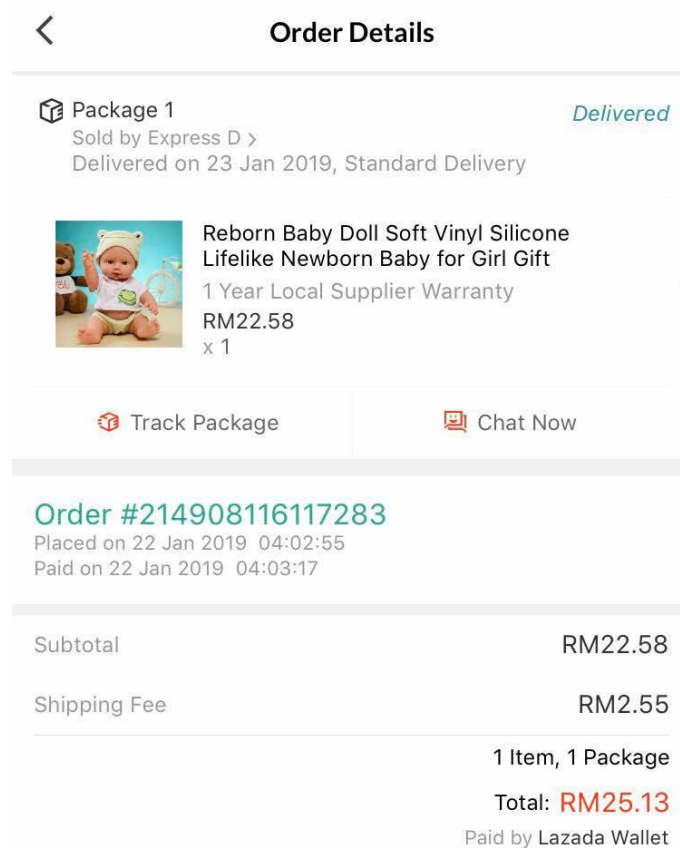
**Figure 5.2.3:** Micro SD Card with Adapter purchased from LAZADA website.



**Figure 5.2.4:** Female to Female jumper wires purchased from LAZADA website. 36



**Figure 5.2.5:** NFC tags purchased from LAZADA website.



**Figure 5.2.6:** Baby doll purchased from LAZADA website.

### 5.3 Project Team and Individual Responsibilities

This project team consists of three members: Chee Sze Yan who is in-charged of developing the RPi program, Hor Sui Lyn as the person responsible to develop the Android NFC smartphone application, and Liyana Safinaz binti Abdul Kadir who carries the responsibility to integrate the Android application and the RPi.

As the person with the responsibility to develop the Android NFC smartphone application, I designed the user interface and wrote the source codes for the logic as well as the user interface of the said application. My teammate, Chee Sze Yan, coded the Python program for the Raspberry Pi. She also came out with the designs and prototypes of NFC tags and the casing to embed the RPi which are suitable to the problem identified in **Section 1.2** and to be placed in the TCM interactive booths in maternity wards and maternal clinics. Liyana Safinaz, on the other hand, wrote the source codes to allow the communication between the smartphone application and the RPi which uses BLE technology. She is also the main contributor of the production of TCM videos included in our system and the editing the demonstration videos.

## **CHAPTER 6 – CONCLUSION**

In essence, the setup of this system in traditional Chinese medicine (TCM) interactive booths in maternity wards and maternal clinics can expose users, especially pregnant women, to the possible misconceptions about the effects of TCM on pregnancy and clear those misconceptions by providing the proper TCM knowledge to users.

PregHerb Android NFC smartphone application includes the TCM information in text and image forms, allowing users to navigate through the application to obtain the desired TCM information. Besides that, users can play the TCM videos on either the smartphone or the external screen in the TCM interactive booths in maternity wards and maternal clinics either by using the NFC tags or by using the buttons in the mobile application. Hence, users, especially expectant mothers who are directly affected, can obtain the proper TCM knowledge anytime, anywhere, and even instantly if NFC tags are used.

User manual is provided in the application to guide users on the usage of the system. Moreover, the user-friendly and intuitive design of the application ensures users will not be demotivated to use the system. Other than that, this system is specially designed for the target users, who are expectant mothers, by taking their preferences into considerations.

Overall, this system has the potential to increase awareness of pregnant women, who are directly affected, of the misunderstandings about effects of TCM on pregnancy. Hence, they can be informed of the precautions of consuming different TCMs during pregnancy and avoid tragedies due to their ignorance and carelessness besides increasing the change to get a healthy baby.

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