INTERACTIVE FOOD MENU APPLICATION VIA AUGMENTED REALITY

BY

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ABSTRACT

This project is an Augmented Reality (AR) based interactive food menu mobile application that allow customer to view AR 3D food models which can display an appropriate representation of both appearance and portion. As the digital trend continues, restaurant try to come up with an innovative way to attract more customers. However, most of the restaurant still using traditional printed food menu where the food images often mispresent the quality and portion size of the menu item. This has results in a disappointment on the customer side since they are not able to see the real look of the food in advance. Hence, the motivation of this project is to enhance and improve the experience of customers on ordering food in restaurant. This project will become an effective marketing tool for the restaurant, from popular fast-food chains to high-end fine dining outfits. This project aims to provide convenience for customers to view AR 3D food model and enjoy an immersive AR experience during the process of food ordering. Besides, this project is focus on provide an easy access to important information about the ingredient and nutrition of dishes. With the AR technology, it will be more optimised and responsive to give customers exactly what they are looking for. This AR app is aiming to bring the next big technology-influenced change for restaurants and culinary industry in coming few years. The Agile methodology approach will be used to develop this project. The main software that used to develop this project are Android Studio, Firebase, and Sceneform SDK plugin. As a result, this application has a great potential to benefit customers and allow them to enjoy an immersive AR experience during the process of food ordering.

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LIST OF ABBREVIATIONS

AR	Augmented Reality
VR	Virtual Reality
2D	2-Dimensional
3D	3-Dimensional
SURF	Speeded Up Robust Features
DART	Designers Augmented Reality Toolkit
HMD	Head-Mounted Display
GPS	Global Positioning System
JDK	Java Development Kit
SDK	Software Development Kit
NDK	Native Development Kit
JRE	Java Runtime Environment
GUI	Graphical User Interface

CHAPTER 1: INTRODUCTION

In this chapter, problem statement and motivation, project scope, project objectives, project contribution and report organization will be presented.

1.1 Problem Statement and Motivation

Recently, as competition in the food industry intensifies, restaurants offering unusual foods are increasing to meet customer demand. However, most of the restaurateur still using the traditional printed menu which contain less variety of information about their dishes. The information provided by traditional printed menu is limited which consist only few numbers of food image without the appropriate portion and size of food. According to [1], 'small size of portion is always a popular customer complaint in restaurants.' Using traditional printed menu, customers might mislead if the food that have been ordered did not resemble the food menu that is referring to a specific dish. Therefore, it is important to solve the problem of food portion size accuracy to ensure every dish would be consistent in size to have manageable expectations. Hence, by applying AR technology on food menu, customer will have better understanding of restaurant's dishes by viewing AR 3D food model that can display an appropriate representation of both appearance and portion.

Besides, people nowadays are more focus on their health and looking into finding out the nutrition and calories of food. The nutrition and ingredient used will be the concern for most of the people in this present era. Hence, the identification of food ingredients become one of the challenging tasks since most of the restaurant still practices traditional printed food menu which consist only few numbers of food image without ingredients being used. Therefore, customers will not be able to understand and identify the food ingredients and nutrition information they had no prior knowledge of. Besides, customer who would like to experience some unusual dishes will be restricted by the food ingredients being used especially for those who have dietary restrictions. To solve this problem, food such as pizza with ingredients being used has been attached as 2D image on our food menu application. Besides, AR has been also applied on the food menu so that customer can have an exact look of real food during the process of food ordering. In this way, they can request to change the ingredients used which they dislike before ordering.

Sometimes, there might have some tourists from different country who visit the restaurants. With the current existing food menu, it will be very challenging for travellers to experience local cuisine due to the communication gaps and language barriers. Some customers who have different native languages might find it difficult and challenging when ordering the food. Some of them might be struggling to select the meals if their language knowledge is limited. The issues and worries will likely to be occurred for the first-time dining travellers without visually preparing understandable food menu for them before ordering the food. It might cause some discomfort of customers when ordering due to the food and language barrier that might affect their ethics, religion, or health. Therefore, by applying AR technology on food menu, it can provide engagement and makes travellers' food experience manageable. Through this way, travellers can truly experience and discover the local food in a simpler and easier way which can help them to choose their desired dishes.

As the digital trend continues, creativity and innovative will become one of the biggest challenges. This project will become an effective marketing tool for any type of restaurant, from popular fast-food chains to high-end fine dining outfits. With the AR technology, it will be more optimised and responsive to give the customers exactly what they are looking for. Therefore, an augmented reality food menu system is needed to provide more realistic and vibrant images than the existing traditional printed menu. Augmented reality-based restaurant will be the latest trend in restaurant marketing by providing AR food menu with digital content that designed to provide an engagement between food menu with customers as well as improve guest experience. This AR food application is aiming to bring the next big technology-influenced change for restaurants and culinary industry in coming few years.

1.2 Project Objectives

The purpose of this project:

1. **To develop a mobile food menu application with AR technology for user to view virtual food with 3D models which displays an appropriate representation of both appearance and portion size.**

   The main objective of this project is to create an AR food menu mobile application which brings benefits and convenience to the user and restaurateurs. User can choose their desire dishes based on this AR food menu application. This application provides a more precise and easier platform which can allow users to view the virtual food with high quality in 3D models which display an appropriate representation of both appearance and portion. Therefore, it can provide a better understanding of the food menu for user and to enhance the easiness of user when ordering the food without wasting their time. There is also a search function which can allow user to choose their desired dishes. This application has a great potential to benefit users and allow them to enjoy an immersive AR experience during the process of food ordering.

2. **To propose a food menu application that provide engagement and interaction between user via augmented reality technology.**

   Next, this application aims to provide engagement and interaction between user and food menu via augmented reality technology. Lack of interaction in traditional food menu is another major issue for customer to understand food menu effectively. As stated in problem statement, customers might find it difficult to understand food menu with full of lengthy words which resulting in lower expectation. Hence, an interactive mobile augmented food menu can transform the boring food order process into an engaging AR experience. Besides, it also elevates user’s interest and improve the attractiveness among customers. Interaction is one of an essential element required in the application. Therefore, user's involvement will be more than usual compared to traditional food menu. In this way, they would tend to order more unusual dishes they had no prior knowledge of.

3. **To embed photo of food ingredients used and nutrition information in the food info page for user to learn and understand the food calories and ingredients.**

Besides, this application aims to enhance the food nutrition knowledge of the user. This application will embed food nutrition information and food description in food information page as well as part of the dish for user to learn and understand the food calories and the used of food ingredients. Therefore, user can know the used of ingredients and food nutrition information they had no prior knowledge of. In this way, they would tend to order more unusual dishes that restricted by their food and ingredient knowledge especially the one who have dietary restrictions. User who does not have basic knowledge about the food nutrition can also easily understand and learn while they are ordering the food.

4. **To implement AR technology on food menu to overcome communication gaps and language barriers of user during food ordering process.**

Communication gaps and language barriers during food ordering is a crucial problem faced in the restaurant and culinary industry. As stated in problem statement, customers with different native language may have difficulties to understand the information provided in the food menu. By applying AR technology on food menu, user will be able to understand through the illustration of food using AR instead of understanding the provided information in words. A picture is worth a thousand words. AR is easier to use and more user-friendly as compared to the traditional food menu. With AR, it can provide immersive experience towards target audience, benefit those customers who have trouble on reading as well as overcome the issues of language barrier to make travellers' food experience manageable.

1.3 Project Scope

The scope of this project is to focus on the development of Augmented Reality (AR) based interactive food menu mobile application. This project will be developed in Android version and this application is a Markerless based Augmented Reality (AR) where it does not require a special marker to be detected by phone's camera. It does not require prior knowledge of a user's environment to overlay virtual 3D content into a scene and hold it to a fixed point in space. This project can allow user to virtually preview their food menu choices before making an order. The AR food menu can allow user to point their smartphone devices at the physical environment to view an AR based content. With this Markerless AR, it places virtual 3D objects in the physical environment depending on the environment's real features rather than identifying markers. Markerless AR experiences can eliminate the need for object tracking systems due to the advancements in cameras, sensors, processors, and algorithms capable of accurately detecting and mapping the real-world.

Hence, it can directly render realistic 3D scenes in AR and provide user the virtual view in different angles and dimensions of AR 3D food model. This project will consist of ten AR 3D models of restaurant foods such as burger, pizza, french fries, pancake, snacks, and desserts. This project aims to focus on displaying virtual food which consist of multiple 3D digital rendering photographs of food on the plate. With the AR technology, it can display food in AR 3D models where all the model dimensions are identical to the food they present, which can display an appropriate representation of both appearance and portion.

This project will focus on the function which can provide an overview of 3D food model, which allows user to perform drag and move, rotate, and perform scaling by enlarging or minimise the illustration of food. Hence, it engages customers and provide interaction with users in the restaurant when they are ordering the food. This project can provide user to view in different angles and dimensions of 3D virtual food. Besides, the implementation of AR technology in food menu app can be easily navigated from user's smartphone with mouth-watering images so that the issues of language barrier can be resolved. In addition, it can also provide easy access to important information about the food ingredient and nutrition value of dishes to improve the food selection process and to enhance user experience when dining. In this

way, it can create a unique atmosphere that compliments the meal. The proposed application will combine augmented reality technology to provide information about food on the menu which can provides more realistic and vibrant images than the existing printed menu.

1.4 Impact, Significance and Contributions

Due to the recent improvement in the quality of life and the increasing of interest in food, the number of people looking for restaurants and special foods has increasing significantly. Customer who visits the restaurant are interested to know the used of food ingredients as well as the information about the origin, cooking method and efficacy of the food. However, most of the restaurant still maintain the original business mode where most of the menus served are simple and consists only several images with text. Those traditional printed menu causes a difficulty for restaurant to come up with a unique selling point in an oversaturated food industry. As the digital trend continues, innovative and creativity has become one of the biggest challenges in the present era. Therefore, this project has introduced an AR technology which brings an innovative and unique idea to stand out from all the competitors. The AR food menu will become an efficient marketing tool for any type of restaurant. This proposed solution has introduced a smart device interactive food menu that would contain an augmented reality features with some useful function. It will be reproduced in 3D with the help of photogrammetry method. This project can show how the merge of culinary arts with technology that can help to assist in building trust between restaurants and customers.

Nowadays, creativity and visual depiction can be valued as one of the ways to elevate customers interest when they patiently order for their meals. With the proposed AR food menu, it can bring benefits and convenience to the user and restaurateurs. This project has introduced an AR technology which is an innovative and unique idea to stand out from all the competitors. This application provides a more precise and easier platform that can allow users to view virtual food in 3D models which display an appropriate representation of both appearance and portion.

With adoption of AR technology, it will be interesting and fun to elevate customer's food experience visually with augmented reality to meet their expectations. In this way, food industry businesses can provide more engagement with their customer in a new

creative and innovative way. The project shows the benefits of incorporating a digital food menu with augmented reality to promote the immersion of user experience and elevate the gourmet food experience in the culinary world.

1.5 Report Organization

This report is organised into 6 chapters: Chapter 1 Introduction, Chapter 2 Literature Review, Chapter 3 System Methodology and Approach, Chapter 4 System Design, Chapter 5 System Implementation and Testing, Chapter 6 System Evaluation and Discussion, Chapter 7 Conclusion and Recommendation.

The first chapter is the introduction of this project which includes problem statement and motivation, project scope, project objectives, project contribution, highlights of project achievements, and report organisation. The second chapter is literature review that carried out on several existing Augmented Reality (AR) applications in the market to evaluate the strengths and weaknesses of each application. Besides, paper reviewed on journal articles of Augmented Reality based food menu system and review of existing technologies has been carried out in this chapter. The third chapter is the overview of system methodology and approach. The overall system flow diagram, user requirements, system architecture diagram, network diagram, use case diagram, use case description and activity diagram has been discussed in this chapter.

The fourth chapter is discussing the overview of system design. This chapter describes in detail on how the project is developed. The top-down system design diagram such as system flowchart, system block diagram, user interface and storyboard, system modules and features has been carried out. The fifth chapter is regarding the details of system implementation. This chapter describes on how to implement the hardware and software setup on the system. Besides, system operations, settings and configuration of project has been discussed in this chapter. Furthermore, the sixth chapter reports the system evaluation and discussion. The system testing, performance matrices and testing result has been carried out. Moreover, project challenges, objective evaluation and novelty of the project has been discussed in this chapter. Lastly, the last chapter is discussing the conclusion and recommendation of the project future enhancement.

CHAPTER 2: LITERATURE REVIEW

In this chapter, some relative work that have been done by other researchers and developers will be presented. There are two papers, and four existing apps were reviewed in this section.

2.1 Review on Journal Articles

2.1.1 Papers Reviewed on Design and Implementation of Augmented Reality Based Food Menu Guidance System

In the past few years, many researchers about Augmented Reality based system have been done by researcher in different field. The research in Augmented Reality (AR) based Food Menu Guidance System was done by [2]. They claimed that augmented reality technology is used to guide the food menus and grafting all the food to the customers who visit the restaurant. The food menu guidance system provided augmented video that consist of variety information on a smartphone or tablet PC. The proposed system uses AR technology and video content that combined information of the food on the menu. Thus, the food is more realistic and comes with appealing rich visual effects and with lively video as compared to provide only the food information on the existing menu board in the form of simple image. Therefore, it will be more convenient to the guests where they can know the fun food origin, cooking process as well as the nutrients of the food. Augmented reality creates all environments with computer programs unlike the virtual environment that the user sees and feels. Various information such as data, images, and 3D models can be added to the beam and the information is superimposed and displayed on a smartphone or a tablet. Augmented reality creates virtual objects in the original environment. It is a technology that makes the food look like an object before serves to the guests. The example of AR systems that related to food as shown in Figure 2.1.1.1

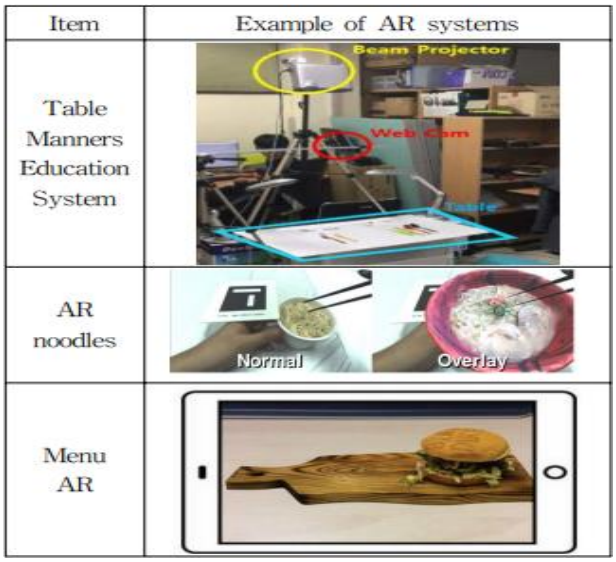


Figure 2.1.1.1 Augmented Reality Systems Related to Food [2]

In this paper, the cooking process for each food through the menu board and ingredients of origin are provided as a video through augmented reality. They have proposed a new version of guidance system which can guide to the suggested menu board. The system is a menu board that using the camera of a smartphone or a tablet PC. When it is illuminated, it will align on the food menu and the food menu is recognized and match it over the food which can provides a variety of information about food in the video.

For this purpose, video augmented reality is divided into two steps where the first step is to provide service using smartphone or tablet so that the PC can identify and recognize the food on the menu board. This is the step where it can store image and extract the feature points. Then, the second step is to formulate the menu board using the extracted feature points. With this feature points, it can match and play videos in each different location with high accuracy. The preliminary steps for menu image recognition as shown in Figure 2.1.1.2 and the architecture of building a feature database as shown in Figure 2.1.1.3 The steps for menu recognition and enhanced video as shown in Figure 2.1.1.4

Step	Description
1	Shoot the menu board with the tablet PC's camera. Build an image database for the menu board.
2	The feature points of the images stored in the menu image database are extracted.
3	Store the extracted feature points in the database.

Figure 2.1.1.2 Preliminary Steps for Menu Image Recognition [2]

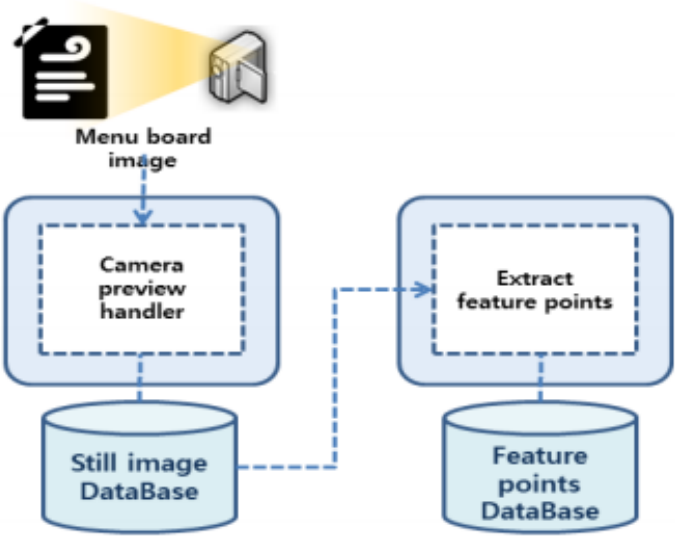


Figure 2.1.1.3 Architecture of Building a Feature Database [2]

Step	Description
1	Shoot the menu board with the tablet PC's camera.
2	Extract feature points for acquired images
3	Similarity check is performed on the stored feature database using SURF algorithm
4	When the video is matched, the video is loaded and matched to the screen
5	If the images do not match, execute step 1 again.

Figure 2.1.1.4 Steps for Menu Recognition and Enhanced Video [2]

For the menu board recognition and video enhancement stage, Figure 2.1.1.5 below shows the process of enhancing the video by recognizing the menu board. First, the camera of the smartphone or tablet PC point to the menu board to acquire the camera image. The feature points will then be extracted from the acquired image. In camera footage, the extracted feature points will be stored in the feature point database. Then, it used the SURF algorithm to check the points for similarity and perform an attempt to match the image.

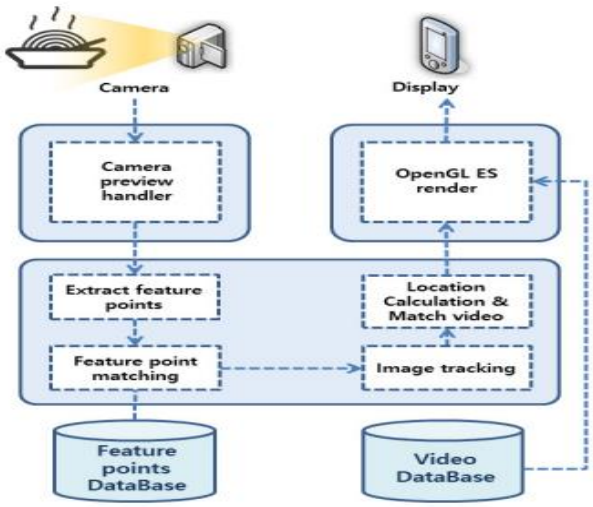


Figure 2.1.1.5 Architecture of Menu Board Recognition and Video Enhancement Stage [2]

When the matching is made, the camera image frame-by-frame is tracked, it coordinates to match the video using the following formula as shown in Figure 2.1.1.6

$$\begin{bmatrix} x_c \\ y_c \\ z_c \\ 1 \end{bmatrix} = \begin{bmatrix} R_{11} & R_{12} & R_{13} & T_x \\ R_{21} & R_{22} & R_{23} & T_x \\ R_{31} & R_{32} & R_{33} & T_x \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_m \\ x_m \\ z_m \\ 1 \end{bmatrix}$$

Figure 2.1.1.6 Calculation of Camera Coordinate System [2]

The X_c, Y_c, Z_c, denote the camera coordinate system, and X_m, Y_m, Z_m, are the coordinate system of the real-world image which is the menu board. The R_{11}, R_{12}, …, R_{33} means the rotational components and T_x, T_y, T_z means a moving transformation vector. It has been suggested by (Kato et. al. 1999), 'by using this calculation method, R_{11}, R_{12}, …, R_{33} and T_x, T_y, T_z, it can perform rotation and translation for each frame of the next video and display it on the screen of the smartphone. The figure of the calculation of enhanced video location, scale and rotation as shown in Figure 2.1.1.7.

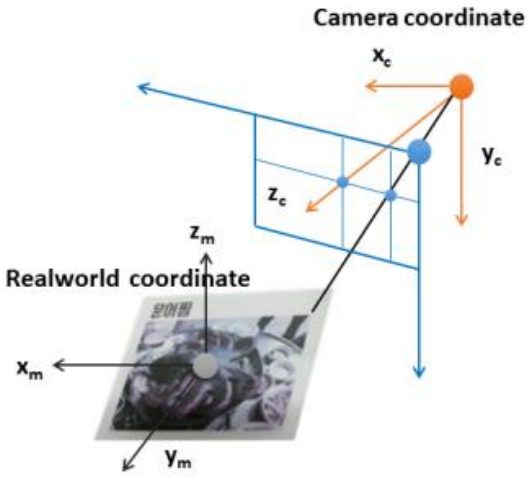


Figure 2.1.1.7 Calculation of Enhanced Video Location, Scale, Rotation [2]

2.1.2 Papers Reviewed on Digital Food Menu Application for Restaurants Based on Augmented Reality

This paper introduced an augmented reality application developed by the researchers based on the android platform for the restaurants. In the proposed application, a consumer can view realistic 3D models of the food items available in restaurant virtually using augmented reality technology. This project is mainly focused on displaying a realistic 3D model of the food item that is rendering on the sticker and is seen through the user's device camera. By applying this concept, the end user can see the food in its regular and actual serving size, thus providing help to make greater order choices as it can visualize any food item available in the menu. It can also save the time for consumer where they no need to spend imagining the food item from regular verbal description of the dish. Besides, the proposed application has several features such as wine classifier where user can scan a wine bottle and predicts the brand of the wine. The researchers have also developed an interactive chatbot in the system which can guide user for making a perfect food's choices.

Figure 2.1.2.1 UI of Desserts category with undetected sticker [3]

Figure 2.1.2.2 Displaying of 3D Model of Selected Food Item on Screen [3]

To implement this idea, the researchers have proposed development of an AR application using the registering image target in the Vuforia SDK and then rendering an 3D object over it when the image target is scanned through a mobile device. This paper discussed about the application in which a 3D model is overlay on the image where the image target is saved in a pre-processed database of Vuforia SDK, which is implemented using the principle of FAST algorithm as the Vuforia SDK uses the image recognition [3]. When the user clicks on any of the food's item name, the system scans if the correct image target is detected and then render the 3D model of the food item on the image target accordingly. According to [3], the image target is being distinguished by making use of the FAST algorithm (Features from Accelerated Segment Test), which is a detection method that used to extract feature points and track image targets in the computer vision tasks. Hence, researchers have making use of the AR framework of Vuforia Library in Unity 3D to develop the proposed system. The preliminary steps for digital food menu image application as shown in Figure 2.1.2.3

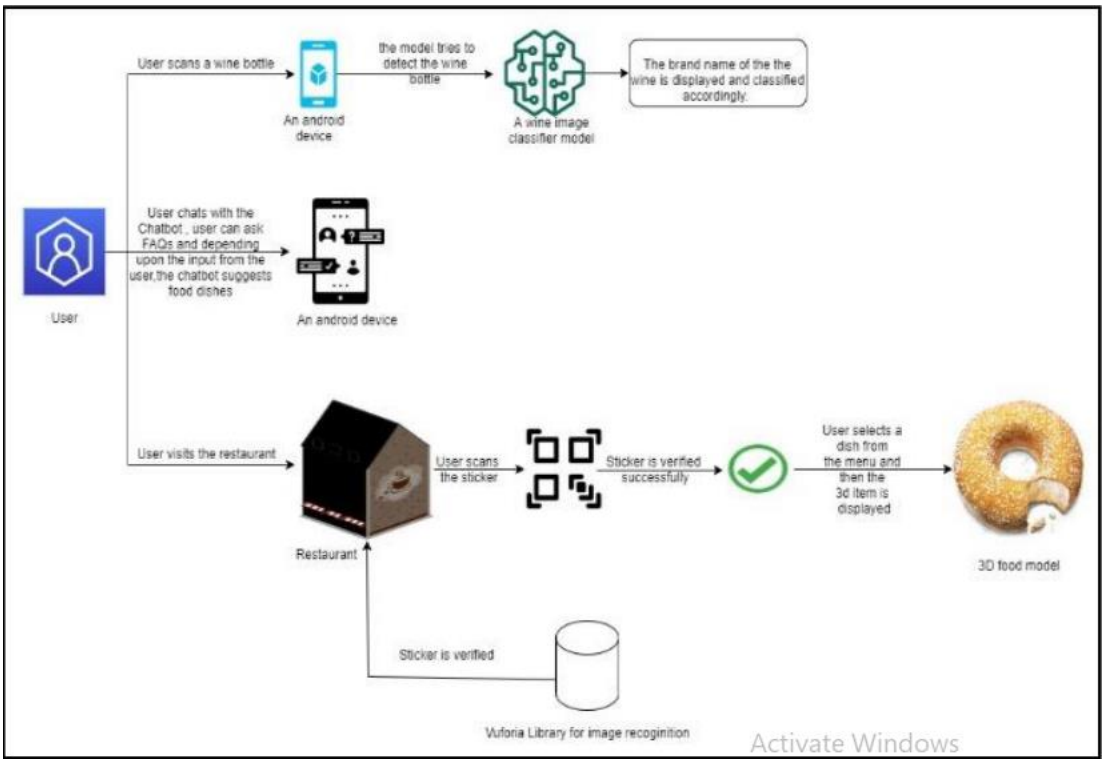


Figure 2.1.2.3 Block Diagram of Digital Food Menu Application Based on Augmented Reality [3]

2.2 Review of the Existing Applications

2.2.1 Kabaq AR Application

Kabaq AR application has developed a revolutionary tool which can allow the catering industry to radically change their way to present the food menu with innovative way to cater their customer needs. According to [4], 'Kabaq was founded in 2016 and has optimized a proprietary way to capture and generate 3D models of food that many observers find realistic.' Levine [4] note that 'the Kabaq AR food imagery was launched in the first quarter of year 2018, where it started on a menu for the Bareburger locations in New York.' Kabaq has implemented an AR technology which can allow customers to visualize the menu board through a process of digital rendering and photography in 3D. Kabaq uses advanced scanning technologies to create an ultra-high qualities of 3D model. A dish is photographed in high-resolution pixels from a variety of angles which then optimizes it in one file with different AR formats. It then can be distributed to Facebook, Instagram, Snapchat, or any other websites. In this way, it can create an immersive Facebook and Snapchat experiences as well as immersive shopping experience on social media. Using the smart device technology, the food menu can be presented in 3D with rich visual effects which can enable customers to make informed food choices to meet their expectations. Users can see the amazing food on their table by using Kabaq AR app which can allow them to make their choice more easily. The AR view of the Kabaq AR app as shown in Figure 2.2.1.1

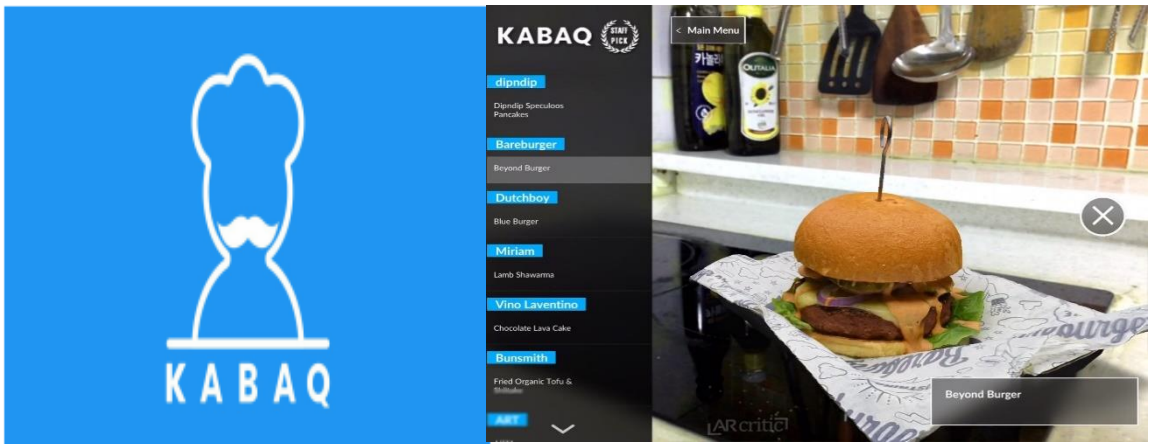


Figure 2.2.1.1 Interface of Kabaq AR application [5]

The Kabaq AR app has provided benefit to adjust the angle. The virtual food menu can be rotated in several angles. Users can also move and drag the food to the desired places. It can used to provide the interaction between the customers and food menu as well as enhance user dining experience. They can also zoom in or zoom out on the 3D food model. Besides, it is available on several platform such as Facebook, Instagram, and Snapchat. There will be a QR code on the printed menus which can allow users to see AR imagery of the food on their smartphone, by pointing their camera at the Snap code while they are inside their Snapchat app. With the AR imagery, it can boost the impact when users are ordering outside of the restaurant. This application is also supported on both iOS and Android with offline features. Therefore, users do not require the internet access to enter Kabaq AR app. In addition, there is also a filtering function that provided in this app. Users can filter the restaurant types by food categories as well as search their favourite restaurant by enter related keywords. It will be more optimized and responsive to give customers exactly what they are looking for.

Although Kabaq AR app has much more advantages, but there are also some of limitation in this application. Firstly, there is no food nutritional information in the application. Since users nowadays tend to practice healthy lifestyle and focus on balance diet. Thus, the nutritional information will play an important role in the app. If users are the one who need to maintain balance diet, they need to search the information by themselves. Besides, there is no video and audio embedded inside the Kabaq AR app. The video and audio sound can used to enhance the user experience and improve the quality of AR app.

Those limitations can be resolved by embedded the nutritional values and information of the food into the system. The food information and nutritional values can act as a supporting information which can help to ease the readiness of users. Users can also understand the calories and nutrition values in the respective food menu. This can help customers to choose their desire dishes more easily. Besides, the audio and video should be introduced in the new system, it provides immersive user experience with video and audio sound which can connect between food menu and user during the ordering of food.

2.2.2 Quytech AR Application

In recent years, the food industry saw a potential of AR that can be used to improve consumer interest. As (QuytechAR, n.d.) point out, 'Quytech AR app allowed catering industry to incorporate their food menu to connect with users via smart devices such as smartphones.' The food industry is much dependent on customer experiences. Hence, AR food menu is a unique way to connect the customer and grab their attention. Quytech AR food menu displays virtual food which consist of multiple 3D digital rendering photographs of food on the plate, providing user with a fun and immersive experience. It endorses and encourages food products by delivering immersive AR experience. Through Quytech AR app, restaurant businesses can provide engagement with their customers in an innovative way. The interface of Quytech AR app as shown in Figure 2.2.2.1

Figure 2.2.2.1 Interface of Quytech AR application [6]

The strength of the Quytech AR app include that customer can view a live demo. It has the advantage which similarly to Kabaq AR app where the customers can view the virtual food menu with ultra-high quality in 3D models. All the model dimensions are identical to the food they present, which can display an accurate representation of both appearance and portion of food. Besides, user can also find the famous restaurant with Quytech AR app. It provides the filter function for the user to search for their favourite restaurant. Moreover, Quytech AR app does provide the food nutritional information and the ingredient they used to make the food. Therefore, users can know the ingredients and portions of the food as well as the nutritional values that contain inside it.

However, there are some of the weakness and limitation with the Quytech AR app. First, it is an online application. Users need to access the Quytech AR app with internet. If the restaurant did not provide free internet or the users do not have their own mobile data, they cannot access the Quytech AR app to view the virtual food menu in 3D models. On the contrary, they can only view the traditional food menu in 2D image with some description. Besides, the 3D food model cannot be drag from one place to another. Users need to press the reset button and point at the places they want if they need to move the food model. Thus, it cannot provide the interaction between food menu and users since they could only view the model in a fixed manner. Besides, there is no video and audio sound embedded in the system which similarly to Kabaq AR app.

The limitations of the Quytech AR app can be resolved by implementing an offline application. In this way, user can access Quytech AR app at anywhere and anytime without using the internet. Besides, the function such as move and drag should be embedded in the app to enhance the interaction with the users where they can drag the food model to their desired place. Lastly, a built-in video and audio sound should be also introduced in the new system to engage users.

2.2.3 Menu AR Application

Menu AR application introduces a creative way to increase the effectiveness of cuisines with its detailed information. Through this app, customers can see a live demo of the food preparation process with a clear preview. Besides, there is a filter option which can allow user to filter the food categories and search for the restaurant by entering related keywords. There is also a GPS tracking system which can track the user current location. Besides, Menu AR app has the cart function where user can add their desire and favourite dishes into the cart list. User can also delete the dishes from their cart list if they have changed their mind. Besides, there are the food information and prices stated in Menu AR app to allow users understand the ingredients and prices of food. This AR application has also provided the user with an option to view the food model in 3D image or AR image. Therefore, user can watch the dish from all sides in 360 degrees mode as well as zoom in and zoom out the food with augmented reality feature. In this way, customers can see its composition and every detail of the dishes. Hence, it provides a better understanding of the food menu and allow users order food more easily. The interface of Menu AR app as shown in Figure 2.2.3.1

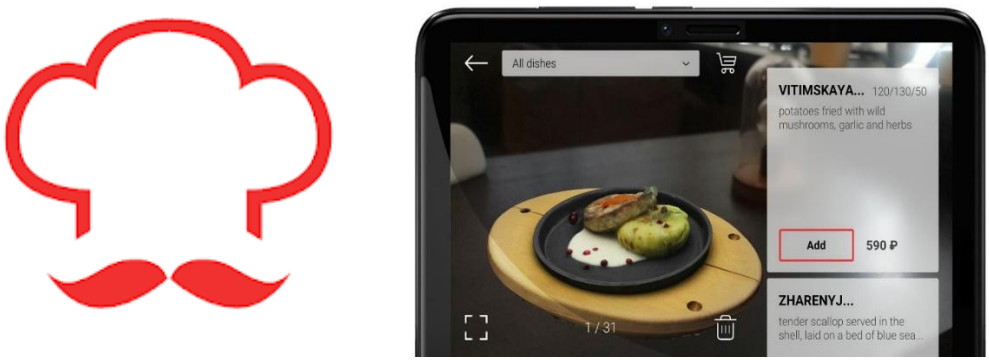


Figure 2.2.3.1 Interface of Menu AR application [7]

The disadvantages of the Menu AR app include that there is no food nutritional information and the use of ingredient in this application. Besides, the food model cannot be moved to other places. Users need to drop the AR image and place it again to the places they want. Hence, it is lack of interaction between the user and the food menu. In addition, there is no video and audio sound in Menu AR app to enhance user experience.

Those limitation can be resolved by applying the food information and food nutritional values in the new AR application. Next, the function such as move and drag should be introduced to allow the flexibility of the food model. Besides, a built-in video and audio sound should be also embedded into the new AR application.

2.2.4 JARIT AR Application

JARIT AR application is a new world in the food and beverages industry. This augmented reality application allows user to preview their potential order in 3D model. JARIT team has created realistic 3D images of dishes in the menu and showcases them through AR with the help of photogrammetry. JARIT enables its partner restaurant makes their food products more attractive to their customer through mouth-watering visualization of the dishes. The JARIT app is a substantial addition to the menu, making the choosing processes more fun and compelling for customers. In this JARIT AR app, it consists of a menu page with different categories of food such as sushi, pasta and pizza, burger as well as coffee and dessert. User can visualize the high quality of 3D food model where the dish is photographed in high resolution pixels from a variety of angles. Besides, there is also an option button which can allow user to know the price, food ingredients and nutrition value of each food product. Besides, there is a phone capture function which can prompt the user to capture different angle of the virtual food and save to album as well as share it to the social media. Through the JARIT AR app, user can also add their desired food into the favourite list for future references. In this way, it can elevate the gourmet food experience and promotes the immersion of user experience while they are ordering the food. The interface of Menu AR app as shown in Figure 2.2.4.1

Figure 2.2.4.1 Interface of JARIT AR application [8]

One of the weaknesses of this application is that it does not provide flexibility for user to drag the food from one place to another. User can only view the food model on the image target that have been provided. Hence, there is lack of customer engagement since it cannot provide the interaction between food menu with users. Besides, there is no video that can promote the restaurant's background and food as well as lack of audio sound embedded in the system which can used to enhance user experience.

The limitation of JARIT AR app can be resolved by adding some extra function such as darg and move to enhance the flexibility of 3D food model. Besides, a promotional video should be introduced in this system to attract more customer for upselling and cross-selling. Lastly, the audio sound should be also embedded into the system to engage the users and elevate user's interest.

2.3 Summarize and Comparison Between Reviewed Systems and Proposed System

TABLE 2.3.1 Table of Comparison Between Reviewed Systems and Proposed System

Features/ Application	KABAQ AR Application	QUYTECH AR Application	Menu AR Application	JARIT AR Application	Proposed System - Signature by Nosh Application
Platform	Android & iOS	Android	Android & iOS	Android & iOS	Android
View in 3D Model	Yes	Yes	Yes	Yes	Yes
View in Different Angle	Yes	Yes	Yes	Yes	Yes
Rotation	Yes	No	No	Yes	Yes
Scaling	Yes	Yes	Yes	No	Yes
Drag and Move	Yes	No	No	No	Yes
Food Description and Prices	Yes	Yes	Yes	Yes	Yes

Food Nutrition Information	No	Yes	No	Yes	Yes
Offline	Yes	No	No	Yes	Yes
Video / Audio	No	No	No	No	No
Animation	Yes	No	No	No	No
Social Media Upload	Yes	No	Yes	Yes	Yes, need to upload using social media platform
Cart List / Favourite List	No	No	Yes	Yes	Yes
Location Tracking	No	No	Yes	Yes	Yes

CHAPTER 3: SYSTEM METHODOLOGY/APPROACH

In this chapter, an overview of design specifications, system methodology, user requirements, system architecture diagram, network diagram, use case diagram, use case description and activity diagram for this project will be presented.

3.1 Design Specification

3.1.1 Overview of Methodologies

This project will focus on the agile development. The aim of the agile method is intended to deliver software quickly and able to meet the changing requirements. It can be used to reduce the overheads in the software process. This methodology can systematically overcome all the problems arise to make sure the project working well. It can also be used to make sure all the project objectives have been achieved after the application has been completely developed.

Therefore, the Addie model has been introduced to apply in this augmented reality food menu app. The Addie model has been chosen as our methodology to develop this project because a good planning can ensure project are well-defined and project objective can be easily achieved. This Addie model consist of five stages of a development process which is analysis phase, design phase, development phase, implementation phase and evaluation phase. The screenshot of Addie model as shown in Figure 4.1.1.

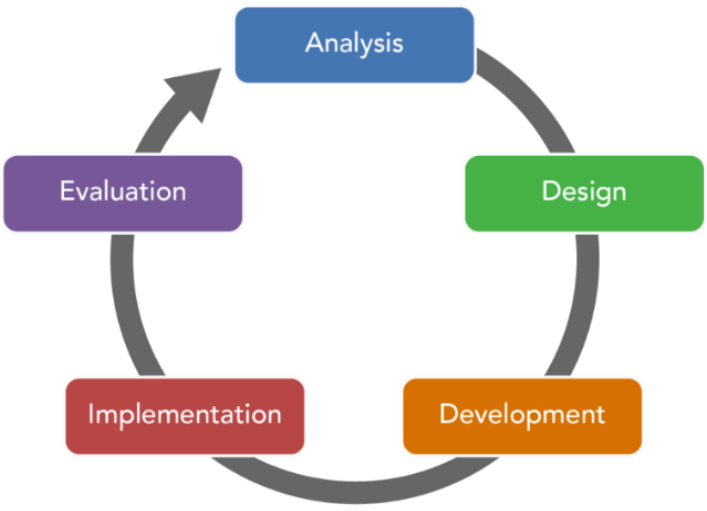


Figure 3.1.1.1 Screenshot of Addie model

Each iteration of development process is divided into 5 different phases, which include analysis, design, development, implementation, and evaluation.

Analysis

In the analysis phase, problem statement and project objective has been well-defined. The existing applications and journal articles about the augmented reality food menu are compared and reviewed to get the information which can help the project working well in later stage. User requirements are gathered, analysed, and documented in the form of user stories.

Design

In design phase, system diagram and flowchart has been drawn to present the system flow. The project interface has been created by designing a storyboard with low-fidelity prototype.

Development

In development phase, programming and coding have been carried out to produce a desired outcome based on the research. After that, the final prototype has been produced and build it on the android phone to test the functionality of the application.

Implementation

After the application completed, it will be tested by supervisor. The performance and functionality will be tested to detect unknown mistake and errors occur. The testing phase will be repeated until all the errors are fixed properly.

Evaluation

Review and feedback will be made during the evaluation phase. The evaluation phase can used to measure the effectiveness of application to ensure it is in line with the user needs. After all the testing, questionnaire and interviews will be conducted and released to the end user.

3.1.2 User Requirements

TABLE 3.1.2.1 User requirements (User Module)

No.	As a	I want to	So that
1	User	view food in AR 3D model	I can know the appropriate representation of both appearance and portion size of food.
2	User	drag and move AR 3D food model	I can have an interaction with the AR 3D food model.
3	User	rotate and scale AR 3D food model	I can view the food in detail.
4	User	click “remove button”	I can remove the existing 3D food model and placed a new 3D food model.
5	User	view the food image with some description	I can have an overview of food.
6	User	view the food price	I can decide the food that are affordable.
7	User	search for a specific food by key in related keywords	I can find the food that I want.
8	User	add the food into wish list	I can decide whether want to purchase it later.
9	User	add the food into shopping cart	I can purchase my food.
10	User	view my wish list page	I can know my favourite food
11	User	view my shopping cart list	I can know the quantity of my food product and total amount.
12	User	choose different payment method	I can pay via card payment or cash on delivery.
13	User	view my profile	I can check my personal information and profile picture.

14	User	change my profile	I can edit my username, email, phone number and change new profile picture.
15	User	reset password	I can change a new password in case I have forgot my existing password.
16	User	view the food description	I can have a better understanding about the food that had no prior knowledge of.
17	User	view the food ingredients used	I can know the used of ingredients to prevent dietary restrictions.
18	User	view the food calories	I can select the food according to my diet plan.
19	User	view customer gallery	I can have a look on the restaurant's environment and the quality of food.
20	User	type some messages in the contact page	I can send feedback to the restaurant directly via email.
21	User	click restaurant's website link in this application	I can access directly to the restaurant's website without searching on Google.
22	User	view restaurant's phone number	I can make a phone call to the restaurant.
23	User	view the location of restaurant	I can know the restaurant's location, distance from user current location and estimated arrival time.

TABLE 3.1.2.2 User requirements (Admin Module)

No.	As an	I want to	So that
1	Admin	view user report	I can know the user details such as user email, username, and user phone number.
2	Admin	search for user by key in related keywords - username	I can view all the details of the user.
3	Admin	add food products	I can upload food image and input name, price, and type of the food product.
4	Admin	view order report	I can know the order details such as order ID, username, date, time, address, and payment mode.
5	Admin	search for order by key in related keywords - date	I can view all the food orders on the specific date.
6	Admin	view the summary of food order by each order ID	I can know the food items and food quantity that have been ordered by customer.

3.2 System Design Diagram

3.2.1 System Architecture Diagram

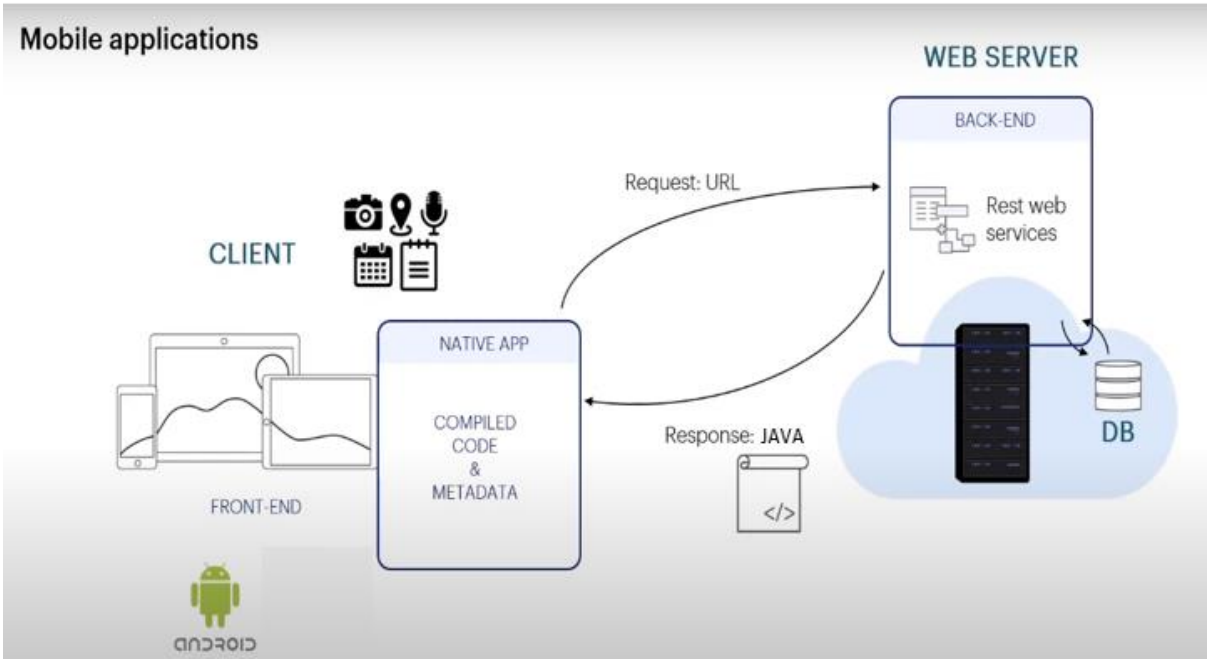


Figure 3.2.1.1 System Architecture Diagram

3.2.2 System Network Diagram

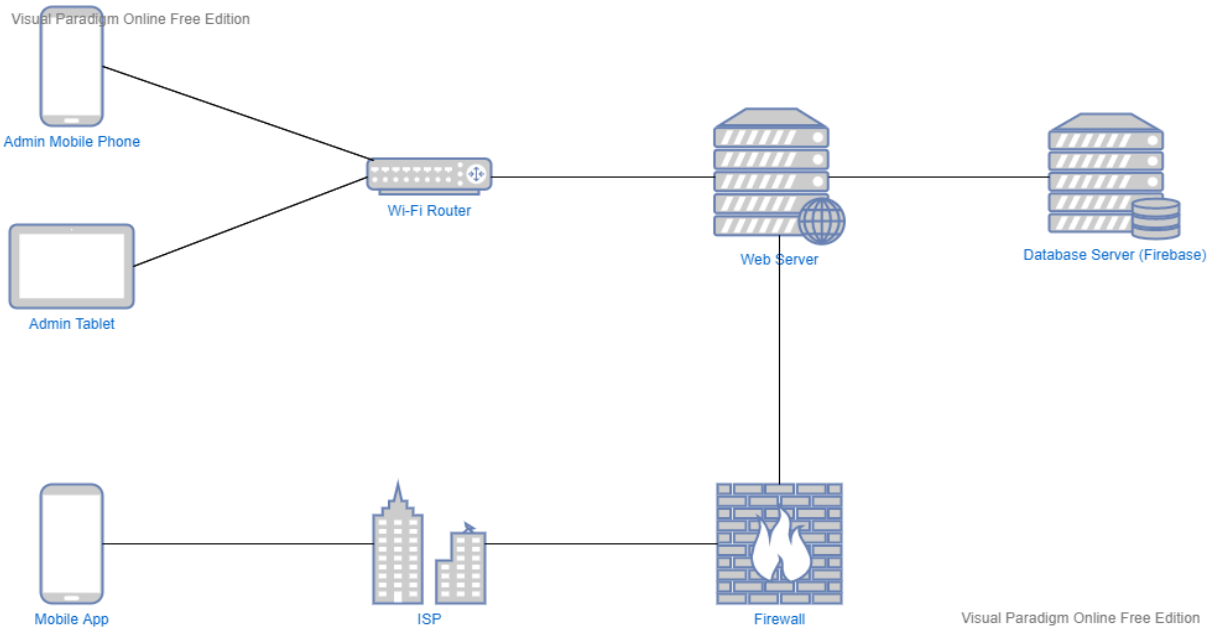


Figure 3.2.2.1 System Network Diagram

Based on the Figure 3.2.1.1 system architecture diagram and Figure 3.2.2.1 system network diagram, restaurant's admin can use mobile phone or tablet to access web server and update the database regarding the variety of food products. They can update the food menu by inputting the name, price, and category of food products as well as upload food image in the food menu system. Then, all the food information will be stored into the database server. Besides, admin can view each of the user report details such as user email, username, and user phone number after user has created an account using the food menu system.

On the other hand, user can use their mobile phone to access the food menu application via web server of the application. After admin has updated the food menu, user can login the system and view the food menu in advance before they reach the restaurant. User can view the AR 3D food model by clicking the camera button to know the appropriate representation of both appearance and portion size of food. Besides, they can have some interaction with the food model by performing variety of function such as drag and move, scale, and rotate the AR 3D food model in order to view the food in detail. User can also add their favourite food into wish list and shopping cart. After they have added to the cart list, they can made payment via cash on delivery or card payment.

After payment done, food order will be stored inside the database server which is known as Firebase. Then, the admin can login to the admin page to view order report with order details such as order ID, username, date, time, address, and payment mode. Besides, they can also view the summary of food order by each order ID. In this way, they know the total food items and food quantity that have been ordered by each of the customer.

3.2.3 Use Case Diagram

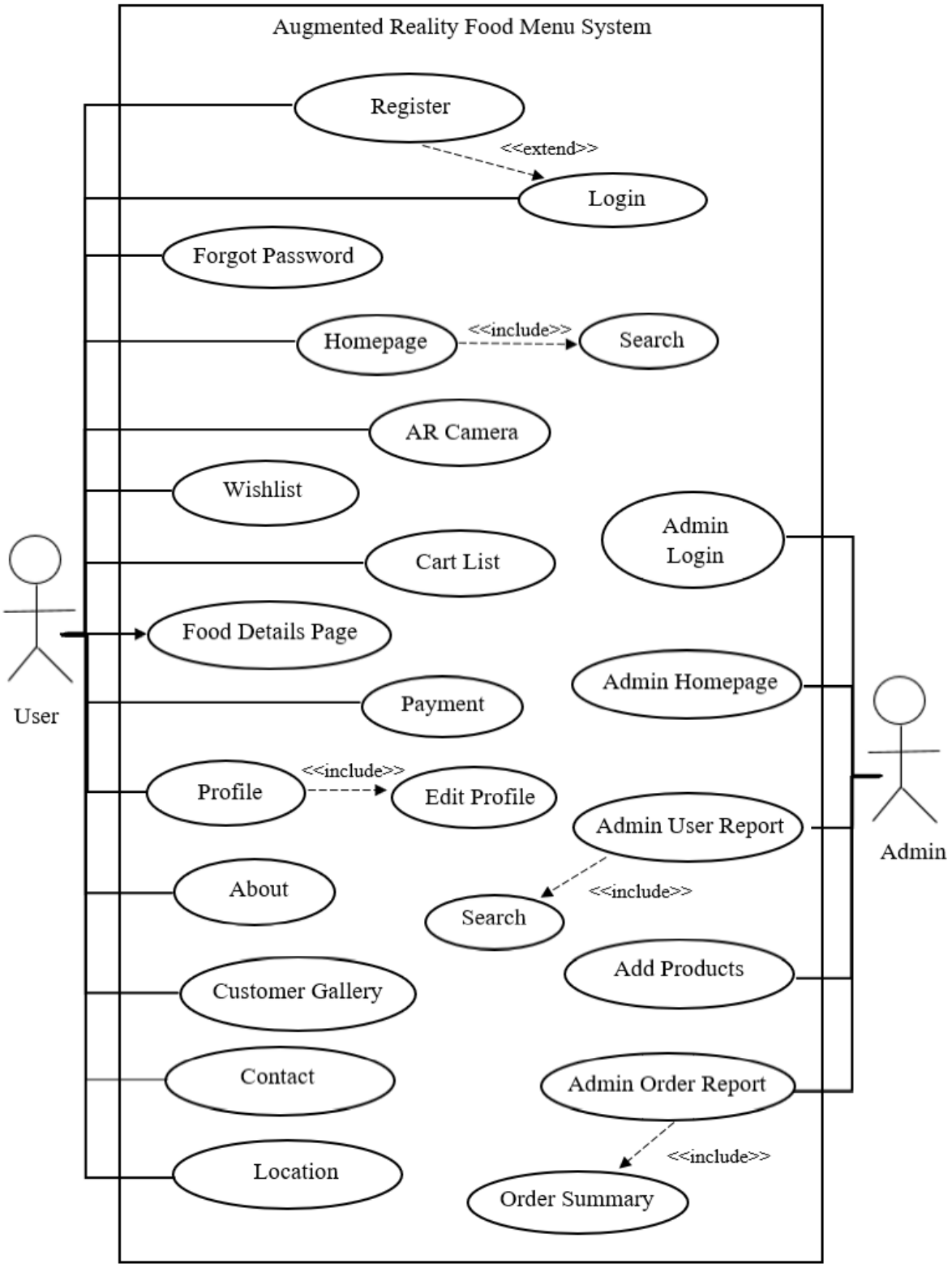


Figure 3.2.3.1 Use Case Diagram of AR Food Menu

3.2.4 Use Case Description

TABLE 3.2.4.1 Use Case Description [F001] Register

Use Case ID	UC001	**Version**	**1.0**
Use Case	Register		
Purpose	To authenticate the user and protect their private content to prevent unauthorised access to the system.		
Actor	User		
Trigger	User launches the application.		
Precondition	User has not registered the application.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User launches the application using smartphone.	
	2	User clicks [Create New Account] for Sign Up	
	3	System requests for the input of username, phone number, email, and password.	
	4	User inputs the username, phone number, email, and password.	
	5	System validates the user's personal information.	
	6	System displays a message "Logged in Successfully" and redirects user to Home Page.	
Sub Flow	**-**	-	
Alternative Flow - Invalid Username, Phone Number, Email or Password	**3.1**	User inputs invalid username, phone number, email, or password.	
	3.2	System validates the username, phone number, email, and password.	
	3.3	System displays an error message "Full Name is Required", "Phone Number is Required", Email is Required", "Password Must be >= 6 Characters"	
	3.4	Back to Main Flow Step 3.	
Rules	-		

TABLE 3.2.4.2 Use Case Description [F002] Login

Use Case ID	UC002	**Version**	**1.0**
Use Case	Login		
Purpose	To authenticate the user and prevent unauthorised access to the system.		
Actor	User		
Trigger	User launches the application.		
Precondition	User is not logged in.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User launches the application using smartphone.	
	2	System requests for the input of email and password.	
	3	User inputs the email and password.	
	4	System validates the email and password.	
	5	System displays a message “Logged in Successfully” and redirects user to Home Page.	
Sub Flow	**-**	-	
Alternative Flow - Invalid Email and Password	**2.1**	User inputs invalid email or password.	
	2.2	System validates the email and password.	
	2.3	System displays an error message “Error !”	
	2.4	Back to Main Flow Step 2.	
Rules	-		

TABLE 3.2.4.3 Use Case Description [F003] Forgot Password

Use Case ID	UC003	**Version**	**1.0**
Use Case	Forgot Password		
Purpose	To allow user to reset the password.		
Actor	User		
Trigger	User clicks [Forgot Password] in the Login Page.		
Precondition	User has forgot the password.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User clicks [Forgot Password] in the Login Page.	
	2	System pop-out dialogue box and requests for the input of user email.	
	3	User inputs the email to receive password reset link.	
	4	System performs sub-flow according to the user's input.	
Sub Flow – Yes for reset password	**4a.1**	User clicks “Yes” button to reset password.	
	4a.2	System validates the email.	
		System sends a reset link into user’s email.	
	4a.3	System closes the dialogue box and displays a message “Reset Link Sent to Your Email”.	
	4a.4	System redirect user back to Login Page.	
Sub Flow – No for reset password	**4b.1**	User clicks “No” button to reset password.	
	4b.2	System closes the dialogue box and redirect user back to Login Page.	
Alternative Flow - Invalid Email Address Format	**2.1**	User inputs invalid email.	
	2.2	System validates the email.	
	2.3	System displays an error message “Error ! Reset Link is Not Sent”.	
	2.4	System redirect user back to Login Page.	
Rules	-		

TABLE 3.2.4.4 Use Case Description [F004] Home Page

Use Case ID	UC004	**Version**	**1.0**
Use Case	Home Page		
Purpose	To allow user to select options of Home Page, Food Details Page, Search for Food, Wishlist, Cart List, Payment, Profile, AR Camera, About, Customer Gallery, Contact us and Location.		
Actor	User		
Trigger	User successfully login to the system.		
Precondition	User is on the Login Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	System displays a list of options for user.	
	2	System requests for the user's options.	
	3	Users click different icons to perform different functions.	
	4	System performs sub-flow according to the user's options.	
Sub Flow – Food Details Page	**4a.1**	Users click the [food image] to view in details page.	
	4a.2	System validates the input of options.	
	4a.3	System redirects user to Details Page.	
Sub Flow – Wishlist	**4b.1**	Users click [Favourite icon] to view Wishlist items.	
	4b.2	System validates the input of options.	
	4b.3	System redirects user to Wish List Page.	
Sub Flow – Cart List	**4c.1**	Users click [Cart icon] to view shopping cart items.	
	4c.2	System validates the input of options.	
	4c.3	System redirects user to Cat List Page.	
Sub Flow – Payment	**4d.1**	Users click [Buy Now] button to make payment.	
	4d.2	System validates the input of options.	
	4d.3	System redirects user to Payment Page.	
Sub Flow – Profile	**4e.1**	Users click [Profile icon] to view profile information.	
	4e.2	System validates the input of options.	
	4e.3	System redirects user to Profile Page.	

Sub Flow – AR Camera	**4f.1**	Users click [Camera icon] to launch the AR camera function to view the food in 3D models.
	4f.2	System validates the input of options.
	4f.3	System redirects user to AR Camera Page.
Sub Flow – Search for Food	**4g.1**	Users click the [search bar] to search for the name of foods in the system.
	4g.2	System validates the input of options.
	4g.3	System redirects user to Search for the food.
Sub Flow – About	**4h.1**	Users click the hamburger icon to view more info.
	4h.2	Users click the [About] to view the food ingredients used, food calories, photo, and story of the restaurant.
	4h.3	System validates the input of options.
	4h.4	System redirects user to About Page.
Sub Flow – Customer Gallery	**4i.1**	Users click the hamburger icon to view more info.
	4i.2	Users click the [Customer Gallery] to view the photos and pictures of the restaurant's environment.
	4i.3	System validates the input of options.
	4i.4	System redirects user to Customer Gallery Page.
Sub Flow – Contact us	**4j.1**	Users click the hamburger icon to view more info.
	4j.2	Users click the [Contact us] to send email and feedback to the restaurant.
	4j.3	System validates the input of options.
	4j.4	System redirects user to Contact us Page.
Sub Flow – Location	**4j.1**	Users click the hamburger icon to view more info.
	4j.2	Users click the [Location] to view the restaurant's location.
	4j.3	System validates the input of options.
	4j.4	System redirects user to Location Page.
Alternative Flow -	**-**	-
Rules	-	

TABLE 3.2.4.5 Use Case Description [F005] Food Details Page

Use Case ID	UC005	**Version**	**1.0**
Use Case	Food Details Page		
Purpose	- To allow user to view food information in details such as product name, food price and food category. - To allow user to add food items into wish list or shopping cart.		
Actor	User		
Trigger	User clicks variety of food image from the Home Page.		
Precondition	User is currently in Home Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User clicks the selected food image in Home Page.	
	2	System validates user's option based on the selected food image.	
	3	System redirects user to the selected Food Details Page.	
	4	System performs sub-flow according to the user's option.	
Sub Flow – Click AR Camera Button	**4a.1**	User clicks AR Camera button.	
	4a.2	System validates the user's option.	
	4a.3	System redirect user to the AR Camera Screen.	
Sub Flow – Click Plus Button	**4b.1**	User clicks plus button.	
	4b.2	System increases the quantity of food items based on user's input.	
Sub Flow – Click Minus Button	**4c.1**	User clicks minus button.	
	4c.2	System deducts the quantity of food items based on user's input.	
Sub Flow – Click Add to Cart	**4d.1**	User clicks Add to Cart button.	
	4d.2	System validates the user's option.	
	4d.3	System displays a message "Added to Cart" and adds selected food items into the shopping cart.	
	4e.1	User clicks Add to Wishlist button.	

Sub Flow – Click Add to Wishlist	**4e.2**	System validates the user's option.
	4e.3	System displays a message "Added to Wishlist" and adds selected food items into the Wishlist.
Alternative Flow -	**-**	-
Rules	-	

TABLE 3.2.4.6 Use Case Description [F006] Search for Food

Use Case ID	UC006	**Version**	**1.0**
Use Case	Search for Food		
Purpose	To allow user to search for the existing food items in the system.		
Actor	User		
Trigger	User clicks the search bar food image in the Home Page.		
Precondition	User is currently in Home Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	Users click the search bar in the Home Page.	
	2	User input the keyword of food name to search for the existing food items in the system.	
	3	System reads input for existing food item's name from user.	
	4	System validates food item's name.	
	5	System displays food's details of the inputted food item's name.	
	6	User deleted the food item's name.	
	7	System redirect user to Home Page.	
Sub Flow –	**-**	-	
Alternative Flow - Invalid Food Item's Name	**3.1**	User inputs invalid food item's name.	
	3.2	System reads input for existing food item's name from user.	
	3.3	System validates food item's name.	
	3.4	System displays empty screen.	
	3.5	User deleted the food item's name.	
	3.6	System redirect user to Home Page.	
Rules	-		

TABLE 3.2.4.7 Use Case Description [F007] Wishlist

Use Case ID	UC007	**Version**	**1.0**
Use Case	Wishlist		
Purpose	To allow user to save their favourite food into Wishlist Page.		
Actor	User		
Trigger	User clicks the Favourite icon using the bottom navigation bar in the Home Page.		
Precondition	User is currently in Home Page.		
Scenario Name	**Step**	**Action**	
	1	User clicks the Favourite icon using the bottom navigation bar in the Home Page.	
	2	System redirects user to the Wishlist Page.	
	3	System performs sub-flow according to the user's options.	
Sub Flow – Wishlist Details Page	**3a.1**	User clicks selected food image from Wishlist Page to view the details of food.	
	3a.2	System reads user's option for the selected food item.	
	3a.3	System redirects user to the respective Wishlist Details Page.	
	3a.4	User clicks Camera icon, Plus and Minus icon, and Add to Cart icon to perform different actions.	
Sub Flow – Delete Wishlist Food Items	**3b.1**	User clicks remove icons to delete the selected favourite food items from Wishlist Page.	
	3b.2	System validates user's option.	
	3b.3	System displays a message "Product deleted" and removes food item from user's Wishlist Page.	
Alternative Flow -	**-**	-	
Rules	-		

TABLE 3.2.4.8 Use Case Description [F008] Shopping Cart List

Use Case ID	UC008	**Version**	**1.0**
Use Case	Shopping Cart List		
Purpose	To allow user to add their food into shopping cart.		
Actor	User		
Trigger	User clicks the Cart icon using the bottom navigation bar in the Home Page.		
Precondition	User is currently in Home Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User clicks the Cart icon using the bottom navigation bar in the Home Page.	
	2	System redirects user to the Shopping Cart Page.	
	3	System performs sub-flow according to the user's options.	
Sub Flow – Buy Now Button	**3a.1**	User clicks “Buy Now Button” in the Shopping Cart Page to make payment.	
	3a.2	System validates user’s option.	
	3a.3	System redirects user to the Payment Page.	
Sub Flow – Delete Shopping Cart Food Items	**3b.1**	User clicks remove icons to delete the selected food items from the shopping cart list.	
	3b.2	System validates user’s option.	
	3b.3	System displays a message “Product deleted” and removes food item from user’s Shopping Cart.	
Alternative Flow -	**-**	-	
Rules	-		

TABLE 3.2.4.9 Use Case Description [F009] Payment

Use Case ID	UC009	**Version**	**1.0**
Use Case	Payment		
Purpose	To allow user to make payment		
Actor	User		
Trigger	User clicks the "Buy Now" button in the Shopping Cart Page.		
Precondition	User is currently in Shopping Cart.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User clicks the "Buy Now" button in the Shopping Cart Page.	
	2	System redirects user to the Payment Page.	
	3	User input name and home address.	
	4	System performs sub-flow according to the user's options.	
Sub Flow – Option One: Cash on Delivery	**4a.1**	User chooses Cash on Delivery.	
	4a.2	User clicks "Pay Now" button in the Payment Page.	
	4a.3	System reads user's input.	
	4a.4	System accepts order and redirects user to the Success Payment Page.	
	4a.5	System displays a message "Order Placed Successfully !"	
	4a.6	User clicks continue shopping and system redirects user to the Home Page.	
Sub Flow – Option Two: Card Payment	**4b.1**	User chooses Card Payment.	
	4b.2	System requests for the input of Card Number, Expiration Date, CVV, Postal Code, Mobile Number	
	4b.3	User input valid Card Number, Expiration Date, CVV, Postal Code, and Mobile Number.	
	4b.4	User clicks "Pay Now" button in the Payment Page.	
	4b.5	System reads user's input for the required card information.	
	4b.6	System validates Card Number and Card Information	

	4b.7	Systems pop-out a dialogue box to alert user for the confirmation before purchase.
	4b.8	User clicks “Confirm” button
	4b.9	System accepts order and redirects user to the Success Payment Page.
	4b.10	System displays a message “Order Placed Successfully !”
	4b.11	User clicks “Continue Shopping” button and system redirects user to the Home Page.
Alternative Flow – Invalid Card Number, Expiration Date and CVV.	**4b.2.1**	User inputs invalid Card Number, Expiration Date and CVV.
	4b.2.2	System validates the Card Number, Expiration Date and CVV information.
	4b.2.3	System displays an error message “Card Number is Invalid”, “Expiration Date is Invalid”, “CVC is Invalid”.
	4b.2.4	Back to Sub Flow 4b.2
Rules	-	

TABLE 3.2.4.10 Use Case Description [F010] Profile

Use Case ID	UC010	**Version**	**1.0**
Use Case	Profile		
Purpose	To allow user to edit profile, reset password and logout		
Actor	User		
Trigger	User clicks the Profile icon using the bottom navigation bar in the Home Page.		
Precondition	User is currently in Home Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User clicks the Profile icon using the bottom navigation bar in the Home Page.	
	2	System redirects user to the Profile Page.	
	3	System performs sub-flow according to the user's options.	
Sub Flow – Change Profile	**3a.1**	User clicked “Change Profile” to edit the user information included username, email, phone number and profile picture.	
	3a.2	System validates user’s option.	
	3a.3	System redirect user to Edit Profile Page.	
	3a.4	User clicks profile icon in the Edit Profile Page.	
	3a.5	System redirects user to the album.	
	3a.6	User selects a photo from album to add new profile picture.	
	3a.7	User edits username, email, or phone number.	
	3a.8	User clicks save button in Edit Profile Page	
	3a.9	System reads user’s option for the username, email, phone number, and profile picture.	
	3a.10	System validates user’s option.	
	3a.11	System displays a message “Profile Updated” and displays the new user profile information in the Profile Page.	
	3b.1	User clicked “Reset Password” in the Profile Page.	

Sub Flow – Reset Password	**3b.2**	System pop-out dialogue box and requests for the input of user new password.
	3b.3	User inputs the new password in the dialogue box.
	3b.4	User clicks “Yes” to reset password.
	3b.5	System reads user’s input for new password.
	3b.6	System validates user new password.
	3b.7	System closes the dialogue box and displays a message “Password Reset Successfully”.
	3b.8	System redirects user back to Profile Page.
Sub Flow – Logout	**3c.1**	User clicked “Logout” in the Profile Page.
	3c.2	System validates user’s option.
	3c.3	System logout successfully and redirect user back to the login page.
Alternative Flow - Invalid Password Format	**3b.3.1**	User inputs invalid new password.
	3b.3.2	System validates the new password format.
	3b.3.3	System displays an error message “Password Reset Failed”.
	3b.3.4	System redirect user to Profile Page.
Rules	-	

TABLE 3.2.4.11 Use Case Description [F011] AR Camera

Use Case ID	UC011	**Version**	**1.0**
Use Case	AR Camera		
Purpose	To allow user view virtual food with 3D models which displays an appropriate representation of both appearance and portion.		
Actor	User		
Trigger	User clicks the Camera icon using the bottom navigation bar in the Home Page.		
Precondition	User is currently in Home Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User clicks the Camera icon using the bottom navigation bar in the Home Page.	
	2	System validates the compatibility of Google Play Services for AR in user's smartphones.	
	3	System redirect user to AR Camera Screen.	
	4	User clicks one of the food images at the bottom part of AR Camera Screen Page.	
	5	System reads user's option of the selected food.	
	6	User moves their camera around and find a flat surface such as table or floor for placing the AR elements	
	7	System trigger computer generated vision technology by scanning the surrounding environment to retrieve augmented reality contents.	
	8	System displays multiple white dots on the flat surface which indicates the 3D food model is ready to be placed by user.	
	9	User clicks the multiple white dots on the AR Camera Screen to place the 3D food model on the flat surface environment.	
	10	System displays the augmented reality contents successfully on the AR Camera Screen.	

	11	System performs sub-flow according to user's input.
Sub Flow – Drag and Move, Rotate, Scaling	**11a.1**	User clicks the 3D food model to perform Rotate, Scaling, Drag and Move function.
	11a.2	System reads the options for the Rotate, Scaling, Drag and Move function which performed by user.
	11a.3	System performs Rotation, Scaling, Drag and Move function on 3D food model successfully.
Sub Flow – Remove	**11b.1**	User clicks the remove button on the top right corner of AR Camera Screen.
	11b.2	System reads the user's options for removing 3D food model.
	11b.3	Systems remove the 3D food model successfully.
Sub Flow – Click to Saved	**11c.1**	User clicked the "Click to Saved" button on the top left corner of AR Camera Screen.
	11c.2	System reads user's options to save 3D food model.
	11c.3	System saves the 3D food model successfully.
Alternative Flow – Incompatible version of Google Play Services for AR	**2.1**	User do not have the latest version of Google Play Services for AR.
	2.2	System validates the compatibility of Google Play Services for AR in user's smartphones.
	2.3	System displays a pop-out message "This application requires the latest version of Google Play Services for AR".
	2.4	User clicks "Continue" button and system redirects user to the Google Play Store.
	2.5	Google Play Store displays an error message "Your device isn't compatible with this version".
	2.6	User closes the Google Play Store.
	2.7	System redirects user back to AR Camera Screen and displays an error message "Failed to create AR session".
Rules	-	

TABLE 3.2.4.12 Use Case Description [F012] About

Use Case ID	UC012	**Version**	**1.0**
Use Case	About		
Purpose	To allow user to learn and understand food calories and the used of food ingredients.		
Actor	User		
Trigger	User clicks the About button in the More Info Page.		
Precondition	User is currently in More Info Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User clicks the About button in the More Info Page.	
	2	System redirects user to the About Page.	
	3	User scrolls to view story of restaurant, food ingredients used, photo of ingredients and food calories information.	
	4	System performs sub-flow according to the user's option.	
Sub Flow – Drop Down Button	**4a.1**	User clicks “Drop Down” button on the top right side	
	4a.2	System redirect user back to More Info Page.	
Sub Flow – Order Now Button	**4b.1**	User clicks “Order Now” button at the bottom part of About Page.	
	4b.2	System redirect user to Home Page.	
Alternative Flow -	**-**	-	
Rules	-		

TABLE 3.2.4.13 Use Case Description [F013] Customer Gallery

Use Case ID	UC013	**Version**	**1.0**
Use Case	Customer Gallery		
Purpose	To allow user to view the environment of restaurant.		
Actor	User		
Trigger	User clicks the Customer Gallery button in the More Info Page.		
Precondition	User is currently in More Info Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User clicks the Customer Gallery button in the More Info Page.	
	2	System redirects user to the Customer Gallery Page.	
	3	User scrolls to view the environment and pictures of the restaurant.	
	4	User clicks back button.	
	5	System redirects user back to More Info Page.	
Sub Flow –	**-**	-	
Alternative Flow -	**-**	-	
Rules	-		

TABLE 3.2.4.14 Use Case Description [F014] Contact

Use Case ID	UC014	**Version**	**1.0**
Use Case	Contact		
Purpose	To allow user to send feedback to the restaurant through E-mail and contact restaurant for any enquiries.		
Actor	User		
Trigger	User clicks the Contact button in the More Info Page.		
Precondition	User is currently in More Info Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User clicks the Contact button in the More Info Page.	
	2	System redirects user to the Contact Page.	
	3	System performs sub-flow according to user's options.	
Sub Flow – Send Email	**3a.1**	User input email address, subject and messages in the given provided box.	
	3a.2	User clicks “Send” button after completing the input.	
	3a.3	System redirects user to the Gmail application.	
	3a.4	System auto-fill in all the information that have been typed in the Contact us Page into Gmail.	
	3a.5	User checks all the information in Gmail and click compose button using third party software which is the Gmail application.	
	3a.6	User closes the third-party software, Gmail.	
	3a.7	System redirects user back to More Info Page.	
Sub Flow – Website Link	**3b.1**	User clicks the website link below.	
	3b.2	System redirects user to the restaurant’s website page.	
Sub Flow – Phone Number	**3c.1**	User clicks the phone number below.	
	3c.2	System redirects user to the restaurant’s phone contact.	
Sub Flow – Email Link	**3d.1**	User clicks the Email link below.	
	3d.2	System redirects user to the restaurant’s Email.	
Alternative Flow -	**-**	-	
Rules	-		

TABLE 3.2.4.15 Use Case Description [F015] Location

Use Case ID	UC015	**Version**	**1.0**
Use Case	Location		
Purpose	To allow user to access restaurant's location		
Actor	User		
Trigger	User clicks the Location button in the More Info Page.		
Precondition	User is currently in More Info Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	User clicks the Location button in the More Info Page.	
	2	System redirects user to the Location Page.	
	3	User clicks "WE ARE HERE" button to access Google map.	
	4	System reads user's option.	
	5	System redirects user to the Google Map application.	
	6	User views the restaurant's location, distance from user current location, rating, and operation hours.	
	7	User clicks "Direction" button using third party software which is the Google Map application.	
	8	System displays restaurant's location, distance from user current location and estimated arrival time.	
Sub Flow –	**-**	-	
Alternative Flow -	**-**	-	
Rules	-		

TABLE 3.2.4.16 Use Case Description [F016] Admin Login

Use Case ID	UC016	**Version**	**1.0**
Use Case	Admin Login		
Purpose	To authenticate the admin and prevent unauthorised access to the system.		
Actor	Admin		
Trigger	Admin launches the system.		
Precondition	Admin is not logged in.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	Admin launches the application using smartphone.	
	2	System requests for the input of username and password.	
	3	Admin inputs the username and password.	
	4	System validates the username and password.	
	5	System displays a message “Logged in Successfully” and redirects admin to Admin Home Page.	
Sub Flow	**-**	-	
Alternative Flow - Invalid Email and Password	**3.1**	Admin inputs invalid username or password.	
	3.2	System validates the username and password.	
	3.3	System displays an error message “Error !”	
	3.4	Back to Main Flow Step 2.	
Rules	-		

TABLE 3.2.4.17 Use Case Description [F017] Admin Home Page

Use Case ID	UC017	**Version**	**1.0**
Use Case	Admin Home Page		
Purpose	To allow admin to select options of User Report, Add Products, Order Report, and Logout.		
Actor	Admin		
Trigger	Admin successfully login to the system.		
Precondition	Admin is on the Admin Home Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	System displays a list of options for admin.	
	2	System requests for the admin's options.	
	3	Admin clicks different icons to perform different functions.	
	4	System performs sub-flow according to the user's options.	
Sub Flow – View User Report	**4a.1**	Admin clicks the Profile icon to view User Report.	
	4a.2	System validates the admin's options.	
	4a.3	System redirects user to User Report Page.	
Sub Flow – Add Products	**4b.1**	Admin click Menu icon to add new products.	
	4b.2	System validates the admin's options.	
	4b.3	System redirects user to Add Products Page.	
Sub Flow – View Order Report	**4c.1**	Admin clicks the List icon to view Order Report.	
	4c.2	System validates the admin's options.	
	4c.3	System redirects user to Order Report Page.	
Sub Flow – Logout	**4d.1**	Admin clicks the Exit icon to logout from the system.	
	4d.2	System validates the admin's options.	
	4d.3	System redirects admin to Login Page.	
Alternative Flow -	**-**	-	
Rules	-		

TABLE 3.2.4.18 Use Case Description [F018] Admin User Report

Use Case ID	UC018	**Version**	**1.0**
Use Case	Admin User Report		
Purpose	To allow admin to view user reports in details such as Email, Username, and User Phone Number.		
Actor	Admin		
Trigger	Admin clicks the Profile icon to view User Report.		
Precondition	Admin is on the Admin Home Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	Admin clicks the Profile icon to view User Report.	
	2	System reads admin's options.	
	3	System redirects admin to User Report Page.	
	4	Admin can scroll to view different user reports in details such as Email, Username, and Phone Number.	
	5	System performs sub-flow according to the user's option.	
Sub Flow – Search	**5a.1**	Admin clicks the search bar in User Report Page.	
	5a.2	Admin inputs the keyword of username to search for the existing user report in the system.	
	5a.3	System reads input for existing username from admin	
	5a.4	System validates username.	
	5a.5	System displays the user report of inputted username.	
	5a.6	Admin deleted the username.	
	5a.7	System redirect admin to Admin Home Page.	
Alternative Flow -	**5a.2.1**	Admin inputs invalid username.	
	5a.2.2	System reads input for existing username from admin	
	5a.2.3	System validates username.	
	5a.2.4	System displays empty screen.	
	5a.2.5	Admin deleted the username.	
	5a.2.6	System redirect admin to Admin Home Page.	
Rules	-		

TABLE 3.2.4.19 Use Case Description [F019] Add Products

Use Case ID	UC019	**Version**	**1.0**
Use Case	Add Products		
Purpose	To allow admin to add new products.		
Actor	Admin		
Trigger	Admin clicks the Menu icon to Add New Products.		
Precondition	Admin is on the Admin Home Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	Admin clicks the Menu icon to add new products.	
	2	System reads admin's options.	
	3	System redirects admin to Add Products Page.	
	4	Admin clicks "Upload Image" button.	
	5	System redirects admin to the album.	
	6	Admin chooses the selected food picture.	
	7	System redirects user to Add Products Page.	
	8	Admin inputs name of the food product.	
	9	Admin inputs price of the food product.	
	10	Admin inputs type of the food product.	
	11	Admin clicks "Add" button.	
	12	System reads input for all existing fields.	
	13	System displays a message "Product Added." and redirects user back to Add Products Page.	
Sub Flow –	**-**	-	
Alternative Flow – Click Add Button Without Entering All Fields	**11.1**	Admin clicks "Add" button without entering all fields.	
	11.2	System reads input for all the existing field from admin.	
	11.3	System validates admin's input.	
	11.4	System displays an error message "Enter All Fields."	
	11.5	Back to Main Flow 7.	
Rules	-		

TABLE 3.2.4.20 Use Case Description [F020] Admin Order Report

Use Case ID	UC020	**Version**	**1.0**
Use Case	Admin Order Report		
Purpose	To allow admin to view order reports in details such as Order ID, Address, Date, Time, Payment Mode, and Username.		
Actor	Admin		
Trigger	Admin clicks the List icon to view Order Report.		
Precondition	Admin is on the Admin Home Page.		
Scenario Name	**Step**	**Action**	
Main Flow	**1**	Admin clicks List icon to view Order Report.	
	2	System reads admin's options.	
	3	System redirects admin to Order Report Page.	
	4	Admin can scroll to view different order reports in details such as Order ID, Address, Date, Time, Payment Mode, and Username.	
	5	System performs sub-flow according to the user's option.	
Sub Flow – Order Summary Page	**5a.1**	Admin clicks one of the selected order reports in Order Report Page.	
	5a.2	System redirects admin to the Order Summary Page.	
	5a.3	Admin can scroll to view user's food items in details such as food name, food price and quantity that have been purchased by user.	
	5a.4	Admin clicks the "exit" button on the top left corner in Order Summary Page.	
	5a.5	System redirects admin to the Order Report Page.	
Alternative Flow -	**-**	-	
Rules	-		

3.2.5 Activity Diagram

3.2.5.1 Activity Diagram [F001] Register

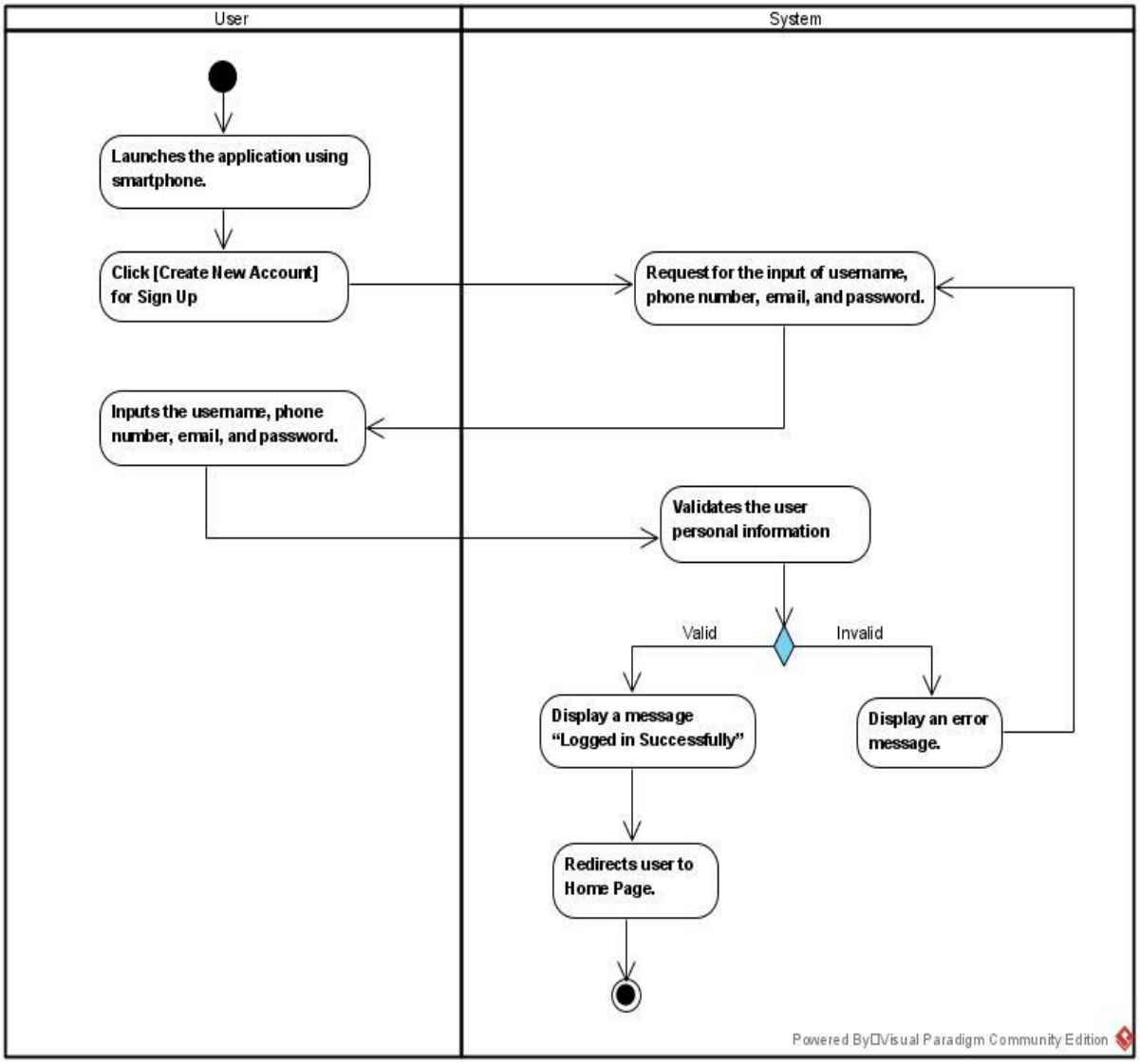


Figure 3.2.5.1 Activity Diagram [F001] Register

3.2.5.2 Activity Diagram [F002] Login

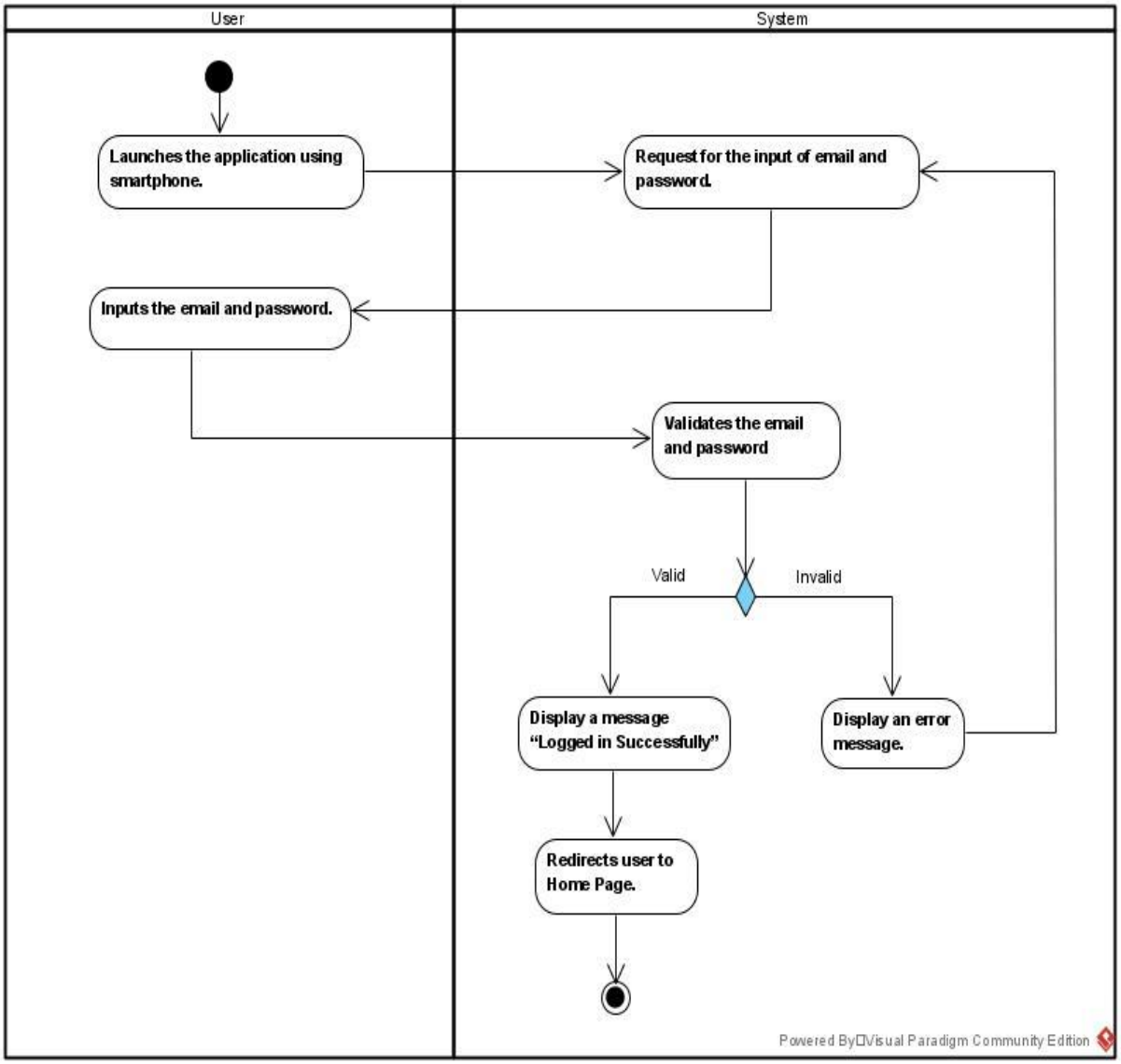


Figure 3.2.5.2 Activity Diagram [F002] Login

3.2.5.3 Activity Diagram [F003] Forgot Password

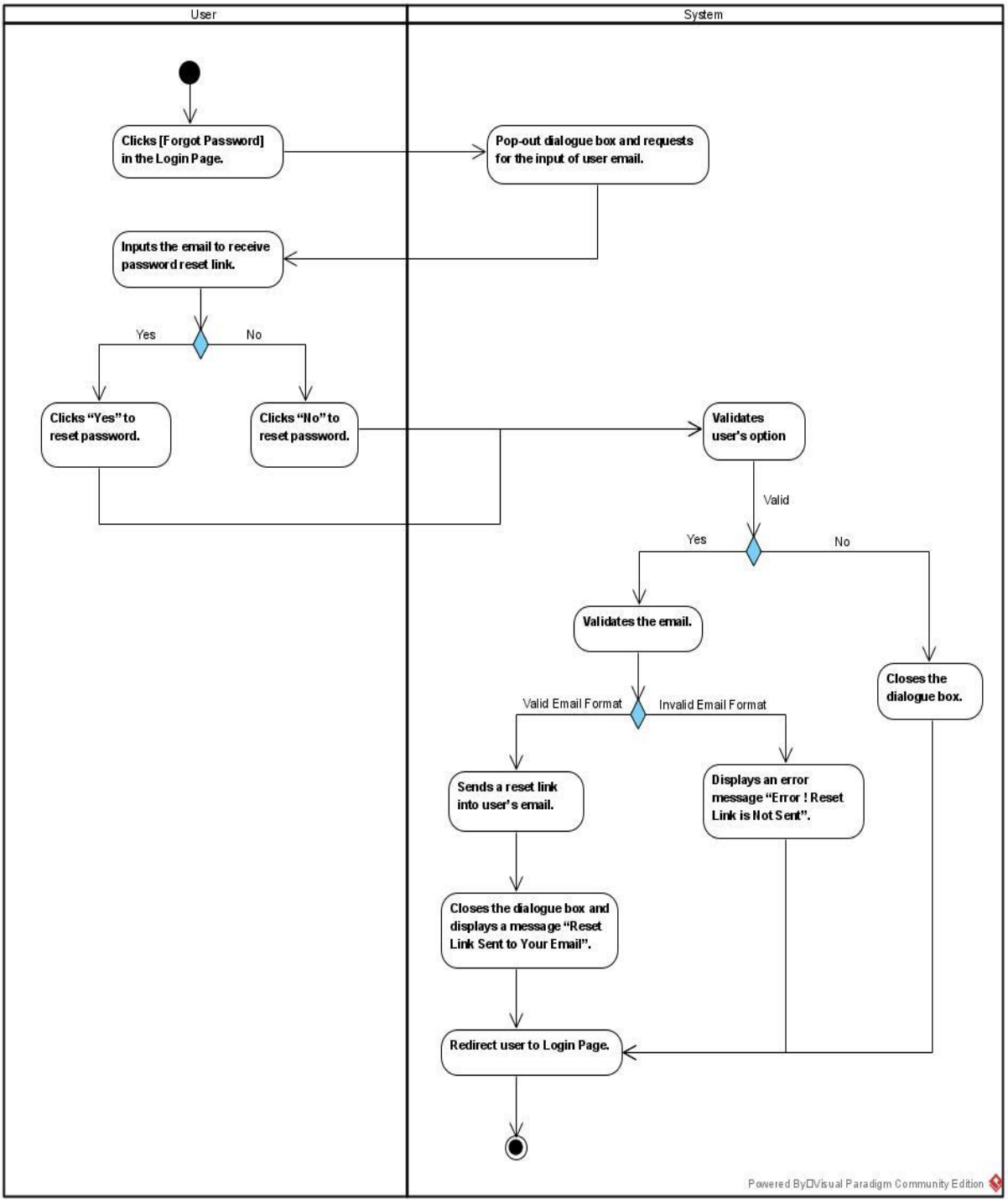


Figure 3.2.5.3 Activity Diagram [F003] Forgot Password

3.2.5.4 Activity Diagram [F004] Home Page

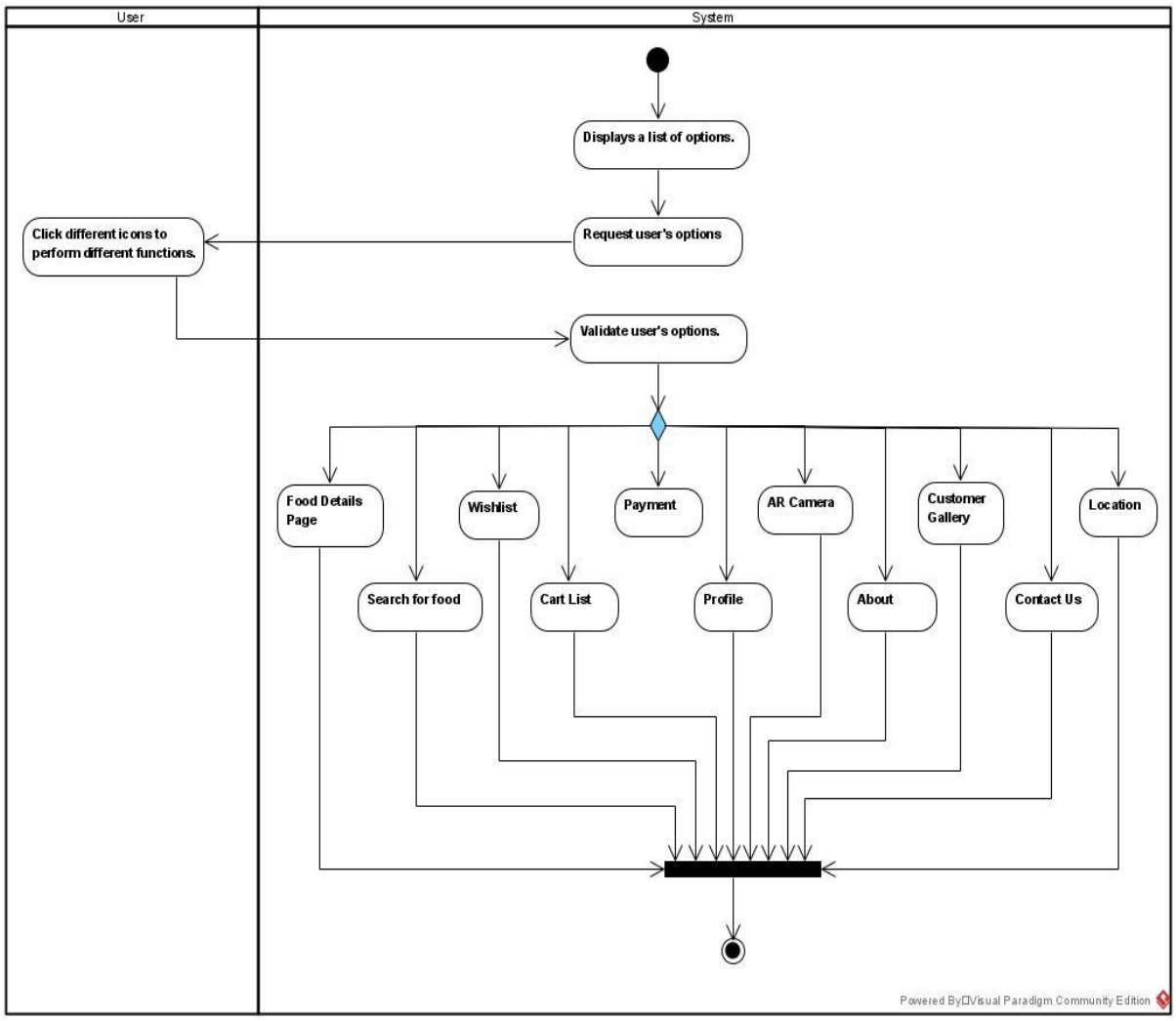


Figure 3.2.5.4 Activity Diagram [F004] Home Page

3.2.5.5 Activity Diagram [F005] Food Details Page

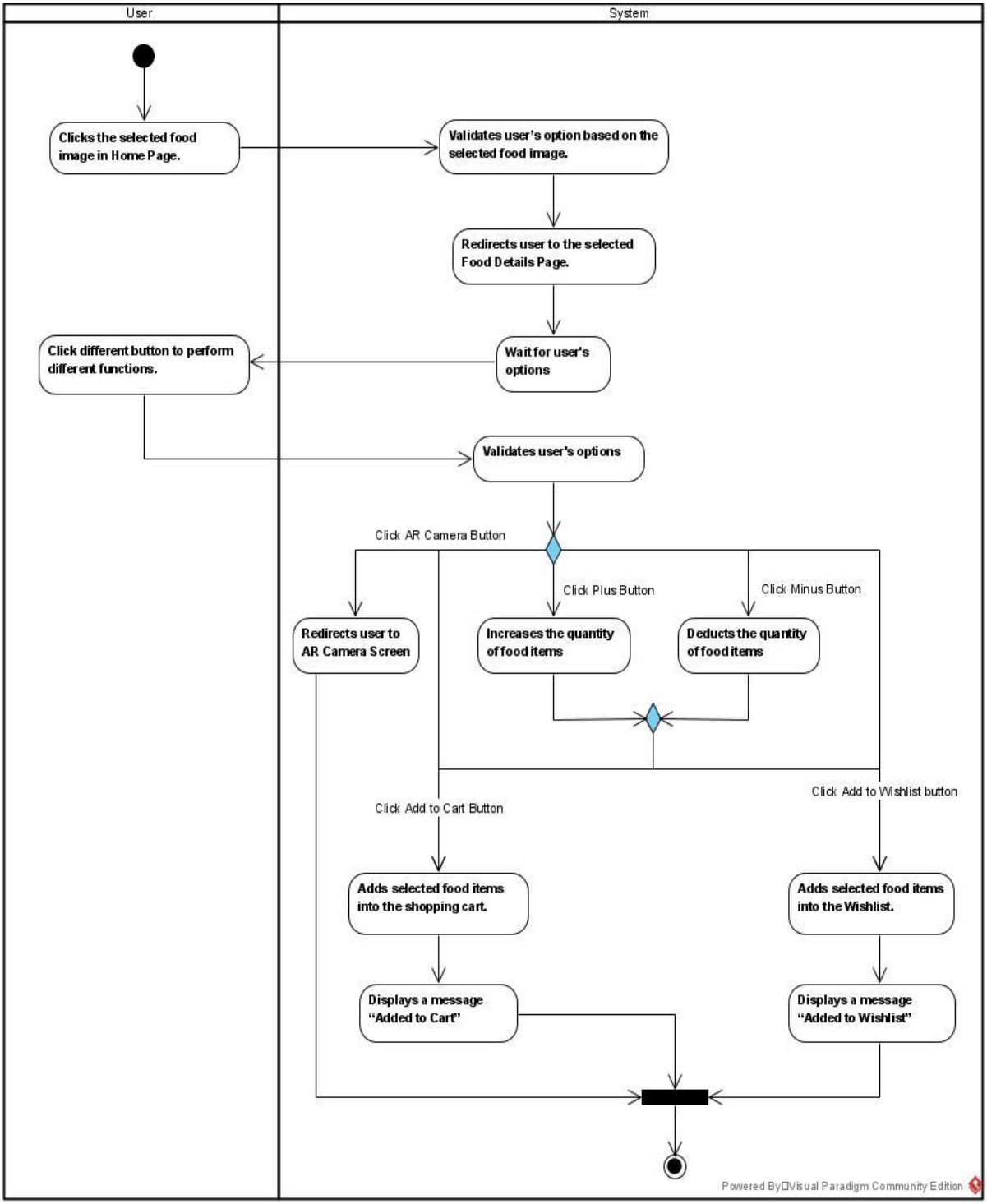


Figure 3.2.5.5 Activity Diagram [F005] Food Details Page

3.2.5.6 Activity Diagram [F006] Search for Food

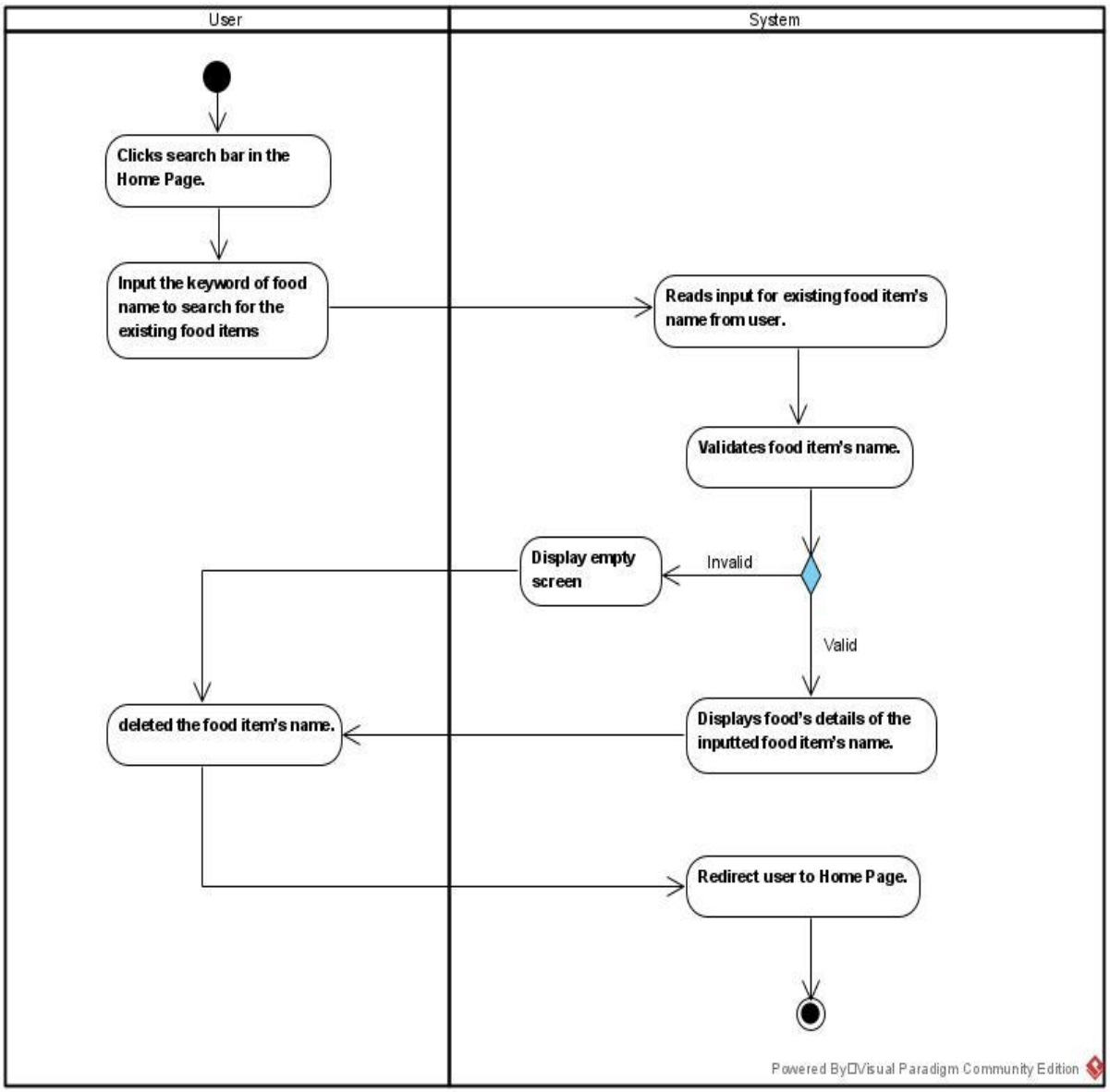


Figure 3.2.5.6 Activity Diagram [F006] Search for Food

3.2.5.7 Activity Diagram [F007] Wishlist

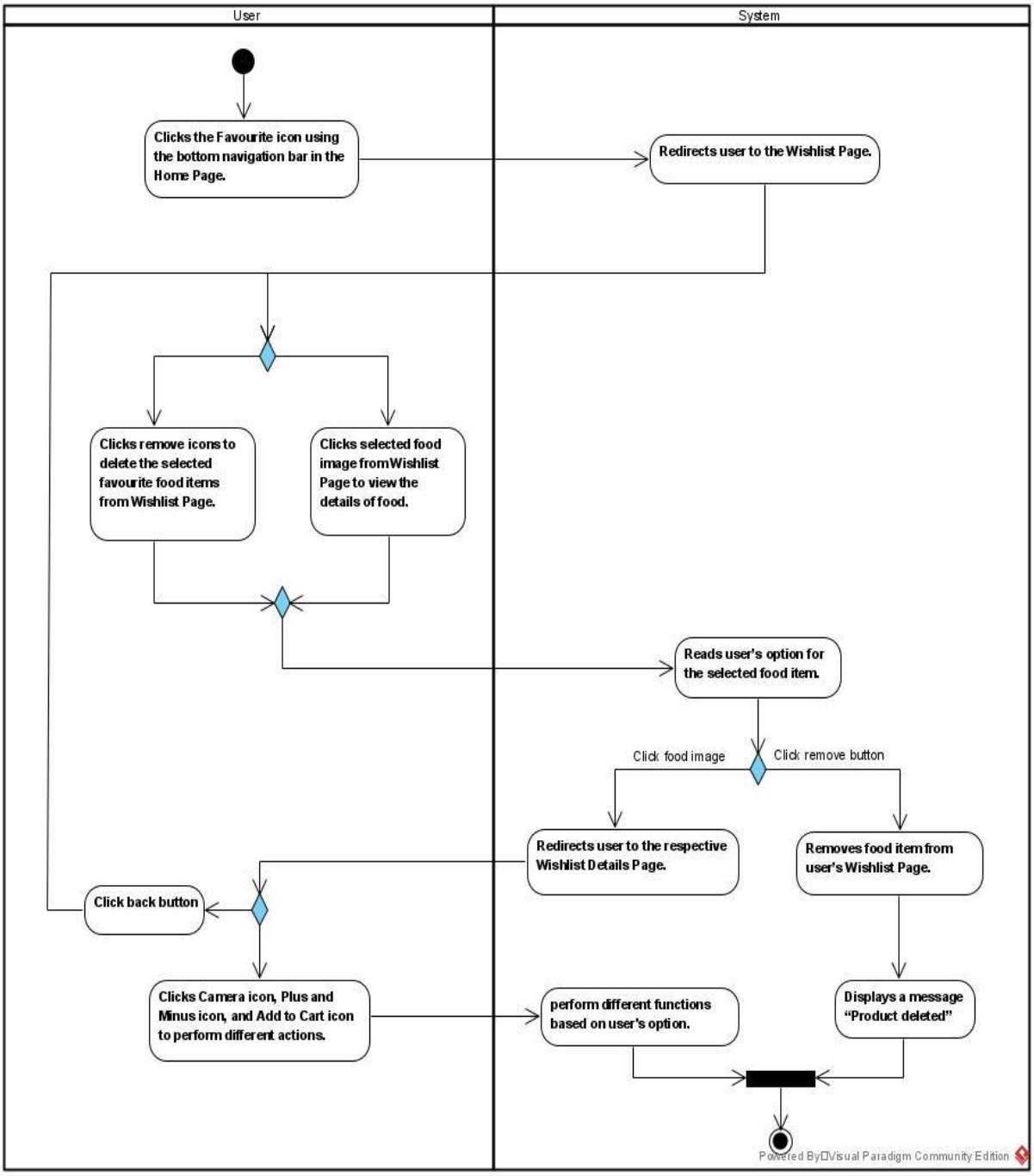


Figure 3.2.5.7 Activity Diagram [F007] Wishlist

3.2.5.8 Activity Diagram [F008] Cart List

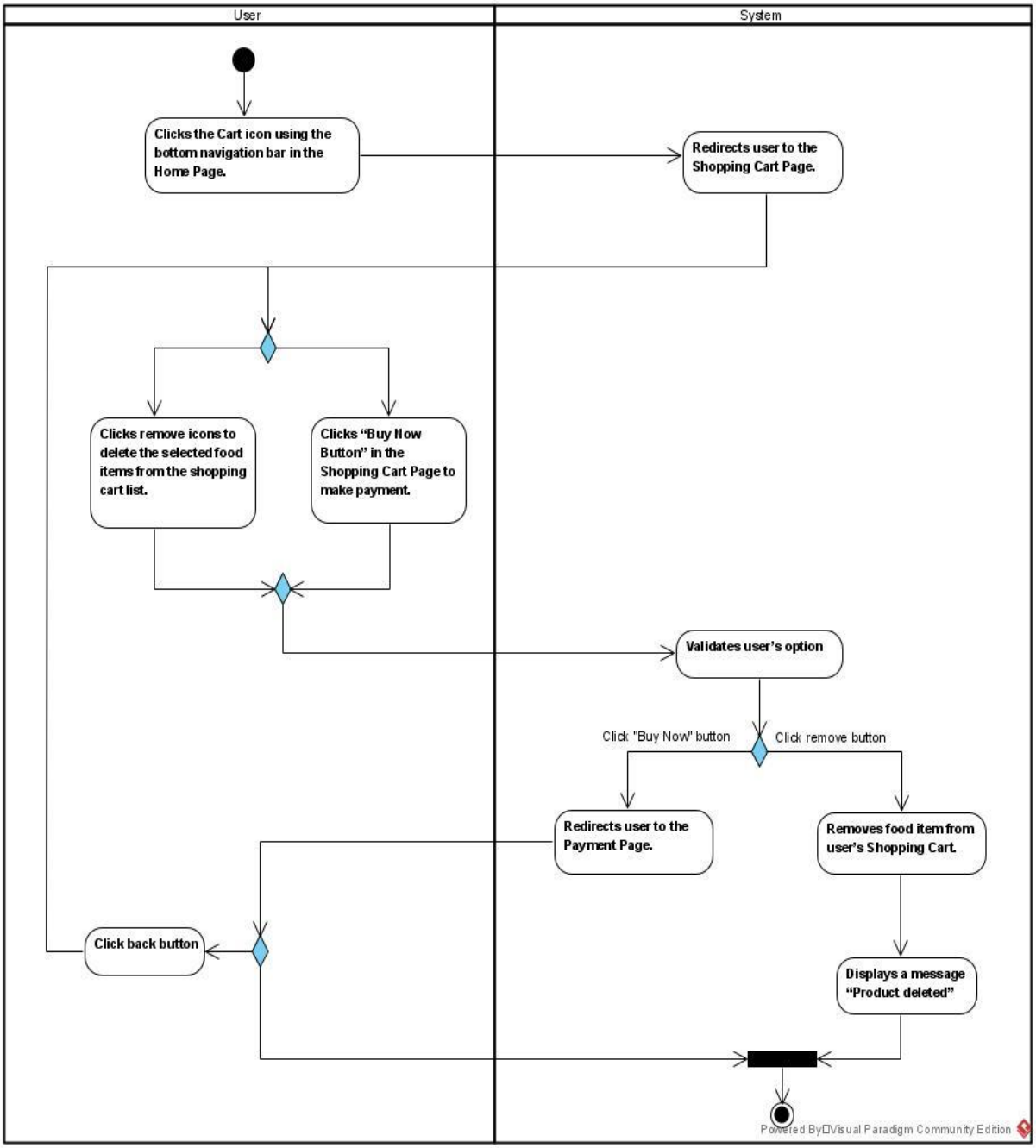


Figure 3.2.5.8 Activity Diagram [F008] Cart List

3.2.5.9 Activity Diagram [F009] Payment

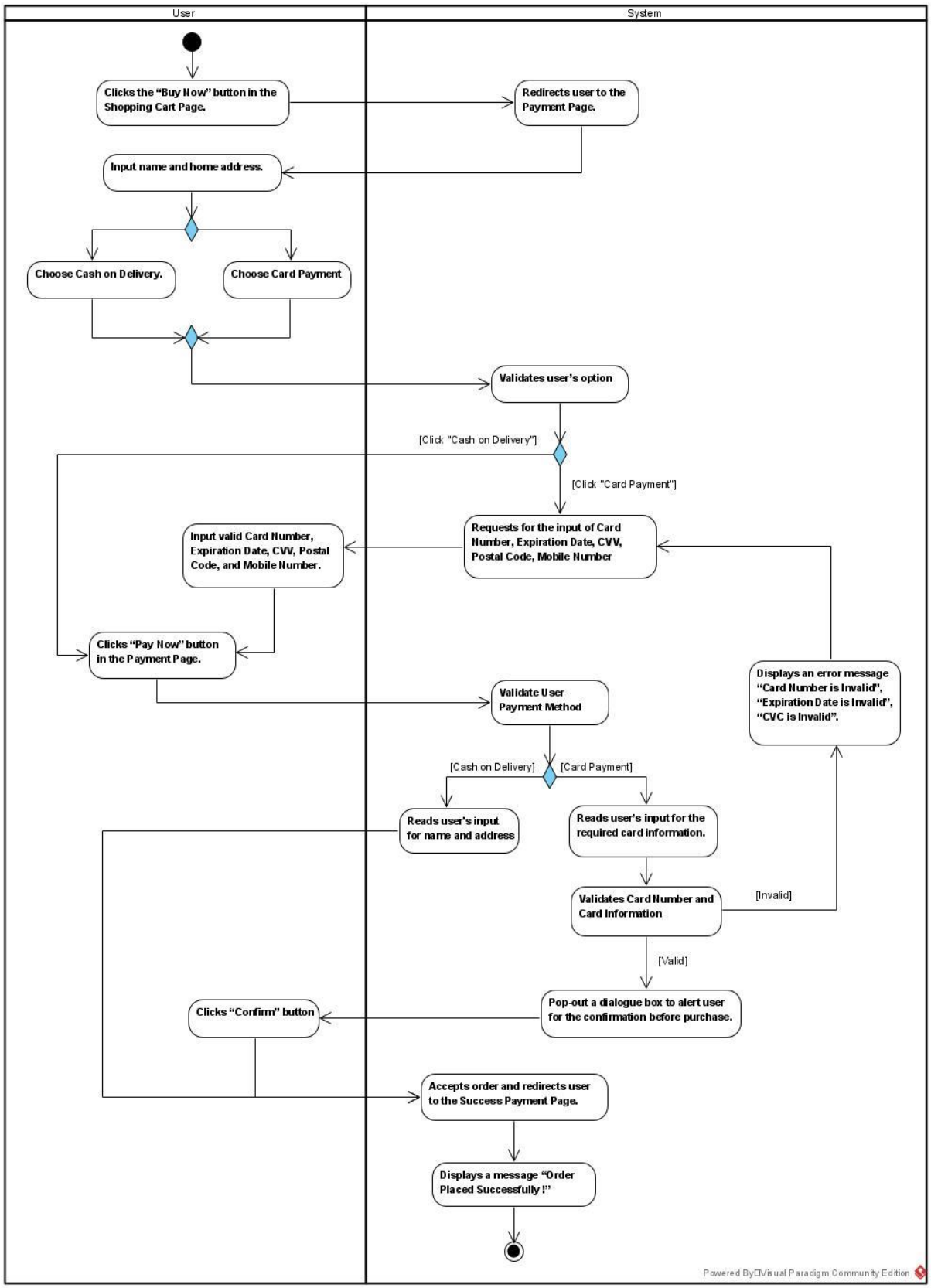


Figure 3.2.5.9 Activity Diagram [F009] Payment

3.2.5.10 Activity Diagram [F010] Profile

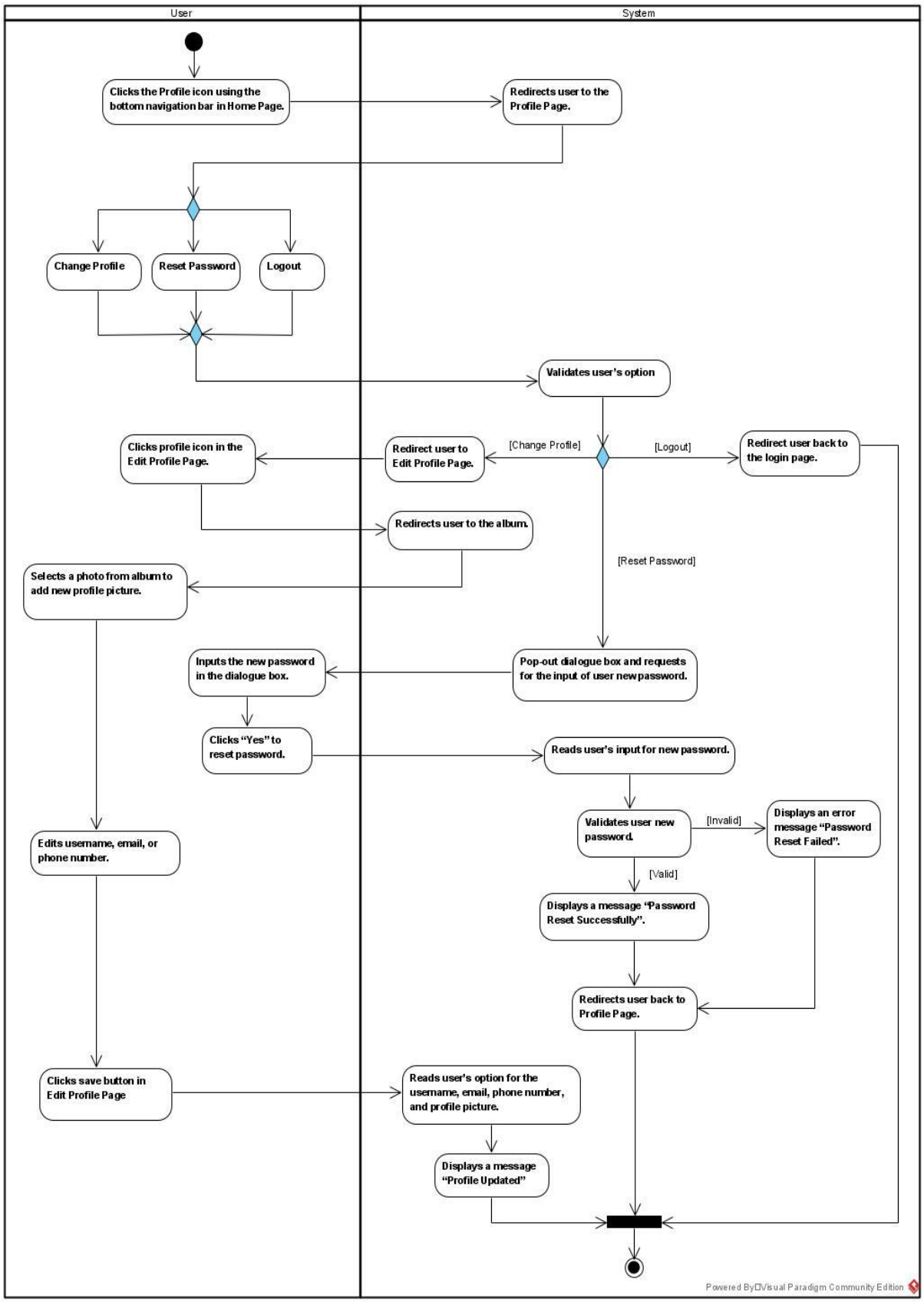


Figure 3.2.5.10 Activity Diagram [F010] Profile

3.2.5.11 Activity Diagram [F011] AR Camera

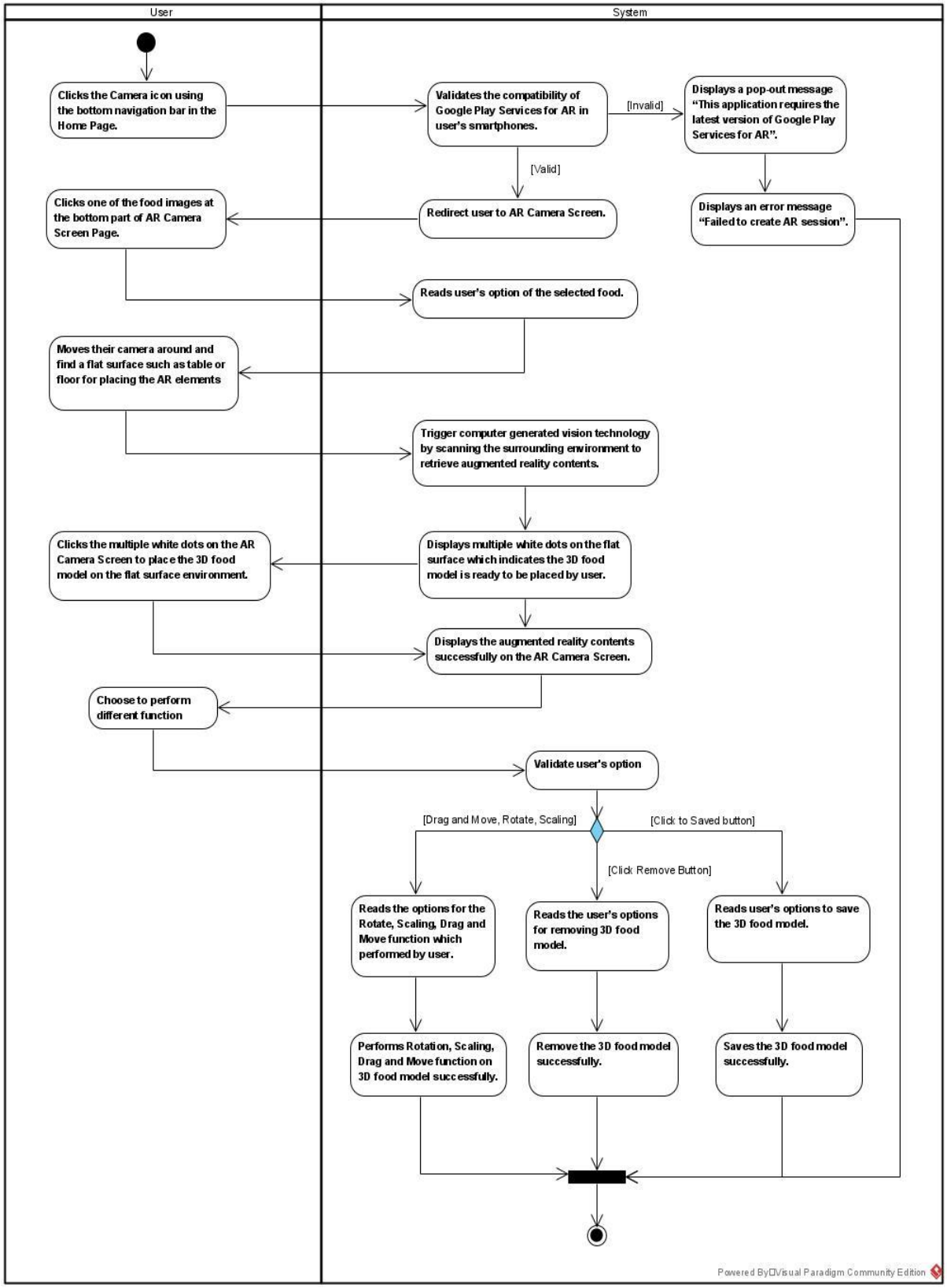


Figure 3.2.5.11 Activity Diagram [F011] AR Camera

3.2.5.12 Activity Diagram [F012] About

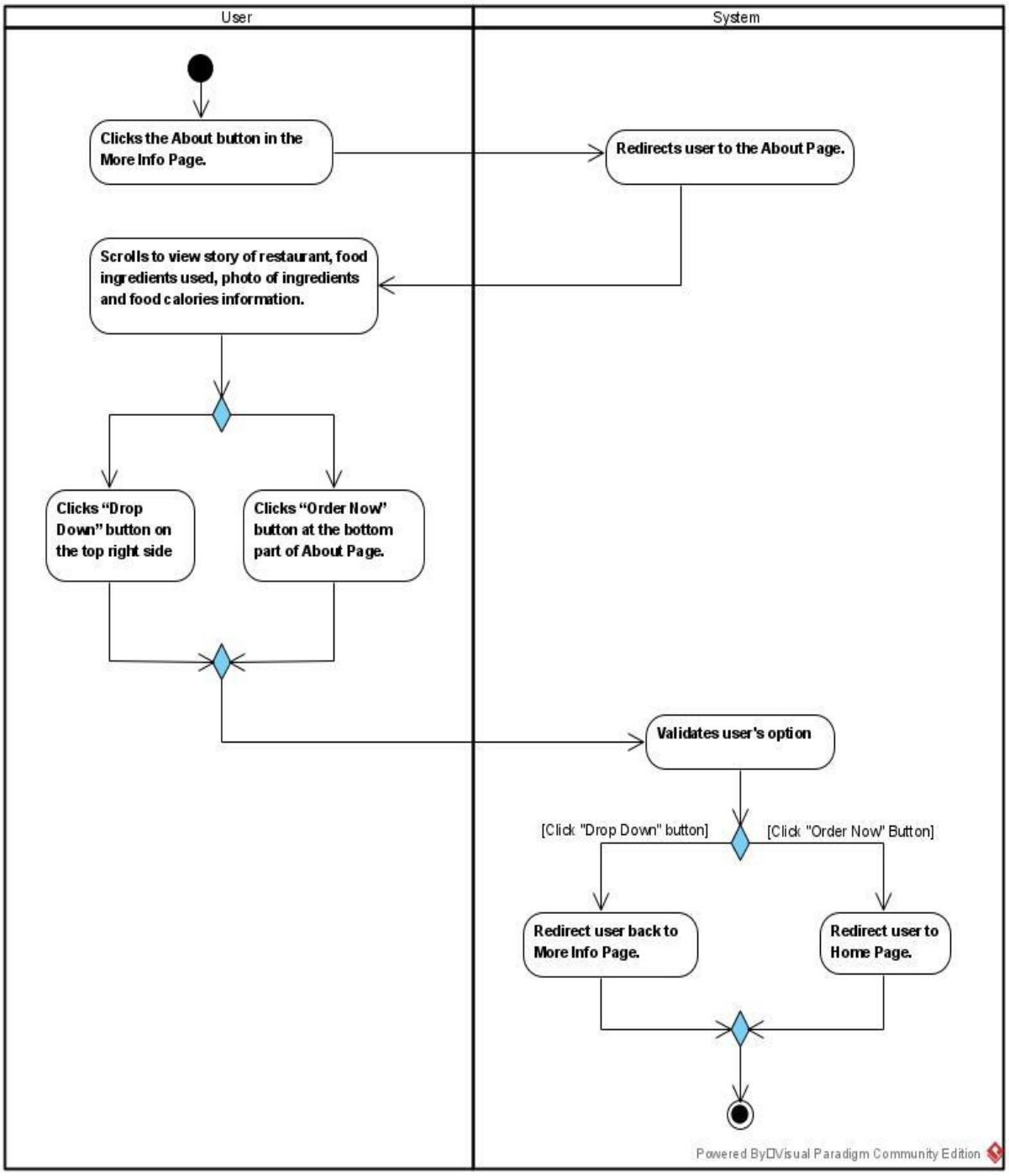


Figure 3.2.5.12 Activity Diagram [F012] About

3.2.5.13 Activity Diagram [F013] Customer Gallery

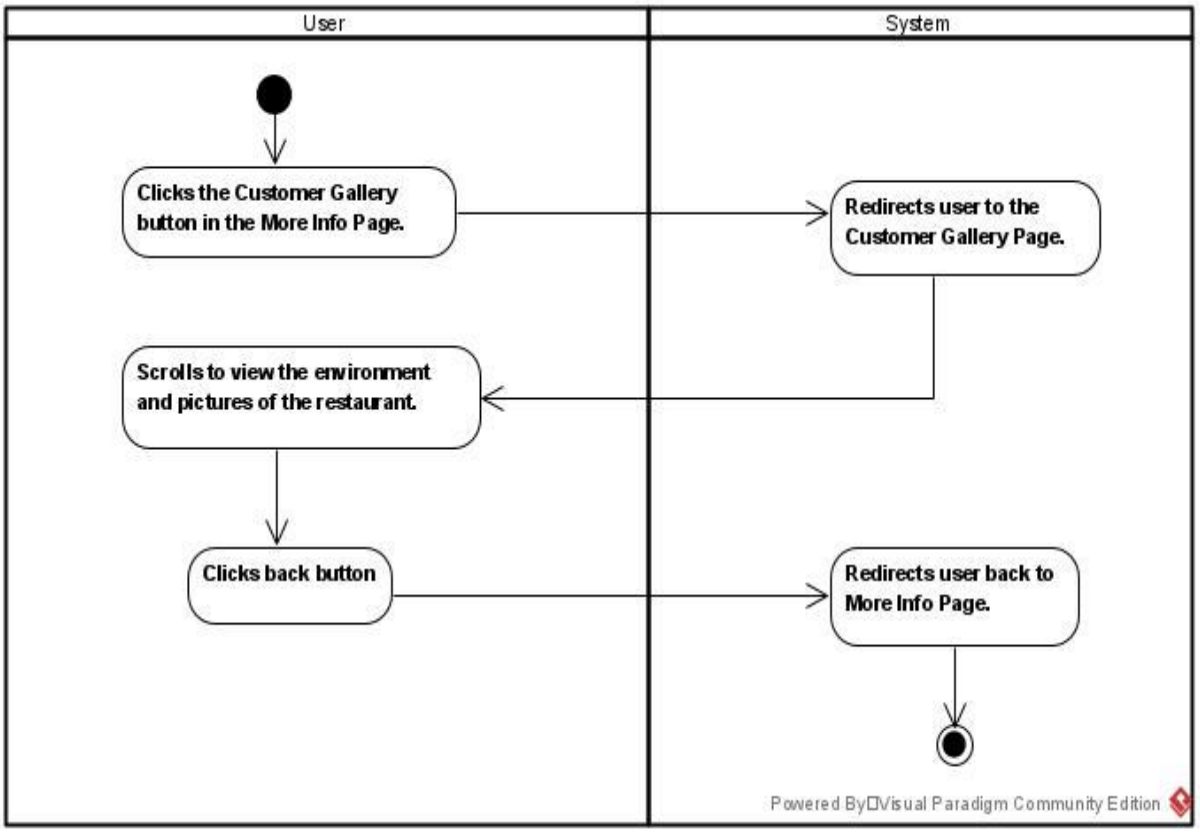


Figure 3.2.5.13 Activity Diagram [F013] Customer Gallery

3.2.5.14 Activity Diagram [F014] Contact us

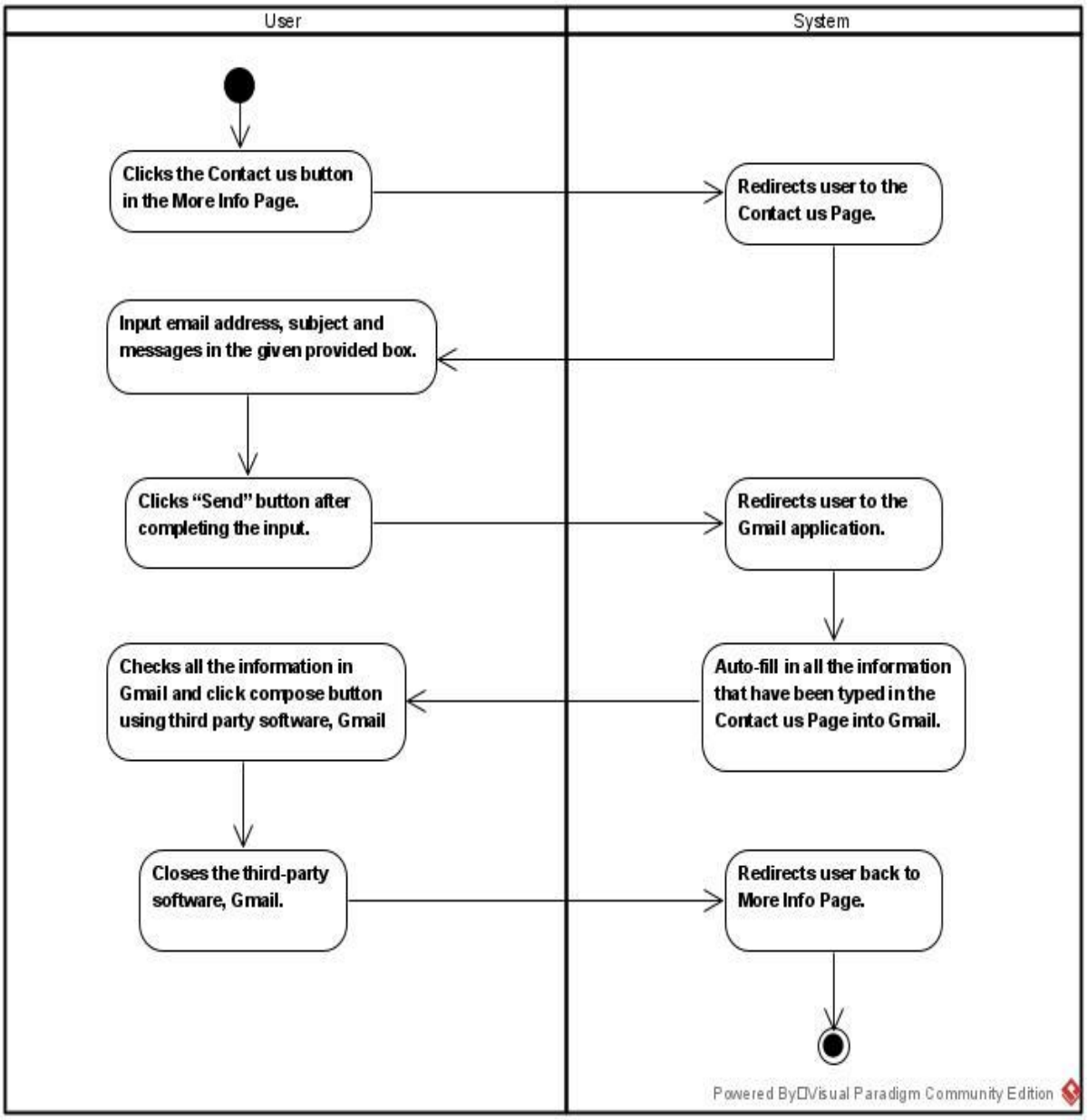


Figure 3.2.5.14 Activity Diagram [F014] Contact us

3.2.5.15 Activity Diagram [F015] Location

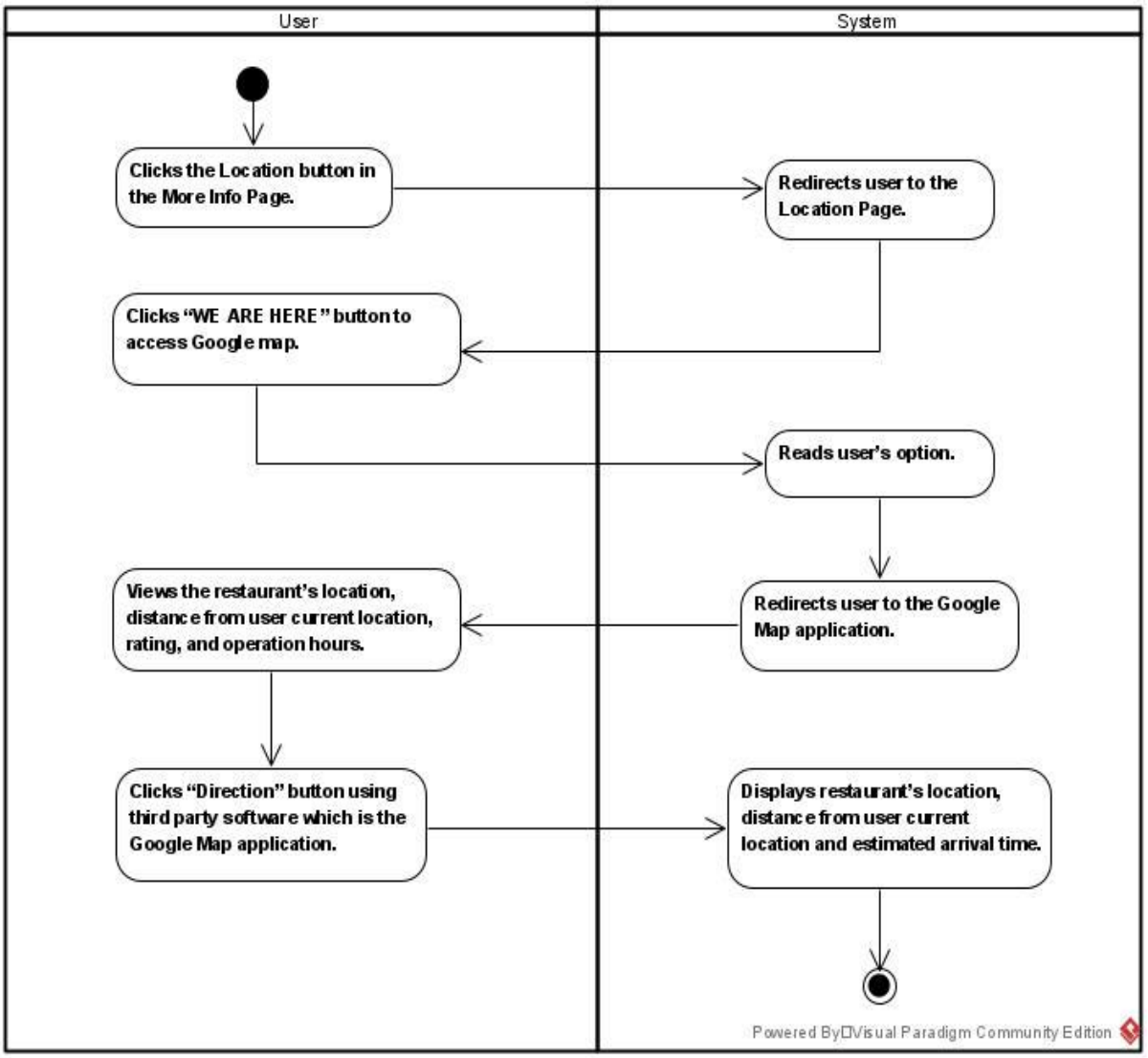


Figure 3.2.5.15 Activity Diagram [F015] Location

3.2.5.16 Activity Diagram [F016] Admin Login

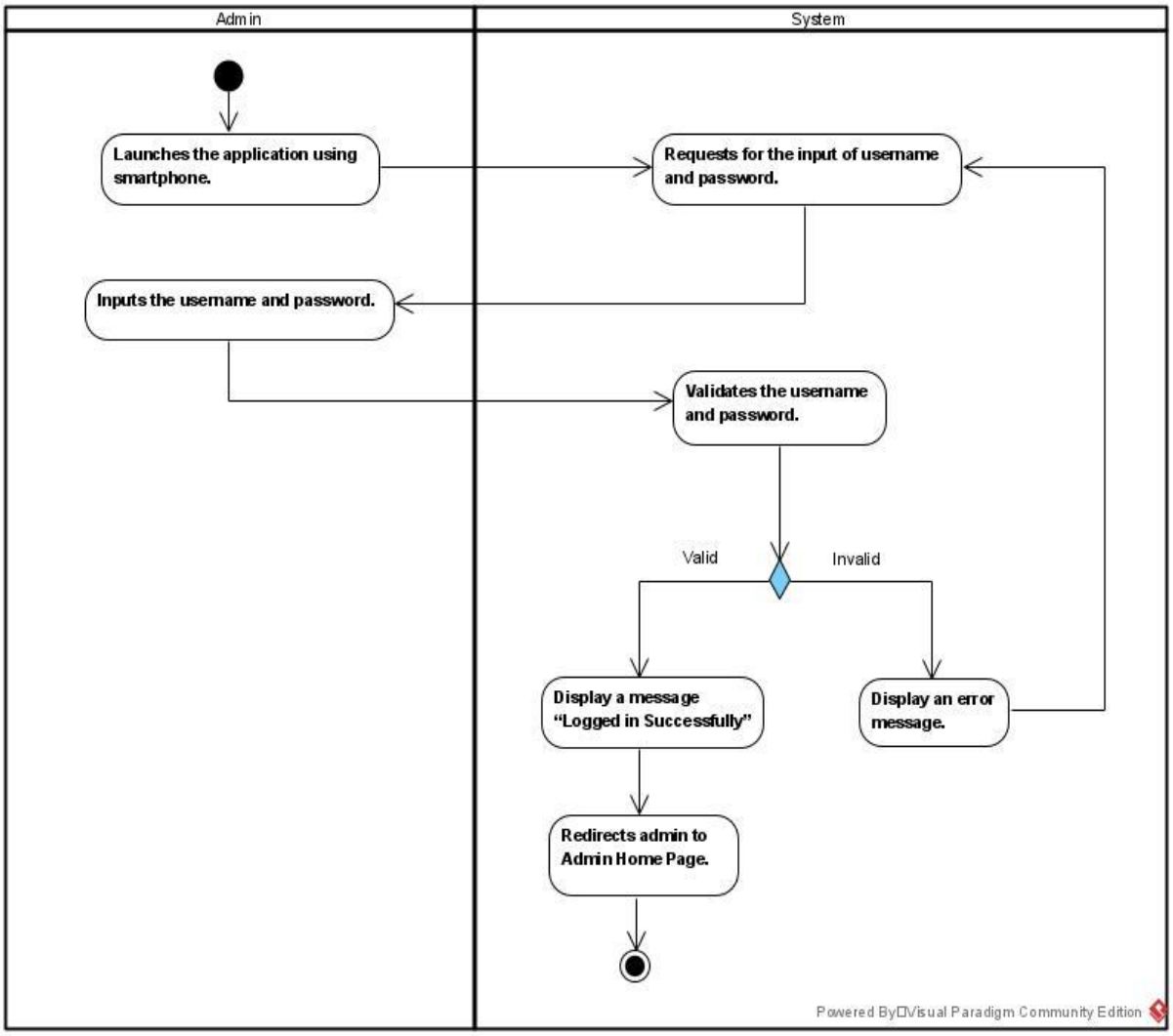


Figure 3.2.5.16 Activity Diagram [F016] Admin Login

3.2.5.17 Activity Diagram [F017] Admin Homepage

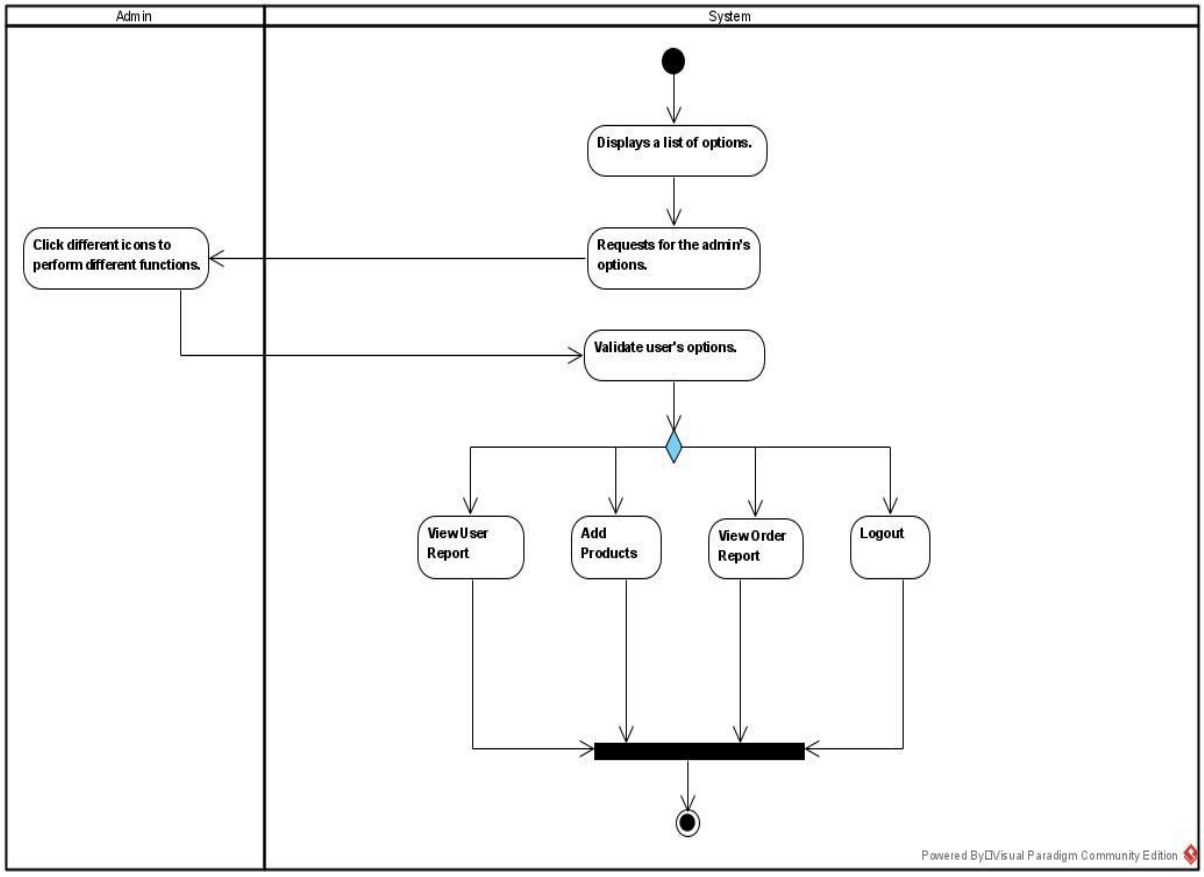


Figure 3.2.5.17 Activity Diagram [F017] Admin Homepage

3.2.5.18 Activity Diagram [F018] Admin User Report

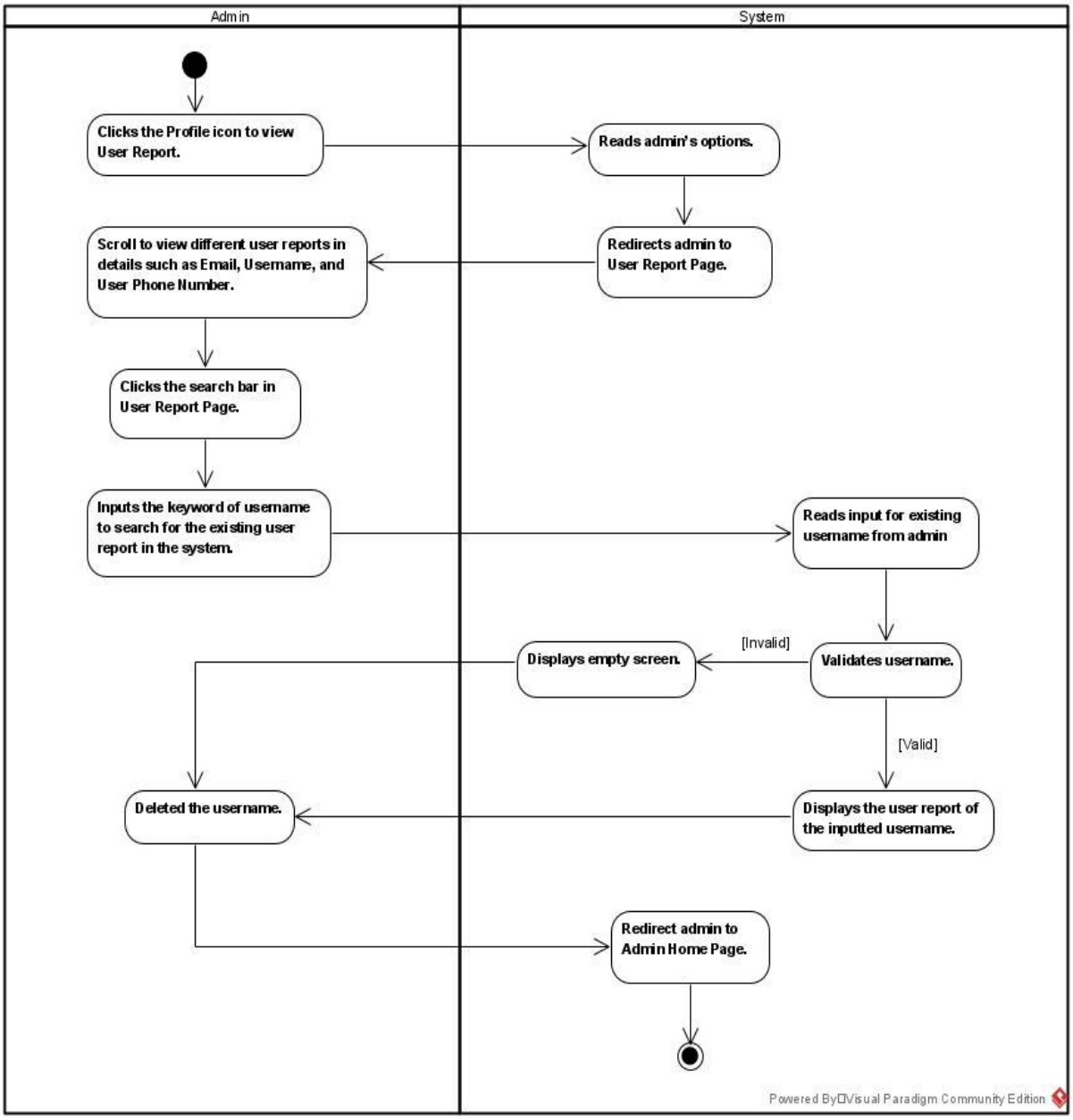


Figure 3.2.5.18 Activity Diagram [F018] Admin User Report

3.2.5.19 Activity Diagram [F019] Add Products

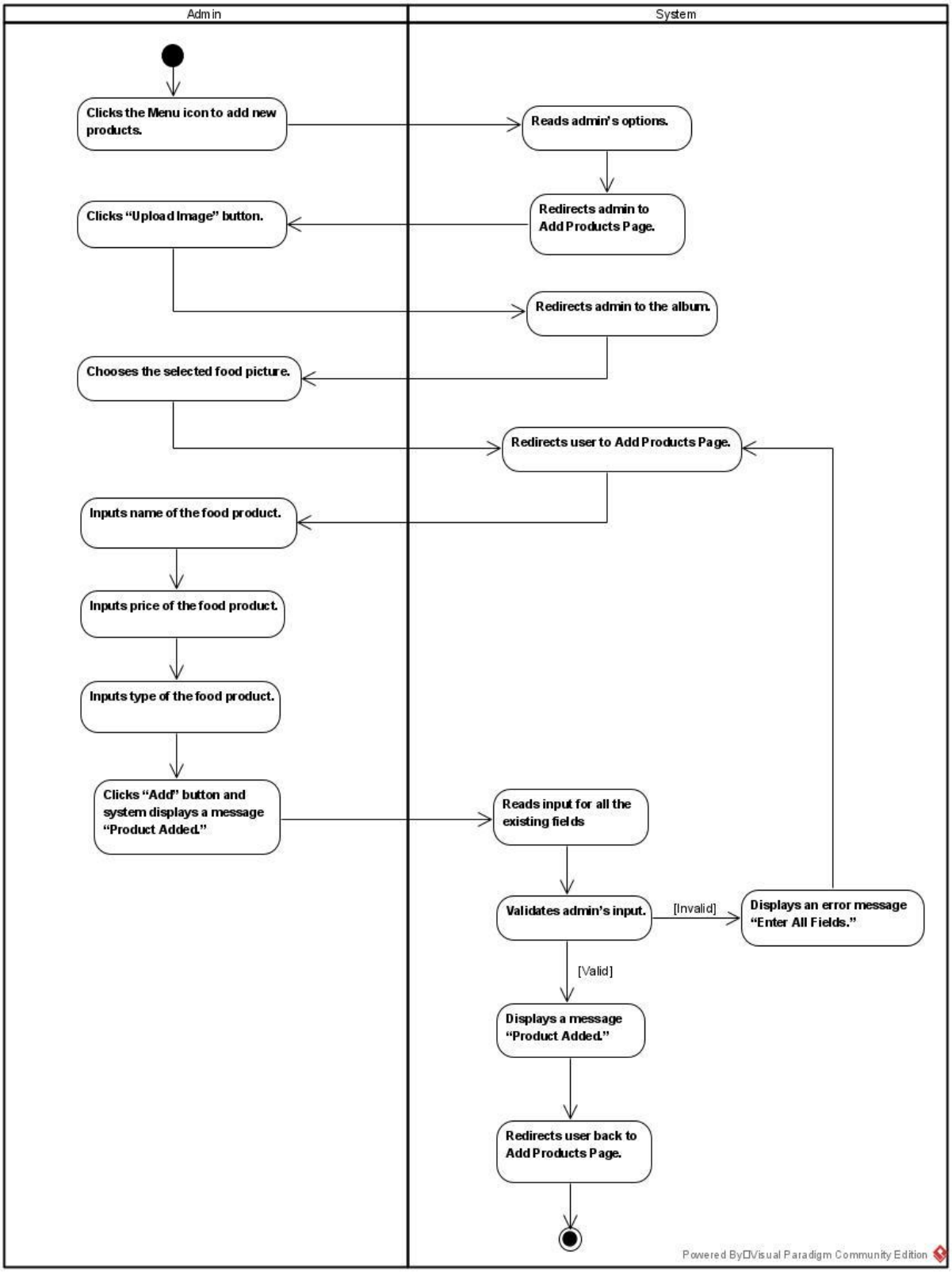


Figure 3.2.5.19 Activity Diagram [F019] Add Products

3.2.5.20 Activity Diagram [F020] Admin Order Report

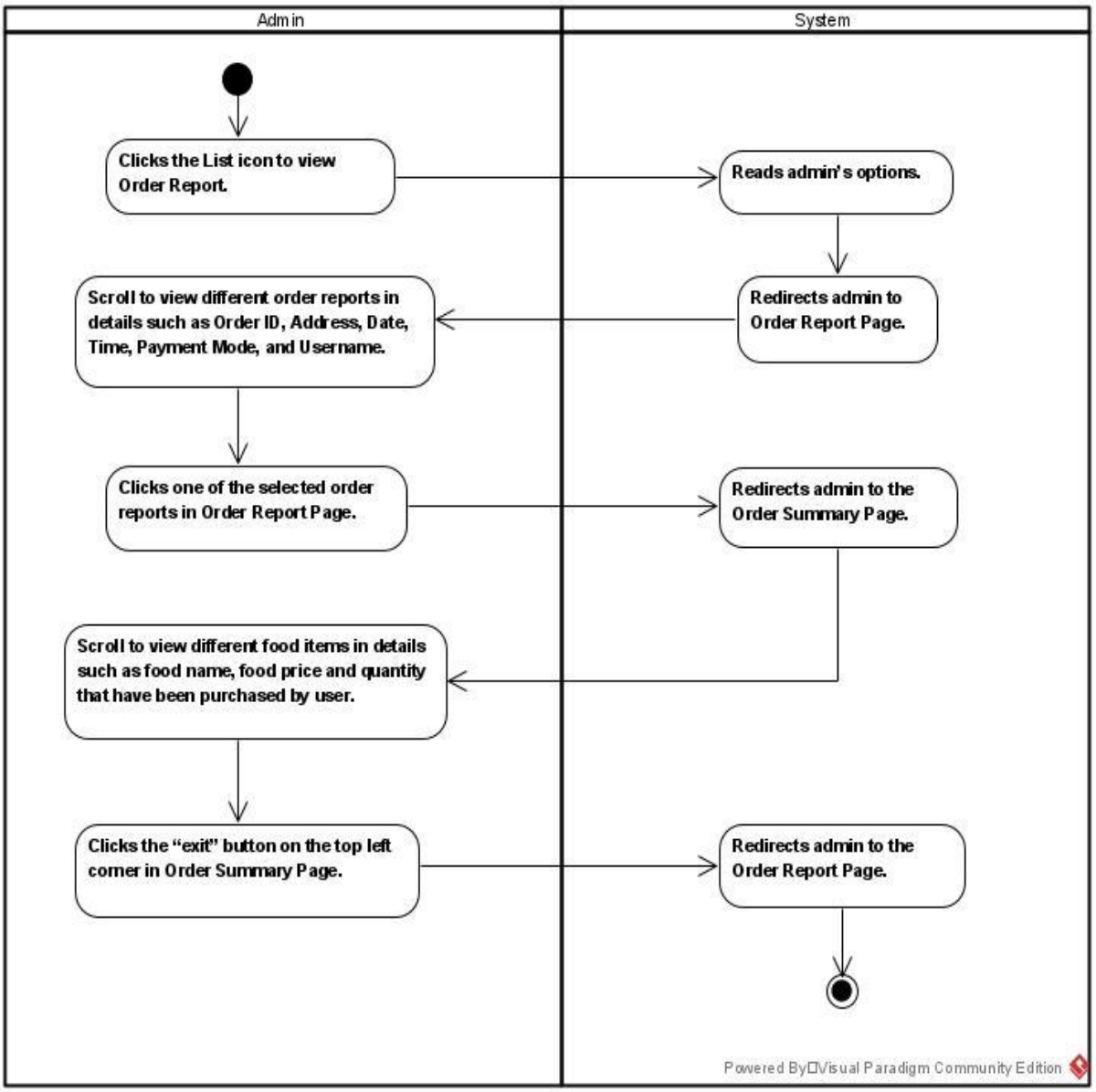
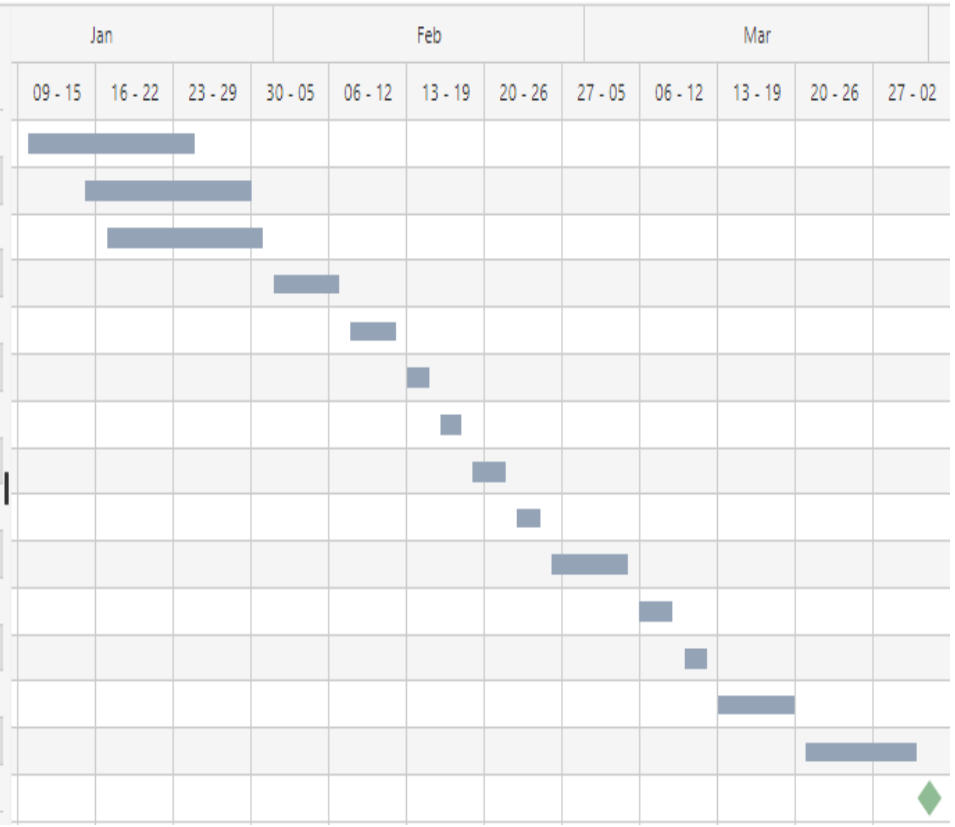


Figure 3.2.5.20 Activity Diagram [F020] Admin Order Report

3.3 Timeline Planning for FYP 1

TABLE 3.3.1 Timeline for FYP 1

ID	Title	Start Time	End Time
1	Implement New Modules	01/10/2022	01/25/2022
2	Produce 3D Food Model	01/15/2022	01/30/2022
3	Coding	01/17/2022	01/31/2022
4	Error and Bug Fixing	02/01/2022	02/07/2022
5	Test Implementation of 3D Food Model	02/08/2022	02/12/2022
6	Test Functional of Application	02/13/2022	02/15/2022
7	Further Enhancement	02/16/2022	02/18/2022
8	User Application Testing	02/19/2022	02/22/2022
9	Collect Feedback	02/23/2022	02/25/2022
10	Bug Fixing and Further Enhancement	02/26/2022	03/05/2022
11	User Application Testing 2.0	03/06/2022	03/09/2022
12	Collect Feedback 2.0	03/10/2022	03/12/2022
13	Bug Fixing and Further Enhancement 2.0	03/13/2022	03/20/2022
14	Arrange Documentation of FYP 2	03/21/2022	03/31/2022
15	Submission of FYP 2	04/01/2022	04/01/2022



CHAPTER 4: SYSTEM DESIGN

In this chapter, an overview of system design, system block diagram, system flowchart, storyboard, system modules and features for this project will be presented.

4.1 System Design

4.1.1 System Block Diagram

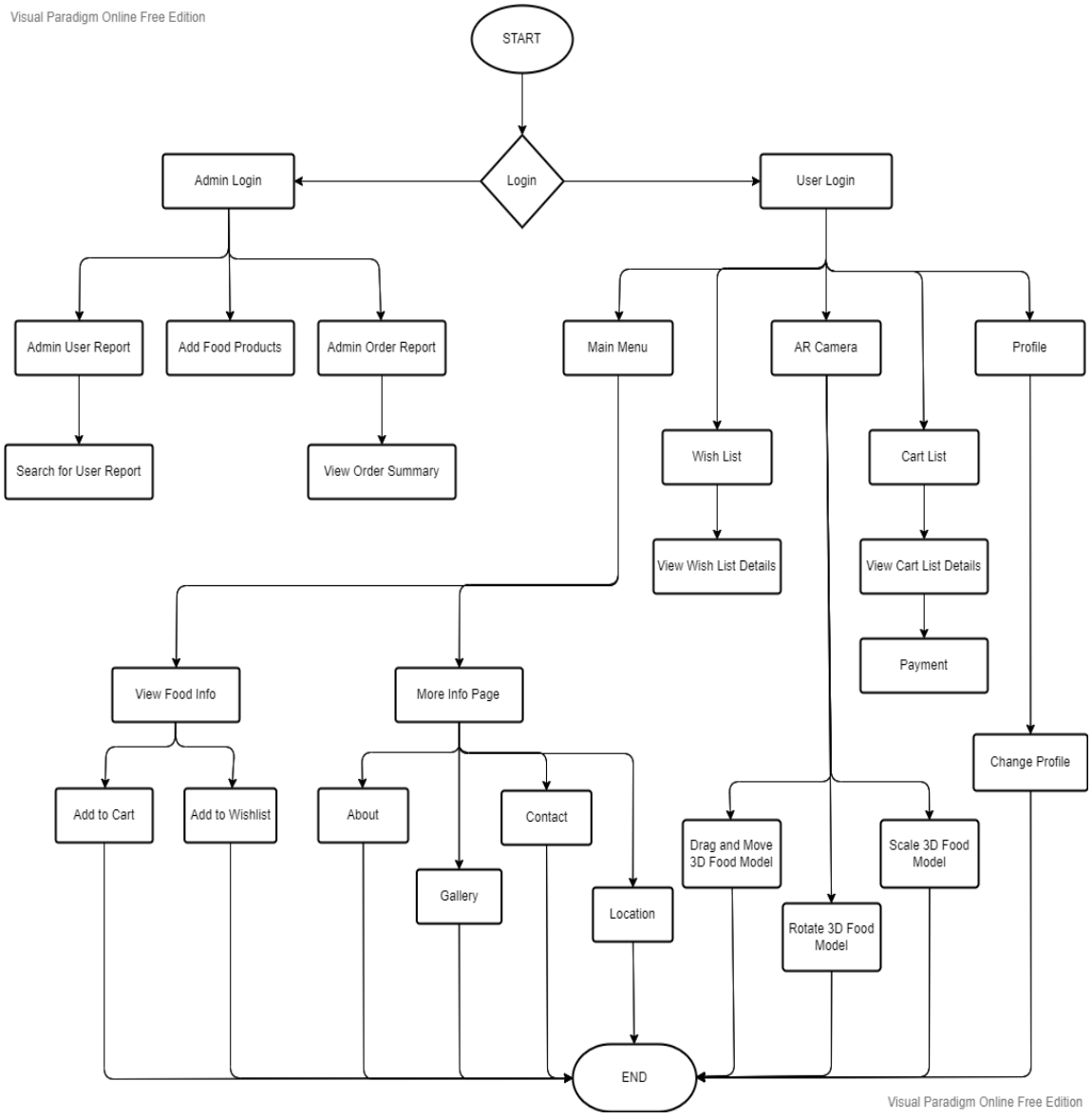


Figure 4.1.1.1 Overall system flow diagram

4.1.2 Storyboard

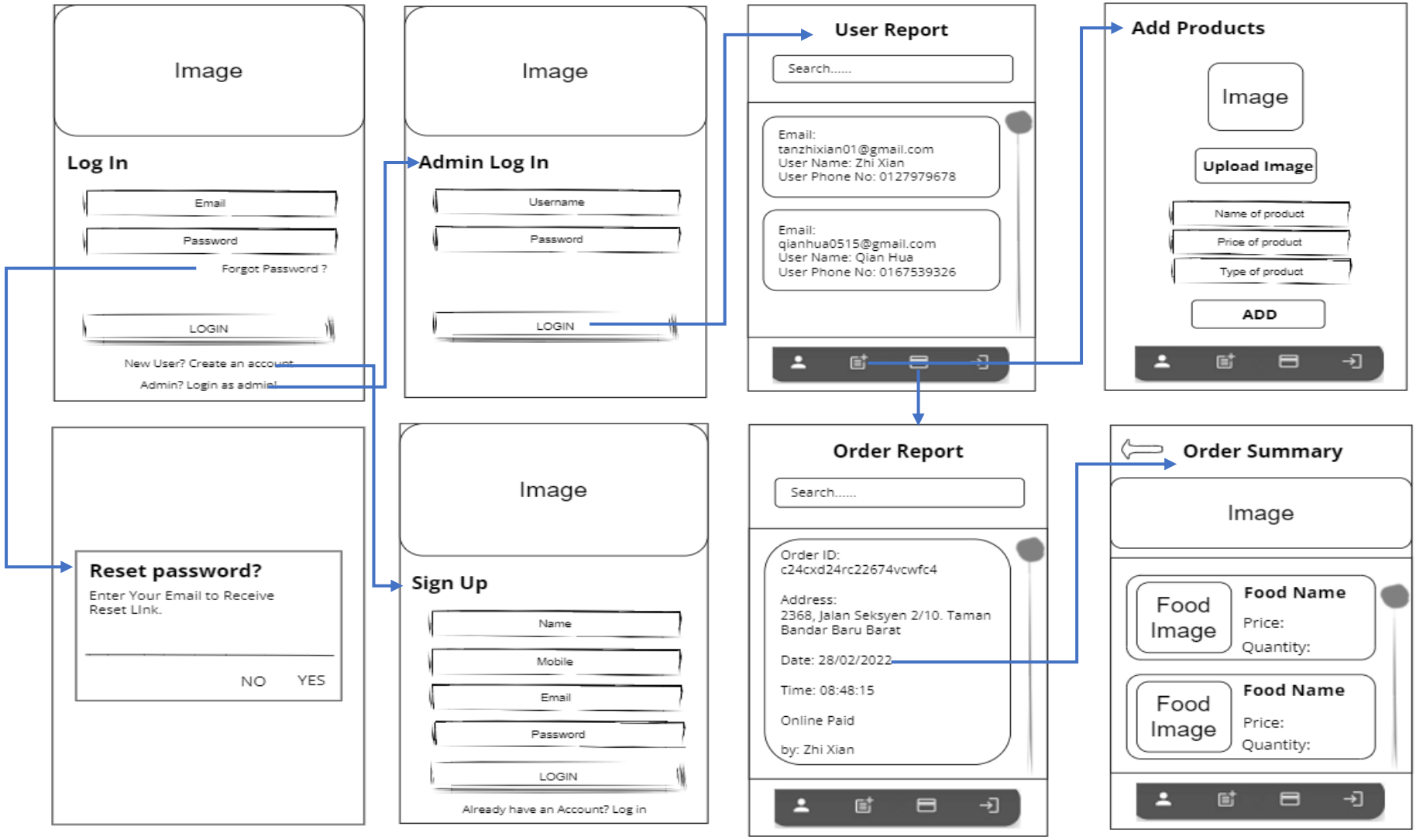


Figure 4.1.2.1 Story Flows of AR Food Menu Project (Admin Module)

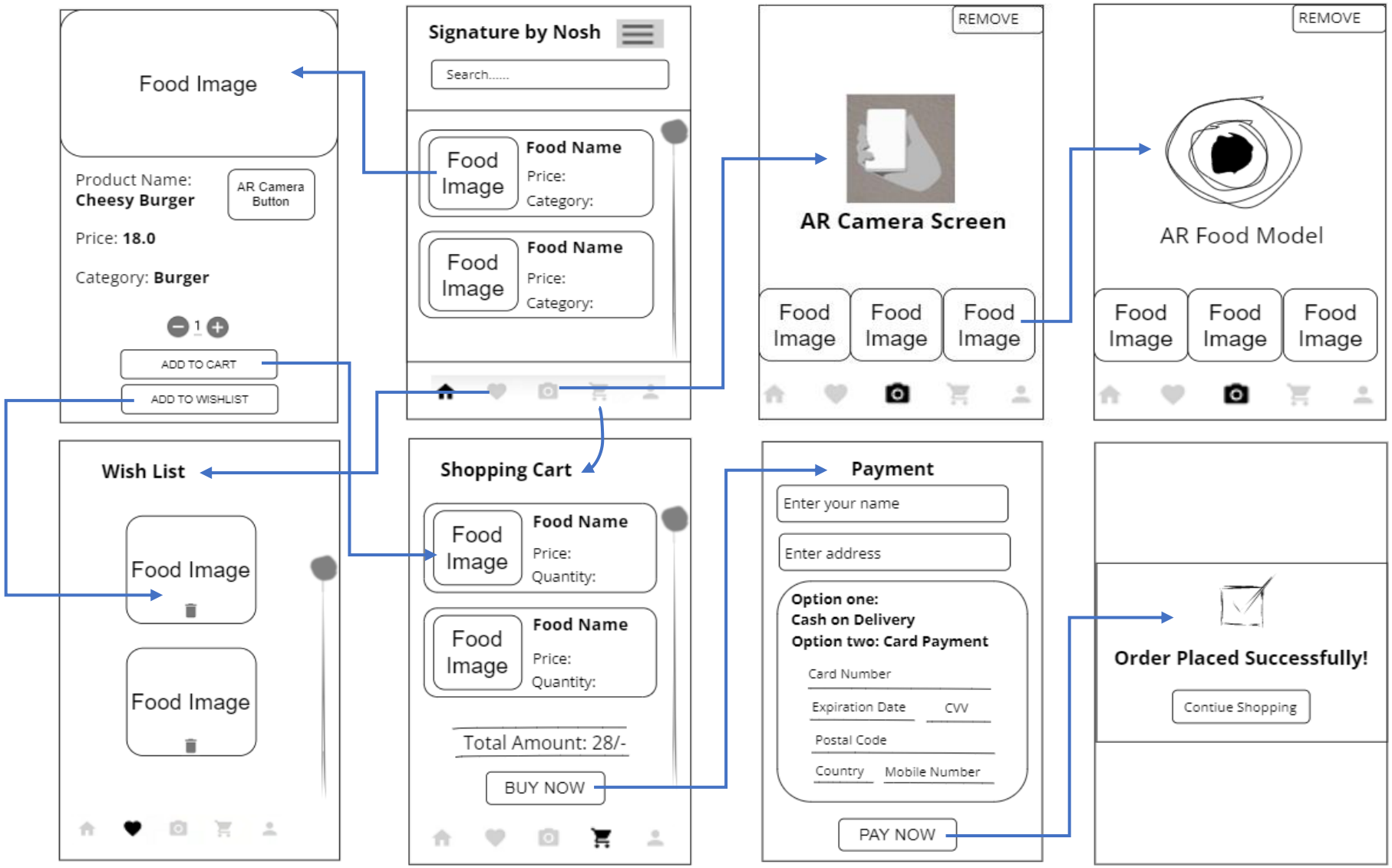


Figure 4.1.2.2 Story Flows of AR Food Menu Project (User Module Part I)

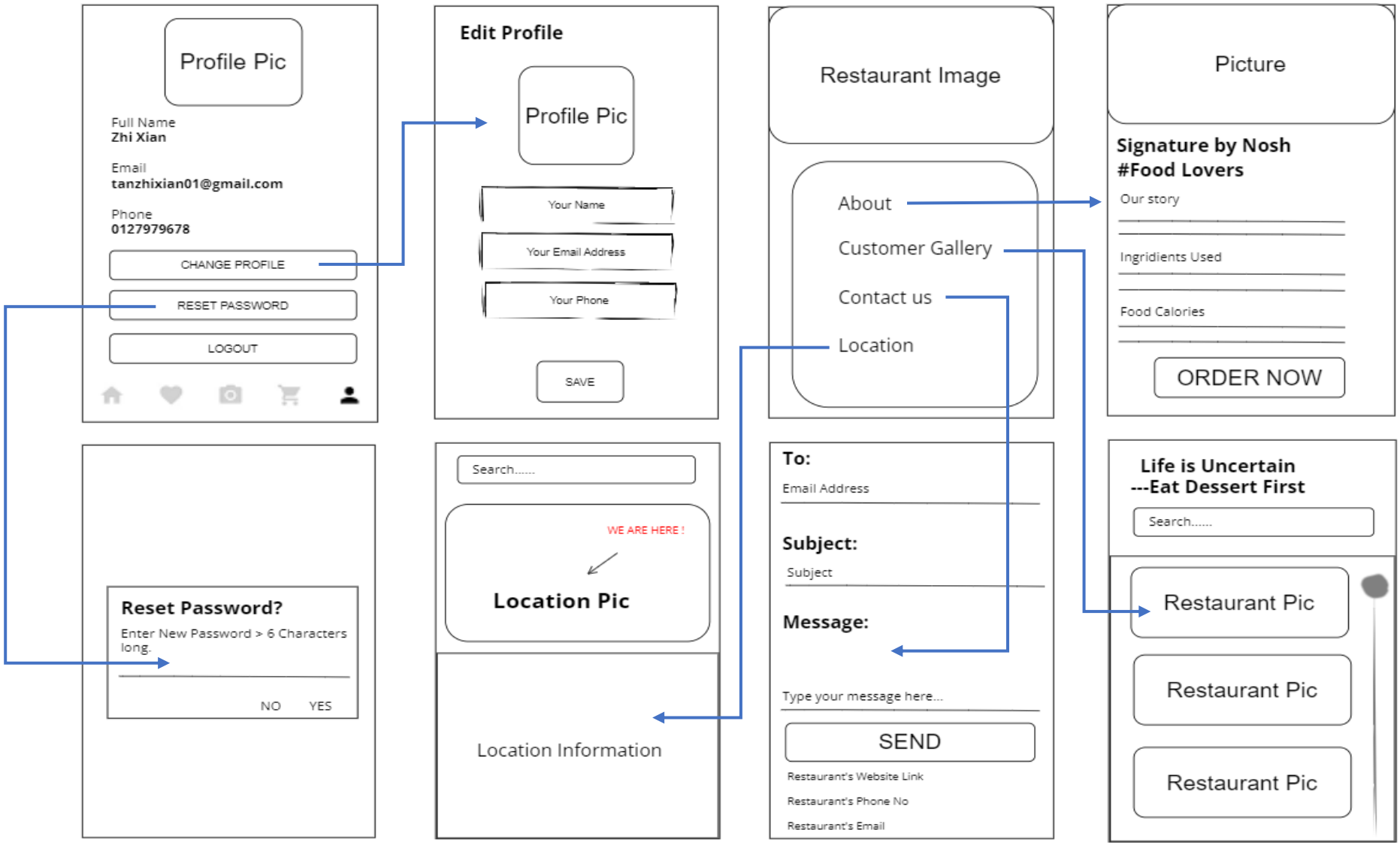


Figure 4.1.2.3 Story Flows of AR Food Menu Project (User Module Part II)

4.2 System Modules and Features

4.2.1 Login and Register Module

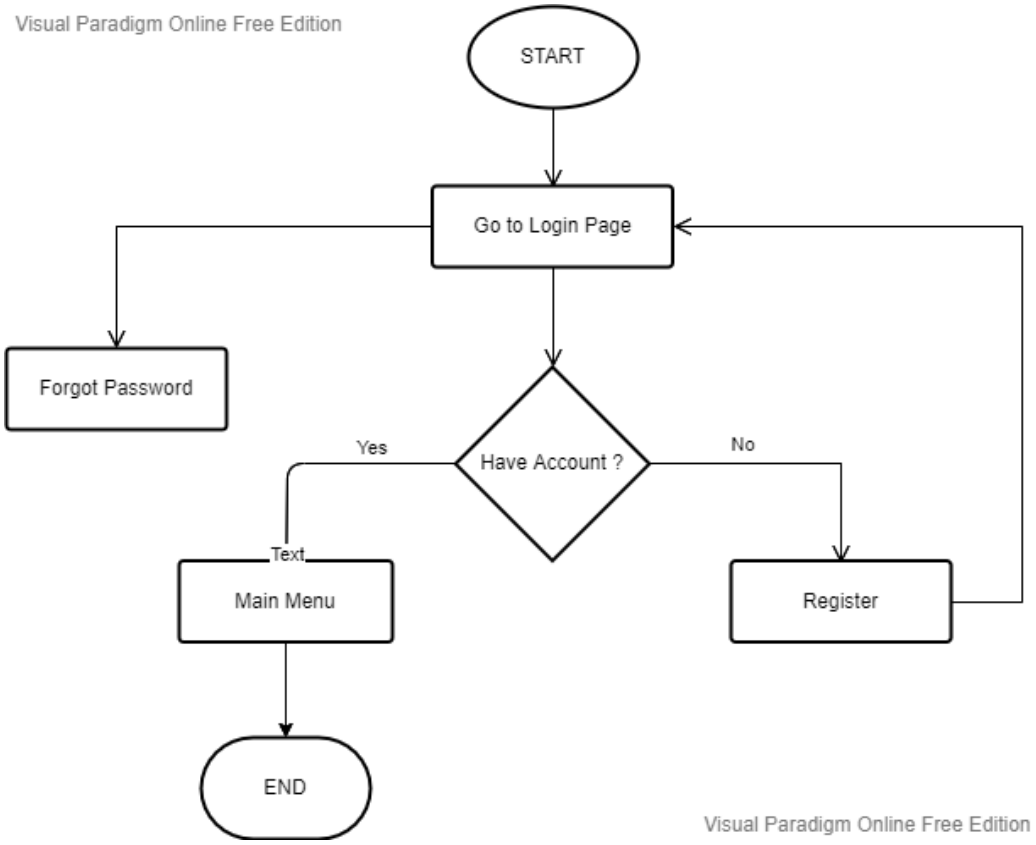


Figure 4.2.1.1 Flowchart of Login and Register Module

Based on the Figure 4.2.1.1, it shows the flow of login and register module. In this system, it consists of two different login which is admin login and user login. After launching the application, it will redirect user to the login page. For existing users, the system will redirect user automatically to the food menu main page. For new users, they can click the sign-up button and the system will redirect them to the Register page to sign up as a new user. Besides, if user has forgot their password, they can click the "forgot password" button and enter their email to receive password reset link. For admin, they can login as admin by key in the correct username and password. Once the admin has been authenticated, system will redirect admin to the admin main menu. In this module, Firebase Authentication has been implemented to authenticate admin and prevent unauthorised access to the system. Firebase Realtime Database has been used to store user information.

```
mRegisterBtn.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        final String email = mEmail.getText().toString().trim();
        String password = mPassword.getText().toString().trim();
        final String fullName = mFullName.getText().toString();
        final String phone    = mPhone.getText().toString();

        if(TextUtils.isEmpty(fullName)){
            mFullName.setError("Full Name is Required.");
            return;
        }

        if(TextUtils.isEmpty(phone) || phone.length() != 10){
            mPhone.setError("Phone number is Required.");
```

Figure 4.2.1.2 Implementation of Signup Java Class

In Figure 4.2.1.2, string email, password, full name, and phone will be created in Signup Java Class to allow user fill in all the necessary information. If the text is empty, it will set an error message to alert user to input all the personal information.

```
// register the user in firebase

fAuth.createUserWithEmailAndPassword(email,password).addOnCompleteListener(new OnCompleteListener<AuthRe
    @Override
    public void onComplete(@NonNull Task<AuthResult> task) {
        if(task.isSuccessful()){
```

Figure 4.2.1.3 User Registration

After creating string email, password, full name, and phone, it will register user with email and password in Firebase Authentication. All the user email, user ID, date created, and date signed in will be store in Firebase server as shown in Figure 4.2.1.4 below. Email verification has been implemented in the application to identify user identity.

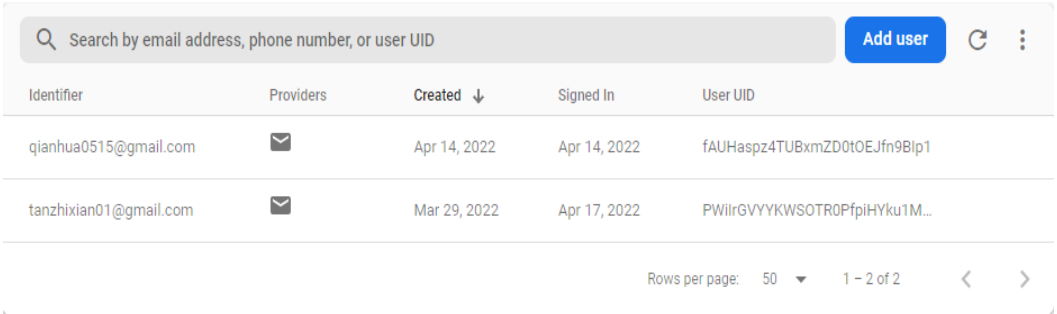


Figure 4.2.1.4 Registration of User in Firebase

```
// authenticate the user

fAuth.signInWithEmailAndPassword(email,password).addOnCompleteListener(new OnCompleteListener<AuthResult>() {
    @Override
    public void onComplete(@NonNull Task<AuthResult> task) {
        if(task.isSuccessful()){
            Toast.makeText( context: Login.this,  text: "Logged in Successfully", Toast.LENGTH_SHORT).show();
            startActivity(new Intent(getApplicationContext(),gallery.class));
        }else {
            Toast.makeText( context: Login.this,  text: "Error ! " + task.getException().getMessage(), Toast.LENGTH_SHORT)
            progressBar.setVisibility(View.INVISIBLE);
        }
```

Figure 4.2.1.5 Implementation of Login Java Class

Once the user authentication operation succeeds, authentication result will be passed to the success listener, as shown in Figure 4.2.1.5 above.

```
forgotTextLink.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {

        final EditText resetMail = new EditText(v.getContext());
        final AlertDialog.Builder passwordResetDialog = new AlertDialog.Builder(v.getContext());
        passwordResetDialog.setTitle("Reset Password ?");
        passwordResetDialog.setMessage("Enter Your Email To Received Reset Link.");
        passwordResetDialog.setView(resetMail);
```

Figure 4.2.1.6 Forgot Password

In Figure 4.2.1.6, user password reset link will be displayed in user email once the user clicks the reset button. After user has changed the password, it will be stored in Firebase.

```
public void validate(String inputEmail, String password) {

    Log.d( tag: "Value",  msg: "is email " +inputEmail);
    Log.d( tag: "Value",  msg: "is password" +password);

    if (inputEmail.equals("admin")){
        if(password.equals("pass")){
            startActivity(new Intent(getApplicationContext(),Admin_userReport.class));
            Toast.makeText( context: admin_login.this,  text: "You have successfully logged in", Toast.LENGTH_SHORT).show()
        }
        else{
            Toast.makeText( context: admin_login.this,  text: "Please enter correct credentials", Toast.LENGTH_SHORT).show()
        }
```

Figure 4.2.1.7 Validation of Admin Login

In figure 4.2.1.7, nested if functions will be used to verify admin authentication. If admin username equal to admin; and password equal to pass, admin will be verified and logged into the admin page.

4.2.2 Admin User Report Module

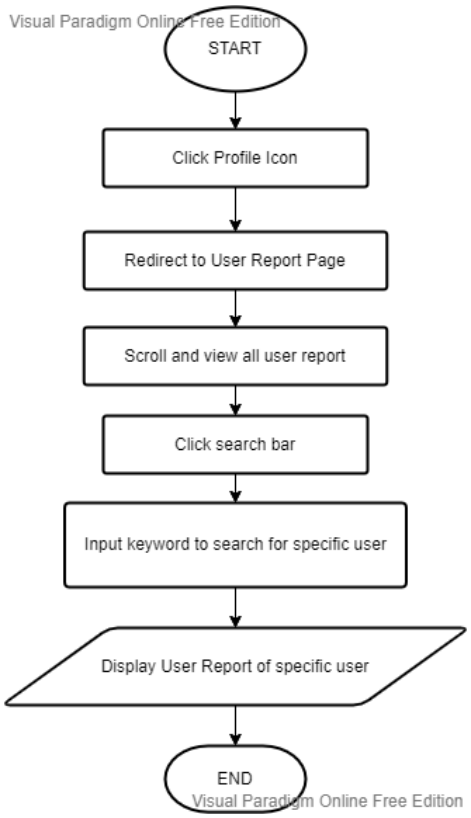


Figure 4.2.2.1 Flowchart of Admin User Report Module

Figure 4.2.2.1 above shows the flow of admin user report module. In admin page, admin can click the admin profile icon and system will redirect admin to the user report page. In this page, admin can scroll and view all the user report. Besides, user can also click the search bar and input keyword such as username to search for specific user report. After user key in valid username, it will display the search user report with all the personal information such as name, email, and phone number in admin user report page.

```
public class getUserData {

    //private String image;
    private String email,fName,phone;

    public getUserData() {
    }

    public getUserData(String email, String fName, String phone) {
        this.email = email;
        this.fName = fName;
        this.phone = phone;
    }

    public String getEmail() { return email; }
    public String getfName() { return fName; }
    public String getPhone() { return phone; }
```

Figure 4.2.2.2 Implementation of getUserData Class

In Figure 4.2.2.1 above, constructor for getUserData class has been created to pass three parameters which is email, FName and phone. Then, the value is assigned into the main variables and the getter is being created to allow calling in Admin_userReport java class.

```
//search data
public Filter getFilter(){
    return new Filter() {
        @Override
        protected FilterResults performFiltering(CharSequence constraint) {
            String key = constraint.toString();
            if(key.isEmpty()){
                filteredList = ulist;
            }
            else {
                ArrayList<getUserData> isfiltered = new ArrayList<>();
                for(getUserData row: ulist){
                    if(row.getfName().toLowerCase().contains(key.toLowerCase())){
                        isfiltered.add(row);
                    }
                }
                filteredList = isfiltered;
            }
            FilterResults filterResults = new FilterResults();
            filterResults.values = filteredList;
            return filterResults;
```

Figure 4.2.2.3 Implementation of UserReportAdapter Class

In Figure 4.2.2.3 user report adapter acts as a bridge between UI component and data source that can used to hold the data and send the data to an Adapter view. The ArrayAdapter has been used in getFilter() function to search for user report because the adapter can convert an ArrayList of objects into view items and loaded into the ListView container. The getFilter() has been called in Admin_userReport java class as shown in Figure 4.2.2.4 below.

```
//search
search.addTextChangedListener(new TextWatcher() {
    @Override
    public void beforeTextChanged(CharSequence s, int start, int count, int after) {

    }

    @Override
    public void onTextChanged(CharSequence s, int start, int before, int count) {

        mAdapter.getFilter().filter(s);
        searchC = s;
```

Figure 4.2.2.4 Implementation of Admin_userReport Class

4.2.3 Add Product Module

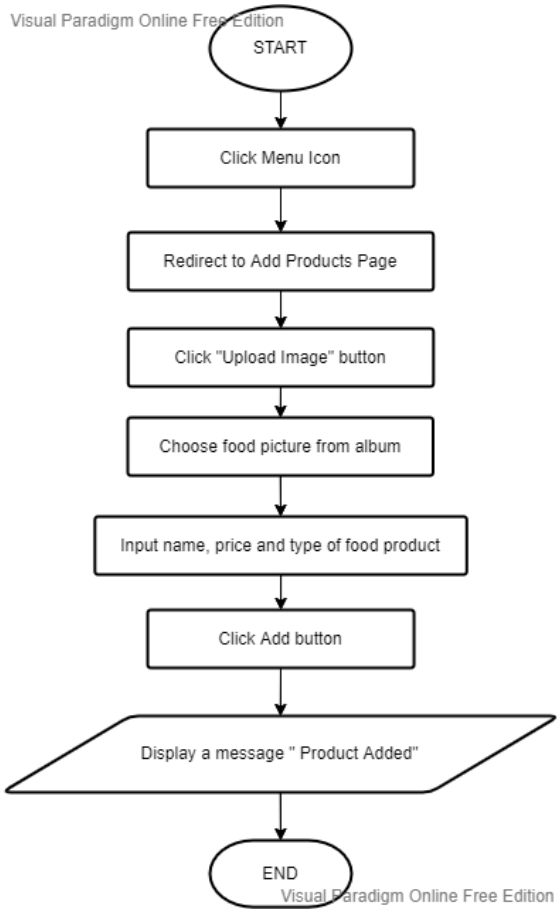


Figure 4.2.3.1 Flowchart of Add Product Module

Based on the system flowchart as shown in Figure 4.2.3.1 above, admin can click the menu icon at the bottom navigation bar and system will redirect admin to the add product page. In this page, admin can click upload image button and system will redirect admin to album. Then, admin can select the food image from their album. Besides, admin will also need to input the name, price and type of product. After inputting all the necessary food information, admin can click the add button and system will display a message “Product Added”. The food product will then upload to Firebase server and display on user food menu home page.

```
public class Products implements Serializable {
    private String name,type,imageUrl;
    private double price;

    public Products(){}

    public Products(String name1, String type1, String imageUrl1, double price1){
        this.name = name1;
        this.type = type1;
        this.imageUrl = imageUrl1;
        this.price = price1;
```

Figure 4.2.3.2 Implementation of Products Class

In Figure 4.2.3.2 above, constructor for Products class has been created to pass four parameters which is name, type, imageUrl and price. Then, the value is assigned into the main variables and the getter is being created to allow calling in Add_products java class.

```
if (name1.equals("") || price1.equals("") || type1.equals("") || imagedata == null) {
    Toast.makeText( context: Add_products.this, text: "Enter all fields", Toast.LENGTH_SHORT).show();
} else {

    StorageReference imagename = folder.child("image"+imagedata.getLastPathSegment());
```

Figure 4.2.3.3 Passing to dbProducts Method

In Figure 4.2.3.3, if else statement used to ensure name, price, type, and image have been entered correctly. Once all the field has been filled, a list of objects will be passed to the success listener, as shown in Figure 4.2.3.4 below.

```
dbProducts.add(product)
        .addOnSuccessListener(new OnSuccessListener<DocumentReference>() {
            @Override
            public void onSuccess(DocumentReference documentReference) {
                Toast.makeText( context: Add_products.this, text: "Product Added", Toast.LENGTH_LONG).show();
                finish();
```

Figure 4.2.3.4 Implementation of Add_products Class

Then, the food products name, price, category, and image will be stored into Firebase server which is the Cloud Firestore and Cloud Storage.

4.2.4 Admin Order Report Module

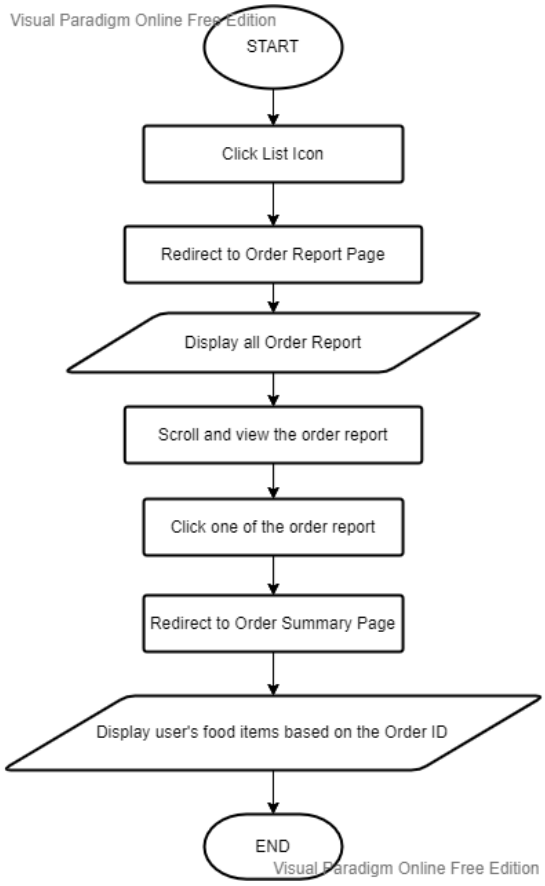


Figure 4.2.4.1 Flowchart of Admin Order Report Module

Based on the system flowchart as shown in Figure 4.2.4.1 above, admin can click the list icon at the bottom navigation bar and system will redirect admin to the order report page. In this page, admin can scroll and view all the customer's order report. Each of the order report will include order ID, address, date, time, payment method and username. Then, admin can click one of the order report and system will redirect admin to the order summary page. In order summary page, admin can view all the details of user's food items based on the order ID. For example, the food name, price, and quantity will be shown on the order summary page.

```
@Override
public void onBindViewHolder(@NonNull OrderAdapter.OrderViewHolder holder, int position) {
    getOrderData current = mlist.get(position);
    holder.omethod.setText(String.valueOf(current.getMethod()));
    holder.oid.setText(String.valueOf(current.getOrderId()));
    holder.otime.setText(String.valueOf(current.getTime()));
    holder.odate.setText(String.valueOf(current.getDate()));
    holder.oaddress.setText(String.valueOf(current.getAddress()));
    holder.oname.setText(String.valueOf(current.getUserName()));
```

Figure 4.2.4.2 Implementation of OrderAdapter Class

In Figure 4.2.4.2, onBindViewHolder has been called by RecyclerView to display the order report details at the Admin Order Report Page.

```
db.collection( collectionPath: "Admin_Orders").get()
        .addOnSuccessListener(new OnSuccessListener<QuerySnapshot>() {
            @Override
            public void onSuccess(QuerySnapshot queryDocumentSnapshots) {

                if (!queryDocumentSnapshots.isEmpty()) {

                    List<DocumentSnapshot> ulist = queryDocumentSnapshots.getDocuments();

                    for (DocumentSnapshot d : ulist) {
                        getOrderData p = d.toObject(getOrderData.class);
                        list.add(p);
                    }
                    mAdapter.notifyDataSetChanged();
```

Figure 4.2.4.3 Implementation of Admin_orderReport Class

Once user has complete order payment, data will be passed to the success listener, as shown in Figure 4.2.4.3 above and the order will be stored at the collection of Admin_Orders in Firebase server.

4.2.5 Food Menu Homepage Module with Search Feature

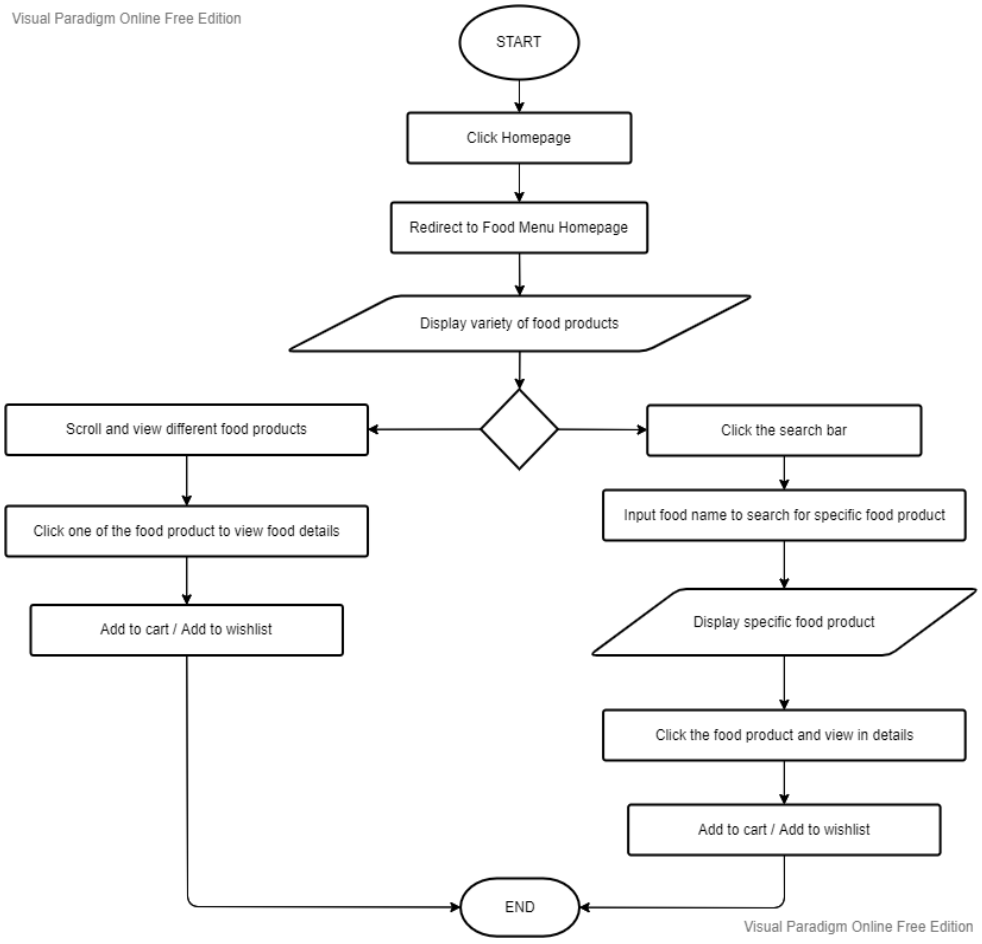


Figure 4.2.5.1 Flowchart of Food Menu Homepage Module with Search Feature

Figure 4.2.5.1 above shows the flowchart of food menu homepage module with search feature. After user has successfully login to the system, it will redirect user to the main page which is the food menu homepage. In this page, user can scroll and view different variety of food products. They can also click the food products to view in details page. In the food details page, user can view the name, price and category of food product. They can increase or decrease the quantity of product, add food product into shopping cart list or wish list. Besides, they can also click the camera button to view the AR 3D food model. In addition, user can click the search bar in the food menu homepage to search for a specific food product. After input the valid food name, system will display food product that have been search by user. Then, user can click the food product to view in detail, add products into shopping cart list or wish list.

4.2.6 Wishlist Module

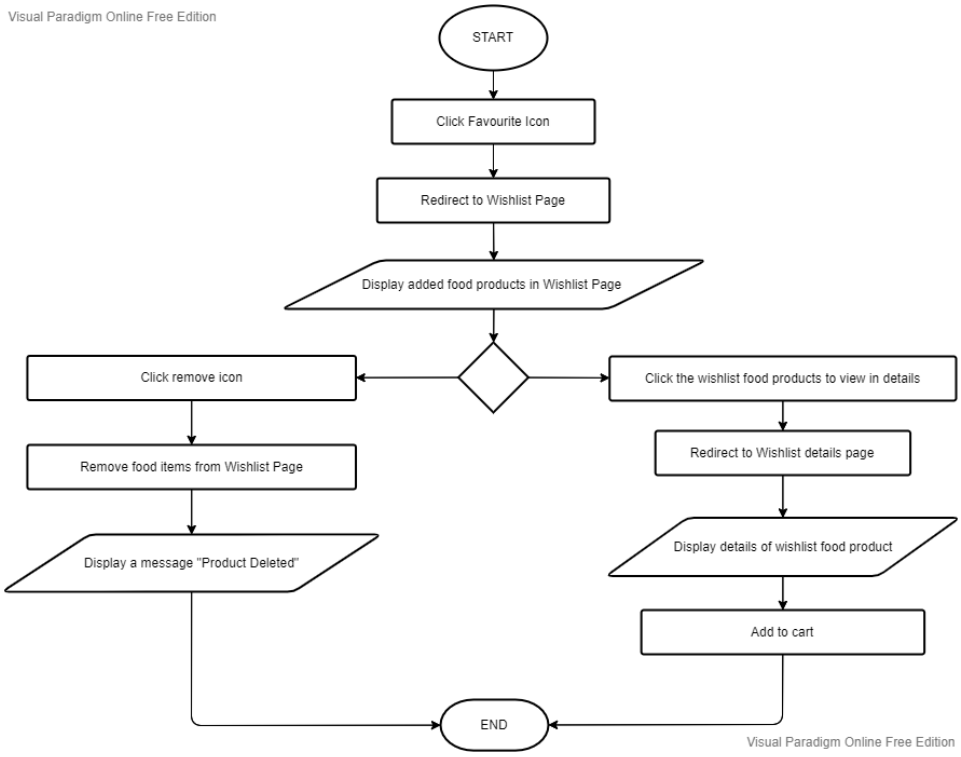


Figure 4.2.6.1 Flowchart of Wishlist Module

Based on the Figure 4.2.6.1, it shows the flow of wish list module. In this module, user can click the favourite icon and system will redirect user to the wish list page. After user has added food products into wish list, system will display the wish list products in this page. Then, user can scroll and view all the added wish list products. User can also choose to click the wish list food product to view in detail or click the remove button to remove food products from the wish list page.

```
public class getWishlistData implements Serializable {
    private String id, image, type,name;
    private double price;

    public getWishlistData(){}

    public getWishlistData(String id, String image, String type, String name, double price) {
        this.id = id;
        this.image = image;
        this.type = type;
        this.name = name;
        this.price = price;
```

Figure 4.2.6.2 Implementation of getWishlistData Class

In Figure 4.2.6.2 above, constructor for getWishlistData class has been created to pass five parameters which is id, image, type, name, and price. Then, the value is assigned into the main variables and the getter is being created to allow calling in wish list java class.

```
@NonNull
@Override
public WishlistViewHolder onCreateViewHolder(@NonNull ViewGroup parent, int viewType) {
    View v = LayoutInflater.from(parent.getContext()).inflate(R.layout.wishlist_items, parent,  attachToRoot: false);
    return new WishlistAdapter.WishlistViewHolder(v, mListener);
}

@Override
public void onBindViewHolder(@NonNull WishlistViewHolder holder, int position) {
    getWishlistData current = ulist.get(position);
    Picasso.get().load(current.getImage()).into(holder.mimage);
```

Figure 4.2.6.3 WishlistAdapter

In Figure 4.2.6.3, onCreateViewHolder creates a new view holder to allow user add food items into the wish list. Then, the wishlist data has been called in wishlist java class and stored into the Firebase server as shown in Figure 4.2.6.4 below.

```
db.collection( collectionPath: "Wishlist").document(auth.getCurrentUser().getUid())
        .collection( collectionPath: "users").get()
        .addOnSuccessListener(new OnSuccessListener<QuerySnapshot>() {
            @Override
            public void onSuccess(QuerySnapshot queryDocumentSnapshots) {

                if(!queryDocumentSnapshots.isEmpty()){

                    List<DocumentSnapshot> clist = queryDocumentSnapshots.getDocuments();

                    for(DocumentSnapshot d : clist){
                        getWishlistData p = d.toObject(getWishlistData.class);
                        list.add(p);
                    }
                    mAdapter.notifyDataSetChanged();
```

Figure 4.2.6.4 Implementation of Wishlist Class

4.2.7 Shopping Cart Module with Payment Function

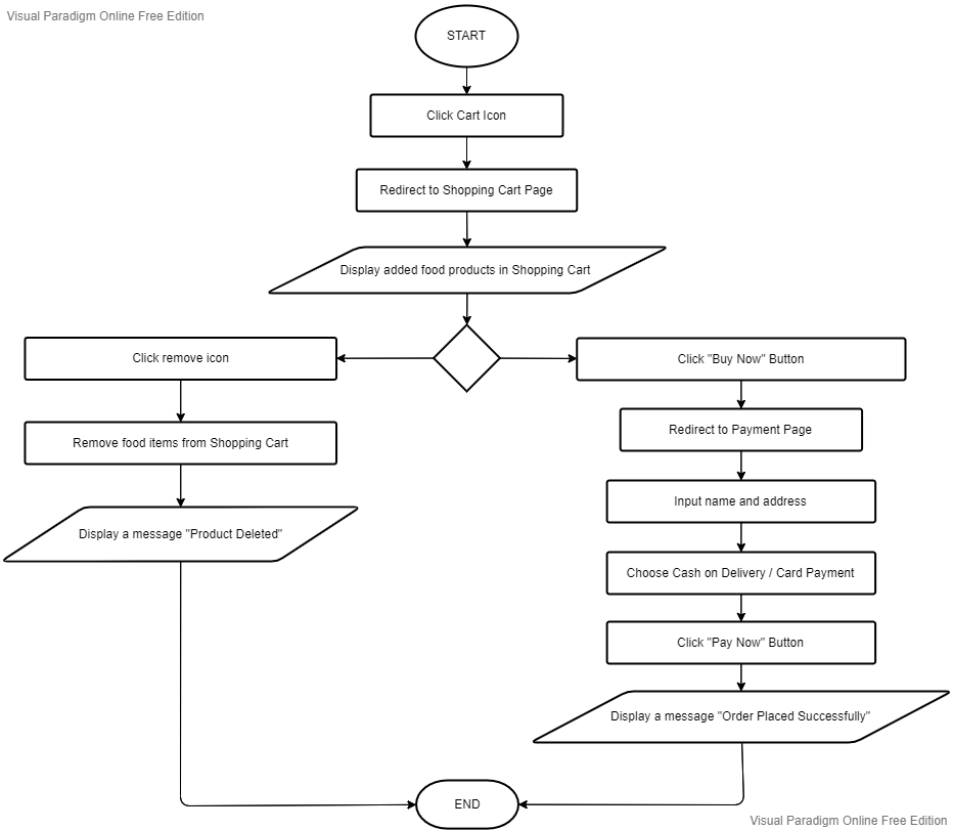


Figure 4.2.7.1 Flowchart of Shopping Cart Module with Payment Function

Figure 4.2.7.1 shows the flow of shopping cart module with the payment feature. After user has added food products from food menu homepage or wish list page into shopping cart, system will display user's food products in the cart list page. Then, user can scroll and view all the food product's information such as food name, price, and quantity. Besides, user can also click remove button to remove the food product from shopping cart. After user has confirmed their shopping cart items, they can made payment by clicking the "Buy Now" button. System will then redirect user to the payment page. In payment page, user will need to fill in their name, address and choose payment method. If user choose card payment, they will need to fill in card number, expiration date, CVV, postal code and mobile number. After filled in all the necessary information, user can click "Pay Now" button and system will display a message "Product Placed Successfully" and system will redirect user to food menu homepage.

```
public getCartData(String id,String image2, String name2, double price2, double quantity2) {
    this.id = id;
    this.image = image2;
    this.name = name2;
    this.price = price2;
    this.quantity = quantity2;
```

Figure 4.2.7.2 Implementation of getCartData Class

In Figure 4.2.7.2 above, the working concept of the shopping cart is the same as wishlist. Constructor for getCartData class has been created to pass the parameters and the value is assigned into the main variables. Getter has been created to allow calling in cart java class.

```
//get data from adapter
LocalBroadcastManager.getInstance(this)
        .registerReceiver(mMessageReceiver,new IntentFilter( action: "MyTotalAmount"));

mRecycleView = findViewById(R.id.recyclerView);
total = findViewById(R.id.total);
mRecycleView.setHasFixedSize(true);
mManager = new LinearLayoutManager( context: this);
mAdapter = new CartAdapter(list);
mRecycleView.setLayoutManager(mManager);
mRecycleView.setAdapter(mAdapter);
```

Figure 4.2.7.3 CartAdapter Class

In Figure 4.2.6.3, implementation of Cart Adapter Class enables Cart Java Class to get data from adapter. Then, the food items can be added into shopping cart where it will be stored into the collection path “Cart” in Firebase server.

```
//Adding cart database
db = FirebaseFirestore.getInstance();
folder = FirebaseStorage.getInstance().getReference().child("image");

db.collection( collectionPath: "Cart").document(auth.getCurrentUser().getUid())
        .collection( collectionPath: "users").get()
        .addOnSuccessListener(new OnSuccessListener<QuerySnapshot>() {
            @Override
            public void onSuccess(QuerySnapshot queryDocumentSnapshots) {

                if(!queryDocumentSnapshots.isEmpty()){

                    List<DocumentSnapshot> clist = queryDocumentSnapshots.getDocuments();

                    for(DocumentSnapshot d : clist){
                        getCartData p = d.toObject(getCartData.class);
                        list.add(p);
                    }
                    mAdapter.notifyDataSetChanged();
```

Figure 4.2.7.4 Implementation of Shopping Cart Class

```
cardForm.cardRequired(true)
        .expirationRequired(true)
        .cvvRequired(true)
        .postalCodeRequired(true)
        .mobileNumberRequired(true)
        .mobileNumberExplanation("SMS is required on this number")
        .setup(Payment.this);
cardForm.getCvvEditText().setInputType(InputType.TYPE_CLASS_NUMBER | InputType.TYPE_NUMBER_VARIATION_PASSWORD);
buy.setOnClickListener(new View.OnClickListener() {
```

Figure 4.2.7.5 Implementation of Payment Class (i)

In Figure 4.2.6.5, card form which allow user to input all the necessary card information such as card number, expiration date, CVV, postal code, and mobile number.

```
final HashMap<String, Object> cartMap2 = new HashMap<>();
cartMap2.put("date", saveCurrentDate);
cartMap2.put("time", saveCurrentTime);
cartMap2.put("method", method1);
cartMap2.put("orderId", id);
cartMap2.put("address", address.getText().toString());
cartMap2.put("userName", name2.getText().toString());
db.collection( collectionPath: "Admin_Orders").document(id)
        .set(cartMap2).addOnCompleteListener(new OnCompleteListener<Void>() {
```

Figure 4.2.7.6 Implementation of Payment Class (ii)

Figure 4.2.6.6 shows HashMap that has been used to store key and value items. A hash function will pair each key to an array index where the value will be stored.

4.2.8 AR Camera Module with Drag, Move, Rotate and Scale Features

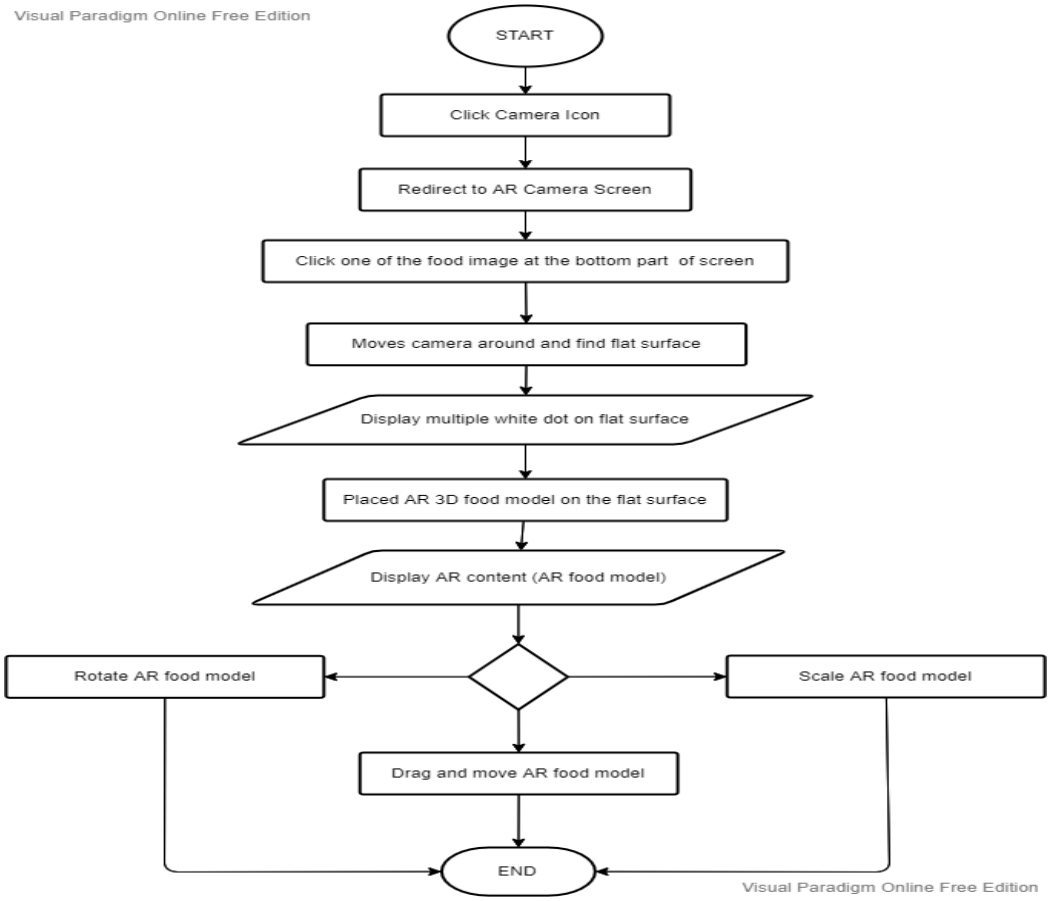


Figure 4.2.8.1 Flowchart of AR Camera Module with Drag, Move, Rotate and Scale Features

Figure 4.2.8.1 above shows the flowchart of AR camera module with drag, move, rotate, and scale features. First, user can click the camera icon using the bottom navigation bar and system will redirect user to the AR camera screen page. User can scroll and view the food images at the bottom part of AR camera screen. Then, user can click one of the food images and moves the camera around and find a flat surface such as table or floor for placing the AR elements. System will then trigger computer generated vision technology by scanning the surrounding environment to retrieve augmented reality contents. After retrieving, system will display multiple white dots on the flat surface which indicates the 3D food model is ready to be placed by user. After that, user can click multiple white dots on the AR Camera Screen to place 3D food model on the flat surface environment. After augmented reality contents has been successfully display on AR camera screen, user can click the 3D food model to perform rotate, scaling, drag and move function. Besides, user can also click the remove button on the top right corner of AR camera screen to remove 3D food model.

```
plugins {
    id 'com.android.application'
    id 'com.google.gms.google-services'
    id 'com.google.ar.sceneform.plugin'
```

Figure 4.2.8.2 AR Module Plugins in Build Gradle File (app)

```
// Provides ARCore Session and related resources.
implementation 'com.google.ar:core:1.29.0'
// Provides ArFragment, and other UX resources.
implementation "com.google.ar.sceneform.ux:sceneform-ux:1.17.1"
// Alternatively, use ArSceneView without the UX dependency.
implementation 'com.google.ar.sceneform:core:1.17.1'
```

Figure 4.2.8.3 Implementation of AR Core

```
sceneform.asset('sampleData/model.obj',
        'default',
        'sampleData/model.sfa',
        'src/main/assets/model')

sceneform.asset('sampleData/Hamburger_01.obj',
        'default',
        'sampleData/Hamburger_01.sfa',
        'src/main/assets/Hamburger_01')
```

Figure 4.2.8.4 Implementation of Sceneform Asset in Build Gradle File (app)

To enable Sceneform SDK for Android, AR plugin “com.google.ar.sceneform.plugin” has been implemented into project dependencies as shown in Figure 4.2.8.2 above. Figure 4.2.8.3 shows the implementation of Google AR Core that has been implemented to provide ARCore Session and its related resources. Besides, Google AR Sceneform UX and Google AR Sceneform Core has been also implemented into the project dependencies to provide AR fragment and other UX resources as well as provide AR SceneView without the UX dependencies.

```
public class camera extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_camera);
```

Figure 4.2.8.5 Implementation of Camera Class

```
arFragment = (ArFragment)getSupportFragmentManager().findFragmentById(R.id.fragment);
btnRemove = (Button)findViewById(R.id.remove);
getImages();

arFragment.setOnTapArPlaneListener((hitResult, plane, motionEvent) -> {

    Anchor anchor = hitResult.createAnchor();

    ModelRenderable.builder()
            .setSource( context: this, Uri.parse(Common.model))
            .build()
            .thenAccept(modelRenderable -> addModelToScene(anchor,modelRenderable));
```

Figure 4.2.8.6 Configuration of AR Fragment

Figure 4.2.8.6 shows the configuration of AR fragment. If the camera is part of an AR SceneView, then the camera will automatically track the camera pose from ARCore. The setOnTapArPlaneListener will calculate a ray in world space from the near-plane of camera and render the 3D model in screen space. In this system, 3D model can be set to rotate, scale, and move with the help of Google ARCore function.

```
private void getImages() {

    imagesPath.add(R.drawable.cheeseburger);
    namesPath.add("Cheeseburger");
    modelNames.add("Hamburger_02.sfb");
```

Figure 4.2.8.7 AR model and 2D Images

In Figure 4.2.8.7, image path, name path and AR model has been added into Main Activity java class. Then, the AR food model will be added to AR SceneView and trigger model renderable in AR camera screen page. Figure 4.2.8.8 shows the display of AR model.

```
private void addModelToScene(Anchor anchor, ModelRenderable modelRenderable) {

    anchorNode = new AnchorNode(anchor);
    TransformableNode node = new TransformableNode(arFragment.getTransformationSystem());
    node.setParent(anchorNode);
    node.setRenderable(modelRenderable);
    arFragment.getArSceneView().getScene().addChild(anchorNode);
    node.select();
```

Figure 4.2.8.8 Display of AR model

4.2.9 Profile Module

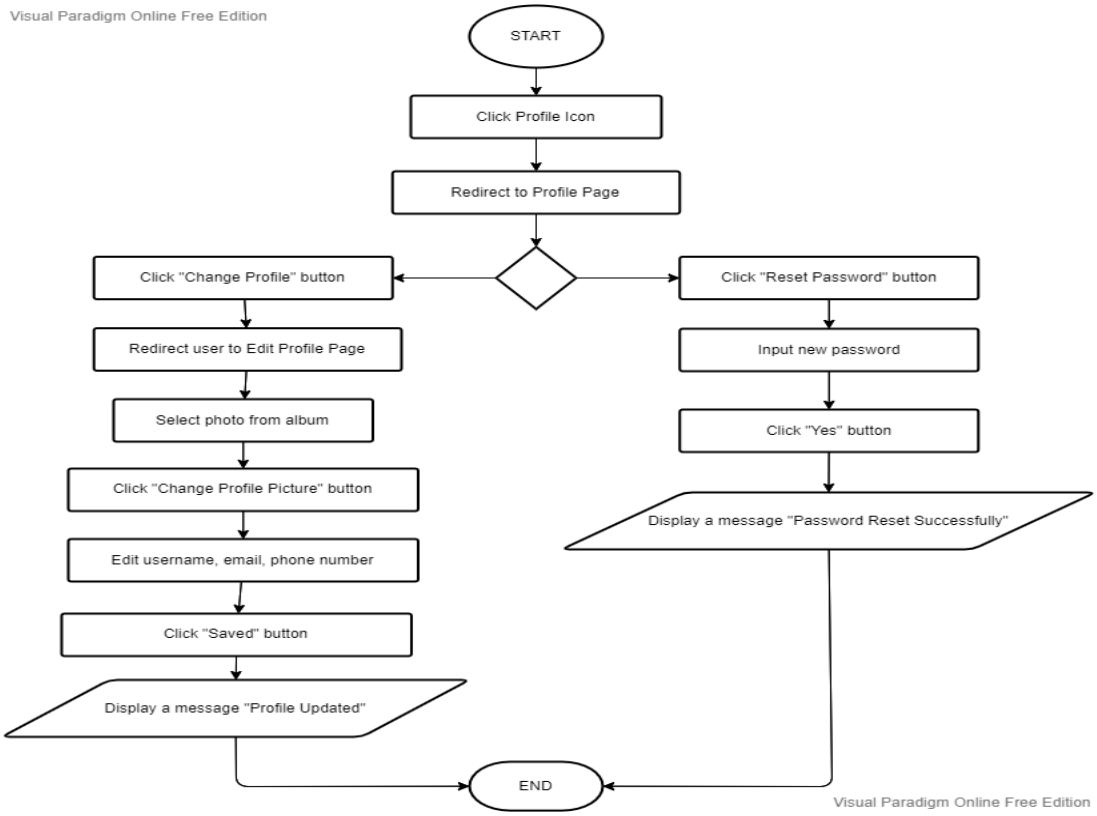


Figure 4.2.9.1 Flowchart of Profile Module

Based on the system flowchart as shown in Figure 4.2.9.1, user can click the profile icon using the bottom navigation bar and system will redirect user to the profile page. In this page, user can choose to change profile, reset password or logout the system. When user click “Change Profile” button, system will redirect user to edit profile page and user can edit their personal information such as username, email, and phone number. Besides, they can also change new profile picture by selecting a photo from album. After user click “Saved” button, system will display a message “Profile Updated” and display new user profile information in user profile page. Besides, user can click “Reset Password” button in user profile page to reset new password. System will pop-out a dialogue box and requests for the input of new user password. Lastly, user can click “Logout” button to logout from the system.

4.2.10 More Info Module

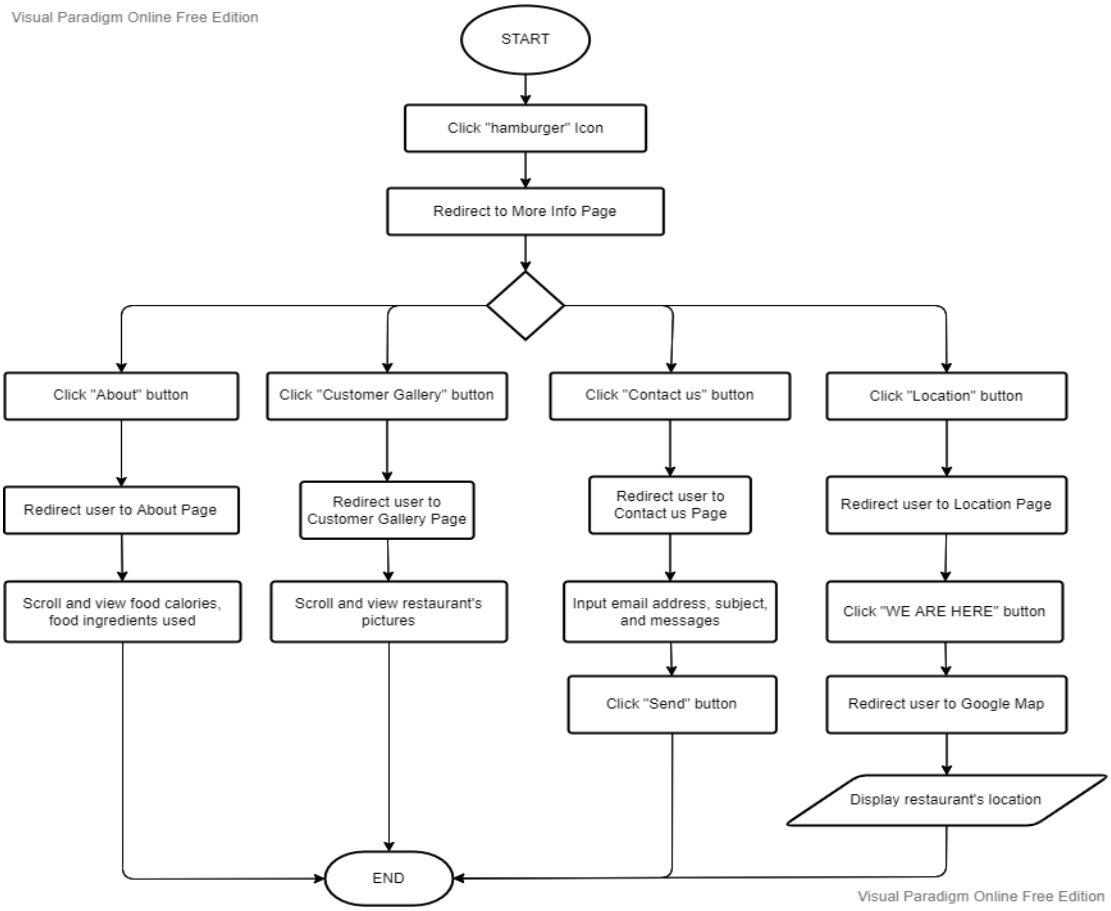


Figure 4.2.10.1 Flowchart of More Info Module

Figure 4.2.10.1 above shows the flowchart of More Info module. User can click the hamburger icon on the top right corner in food menu homepage and system will redirect user to the more info page. In this page, user will have four different options which is the About page, Customer Gallery page, Contact us page, and Location page. First, user can click the "About" button and system will redirect user to about page. User can scroll to view history of restaurant, food ingredients used, photo of ingredients and food calories information. Besides, user can click "Customer Gallery" button in the More Info Page. In customer gallery page, user will be able to scroll and view the environment and pictures of the restaurant. Next, user can click "Contact us" button and system will redirect user to Contact us Page. User can input email address, subject, and messages in the given provided box. After user click "Send" button, system will redirect user to the Gmail and compose the messages. Lastly, user can click the "Location" button and system will redirect user to the Location Page. Then, user can click "WE ARE HERE" button to access Google map and view the restaurant's location.

4.3 Development of 3D Food Model

In the development phase, Blender will be used to construct the 3D food model. Blender is a 3D computer graphics software toolset that is flexible and had numerous of fantastic features to design and create realistic 3D model. Figure 4.3.1 shows the main menu of Blender software.

Figure 4.3.1 Main Menu of Blender Software

The 3D development process will begin by image, animation, rendering and authoring process. In this stage, it includes the production such as modelling, texturing, rigging, and lightning. Modelling will be the very first step in development phase. After that, texturing will be carried out to make the food model have a more realistic view. Lastly, painting component of the production stage such as lightning and mood will be carried out. The development process and design of 3D food model as shown in Figure 4.3.2.

Figure 4.3.2 Pizza Food Model (Standard Unity Asset Store EULA, 2018)

CHAPTER 5: SYSTEM IMPLEMENTATION

In this chapter, the software setup, hardware setup, system setting and configuration, system operation with screenshot and concluding remarks for this project will be presented.

5.1 Hardware Setup

The hardware that used to develop this project as shown in Table 5.1.1 and Table 5.1.2 below.

TABLE 5.1.1 Laptop Specifications

System Type	64-bit Operating System
Operating System	Microsoft Windows 10 Pro
Processor (CPU)	Intel(R) Core (TM) i5-3210M CPU @ 2.50GHz 2.50 GHz
Memory (RAM)	8 GB RAM
Storage	512 GB Solid State Drive

TABLE 5.1.2 Smartphone Specifications

Model	INE-LX2r
Processor	Hisilicon Kirin 710
Graphic	Mali-G51 MP4
RAM	4.0 GB
Storage	128 GB
Rear Camera	16MP, f/2.2, PDAF 2MP, depth
Front Camera	24MP, f/2.0, 26mm(wide), ½.8”, 0.9µm 2MP, depth sensor
Software Edition	Android 9.0
Display	Resolution 1920 x 1080 or better

5.2 Software Setup

The software that used to develop this project as shown in Table 5.2.1 below.

TABLE 5.2.1 Software to be used

Software Used	Figure	Use
Development Tool		
Android Studio		Used to provide a rich application framework that can allow user to build innovative application for mobile devices in Java language environment.
Java Language		A programming language that is used to develop software and writing script for the AR food menu app in Android App Development.
Firebase - Realtime Database & Cloud Firestore		A cloud-hosted database that used data synchronization - every time data changes, any connected device receives that update within milliseconds. - Used to store users, products, orders, admin orders, cart list and wish list.
Firebase – Cloud Storage		A stand-alone solution for uploading user generated content such as images and videos from Android device. - Used to store user profile picture and food images.

Software Used	Figure	Use
3D Modelling Tool		
Blender		Used for 3D modelling and animation which provide 3D effects with a realistic view.
AR SDK		
ARCore SDK		A Software Developer Kit (SDK) which can provides APIs for all the essential AR features like motion tracking, environmental understanding, and light estimation to build entirely new AR experiences and enhance existing apps with AR features.
Sceneform SDK		A 3D framework that is simple and convenient to build ARCore apps without OpenGL, used to import 3D assets and build AR apps in Android Studio.
Graphic Design		
Adobe Photoshop		Used for photo editing and manipulation of software.
Adobe Illustrator		Used to design poster, logo, and image target.

5.3 Setting and Configuration

5.3.1 Google Play Service for AR Core using Smartphone

To use the function of AR Camera Module, user must have the AR Core enabled devices which require the latest version of Google Play Services for AR. There are several requirements that has been listed by Android (Google Play) to support the use of AR Core through Google Play Services for AR and built the augmented reality (AR) experiences app with the AR Core SDK. First, the device must be originally shipped from the Google Play Store. Besides, the device must be running minimum Android version 7.0 or higher. AR application must declare minimum SDK Version >= 24 (API Level 24). The Table 5.3.1 below summarizes a list of currently supported specific device models by Huawei manufacturer.

TABLE 5.3.1.1 AR Supported Device Models

Equipment List (table)

manufacturer	Device model	Remark
Huawei	Mate 20 Lite	Support Depth API
Huawei	Mate 20	Support Depth API
Huawei	Mate 20 Pro	Support Depth API
Huawei	Mate 20 X	Support Depth API
Huawei	Nova 3	Supports multiple GPU texture resolutions - 1440x1080, 1280x960, 480p supports Depth API
Huawei	Nova 3i	Support Depth API
Huawei	Nova 4	Supports multiple GPU texture resolutions - 1440x1080, 1280x960, 480p supports Depth API
Huawei	P20	Supports multiple GPU texture resolutions - 1440x1080, 1280x960, 480p supports Depth API
Huawei	P20 Pro	Supports multiple GPU texture resolutions - 1440x1080, 1280x960, 480p
Huawei	P30	Supports multiple GPU texture resolutions - 1440x1080, 1280x960, 480p supports Depth API

5.3.2 Development of AR Food Menu using Sceneform SDK

To get started with Sceneform SDK in AR food menu project, there are several steps that will need to be configured as shown below:

1. Import Sceneform SDK Plugins
2. Configure project build.gradle files
3. Update Android Manifest.xml
4. Perform runtime checks and create a scene view
5. Create renderables
6. Build the Scene

First, Import the Sceneform SDK Plugins into the project. Once installed, Sceneform plugin can import, view, and build 3D assets in the Sceneform SDK for AR application in Android Studio. It requires Android Studio versions 3.1 and above.

To install the plugin:

In Android Studio, search **File > Settings > Plugins > Browse Repositories**, then click Browse Repositories and install the Google Sceneform Tools (Beta).

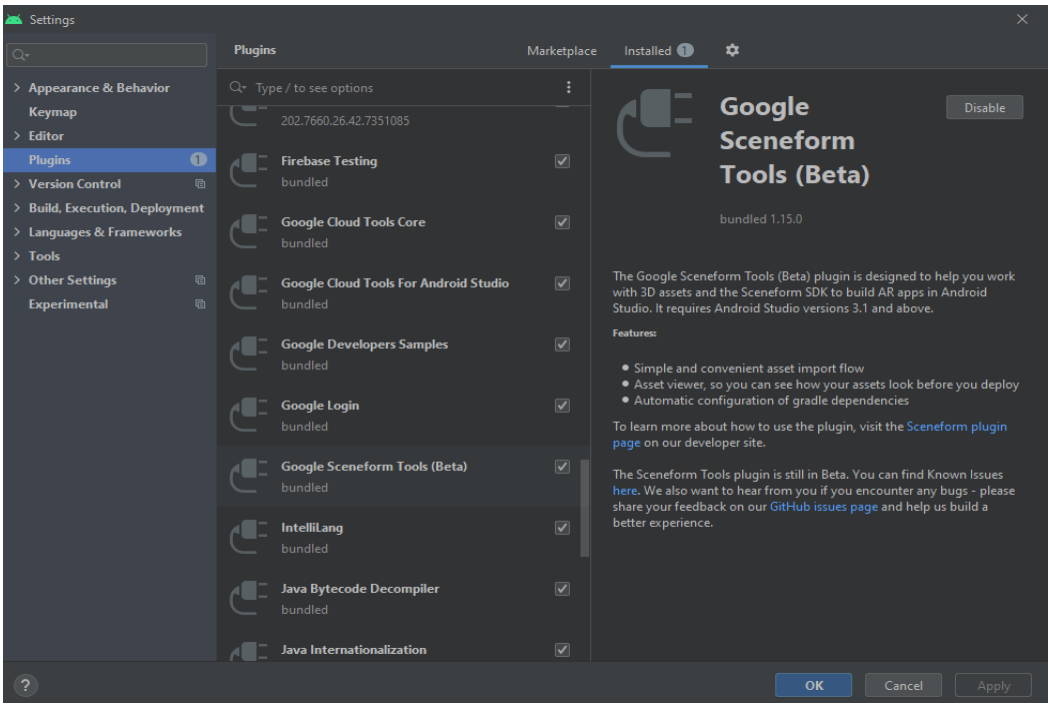


Figure 5.3.2.1 Installation of Google Sceneform Tools (Beta)

Secondly, Configure project's build.gradle files. Make sure the project's build.gradle includes Google's Maven repository. Then, update app's build.gradle by adding the latest ARCore and Sceneform UX dependencies to ensure the project settings are compatible with both libraries. Figure 5.3.2.2 shows the configuration of ARCore and Sceneform UX dependencies.

```
// Provides ARCore Session and related resources.
implementation 'com.google.ar:core:1.29.0'
// Provides ArFragment, and other UX resources.
implementation "com.google.ar.sceneform.ux:sceneform-ux:1.17.1"
// Alternatively, use ArSceneView without the UX dependency.
implementation 'com.google.ar.sceneform:core:1.17.1'
```

Figure 5.3.2.2 Configuration of ARCore and Sceneform UX Dependencies

Thirdly, Update Android Manifest.xml to indicate that the app requires ARCore, ensure the app is visible only in the Google Play Store on devices that support ARCore. Figure 5.3.2.3 shows the update of Android Manifest.

```
<!-- Both "AR Optional" and "AR Required" apps require CAMERA permission. -->
<uses-permission android:name="android.permission.CAMERA" />

<!-- Sceneform requires OpenGL ES 3.0 or later. -->
<uses-feature android:glEsVersion="0x00030000" android:required="true" />

<!-- Indicates that app requires ARCore ("AR Required"). Ensures the app is
     visible only in the Google Play Store on devices that support ARCore.
     For "AR Optional" apps remove this line. -->
<uses-feature android:name="android.hardware.camera.ar" />

<application>
    …
    <!-- Indicates that app requires ARCore ("AR Required"). Causes the Google
         Play Store to download and install Google Play Services for AR along
         with the app. For an "AR Optional" app, specify "optional" instead of
         "required".
    -->
    <meta-data android:name="com.google.ar.core" android:value="required" />
</application>
```

Figure 5.3.2.3 Update of Android Manifest

Fourth, perform runtime checks and create a scene view by using an ArFragment, which automatically handles ARCore session after performing necessary ARCore runtime checks. The checking includes compatibility version of Google Play Services for AR and permission of access to the camera. Once the check pass, ArFragment will create an ArSceneView that renders the camera images from the session onto its surface and renders a built-in Sceneform UX animation that shows user how they should move their phone to activate AR experiences.

Fifth, create renderables that enables 3D model can be placed anywhere in the scene and consists of Meshes, Materials and Textures. Renderables can be created from 3D asset files such as OBJ, FBX, and gITF. Figure 5.3.2.4 shows the creation of Model Renderable.

```
sceneform.asset('sampleData/Hamburger_01.obj',
        'default',
        'sampleData/Hamburger_01.sfa',
        'src/main/assets/Hamburger_01')
```

Figure 5.3.2.4 Creation of Model Renderable

Lastly, Build the Scene. ARSceneView hold the Nodes that are the virtual objects to be rendered. Each node contains all the information that Sceneform needs to render including its position, orientation, and renderable object.

5.4 System Operation

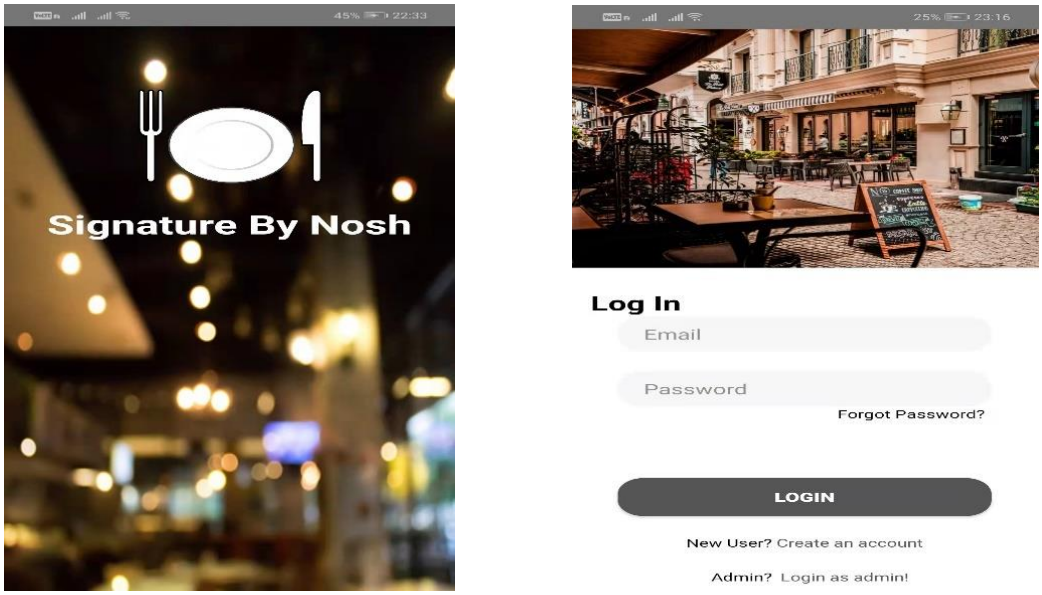


Figure 5.4.1.1 Splash Screen and User Login Page

First, there will be a simple splash screen when user click the application icon. After 3 seconds, it will lead user to the main login page. As shown in Figure 5.4.1.1, user can enter their respective email address and password to enter the AR Food Menu app. If they have not yet register, they can click the text “Create an account” to register their account. If user has forgotten their password, they can also click the text “Forget password?” to change their new password. Besides, admin can click the text “Login as admin” to login admin page. Figure 5.4.1.2 shows the Signup and Admin Login Page.

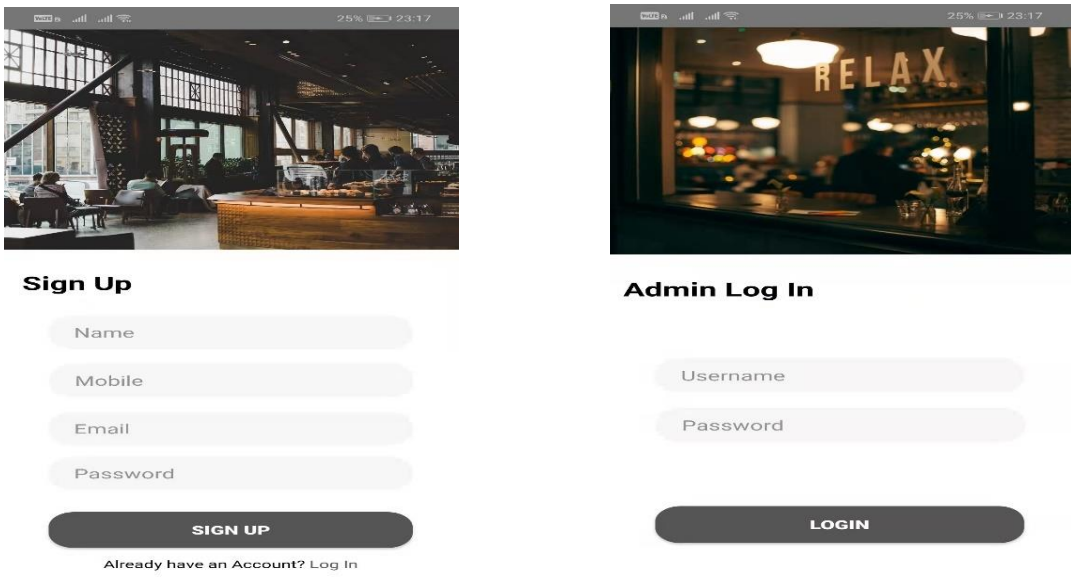


Figure 5.4.1.2 Signup and Admin Login Page

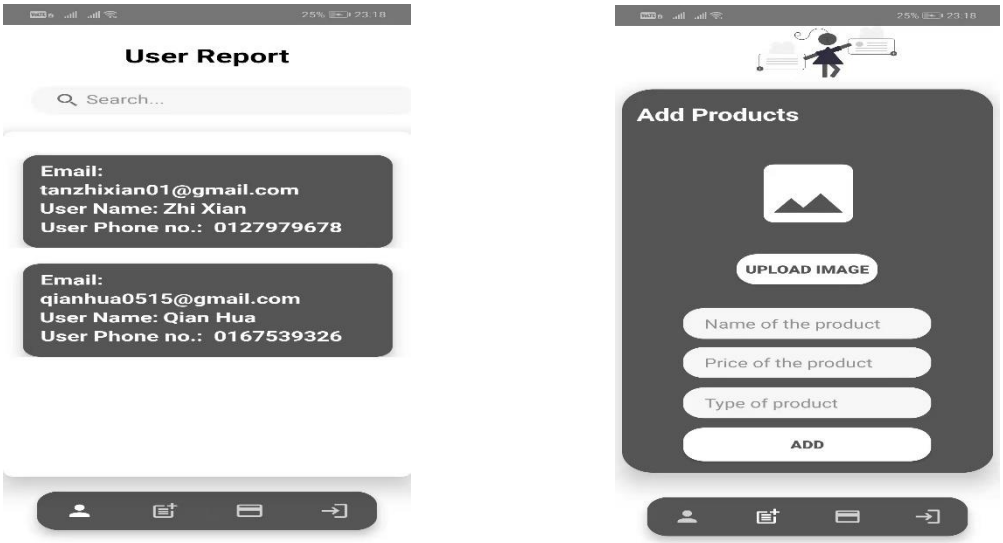


Figure 5.4.1.3 User Report and Add Product Page

After admin login to the admin page, system will redirect admin to the user report page where admin can view all the information of user such as email, username, and phone number. Besides, admin can search for a specific user using the search bar. Then, admin can click the list icon at the bottom navigation bar. System will redirect admin to the add products page where admin can upload food image, input name, price, and type of food products as shown in Figure 5.4.1.3 above.

Figure 5.4.1.4 Order Report and Order Summary Page

Besides, Admin can click the third icon and system will redirect admin to the order report page. In this page, admin can view all the order details such as order ID, address, date, time, username, and payment method. Admin can also click each of the order card to view order summary page.

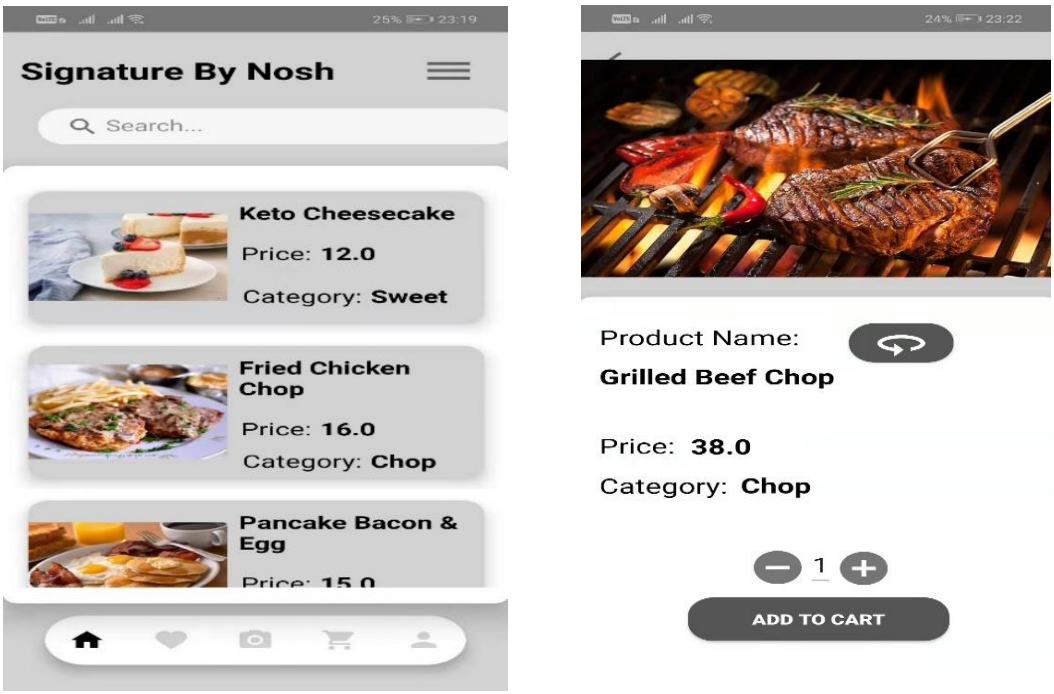


Figure 5.4.1.5 Food Menu Homepage and Food Details Page

After successfully login, system will redirect user to the food menu homepage. As Figure 5.4.1.5 shown above, user can scroll and view the food menu card. Besides, user can search for their desired food by key in the food name using the search bar. Moreover, user can click the hamburger button on top right corner and system will redirect user to the more information page. User can also click each of the food menu card to view the details of food information such as name, price, and category. User can click the camera button to view food item in AR mode, click the button to add food items into shopping cart or wish list.

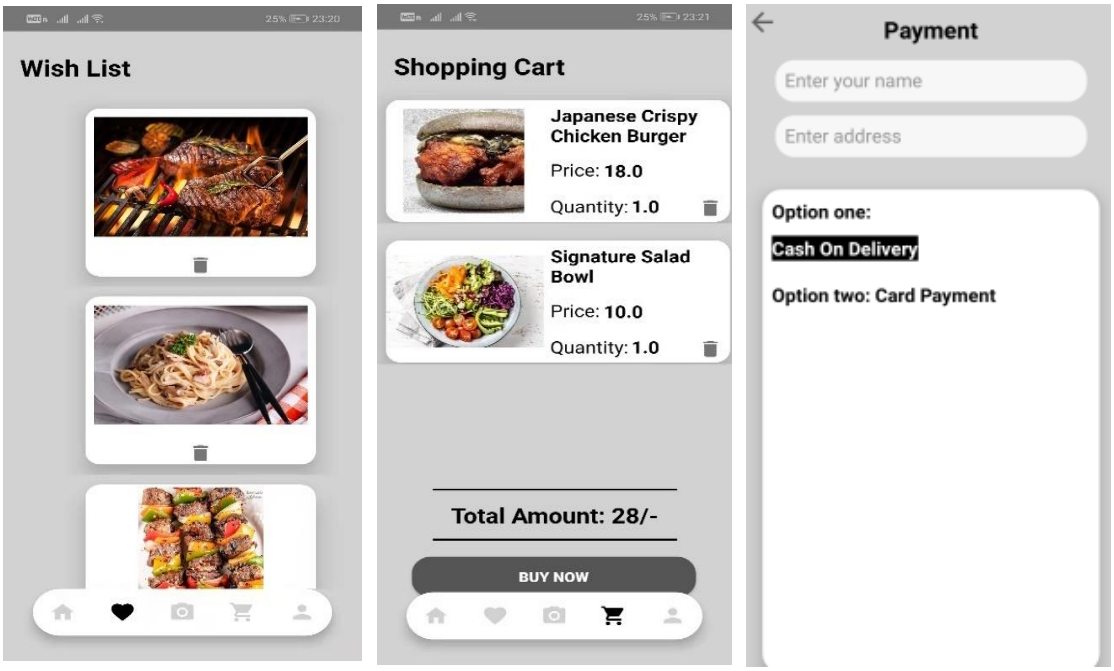


Figure 5.4.1.6 Wishlist, Shopping Cart, and Payment Page

After user has added food items, they can click the bottom navigation bar to the wish list page or shopping cart to view their added food items. In wish list page, user can click the food menu card to view the details of food information. Besides, they can also click the remove button to remove food items from wish list. In shopping cart, user can view their cart items and click remove button to remove food items from the shopping cart. After that, user can click “Buy Now” button and system will redirect user to the payment page as shown in Figure 5.4.1.6.

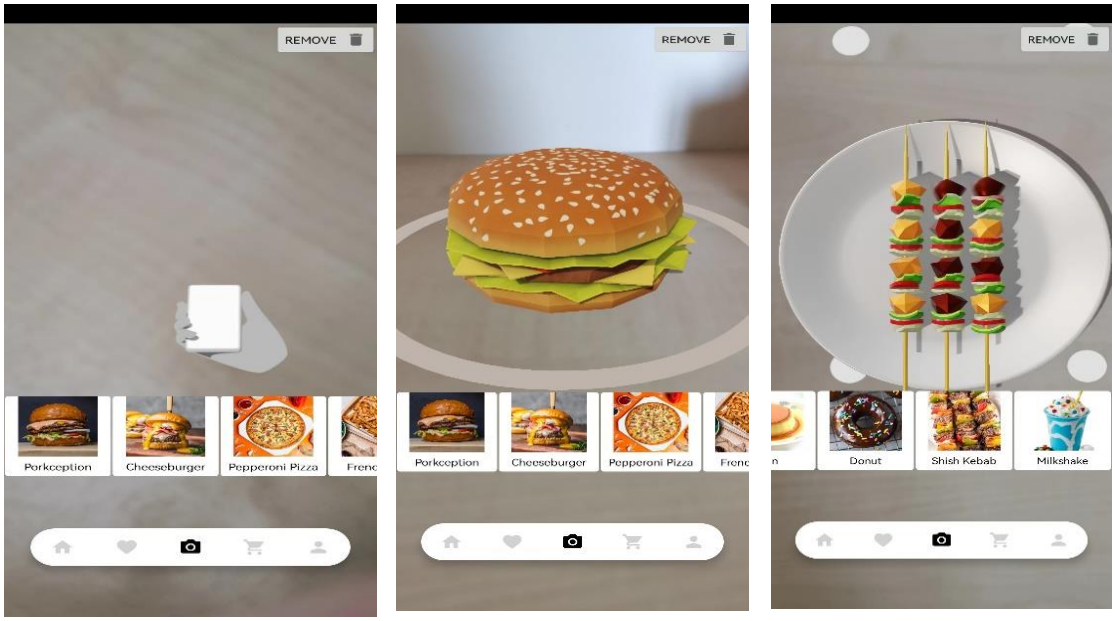


Figure 5.4.1.7 AR Camera Page (i)

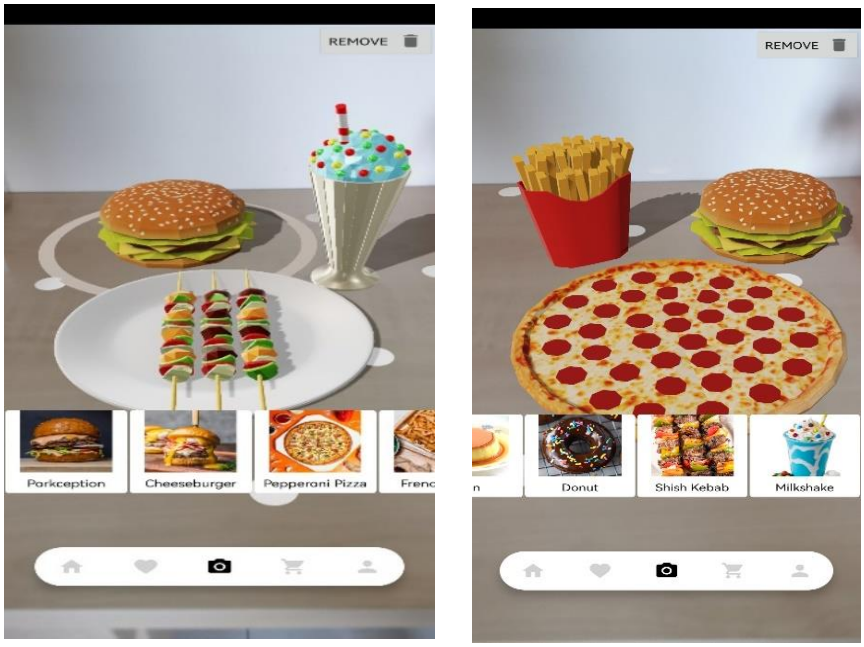


Figure 5.4.1.8 AR Camera Page (ii)

In AR camera function, user can view food items in AR mode. First, user can click the camera icon using the bottom navigation bar and system will redirect user to the AR camera screen page. User can scroll and view the 2D food images at the bottom part of AR camera screen. Then, user can click one of the food images and moves the camera around and find a flat surface such as table or floor for placing the AR elements. System will then trigger computer generated vision technology by scanning the surrounding environment to retrieve augmented reality contents. After retrieving, system will

display multiple white dots on the flat surface which indicates the AR 3D food model is ready to be placed by user. After that, user can click multiple white dots on the AR Camera Screen to place 3D food model on the flat surface environment. After AR 3D food model has been successfully displayed, user can click the AR food model to perform rotate, scaling, drag and move function. Besides, user can also click the remove button on the top right corner of AR camera screen to remove the 3D food model. The sample of AR 3D food model as shown in Figure 5.4.1.7 and Figure 5.4.1.8 above.

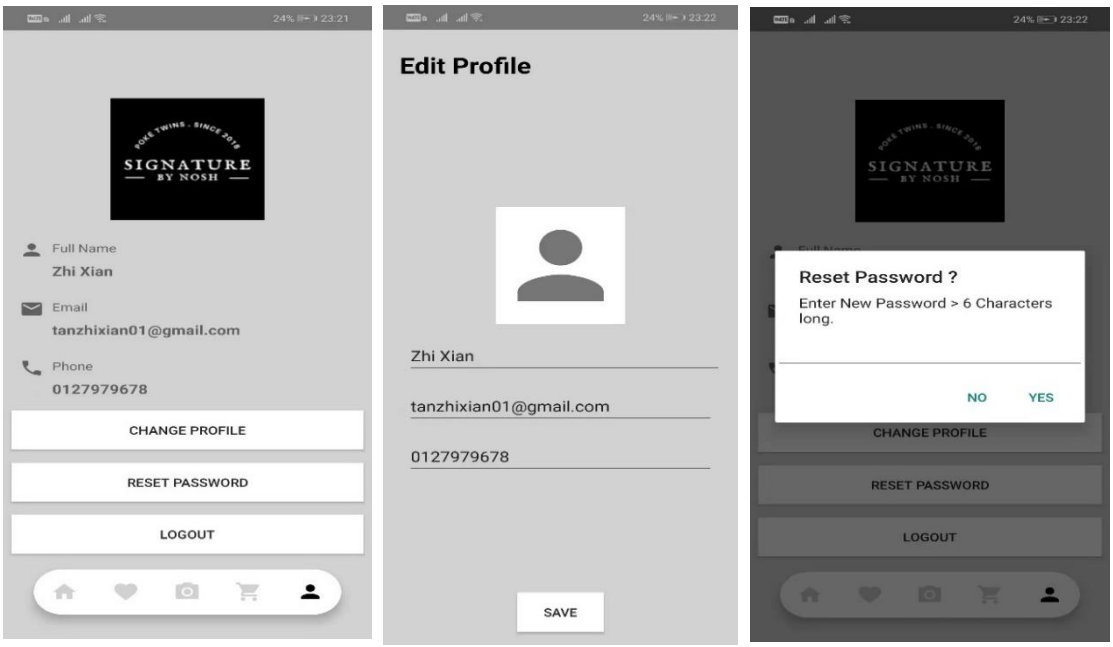


Figure 5.4.1.9 Profile Page

Figure 5.4.1.9 shows the profile page. In profile page, user can view their profile picture, full name, email, and phone number. Besides, user can click the "Change Profile" button to manage their profile. In edit profile page, user can click the profile icon to choose picture from their album. Then, user can edit their username, email, and phone number. After clicking the "save" button, user profile will be updated successfully. Besides, user can click the "reset password" button to reset their old password. After they click the reset password button, system will pop-out a dialog box which can allow user to enter a new password.

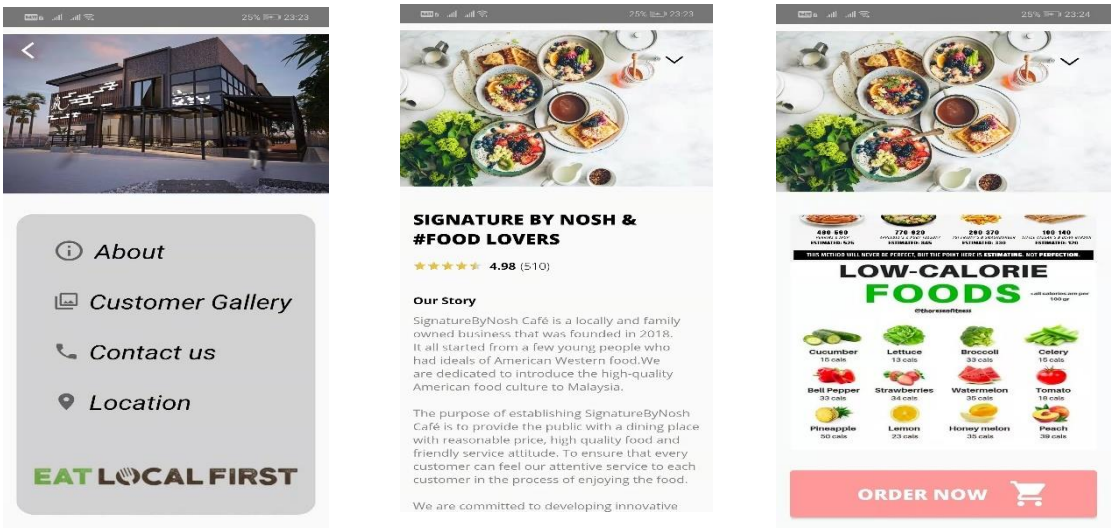


Figure 5.4.1.10 More Info and About Page

After user click the hamburger icon on the top right corner in food menu homepage, system will redirect user to the more info page as shown in Figure 5.4.1.10 above. In more info page, user can click different options such as About, Customer Gallery, Contact us, and Location. First, user can click the "About" button and system will redirect user to about page. User can scroll to view history of restaurant, food ingredients used, photo of ingredients and food calories information.

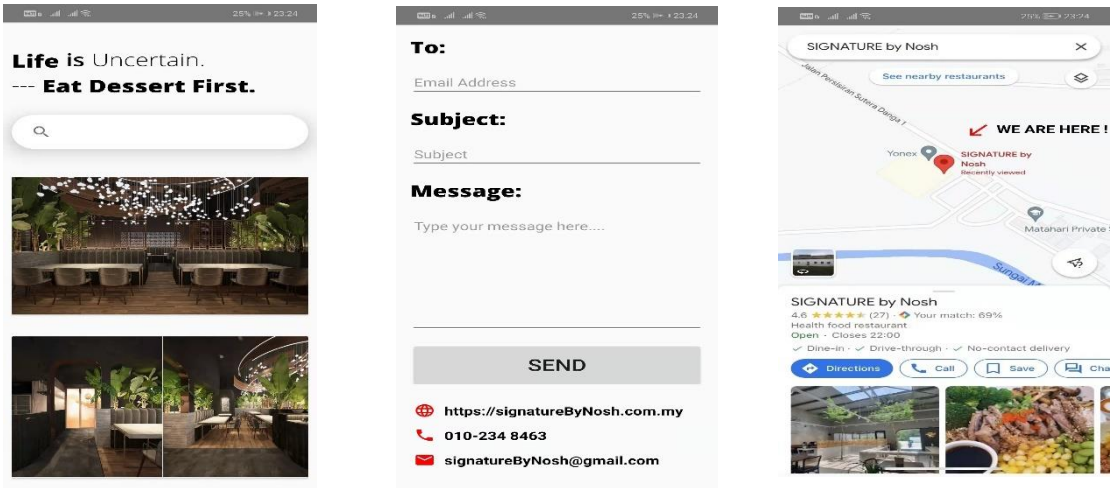


Figure 5.4.1.11 Customer Gallery, Contact and Location Page

Besides, user can click "Customer Gallery" button to view the environment and pictures of the restaurant. Next, user can click "Contact us" button and system will redirect user to contact page. User can input email address, subject, and messages in the given provided box to send feedback to the restaurant. Lastly, user can click the "Location" button and system will redirect user to the Location Page. Then, user can click "WE ARE HERE" button to access Google map and view the restaurant's location.

5.5 Concluding Remark

As a concluding remark, the hardware that have been used to develop this project include Asus's laptop with Microsoft Windows 10 Pro and 64-bit Operating System. Besides, different model of Huawei smartphone such as Huawei model 3i, Huawei mate 9, and Huawei p30 has been used to develop and perform testing on the project. This AR food menu application is developed using Android Studio and Firebase. Android Studio with Java programming language has been used to develop software and writing script for the AR food menu application. All the data user profile and food information are stored in Firebase Realtime Database, Cloud Firestore and Cloud Storage. Besides, 3D modelling tools such as blender has been used to design and produce AR 3D food model. Sceneform SDK also has been used to build an AR experience food menu app for all the essential AR features like motion tracking, environmental understanding, and light estimation. Moreover, Adobe Photoshop and Adobe Illustrator has been used for photo editing, manipulation of software and to design poster.

To use the AR function, device must be running minimum Android version 7.0 or higher. For the development of AR Food Menu using Sceneform SDK, there are some configurations need to be done included import Sceneform SDK Plugins, configure project build.gradle files as well as update Android Manifest. Besides, perform runtime checks and create a scene view, create renderables and finally build the Scene.

Besides, system operation has been covered in this chapter. In this application, it will consist of two module which is admin module and user module. In admin module, admin can view user report, view order report, and add products to user main page. In user module, user can view food menu card with rich visual-appealing 2D images, view the food details, add food items into wish list and shopping cart list, manage user profile, access AR camera function. Besides, user can also access the more info page to view customer gallery, view story of restaurant, view photo and information of ingredients used as well as learn the nutrition knowledge. Furthermore, user can leave feedback in contact page and access the restaurant's location. In short, this AR food menu project will have a more organized and systematic platform for user to order food, view virtual food with AR 3D models as well as for user to learn and understand the calories and food ingredients used.

CHAPTER 6: SYSTEM EVALUATION AND DISCUSSION

In this chapter, system testing and performance metrics, testing setup and result, project challenges, objective evaluation and concluding remark for this project will be presented.

6.1 System Testing and Performance Metrics

TABLE 6.1.1 Verification Plan for Signup Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Enter valid name, phone number, email, password, Sign Up button is pressed	Name: Tan Zhi Xian Phone:0123657867 Email: tanzhixian01@gmail.com Password:123456abc	Sign Up should be successful	Sign Up was successful	Pass
2	Enter invalid email, Sign Up button is pressed	Email: www.tanzx.com	Display “Email is Required”, Sign Up should be failed	Sign Up was failed	Pass
3	Enter invalid password, Sign Up button is pressed	Password: eeef4	Display “Password Must be >= 6 Characters”, Sign Up should be failed	Sign Up was failed	Pass

4	Empty data, Sign Up button is pressed	Name: NULL Phone: NULL Email: NULL Password: NULL	Display “Full Name, Phone Number, Email is Required”, Sign Up should be failed	Sign Up was failed	Pass

TABLE 6.1.2 Verification Plan for User Login Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Enter existing user data, Login button is pressed	Email: tanzhixian01@gmail.com Password: 123456abc	Login should be successful	Login was successful	Pass
2	Enter non-existing user data, Login button is pressed	Email: tanzhixian@gmail.com Password: 123456abc	Display “There is no user record”, Login should be failed	Login was failed	Pass
3	Enter existing user email, wrong password, Login button is pressed	Email: tanzhixian01@gmail.com Password: 009878tan	Display “Password is invalid”, Login should be failed	Login was failed	Pass
4	Empty data, Login button is pressed	Email: NULL Password: NULL	Display “Field cannot be empty”, Login should be failed	Login was failed	Pass

TABLE 6.1.3 Verification Plan for Admin Login Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Enter existing admin data, Login button is pressed	Username: admin Password: pass	Login should be successful	Login was successful	Pass
2	Enter non-existing admin data, Login button is pressed	Username: adminnn Password: pass	Display “Please enter correct credentials”, Login should be failed	Login was failed	Pass
3	Enter admin username, wrong password, Login button is pressed	Username: admin Password: xxdxs	Display “Please enter correct credentials”, Login should be failed	Login was failed	Pass
4	Empty data, Login button is pressed	Username: NULL Password: NULL	Display “Please enter correct credentials”, Login should be failed	Login was failed	Pass

TABLE 6.1.4 Verification Plan for Forgot Password Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Check response when users key in valid email and click on “YES” button	Email: tanzhixian01@gmail.com	Display “Reset link sent to your email”, User should receive email link to reset new password.	User has successfully received email link to reset new password.	Pass

2	Check response when users key in invalid email and click on “YES” button	Email: tanzhixian01gmail.com*	Display “Reset link is not sent, email is badly formatted”, User should not receive email link to reset new password.	User could not receive email link to reset new password.	Pass

TABLE 6.1.5 Verification Plan for User Report Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Check user report data when user has successfully signup on the system	Email: tanzhixian01@gmail.com Username: Zhi Xian Phone: 0127979827	Admin should see the user report that displaying user email, username, and phone number.	Admin could see the user report that displaying user email, username, and phone number.	Pass

TABLE 6.1.6 Verification Plan for Add Products Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Check response when admin click on “Upload Image” button	Click on “Upload Image” button	System should redirect user to the photo album.	System has successfully redirect user to the photo album.	Pass

2	Enter name, price, and type of food product, "Add" button is pressed	Name: McChicken Price: 12 Type: burger	Food product should be added on food menu homepage.	Food product has been successfully added on food menu homepage.	Pass
3	Empty data, "Add" button is pressed	Name: NULL Price: NULL Type: NULL	Display "Enter all fields", Food product cannot be added.	Food product was failed to be added.	Pass

TABLE 6.1.7 Verification Plan for Order Report Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Check order report data when user has successfully made payment for their order	Order ID: xvrtcb24bx43x Address: Jalan Seksyen Date: 10/04/2022 Time: 20:14:59 Cash on Delivery By: Zhi Xian	Admin should see the order report that displaying order ID, address, date, time, payment method, and username.	Admin could see the order report that displaying order ID, address, date, time, payment method, and username.	Pass
2	Check response when admin click on one of the order reports	Click on one of the order reports	Admin should see the order summary which consists of food name, price, and quantity	Admin could see the order summary which consists of food name, price, and quantity.	Pass

TABLE 6.1.8 Verification Plan for Food Menu Homepage Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Check response when user click on one of the food menu cards	Click on one of the food menu cards	User should see the food details page that displaying food product name, price, and category	User could see the food details page that displaying food product name, price, and category	Pass
2	Check response when user click on camera button in food details page	Click on camera button	System should redirect user to AR camera screen	System has successfully redirect user to AR camera screen	Pass
3	Check response when user click on “add to cart” button	Click on “add to cart” button	Display “Product Added”, Food product should be added to shopping cart.	Food product has been successfully added to shopping cart.	Pass
4	Check response when user click on “add to Wishlist” button	Click on add to Wishlist” button	Display “Product Added”, Food product should be added to wish list.	Food product has been successfully added to wish list.	Pass
5	Check response when user click on hamburger button	Click on hamburger button	System should redirect user to More Info page	System has successfully redirect user to More Info page	Pass

TABLE 6.1.9 Verification Plan for Wishlist Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Check response when user click on one of the wish list food products	Click on one of the wish list food products	User should see the food details page that displaying food product name, price, and category	User could see the food details page that displaying food product name, price, and category	Pass
2	Check response when user click on remove button	Click on remove button	Display “Product deleted”, Food product should be removed from wish list.	Food product has been successfully removed from wish list	Pass

TABLE 6.1.10 Verification Plan for Shopping Cart Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Check response when user click on one of the wish list food products	Click on one of the wish list food products	User should see the food details page that displaying food product name, price, and category	User could see the food details page that displaying food product name, price, and category	Pass
2	Check response when user click on remove button	Click on remove button	Display “Product deleted”, Food product should be removed from wish list.	Food product has been successfully removed from wish list	Pass

TABLE 6.1.11 Verification Plan for Payment Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Choose option one, Enter name and address, “Pay Now” button is pressed	Name: Zhi Xian Address: Jalan Seksyen Option one: Cash on Delivery Click on “Pay Now” button	Order placed should be successful	Order placed successfully	Pass
2	Choose option two, Enter name and address, “Pay Now” button is pressed	Name: Zhi Xian Address: Jalan Seksyen Option one: Card Payment Click on “Pay Now” button	Display “Card number is required”, payment should be failed	Payment was failed	Pass
3	Choose option two, Enter name and address, Enter invalid card number, “Pay Now” button is pressed	Name: Zhi Xian Address: Jalan Seksyen Option one: Card Payment Card number: Invalid	Display “Card number is invalid”, payment should be failed	Payment was failed	Pass
4	Choose option two, Enter name and address, Enter valid card number, expiration date, CVV, “Pay Now” button is pressed	Name: Zhi Xian Address: Jalan Seksyen Option one: Card Payment Card number: Valid	Order placed should be successful	Order placed successfully	Pass

5	Empty data, “Pay Now” button is pressed	Name: NULL Address: NULL	Display “Enter all fields”, payment should be failed	Payment was failed	Pass

TABLE 6.1.12 Verification Plan for Profile Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Check response when user click on “Change Profile” button	Click on “Change Profile” button	System should redirect user to Edit Profile page	System has successfully redirect user to Edit Profile page	Pass
2	Check response when user click on Profile icon in Edit Profile page	Click on Profile icon	System should redirect user to the photo album.	System has successfully redirect user to the photo album.	Pass
3	Edit new user data, “Save” button is pressed	Name: ZX Email: tzx@gmail.com Phone: 0127979273	Display “Profile Updated”, Edit profile should be successful.	Edit profile was successful.	Pass
4	Empty data, “Save” button is pressed	Name: NULL Email: tzx@gmail.com Phone: 0127979273	Display “One or many fields are empty”, Edit profile should be failed.	Edit profile was failed.	Pass

TABLE 6.1.13 Verification Plan for AR Camera Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Check response when user click on “AR Camera” button	Click on “AR Camera” button	System should render a built-in Sceneform UX animation that shows users how they should move their phone to activate AR experience	System has successfully render a built-in Sceneform UX animation in AR Camera Screen	Pass
2	Check response when user moves camera around surroundings	Moves camera around surroundings	System should trigger computer generated vision technology by scanning the surrounding environment and display multiple white dots on flat surface.	System has successfully display multiple white dots on flat surface which indicates AR 3D food model is ready to be placed.	Pass
3	Check response when user placed AR 3D food model	Placed AR 3D food model	AR 3D food model should be successfully placed on the flat surface.	Placing of AR 3D food model was successful.	Pass
4	Check response when user move camera away from flat surface	Move camera away from flat surface	AR 3D food model should be disappeared on screen.	AR 3D food model has been disappeared on screen.	Pass

5	Check rotate function of AR 3D food model	Rotate food model	AR 3D food model should be rotate by user on screen	Rotation of AR 3D food model was successful.	Pass
6	Check scale function of AR 3D food model	Scale food model	AR 3D food model should be scale by user on screen	Scaling of AR 3D food model was successful.	Pass
7	Check drag and move function of AR 3D food model	Drag and move food model	AR 3D food model should be move from one place to another within range.	Drag and move of AR 3D food model was successful.	Pass

TABLE 6.1.14 Verification Plan for More Info Module

Test Case	Test Case Description	Test Data	Expected Result	Actual Result	Pass/Fail
1	Check response when user click on “About” button	Click on “About” button	System should redirect user to About page	System has successfully redirect user to About page	Pass
2	Check response when user click on “Customer Gallery” button	Click on “Customer Gallery” button	System should redirect user to Customer Gallery page	System has successfully redirect user to Customer Gallery page	Pass
3	Check response when user click on “Contact” button	Click on “Contact” button	System should redirect user to Contact page	System has successfully redirect user to Contact page	Pass
4	Enter all fields, “Send” button is pressed	Click on “Send” button	System should redirect user to Gmail	System has successfully redirect user to Gmail	Pass

5	Check response when user click on “Location” button	Click on “Location” button	System should redirect user to Location page	System has successfully redirect user to Location page	Pass
6	“WE ARE HERE” button is pressed	Click on “WE ARE HERE” button	System should redirect user to Google Map	System has successfully redirect user to Google Map	Pass

6.2 Testing Setup and Result

6.2.1 Qualitative Usability Testing

TABLE 6.2.1 Summary of Five User's Emotions and Feedbacks

Participants	Summary of Emotions and Feedbacks
User 1	- Appeared calm while using this application. - Able to use this application without any guidance. - Satisfied with the interface design of this application.
User 2	- Facial expression looks relax throughout the session. - Able to use this application with least guidance. - Look amazed when using AR Camera function. - Mentioned that AR 3D food model can be more realistic, improve the quality in 3D models
User 3	- Excited to try out all the features and function - Admitted the prototype is very easy to use - Mentioned that there can be some improvement in the order report module to allow admin filter different order report by date. - Mentioned that AR function is creative and innovative to be implemented on food menu.
User 4	- Appeared smiling and happy when using the app - Mentioned that there are only 10 food models provided in the system so that cannot try out others food model. - Mentioned that the interface design is attractive. - Mentioned that there is some error in the margin of customer gallery page because there is the different size in different smartphones. - Overall satisfy with the prototype.
User 5	- Facial expression looks like satisfied the application. - Give suggestion for the future work (sort the food menu by category) - Mentioned application is easy to use without any guidance.

6.2.2 Quantitative Usability Testing

In the quantitative usability testing, there are twenty users has tested the application. Based on the survey data in Appendix B, as shown in survey form, most of the users often go to restaurants 3 to 4 times per month to enjoy their meals. Half of them prefer eating usual favourite food than trying out unusual new dishes because some of them might have dietary restrictions where they do not know the ingredient being used in a meal. Hence, they will tend to order usual dishes. Besides, half of the respondents would like to try out a new restaurant because of the gourmet food. According to the survey, new technology concept such as AR food menu would be their second choices while the price and location would be least attracted by respondents. As shown in appendix B, most of the respondents have ever used the digital menu to order food using phone, tablet, and Computer. Among those three devices, phone is one of the popular devices that have been used to order food.

Based on the survey form, 65% of the user would like to know the food ingredients used and understand food calories in the meal while the others 35% of user remain neutral view. After reading the ingredients in a meal, 15 of the respondents cannot envision the actual appearance of food while the other 5 respondents would have the imagination of the food appearance. Among all the 20 respondents, all of them would like to view virtual food appearance in AR 3D model before the actual food is served. This is because this food menu application has introduced an AR technology which brings an innovative and unique idea to attract most of the user and stand out from all the competitors.

Based on survey data, 12 of the respondents could not envision the food portion size accurately and 15 of the respondents had trouble in recognizing some of the ingredients in meal. Therefore, most of them would tend to identify the food ingredients and portion size by searching online or asking waiter for help. Hence, the proposed solution has introduced a smart device interactive food menu that would contain an augmented reality features which can allow user to view virtual food in AR 3D model which display an appropriate representation of both appearance and portion.

As shown in survey data, twelve users able to use the AR camera function without any guidance while the other eight users find it difficult to use the AR function. Among those eight respondents, five of them mention that there can be some improvement in

the quality of food models, 2 of them suggest providing more options to view different food models while the other one user suggest adding screenshot button to save food models into album.

Majority of user feel satisfied with AR camera function while two of the users feel extremely satisfied with this function since it provides a better understanding of the food menu for user. However, eight of the users feel moderate when using the AR function. As shown in user satisfaction score, majority of users are most preferably the AR camera function, six users prefer food menu homepage, and the other two users prefers each of the shopping cart function and more info function. For the overall satisfaction of AR food menu application, majority of the users leave a good comment and feedback where they feel the interface and functionality of the application is satisfied or extremely satisfied. With this function, it provides a more precise and easier platform which can allow users to view AR food model that can provide a better understanding of the food menu.

6.3 Project Challenges

There are a few implementation issues and challenges has been occurred throughout the development of AR food menu project. During implementation phase, the main issue and challenge that has been occurred in this project is due to the lack of knowledge and experience in developing the proposed project using Sceneform SDK. Since the Google Sceneform Tools (Beta) require lot of configurations of ARCore and Sceneform UX dependencies, hence it took for a few weeks to learn the usage of tools and functions such as performing runtime checks and create a scene view by using an ArFragment that can automatically handle ARCore session. Therefore, most of the time was spent to find out the solution on the implementation of Sceneform SDK plugin into AR food menu project.

Other than that, difficulty in designing of 3D food model and objects is one of the most challenging parts in this project. To construct a realistic 3D food model, drawing skills is highly required. However, due to the time constraints and unfamiliarized of the 3D computer graphics software, it is very difficult to produce an ultra-high quality of 3D food model. Therefore, one of the solutions is to download OBJ file from Google Poly and import the 3D assets file to the system. Besides, search for a similar 3D model to edit can be considered as one of the best ways to construct the 3D model. Although the Blender software is a flexible and free open-source 3D computer graphics toolset, but it is not user-friendly for beginners to construct an interactive 3D model since it is more suitable for the experience 3D designer. Thus, solutions for this problem could be importing 3D assets file from free resources such as Google Poly, purchasing an ultra-high quality of 3D food model or seek for some friend who is good in drawing skill and use the Blender software.

Furthermore, create rig and bones into a constructed 3D model is also challenging and time consuming. It includes the production such as modelling, texturing, rigging, and lightning. Modelling will be the very first step in development phase and texturing will be carried out to make the food model have a more realistic view. Besides, there is total of 10 food model need to be created in this AR food menu project.

6.4 Objective Evaluation

According to project objectives stated in Chapter 1, the project objectives has been successfully achieved as shown below:

1. Successfully developed a mobile food menu application that integrate with augmented reality technology for user to view virtual food with 3D models which displays an appropriate representation of both appearance and portion size.

2. Successfully developed a food menu application that provide engagement and interaction between user via augmented reality technology.

3. Successfully embed photo of food ingredients used and nutrition information in the food info page for user to learn and understand the food calories and ingredients.

4. Successfully implement AR technology on food menu to overcome communication gaps and language barriers of user during food ordering process.

6.5 Concluding Remark

To perform testing on AR food menu project, testing setup has been carried out such as qualitative usability testing and quantitative usability testing. Qualitative usability testing involves observing users to understand how they experience the AR food menu app and to research on target audience's pain points, opinion, and mental mode. To perform qualitative usability testing, AR food menu APK file has been installed on user's Android phone to performed certain actions and test the functionality. User has been assigned to test the app and user's emotions and feedbacks has been recorded. It is used to design decisions and gain in-depth insights into users' behaviours and emotions. During the qualitative testing phase, most of the user are excited to try out all the features and function while some of them appeared calm while using this application. Throughout this way, data can be collected successfully by observing user's interactions and reactions. In short, qualitative testing is incredibly useful since it involves participants attempting to test the application and all the findings are based on participant's impressions, comments, and feedback.

Besides, quantitative usability testing plays an important role in system testing since it measures user's performance based on a given task, such as the task-completion times, success rate, and number of errors which can provides a basis for benchmarking programs. To perform quantitative usability testing, survey form of user satisfaction score has been conducted to measure user experience with statistical data that can be quantified and expressed in numerical terms. Based on the quantitative survey data, it shows that the AR food menu application is easy to use without any guidance and most of the user feel satisfied with the interface design of this application. In short, quantitative testing can accumulates data about users' behaviours and attitudes in an indirect way which allow researcher to find out user's perception towards the functionality of application and find usability issues while using the applications.

As a concluding remark, both qualitative and quantitative user testing are complementary methods to provide a basis of benchmarking to evaluate the performance and functionality of this application. Although there are some issues and challenges occurred throughout the whole development of AR food menu project, system requirements and project objectives stated in Chapter 1 had been successfully achieved.

CHAPTER 7: CONCLUSION AND RECOMMENDATION

In this chapter, project discussion, novelty of the project, future work, and conclusion for this project will be presented.

7.1 Discussion

Augmented Reality technology trend is nowadays rapid evolution. After exposing the project to public and respondents, there are some of the positive critiques had been received. One of the positive comments received from user was that the idea of AR 3D food menu project was quite innovative, and the 3D food models looked appealing and appetizing. People also like the fact that they could view the food portion size and could see how each ingredient was placed on plates. Besides, another thing they liked most was that the application offers customers an opportunity to view how the food appearance of their order would look like before they placed any order.

In short, the outcome of this project was successful. It has been proven that people do not have to feel reserved when they come to try out gourmet restaurants because of the language barriers, communication gaps, food ingredients knowledge or portion sizes. It has also proven that sooner or later the AR technology will be available for all the restaurant and the traditional printed menus will be replaced. AR introduces an innovative way to boost the effectiveness of cuisines. An AR food menu will help improve customer engagement and build brand visibility to increase clientele and expanding the client base of business. Signature by Nosh could be the food menu ordering tool that can provide trustworthiness with its augmented reality feature.

7.2 Novelty of the Project

Due to the recent improvement in the quality of life and the increasing of interest in food, the number of people looking for restaurants or special foods has increasing significantly. The customer who visits the restaurant are interested to know the ingredients of the food as well as the information about the origin, cooking method and efficacy of the food. The proposed solution is an introduction of smart device interactive food menu that will implement augmented reality features with some useful function. It will be reproduced in 3D with the aids of the photogrammetry method. This project can show how the merge of culinary arts with technology that can assist in building trust between restaurants and customers.

This project has introduced an AR technology which is an innovative and unique idea to stand out from all the competitors. It can act as a business strategy to attract more customers with the implementation of AR technology. It can enhance user engagement and improve brand loyalty. The use of low-cost devices as compared to the costly head mounted display devices can be considered as one of the main advantages in this project. Besides, this project has provided user with a better idea about the product before buying. Although there is no sense of aroma, cuisine, taste, and uniqueness, but it provided user with an immersive AR experience during the process of food ordering. This application provided good user interaction and helped in removing all the language barriers and odd names of food items problem.

With the implementation of AR technology, it will be fun and interesting to elevate user's food experience and managed to meet their expectations visually. Through AR food menu application, culinary industry can provide engagement and interaction with their customer in a new and innovative way. The project shows the advantages of incorporating a digital food menu with augmented reality technology to elevate user's food experience and promotes the immersion of user experience in the culinary world.

The adaption of AR technology was ground-breaking since it can be applied in different industries to streamline the processes. Since majority of the people have a smartphone with them everywhere and anytime, the adoption of AR technology will begin to rise in a short period of time. As people become increasingly dependent and rely on the mobile devices, AR technology will slowly become the norm in this digital world in the coming few years.

7.3 Future work

The current version of application is complete on basic requirement, there are some of the recommendation and future work can be improved. A list of recommendation that could be possible to be improved in future as shown below:

1. **Improve the 3D food model to become more realistic and visual-appealing.**

   An ultra-high quality of AR 3D food model can be designed in future to make the food model more realistic. Besides, increase more choices of 3D food models.

2. **Implement a filter function to sort the food by category.**

   With the filter function, user can select the food by different category. It will be more user-friendly and convenient during the food ordering process.

3. **Implement a built-in customer feedback function to measure customer satisfaction**

   Augmented reality food menu app can have built-in feedback features in future. It can serve as a tool to collect data about customer preferences. Through this way, user time spent on viewing popular dishes and promotional features can be collected. Hence, the survey can be used to provide valuable information to business owners.

4. **Implement a phone capture function for user to capture different angle of AR 3D food models and save into album.**

   With this function, user can click a save button to capture different angle of their favourite dishes' photo and save into photo album. Besides, user can share the picture of 3D food model with their friends and family. They can also choose to upload the photo of 3D food model to the social media such as Facebook, Instagram, Twitter, and many others.

5. **Add on AR cooking game that can allow user to learn and cook the dish.**

   There might be a collaboration of AR food menu project with AR mini cooking game in future. This mini cooking game is an augmented reality mobile games which can allow user to learn and cook their own dish. With the combination of works, it will be interesting and fun to promote the immersion of user experience and elevate gourmet food experience in the culinary world with AR cooking game.

7.4 Conclusion

The combination of reality and digital technology has further strengthened the aspect of modern society life to cater for new developments in the industrial revolution 4.0. Augmented Reality technology are currently matured and by utilizing this technology, it can superimpose computer-generated images on a user's view of the real world and all the imaginary things can come true. As the digital trend continues, creativity and visual depiction can be valued as one of the ways to elevate customers interest when they patiently wait for their meals. However, most of the restaurant still maintain the original business mode where the menus served are simple and consists only the images and text. Those traditional printed menu causes a difficulty for restaurant to come up with a unique selling point in an oversaturated food industry. The problem with inconsistency of food portion size and appearance, loss of engagement in traditional food menu, lack of information about the food ingredients used and food calories, problem of communication gaps and language barriers can be identified. Therefore, the proposed mobile application is intended to solve these problems. These problems have become a strong motivation to develop this project that can bring benefits and convenience to the user where they can choose their desire dishes based on the AR food menu application.

The objective of this project is to create an AR food menu mobile application that allow user to view virtual food with 3D models which displays an appropriate representation of both appearance and portion. It can provide a better understanding of food menu and enhance the easiness of user during the food ordering process. Other than that, this project wishes to provide the customers to have an interactive and interesting food ordering experience by implementing rotate, scaling, drag and move function on the AR 3D food model. In this way, it provides engagement and interaction between user and food menu. As the customer are interested in the new AR technology, it can grab their attention to the restaurant and act as a unique selling point for the business to increase the return rate of customers.

As a conclusion, this project proposed on AR food menu application using Android operating system that can completely overlaying digital content onto the real world. The result of this project shows that the AR food menu application was able to trigger computer generated vision technology by scanning the surrounding environment

to retrieve augmented reality contents, AR 3D food model that can be placed on the flat surface environment. Besides, this application has provided variety of sub-function such as admin module, user profile, wish list, and shopping cart. In a nutshell, this application has a great potential to benefit users, allow them to enjoy an immersive AR experience during the food ordering process, but also act as a great marketing plan for the business.

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Appendix A: Final Year Project 2 Biweekly Report

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** WEEK 3
Student Name & ID: TAN ZHI XIAN_18ACB05121	
Supervisor: TS. SAW SEOW HUI	
Project Title: Interactive Food Menu Application Via Augmented Reality	

1. WORK DONE

In week 3, I have the first FYP meeting with my supervisor. We have discussed an overview of this project. My supervisor has share the latest FYP guideline and give me some brief introduction. The work that has been done include refined the precious FYP 1 report, construct 3D food model.

2. WORK TO BE DONE

The work to be done include design more 3D food model, find free online sources of the 3D food model

3. PROBLEMS ENCOUNTERED

- Time constraint to draw 3D food model

4. SELF EVALUATION OF THE PROGRESS

There will be more research and analysis to learn how to sketch for 3D model.

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** WEEK 5
Student Name & ID: TAN ZHI XIAN_18ACB05121	
Supervisor: TS. SAW SEOW HUI	
Project Title: Interactive Food Menu Application Via Augmented Reality	

1. WORK DONE

In week 6, there is a FYP meeting regarding of the system diagram and system flowchart. My supervisor has discussed with me on the system diagram that need to be put inside report and give me some comment on the diagram that will need to change after. The work done include system diagram, system flowchart and user requirements.

2. WORK TO BE DONE

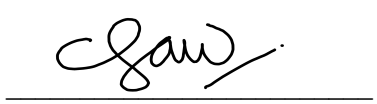
There will be some modifications on the system diagram. Besides, more user requirements need to be gathered, analysed, and documented in the form of user stories. Programming and coding need to be carried out to produce a prototype.

3. PROBLEMS ENCOUNTERED

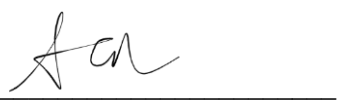
-

4. SELF EVALUATION OF THE PROGRESS

I will improve the system diagram and system flowchart. Besides, I will start to learn more about the software such as Blender and Sceneform SDK plugin to ensure an effective project can be delivered and achieved.



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** WEEK 7
Student Name & ID: TAN ZHI XIAN_18ACB05121	
Supervisor: TS. SAW SEOW HUI	
Project Title: Interactive Food Menu Application Via Augmented Reality	

1. WORK DONE start to do coding for new module, wish list and cart list using android studio.
2. WORK TO BE DONE The work to be done include other module such as profile, more info page.
3. PROBLEMS ENCOUNTERED
4. SELF EVALUATION OF THE PROGRESS Need to speed up to do for other modules

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** WEEK 9
Student Name & ID: TAN ZHI XIAN_18ACB05121	
Supervisor: TS. SAW SEOW HUI	
Project Title: Interactive Food Menu Application Via Augmented Reality	

1. WORK DONE

Complete wish list and cart list module, learn how to implement Sceneform SDK into AR food menu project.

2. WORK TO BE DONE

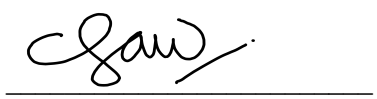
The work to be done focus on AR camera module. Since my project is an interactive AR food menu, hence more research and analysis need to be conducted to learn how to enhance user interaction with food model.

3. PROBLEMS ENCOUNTERED

Lack of time constraint and will need to learn lot of things, besides, implementation of AR Core is unfamiliarized and will need to put more effort in making the 3D model more realistic and visual-appealing.

4. SELF EVALUATION OF THE PROGRESS

Strictly follow the timeline to ensure an effective project can be delivered at the end of semester.



Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** WEEK 11
Student Name & ID: TAN ZHI XIAN_18ACB05121	
Supervisor: TS. SAW SEOW HUI	
Project Title: Interactive Food Menu Application Via Augmented Reality	

1. WORK DONE

In week 11, I have discussed the prototype with my supervisor. I have demonstrated my preliminary work to my supervisor. Besides, we have also discussed which of the function can be further enhanced and improved such as scaling, drag and move function.

2. WORK TO BE DONE

Some further enhancement on the initial prototype needed to be modify. There will be some add on function to make the project well-defined. Besides, report draft also needs to be done for my supervisor to check and give me some comment on it.

3. PROBLEMS ENCOUNTERED

There are still some problems on implement function such as scaling, drag and move features. Hence, there will be more research on this problem.

4. SELF EVALUATION OF THE PROGRESS

To solve the problem, I will schedule my timeline properly to ensure the report draft can be submitted on time. Besides, some changes that have been commented by my supervisor will be further improved. Project prototype will also be modified to provide more interaction with user.

Supervisor's signature

Student's signature

Appendix B:

Survey Questionnaire

User Satisfaction Score - Interactive Food Menu Application Via Augmented Reality (AR)

I am a final year undergraduate student from University Tunku Abdul Rahman (UTAR) Kampar Campus, currently pursuing Bachelor of Computer Science (Hons).

This survey form will take around 3 to 5 minutes to complete. This survey questionnaire is conducted to study and analyse user perception towards the system usability such as satisfaction ratings and user friendly of the mobile application as a basis for benchmarking to measure user experience with data.

The purpose of this survey form is to collect your feedbacks and comments after using the Augmented Reality (AR) Food Menu Mobile Application, SignatureByNosh.

Thank you for your precious time and your participation is highly appreciated.

tanzhixian01@1utar.my (not shared) Switch account

* Required

1) How oftens do you go to restaurants? *

- ◯ Regularly (3 - 4 times per week)
- ◯ Often (3 - 4 times per month)
- ◯ Rarely (0 - 1 times per month)

2) Do you prefer eating at your usual favourite restaurants or like to try out something new? *

- ◯ Prefer usual favourite food
- ◯ Prefer try out new food
- ◯ Both favourite and new food

3) What would attract you to try out a new restaurant? *

- ◯ Food
- ◯ Location
- ◯ Price
- ◯ New Technology Concept (AR Food Menu)
- ◯ Other: _____

4) Have you ever used a digital menu to order food? *

- ◯ Yes
- ◯ No

User Satisfaction Score - Interactive Food Menu Application Via Augmented Reality (AR)

tanzhixian01@1utar.my (not shared) Switch account

* Required

If yes, on what device? *

- ◯ Phone
- ◯ Tablet
- ◯ Computer/Laptop
- ◯ Ziosk
- ◯ Other: _____

Back Next Clear form

User Satisfaction Score - Interactive Food Menu Application Via Augmented Reality (AR)

tanzhixian01@1utar.my (not shared) Switch account

* Required

5) Would you like to know the food ingredients used and understand food calories in the meal? *

- ◯ Yes
- ◯ No
- ◯ Maybe

6) After reading the ingredients contained in a meal, can you envision what your food would look like? *

- ◯ Yes
- ◯ No

7) Would you like to view virtual food apperance in AR 3D model before actual food is served? *

- ◯ Yes
- ◯ No

8) Can you envision the food portion size accurately? *

- ◯ Yes
- ◯ No
- ◯ Maybe

9) Have you ever had trouble recognizing some of the ingredients in a meal? *

- ◯ Yes
- ◯ No

Back Next Clear form

If yes, what would be your actions towards identifying them? *

- ◯ Search online
- ◯ Ask waiter
- ◯ Other: _____

10) After using the AR Food Menu Application, do you find it difficult to use the AR Camera Function? *

- ◯ Yes
- ◯ No

Back Next Clear form

If yes, any feedback to the AR Camera Function? *

- ◯ Improve the quality of AR 3D food model
- ◯ Provide more options for AR 3D food model
- ◯ Add screenshot button to save AR 3D food model
- ◯ None of them

Back Next Clear form

11) How satisfied were you with the AR Camera function? *

	1	2	3	4	5	
Extremely unsatisfied	◯	◯	◯	◯	◯	Extremely satisfied

12) Which function are you most preferable? *

- ◯ Food Menu Homepage
- ◯ Wishlist
- ◯ AR Camera
- ◯ Shopping Cart
- ◯ Profile
- ◯ More Info

13) How satisfied were you with the AR Food Menu Mobile Application? *

	1	2	3	4	5	
Extremely unsatisfied	◯	◯	◯	◯	◯	Extremely satisfied

Thanks for your participation ! Have a nice day~

Back Submit Clear form

20 responses

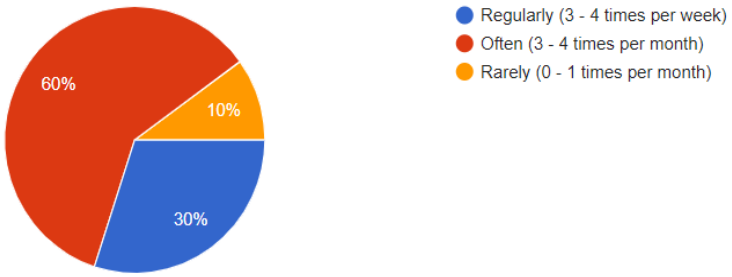
Accepting responses

Summary Question Individual

1) How oftens do you go to restaurants?

Copy

20 responses



2) Do you prefer eating at your usual favourite restaurants or like to try out something new?

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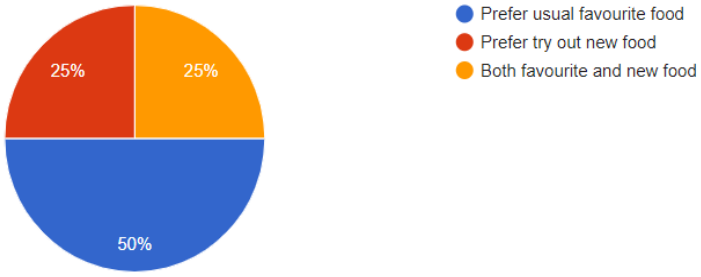
20 responses



3) What would attract you to try out a new restaurant?

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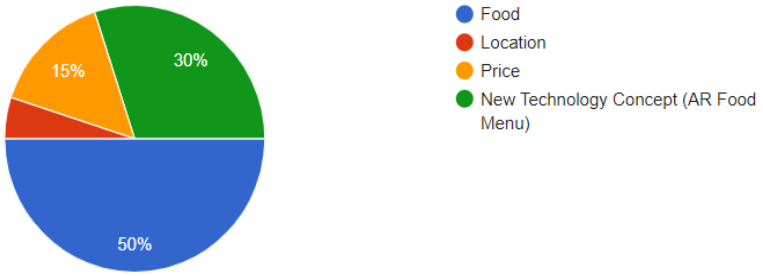
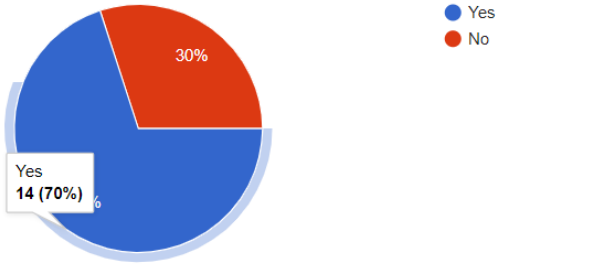
20 responses



4) Have you ever used a digital menu to order food?

Copy

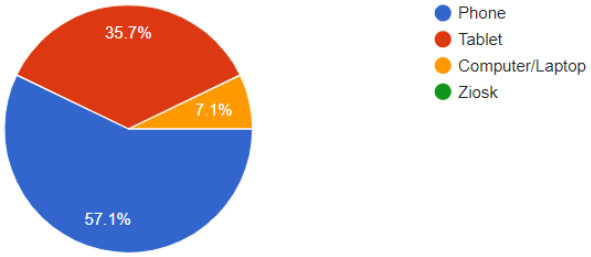
20 responses



If yes, on what device?

Copy

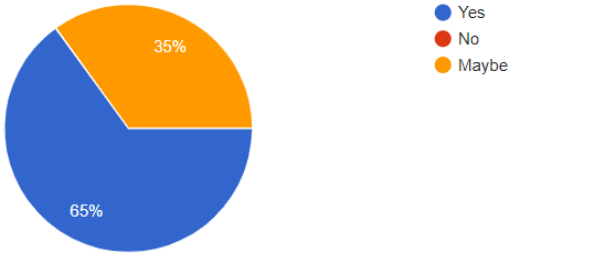
14 responses



5) Would you like to know the food ingredients used and understand food calories in the meal?

Copy

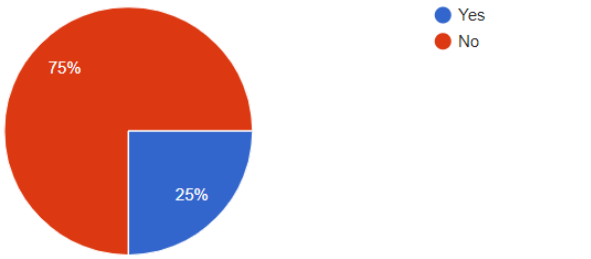
20 responses



6) After reading the ingredients contained in a meal, can you envision what your food would look like?

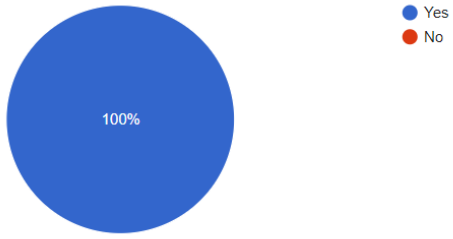
Copy

20 responses



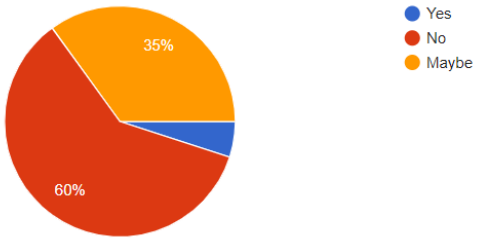
7) Would you like to view virtual food apperance in AR 3D model before actual food is served? Copy

20 responses



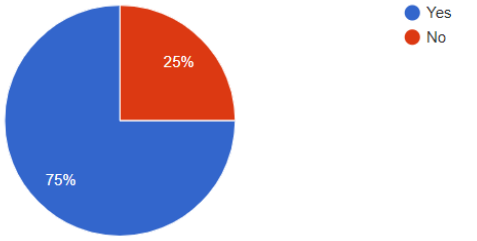
8) Can you envision the food portion size accurately? Copy

20 responses



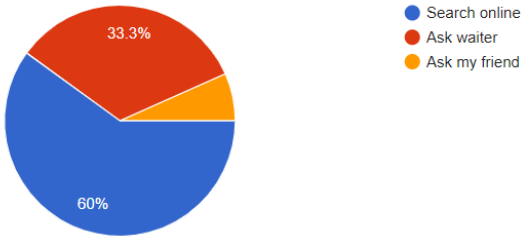
9) Have you ever had trouble recognizing some of the ingredients in a meal? Copy

20 responses



If yes, what would be your actions towards identifying them? Copy

15 responses



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10) After using the AR Food Menu Application, do you find it difficult to use the AR Camera Function?

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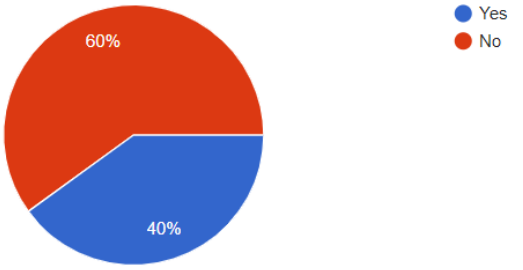

If yes, any feedback to the AR Camera Function?

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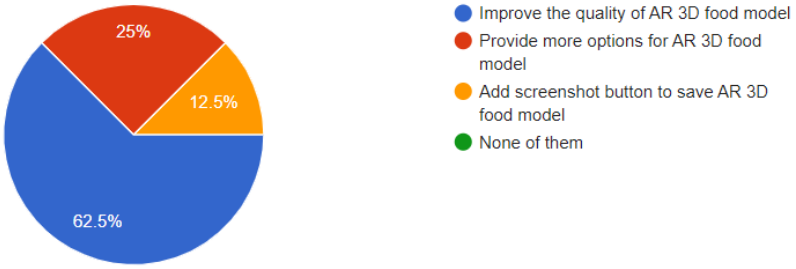
8 responses

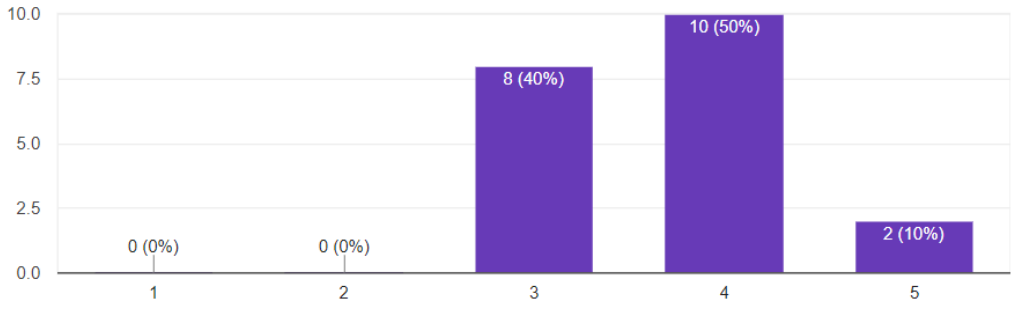


Untitled Section

11) How satisfied were you with the AR Camera function?

Copy

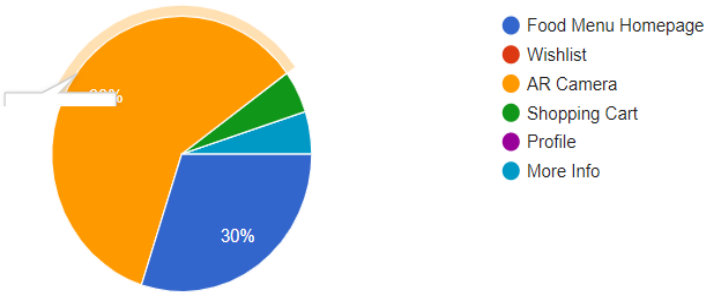
20 responses



12) Which function are you most preferable?

Copy

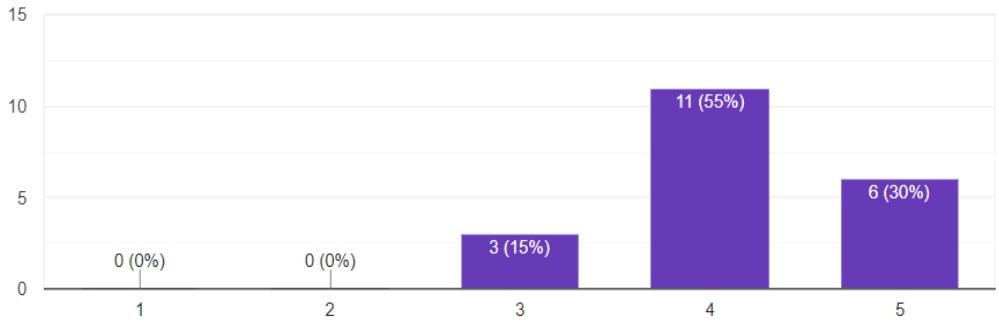
20 responses



13) How satisfied were you with the AR Food Menu Mobile Application?

Copy

20 responses



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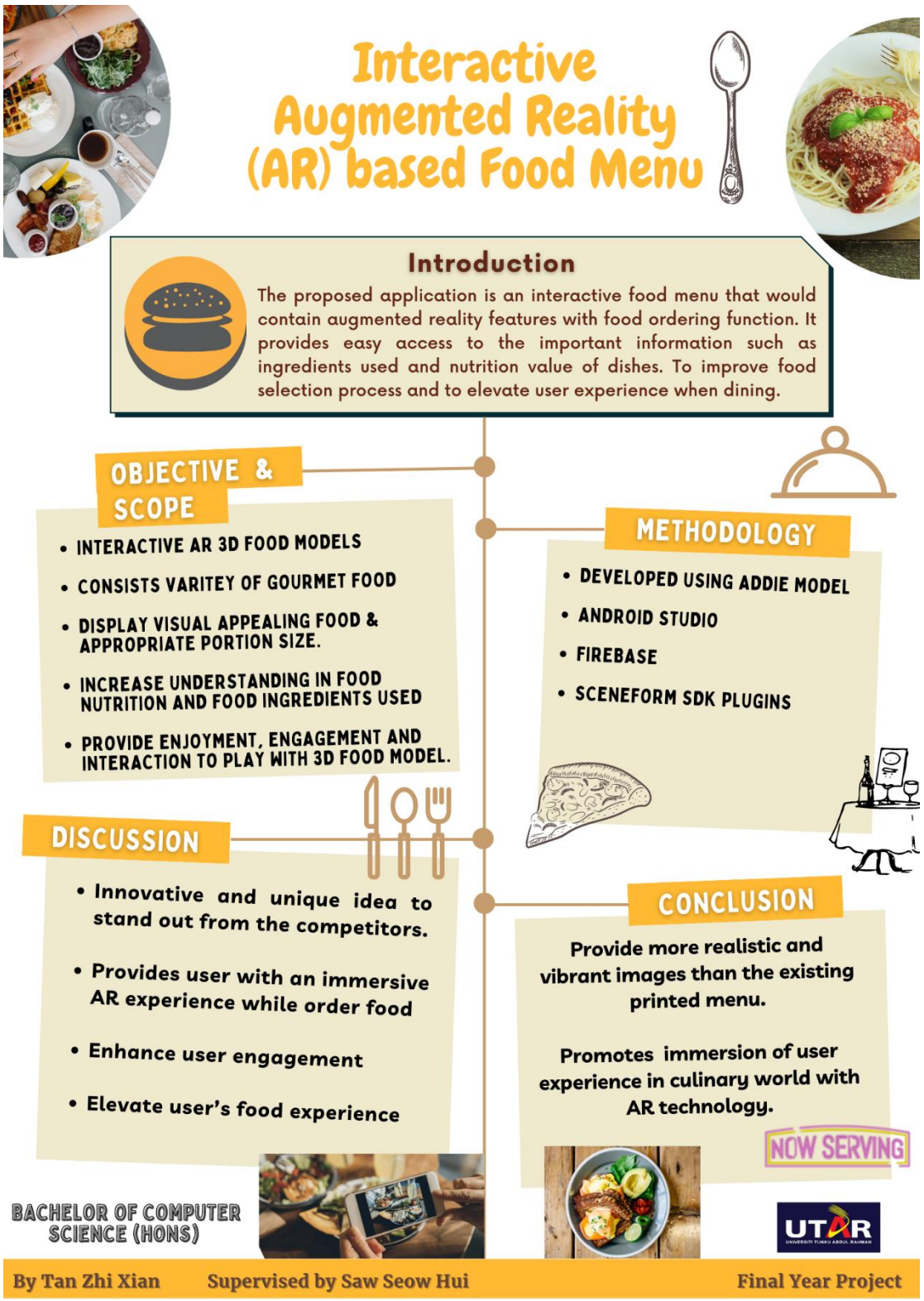
Interactive Augmented Reality (AR) based Food Menu
Introduction
The proposed application is an interactive food menu that would contain augmented reality features with food ordering function. It provides easy access to the important information such as ingredients used and nutrition value of dishes. To improve food selection process and to elevate user experience when dining.
OBJECTIVE & SCOPE
• INTERACTIVE AR 3D FOOD MODELS
• CONSISTS VARITEY OF GOURMET FOOD
• DISPLAY VISUAL APPEALING FOOD & APPROPRIATE PORTION SIZE.
• INCREASE UNDERSTANDING IN FOOD NUTRITION AND FOOD INGREDIENTS USED
• PROVIDE ENJOYMENT, ENGAGEMENT AND INTERACTION TO PLAY WITH 3D FOOD MODEL.
METHODOLOGY
• DEVELOPED USING ADDIE MODEL
• ANDROID STUDIO
• FIREBASE
• SCENEFORM SDK PLUGINS
DISCUSSION
• Innovative and unique idea to stand out from the competitors.
• Provides user with an immersive AR experience while order food
• Enhance user engagement
• Elevate user's food experience
CONCLUSION
Provide more realistic and vibrant images than the existing printed menu.
Promotes immersion of user experience in culinary world with AR technology.
NOW SERVING
BACHELOR OF COMPUTER SCIENCE (HONS)
UTAR
By Tan Zhi Xian
Supervised by Saw Seow Hui
Final Year Project

PLAGIARISM CHECK RESULT

Interactive Food Menu Application via Augmented Reality (AR)

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	TAN ZHI XIAN
ID Number(s)	18ACB05121
Programme / Course	Bachelor of Computer Science (Honours)
Title of Final Year Project	Interactive Food Menu Application Via Augmented Reality

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

Signature of Supervisor

Name: Ts. Saw Seow Hui

Date: 22/4/2022

Signature of Co-Supervisor

Name: _____

Date: _____

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY (KAMPAR CAMPUS)

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Student Name	TAN ZHI XIAN
Supervisor Name	TS. SAW SEOW HUI

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✓	Signed form of the Declaration of Originality
✓	Acknowledgement
✓	Abstract
✓	Table of Contents
✓	List of Figures (if applicable)
✓	List of Tables (if applicable)
✓	List of Symbols (if applicable)
✓	List of Abbreviations (if applicable)
✓	Chapters / Content
✓	Bibliography (or References)
✓	All references in bibliography are cited in the thesis, especially in the chapter of literature review
✓	Appendices (if applicable)
✓	Weekly Log
✓	Poster
✓	Signed Turnitin Report (Plagiarism Check Result - Form Number: FM-IAD-005)
✓	I agree 5 marks will be deducted due to incorrect format, declare wrongly the ticked of these items, and/or any dispute happening for these items in this report.

*Include this form (checklist) in the thesis (Bind together as the last page)

I, the author, have checked and confirmed all the items listed in the table are included in my report.

_____

(Signature of Student)
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