Kingdom of Saudi Arabia
Ministry of Education
King Faisal University
College of Computer Sciences & Information Technology

Scan and Eat (SAE)
An innovative approach toward improving restaurants using Deep Learning and Computer Vision

A project submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Science in Computer Science

by

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UNDERTAKING

This is to declare that the project entitled “SAE: Scan and Eat” is an original work done by the undersigned, in partial fulfillment of the requirements for the degree “Bachelor's in Computer Science” at the Computer Science Department, College of Computer Sciences and Information Technology, King Faisal University.

The undersigned has accomplished all the analysis, design, and system development. Moreover, this project has not been submitted to any other college or university.

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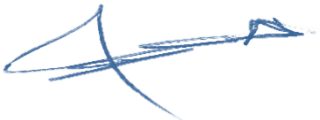

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ABSTRACT

This project leverages computer science to address the inefficiencies in restaurant checkout and healthcare management. We developed a mobile application that automates billing by scanning food items on a customer's plate, calculating the total cost instantly. Additionally, the app improves health care by cross-referencing customer-provided health data (like allergies or chronic conditions) against their food choices, offering real-time dietary recommendations. This dual functionality not only streamlines the payment process, reducing wait times and cashier crowding, but also enhances customer health management. The application benefits both customers and restaurant owners by facilitating faster service and providing a platform for easy menu and pricing updates.

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1 Introduction

Scan and Eat is an innovative project that uses deep learning and computer vision to reduce restaurant congestion, decrease employee error rates, and encourage healthy food choices. The project's unique feature of identifying potentially unhealthy food items based on user information can have a positive impact on healthcare by helping to prevent chronic diseases.

The project automates the process of identifying and analyzing food items, providing users with instant information about the type of food and its price. In addition to reducing market or restaurant traffic and employee errors, Scan and Eat can help users make healthier food choices by alerting them to food items that may be unhealthy based on their specific dietary needs and preferences.

By providing users with information about potentially unhealthy food choices, Scan and Eat can help prevent chronic diseases and obesity. The project encourages individuals to maintain a healthy lifestyle by empowering them with information about the nutritional content of their food choices.

The owner or admin of the restaurant, on the other hand, will be used to getting a rapid overview of the invoices and the top-selling food items. The project will also assist in increasing the number of consumers since customers will not have to wait in the cashier's line for extended periods.

1.1 Background

Food is one of the most essential and enjoyable aspects of human life. It nourishes our bodies and satisfies our senses. Restaurants are places where we can experience a variety of food options, from local specialties to international cuisines, in a comfortable and convenient setting. Overcrowding of restaurants is a common phenomenon in the food service industry, especially during peak hours or seasons. Therefore, customer

service is one of the most important factors affecting the satisfaction and loyalty of restaurant customers. While some customers may perceive a crowded restaurant as a sign of high food quality, good reputation, and low price, others may feel uncomfortable, dissatisfied, and frustrated by the long waiting time, noisy environment, reduced personal space and the service might be slow. and unreliable, where the staff should deal with many customers at once.

However, many restaurants struggle to provide timely and efficient service as they face many challenges and changes over time. They had to compete with other forms of food service, such as street vendors, cafeterias, or delivery services. They had to adapt to changing customer preferences, such as health consciousness, environmental awareness, or ethical concerns. They had to cope with rising costs, labor shortages, regulations, or crises. They had to innovate with new technologies, such as online ordering, digital payments, or artificial intelligence.

The COVID-19 pandemic was one of the biggest shocks that crowds of restaurants ever faced. It forces many restaurants to close temporarily or permanently due to lockdowns, social distancing measures, or reduced demand. It also accelerated the shift to online platforms, such as delivery apps or cloud kitchens. Because of this, many countries have implemented social distancing protocols to prevent customers from crowding in these places. For example, in Saudi Arabia, the Ministry of Municipal and Rural Affairs and Housing has issued a mechanism to prevent Saudi customers from crowding in restaurants and cafes. According to this mechanism, no more than five people can share one table, and the waiting customers must be 1.5 meters apart. The mechanism also requires restaurants and cafes to provide electronic payment methods and online reservation systems.

One of the factors that influence customer satisfaction and loyalty in the restaurant industry is the speed of service. The delay in customer service can be defined as the difference between the expected and actual waiting time for receiving the ordered food or drink. According to a study by Cornell University, the average acceptable waiting

time for casual dining restaurants is 12 minutes, while for fast food restaurants, it is 6 minutes. However, these expectations may vary depending on the type of cuisine, the complexity of the order, the quality of the food, and the customer's mood and hunger level. Customers expect to receive their orders within a reasonable time frame, and any delay can negatively affect their perception of the quality and value of the food, as well as their overall dining experience. Here, we will provide an overview of the causes and consequences of service delays in restaurants.

Service delays can occur at any stage of the order fulfillment process, from taking the order to preparing the food to deliver it to the table. Some of the common causes of service delays are:

- Understaffing or poor staff allocation: If there are not enough staff members to handle the volume of customers, or if they are not assigned to the right tasks, the service can become slow and inefficient.
- Inadequate training or communication: If the staff members are not well-trained or informed about the menu items, ingredients, cooking methods, or special requests, they may make mistakes or take longer to complete their tasks.
  Equipment or supply issues: If the kitchen equipment is faulty or outdated, or if there are shortages of ingredients or utensils, the food preparation can be delayed or compromised.
- Customer behavior or preferences: If the customers are indecisive, change their orders frequently, have complex or special requests, or complain about the food or service, they can cause interruptions or disruptions in the service flow.

Service delays can have several negative impacts on both the customers and the restaurant. Some of the possible consequences are:

- Customer dissatisfaction and frustration: Customers who experience long waits for their food may feel annoyed, bored, hungry, or angry. They may lose their

appetite or interest in the food and perceive it as less tasty or fresh. They may also feel that they are not valued or respected by the restaurant staff.

- Customer complaints and negative word-of-mouth: Customers who are unhappy with the service may express their dissatisfaction verbally or nonverbally to the staff, other customers, or online platforms. They may also discourage others from visiting the restaurant or giving it a low rating or review.
- Customer defection and loss of revenue: Customers who encounter service delays may decide to leave the restaurant before completing their order, request a refund or compensation, or not return in the future. This can result in a loss of sales and profits for the restaurant, as well as damage to its reputation and image.

On the other hand, for the health of food in restaurants, restaurants may have negative effects on the health and nutrition of customers. They may use low-quality ingredients, artificial additives, or excessive amounts of salt, sugar, fat, or calories in their food and beverages. They can also serve large portions that exceed the recommended amount for customers. Restaurants can expose customers to various risks and risks. They may suffer from poor hygiene or sanitation practices that lead to food poisoning or allergies because customers are not aware of the nutritional food information or its harm if he has chronic diseases. They may also have unsafe or uncomfortable environments that cause accidents, injuries, or stress for clients.

Food poisoning: A condition that occurs because of eating food contaminated with bacteria, viruses, parasites, or toxins, and its symptoms appear hours or days after eating and include diarrhea, vomiting, nausea, cramps, heat, and headache. Food poisoning can lead to serious conditions such as dehydration, low blood pressure, kidney failure, and in some cases death. Food poisoning can be caused by several factors, such as improper storage, preparation, heating, or cooling of food, use of expired or contaminated ingredients, or failure to follow hygiene and sterilization standards by restaurant workers.

Food allergy: It is an abnormal immune reaction that occurs when some people eat certain foods that they are allergic to, and its symptoms appear quickly after eating,

and include a rash, itching, swelling in the mouth, throat, or face, and difficulty breathing. Respiration, swallowing, and hypotension. blood and loss of consciousness. Food allergies may lead to serious conditions such as anaphylactic shock that threatens the patient's life. The most allergenic foods are nuts, eggs, fish, crustaceans, milk, wheat, and soybeans. It may be difficult for some restaurants to avoid using it.

1.2 Motivation

The motivation behind Scan and Eat is to provide a solution to the problem of market or restaurant congestion and employee errors, while also encouraging healthy eating habits. With the increase in demand for healthy food options, markets and restaurants are becoming increasingly crowded and hectic, making it difficult for consumers to make informed decisions about their food choices.

Scan and Eat addresses this problem by leveraging the power of automation, deep learning, and computer vision to automate the process of identifying food items and providing users with instant information about their nutritional content and price. By automating this process, Scan and Eat reduces the need for manual data entry, saving users time and making it easier for them to make informed decisions about their food choices.

Additionally, Scan and Eat’s ability to identify potentially unhealthy food choices based on the user’s information can have a positive impact on health care by helping to prevent chronic diseases and obesity. By encouraging healthy eating habits, Scan and Eat can also improve the quality of life for people and communities.

In summary, Scan and Eat is motivated by the desire to reduce market or restaurant congestion, decrease employee errors, and encourage healthy eating habits. By leveraging the power of automation, deep learning, and computer vision, Scan and Eat offers a unique and user-friendly solution to making informed food choices, making it an ideal solution for people and communities seeking to maintain a healthy lifestyle.

1.3 Problem statement

Human mistakes are unavoidable. Buffet employees may make billing errors and charge clients differently based on the type of food on their plates. In some cases, such as iftar during Ramadan, employees are unable to handle the influx of customers. Some people might ignore what is written on food items and their contents, or it may not be written at all. Some people have illnesses such as diabetes, wheat allergies, or high cholesterol. And some goods will probably give them health problems.

1.4 Project innovations and utility

There is no doubt that new technologies advance society in every sphere into which they are introduced, and Saudi Arabia's new Vision 2030, which emphasizes the importance of technology, particularly machine learning and artificial intelligence (AI), our system (Scan and Eat) will adopt such innovative technologies to assist in restaurant management by saving customers time from waiting in long cashier queues and helping in healthcare.

1.4.1 Project Innovations

This section will provide all the innovations that will be used to help the project reach the requirements.

- Automation: Scan and Eat automates the process of identifying food items, providing users with instant information about the type of food and its price. This eliminates the need for manual data entry, saving users time and reducing the chance of errors.
- Deep Learning and Computer Vision: The project uses deep learning and computer vision to identify and analyze food items, providing users with detailed information about the nutritional content of their food choices.
- User Information: Scan and Eat incorporates user information to provide personalized recommendations for healthy food choices, alerting users to

potentially unhealthy food items based on their specific dietary needs and preferences.

1.4.2 Project Utility

- Reduction of Market or Restaurant Congestion: Scan and Eat reduces market or restaurant congestion by automating the process of identifying and analyzing food items. This eliminates the need for manual data entry and reduces the amount of time users spend in markets or restaurants.
- Decrease Employee Error Rates: By automating the process of identifying and analyzing food items, Scan and Eat reduces the chance of errors by employees. This leads to greater efficiency and increased customer satisfaction.
- Encouraging Healthy Eating Habits: Scan and Eat encourages healthy eating habits by providing users with information about the nutritional content of their food choices. The project alerts users to potentially unhealthy food items based on their specific dietary needs and preferences, helping to prevent chronic diseases and obesity.
- Improved Quality of Life: By providing users with information about the nutritional content of their food choices, Scan and Eat can improve the quality of life for individuals and communities. The project encourages healthy eating habits and helps prevent chronic diseases and obesity.

1.5 Scope of the project

The focus of the project was to create a mobile application that can detect and recognize food that is on the plate and give a total bill based on the food items that have been detected. This app will detect and recognize using a model that will be trained for this mission. After the app recognizes the food and the quantity of the items this will let the application check the database for the price and will return the bill which will help

save time and stand in long lines for the cashier by using the application to automate the purchase process without involving human actions. Another thing is that when the user has a health issue that might be because the food has been detected then the user will have a notification about that which will lead to a significant reduction in the risk of these diseases.

1.6 Degree of challenge

In every project, some challenges and difficulties are known and two are those that appear within time. In our project, first, we had to train a model that recognizes the food. Then we had to make sure that the model was doing well by testing it. Secondly, we had to build a dataset that has been provided by users of their health illnesses. Using this dataset to give alerts based if the food that has been added to the plate is good for them or not.

2 Comprehensive Analysis of Related Works

This section examines projects like Amazon Go Store, MEZLI, and mocca.food recognition to understand their contributions to improving customer experiences through technology, providing valuable insights and inspiration for enhancing the Scan and Eat project.

2.1 Amazon Go Store

The first example is about a store that doesn't have any cashiers. The customer should download an app to enter the store by scanning the in-store code in the Amazon Go app over the scanner at the gate of the store. Then, the gate will open to enter the store. Some sensors track every single item the customer takes off the shelf it will be added to their cart in the app and the opposite is where the customer returns it on the shelf. When the customer is finished, he is free to leave the store, but he will receive the receipt after a while time to pay for what he took[1] [2].

Figure 1:One of the Amazon Go store branches[1]

2.2 MEZLI

MEZLI, located in San Francisco, is the world's first automated restaurant. There are no cashiers or servers at the restaurant, and all orders are taken using an iPad. Food is prepared by machines and served in cubbies labeled with the customer's name. The restaurant has now closed, but the technology it employed is being used in other businesses[3] [4].

2.3 mocca.foodrecognition

Figure 2:MEZLI restaurant[3]

mocca.foodrecognition, a product by Ventopay that uses an AI-supported solution for food recognition mentioned on the page allows menus and drinks to be captured by the camera and booked fully automatically in the POS system. The tray with the selected food and drinks is brought under the camera. The products are then automatically scanned, recognized, and booked into the POS system. Customers can then be paid immediately without cash. The entire checkout process takes a maximum of 3 seconds, including cashless payment. It also features a hybrid mode that allows switching between self-service and attended checkout[5].

Table 1: A table showing the differences between related works

	Amazon Go Store	MEZLI	Mocca.foodrecognition
Developer	Amazon	Three Stanford engineers	Ventopay
Focus of services	Sell a variety of products	Food	Food, drinks
Products	wide range of products, including groceries, snacks, and meals	Limited menu of food	Recognize any food that is trained and stored in the system
Require scanning a QR code	needed	No	No
Payment	Cards or the app	Cards or the app	Wages, salaries, prepaid credit, or cards

3 Objective and Expected Outcome

This section presents the objectives and expected outcomes of the Scan and Eat (SAE) project. It aims to develop a mobile application that automates food scanning, calculates bills, and provides personalized recommendations, to improve the checkout process, promoting healthier choices, and enhancing the overall dining experience.

3.1 Objective

In this section of the research, we will try to present a specific result that we are trying to achieve in a time frame and with the resources available to us and the results that we hope to achieve when achieving the goal. This project aims to build a mobile application capable of automating the purchase process and helping improve health care by recommendations based on the health of each person:

- A simple and precise method for speeding up buffet processing and billing.
- An easy mobile application that allows users to keep track of their meals and be warned if it is harmful to their health.
- If the user chooses the wrong type of food, assist them in finding a better one for their health.

3.2 Expected Outcome

What is the expected from this app, and what impact does this app have on the user's life and admin or the owner of the restaurant:

- There will be a mobile application with user-friendly features that are simple to use, accessible, and constantly available.
- Using the application, a system gives a simple and accurate way to determine what type of food users are having.

- It will be a favorable customer experience because the crowd will be less than at a regular buffet, which may benefit the restaurant owner's financial situation.
- The restaurant owners can add, modify, or delete new types of food.
- The ability to view users' information such as their names and contact information.
- Showing the restaurant's food and sales bill.

3.3 Methodology

The Scan and Eat project will utilize the Waterfall development methodology, known for its structured and linear approach. This method involves completing each phase of development in sequence, ensuring thoroughness and accuracy at each step. Here is a concise overview of each phase:

- Requirements Gathering and Analysis: The project begins with the collection of a wide range of food images, prices, and types to create a comprehensive and representative dataset. This initial phase is crucial for setting a solid foundation for the project.
- System and Software Design: The second phase focuses on designing the Scan and Eat system. This includes developing the architecture for the deep learning model, which will handle food identification and nutritional analysis, and crafting a user-friendly interface. The design aims to enhance efficiency in markets or restaurants and reduce errors.
- Implementation: In this stage, the actual development of the software takes place. This involves coding the image processing and nutritional analysis functionalities and integrating the user interface with the backend systems.
- Verification and Testing: After implementation, the system undergoes extensive testing. This phase ensures the accuracy of the

deep learning model and the effectiveness of the user interface in practical scenarios. Feedback from testing might lead to adjustments in previous phases.

- Deployment: Successful testing leads to the deployment phase, where the system is introduced into real-world environments. This step involves setting up the system in targeted settings and ensuring its seamless operation.
- Maintenance and Enhancement: The final phase involves the ongoing maintenance of the system, addressing any post-deployment issues, and making regular updates for improved performance and adaptability.

Through this structured and systematic approach, the Scan and Eat project is set to develop a reliable and efficient system for automated food identification and nutritional analysis, aiming to reduce congestion and errors in markets and restaurants.

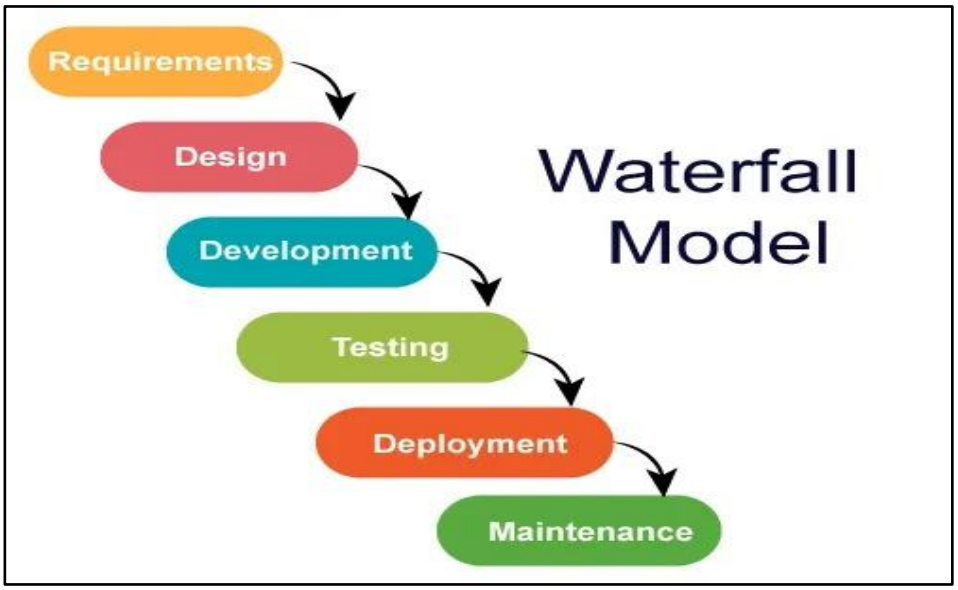

Figure 3: Waterfall Model [6]

3.4 Project Requirements

In this section, we will be talking about the functional requirements of the Scan and Eat application. The table below will show the requirement and its description.

Table 2: Requirements table

Requirement name	Requirement Description
"Detection and Recognition"	The system should be able to detect the type of the object and tell what type of food this is.
"Healthcare alarm"	The system should alarm the customer if the food is not good for the customer's health depending on the database of the system including the customer's info.
"Bill"	The system should be able to display a bill of the scanned food by listing the names of the objects, prices, and the total amount.

4 Preliminary Solution Identification and Justifications

This section outlines the identified solutions and justifications for addressing checkout waiting times and health concerns in our project, Scan and Eat.

4.1 Dataset Description

We selected the MyFoodRepo-273 dataset that was released by the benchmark [7] as begging for the proposed of the project. MyFoodRepo-273, a database of food constituting 24,119 images and a total of 39,325 segmented polygons categorized into 273 different classes with at least 35 annotations per class.

4.2 Algorithm

Supervised learning[8], often known as supervised machine learning, is a machine learning and artificial intelligence subcategory. It is distinguished by using labeled datasets to train algorithms that categorize data or properly anticipate outcomes. As input data is fed into the model, the weights are adjusted until the model is properly fitted, which occurs as part of the cross-validation process.

4.3 Technique

We utilized the CNN model[9] to transform single float data into categorical values. CNN stands for Convolutional Neural Networks, which are used to extract picture characteristics using many layers of filters. CNN analyzes the raw pixel data from the image, trains the model, and then automatically extracts the features for improved categorization.

4.4 Data Processing Approach

The Scan and Eat project employ a sophisticated data processing approach to optimize various functionalities within the mobile app. The process commences by capturing high-quality images of food items, followed by meticulous image processing techniques to ensure precise identification. These images are then inputted into a deep-

learning model that has been trained extensively on a diverse set of food images. Leveraging advanced visual features, the model accurately classifies the type of food depicted in the images.

To augment user experience, the app retrieves comprehensive nutritional information from a dedicated food database. By integrating this data with the identified food items, the app performs precise calculations of the meal's nutritional content, empowering users to make informed dietary decisions. Moreover, the app takes into consideration the user's health profile, encompassing details about allergies and existing illnesses. This information enables the app to deliver personalized recommendations and notifications for potentially harmful food items.

Through this comprehensive data processing approach, the Scan and Eat app ensures reliable food recognition, tailored recommendations, and efficient billing processes, thereby enhancing the overall dining experience for users.

5 Tools and Techniques

This section highlights and examines the tools and techniques utilized in the project proposal, as well as those that will be employed during the project implementation phase.

5.1 Tools and Techniques Used During Project Proposal

- **Online searching:** Google provides powerful services such as Google Scholar, a search engine that specializes in academic content. It served as a solid basis for our project.

- **Discord:** is a collaboration platform from Discord Inc. It provides file storage as well as chat, video, and voice calling[10]. It was used by our team to keep organized, have conversations, arrange group meetings, and preserve all the used materials in one place.

- **Draw.io:** is the world's most popular browser-based end-user diagramming software and an open-source technology stack for constructing diagramming apps[11]. We utilized it to create several sorts of diagrams, such as system flow diagrams and system architecture diagrams.

- **Grammarly:** is a typing assistant that works in the cloud to help you evaluate your spelling, grammar, punctuation, and tone and makes recommendations to enhance your writing style and vocabulary[12].

- **WhatsApp:** Was used as a hub for sharing files and coordinating meetings.

5.2 Tools and technique required for project implementation

- **Online searching:** Google provides powerful services such as Google Scholar, a search engine that specializes in academic content. It would be used for getting more clarity and solving some issues that might happen in implementation.

- **Discord:** is a collaboration platform from Discord Inc. It provides file storage as well as chat, video, and voice calling. It was used by our team to keep organized, have conversations, arrange group meetings, and preserve all of the used materials in one place.

- **Python:** It is a programming language, interpreted, simple, object-oriented, and high-level programming language with dynamic features for web and app development[13]. We will use Python to write the code that helps detect and identify the items on the plate.

- **PyCharm:** It is a Python-specific integrated development environment (IDE) used in computer programming[14]. It will be used to build and run our Python code.

- **Android Studio:** is Google's official integrated development environment (IDE), based on JetBrains' IntelliJ IDEA software and intended exclusively for Android development[15]. It will be utilized in developing our mobile application.

- **Database:** MySQL will be used to store users' information like login, health information, and bills. Also, need it to store the food menu and prices.

6 Appropriate Analysis

In this section, a thorough analysis is conducted to ensure the suitability and effectiveness of the proposed system. It includes an examination of the system architecture, use case diagram system flowcharts, database design, and system interface.

6.1 System Architecture

The system architecture outlines of the Scan and Eat mobile Application is food detection and health monitoring. At its core is a user interface that integrates a camera and a food detection model to identify food items and relay this information to the health engine. This engine evaluates the food's nutritional content against user health data to offer personalized advice and alerts, signaled through a health notification system. Additionally, the application supports a shopping cart feature for selecting and purchasing food, with an integrated payment system for transactions. All data, including food information and user health status, is stored in a central database, forming the system's backbone. The architecture aims to seamlessly combine food identification, health assessment, user alerts, and transaction handling in a cohesive and user-friendly interface.

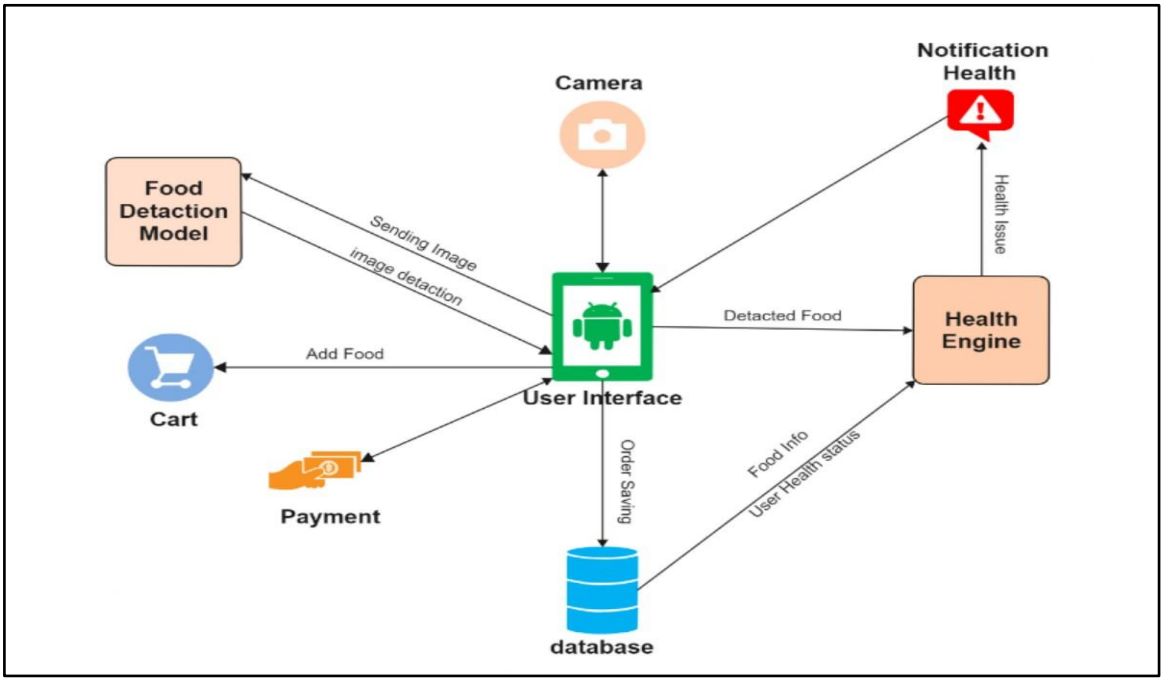

Figure 4:System architecture

6.2 Use Case Diagram

This subsection will visually present the interactions between users and the Scan and Eat mobile application. It illustrates the different actions and functionalities available to users, providing a clear overview of their involvement and the system's behavior.

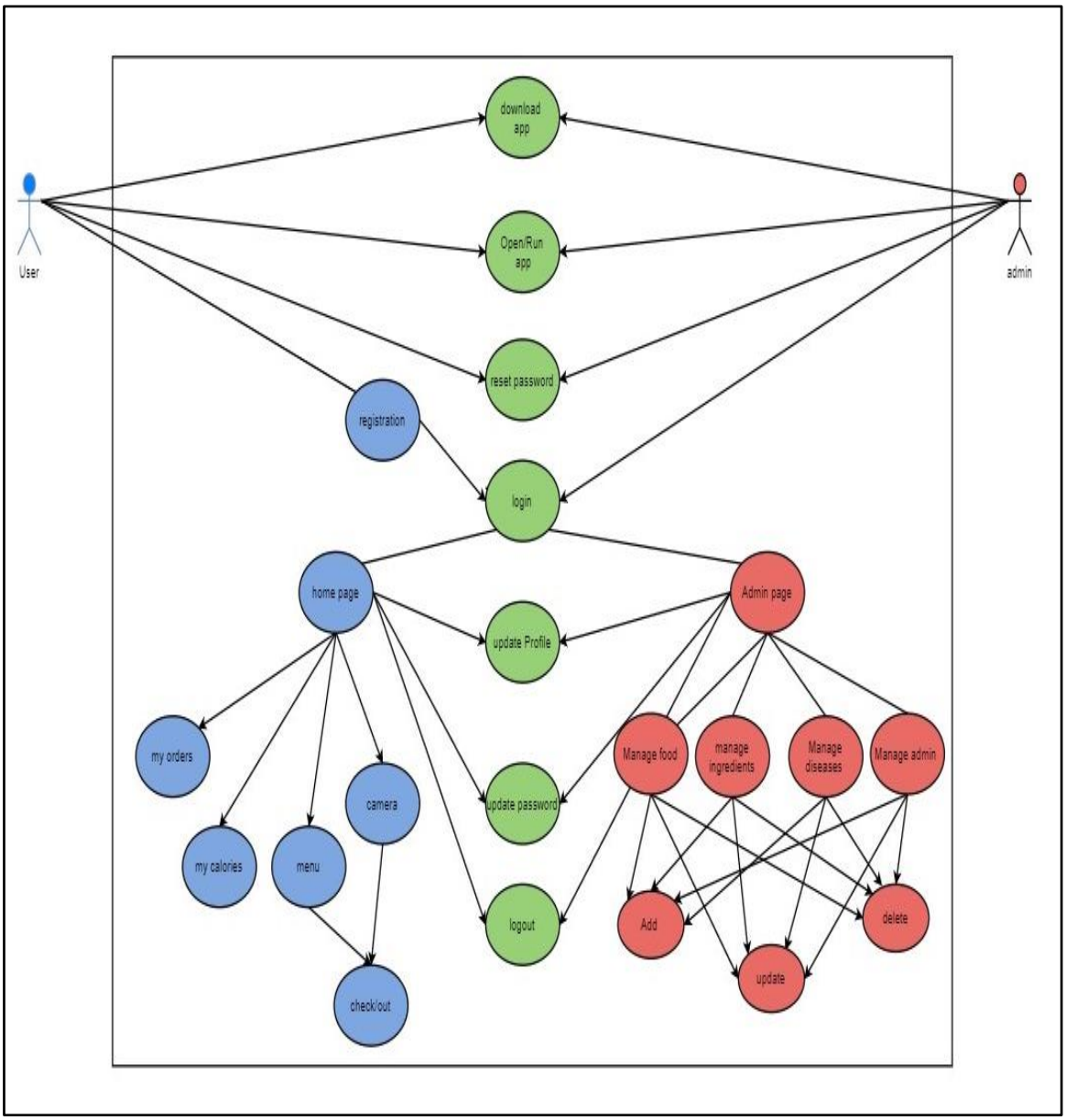

Figure 5:Use cases diagram.

6.3 System Flowchart

The system will begin with the user placing his meal on a plate and then opening the program to scan the food to be detected using the camera. Then there are two conditions: first, if the camera does not deduct the food, the photo is ignored, and the system returns to the camera to scan again. Second, if the food has been identified, there will be two conditions: First, when the food will not cause any health issues for the users based on the information that was provided by the users when they registered, the bill information will be printed. Second, if the food is not healthy, it will display a message that the food is not good for their health, and it will again ask them if they want to continue or remove the food that has been identified as not good food for the user. If they decide not to continue, the user will be returned to the beginning of the process. Otherwise, if they want to keep going, they will have the bill information printed.

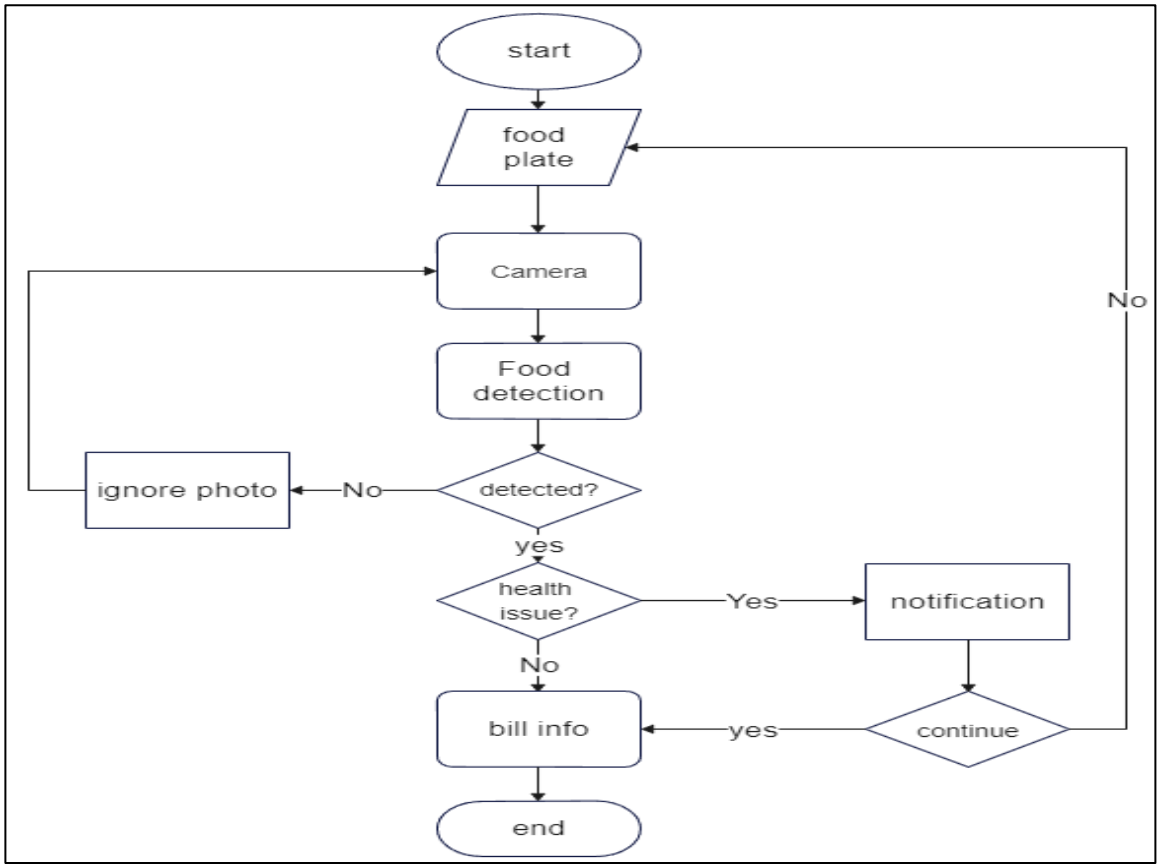

Figure 6: System flowchart for the user

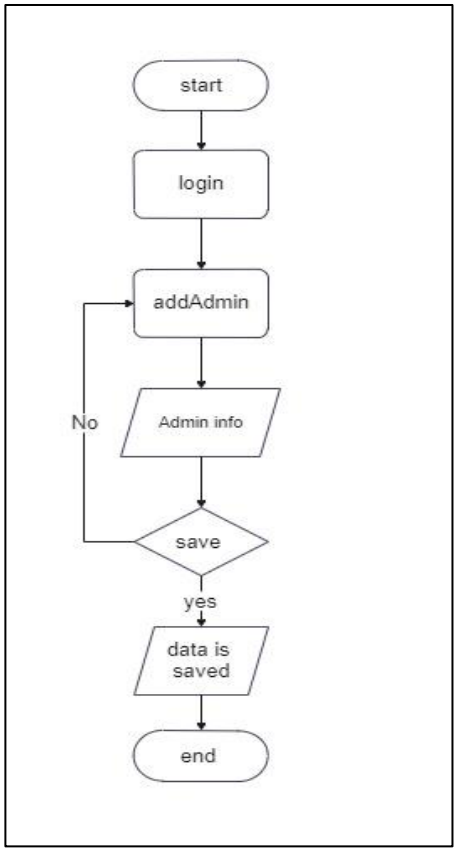

Figure 8:Owner flowchart to add new Admin

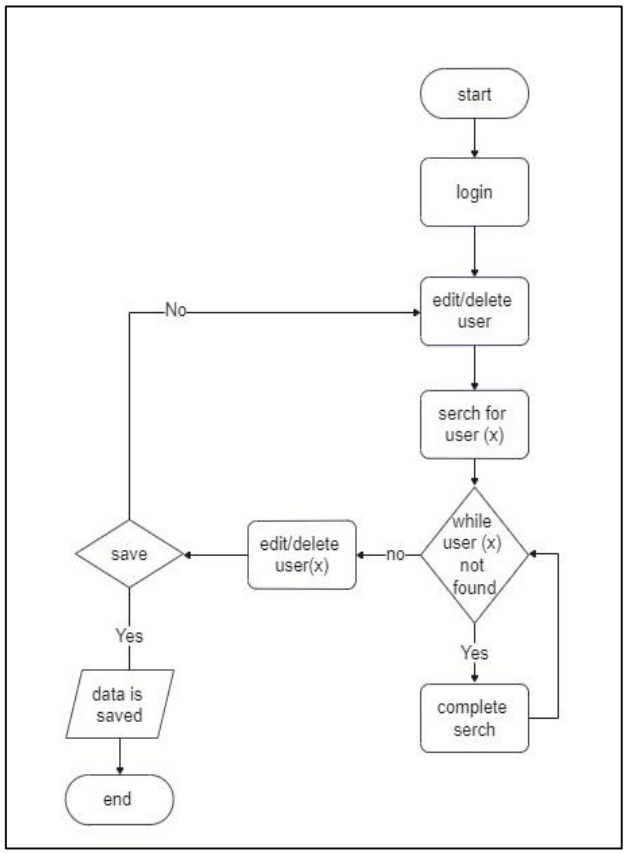

Figure 7:Owner flowchart to edit or delete user

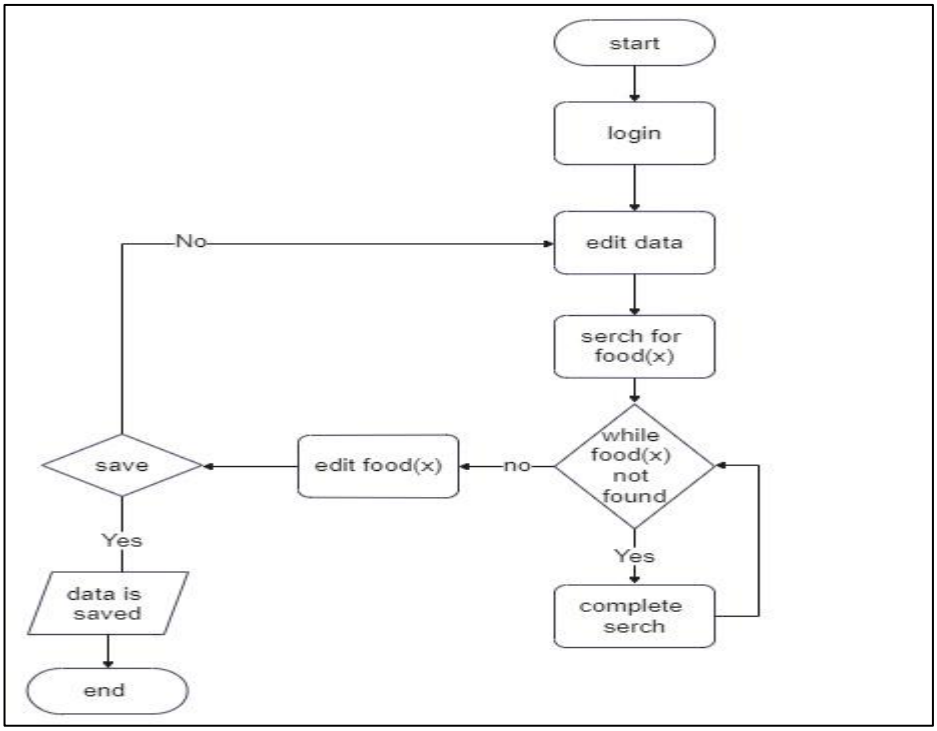

Figure 9:Owner flowchart to add new food data.

6.4 Database Design

This subsection discusses the database and shows the ER diagram.

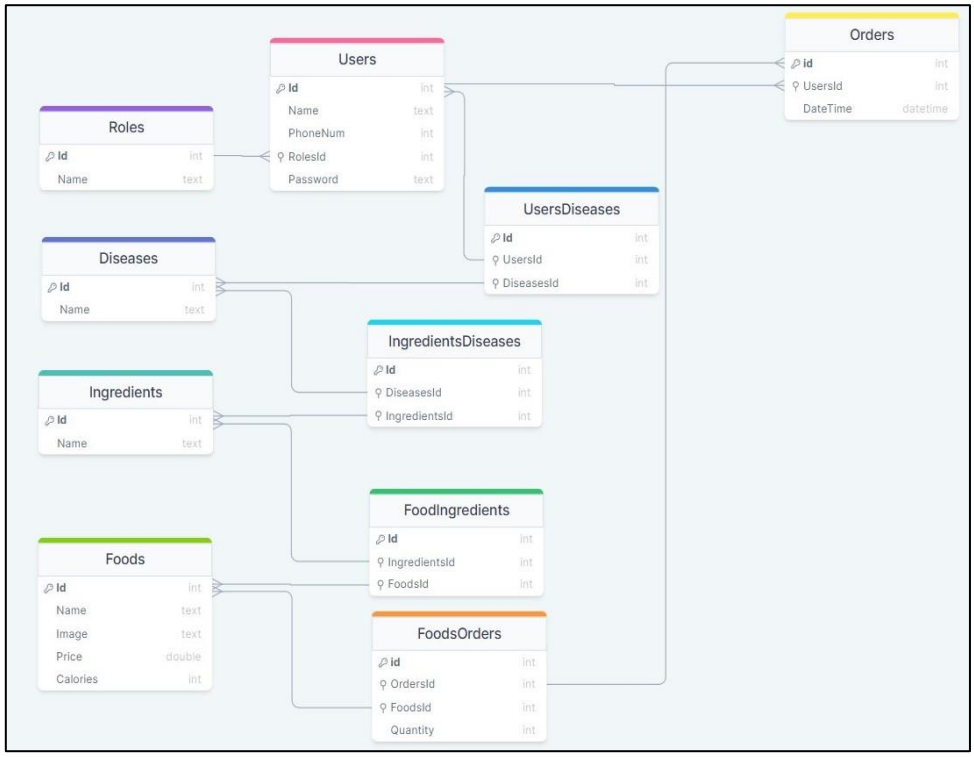

Figure 10: ER Diagram

Figure 10 shows a modification ER diagram for the Scan and Eat database:

- Users: Contains information about the restaurant's customers, such as their name, phone number, and any diseases or allergies they have.
- Diseases: Contains information about diseases and allergies that customers may have.
- Ingredients: Contains information about the ingredients used in the restaurant's food.
- IngredientsDiseases: Contains information about which ingredients are incompatible with which diseases and allergies.
- Foods: Contains information about the restaurant's food, such as its name, price, calorie content, and ingredients.
- FoodsOrders: Contains information about which foods are ordered in which orders.
- Orders: Contains information about the restaurant's orders, such as the customer who placed the order, the time the order was placed, and quantity

6.5 System Interface

This section will provide the user interface (UI) basic structure of the mobile application.

- The first page contains the logo and Username and password text field. There are two types of users which are Admin and Operator where the user enters his/her username and password to access the system.

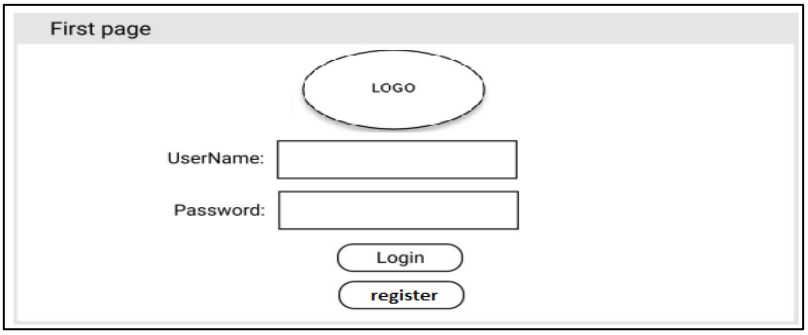

Figure 11:First page

- The home page consists of four things: First is scan, when the user logs in and wants to scan the food, they can click the first option which is scan and the camera will be open to scan the plate. The second option is a profile where user can check their information and edit it, for example, username and password and name. The third option is bills, the user can look at his old bills and their date and price. The fourth option is to log out when the user wants to sign out

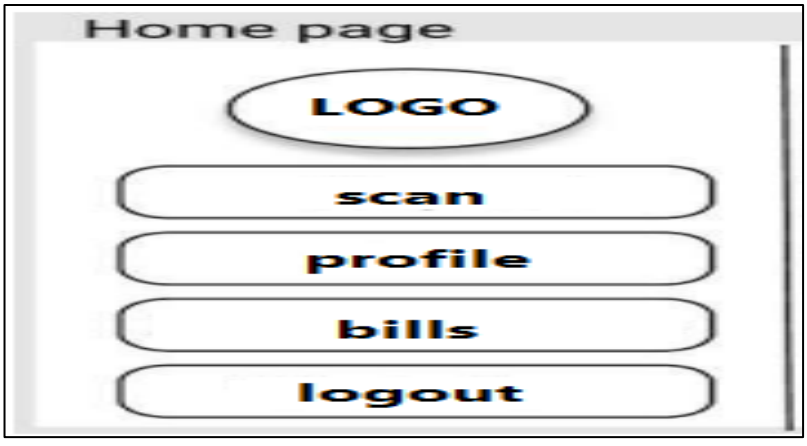

Figure 12: Home page

of the system.

- Registration page that will ask all the user's information like name, username, password, and health issues.

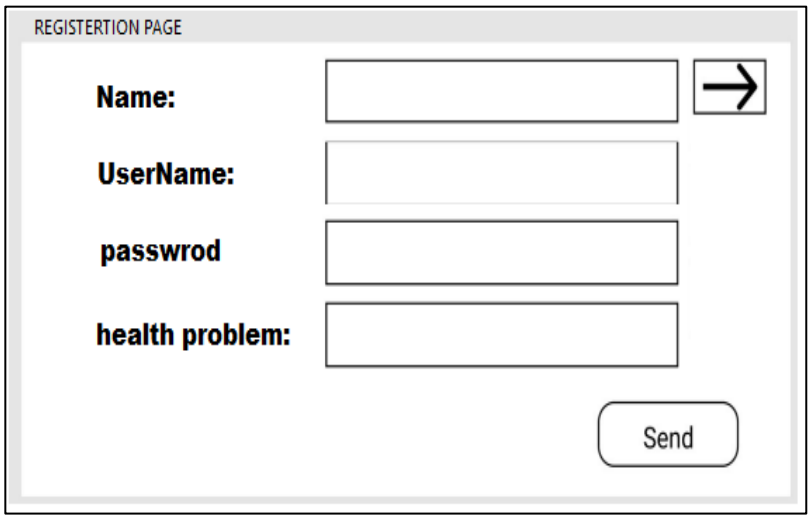

Figure 13: Registration page

- The *Admin page contains three options which are Add New Admin, Edit/ Delete User, and Edit Data. In the Add New Admin, the admin can upgrade a user to admin. In editing/deleting users is to change the user's information or remove it from the system. The last one is editing data used to change the prices of the food and add new items.

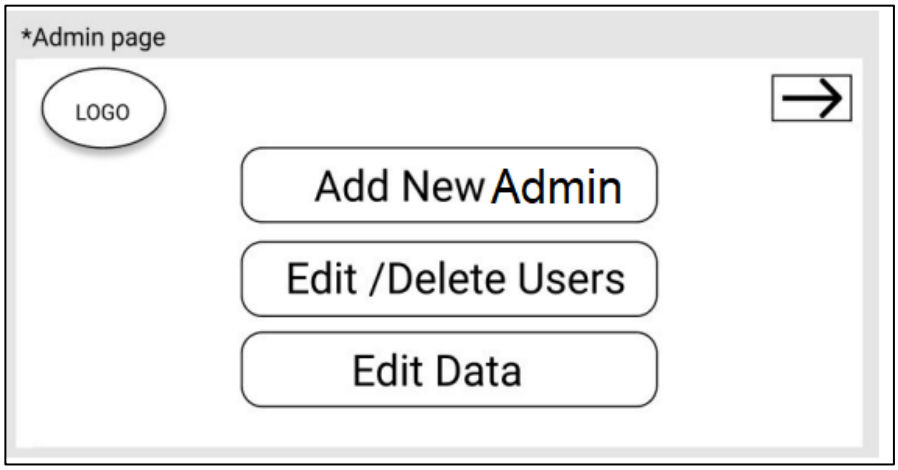

Figure 14: Admin page

7 Implementation Project Progress

This section outlines our project's implementation progress, detailing the Dataset, Model, Database, Admin Interface, and User Interface developments. Each subsection reflects our advancements in these key areas, showcasing the current state of the Scan and Eat project.

7.1 Dataset

The dataset comprises 4,710 high-resolution images, categorized for a robust training process. With 4,104 images allocated for training, 203 for validation, and 403 for testing, the dataset ensures coverage of various food items. The preprocessing step standardizes all images to a uniform size of 640x640 pixels, optimizing them for the learning algorithm. Augmentation techniques, such as flipping, rotating, and saturation adjustments, have been applied to enhance the model's ability to generalize from diverse visual representations.

Figure 15: Labeled Image sample

7.2 Model

The model we initially embarked on training is a custom model. However, due to constraints in accuracy that impacted our target of achieving a highly reliable model, coupled with time limitations for developing a mobile application and constructing the model framework, we opted to implement a pre-trained model. This pre-trained model exhibits commendable performance metrics with a mean Average Precision (mAP) of 86.7%, Precision of 81.4%, and Recall of 83.9%, underscoring its effectiveness and reliability for integration into our application.

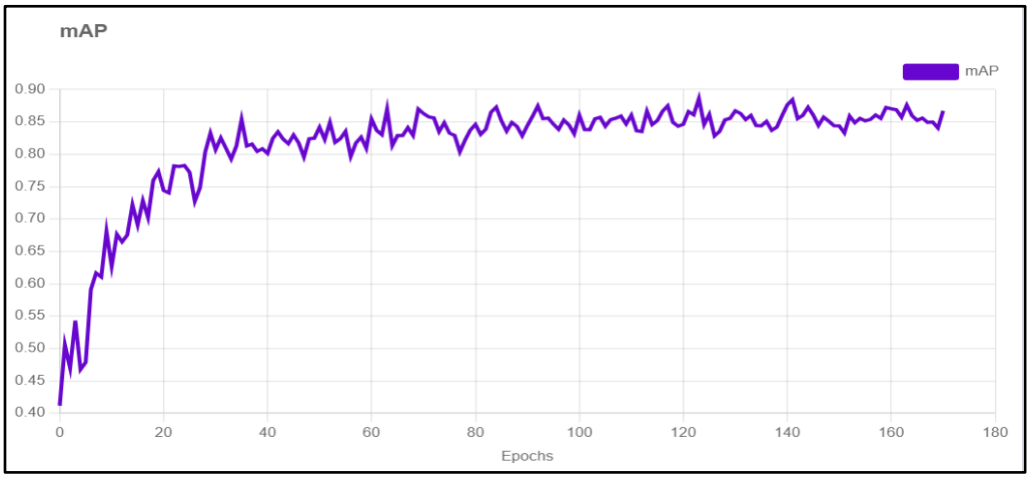

Figure 16: mAP Training Graph

Figure 17: Model Test Sample

7.3 Database

We use Firebase as a database platform instead of MySQL because Firebase is integrated well with Android Studio.

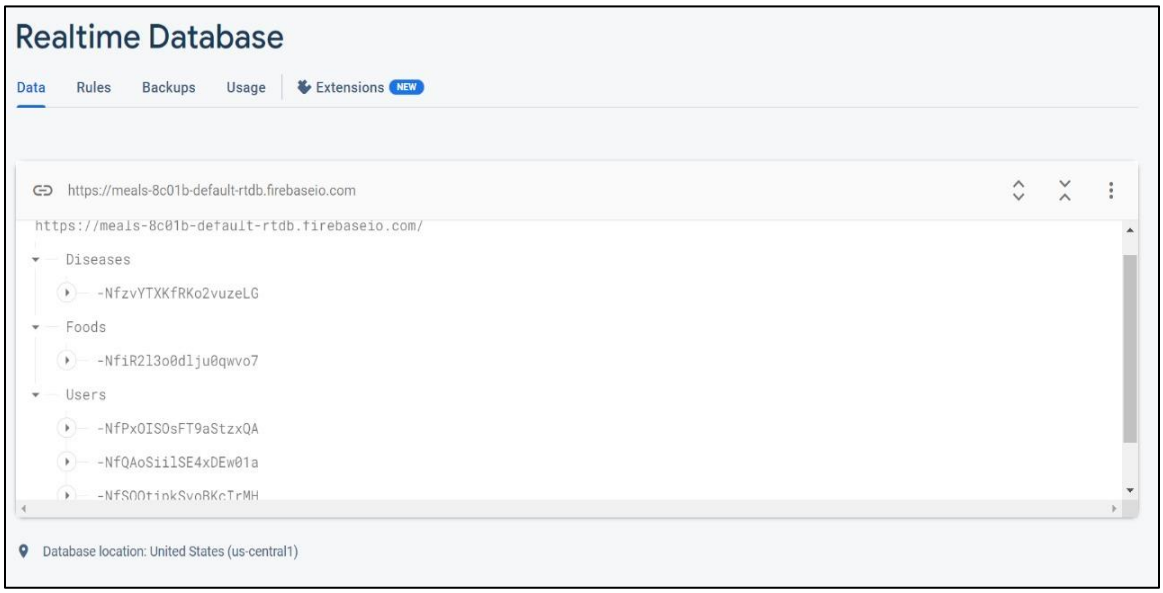

Figure 18: Database in Firebase

Figure 18 shows the current tables with information saved in it.

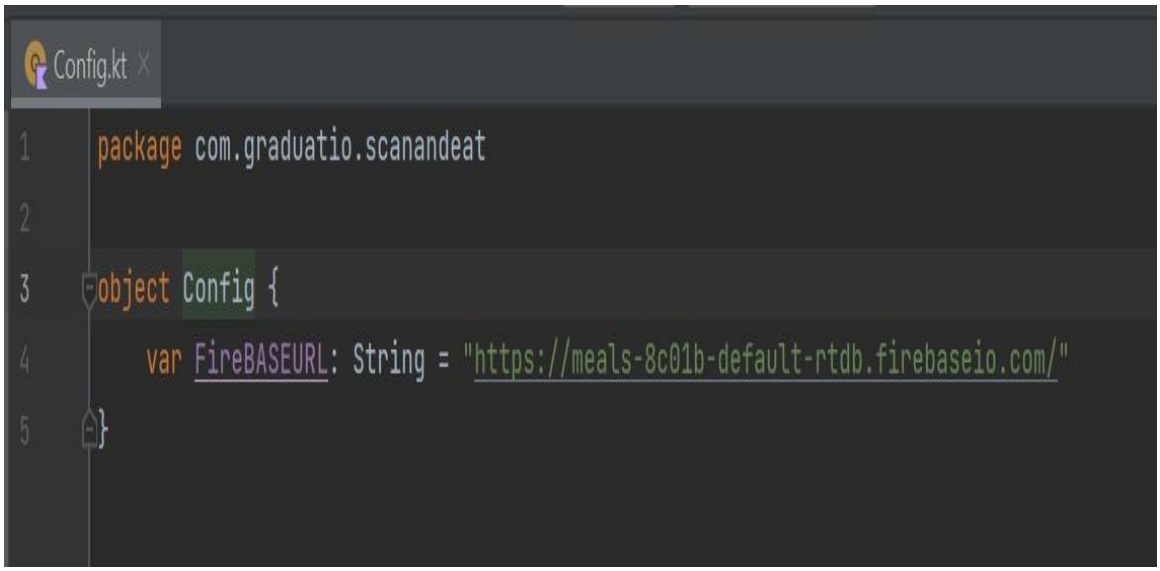

Figure 19: Database connection in Android Studio

7.4 Admin interface

This subsection shows the progress in admin pages for the mobile application.

- **Login page**

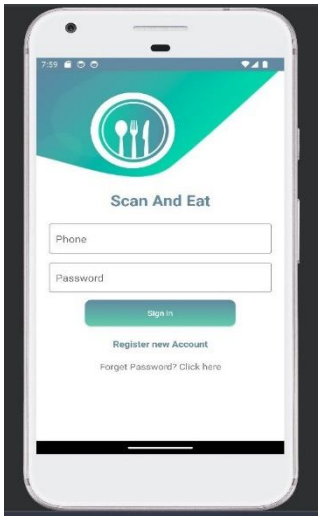

Figure 20: Login page

Figure 20 shows the login page It is the first page that will be displayed when users open the application. Users have two options either sign in or register.

- **Manage admin pages**

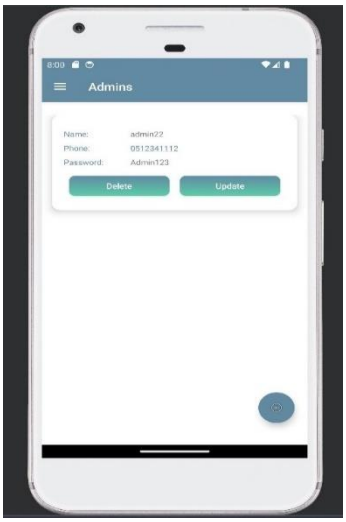

Figure 21: Admin page

Figure 21 shows a list of admins' information and buttons for updating, deleting, and adding a new admin as figures will be showing below.

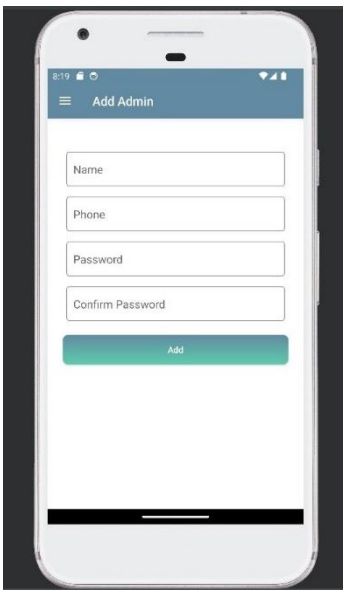

Figure 22: Add new admin page

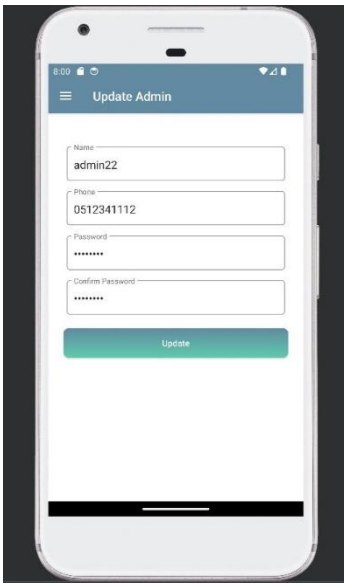

Figure 23: Update admin page

- **Manage diseases pages**

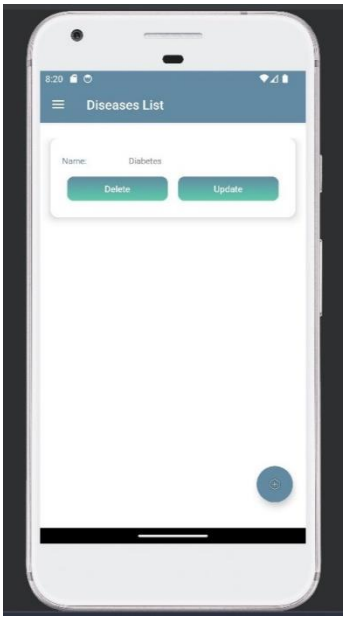

Figure 24: diseases page

Figure 24 shows a list of disease information and buttons for updating, deleting, and adding a new disease as figures will be showing below.

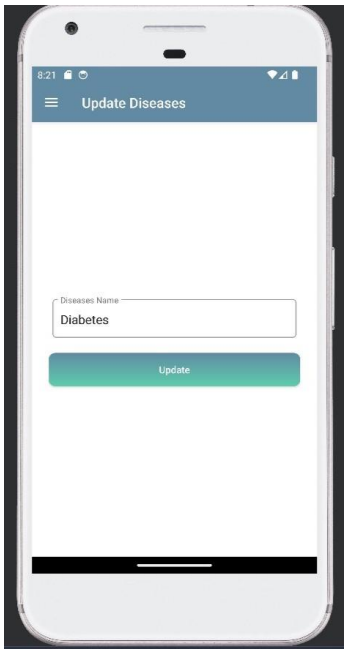

Figure 26: Update disease page

Figure 25: Add new disease page

- **Manage food pages**

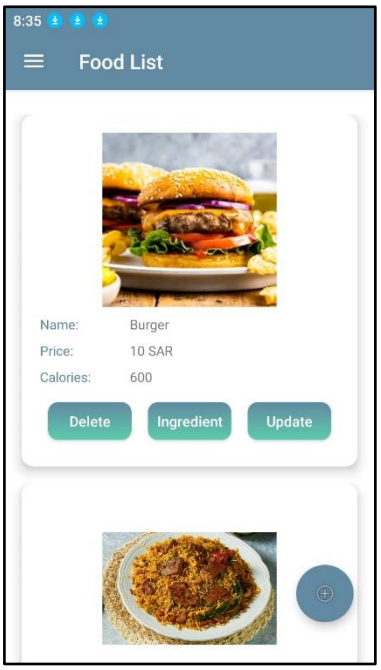

Figure 28: Food page

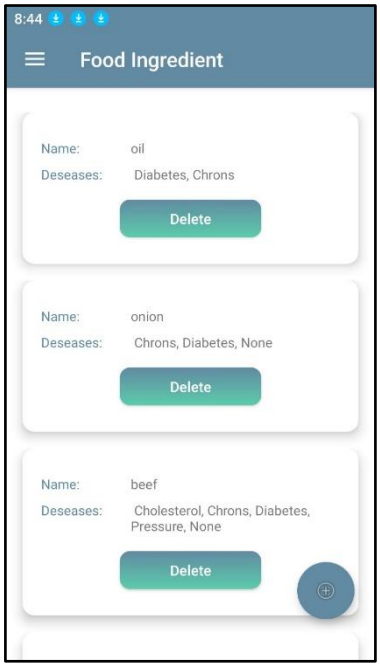

Figure 27:Food Ingredient

Figure 28 shows a list of food information and buttons for updating, deleting, add ingredient, and adding a new food as figures will be showing here.

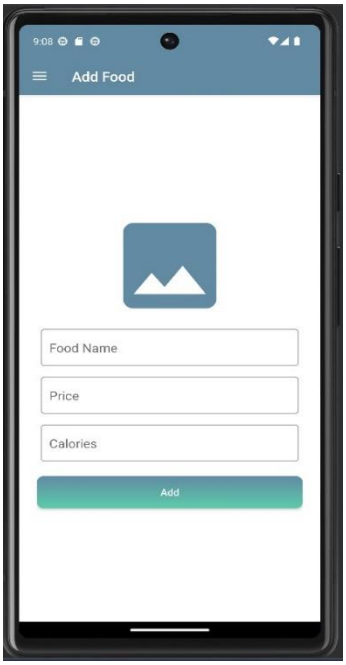

Figure 29: Add new food page

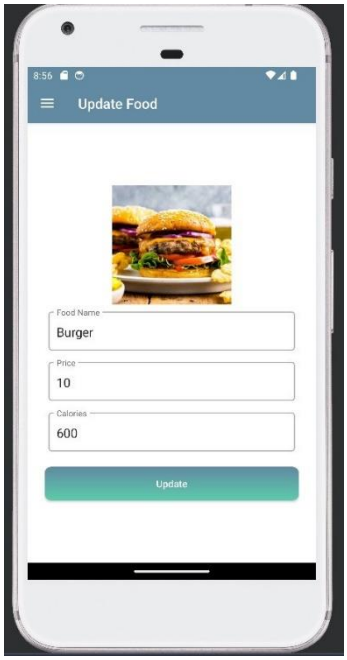

Figure 30: Update food page

- **Manage ingredients pages**

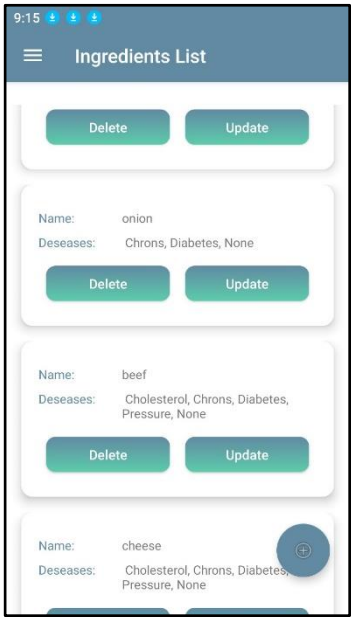

Figure 32: Ingredients page

Figure 31: Update Ingredients

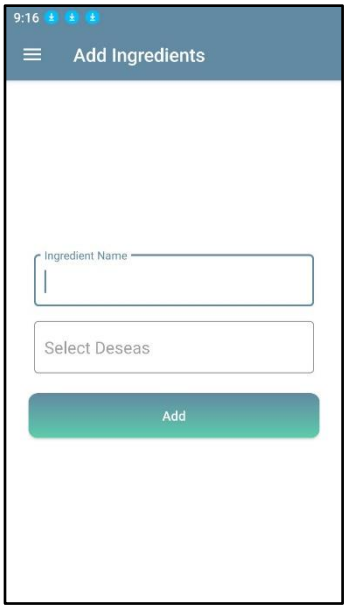

Figure 33: Add new Ingredients page

Figure 32 shows a list of Ingredients and buttons for updating, deleting, and add ingredient as figures will be showing here.

- **Manage orders pages**

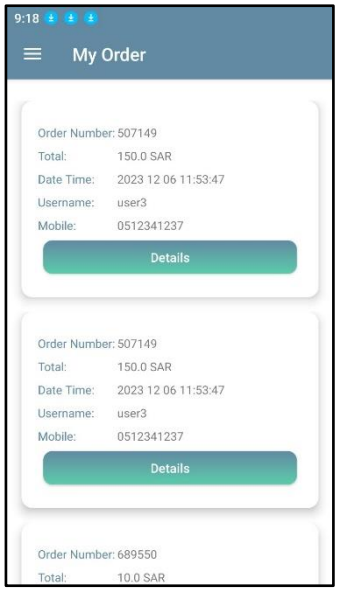

Figure 35: Orders page

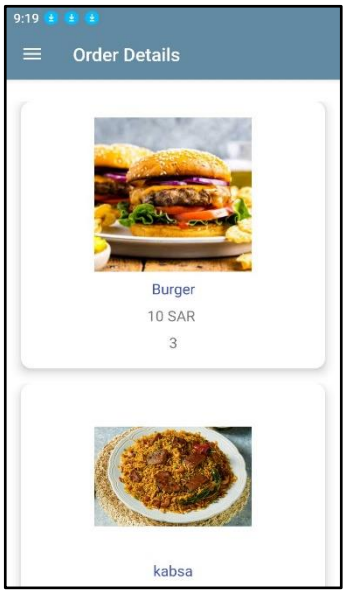

Figure 34: Orders details

Figure 35 shows a list of orders and a button for show the details as a figure shows above.

- **Other pages**

Figure 37: Update password page

Figure 36: Update profile page

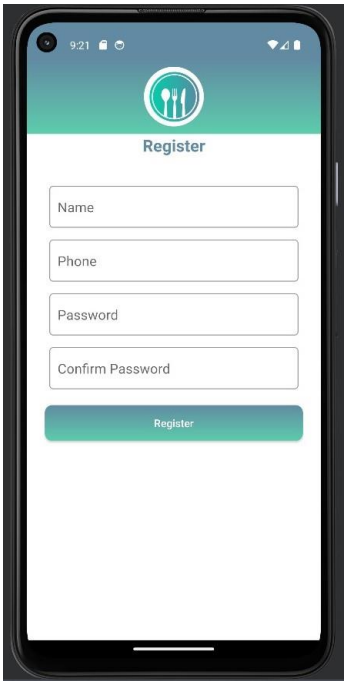

Figure 38: Register page

In Figure 36, the update password page is displayed, where the user is required to enter their old password, followed by the new password and its confirmation Additionally, in Figure 37, the update profile page is shown, where the user can modify their name and phone number. Finally, Figure 38 showcases the registration page for new users of the application. Here, they are prompted to provide their name, phone number, and password, and confirm the password.

7.5 User interface

This subsection shows the progress in admin pages for the mobile application.

- **User home page**

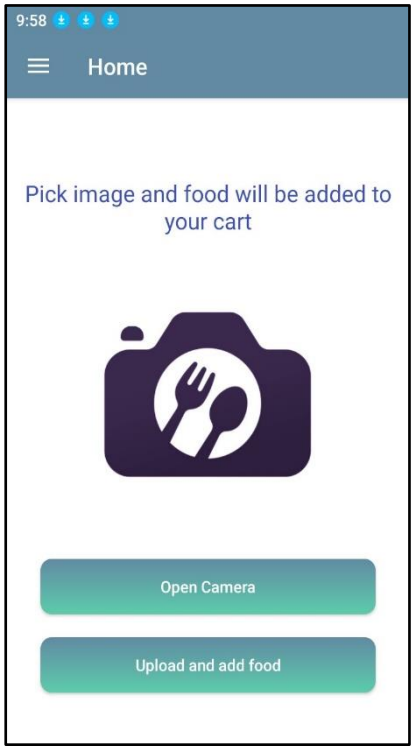

Figure 39: Home page

Figure 39 shows buttons that can be used to take images from a camera or import from the gallery.

- **Food menu pages**

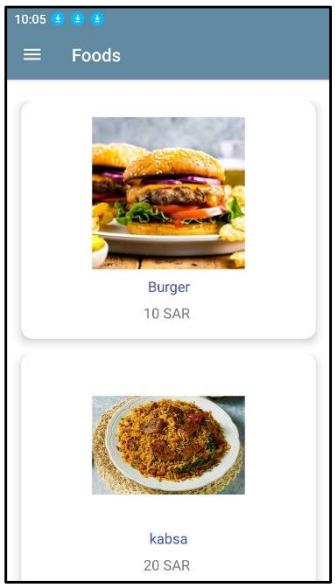

Figure 41: Menu page

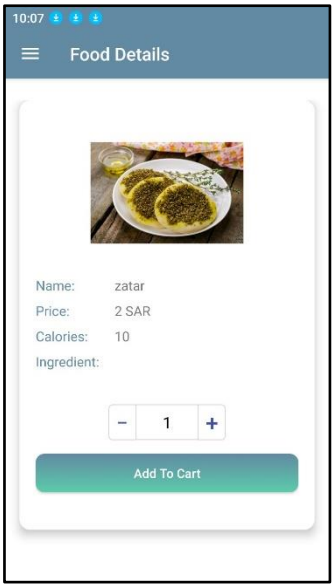

Figure 40: Selected food details

- **Orders page**

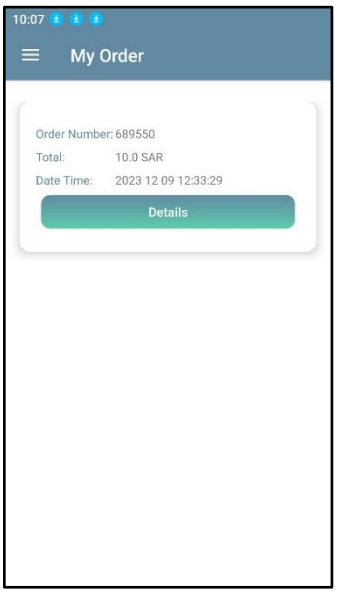

Figure 42: Orders page

Figure 42 shows a list of orders and a button that can be used to show the order details.

- **Cart pages**

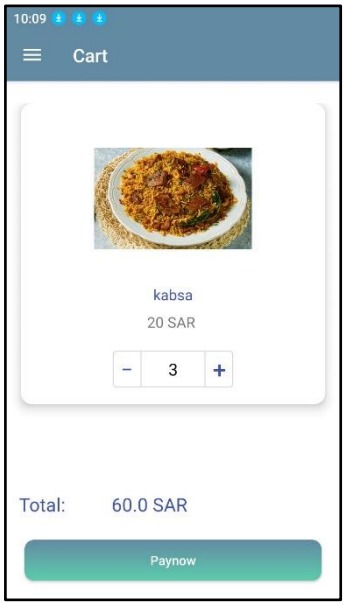

Figure 44: Cart page

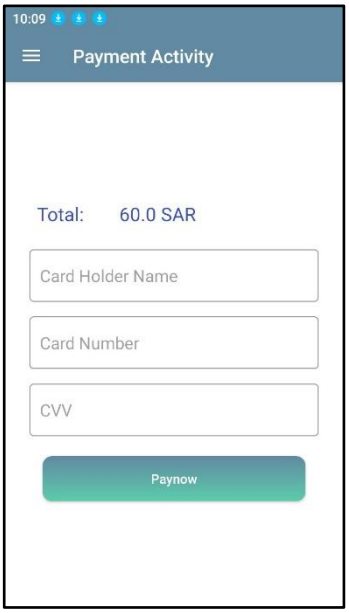

Figure 43: Payment page

- **Diseases page**

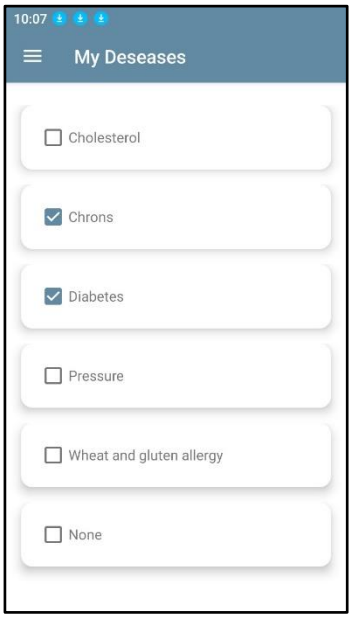

Figure 45: Diseases page

Figure 45 shows a list that enable the user to select any diseases that the user had from it.

8 Tools & techniques being used during project implementation

This section will show all tools and techniques that have been used until now in the project implementation.

- **Android Studio:** is Google's official integrated development environment (IDE), based on JetBrains' IntelliJ IDEA software and intended exclusively for Android development [15]. It will be utilized in developing our mobile application.
- **Database**: Firebase has been used to store the database. Firebase is a comprehensive mobile and web application development platform provided by Google. It offers a range of cloud-based backend services, including real-time database, authentication, hosting, and analytics, simplifying the development process [16].
- **Discord:** is a collaboration platform from Discord Inc. It provides file storage as well as chat, video, and voice calling. It was used by our team to keep organized, have conversations, arrange group meetings, and preserve all of the used materials in one place.
- **Python:** It is a programming language, interpreted, simple, object-oriented, and high-level programming language with dynamic features for web and app development [13]. We will use Python to write the code that helps detect and identify the items on the plate.
- **PyCharm:** It is a Python-specific integrated development environment (IDE) used in computer programming [14]. It will be used to build and run our Python code.

9 Conclusion and future work

In conclusion, the "Scan and Eat (SAE)" project has successfully demonstrated the effective use of deep learning and computer vision in enhancing restaurant experiences. As for future work, the project can explore integrations with wearable health devices for personalized health insights and consider global expansion to cater to diverse dietary needs. Collaborations with nutrition experts can further refine the app's dietary guidance, keeping it aligned with the latest in nutritional science, thus cementing SAE's role in the intersection of technology, dining, and health.

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