UNIVERSITI PUTRA MALAYSIA

APPOINTMENT MANAGEMENT SYSTEM: AQHEALTH

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APPOINTMENT MANAGEMENT SYSTEM: AQHEALTH

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My sincere thanks also go to all my friends, who always give me support for completing this project. I would also like to thank my friends for their valuable comments and suggestions on this project which gave me aspiration to improve this project. With all your help, I am able to solve many difficulties in order to complete this project

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ABSTRACT

Appointment management system is continuously used for healthcare organizations such as hospitals and clinics. Healthcare organizations can save time and resources by automating the appointment scheduling process, reducing the risk of double bookings, and improving the overall experience for both staff and patients. However, the absence of booking efficiency and real-time queue update in nowadays applications bring disappointments to patients who always plan and manage their time accordingly. Appointment management system (AQHealth) is designed for hospitals so that patients can schedule their appointment with the doctor they choose based on the doctor specialist. Hospital staff can reschedule patients' appointments and assign patients to their consultation rooms

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CHAPTER 1: INTRODUCTION

This chapter will briefly explain the project's background and other related components for outlining the project proposed.

1.1 Background study

Prolong time-wasting is one of the most encountered problems by patients in many hospitals globally, and it has been a long-standing issue that health care professionals have struggled to resolve. This issue is continuously discussed by health care users and family members since it contributes to their time management. Mostly they are dissatisfied with the "appointment process" and the "waiting queue" in the hospital. Nearly all hospitals use a traditional appointment system with a paper-based record for each patient. These records are then stored in a filing system that is sorted with the first name alphabet or user identification. This kind of system has a lot of flaws and needs a lot of manual jobs to write, find and store the patient's information. These manual tasks may burden the hospital staffs that are overworked and underpaid based on their work. The paper-based appointment also burdens patients to safely store their appointment cards which are easily misplaced and disrupted. Time management in hospital is important in the hospital where it provides patients satisfaction with the healthcare services provided by the hospital. Most patients complain about the time it takes between walking or driving into the hospital and being attended to by hospital staff, especially doctors which need proper handling. Those wasted time should be reduced with a proper appointment structure or system by reorganizing the current system into an advanced technological system.

However, the time issue continuously distresses patients with a long waiting time before getting a consultation with a doctor. this long waiting time is undoubtedly difficult to encounter with a hundred sick patients coming to hospitals. Healthcare facility priorities are to provide quality and satisfactory services for patients which is hard to achieve with an outrageous number of patients daily. Nevertheless, a long waiting queue could be treated by doing another useful thing while waiting for the arrival queue to meet with a doctor. Patients' concerns are not centered on a long waiting time but are more on time management to fulfill the waiting time. Patients could not go anywhere or else they will miss their turn to consult with a doctor. Queue systems nowadays lack in terms of queue information such as estimated arrival queue, queue notification, and real-time queue updates. A highly integrated system with a common device such as a mobile phone is crucial to providing this sort of information to patients.

There is a focus on the need to modify the way healthcare services are offered by adapting e-Health technologies to achieve the national vision of applying information and communication technologies (ICT) in the health sector. Making appointments with mobile phones have more benefits rather than old fashion appointment. Numerous advanced technologies and tools need to be fully utilized to ensure a quality system could be deployed and safely used by the patients and hospital staff.

1.2 Problem Statement

Crowded waiting area with patients increases the risk of infections.

Hospital is a place that should not be stayed for a long period of time because the longer you stay, the higher the risk of getting infected by a disease. Nathan R.H & Dominik A. (2018) stated that the effect of the crowded waiting area could reduce quality and impair access. Indicators of the care delivery process revealed the diminished quality and patients' capacity to receive timely care at their preferred institutions was impacted by the extent to which access was restricted. Hence, each patient may need to wait longer than they should before meeting with Doctor. Therefore, it is contrary to extremely time-sensitive healthcare services. Because of this sensitivity, the idea of time is critical in managing healthcare services (Özel et al., 2018). Other than that, since we are in the pandemic era of Covid-19, the Ministry Of Health Malaysia has created a restriction on the number of patients and hospital staff daily. This is because the infection rate of covid-19 is very high, and the mortality rate for this virus is very low. Healthcare providers highly demand an efficient appointment system nowadays to ensure the number of patients daily is within the limit being restricted.

Unsatisfied patients in a long waiting queue

An inefficient queue system increases waiting time, reducing patients' satisfaction with the healthcare services. Raja et al. (2009) observe that long wait times at outpatient clinics and consultations typically judged of low quality have also driven many patients to forego treatment or seek outpatient therapy in private hospitals. Patients cannot track the queue in real-time and have no easy access to the queue. Therefore, they are tireless in waiting for their turn and unable to leave the waiting area as they might miss their turn. Many variables could affect the waiting time, such as patients being late to the hospital, doctors not being punctual and too long consultation time. However, this problem can only be solved with the policy appointed by the hospital.

The lack of efficiency in scheduling appointment

The appointment system should be high in usability of the system. It needs to be carefully designed to ensure patients can easily book an appointment with the hospital. The system's complexity would make patients hesitate to use technologies and return to the traditional process of physically making appointments in the hospital. An appointment system should follow the 10-usability heuristic to ensure users can use the application as it is intended.

Therefore, AQHealth will provide an efficient appointment and queue system that needs to have a reliable appointment date consistent with the available doctors, real-time updates of eligible dates, a proper reminder of the appointment dates, and informative queue data.

1.3 Objective

To digitalise the appointment with high usability system

The system will provide a systematic structure of an appointment system where patients can easily book an appointment with their mobile phones. This system allows the patient to choose the date and time for an appointment based on the availability of doctors and the number of patients. Hence, the number of patients daily could be limited to a certain number with an appointment-based system.

Patients should be able to access the appointment system wherever they go and can be accessed anytime. The easiness for patients to book an appointment system is important, where it should simplify the way patients communicate with the hospital staff. Other than that, 83.72% person in the world's population owns a smartphone. Therefore, a mobile appointment system will be developed to ensure every patient can access the system with a minimum mobile configuration.

To solve patients' satisfaction with waiting time in the queue system

The queue system provided by the hospital is absent in information such as estimated waiting time and the queue number before the turn. This system will provide those features to ensure the satisfaction of patients and give flexibility for patients to do something else rather than just waiting for their arrival queue. This system provides user-friendly informative data about the queue system, such as room number, estimated waiting time, and notification when the queue has arrived.

1.4 Scope

The project’s scope is to develop a mobile and web-based application to manage a hospital's appointment and queue system. The mobile application will be the platform for patients to make appointments and review the queue. A web-based application is for the admin to control a hospital management system.

User Scope

There are two main users for this system: patients and system admin. Patients are eligible to make appointments and check the queue in the system. System admins can filter patient appointments and sort the patient with their specialist Doctor. Other than that, the system admin may delete or edit the appointment and sort the patient with the appointment to the queue to meet the Doctor.

System Scope

The system scope for this project is as follows:

1. This project focuses on developing the front-end and back-end of mobile and web-based applications.
2. The system should focus on enabling patients to make online appointments.
3. The system should ease the admin to schedule the queue of patients who make appointments.
4. The system should enable patients to see informative data about the progress queue.

CHAPTER 2: LITERATURE REVIEW

This chapter will discuss appointment management system characteristics, research gaps, methods, and comparison of related work.

2.1 Introduction

This chapter will describe the research and study on online appointment management systems and their related existing system in detail to assist readers in their understanding of the project. Besides, this chapter will also discuss more about the queue system in more details. Some related works will also be presented to the reader to share the benefits and drawback of the existence system to provide a clear view of appointment system towards readers. After conducting a lot of research by reviewing the articles, journal and application from past researchers and developer, hence a better solution to improve current appointment system will be discuss in this chapter.

2.2 Online Appointment

Online appointments are common nowadays with a mass update on technologies which change the perspective of building applications into more possible with a minimum requirement device. An online appointment system is not only used by healthcare services, but other business sector also uses this to set an appointment with their client. This approach is more favorable due to its simplicity, practicality and functionality, which work as a booking process before getting the services.

Moreover, the appointment system can be easily accessed from mobile phones statistic from “bankmycell” shows that in 2022, the global smartphone user population will be 6.648 billion, representing 83.72 per cent of the world's population. From the statistics, we know that most people can get access to mobile applications with their own smartphones.

The advantage of having an appointment system is the system provides a convenient way to book an appointment with a lot of informative data about the times, dates and doctor availability which is a huge difference experience from making a physical appointment.

2.3 Queue Algorithm

The normal queuing process in the outpatient department is a first-In, first-out (FIFO) order. FIFO is the most basic queue process, which is similar to the behavior of people standing in a line or queue where the person leaves the queue in the order they arrive. But FIFO is not the best order to assist patients in a hospital because some patients have more urgent and critical injuries than others. As patients check in at the hospital, the staff could assign the patients to a priority integer if there is a need. When a doctor is available to see a patient, the patient with the highest priority is seen first. That is, regardless of the order in which the elements are added/enqueued, when they are removed/dequeued, the one with the lowest priority number comes out first, followed by the next-smallest, and so on, with the highest priority item coming out last. Priority ties are broken by first dequeuing patients with the same priority in the order they were enqueued.

Building a priority queue using a heap is another alternative queue technique that can be used. This allows us to generate a priority queue while still maintaining FIFO orders. A heap is a type of binary tree that preserves the characteristic that the value stored at every node is either less than or equal to the value stored at any of its child nodes. This trait distinguishes a heap from other types of binary trees.

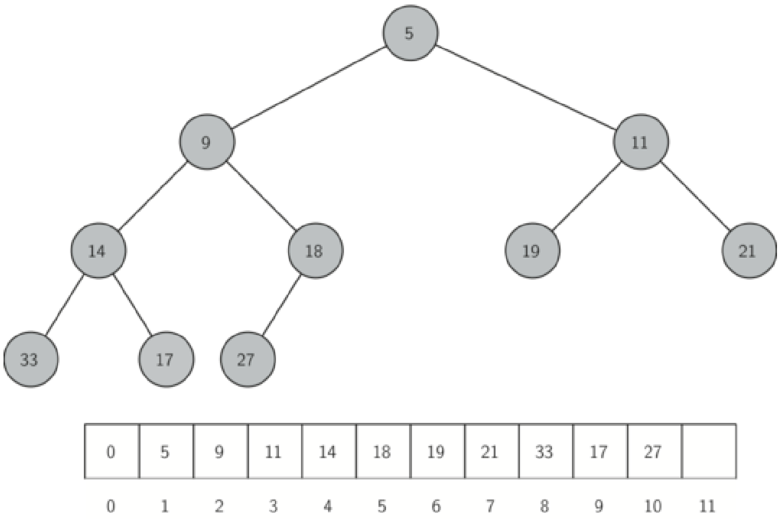


Figure 2.1 binary tree

The method that will be used to store queue numbers in a heap relies on maintaining the order property. The order heap property is as figure 2.1. To insert a new queue number into a heap by simply appending the number to the end of the list. However, this method will likely violate the property of heap structure. The two numbers can be swapped if the newly added number is less than its parent.

When a number is percolated up, the heap property between the newly added number and its parent is restored. Additionally, we are preserving the heap property for any siblings. Obviously, if the newly added number is extremely small, moving it to a higher level may be necessary. In fact, we might have to continue trading until we reach the summit of the tree. Figure 2.2 shows the new node being percolated into far up tree. We can determine the parent of any node using division by integers. The parent of the current node can be determined by dividing the current node's index by two.

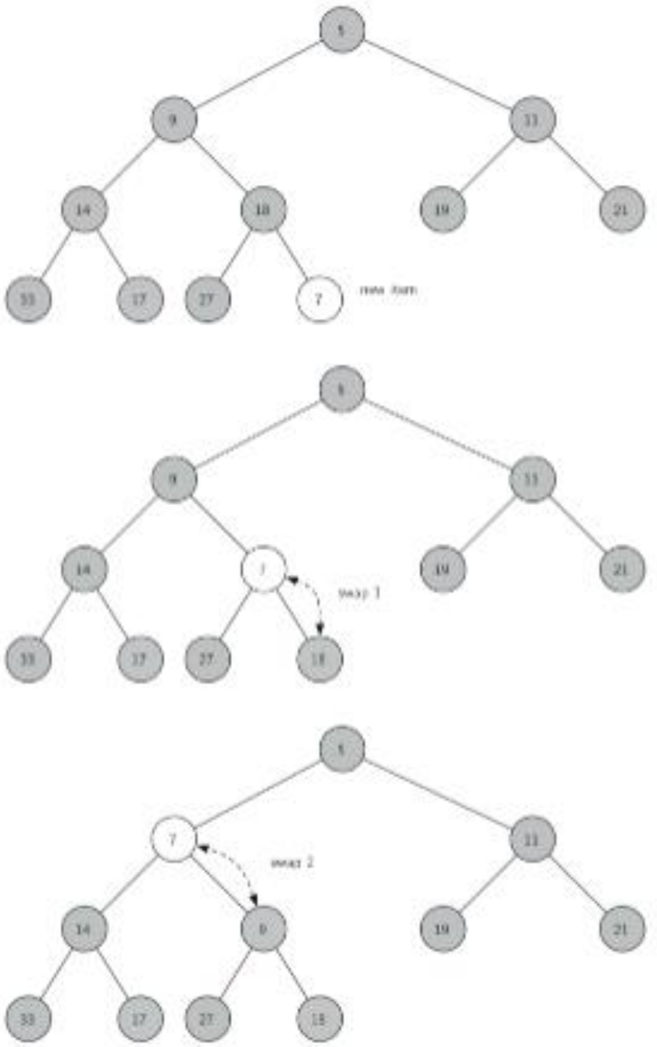


Figure 2.2 percolate the new node.

After dequeuing or deleting a node, we need to replace the root with a minimum infinite node by traversing up the smallest node less than the root to fix the violated heap property. We may repeat the procedure of swapping a node and its children until the node is swapped into a position on the tree where it is already less than both of its children.

Other than that, there is another queue algorithm that could benefit this project which is a circular queue. Circular queues offer a quick and clean way to store FIFO data with maximum size utilization. The Circular Queue is similar to a Linear Queue in that it adheres to the FIFO (First In First Out) principle, but it differs in that the last place is connected to the first position in order to replicate a circle.

2.4 Framework Technologies

In programming, a framework is a tool that offers pre-made elements or customized solutions to speed up development. Although a framework may contain a library, it is characterized by the inversion of control concept (IoC). In conventional programming, reusable code is accessed by a call from the custom code to the library. When required, the framework uses IoC to call on specialized code. There are a lot of native frameworks nowadays that provide a layer of reusable components, such as React Native, Flutter and Xamarin.

I will discuss the benefits of using the flutter framework for mobile developments.

Figure 2.3 Flutter framework

Google's Flutter is a free and open-source UI framework for building native mobile applications. Flutter, which was introduced in 2017, enables programmers to create mobile applications using a single codebase with Dart programming language. Building apps for both iOS and Android is now easier and quicker, thanks to these capabilities. Flutter offers a wide range of benefits for developers and business folks. Flutter offers a single codebase feature to enable developers to write once and deploy on multiple platforms such as Android and IOS. The cost of creating a multi-platform application will be cut significantly, and the time to market the application will be faster.

2.5 Existing System

There is three existing application that has been chosen to be compared with the AQHealth application. Those existing applications are chosen based on features that suit the project goals.

2.4.1 Qmed.Asia

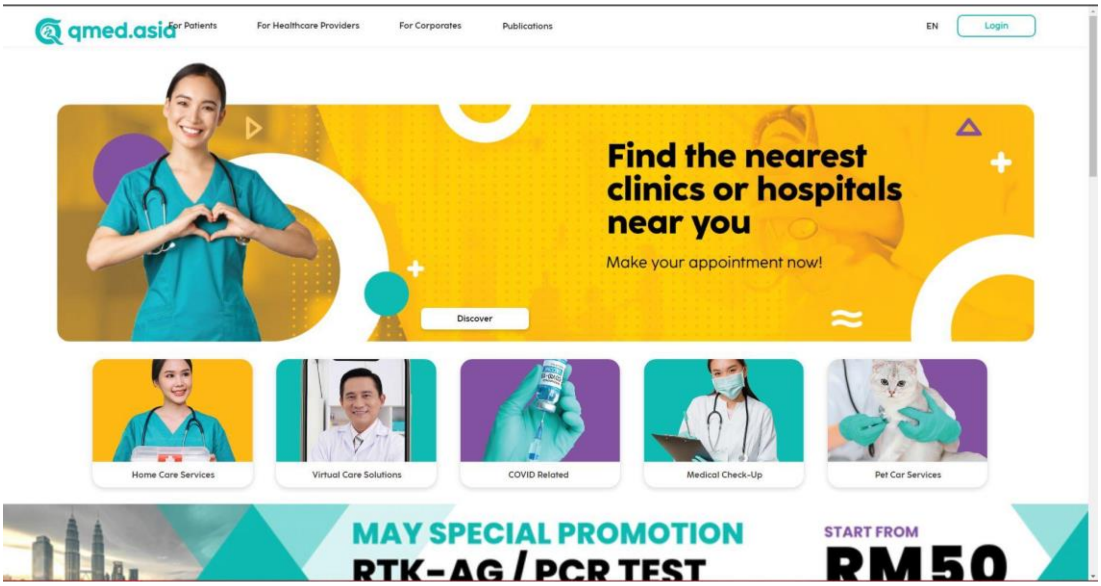


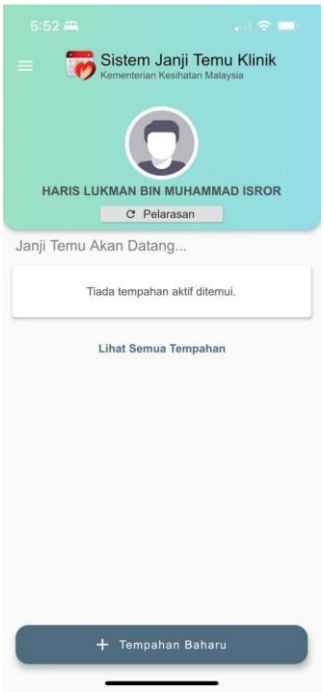
Figure 2.4.1 qmed.Asia front page

Qmed.Asia is a healthcare technology firm created in 2018 by a group of doctors and engineers to help public and private healthcare providers with their digital health transformations. Their primary goal was to solve the issue of long queues at hospitals. They have collaborated with government and private health care providers to expand the purpose of their system. This system only applies to a web application for patient use and a mobile application for healthcare staff.

There are two approaches they use to solve the long queues in hospitals. Firstly is an online appointment system that enables patients to make appointments with doctors who have engaged with them. Patients will be able to access the Doctor's roster and availability, and the Doctor will have a platform to contact the patient. This appointment system also includes online banking or e-payment, enabling the patient to pay directly after the consultation. However, these features are only applicable to private healthcare services. The government healthcare sector provides a list of available clinics that can be accessed for making appointments. Patients can select the wanted clinics with the available dates and times for making an appointment. All dates and times in this system are in real-time, which will be updated continuously when patients book an appointment.

The next approach is a mobile queue system. This queue system can only be accessed by the hospital staff or the admin of the system. They provide a computerised live queue system that specifies the order of patients' queues at the healthcare service providers’ facilities by using priority-based sorting algorithms. This system will give priority to patients with pre-arranged appointments and special care patients such as wheelchair-bound and medical emergencies. The admin has control to alter the queue at their own discretion.

2.4.2 government



HARIS LUKMAN BIN MUHAMMAD ISROR

Janji Temu Akan Datang...

Tiada tempahan aktif ditemui.

Figure 2.2 MyGovernment user profile

government is a collaborative initiative between MAMPU and the Ministry of Health Malaysia (MOH) through the Family Health Development Division and the Dental Health Program. This endeavour is in line with the Ministry of Health Malaysia’s new offer, which includes the digitisation of health and dentistry services in the aftermath of the COVID-19 pandemic. This system provides Malaysian citizens and non-citizens to make online appointments with government dental and health clinics.

This system suggests patients register an account with their web application "MyGovernment Portal" as a one-time activity, and patients can proceed with booking appointments in the mobile application. Patients can make an appointment for themselves and their family members, including their children, spouse, and both parents. This appointment system provides real-time dates and times, a list of available clinics, and appointment history.

2.4.3 Columbia Asia

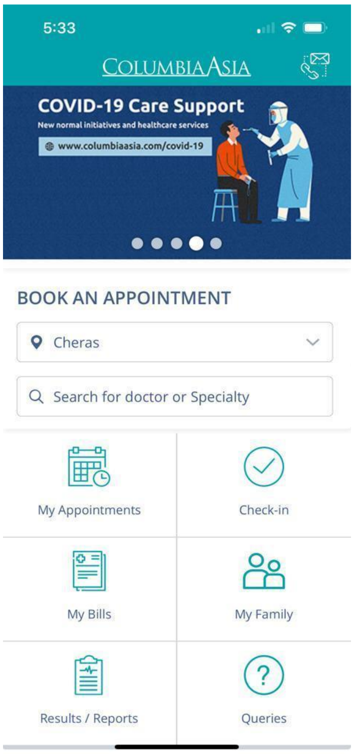


Figure 2.3 Columbia Asia user interface

Columbia Asia is a private healthcare organisation based in Malaysia that was founded in 1996. In 1997, it opened its first hospital in Sarawak, Malaysia. Columbia Asia now has 19 medical centres in Asia, 13 of which are in Malaysia. This system provides features for outpatient and inpatient. Features that are available for outpatients and inpatients are making online appointments and adding a family member as a dependent. However, there are external features such as bill information, ward check-in and result or report for any kind of consultation. Patients have the flexibility to choose a hospital location that is under their organisation.

The system is highly usability where it is easy to learn and contains most of the 10-usability heuristic. The appointment system for this system is centered on the availability of doctors and specialties where both need to be available as pre-requisite for patients to make an appointment. Patients have the flexibility to cancel the appointment for suggested reasons. Patients can also track their history appointment with this system. The system will generate a notification once the patient book and cancel the appointment.

Comparison matrix

A comparison matrix is made to compare AQHealth with the existed application. The features that are being compared are based on the available and new features between existed applications.

Make an online appointment: this feature will ensure patients can make an online appointment with the hospital. This feature is the first step of the consultation process where patients need to choose which healthcare department they want to access.

System UI and UX: this feature ensures the system's usability. The appointment management system needs to be easily configured by the patients. Patients should be able to understand all the features in the application for them to use in making an appointment with the hospital.

View appointment history: the appointment history is for patients to view their previous appointment, store previous appointment information and keep track of future appointments.

Appointment reminder: This reminder feature is created to ensure patients will not miss the appointment schedule. This application will generate a reminder notification once the appointment is within 24 hours.

Queue scheduling: this feature is developed for the admin to reschedule the queue for any patients with extra care or in emergency needs by prioritising the queue. The previous queue will be moved from one spot to the back to fill with priority patients.

Display queue information and status: This feature gives access to patients on the queue status, which they can see a number of patients queueing before them. They could also see the expected time for their queue to arrive.

Comparison features between MyGovernment, Qmed.Asia, Columbia Asia and AQHealth.

Features	government	Qmed.Asia	Columbia Asia	AQHealth
Make online appointment	✓	✓	✓	✓
View appointment history	✓	x	✓	✓
Appointment reminder	x	x	✓	✓
Queue scheduling	x	✓	x	✓
Display queue info and status for patients	x	x	x	✓

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter will explain about the methodology used.

3.2 Project Methodology

The methodology that will be used to develop the project is Rapid Application Development (RAD), which is a form of agile software development methodology. RAD has been chosen for many beneficial reasons and its compatibility with this type of project. It allows the project to focus on the system's design with the iterative prototyping cycle, which includes prototype, testing, and refining. RAD gives the flexibility to change or adjust the requirement in the prototype phase until it satisfies the project goals. A RAD technique is significantly less risky than a traditional plan-based strategy because of its flexibility and adaptation to new inputs. With an early prototype, detecting any major project issues is quite straightforward. As a result, RAD weeds out possible issues early in the life cycle, making them less expensive and easier to resolve during development.

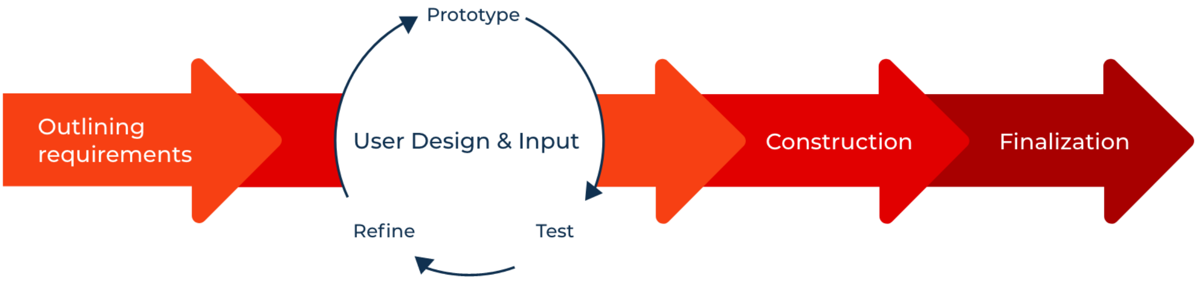


Figure 3.1 Rapid Application Development (RAD) diagram

The stage of development in RAD is as follows:

Requirement Planning

At first, requirements will be gathered through an online survey and interview with the stakeholders, who are patients and hospital staff. Then, the requirement will be analysed and specified to meet the project goals. The requirement in this phase is flexible for changes until the next phase. The outcome of this phase is Software Requirement Documentation.

User Design

In this phase, the initial prototype for the project will be built. After that, the prototype will be tested with usability testing by the stakeholders to get feedback on the prototype. Then, the prototype will be refined based on the feedback. This process cycle will iterate at least three times until a true final design is approved. The outcome of this phase is high-fidelity prototype and Software Design Documentation.

Construction

This is the phase where the project will be implemented based on the approved prototype through coding and testing. The testing process will include black-box testing and white-box testing. Stakeholders will participate in this phase to provide feedback as features get implemented. The outcome of this phase is a working application and Software Testing Plan.

Cutover

This is the final phase of development, where the finishing touches for the application in the form of user acceptance testing are allocated. The patients and hospital staff will test the application to determine whether it can be accepted or not. The outcome of this phase is an updated Software Testing Plan.

CHAPTER 4: SYSTEM ANALYSIS & DESIGN

4.1 Overview

System analysis is the process for gathering requirements, analyzing requirements, and planning the system of subsequent design. The Software Development Life Cycle models that will be followed in this project is Agile Model. In Agile Model, it separates the products into cycles and delivers a working product very quickly. Therefore, they will be continuing change in requirement and designing phase to cater the customer requirement. This chapter will explain a high-level requirement and design of the system.

4.2 System analysis

The first step of SDLC Model is system analysis, which gathering the requirement from the customer. Then, the requirement will be analyse to ensure all functionality and non-functionality could be documented as Software Requirement Specification (SRS) as a guideline before designing the system.

4.2.1 Functional Requirement

The functional requirement of this system is based on the surveys and user that have experienced in the appointment system. After that, the requirement is filtered and displayed in a use case diagram to identify and organize the requirement of the system. Below shows the use case diagram of AQHealth system.

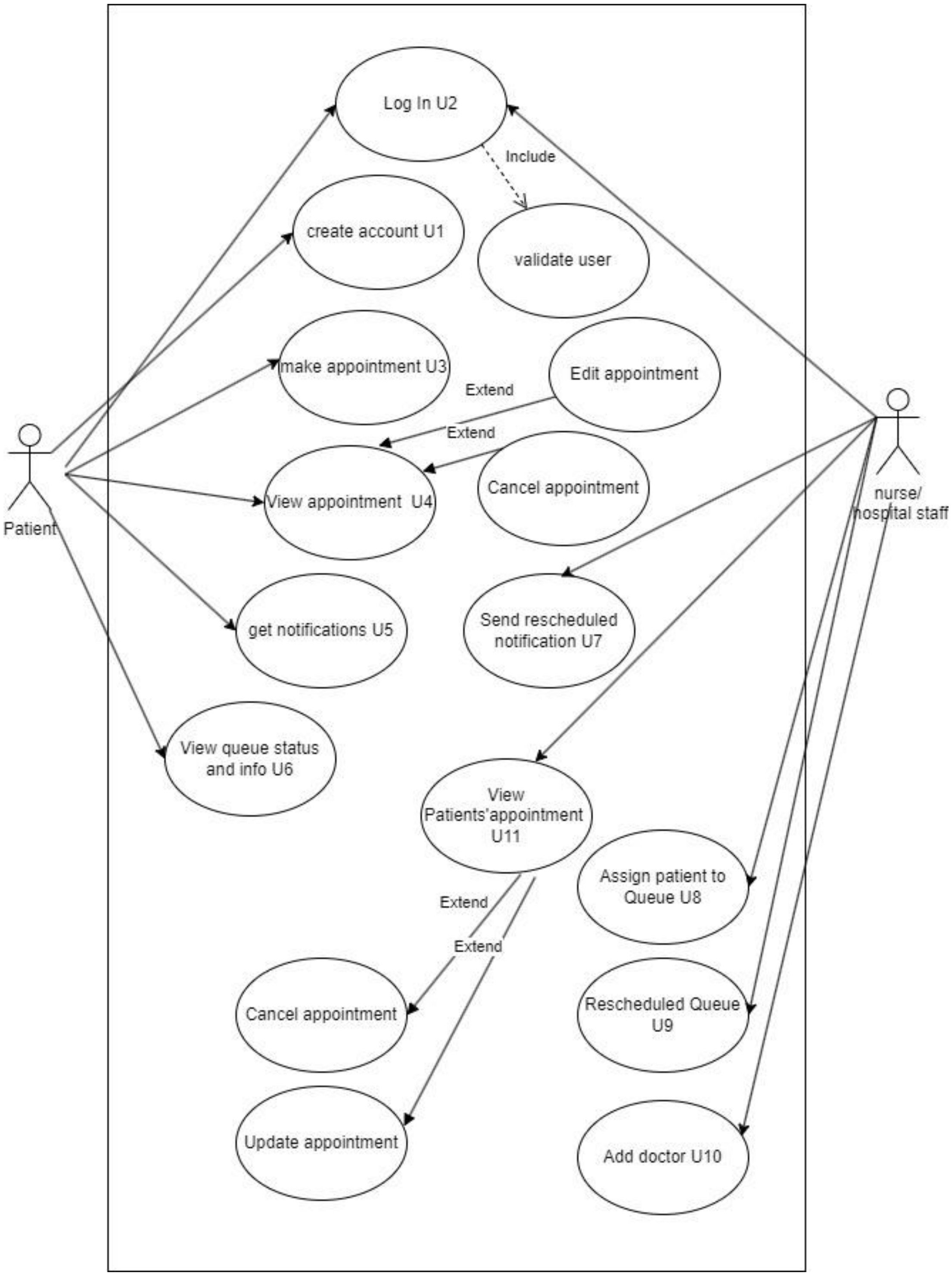


Figure 1.0 Use Case AQHealth

Based on the figure 1.0 there are several use cases that being created to fulfill customer appointment system for medical checkup in hospital. This use case will be explained in detail in use case description.

4.2.2 Use Case Description

Identifier	Use cases	Description of use cases
U1	Create account	Patients need to create an account first before gaining access to the application.
U2	Log in	Patients and nurse or hospital staff can login into the application. Patients need to log in with the mobile application while hospital staff or nurse will log in from the web application.
U3	Make appointment	Patients can make appointments through application by selecting a specialist concerned then selecting doctor, time, and date.
U4	View appointment	Patients can view their past and incoming appointments with the details such as time, date, and doctor chosen. Patient can also edit and cancel their appointments.
U5	Get notifications	Patients will receive notifications if nurse or hospital staff reschedule the appointment date and time.
U6	View queue status and info	Patients will see their queue status once a nurse or hospital staff assigns the room for the patient.
U7	Send notifications	Nurse or hospital staff can send a notification once he/she reschedules a patient appointment.
U8	Assign patient to Queue	Nurse or hospital staff who handle the web system will assign the check-in patient to their consultation room.
U9	Rescheduled queue	Nurse or hospital staff who handle the web system could reschedule the queue of patience based on their priority.
U10	Add doctor	Nurse or hospital staff can add a list of doctors who work in the hospital.

U11	View Patients' appointment	Nurse or hospital staff can view, edit and delete all patients' appointment

4.2.3 Non-Functional Requirement

Non-functional requirements or NFRs are a set of specifications that describe the system's operational capabilities and constraints and attempt to improve its functionality. These are basically the requirements that outline how well the system will operate.

4.2.3.1 Performance Requirements

The system shall be run on mobile and web server. The system shall take initial load time depending on internet connection strength which also depends on the media from which the system is run. The system shall depend upon hardware components of the client/customer. The landing page supporting 1000 users per hour must provide 6 seconds or less response time in a chrome desktop browser, including the rendering of text and images and over a Lan connection.

4.2.3.2 Security Requirements

The system shall provide AES encryption for all users' passwords. The system shall be accessed by users that have been authorized by the system only. The system shall provide an error message to users and store it in the error logs.

4.3 System Design

4.3.1 Sequence Diagram

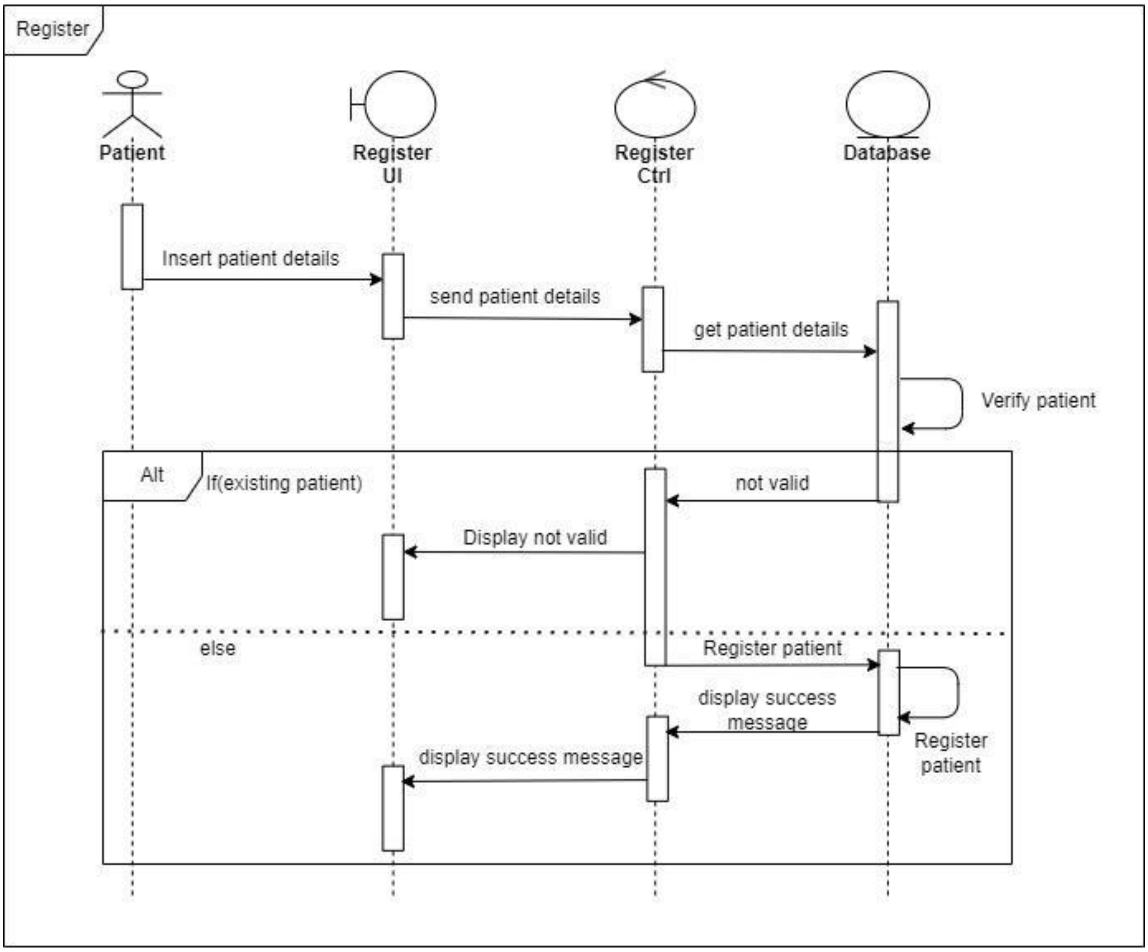
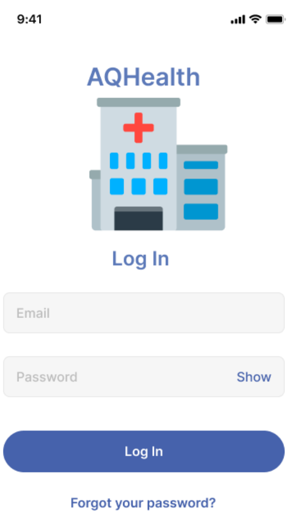


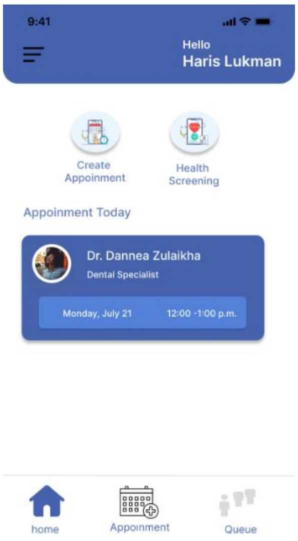
Figure 3 Sequence Diagram: Register

Figure 3 shows the sequence diagram of Create Account use case. Other sequence diagrams are shown in **Appendix A** and **Appendix B.**

This diagram explained the flow when patient insert their details information that is required. This operation needs to be completed by patient before gain access to the system. This operation is for determine the validity of patient to ensure no duplication of user and save the legit user into firebase database. The user email must be different from other user to ensure it validity. If patient key in the same email address therefore the system will recognize the patient as the same user.

4.3.2 User Interface Design



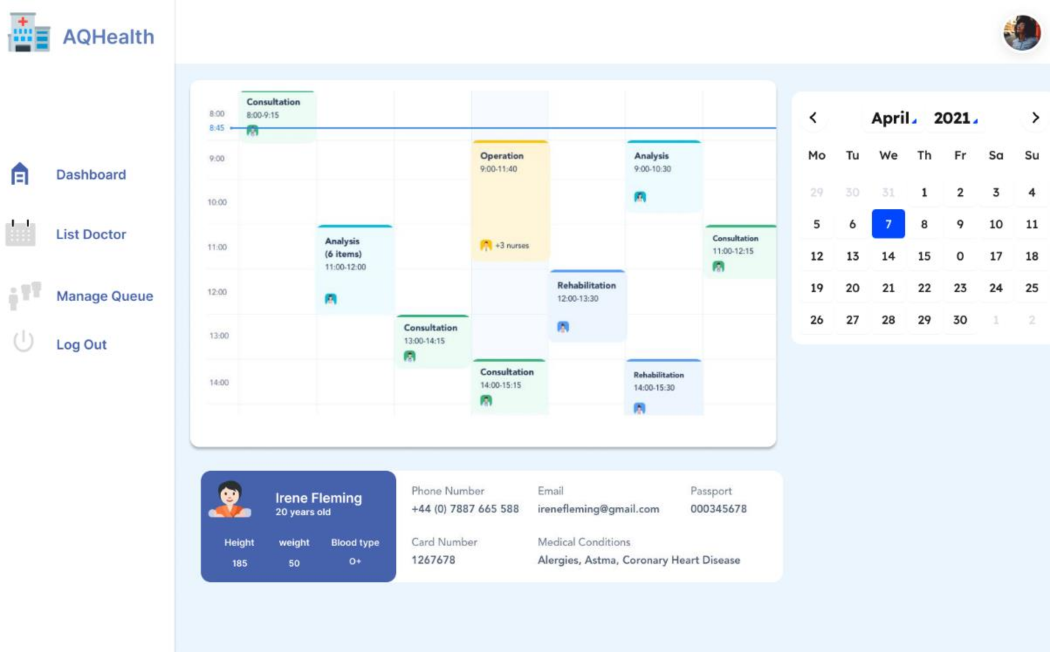


Hello
Haris Lukman

Dr. Dannea Zulaikha
Dental Specialist
Monday, July 21 12:00 -1:00 p.m.

Figure 4.1 Login Page

Figure 4.2 Home Page



Irene Fleming
20 years old

Height: 185
weight: 50
Blood type: O+

Phone Number: +44 (0) 7887 665 588
Email: ireneflemıng@gmail.com
Passport: 000345678
Card Number: 1267678
Medical Conditions: Alergies, Astma, Coronary Heart Disease

Figure 4.3 Dashboard Page

Figure 4.1, 4.2, and 4.3 shows the user interface design for login, home, and dashboard page. Other user interface design is shown in **Appendix B.**

4.3.4 Architecture Design

The system architectural pattern selected is Model-View-View Model (MVVM) for building both mobile and Web system. MVVM aids in the organisation of code and the division of programs into modules, making development, updating, and reusing code easier and faster. This design pattern is useful for developing an application with flutter framework and a firebase back-end. The separation of code in MVVM is divided into View, ViewModel and Model:

- **View**

  collection of visible elements, which also receives user input. This includes user interfaces (UI), animations and text. The content of View is not interacted with directly to change what is presented.

- **ViewModel**

  located between the View and Model layers. This is where the controls for interacting with View are housed, while binding is used to connect the UI elements in View to the controls in ViewModel.

- **Model**

  houses the logic for the program, which is retrieved by the ViewModel upon its own receipt of input from the user through View.

There are several advantages when using this MVVM architecture.

Maintainability

- **Separation of concern**

  Separation between the different part of component of source code brings a level of structure and uniformity to the code. The system will be easy to maintain where the components is independent from each other.

- **Code reuse**

  It allows the use of reuse between different layers of codes. The idea of separation makes the code useful for other part of function and with the help of ViewModel that are strongly tied to something in the view Layer of the system.

Testing

- **Ease of testing**

  MVVM should break the coupling between the application logic and the UI, making testing easier. All testing should not be done through the UI, making tests faster and easier to set up and run.

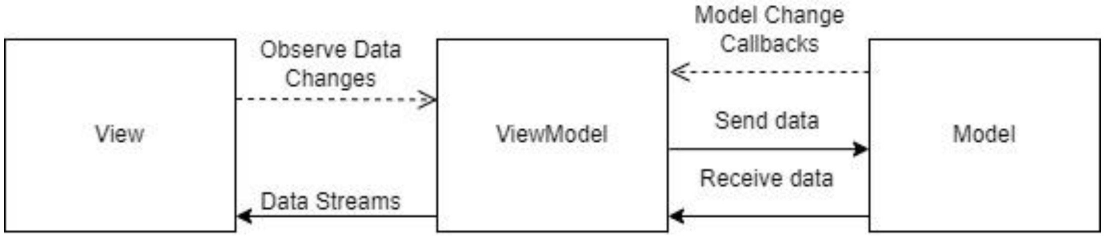


Figure 4.1 MVVM Design Pattern

Based on the diagram on figure 4.1 it shows that there are three layers which consist of View, ViewModel, and Model. These layers will interact to retrieve and send data in the system.

Other architectural design details will be explained in **Appendix B.**

4.3.5 Database Design

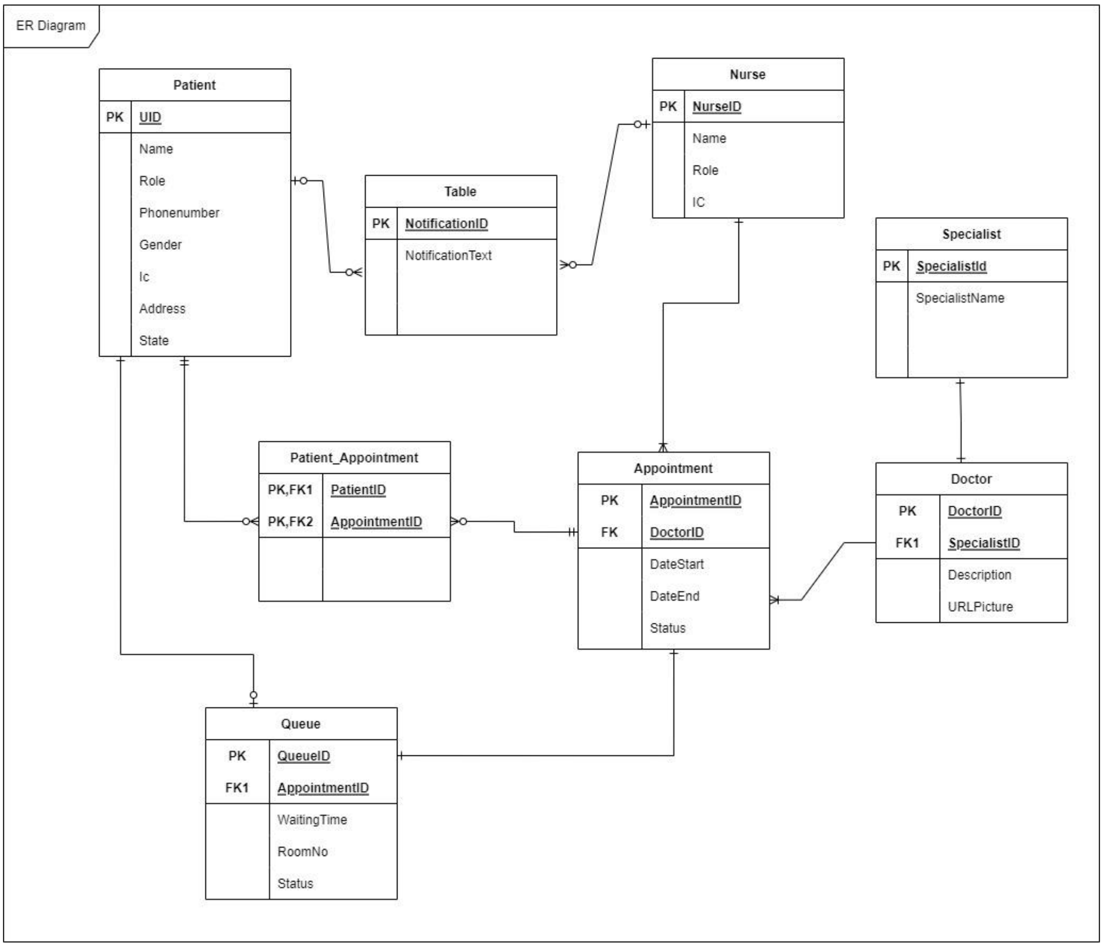


Figure 5 Entity Relationship Diagram

Figure 5 show the entity relationship diagram for Appointment Management System: AQHealth. Patient has many to many relationships with Appointment, however, Patient only has one to one relationship with the Queue table. Each doctor can only have one specialist and many appointments can be assigned into one doctor. One nurse or hospital staff can create many notifications. While one patient can have many notifications. Lastly, A nurse or hospital staff can manage many appointments at a time.

4.3.6 Data Dictionary

Patient

PatientID	name	role	phone_number	gender	ic	address	state

Nurse

NurseID	Nurse_name	role	ic

Doctor

DoctorID	specialistID	doctor_name	description	photo_url

Specialist

SpecialistID	specialist_name

Appointment

AppointmentID	DoctorID	date_start	date_end	status

Queue

QueueID	AppointmentID	room_no	waiting_time	status

Patient_Appointment

PatientID	AppointmentID

CHAPTER 5: IMPLEMENTATION & EVALUATION

This chapter will show the result of the implementation phase of the application. The results are displayed by describing the user interface designed during the design phase. The implementation phase is conducted using Flutter framework and Dart language as the programming language. The application is connected to Firebase as online database for the system for string application's data. The testing report then illustrate the application's actual result either the application passes the requirement or fail. The application has two platform which are mobile application platform for patient and web application for the nurse or hospital staff.

5.1 User Interface Design

Web Application

5.1.1 Login Page

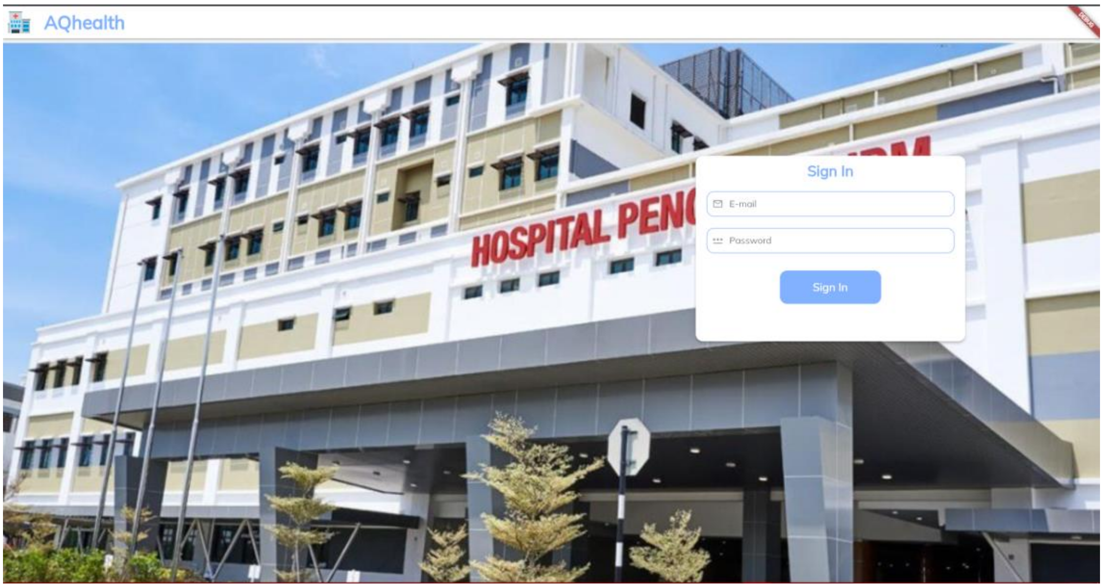
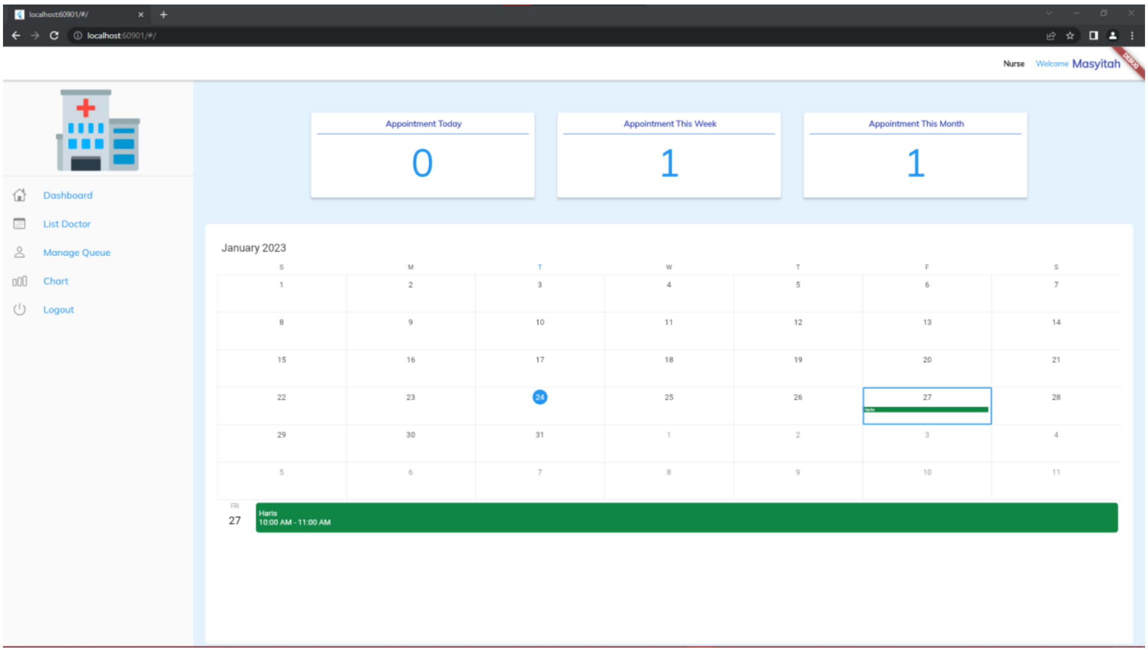


Figure 5.1.1 Login Page

1. Only nurse or hospital staff can view this Login Page
2. Nurse or hospital staff is already registered with email and password
3. Nurse or hospital staff need to fill the email and password to gain access to the system.

5.1.2 Dashboard page



Appointment Today	Appointment This Week	Appointment This Month
0	1	1

January 2023

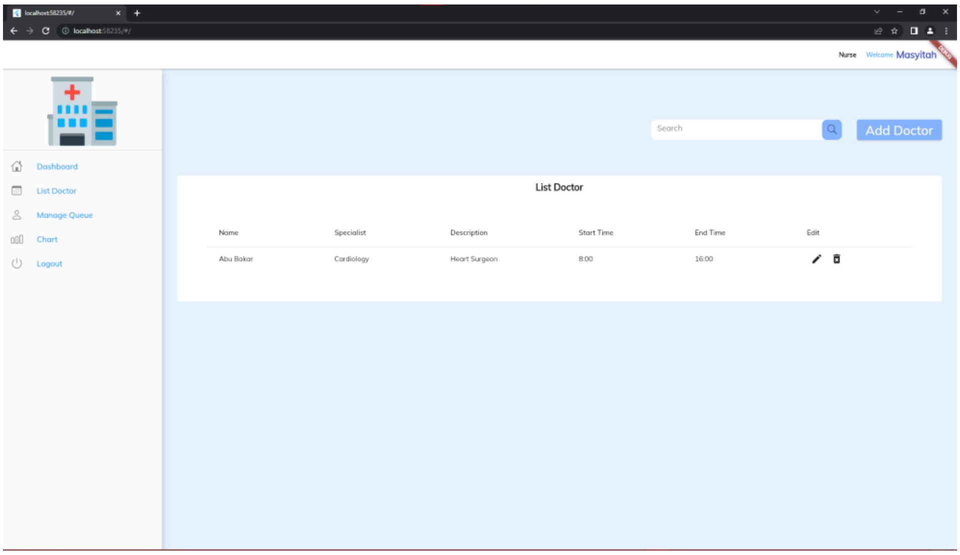
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27 Haris	28
29	30	31	1	2	3	4
5	6	7	8	9	10	11

FRI 27 Haris 10:00 AM - 11:00 AM

Figure 5.1.2 Dashboard Page

1. After Login, the system will navigate user into dashboard page that contains calendar with the doctor's name and appointment time. User also can see the number of appointments by day, week and month.
2. Nurse and hospital staff can view the details of this page if patients' appointment exist.

5.1.3 List Doctor page



List Doctor

Name	Specialist	Description	Start Time	End Time	Edit
Abu Bakar	Cardiology	Heart Surgeon	8:00	16:00	

Figure 5.1.3 List Doctor Page

1. Nurse or hospital staff can view list of doctors by click the “List Doctor” page at the drawer menu.
2. Doctor details such as name, description and start working time will be display here.
3. Nurse or hospital staff can add, edit or delete a specific doctor.

5.1.4 Add Doctor Dialog

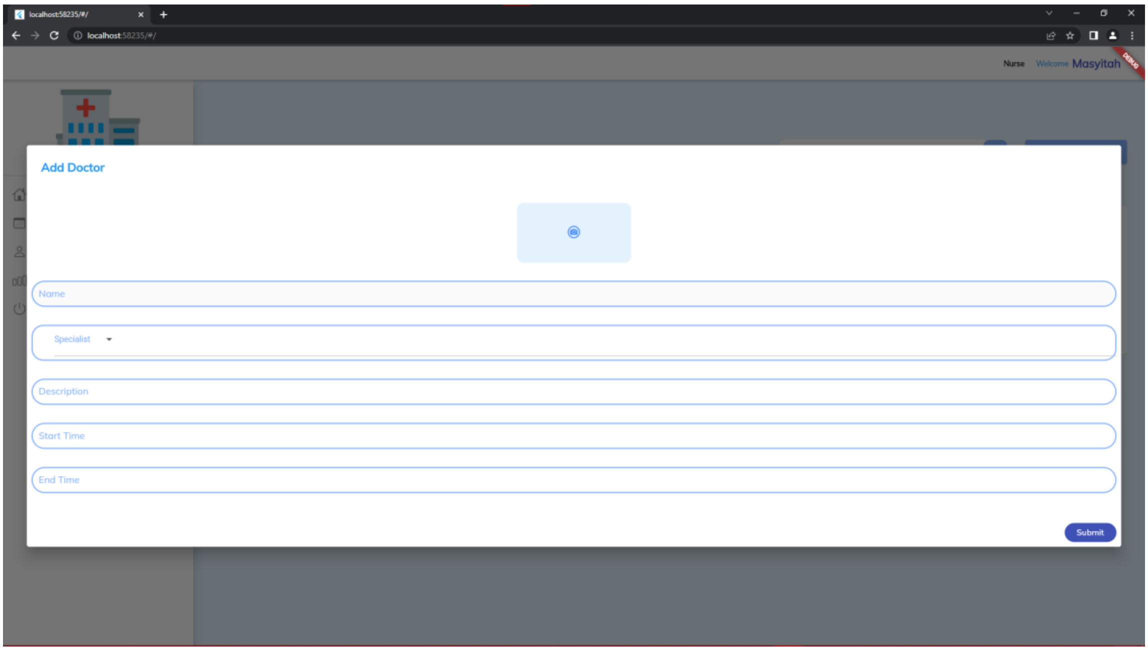
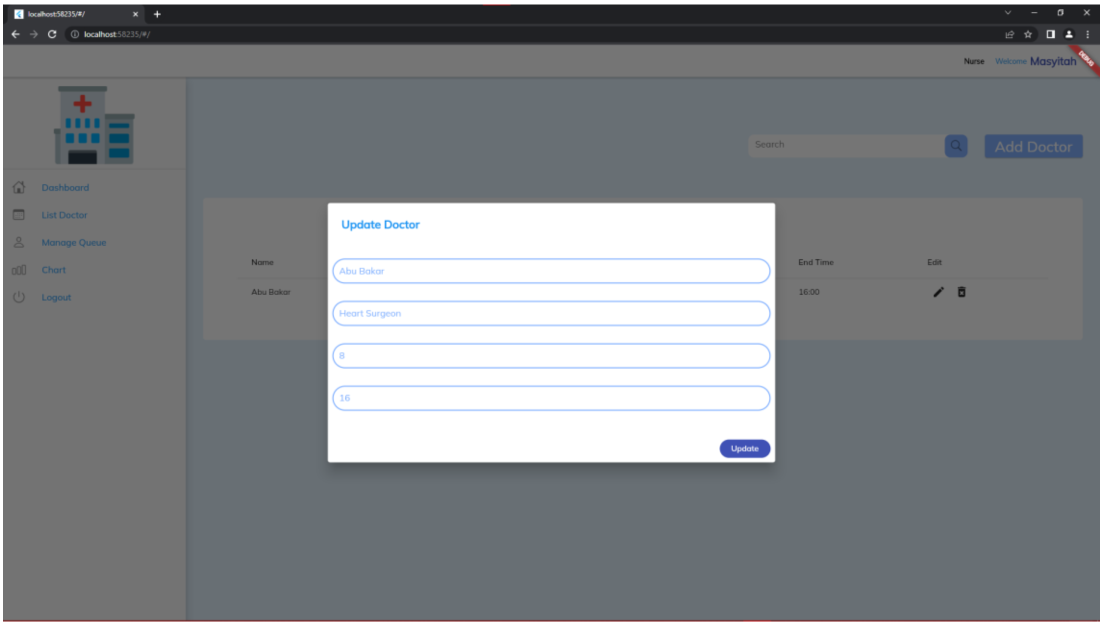


Figure 5.1.4 Add Doctor Dialog

1. Nurse and hospital staff can add a doctor by click the “Add Doctor” button at the list doctor page.
2. Then, the system will pop up a dialog that have required input to be set by nurse or hospital staff.
3. After click the submit button the system will display doctor details at list doctor page.

5.1.5 Update Doctor Page



Update Doctor

Abu Bakar

Heart Surgeon

8

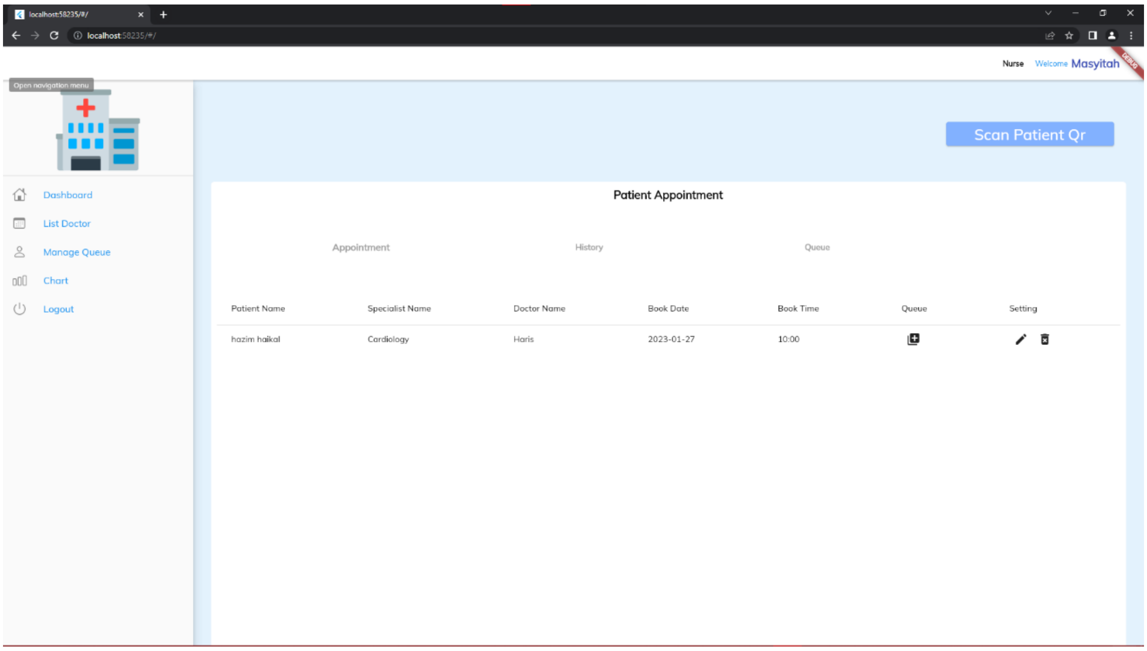
16

Name	End Time	Edit
Abu Bakar	16:00	

Figure 5.1.5 Update Doctor Page

1. Nurse or hospital staff can edit doctor information by click the pencil icon at a specific doctor wanted in the list doctors table.
2. After click update button the information will be store into database and update the information at the list doctors table.

5.1.6 Manage Queue Page



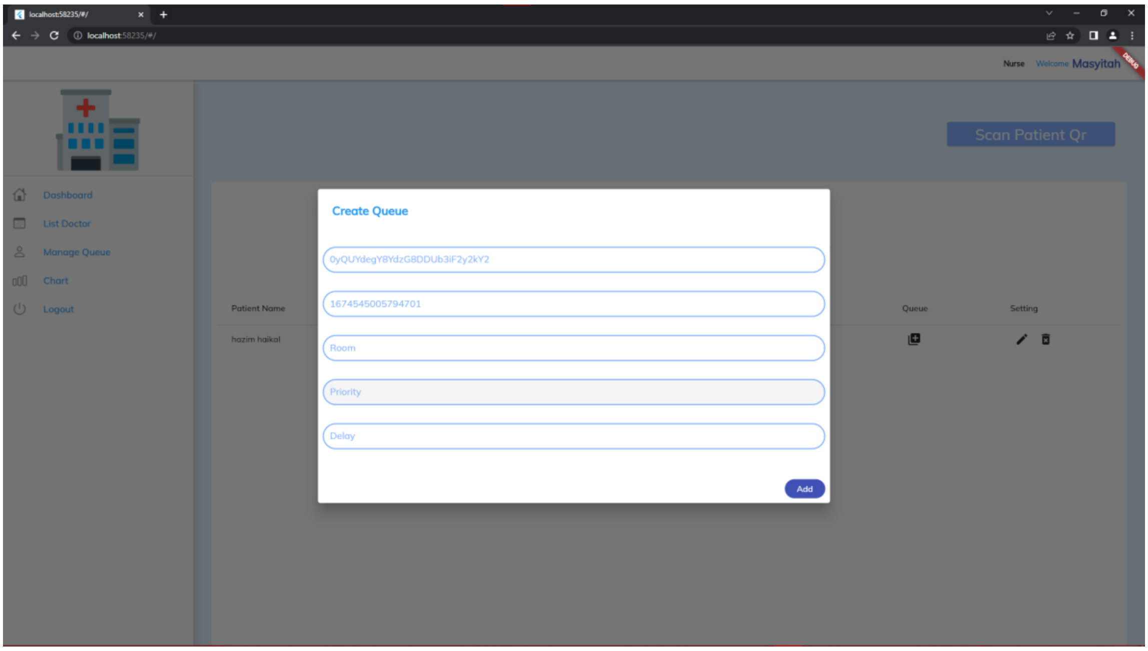
Patient Appointment

Patient Name	Specialist Name	Doctor Name	Book Date	Book Time	Queue	Setting
hazim haikal	Cardiology	Haris	2023-01-27	10:00		

Figure 5.1.6 Manage Queue Page

1. Nurse or hospital staff will be navigate to manage queue page after clicking the “ Manage Queue” at the side drawer menu.
2. User will see the table of upcoming patients’ appointment with edit and delete appointment and add queue icon.

5.1.7 Add Queue Dialog



Create Queue

0yQUYdegY8YdzG8DDUb3iF2y2kY2

1674545005794701

Room

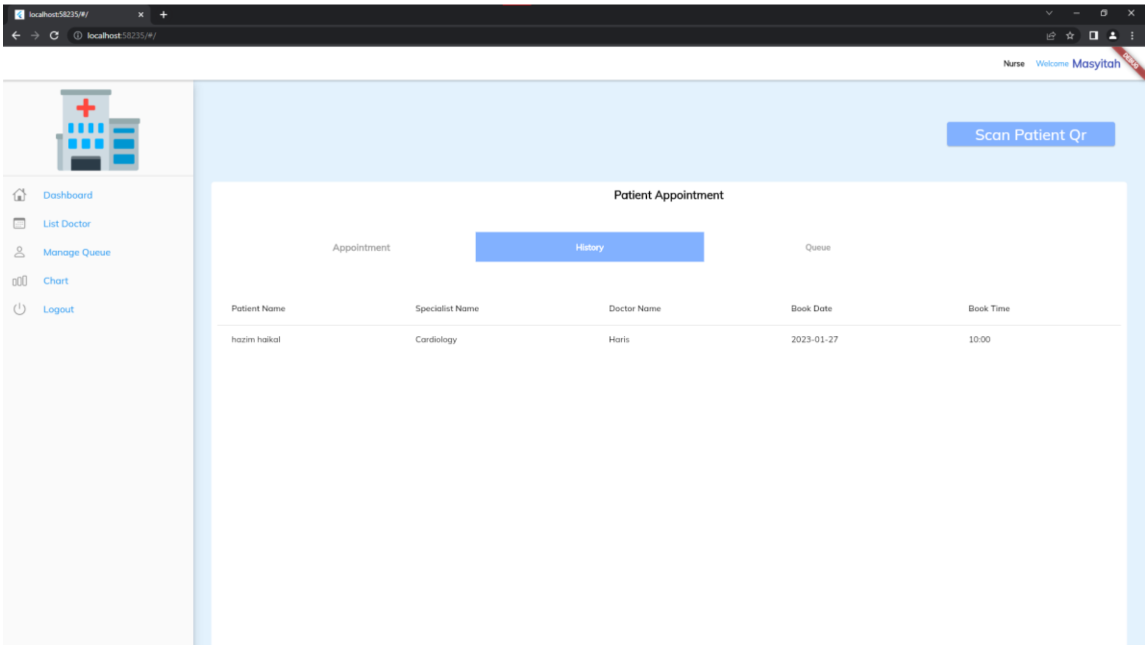
Priority

Delay

Figure 5.1.7 Add Queue Dialog

1. Nurse or hospital staff can assign patient into their consultation room, then, into the list of queues.
2. User needs to feel the input required such as room number, patient priority and the waiting time.
3. After click the add button the list of queue table will be display as shown in figure 5.1.9 .

5.1.8 Patients' Appointment History

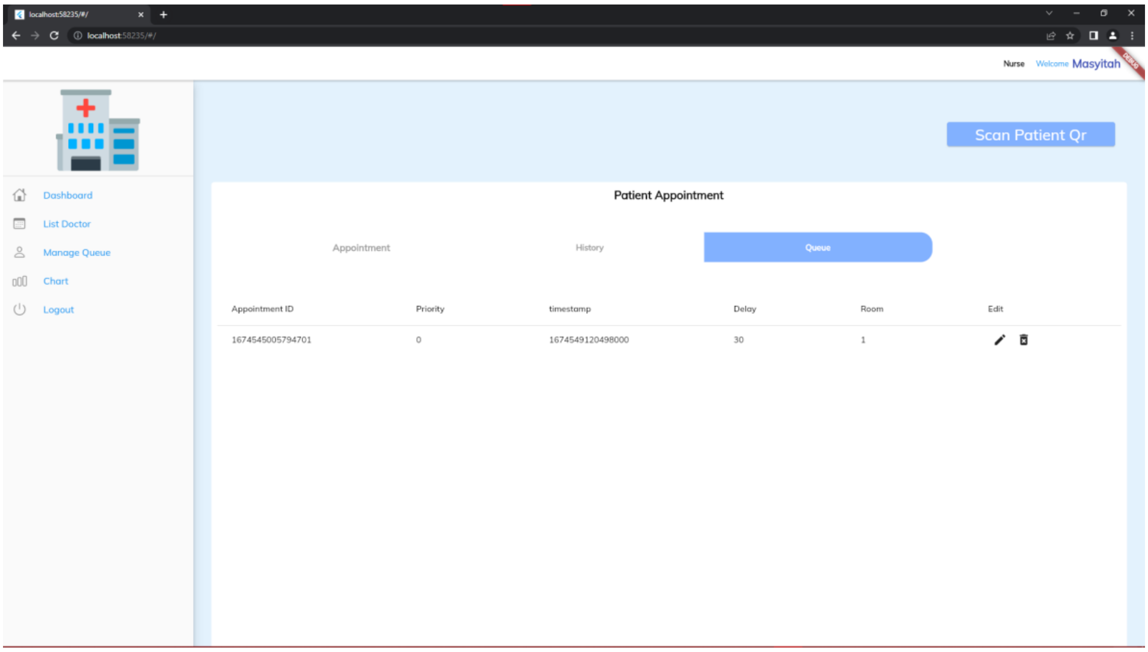


Patient Name	Specialist Name	Doctor Name	Book Date	Book Time
hazim haikal	Cardiology	Haris	2023-01-27	10:00

Figure 5.1.8 Patients' Appointment History

1. Nurse or hospital staff can view patient's appointment history by clicking to "History" at the sliding menu bar.
2. Then, the page will navigate user into a list of patients' appointment history table.

5.1.9 Queue Page



Appointment ID	Priority	timestamp	Delay	Room	Edit
1674545005794701	0	1674549120498000	30	1	✎ 🗑

Figure 5.1.9 Queue Page

1. Nurse or hospital staff can view the queue progress of patients by clicking the “Queue” button at sliding menu bar.
2. User can either delete or edit the queue details in this page.

5.1.1.4 Chart page

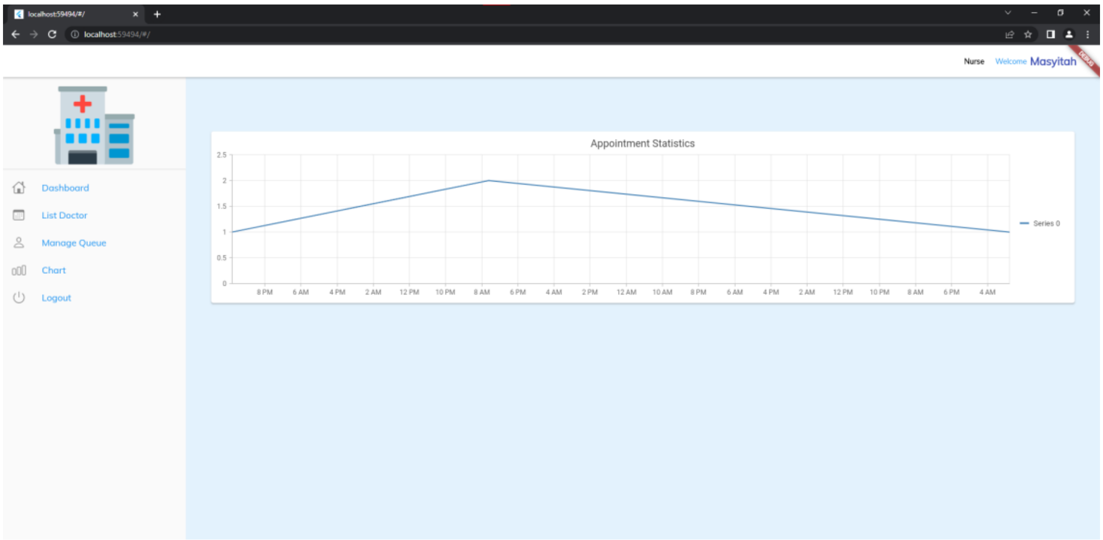


Figure 5.1.10 Chart Page

1. Nurse or hospital staff can view the trend of appointment time booked by the patient.

5.1.2 Mobile Application

5.1.2.1 Login Page

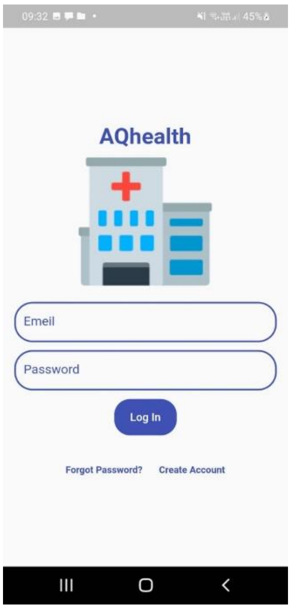


Figure 5.1.11 Login Page

1. Patients need to login by filled the email and password to gain access into the system
2. If patients did not have account, patients need to create an account first by clicking the create account text button

5.1.2.2 Register Page

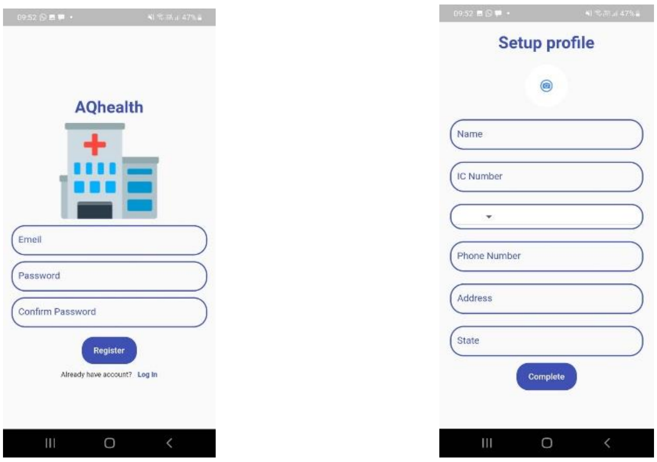


Figure 5.1.12

1. Patients can create an account by input the details required.
2. Patients need to put email and password first before fill the user information details.

5.1.2.3 Patient Home page

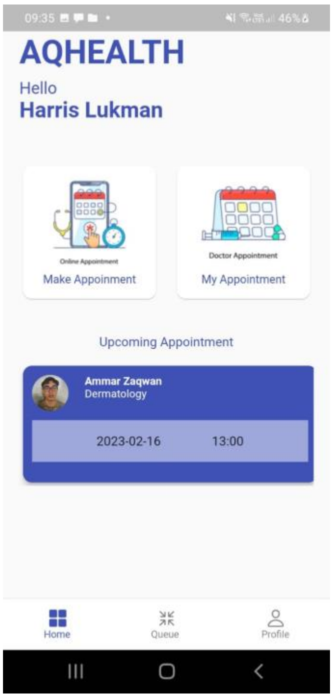


Figure 5.1.13 Patient Home Page

1. This page enable patient to view their upcoming appointments.
2. Patient can make appointment by clicking the Make Appointment at the Grid Button.

5.1.2.4 Make Appointment page

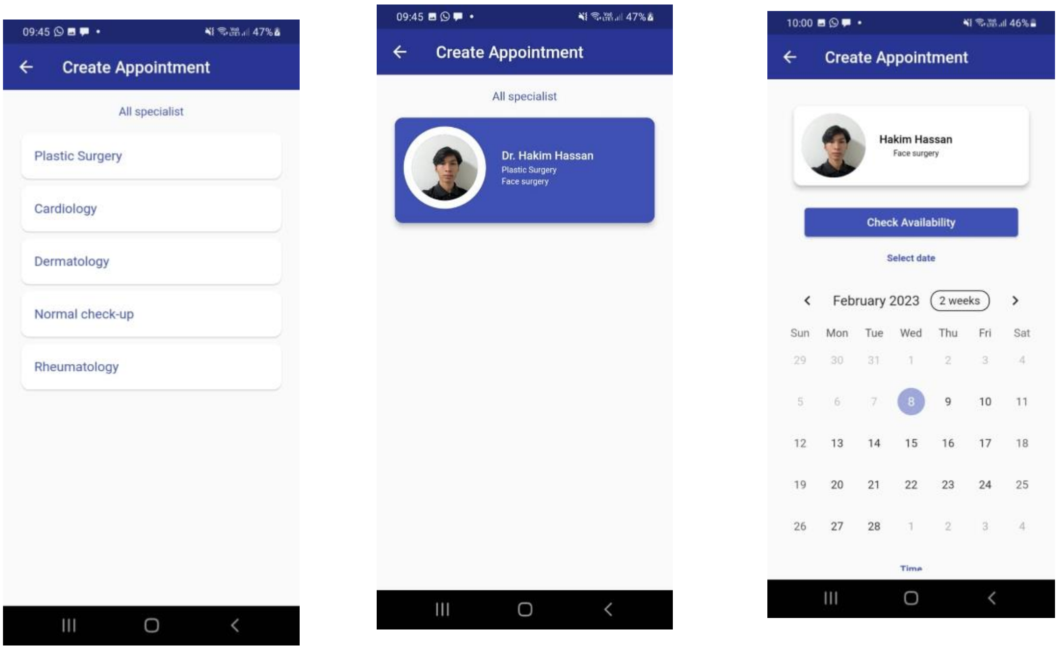


Figure 5.1.14 Make Appointment Page

1. Figure 5.1.14 enable patients to make an appointment by choose specialist. Then, doctor based on specialist. lastly, date, and time.
2. Patient can only choose the available date and time for that doctor.

5.1.2.5 Appointment page

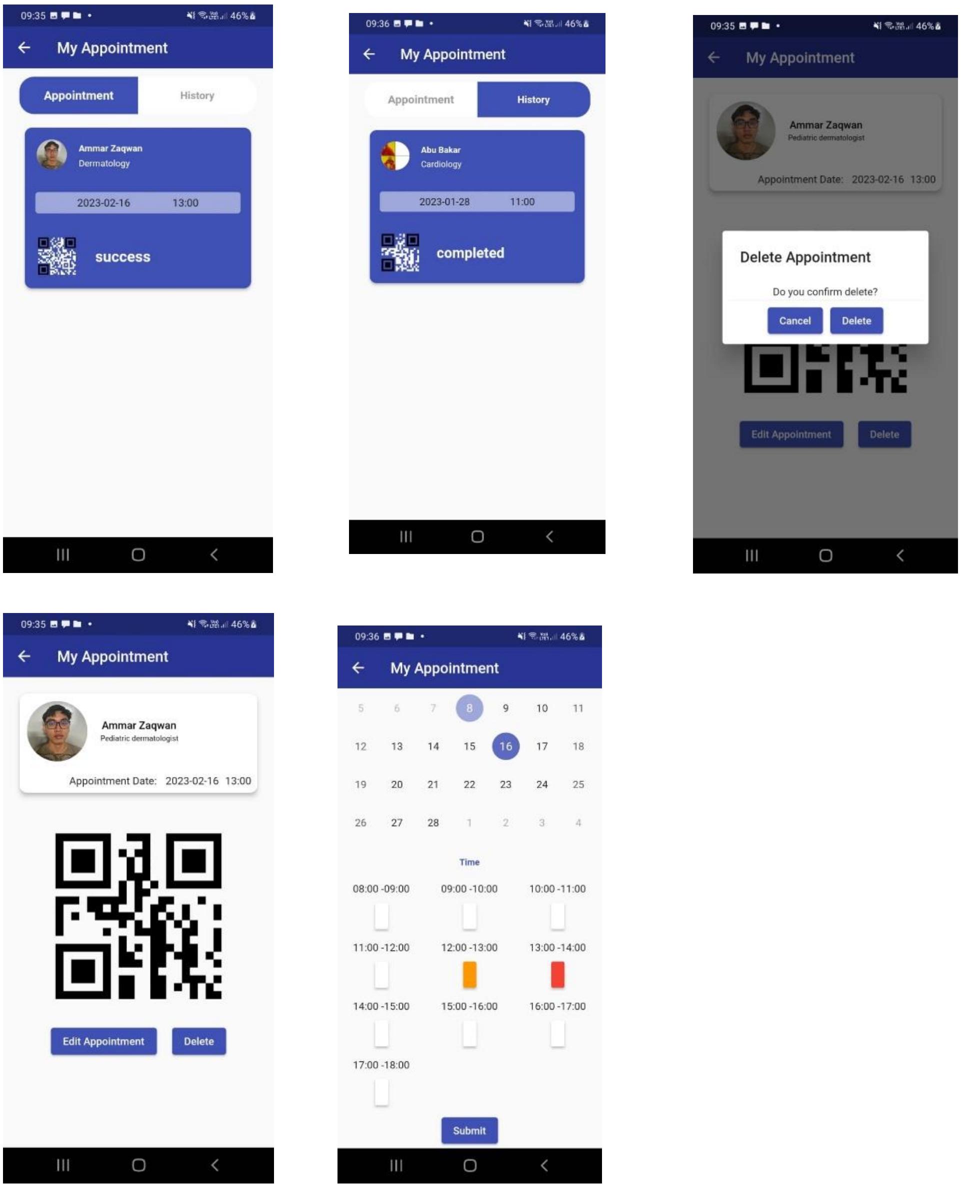
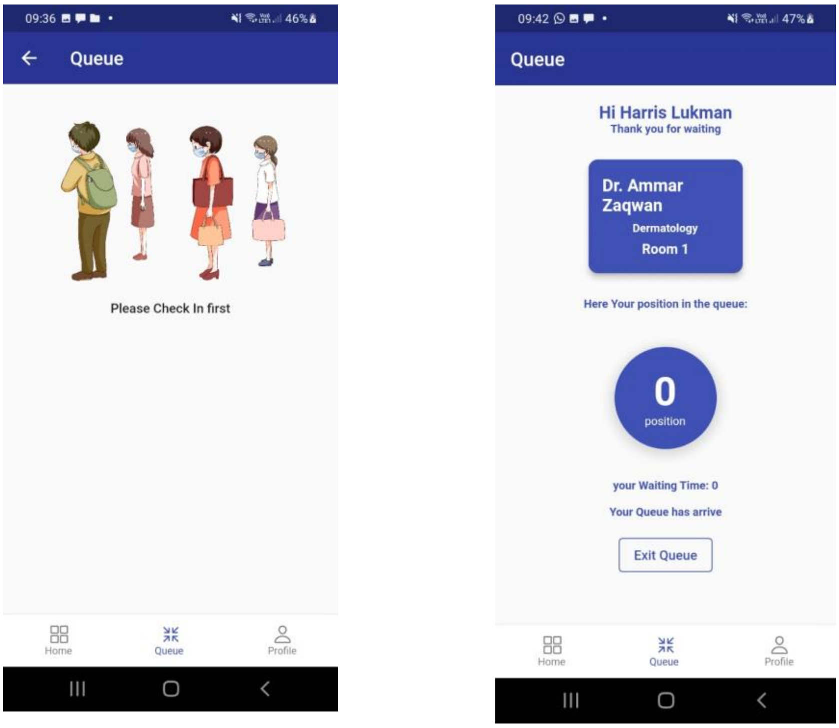


Figure 5.1.15

1. Figure 5.1.15 enables patients to view new appointment, history appointment, edit and delete new appointment.

5.1.2.6 Queue page



Please Check In first

Hi Harris Lukman

Thank you for waiting

Dr. Ammar Zaqwan

Dermatology

Room 1

Here Your position in the queue:

0

position

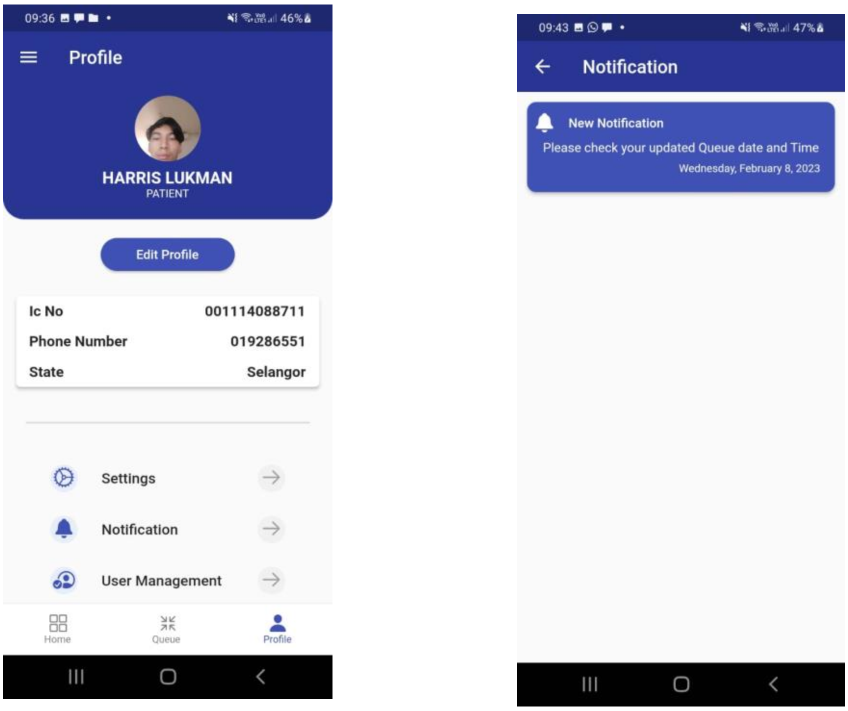
your Waiting Time: 0

Your Queue has arrive

Figure 5.1.16 Queue Page

1. Figure 5.1.16 enables patient to view queue progress with a detail such as doctor name, room number, queue position and waiting time.
2. Nurse or hospital staff need to assign patient into queue to enable patient to see the queue progress.

5.1.2.7 Profile page



HARRIS LUKMAN
PATIENT

Ic No	001114088711
Phone Number	019286551
State	Selangor

New Notification
Please check your updated Queue date and Time
Wednesday, February 8, 2023

Figure 5.1.17

1. Figure 5.1.17 shows patients' profile where patient can edit their information, view notification, and log out from the system.
2. Notification only visible went nurse or hospital staff send a rescheduled message.

5.2 Testing

After the implementation phase, testing is conducted to ensure the AQHealth application can fulfill the project's requirement. Two testing are conducted to test the individual functionalities and user experience. The testing includes unit Testing and User Acceptance test.

5.2.1 User Acceptance Testing

User Acceptance Testing (UAT) is conducted with several users from software engineering background to verify or accept the system before moving into the production environment phase. Those users are required to test the system by following the task provided as guideline. Feedback of the testing will come from multiple aspects such as system efficiency, smoothness, and user interface. The feedback will help developer to improve and fix the system to meet the requirements.

5.2.1.1 Task Description

In the usability with our target participants, the participants are given a 2 set of tasks: mobile application task and web system task to simulate the experience of Appointment Management system.

Mobile application task

No	Task
1	Create an account by inserting email, password, name, IC, phone number, state, and address
2	Log in to the system by filling email and password
3	Create new appointment at the home page
4	Check the new appointment

5	Edit appointment date and time
6	Check the appointment history
7	Check queue status to see the queue progress
8	Log out the mobile application

Web system task

No	Task
1	Log in to the system by filling email and password
2	Click the date in calendar with appointment
3	Check list of doctors on list doctor page
4	Add new doctor on list doctor page
5	Check the new patient’s appointments
6	Check the patient’s appointments history
7	Add patient into queue
8	Log out the web system

5.2.1.2 Task Completion Rate

This table shows the number of tasks completed as well as the task completion rate for each respondent.

Usability Testing with Software Engineering Student			
Respondents	**No. of Task Completed**		**Task Completed Rate**
	Mobile application	**Web system**	
Respondent 1	8/8	8/8	100%
Respondent 2	8/8	8/8	100%
Respondent 3	8/8	8/8	100%
Respondent 4	8/8	8/8	100%

Respondent 5	8/8	8/8	100%

Table 5.2: Respondent completion rate

As shown in table 5.2, all respondents had successfully completed all the assigned task and had the task completion rate of 100%.

5.2.1.3 Task Completion Time

Task completion time is conducted to find out the average time for each task that are being assigned to five software engineering respondents. Table below shows the average time for each task:

Usability Testing Mobile Application						
Task	**R1(s)**	**R2(s)**	**R3(s)**	**R4(s)**	**R5(s)**	**Avg(s)**
1	48	50	53	60	57	53.6
2	12	10	11	14	9	11.2
3	20	21	24	27	25	23.4
4	5	4	4	6	6	5
5	22	20	24	30	25	20.6
6	6	8	7	9	7	7.4
7	3	5	3	4	3	3.6
8	10	14	13	15	12	12.8

Usability Testing Web System						
Task	**R1(s)**	**R2(s)**	**R3(s)**	**R4(s)**	**R5(s)**	**Avg(s)**
1	15	17	19	21	16	17.6
2	5	4	6	5	4	4.8
3	6	7	9	8	6	7.2

4	30	37	35	40	36	35.6
5	7	8	6	8	9	7.6
6	4	3	5	5	4	4.2
7	17	18	19	21	24	19.8
8	8	9	12	14	10	10.6

Mobile Application			
Task	Highest Task Completion (seconds)	Lowest Task Completion (seconds)	Difference (seconds)
1	57	48	6
2	14	9	5
3	27	20	7
4	6	4	2
5	30	20	10
6	9	6	3
7	5	3	2
8	15	10	5

Web System			
Task	Highest Task Completion (seconds)	Lowest Task Completion (seconds)	Difference (seconds)
1	21	15	6
2	6	4	2
3	9	6	3
4	40	30	10

5	9	6	3
6	5	3	2
7	24	17	7
8	14	8	6

5.2.1.4 Questionnaire Analysis

A set of questionnaires is answered by each of the five software engineering students in order to get their feedback and satisfaction level towards the Appointment Management System (AQHealth). The questionnaire is based on the System Usability Scale (SUS) evaluation. The Sus evaluation help in validating the system is a usable or an unusable system. Table below show the score of the questionnaire.

Respondents	**SUS Score**
Respondent 1	82.5
Respondent 2	82.5
Respondent 3	75.5
Respondent 4	85
Respondent 5	85

The average SUS Score of the Appointment Management System (AQHealth) is **82.1**, which means that the Mobile Application and Web System are satisfied but some improvements could be made. Based on SUS scale, the passing score of a system is 68 and above and system with score of 80 and above signifies an excellent score.

SUS Score	Grade	Adjective Rating
> 80.3	A	Excellent
68 – 80.3	B	Good
68	C	Okay
51 – 68	D	Poor
< 51	F	Awful

5.2.1.5 Motivation

The usability testing that being conducted with five participants has successfully concluded. Insightful information and feedback have been gathered from this testing with all participants are pleased and positive about Appointment Management System (AQHealth) flow, content, and features. The developed system successfully complies with the specification listed in the analysis section. Participants gave the system's evaluation a good usability rating, giving it a 100% task completion rate score.

CHAPTER 6: CONCLUSION

6.1 Conclusion

In conclusion, Appointment Management System (AQHealth) is an initiative to improve current hospital management system with a more reliable and organize system. AQHealth is a platform for patient and hospital staff to create and manage their appointment with flexibility and accuracy which increased the satisfaction for both parties. The implementation of this system has result in increasing efficiency, greater organization, and high in usability. The system also provides and organized record of appointment and reduces the likelihood of scheduling conflicts such as double-booking and a lack of real-time visibility for hospital staff to track and manage the appointments.

The system is not only specified for booking an appointment, but it also caters the queue progress for patient to enter the consultation room. Nowadays, hospital still using traditional queue system or semi-auto queue system that bring displease experienced for most patients. The absence of informative details about the queue progress and a centered queue information brings another disappointment for patients. However, the problem in a long waiting time is difficult to resolve since the comparison between the number of patients and doctors in hospital are significantly huge which bottleneck the numbers of patients that could be entertain at a time. By enabling a real-time access for queue progress in mobile phone, it will bring flexibility for patients to manage their time while waiting their queue position.

Therefore, AQHealth is expected to bring an improvement from the current appointment management system where patients can make an online appointment and review their queue progress with their own mobile devices. Furthermore, nurse or hospital staff can easily manage their patients’ appointment with a real-time appointment scheduling and highly integrated system between mobile application and web system.

6.2 Future Enhancements

There are several enhancements needed for Appointment Management System (AQHealth) in future to resolve the absence of several features and improvement in terms of usability of the system which is the core in ensure the satisfaction of users in many ways. The enhancements are stated as below:

1. **Develop an automatic check-in system for patients**

   This system is lack in automation for receiving patients into hospital queue system. Developing a QR code features may enable patients to only scan the QR code to enter the queue system. This function may change the way hospital standard operating procedure by reducing queue of patients to enter the queue system.

2. **Develop another web system for doctor to monitor patients’ appointments**

   This system currently only provide interaction between patient and hospital staff. By allowing doctor in the middle, it will build a high integrated system with a lot of interaction between patients and doctor. The doctor web system will enable doctors to prescribe patient medicine, review patient past diseases and monitoring patient queue system. Hence, doctor can easily track patients’ diseases and prescribe the best medicine for those patients. Doctors will take a significant role to ensure the queue system is efficient and dependable by monitoring the trend of queue system.

3. **Develop in-app consultation service**

   This feature will help patient to receive medical consultation from a licensed doctor via mobile devices. This can be done through video call, chat, or voice call. The goal of these services is to make healthcare more accessible and convenient for patients who may not be able or willing to visit a doctor in person.

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APPENDIXE A: SOFTWARE REQUIREMENT SPECIFICATION

APPOINTMENT MANAGEMENT SYSTEM: AQHEALTH

Software Requirements Specification

for

<Appointment Management System: AQHealth>

Version 1.0 approved

Prepared by Haris Lukman Bin Muhammad Isror

University Putra Malaysia

18 October 2022

Revision History

Name	Date	Reason For Changes	Version

1. Introduction

1.1 Purpose

The purpose of this documentation is to capture, in natural language and at functional level, description and requirements of an appointment system for any hospital. This is a functional description of features required to address current appointment requirements. A short discussion accompanies each requirement, to add the background and framework necessary to explain the functionality. It also describes nonfunctional requirements and other factors necessary to provide a complete and comprehensive description of the requirements for the software.

1.2 Project Scope

The project's scope is to develop a mobile and web-based application to manage a hospital's appointment and queue system. The mobile application will be the platform for patients to make appointments and review the queue. A web-based application is for the admin to control the appointment system.

1.3 References

IEEE. IEEE Std. 830-1998 IEEE Recommended Practice for Software Requirements Specifications. IEEE Computer Society, 1998.

2. Overall Description

2.1 Product Perspective

(AQhealth) is meant to serve as a common platform where management of everyday appointment task can be carried out conveniently. The goal is to develop an intuitive appointment system for any hospital and promote the use of technology among patients and nurse.

2.2 Product Features

This system provides an efficient system for managing appointment in hospital. The main feature for this system is appointment booking system and appointment management system. This system will enable patients to book appointment and view their progress queue once check-in to hospital. Other than that, this system enables nurse or hospital staff to manage patients' appointment by reschedule patient appointment if there is changes happen in doctor availability and assign patient into their consultation room. After the patient is assign into their consultation room, patients will be able to see their queue progress such as position in queue, room number and the waiting time.

2.3 User Classes and Characteristics

The user classes involved in the usage of this product are up to two levels. The two users in this appointment management system are:

i. Patients

ii. Nurse or hospital staff

a) Nurse or hospital staff

The nurse or hospital staff acts as an administrator for the system. The administrator is the person in charge of this system which could add, edit, and remove patients' appointments, reschedule the patient's queue, and assign patients to their consultation room. Other than that, administrators have access to add, edit, and remove the list of doctors in the hospital.

b) Patients

Patients are people who seek help from the hospital. They will need to book an appointment with the hospital to get a consultation from a doctor. They will be able to book an appointment, view their appointment, view queue status, and get reschedule notification from the application.

2.4 Operating Environment

AQHealth is a mobile and web-based application for managing appointment systems. The operating environment of the applications are chosen based on the capability of the hardware to support the software. The software aspect needed to support the operation of the system is listed as below:

1) Database: Firebase
2) Operating system: Android and Chrome Browser
3) Framework: Flutter

2.5 Design and Implementation Constraints

The constraint in design and implementation phase are as follows

i. Language requirement: this system is only applicable in the English language.

ii. Mobile application support limitations:

2.6 Assumptions and Dependencies

I. The mobile and web applications can only be accessed if the systems are connected to an internet.

II. Only patients with an account in the mobile application can book an appointment with the system.

III. The nurse or hospital staff need to know the availability of the doctor to reschedule patient appointments.

3. System Use Cases

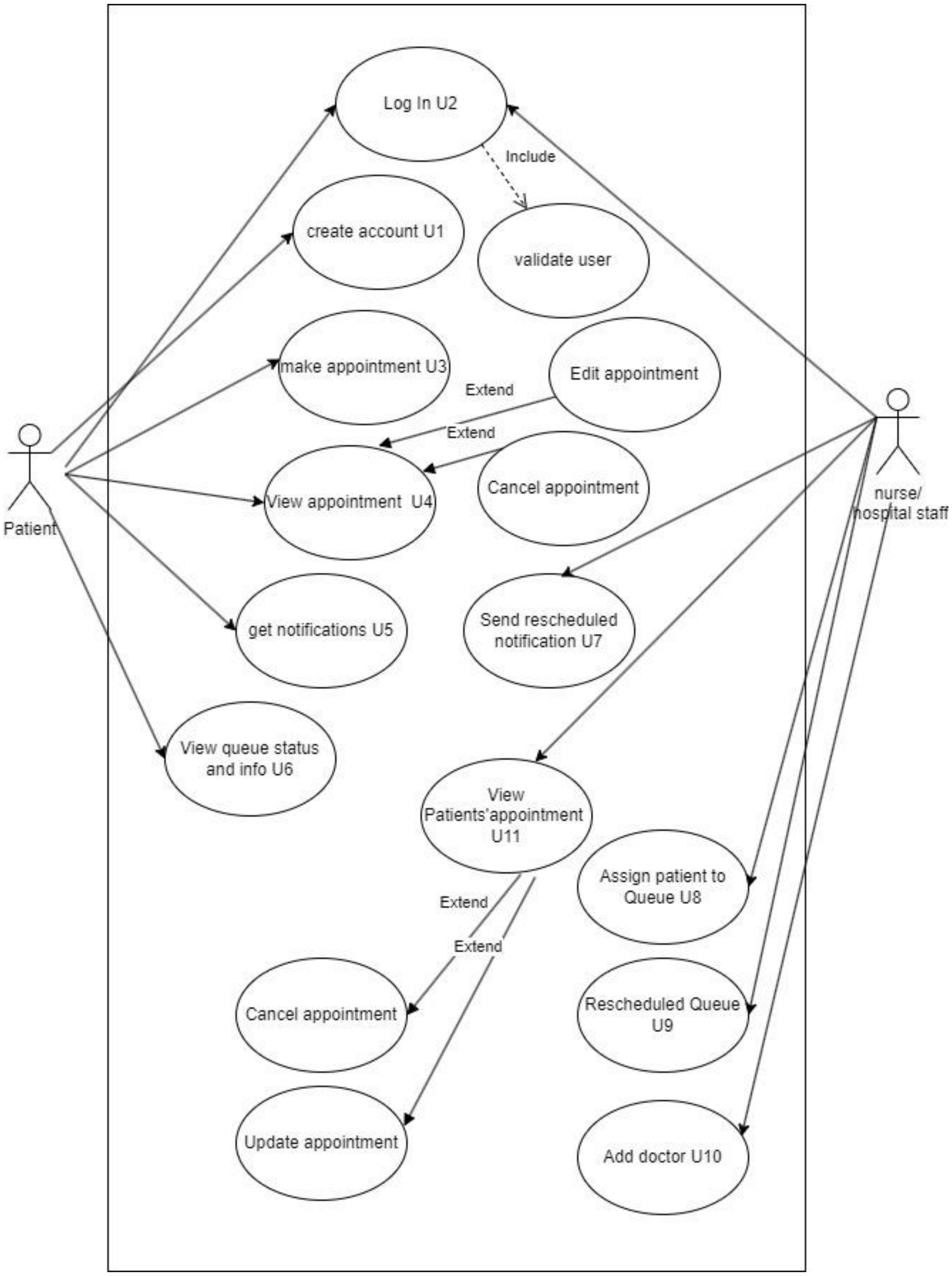


Figure 1.0 use case diagram

Description of use case diagram

Identifier	Use cases	Description of use cases
U1	Create account	Patients need to create an account first before gaining access to the application.
U2	Log in	Patients and nurse or hospital staff can login into the application. Patients need to log in with the mobile application while hospital staff or nurse will log in from the web application.
U3	Make appointment	Patients can make appointments through application by selecting a specialist concerned then selecting doctor, time, and date.
U4	View appointment	Patients can view their past and incoming appointments with the details such as time, date, and doctor chosen. Patient can also edit and cancel their appointments.
U5	Get notifications	Patients will receive notifications if nurse or hospital staff reschedule the appointment date and time.
U6	View queue status and info	Patients will see their queue status once a nurse or hospital staff assigns the room for the patient.
U7	Send notifications	Nurse or hospital staff can send a notification once he/she reschedules a patient appointment.
U8	Assign patient to Queue	Nurse or hospital staff who handle the web system will assign the check-in patient to their consultation room.
U9	Rescheduled queue	Nurse or hospital staff who handle the web system could reschedule the queue of patience based on their priority.
U10	Add doctor	Nurse or hospital staff can add a list of doctors who work in the hospital.

U11	View Patients' appointment	Nurse or hospital staff can view, edit and delete all patients' appointment

3.1 System Feature

U1 Create Account

Unique identifier	U1
Objective	Enable patient to create their account
Priority	High
Actor	Patient
Pre-Conditi on(s)	-
Post-Conditi on(s)	Patient details such as name, email and password will be stored in the database system.
Flow of events	Patient will enter name, email and password in text form field Patient will enter submit and the data will be stored into databased
Alternative flow	The system will display error message if patient input an incorrect name, email and password format.

U2 Log in

Unique identifier	U2
Objective	Enable nurse or hospital staff, and patient to log in to the system with the correct access.
Priority	High
Actor	nurse, and patient
Pre-Condition(s)	All the actors need to have an account before log in to the system
Post-Condition(s)	Patients will be route to the main dashboard of the mobile application. Nurse will enter the main dashboard of the web application.
Flow of events	Patient and nurse need to input their email and password. Then click “Log In” button.
Alternative flow	Patient and nurse could click the forgot password link if they forgot their password. The link will redirect them into password reset page

U3 Make Appointment

Unique identifier	U3
Objective	Enable the patient to make an appointment.
Priority	High
Actor	Patient
Pre-Conditi on(s)	The patient needs to log in to the application in the first place.
Post-Conditi on(s)	Patient will see the appointment details in the dashboard.
Flow of events	Patient click the “make appointment” menu Patient selects a type of health specialist. Patient selects doctor option Patient selects a date and time available and click “submit” button
Alternative flow	none

U4 View Appointment

Unique identifier	U4
Objective	Enable the patient to see their past and upcoming appointments.
Priority	High
Actor	Patient
Pre-Conditi on(s)	The patient needs to book an appointment with the mobile application.
Post-Conditi on(s)	The patient can view the details of their past and incoming appointments.
Flow of events	Patient need to click “MyAppointment” at the Grid button menu Patient can choose to see either new appointment or past appointment at the top menu. Patient can update or delete their new appointment. Patient can see the detail of their past appointment
Alternative flow	none

U5 Get Notifications

Unique identifier	U5
Objective	This use case enables the patient to receive notification if nurse or hospital staff are scheduling the appointment.
Priority	Medium
Actor	Patient
Pre-Conditi on(s)	The patient needs to make an appointment.
Post-Conditi on(s)	The use case end when no appointment created
Flow of events	Patient will receive a notification when the nurse or hospital staff schedule his appointment. Patient need to click “profile” at the bottom navbar and click “Notifications” to see the notifications.
Alternative flow	none

U6 View Queue status and Info

Unique identifier	U6
Objective	Enable the patient to see the queue status
Priority	High
Actor	Patient
Pre-Conditi on(s)	The nurse or hospital staff need to assigned the patient to his consultation room.
Post-Conditi on(s)	The use case ends after the patient completes the check-up and click “Exit Queue”..
Flow of events	The nurse or hospital staff need to assign a patient into his consultation room. The system will update the list queue. Patients can see the queue progress when they click “Queue” at bottom navbar menu
Alternative flow	none

U7 Send Reschedule Message

Unique identifier	U7
Objective	Enable nurse or hospital staff to send reschedule message towards patients.
Priority	Medium
Actor	Patient
Pre-Conditi on(s)	The patient needs to create an account and make an appointment.
Post-Conditi on(s)	The use case ends when nurse or hospital staff click “Submit” button
Flow of events	1. Nurse or hospital staff click “Manage Queue” at the sidebar menu. 2. Nurse or hospital staff need to click the notifications icon at the list of patient appointments. 3. Nurse or hospital staff can edit the default text message. 4. Nurse or hospital staff click the “submit” button.
Alternative flow	none

U8 Assign patient to room

Unique identifier	U8
Objective	Enable the nurse to assign patients to their consultation room.
Priority	High
Actor	Nurse
Pre-Conditi on(s)	The nurse needs to log in to the web application.
Post-Conditi on(s)	The use case ends after the nurse complete assigns the patient to their consultation room
Flow of events	1. Nurse or hospital staff will choose the patient and assign by clicking the queue button at the list of patient appointments. 2. Nurse or hospital staff need to provide room number, priority number and the delay time. 3. Nurse or hospital staff click the “Add Queue” button after complete filling all the input required.
Alternative flow	none

U9 Rescheduled Queue

Unique identifier	U9
Objective	Enable the nurse or hospital staff to reschedule the patient queue
Priority	High
Actor	Nurse or hospital staff
Pre-Conditi on(s)	The nurse or hospital staff needs to log in to the web application. The patient needs to enter the queue first.
Post-Conditi on(s)	The use case ends after the nurse or hospital staff completes rescheduling patient queue
Flow of events	1. Nurse or hospital staff need to click the “Manage Queue” menu at the side menu. 2. Nurse or hospital staff need to choose the patient that need to be rescheduled. 3. Nurse or hospital staff reschedule patient queue based on their priority. 4. Nurse or hospital staff click “update Queue” button to complete the task.
Alternative flow	none

U10 Add Doctor

Unique identifier	U10
Objective	Enable Nurse or hospital staff to add doctor
Priority	High
Actor	Nurse or hospital staff
Pre-Conditi on(s)	The Nurse or hospital staff needs to log in to the web application.
Post-Conditi on(s)	The use case ends when the nurse or hospital staff completes adding a doctor.
Flow of events	1. The nurse or hospital staff click the “Doctor List” menu at side menu button 2. The nurse or hospital staff needs to click the “Add Doctor” button to add an additional doctor. 3. The nurse or hospital staff need to insert the doctor information such as picture, name, specialist and description about the doctor. 4. the nurse or hospital staff click the “Submit” button to complete adding a doctor.
Alternative flow	none

U11 View Patients' Appointment

Unique identifier	U11
Objective	Enable nurse or hospital staff to view, edit and delete patients' appointment
Priority	High
Actor	Nurse or hospital staff
Pre-Conditi on(s)	The patient needs to book an appointment with the mobile application.
Post-Conditi on(s)	Nurse or hospital staff can view latest patients' appointment details in the Manage Queue Page.
Flow of events	Nurse or hospital staff need to click "Manage Queue" button at drawer menu Patient can choose to see either new appointment or past appointment or at the top menu. Nurse or hospital staff can update or delete patients' new appointment. Nurse or hospital staff can see the detail of patients' past appointment
Alternative flow	none

4. External Interface Requirements

4.1 User Interfaces

Refer to Software Design Documentation for Appointment Management System: AQHealth (SDD)

4.2 Hardware Interfaces

This section specifies the requirement regarding mobile and computer hardware that is used to support the application development.

Mobile

- Android Version: Android 10.0
- Chipset: Qualcomm SDM845 Snapdragon 845 (10 nm)
- Storage: Internal 64GB
- GPU: Adreno 630
- RAM: 4GB

Computer

- Processor: Intel Core i5 10400 Comet Lake
- Storage: SSD SATA 480GB
- RAM: 16GB
- GPU: NVIDIA GeForce RTX 3060 12GB
- Operating System: Windows 10 Home Single Language 64-bit

4.3 Software Interfaces

The software requirement for AQHealth is Visual Studio Code as IDE to run flutter and Laravel framework. This IDE will be used to write Dart and PHP programming languages. Other than that, this project will use the Figma tool for creating a wireframe and prototype. GitHub will be used as a configuration management tool. The Draw.io tool is used for creating UML diagrams and design diagrams.

The database that will be used for this project is Firebase. Firebase is a NoSQL document database which makes store, sync, and query data more convenient. The data is stored in the structure of collection and documents. Firebase is a serverless database by using Cloud FireStore and web SDKs with a comprehensive set of security rules that help developers to build an app without any server.

Framework	**Flutter**
Language	**Dart, JavaScript, C++**
Versioning Control	**GitHub**

Figure 2.0 Technologies Used

This project will use the Flutter framework for building native mobile applications and web applications by connecting both to a Firebase database. GitHub will be used as a versioning control and a platform for easy access to the project code.

4.4 Communications Interfaces

The communication requirement for this system is based on e-mail for accessing the application only legitimate email will gain access. The communication standard used for this system is HTTPS Callable function in Cloud Functions, which is used to call any function in the system by adding client logic to call the function in the app.

5. Non-functional Requirements

Non-functional requirements or NFRs are a set of specifications that describe the system’s operational capabilities and constraints and attempt to improve its functionality. These are basically the requirements that outline how well the system will operate.

5.1 Performance Requirements

The system shall be run on mobile and web servers. The system shall take initial load time depending on internet connection strength which also depends on the media from which the system is run. The system shall depend upon hardware components of the client/customer. The landing page supporting 1000 users per hour must provide 6 seconds or less response time in a chrome desktop browser, including the rendering of text and images and over a Lan connection.

5.2 Security Requirements

The system shall provide AES encryption for all users' passwords. The system shall be accessed by users that have been authorized by the system only. The system shall provide an error message to users and store it in the error logs.

5.3 Software Quality Attributes

5.3.1 Availability

The system shall be available to all users 99.98 percent of the time every month during office hours.

5.3.2 Reliability

The system must perform without failure in 95 percent of use cases during a month.

5.3.2 Usability

The system shall follow the 10-usability heuristic by Jakob Nielson to implement the user interface of the system.

5.4 Class Diagram

A class diagram is a type of diagram in the Unified Modeling Language (UML) that illustrates the structure of a system by representing its classes, attributes, and actions. It is used to represent the system's static elements, such as class connections, class hierarchy, and the attributes and functions of each class. A class diagram is made up of classes that represent the system's objects and their relationships. Each class is represented by a box that contains the class name, attributes, and the operations that the class can perform. The class diagram for Computer Maintenance System (CMS) shown below includes the class, attributes, operations, and the relationship between classes.

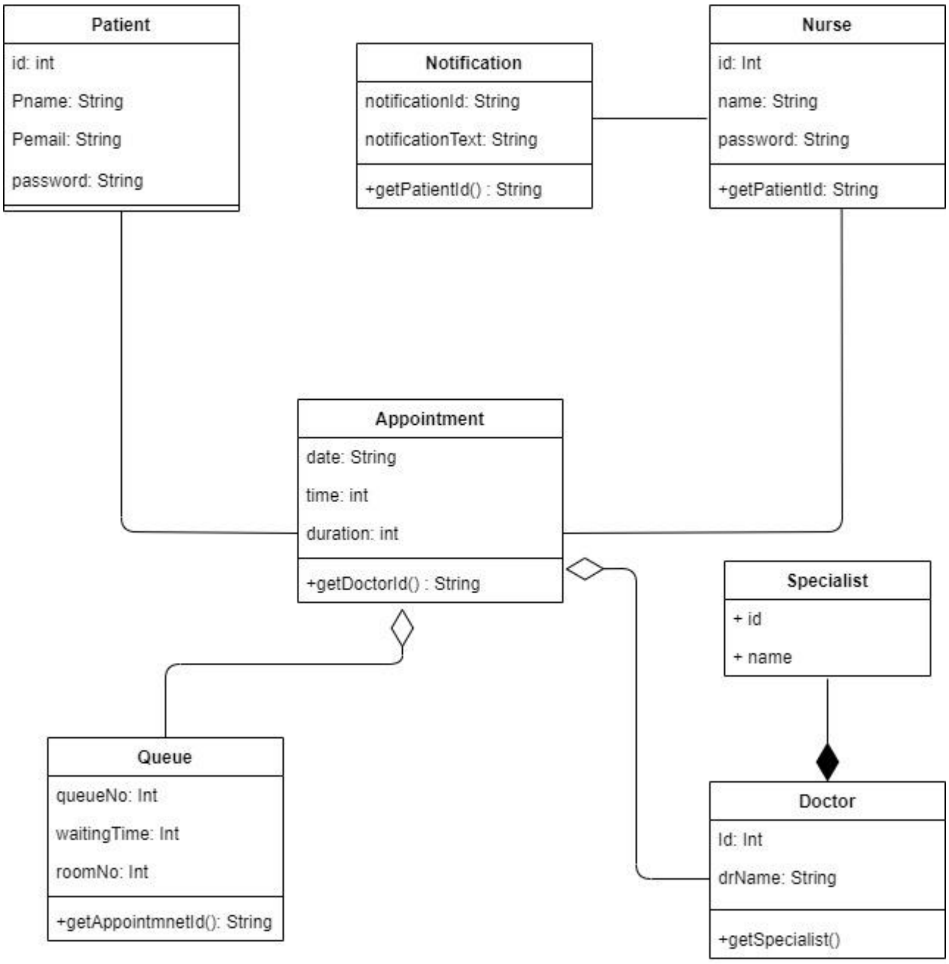


Figure 2.0 class diagram

Figure 2.0 shows the class diagram for Appointment Management System (AQHealth). Based on the diagram, patient and nurse class are associate with appointment class. Class specialist has a composition relationship with class doctor where class doctor can build by itself. Class appointment has aggregation relationship with the class Queue and class Doctor.

APPENDIX B: SOFTWARE DESIGN DOCUMENTATION (SDD)

APPOINTMENT MANAGEMENT SYSTEM: AQHEALTH

Software Design Documentation

for

<Appointment Management System : AQHealth>

Version 1.0 approved

Prepared by Haris Lukman Bin Muhammad Isror

Faculty of Computer Science and Information Technology

University Putra Malaysia

18 October 2022

1 Introduction

1.1 Purpose

The purpose of this Software Design Document (SDD) is to give in formation and detailed design for the Appointment Management System in hospital for Outpatient. It will explain the system design and operation of the system.

1.2 Scope

Appointment Management System in Hospital allow Outpatient to book an appointment with the selected Doctor based on their specialist and enable the nurse to manage the appointment system to ensure appointment are coherent with doctor schedule.

1.3 Audience

This document is intended for designer, programmers, and testers. It will guide the designer how to design a good system based on what customers need. It also contains information about the design such as class diagram, sequence diagram and state diagram and it contains information that the designer needed as a guide to build the application such as the prototype. This document also will be used as a guide for maintenance to maintain and update the software system. The programmer also can use this document for developing the code.

1.4 Pertinent Documents References

- Software Requirement Specification Appointment Management System: AQHealth (SRS)

1.5 Summarise Document

The use of Use Case Diagram, Sequence Diagram, Class Diagram and Database improved how the system would work. It helps to understand how the system works, from Login to managing the appointment system.

2 System Overview

2.1 Operating System

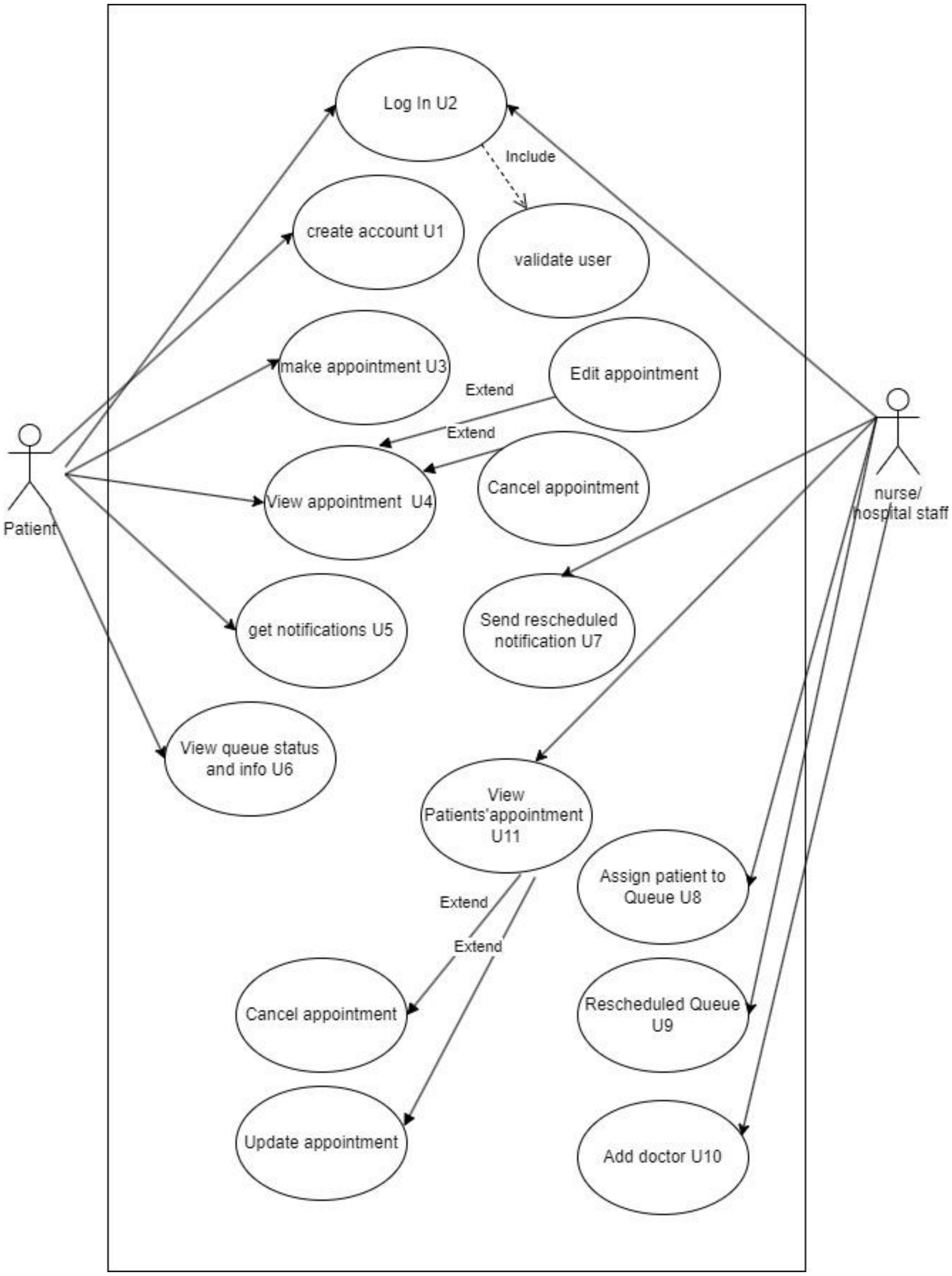
There are two operating system for this project:

- Android

  Android operating system is for mobile application of this project which the user of this application is patient. This system should be access for android 10 and above based on the development environment.
- Web Browser

  Web browser that are supported for this system is Google Chrome and Microsoft Edge. This environment is made for nurse that will handle patient appointment and the queue system.

2.2 System Use Case



U1 Create Account

Unique identifier	U1
Objective	Enable patient to create their account
Priority	High
Actor	Patient
Pre-Conditi on(s)	-
Post-Conditi on(s)	Patient details such as name, email and password will be stored in the database system.
Flow of events	Patient will enter name, email and password in text form field Patient will enter submit and the data will be stored into databased
Alternative flow	The system will display error message if patient input an incorrect name, email and password format.

U2 Log in

Unique identifier	U2
Objective	Enable nurse or hospital staff, and patient to log in to the system with the correct access.
Priority	High
Actor	nurse, and patient
Pre-Conditi on(s)	All the actors need to have an account before log in to the system
Post-Conditi on(s)	Patients will be route to the main dashboard of the mobile application. Nurse will enter the main dashboard of the web application.
Flow of events	Patient and nurse need to input their email and password. Then click “Log In” button.
Alternative flow	Patient and nurse could click the forgot password link if they forgot their password. The link will redirect them into password reset page

U3 Make Appointment

Unique identifier	U3
Objective	Enable the patient to make an appointment.
Priority	High
Actor	Patient
Pre-Conditi on(s)	The patient needs to log in to the application in the first place.
Post-Conditi on(s)	Patient will see the appointment details in the dashboard.
Flow of events	Patient click the “make appointment” menu Patient selects a type of health specialist. Patient selects doctor option Patient selects a date and time available and click “submit” button
Alternative flow	none

U4 View Appointment History

Unique identifier	U4
Objective	Enable the patient to see their past and incoming appointments.
Priority	High
Actor	Patient
Pre-Conditi on(s)	The patient needs to book an appointment with the mobile application.
Post-Conditi on(s)	The patient can view the details of their past and incoming appointments.
Flow of events	Patient need to click “MyAppointment” at the Grid button menu Patient can choose to see either new appointment or past appointment at the top menu. Patient can update or delete their new appointment. Patient can see the detail of their past appointment
Alternative flow	none

U5 Get Notifications

Unique identifier	U5
Objective	This use case enables the patient to receive notification if the appointment is being scheduled by nurse or hospital staff.
Priority	Medium
Actor	Patient
Pre-Conditi on(s)	The patient needs to make an appointment.
Post-Conditi on(s)	The use case end when no appointment created
Flow of events	Patient will receive a notification when his appointment is scheduled by the nurse or hospital staff. Patient need to click “profile” at the bottom navbar and click “Notifications” to see the notifications.
Alternative flow	none

U6 View Queue status and Info

Unique identifier	U6
Objective	Enable the patient to see the queue status
Priority	High
Actor	Patient
Pre-Condition(s)	The nurse or hospital staff need to assigned the patient to his consultation room.
Post-Condition(s)	The use case ends after the patient completes the check-up and click “Exit Queue”..
Flow of events	The nurse or hospital staff need to assign a patient into his consultation room. The system will update the list queue. Patients can see the queue progress when they click “Queue” at bottom navbar menu
Alternative flow	none

U7 Send Reschedule Message

Unique identifier	U7
Objective	Enable nurse or hospital staff to send reschedule message towards patients.
Priority	Medium
Actor	Patient
Pre-Conditi on(s)	The patient needs to create an account and make an appointment.
Post-Conditi on(s)	The use case ends when nurse or hospital staff click “Submit” button
Flow of events	5. Nurse or hospital staff click “Manage Queue” at the sidebar menu. 6. Nurse or hospital staff need to click the notifications icon at the list of patient appointments. 7. Nurse or hospital staff can edit the default text message. 8. Nurse or hospital staff click the “submit” button.
Alternative flow	none

U8 Assign patient to room

Unique identifier	U8
Objective	Enable the nurse to assign patients to their consultation room.
Priority	High
Actor	Nurse
Pre-Conditi on(s)	The nurse needs to log in to the web application.
Post-Conditi on(s)	The use case ends after the nurse complete assigns the patient to their consultation room
Flow of events	4. Nurse or hospital staff will choose the patient and assign by clicking the queue button at the list of patient appointments. 5. Nurse or hospital staff need to provide room number, priority number and the delay time. 6. Nurse or hospital staff click the “Add Queue” button after complete filling all the input required.
Alternative flow	none

U9 Rescheduled Queue

Unique identifier	U9
Objective	Enable the nurse or hospital staff to reschedule the patient queue
Priority	High
Actor	Nurse or hospital staff
Pre-Conditi on(s)	The nurse or hospital staff needs to log in to the web application. The patient needs to enter the queue first.
Post-Conditi on(s)	The use case ends after the nurse or hospital staff completes rescheduling patient queue
Flow of events	5. Nurse or hospital staff need to click the "Manage Queue" menu at the side menu. 6. Nurse or hospital staff need to choose the patient that need to be rescheduled. 7. Nurse or hospital staff reschedule patient queue based on their priority. 8. Nurse or hospital staff click "update Queue" button to complete the task.
Alternative flow	none

U10 Add Doctor

Unique identifier	U10
Objective	Enable Nurse or hospital staff to add doctor
Priority	High
Actor	Nurse or hospital staff
Pre-Conditi on(s)	The Nurse or hospital staff needs to log in to the web application.
Post-Conditi on(s)	The use case ends when the nurse or hospital staff completes adding a doctor.
Flow of events	5. The nurse or hospital staff click the “Doctor List” menu at side menu button 6. The nurse or hospital staff needs to click the “Add Doctor” button to add an additional doctor. 7. The nurse or hospital staff need to insert the doctor information such as picture, name, specialist and description about the doctor. 8. the nurse or hospital staff click the “Submit” button to complete adding a doctor.
Alternative flow	none

U11 View Patients' Appointment

Unique identifier	U11
Objective	Enable nurse or hospital staff to view, edit and delete patients' appointment
Priority	High
Actor	Nurse or hospital staff
Pre-Condition(s)	The patient needs to book an appointment with the mobile application.
Post-Condition(s)	Nurse or hospital staff can view latest patients' appointment details in the Manage Queue Page.
Flow of events	Nurse or hospital staff need to click "Manage Queue" button at drawer menu Patient can choose to see either new appointment or past appointment or at the top menu. Nurse or hospital staff can update or delete patients' new appointment. Nurse or hospital staff can see the detail of patients' past appointment
Alternative flow	none

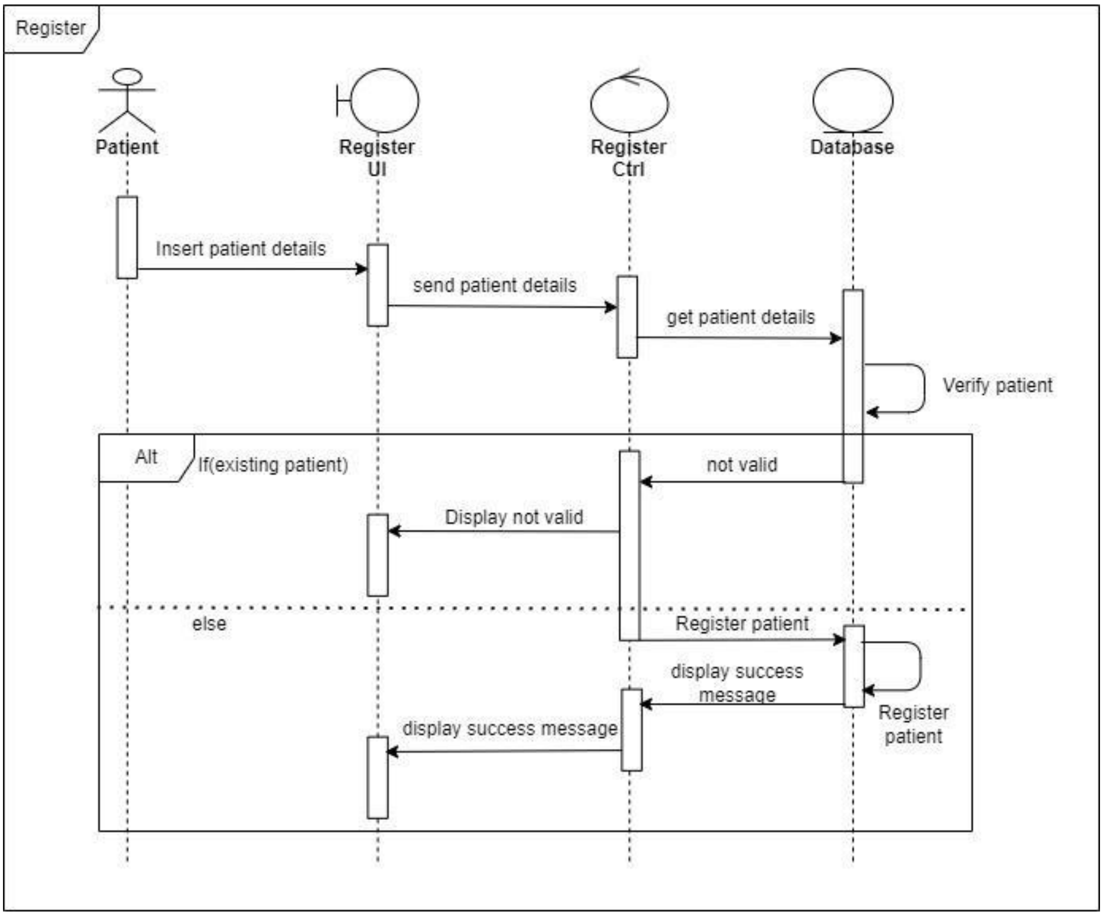
3 Detail Design

Assumptions and Dependencies

General Constraints

Goals and Guidelines

3.1 Create Account



Definition

This operation is where patient inserts information that is required.

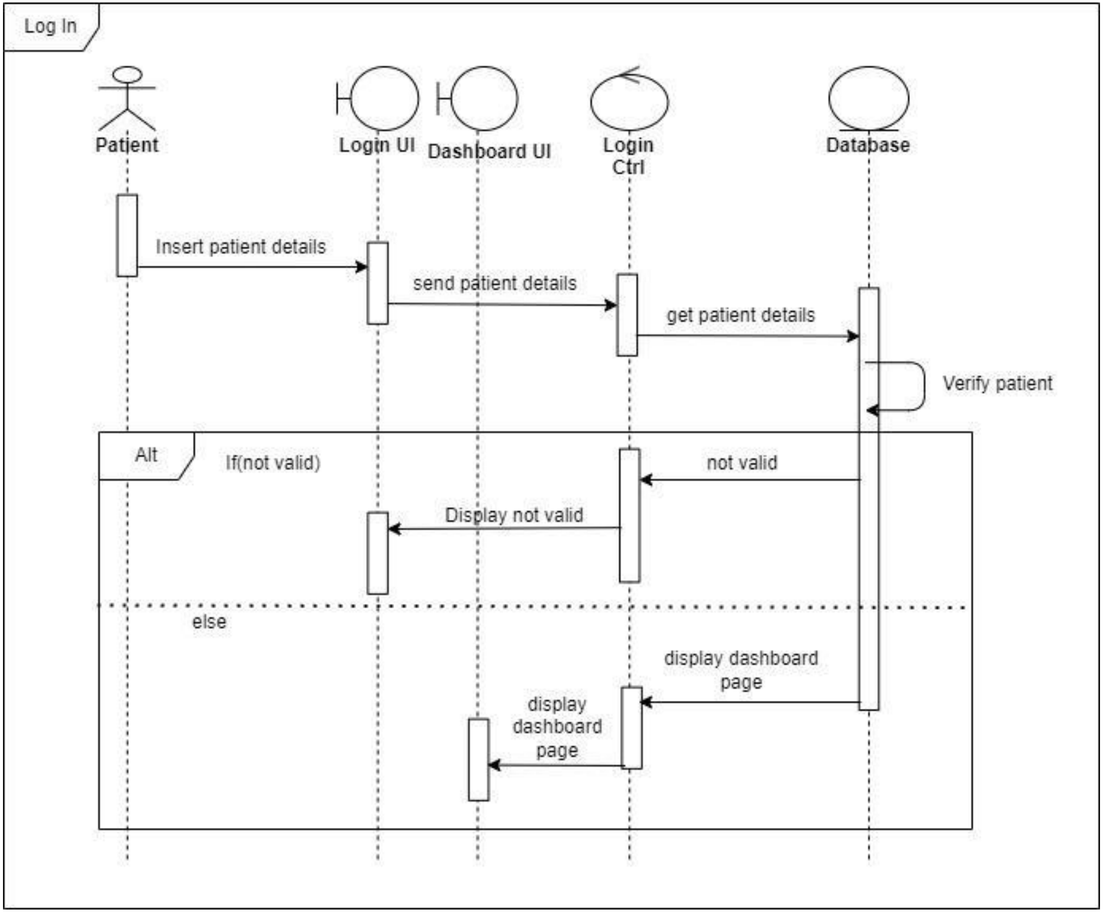
Responsibilities

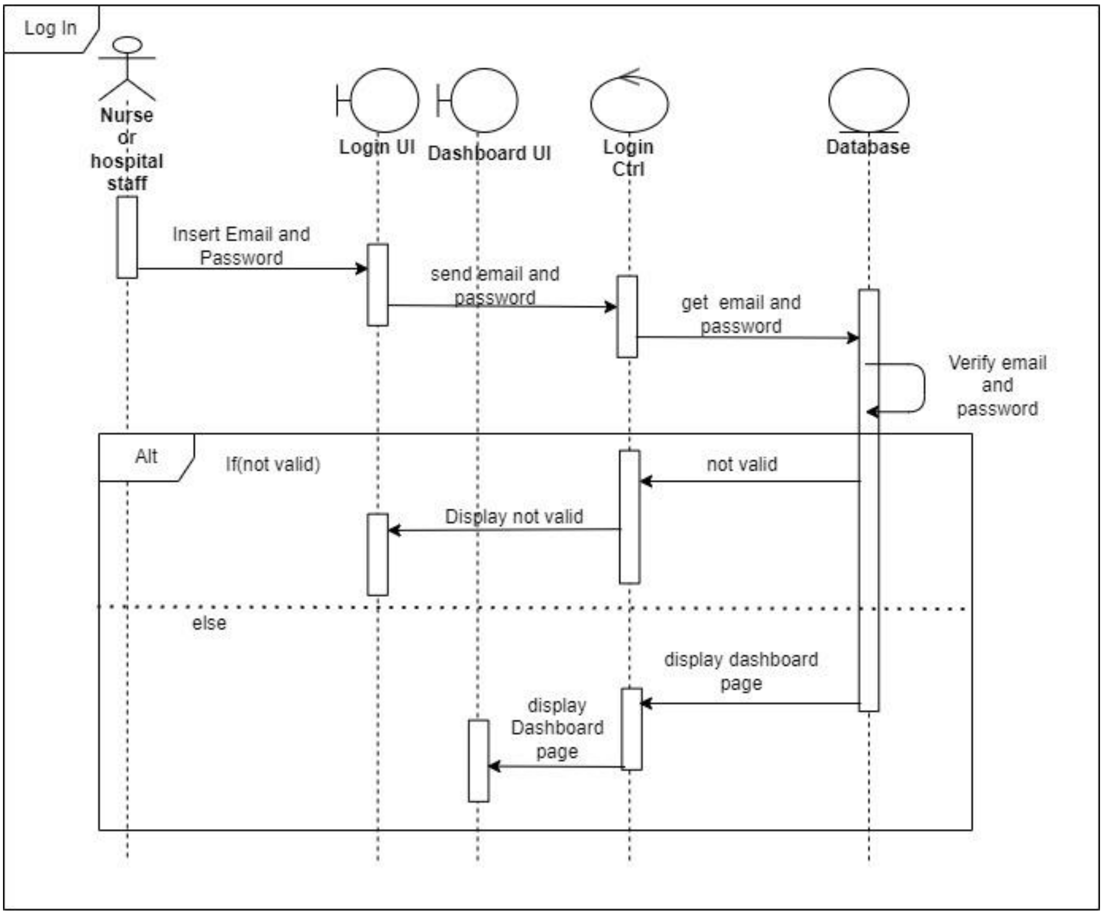
This operation need to be completed by patient before getting access to the system. The system will gather user information, verify the user and store the information into database.

Constraint

Patient can only create one account with single email. Email is the constraints of the system to ensure there is no duplication in number of the same users. It will display invalid message if the patient has already created an account.

3.2 Log In





Definition

This operation is where patient and nurse or hospital stuff insert email and password.

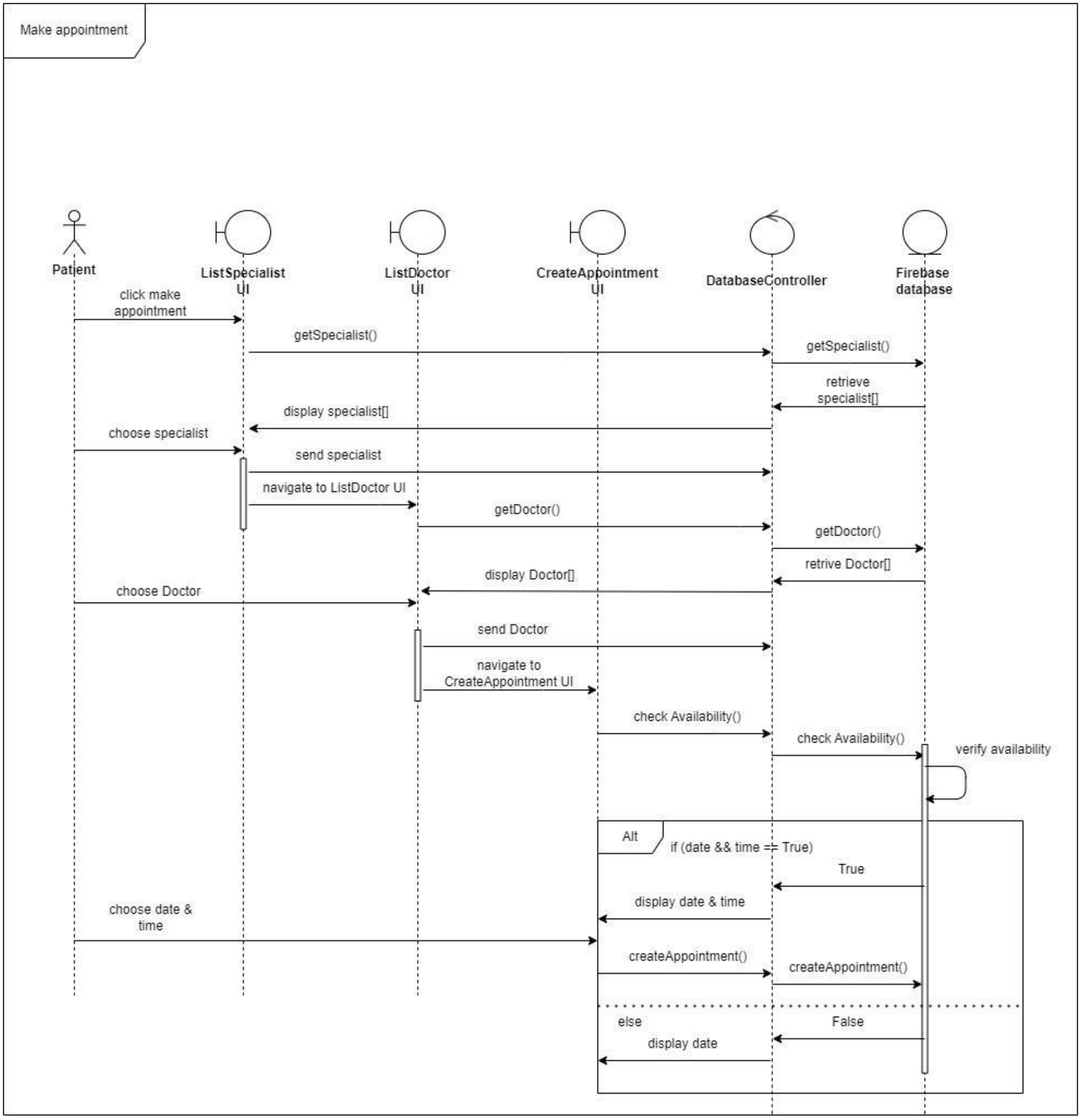
Responsibilities

This operation will verify either patient and nurse or hospital staff has an account within the system or not creating any account before. Furthermore, the system will also verify the role of actor either patient or hospital staff. If the patient is entering the correct email and password, the system will give access for patient to enter the system.

Constraint

Patients need to create an account first before logging in to the system.

3.3 Make Appointment



Definition

This operation allow patient to book an appointment with a doctor based on the specialist, date, and time available.

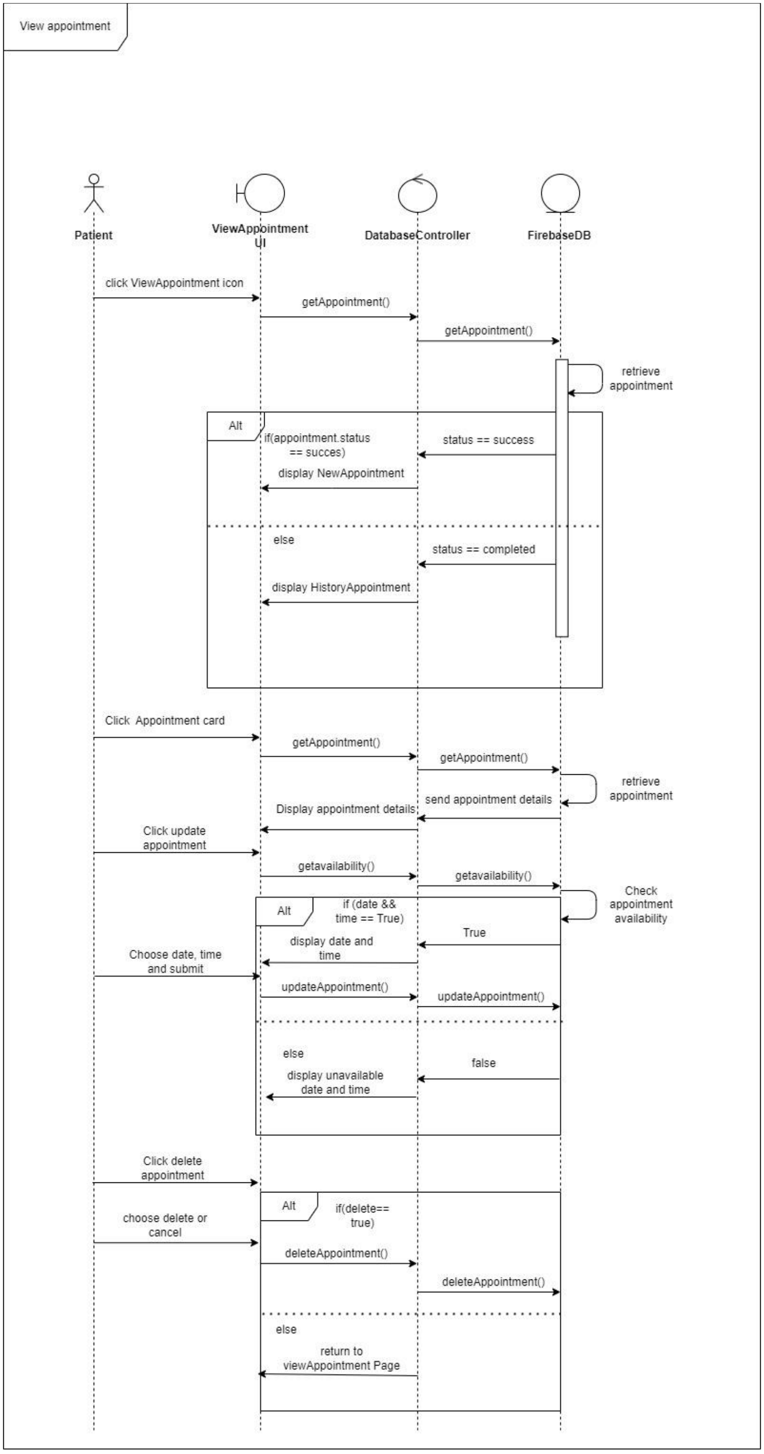
Responsibilities

This operation will enable patient to book an appointment. The system will display the available specialist and the doctor within the specialist. Then, it will display the available date and time for the doctor selected.

Constraint

Patient can only book the available date and time for a doctor. If the date and time are already being book the button will disable and turn into red.

3.4 View Appointment



Definition

This operation is where patient insert email and password.

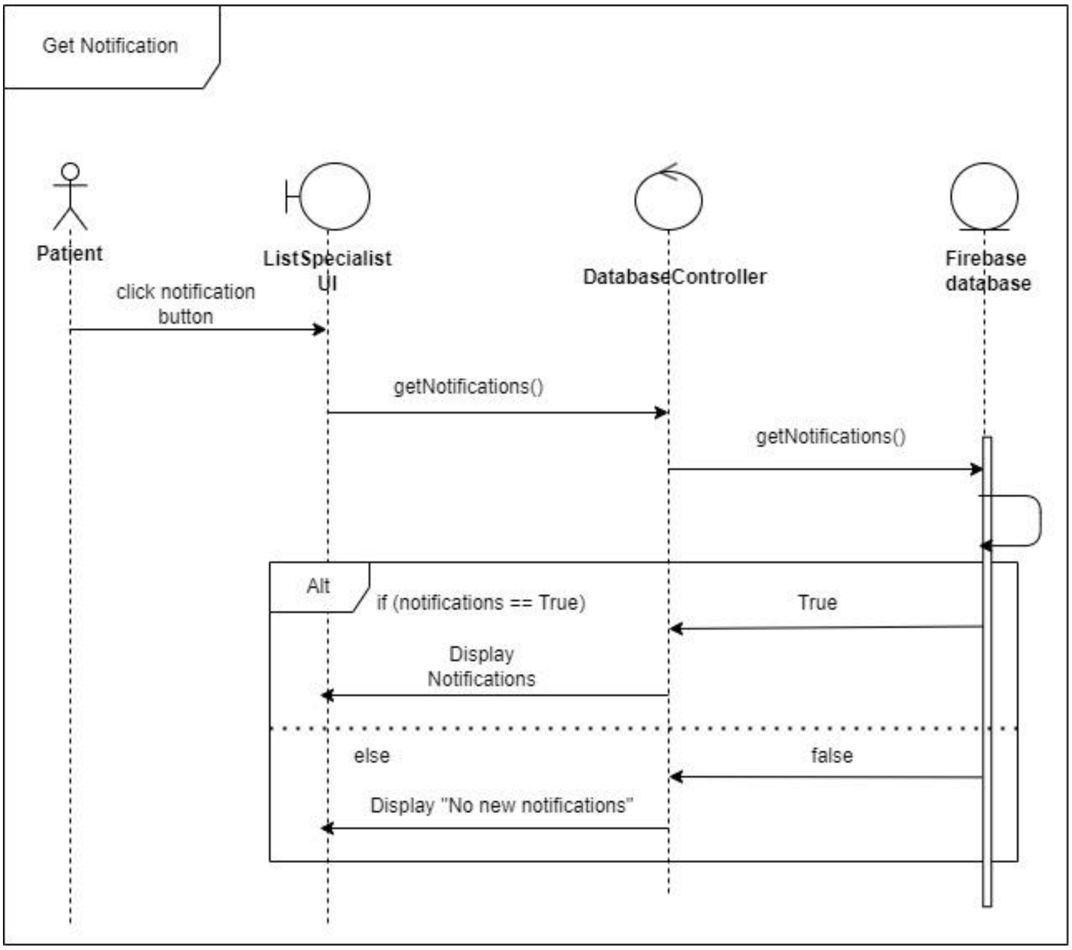
Responsibilities

This operation will verify either patient has an account within the system or not creating any account before. If the patient is in the system and entering the correct email and password, the system will give access for patient to enter the system.

Constraint

Patients need to create an account first before log in to the system.

3.5 Get Notification



Definition

This operation is where patient receive notification from nurse or hospital staff

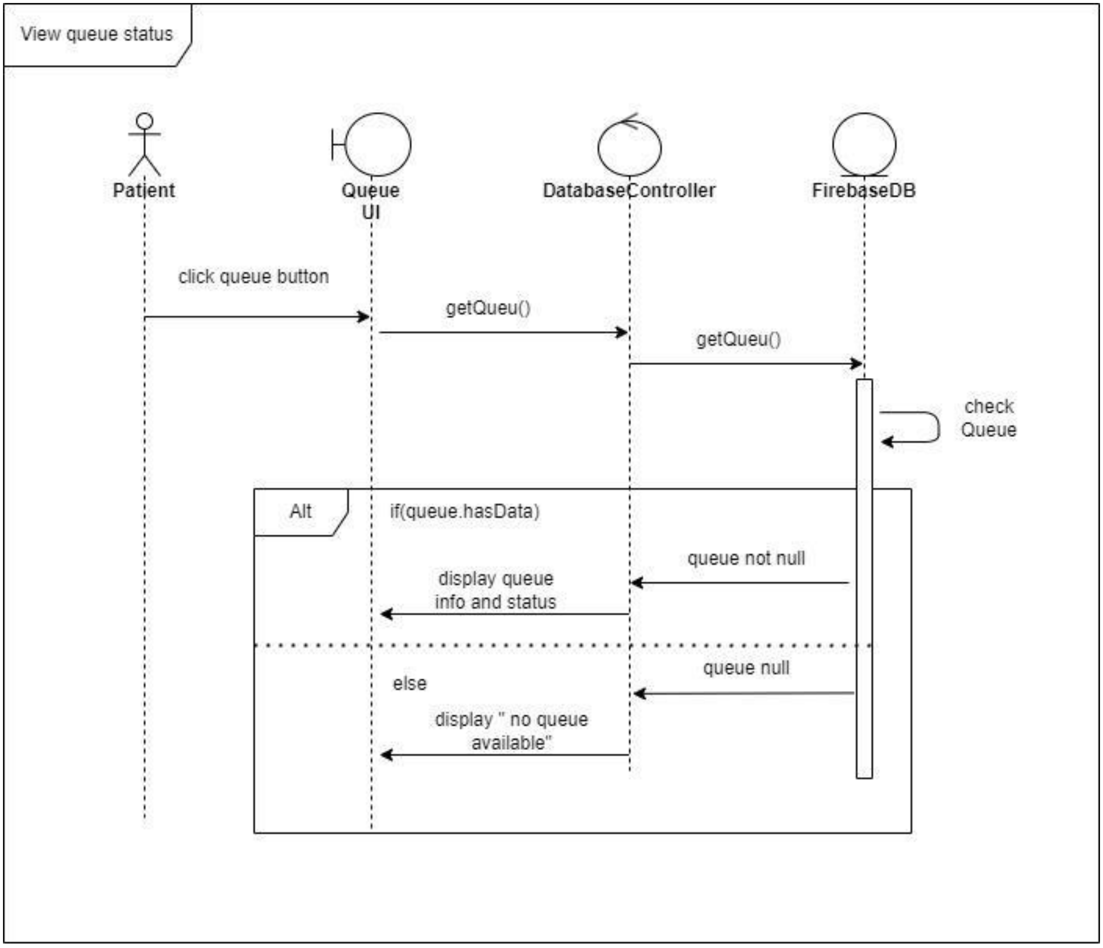
Responsibilities

This operation will display the notification in the notification page if the patient has any notifications.

Constraint

Notification needs to be created by nurse or hospital staff.

3.6 View Queue Status



Definition

This operation is where patient could see their queue number in the system.

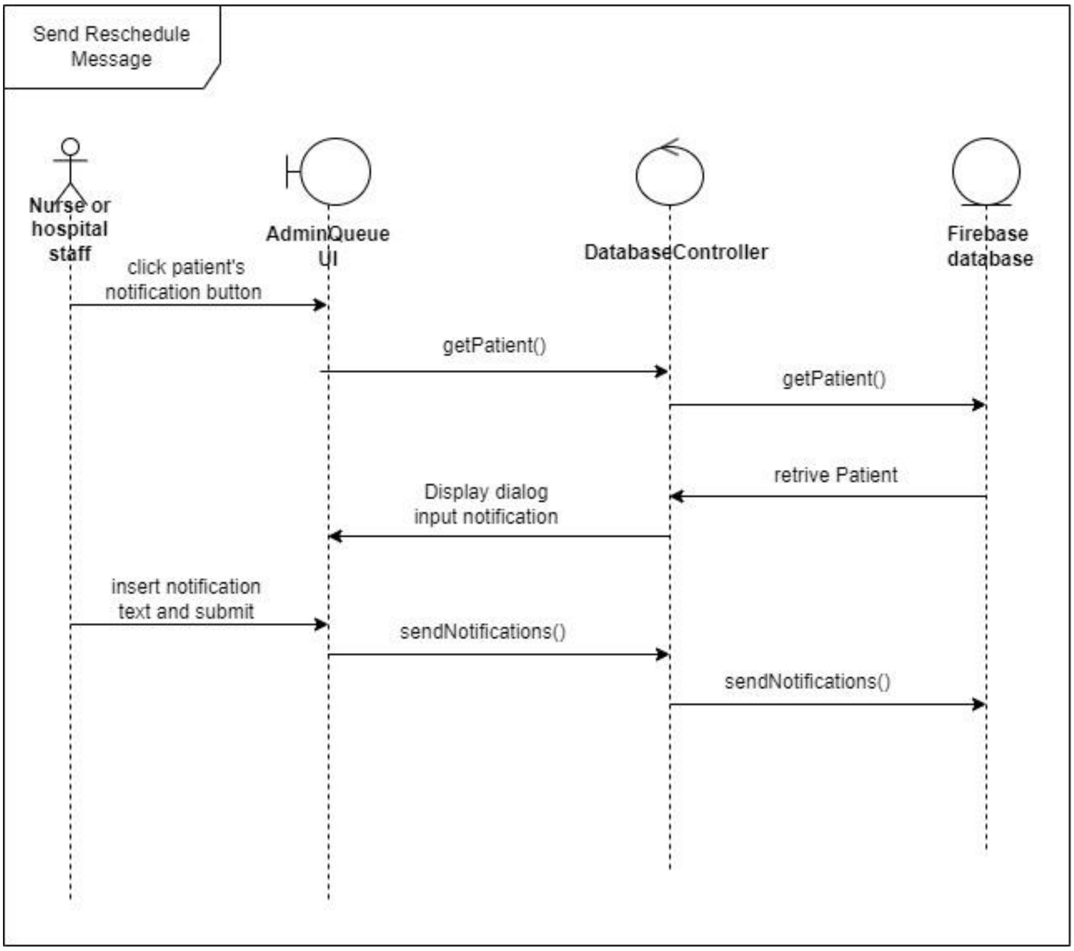
Responsibilities

This operation will display the patient position in queue and its expected waiting time based on the appointment time with doctor.

Constraint

The queue progress can only be seen by patient after nurse assigned the patient into the consultation room.

3.7 Send Reschedule Message



Definition

This operation is nurse will create notification for patients.

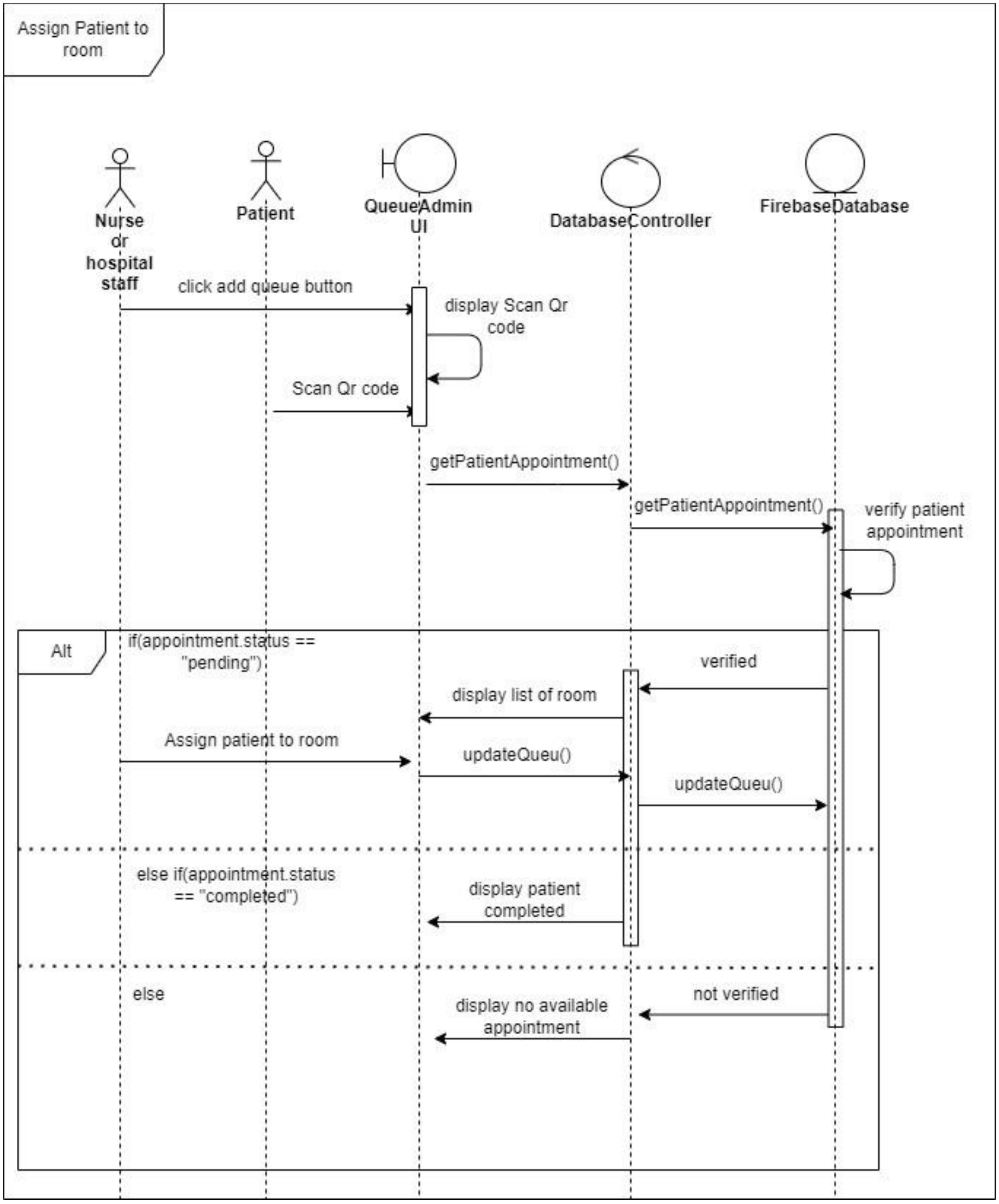
Responsibilities

This operation will enable nurse or hospital staff to create a notification for informing patient about their reschedule appointment.

Constraint

Nurse or hospital staff can only send notification to patient that has created appointment in the system

3.8 Assign Patient to room



Definition

This operation is where Nurse assigned patient into their consultation room.

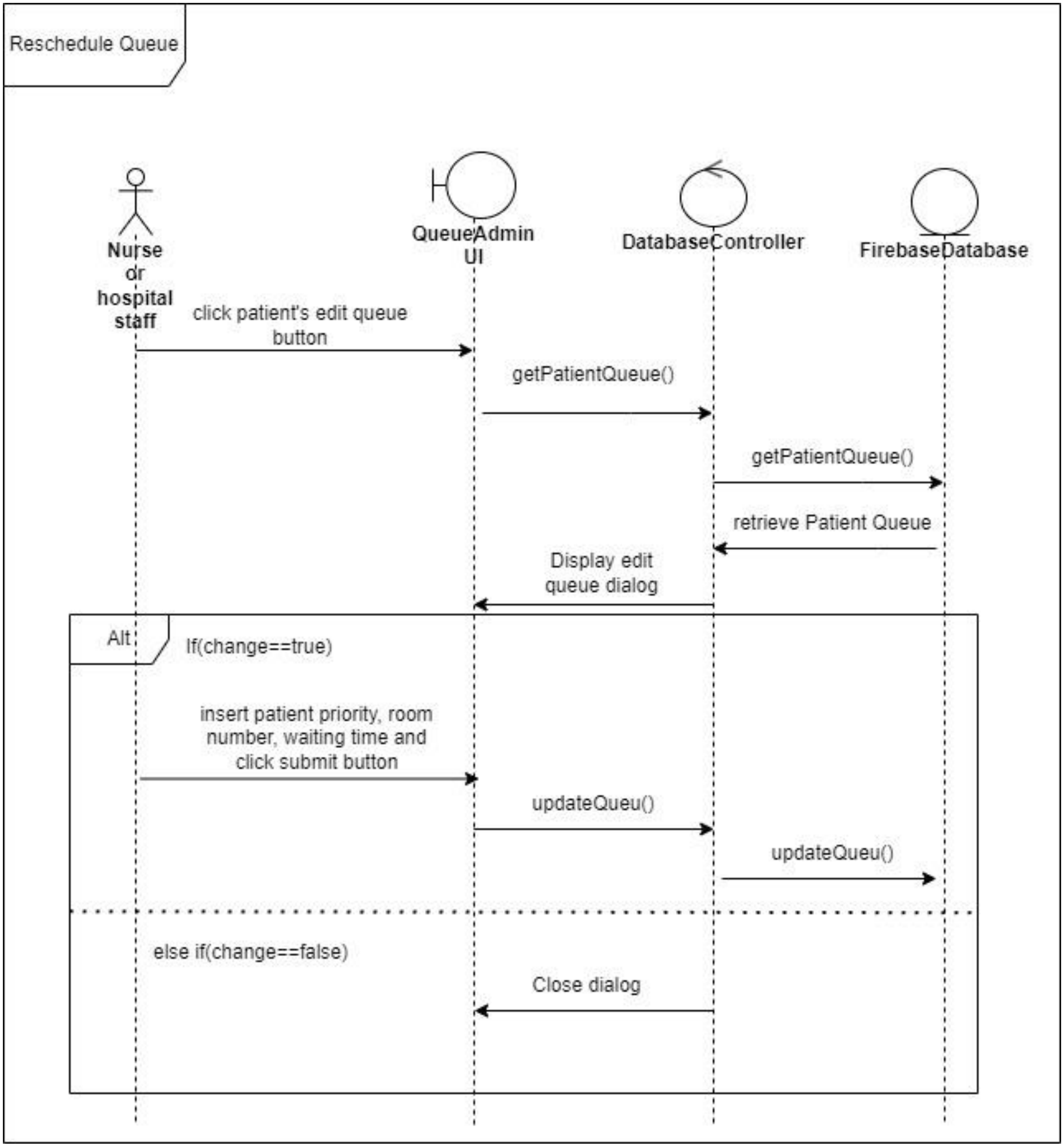
Responsibilities

This operation enable nurse to insert patient consultation room and their expected waiting time to enable patient to see their queue progress.

Constraint

Only patient with appointment can be assigned by the nurse into the consultation room.

3.9 Reschedule Queue



Definition

This operation is where nurse or hospital staff reschedule patient queue.

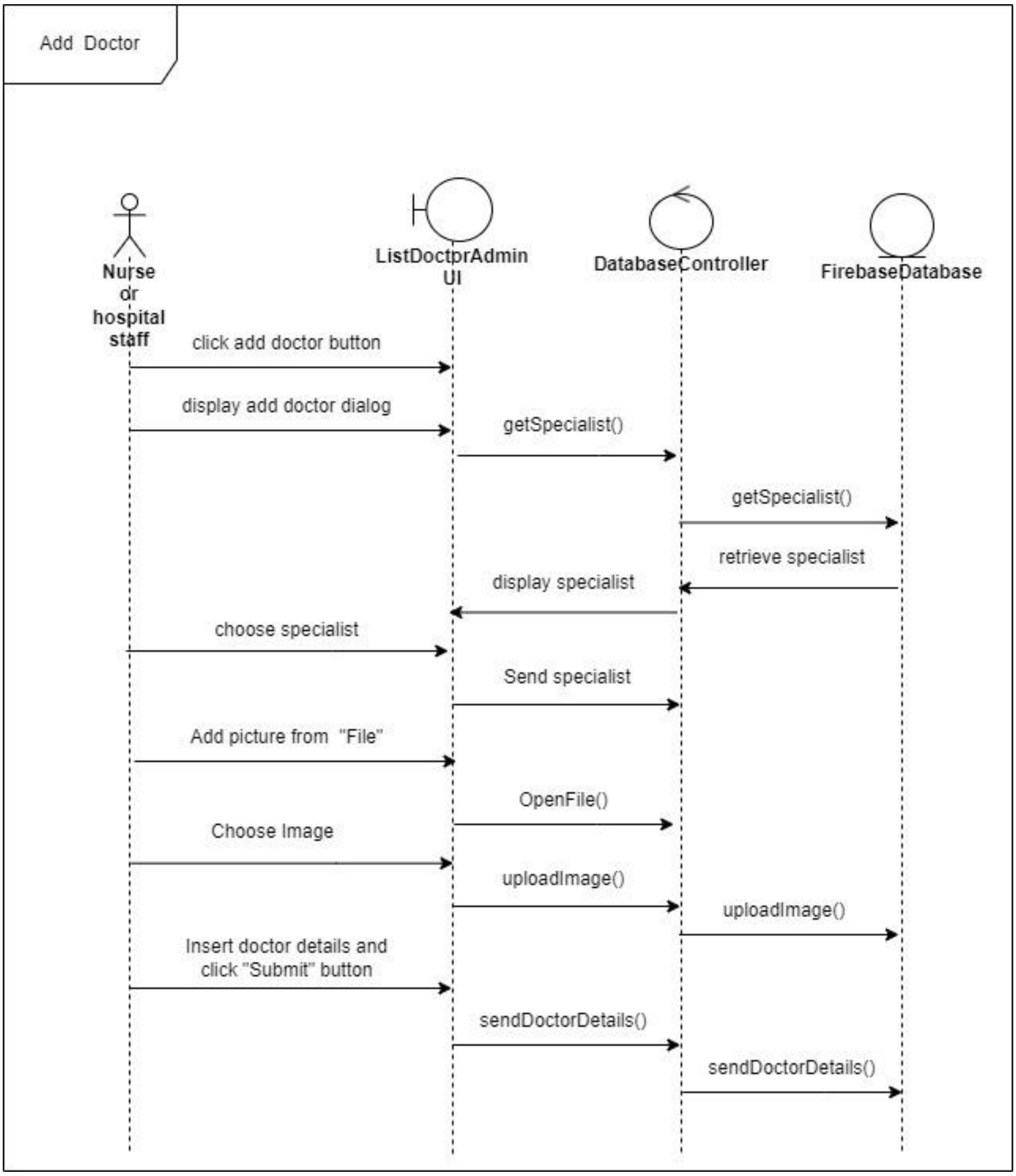
Responsibilities

This operation will enable nurse or hospital staff to change patients' queue based on the priority and waiting time.

Constraint

Queue can only reschedule by nurse or hospital staff if the patient is already in the queue system.

3.10 Add Doctor



Definition

This operation is nurse or hospital staff can add new doctor into the system

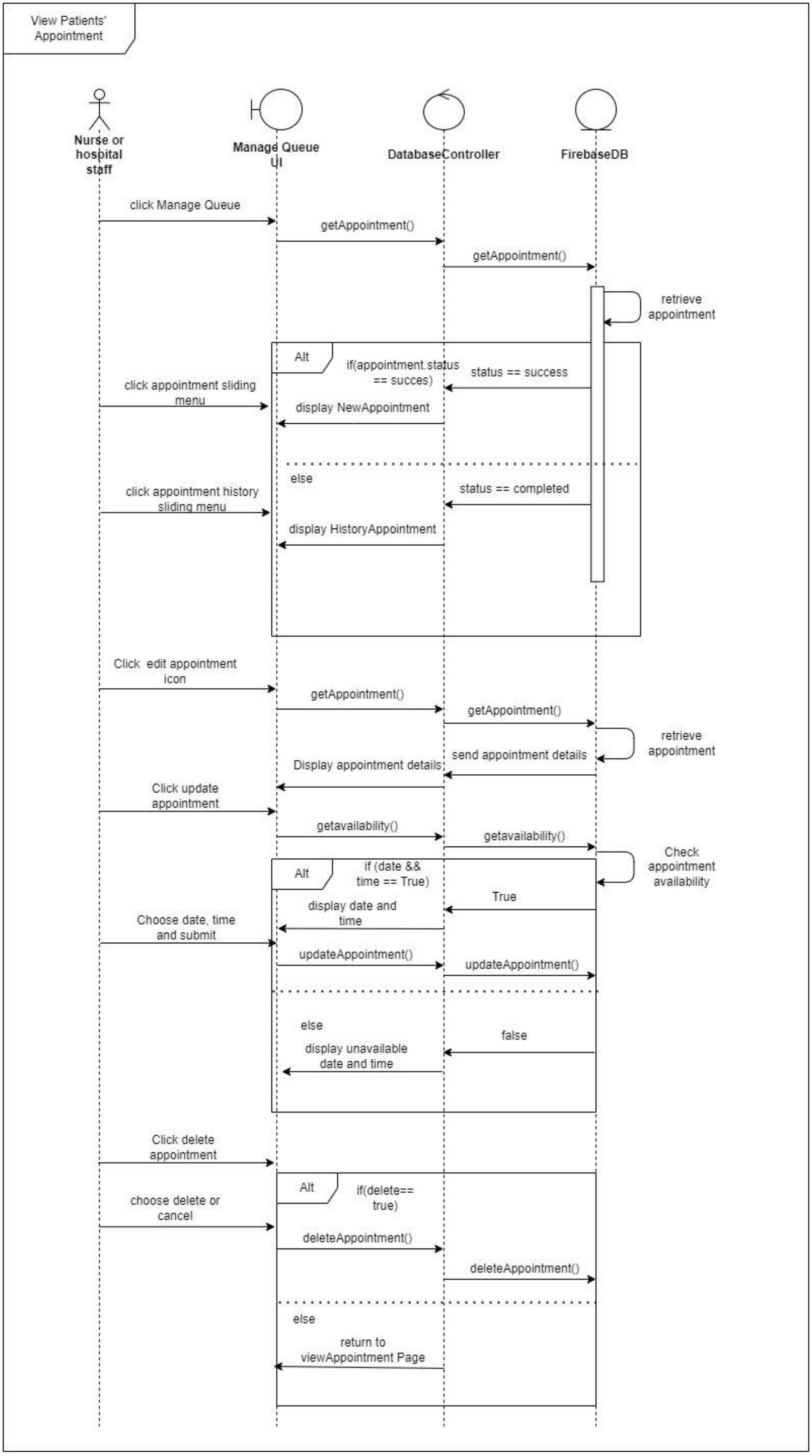
Responsibilities

This operation will enable to add a new doctor into the system by entering doctor name, specialist, description, working time and image of the doctor.

Constraint

None

3.11 View Patients Appointment



Definition

This operation is nurse or hospital staff can view upcoming and history patients' appointment. Other than that, it enables nurse or hospital staff to edit and delete patients' appointment

Responsibilities

This operation will enable to nurse or hospital staff to view, edit and delete patients' appointment. Those appointment can be rescheduled by edit the date and time based on the availability and cancel the appointment by delete it.

Constraint

none

4 System Architecture and Detailed Design

4.1 Architecture Design

The system architectural pattern selected is Model-View-View Model (MVVM) for building both mobile and Web system. MVVM aids in the organisation of code and the division of programs into modules, making development, updating, and reusing code easier and faster. This design pattern is useful for developing an application with flutter framework and a firebase back-end. The separation of code in MVVM is divided into View, ViewModel and Model:

- **View**

  collection of visible elements, which also receives user input. This includes user interfaces (UI), animations and text. The content of View is not interacted with directly to change what is presented.
- **ViewModel**

  located between the View and Model layers. This is where the controls for interacting with View are housed, while binding is used to connect the UI elements in View to the controls in ViewModel.
- **Model**

  houses the logic for the program, which is retrieved by the ViewModel upon its own receipt of input from the user through View.

There are several advantages when using this MVVM architecture.

Maintainability

- **Separation of concern**

  Separation between the different part of component of source code brings a level of structure and uniformity to the code. The system will be easy to maintain where the components is independent from each other.

- **Code reuse**

  It allows the use of reuse between different layers of codes. The idea of separation makes the code useful for other part of function and with the help of ViewModel that are strongly tied to something in the view Layer of the system.

Testing

- **Ease of testing**

  MVVM should break the coupling between the application logic and the UI, making testing easier. All testing should not be done through the UI, making tests faster and easier to set up and run.

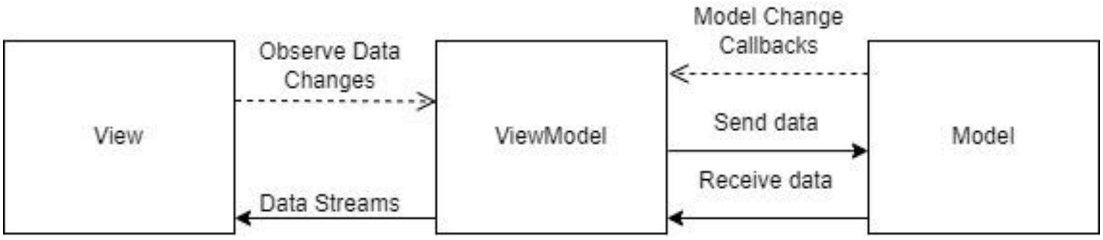


Figure 4.1 MVVM Design Pattern

Based on the diagram on figure 4.1 it shows that there are three layers which consist of View, ViewModel, and Model. These layers will interact to retrieve and send data in the system.

There is a better view of the architectural design for this system that shows how the design pattern will help the system to run efficiently Which could be see in the figure below.

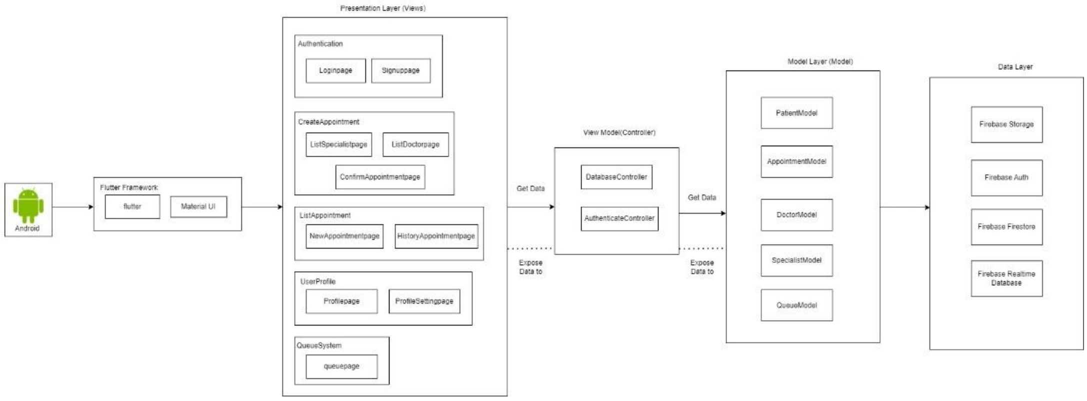


Figure 4.2 MVVM Mobile Application

Figure 4.2 shows the interaction between component in AQHealth mobile application. DatabaseController (ViewModel) is the middle layer for any component in presentation or view layer to stream data from the model layer. Then, model layer will interact directly with the database to receive or send data when changes happen.

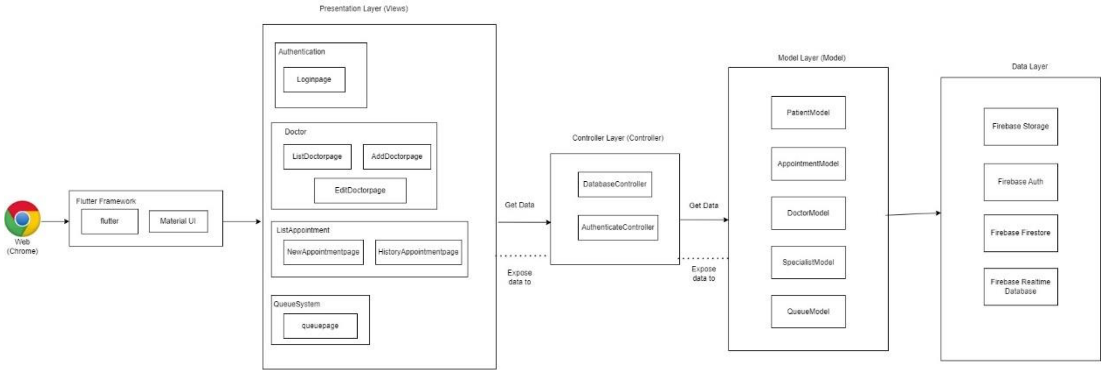


Figure 4.3 MVVM Web System

Figure 4.3 shows the architectural pattern MVVM implemented in the web system which running in the chrome browser. The web system also uses flutter framework with MVVM design pattern. This pattern helps to ensure the system can easily understand and add new features into this system.

5 Database Design

Entity relationship diagrams graphically depict the interactions between entities in a database (ERDs). An entity is a real-world object or idea that can be represented in a database. Entities include people, businesses, and projects. The relationships between the entities are represented by the lines that connect them. The type of sentence used reveals the strength of the relationship. A strong connection may be represented by a solid line, whereas a weak connection may be represented by a dotted line. Because ERDs are used to build and document database systems, they can be useful for understanding how data is organised and used within a system. The entity relationship diagram for Computer Maintenance System (CMS) includes the entity, attributes, and the relationship between entity.

5.1 Data Model

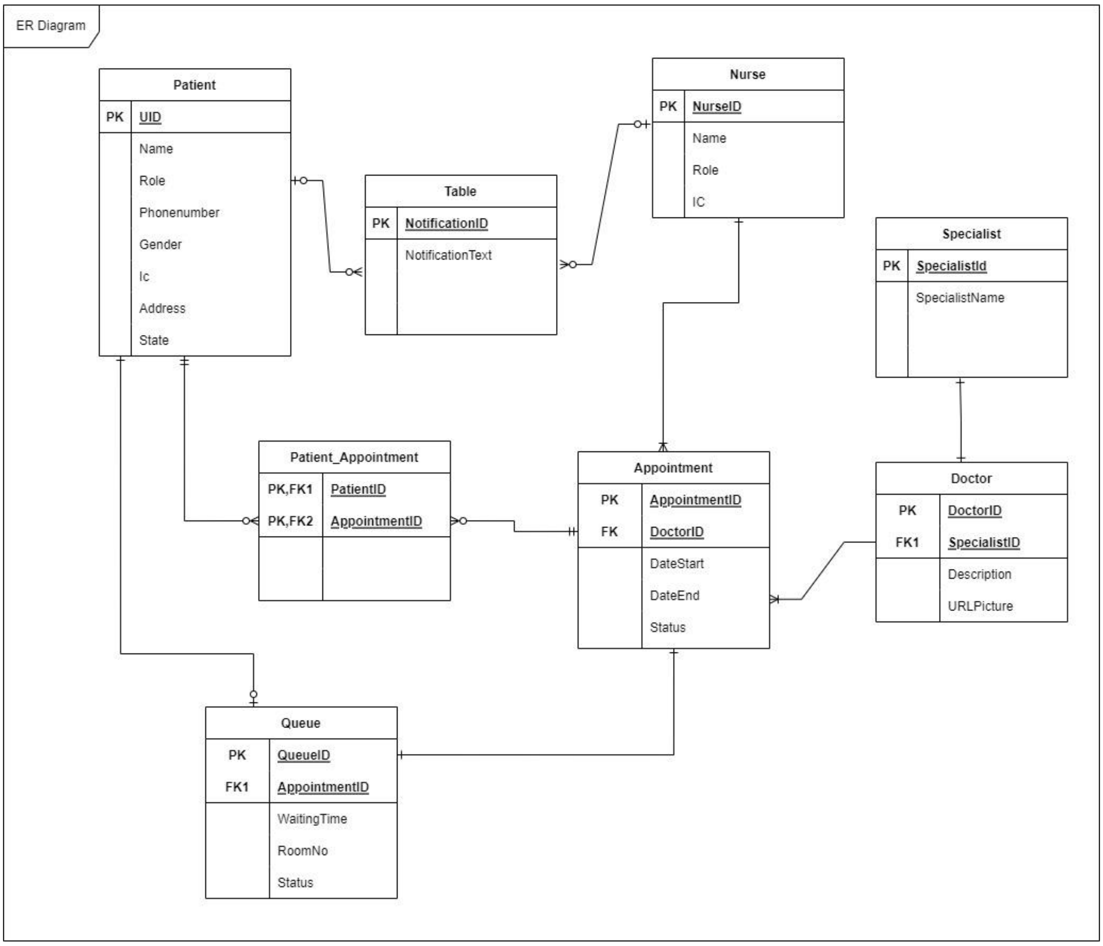


Figure 5.1 ERD Diagram

Figure 5.1 show the entity relationship diagram for Appointment Management System: AQHealth. Patient has many to many relationships with Appointment, however, Patient only has one to one relationship with the Queue table. Each doctor can only have one specialist and many appointments can be assigned into one doctor. One nurse or hospital staff can create many notifications. While one patient can have many notifications. Lastly, A nurse or hospital staff can manage many appointments at a time.

5.2 Data Dictionary

Patient

PatientID	name	role	phone_number	gender	ic	address	state

Nurse

NurseID	Nurse_name	role	ic

Doctor

DoctorID	specialistID	doctor_name	description	photo_url

Specialist

SpecialistID	specialist_name

Appointment

AppointmentID	DoctorID	date_start	date_end	status

Queue

QueueID	AppointmentID	room_no	waiting_time	status

Patient_Appointment

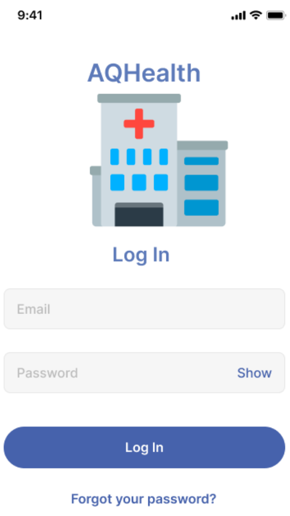
PatientID	AppointmentID

6 Human Interface Design

6.1 Overview User Interface

The designing of user interfaces is followed with the role of the users. This includes factors such as their goals and tasks, and the context in which they will be using the interface. Additionally, the role of the user should also inform the layout, navigation, and overall functionality of the interface. It is important for them to understand the user's roles and requirements to create an effective and efficient user interface.

6.2 Mobile Interface



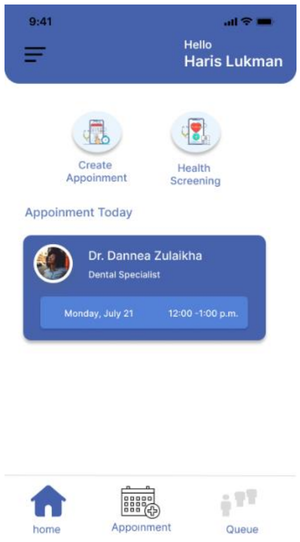


Figure 6.2.1 Login page

Figure 6.2.2 Home Page

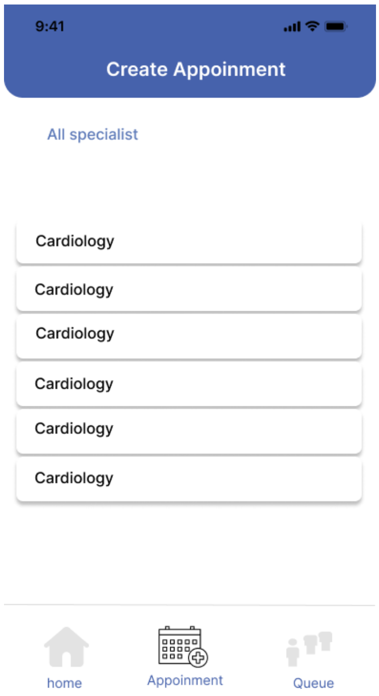
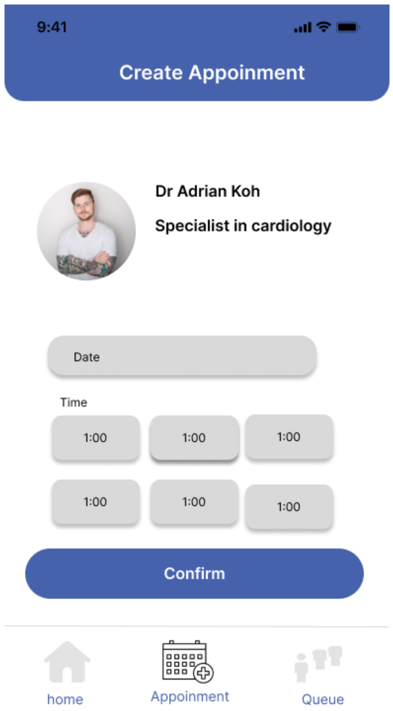
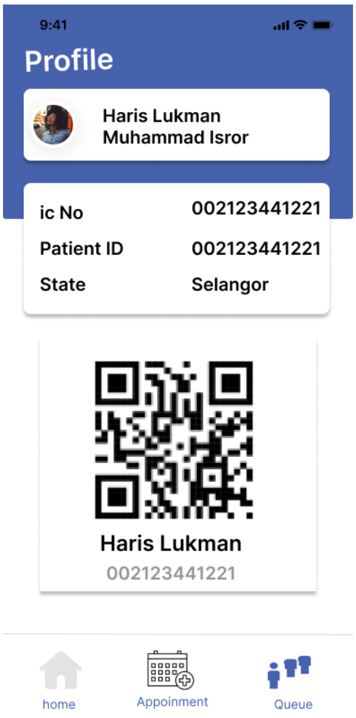


Figure 6.2.3 List Specialist Page



6.2.4 Confirm Appointment Page

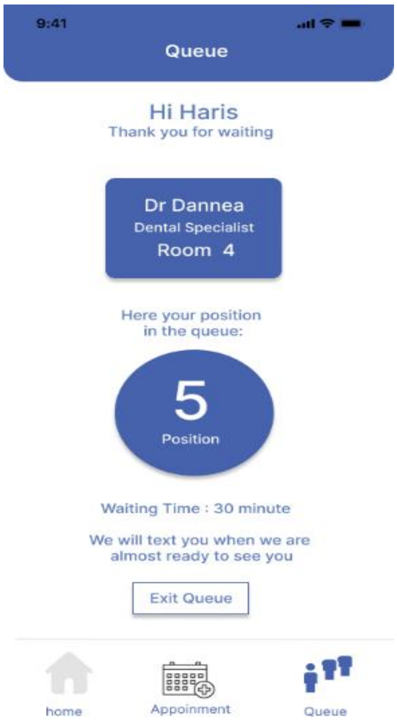


Haris Lukman Muhammad Isror

ic No	002123441221
Patient ID	002123441221
State	Selangor

Haris Lukman
002123441221

Figure 6.2.5 Profile Page



Hi Haris
Thank you for waiting

Dr Dannea
Dental Specialist
Room 4

Here your position in the queue:

5
Position

Waiting Time : 30 minute

We will text you when we are almost ready to see you

Figure 6.2.6 Queue Page

6.2 Web Interface

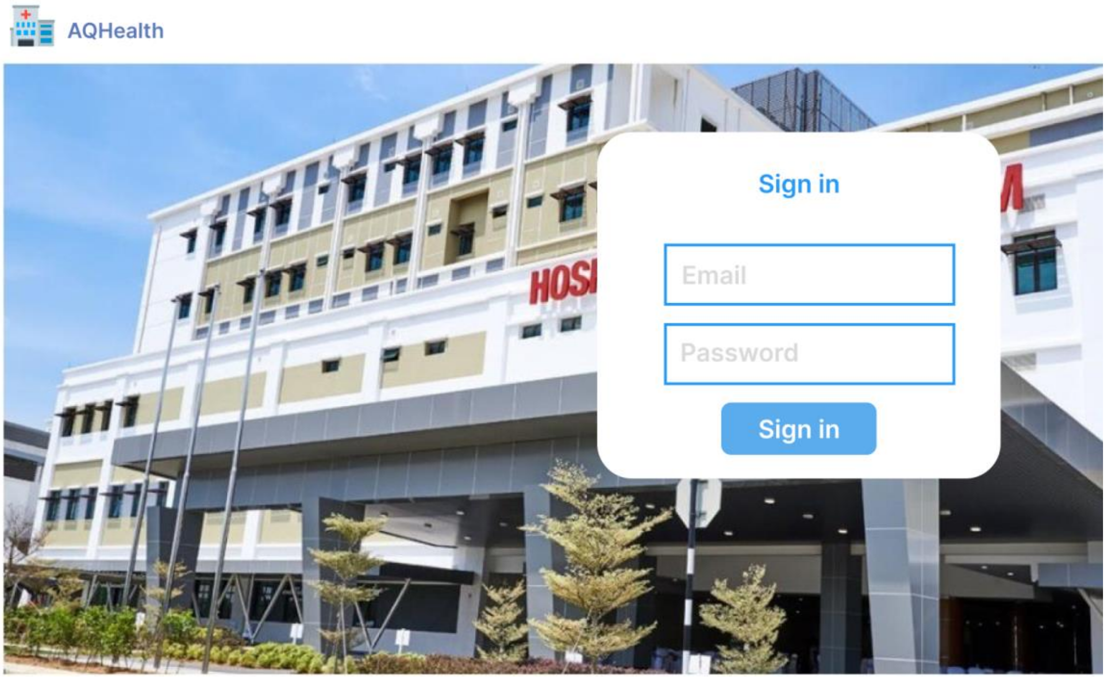
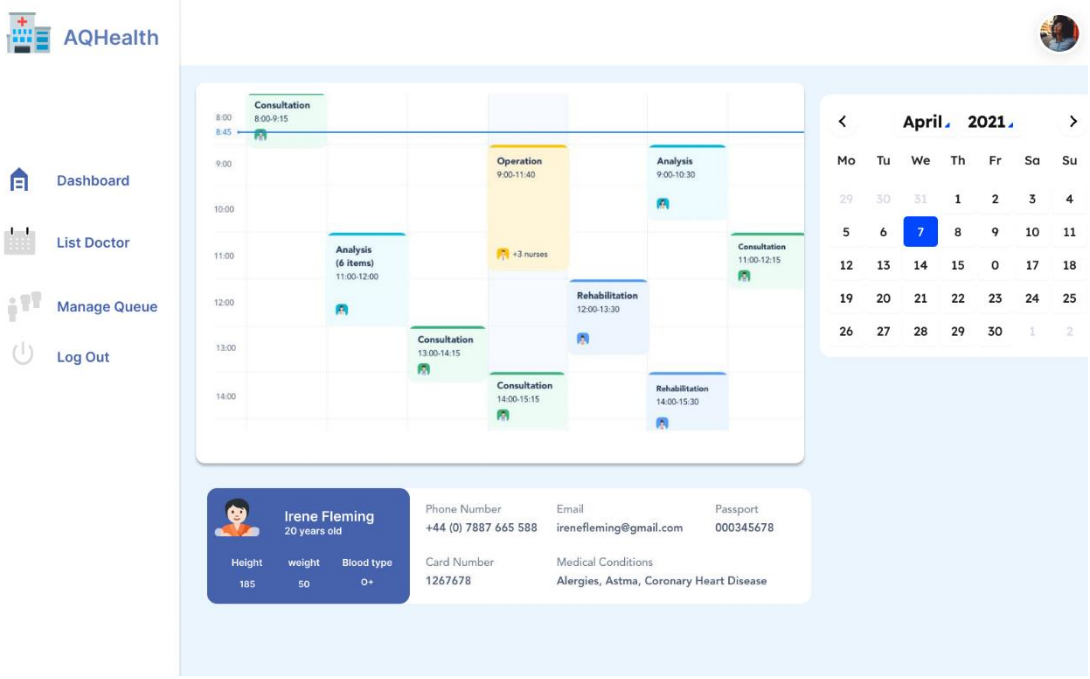


Figure 6.2.1 Web Login Page



8:00
8:45
9:00
10:00
11:00
12:00
13:00
14:00

Consultation
8:00-9:15

Analysis
(6 items)
11:00-12:00

Consultation
13:00-14:15

Operation
9:00-11:40
+3 nurses

Consultation
14:00-15:15

Rehabilitation
12:00-13:30

Analysis
9:00-10:30

Rehabilitation
14:00-15:30

Consultation
11:00-12:15

April 2021

Mo	Tu	We	Th	Fr	Sa	Su
29	30	31	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	0	17	18
19	20	21	22	23	24	25
26	27	28	29	30	1	2

Irene Fleming
20 years old

Height	weight	Blood type
185	50	O+

Phone Number
+44 (0) 7887 665 588

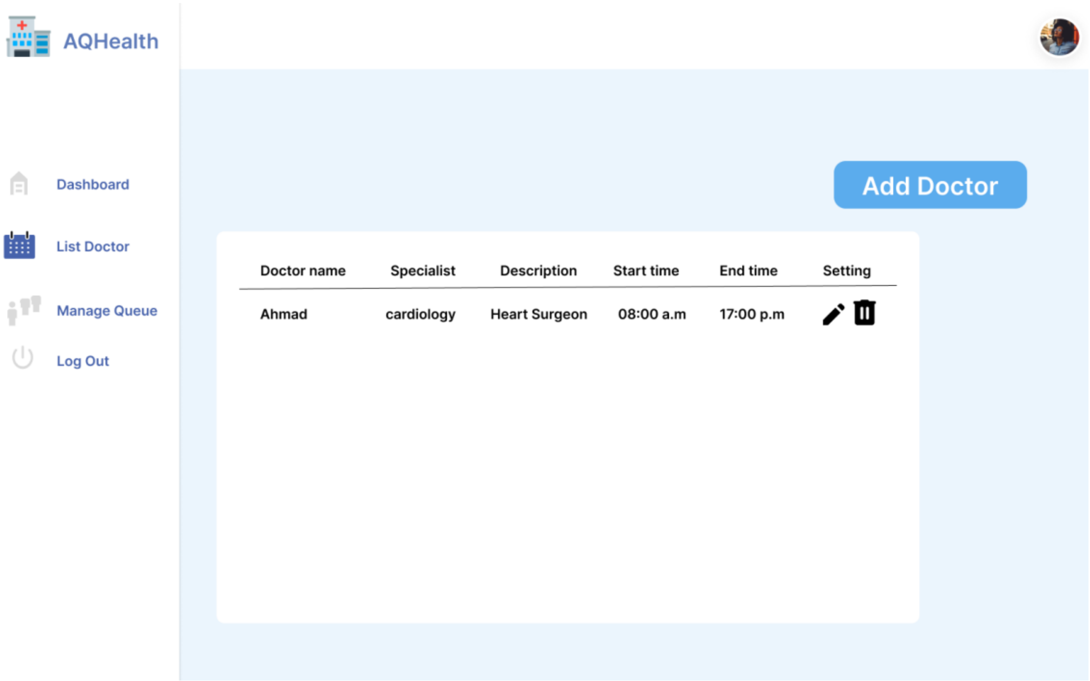
Email
ireneflemng@gmail.com

Passport
000345678

Card Number
1267678

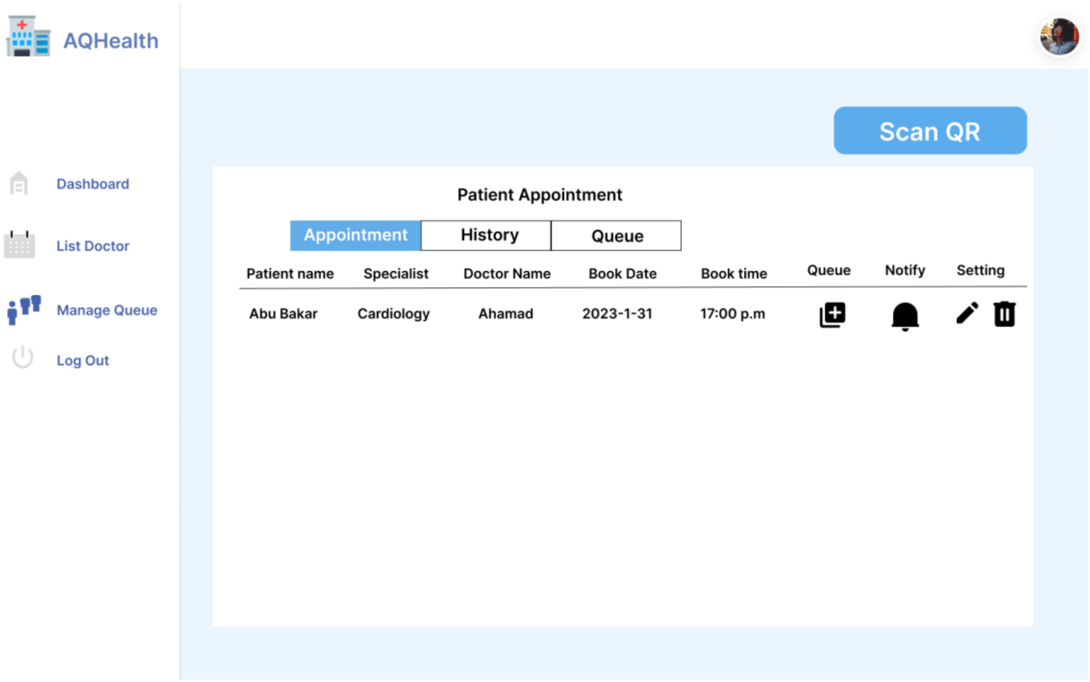
Medical Conditions
Alergies, Astma, Coronary Heart Disease

Figure 6.2.2 Dashboard Page



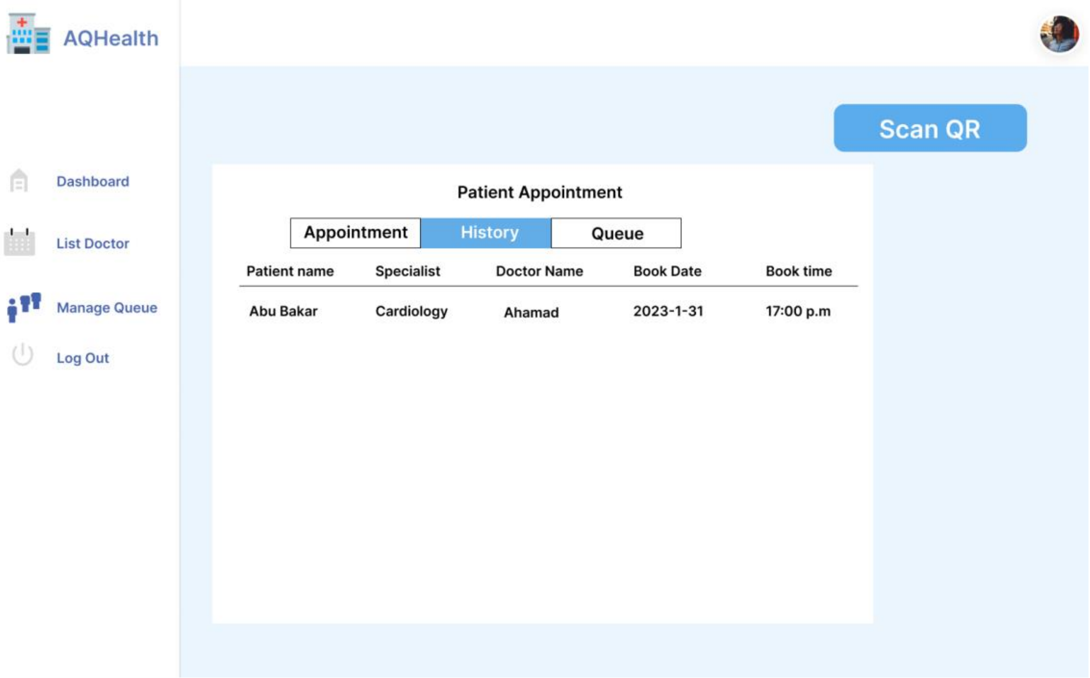
Doctor name	Specialist	Description	Start time	End time	Setting
Ahmad	cardiology	Heart Surgeon	08:00 a.m	17:00 p.m	✎ 🗑

Figure 6.2.3 List Doctor Page



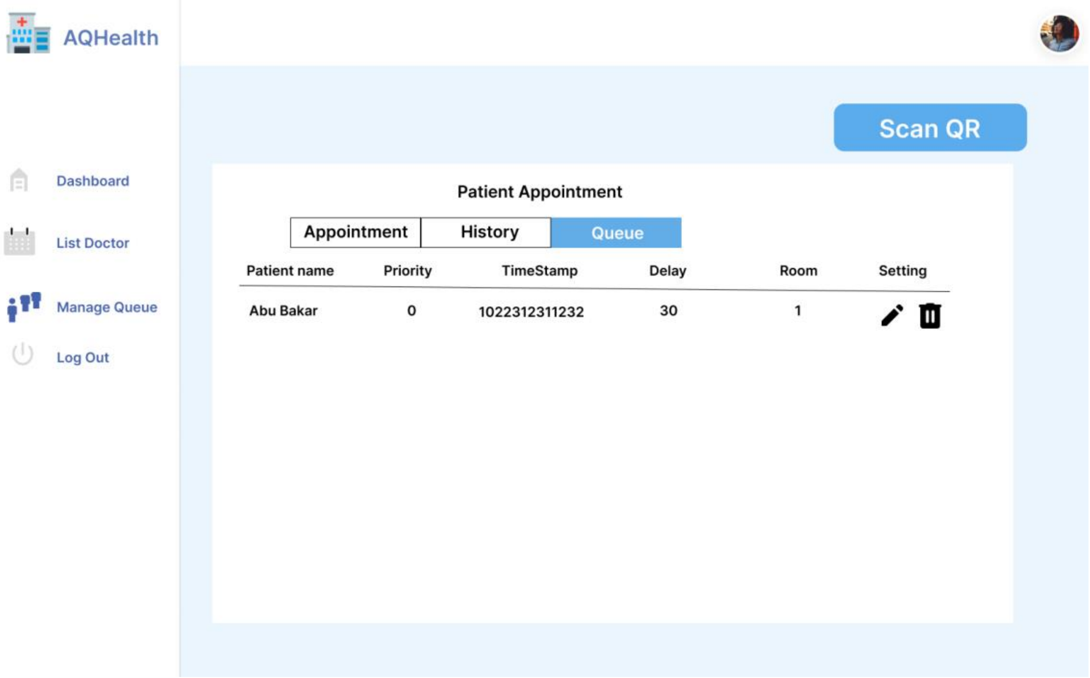
Patient name	Specialist	Doctor Name	Book Date	Book time	Queue	Notify	Setting
Abu Bakar	Cardiology	Ahamad	2023-1-31	17:00 p.m	⊞	🔔	✎ 🗑

Figure 6.2.4 List Appointment Page



Patient name	Specialist	Doctor Name	Book Date	Book time
Abu Bakar	Cardiology	Ahamad	2023-1-31	17:00 p.m

Figure 6.2.5 List Appointment History Page



Patient name	Priority	TimeStamp	Delay	Room	Setting
Abu Bakar	0	1022312311232	30	1	✎ 🗑

Figure 6.2.6 Queue Page