PATIENT APPOINTMENT SCHEDULING SYSTEM

By

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A REPORT

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ABSTRACT

This is a development-based project, and the area of study is Information System. This project focuses on building a Patient Appointment Scheduling System for academic purposes. This project is a platform to let patients make appointments for consultation and treatment, while also enables doctors to manage the appointment schedule more efficiently. Furthermore, providers who sign up for the system will be able to add their doctors. The system handles typical problems such as unclear appointment status, fragmented appointment process, and limited provider accessibility. Patients are allowed to view the profiles of the doctors before choosing their preferred and most suitable time slots, ensuring a smoother and more transparent appointment procedure. This is due to the fact that the system is a one-stop solution, which prioritizes user-friendliness and improves the overall experience for both patients and healthcare providers. The technologies that will be used in the system include Visual Studio 2022 ASP.NET Core (C#), and Microsoft SQL Server. The system investigates color classification methods to clearly represent appointment statuses in order to further enhance visualization clarity and avoid misunderstanding.

Area of Study: Patient appointment management, booking system

Keywords: available slot, wider network accessibility, patient appointment, color classification, appointment status

TABLE OF CONTENTS

TITLE PAGE i

COPYRIGHT STATEMENT ii

ACKNOWLEDGEMENTS iii

ABSTRACT iv

TABLE OF CONTENTS v

LIST OF FIGURES vii

LIST OF TABLES viii

LIST OF ABBREVIATIONS xi

CHAPTER 1 INTRODUCTION 1

1.1 Problem Statement 2

1.2 Motivation 4

1.3 Project Objectives 5

1.4 Project Scope and Direction 7

1.5 Contribution 9

1.6 Report Organization 10

CHAPTER 2 LITERATURE REVIEW 11

2.1 System Review 11

2.1.1 Zocdoc 11

2.1.2 Healthgrades 13

2.1.3 DoctorOnCall 15

2.2 Limitation of Previous Studies 17

2.3 Proposed Solutions 18

CHAPTER 3 SYSTEM METHODOLOGY/APPROACH 20

3.1 Methodology 20

3.2 System Design Diagram 22

3.2.1 Use Case Diagram 22

3.2.2 Activity Diagram 23

3.2.2.1 Patient Module Activity Diagram 23
3.2.2.2 Doctor Module Activity Diagram 24
3.2.2.3 Provider Module Activity Diagram 25
3.2.3 Web Application Architecture Diagram 26

CHAPTER 4 SYSTEM DESIGN
4.1 System Block Diagram 27
4.2 Entity Relationship Diagram 29
4.3 Wireframe 30

CHAPTER 5 SYSTEM IMPLEMENTATION
5.1 Hardware Setup 32
5.2 Software Setup 33
5.3 Setting and Configuration 33
5.4 System Operation (with Screenshot) 34
5.4.1 Landing Page 34
5.4.2 Patient Module 38
5.4.3 Doctor Module 44
5.4.4 Provider Module 49
5.5 Implementation Issues and Challenges 57

CHAPTER 6 SYSTEM EVALUATION AND DISCUSSION
6.1 System Testing and Performance Metrics 58
6.2 Project Challenges 62
6.3 Objectives Evaluation 62

CHAPTER 7 CONCLUSION AND RECOMMENDATION
7.1 Conclusion 63
7.2 Recommendation 63

REFERENCES 64

POSTER 67

LIST OF FIGURES

Figure Number	Title	Page
Figure 1.1	Block Diagram	1
Figure 2.1.1.1	Zocdoc Logo	11
Figure 2.1.1.2	Insurance Plans	11
Figure 2.1.1.3	Unclear Color Classification for Appointment Type	12
Figure 2.1.2.1	Healtgrades Logo	13
Figure 2.1.2.2	Healthgrades Family Doctors	13
Figure 2.1.2.3	Healthgrades Phone Call Appointment	14
Figure 2.1.3.1	DoctoronCall Logo	15
Figure 2.1.3.2	Well-organized Layout	15
Figure 2.1.3.3	Limited Partnership	16
Figure 3.2.1.1	Use Case Diagram	22
Figure 3.2.2.1	Patient Module Activity Diagram	23
Figure 3.2.2.2	Doctor Module Activity Diagram	24
Figure 3.2.2.3	Provider Module Activity Diagram	25
Figure 3.2.3.1	Web Application Architecture Diagram	26
Figure 4.1.1	Patient Block Diagram	27
Figure 4.1.2	Doctor Block Diagram	27
Figure 4.1.3	Provider Block Diagram	28
Figure 4.2.1	Entity Relationship Diagram	29
Figure 4.3.1	Patient Search Available Slot	30
Figure 4.3.2	Doctor View Upcoming Appointment	30
Figure 4.3.3	Provider Add Doctor	31
Figure 5.4.1.1	Hero Section of Landing Page	34
Figure 5.4.1.2	Categorized Features Section of Landing Page	35
Figure 5.4.1.3	How It Works Section of Landing Page	35
Figure 5.4.1.4	Our Doctors Section of Landing Page	36
Figure 5.4.1.5	Our Providers Section of Landing Page	36
Figure 5.4.1.6	Our Insurance Providers Section of Landing Page	37
Figure 5.4.1.7	Footer of Landing Page	37
Figure 5.4.2.1a	Patient Register Page	38
Figure 5.4.2.1b	Patient Login Page	38
Figure 5.4.2.1c	Forget Password	39

Figure 5.4.2.2	Patient Home Page	39
Figure 5.4.2.3	View Available Doctor	40
Figure 5.4.2.4	View Doctor Details and Appointment Slot	40
Figure 5.4.2.5	My Appointment Page	41
Figure 5.4.2.6	Patient Profile Page	42
Figure 5.4.2.7	Patient Update Profile Page	43
Figure 5.4.3.1	Doctor Login Page	44
Figure 5.4.3.2	Doctor Home Page	44
Figure 5.4.3.3	Add Available Slot Page	45
Figure 5.4.3.4	Add Slot Container	46
Figure 5.4.3.5	Upcoming Appointment Page	47
Figure 5.4.3.6	View Patient Detail Page	47
Figure 5.4.3.7	Doctor Profile Page	48
Figure 5.4.4.1	Provider Register Page	49
Figure 5.4.4.2	Provider Login Page	50
Figure 5.4.4.3	Provider Home Page	50
Figure 5.4.4.4	Provider Add Doctor Page	51
Figure 5.4.4.5	View Doctor List	52
Figure 5.4.4.6	Update Doctor Profile	53
Figure 5.4.4.7	View Patient List	54
Figure 5.4.4.8	Provider Profile Page	55
Figure 5.4.4.9	Provider Update Profile	56

LIST OF TABLES

Table Number	Title	Page
Table 2.2	Comparison between Existing System and Proposed System	17
Table 5.1.1	Specifications of Laptop	32
Table 5.1.2	Software and Technologies	33
Table 6.1.1	Register Account Testing	58
Table 6.1.2	Forget Password Testing	58
Table 6.1.3	Login Testing	59
Table 6.1.4	Patient Search and Filter Testing	59
Table 6.1.5	Patient Make Appointment Testing	60
Table 6.1.6	Doctor Add Available Slot Testing	61
Table 6.1.7	Provider Add Doctor Testing	61

CHAPTER 1

Introduction

A **Patient Appointment Scheduling System** is an online system that allows patients to book medical consultation and treatment with doctors. This system is designed to streamline the process of planning, managing and optimizing patient appointments, ensuring that healthcare providers can efficiently allocate resources and enhance the overall patient experience. Originally, patient scheduling relied on a traditional paper-based system, where healthcare staff manually record and manage appointments in books or calendars. As technology advanced, these systems have grown into basic computer-based solutions, such as standalone scheduling software. With further technological advancements, modern online patient appointment scheduling systems have improved, offering improved efficiency, accessibility and convenience. Some of the examples of Patient Appointment Scheduling System are Zocdoc [1], Healthgrades [2], and DoctorOnCall [3].

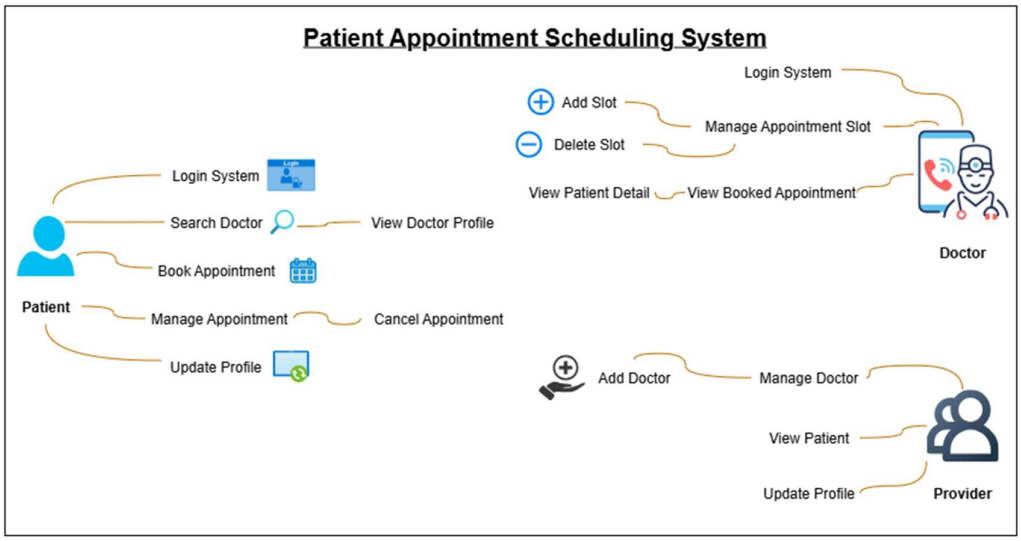

Figure 1.1 Block Diagram

1.1 Problem Statement

In this section, we will discuss the problem statement that has been research on the existing system. These problems can directly or indirectly affect the user experience and satisfaction of the system.

The first problem statement is **unclear differentiation of appointment types**. The current systems rely on color to represent the appointment types and status, whether a slot is for an in-person visit or video visit or the appointment has been booked. This makes it difficult and misunderstanding for users to quickly identify the availability and the type of the appointment slot. For instance, a yellow color with a video icon might represent video consultations. This might cause confusion for patients to identify with this system only providing video consultation or in-person visit are also available. Patient difficult to differentiate the appointment types without a clear labelling at the appointment page. Without the clear labelling also causes accessibility concerns for color blind people. So, by integrating the symbols and text labels can convey message effectively. [4]

The second problem statement is that you are **unable to book appointments directly after viewing doctor profiles**. In the current system, patients cannot make an appointment directly from the page after reviewing his or her qualifications and feedback. Instead, patients are required to make a phone call to check the available appointment time slot. This creates an extra step to schedule appointments which make the appointment procedure more difficult and frequently lead to abandoned bookings. When the patients need to make a phone call to inquire about the available time slots, they cannot quickly decide and confirm the appointment time because they might have other plans. This will cause patients to delay decision-making and postpone the consultation.

The third problem statement is the **limited provider partnerships** [9]**.** Platforms that only work with selected hospitals or clinics, this will reduce the options in specialties, locations, and available time slots for patients. This has become troublesome for rural areas where medical service provider options are already limited [5]. The restricted network also reduces scheduling flexibility as

patients have fewer choices of doctors and times. Although selected collaborations might help keep quality standards, they frequently lose accessibility and convenience. On the other hand, an open system gives patients more options for healthcare and more appointment availability.

1.2 Motivation

This project aims to enhance the patient appointment scheduling system for patients, doctors and providers to use. The existing system suffers from a few limitations. By developing an improved patient appointment scheduling system, patients and doctors will be able to clearly differentiate the appointment type and status with different colors and text-labels. Additionally, because there are no restrictions on which providers can join and integrate into the system, patients have more selection of hospitals and clinics to choose from. Patients can also make an appointment for medical checks or consultations after reviewing detailed information about the available doctors. For providers, it can decrease unnecessary phone calls and missed calls throughout the day.

1.3 Project Objectives

Project objectives are defining a specific goal that outlines the project's expected outcome. They provide direction and measurable objective for achievement. Basically, in the project objectives will include describing the purpose of the project, scope of improvement and the expected outcomes.

1. **Improved Appointment Type Clarity**

   The first objective is to improve clarity of appointment types for users. Current platforms use confusing labels to represent appointment types or status. Patients can quickly determine if a time slot is booked or available, as well as whether it is for a video consultation or an in-person visit due to the combination of clear text-labels, icons and color classifications. Patients can quickly understand the available time slots, prevent booking problems and have more seamless and accessible scheduling experience.

2. **Streamline the Appointment Scheduling Process**

   The second objective is enabling direct booking from doctor profiles. Patients can immediately select and confirm an appointment time without navigating away from the profile page or making phone calls. This feature increases patient convenience and efficiency by minimizing the unnecessary steps from the appointment process. By streamlining this procedure, the solution reduces unnecessary administrative work for staff and ensures that availability of appointment slots is displayed clearly and transparently. While phone support might still be provided in certain situations, most patients can make appointments directly through the patient appointment scheduling system faster and more comfortable for everyone.

3. **Expand Provider Network Accessibility**

   The third objective is to expand the system's reach by involving more healthcare providers. To achieve this, the system will develop an open registration system that allows doctors or clinics to join easily. This approach increases patient options and maintains quality standards. By

improving geographical coverage, we will make sure that rural communities where healthcare services are often limited have better access to medical care. This method balance between flexibility and reliability, allowing patients greater choices.

1.4 Project Scope and Direction

The project scope is about developing a web-based patient appointment scheduling system for patients and doctors. This system will include a patient module, a doctor module and a provider module. Each different module has different roles in this patient appointment scheduling system. Patients will be able to search for and make medical appointments. Doctors will be able to add appointment slots, and the provider will manage patient and doctor information. At the end of the project, I intend to improve the features which are appointment type clarity, appointment process, and provider accessibility.

Module 1: Patient Module

The patient module delivers core features that allow patients to use the system to manage their medical appointments. Patients can register for an account, log in to the system securely, and search for doctors either by specialties or by name. Patients can schedule appointments by viewing the available time slots provided by doctors. Patients are allowed to choose the appointment type that matches their needs. In addition, patients can view their upcoming and past appointments through an appointment dashboard. From the dashboard, they can also reschedule or cancel their booked appointment. Patients can modify and manage their profile information in order to have a customized experience.

Module 2: Doctor Module

The doctor module focuses on giving doctors the ability to manage their appointment schedules. Doctors are required to log in to the system to access their dashboard and manage available time slots. They can create, update or delete the appointment slot based on their own schedules and time management preferences. Furthermore, doctors have the flexibility to offer different types of appointments, such as video visits or in-person visits. This not only helps doctors to organize their working hours more efficiently but also provides patients with more options to choose the type of consultation that best suits their needs.

Module 3: Provider Module

The provider module focuses on managing both patient and doctor information within the system. The patient appointment scheduling system enables any

hospitals and clinics to register an account and use the system to improve their appointment management system. This integration helps healthcare providers enhance their productivity and streamline daily operations. Once a hospital or clinic has registered an account, its administrator can add doctors to the system and manage their details. This gives patients access to a wider range of healthcare options while ensuring that providers keep control over the information about their own medical staff.

1.5 Contribution

The proposed system will reduce misunderstanding, improve data integration and wider the provider partnership to improve patient satisfaction and doctor efficiency. The key contributions of this system are as follows:

1. **Classification of Appointment Type and Status**

   Appointment status is a crucial part of managing healthcare appointments. A challenge for patients to classify the status of a type of an appointment. To overcome this, the proposed system will implement different color, icon and text labels to differentiate each of the appointment status and appointment types. A proper classification helps patients, doctors and administrative staff efficiently manage their time arrangement, thereby improving time management and reducing errors.

2. **Appointment Scheduling Process**

   The appointment scheduling process involves a few stages to ensure patients can meet their chosen doctor with available time. In the previous system, patients need to take extra steps like phone calls to confirm the availability of consultation or treatment. The proposed system will be able to let patients make medical appointments directly with doctors or healthcare providers after reviewing detailed information on their profiles. This enhances the scheduling process and decreases friction for the patient.

3. **Partnership Accessibility**

   Partnership integration is one of the important roles in streamlining patient care and improving operational efficiencies. The limited partnership accessibility is one of the challenges in the current system, which limits the available options to patients. To solve this, an open registration system will be developed to allow more healthcare providers to join and integrate with the system. At the end, this strategy increases patient choice and healthcare availability by not only reaching a wider audience but also finding a balance between accessibility and quality requirements.

1.6 Report Organization

The Patient Appointment Scheduling System report includes seven chapters. The project background is covered in Chapter 1, along with the problem statement, motivation, project objective, project scope, project direction and contributions. Research and literature review will be conducted in Chapter 2. We will review the advantages and disadvantages of the existing systems in Chapter 2, then propose the solutions. In Chapter 3 we will discuss the system methodology used, which includes the system design diagram such as use case diagram and activity diagram. Furthermore, Chapter 4 is preliminary work stage which will cover the system design by identifying the system block diagram and entity relationship diagram. Chapter 5 will then show the system implementation. The setup and configuration of the hardware and software, user interface design and the issues faced during implementation will all be covered in Chapter 5. The topic in Chapter 6 are system evaluation and discussion. System testing will be carried out in Chapter 6 to evaluate the overall system's functionality. Last but not least, Chapter 7 will conclude the project overall and provides suggestions for future enhancements.

CHAPTER 2

Literature Reviews

2.1 System Reviews

2.1.1 Zocdoc

Figure 2.1.1.1 Zocdoc Logo

Zocdoc is a New York-based provider of an online medical appointment booking platform that connects patients with doctors, dentists, and healthcare specialists. By giving patients, the ability to see and choose, they give patients power. Zocdoc empowers patients to choose doctors they trust [1].

STRENGTH

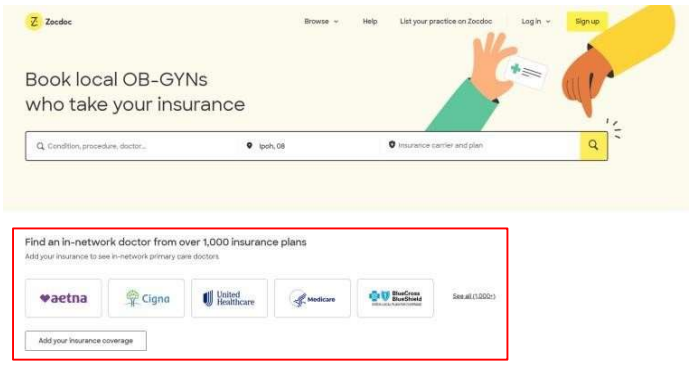

Figure 2.1.1.2 Insurance Plans

Zocdoc's strength is that it offers **insurance plans** [6], which improves the patient experience by making it easier to select an in-network healthcare provider. Patients may choose their exact insurance plan such as UnitedHealthCare Choice Plus, ensuring that they only see doctors who accept their particular insurance plan. Patients no longer have to phone clinics or hospitals to confirm insurance acceptance. By providing clear insurance filtration, patients can make appointments knowing that their insurance will be accepted, increasing overall satisfaction and retention. **Video visits** [7] are another strength where Zocdoc delivers. Since the arrival of COVID-19, everyone must stay at home. This situation decreased the rate of hospital visits. So, Zocdoc launched a video visit, allowing patients to safely get treatment from home while also assisting providers in keeping their digital doors open for business.

WEAKNESS

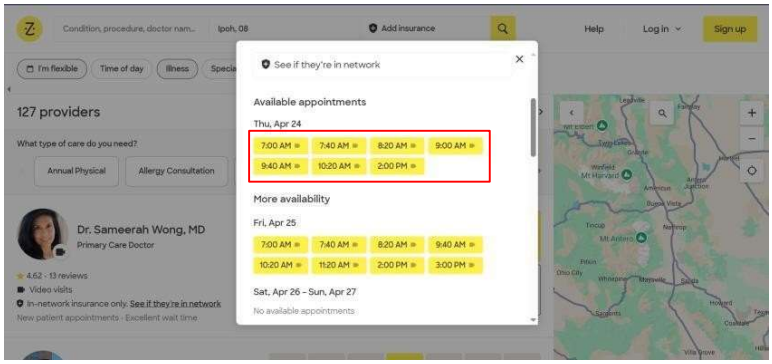

Figure 2.1.1.3 Unclear Color Classification for Appointment Type

Zocdoc's patient appointment booking system contains a weakness which is **unclear classification of appointment type**. It is a kind of insufficient labeling, where there is only a single color used to represent the appointment type whether it is video or in person. As a result, patients cannot quickly differentiate between the two. Although in-person appointments are also provided as well, this confusion frequently causes the misunderstanding that all available slots for video consultations. This kind of uncertainty increases the possibility of booking errors, time loss, and dissatisfaction with the platform.

2.1.2 HealthGrades

Figure 2.1.2.1 Healthgrades Logo

Healthgrades is an online platform that provides information about healthcare providers such as doctors, dentists and hospitals. The mission of Healthgrades is to make healthcare simpler, more transparent and more trustworthy [2].

STRENGTH

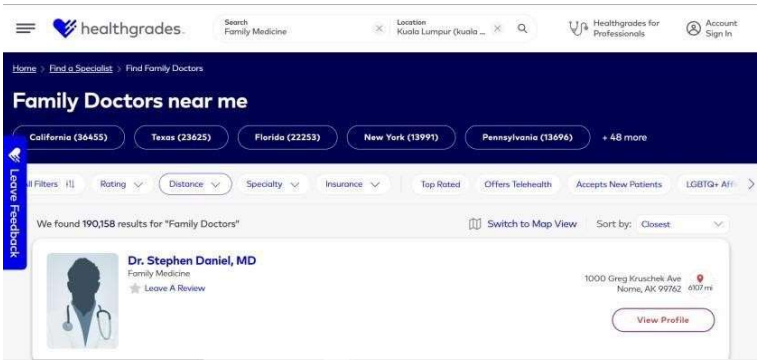

Figure 2.1.2.2 Healthgrades Family Doctors

The strength of HealthGrades is it has a useful feature which is **family doctors** [8]. Family doctors are also known as primary care physicians that play a vital role in maintaining long-term health for you and your loved ones. Unlike specialists who focus on specific conditions, family doctors provide continuous and comprehensive care for patients of all ages. It is a long-term care. They get to know your medial history, lifestyle and family health trends. Over time, they can spot early warning signs and help manage chronic conditions such as diabetes or high blood pressure before they become serious.

WEAKNESS

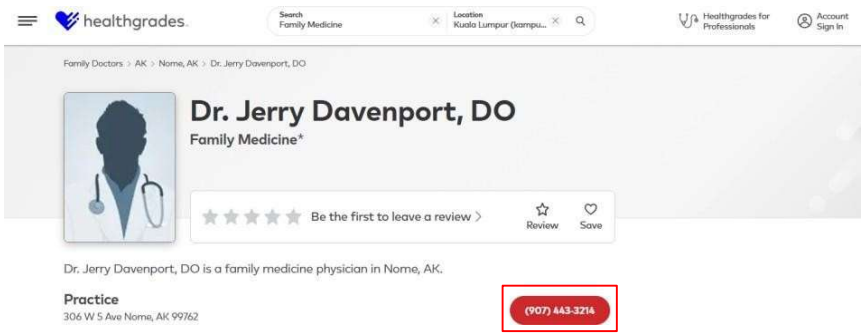

Figure 2.1.2.3 Healthgrades Phone Call Appointment

The biggest problem with HealthGrades is that you **can't actually book appointments through the platform.** While it helps you search for doctors and hospitals, the process stops there. The site uses blurred title like 'Find the care you need", which make users think they can schedule appointments directly. But in reality, after finding a doctor, you still have to call the clinic yourself to make an appointment. This extra step creates frustration and waste time for patients who expect a complete booking solution.

2.1.3 Doctoroncall

Figure 2.1.3.1 DoctornCall Logo

DoctoronCall is a digital healthcare platform that offers three different services, which are Teleconsultation, Online Pharmacy and Book a specialist [3]. It is integrated with hospitals, clinics and pharmacies. With a click of button, patients can quickly and simply schedule an appointment with specialists or doctors.

STRENGTH

Figure 2.1.3.2 Well-organized Layout

The strength of DoctoronCall is its **well-organized layout**. Popular medical services including pharmacy, doctor consultation, and medical checkup are grouped together. It allows patients quickly to locate what services they need without manually searching for the exact services. This is especially helpful because patients may not always be familiar with professional medical terms, it will cause difficulty for them to search for the right services. In addition, the clean layout will improve user trust as transparency in services makes healthcare feel more accessible.

WEAKNESS

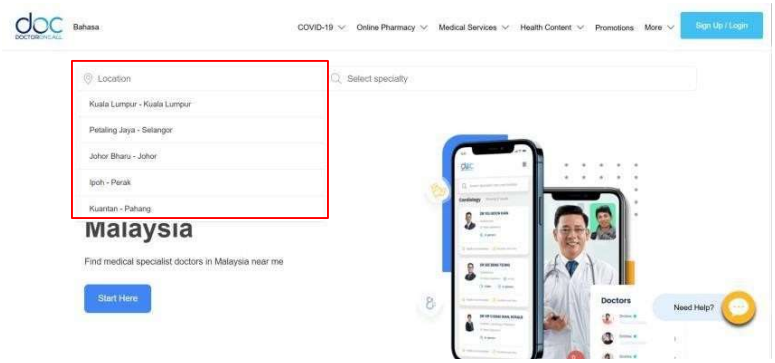

Figure 2.1.3.2 Limited Partnership

One of weakness of DoctorOnCall is its **limited partnership** [9]. Unlike open healthcare platforms, it does not allow any hospitals or clinics to join freely. This platform only lists partners who have been pre-approved. As a result, patients have fewer choices because the platform does not free to invite others skilled doctors to integrate with their system. Limited partnership will cause patient choice to be restricted. For example, if a patient uses DoctoronCall to look for a pediatric specialist, but patient may find that it is available for limited numbers of areas. In smaller towns or rural areas, the lack of partnerships may lead users to consider that there are no doctors or clinics, forcing people to seek care elsewhere.

2.2 Limitation of Previous Studies

	ZocDoc	HealthGrades	DoctoronCall	Proposed System
Allow patients to book appointments	Yes	No	Yes	Yes
Clear classification of appointment type and status	No	No	Yes	Yes
Support open healthcare platforms	Yes	Yes	No	Yes
Categorized popular medical services	Yes	Yes	Yes	Yes
Able to check insurance plans	Yes	No	No	Yes
Able video visits	Yes	No	Yes	Yes
Able in-person visit	Yes	No	No	Yes

Table 2.2 Comparison between Existing System and Proposed System

The limitations of the previous systems discuss the several weaknesses in existing patient appointment scheduling system.

The first limitation is that the system does not clearly state the appointment type for each available slot. This limitation will lead to confusion about which the available slots accept video visit and in-person visit. Patients may mistakenly assume that some hospitals or doctors are only accepting virtual medical consultations. This may stop them from making an appointment.

The second limitation is that the system does not allow patients to directly schedule an appointment after viewing a doctor's detailed profile. Instead, users are required to make a phone call or use another platform to check the available time slots. This limitation will lead to the abandonment of medical appointments because they are unable to make the decision on the spot due to conflicting schedules.

The third limitation of the existing system is that the previous system limits the provider partnership. Limited provider partnership with hospitals and clinics can significantly affect patients, especially in rural areas where healthcare options are very limited. As a result, patients may be forced to travel longer distances to access medical services that are available in the system.

In summary, we can conclude that none of the existing systems properly handle important scheduling issues. Current issues include limited provider partnership, unclear appointment type and inability to book appointments directly. These issues show that a more optimized system is required, which the proposed solution aims to provide.

2.3 Proposed Solutions

A patient appointment scheduling system usually involves technologies and methodologies aimed at streamlining the process of booking, managing and tracking medical appointments. The system is to make sure that patients can easily make appointments for medical treatments with healthcare providers while improving clinic operations.

To solve the problem of unclear classification of appointment slots, the system will implement **redundant visual indicators** that integrate color, symbols and text labels [10]. This ensures the message is delivered clearly but not only reliable to the color. To improve readability and avoid blurred vision, we should ensure that there is enough contrast between the text, and the backdrop will be applied. In addition, we should **avoid combining certain colors** like green and red or blue and yellow [11]. This is because they have low contrast which may cause challenges and difficulties for color-deficient users to differentiate. Therefore, a clarification bar with text-labels, color and symbols will be included that clarifies the meaning of each indicator. For example, a green color with “Video Visit” and a video icon, a purple color with “In-person Visit” and a person icon, and a red color with “Is Booked” and a red cross mark. By using purple color to break the green and red confusion and uses labels or icons make it more user-friendly.

The existing system does not allow patients to schedule appointments directly with doctors or healthcare providers. To overcome this issue, the proposed

patient appointment scheduling system will introduce a **structured and one-stop solution system** that streamlines booking. Patients will be able to review the profile of doctors or healthcare providers, then immediately book appointments based on the available slots that are offered by the doctors within the platform. For example, making good use of **profile-to-booking workflow integration** ensures a smoother scheduling process [14]. According to the studies of Electronic Health Records (EHRs) [14] highlight that the workflow integration removes extra and unnecessary actions, increases efficiency and improves the user experience.

Last but not least, the proposed solution to overcome the problem of limited provider partnership is implementation of an **open registration system**. The system will be owned and managed by a third party but not a specific hospital, which allows any hospital or clinic to register. So, patients can view all registered hospitals or clinics within this system. This strategy expands access to healthcare, especially in underserved and rural areas [12]. It is also supported by online healthcare platforms (OHPs) which mention that increasing provider involvement results in **network externalities** whereby the platform's value increases because more providers sign up [15]. When more providers join, patients find the system more useful and are more likely to use it. By boosting provider involvement, the system finds a balance between quality standard and accessibility thereby giving patients additional options and convenience.

CHAPTER 3

System Methodology/Approach

The project's activities were divided into five development stages, which are project planning, system analysis, design, implementation and maintenance. In project planning, a basic project outline is presented. System analysis is the process of selecting an existing system, analyzing its strengths and weaknesses, and then determining which features require improvement. The following are design stages, which will involve the flow of the entire system. Finally, there are the implementation and maintenance stages. The implementation step is putting the real system into action after extensive research and preparation. After implementing the system, we must continue to maintain it when problems arise.

3.1 Methodology

This project uses an Agile Development Lifecycle that is suited to a development-based project. The aim of agile methods is to reduce overhead costs and delivery time during software development process. Agile method enables the system to be developed step by step, compared to traditional methods that focus on finishing the entire system before showing final outputs. This ensures that it is possible to deliver useful features earlier, feedback collection and ongoing improvement until the final product is ready.

Firstly, Agile methods provide a quick, flexible and team-friendly approach to developing projects that involve the client at every stage. So, if there is any feedback or requirement changes, Agile method can easily respond to change to ensure that the final products meet user needs. Agile is a good methodology for projects where user needs may change as development progresses since it emphasizes adapting to change over following to a fixed plan.

Secondly, Agile method breaks the entire system into small parts which means the work is divided into short cycles called sprints. Each sprint will take 2 – 4 weeks, therefore customers can see on-time delivery of increments and gain feedback on how the product works. This makes it easier to test, get feedback and

make improvement along the way. For example, the first sprint may focus on registration part, while the second sprint will add direct booking features. This step-by-step method ensures continuous progress and clear visibility of the system's development.

Furthermore, Agile focuses on quality through continuous testing. By using Agile methods will ensure the final outcome with a higher quality because testing happens in every sprint, which helps detect and debug errors on the spot. Continuous feedback from clients after each sprint is also an important part in the project development because the client's feedback is valuable to improve the quality of the product. The product can be modified and enhanced after each sprint to make sure the final output satisfies the requirements and expectations of patients, doctors, and providers.

In short, Agile Development Lifecycle supports faster delivery, flexibility, continuous enhancement and higher quality. It is the best approach for creating the Patient Appointment Scheduling System because of the advantages.

3.2 System Design Diagram

3.2.1 Use Case Diagram

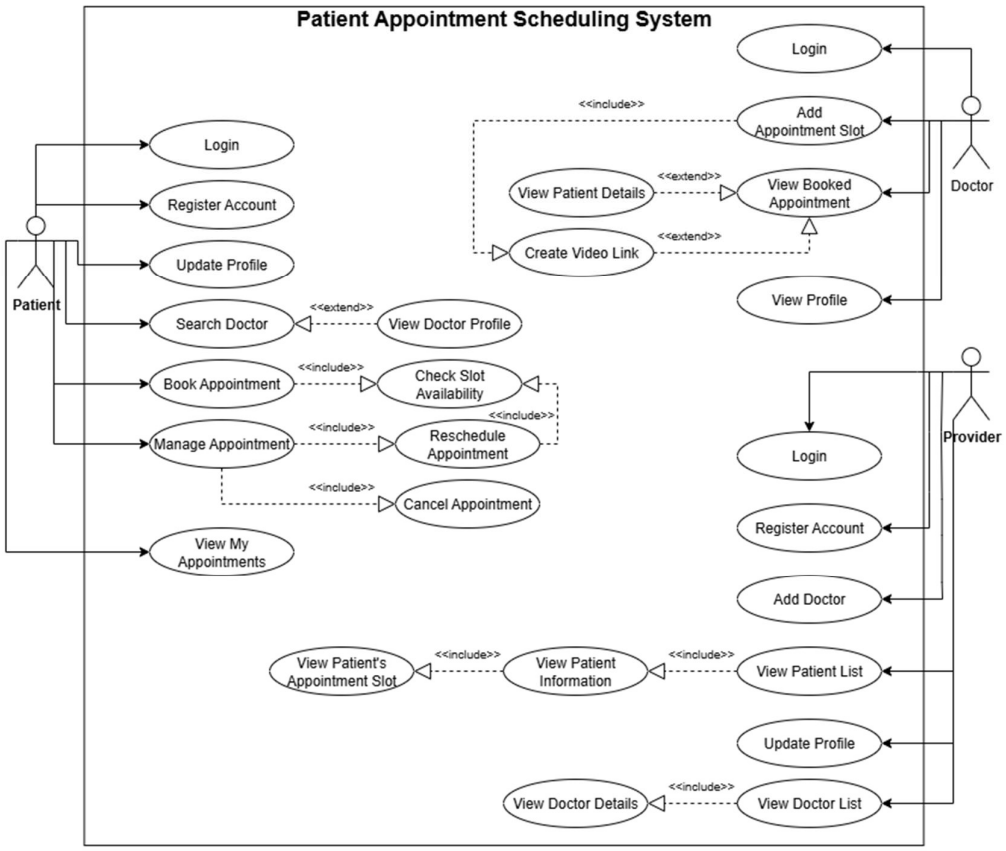

Figure 3.2.1.1 Use Case Diagram

The use case diagram for the Patient Appointment Scheduling System shows the interactions between the three main characters which are patient, doctor and provider include their respective system functionalities. The main function of patients is to search for available doctor with available appointment slot then book the appointment. After booking the appointment, patients can have a check on their booked appointment slot and manage them. While the main functionality for doctors is creating appointment slots for patients, then doctor can view the booked appointment and patient details. Providers will add and register their doctor into the system, manage their profiles and access patient lists and information to ensure smooth coordination.

3.2.2 Activity Diagram

3.2.2.1 Patient Module Activity Diagram

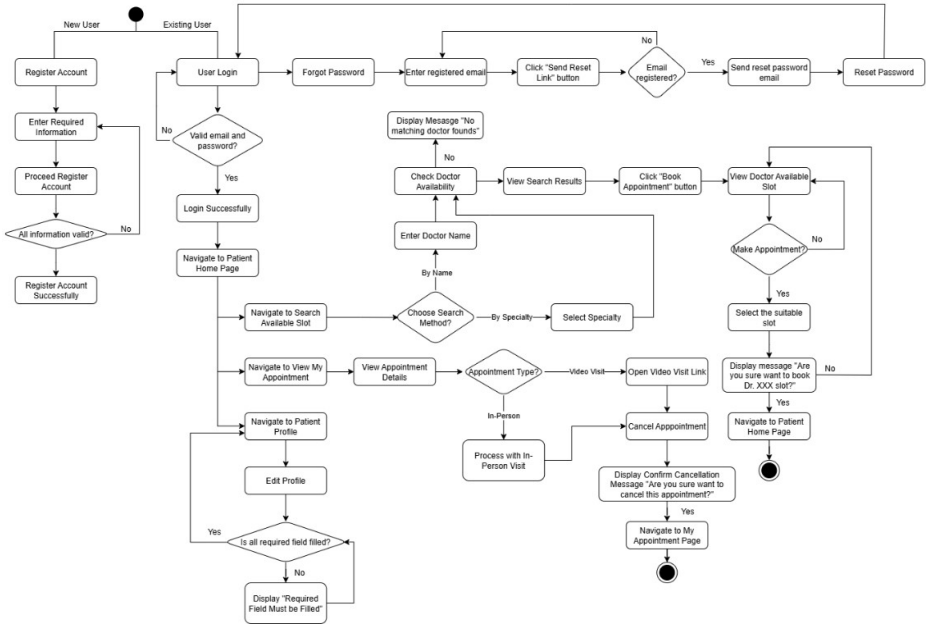

Figure 3.2.2.1 Patient Module Activity Diagram

The Patient Module Activity Diagram illustrates the workflow of a patient interacting with the patient appointment scheduling system. It starts with the account registration where patients need to fill in the detailed information and create a secure password then submit forms. Existing users can direct login to the page by entering their registered email address and password. In the patient homepage, patient able to search for available slots, view booked appointments and manage their profile effectively. In addition, patients are allowed to perform forgot password action.

3.2.2.2 Doctor Module Activity Diagram

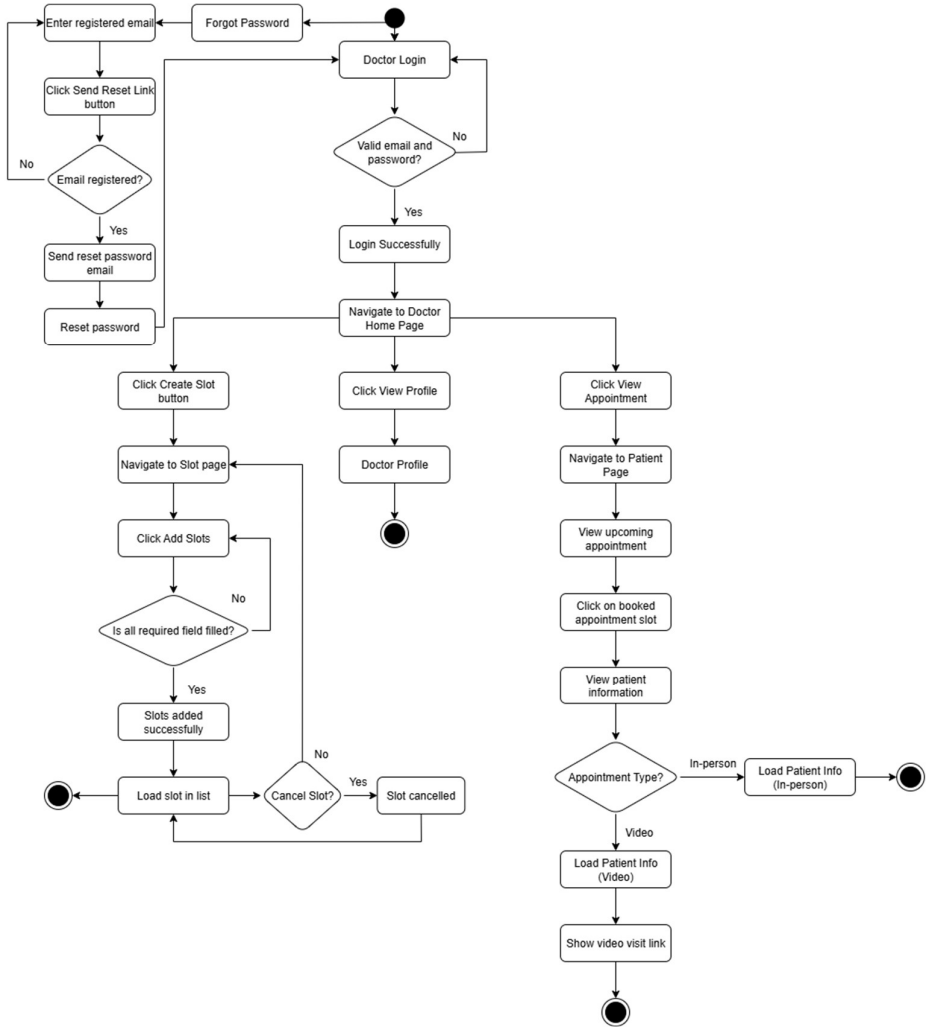

Figure 3.2.2.2 Doctor Module Activity Diagram

The Doctor Module Activity Diagram illustrates the workflow of a doctor interacting with the patient appointment scheduling system. For the doctor, they are only able to login to the system by using the email address and password provided by their provider because they are under controlled by their providers. But doctor able to perform forgot password action. Doctor will create the available appointment slot according to their time management. Doctor needs to select the appointment type during add slot. Doctors can navigate to the profile for viewing purposes.

3.2.2.3 Provider Module Activity Diagram

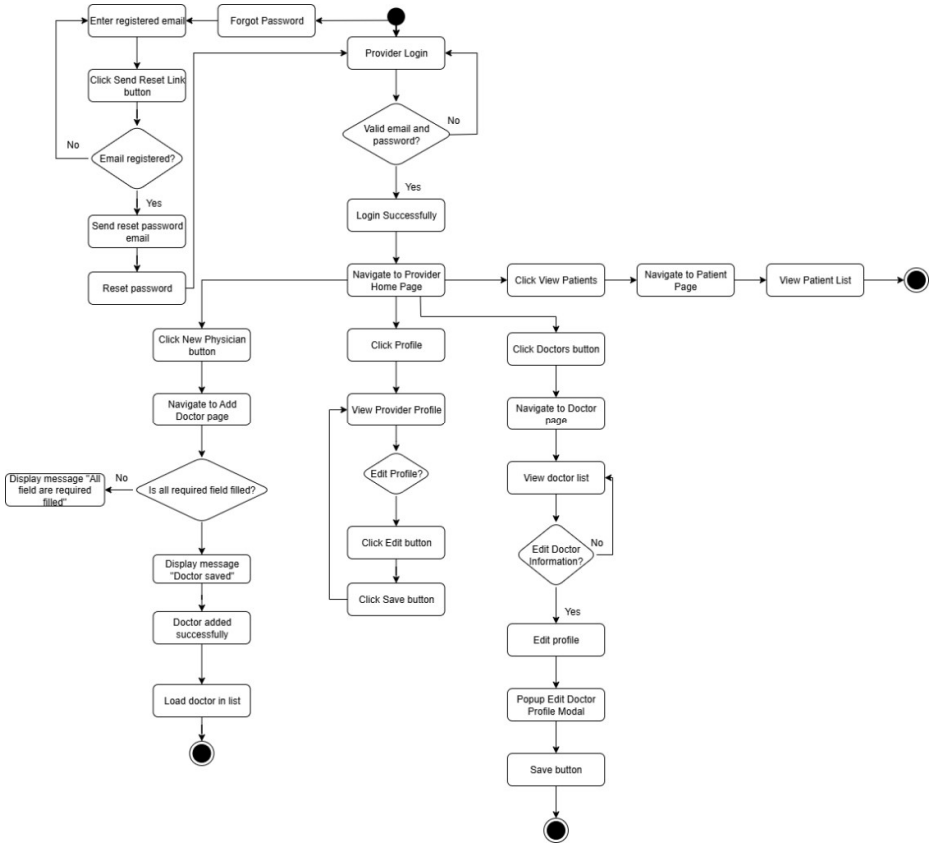

Figure 3.2.2.2 Provider Module Activity Diagram

The Provider Module Activity Diagram illustrates the workflow of a provider interacting with the patient appointment scheduling system. It starts with the account registration where providers need to fill in all the basic information such as provider type, ownership type and the specialty the provider has. Once the account is registered successfully, it will navigate to login page and use the registered email address and password login to the system. Then, in the provider home page, provider able to add new doctors and view patients' information. Once the doctor's record is saved, it will show in the doctor list. Provider able to manage and update their profile effectively.

3.2.3 Web Application Architecture Diagram

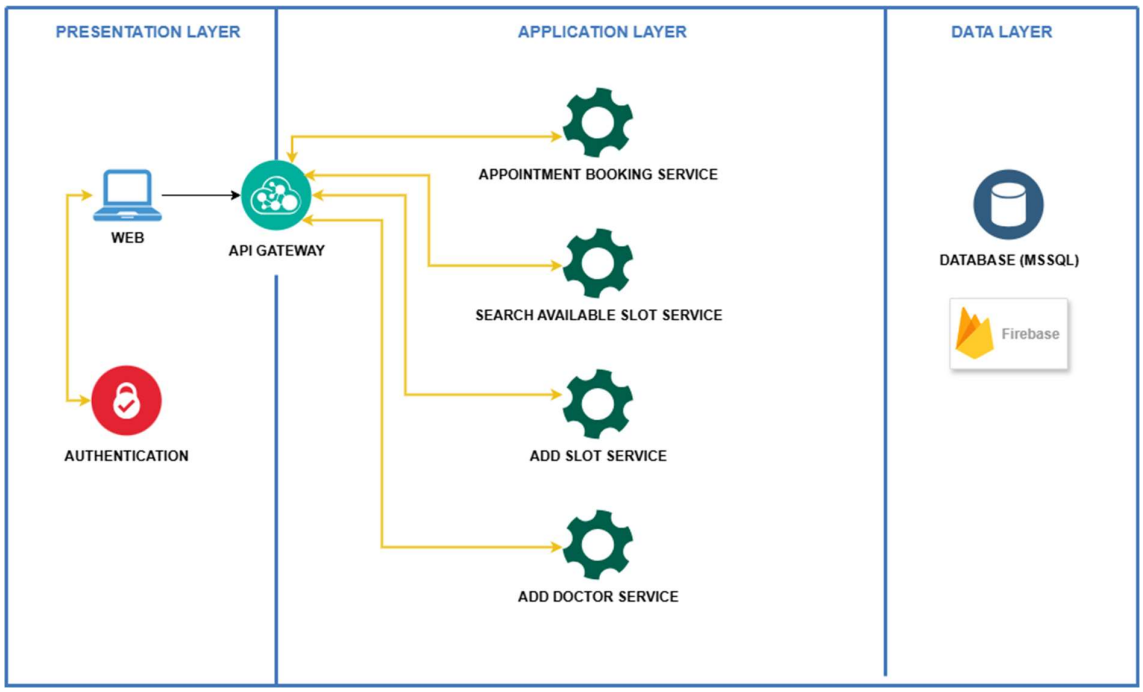

Figure 3.2.3.1 Web Application Architecture Diagram

The Web Application Architecture Diagram shows a three-tier structure for the Patient Appointment Scheduling System. The Presentation Layer includes web interface and authentication, which pass the user requests over an API Gateway. Appointment booking service, search available slot service, add slot service and add doctor service are the modular services in the Application Layer. Then, the Data Layer which includes MSSQL and Firebase to store database and image.

CHAPTER 4

System Design

4.1 System Block Diagram

4.1.1 Patient Block Diagram

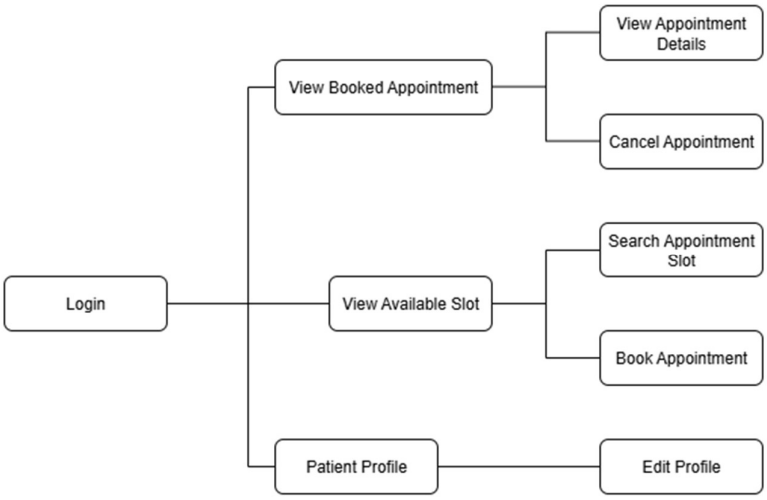

Figure 4.1.1 Patient Block Diagram

The block diagram above shows the patient workflows after login such as view booked appointment, view available slot and profile management within the patient appointment scheduling system.

4.1.2 Doctor Block Diagram

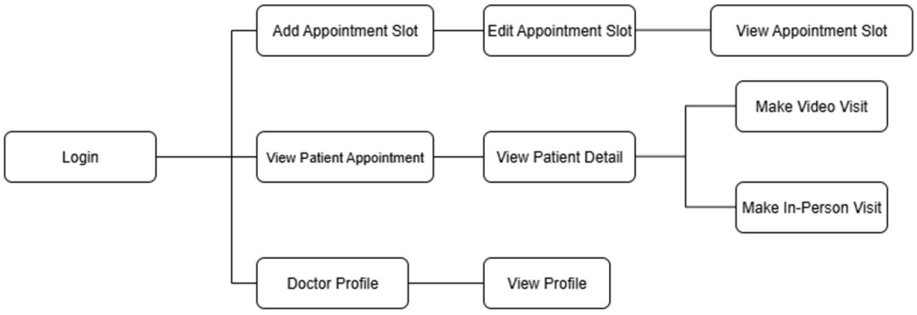

Figure 4.1.2 Doctor Block Diagram

The block diagram above shows the doctor workflows after logging in such as add appointment slot, view patient appointment and view profile within the

patient appointment scheduling system.

4.1.3 Provider Block Diagram

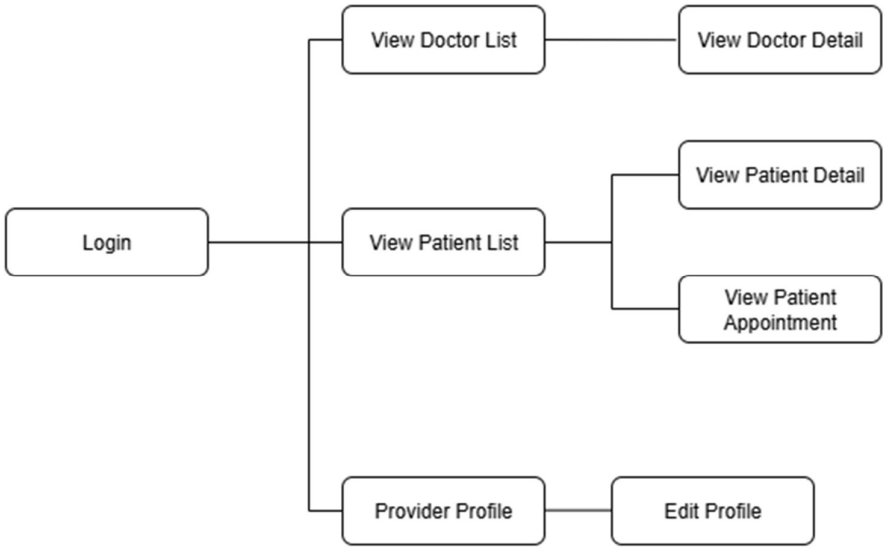

Figure 4.1.3 Provider Block Diagram

The block diagram above shows the provider workflows after login such as add doctor, view doctor list, view patient list and profile management within the patient appointment scheduling system.

4.2 Entity Relationship Diagram

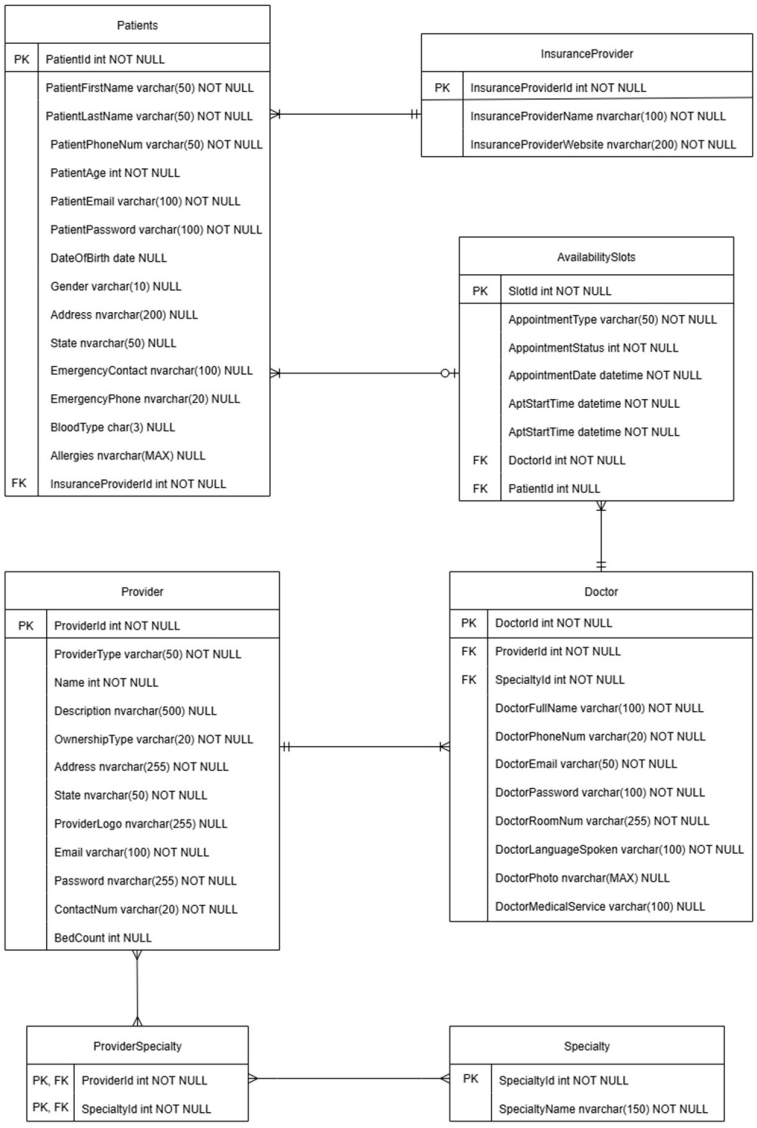

Figure 4.2.1 Entity Relationship Diagram

The Entity Relationship Diagram illustrates the system's data structure, describing the relationships between patients, doctors, and providers, specialty and availability slots. Each patient has specific information such as name, contact details, medical history and a PatientID that connects them to appointments. By recording the date, time, appointment type and status of each appointment slots connecting both PatientID and DoctorID. The Provider entity refers to ProviderID which connects the SpecialtyID through a ProviderSpecialty table because there are many to many relationships. The Doctor table connects both Provider table and Specialty table together, enabling structured access to specialty and provider afiiliations.

4.3 Wireframe

4.3.1 Patient Search Available Slot

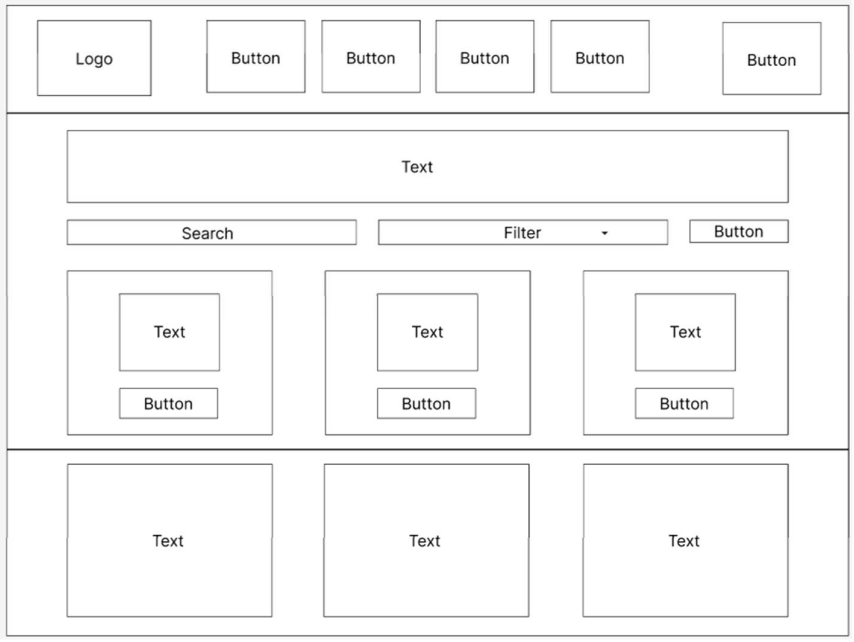

Figure 4.3.1 Patient Search Available Slot

This is a wireframe for the patient search available slot pages. There are three sections which are navigation bar, body and footer. In this page include the logo, filter, search, few text and buttons.

4.3.2 Doctor View Upcoming Appointment

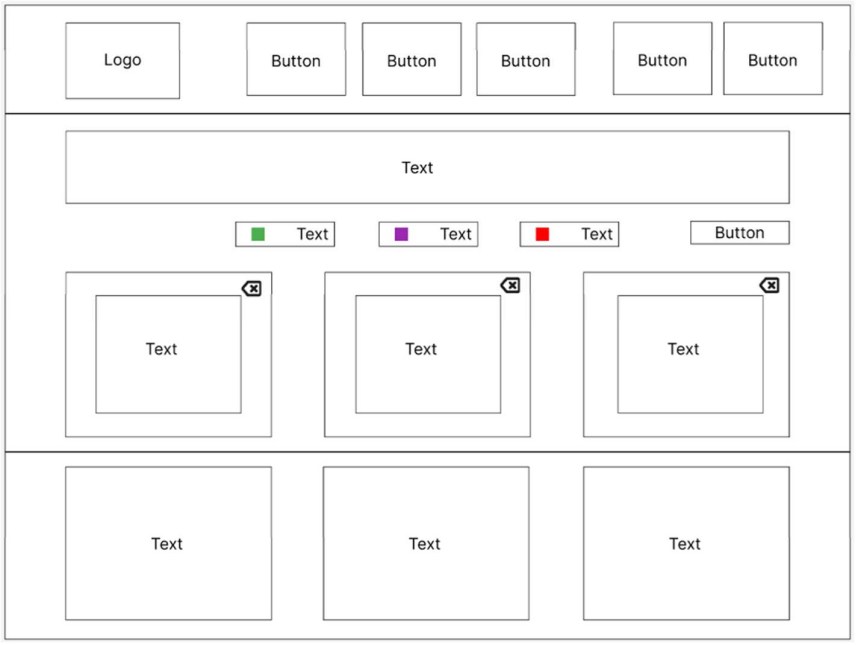

Figure 4.3.2 Doctor View Upcoming Appointment

This is a wireframe for doctors view upcoming appointment page. There are three sections which are navigation bar, body and footer. In this page include logo, buttons, color indicator, and some texts.

4.3.3 Provider Add Doctor

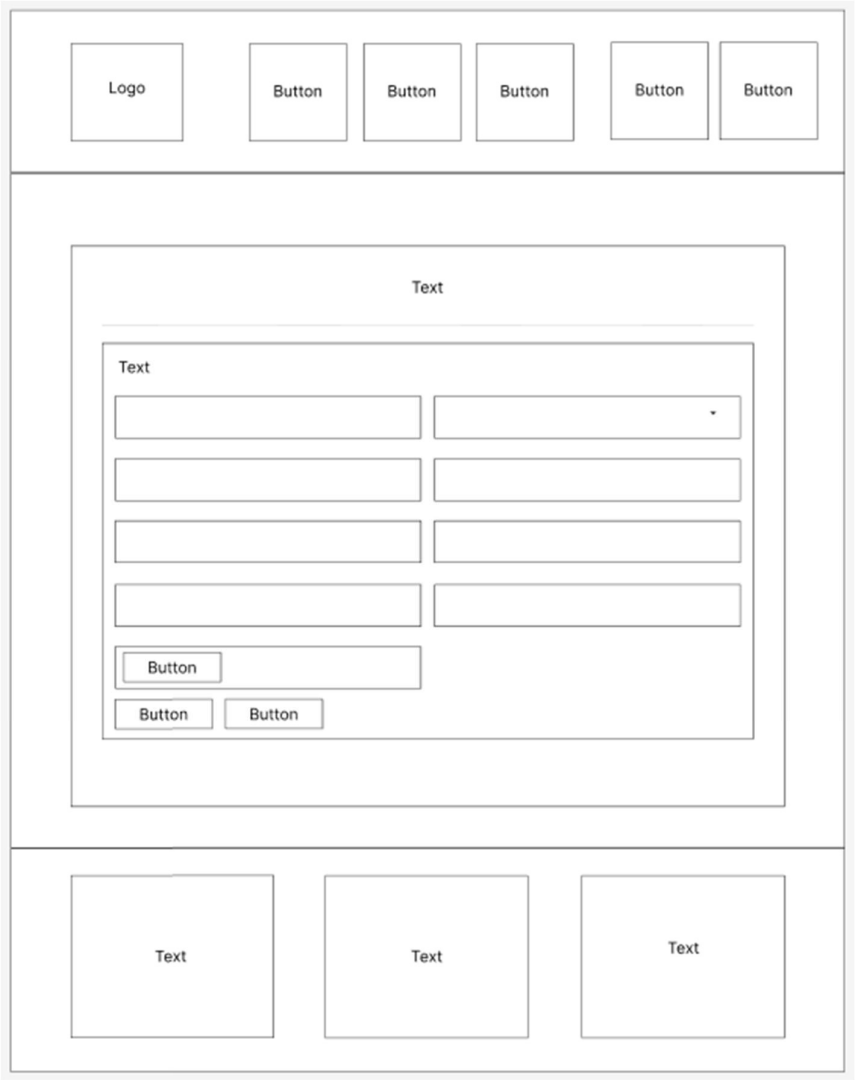

Figure 4.3.3 Provider Add Doctor

This is a wireframe for provider add doctor page. There are three sections which are navigation bar, body and footer. In this page include logo, buttons, filter, images, and some texts.

CHAPTER 5

System Implementation

5.1 Hardware Setup

The hardware involved in this project is my laptop. This hardware will be involved in the whole development process:

Description	Specifications
Model	Hp Elitebook 800
Processor	Intel® Core ™ i5-8350U CPU @ 1.70GHz 1.90GHz
Operating System	Windows 10, 64-bit operating system
Graphic	Intel® Iris® Graphics
Memory	32GB
Storage	237GB

Table 3.1.1 Specifications of laptop

5.2 Software Setup

Description	Specification
Programming Language	C#
Database	Microsoft SQL (MSSQL)
Software	Visual Studio 2022

Table 3.1.2 Software and Technologies

- **Programming Language (C#)**

  In the proposed system, the main programming language will be C# ASP.NET Core Web Application. ASP.NET Core is an open-source modular web- application framework that features a user-friendly user interface design. At the same time, the user interface design can be directly linked to the backend code.

- **Database (MSSQL)**

  The system's database plans to use Microsoft SQL Server to manage healthcare data. The purpose of MSSQL is to store patient data, appointment schedules and doctor availability. MSSQL was developed to integrate well with .NET (C#). It includes built-in libraries such as ADO.NET and Entity Framework Core.

- **Software (Visual Studio 2022)**

  Visual Studio 2022 has been selected to develop a patient appointment scheduling system. ASP.NET Core enables safe and scalable web-based scheduling systems. It simplifies database interactions with MSSQL, by minimizing the need for manual SQL code. Visual Studio 2022 allows for plugin-based extension. For example, NuGet Package Manager includes Hangfire for the purpose of appointment reminders.

5.3 Setting and Configuration

Before starting the development of the proposed system, there are two software applications that need to be installed on my laptop. The first is Visual Studio 2022 Enterprise Edition, which will be used to design the user interface and write C# code. The second is Github which will be used to manage and backup the source code.

5.4 System Operation

5.4.1 Landing Page

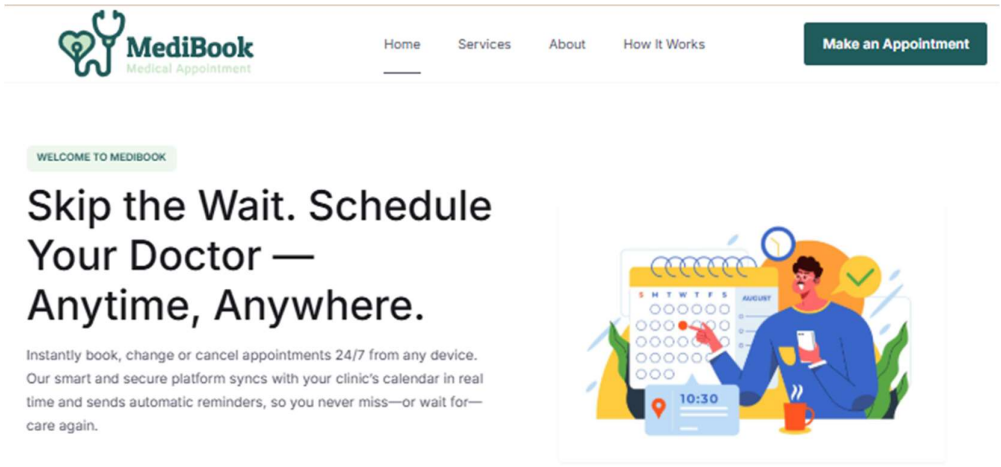

Figure 5.4.1.1 Hero Section of Landing Page

This is a hero section of the landing page which visitors reach after entering the website from an external advertisement or search results. There is a navigation bar with few buttons such as Home, Services, About and How It Work. These buttons can let visitors quickly navigate the content they want to understand. An Make An Appointment button able to let patient to login and make appointments.

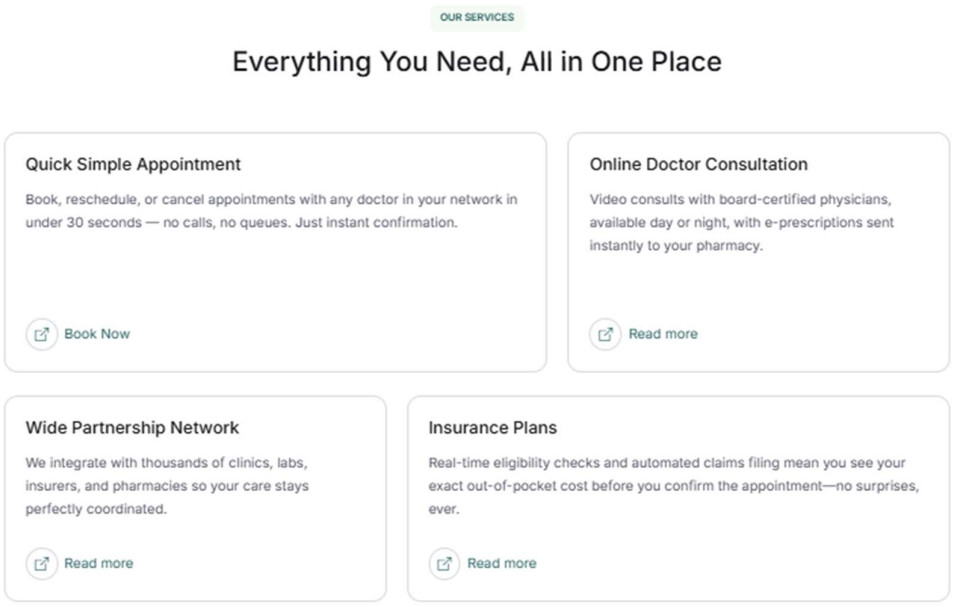

Figure 5.4.1.2 Categorized Features Section of Landing Page

This categorized features section is a service overview that includes appointments, doctor consultation, partnership network, and insurance coverage. In each container have a read more buttons will navigate visitors to more detail section.

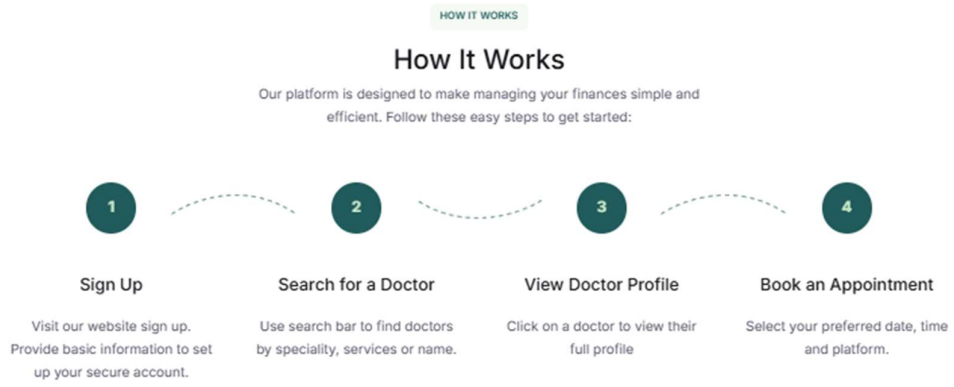

Figure 5.4.1.3 How It Works Section of Landing Page

This “How it Works” section shows the steps on making an appointment with doctor successfully.

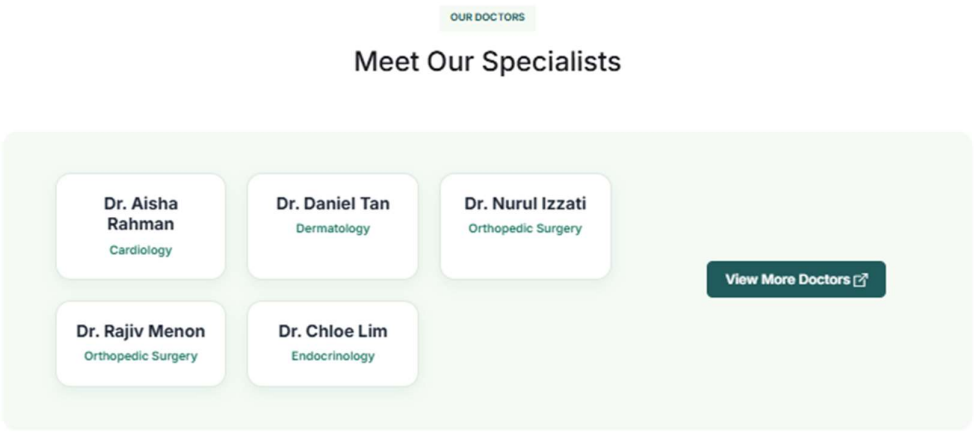

Figure 5.4.1.4 Our Doctors Section of Landing Page

This "Our Doctors" section are showing the doctors who have the video visit appointment. Users can click on "View More Doctors" to check out more available doctor with video visits.

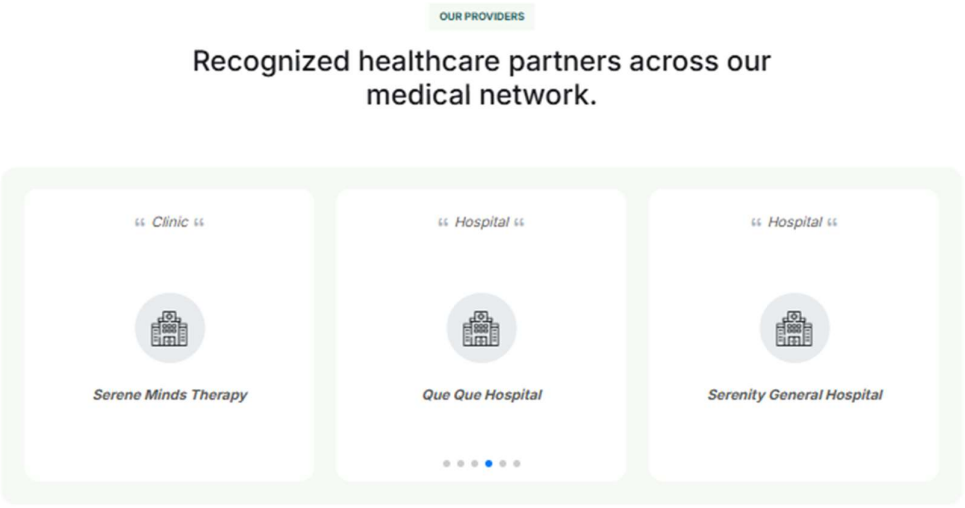

Figure 5.4.1.5 Our Providers Section of Landing Page

The "Our Providers" section highlights the clinics and hospital that have integrated with the system.

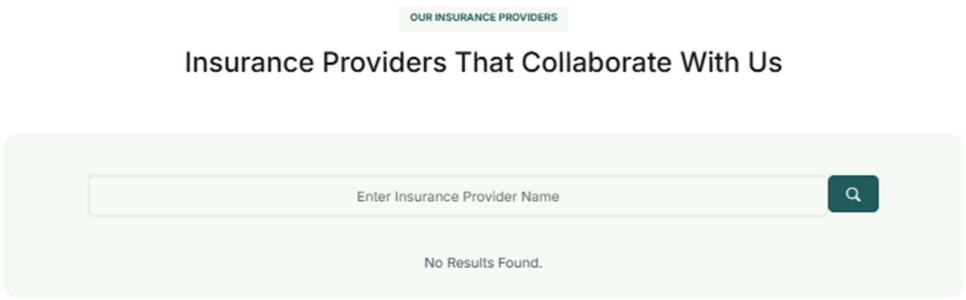

Figure 5.4.1.6 Our Insurance Providers Section of Landing Page

The "Our Insurance Providers" section able to let visitors or users to search for insurance providers that integrate with the system.

Figure 5.4.1.7 Footer of Landing Page

This footer is placed at the bottom section of the landing page. It has included a "Join Us" section that invite healthcare providers to use and join the system through the "Register" link.

5.4.2 Patient Module

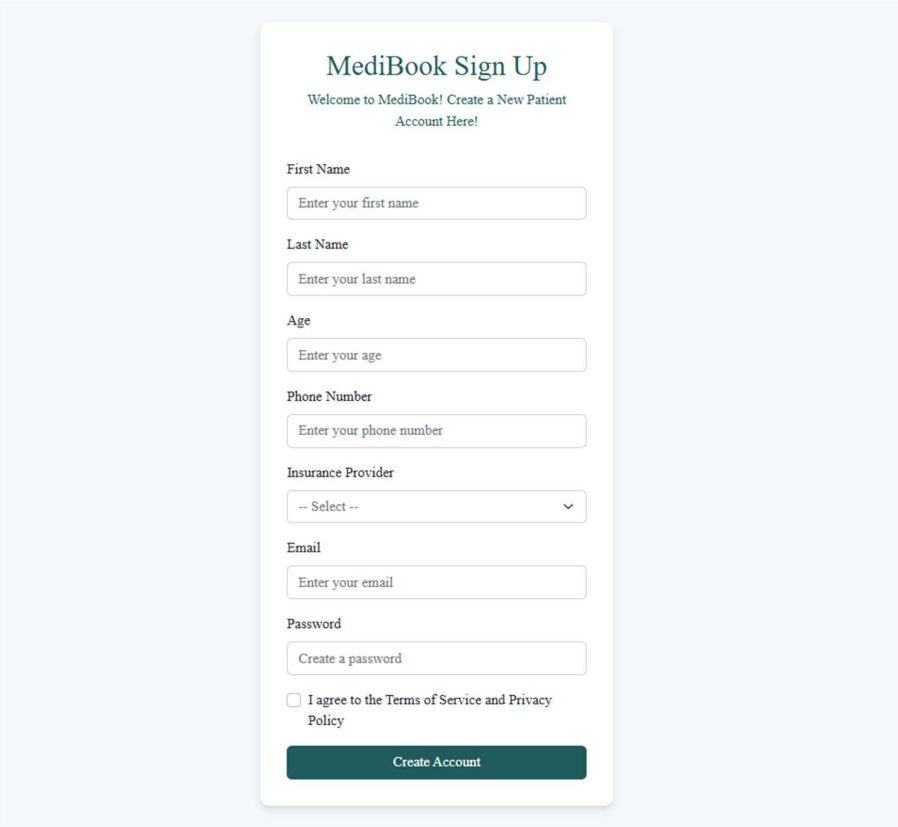

Figure 5.4.2.1a Patient Register Page

Patients need to register an account before using the system. The name, age, phone number, insurance provider email address and password are required.

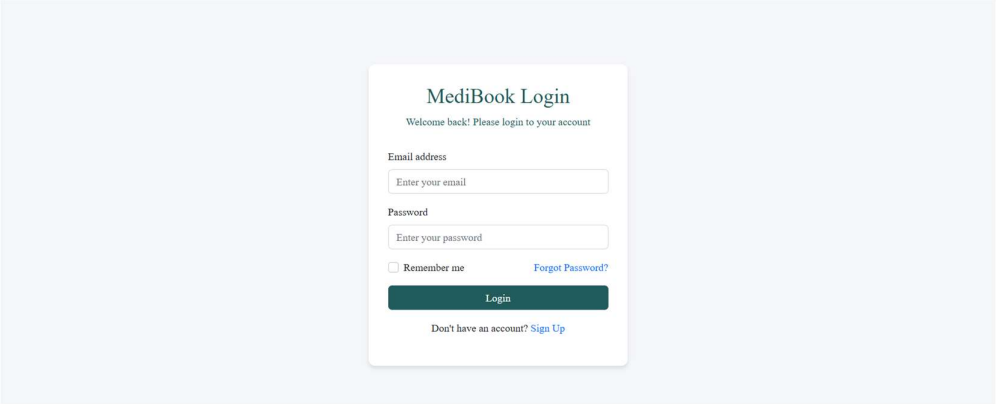

Figure 5.4.2.1b Patient Login Page

Patients need to enter the email address and password that have been set during the new account registration.

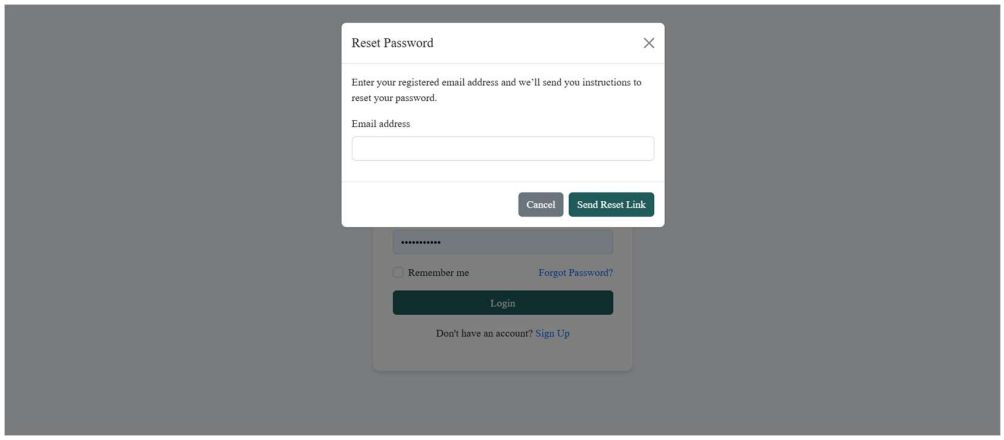

Figure 5.4.2.1c Forget Password

If patient forgets his/her password, they can perform reset password by clicking the Forget Password button. Patient needs to enter the email address that have been registered. Once the validation is done, patient will receive a reset password email and use the password provided to login to their account.

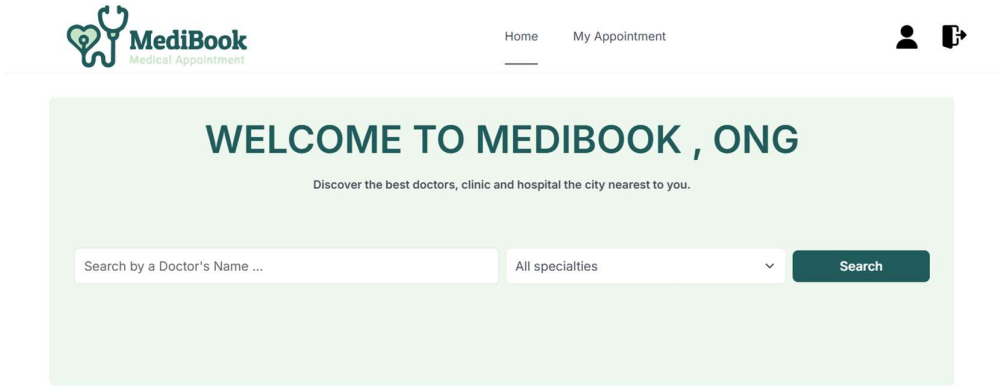

Figure 5.4.2.2 Patient Home Page

The search function on the Patient Home Page is used to help patients quickly find the available doctors according to their needs. Patients can search by doctor name through the search bar or use the specialties dropdown menu to select their related medical specialty. So when patients click on the Search button, the system will filtered out the result according to the search requirements.

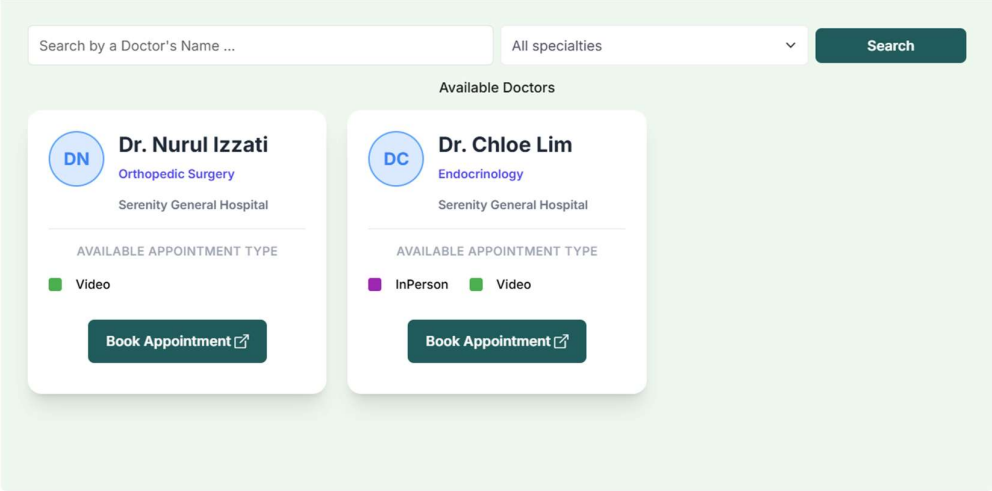

Figure 5.4.2.3 View Available Doctor

Patients are able to view only the doctors who have created appointment slots which match the patient's search criteria. If a doctor has not added any appointment slots, their profile will not appear in the search results. Each card will display the doctor's name, specialty, medical service and affiliated hospital or clinic. In addition, the card will also show the available appointment type whether video visit or in-person visit.

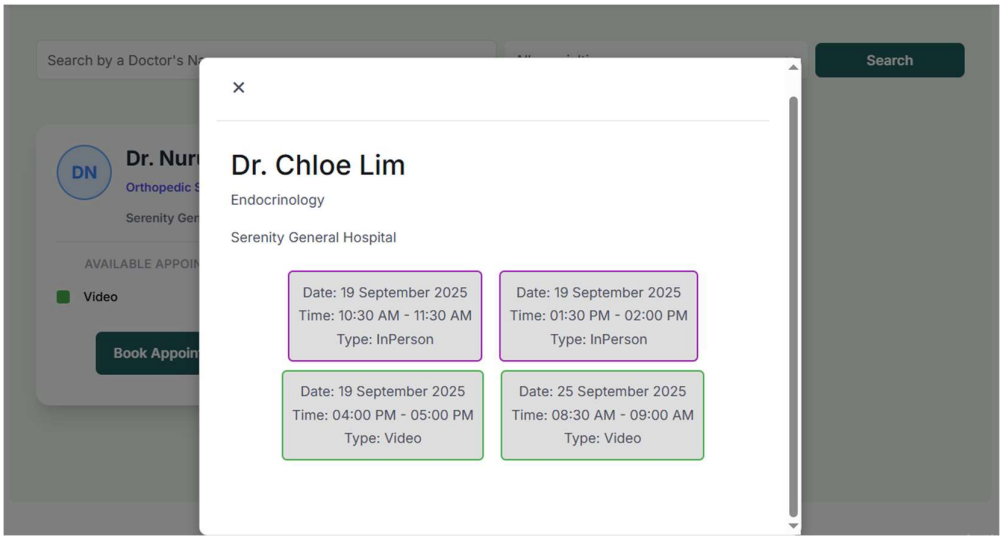

Figure 5.4.2.4 View Doctor Details and Appointment Slot

After the patients click on the Book Appointment button from the available doctor list, the system will display a popup window that shows the appointment slots and appointment types created by the doctor. Therefore, patients able to choose a suitable date, time and appointment type.

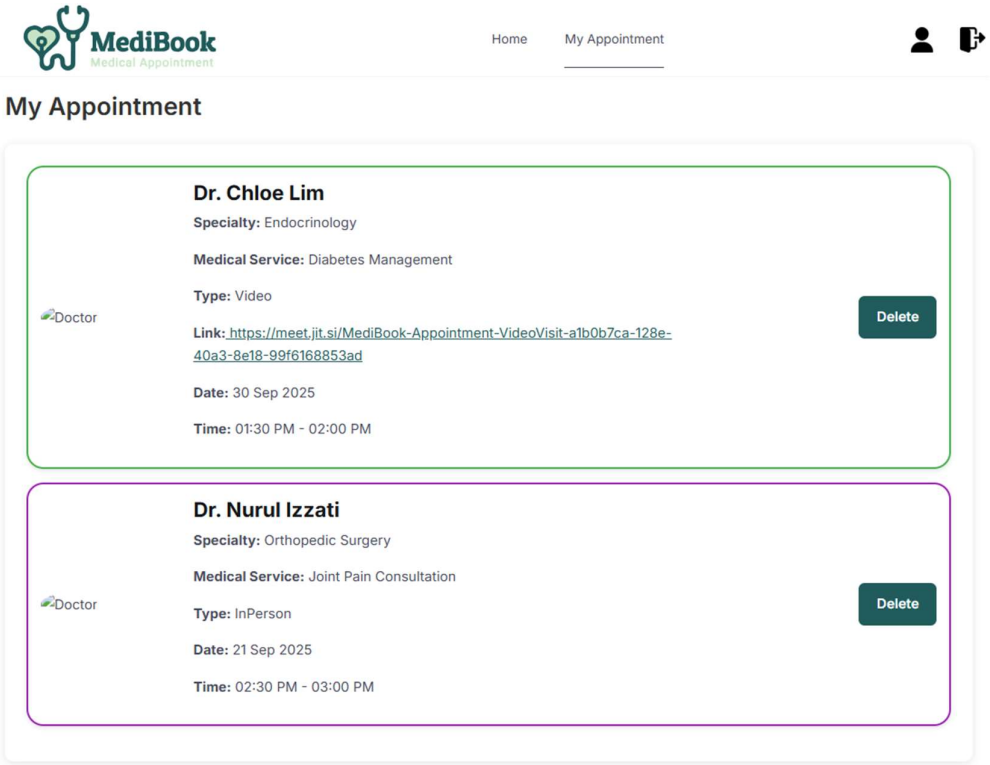

Figure 5.4.2.5 My Appointment Page

In My Appointment page, patient able to check their booked appointment. In each of the appointment slots there is a delete button which allows patients to cancel the appointment. If the appointment type is video visit, so in that appointment container will provide the link for video visit. Patients can click on that link and navigate to a new window or new tab to join the video visit.

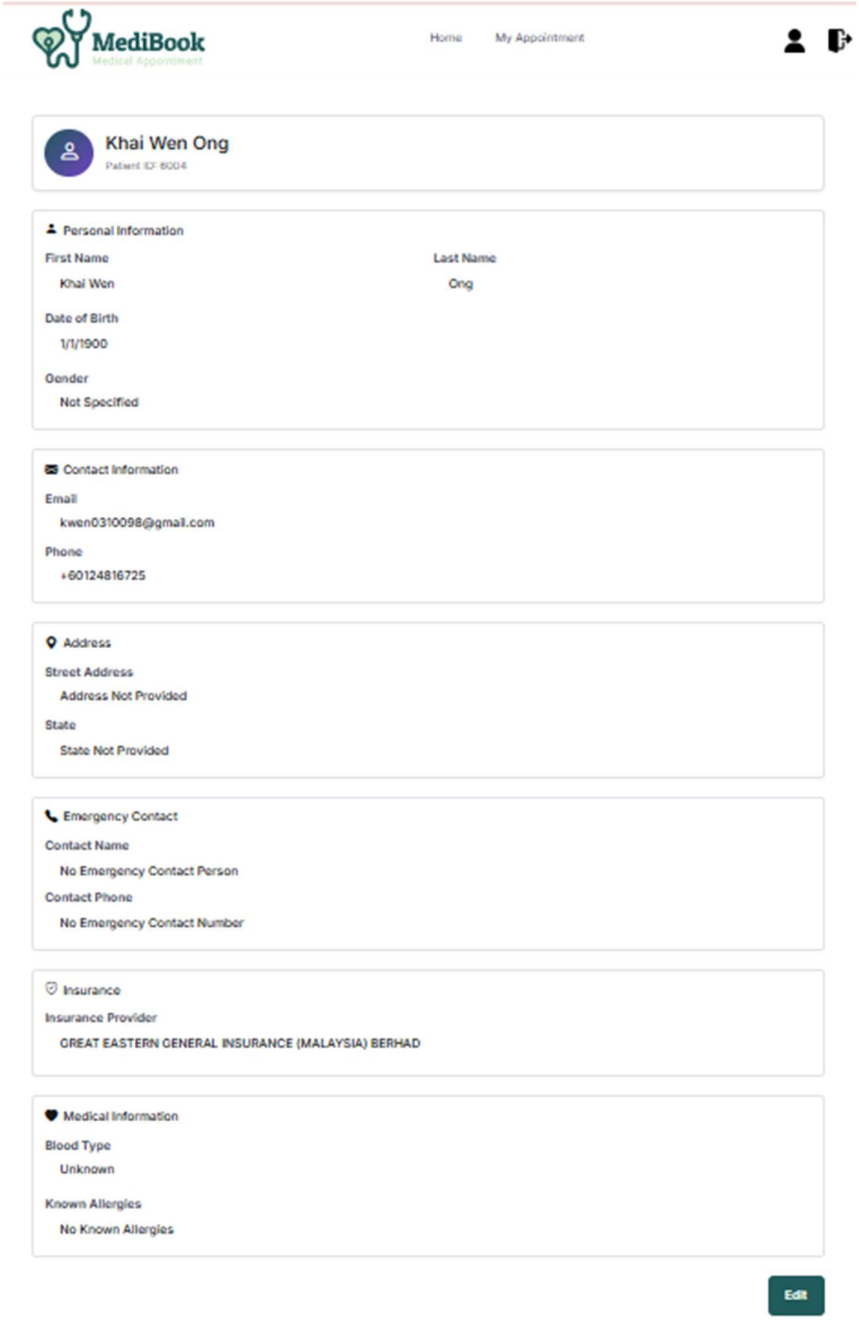

Figure 5.4.2.6 Patient Profile Page

This is the patient profile page which lets the patient view their detailed information. They can click on the Edit button to update and manage their personal information such as blood types, known allergies, emergency contact person and emergency contact number.

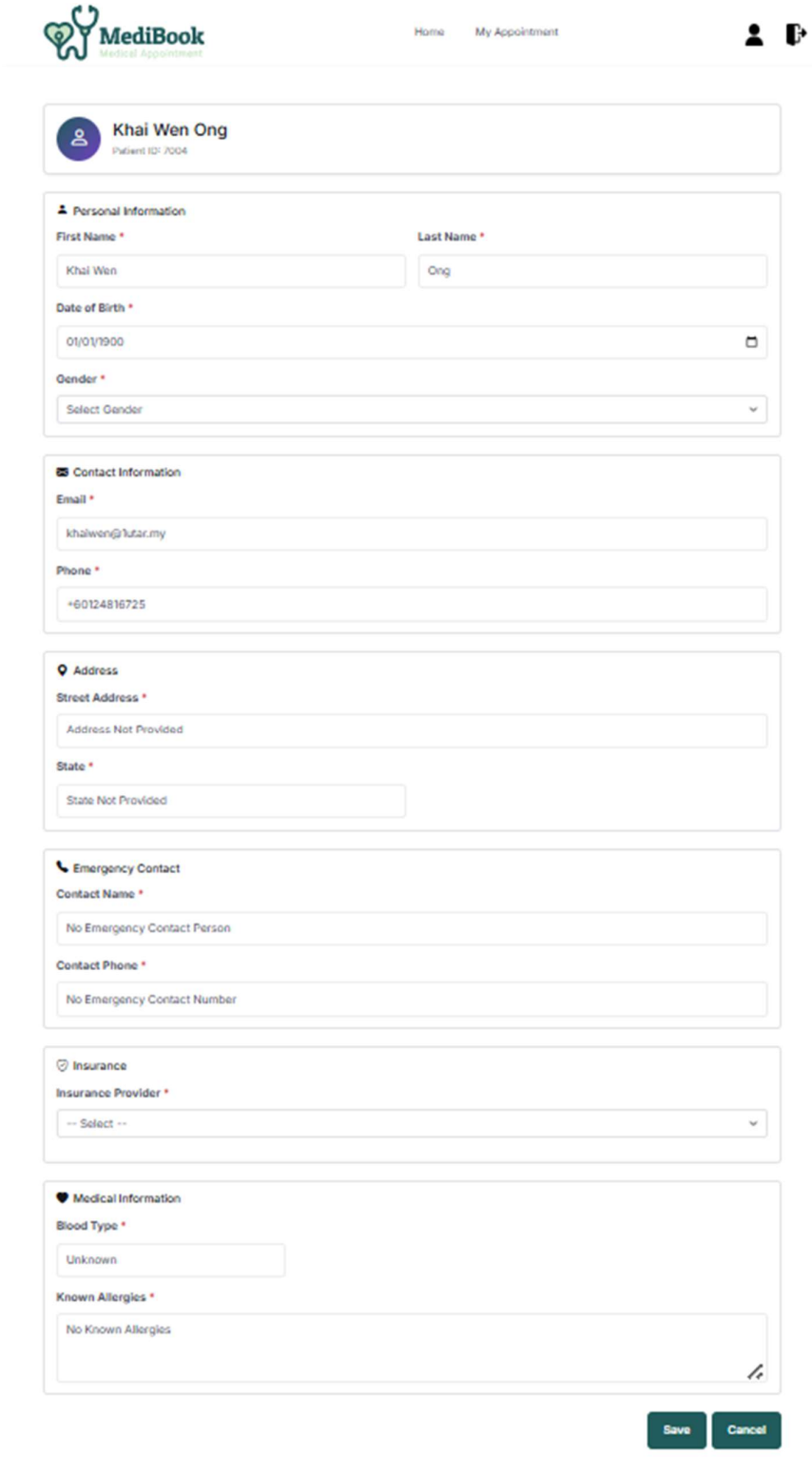

Figure 5.4.2.7 Patient Update Profile Page

After patients click on the Edit button, it will let patients update their personal and medical information.

5.4.3 Doctor Module

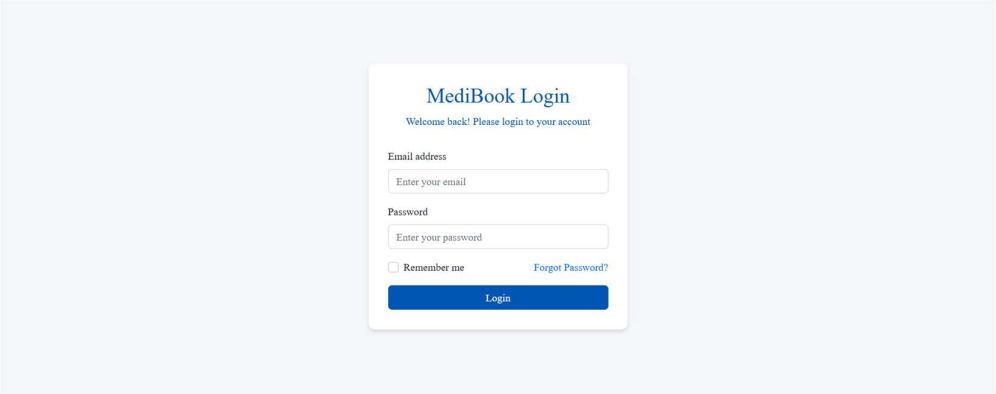

Figure 5.4.3.1 Doctor Login Page

Doctors need to enter the email address and password that have been created by their affiliated hospital or clinic. Doctors will not be able to register the account by themselves.

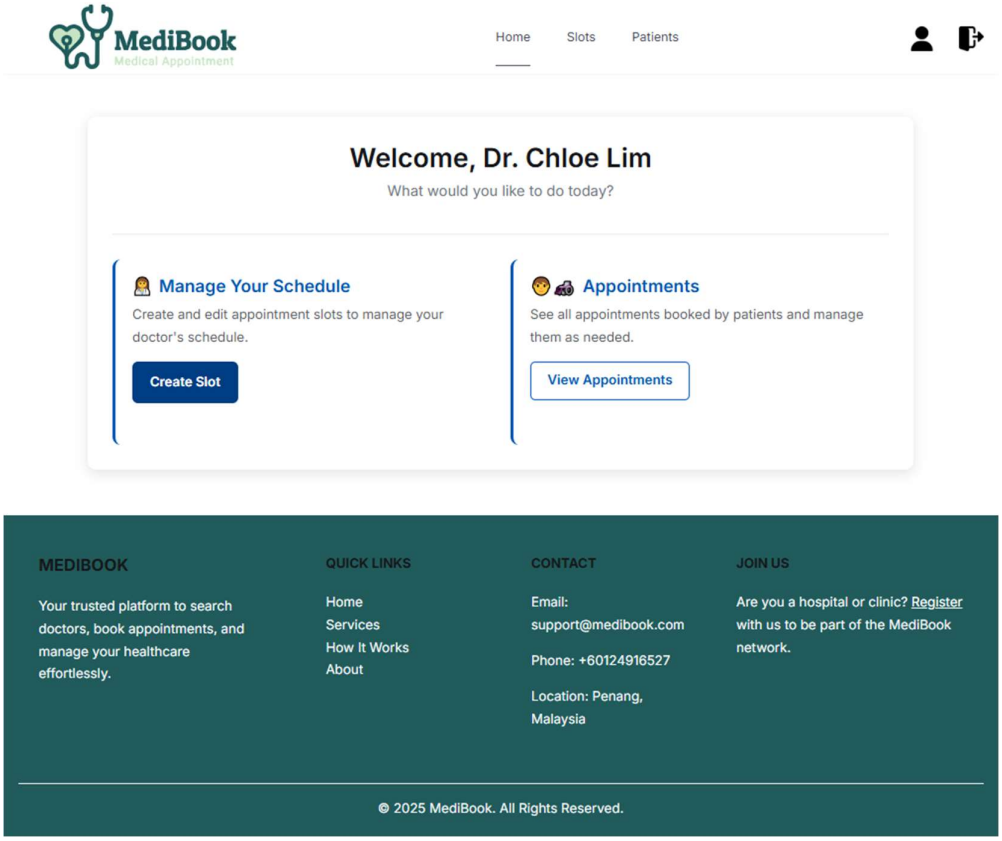

Figure 5.4.3.2 Doctor Home Page

The doctor's home page includes a navigation bar with 3 buttons which are Home, Slots and Patients. The dashboard allows doctors to create appointment slots and view

booked appointments. In addition, the page also has a footer section for navigation.

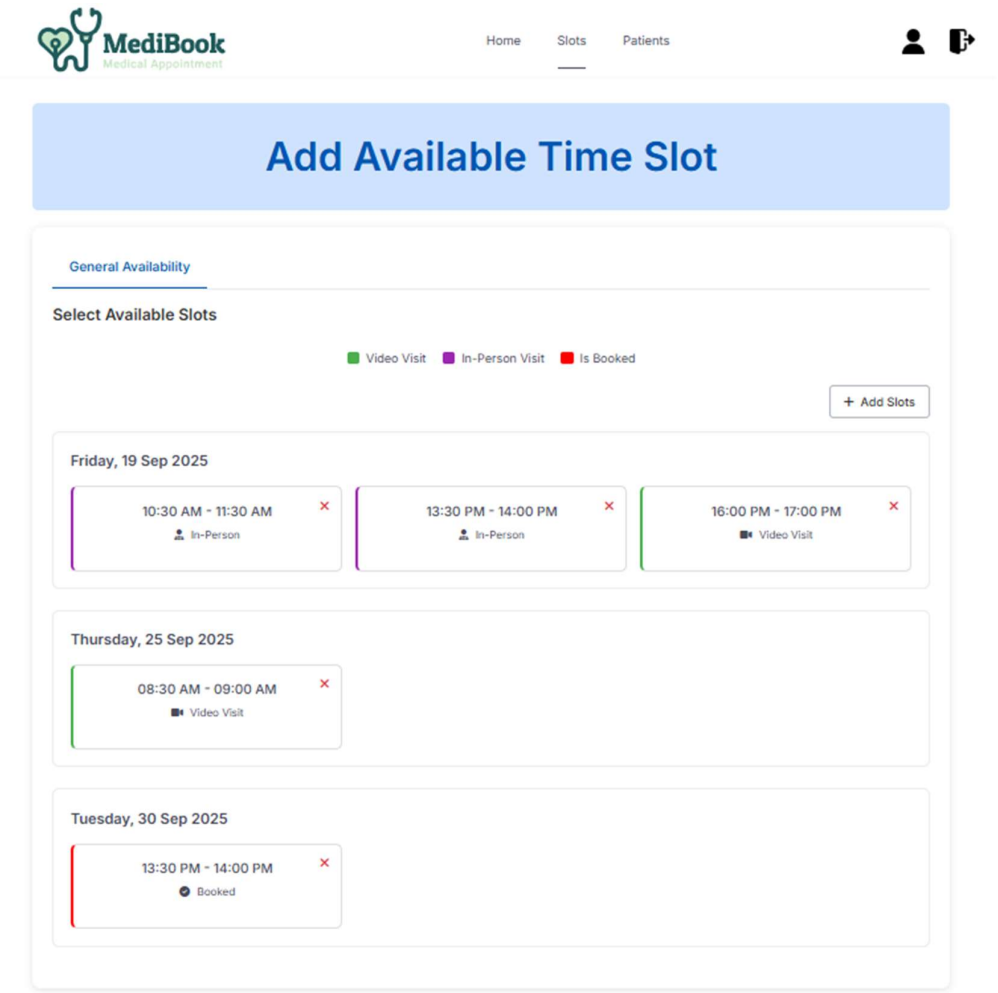

Figure 5.4.3.3 Add Available Slot Page

For the add appointment slot page, doctor able to create their available slot and specify the appointment type based on their time management by clicking the Add Slots button. There will be extra information with color indicators which clarify green color represents video visit, purple color represents in-person visit while red color represents booked slots. Doctor can click on the cross icon in each slot container to delete the slot.

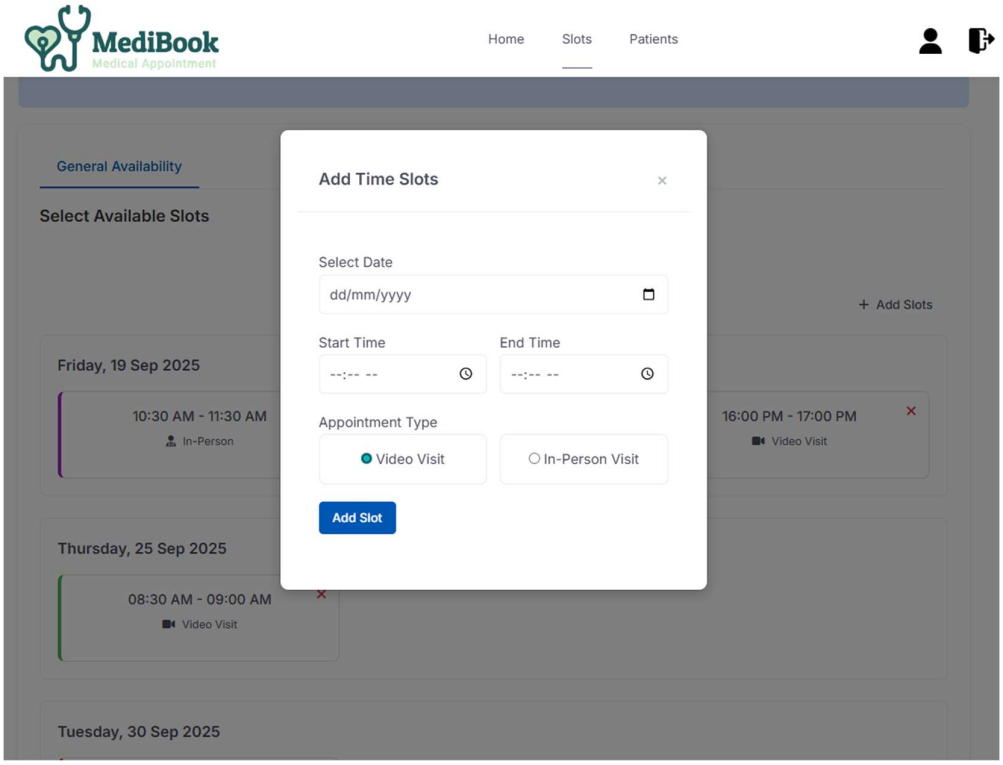

Figure 5.4.3.4 Add Slot Container

After clicking on the Add Slots button, the system will display a popup window to let doctor add time slots. Doctor can select the date through the calendar, set the start time and end time and choose the appointment type. Once a slot is successfully created, it will display on the add appointment slot age.

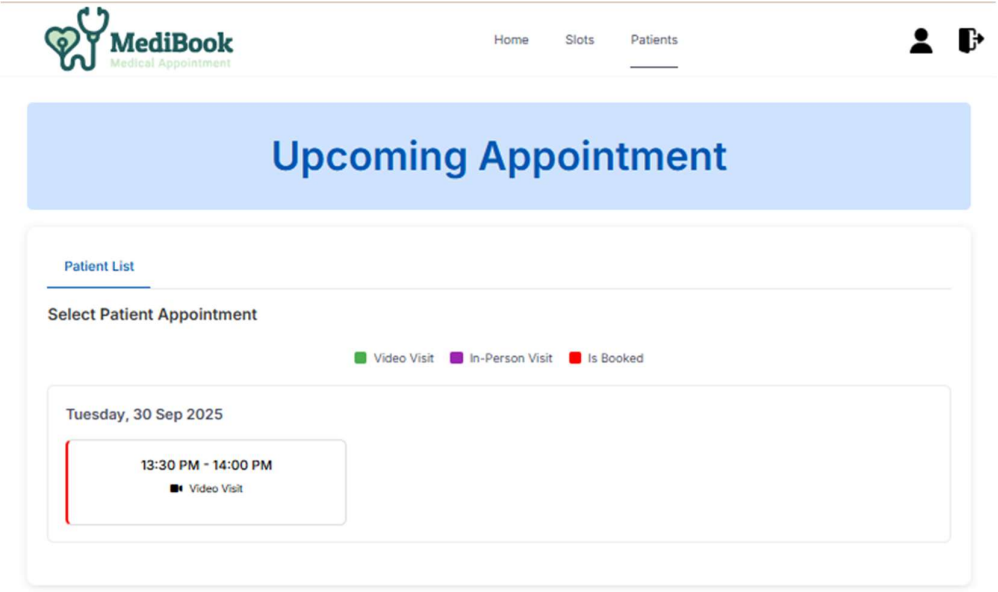

Figure 5.4.3.5 Upcoming Appointment Page

For the upcoming appointment page, doctor can check the booked appointment here. Once the appointment slot has been booked by patients the appointment container will turn into red color indicators.

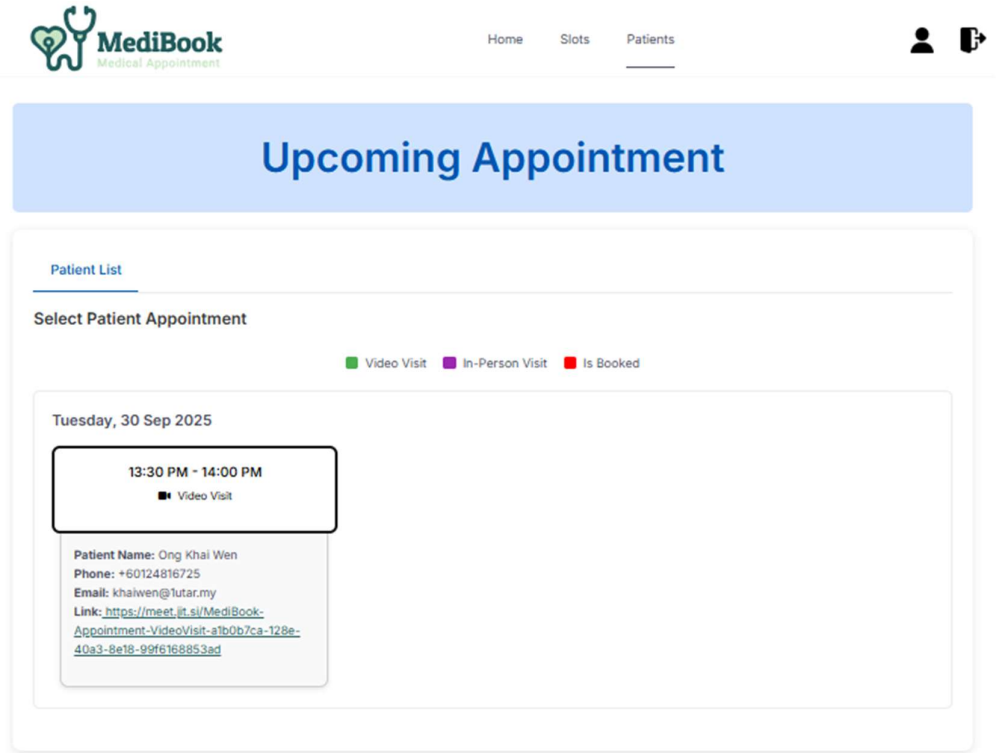

Figure 5.4.3.6 Upcoming Appointment

Doctor able to click on the appointment container to view patient details. If the

appointment type is video visit, doctor will also get the video visit link same as the patient.

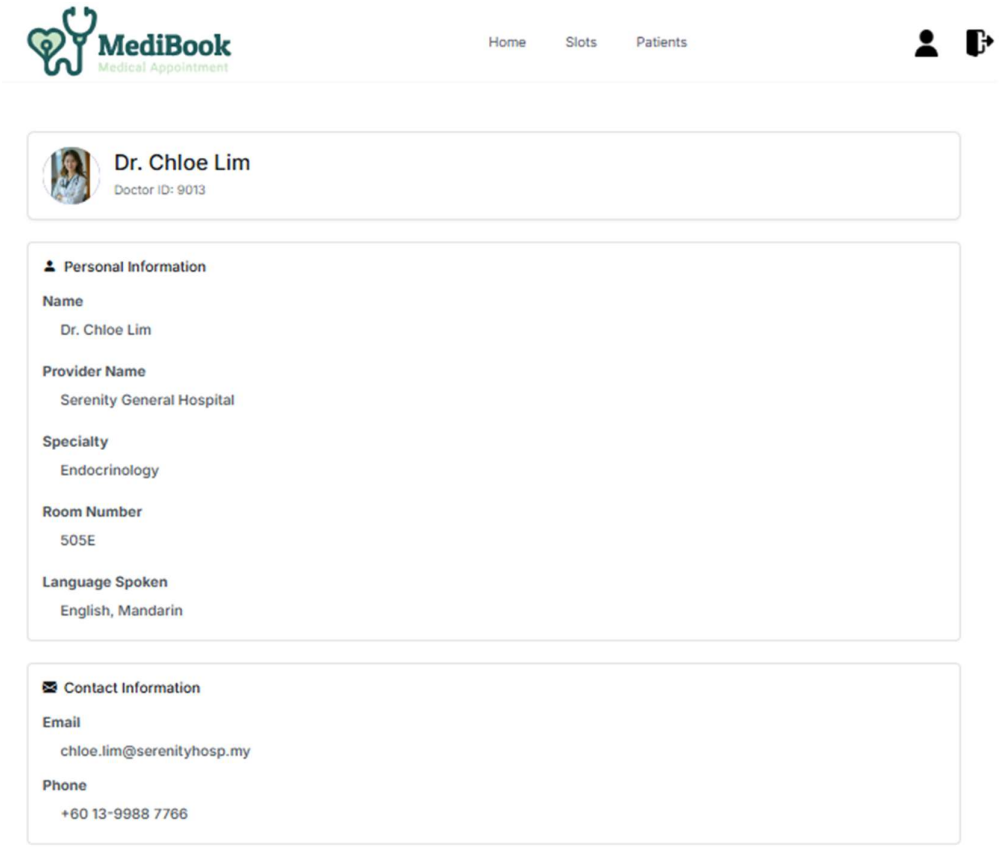

Figure 5.4.3.7 Doctor Profile Page

The doctor's profile page allows doctors to view their detailed information. However, they are not allowed to update and manage their profile.

5.4.4 Provider Module

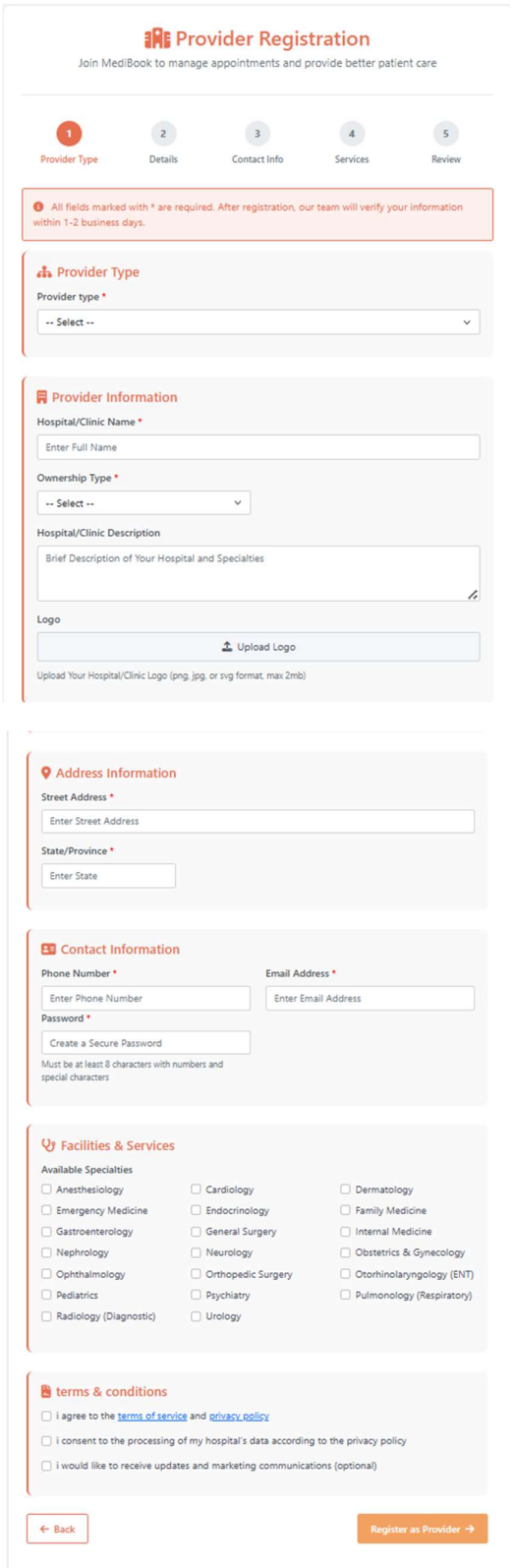

Figure 5.4.4.1 Provider Register Page

Healthcare providers able to join and use the system through an open registration process. Providers are required to fill in all the necessary information. Once successfully create an account, the system will navigate to provider login page.

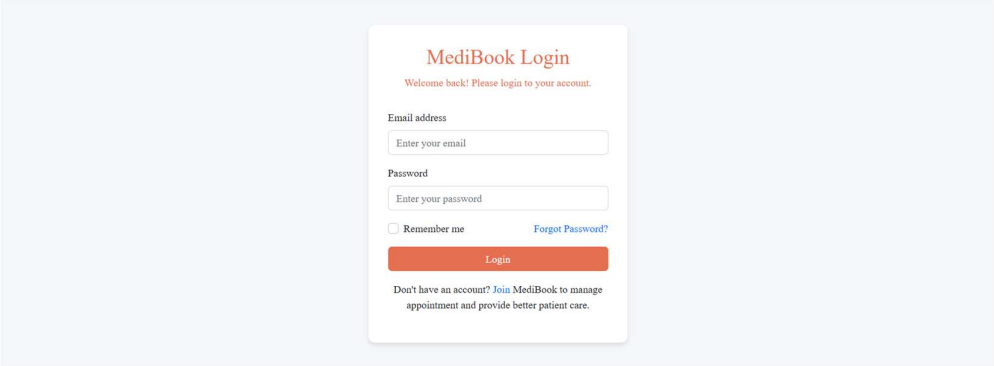

Figure 5.4.4.2 Provider Login Page

Providers need to enter the email address and password to login to the provider homepage.

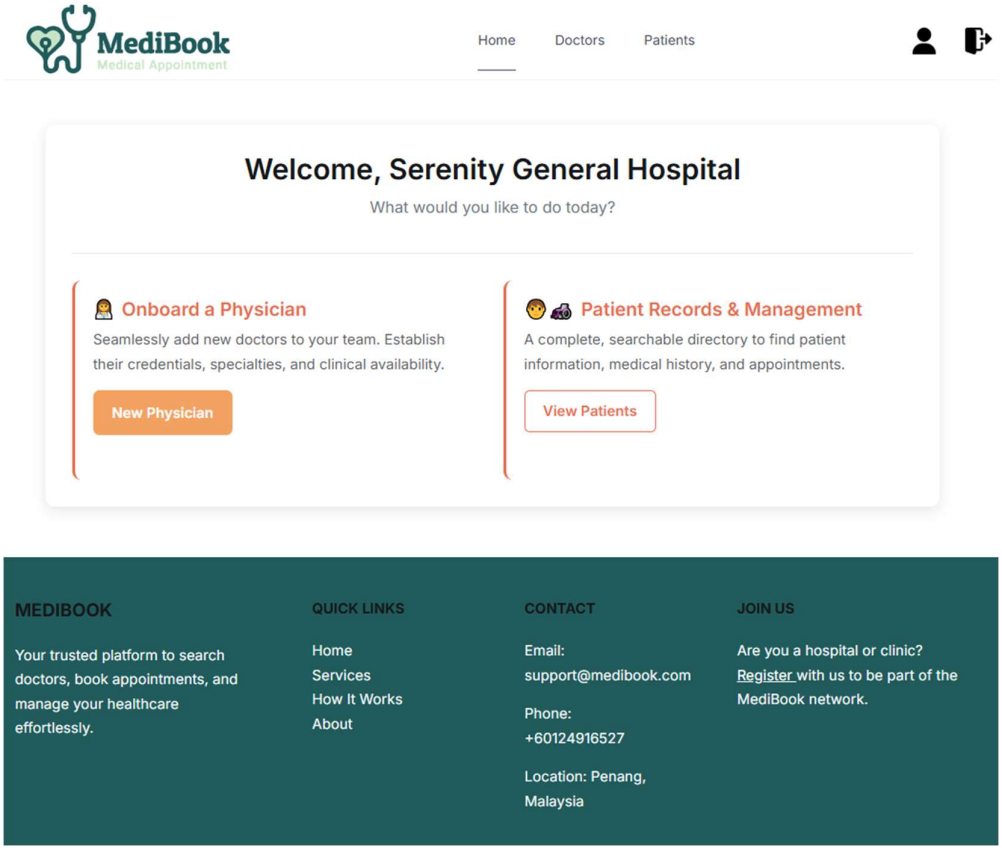

Figure 5.4.4.3 Provider Home Page

The provider homepage contains a navigation bar, dashboard and footer section. On

the navigation bar have three buttons which are home, doctors and patients. Providers can add new doctors and view patients who have scheduled appointments with their doctors.

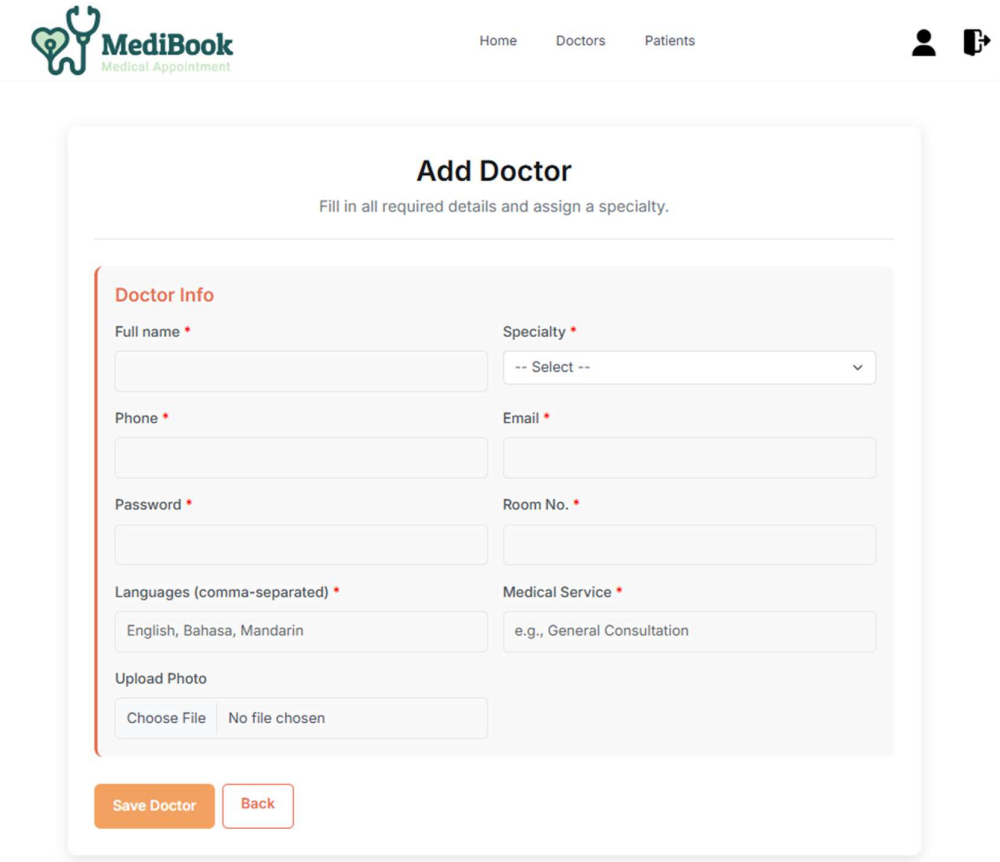

Figure 5.4.4.4 Provider Add Doctor Page

This is an Add Doctor Page that allows providers to register new doctors by filling in all the necessary information. This form includes full name, specialty, phone number, email address, password, room number, language spoken, medical service. Provider can upload a profile photo for doctor. Then, there are two buttons which are Save Doctor button to submit the form and Back button to return to the previous page.

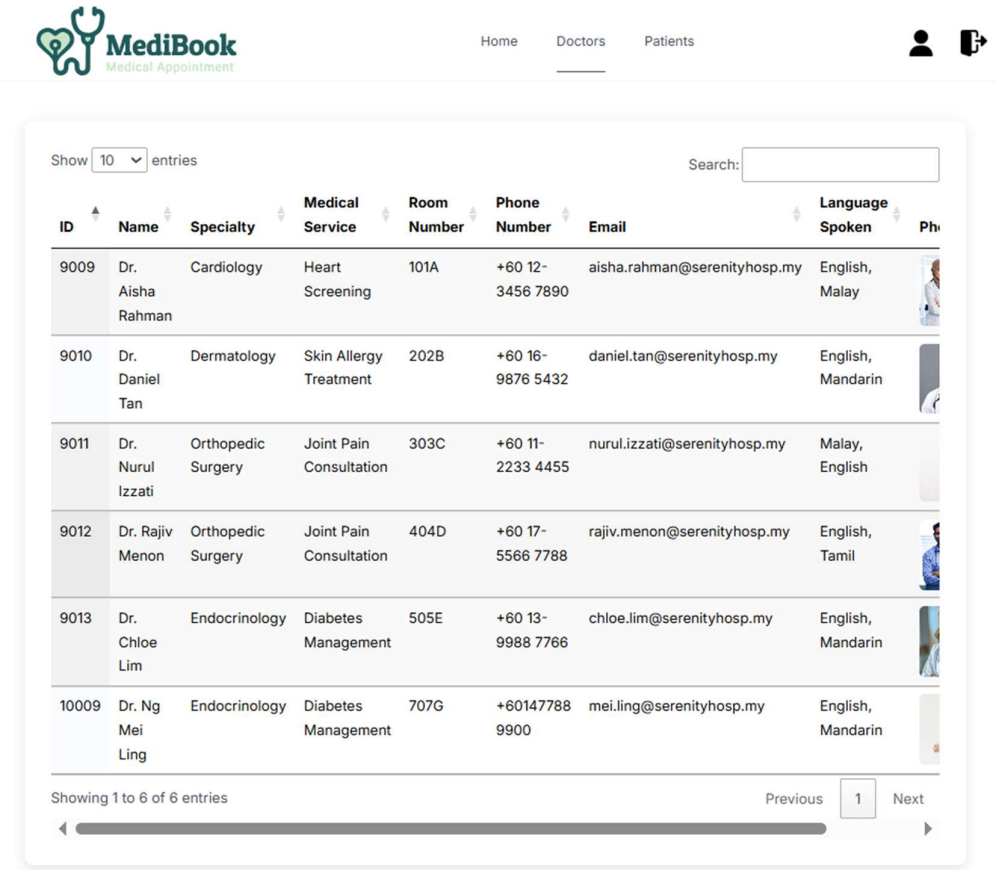

Figure 5.4.4.5 View Doctor List

For the view doctor list page, here contains a table that shows about all registered doctor information. To manage and update the doctor's information, providers can click the pencil icon located at the end of the corresponding row.

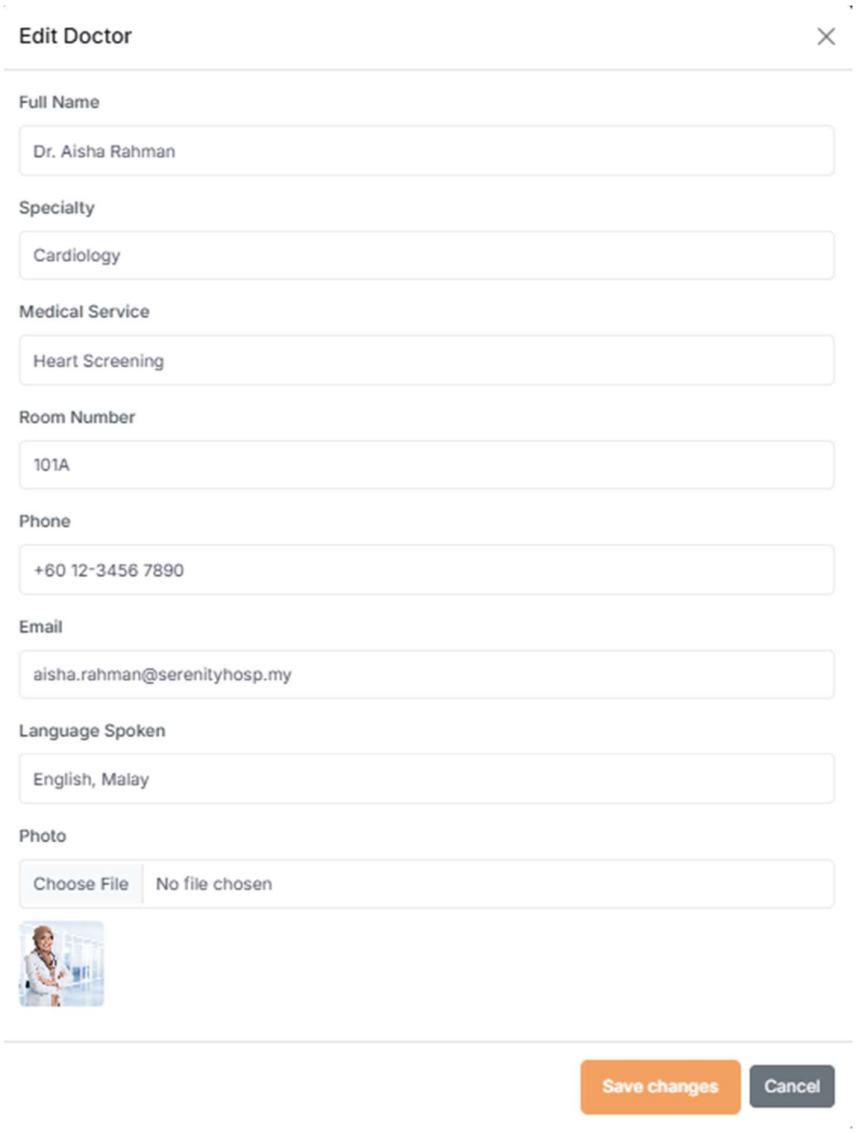

Figure 5.4.4.6 Update Doctor Profile

This is a popup window that allows providers to update the information of doctors. Once the changes are made, they just need to click the Save changes button to apply the updates.

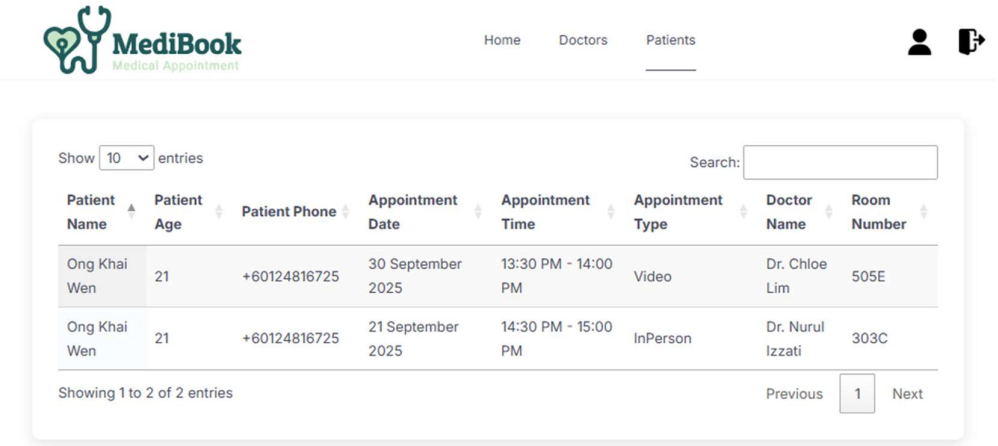

Figure 5.4.4.7 View Patient List

This is a view patient list page. In this page will shows the patient information who have make appointments with their registered doctors.

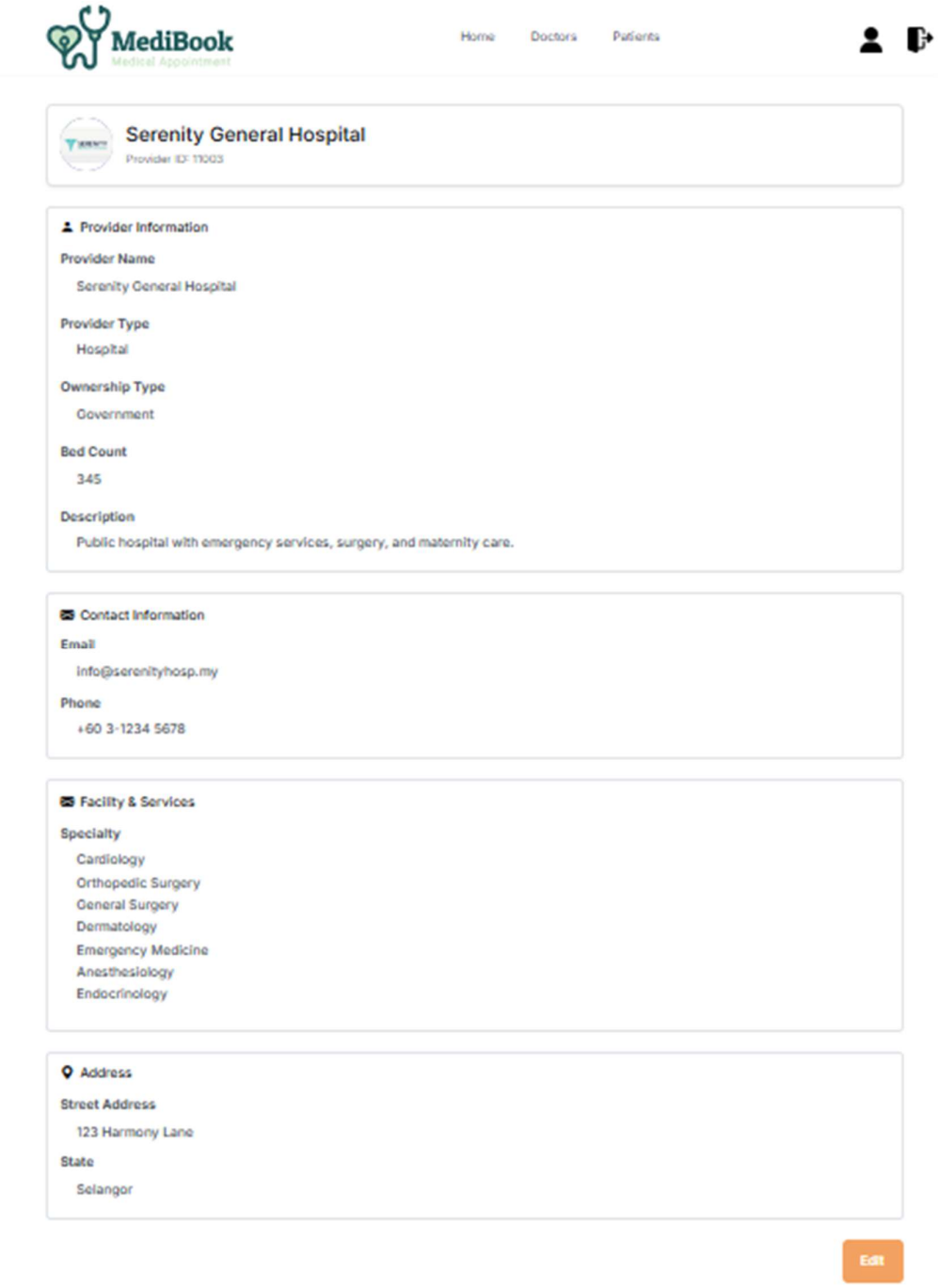

Figure 5.4.4.8 Provider Profile Page

In the provider profile page, it will display the key information about the provider. Providers can use this page to review and update their own information. If provider wants to update their information, they can click on the Edit button to make changes.

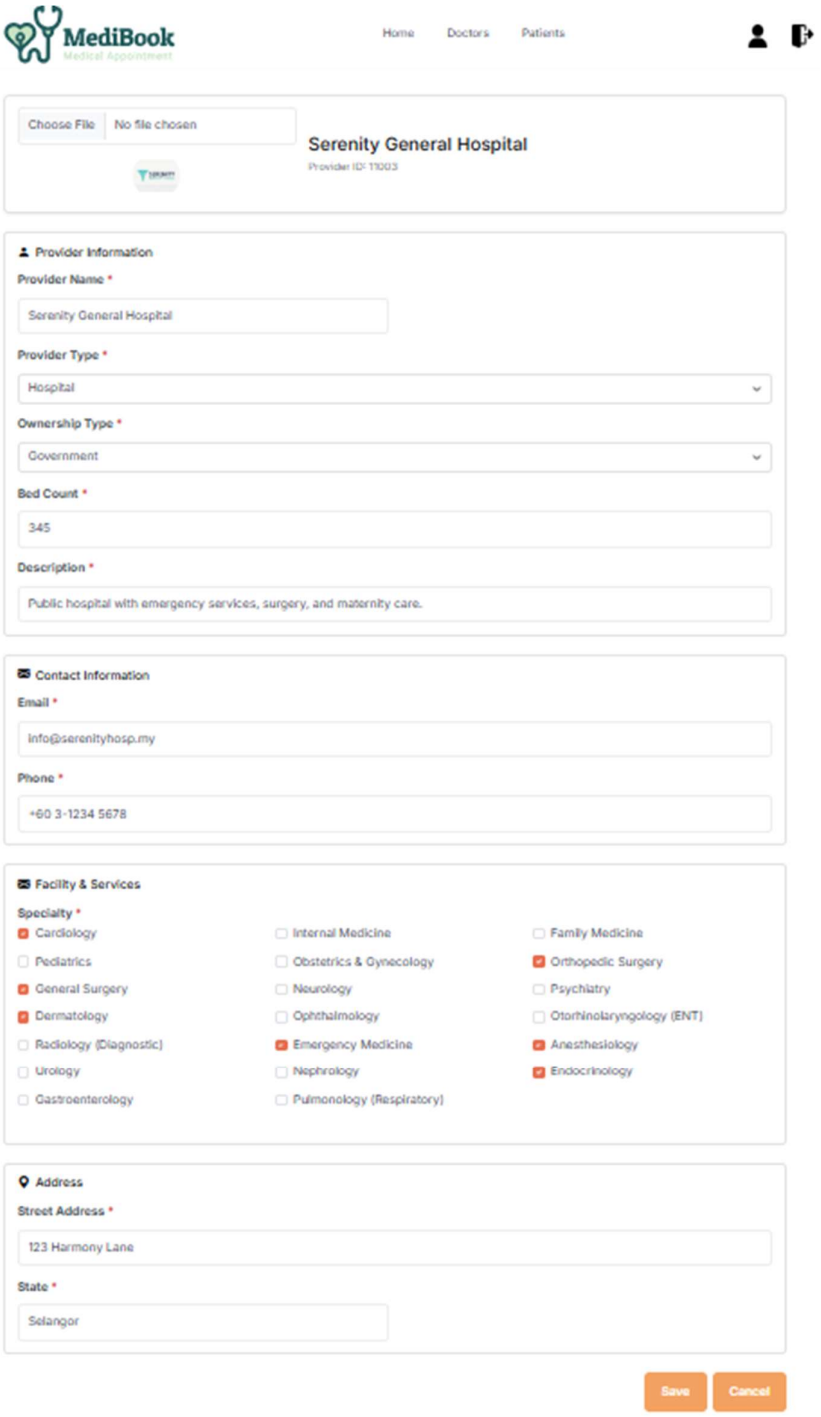

Figure 5.4.4.9 Provider Update Profile

After clicking the Edit button, the system will display the editable fields that allow providers to make changes and update their information.

5.5 Implementation Issues and Challenges

The challenges and issues that I have faced during system implementation and development are about the store image to Firebase storage and retrieve the URL. Therefore, I need to set the correct path which must clearly specify where the image should be stored. Another challenge is struggling with the Razor Pages form validation. For example, the drop-down menu of specialties does not bind properly. This is because of the ProviderSpecialty table which connect ProviderId and Specialtyid.

CHAPTER 6

System Evaluation and Discussion

6.1 System Testing and Performance Metrics

Register Account

No	Test Case	Expected Output	Actual Output	Action Needed
1.	Register button clicked with all field filled	Navigate to Login page	Navigate to Login Page	Pass
2.	Register button clicked with email without proper format (com, .my, etc.)	Warning message "Please enter a valid email address"	Navigate to Login Page	Use ASP.NET Core's built-in asp-validation
3.	Register button clicked with phone numbers without + sign and less than 9 digits	Warning message "Phone number must between 9 and 15 digits and can start with +"	Warning message "Phone number must between 9 and 15 digits and can start with +"	Pass

Table 6.1.1 Register Account Testing

Forget Password

No	Test Case	Expected Output	Actual Output	Action Needed
1.	Enter correct email address	Success Message "Reset Password email had sent"	Success Message "Reset Password had sent"	Pass
2.	Enter wrong email address	Warning message "Email not found in	Warning message "Email not found	Pass

		system"	in system"	
3.	Enter the reset password that receive from email	Login successful	Warning message "Invalid login attempt"	Check the correct return page

Table 6.1.2 Forget Password Testing

Login

No	Test Case	Expected Output	Actual Output	Action Needed
1.	Login button clicked when email address and password entered	Direct navigate to home page	Direct navigate to home page	Pass
2.	Login button clicked with email address without proper format	Direct navigate to home page	Warning message "Invalid email or password"	Implemented ASP.NET Core Model Validation with ModelState.IsValid
3.	Login button clicked when email address or password not filled	Warning message "Invalid login attempt"	Warning message "Invalid login attempt"	Pass

Table 6.1.3 Login Testing

Patient Search and Filter

No	Test Case	Expected Output	Actual Output	Action Needed
1.	Search button clicked with all specialties	Load all the doctor with available slot	Load all the doctor with available slot	Pass

2.	Search button clicked when Search bar entered with a character "a"	Load available doctor with the name have character "a"	Load available doctor with the name have character "a"	Pass
3.	Search button clicked when a selected specialty does not exist	Warning message "No matching doctor found"	Load all doctor	Add on the checking like load specialty table first then load doctor table

Table 6.1.4 Patient Search and Filter Testing

Patient Make Appointment Testing

No	Test Case	Expected Output	Actual Output	Action Needed
1.	Patients click on Book Appointment button and select available slot	Popup message "Are you sure want to book Dr. XXX slot?"	Popup message "Are you sure want to book Dr. XXX slot?"	Pass
2.	Patient books a Video appointment slot	Appointment is saved as "Video" includes video visit link	Link column is empty without the video visit link	Add on the checking is that the appointment type is video then shows the autogenerated link
3.	Patient books an in-person appointment slot	Appointment is saving as "In-person" in My Appointment	Appointment is saving as "In-person" in My Appointment	Pass

Doctor Add Available Slot

No	Test Case	Expected Output	Actual Output	Action Needed
1.	Add slots button clicked with all field filled	Slots are successfully saved and displayed	Slots are successfully saved and displayed	Pass
2.	Add slots button clicked with selected date before the current date	Warning message "Appointment date cannot earlier than today"	Slots are successfully saved and displayed	Add on the checking for the Appointment Date is that earlier than today.
3.	Add slots button clicked where end time is earlier than start time	Warning message "End time must be after start time"	Warning message "End time must be after start time"	Pass
4.	Create multiple slots for the same date with different times	All slots display correctly in the schedule	All slots display correctly in the schedule	Pass

Provider Add Doctor

No	Test Case	Expected Output	Actual Output	Action Needed
1.	Specialty drops down menu displays the specialties selected during account registration	Drop down menu correctly shows the selected specialties during account registration	Drop down menu shows all specialties	Should be based on Provider Id then select the Provider Specialties
2.	Save button	Navigate back to	Navigate back to	Pass

	clicked with all field filled	the ProviderHomePage	the ProviderHomePage	
3.	Save button clicked without uploading a photo	Warning message "The DoctorPhoto filed is required"	Warning message "The DoctorPhoto filed is required"	Pass

6.2 Project Challenges

The challenge that has been faced during development of this project is implementing the search and filter functions. For instance, filtering doctors by specialty is necessary to load the specialty data from the database first before retrieving the doctors with available slots. If the doctor data was loaded first, the specialty filter would not apply correctly. So, in the search results no matter which specialty has been selected all doctors with available slots will be shown.

6.3 Objectives Evaluation

Basically, this patient appointment scheduling system is developed to achieve the main objective. The first objective is to improve the appointment type clarity. According to the existing system, their available appointment slot is using one color and an icon to represent the appointment type. This will cause confusion and misunderstanding regarding their available appointment. So, a patient appointment scheduling system has implemented a clear clarity of appointment type and status with the combination of text-labels, color indicator and icon. Furthermore, this system also achieves the second objective which is to streamline the appointment scheduling process. Patient able to make appointments by selecting the slots that fit their needs after viewing the doctor's details, reducing unnecessary steps. From the existing system, they do not provide the book appointment services after viewing the doctor's profile. The third objective is to expand provider network accessibility. From the study of existing systems, they only integrate with the provider they selected. It was not an open registration system to let public providers join and use the system. Therefore, the proposed system has implemented an open registration system which invites the public provider to join and use the system efficiently.

CHAPTER 7
Conclusion and Recommendations

7.1 Conclusion

The proposed Patient Appointment Scheduling System brings out a comprehensive and user-friendly system to improve efficiency and accessibility of patient appointment scheduling system. First of all, the proposed system successfully improved the efficiency of and booking process by streamlining the appointment process. Patients can directly make an appointment after viewing the doctor's profile. In addition, the system also enhances the clarity for appointment types. Combination of text-labels, color indicator and icon provide a clear understanding of whether the appointments are in-person or video visit. Furthermore, an open registration system for hospitals and clinics helps expand healthcare access, offers more selection for patients and connects them with a wide range of healthcare professionals. With this innovation, the proposed system becomes more useful and convenient for every user.

7.2 Recommendation

The recommendation for the future implementation is to implement an automated notification for video visit through email. When a patient makes an appointment with video visit, the system could automatically generate the video visit link and send it to the patient's email. With this recommendation, patients might more easily get the online consultation link rather than get the link through the website. In addition, another improvement could be developing an automated patient check-in system. This improvement can reduce the traditional paperwork and update the status on time. The third improvement that can be made in future is to integrate appointment analytics into the provider dashboard. Therefore, provider can analyze the booking behavior, cancellation rates, and the patient demographics through interactive charts.

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Poster

FACULTY OF INFORMATION COMMUNICATION AND TECHNOLOGY

Patient Appointment Scheduling System Using Web Application

1 Introduction

An online patient appointment scheduling system

This helps to streamline the process of planning, managing and optimizing patient appointments, ensure that healthcare providers allocate resources efficiently

2 Objective

- Improved Appointment Type Clarity
- Streamline the Appointment Scheduling Process
- Expand Provider Network Accessibility

3 Problem Statement

- Unclear differentiation of appointment types
-
- Unable direct booking after viewing doctor profile
- Limited provider partnership

4 Proposed Method

- Implement redundant visual indicators
- Implement structured and one-stop solution system
- Implement an open registration system

5 Why the proposed system in this project is better than the existing system

1. **Satisfy**- Clearly identify each appointment type and appointment status
2. **Effective** - Arrange available appointment type according to time arrangement
3. **User-friendly** - Able to direct make appointment on the system after reviewing doctor profiles

6 Conclusion

The proposed system enhances efficiency, clarity, and accessibility, while future improvements include notifications, automated check-in, and provider analytics integration.

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