Faculty of Computer Science and Information Technology

APPOINTMENT MANAGEMENT SYSTEM FOR PUSAT KESIHATAN

PRIMA UNIMAS

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Bachelor of Computer Science with Honours

(Software Engineering)

2024

CHAPTER 1 : INTRODUCTION

1.1   Introduction

Pusat Kesihatan Prima (PKP) Universiti Malaysia Sarawak (UNIMAS) serves as the primary healthcare provider for UNIMAS, offering comprehensive medical and healthcare services to students, staff, and the surrounding community. Established as a teaching hospital, PKP UNIMAS plays a pivotal role in producing quality undergraduates and postgraduates in the medical field while meeting the healthcare needs of the community. The centre provides seamless healthcare services through collaboration with public and private healthcare providers, acting as a regional referral centre, and conducting world-class research and innovation. PKP UNIMAS also engages in community health and wellness promotion, positioning itself as a leader in clinical education, service, and research.

The current workflow for the appointment booking and scheduling at PKP UNIMAS is heavily reliant on manual processes. For follow-up appointment, the doctor will typically discuss the date and time with the patient immediately after the consultation. The discussion is based on the patient's availability. In some cases, the doctor instructs the nurse to set a follow-up appointment for the patient. This is done by writing the date and time for the next follow-up appointment on a piece of paper or on the patient's medical history card, which is then provided to the patient. In these situations, the appointment is sometimes set without discussing the patient's availability. For a patient that is needed to refer to another section, facility, or external health provider, the doctor or nurse will ask the patient to go to the referred section or facility right after the consultation if it is available at that time. If it is not available, then the nurse will inform patient that they will make a phone call to the patient if there is any available slots at the section, facility or external health provider. For a patient that has referral letter, they can bring the referral letter directly to the registration counter and proceed to the referred section or facility if it is available. Most cases, the patient still need to attend consultation or

1

diagnosis from the doctor at the PKP UNIMAS. This is to verify and confirm the necessity of the referral or the referral might need changes such as change on the referred section.

To streamline these workflows, this project aims to develop an Appointment Management System for PKP UNIMAS. This system will allow patients to book, cancel or reschedule appointments online, upload referral letters, and select their preferred time slots. The doctor also can book appointments for patients directly after consultations. To ensure accurate scheduling, the system provides real-time updates on the availability of sections, facilities, and specialists. Additionally, the system will send notifications to patients to remind them of upcoming appointments, notify them of any required changes, and confirm approved appointment requests. Nurses and doctors will have the capability to view and verify patient referral letters uploaded through the system. They can also approve, reject, or request changes to appointment requests based on the verification and availability of resources. By automating these processes, the system will enhance efficiency, improve communication, and provide a seamless experience for both patients and healthcare staff.

1.2   Problem statement

The current appointment scheduling workflow at Pusat Kesihatan PRIMA (PKP) UNIMAS relies heavily on manual processes, which are inefficient and prone to errors. For follow-up appointments, doctors either discuss the date and time with patients immediately after consultations or instruct nurses to set appointments without always considering the patient's availability. This often results in scheduling conflicts and patient dissatisfaction.

For referrals to other sections, facilities, or external health providers, the process becomes more complex. Nurses must communicate the availability of the referred facility to the patient, often requiring follow-up calls to confirm details. If the patient has referral letter from external health provider and bring it directly to the PKP UNIMAS, there is no

confirmation that the patient can proceed to go to the referred section or facility as not all sections or facilities operate daily or have available slots. This often resulting in wasted trips for patients unaware of the availability.

Additionally, the lack of an automated notification system exacerbates the inefficiencies. There is currently no reminder mechanism to alert patients about their upcoming appointments. Based on my interview with the healthcare staff at PKP UNIMAS, this results in a 30% probability of patients missing their scheduled appointments. This "no-show" issue disrupts the clinic's workflow, wastes resources, and increases the waiting time for other patients seeking care.

The absence of a centralised and automated system to manage appointments has created significant administrative burdens and operational inefficiencies. With the expected growth of an average of 300 patients per day at PKP UNIMAS, these issues can lead to increased workload for healthcare staff, longer wait times for patients, and reduced overall service quality. These challenges necessitate the development of a robust Appointment Management System to streamline the booking, scheduling, and verification processes while incorporating notification features to improve patient attendance and enhance the overall efficiency of healthcare delivery at PKP UNIMAS.

1.3   Aims and Objectives

The objectives of this project are:

- To develop a web-based appointment management system to simplify booking, rescheduling, and cancelling appointments.
- To automate scheduling processes to minimise manual errors.
- To provide healthcare staff with a centralised, real-time system to manage appointments and improve service efficiency.

1.4   Scope

The project will focus on developing a web-based appointment management system that can be accessed by both patients and healthcare staff. Patients will be able to register, view available appointment slots. Doctor and patient can book appointment online. Healthcare staff will be able to manage the appointments through a centralised system, enabling them to track, modify, and organise patient bookings.

1.5   Brief Methodology

For this project, the Waterfall methodology will be used to develop a web-based appointment management system for Pusat Kesihatan Prima UNIMAS. The Waterfall methodology is a sequential approach to software development where each phase must be completed before the next one begins. This model is suitable for the appointment system project due to its straightforward requirements and the need for a well-defined structure. The methodology will involve the following key phases:

1. **Requirement Analysis**

   In this initial phase, the project requirements for the appointment system will be gathered and documented. This includes understanding the needs of both patients and healthcare staff at PKP UNIMAS. The focus will be on identifying key functionalities, such as patient registration, appointment booking, rescheduling, cancellation, and staff management of appointments.

2. **System Design**

   Based on the requirements, the system's architecture will be designed. This phase involves creating detailed design documents that outline the system's structure, database schema, user interface layouts, and workflows. Each module, such as user

authentication and appointment management, will be specified in this stage to ensure clarity before development begins.

3. **Implementation**

The system will be developed according to the design documents, utilising HTML, PHP, and CSS for front-end and back-end development to create a responsive interface. The database will be configured using MySQL to securely store and manage patient, doctor, and appointment data. Code will be written for each component, starting with core functionalities such as patient account registration, login authentication, and appointment booking. This phase will integrate front-end elements for user interaction with back-end logic to process data and database operations, ensuring seamless functionality and data integrity across the system.

4. **Testing**

After implementation, the system will undergo comprehensive testing. This includes functional testing to ensure all features work as expected usability testing to assess user-friendliness. The testing phase ensures that the system meets all requirements and functions reliably before deployment.

5. **Deployment**

Once testing is complete, the system will be deployed to PKP UNIMAS. This phase includes setting up the live environment, configuring the system for production use, and providing initial training for healthcare staff.

6. **Maintenance**

Post-deployment, the system will enter the maintenance phase, where any issues identified by users will be addressed. Updates and improvements may be implemented over time based on user feedback to enhance functionality and user experience.

1.6   Significance of Project

The development of an appointment management system for PKP UNIMAS will have significant benefits for both patients and healthcare staff. By providing a centralised, this project will streamline appointment scheduling and reduce the time and effort spent on manual booking processes. Patients will have more control over their appointments, with the ability to book, reschedule, or cancel with ease. For healthcare staff, the system will provide a real-time overview of appointments, reduce administrative burdens, and minimise the likelihood of scheduling conflicts.

Additionally, the system's data management capabilities, including automated reminders and record-keeping, will contribute to more organised operations and improved patient satisfaction. This project will not only improve efficiency and service quality for PKP UNIMAS but will also serve as a foundation for future digital transformation initiatives within UNIMAS.

1.7   Project Schedule
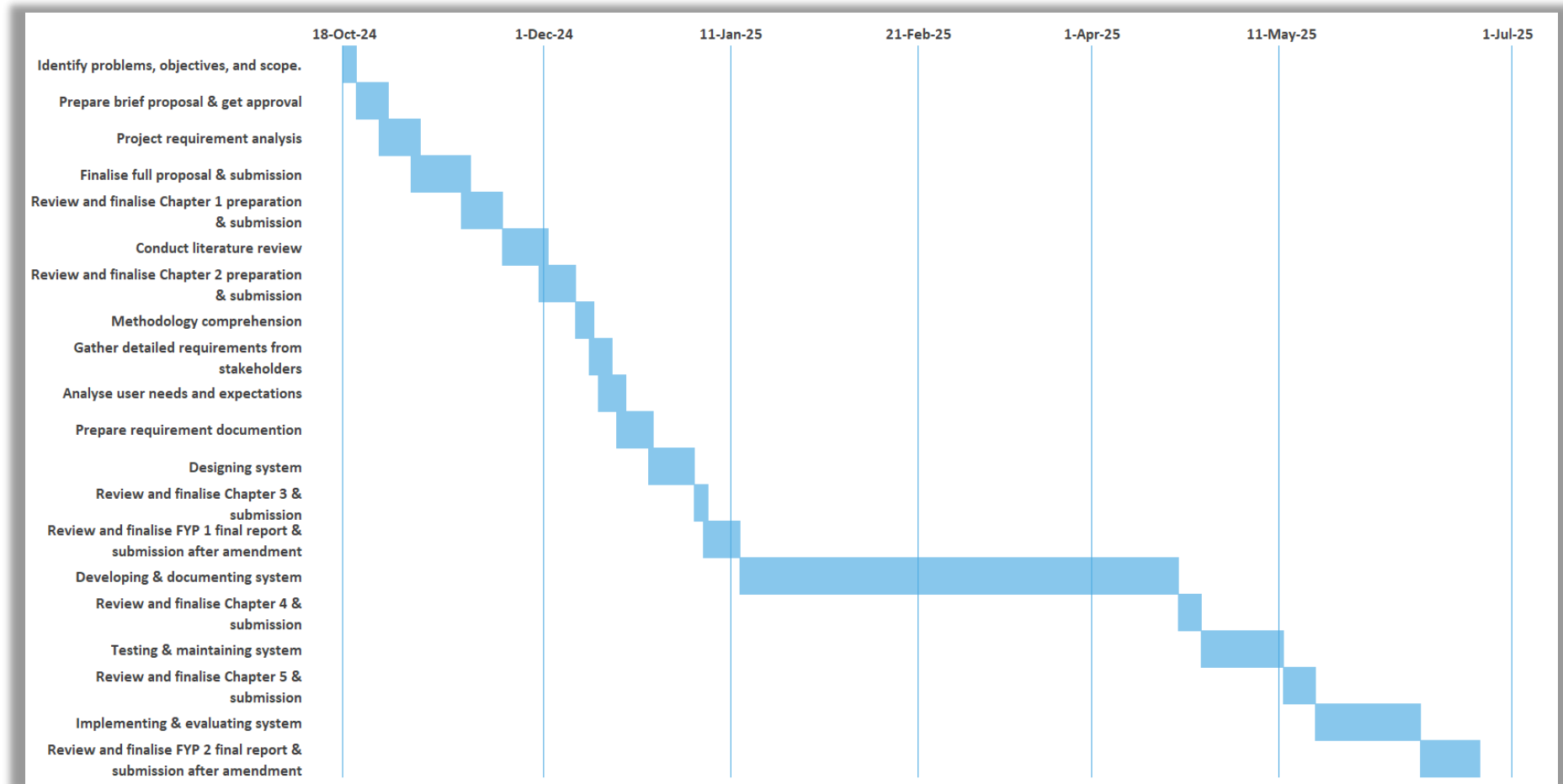
Figure 1.1. Gannt Chart of the Project Schedule.

The Figure 1.1 shows a Gantt chart outlining the timeline and key milestones for the development of the Appointment Management System project. Spanning from 18 October 2024 to 15 January 2025, the chart provides a clear depiction of the sequential phases involved in the project. It begins with identifying the problems, objectives, and scope of the project, followed by the preparation and approval of a brief proposal to formalize its initiation. Subsequently, a comprehensive requirement analysis is conducted to establish the foundation for the system. The finalized proposal is then prepared and submitted for review.

The timeline includes the preparation, review, and submission of key report chapters. Chapter 1 focuses on problem definition, while Chapter 2 highlights the literature review and contextual understanding of the project. A thorough literature review is conducted to provide theoretical support, followed by refining Chapter 2. Methodology comprehension is emphasized to ensure a structured approach, and detailed requirements are gathered from stakeholders to capture functional and non-functional needs. These requirements are analysed to align with user expectations, and a detailed requirement documentation is prepared.

The system's design phase translates the requirements into a structured architecture and interface. Chapter 3, which focuses on the methodology, is reviewed and finalized. Finally, the complete Final Year Project (FYP) report is refined after necessary amendments and submitted for evaluation.

After the submission of Chapter 3, the project progresses into the system development phase. This involves the process of coding, integrating, and documenting the system based on the requirements and design specifications. Chapter 4, which focuses on the system development, is prepared, reviewed, and finalized during this phase. Following this, the system enters the testing and maintenance stage, where its functionality, performance, and reliability are thoroughly validated to ensure it meets the predefined requirements. Any identified issues or bugs are addressed during this stage.

Subsequently, Chapter 5, which details the system's testing results and overall evaluation, is prepared and finalized. Once the testing phase is completed, the project transitions into the implementation and evaluation stage, where the system is deployed for real-world use. Feedback from end-users and stakeholders is gathered to evaluate the system's effectiveness and identify potential areas for improvement.

Finally, the second phase of the Final Year Project (FYP) report, encompassing all chapters and necessary amendments, is reviewed and finalized. The completed report is submitted for final evaluation, marking the culmination of the project timeline as outlined in the Gantt chart.

1.8 Expected Outcome

The expected outcome of this project is the development of a comprehensive, web-based appointment management system specifically designed for PKP UNIMAS. The system will prioritise patient convenience by providing an intuitive platform where patients can easily book, reschedule, or cancel their appointments. With this feature, patients will have the flexibility to cancel or reschedule appointments through the system. Patients will also benefit from real-time updates on the available slots. Furthermore, automated notifications and reminders will ensure patients are informed of their upcoming appointments which will help a lot in reducing no-shows and missed dates.

For doctors, the system will provide a centralised system, enabling them to efficiently manage patient appointments. Doctors will be able to book appointments on behalf of patients, view uploaded referral letters, and check available time slots.

As for nurses, the system will allow them to approve appointment requests from patients and access uploaded referral letters. These features will streamline their workflow, reducing administrative workload and ensuring smooth daily operations.

Ultimately, the appointment management system will deliver a well-organised, efficient, and effective solution for managing patient appointments. It will improve patient satisfaction, optimise service delivery, and provide healthcare staff with the tools needed to deliver high-quality care at PKP UNIMAS.

1.9   Summary

This chapter introduces the development of a web-based Appointment Management System for Pusat Kesihatan Prima (PKP) UNIMAS to address inefficiencies in their current manual appointment scheduling process. The system aims to streamline patient bookings, rescheduling, and cancellations while integrating features such as real-time slot availability, automated notifications, and referral letter uploads.

The problem statement highlights the challenges of the manual system, including scheduling conflicts, communication delays, high administrative burdens, and a 30% no-show rate that disrupts operations. These issues necessitate an automated solution to improve patient satisfaction and staff efficiency, especially with the growing number of patients at PKP UNIMAS.

The project's objectives include automating scheduling processes, providing a centralized appointment system, and reducing manual errors. Using the Waterfall methodology, the project will be developed in phases: requirement analysis, system design, implementation, testing, deployment, and maintenance. The significance of this project lies in its potential to enhance healthcare service quality, reduce administrative workload, and optimize operational efficiency at PKP UNIMAS.

The chapter concludes with an expected outcome: an efficient, patient-friendly, and staff-supportive appointment system that facilitates seamless scheduling, improves patient attendance, and supports future digital transformation efforts within UNIMAS.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This chapter provides a comprehensive review of literature and existing systems relevant to the development of an Appointment Management System. The focus is on identifying key features, functionalities, and limitations of comparable systems to inform the design of an efficient, user-friendly, and robust solution for Pusat Kesihatan Prima (PKP) UNIMAS. By analysing related studies and technologies, this review lays the foundation for incorporating best practices and addressing the unique needs of PKP UNIMAS. Furthermore, the chapter explores challenges in existing solutions, providing insights into areas for improvement and innovation.

2.2 Reviews on Similar Existing Systems

This section delves into similar existing hospital and appointment management systems to evaluate their strengths, weaknesses, and relevance to the proposed solution. It examines the design and functionality of systems currently employed in healthcare settings which focusing on features such as appointment scheduling, patient record management, and user experience. By identifying the approaches these systems use to solve common healthcare workflow challenges, this review offers valuable insights for designing a tailored solution for PKP UNIMAS. These comparisons also highlight opportunities to address gaps in automation, integration, and patient engagement.

2.2.1   User Interactive Hospital Management System by using Web application

Devi et al. (2021) describes a comprehensive hospital management system designed to streamline healthcare operations by incorporating various modules that cater to the needs of patients, doctors, and administrators.

The system has Login Module which manages user authentication by verifying credentials such as ID, username, and password against the database and directing users to their respective home pages. This module also includes an additional security feature for administrators, requiring a password to access the Admin Home page.

The Admin Module enables administrators to manage profiles for patients and doctors, update appointment statuses (e.g., Booked, Consulted, Cancelled), send appointment reminders via email, and handle laboratory reports linked to specific appointments. Administrators can also add or remove doctor profiles, ensuring the database remains current.

The Patient Module allows patients to register personal and medical details, upload profile pictures, and manage their appointments. Patients can view confirmed appointments, cancel bookings and access their medical history and lab reports through this module.

The Doctor Module enables doctors to update their profiles, access patient records, and review medical histories, including previous prescriptions and test results. Additionally, doctors can prescribe medications and request laboratory tests digitally, enhancing efficiency and accuracy.

The system also includes an Appointment Booking feature, where patients can select doctors based on specialization, availability, and timing. Automated email reminders are sent to patients before their appointments to reduce no-shows.

The Online Prescriptions feature allows doctors to issue prescriptions digitally, which are stored in the patient's medical history and can be accessed by patients and laboratory staff for further actions, such as conducting prescribed tests.

Finally, the Medical History module maintains a detailed database of patient records, including disease history, test results, and prescribed treatments. This data is easily accessible to both doctors and patients, ensuring continuity of care, accurate diagnoses, and better health monitoring. Collectively, these features make the system a robust solution for improving efficiency and effectiveness in hospital management. The block diagram of the proposed system is as figure below.
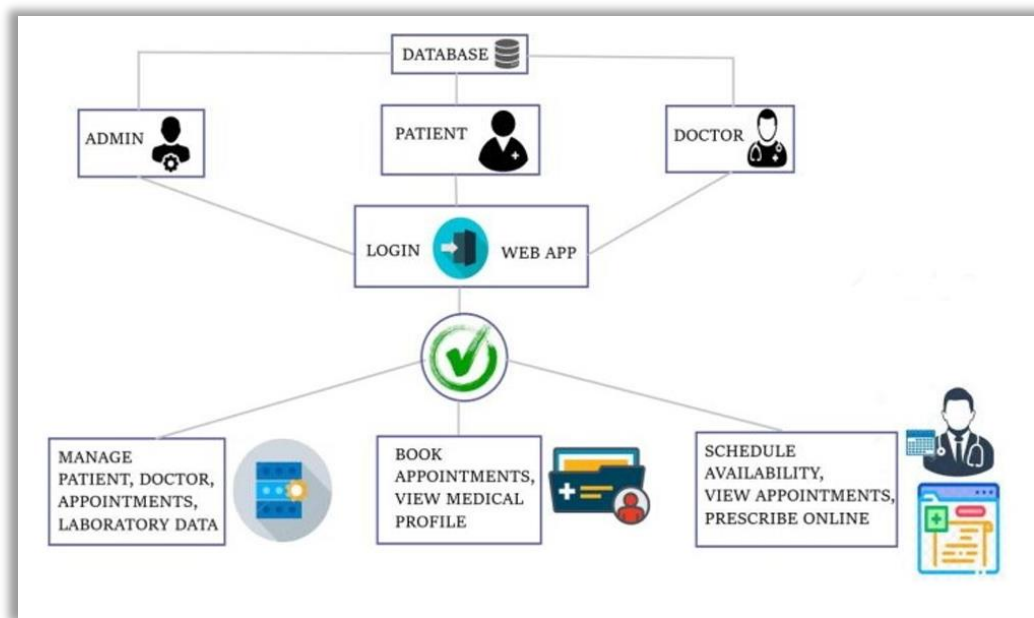

Figure 2.1. The block diagram of the proposed system (Sharmila Devi et al., 2021).

Figure 2.1 is the diagram represents the architecture and functionality of a hospital management system utilizing a web application. At its core is a centralized database that stores and manages information for three primary user roles: Admin, Patient, and Doctor. Each role interacts with the system through a login portal within the web application. The administrator oversees and manages key data, including patient records, doctor profiles, appointments, and laboratory information. Patients can access features such as booking appointments, viewing their medical profiles, and retrieving healthcare information. Meanwhile, doctors can schedule their availability, review appointment details, and prescribe medications online. This system

promotes seamless interaction among all stakeholders, ensuring efficient hospital management processes through a structured digital platform.

The web-based hospital management system described by Devi et al. (2021) demonstrates significant potential to streamline healthcare operations through its modular design and comprehensive features. While the system offers numerous advantages, certain limitations must be addressed to ensure optimal functionality and adaptability in diverse healthcare environments. The strengths and weaknesses of the system are summarised in the table below.

Table 2.1 Summary of the strengths and weaknesses of the proposed system.

Strength	Weakness
Provides appointment reminders for patient, reducing patient no-shows.	Scalability for managing large volumes of users and data is not explicitly addressed.
Facilitates contactless access to lab reports, reducing the need for physical interaction.	The system's dependency on users to input accurate data could lead to inconsistencies in records.
Supports real-time data updates, ensuring all stakeholders access the latest information.	Does not mention advanced analytics or reporting capabilities for healthcare providers.

2.2.2 Online Hospital Appointment Booking

Natarajan et al. (2024) describe an online hospital appointment booking system designed to improve the efficiency and reliability of healthcare services. This system offers various functionalities aimed at enhancing patient experience, reducing waiting times, and optimizing resource allocation. Key features include online doctor appointment booking, where users can search for doctors based on specialization, availability, and their preferences for date and time. Patients can also make online payments for their appointments and download receipts

directly from the portal. Additionally, the system provides automated email and text message reminders to patients about their scheduled appointments, minimizing no-shows.

The system also includes modules for different users: patient, doctor, and administrator. The patient module enables users to register, log in, search for doctors, book appointments, reschedule or cancel them, and communicate with doctors or hospital management via mail or phone. Patients can also access and monitor their medical records stored in the database, ensuring continuity of care.

The doctor module allows doctors to view their schedules, monitor patient records, and update availability for appointments. Doctors can also access patient medical histories stored in the system to make informed decisions during consultations.

The admin module provides full control over managing doctors' and patients' data. Administrators can add or update doctor profiles, manage appointment schedules, and oversee the database. Additionally, the system dynamically adjusts appointment slots based on cancellations, ensuring that no available slots are wasted. The web-based system is compatible with various devices such as smartphones, tablets, and computers, making it accessible to a wide range of users. This approach emphasizes patient-centric care while maintaining a balance between the needs of doctors and healthcare administrators. The table of strengths and weaknesses, the flowchart and the block diagram of the proposed system are as below.

Table 2.2. Summary of the strengths and weaknesses of the proposed system.

Strength	Weakness
Enables patients to access and monitor their medical records, enhancing continuity of care.	The system's dependency on users to input accurate data could lead to inconsistencies in records.
Facilitates efficient time slot reallocation due to late cancellations, reducing resource waste.	Lacks clarity on handling same-day appointments alongside pre-scheduled appointments.
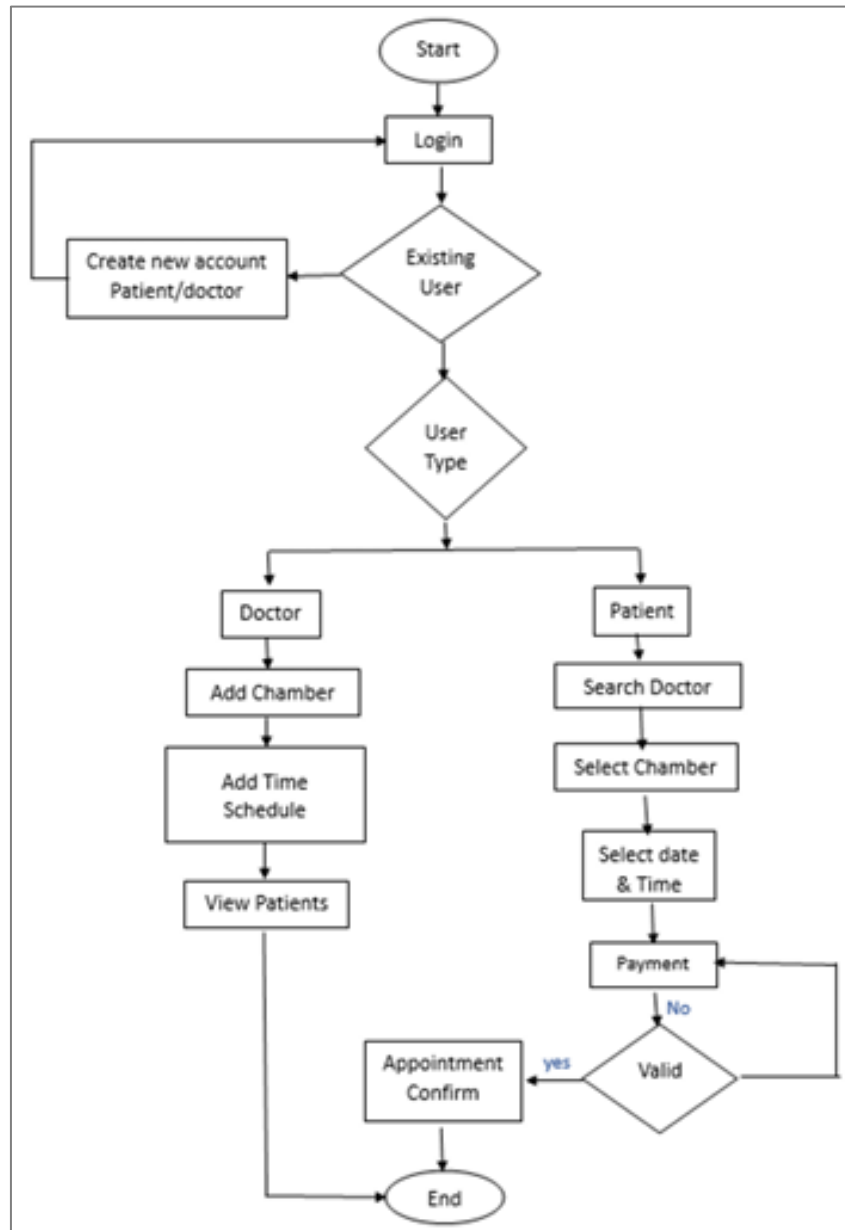
Figure 2.2. Flowchart of the proposed system (Natarajan et al., 2024).

Figure 2.2 is a flowchart illustrates the workflow of a system designed for scheduling medical appointments between doctors and patients of the proposed system by Natarajan et al. (2024). The process begins with the user logging into the system. If the user is not already registered, they are prompted to create a new account, choosing whether they are a patient or a doctor. After login, the system identifies the user type and provides options based on their role.

16

Doctors can add chambers (locations where they consult patients), set their availability by adding time schedules, and view the list of patients. On the other hand, patients can search for a doctor, select a chamber, choose an appointment date and time, and proceed with payment. If the payment is valid, the appointment is confirmed. The process concludes with the confirmation of the appointment, ensuring a smooth interaction between the doctor and patient. This flowchart provides a clear representation of the steps involved in the appointment scheduling system.
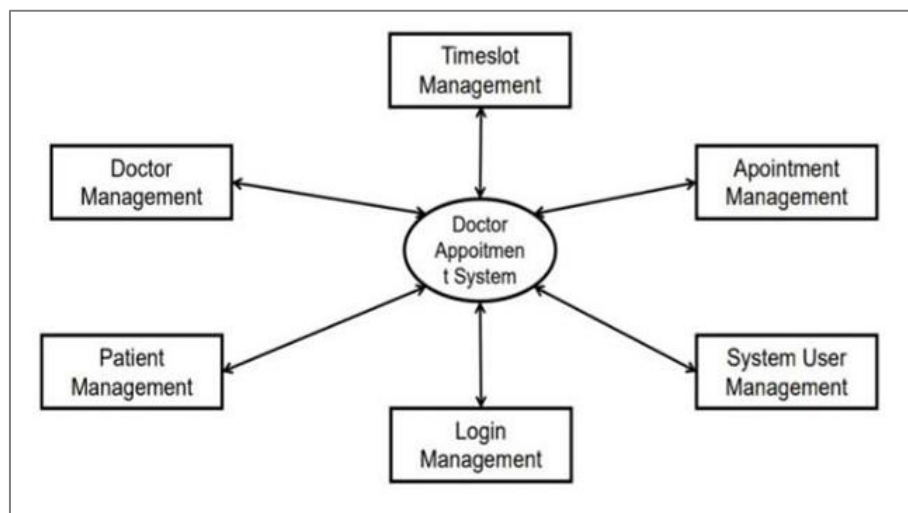
Figure 2.3. Block diagram of the proposed system (Natarajan et al., 2024).

Figure 2.3 is a block diagram represents the key components and functionalities of a doctor appointment system. At the center of the diagram is the main system, which is connected to six primary modules. These include Doctor Management, where information about doctors is maintained; Patient Management, which handles patient details and records; and Timeslot Management, responsible for managing doctors' availability and scheduling. Additionally, there is Appointment Management, which oversees the process of booking and confirming appointments, and System User Management, which manages user accounts, roles, and access permissions. Lastly, Login Management ensures secure user authentication and access to the

system. Together, these interconnected modules create a comprehensive framework for efficiently managing medical appointments.

2.2.3   Web Based Hospital Management System

Babu et al. (2023) proposes a web-based hospital management system that simplifies healthcare management by providing tailored modules for patients, doctors, and administrators. The system is designed to store and manage information related to patients, doctors, and appointments while ensuring secure access and efficient data handling.

The Patient Module allows patients to register by providing their personal and contact details, including name, gender, email, and phone number. After logging in, patients can schedule appointments by selecting a doctor based on specialization, availability, and consultation fees. Patients can also view their appointment history, including the doctor's name, appointment status, and fees. They can pay online for doctor consultations and receive an electronic receipt via email. Additionally, patients can cancel or reschedule their appointments as needed. The figures below are the Patient Registration page and the Appointment Booking page.

Figure 2.4. Patient registration page (Babu et al., 2023).

Figure 2.5. Appointment booking page (Babu et al., 2023).

The Doctor Module facilitates login credentials provided by the administrator, enabling doctors to log in and access their dashboards. Doctors can view and update their appointments, treat patients during the specified consultation times, and provide online prescriptions that are

stored in the system. The module also includes a search functionality, allowing doctors to locate specific patients or appointments using phone numbers. This feature is especially beneficial for managing real-time appointments efficiently. Below are the figures for Doctor Login page, Appointment History page and Doctor Appointment List.

Figure 2.6. Doctor login page (Babu et al., 2023).

Figure 2.7. Doctor Appointment History page (Babu et al., 2023).
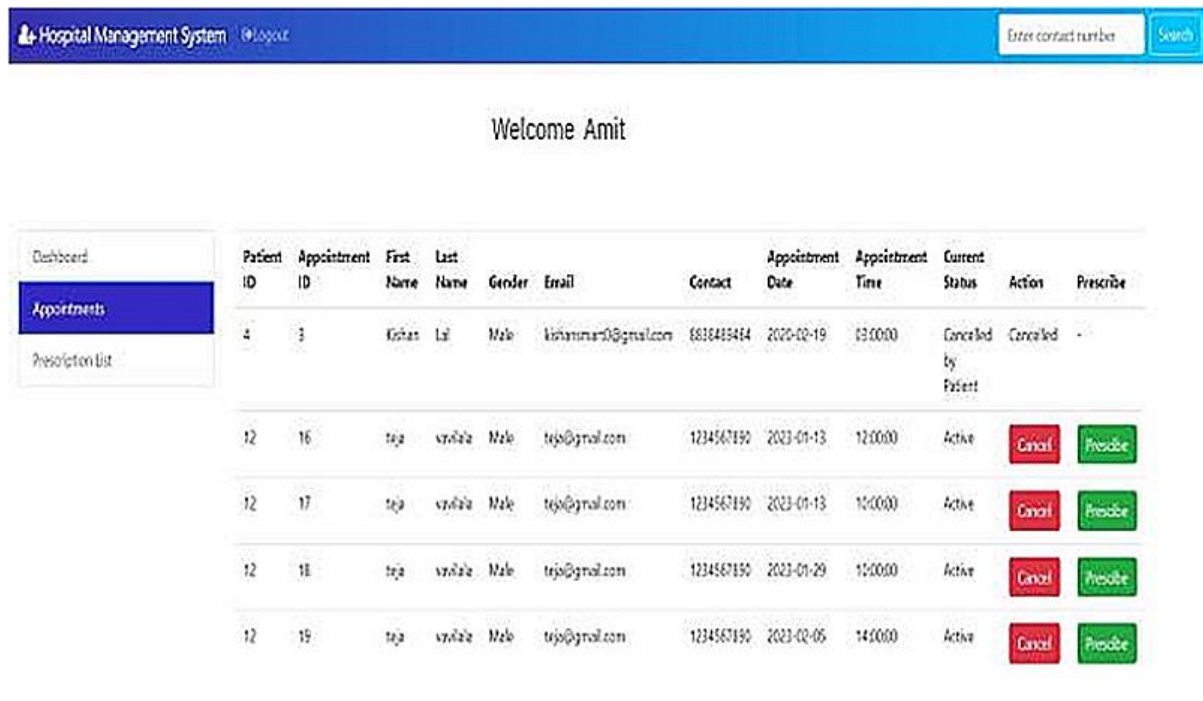
Figure 2.8. Doctor Appointment List page (Babu et al., 2023).

The Admin Module acts as the core control panel of the system. Administrators can view, add, or remove doctor and patient profiles. They can manage appointment lists, which include patient and doctor details such as names, email addresses, phone numbers, and appointment schedules. The admin has complete access to the database, enabling them to retrieve or modify patient and doctor records, view prescriptions, and monitor appointment statuses. Additionally, the admin can use a search feature to find specific doctors or patients, add new doctors with details like specialization and consultation fees, and delete doctors from the system when necessary. Below is the figure of the Admin Login page. The strengths and weaknesses of the proposed system are also displayed below.
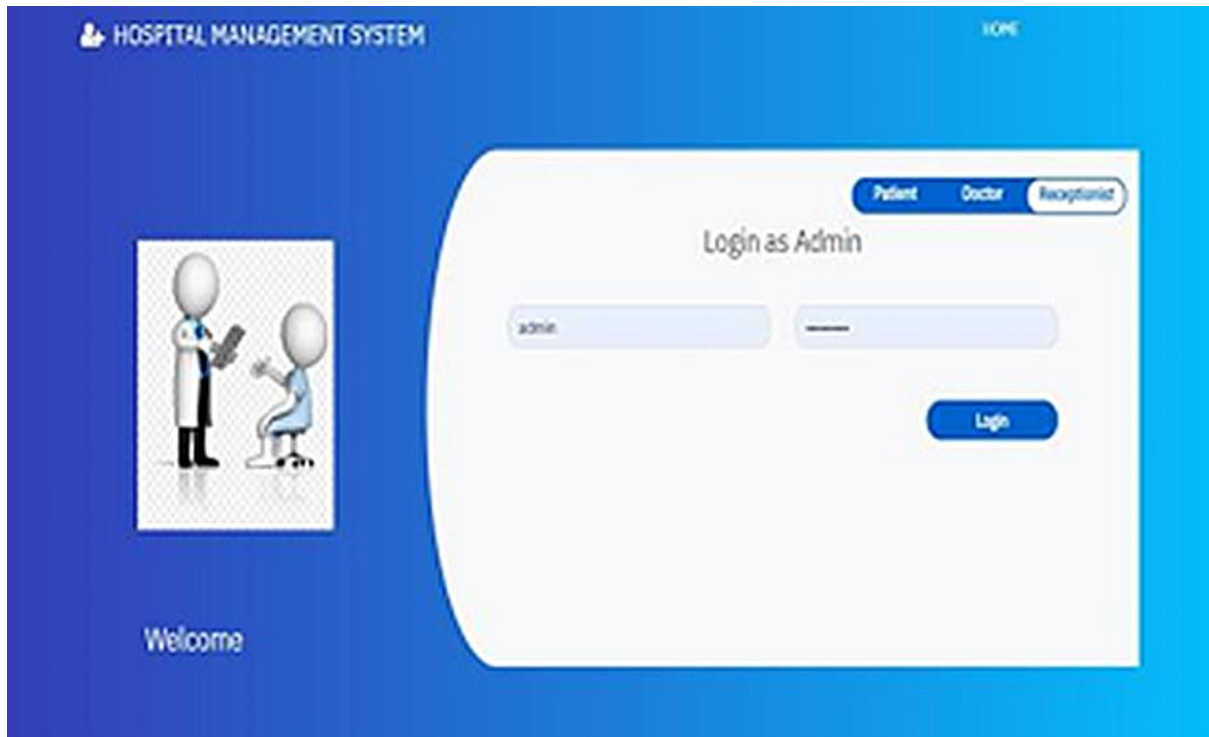
Figure 2.9. Admin Login page (Babu et al., 2023).

Table 2.3. Summary of the strengths and weaknesses of the proposed system.

Strength	Weakness
Doctors and admins can efficiently locate patients or appointments by using search filters.	Managing overlapping or excessive appointments is not explicitly discussed.
Patients can reschedule appointments, while automated email notifications reduce no-shows.	No mention of tools to provide insights into patient trends or system performance.

2.2.4 Clinic Management System

The Clinic Management System (CMS) proposed by Ang et al. (2015) is a comprehensive web-based platform designed to improve the operational efficiency of

healthcare clinics by automating various processes. The system addresses common challenges in clinic management, such as manual data entry, long waiting times, and inefficient appointment scheduling. Key features of the system include:

The Appointment Module, one of the primary features of the system, allows patients to schedule appointments online or via phone. Once an appointment is booked, the system sends automatic SMS notifications to the patients, reminding them of their scheduled time and reducing the chances of no-shows. This feature helps to ensure that patients are informed and reduces the administrative burden on clinic staff.

The Registration Module integrates with Malaysia's MyKad system, which enables automated extraction of patient data such as names, identification numbers, and addresses. This integration reduces manual entry errors, speeds up the registration process, and ensures the accuracy of patient records. However, the module is limited in that it currently supports only Malaysian citizens, meaning that non-citizens or minors who do not have a MyKad would require manual data entry, adding complexity for these patient groups.

The Queue List Module is another important feature, designed to track patient waiting times and provide updates on the queue status. This module ensures that patients are served in an orderly fashion based on appointment times, which helps in reducing frustration and long wait times. The system provides real-time updates for both patients and staff, ensuring transparency. However, while this system addresses some concerns, it does not offer advanced features such as alerts for patients who have waited beyond a certain time, which could further improve patient satisfaction.

The Document Generation functionality automates the creation of medical certificates (MC) and diagnostic reports in PDF format. By automating these tasks, the system reduces paperwork for doctors, improves the speed at which documents are generated, and ensures

accuracy in the documentation. This feature significantly enhances the efficiency of clinic staff, allowing them to focus more on patient care rather than administrative duties.

The Search and Edit Functions feature allows staff to easily search for and update patient records using key identifiers such as the patient's IC number. This makes record retrieval and modification straightforward and quick, which is particularly beneficial in busy clinics. However, this module lacks more advanced features like bulk record updating or additional search filters, which could be useful in larger clinics dealing with high patient volumes.

This Custom SMS module enables clinic staff, including nurses and doctors, to manually type and send SMS reminders to patients about upcoming appointments. This feature allows flexibility in communication, as messages can be tailored for specific patient needs or appointments. However, the lack of pre-set templates can lead to inefficiencies and inconsistencies in the messaging process.

This SMS List module tracks the delivery status of SMS messages sent to patients and provides a report on the available SMS credit from the service provider. When the SMS credit runs out, the system will not be able to send further messages, which could disrupt communication with patients. This highlights the need for regular monitoring and management of the SMS credits to ensure uninterrupted service. The strengths and weaknesses of the system are summarised in the table below. The use case of the system is displayed below.

Table 2.4. Summary of the strengths and weaknesses of the proposed system.

Strength	Weakness
SMS reminders help reduce patient no-shows and ensure accurate appointment information.	Relies on SMS for communication, which may be less reliable than other methods and depends on internet connectivity.

The MyKad integration streamlines registration, improving accuracy and reducing manual entry errors.	Limited to Malaysian citizens or those with MyKad; non-citizens or minors require manual data input, adding complexity.
Automates the creation of medical certificates and reports, improving accuracy and efficiency.	MyKad integration is limited to Internet Explorer due to ActiveX dependency, reducing flexibility for users.
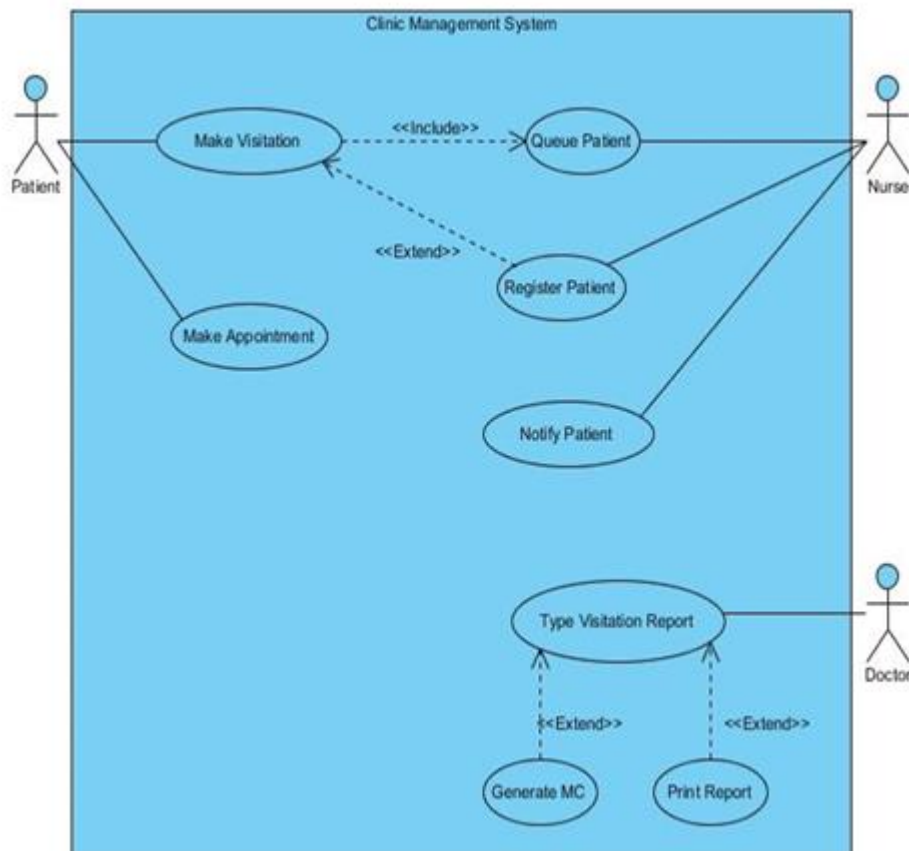
Figure 2.10. Use case diagram of the system (Ang, Kwan, & Rahman, 2015).

Figure 2.10 is the use case diagram represents a Clinic Management System, detailing the interactions between three primary actors: the patient, nurse, and doctor. The patient can interact with the system to either make a visitation or schedule an appointment. The Make Visitation use case includes the Queue Patient process managed by the nurse and may extend to Register Patient, depending on the scenario. Nurses are also responsible for sending notifications to patients through the Notify Patient use case. Doctors interact with the system

by using the Type Visitation Report use case, which involves documenting patient visits. This use case can extend to generating a medical certificate (Generate MC) or printing the report (Print Report) as needed. The diagram uses relationships such as "include" to indicate mandatory actions and "extend" to represent optional or conditional steps, ensuring flexibility in workflows. This visualization provides a clear structure for how tasks are allocated and performed within the clinic, streamlining its operations.

2.2.5   UTP Clinic Management System

The Universiti Teknologi PETRONAS (UTP) Clinic Management System, proposed by Bopabote (2014), aims to automate clinic operations at Universiti Teknologi PETRONAS. The system addresses common issues found in manual processes, such as mismanagement of patient records, data redundancy, and inefficiencies in appointment handling. Its design emphasizes simplicity, accuracy, and efficiency to enhance clinic operations for both staff and patients.

A key feature is the patient registration, which allows patients to register their details and securely store them in a centralized database. This module eliminates the need for repetitive data entry during subsequent visits. Patients can also book appointments online by selecting their preferred time and doctor. The system offers flexibility by enabling patients to reschedule or cancel appointments when necessary and view their appointment history, fostering a user-friendly experience.

The administrator module provides administrators with full control over clinic operations. Admins can add, update, or remove patient and doctor records, as well as manage appointment schedules. This module includes tools to generate reports, ensuring efficient clinic management. Admins can also monitor system usage and ensure the integrity of stored data, supporting operational transparency and accountability.

The doctor module enhances the workflow for healthcare professionals by granting access to patient medical histories, appointment details, and diagnostic test results. Doctors can input and save prescriptions directly into the system, which patients can access for follow-up or further consultation. The module facilitates streamlined communication between doctors, patients, and administrative staff, ensuring continuity of care.

Built on a web-based platform, the system leverages technologies such as MySQL for database management and front-end tools like HTML, PHP, and JavaScript to create a responsive and user-friendly interface. Authentication mechanisms restrict system access to authorized users, ensuring data security. The system is also designed for multi-tasking, enabling staff to handle multiple operations—such as retrieving records and scheduling appointments—simultaneously, further improving efficiency. The table summarises the strengths and weaknesses of the system is as below.

Table 2.5. Summary of the strengths and weaknesses of the proposed system.

Strength	Weakness
Eliminates manual recordkeeping, reducing errors and time spent searching for patient files.	Does not include features like automated reminders for appointments or notifications for missed visits.
Centralised database improves data security and simplifies record retrieval.	Limited information on user feedback incorporation or usability testing.

2.3 Comparison between similar existing system and proposed system.

Table 2.6. Comparison between similar existing systems and proposed system.

Features \ Systems	Similar Existing System					Proposed System
	User Interactive Hospital Management System by using Web application	Online Hospital Appointment Booking	Web Based Hospital Management System	Clinic Management System	UTP Clinic Management System	Appointment Management System for PKP UNIMAS
Patient registration	✓	✓	✓	✓	✓	✓
Patient book appointment	✓	✓	✓	✓	✓	✓
Doctor book appointment	-	-	-	-	-	✓
Upload referral letter	-	-	-	-	-	✓
Appointment notification	✓	✓	-	✓	-	✓
Real time available slots updates	✓	✓	✓	-	-	✓

Table 2.6 compares similar existing systems with the proposed Appointment Management System for PKP UNIMAS. The existing systems evaluated include:

1) User Interactive Hospital Management System using a web application

2) Online Hospital Appointment Booking

3) Web-Based Hospital Management System

4) Clinic Management System

5) UTP Clinic Management System

The comparison focuses on six key features: patient registration, patient appointment booking, doctor appointment booking, referral letter uploads, appointment notifications, and real-time available slot updates. All systems, including the proposed one, support patient registration and appointment booking by patients. However, only the proposed system introduces the capability for doctors to book appointments and allows for the upload of referral letters. While appointment notifications are provided by some existing systems (specifically the User Interactive Hospital Management System and UTP Clinic Management System), this feature is also included in the proposed system. Additionally, real-time updates on available appointment slots are supported only by the User Interactive Hospital Management System and the proposed system. Overall, the proposed system builds upon the functionalities of existing systems by incorporating all their features while adding new capabilities, making it a more comprehensive solution.

2.4   Summary

This chapter provided a comprehensive literature review to evaluate existing hospital management and appointment systems, identifying their features, strengths, and limitations. Systems such as the User Interactive Hospital Management System, Online Hospital Appointment Booking System, Web-Based Hospital Management System, Clinic Management

System, and UTP Clinic Management System were analysed to highlight functionalities like appointment scheduling, patient record management, and automated reminders. However, these systems often lack features like real-time availability updates, doctor appointment booking, and referral letter uploads.

The review established that while existing systems address common challenges in healthcare workflows, gaps remain in automation, integration, and patient engagement. A comparative analysis highlighted the proposed Appointment Management System's improvements, including comprehensive features tailored to the needs of PKP UNIMAS. These include real-time slot availability, referral management, and enhanced user interactions for patients, doctors, and nurses. This literature review lays a strong foundation for designing an efficient and robust system to streamline appointment management processes and improve service delivery at PKP UNIMAS.

CHAPTER 3 : REQUIREMENT ANALYSIS AND DESIGN

3.1   Introduction

This chapter presents the detailed requirement analysis and design process for the development of the Appointment Management System for Pusat Kesihatan Prima UNIMAS (PKP UNIMAS). The purpose of this chapter is to establish a clear understanding of the system's requirements and to outline the design that addresses these requirements. The requirements were gathered using various methods, including questionnaires and interviews to ensure a comprehensive understanding of user needs and expectations. The collected requirements were then analysed, prioritised, and documented in measurable terms to ensure they align with the project's objectives. Additionally, this chapter includes the design approach, conceptual framework, and justification for the chosen design to meet the identified requirements effectively.

3.2   Requirement Gathering Process

To gather the necessary requirements for the Appointment Management System, multiple approaches were employed to ensure a thorough understanding of the current workflow and the needs of users at PKP UNIMAS.

3.2.1 Questionnaire

A questionnaire was distributed to patients who had previously visited PKP UNIMAS to gather insights into their experiences and challenges with the current appointment process. A total of 15 respondents participated and provided valuable feedback on the current appointment booking workflow. The questionnaire focused on areas such as their experience on the current booking process, brief opinion on the proposed system and preferred methods to receive appointment reminder. The figures below are the results of each question in the questionnaire.
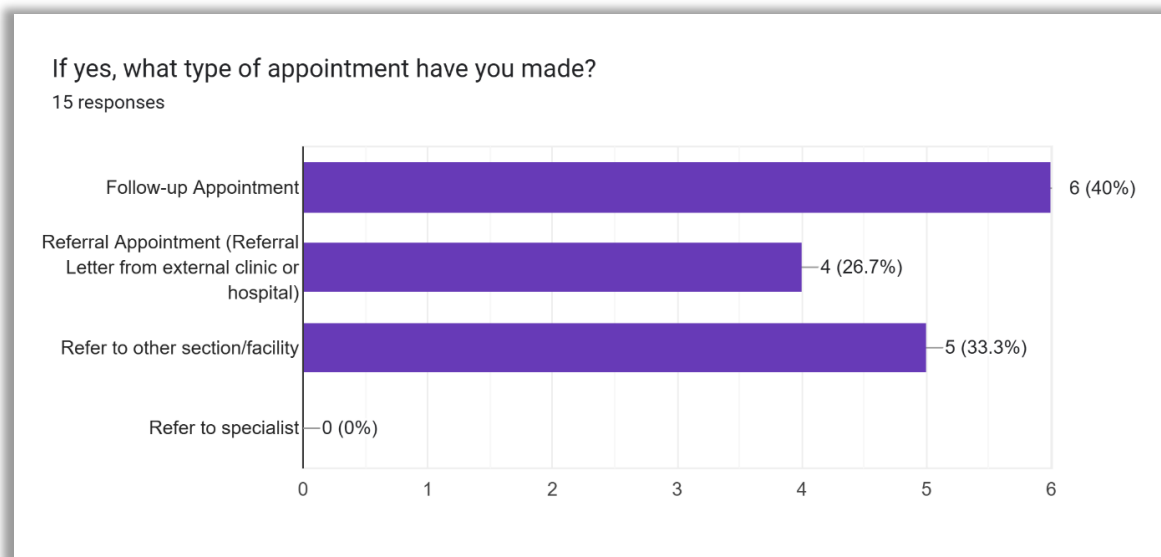
Figure 3.1. Appointment types made by respondents.

Figure 3.1 shows the bar chart of the distribution of different types of appointments have made by the respondents. The most common type of appointments was follow-up appointments, accounting for 40% (6 out of 15 responses). Meanwhile, referral appointments involving referral letters from external clinics or hospitals accounted for 26.7% (4 responses) and 33.3% (5 responses) for refer to other section/facility. Notably, no respondents reported booking an appointment to refer to a specialist.
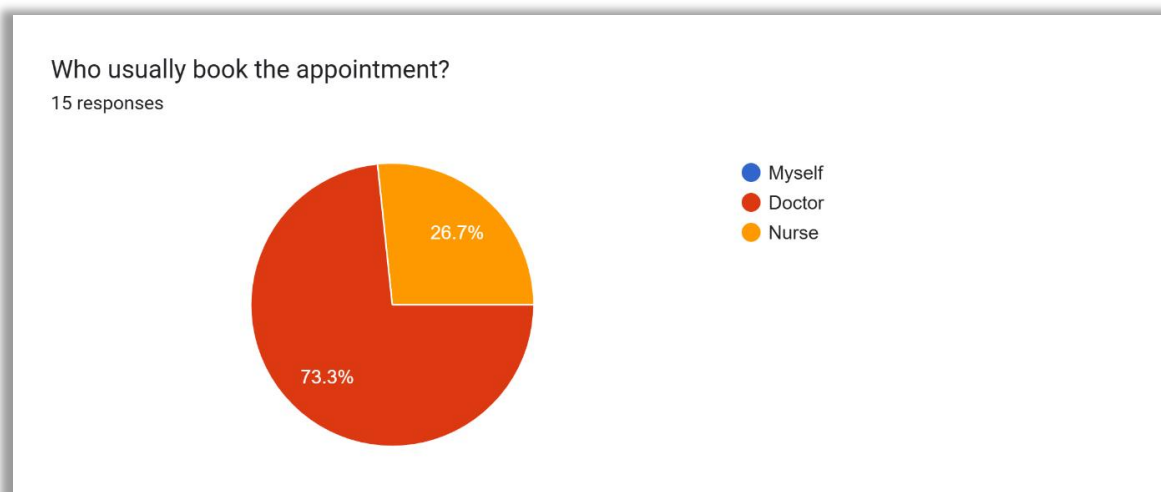
Figure 3.2. Person to book respondent's appointments.

Figure 3.2 is a pie chart illustrates who typically books appointments. Most appointments are booked by doctors, representing 73.3% of the responses, while nurses account for the remaining 26.7%. No respondents reported booking appointments themselves.
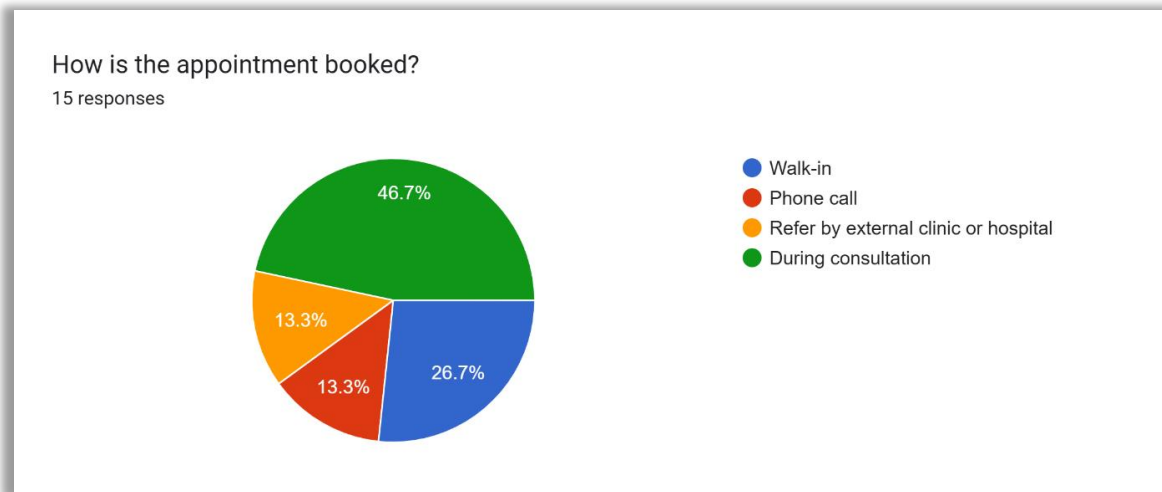
Figure 3.3. Methods of appointment booking.

Figure 3.3 illustrates a pie chart of the different methods used to book appointments, based on 15 responses. The data shows that "During consultation" is the most common method, followed by walk-in appointments. 46.7% were booked during a consultation. A significant portion (26.7%) were walk-in appointments. Phone calls and referrals by external clinic or hospital both accounted for 13.3%.
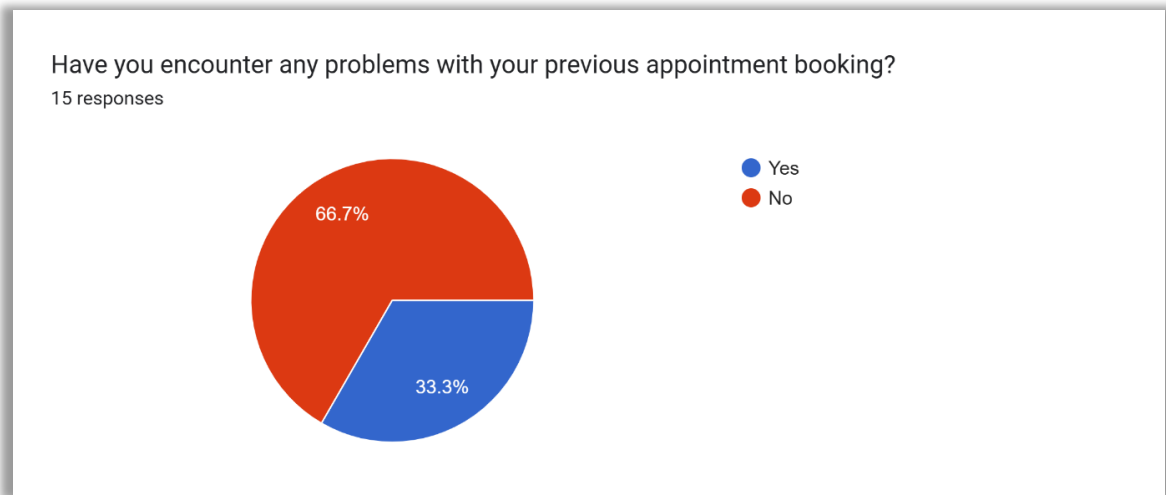
Figure 3.4. Appointment Booking Problems Encountered by Respondents.

Figure 3.4 visualises a pie chart of the results of a survey asking respondents whether they encountered any problems with their previous appointment booking. 66.7% of the respondents have not encountered any problems with their previous appointment booking while 33.3% of them have encountered problems.

Figure 3.5. Description of the problem occur in booking process.

This figure 3.5 shows responses to the question, "If yes, what is the problem?" regarding issues encountered during the appointment scheduling process. The four responses highlight common problems.

1) "Time is not correct" – indicates inaccuracies in the scheduled time.

2) "The time of my appointment was not accurate" – reiterates scheduling errors.

3) "Forgot the appointment date" – points to a lack of reminders or notifications.

4) "I go to the wrong section" – reveals issues with communication or clarity regarding appointment locations.

On a scale of 1-5, how was your experience with the current appointment booking process?
15 responses
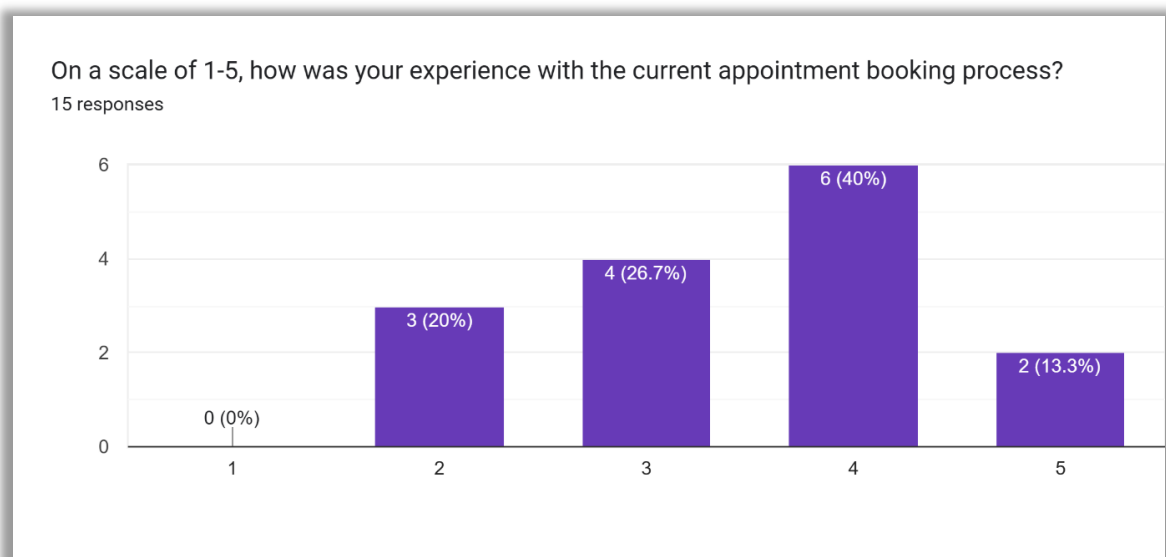
Figure 3.6. Satisfaction level of respondent on the current appointment booking process.

Figure 3.6 is a bar chart illustrating the responses to the question, "On a scale of 1-5, how was your experience with the current appointment booking process?" based on feedback from 15 respondents. The x-axis represents the scale as below:

1 – Very Dissatisfied

2 – Dissatisfied

3 – Neutral

4 – Satisfied

5 – Very satisfied

The y-axis shows the number of respondents and corresponding percentages. The results reveal that none of the respondents rated their experience as 1 (0%), 3 respondents gave a rating of 2 (20%), 4 respondents rated it as 3 (26.7%), another 6 rated it as 4 (40%), and 2 respondents gave the highest rating of 5 (13.3%). This distribution provides insight into the varying levels of satisfaction with the current booking process. This concludes that most respondent find the current booking process acceptable but not exceptional, with opportunities for enhancement to achieve higher satisfaction levels.
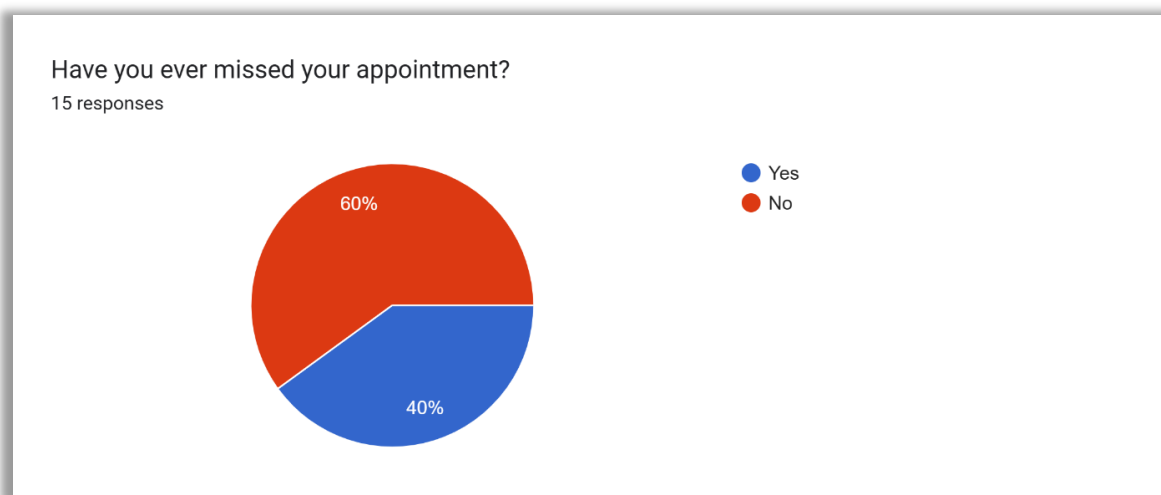
Figure 3.7. The percentage of "yes" and "no" responses given by respondents.

The figure 3.7 is a pie chart representing the responses to the question, "Have you ever missed your appointment?" among 15 respondents. It shows that 40% of respondents answered "Yes," while 60% answered "No." This indicates that slightly more than half of the participants have not missed an appointment.
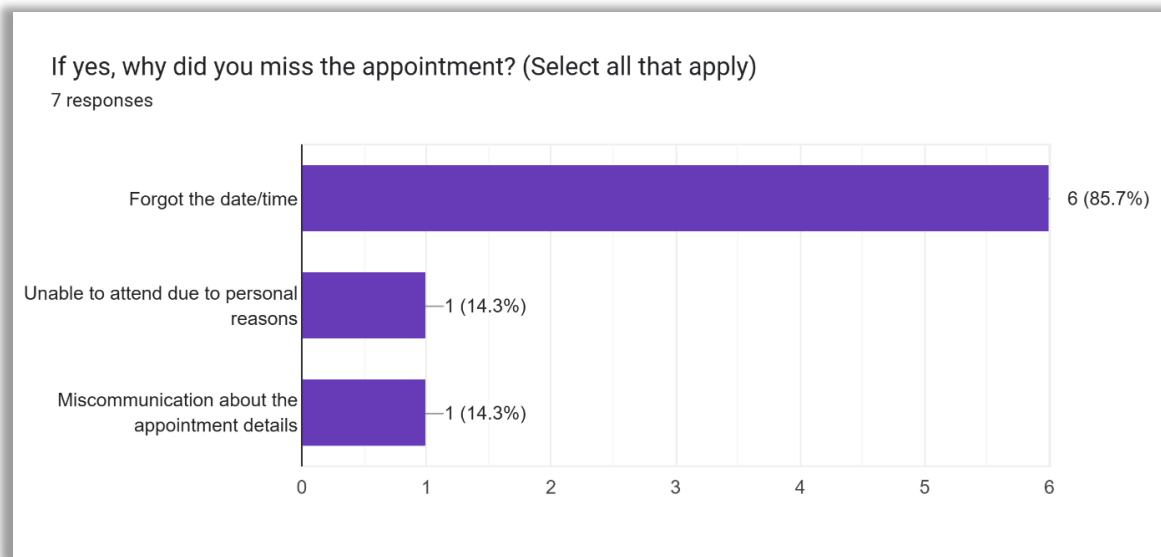
Figure 3.8. Reasons for respondents missed their appointment.

Figure 3.8 is a bar chart illustrating the reasons provided by those who answered "Yes" to the previous question. Out of 6 responses, the majority (6 responses, or 85.7%) indicated that they missed their appointment because they forgot the date or time of the appointment. One respondent (14.3%) cited personal reasons, and another (14.3%) mentioned miscommunication about the appointment details. This data highlights that forgetting the appointment date or time is the most common reason for missed appointments.
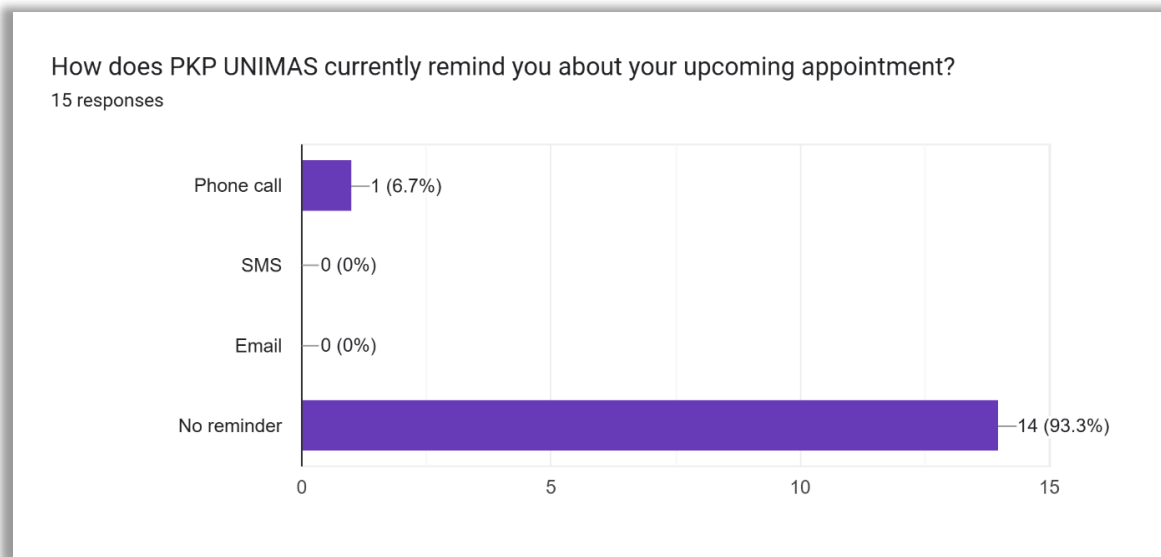
Figure 3.9. Current methods used by PKP UNIMAS to remind patient about upcoming appointments.

This bar chart displays how PKP UNIMAS reminds users of their upcoming appointments based on 15 responses. The majority (93.3%, or 14 respondents) reported receiving no reminders. A small percentage (6.7%, or 1 respondent) indicated receiving reminders via phone call. No respondents reported receiving reminders through SMS or email. This data concludes that a significant lack of reminder mechanisms for appointments.
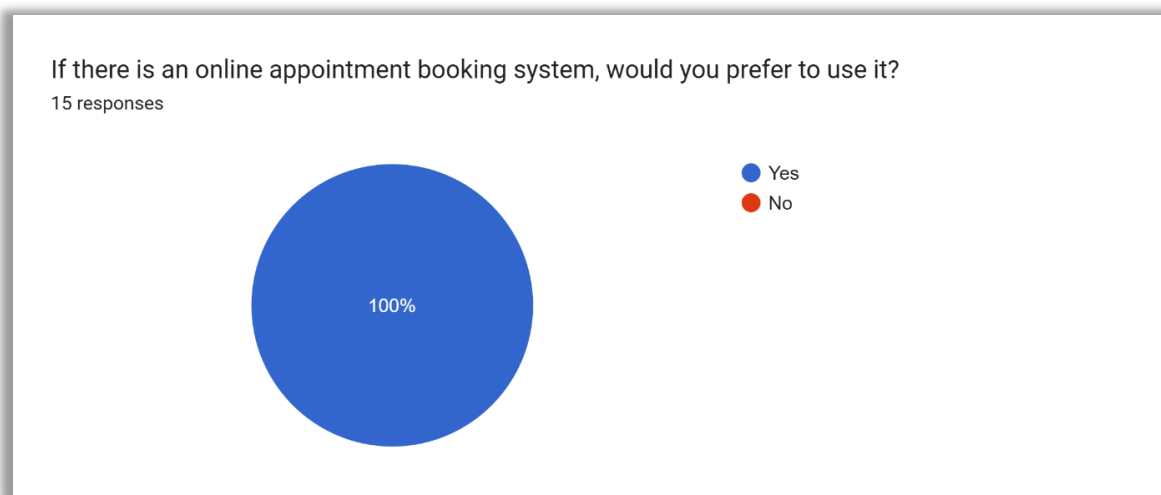
Figure 3.10. Respondents' preference on the proposed Appointment Management System.

Figure 3.10 is a pie chart illustrates the preference of respondents regarding the use of an online appointment booking system. Out of 15 responses, 100% of the participants indicated that they would prefer to use such a system. The chart uses a single blue segment labelled "Yes," reflecting unanimous agreement, while the red segment for "No" is absent, indicating no opposing responses. This concludes that all respondents agree with the idea of using an online system to book and manage appointments.
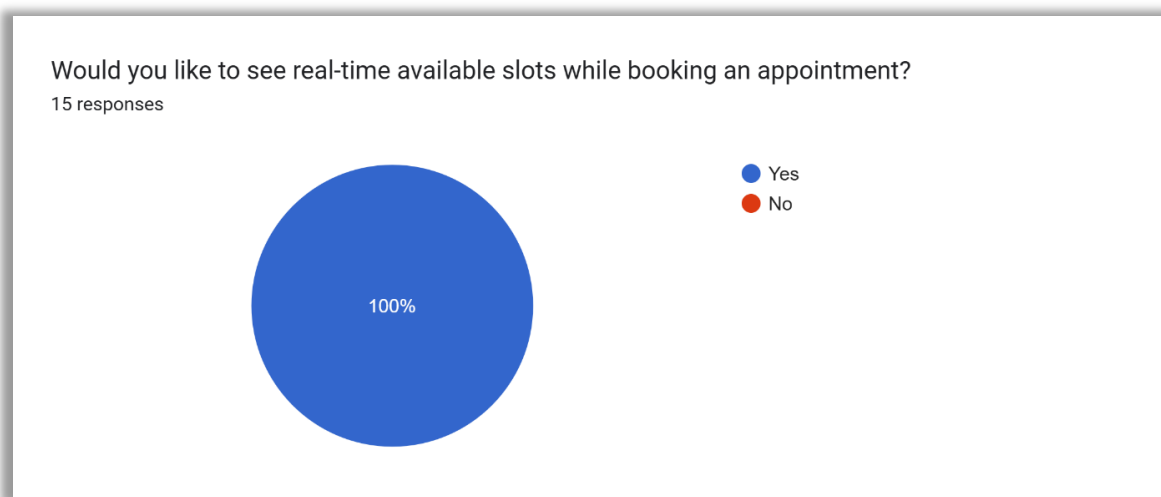
Figure 3.11. Respondents' opinion on the real-time availability of slot feature.

Figure 3.11 is a pie chart illustrates survey results regarding the question, "Would you like to see real-time available slots while booking an appointment?". 100% of the 15 respondents answered "Yes," represented by a blue colour. This unanimous agreement indicates a strong preference among respondent for the ability to view real-time availability, which can enhance their booking experience.

Figure 3.12.Respondents' opinion on the automated appointment reminders feature.

Figure 3.12 is a pie chart represents the results for the question, "Would you find automated reminders for your appointments be helpful?". 100% of the respondents answered "Yes," highlighted in blue. This response demonstrates that all respondents agree if the system has automated appointments reminder.
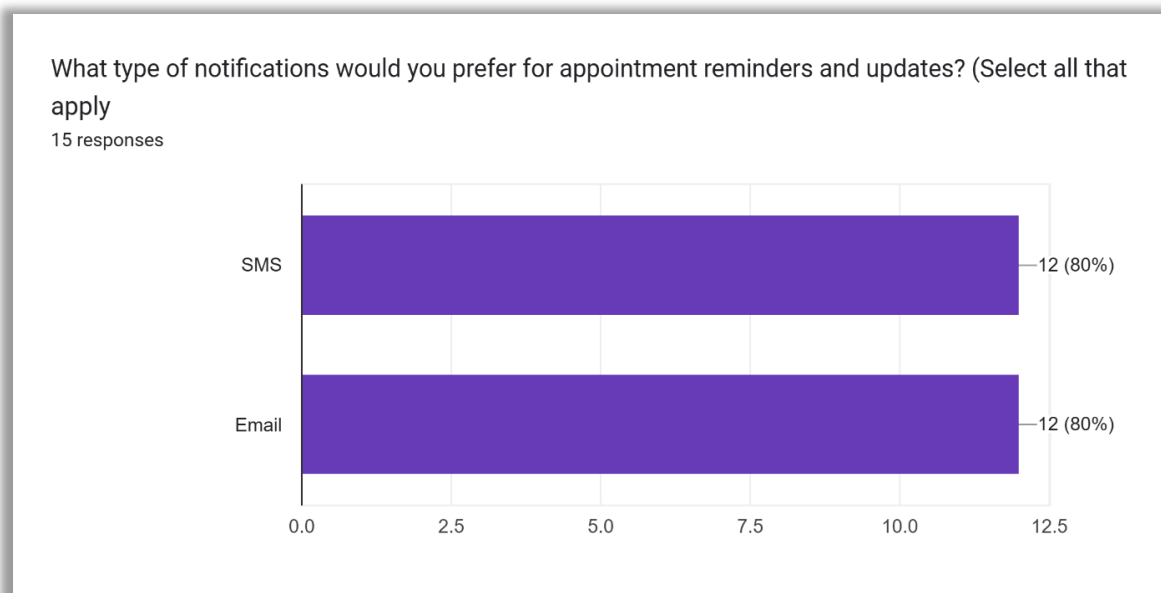
Figure 3.13. Preferred notification type for appointment reminders and updates.

Figure 3.13 is a bar chart shows respondents' preferences for notification types to receive appointment reminders and updates, based on 15 responses. SMS and email were equally favoured, with 12 respondents (80%) selecting each option. The data suggests that implementing both SMS and email notifications could effectively meet user preferences for appointment reminders.
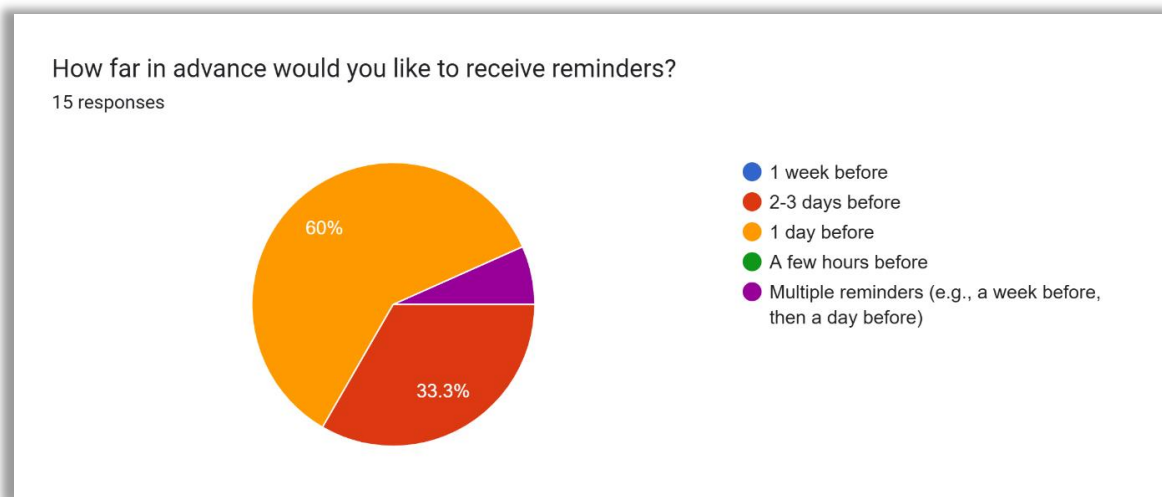
Figure 3.14. Respondents' preferences on how advance they would like to receive reminders.

Figure 3.14 shows a pie chart summarises the responses from 15 participants regarding how far in advance they would like to receive reminders. The largest proportion, 60%, preferred receiving reminders 1 day before the appointment. Another 33.3% indicated a preference for reminders 2-3 days before. A smaller segment, represented by a purple section, opted for multiple reminders at different intervals (e.g., a week before and a day before). There were no responses for options like reminders 1 week before or a few hours before. This concludes that most of respondent prefer to get reminders when it is near to the appointment date.
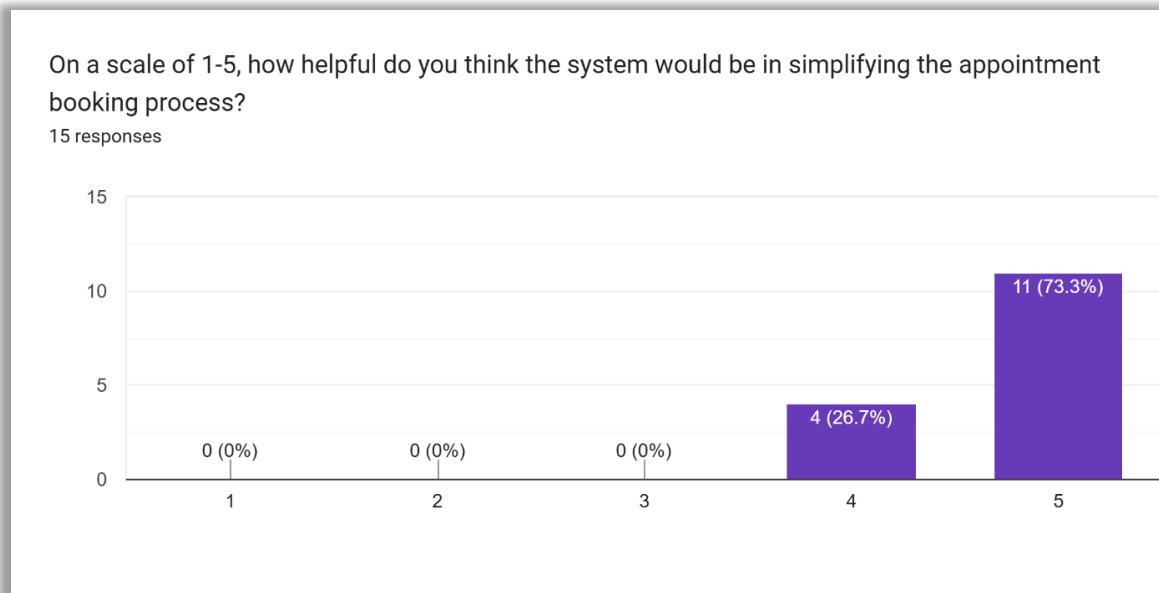
Figure 3.15. Respondents' opinion on the rating of the helpfulness of the proposed system.

Figure 3.15is a bar chart illustrates the responses of 15 participants to a survey question rating the helpfulness of a system in simplifying appointment bookings on a scale of 1 to 5. The scale is as below:

1 – Not helpful at all

2 – Slightly helpful

3 – Moderately helpful

4 – Very helpful

5 – Extremely helpful

The majority (73.3%, or 11 respondents) rated the system as extremely helpful with a score of 5. Additionally, 26.7% (4 respondents) gave a score of 4. No participants rated the system with scores of 1, 2, or 3. This data suggests that the respondent find the proposed system would be help a lot in simplifying the appointment booking process.

Overall, the data indicate that the proposed system has received overwhelmingly positive feedback and support from the respondents. The unanimous preference for an online booking system, coupled with the identified need for improved appointment reminders and the

clear preference for SMS and email notifications, highlights the respondents' readiness to adopt and benefit from the proposed solution.

3.2.2 Interview

An interview session with Dr. Dessmon, a doctor from PKP UNIMAS was conducted to gather insights into the current appointment management workflow and identify user requirements for the proposed system. The doctor explained that for follow-up appointments, discussions about date and time typically occur immediately after consultations, with patient availability being considered. However, challenges arise when referring patients to specialists or other facilities, as the availability of these sections is often unknown. This requires follow-up calls, and some patients are difficult to contact, further complicating the process. For patients with referral letters, the doctor mentioned that the letters are reviewed first to determine if further action is needed. In most cases, even with a referral letter, patients are required to undergo consultation and diagnosis before proceeding. The transcription of the interview is available in Appendix A.

Another interview session with Madam Rogayah, a staff nurse at PKP UNIMAS, was conducted to gather insights into the current appointment workflow. According to Madam Rogayah, nurses are actively involved in booking appointments for patients, typically based on instructions from doctors. They will write the appointment details, including the section, date, and time on the patient's medical history card or a piece of paper. When managing patients with referral letters, the letters are first reviewed to ensure all details are complete and clear. In most cases, however, the doctor will also diagnose the patient before deciding on the next steps for the referral.

For instances where sections or facilities are unavailable, patients are informed, and nurses follow up with a call once the facility becomes available. Madam Rogayah emphasized

the importance of having real-time updates on section or facility availability, as this would allow nurses to make bookings more efficiently and avoid delays. Additionally, she highlighted the benefits of automated reminders for upcoming appointments, which would help reduce missed appointments by ensuring patients remember their scheduled dates and times. The insights provided by Madam Rogayah underscore the need for an automated and centralized system to streamline appointment management and improve the overall patient experience. The combination of these methods provided a well-rounded understanding of the requirements, capturing the perspectives of both patients and healthcare providers. The complete transcription of the interview with Madam Rogayah can be found in the Appendx B.

An interview session was conducted also with Mr. Hazman and Mr. Zaba, Information Technology (IT) staff at PKP UNIMAS, to gain insights into the current hospital management system and gather input for the proposed Appointment Management System. They briefly explained that the existing hospital management system is strictly for internal use by staff, including doctors, nurses, and IT administrators. The system provides essential features for managing patient records and hospital operations but does not support direct appointment booking by patients or referral management processes.

Mr. Hazman and Mr. Zaba also identified several challenges in the current booking process, including delays caused by the manual coordination between departments, limited visibility of section or facility availability, and the absence of a mechanism for patients to book or manage appointments independently. Additionally, the ability of patients to request bookings and upload referral letters from their own side was discussed. This feature was proposed to address the current workflow, where patients must bring referral letters in person, requiring registration at the counter and subsequent consultation. This procedure often results in delays. Allowing patients to upload referral letters during the appointment request process

would optimize the workflow, as doctors or nurses could review the letter directly through the system, saving time and streamlining the booking process.

The discussion also covered ways to smoothen the workflow and improve the functionality of the proposed system such as the flow for patient to book appointments. Instead of directly book for the appointment, patients must request the appointment as it needs to be reviewed by the nurse first. This is to ensure right section, facility or specialist will be appoint to the patients.

3.2.3 Functional Requirements

The functional requirements of the Appointment Management System for Pusat Kesihatan PRIMA (PKP) UNIMAS are outlined in the table below. These requirements are designed to address the needs of patients, doctors, nurses, and administrators, ensuring a streamlined, efficient, and user-friendly appointment management process.

Table 3.1. Functional Requirement for all the users.

ID	Description	Priority	Actor(s)
FR001	The system shall allow patients to register using their MyKad number and create a secure account.	High	Patient
FR002	The system shall validate the MyKad number during registration against the existing database	High	System
FR003	The system shall allow patients to log in using their MyKad number and password.	High	Patient
FR004	The system shall enable patients to book an appointment by selecting a date, time, and type of appointment.	High	Patient
FR005	The system shall provide real-time updates on available appointment slots.	High	Patient, Doctor

FR006	The system shall allow patients to upload referral letters for referral-based appointments.	Medium	Patient
FR007	The system shall notify patients of appointment status updates (approved, rejected, or change requested).	High	System
FR008	The system shall allow doctors to book follow-up appointments for their patients.	High	Doctor
FR009	The system shall allow nurses to manage appointment requests, including approval, rejection, or requests for changes.	High	Nurse
FR010	The system shall allow staff to review referral letters uploaded by patients.	Medium	Nurse, Doctor
FR011	The system shall send automated reminders for upcoming appointments via SMS and email.	High	System
FR012	The system shall allow patients to view, reschedule, or cancel their appointments.	High	Patient
FR013	The system shall allow patients to view their appointment history, including past and upcoming bookings.	Medium	Patient
FR014	The system shall allow nurses to register first-time patients during their initial visit.	High	Nurse
FR015	The system shall enable patients to update their profile information, such as contact details.	Medium	Patient
FR016	The system shall enable administrators to manage staff accounts, including adding, updating, or removing accounts.	Low	Admin
FR017	The system shall restrict access to modules based on user roles (e.g., patient, nurse, doctor, admin).	High	System
FR018	The system shall provide a dashboard for patients displaying upcoming appointments, notifications, and key metrics.	Medium	Patient
FR019	The system shall allow doctors and nurses to view patient profiles and appointment details.	High	Doctor, Nurse
FR020	The system shall generate error messages for invalid login attempts or registration failures.	Medium	System

FR021	The system shall log appointment transactions for audit purposes.	Low	System
FR022	The system shall allow administrators to configure notification preferences (e.g., SMS, email).	Low	Admin

3.3 System Design

This section outlines the design of the Appointment Management System for PKP UNIMAS. It includes the logical and physical aspects of the system design to ensure the solution addresses the identified requirements and provides a clear understanding of its functionality and structure.

3.3.1 Logical Design

The logical design focuses on the high-level representation of the system's structure and functionality. It includes diagrams and models, such as the Use Case Diagram, to illustrate the interactions between users and the system and to define how the system will operate to fulfil its objectives.

3.3.1.1 Use Case Diagram

A use case diagram is a visual representation of the interactions between users (or actors) and a system. It is a part of Unified Modelling Language (UML) used in software engineering and systems design to depict the functionality or features of a system from a user's perspective. The figure below is the use case diagram of this proposed system.

Figure 3.16. System Use Case Diagram

Figure 3.16 is the Use Case Diagram (UCD) represents the primary functionalities of the Appointment Management System for PKP UNIMAS. It identifies the key actors interacting with the system—such as patients, doctors, nurses and system administrator—and outlines their interactions with various system features. This diagram highlights the main use cases, including request appointments, register patient, manage appointment requests, book appointment and register new staff member. The diagram provides a high-level overview of how the system caters to user requirements and ensures seamless workflows. The tables below are the use case description for each use case of the system.

Table 3.2. Use case description for Request Appointment.

Use Case	Request Appointment
Brief Description	To allow patients to request an appointment.
Actor(s)	Patient
Pre-condition(s)	The patient is logged in to the system.
Post-condition(s)	The appointment is successfully booked and visible on the patient's dashboards.
Main Flow	1. The patient logs into the system and navigates to the "Book Appointment" page. 2. The patient selects the type of appointment (referral appointment or follow-up appointment). 3. The system displays available slots of the section or facility. 4. The patient selects a preferred time slot. 5. The patient submits the booking. 6. The system sends the request to the respective section or facility for approval. 7. Once approved, the patient receives a notification confirming the appointment.
Alternative Flow(s)	At step 2, the patient selects referral appointment as the type of the appointment: 2.1 The patient uploads the referral letter. 2.2 Continue to step 3.
Exception Flow(s)	

Table 3.3. Use case description for Edit Personal Details.

Use Case	View Profile
Brief Description	To allow patient to view their own profile information in the system.
Actor(s)	Patient
Pre-condition(s)	The patient is logged into the system.
Post-condition(s)	The patient's profile is updated with the new information.

Main Flow	1. The patient logs in and navigates to the "View My Profile" section.
	2. The system displays the patient's details.
Alternative Flow(s)	
Exception Flow(s)	

Table 3.4. Use case description for Register.

Use Case	Register
Brief Description	To allow patients to register and create their profile in the system.
Actor(s)	Patient
Pre-condition(s)	The patient has completed an initial physical registration at the PKP UNIMAS registration counter.
Post-condition(s)	The patient's account is successfully created, and they can log in to the system.
Main Flow	1. Patient accesses the system via the web or mobile application.
	2. The system prompts the patient to provide their MyKad number.
	3. The system validates the MyKad number against the database of pre-registered names.
	4. If validated, the system prompts the patient to create a secure password.
	5. After successfully created password, the system prompts the patient to provide a phone number or email address.
	6. The system sends a One-Time Password to the provided phone number or email.
	7. The patient enters the OTP in the system.
	8. Upon successful verification, the system creates the account and confirms registration completion.
Alternative Flow(s)	At step 6, the verification code is not received:
	6.1 The patient can request the system to resend the code.
Exception Flow(s)	At step 2, the MyKad number or name does not match the records:
	2.1 The system displays an error message prompting the patient to contact the registration counter.

Table 3.5. Use case description for Login.

Use Case	Login
Brief Description	To allow users to securely access the system.
Actor(s)	Patient, Doctor, Nurse, System Administrator
Pre-condition(s)	The user has registered in the system.
Post-condition(s)	The user is logged in to the system.
Main Flow	1. The user enters their MyKad and password. 2. The system authenticates the credentials. 3. The user is redirected to their respective dashboard.
Alternative Flow(s)	At step 2, the authentication fails: 2.1 The user is prompted to re-enter their MyKad and password. 2.2 Return to step 1.
Exception Flow(s)	At step 2, the authentication fails: 2.1 The user is prompted to reset password. 2.2 The user navigates to reset password page.

Table 3.6. Use case description for View Appointment Records.

Use Case	View Appointment Records
Brief Description	To allow patients to view their past and upcoming appointment history.
Actor(s)	Patient
Pre-condition(s)	The patient logged in to the system.
Post-condition(s)	The systems display Appointment History page.
Main Flow	1. The patient logs into the system and navigates to the "Appointment Records" page. 2. The system displays a list of all past and upcoming appointments associated with the patient's account with appointment details such as date, time, type of appointment, status. 3. The patient can filter the list by date or type of appointment.

	4. The patient selects a specific appointment to view more details (e.g., doctor's notes or attached documents).
Alternative Flow(s)	
Exception Flow(s)	At step 2, the patient has no recorded appointments: 2.1 the system displays a message indicating no appointments found.

Table 3.7. Use case description for Book Appointment.

Use Case	Book Appointment
Brief Description	To allow doctor to book appointment for a patient.
Actor(s)	Doctor
Pre-condition(s)	The doctor is logged in to the system.
Post-condition(s)	The appointment is successfully booked, and the details can be viewed from the patient side.
Main Flow	1. The doctor navigates to the "Book Appointment" page. 2. The doctor enters the patient's MyKad number. 3. The doctor selects the type of the appointment (follow-up appointment or referral appointment). 4. The doctor selects the type of the referral (refer to specialist or refer to section or facility). 5. The doctor selects the specialist or section or facility. 6. The system displays available slots. 7. The doctor selects the preferred slot. 8. The doctor enters additional notes (if any). 9. The doctor submits the appointment booking. 10. The system notifies the patient on the appointment.
Alternative Flow(s)	
Exception Flow(s)	At step 5, if the MyKad number is not found: 5.1 The doctor will ask patient to register to the system or proceed with manual appointment booking.

Table 3.8. Use case description for Manage Appointment Requests.

Use Case	Manage Appointment Requests
Brief Description	To allow healthcare staff to approve or reject or request changes on the appointment requests.
Actor(s)	Nurse, Doctor
Pre-condition(s)	The healthcare staff is logged in to the system and an appointment booking request exists.
Post-condition(s)	The appointment is either approved, rejected with reasons provided to the patient or need changes.
Main Flow	1. The healthcare staff logs into the system and views pending appointment requests. 2. The healthcare staff reviews the patient details, referral letter (if applicable), and requested time slot. 3. The healthcare staff approves or rejects or request changes on the appointment. 4. The system notifies the patient of the decision.
Alternative Flow(s)	At step 3, the healthcare staff rejects or request changes: 3.1 The healthcare staff provides note to state rejection reason or request changes details to patient. 3.2 Continue to step 4.
Exception Flow(s)	

Table 3.9. Use case description for Manage Available Slots

Use Case	Manage Available Slots
Brief Description	To allow nurse to set and appoint available time slots for each section, facility or specialist.
Actor(s)	Nurse
Pre-condition(s)	The nurse is logged in to the system.
Post-condition(s)	

Main Flow	1. The healthcare staff logs into the system and navigates to "Manage Available Slots".
	2. The nurse selects the section or facility or specialist.
	3. The nurse selects day (Monday, Tuesday, etc).
	4. The nurse select and tick the time slots that should be available on the day selected based on the availability of the section, faciltiy or specialist.
	5. The nurse save the slots into the database.
Alternative Flow(s)	
Exception Flow(s)	

Table 3.10. Use case description for Register First Time Patient.

Use Case	Register First Time Patient
Brief Description	To key in patient details into the system database during their first physical visit, enabling future self-registration for the patient.
Actor(s)	Nurse
Pre-condition(s)	The patient visited PKP UNIMAS physically for the first time.
Post-condition(s)	The patient's name and details are successfully registered in the system database.
Main Flow	1. The patient provides their MyKad and Out-Patient History Card(if any) to the nurse at the registration counter.
	2. The nurse logs in to the system and navigates to "Register First Time Patient".
	3. The system prompts the nurse to input patient details, including MyKad number, name, contact information, and any relevant medical records.
	4. The nurse verifies the input data and submits the information.
	5. The system stores the data in the patient database and confirms successful registration.
Alternative Flow(s)	
Exception Flow(s)	

Table 3.11. Use case description for Register New Staff Member.

Use Case	Register New Staff Member
Brief Description	To allow administrators to add new staff (doctor, nurse or system administrator) to the system.
Actor(s)	System Administrator
Pre-condition(s)	The system administrator is logged in to the system.
Post-condition(s)	The new staff member is added to the system and can log in.
Main Flow	1. The administrator clicks the "Register New Staff" button. 2. The administrator enters the new staff's details, including name, role, department, and contact information. 3. The administrator confirms and saves the registration.
Alternative Flow(s)	
Exception Flow(s)	

Table 3.12. Use case description for Edit Staff Details.

Use Case	Edit Staff Details
Brief Description	To allow administrators to update a staff member's details.
Actor(s)	System Administrator
Pre-condition(s)	The system administrator is logged in to the system and the staff member exists in the system.
Post-condition(s)	The staff member's details are updated in the system.
Main Flow	1. The administrator logs in and searches for the staff member. 2. The system retrieves and displays the staff member's current details. 3. The administrator modifies the necessary fields (e.g., contact information, department). 4. The administrator saves the changes.
Alternative Flow(s)	
Exception Flow(s)	

3.3.1.2 Activity diagram

The Activity Diagrams below illustrates the workflow of the Appointment Management System for PKP UNIMAS. It depicts the sequence of activities involved in appointment management, patient registration and appointment booking. The diagram outlines the roles of patients, doctors, and nurses in the system. This representation helps visualise the flow of operations and ensures the system's design aligns with user requirements and process efficiency.
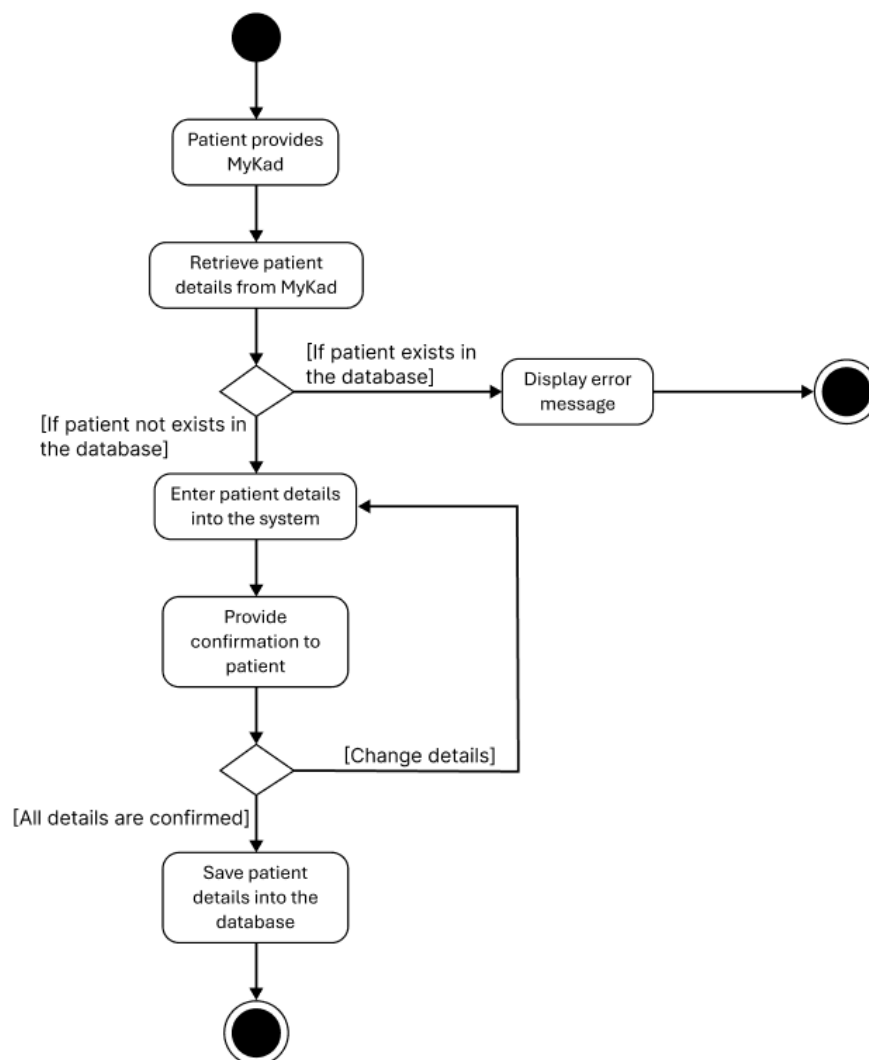
Figure 3.17. Activity diagram for Nurse Register First Time Patient.

Figure 3.17 is the activity diagram for nurse register first time patient. This will be done when the patient come for the first time to the PKP UNIMAS. The patient must register

physically first before they can register themselves into the system. This measure is implemented to ensure that only genuine patients with the intention of receiving treatment at PKP UNIMAS can register. It helps prevent unauthorized registrations from individuals, such as those from other states or countries, who do not plan to visit or utilize the facility's services. For the first time registration, the patient will provide their MyKad to the nurse. The nurse will get the patient's details through the MyKad and input the MyKad number to check whether the MyKad number has already existed in the database or not. If already existed, then the system will display an error message. If the patient's MyKad number still not exist in the database, the system will proceed to a registration form page where nurse will enter the patient's details such as full name, age, gender and address. After that, the nurse will confirm all the details to the patient. If all the details are confirmed, then the nurse save the data in the system and the system will record the data into the database. If any details are not accurate, the nurse will change it and save it to the system.
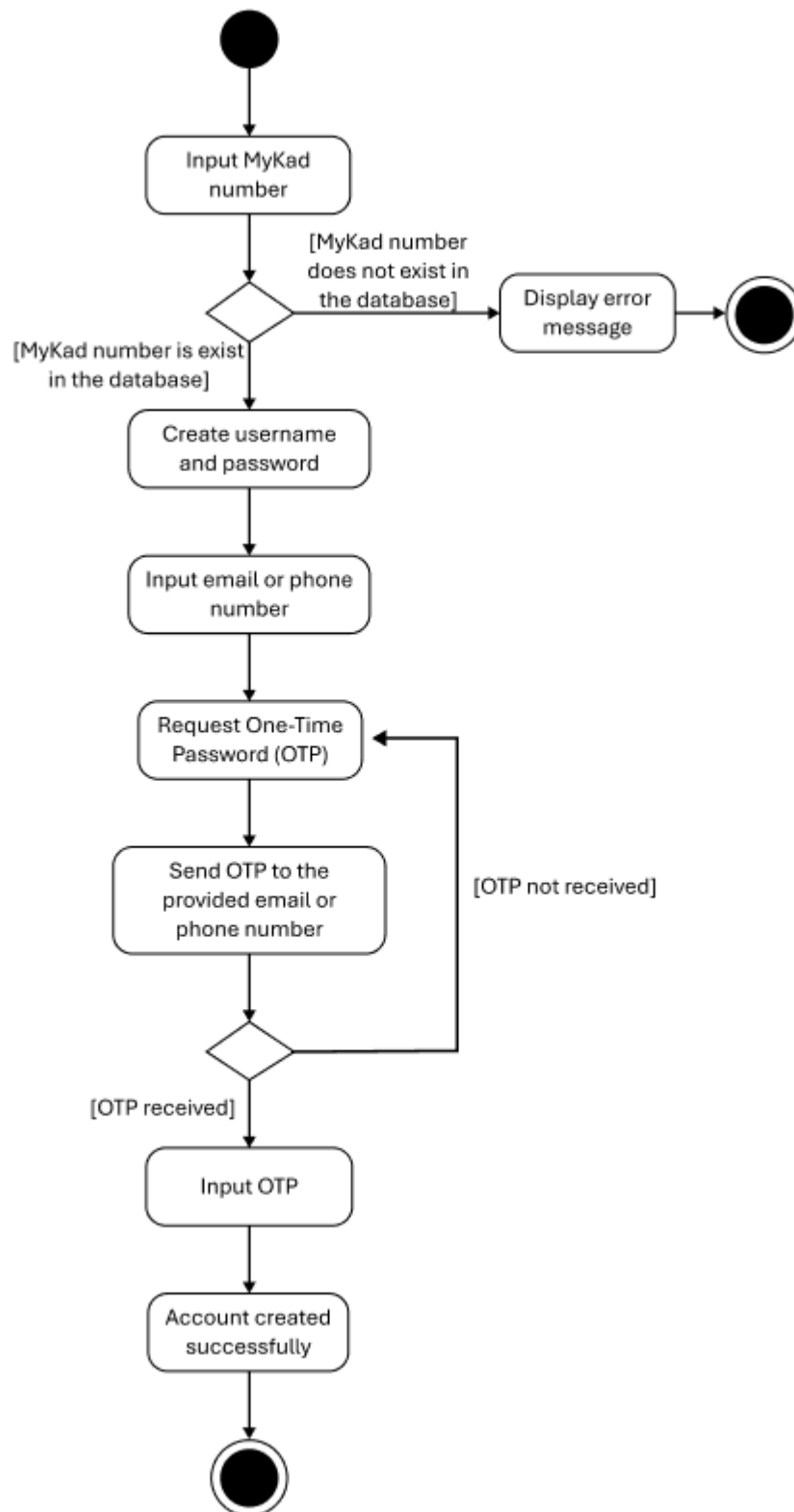
Figure 3.18. Activity diagram for Patient Registration.

The figure 3.18 is the activity diagram for patient registration. At first, the system will

prompt the patient to input their MyKad number. This is to verify whether the patient has

already registered physically at the PKP UNIMAS or not. After the patient input their MyKad number, the system would check the MyKad number if it existed in the database. If existed, the system would proceed to the page where patient needs to create a username and a secure password. If the MyKad does not exist in the database, then the system will display an error message that indicates the patient has not yet registered physically at the PKP UNIMAS. After the patient create a valid username and password, the system will prompt the patient to input their email or phone number. This is for verification purposes. Then, the patient can request verification code that will be sent to the provided email or phone number. The patient will receive the verification code and input the verification code to complete account creation process. If the verification code still not received after a few minutes, the patient can request a new verification code.
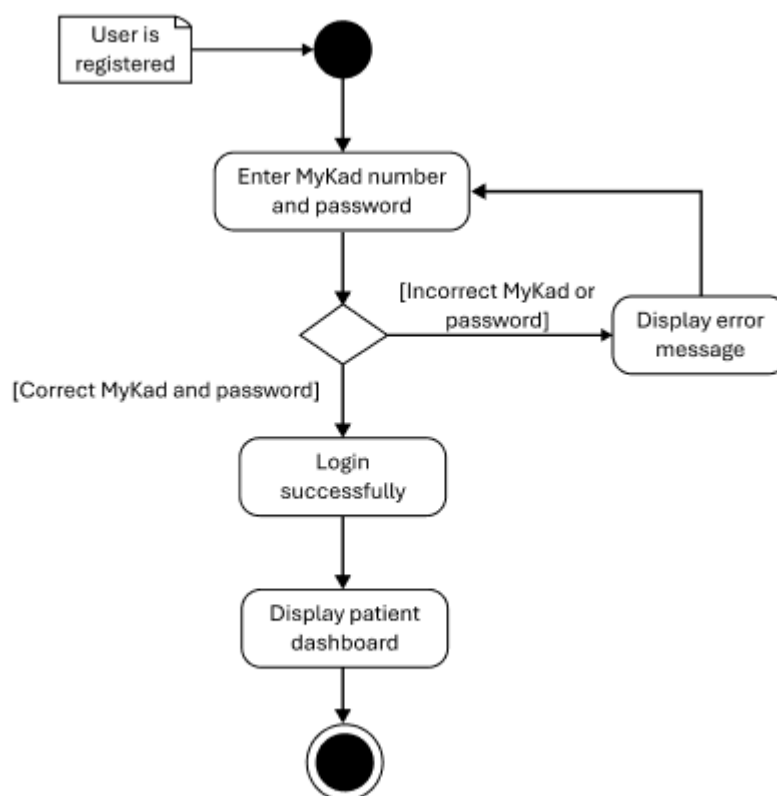
Figure 3.19. Activity diagram for Login.

Figure 3.19 is the activity diagram for login for the system user. System user includes patient, doctor, nurse and system administrator. Before the user can login, the user must already register into the system. First, the system will prompt the user to enter their username and password. If the username and password is correct, then the user will login successfully. If the username or password is incorrect, the system will prompt the user to re-enter the username or password, or reset username or password, or contact support. After a successful login, the system will navigate to the respective dashboard.
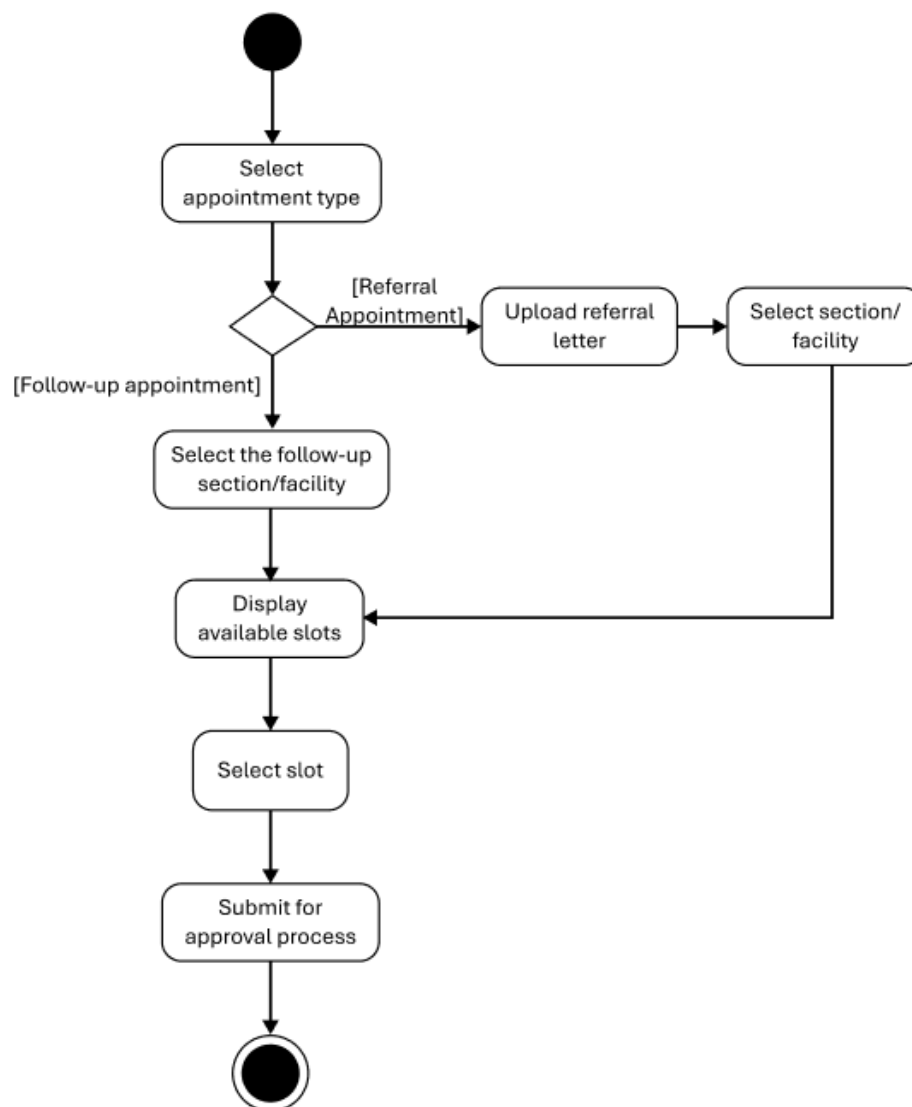
Figure 3.20. Activity diagram for Patient Request Appointment.

Figure 3.20 shows the activity diagram for patient request appointment. To request an appointment, the patient must select the appointment type first. If it is a referral appointment, the patient must upload the referral letter and select the section area or facility based on the referral letter. If the appointment is a follow-up appointment, the patient must select the follow-up section or facility. After selecting the type of appointment, the system will display the available slots. The patient then selects their preferred slot and enter the required details. After all required details are entered, the patient will submit the appointment request for approval process from the nurse or doctor.
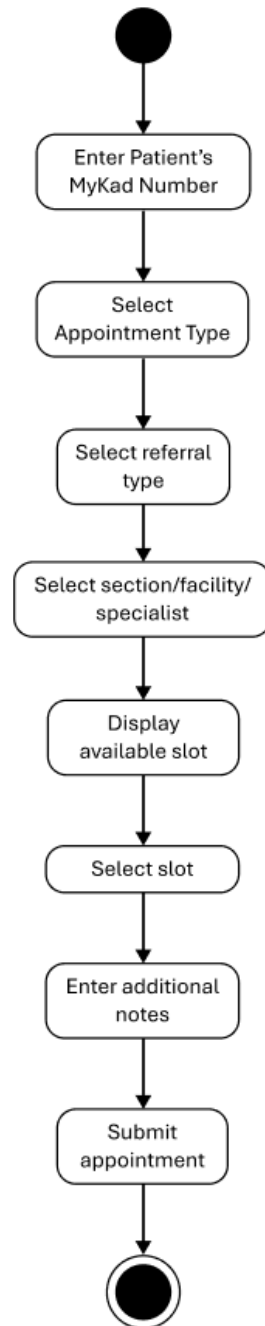
Figure 3.21. Activity diagram for Doctor Book Appointment

Figure 3.21 is the activity diagram for doctor book appointment. Firstly, the doctor must select the appointment type. Then, the doctor selects the appointment type follow by the referral type. After that, the doctor selects which section or facility or specialist. The system then, display the available slots. The doctor select slot and enter any additonal notes if any. The doctor then can proceed to submit the booking.
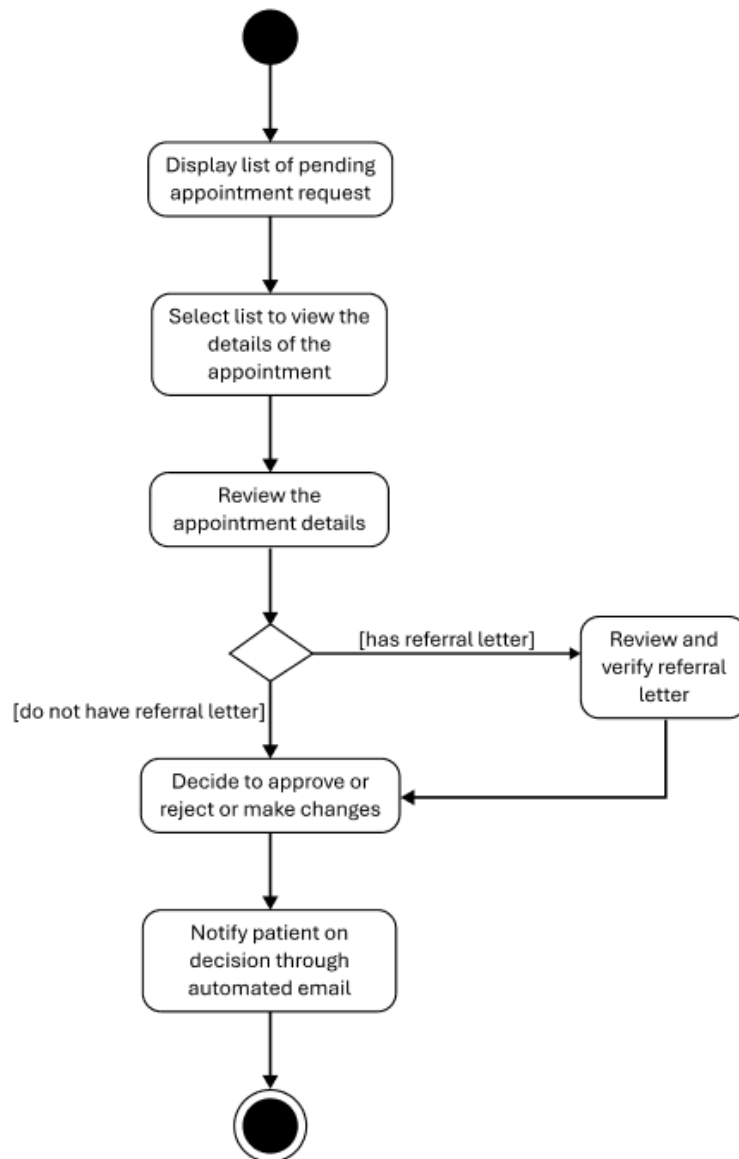
Figure 3.22. Activity diagram for Manage Appointment Request

Figure 3.22 is the activity diagram for manage appointment requests. This manage appointment requests can be done by doctor or nurse. To manage appointment requests, the user (doctor or nurse) will navigate to the "Manage Appointment Requests' page. The page will display list of pending appointment requests. The user can select the list to view the details of the appointment. then, the user will review the appointment details. If the appointment request has referral letter, the user can review and verify the referral letter. After that, the user can proceed to make decision on the appointment request. If the appointment request does not

have referral letter, the user can directly decide to approve or reject or request changes on the appointment request. After decision have been made, the system will notify patient on the decision through an automated email.

3.3.1.3 Entity Relationship Diagram

The Entity Relationship Diagram (ERD) presented below defines the database structure for the Appointment Management System. The ERD provides a clear view of how data will be organised and interconnected within the system.
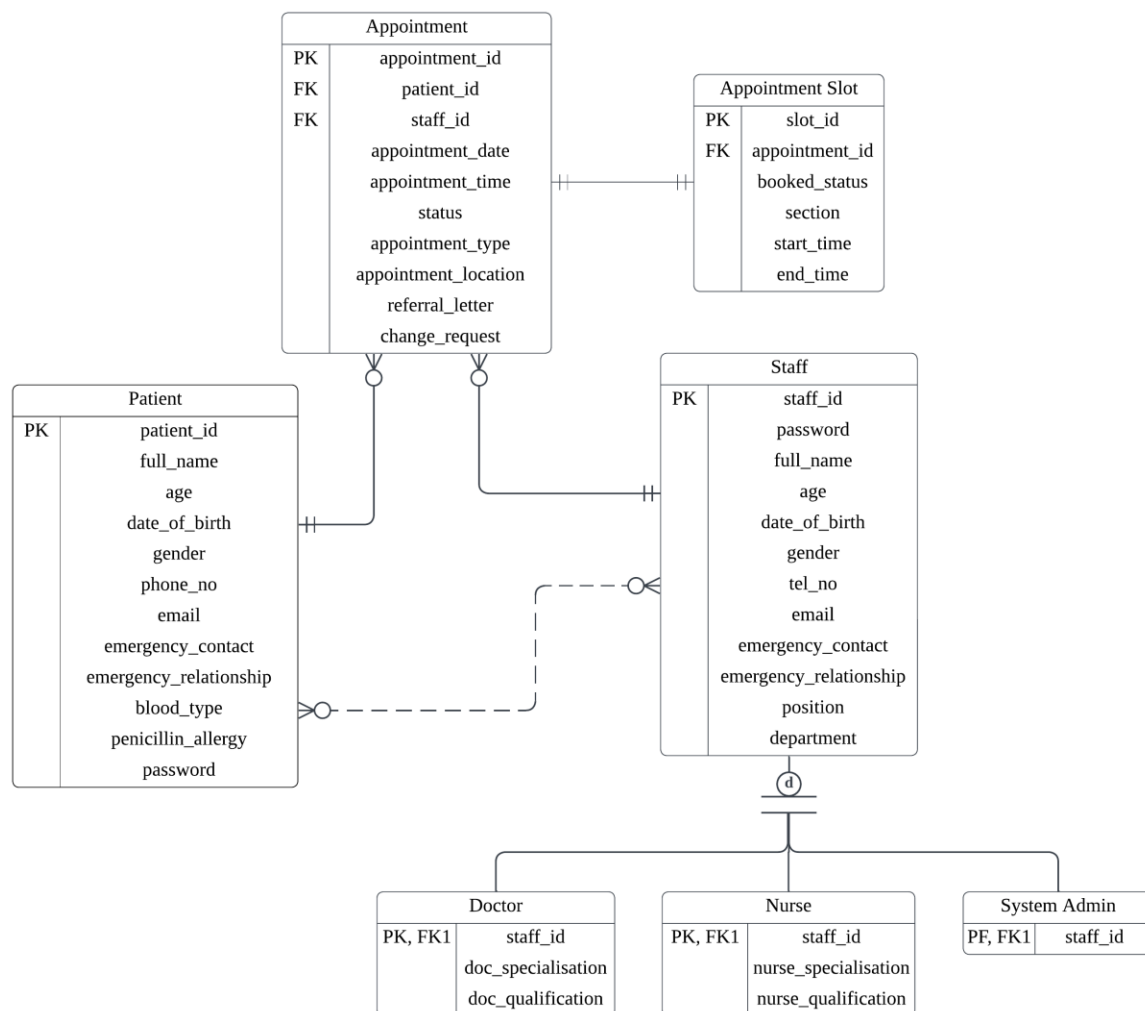
Figure 3.23. Entity Relationship Diagram of the System.

Figure 3.23 is the Entity Relationship Diagram (ERD) of the System. The ERD illustrates the database structure for the proposed Appointment Management System at PKP UNIMAS. It consists of three main entities.

First entity is Patient. The Patient table contains attributes such as patient_id (Primary Key), personal details like full_name, age, gender, religion, address, contact information, and

medical details like blood_type and penicillin_allergy. The database will use the patient's MyKad number as the patient_id which is also the primary key of this table. It also includes login credentials such as username and password. This entity represents all patients registered in the system.

Second entity is Appointment. The Appointment entity manages appointment details and includes attributes like appointment_id, patient_id, staff_id, appointment_date, appointment_time, status, appointment_type, appointment_location, referral_letter, priority_level, and change_request. This table is central to managing the scheduling and tracking of appointments. The appointment_id which is the primary key will use auto increment of six digit. The patient_id which is the primary key for patient table will be taken as a foreign key and the staff_id which is the primary key for staff table will be taken as a foreign key too.

Third entity is Staff. The Staff entity stores information about staff members, with attributes such as staff_id, full_name, gender, address, contact details, and their role (e.g., doctor, nurse, or admin). The staff_id is the primary key. It also includes login details like password. This entity has three subtypes which are Doctor, Nurse or System Admin. The Doctor table includes attributes such as doc_specialisation and doc_qualification. The nurse table includes nurse_specialisation and nurse_qualification. The System Admin table represents administrative roles, linked via the staff_id.

The Appointment Slot entity is designed to manage the scheduling of available time slots for appointments. It includes the primary key slot_id, which uniquely identifies each slot. The appointment_id serves as a foreign key linking the slot to a specific appointment. The booked_status attribute indicates whether the slot is available or booked. Additionally, the section attribute specifies the department or unit associated with the slot, while the start_time and end_time attributes define the time range for the slot. This entity ensures efficient handling of appointment schedules by tracking and organizing available time slots.

3.3.2   Physical Design

The physical design illustrates the system's user interface and architecture through graphical user interface (GUI), showcasing how users will interact with the system in a practical and accessible manner.

3.3.2.1 Graphical User Interface (GUI)

The Graphical User Interface (GUI) is the visual interface of a system that enables users to interact with it through graphical components such as buttons, menus, text fields, icons, and visual indicators. Snapshots of the GUI designed in Figma are included below to provide a visual representation of the system's interface and its functionality. These snapshots illustrate how the system facilitates user interaction.

Figure 3.24. Patient registration page.

Figure 3.24 is the GUI for the first step of the patient registration page at the initial step. This is where patient must enter their MyKad number first in the input box (1). Then, the patient clicked enter (2). The system will check the entered MyKad number in the database.

Figure 3.25. Patient registration page.

Figure 3.25 is the GUI for the second step of the patient registration where the system will prompt the patient to create a secure password. Patient will enter their preferred password in the input box (1). The second input box (2) is for patient to enter the similar password in the first input box. This is to prevent typing mistake when entering the password in the first input

box. Then, the patient will click on Confirm button and the system will validate the password. If valid, then will proceed to the step 3 in patient registration.

Figure 3.26. Patient registration page.

Figure 3.26 is the GUI for step 3 in the patient registration. The system will prompt the patient to enter their email or phone number into the input box (1). Then, the patient must click to request the One-Time Password (OTP). The system will send OTP to the provided email or phone number.

Figure 3.27. Patient registration page.

Figure 3.27 is GUI for step 4 of the patient registration. This is where the patient input the OTP into the input box (1). The patient can also change their email or phone number by clicking the link provided (2), if they required so. If patient does not receive any OTP at the provided email or phone number, the patient can request another OTP (3).
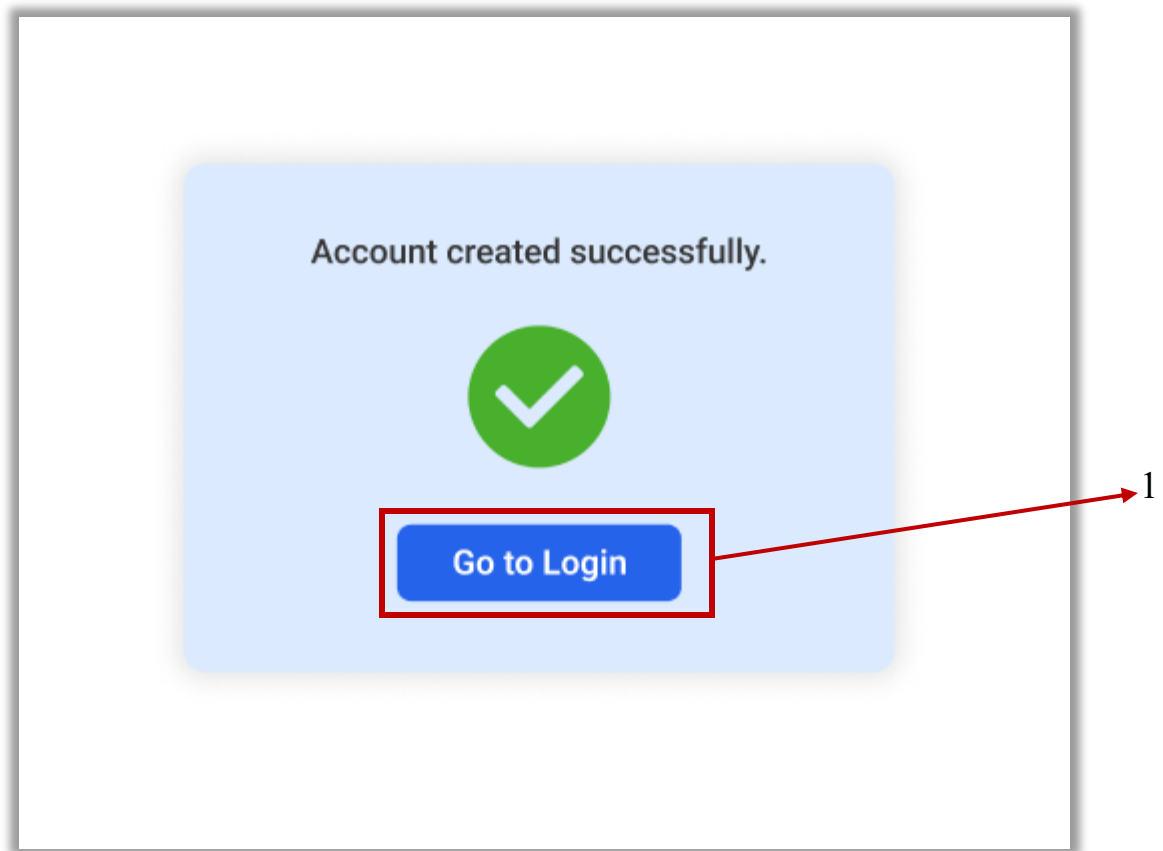
Figure 3.28. System display after patient's account created successfully.

Figure 3.28 is GUI for the system to indicate that the patient's account is created successfully. Patient can click on the "Go to Login" button (1) to navigate to the Login page directly.
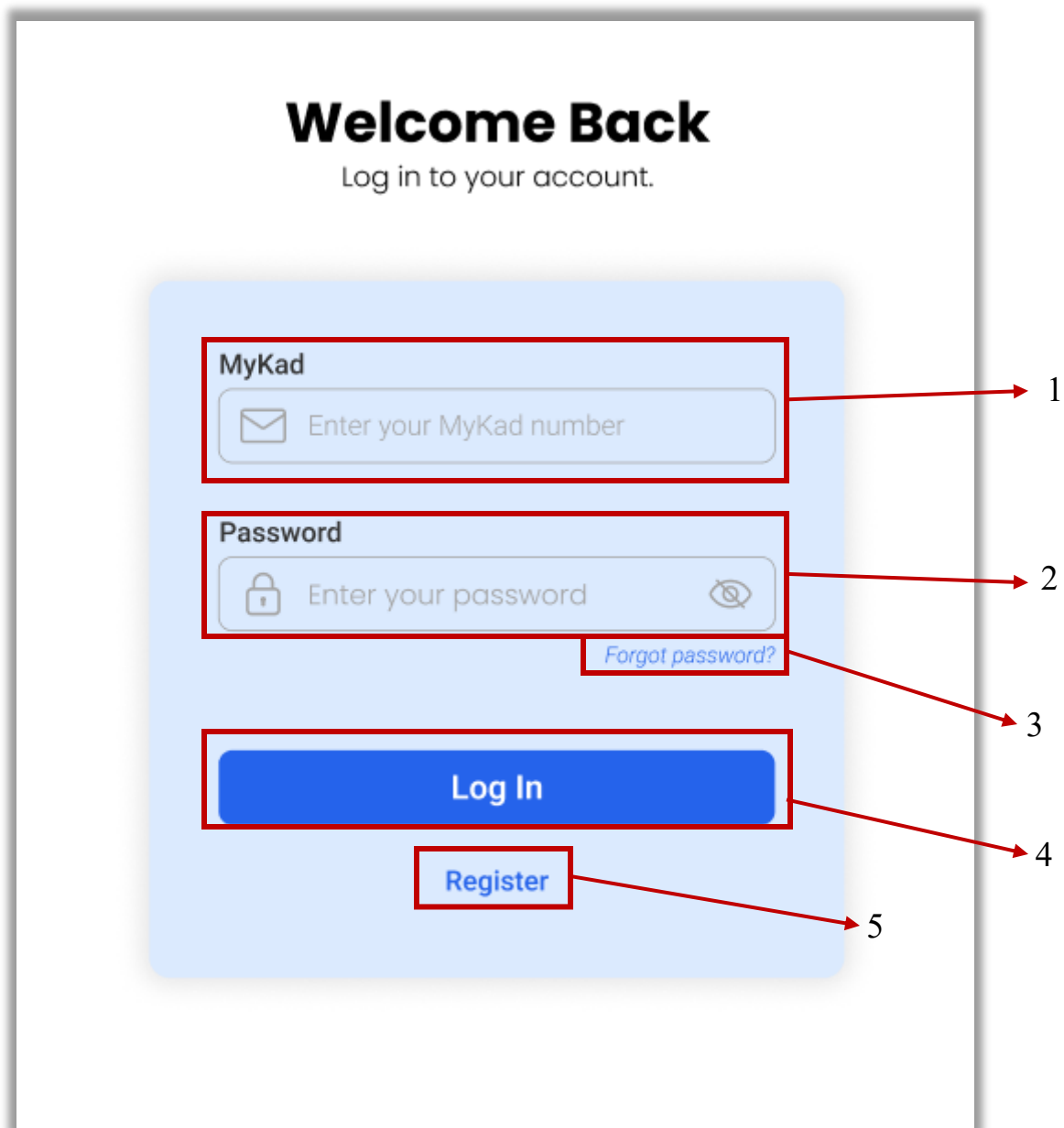
Figure 3.29. Login page.

Figure 3.29 is the GUI for Login page. There will be two input boxes. The first input box (1) with the label "MyKad" is for patient to enter their MyKad number. The second input box (2) with the label "Password" is for patient to enter their password. To log in, the patient must click the "Log In" button (4). If the entered MyKad number and password are correct, the system will navigate to respective dashboard. Else, the patient is required to re-enter their

MyKad number and password. In case, the patient forgot their password, they can click on the "Forgot Password" link (3), the system will prompt the patient to reset their password. If the patient does not have account yet, the patient can click on the "Register" (5) to navigate to the Patient Registration page.
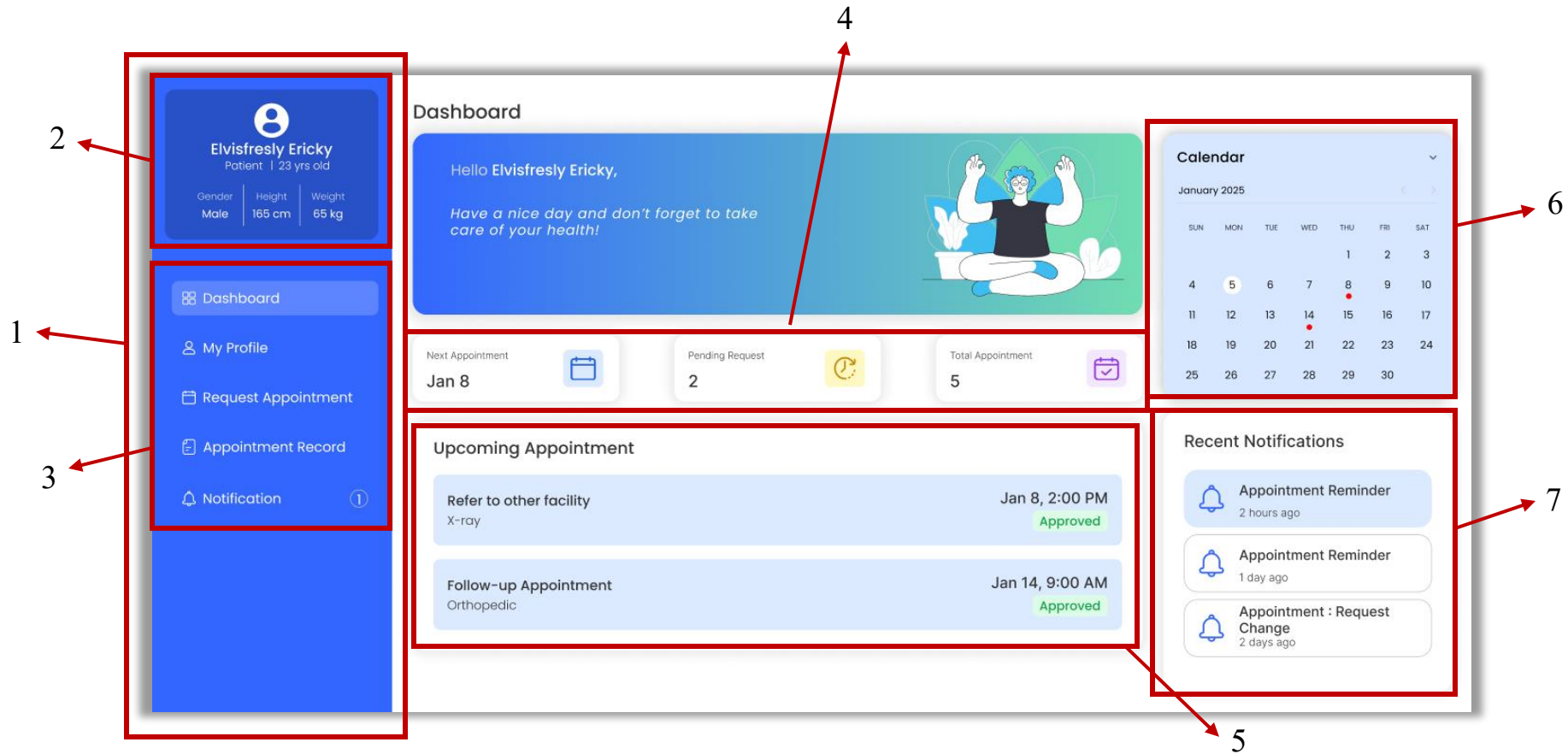
Figure 3.30. Patient dashboard page.

Figure 3.30. is GUI for the patient dashboard page. At the left-side of the page, there is a sidebar (1) containing the patient profile (2) and tabs (3) for each module of the patient. The patient profile will display the patient's name, age, gender, height, and weight. This sidebar (1) is visible and has the same design properties on every page except for registration and login page. The tab module is differing respect to the user's
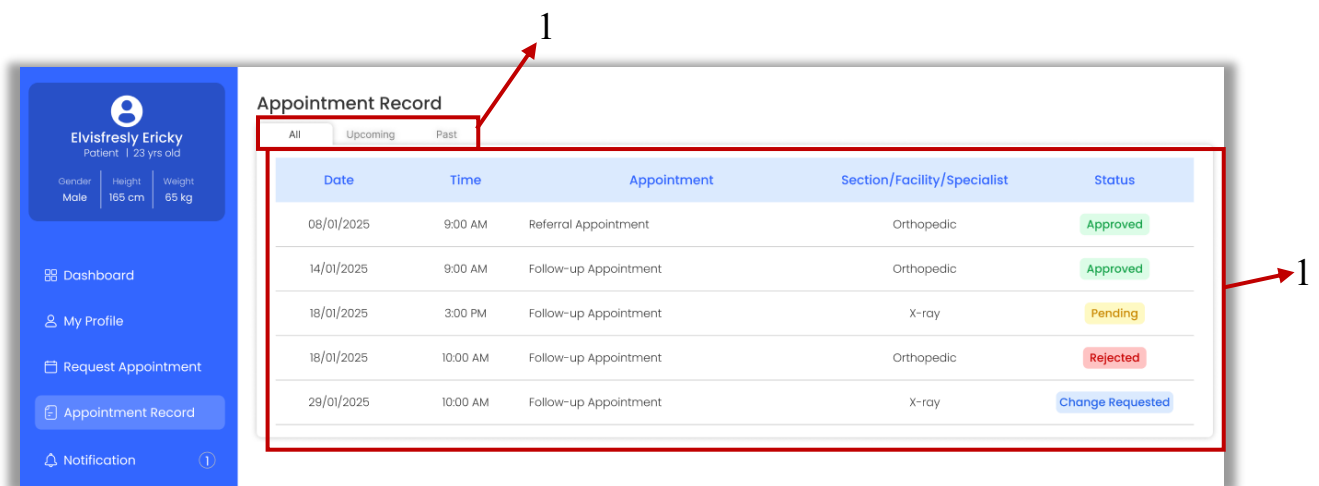
role in the system. At the center of the page, it has three key metrics (4) which highlight the patient's next appointment date, pending appointment request and the total appointment that the patient has booked in the system. Then, there will a section (5) to list the patient's upcoming appointment with some of the appointment details such as appointment type, section or facility, appointment date and time, and the status of the appointment. At the right side of page, it has a calendar (6) which has the mark of the day's date and mark for the upcoming appointment. Below the calendar, there is a notification list (7) which will list the recent patient's appointment reminders and update.

Figure 3.31. Patient Request Appointment page.

Figure 3.31 is the GUI for patients request appointment page. First, the page has a drop-down list (1) for patients to select the appointment type. Second, it has a drop-down list (3) for patients to select the section or facility of the appointment. If the appointment is a referral appointment, an input box (2) to upload referral letter will be visible. The patient can upload referral letter in this input box by clicking the "Click to Upload" button (2) and select the file to upload. After selecting the type of appointment and the section or facility, the patient can

select their preferred date on the calendar shown (4). Pick a date and the available slots will be displayed beside the calendar (4). Then, there will be a box (5) which will display the selected date and time to make the selected date and time clearer to patients. Lastly, click the button "Submit" (6) to submit the appointment request.

Figure 3.32. Patient's appointment record page.

Figure 3.32 is GUI for the patient's appointment record page. This page has a table (1) which list all the patient's appointment. In each row, the details of the appointment such as date, time, appointment type, section or facility or specialist and status of the appointment will be displayed. The table has three tabs, "All", 'Upcoming", and "Past" tab (2). These tabs work like a filter for the list of the appointments. When clicked on the "All" tab, it will list all the appointments. When clicked on the "Upcoming" tab, it will list all the upcoming appointments while for "Past" tab, it will list all the past appointments. Patient can click on each row of the table and the system will navigate to the page that displays the respective appointment details as shown in Figure 3.33. Different status of appointments will result in additional details and action will be shown on the appointment details page like in the Figure 3.34 and Figure 3.35.
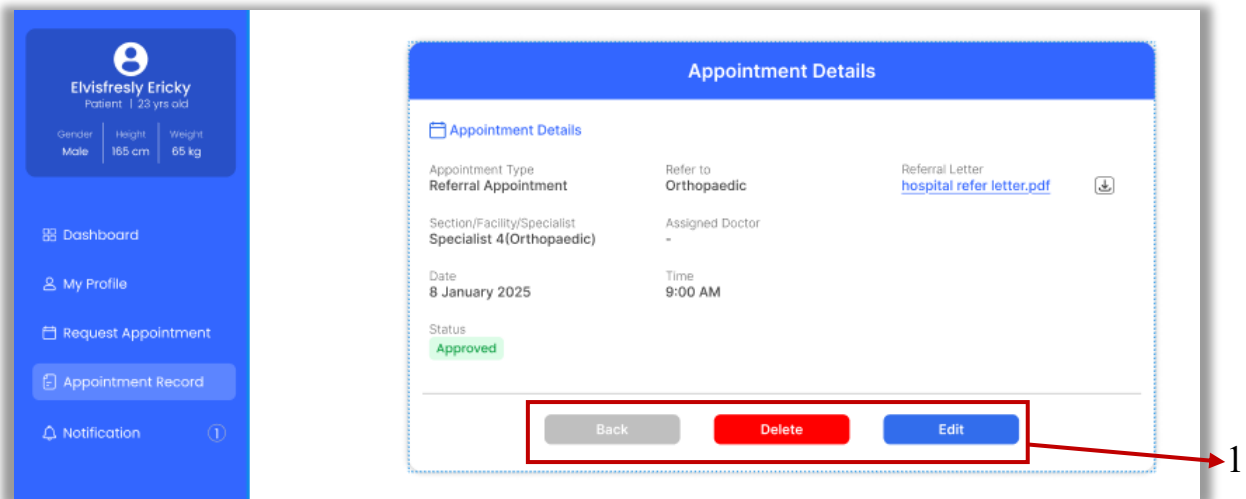
Figure 3.33. Appointment details for "Approveed" appointment

As shown in figure 3.33, it displays the appointment details for an "Approved" appointment. It has three buttons which is "Back", "Delete" and "Edit" button. The "Back" button, when clicked will navigate to the previous page which is the Appointment Record page. The "Delete" button is for patient to delete or cancel the selected appointment. After clicking the "Delete" button, the system will ask confirmation on the patient if they really want to cancel the appointment. If it is confirmed, then the system will remove the appointment data from the database. The "Edit" button is to able the patient to edit or make changes on the appointment details like the appointment type, section or facility, date and time.
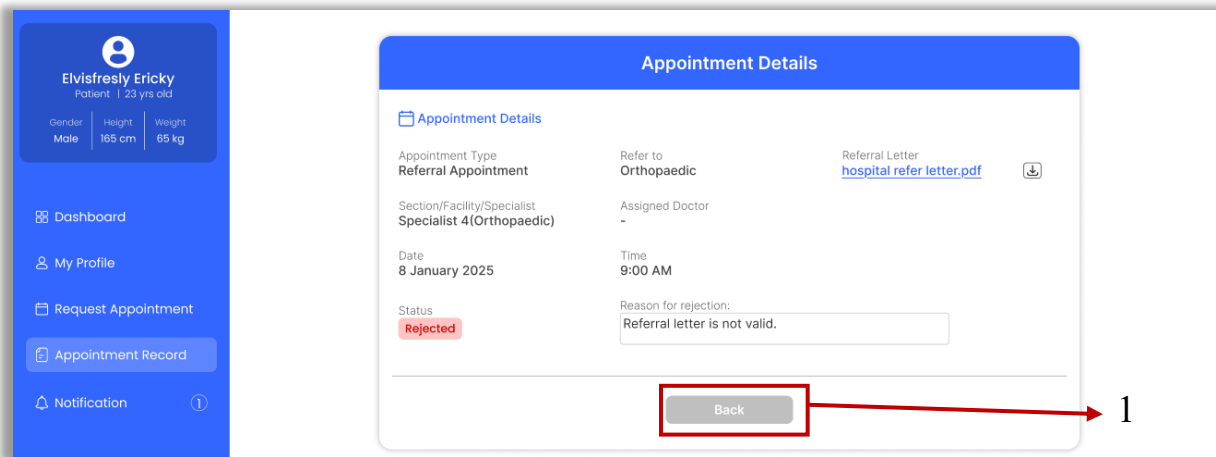
Figure 3.34. Appointment details for "Rejected" appointment.

This figure 3.34 is appointment details for "Rejected" appointment. The appointment details will include the reasons for the rejection of the appointment. It has only one action button which is the "Back" button (1).
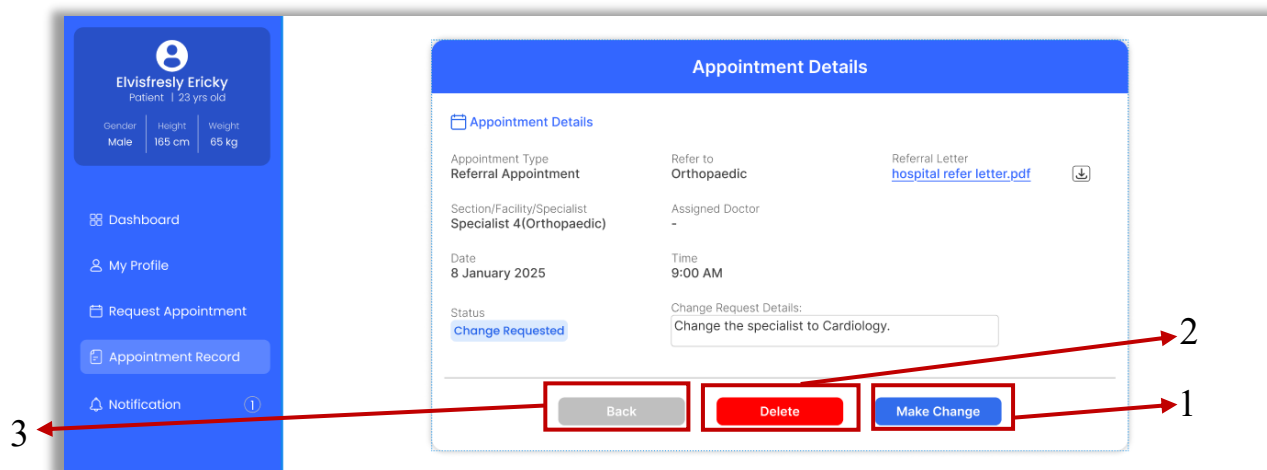
Figure 3.35. Appointment details for "Change Requested" appointment.

Figure 3.35 is the appointment details for "Change Requested" appointment. The appointment details will include the descriptions or instructions of the change request. Patient can directly can click on the "Make Changes" button (1) to make changes as requested by the healthcare staff. When clicking on the "Make Changes" button, the system will navigate to the

Request Appointment page where patient can request and modify their appointment. The "Delete" button (2) is for patients to delete or cancel the selected appointment while the "Back" button (3) is for patient to go to the previous page.

Figure 3.36. Patient's profile page.

Figure 3.36 is the GUI for patient's profile page. This page will show the patient's personal details (1), contact information (2) and some medical information (3). This page also allow patient to modify some of the information such as the phone number, email and emergency contact information. Once confirmed (4), the system will save and update the current information. If no changes made, the information also will not change.
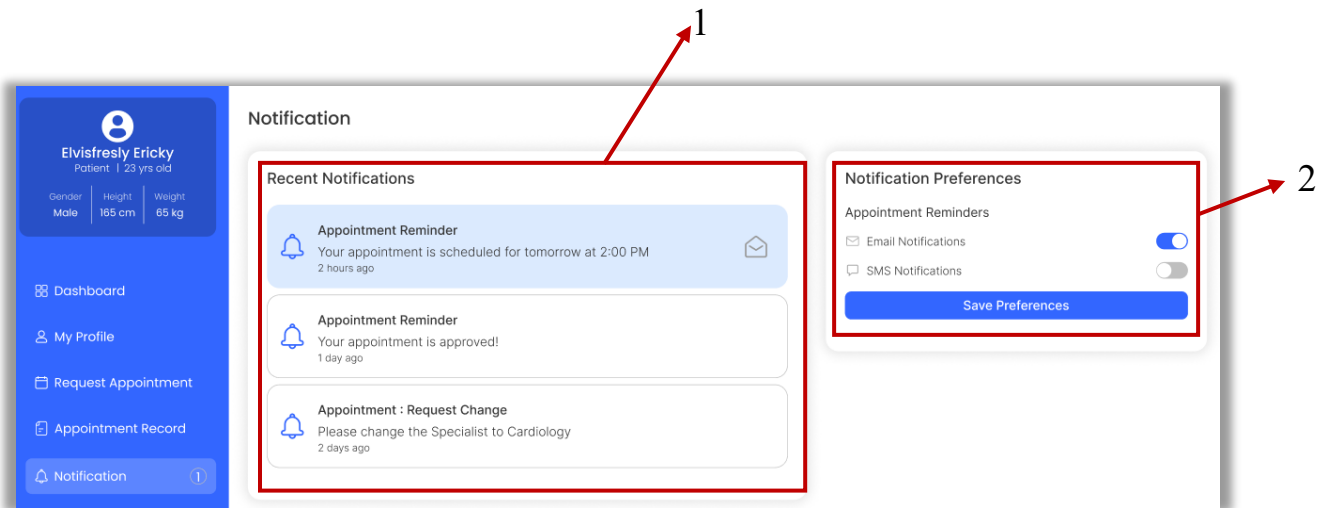
Figure 3.37. Notification page.

Figure 3.37 is the GUI for the patient's notification and preferences of notification. In this page, all the notification related to the patient will be shown here. It will sort out with the latest notification first on the top (1). Each notification contains the title of the notification, the details and the time of the receiving the notification. The notification that has not been read, it box or section will be in light blue colour. It also have an icon at the right side of the box where patient can click on that to mark the notification as read. At the right side of the page, there is a section for the notification preferences (2) where patient can choose which type of notification they would like to receive for the appointment reminders.
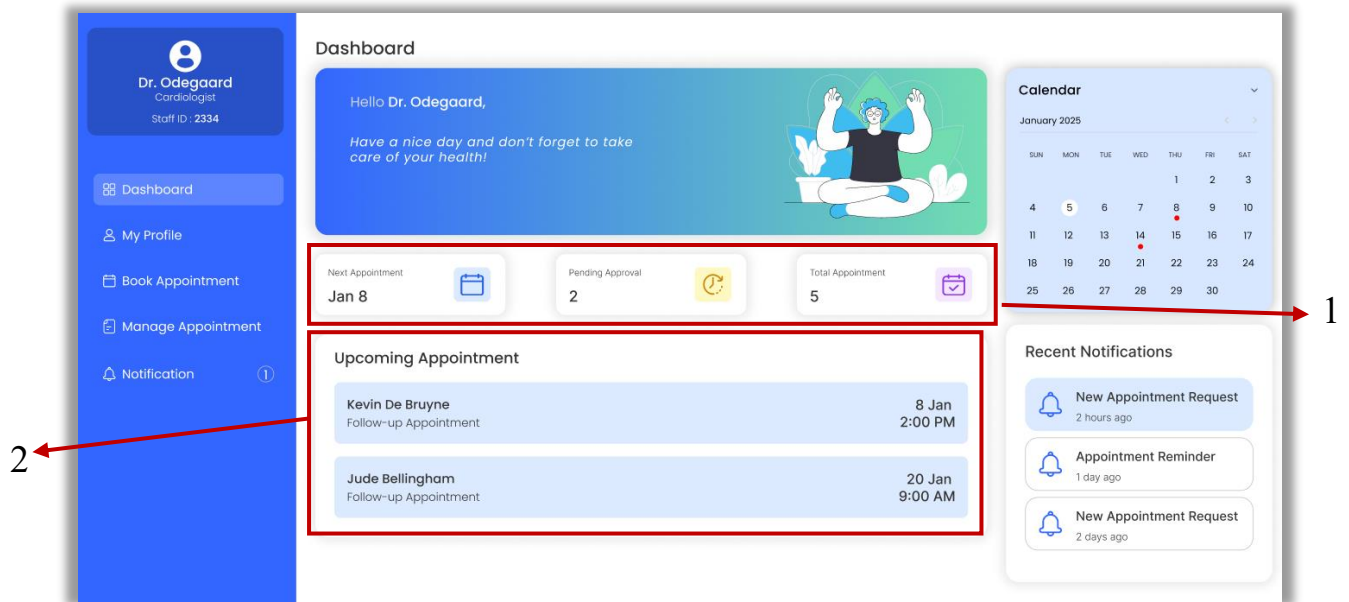
Figure 3.38. Doctor dashboard page.

Figure 3.38 is the GUI for doctor dashboard. The doctor dashboard is quite similar to the patient dashboard. The only differences are the modules at the sidebar, the key metrics and the summary of the upcoming appointment with patients for the doctor. Doctor dashboard has "Book Appointment" and "Manage Appointment" on its sidebar differ to Patient Dashboard and Administrator Dashbaord. The key metrics (1) highlight on the date of upcoming appointment with patient, the total number of pending approval on appointment and total appointment booked by the doctor in the system. The summary of the upcoming appointment (2) with patient includes the name of patient, type of appointment, the date and time of the appointment.
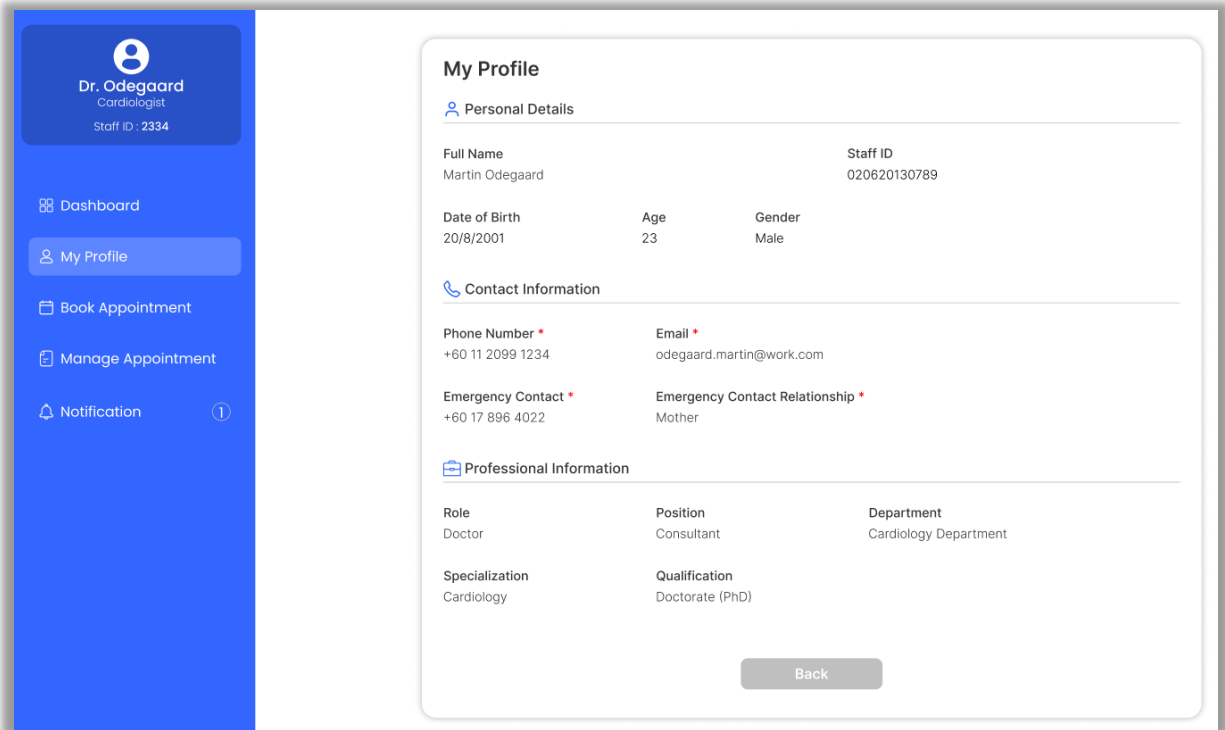
Figure 3.39. Doctor's Profile page.

Figure 3.39 is the GUI for doctor's profile page. This page shows all the information that is registered into the database and related to the doctor. The information includes the personal details, contact information and their professional information. They only can view this page but cannot modify any information on this page. Only the system administrator can edit some of their information such as the phone number, emergency contact, position and specialisation.

Figure 3.40. Book Appointment page.

Figure 3.39 is the GUI for doctor book appointment. This page includes all the information required to book for an appointment. First, the doctor has to input the patient's MyKad number (1), and then select the appointment type (2). After that, the doctor selects the option under "Refer to" selection (3). Then, proceed to select the specialist or section or facility (4). The system will display avaiable slots (5), and the doctor must pick a date and time the appointment. The doctor can add any additional notes on the provided section (6). After all requried field (*) is filled in, the doctor must click on the "Submit" button (7) to complete the appointment booking.

Figure 3.41. Appointment Request List page.

Figure 3.40 is the GUI for the appointment request list from patients. This page can be accessed by both doctor and nurse. This page displays the list of appointment requests in a table (1) that contains the column of patient's name, patient's MyKad number, the type of appointment, the date and time of the appointment and the section or facility or specialist for the appointment. Doctor and nurse can click on each row of the list to view the appointment details. After clicking on the row of the appointment, the system will navigate to the page as shown in Figure 3.4.
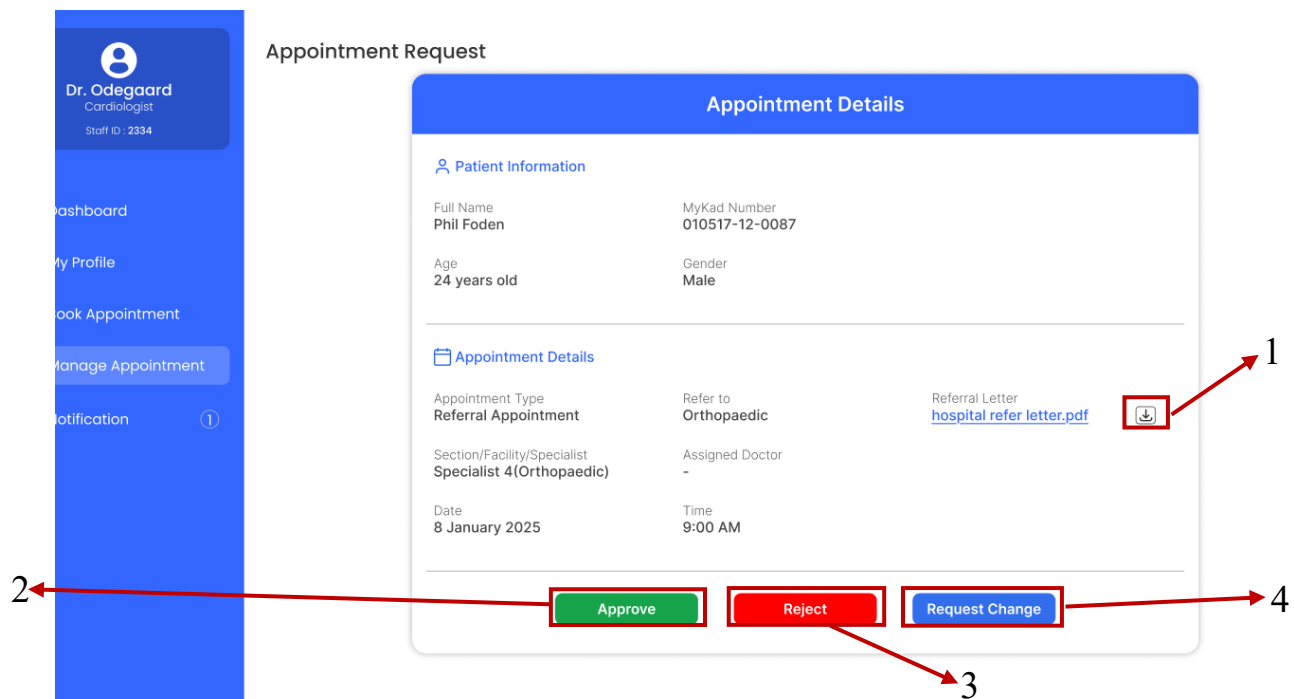
Figure 3.42. Appointment Request Details.

The figure 3.41 is the GUI for the appointment request details. The details of the appointment that will be shown is based on which row of appoinment was clicked from the table as shown in Figure 3.40. This page has the details of the patient's information who requested for the appointment, the details of the appointment and action buttons for doctor or nurse to make decisions. There is also a download button (1) where doctor and nurse can directly download the patient's referral letter. The three action buttons each has different action and result. The "Approve" button (2) is for doctor or nurse to approve the appointment request while the "Reject" button (3) is for doctor or nurse to reject the appointment. When rejecting the appointment, the doctor or nurse is required to state the reason of the rejection for patient future knowledge. The page will be shown in Figure 3.42. The "Request Changes" button (4) then is for doctor or nurse to request the patient to make slight change on their appointment request. When doctor or nurse request changes on the appointment detaisl from patient, the system will required the doctor or nurse to describe and give instructions on the changes as shown in Figure 3.43.
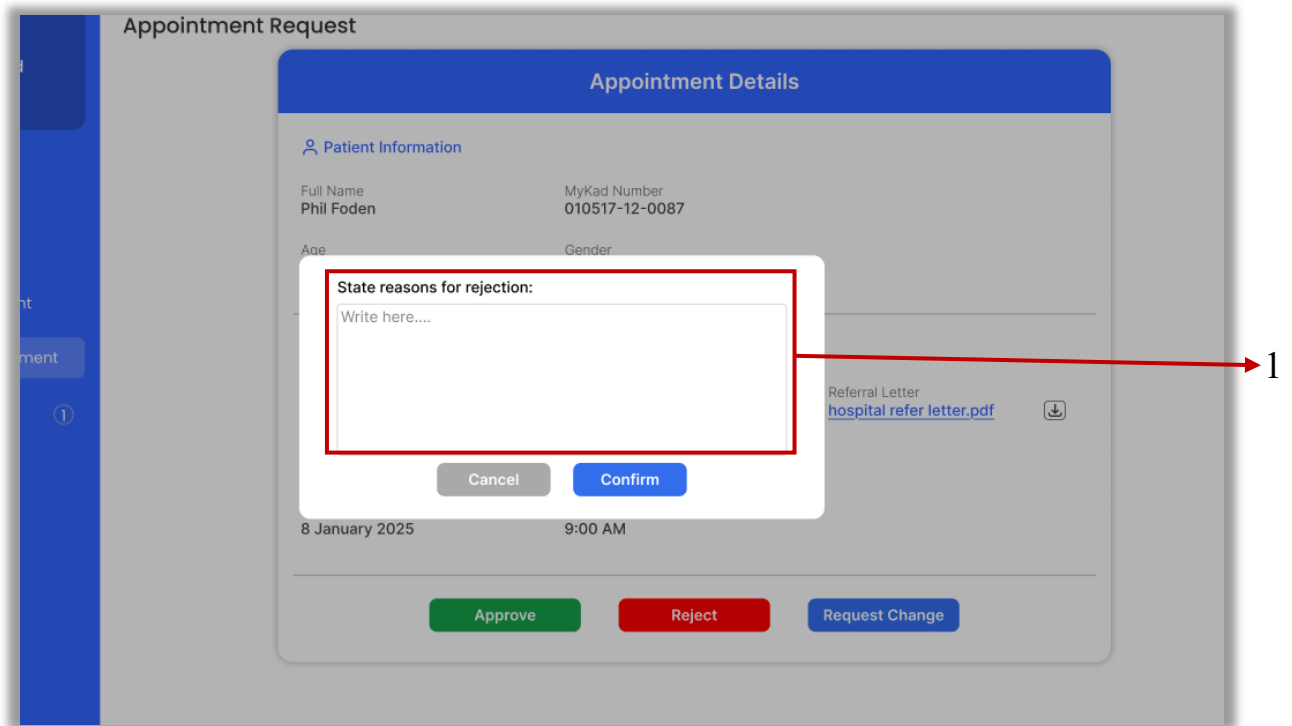
Figure 3.43. State reason for appointment rejection.

This figure 3.42 is GUI for doctor or nurse to state reason for appointment rejection. This page will have a input box (1) where doctor or nurse will state the reason for rejection. After confirmation, the system will update the status of the appointment and notify the patient on the updates.
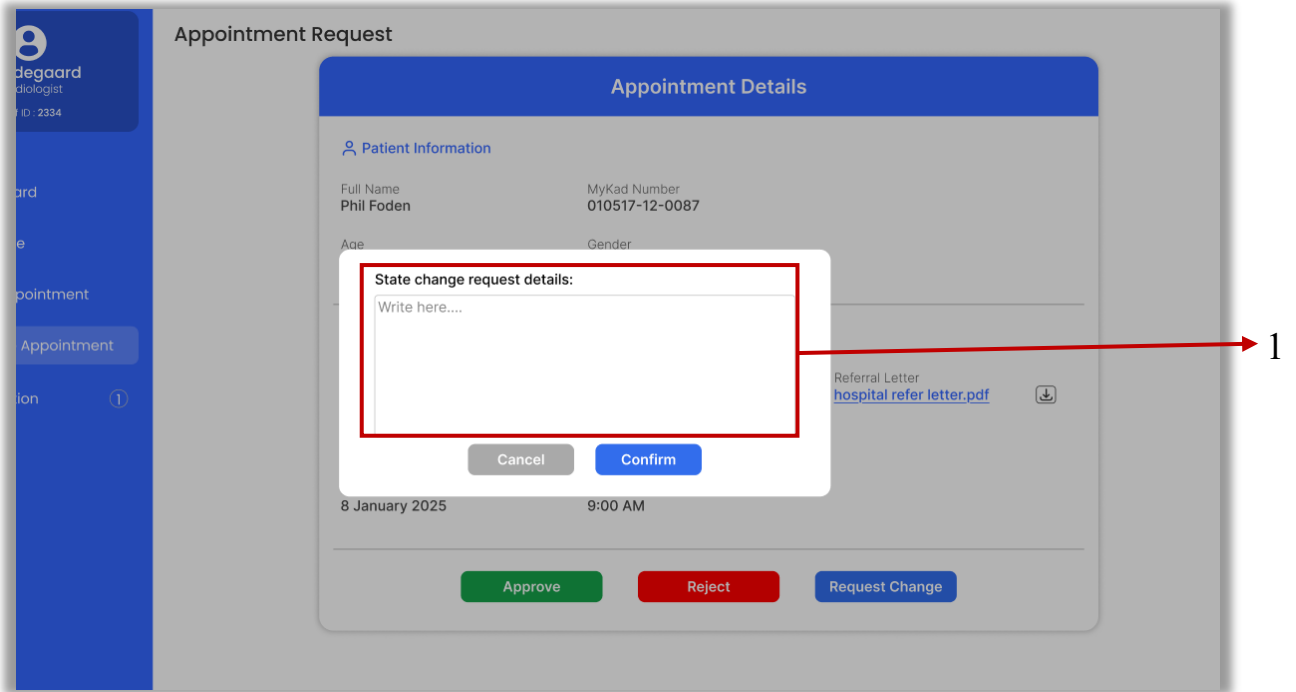
Figure 3.44. State change request details.

This Figure 3.43 is GUI for doctor or nurse to state the description and instruction of the change request. The doctor or nurse will input the description or instruction into the input box (1). After confirmation, the system will update the status of the appointment and notify the patient regarding the appointment and ask for action to make changes as requested.
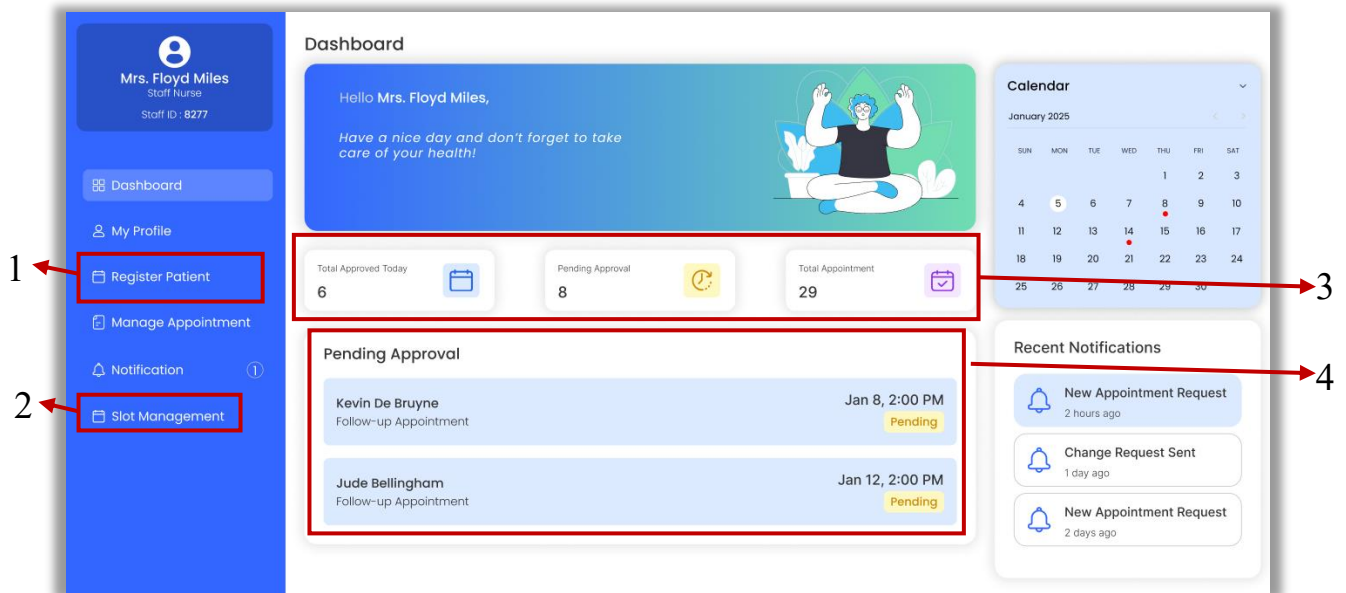
Figure 3.45. Nurse Dashboard page.

Figure 3.45 is the GUI for Nurse Dashboard. This dashboard is quite similar to the Patient Dashboard and Doctor Dashboard. Compare to others, Nurse Dashboard has slight differences on the module at the left sidebar. It has Register Patient (1) and Slot Management (2) compared to Doctor Dashboard. For key metrics (3), it highlights three, which are the total appointments apporved today, the number of appointments pending for approval and the total number of appointments booked in the system. The Nurse Dashboard also has the summary of the pending approval appointment (4). The summary shows the name of the patient, appointment type, the date and time of the appointment and the approval status.

Figure 3.46. First time Patient Registration.

Figure 3.44 is the GUI for registration of the first time patient. The registration form required information on the patient's personal details, contact details and some of the medical information. As for the input box for MyKad number (1), it shows green and tick symbol when the MyKad number is valid and not already registered in the system. Else, the input box will be red in colour.The field with (*) beside its label must be filled out to complete the registration process. Once confirmed, the patient's data is recorded into the database which will allow the patient to register and create themselves an account in this system.
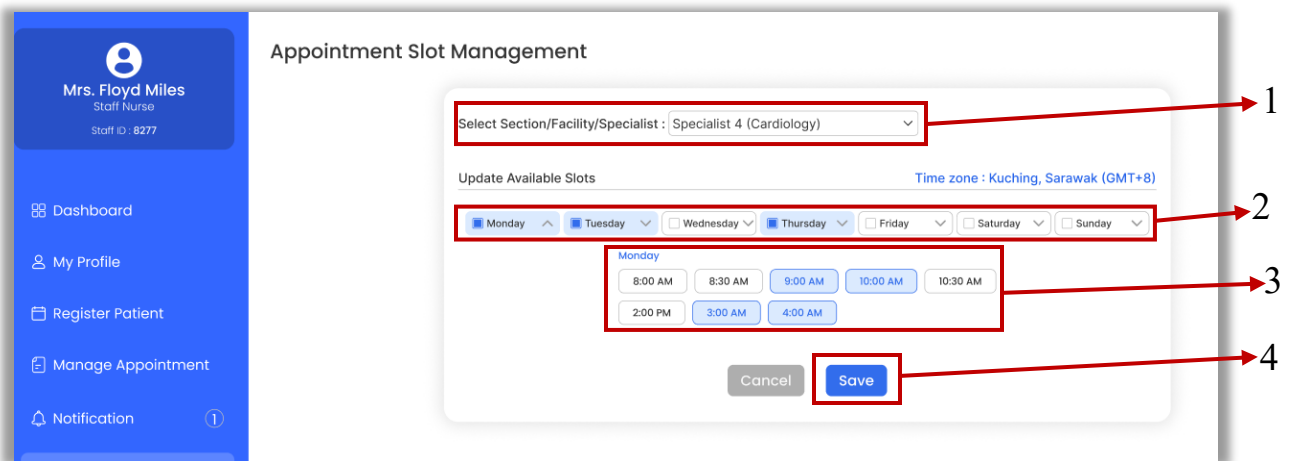
Figure 3.47. Appointment Slot Management.

Figure 3.45 is the GUI for appointment slot management. This is where nurse will set and appoint which slot will be available for each section, facility or specialist. First, the nurse must select the section, facility or specialist (1). Then, the nurse can select the day (2) and select which time slots (3) are available for that day. For example, the nurse first selects Monday. The system will displays all the time slots for Monday, and the nurse must pick which time slots should be available based on the availability of the section, facility or specialist. Each slot is for one patient. Once confirmed, the nurse must click the "Save" button (4) to update the availablility of the slots.
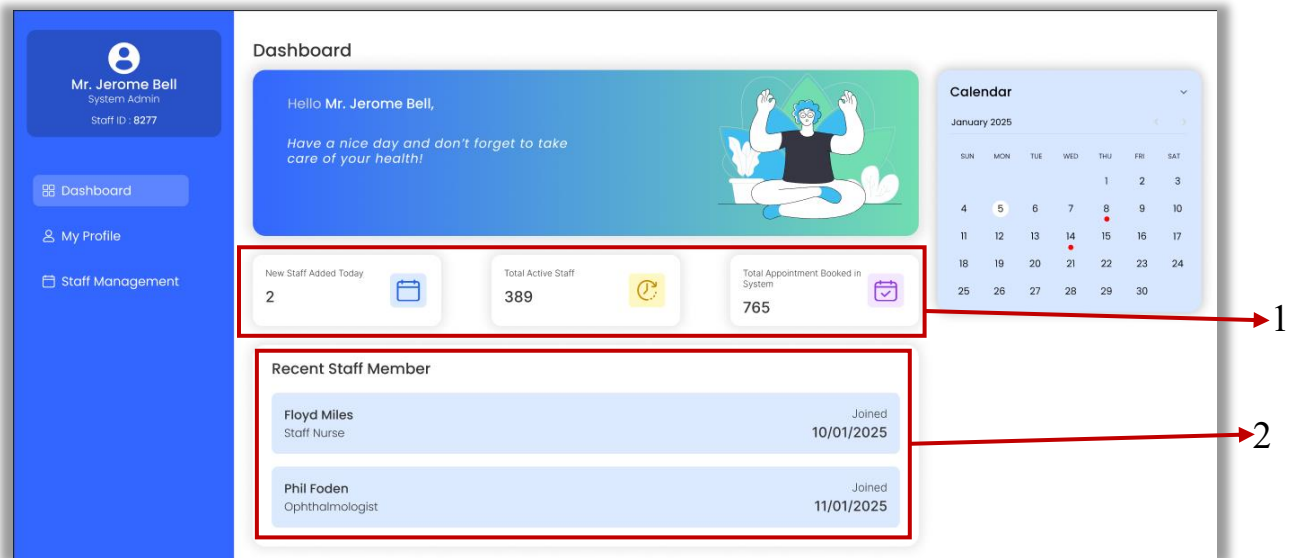
Figure 3.48. Administrator Dashboard page.

Figure 3.46 is the GUI for administrator dashboard. This dashboard is quite similar to the other dashboard. The differences are on the key metrics and the summary of the recent staff member. The Administrator dashboard highlights the key metrics (1) for the number of new staff members joined the system for that day, the number of total active staff members and the total number of appointments booked in the system. As for the summary of the recent staff member (2), it displays some information on the new staff member, which includes their name, roles and the date of their joining.
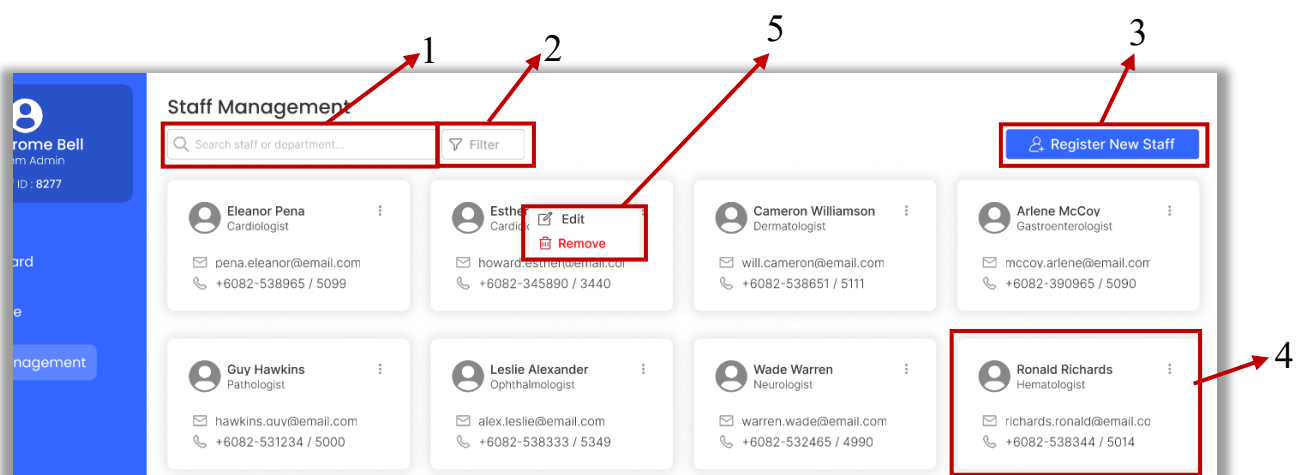

Figure 3.49. Staff Management page.

Figure 3.47 is the GUI for administrator to manage all the staff. This page has search (1) and filter (2) feature which enable administrator to find staff information more easier. There is also a "Register New Staff" button (3) which when clicked will navigate to the "Register New Staff" page. The page is for adminstrator to fill out new staff member information into the system. The page is as shown in Figure 3.48. This page displays the brief details (4) of each staff member. The details includes the name, position, email address and phone number. The "three dots" button, when clicked, will show option to "Edit" or "Remove" (5). The "Edit" option allows administrators to edit the selected staff information. When clicked on the "Edit" option, the system will navigate to the edit staff information as shown in Figure 3.49. The "Remove" button is for administrator to remove the selected staff data from the system, so the staff will not have any access to the system anymore.

Figure 3.50. Register New Staff page.

Figure 3.48 is the GUI for the registration of new staff. Administrator will input the required field on the staff information. The information includes staff's personal details, contact details and professional information. The field with (*) beside its label must be filled out to complete the registration process. Once confirmed with information, the administrator can click on the "Confirm" button (1) to complete the registration process. The new staff data is recorded into the database and they will have access to the system.

Figure 3.51. Edit Staff Details page.

Figure 3.49 is the GUI for administrators to edit staff details. This page will show the staff's personal details, contact information and some professional information. This page also allow administrator to modify (1) some of the information such as the phone number, emergency contact information, position, department, specialisation and qualification. Once confirmed, the administrator must click on the "Confirm" button (2) to save and update the information to the database.

3.4 Summary

This chapter outlined the requirement analysis and design process for the Appointment Management System at PKP UNIMAS. The requirements were gathered using questionnaires and interviews with patients, healthcare staff, and IT personnel, providing insights into the existing appointment workflow, challenges, and user needs. Key findings included the need for automated reminders, real-time availability updates, and an online referral management process to address inefficiencies in the current manual system.

The chapter also detailed the system's design, including logical and physical designs. The logical design involved use case diagrams and descriptions to define user interactions with the system, while activity diagrams illustrated workflows for critical processes such as appointment booking, referral management, and system login. The physical design showcased user interface prototypes, highlighting how the system will facilitate patient, doctor, and staff interactions. Additionally, the Entity Relationship Diagram (ERD) was developed to outline the database structure.

Overall, the analysis and design process established a comprehensive framework to guide the development of the system, addressing key user requirements and ensuring a seamless and efficient appointment management experience at PKP UNIMAS.

APPENDIX A : INTERVIEW QUESTIONS WITH DOCTOR

Interview date: 8th January 2025

Interview location: Pusat Kesihatan Prima UNIMAS

A (Interviewer): Elvisfresly Ericky

B (Interviewee): Dr. Dessmon (Doctor at PKP UNIMAS)

A: Have you ever made an appointment booking on behalf of a patient? If yes, can you describe the process and any challenges you faced?

B: Yes, I have. For follow-up appointments, I usually discuss the date and time with the patient immediately after the consultation, considering their availability. If the patient needs a referral to another section, like X-ray, I ask the nurse to arrange it for them. If the section is available, the patient can proceed directly to the facility. However, if it is unavailable, the nurse will later inform the patient by phone once it becomes available. A significant challenge arises when referring patients to specialists, as we often do not know the specialist's availability. This requires making phone calls to inform the patient when they can see the specialist. Additionally, some patients are difficult to contact, which complicates the process.

A: How do you manage patients with referral letters in the current workflow?

B: If a patient has a referral letter, we review the letter first. If no further action is required, the patient can go directly to the referred section or schedule an appointment. In most cases, however, we still conduct a consultation and diagnosis, even if the patient has a referral letter.

A: If a patient wants to change their appointment date, what is the current process for handling this request? Are there any challenges involved?

B: Patients can call us to request a change in their appointment date. However, it is often challenging to communicate with them effectively to rearrange the appointment.

A: **Do you think allowing patients to book appointments online through a dedicated system would be helpful in improving the efficiency of the current appointment process? Why or why not?**

B: Yes, I believe it would be very helpful. It would simplify and clarify the appointment process, making it more efficient.

A: **Would a feature allowing patients to upload referral letters and select appointment slots directly benefit your workflow?**

B: Yes, this feature would be very helpful. It would allow us to review referral letters immediately and save patients time and effort by eliminating the need to visit us without knowing whether the procedure can be done immediately or if they need to wait.

A: **Do you encounter cases where patients fail to attend their scheduled appointments? How is this managed?**

B: Yes, we do encounter such cases. When patients fail to attend their appointments, the nurse follows up with a phone call to remind them.

A: **Do you think automated reminders and notifications for upcoming appointments would help reduce missed appointments? Why or why not?**

B: Yes, automated reminders and notifications would be very helpful. They would serve as a timely reminder for patients about their appointments and reduce the likelihood of missed appointments.

APPENDIX B : INTERVIEW QUESTIONS WITH NURSE

Interview date: 7th January 2025

Interview location: Pusat Kesihatan Prima UNIMAS

A (Interviewer): Elvisfresly Ericky

B (Interviewee): Puan Rogayah (Staff Nurse at PKP UNIMAS)

A: Do you ever involve in booking an appointment for patient? If yes, what is the process?

B: Yes, we are involved in booking appointments for patients. Typically, we wait for instructions from the doctor. Once instructed, we write down the appointment details, such as the section the patient should go to, along with the date and tim

A: How do you manage patient with referral letter?

B: When managing patients with referral letters, we first review the referral letter. If everything is complete and clear with no further action required, the referral can proceed. However, in most cases, the doctor needs to diagnose the patient first, after which the doctor decides on the referral process.

A: How do you communicate with patients when sections or facilities are unavailable?

B: If sections or facilities are unavailable, we inform the patients about the unavailability and let them know that we will call them once the section or facility becomes available.

A: How important would it be to have real-time updates on the availability of sections or facilities?

B: Real-time updates on the availability of sections or facilities are very important. This allows us to quickly book appointments and check availability immediately, making the process more efficient.

A: Do you think automated reminders for upcoming appointments would help reduce missed appointments?

B: Automated reminders for upcoming appointments would be extremely helpful. They would ensure that patients remember their appointment dates and times, reducing the likelihood of missed appointments.

APPENDIX C : Similarity Check Report