

# **A Web-based Solution for Streamlining Doctor Appointments and Healthcare Access: Public Healthcare System**

By

**Md. Harunur Rashid**  
ID: 201-15-13726

## **FINAL YEAR DESIGN PROJECT REPORT**

This Report Presented in Partial Fulfillment of the  
Requirements for the **Degree of Bachelor of Science in**  
**Computer Science and Engineering**

### **Supervised By**

**Mr. Rahmatul Kabir Rasel Sarker**  
**Lecturer**  
Department of Computer Science and  
Engineering Daffodil International  
University

### **Co-Supervised By**

**Mr. Rahmatul Kabir Rasel Sarker**  
**Lecturer**  
Department of Computer Science and  
Engineering Daffodil International  
University



**DAFFODIL INTERNATIONAL UNIVERSITY**  
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# APPROVAL

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This Project titled “A Web-based Solution for Streamlining Doctor Appointments and Healthcare Access: Public Healthcare System” submitted by **Md. Harunur Rashid** to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on **15-12-2024**.

## BOARD OF EXAMINERS

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**Name**

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**Name**

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---

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**Internal Examiner 2**

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International University

---

**Name**

**External Examiner**

Designation, Department of  
CSE, FSITDaffodil  
International University

# DECLARATION

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I hereby declare that this project has been done by me under the supervision of **Mr. Rahmatul Kabir Rasel Sarker, Lecturer** Department of Computer Science and Engineering, Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for the award of any degree or diploma.

## **Supervised by:**

---

**Mr. Rahmatul Kabir Rasel Sarker**

Lecturer

Department of Computer Science and

Engineering Daffodil International

University

## **Co-Supervised by:**

---

**Mr. Rahmatul Kabir Rasel Sarker**

Lecturer

Department of Computer Science and

Engineering Daffodil International

University

## **Submitted by:**

---

**Md. Harunur Rashid**

Student ID: 201-15-13726

Department of Computer Science and

Engineering Daffodil International

University

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# ABSTRACT

In traditional healthcare systems, patients often face significant challenges when booking appointments with doctors. Long waiting times, inefficient scheduling, and the lack of direct communication with medical professionals contribute to patient frustration and wasted time. Additionally, managing appointments and payments through outdated methods often leads to unnecessary delays, errors, and reduced trust in the healthcare process. These issues highlight the need for a modern, streamlined approach to connecting patients with doctors [1].

The "Public Healthcare System" addresses these challenges by offering a comprehensive online platform that eliminates inefficiencies in patient-doctor interactions. This system supports three user roles: normal users, doctors, and administrators. Normal users can register or log in using email-password credentials or Google authentication to book appointments with doctors during their available times, engage in direct conversations, and make secure payments for appointments. Doctors can upload posts for public awareness, manage their schedules, and confirm appointments with patients via email notifications. Administrators oversee the platform's functionality, with exclusive privileges to create accounts for doctors and ensure smooth operations [2].

By digitizing and optimizing the appointment process, the "Public Healthcare System" minimizes patient wait times, ensures effective communication, and enhances trust between patients and healthcare providers. Through its user-friendly design, secure payment integration, and structured appointment management, the platform revolutionizes the healthcare experience, making it more accessible, efficient, and patient-centered. This innovative solution seeks to transform the way patients and doctors connect, ensuring a seamless and reliable healthcare journey for all [3].

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# Chapter 1

## Introduction

### 1.1 Introduction

The Public Healthcare System is an online appointment platform designed to streamline patient-doctor interactions. It allows patients to book appointments with doctors at their available times, reducing waiting periods and inefficiencies in traditional systems. With features like secure payments, direct communication, and appointment confirmation via email, the system ensures a seamless, convenient, and patient-focused healthcare experience.

### 1.2 Motivation

The Public Healthcare System is driven by the need to eliminate long waiting times, inefficient appointment processes, and communication gaps in traditional healthcare. By creating a modern, user-friendly platform, it aims to simplify doctor-patient interactions, enhance accessibility, and ensure a seamless, time-saving healthcare experience.

### 1.3 Objectives

- **Simplify Appointment Scheduling:** Provide patients with an easy-to-use platform to book appointments with doctors at their available times.
- **Enhance Accessibility:** Enable seamless login via email, password, or Google for all users, ensuring broad access to the platform.
- **Improve Communication:** Facilitate direct conversations between patients and doctors for better understanding and trust.
- **Streamline Payment Process:** Offer secure online payment options for appointments to ensure convenience.
- **Support Doctors:** Allow doctors to manage appointments, upload posts for public awareness, and confirm schedules with patients via email.

- **Ensure Administrative Oversight:** Provide administrators with tools to manage user roles, create doctor accounts, and oversee platform operations.
- **Save Time and Reduce Frustration:** Minimize waiting times and inefficiencies inherent in traditional healthcare systems.
- **Promote Transparency:** Build trust through clear communication and organized appointment management.

## **1.4 Expected Outcome**

- **The Efficient Appointment Management:** Patients can easily schedule appointments with doctors at convenient times, reducing waiting periods.
- **Improved Patient Experience:** A user-friendly interface ensures seamless navigation, enhancing satisfaction and accessibility.
- **Secure Payment Processing:** Patients can make hassle-free, secure payments for their appointments.
- **Enhanced Communication:** Direct conversations between patients and doctors foster trust and better understanding.
- **Streamlined Operations for Doctors:** Doctors can efficiently manage appointments, share medical posts, and confirm schedules via email.
- **Effective Administration:** Administrators can maintain smooth platform operations by managing user roles and ensuring functionality.
- **Time and Resource Optimization:** The platform saves time for both patients and doctors by reducing inefficiencies in the healthcare process.
- **Improved Healthcare Access:** The system ensures wider accessibility to quality healthcare services for all users.

## **1.5 Project Management and Financial Analysis**

### **1.5.1 Project Management:**

The Public Healthcare System project will be managed using an iterative and collaborative approach to ensure timely delivery and high-quality results. Key phases include:

- **Requirement Analysis:** Understanding user needs and defining functional and technical requirements.

- **System Design:** Developing the architecture, database design, and user interface prototypes.
- **Development:** Implementing the frontend, backend, and integration of key features such as appointment scheduling, payments, and communication tools.
- **Testing:** Conducting rigorous testing to identify and fix bugs, ensuring a secure and user-friendly experience.
- **Deployment and Maintenance:** Launching the system and providing ongoing support for updates and feature enhancements.

### 1.5.2 Financial Analysis:

Here's a revised Financial Analysis with the total estimated costs under **BDT 50,000**, adjusting the values to fit within the budget:

Table 1.1 Financial Analysis

Category	Estimated Costs (BDT)	Revenue Streams
<b>Development Costs:</b>		
Frontend and Backend Development	15,000	
Database Setup and Server Infrastructure	10,000	
Third-Party Integrations (e.g., Payment Gateways)	5,000	
<b>Operational Costs:</b>		
Cloud Hosting and Server Maintenance	5,000/year	
Payment Gateway Transaction Fees	2-3% per transaction	
<b>Marketing and Promotion:</b>		
Digital Advertising and Outreach	5,000/year	

<b>Maintenance and Updates:</b>		
Technical Support and Upgrades	5,000/year	
<b>Revenue Generation:</b>		
Appointment Fees (commission per booking)	-	BDT 10 per booking (e.g., 500 bookings/month)
Subscription Plans (Premium Features for Doctors)	-	Monthly/annual subscription fees
Advertisement Slots (for healthcare products)	-	Revenue from advertisements
<b>Break-Even Analysis</b>		
Estimated Monthly Appointments	-	500 appointments/month
Estimated Revenue (based on BDT 10 commission)	-	BDT 5,000/month

#### **Key Adjustments:**

- Development Costs: Reduced by simplifying the scope of work and using cost-effective tools and technologies.
- Operational and Marketing Costs: Lowered through the use of more affordable cloud hosting and marketing options.
- Revenue Generation: The platform can still generate income through small commissions on bookings and potentially from advertisements, all designed to fit within the budget.

## **1.6 Report Layout**

For your Public Healthcare System Web Application, the report layout would follow a structured approach to present the project's development and its impact effectively. Here's a suggested layout:

- **Abstract:** A concise summary of the entire project that includes the problem the application solves, the technologies used (e.g., MERN stack, Tailwind CSS, DaisyUI), and a high-level view of the outcome. This section will allow the reader to grasp the essence of your project in a few sentences.
- **Table of Contents:** An organized list of all sections in the report, along with their page numbers, to ensure that the document is easy to navigate.
- **Introduction:** The introduction explains the significance of the public healthcare system, the challenges it addresses, and the motivation behind the development of this web application. You can highlight how the project uses modern technologies to improve healthcare accessibility and user experience.
- **Literature Review:** Summarize previous research, trends in the healthcare industry, and existing solutions in the market. Include references to studies or other web-based healthcare systems, their successes, and limitations, helping to position your project in the broader context of healthcare technologies.
- **Methodology:** In this section, describe the process used for building the web application. Explain the decision-making process regarding the technology stack (MERN, Firebase for authentication, Tailwind CSS for design), and outline the development phases, including planning, designing, and implementation.
- **System Design:** This section explains the architecture of the system, including the front-end (using Tailwind CSS and DaisyUI), back-end (Node.js and Express.js), and database (MongoDB). Visual aids such as UML diagrams or system architecture flowcharts can help illustrate the design.
- **Implementation:** Detail the coding process for both the front-end and back-end. For example, explain how you built features like patient registration, doctor-patient interactions, and appointment booking. Discuss how Tailwind CSS and DaisyUI were used to make the interface responsive and visually appealing.
- **Testing:** Outline the testing process, including unit testing, integration testing, and system testing. Mention any tools (e.g., Jest, Mocha) used to validate the application. Explain how testing ensures functionality across various devices, with a focus on ensuring the platform is user-friendly for healthcare providers and patients alike.
- **Results and Discussion:** Discuss how the project meets the initial objectives and its impact on users. Compare the final implementation against the initial design,

highlighting any challenges faced and how they were overcome. Evaluate the success of the system in terms of performance, user adoption, and scalability.

- **Conclusion:** Summarize the findings and outcomes of your project. Reflect on the contributions your application makes to the healthcare industry, especially in improving accessibility and the efficiency of healthcare delivery. You can also discuss the potential for scaling or expanding the project in the future.
- **References:** List all the resources, papers, books, and online references you've used to support the project. Follow a consistent citation style such as IEEE or APA, and include references to the tools and frameworks used.
- **Appendices:** Provide additional materials that support the content of the report, such as detailed code snippets, user interface screenshots, or data used in testing.

This layout ensures that the report covers every aspect of the development and implementation of the web application. It is structured to provide a clear, logical progression from conceptualization to conclusion, ensuring that the project is well-documented and easily understood by readers or reviewers.

## 1.7 Summary

The “Public Healthcare System” project is an online platform designed to streamline the process of booking medical appointments and facilitating communication between patients and doctors. It allows patients to schedule appointments with doctors at their available times, reducing the traditional waiting time in clinics. Through features like doctor profiles, appointment scheduling, payment integration, and email confirmations, the system offers a more efficient and convenient healthcare experience. Additionally, it provides a communication channel for users to interact with doctors, ensuring timely and accurate consultations. The platform aims to make healthcare more accessible, transparent, and user-friendly for both patients and doctors.

# Chapter 2

## Background

### 2.1 Terminologies

Terminologies for Public Healthcare System

- **MERN Stack:** A set of technologies used to develop the project, consisting of MongoDB (database), Express (backend framework), React (frontend library), and Node.js (runtime environment for JavaScript).
- **Tailwind CSS:** A utility-first CSS framework used to style the web application, providing customizable and responsive design.
- **DaisyUI:** A component library that works with Tailwind CSS to provide pre-built UI components for faster design and development.
- **ImageBB:** A cloud-based image storage service used in the project to store and manage images uploaded by users and doctors.
- **Chat Integration:** A feature enabling real-time communication between users and doctors within the platform, enhancing interaction and consultation.
- **Payment Gateway:** A system that allows users to make payments for appointments. Integrated payment methods include cards, SSL, Commerz, Bkash, Nogod, and Rocket.
- **SSL (Secure Sockets Layer):** A security protocol used to establish an encrypted link between the web server and the user's browser, ensuring secure data transmission during payment transactions.
- **Commerz:** A payment service provider that facilitates online payments in the platform, specifically for users in Bangladesh.
- **Bkash:** A mobile financial service provider in Bangladesh that enables users to make payments through mobile money.
- **Nogod:** A mobile payment service in Bangladesh, used for handling payments within the healthcare system.
- **Rocket:** Another mobile financial service used for payments in the healthcare platform.



- **Doctor Appointment:** A feature allowing patients to schedule a time slot with available doctors for consultation.
- **User Authentication:** A process that ensures only authorized users (patients, doctors, or admin) can access certain features of the system, typically using email/password or Google login.
- **Admin Panel:** A backend interface used by the admin to manage users, doctors, appointments, and other system settings.
- **Real-time Notification:** A feature that notifies users and doctors about upcoming appointments or any changes via email or in-app notifications.
- **Post/Upload Medicine Review:** Doctors can upload posts to share information about medicines or treatments for review by patients.

## 2.2 Related Work

The evolution of online healthcare systems has addressed several challenges in patient care, appointment scheduling, and communication between doctors and patients. Various platforms have been developed globally to improve healthcare accessibility and efficiency. One prominent example is Teladoc, which allows users to book online consultations and engage with healthcare providers remotely through video calls and messaging. Similarly, Amwell provides a telehealth platform that facilitates seamless communication between patients and doctors, offering flexible appointment scheduling and real-time interactions. These systems, like the Public Healthcare System, leverage online platforms for efficient consultation and appointment management, streamlining healthcare services for both patients and doctors [4].

Another notable example is Zocdoc, a widely used doctor appointment scheduling system that enables patients to find healthcare providers, view available time slots, and schedule appointments online. This model has been adopted in the Public Healthcare System, where users can search for doctors, check their availability, and book appointments directly through the platform, ensuring convenience and transparency. Moreover, eClinicalWorks and Cerner, two major Health Management Systems (HMS), integrate various healthcare functions, such as patient records, appointment scheduling, and billing, into a unified platform. These systems' ability to consolidate multiple services informs the design of the Public Healthcare System, where similar features are integrated into one cohesive platform to enhance patient care and management [5].

Additionally, the incorporation of payment gateways into healthcare systems has become crucial for modernizing payment processing. Platforms such as PayPal and Stripe offer seamless online payment options for healthcare services, and this model is extended in the Public Healthcare System with the integration of both international and local payment solutions like Bkash, Nogod, and Rocket. This allows users to easily pay for medical consultations and appointment bookings through secure, user-friendly platforms. Furthermore, AI-powered healthcare chatbots have gained popularity in platforms like Babylon Health, which uses AI to assist with basic consultations and appointment bookings. The Public Healthcare System similarly utilizes AI-driven chat features to help users book appointments, get general health advice, and interact with the platform in a more engaging manner [6].

Finally, the integration of image storage solutions, such as ImageBB, enables secure uploading and sharing of medical images. Doctors in the Public Healthcare System can upload medical images related to consultations, providing patients with easy access for review. This ensures that medical information is securely stored and can be accessed remotely, improving the overall patient experience. By integrating these technologies, the Public Healthcare System aims to provide a comprehensive, accessible, and user-friendly healthcare solution that enhances communication between patients and doctors, streamlines appointment scheduling, and facilitates secure payment transactions.

## 2.3 Comparative Analysis

The Public Healthcare System is an integrated platform designed to address the healthcare needs of patients and doctors by offering online appointment scheduling, doctor-patient communication, and payment processing. When compared to other similar healthcare systems globally and locally, several key differences and similarities emerge, particularly in terms of functionality, technology stack, and the target user base.

### **Appointment Scheduling:**

- Zocdoc, a widely used platform in the United States, provides a feature-rich appointment booking system that allows users to search for doctors based on specialty, location, and availability. Patients can easily book, reschedule, or cancel appointments with healthcare providers. Similarly, the Public Healthcare System

enables users to book appointments with doctors based on their availability and specialization. However, the Public Healthcare System offers additional features, such as appointment confirmation via email and local payment gateway integration, catering specifically to the needs of users in Bangladesh.

- Teladoc and Amwell also offer similar appointment booking features with a focus on virtual consultations. Unlike these platforms, which are primarily geared toward telemedicine, the Public Healthcare System supports both in-person and online consultations, making it versatile for different types of healthcare needs.

#### **Payment Systems:**

- Payment processing in healthcare systems is a critical function, especially with the rise of online consultations. Platforms like Zocdoc and Amwell use international payment systems like Stripe and PayPal to process payments. In contrast, the Public Healthcare System offers both international payment options (such as Stripe) and local solutions like Bkash, Nogod, and Rocket, which are more commonly used in Bangladesh. This local integration allows the Public Healthcare System to serve its target demographic more effectively, providing flexible and familiar payment options for users.
- The Public Healthcare System also integrates payment confirmations within the platform, which provides a seamless experience for both patients and doctors. This feature enhances transparency and reduces the likelihood of scheduling conflicts, which is not as prominently featured in many international platforms.

#### **Doctor-Patient Communication:**

- Babylon Health employs AI-powered chatbots to assist patients in obtaining medical advice and booking consultations. This feature allows the platform to scale efficiently and provides immediate access to healthcare information. The Public Healthcare System also integrates a chatbot, but it is specifically designed to assist users in booking appointments and providing general health advice, rather than offering full consultations. This reflects a more localized approach to healthcare needs in Bangladesh.
- Communication between doctors and patients in Teladoc and Amwell is facilitated through video calls and text chat, enabling real-time consultations. The Public Healthcare System similarly offers a chat feature for real-time conversations,

allowing patients to ask questions and clarify issues related to their appointments, prescriptions, or healthcare queries.

### **Image and Data Storage:**

- The Public Healthcare System uses ImageBB for image storage, allowing doctors to upload medical images securely and enabling easy access for patients. This is comparable to platforms like eClinicalWorks, which offers integrated image management and patient records. However, while eClinicalWorks is an extensive healthcare management system used by hospitals and clinics, the Public Healthcare System focuses more on streamlining doctor-patient interactions and providing an easy-to-use interface for individual users.
- Platforms like Teladoc and Amwell also provide digital health records, but they tend to focus more on the telemedicine aspect, with less emphasis on local image storage and secure sharing. The Public Healthcare System, by using ImageBB, ensures that medical images related to consultations are securely stored and accessible, providing a localized solution for users who require it.

### **User Experience and Accessibility:**

- User experience is central to platforms like Zocdoc and Amwell, where users are guided through the appointment booking process with intuitive interfaces. The Public Healthcare System also focuses heavily on usability, using Tailwind CSS and DaisyUI to create a modern, responsive design that ensures ease of use across both mobile and desktop devices. This emphasis on accessibility ensures that even users with minimal technical knowledge can navigate the platform and access healthcare services efficiently.
- While international platforms often cater to a more general user base, the Public Healthcare System is specifically designed with the needs of Bangladeshi users in mind, addressing issues such as local payment systems and language preferences, which makes it more accessible to its target audience.

## **2.4 Comparison Between Existing Works**

Table 2.1 Comparative analysis with previous work

SL No	Criteria	Public Healthcare System	Other Healthcare Platforms	Zocdoc	Amwell	Teladoc

1	User-Friendliness	Yes	Yes	Yes	Yes	Yes
2	Appointment Booking	Yes	Yes	Yes	Yes	Yes
3	Payment Integration	Yes (Local & International)	Yes	Yes	Yes	Yes
5	Live Chat	Yes	No	No	Yes	Yes
6	Doctor-Patient Communication	Yes	Yes	Yes	Yes	Yes
7	Image Storage	Yes (ImageBB integration)	Yes	Yes	Yes	Yes
8	Google Login	Yes	No	Yes	Yes	Yes
9	Multi-Device Support	Yes	Yes	Yes	Yes	Yes
10	Language Support	Yes (Localized for Bangladesh)	No	Yes	Yes	Yes
11	Appointment Confirmation (Email)	Yes	No	Yes	Yes	Yes
12	Telemedicine Support	Yes	Yes	Yes	Yes	Yes

### Key Points of Comparison:

- **User-Friendliness:** All platforms are designed to be user-friendly, though Zocdoc and Teladoc offer more extensive international access, while Public Healthcare System focuses on a more localized experience for Bangladeshi users.
- **Chatbot AI:** The Public Healthcare System integrates a chatbot to assist with booking and general health-related queries, which is not a feature in other platforms like Zocdoc or Amwell.
- **Live Chat:** Unlike Zocdoc and Teladoc, Public Healthcare System allows real-time live chat between patients and doctors, facilitating better communication.
- **Appointment Confirmation:** The Public Healthcare System provides appointment confirmations through email, ensuring transparency and reducing scheduling conflicts, a feature not typically seen in many other platforms.
- **Payment Integration:** Local payment gateways like Bkash, Nogod, and Rocket make the Public Healthcare System more suitable for the Bangladeshi user base, unlike global platforms which rely on international payment systems.

- **Language Support:** Public Healthcare System is localized to cater to Bangladeshi users, unlike some international platforms that provide services in English only, limiting access to non-English speakers.
- **Google Login:** The integration of Google login in Public Healthcare System makes it easier for users to register and access the platform, a feature not available in many local healthcare platforms.

In conclusion, the Public Healthcare System provides several unique features like chatbot AI, live chat, localized payment systems, and appointment confirmation via email, which make it distinct from other global healthcare platforms. It combines global best practices with local customizations to better serve the healthcare needs of users in Bangladesh.

## 2.5 Gap Analysis

The Public Healthcare System project aims to bridge several gaps in existing healthcare platforms:

- **Localization:** Existing platforms lack local language support and payment methods. The Public Healthcare System offers Bengali language support and local payment gateways like Bkash, Nogod, and Rocket.
- **Communication:** Many platforms rely on phone calls or emails. Our system integrates live chat and AI-powered chatbot for improved communication between doctors and patients.
- **Appointment Scheduling:** Existing systems lack seamless appointment confirmation and rescheduling options. Our platform confirms appointments via email and allows easy rescheduling.
- **Payment System:** Global platforms often rely on international payment methods. We provide local payment options, enhancing accessibility for users in Bangladesh.
- **Doctor Availability:** Users often struggle to find doctors with matching availability. Our system allows users to book appointments based on doctor availability.
- **Telemedicine:** While telemedicine is common globally, it's limited locally. We offer remote consultations via video calls for better healthcare access.
- **Data Security:** Existing platforms sometimes have weak security. Our system ensures secure patient data handling with SSL encryption.

- **User Experience:** Some platforms lack user-friendly designs. We focus on an intuitive interface, making it easy for all users to navigate the platform.

In conclusion, the Public Healthcare System addresses these gaps, providing a more accessible, secure, and user-friendly healthcare platform tailored to Bangladesh's needs.

## 2.6 Challenges

### Challenges for the Public Healthcare System Project

- **User Adoption:** Convincing users, especially in rural areas, to transition from traditional healthcare practices to an online system can be challenging. Many people may not be comfortable with technology, making it harder to gain widespread adoption.
- **Internet Accessibility:** While internet penetration in Bangladesh is growing, many remote areas still face poor internet connectivity. This could hinder the accessibility of the healthcare system, especially for patients relying on telemedicine and online consultations.
- **Data Privacy and Security:** Handling sensitive patient data securely is a major challenge. Ensuring compliance with local and international data protection laws (such as GDPR or similar regulations) while preventing breaches requires constant updates and stringent security protocols.
- **Payment Integration:** While integrating local payment methods like Bkash, Nogod, and Rocket is essential, ensuring smooth transactions, and dealing with system failures, or fraud risks in the payment gateway is an ongoing challenge.
- **Doctor and User Trust:** Building trust between doctors and patients in an online environment can be difficult, especially when there is no in-person interaction. Ensuring the platform is reliable and maintaining doctor-patient confidentiality is key to overcoming this challenge.
- **Scalability:** As the platform grows and attracts more users, maintaining the system's performance and scalability can become a challenge. The system must be able to handle increasing numbers of appointments, payments, and conversations without compromising performance.
- **Regulatory Compliance:** Healthcare systems are heavily regulated, and ensuring the platform complies with all necessary health and safety standards in

Bangladesh can be challenging. Keeping up with evolving regulations is vital for the platform's success.

- **Technical Issues:** The platform's backend, involving integration with multiple services (e.g., chat systems, payment gateways, and doctor scheduling), must be bug-free and highly reliable. Any technical issues or downtime can impact user experience and trust in the system.
- **Language and Cultural Barriers:** Although the platform will be localized in Bengali, ensuring it caters to the diverse cultural nuances and medical needs of different regions within Bangladesh can be a challenge.
- **Quality of Online Consultations:** Remote consultations cannot always replicate the quality of face-to-face interactions. Ensuring the platform can provide accurate diagnoses and care remotely is a challenge that needs attention to detail and reliable technologies.

Addressing these challenges will require continuous improvements, user education, and technological innovation to provide a seamless and reliable experience for both patients and healthcare providers.



# Chapter 3

## Requirement Specification

### 3.1 Business Process Modeling

The Public Healthcare System employs a streamlined workflow involving three key user roles: Admin, Doctor, and Patient. Each role contributes to an efficient healthcare journey as follows:

#### 3.1.1 Administrator Process

Input: Admin logs into the system using secure credentials.

- Create doctor accounts with login credentials.
- Monitor platform activities to ensure smooth operations.
- Manage and resolve system issues or conflicts.

Output: Doctor credentials are created and operational; the platform remains efficient and reliable [7].

#### 3.1.2 Doctor Process

Input: Doctor logs into the platform.

- Post disease-related information and solutions for public awareness.
- Update availability schedules for patient appointments.
- Engage in conversations with patients.
- Confirm booked appointments and send email notifications to patients.

Output: Patients access medical posts, book appointments, and receive confirmation emails for their schedules [8].

#### 3.1.3 Patient Process

Input: Patient registers or logs in using email-password or Google authentication.

- Browse available doctors and book appointments based on availability.
- Engage in direct conversations with doctors for queries.
- Make secure payments through integrated payment methods.

Output: Patients receive confirmation via email and attend sessions as scheduled [9].

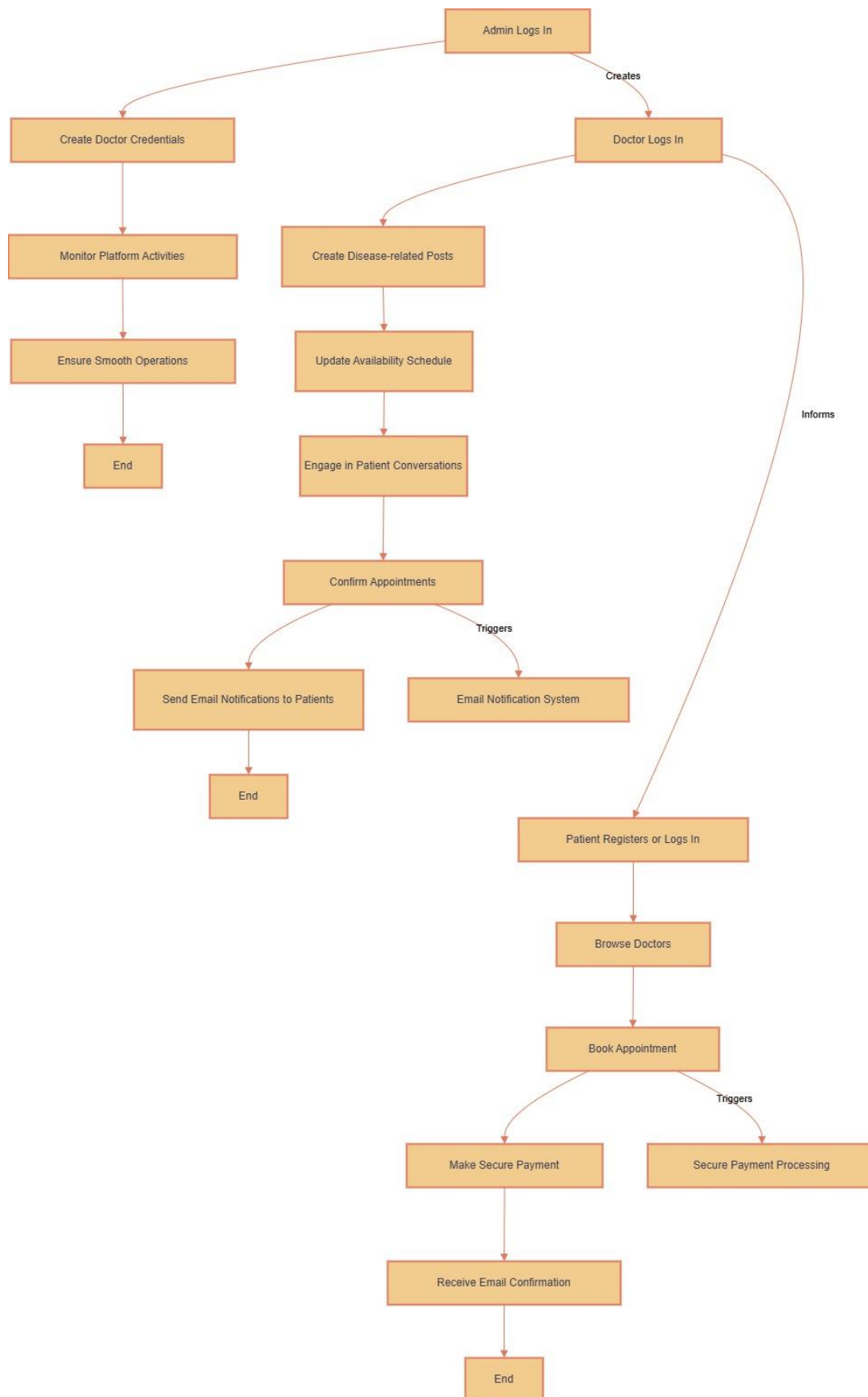


Figure 3.1: A business process model

## 3.2 Requirement Collection and Analysis

Patients, Doctors, and Administrators.

### 3.2.1 Functional Requirements:

Patients:

- Register/login via email or Google.
- Browse doctors and their schedules.
- Book appointments.
- Make secure payments.
- Receive email confirmations.
- Engage in conversations with doctors.

Doctors:

- Log in and manage profiles.
- Post health information.
- Update appointment schedules.
- Confirm bookings with email notifications.
- Communicate directly with patients.

Admins:

- Securely log in.
- Create/manage doctor accounts.
- Monitor platform activities and resolve issues.

System Processes:

- Manage user authentication securely.
- Process payments efficiently.
- Send appointment confirmation emails [10].

### 3.2.2 Non-Functional Requirements:

- Security: Use SSL for payments and JWT for authentication.
- Scalability: Support growing user base.
- Usability: Simple interface for all users.
- Reliability: Ensure minimal downtime and error-free performance [11].

### 3.2.3 Requirement Collection Methods:

- Interviews: Discuss needs with stakeholders (patients, doctors, admins).
- Surveys: Gather feedback on preferred features.
- Observation: Analyze traditional healthcare booking inefficiencies.

- Competitor Analysis: Identify and integrate best practices [12].

### 3.3 Use Case Modeling and Description

There are three main user roles: Admin, Doctor, and Patient.

Admin Use Cases:

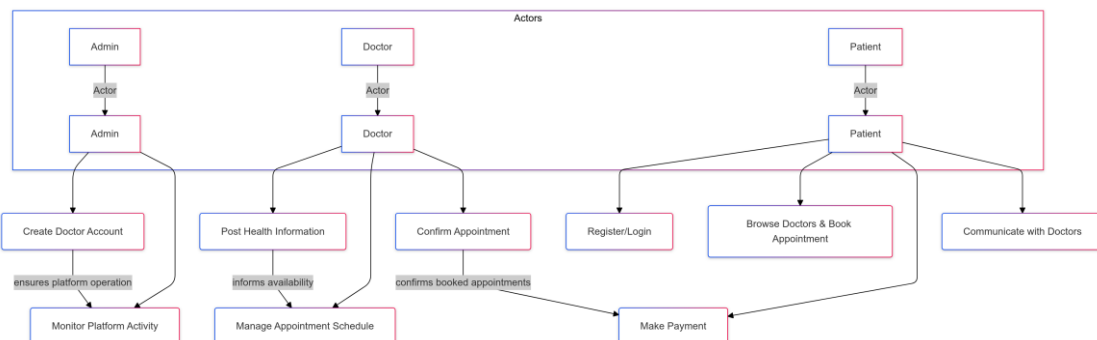
- Create Doctor Account: The admin creates and manages doctor accounts by providing credentials and setting permissions.
- Monitor System Activity: Admin ensures smooth operation by monitoring user activities and resolving issues [13].

Doctor Use Cases:

- Post Health Information: Doctors post disease-related content, treatment options, and solutions for public awareness.
- Manage Appointment Schedule: Doctors can update their availability for patient appointments.
- Confirm Appointments: Upon booking, doctors confirm appointments and notify patients via email [14].

Patient Use Cases:

- Register/Login: Patients register on the platform using email or Google authentication.
- Browse Doctors and Book Appointments: Patients view doctors' availability and book appointments based on preferred schedules.
- Make Payment: After booking, patients make secure payments for appointments.
- Communicate with Doctors: Patients can ask questions or discuss their health with doctors through the messaging system [15].



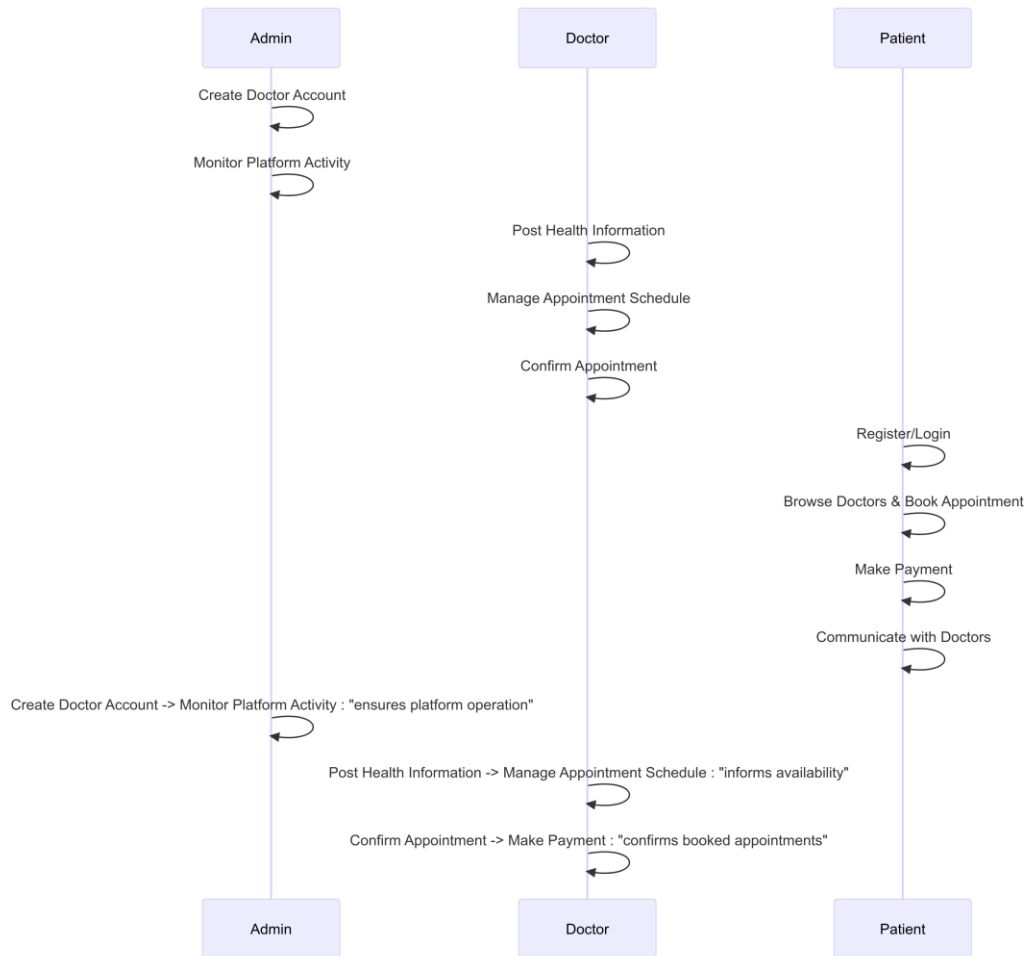


Figure 3.2: Use case diagram

### 3.4 Software Development Life Cycle

For the Public Healthcare System project, the Agile SDLC approach involves the following stages [16]:

- **Requirement Gathering & Analysis:** Collecting feedback from stakeholders (Patients, Doctors, Admins) to define the system's features.
- **System Design:** Designing the platform's architecture and user interface (UI) with wireframes and database schema.
- **Development:** Implementing features using React, Node.js, Express, MongoDB, and integrating payment gateways and chat functionalities.
- **Testing:** Conducting unit, integration, and user acceptance tests to ensure a bug-free platform.
- **Deployment:** Deploying the application on cloud platforms like Vercel.
- **Maintenance & Support:** Providing ongoing updates and bug fixes.

This iterative development, using Agile, ensures continuous feedback, flexibility, and adaptation to changing requirements.

The following Figure 3.2 shows the agile model:

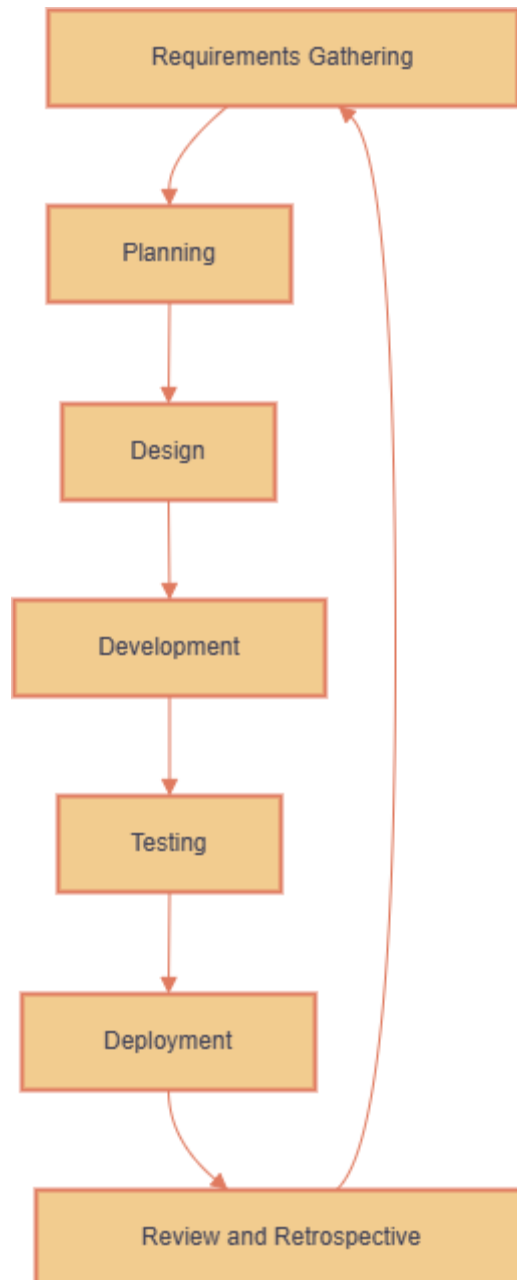


Figure 3.3: agile model.

### 3.5 Logical Data Model

The Logical Data Model (LDM) for this web application defines the core entities and their relationships within the system [17]:

- User Entity: Stores basic user details (e.g., UserID, Name, Email, UserRole).

- Doctor Entity: Linked to the User entity, includes additional attributes like Specialty and LicenseNumber.
- Patient Entity: Stores patient-specific medical details and is linked to the User entity.
- Appointment Entity: Links Patients and Doctors, tracking the status and timing of appointments.
- Payment Entity: Tracks payment details related to appointments (e.g., Amount, Status).
- Health Information Entity: Contains posts by doctors, such as medical tips and disease-related content [18].

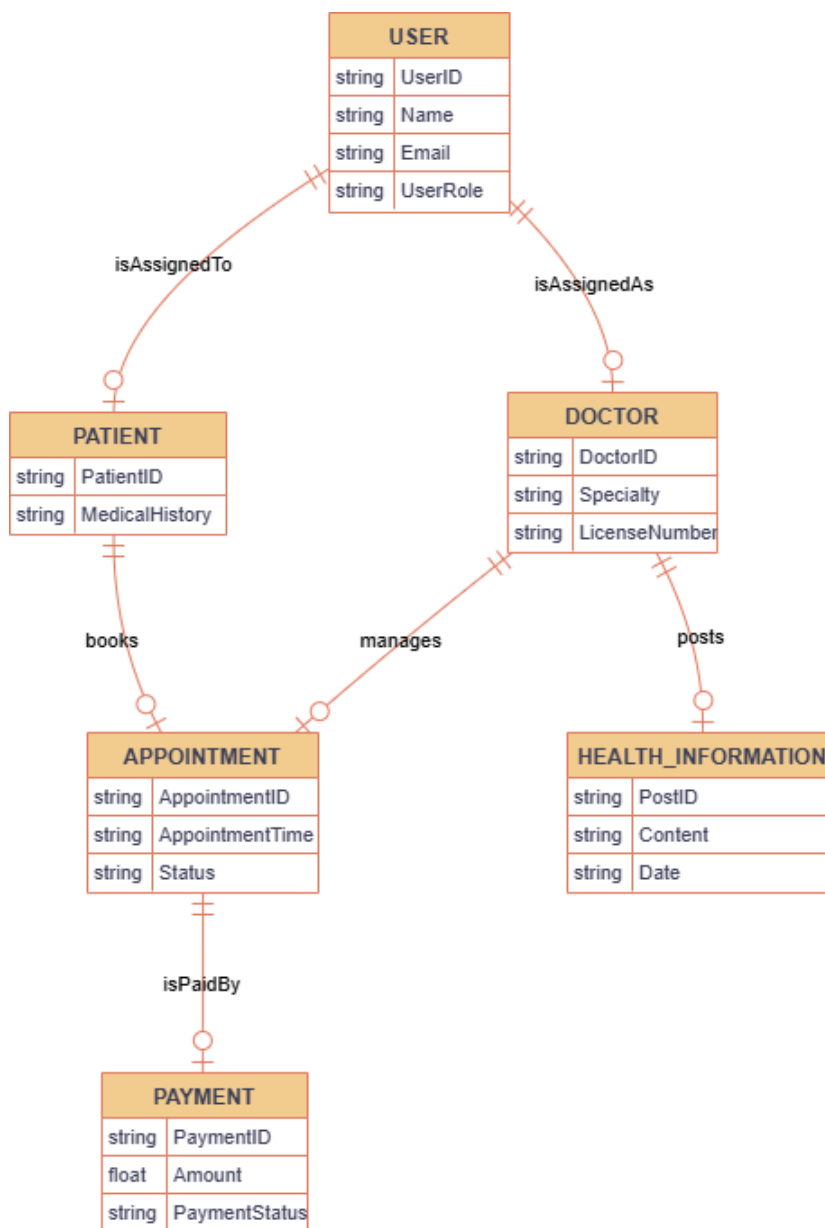


Figure 3.4: Logical Data Model/ER Diagram

## 3.6 Design Requirement

### Responsive Layout:

- Ensure that the website is responsive, providing an optimal user experience across devices. Tailwind CSS utilities for grid layouts, flexbox, and breakpoints will ensure the application adapts to mobile, tablet, and desktop views [19].
- Components like navigation bars, forms, and buttons should be designed to resize and adjust based on screen size.

### User Interface (UI) Design:

- Use Tailwind CSS to implement a clean and minimalist design with a focus on usability [20].
- Leverage DaisyUI components like buttons, modals, inputs, and cards to create a uniform and aesthetically pleasing UI.
- Consistent use of fonts, colors, and spacing for a professional and coherent visual identity. Tailwind's utility classes can be utilized for consistent spacing, color schemes, and typography.

### Accessibility and Interactivity:

- Ensure high accessibility standards for all users, including color contrast and keyboard navigation.
- Tailwind's utility classes can be used to implement focus states, hover effects, and interactive elements like dropdowns and buttons that are user-friendly.
- Use DaisyUI's built-in components for smooth interactions, such as toggles, modals, and tooltips, ensuring that these elements work seamlessly across devices.

### Form Design:

- Design forms for registration, login, and appointment bookings using Tailwind's input styles and DaisyUI's form elements. Forms should be visually appealing and easy to fill out.
- Implement validation feedback with clear error messages that are styled using Tailwind's text utilities and DaisyUI's alert components [21].



**Consistency and Branding:**

- Maintain a consistent design pattern across the platform, focusing on readability and user engagement.
- Use a predefined color palette and font set to align with branding, ensuring that Tailwind CSS's custom configuration can easily integrate brand colors and typography into components.

**Loading Indicators and Animations:**

- Use Tailwind's utility classes and Framer Motion (if applicable) for smooth transitions and animations. Implement loading spinners and progress bars where necessary, ensuring a responsive feel while data is loading.
- DaisyUI can be used to incorporate progress bars and spinners directly into UI components like modals or forms.

**Security and Data Protection:**

- Secure user data with SSL encryption for transactions. Ensure form submissions are protected using proper input sanitization and validation mechanisms.
- Use Tailwind CSS to create secure visual cues for data protection, such as SSL certificate badges or user privacy notices.

**Navigation and User Flow:**

- Utilize Tailwind's navigation components and DaisyUI's dropdowns or sidebars to create an intuitive and easy-to-navigate layout.
- Prioritize ease of access to core functionalities like doctor booking, patient login, and communication systems.

These design requirements help achieve a user-friendly, responsive, and accessible web application using Tailwind CSS and DaisyUI, ensuring a seamless and secure experience for all users.

# Chapter 4

## Design Specification

### 4.1 Front-end Design

The front-end of the Public Healthcare System is built using React for creating dynamic user interfaces. The styling is implemented with Tailwind CSS and DaisyUI, which ensure a responsive and modern design. The color palette includes:

- Primary Color: #6B0DEC (used for key buttons, headers, and highlights).
- Secondary Color: #4444D8 (used for complementary).

Key technologies and features:

- React: For building reusable UI components and handling the dynamic state of the application.
- Tailwind CSS: A utility-first framework for styling, offering flexibility and quick prototyping.
- DaisyUI: A plugin for Tailwind CSS that provides pre-designed components, speeding up the design process.

The design focuses on accessibility, responsiveness, and maintaining a professional aesthetic aligned with the healthcare domain.

### 4.2 Back-end Design

Back-end of the Public Healthcare System is developed using Node.js and the Express.js framework, ensuring scalability and performance. Key features include:

- Payment Integration: Utilizes the Stripe Payment Gateway for secure and seamless transactions, enabling patients to make payments services [22].
- Database Management: MongoDB is used for efficient storage and retrieval of data, such as user profiles, appointment schedules, and payment details.
- API Development: RESTful APIs are implemented to facilitate communication between the front end and back end, supporting features like user authentication, booking management, and data queries.

- **Security:** Middleware and security practices, such as token-based authentication (e.g., JWT), ensure secure user sessions and data protection.

This back-end architecture focuses on modularity, reliability, and smooth interaction with the front-end components.

### 4.3 Interaction Design and User Experience (UX)

Public Healthcare System Web Application is designed to be simple and user-friendly.

- It uses Tailwind CSS and DaisyUI for a clean, attractive look, with consistent colors like #6B0DEC and #4444d8.
- Features like appointment booking and payment are easy to find and use.
- It works on all devices and ensures accessibility for everyone, including users with disabilities.
- Hover effects, animations, and smooth navigation make the website engaging while maintaining trust and reliability.

This ensures a smooth, enjoyable experience for patients and healthcare providers alike.

### 4.4 Implementation Requirements

Implementation Requirements describe the resources, tools, and systems needed to build the Public Healthcare System Web Application effectively.

Front-End:

- **Framework:** React.js for dynamic and responsive UI.
- **Styling:** Tailwind CSS and DaisyUI for clean, customizable, and consistent design.
- **Responsive Design:** Ensures usability across devices like mobile, tablet, and desktop.

Back-End:

- **Framework:** Express.js for creating RESTful APIs.
- **Server-Side Language:** Node.js for efficient and scalable server operations.
- **Database:** MongoDB for managing user data, appointments, and transactions.

Payment System:

- **Gateway:** Stripe for secure online transactions, including card payments.

Additional Requirements:

- Hosting: A reliable platform like AWS or Vercel.
- Authentication: Secure user login with JWT.
- Testing Tools: Jest or similar frameworks to ensure code quality.
- Version Control: Git/GitHub for collaboration and tracking changes.

This structure ensures a scalable, secure, and user-friendly web application tailored for healthcare services.

## 4.5: Home page

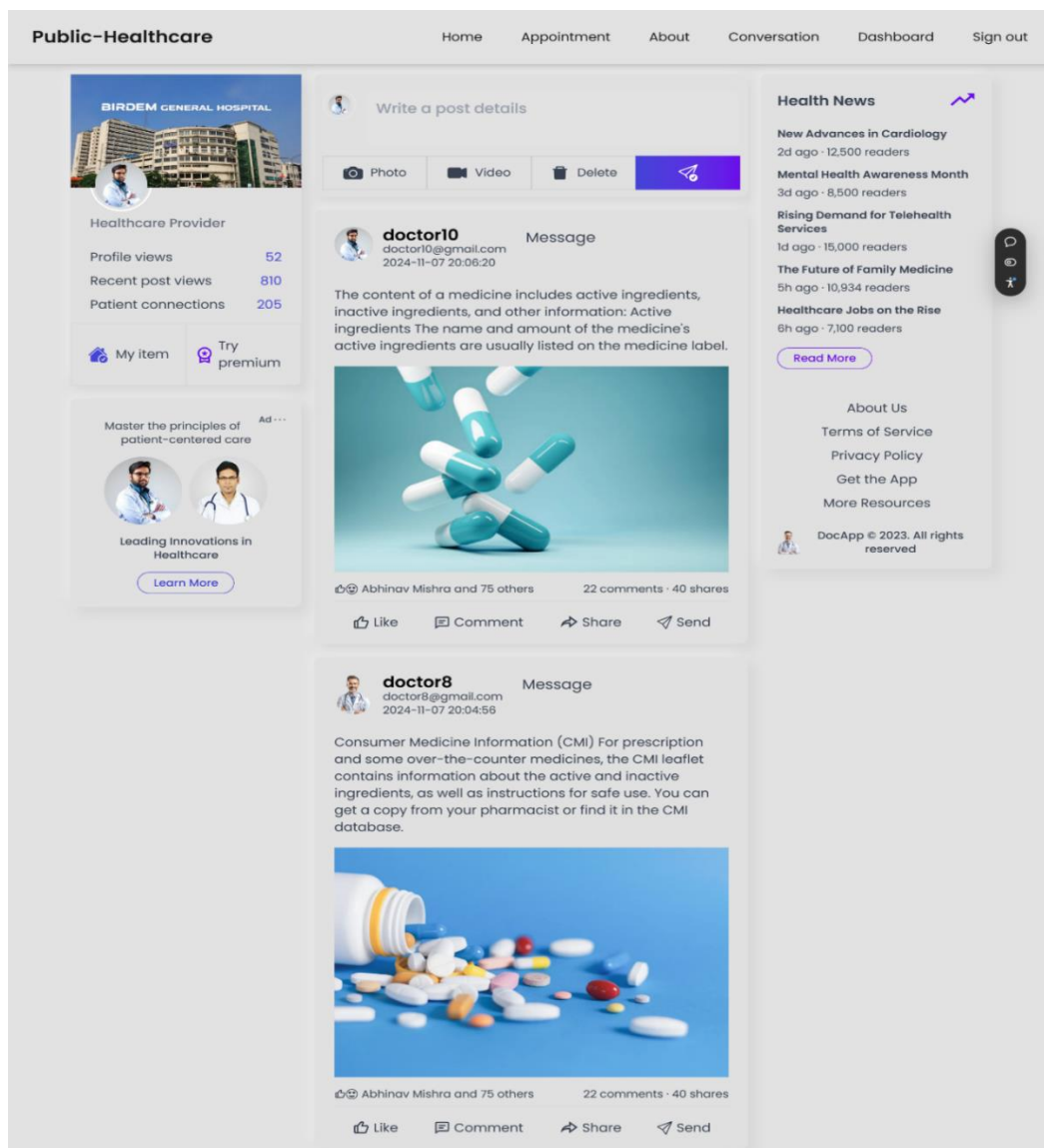


Figure 4.1: Home page

Here's a breakdown of the elements on the homepage: Public Healthcare is a platform specifically designed for healthcare professionals to share information and connect with patients. Doctors can post about health news, research findings, or personal

experiences. Patients can view these posts, learn about different health topics, and message doctors directly for personalized advice or questions.

## 4.6 Login and sign-up page

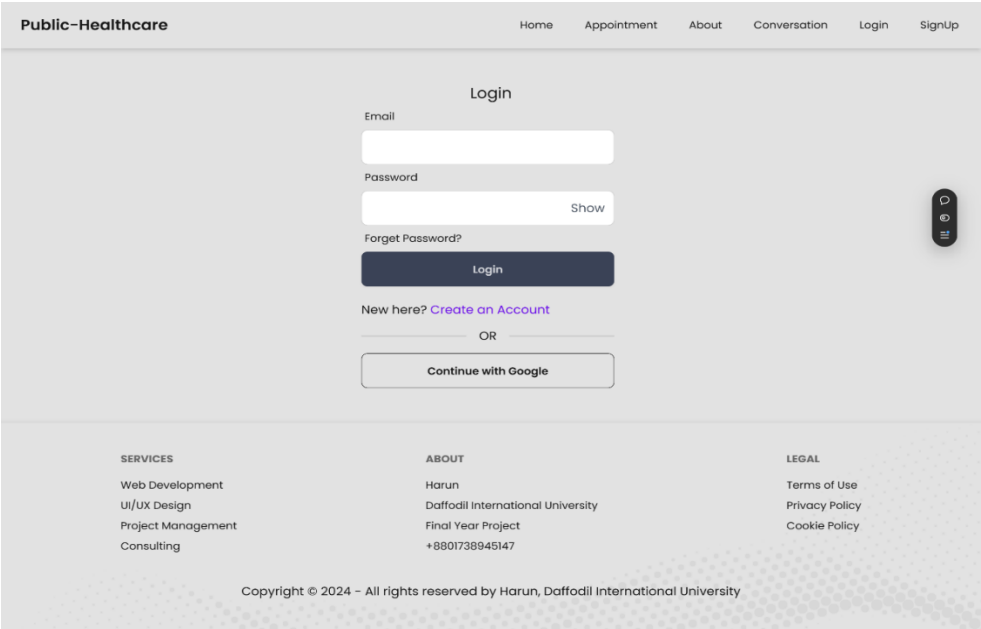


Figure 4.2: Login page

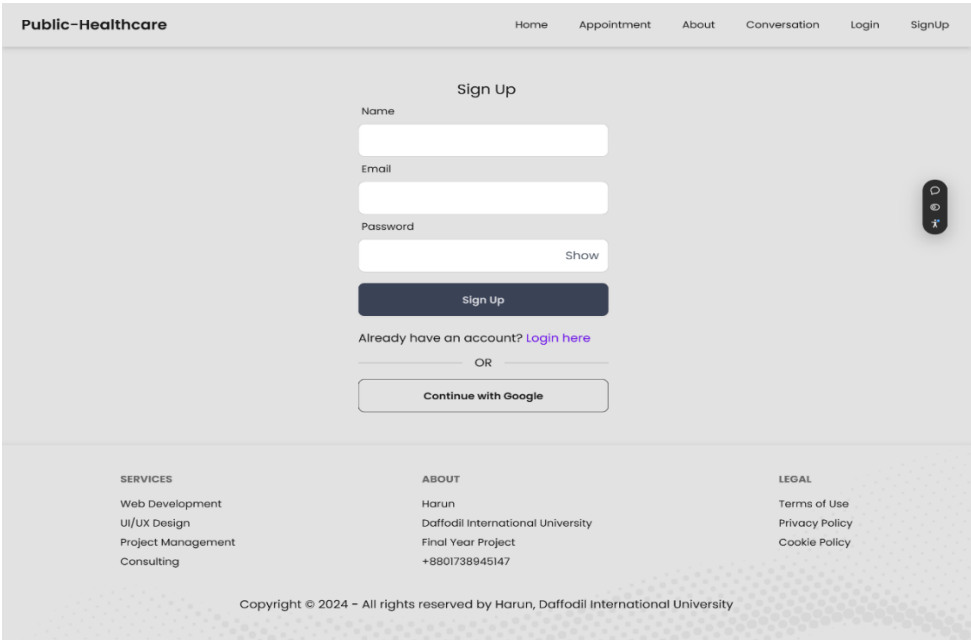


Figure 4.3: Sign up page

### Login Page:

- Users can enter their email address and password to access their accounts.

- Alternatively, they can sign in using their Google account.

### Signup Page:

- New users can create accounts by providing their name, email address, and password.
- They can also sign up using their Google account.
- Existing users can log in to their accounts.

These pages allow users to easily access and manage their accounts on your Public-Healthcare platform.

## 4.7 Appointment page

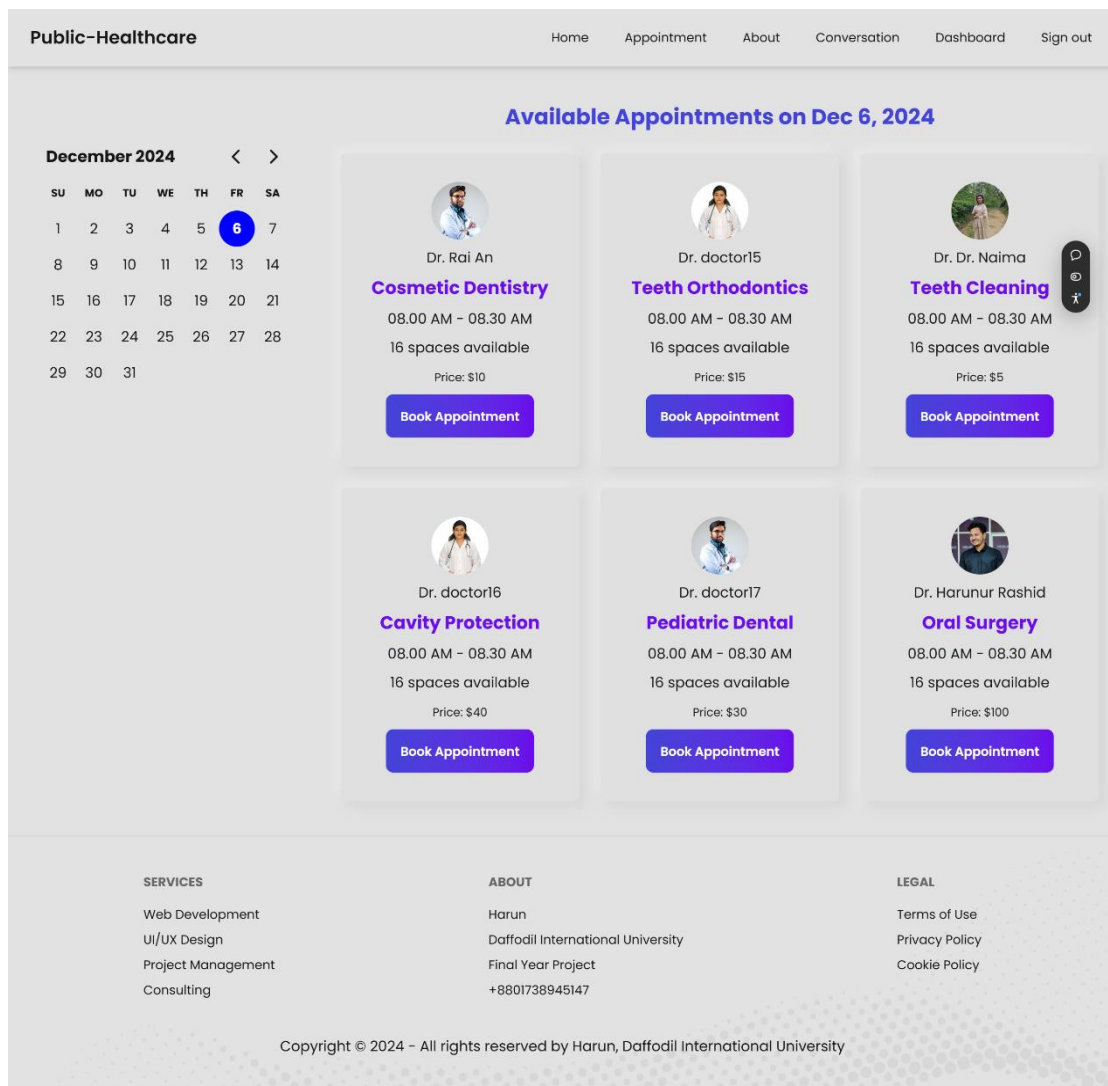


Figure 4.4: Appointment page

Public healthcare allows patients to easily schedule appointments with doctors online. The page displays available appointment slots for different doctors and services. Patients can select their preferred date, time, and doctor, and then proceed to book the appointment by paying the required fee.

## 4.8 About page

**Public-Healthcare** Home Appointment About Conversation Dashboard Sign out

### Book Appointment with Expert Doctors...!

Connect with experienced doctors for face-to-face consultations at a time that suits you. Schedule your appointment online and visit in person for personalized care.

General Pediatrics Cardiology Dental Care

Discover Services Watch our story

Check Availability & Book Now

Check In Select Date	Check Out Select Date	Specialty Specialty	Doctor Select Dr.	Time Pick a Time	Send
-------------------------	--------------------------	------------------------	----------------------	---------------------	------

### Your Health, Our Priority

Book a convenient, face-to-face consultation with experienced doctors. We're here to provide expert medical care when you need it most.

Book an Appointment

**BIRDEM GENERAL HOSPITAL**

### Schedule Your Appointment Today

Don't wait to get the healthcare you deserve! Book an appointment with our expert doctors and receive personalized face-to-face consultations. Your health is our priority.

Book Appointment

Figure 4.5: About page

## 4.9 Conversation page

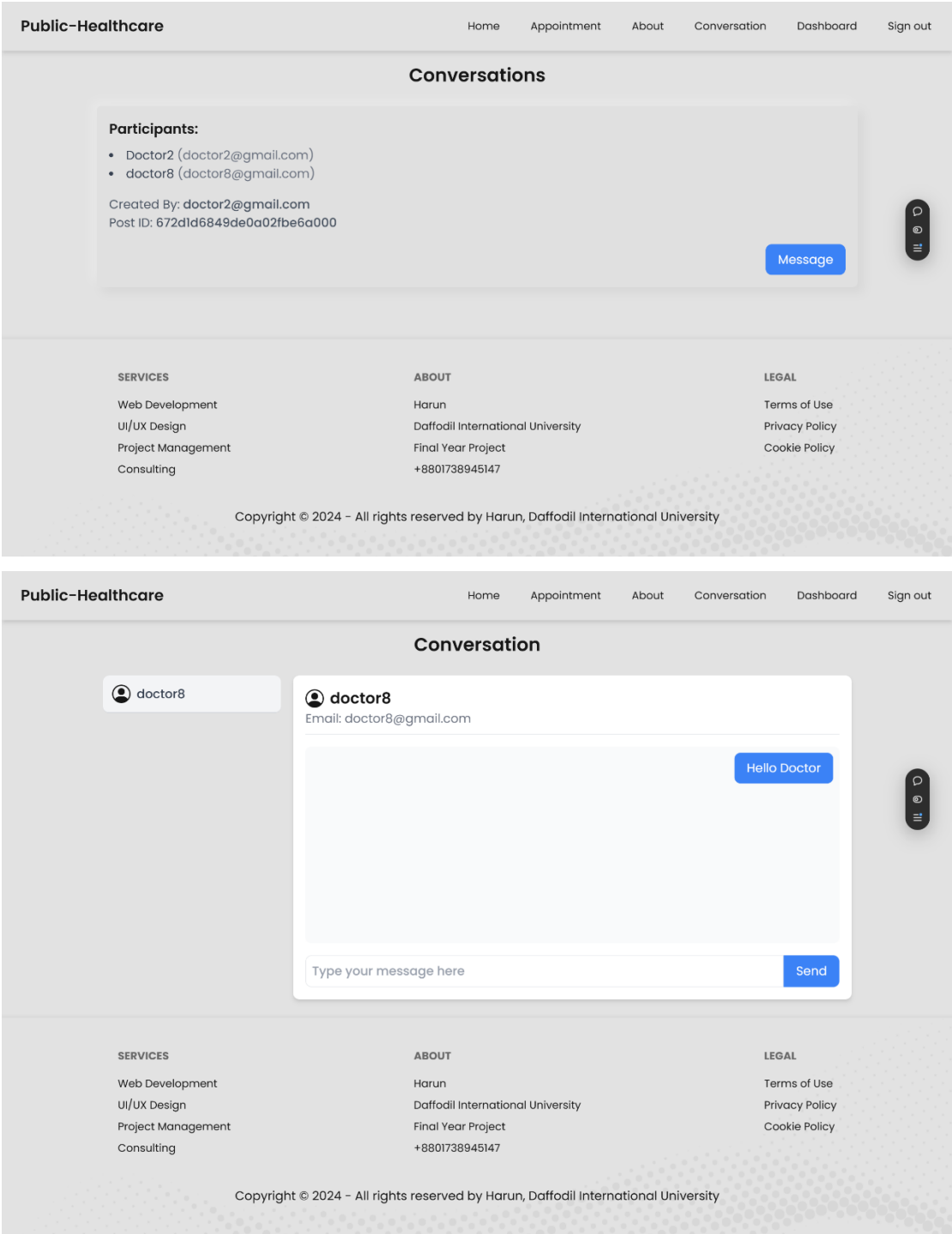


Figure 4.6: Conversation page

Public-Healthcare allows patients to directly message doctors for personalized healthcare advice or questions. The conversation page provides a secure and



convenient platform for one-on-one communication between patients and doctors. Patients can type their messages, send them, and receive replies from the doctor.

### 4.10 Dashboard page

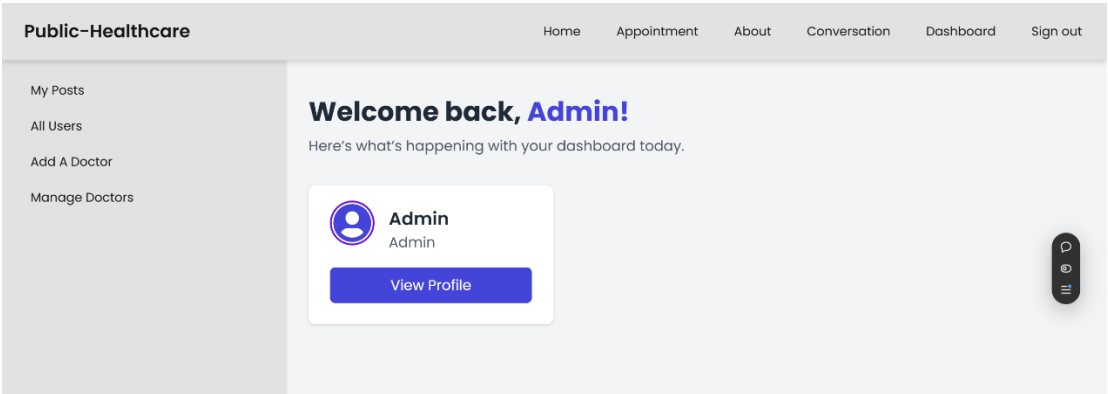


Figure 4.7: Dashboard page

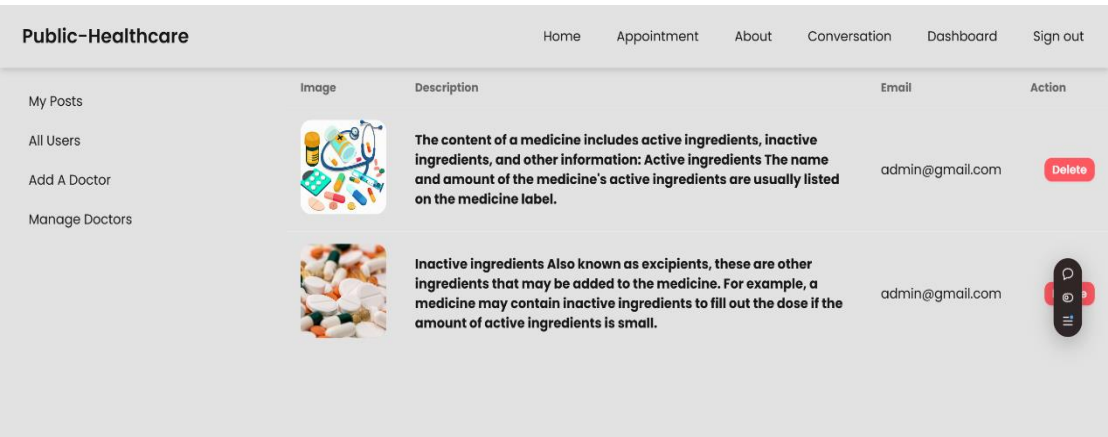


Figure 4.8: My posts page

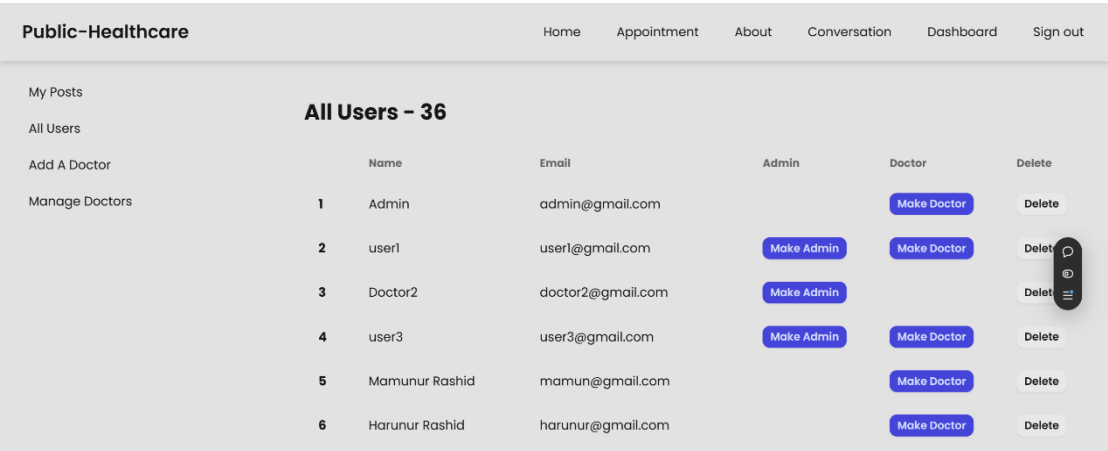


Figure 4.9: All users page

Public-Healthcare
Home
Appointment
About
Conversation
Dashboard
Sign out

My Posts
All Users
Add A Doctor
Manage Doctors

### Doctor Registration

Name

Email

Password

Specialty

Cosmetic Dentistry

Photo

Choose File
No file chosen

Register as Doctor

Figure 4.10: Add doctor page

Public-Healthcare
Home
Appointment
About
Conversation
Dashboard
Sign out

My Posts
All Users
Add A Doctor
Manage Doctors

### Manage Doctors - 22









	AVATAR	NAME	EMAIL	SPECIALTY	ACTION
1		Doctor2	doctor2@gmail.com	Cosmetic Dentistry	Delete
2		Doctor4	doctor4@gmail.com	Pediatric Dental	Delete
3		Doctor5	doctor5@gmail.com	Oral Surgery	Delete
4		Doctor6	doctor6@gmail.com	Oral Surgery	Delete
5		Doctor6	doctor6@gmail.com	Oral Surgery	Delete
6		doctor7	doctor7@gmail.com	Oral Surgery	Delete
7		doctor8	doctor8@gmail.com	Teeth Orthodontics	Delete
8		doctor8	doctor8@gmail.com	Teeth Orthodontics	Delete

Figure 4.11: Manage doctor page

This is the admin dashboard for Public Healthcare. Admins have the ability to manage all aspects of the platform, including adding new doctors, viewing and managing existing users, and viewing their own profiles.

# Chapter 5

## Implementation and testing

### 5.1 Implementation of Database

MongoDB is used to efficiently store, retrieve, and manage data. Here's a brief overview of the implementation process:

- **Database Design:** Define entities such as patients, doctors, appointments, and payments. Create MongoDB collections for each entity and determine how documents relate (e.g., embedding data for appointments within patient documents or using references between doctors and patients).
- **Indexing:** Use indexes to speed up queries, especially on frequently accessed fields such as patient emails, doctor IDs, and appointment dates. Utilize MongoDB's `createIndex()` method to enhance performance.
- **Data Migration:** If necessary, migrate data from existing systems using MongoDB's tools or third-party services to ensure a smooth transition without data loss.
- **Data Access:** Implement CRUD operations using MongoDB drivers or Mongoose in Node.js. Create endpoints to handle operations such as booking, managing, and retrieving patient appointments.
- **Data Validation:** Set validation rules for fields to ensure consistency. For example, enforce unique constraints on patient emails and check for valid dates for appointments using MongoDB's schema validation.
- **Security:** Secure the MongoDB database by configuring authentication, setting access control rules, and encrypting sensitive data both in transit and at rest to protect against unauthorized access.

### 5.2 Implementation of Front-end Design

Implementing The front-end design for the Public Healthcare System Web Application uses Tailwind CSS and DaisyUI to ensure a responsive, user-friendly, and visually appealing interface. Here's a brief overview of the implementation process:

- **Tailwind CSS:** The utility-first framework allows for a highly customizable design while maintaining a responsive layout across devices. Classes like flex, grid, and block are used to create the structure, while custom colors and spacing ensure consistency with the healthcare branding.
- **DaisyUI:** This is a plugin for Tailwind CSS, providing ready-to-use UI components, including buttons, cards, modals, and form elements. It speeds up development by providing accessible, responsive, and customizable components such as navigation bars and forms for patient registrations and doctor profiles.
- **Responsive Design:** The website layout adjusts to various screen sizes, ensuring that users have a seamless experience whether they are accessing the platform on desktops, tablets, or mobile devices. Media queries and Tailwind's built-in breakpoints (sm, md, lg) are utilized for this.
- **Interactive Elements:** Tailwind's utilities and DaisyUI components are leveraged to create interactive elements such as animated buttons, dropdowns, and modal pop-ups for appointment booking and user interactions.
- **Accessibility:** The front-end is designed to be accessible, adhering to web standards such as proper use of ARIA attributes, keyboard navigability, and color contrast guidelines for users with disabilities.
- **By utilizing Tailwind CSS and DaisyUI,** the application ensures a smooth, consistent, and responsive user experience for patients, doctors, and admins.

This implementation provides an easy-to-use interface, optimized for different devices and use cases, contributing to an overall smooth user experience.

### 5.3 Implementation of Back-end Design

The back-end of the Public Healthcare System web application is implemented using Node.js, Express.js, and MongoDB. Here's a summary of the process:

- **Project Setup:** Initialize a Node.js project, configure package.json, and install necessary dependencies (Express.js, Mongoose, JWT, etc.).
- **User Authentication:** Use JWT (JSON Web Tokens) for user authentication. Implement secure login and registration functionality for patients, doctors, and admins.
- **Database Connection:** Set up MongoDB and connect with Mongoose. Define schemas for user profiles, doctor schedules, appointments, and messages.

- **API Development:** Create RESTful API endpoints for user registration, booking appointments, doctor scheduling, and payment processing. Implement controllers to handle business logic, validate requests, and interact with the database.
- **Security:** Secure routes using JWT for authentication and middleware for data validation. Encrypt sensitive data to ensure security.
- **Deployment:** Deploy the back-end to a cloud platform (e.g., Heroku, AWS) and configure environment variables for different stages (development, production).

## 5.4 Testing Implementation

Implementing Testing is essential for ensuring the functionality, security, and performance of the Public Healthcare System web application. Here's a concise breakdown of the testing process:

### Test Planning:

- Identify testing goals based on project requirements and user needs.
- Plan for various types of testing: unit testing, integration testing, system testing, acceptance testing, and performance testing.

### Test Environment Setup:

- Set up a test environment similar to the production environment, including test databases and servers.

### Test Case Design:

- Develop test cases for all features, covering positive and negative scenarios. Specify input data and expected results for each case.

### Unit Testing:

- Write unit tests for individual components using testing frameworks like Jest or Mocha to ensure each module functions correctly in isolation.

### Integration Testing:

- Perform integration testing to validate the interactions between components and verify the flow of data across the system.

### System Testing:

- Conduct system testing to check the end-to-end functionality, including user interfaces and workflows, ensuring proper behavior under different conditions.

# Chapter 6

## Impact on society, environment, and sustainability

### 6.1 Impact on Society

The The Public Healthcare System Web Application significantly benefits society by:

- **Enhancing Accessibility:** It connects patients with doctors remotely, especially aiding underserved communities.
- **Streamlining Healthcare:** Online appointment bookings, secure payments, and communication simplify administrative processes.
- **Promoting Awareness:** Doctors can share health-related content, improving public health literacy.
- **Boosting Efficiency:** Reduces travel and wait times for patients while optimizing doctors' schedules.

This project fosters equitable, efficient, and informed healthcare delivery [23].

### 6.2 Impact on Environment

Public Healthcare System Web Application positively impacts the environment by:

- **Reducing Carbon Footprint:** Encourages remote consultations, minimizing travel-related emissions.
- **Promoting Digitalization:** Decreases reliance on paper-based records, reducing waste.
- **Optimizing Resource Use:** Streamlines healthcare processes, lowering energy consumption in physical facilities [24].

### 6.3 Ethical Aspects

Public Healthcare System Web Application adheres to the following ethical principles:

- **Patient Confidentiality:** Ensures secure handling of sensitive patient data through robust encryption and access control mechanisms.

- **Equitable Access:** Provides healthcare services to all users, including marginalized communities, reducing health disparities.
- **Data Transparency:** Implements clear policies for data usage and ensures users' informed consent.
- **Fairness:** Maintains unbiased algorithms for scheduling and consultation processes.

These practices uphold the ethical integrity of the system and foster user trust.

## 6.4 Sustainability Plan

- **Scalable Infrastructure:** Utilize cloud-based services and modular development approaches to handle increasing user demands efficiently.
- **Energy Efficiency:** Opt for energy-efficient hosting solutions and data centers to reduce the carbon footprint of operations.
- **Regular Maintenance:** Implement periodic system audits and updates to ensure long-term performance and adaptability to emerging technologies.
- **Stakeholder Collaboration:** Involve healthcare professionals and end-users in continuous feedback cycles to align the system with evolving needs.
- **Data Management:** Employ best practices in data storage, retention, and deletion policies to minimize resource usage.
- **Social Impact:** Foster partnerships with NGOs and public health institutions to extend the application's benefits to underserved regions.

This plan ensures the project remains environmentally conscious, socially responsible, and economically viable over time.

# Chapter 7

## Conclusion and future work

### 7.1 Discussion and Conclusion

In The development of the Public Healthcare System Web Application has been a crucial step in addressing various challenges in modern healthcare, including accessibility, communication, and service management. By integrating features like doctor-patient communication, appointment scheduling, and secure payment systems, the platform demonstrates how technology can bridge gaps in the traditional healthcare system [25].

#### 7.1.1 Discussion:

- **Impact on Healthcare Delivery:** The application streamlines healthcare services by providing a centralized platform for interactions between doctors and patients. It promotes timely consultations, better resource management, and a reduction in unnecessary physical visits, thus saving time and costs for both parties [26].
- **Technological Contribution:** Leveraging modern technologies such as MongoDB, React, and Node.js, coupled with design frameworks like Tailwind CSS and DaisyUI, ensures scalability, performance, and an intuitive user experience. These tools provide a robust backend for data management and an engaging frontend for seamless interactions [27].
- **Challenges and Limitations:** Despite its successes, the project faced challenges such as ensuring data security, integrating multiple payment systems, and maintaining consistent communication across diverse user bases. Addressing these required the incorporation of strong authentication protocols, thorough testing, and comprehensive user feedback mechanisms.
- **Social and Ethical Considerations:** The platform ensures inclusivity by allowing patients from diverse demographics to access healthcare services easily. Ethical considerations such as data privacy, patient consent, and equitable access were prioritized throughout the development.



### **7.1.2 Conclusion:**

The Public Healthcare System Web Application represents a significant advancement in digital healthcare solutions, offering benefits like improved accessibility, streamlined processes, and better doctor-patient engagement. By fostering collaboration among healthcare providers and integrating secure, user-friendly features, the system addresses pressing needs in the healthcare industry [28].

Moving forward, the focus should be on enhancing the platform's adaptability to emerging healthcare needs, scaling for broader access, and continually refining features based on feedback and technological advancements. This approach will ensure the project remains relevant, impactful, and aligned with the long-term goals of sustainable healthcare delivery.

## **7.2 Scope for Further Developments**

Public Healthcare System Web Application lays the foundation for enhancing healthcare accessibility and streamlining services for patients and healthcare providers. However, there is significant scope for further development to expand its capabilities and impact [29]:

### **Integration of Advanced Features:**

- **Telemedicine:** Incorporating video consultations and live chat to facilitate remote patient-doctor interactions, particularly for underserved or rural areas.
- **AI-Powered Diagnosis:** Adding AI tools to assist doctors in diagnosis by analyzing patient symptoms, medical history, and test reports.
- **Health Monitoring:** Integration with IoT-enabled devices for real-time health monitoring, such as wearable trackers for heart rate, glucose levels, or fitness data [30].

### **Enhanced User Experience:**

- **Mobile Application:** Developing a dedicated mobile app to improve accessibility and convenience for patients and doctors.
- **Multilingual Support:** Adding language options to cater to diverse populations, improving inclusivity.
- **Accessibility Features:** Ensuring compliance with accessibility standards (e.g., WCAG) for users with disabilities.

**Data Analytics and Reporting:**

- Predictive Analytics: Implementing data-driven insights to predict patient needs, hospital resource allocation, and epidemic trends.
- Comprehensive Reporting: Offering detailed health reports and dashboards for patients and administrative purposes [31].

**Security and Compliance:**

- HIPAA/GDPR Compliance: Ensuring adherence to global standards for data privacy and security.
- Blockchain Integration: Securing patient data with blockchain for enhanced trust and transparency.

**Payment Integration:**

- Expanding payment options to include support for global platforms and local payment methods, making the platform versatile for different markets.

**Community and Preventive Healthcare:**

- Community Engagement: Adding forums or discussion boards for patients to share experiences and receive peer support.
- Preventive Programs: Incorporating educational content and preventive care tools, such as vaccination reminders and lifestyle recommendations [32].

**Global Scalability:**

- Adapting the system to serve international markets by integrating region-specific features, regulations, and healthcare standards.

**Research Collaboration:**

- Enabling collaboration between healthcare institutions for research by providing anonymized patient data for studies, ensuring ethical compliance [33].

## **7.3 Limitations and Conflict of Interests**

### **7.3.1 Limitations**

Despite the comprehensive approach taken in the development of the Public Healthcare System Web Application, there are several limitations that need to be acknowledged for the current version and its potential future iterations:

- **Scalability:** While the application is built to handle a significant number of users, its scalability is limited by the current infrastructure. As the user base grows, further optimization will be required to handle increased traffic and data load. Future improvements might include enhancing server performance or migrating to a more scalable cloud platform [34].
- **User Accessibility:** The application has been optimized for desktop and mobile devices, but accessibility for users with disabilities (such as visual or hearing impairments) has not been fully addressed. This gap in the design may restrict certain user groups from fully benefiting from the platform, pointing to the need for better adherence to accessibility standards (WCAG).
- **Security Concerns:** While basic security measures such as HTTPS, user authentication, and data encryption have been implemented, the application could benefit from advanced security mechanisms such as multi-factor authentication (MFA) and intrusion detection systems. Ensuring the system is fully secure against emerging cyber threats is an ongoing challenge [35].
- **Data Accuracy and Integration:** Data from users and healthcare providers must be accurate and up-to-date. However, there may be challenges in integrating data from various third-party systems or ensuring that data entered by users is verified. Future versions of the application may benefit from more robust data validation and integration mechanisms.
- **User Experience (UX) Limitations:** While the application is designed with Tailwind CSS and DaisyUI to provide a clean, responsive UI, user feedback may indicate areas for improvement, particularly in terms of ease of navigation or intuitive interaction design. Continuous testing and refinement based on real user interactions are necessary [36].
- **Legal and Regulatory Compliance:** As the application processes sensitive healthcare data, it is essential to comply with healthcare regulations such as HIPAA (Health Insurance Portability and Accountability Act) in the U.S. and GDPR (General Data Protection Regulation) in the EU. Compliance with these regulations is complex and requires regular audits and updates.

### 7.3.2 Conflict of Interests

There are no direct conflicts of interest in the development of the Public Healthcare System Web Application. However, potential indirect conflicts might arise due to the involvement of stakeholders with varying interests, such as:

- **Third-party Integrations:** The application may rely on third-party services for functionalities such as payment processing (e.g., Bkash, Paytm) and user authentication (e.g., Firebase). These third-party services could have competing business interests that might influence their terms of service or pricing models, potentially affecting the application's cost and long-term sustainability [37].
- **Healthcare Providers' Incentives:** The healthcare providers who join the platform may have varying incentives for using the system, such as promoting certain treatments or services. This could lead to biases in how healthcare information is displayed or how interactions are facilitated on the platform.
- **Data Privacy:** There might be concerns around data ownership and privacy, especially when dealing with sensitive user data. If healthcare providers or third-party services are granted access to this data, it is important to ensure transparency and avoid any conflict regarding data usage and ownership [38].
- **Monetization Models:** The application's monetization, such as through premium services for healthcare providers or patients, might create conflicts between the users' best interests and the platform's financial goals. These conflicts could affect the development roadmap or the introduction of certain features that prioritize revenue generation over user experience.

In the future, careful attention must be given to managing these potential conflicts through clear policies, user consent, and transparent business practices.

These limitations and conflict of interests should be addressed in the future development phases to ensure the system continues to meet the needs of its users while maintaining security, fairness, and legal compliance.

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