

VIETNAM-KOREA UNIVERSITY OF INFORMATION AND  
COMMUNICATION TECHNOLOGY  
**FACULTY OF COMPUTER SCIENCE**



# GRADUATION PROJECT

## HEALTHCARE APPOINTMENT AND CONSULTATION SYSTEM

**Student's name:** Nguyen Duc Quan  
**Class:** 18IT3  
**Major:** Information Technology  
**Supervisor:** Dr. Huynh Ngoc Tho

*Da Nang - 07/2025*

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## **SUPERVISOR'S COMMENTS**

## ACKNOWLEDGEMENTS

Under the assignment of the Vietnam-Korea University of Information and Communication Technology and with the guidance of Dr. Huynh Ngoc Tho, I have completed the thesis project entitled “*Healthcare Appointment and Consultation System*”

To gain the knowledge and practical results achieved today, I would like to express my sincere gratitude to all the lecturers at the Vietnam-Korea University of Information and Communication Technology for teaching and equipping us with fundamental knowledge throughout the semesters at the university.

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## LIST OF SYMBOLS AND ABBREVIATIONS

<b>ABBREVIATIONS</b>	<b>EXPLANATION</b>
AI	Artificial intelligence
ENT	Ear, nose, and throat
NLP	Natural language processing
JWT	JSON Web Token
EHR	Electronic health record
FAQ	Frequently asked questions
UML	Unified Modeling Language

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# INTRODUCTION

## Problem Statement

Entering the 21st century, the knowledge-based economy—with information technology (IT) as its spearhead—has been demonstrating its vital role and significant influence over human activities. In particular, IT serves as an effective and powerful tool for administrative management in general, healthcare management in particular, and for improving the experience of both patients and doctors.

Currently, the application of IT in the healthcare sector, especially in medical examination and treatment, is no longer a new issue in Vietnam. However, the effectiveness of this model remains fragmented and lacks modernization, synchronization, and professionalism among service providers. The traditional appointment booking method still faces many limitations, such as long patient waiting times, difficulties in managing and arranging patient schedules, and inflexible scheduling for doctors. Especially in the context of epidemics or unforeseen circumstances, remote appointment booking and consultation have become an urgent need.

Fully aware of these challenges and with the desire to contribute to the common goal of national development, I have chosen the topic: “*Healthcare Appointment and Consultation System*” with the aim of developing a technological solution to optimize the appointment booking process, minimize patient waiting time, and enable easy access and management of appointments from various devices such as smartphones, tablets, and personal computers. The system not only serves patients but also provides convenient management tools for doctors and medical staff, thereby improving the quality of healthcare services.

This system is an intelligent technological solution designed to enhance the quality of healthcare services and optimize the medical examination and treatment process at medical centers and clinics.

## Purpose and Objectives

**Main Purpose:** To develop an online platform that allows users to easily book medical appointments and receive personalized health consultations at clinics. The system not only optimizes the appointment booking process but also provides health consultation services based on users’ personal data, thereby improving healthcare effectiveness and enhancing the patient experience.

**Objectives:**

Research information on the application of AI chatbots in the healthcare sector.

- Study technologies and tools for building the system, including NodeJS (NestJS), ReactJS, MongoDB, Restful API, and Google AI Studio
- Analyze and Design a Suitable Health Support System
- Apply an artificial intelligence (AI) chatbot to provide consultation and support for patients. This system helps patients quickly access information, receive useful advice, and supports their decision-making process during treatment.

### **Research Subject**

This research focuses on developing an appointment booking and health consultation support system for clinics. The scope of the study is defined as follows:

#### **Intended Users**

An AI chatbot for clinics.

#### **Scope of Application**

- The chatbot's functions focus on appointment booking and basic health consultation.
- The system does not perform disease diagnosis or provide specialized medical prescriptions.

#### **Research Timeline**

The research will be conducted from March 15 to June 29, 2025, including development and pilot deployment phases.

#### **Implementation Plan**

##### **Requirements Analysis (March 15 – April 14, 2025)**

- Collect requirements from clinics and hospitals.
- Define the functional and non-functional requirements of the chatbot.

##### **System Design (April 28 – May 18, 2025)**

- Design the system architecture, user interface, and database.
- Select suitable tools and technologies.

##### **Chatbot Development (May 19 – June 15, 2025)**

Develop the chatbot using tools such as Google AI Studio, ReactJS, NestJS, and MongoDB.

- Integrate the chatbot with the clinic's appointment management system.

### **Testing and Evaluation (June 16 – June 29, 2025)**

- Perform trial runs and system testing.

### **Reporting and Improvement Proposal (June 30 – July 6, 2025)**

- Complete the final report of the results.
- Provide recommendations and directions for future development.

## **Significance of the Research**

### **Practical Significance**

For Patients:

- Answer frequently asked questions such as disease symptoms, doctors' working schedules, medication instructions, medical examination and treatment procedures, etc.
- Help patients save time without having to wait for medical staff.
- The chatbot can guide users to self-assess initial symptoms and recommend which specialist they should visit.

For Clinics:

- Some chatbots are integrated into the electronic medical record system, allowing patients to quickly access their personal information.
- The chatbot handles repetitive tasks such as explaining procedures, providing service pricing, and answering common questions, enabling staff to focus on their core professional duties.

For the Healthcare Community:

- Disseminate medical knowledge, disease prevention, vaccination, and proactive healthcare through friendly and easy-to-understand conversations.
- Promote the application of technology in healthcare: the AI chatbot system serves as evidence of healthcare modernization and encourages facilities to adopt advanced technologies to improve services.

## **Scientific Significance**

Promote interdisciplinary research (AI – Medicine – Big Data)

- Developing a medical chatbot requires the integration of computer science, artificial intelligence, natural language processing (NLP), and biomedical science. It drives related research fields forward, from building learning models to gaining deeper insights into patient behavior, prediction, and diagnosis.

Potential for Expansion to Other Specialties:

- Develop and test advanced AI models for healthcare.
- Training the chatbot with medical data helps create deep learning or reinforcement learning models optimized for real-world clinical scenarios.
- This forms the basis for researching advanced AI models aimed at early detection, disease classification, personalized treatment recommendations, and more.

Contribution to Future Research:

- Contribute to building an intelligent healthcare system (Smart Healthcare).
- The chatbot is an important component in the Healthcare 4.0 model.
- Widespread adoption will support the development of an intelligent healthcare ecosystem, helping to improve treatment effectiveness, reduce costs, and personalize healthcare services.

## **Structure of the Thesis**

After the Introduction, the thesis consists of four chapters:

*Chapter 1: Theoretical Foundations*

*Chapter 2: System Analysis and Design*

*Chapter 3: System Development*

*Chapter 4: Conclusion and Future Development Directions*

Finally, there is a References section listing related documents.

# CHAPTER 1. THEORETICAL BACKGROUND

## 1.1. Introduction

In the era of digital technology and the rapid transformation of the healthcare sector, chatbots—an application of artificial intelligence (AI)—are becoming an important tool for enhancing the quality of healthcare services and optimizing medical operations. A chatbot is a computer program capable of automatically interacting with users through natural language, either in text or voice form, and is typically integrated into platforms such as websites, mobile applications, or customer service systems.

## 1.2. AI Chatbots and Their Applications in Healthcare

### 1.2.1. Definition of AI Chatbots

An AI chatbot is a computer program built on artificial intelligence (AI) that can simulate conversations with users through platforms such as text (chat) or voice. The goal of an AI chatbot is to understand, process, and respond to user requests in a natural, intelligent, and context-aware manner.

Unlike traditional rule-based chatbots that operate according to predefined scripts, AI chatbots utilize modern technologies and intelligent analysis.

### 1.2.2. Benefits of AI Chatbots in Healthcare

AI chatbots bring significant value to the healthcare sector, including:

- **24/7 Support and Improved Accessibility:** Chatbots can operate continuously without breaks. Patients can receive health consultations anytime, even outside of office hours or in areas with limited medical resources.
- **Reducing the Workload for Medical Staff:** Chatbots handle simple tasks such as answering frequently asked questions, providing procedure instructions, and sending appointment reminders. This allows healthcare staff to focus on more complex professional tasks, thereby improving operational efficiency.
- **Enhancing Patient Experience:** With a user-friendly interface and quick responses, chatbots help patients feel supported in a timely manner. This increases patient satisfaction and strengthens their connection with healthcare facilities.
- **Expanding Access to Services:** Through online platforms, chatbots help patients in remote or rural areas access medical information without having to visit healthcare

facilities in person.

### **1.2.3. Practical Applications of AI Chatbots in Healthcare**

AI chatbots have been widely implemented in the following applications:

- **Appointment Scheduling Support:** The chatbot automatically receives and processes booking requests, synchronizes with doctors' schedules, minimizes errors, and ensures convenience for patients.
- **Medical Record Management:** The chatbot assists in storing, retrieving, and updating medical information, as well as reminding patients about follow-up visits or regular check-ups.
- **Providing Service Information:** The chatbot answers questions about medical services, insurance policies, or explains medical procedures quickly and accurately.[2]

Examples of AI Chatbot Applications in Global Healthcare:

#### **1. Babylon Health (United Kingdom)**

- Babylon Health is one of the pioneering applications integrating AI chatbots into online healthcare services, focusing on symptom analysis and providing preliminary advice to patients.
- **Functions:** The AI chatbot supports users in assessing symptoms, provides basic medical consultation, and allows online appointment booking.
- **Technology:** Based on AI and a verified medical knowledge database.
- **Strengths:** A key strength of Babylon Health is its integration with the UK's public healthcare system, enabling patients to easily and quickly access healthcare services.
- **Benefits:** It reduces the burden on the public healthcare system, especially in primary care, provides health record management features, appointment reminders, and connects patients with specialists, creating a comprehensive healthcare ecosystem [3].

#### **2. Ada Health (Germany)**

- Ada Health is a well-known AI-powered health application from Germany that helps users check symptoms and receive personalized health assessments..
- **Functions:** Ada Health's AI chatbot collects information about the patient's symptoms through interactive questions, then analyzes the data to suggest possible conditions and

recommend appropriate next steps.

- Technology: Uses advanced AI algorithms and a large verified medical database continuously updated by medical professionals.
- Strengths: Ada Health's strength lies in its extensive global user base and its ability to personalize recommendations based on user profiles.
- Benefits: Supports patients in early detection of potential health issues, encourages proactive healthcare behavior, and helps reduce unnecessary hospital visits by providing reliable self-assessment tools.[3]

### **3. Buoy Health (United States)**

- Serving as an initial triage assistant, Buoy Health helps users self-assess their symptoms, determine the appropriate level of care needed, and connect them to the right healthcare system.
- Functions: The AI chatbot asks a series of questions to better understand the patient's condition, then provides appropriate guidance on what to do next (see a doctor, care at home, take medication, etc.).
- Strengths: Improves healthcare accessibility, reduces wasted resources, and enhances the user experience.
- Unique Feature: It does not replace doctors but works as a "smart health guide" that assists patients in making informed decisions.[3]

## **1.3. Tools Used in System Development**

### **1.3.1. Google AI Studio**

Google AI Studio – Artificial Intelligence Development Platform: Google AI Studio is an AI development platform created by Google that enables users to build, test, and deploy AI models quickly and easily-especially for applications related to natural language processing, such as chatbots, virtual assistants, and intelligent Q&A systems.



*Image 1.1 Google AI Studio*

Google AI Studio is an intuitive, powerful, and easy-to-use platform. It is an essential tool in the AI era, suitable for research, experimentation, and practical deployment.[6]

### ***Role in the System***

#### **AutoML**

- AutoML stands for Automated Machine Learning—a technology that automates various steps in the process of building machine learning models. Instead of requiring experts to manually code, select algorithms, process data, and fine-tune models.
- AutoML automates these complex tasks. This makes it easier for users to deploy AI solutions without needing deep expertise in programming or statistics.

#### **Machine learning**

- Machine Learning is a branch of Artificial Intelligence (AI) that focuses on developing algorithms and models that enable computers to learn from data in order to make predictions, classifications, or decisions without being explicitly programmed for each specific task.
- In other words, instead of writing detailed rules for computers to follow, with Machine Learning, the computer learns from experience (data) to improve its performance over time.

#### **Natural Language Processing (NLP)**

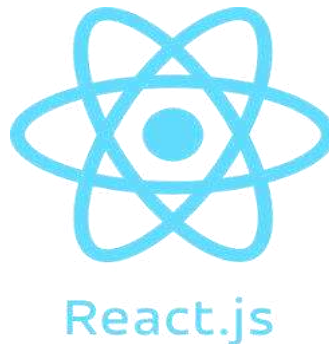
- NLP is the bridge between human language and computers, enabling the development of systems capable of communicating, understanding, and processing natural language just like a human. This greatly expands AI applications in healthcare, education, business, legal, and daily life.

#### **Recommendation System**

- A Recommendation System is a technology within the field of Artificial Intelligence (AI) and Machine Learning that predicts and suggests products, services, or content suited to each user's preferences and needs.
- Recommendation systems use user data to predict what they may be interested in or want to use next [6].

### 1.3.2. ReactJS

ReactJS (commonly referred to as React) is an open-source JavaScript library developed by Facebook (now Meta) for building user interfaces (UI) for web applications in a flexible and efficient way.



*Image 1.2 React - JavaScript Library*

ReactJS is a powerful and flexible JavaScript library that helps build efficient, maintainable, and scalable user interfaces, making it one of the most popular front-end technologies today.

### 1.3.3. NestJS

NestJS is a backend application development framework based on Node.js and TypeScript, designed to build robust, scalable, and maintainable server-side applications.



*Image 1.3 NestJS - Framework Node.js*

- NestJS integrates encoding and authentication mechanisms (such as JWT) to ensure the security of patients' sensitive medical information.
- It supports modular development, allowing new features to be added easily without affecting other parts of the system.

### 1.3.4. MongoDB

MongoDB is an open-source NoSQL database management system designed to store and manage data in document format instead of tables like traditional relational databases.



*Image 1.4 MongoDB - NoSQL Database*

- MongoDB is commonly used for web and mobile applications that need to store unstructured or rapidly changing data. It allows systems to scale easily.
- It integrates seamlessly with backend frameworks through ORM libraries like Mongoose, which helps manage data efficiently and intuitively.

Additional Note: Despite the strengths of these technologies, advanced features such as appointment scheduling or specialized online consultations, as well as integration with public healthcare systems and personalized services, still require further optimization for maximum effectiveness.

## **1.4. Summary**

### ***Strengths***

The integration of artificial intelligence in the healthcare sector brings clear benefits in automating processes, increasing accessibility to services, and optimizing operational costs.

Current AI chatbot applications have demonstrated their ability to improve patient experience, reduce the workload on medical staff, and provide fast and convenient healthcare services.

### ***Limitations***

Despite significant achievements, current AI chatbot applications still have notable limitations, including:

- Most existing chatbots focus on general health consultation services and are not specifically designed to meet the in-depth needs of specialized fields such as ENT (Ear, Nose, Throat), cardiology, or endocrinology. This results in uneven consultation quality and support across different medical specialties.

- Chatbot systems cannot replace the expertise, experience, and clinical judgment of doctors, especially in emergency or complex situations.
- AI chatbots often stop at providing initial symptom advice or suggesting basic next steps. They cannot replace the role of a specialist in analyzing and offering accurate guidance for complex medical conditions.
- Handling personal information and medical records requires a high level of security that current chatbot systems sometimes do not fully meet.

These limitations form the basis for the direction of developing a specialized AI chatbot. Developing a chatbot system focused on this specialty can:

- Focus on common symptoms, helping patients better understand their condition and receive timely guidance.
- Integrate with medical records: Support doctors and patients in tracking medical history, allergy records, or previous treatment plans to provide more accurate advice.

## CHAPTER 2. SYSTEM ANALYSIS AND DESIGN

### 2.1. System Requirements Analysis

#### 2.1.1 User Requirements for the System

- Customer: A user who visits the website but is not a registered member.
- Patient (Member): A registered user of the system.
- Doctor: A medical doctor or consultant who has an account in the system.
- Clinic Management Staff: Responsible for managing appointment schedules at the clinic and assisting patients in booking appointments with doctors.
- Online Support Staff: Interacts with patients online, answers basic questions, and provides psychological support before the patient meets with a doctor.

#### 2.1.2 Functional Requirements

##### *Functional Requirements*

##### **Client/Patient**

- Registration and Login: Users are required to create an account or log in using their email or phone number. This account allows them to manage personal information and medical records.
- Search for Doctors or Diseases by Symptoms: Customers can search for doctors by specialty within the clinic. The website may provide filters to narrow down the search results, helping customers quickly find a suitable doctor for their needs.
- Online Appointment Booking: Users can select a doctor, a suitable date and time, and book an appointment directly on the website. The system displays available time slots and the doctors' open schedules.
- Remote Consultation (Online Medical Examination): Offers options for video or voice consultation, allowing customers to communicate directly with doctors without visiting the clinic. This is especially convenient for follow-ups or quick consultations for minor health concerns.
- Personal Health Record Management: Customers can view and update their medical history, test results, prescriptions, and visit records directly on the website. This helps them track their treatment progress and store essential medical information.

- **Appointment Reminders:** The website can send notifications to remind users of upcoming appointments or follow-up visits. This feature ensures patients do not miss their scheduled consultations.

- **Ratings and Feedback:** Customers can leave ratings and feedback about doctors or medical facilities after their appointments. This helps other patients make informed decisions and contributes to improving service quality.

- 

- **View and Cancel Appointments:** Customers can monitor their booking history and cancel appointments if needed. This feature often comes with cancellation and refund policies depending on the clinic's terms.

### **Doctor/Medical Staff**

- **Login and Personal Account Management:** Doctors can log into the system using their personal accounts, enabling access to their work schedule, patient information, and the ability to manage the healthcare services they provide.

- **Appointment Schedule Management:** Doctors can view and manage their appointments, including upcoming consultations, scheduled visits, and available time slots. They are able to adjust their working hours, add or cancel time slots as needed.

- **View Patient Information:** Prior to each appointment, doctors can access the patient's medical records, including medical history, test results, prescriptions, and other relevant data. This allows them to prepare thoroughly and make accurate diagnoses.

- **Remote Consultation:** Doctors can conduct remote consultations via video call or voice call through the system. This feature supports online diagnosis and consultation, enabling efficient communication of symptoms and treatment without physical presence.

- **Medical Record Note-taking and Updates:** After the consultation, doctors can document visit-related information, update the patient's medical records, add diagnoses, prescribe medications, and monitor treatment progress.

- **Prescription and Test Management:** Doctors can prescribe medication directly through the system, allowing patients to receive prescriptions or treatment instructions without the need for printed documents. Additionally, doctors can request necessary lab tests and review results via the system.

- **Feedback and Rating Management:** Doctors can track feedback and ratings submitted by patients after appointments. This helps them assess the quality of service provided and improve professional effectiveness and patient engagement.
- **Statistics and Reporting:** The system can generate statistical reports such as the number of patients seen, appointment cancellation rates, common illnesses, and other useful data to help doctors manage and enhance their performance.
- **Related Case Consultation:** Some systems integrate Artificial Intelligence (AI) to assist doctors in analyzing symptoms and suggesting appropriate treatment plans based on patient medical records.

### **Clinic Administrator**

- **Doctor Schedule Management:** Management staff can view and adjust doctors' working schedules, including managing available slots, booked appointments, and cancellations when necessary. They can organize appointment schedules to ensure efficiency and optimize time for both doctors and patients.
- **Patient Information Management:** The system allows staff to access personal details, medical records, and appointment history of patients to ensure thorough preparation before each consultation. This enables timely and accurate support for both doctors and patients.
- **Clinic and Resource Management:** Staff can manage clinic facilities, including room allocation, medical equipment, and human resources (doctors, nurses). They ensure that each appointment is scheduled based on room and equipment availability.
- **Payment and Invoice Management:** The system integrates online payment functionality, allowing staff to view and process patient invoices. They can manage pending payments, verify transactions, and issue receipts to patients.
- **Feedback and Review Management:** Staff can monitor feedback and ratings from patients regarding doctors and clinic services. This helps improve service quality by reviewing patient input and implementing necessary changes.
- **User Account and Access Control:** Staff can manage accounts for doctors, nurses, and other personnel. They can assign access permissions to various system functions, ensuring that each user can only access the information and features relevant to their role.

- **Notification and Reminder Management:** The system can automatically send notifications to remind patients of upcoming appointments, follow-up visits, or cancellations. Management staff can also track and customize these reminders to ensure patients are well-informed.

- **Integration with Health Insurance Systems:** Management staff can process insurance claims from patients and coordinate with insurance providers to ensure valid payments for medical services.

### **Online Support Staff:**

- **Responding to Patient Inquiries:** Online support staff are often the first to answer patient questions regarding appointment procedures, clinic services, or instructions on how to use the system. They can respond directly via chat, email, or phone.

- **Technical Support:** When patients experience difficulties with logging in, booking appointments, or making online payments, support staff can assist in troubleshooting technical issues. This includes guiding them through the process again or providing alternative solutions when the system encounters problems.

- **Assisting with Appointment Cancellations or Changes:** If a patient needs to modify or cancel an appointment, support staff can directly intervene to adjust the schedule as requested, ensuring the process is quick and does not disrupt the doctor-patient workflow.

- **Monitoring and Handling Customer Feedback:** Online support staff can collect and manage patient feedback after appointments to improve service quality. They can relay this information to relevant departments such as doctors or clinic management staff.

### ***Non-Functional Requirements***

- **High Performance:** The system must operate smoothly while serving hundreds of users simultaneously.

- **Data Security:** All patient information must be encrypted and comply with medical data privacy regulations.

- **User-Friendly Interface:** The interface must ensure an easy user experience, suitable even for elderly patients or those who are not tech-savvy.

### ***Minimum Website Features***

#### **Homepage**

This is the first page users see when they visit the website. It plays a crucial role in creating the first impression and guiding users to other important sections. It serves as the starting point for user interaction with the website.

### **Registration/Login Page**

The registration page allows users to create a personal account on the website in order to access advanced or personalized features.

It also enables users who already have an account to log in and access personal areas or specific functionalities that are not available to guest users.

### **Appointment Booking Page**

The Appointment Booking Page allows patients to schedule medical appointments online in a convenient and proactive manner, without the need to make phone calls or visit the clinic in person.

It enhances the modernity and professionalism of the service, demonstrating an efficient and well-organized healthcare process.

### **Personal Account Management Page**

The Personal Account Management Page allows users to view and edit their personal information, track activity, and manage features related to their account within the system.

### **Online Consultation Page**

Enables users to communicate directly with specialists, doctors, or support staff through channels such as chat, video call, or online inquiry — without the need to visit the clinic in person.

It offers convenience by allowing users to receive quick consultations anytime, anywhere.

### **Feedback & Review Page**

Allows users to leave comments, suggestions, or service ratings after their experience, helping the organization improve service quality and build credibility.

Users can share their actual impressions of the services they received (e.g., medical consultation experience, staff attitude, reception process, etc.).

### **Support & FAQ Page**

- Provides user guides for navigating the website, answers to frequently asked questions, and online support for patients.
- Includes information about medical services offered by the clinic, such as lab tests, medical consultations, and more.
- Features a medical news section.
- Offers step-by-step instructions from account registration to appointment booking.

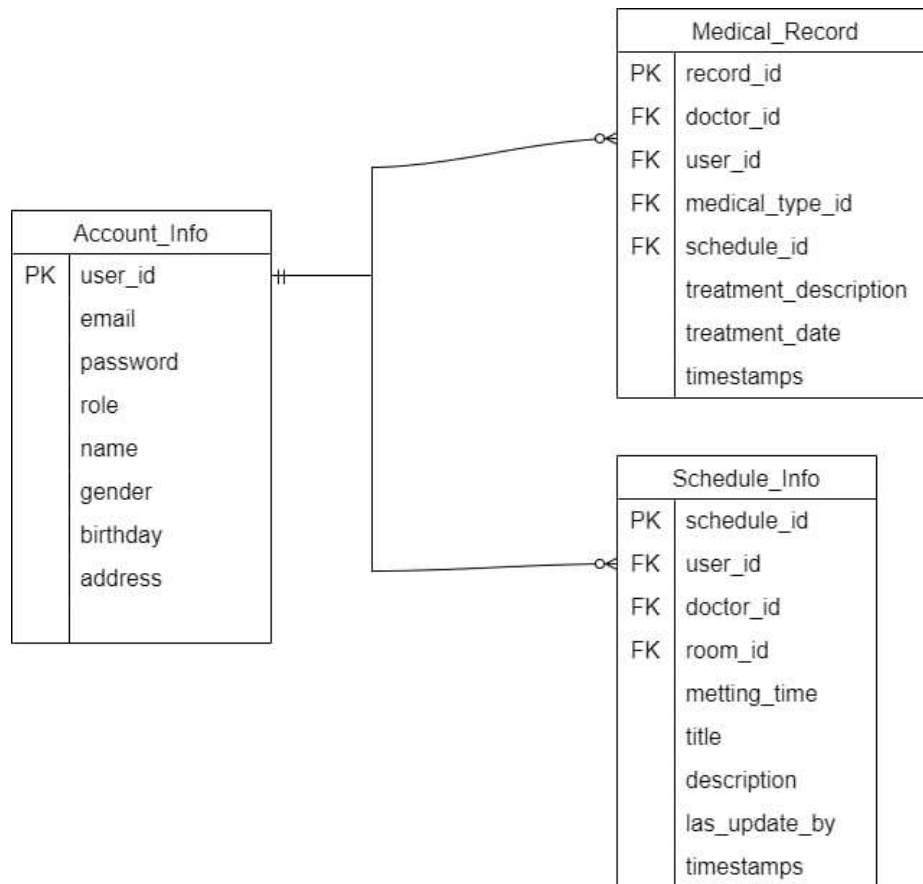
### **Clinic Management Dashboard**

The Staff Management Page is an internal interface designed for administrative personnel, receptionists, and operational managers to efficiently, accurately, and professionally manage clinic operations.

It contributes to improving service quality and enhancing patient satisfaction.

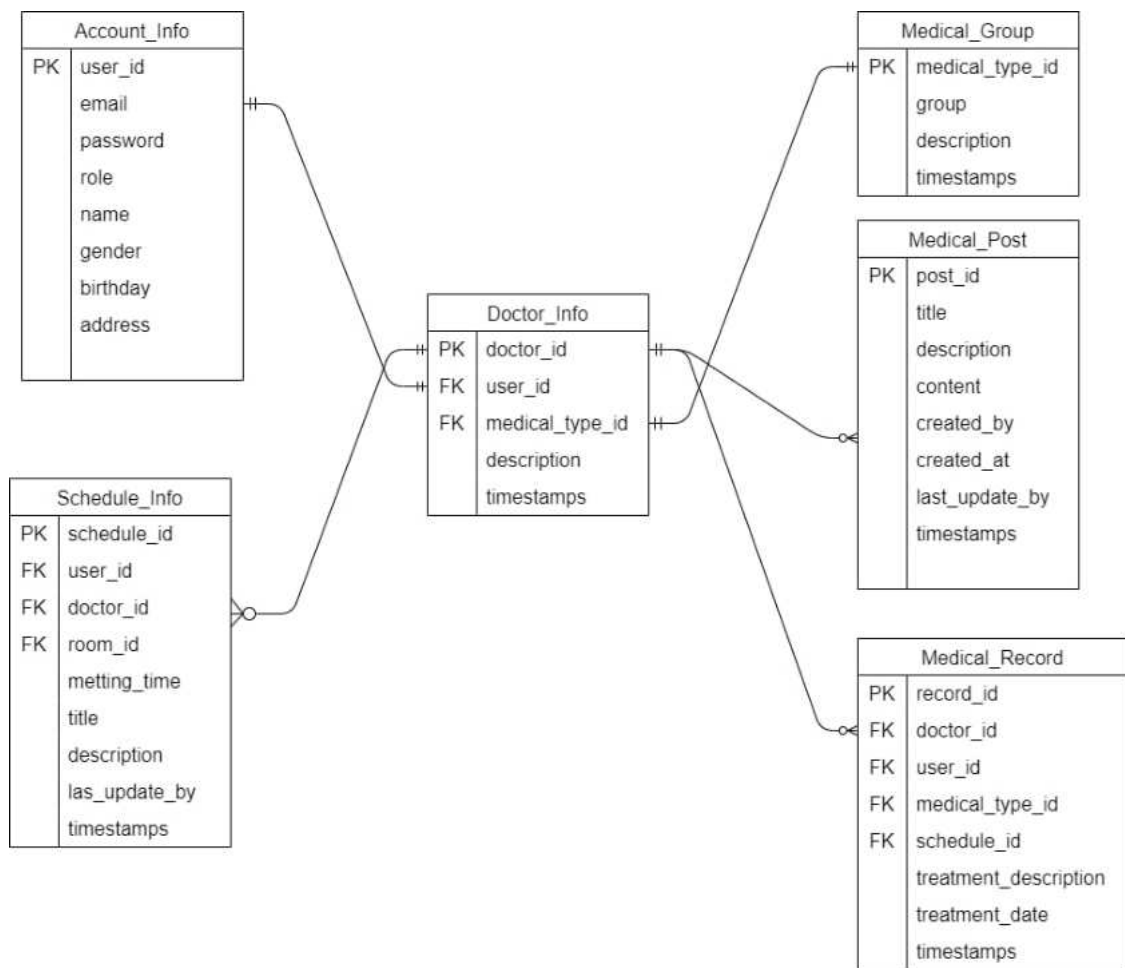
## 2.2 System Design

### 2.2.1 Create UML database modeling



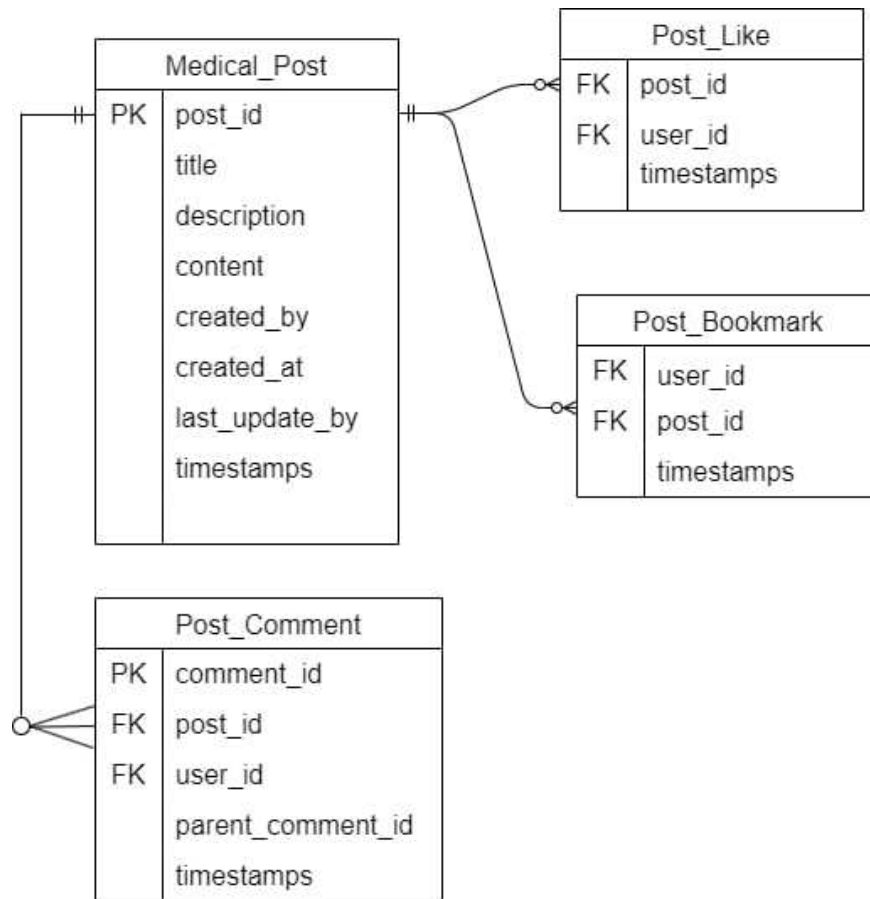
*Image 2.1 Entity relationship user/patient*

- Patients are identified in the Account\_Info table with role = 1.
- A patient can create and check their own appointment schedules.
- They are also able to access and review their own medical records.



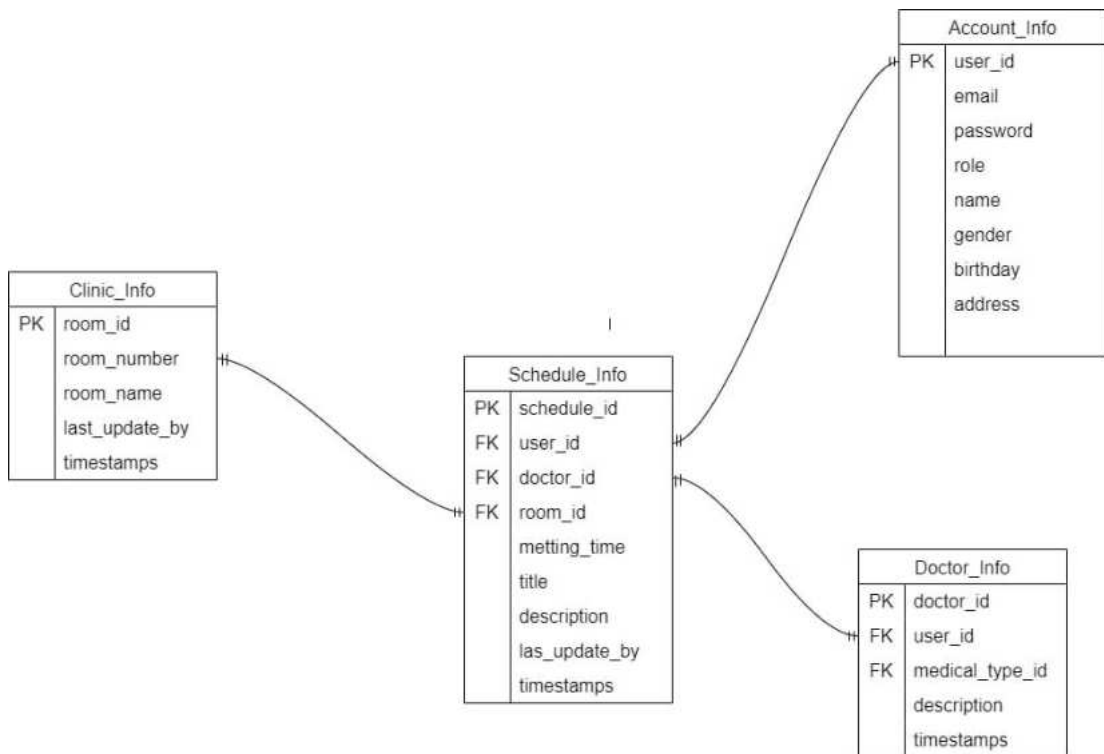
**Image 2.2 Entity relationship doctor**

- Doctors are identified in the Account\_Info table with role = 2.
- They can create medical-related articles.
- They are able to view their patients' appointment schedules and access their medical records.



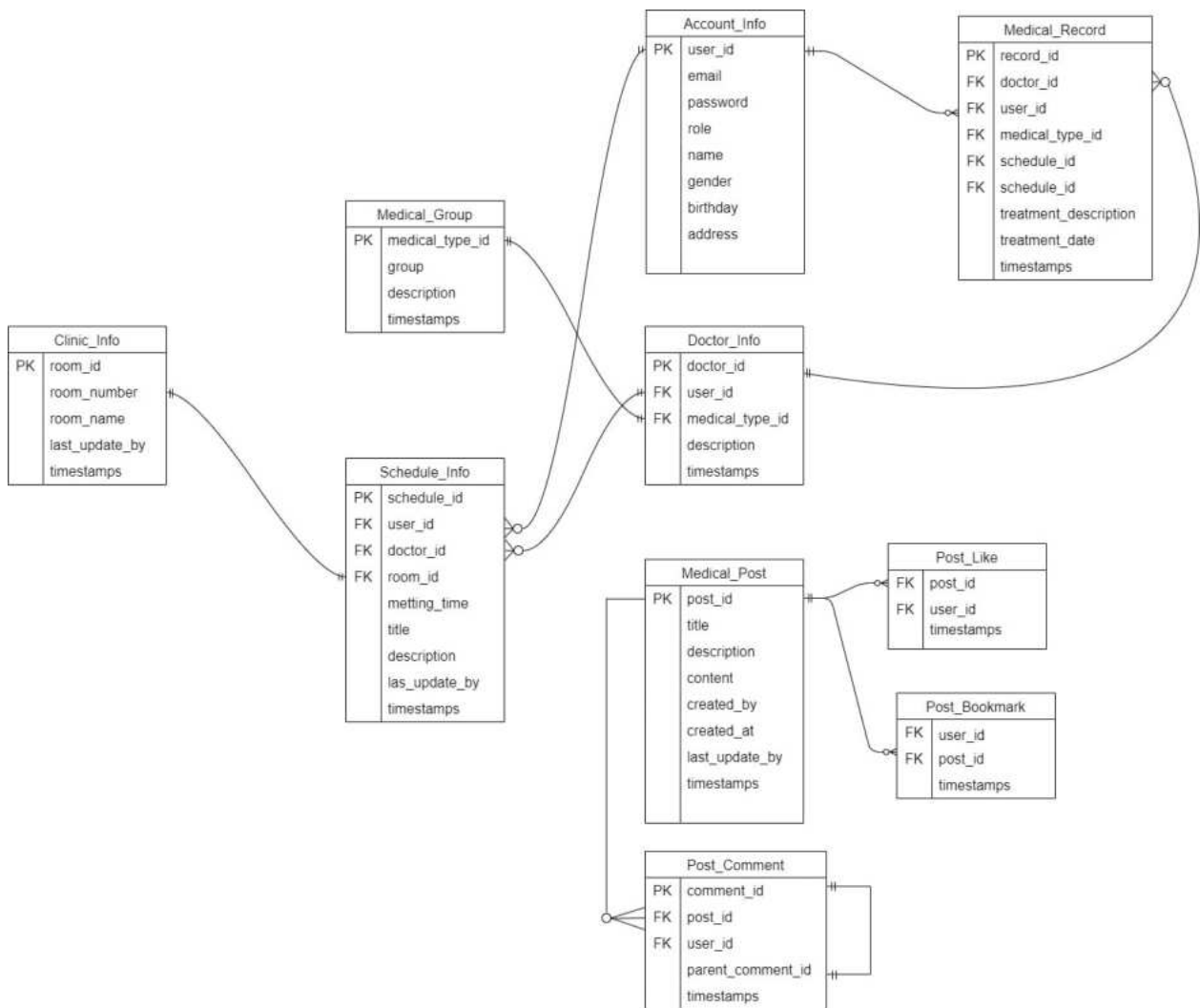
**Image 2.3 Entity relationship medical post**

- A post can be bookmarked, liked, and commented on by multiple users.



**Image 2.4 Entity relationship booking schedule**

- An appointment can include related information such as clinic, doctor, patient, and appointment time.



*Image 2.5 Entity relationship summary*

## 2.2.2 Use-case Diagram

### *Actor*

- Guest (not logged in): a user who visits the website but has not yet registered as a member.
- Customer (member): a user who has registered an account on the system.
- Doctor: a doctor or consultant who already has an account in the system.
- Staff (appointment scheduler): manages appointments at the clinic and assists patients in booking appointments with doctors.
- Admin: the user with the highest level of authority, responsible for managing the entire system.

### *Use-cases Functions*

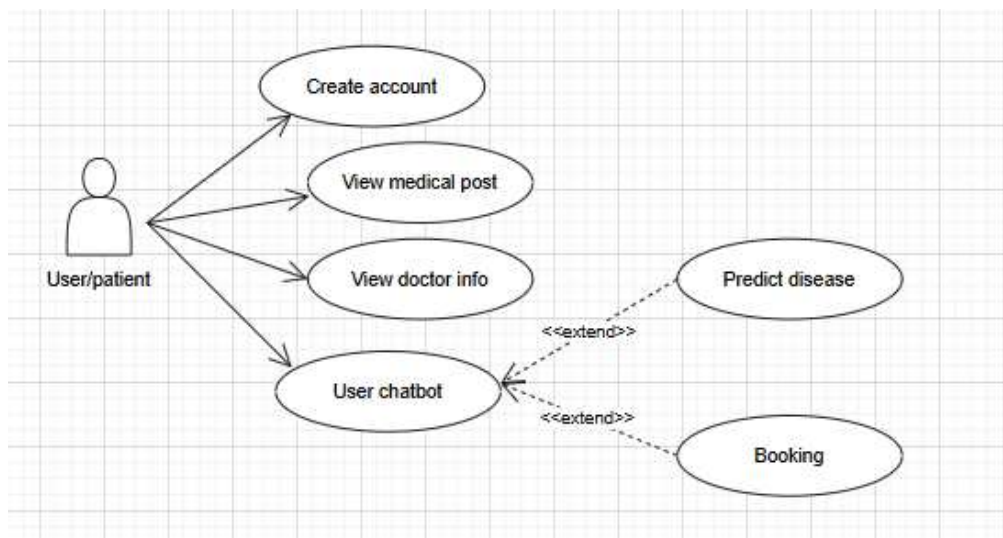
*Table 2.1 Main system*

No#	Function	Describe
1	Search	The system allows users to search for articles, medical information, doctors, and available treatment methods.
2	Medical Article Management	Users are allowed to create, edit, and delete their own articles or treatment method entries.
3	Appointment Booking	The system allows patients to schedule medical appointments online by choosing their preferred doctor and available time slots.
4	Medical History Management	Customers/Doctors can view their own medical records or those of their patients.
5	Chatbot	24/7 online consultation helps answer customer inquiries and assists with quick appointment booking.
6	Data Analytics	Doctors and administrative staff have access to analytics including patient activity, article view counts, and website traffic statistics, helping them monitor performance and improve services.

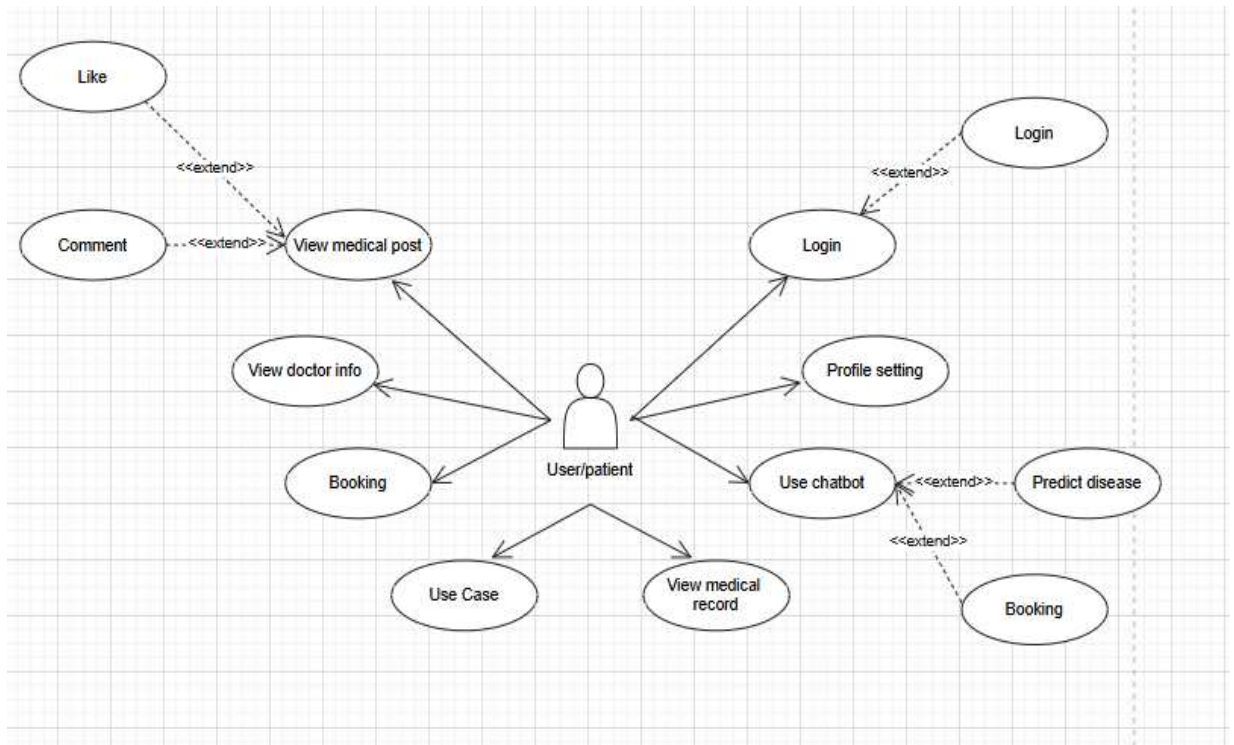
*Table 2.2 Sub system*

No#	Function	Describe
1	Sign Up	Create an account using email.
2	Update profile details	The customer is allowed to edit their personal details.  Doctors have the ability to update their profile information and manage their medical articles/posts.
	Article interaction	Medical articles that receive more interactions (likes, comments, bookmarks) are more likely to appear in the trending section.

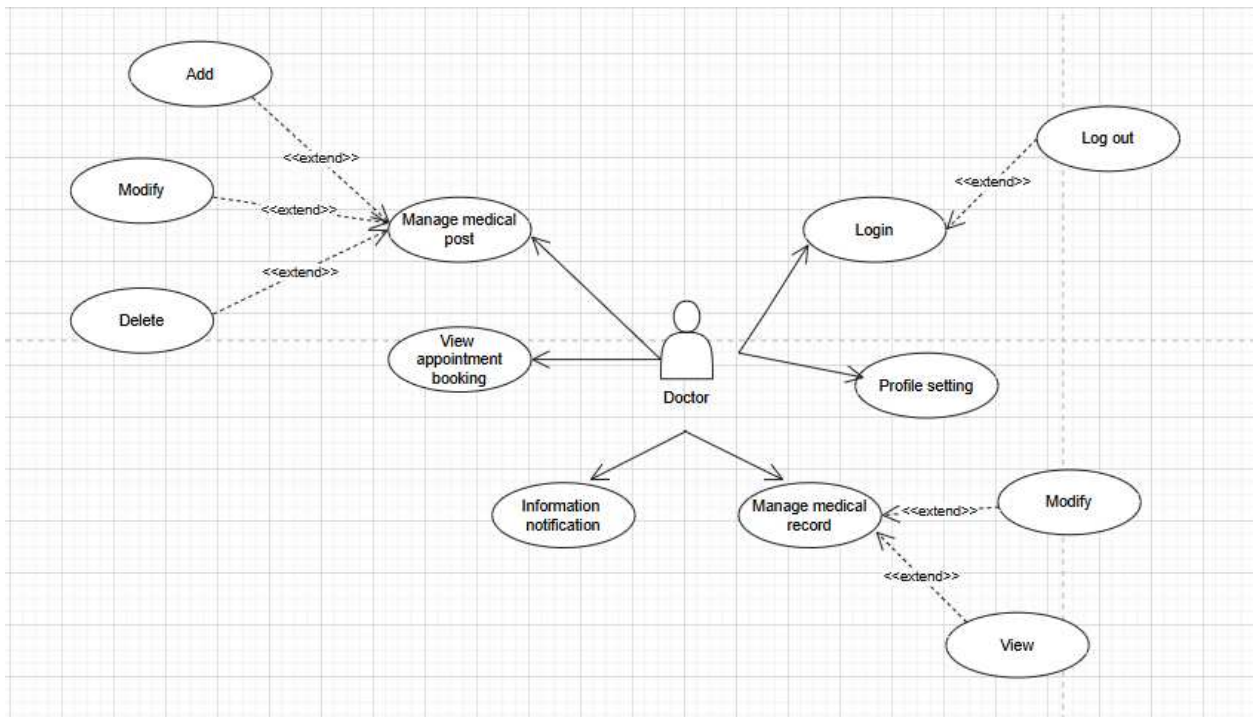
*Use-cases*



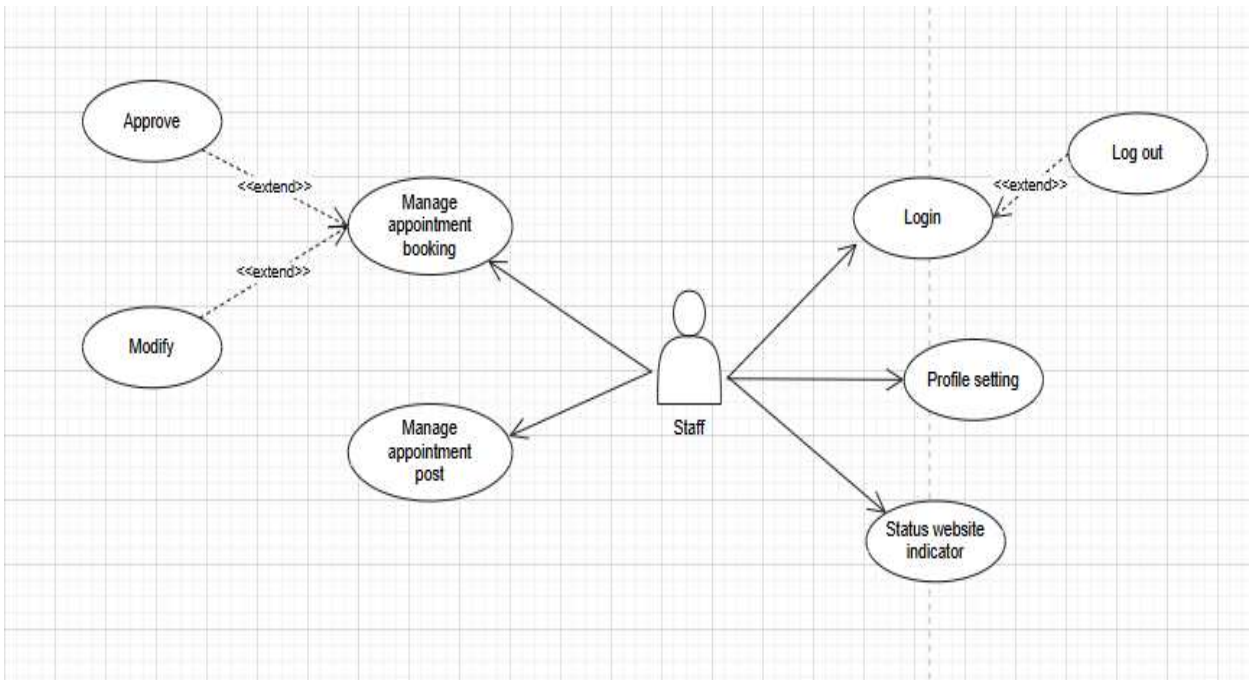
*Image 2.6 Usecase for guest/patient*



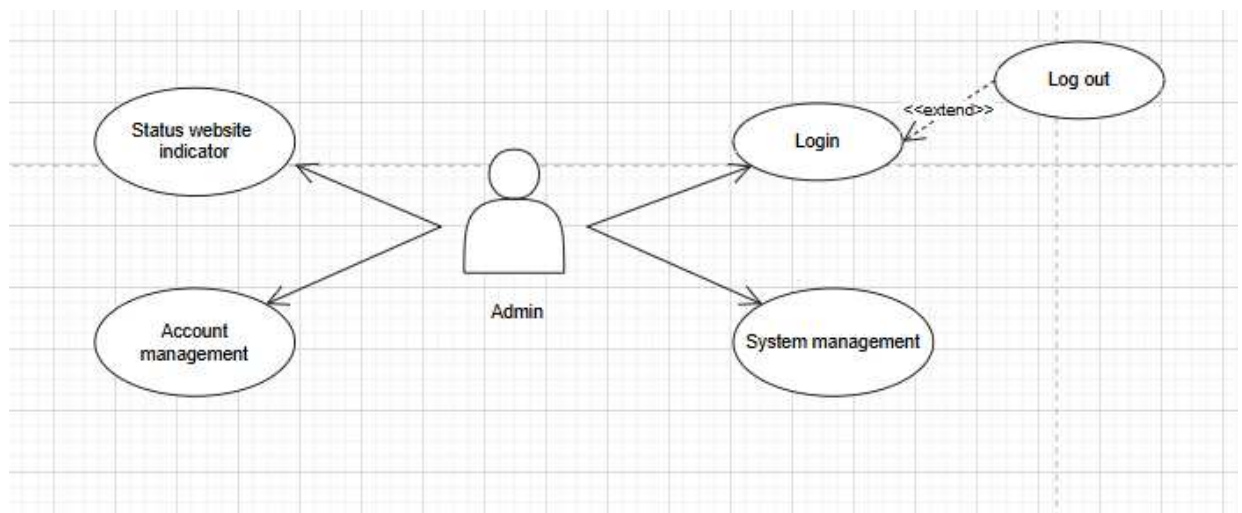
*Image 2.7 Usecase for user registered*



*Image 2.8 Usecase for doctor*



*Image 2.9 Usecase for staff*



*Image 2.10 Usecase for admin*

## *Definition of Use Cases*

**Table 2.3 Usecase register**

<b>Usecase</b>	<b>Register</b>
Register	The user registers an account to log in to the system and access more features
Actor	User without an account
Event Flow	<ol style="list-style-type: none"><li>1. The user registers by filling out an information form.</li><li>2. The system verifies the information and sends a notification to the user.</li></ol>

**Table 2.4 Usecase login**

<b>Usecase</b>	<b>Login</b>
Description	Log in to use the system
Actor	Patient / Doctor / Manager / Admin
Event Flow	<ol style="list-style-type: none"><li>1. The user selects the login option and enters their information.</li><li>2. The system verifies the information.</li><li>3. The system returns a notification to the user.</li></ol>

**Table 2.5 Usecase search**

<b>Usecase</b>	<b>Search</b>
Description	Search for doctors / medical articles
Actor	All actors
Event Flow	<ol style="list-style-type: none"><li>1. The user enters search information.</li><li>2. The system retrieves the data.</li><li>3. The system returns the results and displays them to the user.</li></ol>

*Table 2.6 Usecase check medical post*

Usecase	Medical Post Interaction
Description	Users / anyone with an account
Actor	All actors
Event Flow	<ol style="list-style-type: none"> <li>1. The user selects a medical article.</li> <li>2. The system retrieves the article data.</li> <li>3. The system returns the result and displays the article.</li> <li>4. The user can interact with the article by liking or commenting</li> </ol>

*Table 2.7 Usecase medical post management*

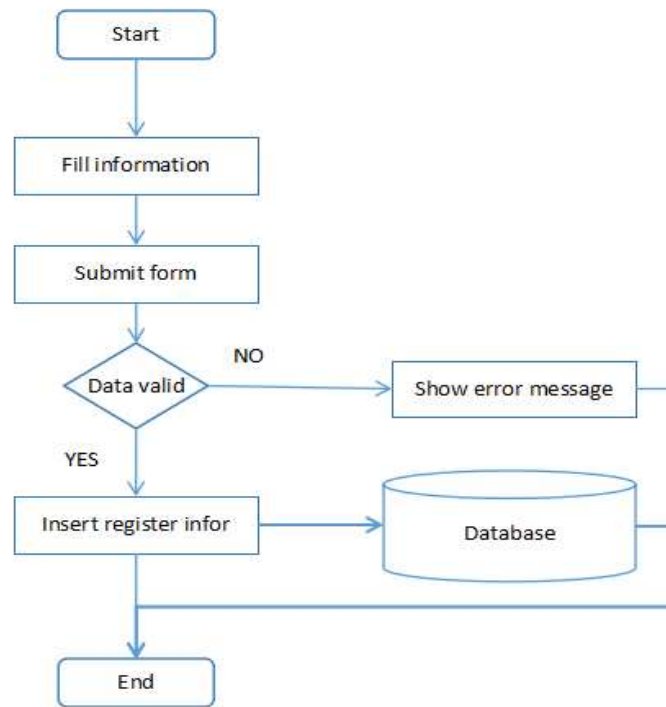
Usecase	Manage Medical Post
Description	Add/Edit/Delete post
Actor	Doctor/Admin
Event Flow	<p><b>Create Article:</b></p> <ol style="list-style-type: none"> <li>5. The user selects the post function and enters the content, then completes the posting.</li> <li>6. The system saves the article.</li> <li>7. The system sends a notification</li> </ol> <p><b>Edit Article:</b></p> <ol style="list-style-type: none"> <li>1. Doctor/Admin selects an article and chooses the edit function.</li> <li>2. The system retrieves the article data.</li> <li>3. The edit form is displayed.</li> <li>4. The user can update the article content and complete the</li> </ol>

	<p>update.</p> <ol style="list-style-type: none"> <li>5. The system saves the updated data.</li> <li>6. The system sends a success notification.</li> </ol> <p style="text-align: center;"><b>Delete Article:</b></p> <ol style="list-style-type: none"> <li>1. The user selects an article and chooses the delete function.</li> <li>2. The system retrieves the information and deletes the article from the database.</li> <li>3. The system sends a notification.</li> </ol>
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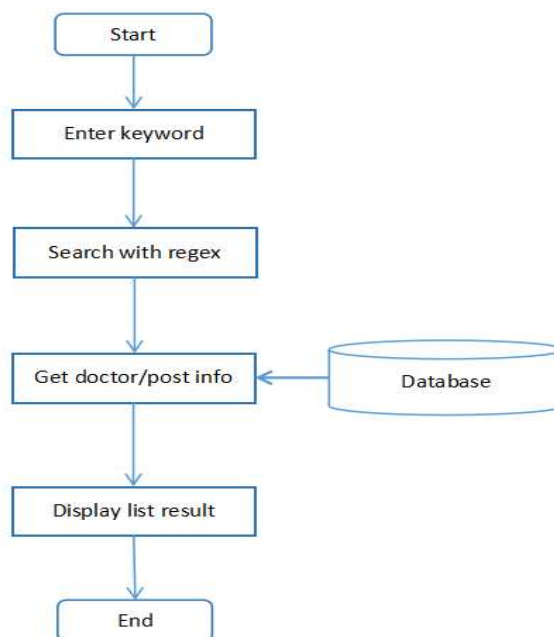
*Table 2.8 Booking appointment*

Usecase	Book an Appointment
Description	Supports booking appointments through two channels: the website or quick booking via chatbot
Actor	Customer/User with an account
Event Flow	<p style="text-align: center;"><b>Website:</b></p> <ol style="list-style-type: none"> <li>1. Select basic information: preferred appointment time, doctor, symptoms, etc.</li> <li>2. The system saves the information.</li> <li>3. The system returns the result and displays the booking post.</li> <li>4. The system responds with a pending status for admin approval.</li> <li>5. Once approved, a notification is sent to the user via their registered account/email.</li> </ol> <p style="text-align: center;"><b>Chatbot:</b></p> <ol style="list-style-type: none"> <li>1. Fill in basic information: name, phone number, symptoms, preferred time or doctor (optional).</li> <li>2. The system saves the information.</li> <li>3. For users without an account, the admin will contact them via the provided phone number to confirm the booking.</li> </ol>

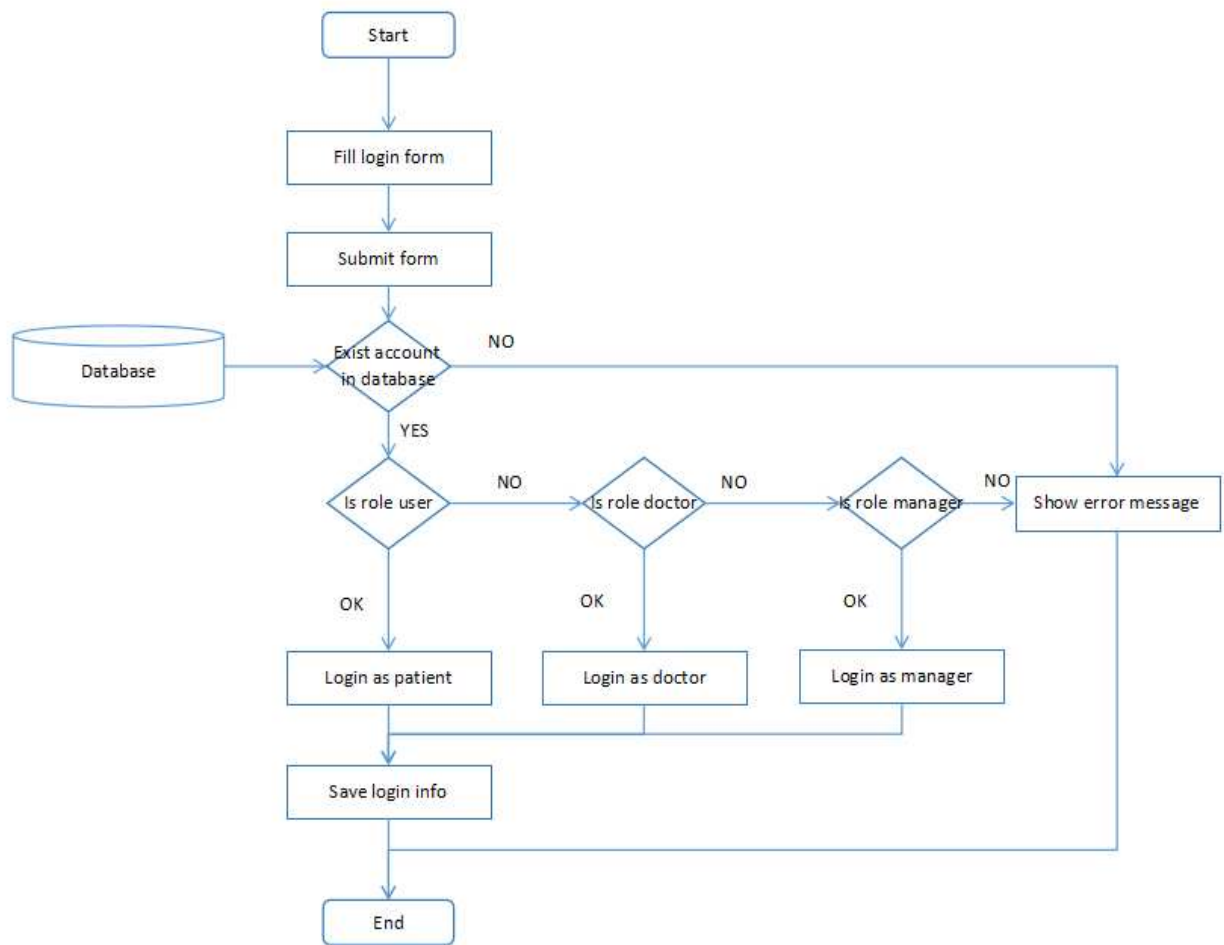
### 2.2.3 Flow chart by functions



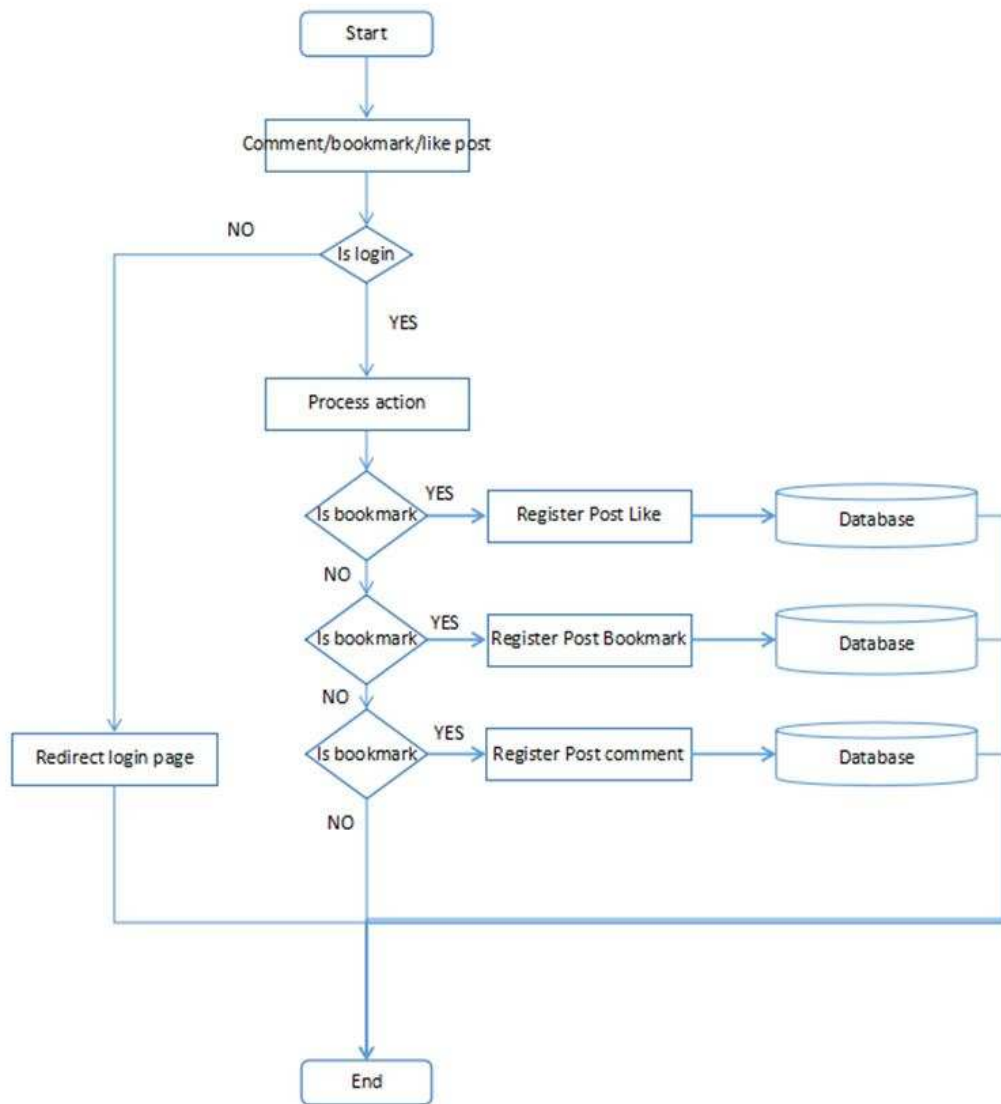
*Image 2.11 Flow chart account register*



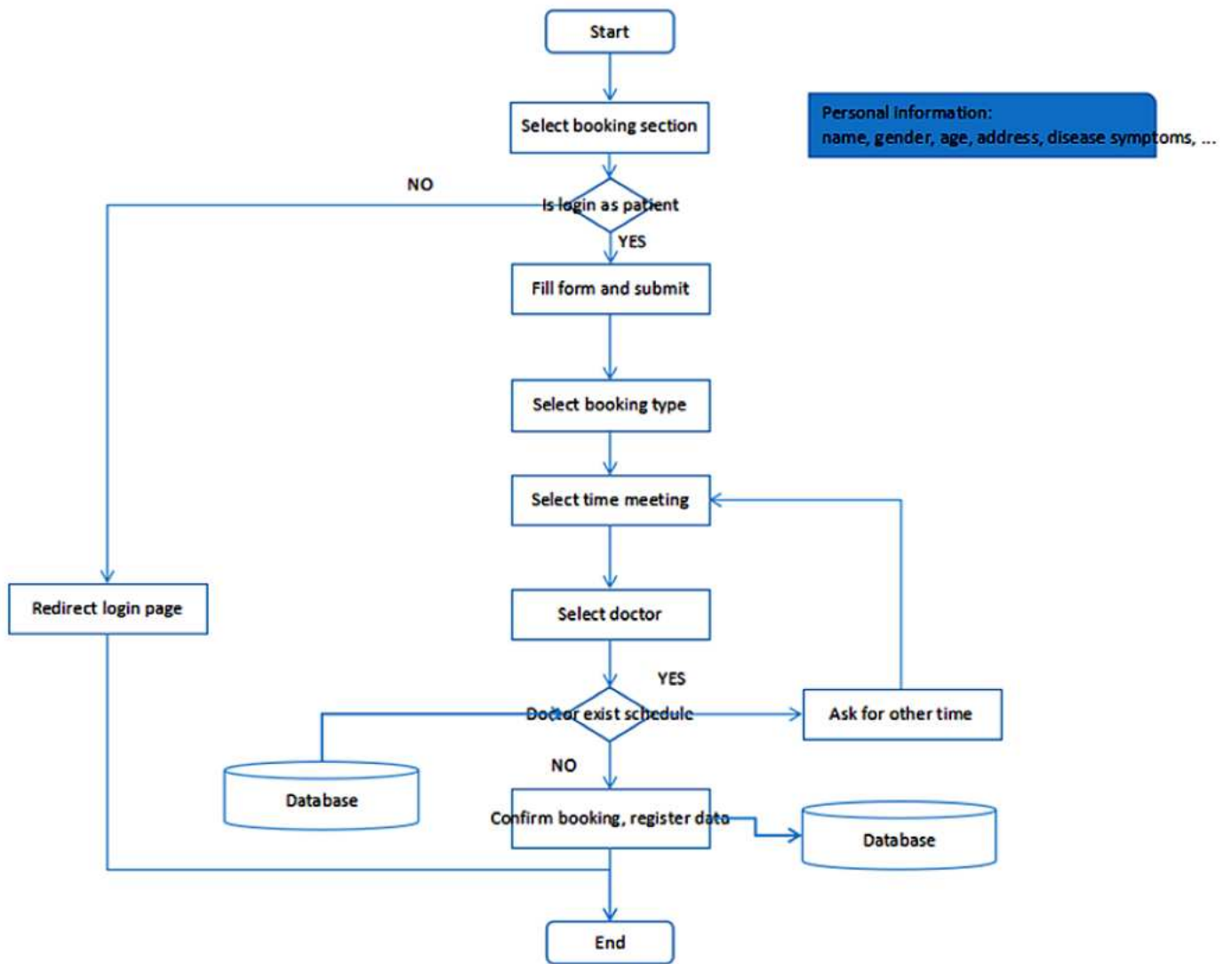
*Image 2.12 Flow chart medical post/doctor search*



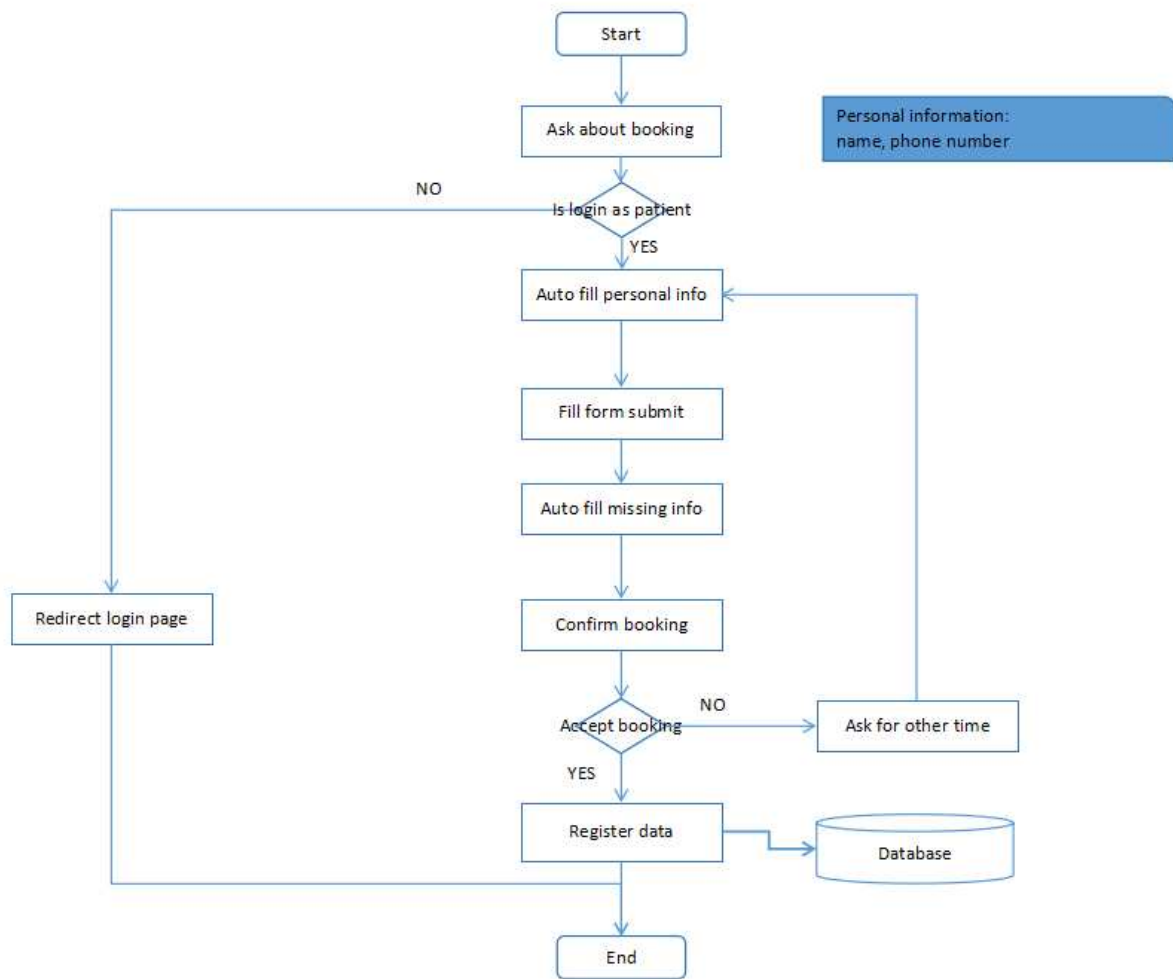
*Image 2.13 Flow chart login*



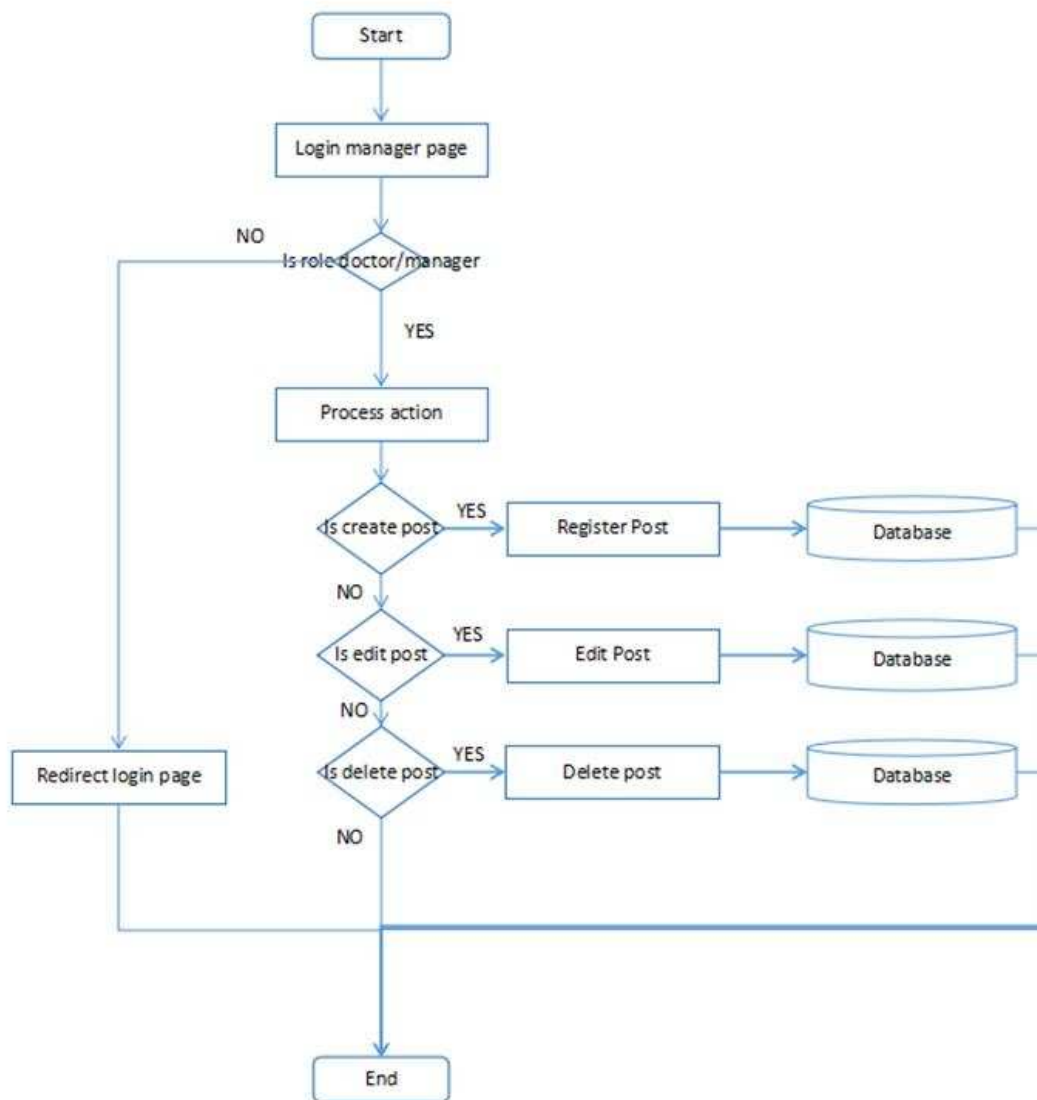
*Image 2.14 Flow chart medical post function*



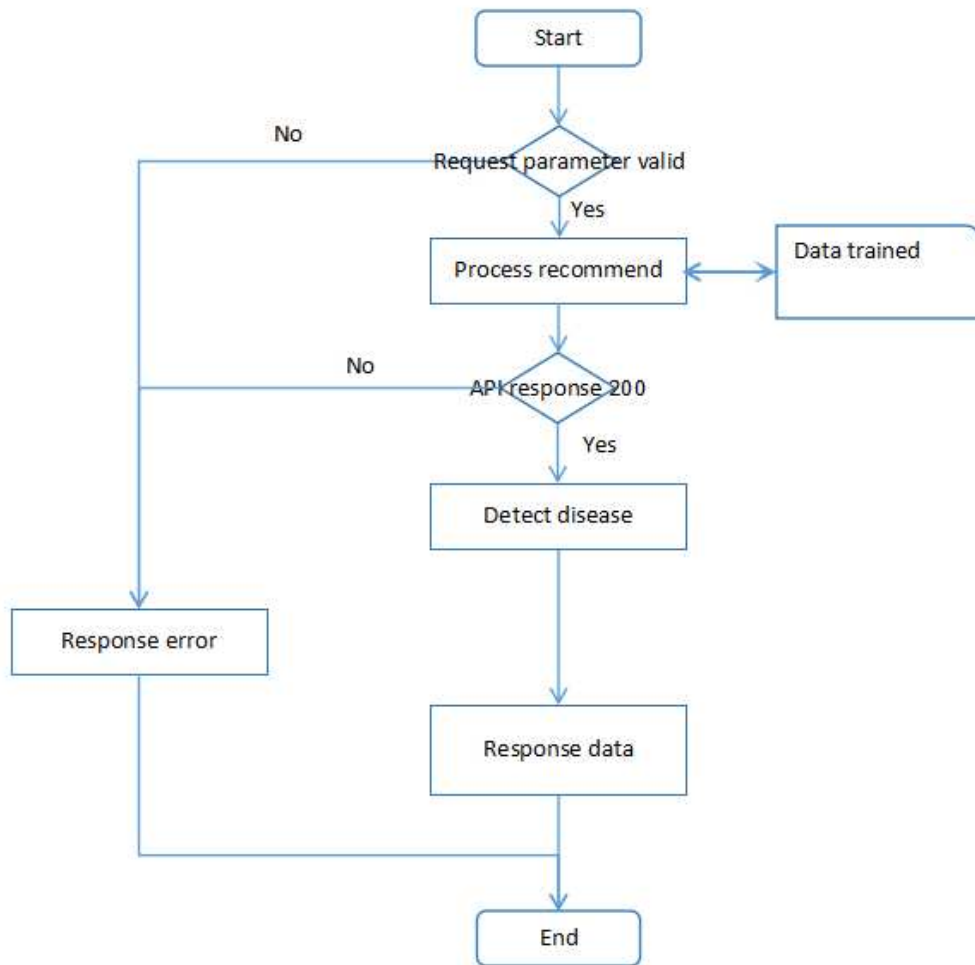
*Image 2.15 Flowchart booking appointment from website*



**Image 2.16** Flowchart booking appointment from chatbot



*Image 2.17 Flow chart medical post functional*



*Image 2.18 Flow chart API Chatbot RecommendBooking*

# CHAPTER 3. SYSTEM DEVELOPMENT

## 3.1. System Setup

### 3.1.1. Data Preparation and API Setup

The prepared dataset was obtained from:

<https://www.kaggle.com/datasets/pb30025030/vimedical-disease/data>

*This dataset may include*

- Information about various diseases.
- Data related to diagnosis or treatment.
- It can be used for research purposes and for developing AI/ML models in the healthcare sector.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
403	Bệnh Cúm	Tôi đang cảm thấy mệt mỏi, đau đầu và viêm họng. Tôi có thể đang bị bệnh gì?												
404	Bệnh Cúm	Tôi hay bị sổ mũi, hắt hơi và đau họng, nhưng triệu chứng xuất hiện đột ngột và sốt cao. Tôi có thể đang bị bệnh gì?												
405	Bệnh Cúm	Tôi đang bị sốt cao, đổ mồ hôi và khó thở. Tôi có thể đang bị bệnh gì?												
406	Bệnh Cúm	Tôi hay nôn mửa và tiêu chảy kèm theo sốt và ho. Tôi có thể đang bị bệnh gì?												
407	Bệnh Cúm	Tôi hiện đang có các triệu chứng như nghẹt mũi, chảy nước mũi và đau đầu. Tôi có thể đang bị bệnh gì?												
408	Bệnh Cúm	Tôi đang cảm thấy mệt mỏi kéo dài, ho khan và sốt nhẹ. Tôi có thể đang bị bệnh gì?												
409	Bệnh Cúm	Tôi hay bị ớn lạnh, viêm họng và sốt cao đột ngột. Tôi có thể đang bị bệnh gì?												
410	Bệnh Cúm	Tôi hiện đang có các triệu chứng như đau đầu, mệt mỏi và ho khan. Tôi có thể đang bị bệnh gì?												
411	Bệnh Cúm	Tôi đang cảm thấy khó thở, tức ngực và sốt cao. Tôi có thể đang bị bệnh gì?												
412	Bệnh Cúm	Tôi hay bị sốt cao kéo dài hơn 3 ngày, kèm theo ho và mệt mỏi. Tôi có thể đang bị bệnh gì?												
413	Bệnh Cúm	Tôi hiện đang có các triệu chứng như mất ý thức, co giật và sốt cao. Tôi có thể đang bị bệnh gì?												
414	Bệnh Cúm	Tôi đang cảm thấy mệt mỏi, đau nhức cơ thể và sốt cao. Tôi có thể đang bị bệnh gì?												
415	Bệnh Cúm	Tôi hay bị sổ mũi, hắt hơi và đau họng, kèm theo sốt và mệt mỏi. Tôi có thể đang bị bệnh gì?												
416	Bệnh Cúm	Tôi hiện đang có các triệu chứng như viêm họng, ho khan và ớn lạnh. Tôi có thể đang bị bệnh gì?												
417	Bệnh Cúm	Tôi đang cảm thấy mệt mỏi, chán ăn và sốt nhẹ. Tôi có thể đang bị bệnh gì?												
418	Bệnh Cúm	Tôi hay bị tiêu chảy, nôn mửa và sốt cao, đặc biệt là trẻ em. Tôi có thể đang bị bệnh gì?												
419	Bệnh Cúm	Tôi hiện đang có các triệu chứng như đau đầu, chóng mặt và sốt cao. Tôi có thể đang bị bệnh gì?												
420	Bệnh Cúm	Tôi đang cảm thấy khó thở, đau ngực và ho có đờm. Tôi có thể đang bị bệnh gì?												
421	Bệnh Cúm	Tôi hay bị sốt cao, co giật và tiểu ít. Tôi có thể đang bị bệnh gì?												
422	Bệnh Cơ Tim Giãn Nở	Tôi hiện đang có các triệu chứng như khó thở, hụt hơi khi gắng sức và sưng phù bàn chân. Tôi có thể đang bị bệnh gì?												
423	Bệnh Cơ Tim Giãn Nở	Tôi đang cảm thấy mệt mỏi, không thể tập thể dục như bình thường và nhịp tim không đều. Tôi có thể đang bị bệnh gì?												
424	Bệnh Cơ Tim Giãn Nở	Tôi hay bị chóng mặt, ngất xỉu và đau tức ngực. Tôi có thể đang bị bệnh gì?												
425	Bệnh Cơ Tim Giãn Nở	Tôi tạo thấy tĩnh mạch cổ nổi lên và thở khò khè. Tôi có thể đang bị bệnh gì?												
426	Bệnh Cơ Tim Giãn Nở	Tôi hiện đang có triệu chứng tăng cân, tăng vòng bụng và cao huyết áp. Tôi có thể đang bị bệnh gì?												
427	Bệnh Cơ Tim Giãn Nở	Tôi đang cảm thấy hồi hộp, đánh trống ngực và khó thở khi nằm. Tôi có thể đang bị bệnh gì?												
428	Bệnh Cơ Tim Giãn Nở	Tôi hay bị sưng phù chân, mệt mỏi và nhịp tim nhanh. Tôi có thể đang bị bệnh gì?												

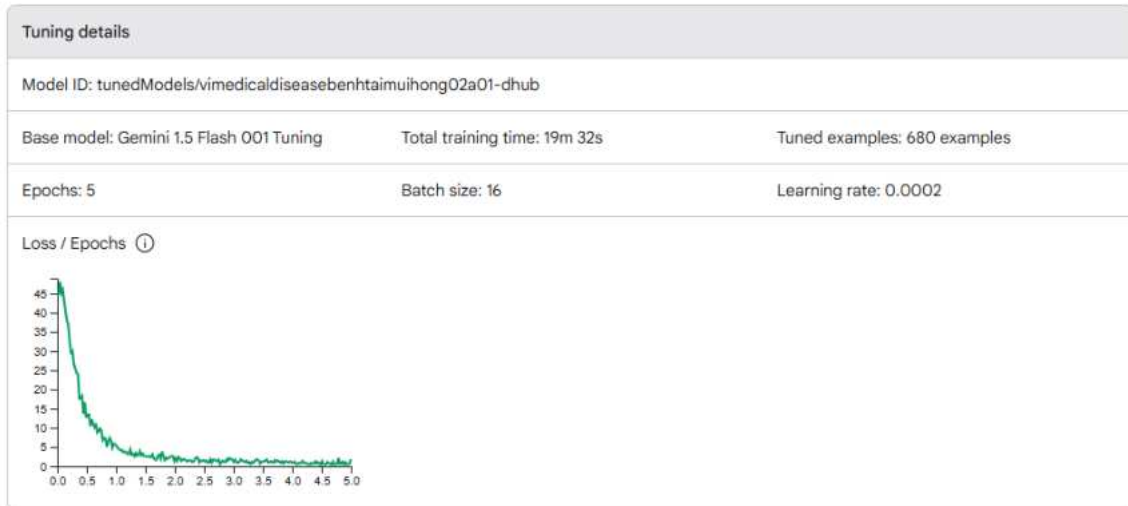
*Image 3.1 Data get from Kaggle not processed*

### *Data Processing*

- Step 1: Manually filter all diseases related to ENT (Ear, Nose, Throat).
- Step 2: Remove stop words such as “I am having...”, “I feel...”, etc.
- Step 3: Combine the cleaned data into a single file as shown below.



## Tuned model results



## Use your tuned model



### *Image 3.3 Result Model training with Google AI Studio*

Additional configuration for chatbot response policies was applied:

- Harrassment: Block (Max lvl 4)
- Hate: Block few (Lvl 3)
- Sexually Explicit: Block few (Lvl 3)
- Dangerous Content: Block (Max lvl 4)
- Civic Integrity: Block low(Lvl 1)

### *Testing and results*

Tôi có triệu chứng Ngón tay tôi có hình dạng bất thường và tôi không thể ngủ. Tay tôi hay bắt chước động tác của nhau và khó thực hiện công việc cần sự khéo léo, sút môi và hở hàm ếch và mất khứu giác, mất thính lực và khó ngửi thấy mùi là bệnh gì

Dựa vào các triệu chứng bạn cung cấp, bạn có thể đang gặp phải Hội chứng Kallmann. Hội chứng này gây ra nhiều triệu chứng khác nhau, bao gồm cả những gì bạn đã mô tả, và nó thường xảy ra khi cơ thể không sản xuất đủ hormone GnRH, một hormone cần thiết cho sự phát triển tinh dục và khứu giác.

Tuy nhiên, để xác định chính xác bạn đang mắc bệnh gì, bạn cần đến gặp bác sĩ để được chẩn đoán. Bác sĩ sẽ hỏi bạn về các triệu chứng, khám sức khỏe cho bạn và có thể yêu cầu bạn làm một số xét nghiệm để xác định chính xác nguyên nhân của các triệu chứng.

Hãy nhớ rằng, việc tự chẩn đoán bệnh là điều không nên. Luôn luôn tham khảo ý kiến bác sĩ để có được chẩn đoán và phương pháp điều trị phù hợp nhất cho bạn.



### *Image 3.4 Test chatbot response model sample 01*

bệnh nhân đang có triệu chứng: ,có khối u trong mũi và khó khăn khi thở bằng mũi ,ngứa mũi và hắt hơi và nghẹt mũi , chảy nước mũi màu vàng xanh và nghẹt mũi ,đau nhức vùng xoang mặt và thường xuyên nghẹt mũi ,ngáy ngủ và khó thở khi ngủ , mắt khòu giác hoàn toàn và nghẹt mũi ,có dị vật trong mũi và khó chịu khi thở ,chảy nước mắt và nghẹt mũi , đau họng và nghẹt mũi kéo dài ,áp lực trong tai và nghẹt mũi là bệnh gì

Dựa vào các triệu chứng bạn mô tả, bệnh nhân có thể đang gặp phải **Bệnh Viêm Xoang Mạn Tính**.

Đây là một tình trạng viêm nhiễm mãn tính ở xoang, thường gây ra các triệu chứng như:

- **Nghẹt mũi:** Nghẹt mũi là triệu chứng phổ biến nhất của viêm xoang mạn tính. Nó có thể xảy ra một bên hoặc cả hai bên mũi.
- **Chảy nước mũi:** Nước mũi có thể trong, đục, màu vàng hoặc màu xanh lá cây, và có thể có mùi hôi.
- **Đau nhức mặt:** Đau nhức mặt thường xảy ra ở vùng má, trán, hoặc quanh mắt.
- **Giảm khứu giác:** Viêm xoang mạn tính có thể làm giảm khả năng ngửi mùi.
- **Đau đầu:** Đau đầu là một triệu chứng phổ biến, đặc biệt là khi bạn cúi xuống.
- **Ngáy ngủ:** Viêm xoang mạn tính có thể gây ra nghẹt mũi và làm tắc nghẽn đường thở, dẫn đến ngáy ngủ.
- **Khó thở khi ngủ:** Viêm xoang mạn tính cũng có thể gây khó thở khi ngủ.
- **Khó chịu:** Bạn có thể cảm thấy khó chịu trong mũi, đặc biệt là khi bạn bị nghẹt mũi.
- **Chảy nước mắt:** Viêm xoang mạn tính có thể gây ra chảy nước mắt, đặc biệt là khi bạn cúi xuống.
- **Đau họng:** Viêm xoang mạn tính có thể gây ra đau họng do dịch mũi chảy xuống cổ họng.
- **Áp lực trong tai:** Viêm xoang mạn tính có thể gây ra áp lực trong tai do viêm nhiễm lan sang tai giữa.

Để chẩn đoán chính xác bệnh, bạn cần đến gặp bác sĩ để được khám và tư vấn. Bác sĩ sẽ hỏi bạn về các triệu chứng, khám sức khỏe cho bạn và có thể yêu cầu bạn làm một số xét nghiệm để xác định chính xác nguyên nhân của các triệu chứng.

### *Image 3.5 Test chatbot response model sample 02*

### 3.1.2. Website development

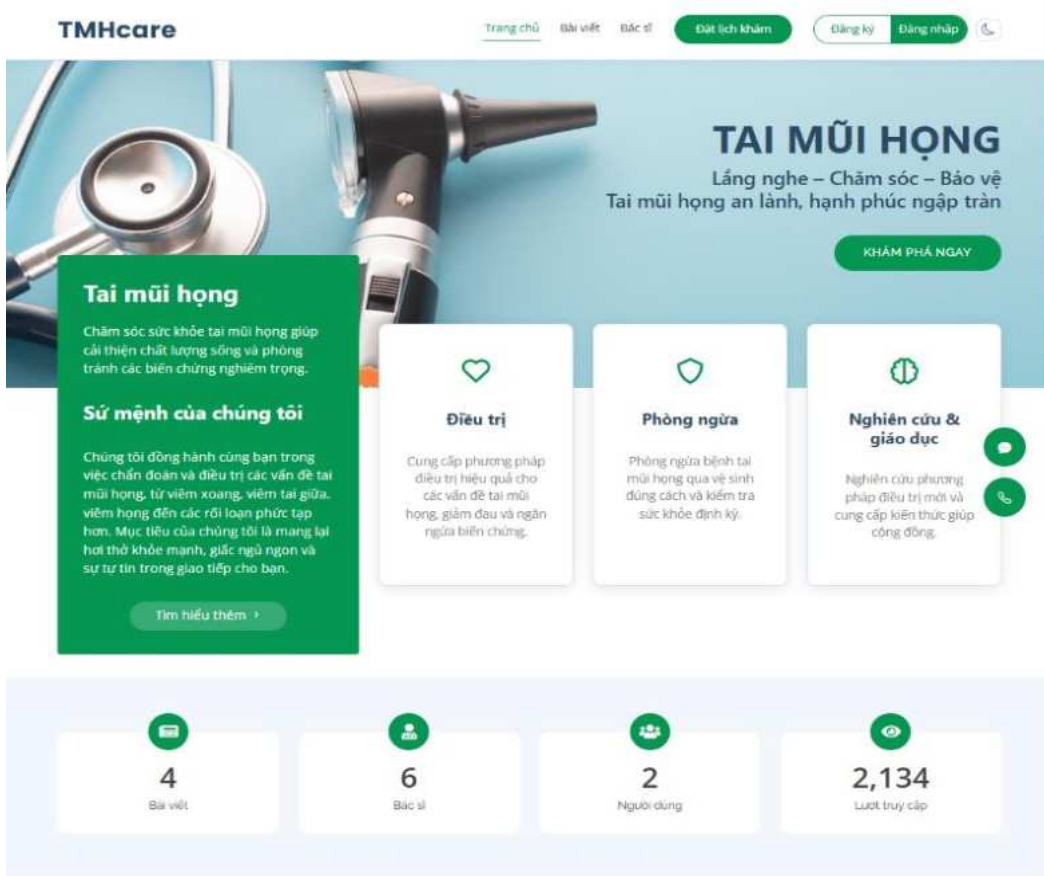


Image 3.6 Home page

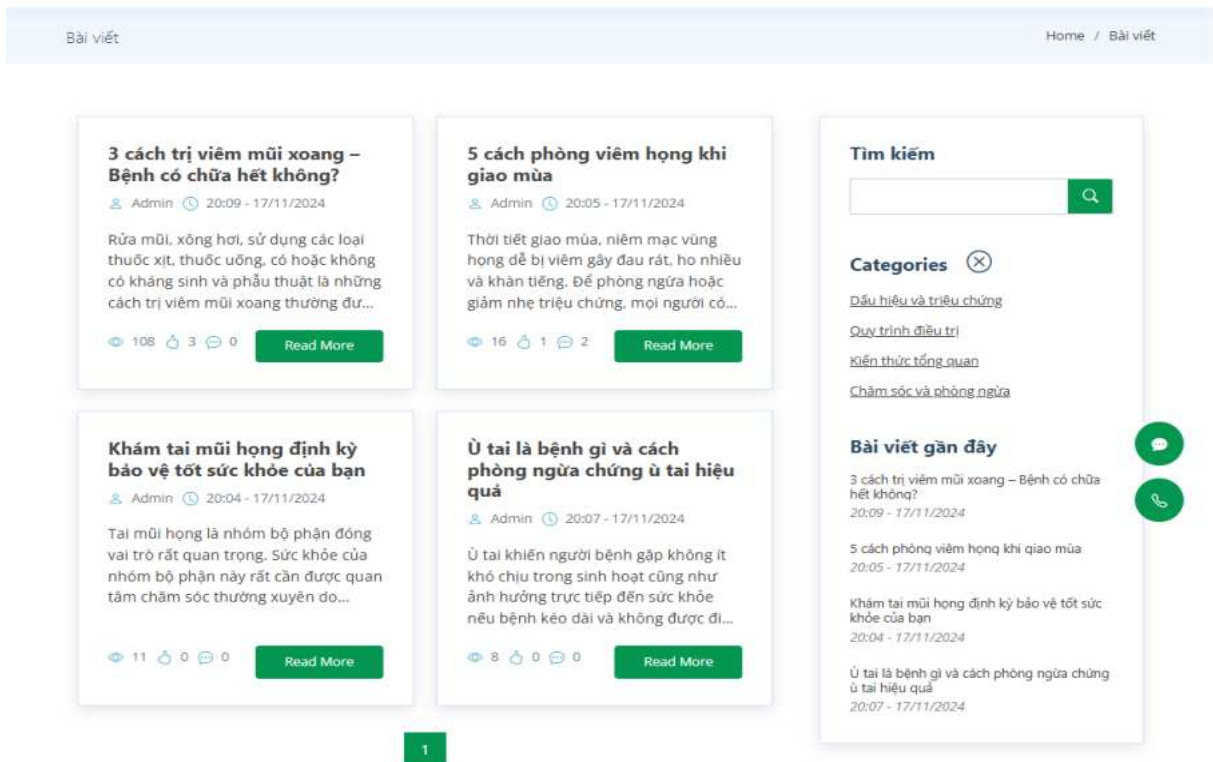


Image 3.7 Medical post page

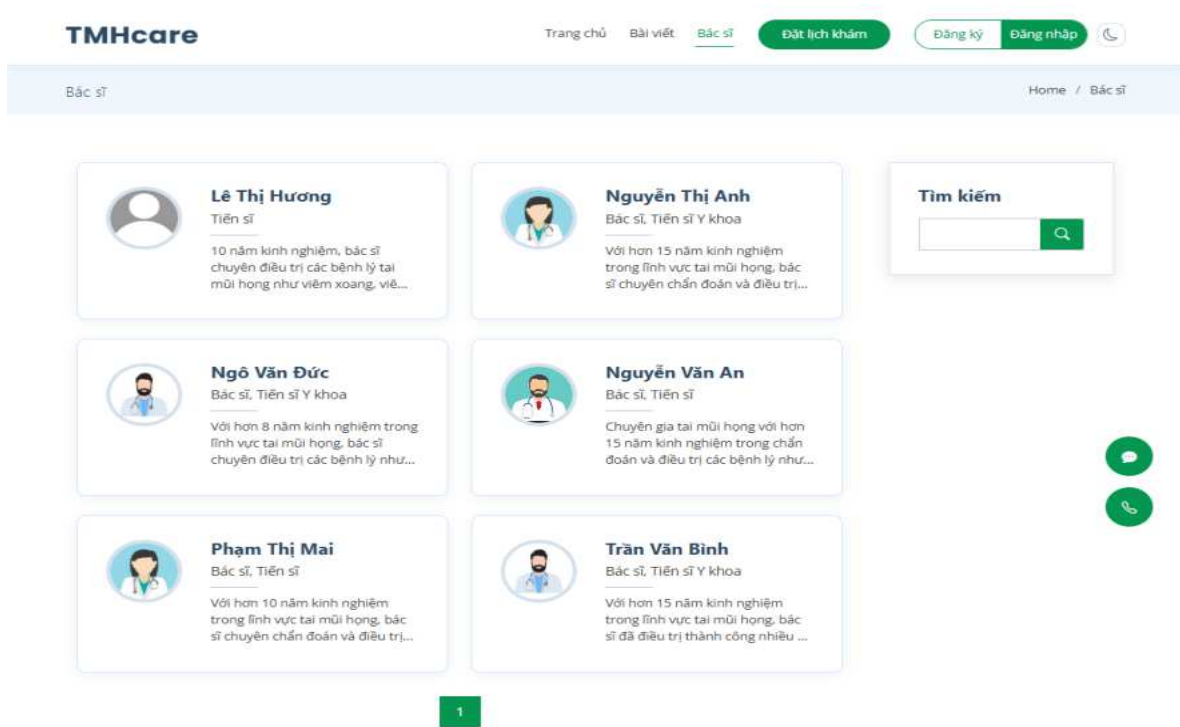


Image 3.8 Booking appointment page

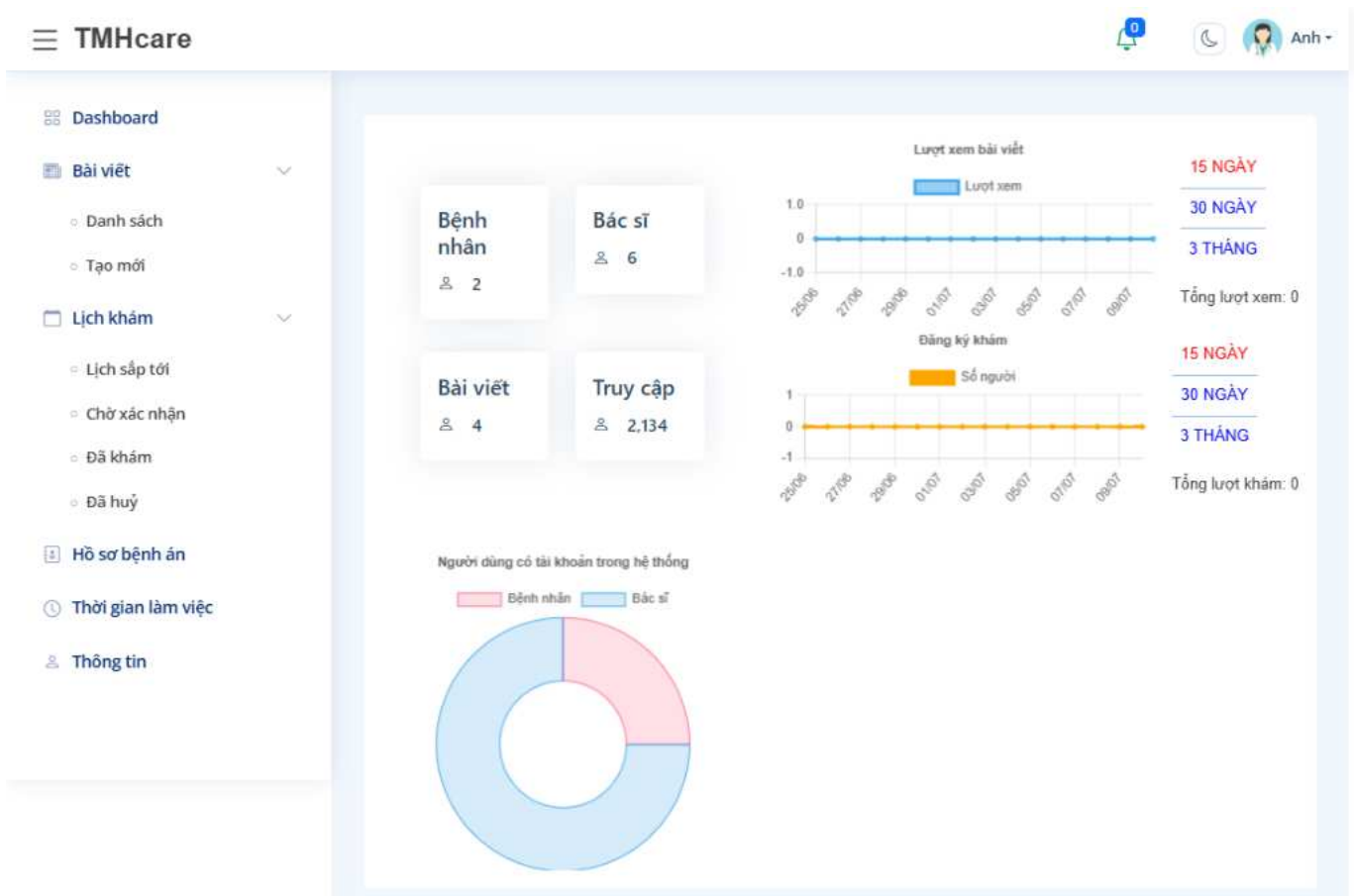


Image 3.9 Website status information page

Dashboard

Bài viết

Danh sách

Tạo mới

Lịch khám

Hồ sơ bệnh án

Thời gian làm việc

Thông tin

Tạo mới

Tiêu đề

Mô tả

Thể loại

Nội dung

← → Paragraph **B** *I*

Image 3.10 Medical post - add page

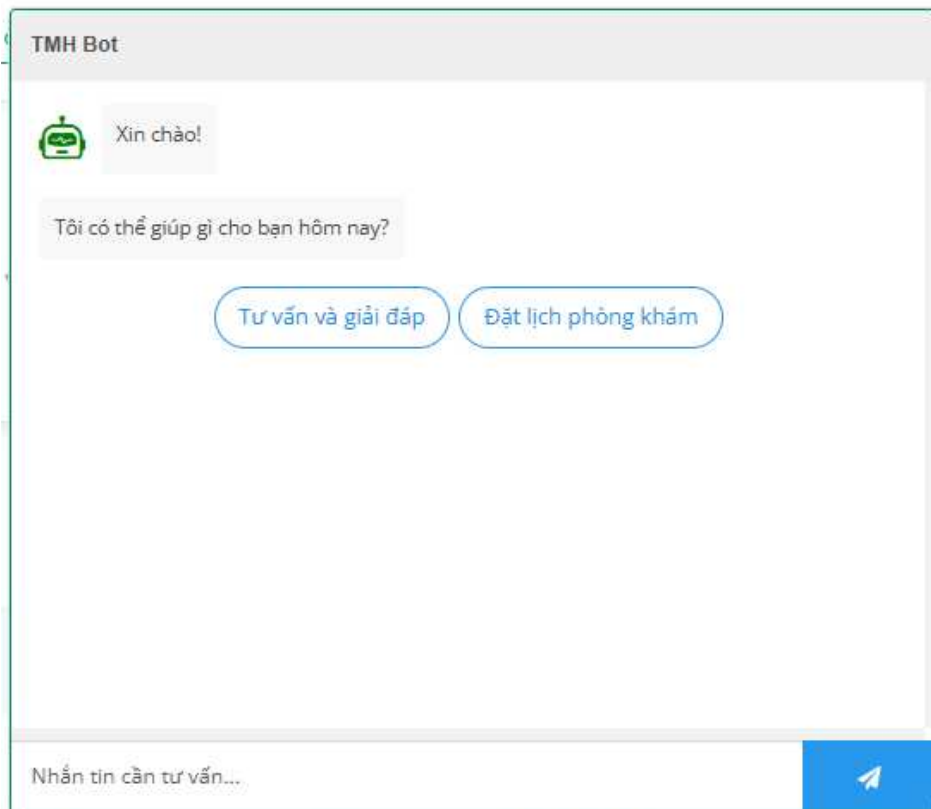
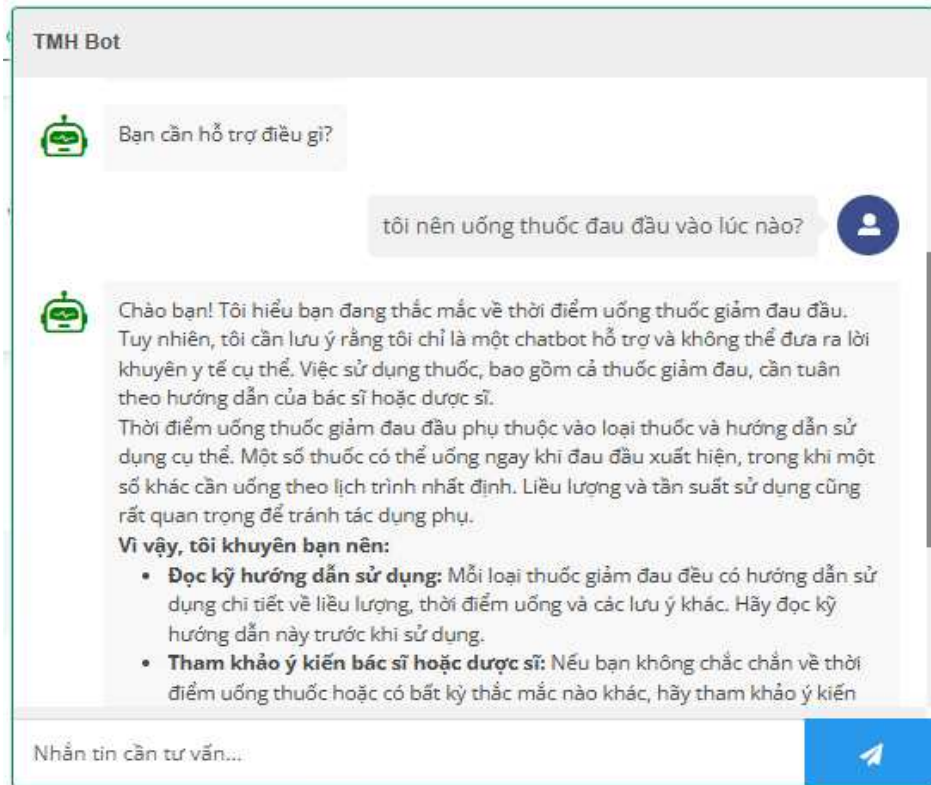
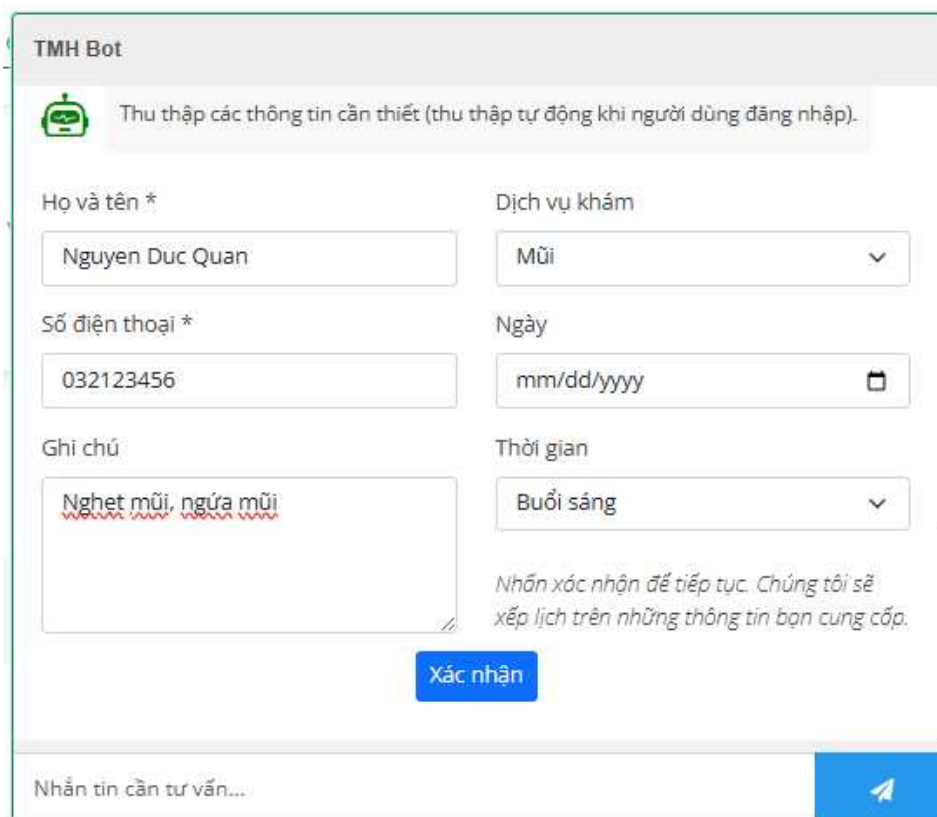


Image 3.11 Chatbot AI



*Image 3.12 Health advice with chatbot AI*



*Image 3.13 Quick booking with Chatbot AI*

## **3.2. System Overview**

### **3.2.1. Unit Testing**

#### ***Login and Registration***

- Validate input fields (email, password).
- Check for mismatched passwords during registration.
- Test notification states when users forget their password.
- Test login and usage flows for each user role.
- Verify correct role-based login and ensure the appropriate page is displayed for different roles.

#### ***Doctor/Treatment Search***

- Test returned results when entering valid keywords.
- Handle errors when no matching results are found.
- Ensure pagination works correctly.

#### ***Appointment Booking***

- Verify logic for valid appointment times (time, date).
- Validate patient input data (name, age, reason for visit).

#### ***Patient Records***

- Ensure the correct medical record is displayed according to the user account.
- Authenticate access rights if the viewer is not the owner.

#### ***Chatbot***

- Test the chatbot's response to random questions and symptom-related queries.

### **3.2.2. Integration Testing**

#### ***Appointment Booking Process***

- Verify the connection between the client's booking function and the staff's confirmation function.
- Test the full flow from selecting an appointment time to sending the request.

#### ***Appointment Management by Staff***

- Confirm that staff can view, edit, and delete appointments.

- Test that notifications are sent to patients when appointments are changed

#### ***Automated Notifications***

- Check synchronization when booking via chatbot and confirming with staff functions.

- Ensure notifications are sent on time and to the correct users.

#### ***Content and Information Management***

- Verify that articles created by doctors are displayed correctly to patients.
- Ensure edit permissions for articles are restricted to doctors or admins only

### **3.2.3. Evaluation**

The website meets the core user requirements well, offering stable functionality, an easy-to-use interface, and secure data handling. However, continuous monitoring of performance and user feedback is needed to further enhance the user experience.

Adding advanced features such as multi-language support, integration with health insurance systems, and data analytics will help the system become more complete and better serve the increasingly diverse needs of users.

## CHAPTER 4. CONCLUSION AND FUTURE DEVELOPMENT

### 4.1. Conclusion

#### *General Remarks*

- Developed a multi-platform online medical appointment booking system.
- Optimized the appointment management process.
- Integrated reminder features and management support for patients.
- Ensured security and data safety.
- Provided a user-friendly and easy-to-use interface.
- Met the initial functional requirements as planned.

#### *Outstanding Issues and Areas for Improvement*

- The user interface is not yet truly appealing and currently only covers basic functionalities.
- No dedicated mobile application has been developed yet.
- Advanced features such as treatment support and online pharmaceutical ordering could not be implemented due to time constraints.

### 4.2. Future Development Directions

#### *Future Development Directions*

- Expand multi-platform integration: Deploy the AI chatbot across other platforms such as mobile applications, Zalo OA, Facebook Messenger, etc.
- Synchronize data across all channels.

#### *Post-visit care & consultation*

- Enhance service quality and build long-term patient relationships by developing post-visit care features, such as sending reminders for taking medication, scheduling follow-up appointments, checking patient status after treatment, and providing home care or suitable dietary guidance

#### *Develop advanced features*

- Add multi-language support for the clinic's website to expand the user base, improve the user experience, and enhance professionalism — especially important in an internationalized urban environment with high-quality healthcare services.

- Integrate health insurance (HI) into the clinic's website to increase convenience, reduce administrative procedures, and enhance the patient experience. This would allow patients to use their HI when booking appointments, receiving treatment, or making online payments.

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