DENTAL AI CHATBOT FOR DIAGNOSTICS AND POST-SURGERY CARE

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LIST OF SYMBOLS

SYMBOL		UNIT
α	Test variable	m^2
λ	Interarival rate	jobs/second
μ	Service rate	jobs/second

LIST OF TECHNICAL VOCABULARY AND ABBREVATIONS

ABC	=	Adaptive Bandwidth Control
MANET	=	Mobile Ad Hoc Network
Test	=	Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nullam non condimentum purus. Pellentesque sed augue sapien. In volutpat quis diam laoreet suscipit. Curabitur fringilla sem nisi, at condimentum lectus consequat vitae.

CHAPTER 1 INTRODUCTION

1.1 Keywords

Keywords: Oral Surgery, Dentistry, Diagnose, Follow-up, Artificial Intelligence, Chatbot, Machine Learning, Natural Language Processing

1.2 Problem Statement

1.2.1 Problem Statement and Motivation

Individuals seeking healthcare in today's world often run into a number of challenges while attempting to acquire correct information regarding their symptoms and appropriate treatment. Many patients have minor illnesses or symptoms that might not necessarily require immediate medical attention from a doctor. Nevertheless, these individuals usually resort to clinics or hospitals for a diagnosis as there is a lack of information and assistance available.

This rise in patient visits not only places a considerable burden on healthcare facilities but also results in financial implications for patients themselves. The associated costs, such as consultation fees, diagnostic tests, and travel expenses, can impose an unreasonable financial strain on individuals. Moreover, this increased demand for medical attention has contributed to an imbalance in the doctor-to-patient ratio, affecting the overall quality of healthcare services provided. According to the National Statistical Office, the ratio of doctor-to-patient ratio is 1 to 8,057.

Furthermore, the challenges do not cease once treatment is initiated. After receiving medical care, many patients still have many concerns about their health conditions. Many patients desire prompt answers to their worries about their conditions. In addition to these concerns, patients often have recurring questions, commonly categorized as frequently asked questions (FAQs).

Regrettably, doctors and medical staff find themselves overwhelmed by the immense workload caused from the increased patient influx. As they aim to deliver quality care and diagnosis, they may have limited time and resources to respond satisfactorily to the patients.

To address these pressing issues and enhance the healthcare experience for both patients and healthcare providers, we were motivated to develop an application that can effectively address these issues. The application will have the capability to diagnose common diseases and answer frequently asked questions from the patient's symptoms. Additionally, it will feature a chatbot designed to follow up on patient conditions after surgery.

1.2.2 Potential Benefits

The purpose of this dental application is to reduce frequently asked questions from patients regarding oral symptoms or diseases and also help with post-surgery follow-up thus reducing the workload of the dentist and medical staff. Dentists can use the extra time they gain to concentrate on patients who require more extensive care.

In addition to the benefits that doctors receive from this application, patients and the general public also get their benefit as they have immediate access to oral diagnosis and knowledge. Since patients can understand their symptoms and get guidance on simple treatments, this helps to decrease needless doctor visits. Moreover, it can benefit patients by decreasing the expense of visiting the doctor to get a diagnosis. Another benefit that patients receive is continuous monitoring of their symptoms, which allows their doctor to be informed of any unexpected post-surgery problems.

1.3 Objectives

- To acquire the knowledge and skills necessary for developing an AI-powered chatbot.
- To build a chatbot specialized in providing accurate answers to specific dental questions.
- To reduce doctors and staff by minimizing repeated questions and explanations from patients.

1.4 Expected Result

This project aims to develop a chatbot utilizing advanced natural language processing and machine learning techniques to be able to address frequently asked questions related to oral surgeries and be able to perform post-surgery follow-up. The chatbot is expected to provide an accurate response.

1.5 Scope of Work

The scope of this project involves the development of a chatbot designed to address frequently asked questions related to oral surgeries and provide post-surgery follow-up support. The chat bot will utilize natural language processing (NLP) and machine learning algorithms. The primary functions of the chatbot includes answering queries about each surgery, performing post-surgery follow-up, offering guidance and suggestions. Our primary focus will be on 4 specific surgical operations: Tooth Extraction, Wisdom Tooth Removal, Periodontal Surgery, Dental Implant Surgery.

The final deliverable of this project will be a fully functional chatbot integrated into a web application, able to handle a range of frequently asked questions and perform post-surgery follow-ups. The project involves extensive research into relevant dentistry information, the development and training of machine learning models for question answering, and the design and implementation of the user interface. A usability test will be conducted to assess the effectiveness and user-friendliness of the chatbot and the associated web application.

1.6 Project Schedule

1.6.1 Semester 1

1. Proposal
    - Discuss Project with Advisors
    - Kick-off meeting
    - Write Project Idea
    - Write Proposal Report
    - Make Proposal Presentation
2. Project Planning
    - Collect Requirement
    - Plan Task Schedule
3. Learning and Research
    - Research on Methodology
    - Research On Oral Symptoms and FAG
    - Research on Related Paper
    - Study 4 Specific Oral Surgical Operations

    - Study Post Surgery Follow-Up Procedure

4. Collect Data
    - Prepare for Data Collecting
    - Data Collecting
    - Clean Data
5. Design and Data Preparation
    - Make Use Case Diagram
    - Make Architecture Diagram
    - Design Ux/Ui
    - Design AI Design
    - Make Navigation Map
6. Implementation
    - Select an Appropriate State-of-the-art AI Model
    - Select an Appropriate Chatbot Framework
    - Select an Appropriate Front End Framework
7. Final Report
    - Write Final Report
    - Make Final Presentation

Deliverables for Term 1

- Final Proposal
- Use case diagram
- Architecture Diagram
- Navigation map
- ER Diagram
- Customer Journey
- Final UX/UI design
- Survey dental FAQ questionnaire for diagnosis and follow-up

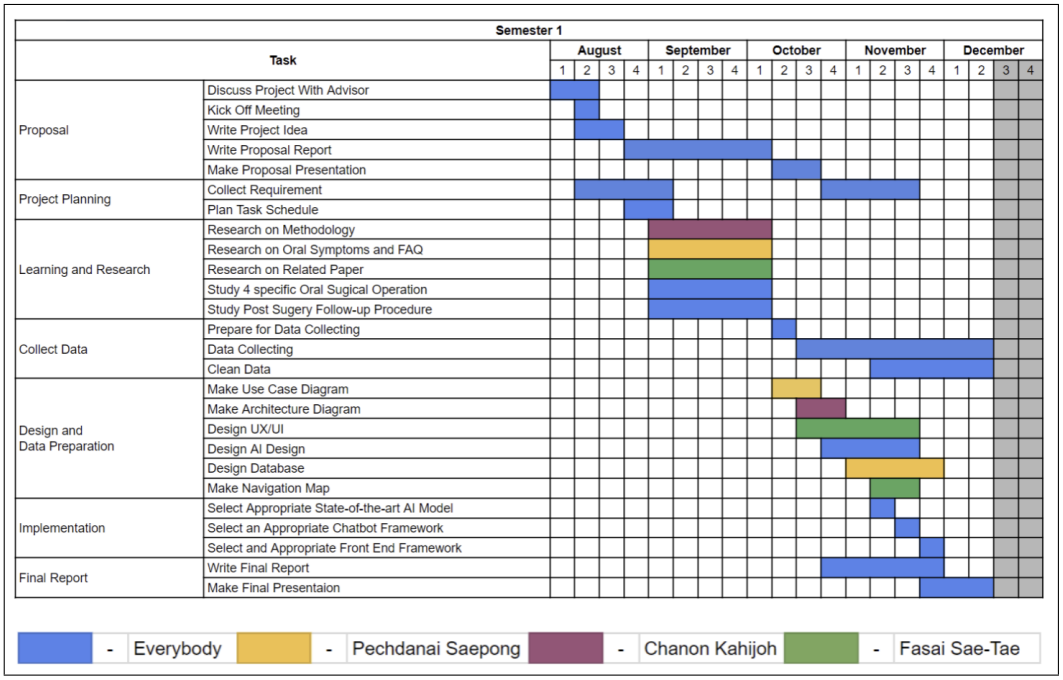

Figure 1.1 Semester 1 plan schedule

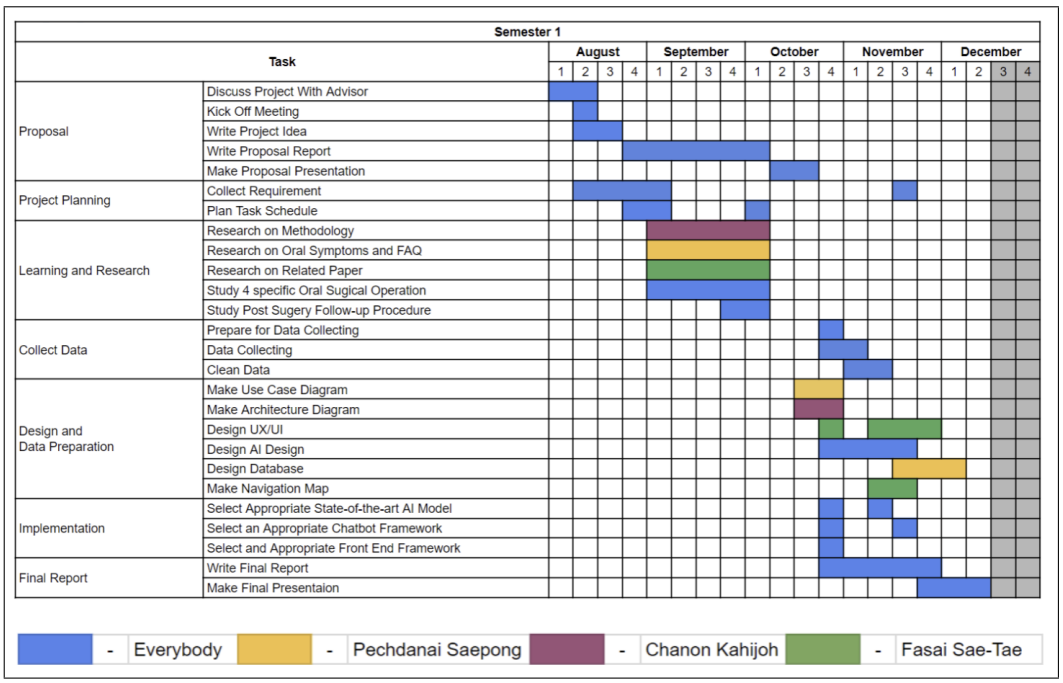

Figure 1.2 Semester 1 actual schedule

1.6.2 Semester 2

1. Deep Learning and Chatbot Implementation
    - Model Implement
    - Model Training
    - Model Testing and Evaluation
2. Web Application Implementation

- Backend
- Frontend
- Test Case Design
- Unit Testing
- Usability Testing

3. Semester 2 Report
    - Write Semester Report
    - Semester Presentation

Deliverables for Term 2

- Mobile application in both iOS and Android platform
- Testing result
- Feedbacks from users
- Senior Project Report

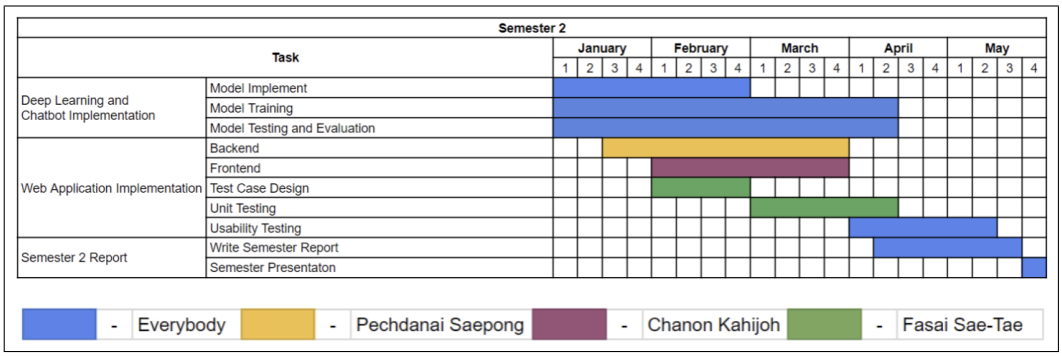

Figure 1.3 Semester 2 plan schedule

CHAPTER 2 THEORY AND RELATED RESEARCH

2.1 Introduction

This chapter will explain the details of the core concept and the solution planning. Theory and core concepts, languages and technologies, and related research will be discussed in this chapter. First, we will cover the theory and core concept of both dentistry and artificial intelligence. Second, programming languages and technologies that are intended to be used in this project will be described in the "Languages and Technologies" section. Lastly, related research and similar solution approaches to the objective will be discussed in the "Related Research and Competing Solutions" section.

2.2 Theory and Core Concepts

Common oral problems, including tooth decay, wisdom teeth complications, and gum disease, require consistent treatment for a considerable number of patients. Dentists, who routinely engage with patient inquiries and symptom tracking, have recommended that our focus be directed towards Tooth Extraction, Wisdom Tooth Removal, Periodontal Surgery, and Dental Implant Surgery. These specific procedures directly address the aforementioned common oral problems, aligning our work with the suggestions of dental professionals.

2.2.1 Tooth Extraction

Tooth extraction is a common dental procedure performed by a dentist or oral surgeon to remove a tooth from its socket in the jawbone. It is necessary for various reasons, including extensive tooth decay, crowding, tooth impaction, or as part of orthodontic treatment. Recovery typically takes a few days to a few weeks. The benefits of tooth extraction vary depending on the reason for the procedure. However, the disadvantages of tooth extraction often include challenges with chewing food and a potential loss of aesthetic appeal. Additionally, there may be complications that require careful monitoring, such as post-surgical swelling or infection.

2.2.2 Wisdom Tooth Removal

Wisdom tooth extraction, also known as third molar extraction, is a dental procedure performed to remove the third molars, commonly referred to as wisdom teeth. These teeth often become impacted or lead to various dental issues due to their slow growth and limited space in the jaw. Surgery becomes necessary for various reasons, including the prevention of pain arising from the inability of third molars to erupt properly or the prevention of issues related to crowded and misaligned teeth. However, the most common concerns associated with this procedure are the potential side effects after surgery, such as swelling, unusually significant or continuous discharge, or facial distortion lasting more than two weeks.

2.2.3 Periodontal Surgery

Periodontal surgery, also known as gum surgery, is a dental procedure aimed at treating various gum diseases and conditions. It involves the removal of infected gum tissue and, in some cases, the reshaping of the underlying bone to restore gum health and improve the stability of teeth. During this surgery, the dentist or periodontist carefully removes the diseased tissue and then shapes and contours the remaining gum and bone to promote optimal healing. In more advanced cases, bone grafts or tissue-stimulating proteins may be used to encourage tissue regeneration. Periodontal surgery is crucial in preventing the progression of gum

diseases, reducing gum pockets, and ultimately preserving the natural teeth. Besides its significant impact on oral health, undergoing periodontal surgery can also enhance an individual's confidence and self-esteem by restoring a healthy, aesthetically pleasing smile.

2.2.4 Dental Implant Surgery

A dental implant is a technology used to replace missing teeth by employing sturdy materials as dental implants to serve as replacements for natural tooth roots. Presently, it is common to use dental implants that encompass both the root and the tooth, as they closely resemble natural teeth in appearance and function realistically. Additionally, they aid in preventing the deterioration of the jawbone where the implant is placed. To be a suitable candidate for dental implants, a patient must possess healthy gums and adequate bone support for the tooth roots. Following a root canal procedure, it is imperative for the patient to consistently maintain their oral health. Dental implants offer numerous advantages, including the prevention of teeth from shifting or becoming misaligned due to tooth loss, as well as contributing to the strengthening and preservation of oral hygiene.

2.3 Languages and Technologies

2.3.1 Web Development Language

2.3.1.1 JavaScript

JavaScript, abbreviated as JS and developed by Netscape in the mid-1990s, is one of the most used programming languages in web development. It enables the development of dynamic content within web pages, enhancing websites responsiveness to user interactions.

Operating as a scripting language on the client side, JavaScript runs directly within web browsers, facilitating interaction with the Document Object Model (DOM), which represents a webpage's structure and content.

JavaScript boasts a rich set of features and capabilities, including support for various data types, loops, functions, and more. Moreover, it offers many libraries and frameworks that simplify complex tasks.

A key attribute of JavaScript is its capacity to handle asynchronous operations. Asynchronous operations enable data retrieval without disrupting the user's experience, as these operations occur independently through mechanisms such as async/await and Promises.

2.3.1.2 TypeScript

Developed by Microsoft, TypeScript (or TS) is an enhanced version of JavaScript, adding strong typing and advanced features to the original language.

One of the most noticeable changes from default JavaScript is the introduction of a strong tying system. TypeScript requires variables, function parameters, and function return types to be explicitly defined with data types. This enhances error detection during the development process, resulting in fewer bugs when the website is deployed. It also promotes easier cooperation between developers, as the code becomes more understandable.

TypeScript offers additional features, such as interfaces and custom type definitions, which enable objects to have specific shapes. This feature enhances code comprehension and facilitates integration with third-party libraries.

2.3.1.3 Python

Python, famous for its ease of use and readability, has gained in popularity in web programming due to its flexibility and an extensive collection of frameworks designed for web application development. It

is frequently employed in web backend development, offering developers a wide range of frameworks and libraries to choose from. This diversity makes it an attractive choice for creating robust and scalable websites.

2.3.1.4 Hypertext Markup Language

Hypertext Markup Language, abbreviated as HTML, serves as the standard language for creating the structural framework of websites. It uses a markup syntax consisting of tags to define various components, including headings, paragraphs, links, images, etc. HTML's simplicity, adaptability, and compatibility with multimedia features have solidified its enduring importance in the realm of website development. It stands as an indispensable tool for developing everything from straightforward web pages to complex websites.

2.3.1.5 Cascading Style Sheet

Cascading Style Sheets, abbreviated as CSS, is commonly referred to as a "style sheet." It is a language used to format HTML documents, with CSS being responsible for defining rules that specify the presentation of content within a document. These rules encompass aspects such as text color, background color, font type, and text positioning. The fundamental concept behind CSS is the separation of HTML document content from the instruction used for formatting its display. By employing this separation, CSS achieves two primary objectives. Firstly, it ensures that the document's display format is independent of its content, facilitating the task of formatting HTML documents, especially when the content undergoes frequent changes. Secondly, CSS enables precise control over the presentation format of HTML documents, ensuring consistency across all pages within the same website. Styling rules for HTML documents were initially introduced in HTML 4.0 back in 1996, in the form of CSS Level 1 recommendations established by the World Wide Web Consortium (W3C).

2.3.2 Front-end Framework

Front-end frameworks play a crucial role in web development by simplifying the creation of user interfaces. They encompass design, layout, and interactive elements such as forms and buttons. These frameworks provide pre-written code that includes HTML, CSS, and JavaScript components, facilitating code reuse and maintaining consistency across web projects. By leveraging front-end frameworks, developers can efficiently generate HTML and CSS, design responsive layouts for various devices, ensure a consistent user experience, automate repetitive tasks, and manage their code efficiently. Ultimately, front-end frameworks streamline and structure the development process, enabling the creation of user-friendly and visually appealing web applications. Examples of front-end frameworks are as follows:

- React: A front-end framework, React stands apart because of its virtual Document Object Model (DOM), which enhances its functionality. It is a perfect framework for those who expect high traffic and require a steady platform to manage it.
- Angular: Formally released in 2016, the Angular framework was established by Google to bridge the gap between the mounting demands of technology and conventional notions that displayed the results. In contrast to React, Angular is distinctive with its two-way data binding trait. It means that there is real-time synchronization between the view and model, where any alteration in the model replicates promptly on the view and vice versa.To reduce doctors and staff by minimizing repeated questions and explanations from patients.
- Vue.js: It has a small size and offers two main benefits – a visual DOM and a component-based structure. It also employs two-way data binding. This front-end framework is versatile and assists with

various tasks when building web applications. The difference between Vue and React is that Vue is a JS framework while React is a JS library. So, Vue is more suitable for large projects.

- Semantic-UI: The objective of Semantic lies in empowering the designers and developers by creating a language for sharing UI. It uses natural language that makes the entire code self-explanatory. The framework is comparatively new to the ecosystem. Still, with its striking user interface, simple functionalities, and features, it has become one of the most popular front-end frameworks.
- Next.js: Used by some of the world's largest companies, Next.js enables you to create full-stack web applications by extending the latest React features and integrating powerful Rust-based JavaScript tooling for the fastest builds.

2.3.3 Backend Framework

A backend framework serves as a foundational platform for developers to expedite the creation of web and mobile applications with standardization. In the context of backend frameworks, they simplify server-side development by offering tools, libraries, and components that streamline the construction of web applications. These frameworks automate various aspects of web development, enhancing efficiency and cleanliness in code design. Examples of backend frameworks are as follows:

- ExpressJS: It is a minimal Node.js framework used to develop highly flexible applications.
- Django: Django is the most popular Python framework used in web development. Based on the Don't Repeat Yourself (DRY) principle, Django focuses on code reusing, thus enhancing the development speed. It is also a very secure framework.
- Node.js: JavaScript is the most popular programming language in the world. With the emergence of Node.js, JavaScript's popularity in the backend development community increased rapidly, and in the last decade, Node.js has become one of the top names.
- Flask: It's a simple, highly flexible, and performing web framework. Being a lightweight framework, or micro-framework, it is easy to learn and understand Flask. Moreover, being a Python framework, it is very user-friendly.

2.3.4 Chatbot

A chatbot is a machine learning (ML) or artificial intelligence (AI) system designed to simulate and handle human conversations, whether written or spoken. These AIs enable users to interact with digital devices as if they were having a conversation with a human. Chatbots can vary widely in complexity, from basic systems that respond to user queries to advanced digital assistants that learn and adapt over time, providing personalized experiences as they collect and process data.

2.3.4.1 Chatbot Framework

A Bot Framework is a platform where developers create and define the behavior of chatbots. It simplifies the complex task of building chatbots that can operate on various messaging platforms and software development kits (SDKs). While some frameworks claim "write once, deploy anywhere" capabilities, in practice, developers often need to create separate chatbots for each messaging platform. The Bot Framework comprises components such as the Bot Builder SDK, Bot Connector, Developer Portal, Bot Directory, and an emulator for testing. However, it may not be the best choice for beginners looking to learn chatbot development due to its complexity.

Examples of Bot frameworks include:

- DialogFlow
- Microsoft Bot Framework
- Rasa
- Amazon Lex
- IBM Watson Assistant
- Wit.ai
- Botpress

2.3.4.2 Pretrained Chatbot Model

A pretrained chatbot model is a Natural Language Processing (NLP) model that has been trained on a wide range of text data from sources such as books, articles, social media, etc. These models are equipped with the capability to understand and generate text that closely resembles human language, making them valuable for chatbot development and other natural language tasks. These chatbots can also undergo fine-tuning or additional training for a specific task or domain to enhance their accuracy and performance.

2.3.4.2.1 DeBERTa

DeBERTa (Decoding-enhanced BERT with disentangled attention) is a neural language model architecture designed to enhance the performance of pre-trained models like BERT (Bidirectional Encoder Representations from Transformers) and RoBERTa (Robustly optimized BERT approach) with two techniques, a disentangled attention mechanism and an enhanced mask decoder.

The disentangled attention mechanism involves representing each word with two vectors—one for content and one for position. Attention weights among words are then calculated using disentangled matrices for content and relative positions, allowing the model to independently consider semantic content and positional relationships during computations.

The enhanced mask decoder replaces the output softmax layer to predict masked tokens during model pre-training. Additionally, a new virtual adversarial training method is applied during fine-tuning to enhance the model's generalization for downstream tasks.

The DeBERTa V2 model is a variant of the transformer architecture designed for question-answering tasks. Its structure consists of an embedding layer for word representations, employing layer normalization and dropout for regularization. The core encoder is composed of multiple DeBERTa V2 layers, each featuring a disentangled self-attention mechanism, an intermediate layer with GELU activation, and output layers for attention and transformation. The model incorporates relative positional embeddings to efficiently capture token dependencies. The final layer includes a linear output module specialized for predicting start and end positions in the input sequence, crucial for question answering. Overall, DeBERTa V2 integrates advanced attention mechanisms and positional embeddings to enhance its ability to capture complex relationships within the input data for improved performance in question-answering tasks.

2.3.4.2.2 mDeBERTa

mDeBERTa is the multilingual version of DeBERTa. Both models have the same architecture but mDeBERTa supports multiple languages while DeBERTa supports only English.

2.3.5 Machine Learning

Machine Learning (ML) is a branch of Artificial Intelligence that tries to replicate how humans work. It uses the accumulated data in order to let machines learn step by step in order to improve its accuracy in the task they are trained to do.

2.3.5.1 Decision Tree

A decision tree is a supervised machine learning algorithm used for categorizing and regression tasks. A decision tree consists of root node, decision nodes, leaf nodes, splitting, pruning, and branches.

The decision tree operates by employing various algorithms to decide to split a node into two or more sub-nodes. Decision trees work by iteratively partitioning nodes based on all available features and subsequently selecting the split that leads to the most uniform or homogeneous sub-nodes in terms of the target variable. This aims to create clear and distinct decision boundaries within the dataset, facilitating more accurate predictions or classifications by the decision tree model.

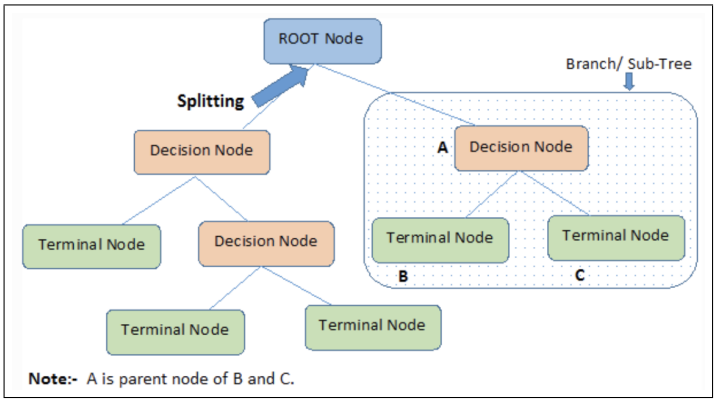

Figure 2.1 Diagram explaining Decision Tree

2.3.5.2 Random Forest

Random Forest is the combination of many decision trees and using results from all decision trees by either averaging or majority voting making it less biased which helps in overfitting problems. As you can see from Figure 1.2, the final results are obtained after getting results from many decision trees.

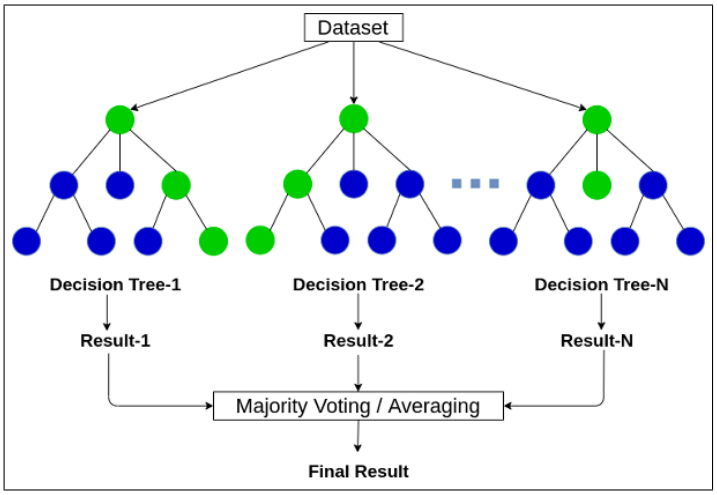

Figure 2.2 Diagram explaining Random Forest

2.3.6 Augmenting Data

We augmented text data to expand data while trying to simulate human error such as misspelling a word or typing a key by mistake. We can achieve this by inserting random characters into the questions, deleting random characters in the questions, and swapping random characters in the questions. We are also able to expand by paraphrasing the sentence. In order to have the best performance for paraphrasing we need to first translate it to English then let the AI model paraphrase as it is an English paraphrasing model then translate the results back to Thai.

2.3.7 Proposed Framework

The proposed framework has 2 components that are to be used together:

- Random Forest: classify the input question into class
- BERT: answer the user's question based on the identified class

We first input a question into a random forest in order to classify which class it belongs to. We then input that class in order to use the correct context in order to get the correct answer. With this method we can reduce time taken while trying to increase its accuracy

2.4 Related research / Competing solutions

2.4.1 Related Research

Designing a Competent Chatbot to Counter the COVID-19 Pandemic and Empower Risk Communication in an Emergency Response System

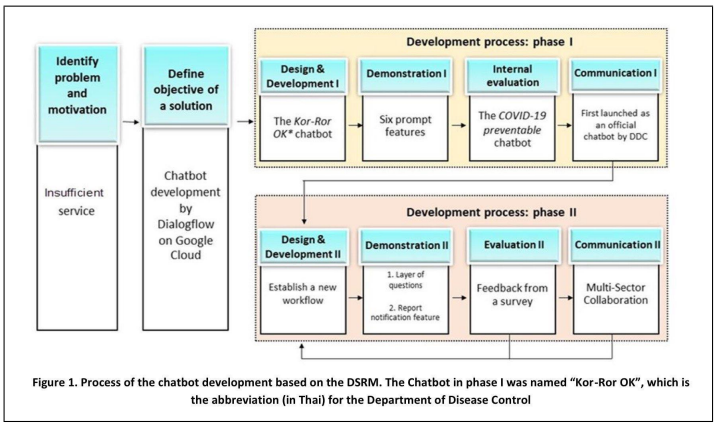

Figure 2.3 Overview of DSRM development process

This paper presented the development process and the characteristics of a competent chatbot, with an emphasis on COVID-19. The paper used Design Science Research Methodology (DSRM) as the development process to implement the chatbot, which consisted of 6 steps. Line Application was chosen as the main channel for the development and was deployed using Dialog Flow. In phase one, the development focused on implementing a chatbot capable of answering various frequently asked questions and providing knowledge about COVID-19. The emphasis shifted to more complex questions and chatbot efficiency in phase 2 of the development.

The knowledge in this paper regarding the development process can be used and applied to our development process since the output products are similar in terms of use. However, the step of product evaluation

will be different since we do not have a large number of users, and some key features, such as follow-up, are different.

2.4.2 Competing Solution

2.4.2.1 DentalChat

Figure 2.4 DentalChat Logo

DentalChat is an AI dental care application that connects and allows users to ask dental questions and is assisted by a dentist in real-time. DentalChat features consist of finding a local dentist, asking dental questions, post consult requests, and chatting with the dentist.

2.4.2.2 PsyJai

Figure 2.5 PsyJai Logo

PsyJai is a comprehensive automated AI mental health assistance system collaboration that can perform mental health assessments and provide psychological care based on the principles of psychology. PsyJai provides services through Facebook and Line. PsyJai has 4 main features: 1. Emotional Status Screening 2. Basic Care with Psychological Principles 3. General Conversations 4. Mood Dashboard.

2.4.3 Comparison Table

Table 2.1 Comparison table between our proposed solution, DentalChat and PsyJai

	Our proposed Solution	DentalChat	PsyJai
Symptom Diagnosis	AI System	Manual	AI System
Post-Surgery Follow Up	AI System	-	-

According to Table 1, our proposed solution has 2 main features: symptom diagnosis and post-surgery follow-up, both of which are AI-based systems. In contrast, DentalChat only has a symptom diagnosis feature, which is manually answered by the doctors. Psyjai also has an AI-based system for symptom diagnosis but does not have the post-surgery follow-up feature.

CHAPTER 3 DESIGN AND METHODOLOGY

3.1 Introduction

This chapter will discuss the features and architecture including the features, functionalities, designing method and diagram of the web application. We will be discussing in detail about the functionality and the architecture of the web.

3.2 Preject Functionality

3.2.1 System Requirements

- The web application must allow user to login via Line Account.
- The web application must automatically login if user access via line.
- The web application must allow all users to ask frequently asked questions from chatbot.
- The web application must allow the login users to scan qr code to create a new follow-up case.
- The web application must allow login users to answer follow-up chatbot.
- The web application must allow login users to view their own profile.
- The web applications must allow all login users to logout.

3.2.2 feature List

3.2.2.1 Patient Registration

This feature is designed as user registration for the web application, and can be accessible through Line Official. When the user accesses the web application via Line Official for the first time, they need to authorize the linking to their Line account. Once the user has authorized, when accessing the web application through Line Official menu, the user will be automatically logged in.

3.2.2.2 Frequently Asked Questions answering Chatbot

This feature is designed to provide information and answer common questions about specific surgical procedures, including Tooth Extraction, Wisdom Tooth Removal, Periodontal Surgery, and Dental Implant Surgery. Users can input their question related to the surgery mentioned, and the chatbot will provide the relevant information. When there are questions that the chatbot has never encountered and cannot answer, the chatbot will return an error message and will keep that question for future training.

3.2.2.3 Follow-up Chatbot

This feature is designed to streamline the post-surgery monitoring process by replacing the traditional method of medical staff making follow-up calls to check on patients' conditions. The chatbot is proactive in questioning by targeting follow-up questions based on the surgery the patient has undergone to gather an insight of the patient's current state to assess their condition and to provide appropriate advice.

3.2.2.4 Add new follow-up case

This feature is to create a new follow-up case by enabling the user to generate a follow-up chatbot by scanning a given QR code at the healthcare unit and selecting the operation that has undergone.

3.2.2.5 View past follow up case

This feature allows the user to view their past follow-up case history.

3.3 System Architecture

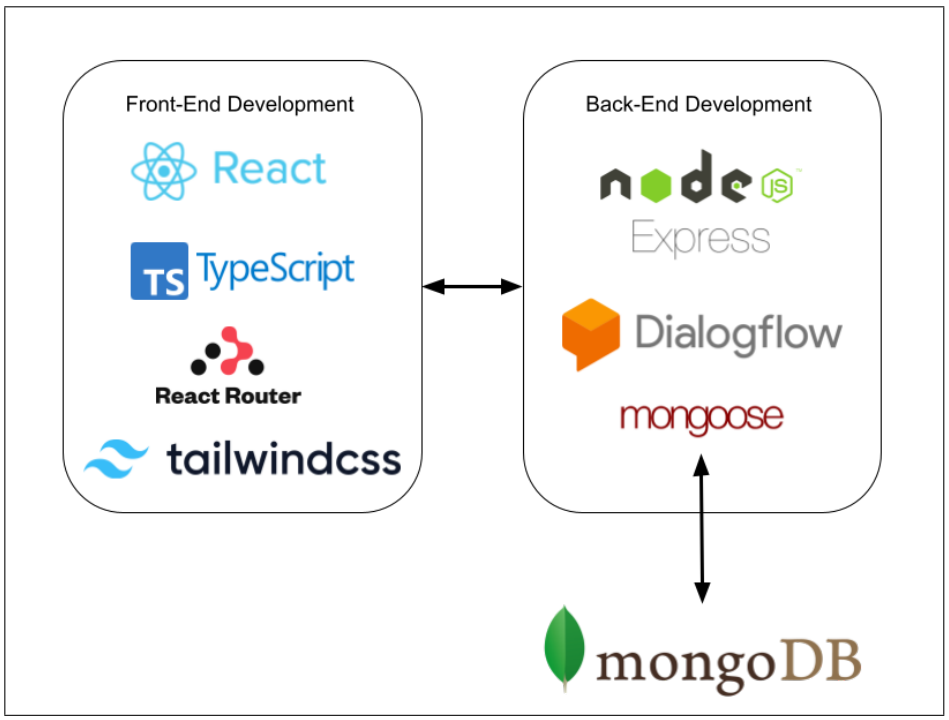

Figure 3.1 Architecture Diagram

In the Figure 3.1 above, show the architecture design of our project. The Technology that we use in this project include.

1. React (Front-end JavaScript library for building UI)
2. Sweetalert2 (beautiful popup box react component use in React)
3. TailwindCSS (Css framework for styling the UI and use with React)
4. Chart.js (free open source JavaScript library for data visualization)
5. Node.js (back-end JavaScript runtime environment)
6. Express (Back-end framework for Node.js for building REST API)
7. MongoDB (NoSQL Database)
8. Mongoose (Node.js based Object Data Modelling (ODM) library for MongoDB)
9. React selects a flexible and beautiful Select Input control for ReactJS with multiselect, autocomplete, async and creatable support
10. Dialogflow is used for follow-up using its api in order to reduce resource used in client browser

3.4 Use Case Diagram

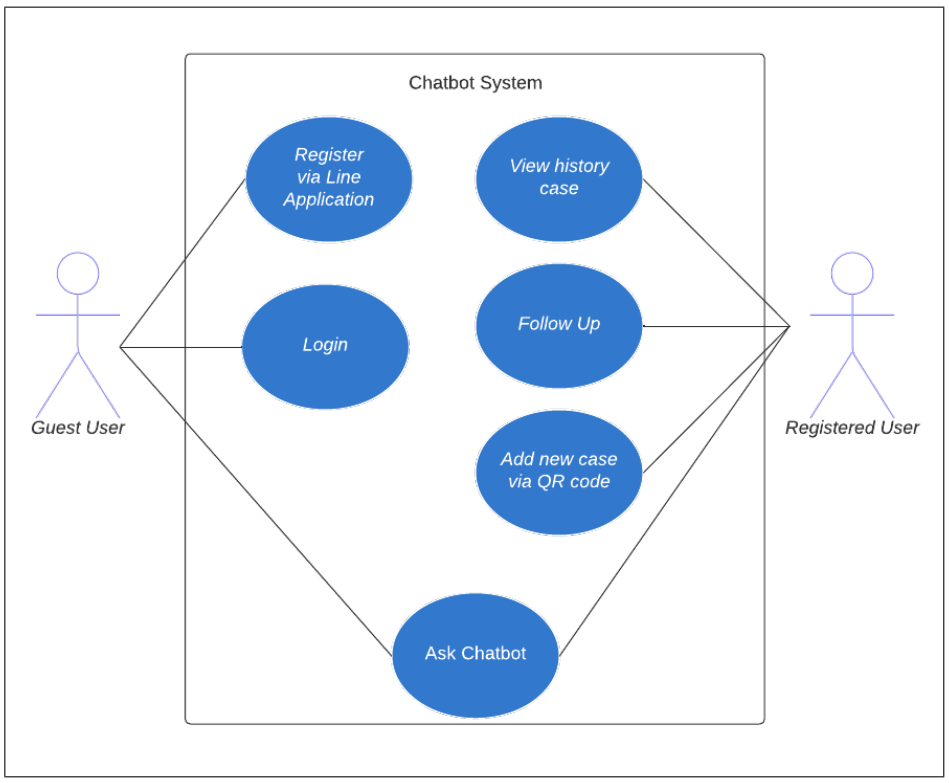

Figure 3.2 Use Case Diagram

3.5 Use Case Narrative

3.5.1 Question Answer

Use case name: Question Answer

Actors: All User

Goal: User ask questions and receive answer

Preconditions: -

Main success scenario:

1. User go to home page
2. User select chatbot button
3. User Input question
4. System answer the question

3.5.2 Login

Use case name: Login

Actors: General User

Goal: User login to the system

Preconditions: User already registered

Main success scenario:

1. User go to website homepage
2. User select login with line application button
3. System navigate to line page and set token to this account
4. System navigate user to FAQ page

3.5.3 Register

Use case name: Register
Actors: General User
Goal: Add new user to the system
Preconditions: -
Main success scenario:

1. User go to website homepage
2. User select login with line button
3. System navigate to line official login page
4. User select allow button
5. System get new user

Extension (a)

1a. User open line application
2a. User scan qr code
3a. User add line official
4a. User select allow button
5a. System get new user

3.5.4 Follow-up

Use case name: Follow up
Actors: Registered User (Patient)
Goal: Registered User answer follow up question then system send suggestion
Preconditions: User have done surgery and scan the QR code
Main success scenario:

1. User login to the system
2. System ask follow-up question
3. Login user answer the question
4. The answer relate to the question
5. System analysis and give suggestion to patient

Extension (a)

4a. The answer does not relate to the question.
5a. System sends an error message. Return to step2.

3.5.5 View case history

Use case name: View case history

Actors: Registered User (Patient)

Goal: Registered User (Patient) access user case page

Preconditions: User have done surgery

Main success scenario:

1. User login to the system
2. System navigate to FAQ Page
3. User select “Profile” button
4. User access to Profile Page with case history

3.5.6 Add new case via QR code

Use case name: Add new case via QR code

Actors: Registered User (Patient)

Goal: Registered User (Patient) add new case to system

Preconditions: User have done surgery

Main success scenario:

1. User login to the system
2. User select scan qr code in system line official
3. User scan qr code
4. User access to the form
5. User select 1 treatment operation
6. User submit the form to system

3.6 Activity Diagram

3.6.1 Question Answering

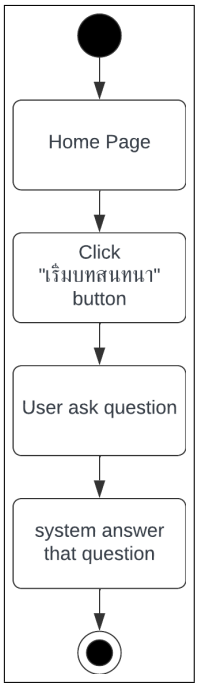

Figure 3.3 Question Answering Activity Diagram

When user access to homepage and click “เริ่มบทสนทนา” button, system will show chatbot interface and user can input a question in input text box then system will answer that question.

3.6.2 Login

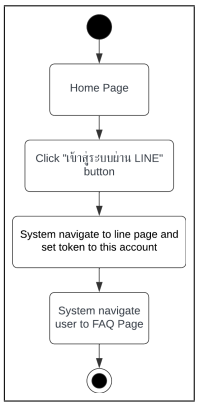

Figure 3.4 Login Activity Diagram

When user access to homepage and click “เข้าสู่ระบบผ่าน LINE”, system will navigate user to line page then navigate to FAQ page.

3.6.3 Register

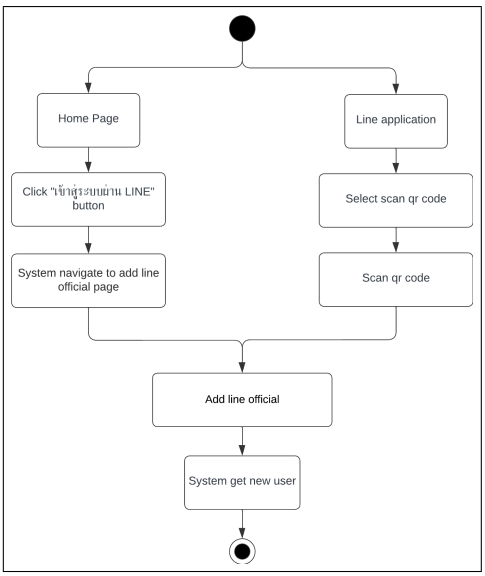

Figure 3.5 Register Activity Diagram

When user access to homepage and click “เข้าสู่ระบบผ่าน LINE” button, system will navigate user to add line official page and user click add line official then system will register this user automatically. In another way, user access via line application and select scan qr code then scan our qr code at medical unit, and select add line official, system will register this user automatically as well.

3.6.4 Follow-Up

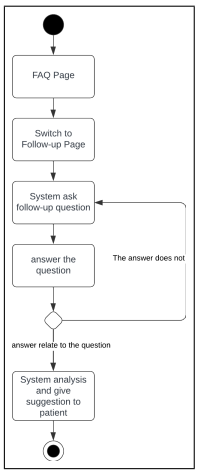

Figure 3.6 Follow-Up Activity Diagram

When user access FAQ page after login completely and switch to Follow-up page, system will show follow-up chatbot interface then system will ask follow-up question, and user answer questions, if answer related to question system will analyze that answer and give suggestion to user, but if answer does not related to question, system will try to ask again to get related answer from user.

3.6.5 View case history

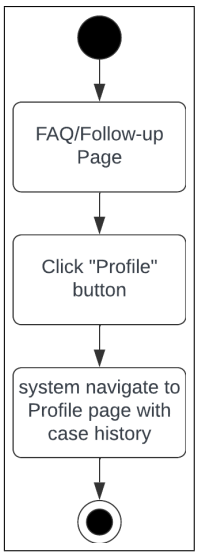

Figure 3.7 View case history Activity Diagram

When user access FAQ or Follow-up page and click on “Profile” button, system will navigate to profile page with case history.

3.6.6 Add new case via QR code

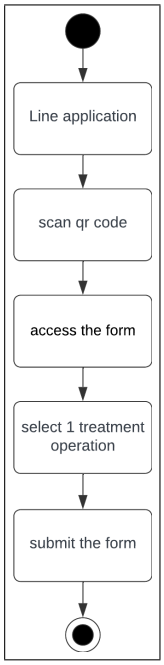

Figure 3.8 Add new case via QR code Activity Diagram

When user open line application and scan our qr code, user will access to the form that user need to select one of treatment operations and submit the form.

3.7 Navigation Map

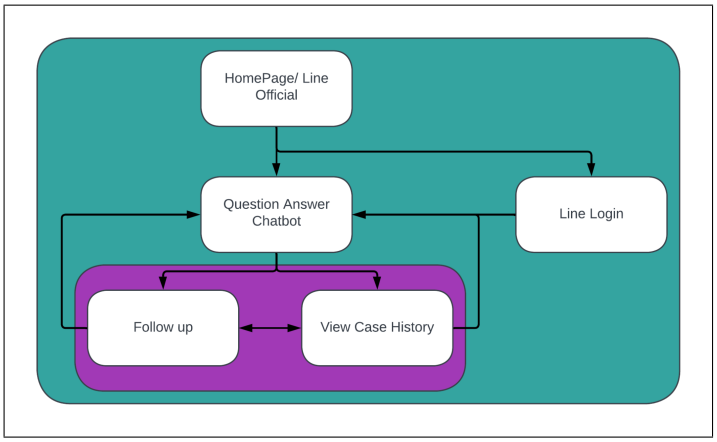

Figure 3.9 Chatbot web application navigation map

For the web application, there are two roles which are Guest user and Registered user. Every user starts with the Homepage, Guest can only access the FAQ Chatbot and Login page, while Registered users can also access the Follow Up page and View Case History page.

When accessing the platform through Line Official for the first time, the account will automatically create and link to the user's line account. For users who already have an existing account, if the user accesses any feature via the menu in Line official, will automatically login. However, if the user accesses the platform through normal web interface, will first land on the homepage and be able to use only Question Answering chatbot without the need to login. To access the follow-up feature through normal web interface, users are required to login via line account.

3.8 ER Diagram

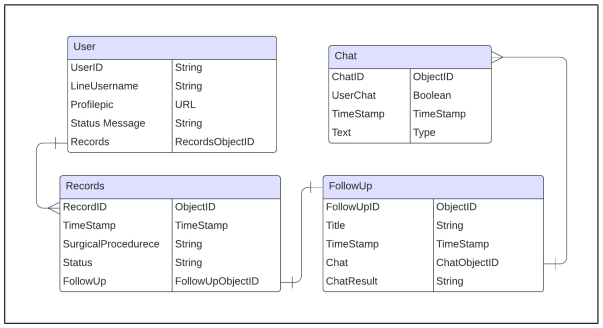

Figure 3.10 ER-Diagram

Figure 3.10 shows the basic database design, which is required for store registered users. There are a total of 4 objects in our application. In the User object, it will have userID, Username, Profilepic, StatusMessage which is linked to Line profile. The User object will also contain lists of RecordObject and FollowUpObject. In RecordsObject, there is RecordID, TimeStamp, SurgicalProcedure and Status. The RecordID is linked to the User object. In FollowUp Object, there is FollowUpID, Title, TimeStamp, Chat and ChatResult. The FollowUpID is linked to the Record object and it is one to one relation. In ChatObject, there is ChatID, UserChat, TimeStamp, and Text. The ChatID is linked to the FollowUp object.

3.9 User Interface

3.9.1 Home Page

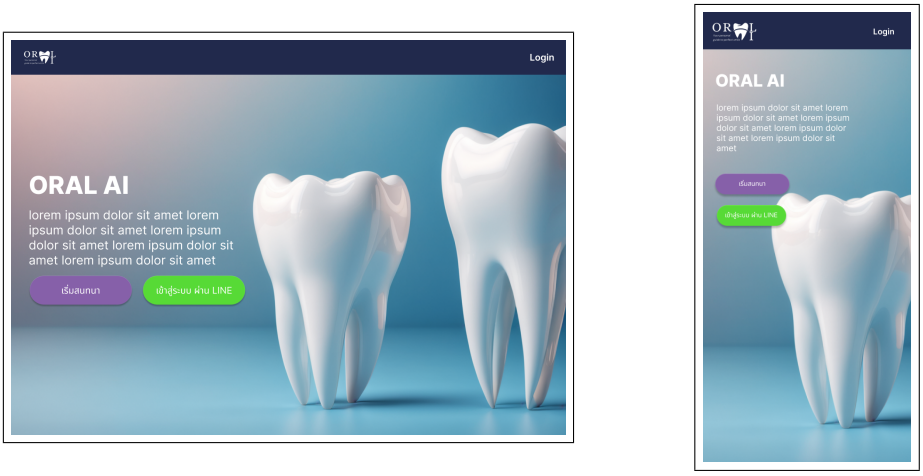

Figure 3.11 Website home page (Desktop and mobile respectively)

Figure 3.11 is the home page of the web application, this page will show a short description about our website and includes 2 buttons, Start Chatting and Login by Line. The Start Chatting button will take the user to the question answering page and Login by Line will link to the Line login page.

3.9.2 Follow-Up page

Figure 3.12 Desktop Follow-Up page

Figure 3.12 is the Follow-Up page of the web application on desktop, this page includes case history in the left side of the page which is able to click to see follow-up chat history and chat box in the middle of the page, and input textbox under the chat box, and switch bar in the top of chat box use for switch between FAQ and Follow-up feature.

3.9.3 Follow-Up page

Figure 3.13 Mobile Follow-Up page

Figure 3.13 is the Follow-Up page of the web application on mobile, on the left is its normal state and on the center is when the keyboard is used. On the right is when the hamburger button is pressed, the keyboard input will be dismissed and be replaced with a long closed button to go back to its normal state.

3.9.4 FAQ page

Figure 3.14 Desktop Question Answering page

Figure 3.14 is the Question Answering page of the web application on desktop, this page includes a chat box in the middle of the page and input textbox in the bottom and switch bar in the top of the chat box used for switching between FAQ and Follow-up feature.

Figure 3.15 Mobile Question Answering page

Figure 3.15 is the Question Answering page of the web application on desktop, on the left is its normal state and on the right is when the keyboard is used.

3.9.5 Patient Info page

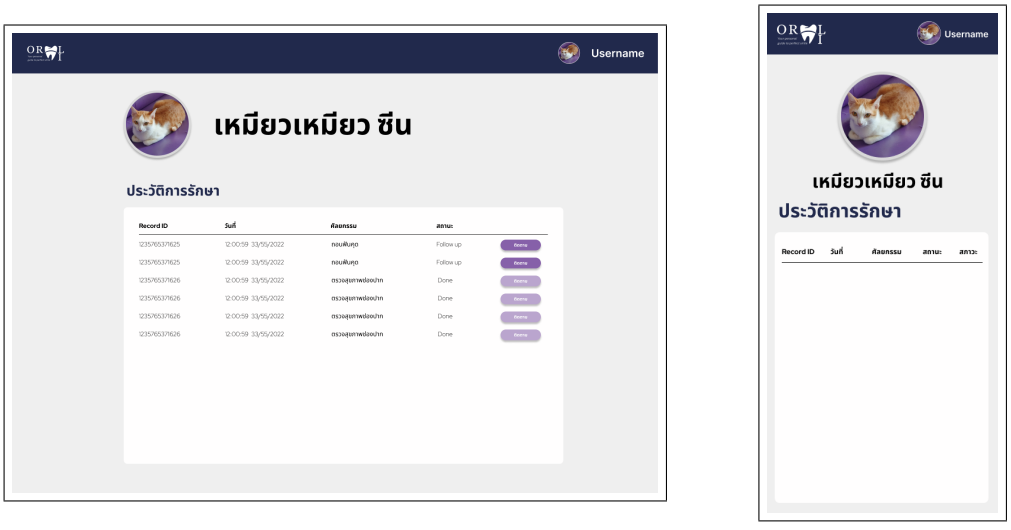

Figure 3.16 Patient Information page (Desktop and mobile respectively)

Figure 3.16 is the Patient Information page of the web application, it shows all the patient oral medical history that they registered. The record shows the record ID, Timestamp, Surgical Procedures type, status and the conditions.

3.9.6 Line official page

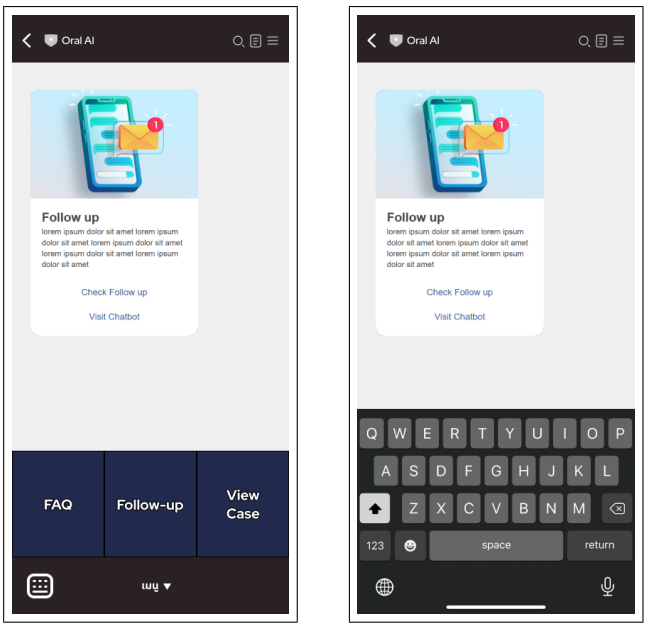

Figure 3.17 Line Login Page

Figure 3.17 is how the line official page will look like, all notifications will be sent through here. The FAQ button will lead to the question answer website, Follow-up will lead to the follow up page of the website and view case will lead to the patient information page.

3.10 Evaluation Plan

3.10.1 User Evaluation

After developing the platform in accordance with our goals , We will test our application and gather user feedback. We will collect the data about overall satisfaction, usability, user experience, and improvement suggestions. After the data has been collected, we will analyze and evaluate the application.

3.10.2 Application Evaluation

In assessing the performance of critical components, focus will be placed on two key metrics. First, Response Latency will be closely monitored the speed at which the chatbot responds to user queries. Additionally, Load Tests will be conducted to evaluate the system's capacity to handle user interactions. Furthermore, accuracy in providing precise and correct answers to dental queries ensures the chatbot's proficiency in delivering accurate information.

CHAPTER 4 EXPERIMENTAL RESULTS

4.1 Dental Frequently Asked Question Collection

Since the project should be able to answer the input queries, we have gathered commonly asked questions about the 4 surgeries mentioned. We conducted surveys and consulted with experts to ensure accurate and appropriate answers. This section contains the questionnaire and its results.

4.1.1 Collection Process

The questions were gathered using Google Forms. The questionnaire below was created aimed to cover a wide range of opinions and concerns regarding dental health and medical treatments. Questions in the questionnaire consisted of คุณเคยผ่านการรักษาหรือการผ่าตัดไหนมาแล้วบ้าง, สาเหตุที่คุณเข้ารับการรักษา/ผ่าตัด, คำถามที่มักจะเจอ-หรือสงสัยเกี่ยวกับโรคและการรักษา/ผ่าตัดข้างต้น, คำถามที่มักสงสัยหลังจากที่ได้รับการรักษา/ผ่าตัด.

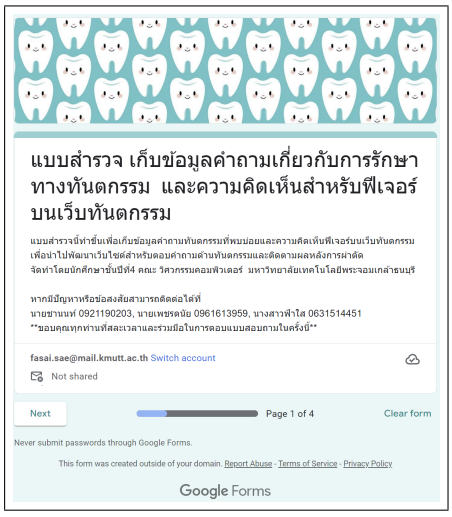

Figure 4.1 First page of the questionnaire

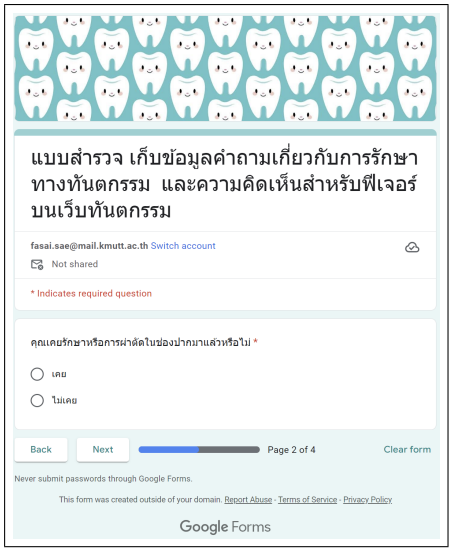

Figure 4.2 Second page of the questionnaire

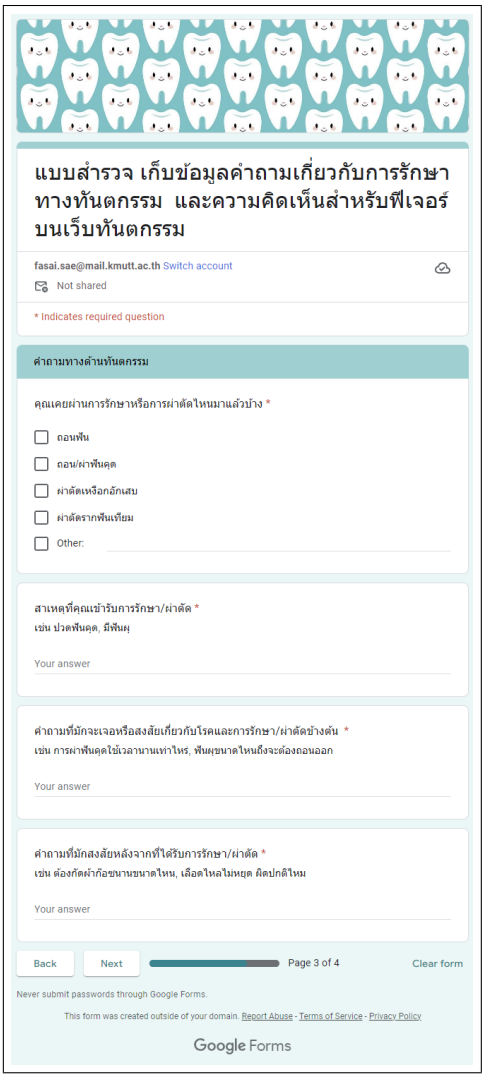

Figure 4.3 Third page of the questionnaire

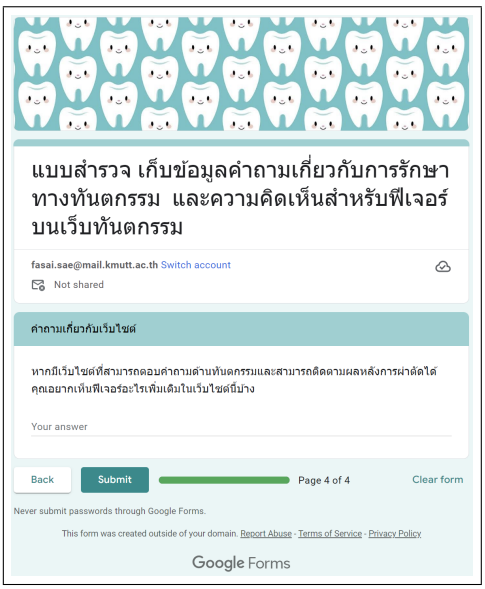

Figure 4.4 Fourth page of the questionnaire

4.1.2 Results

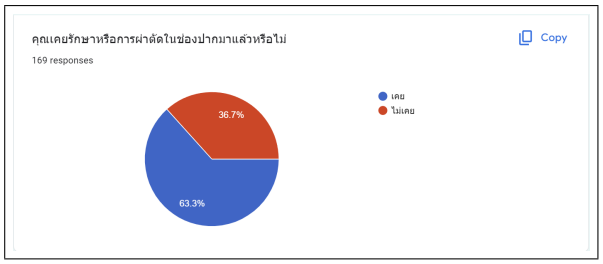

Figure 4.5 Pie chart of Distribution of Oral Surgery Experience

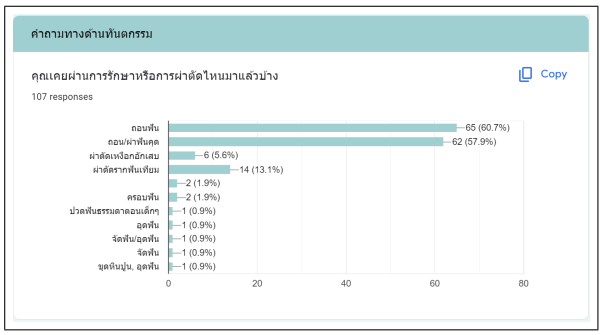

Figure 4.6 Respondent's Oral Surgeries Experience

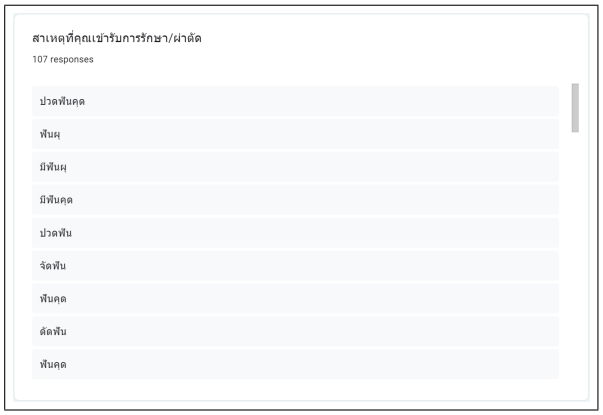

Figure 4.7 Reason the Respondent Attend the Treatment

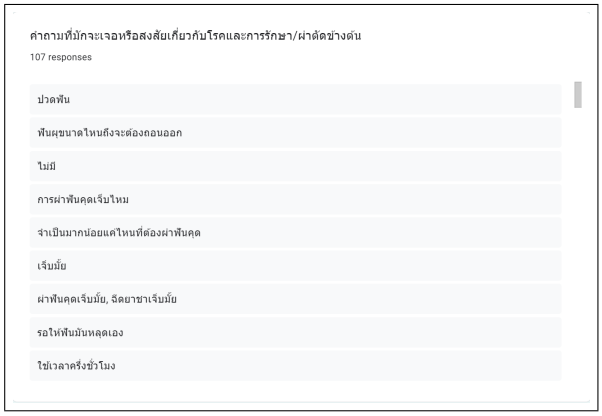

Figure 4.8 Common Questions and Concerns About Surgeries and Treatment

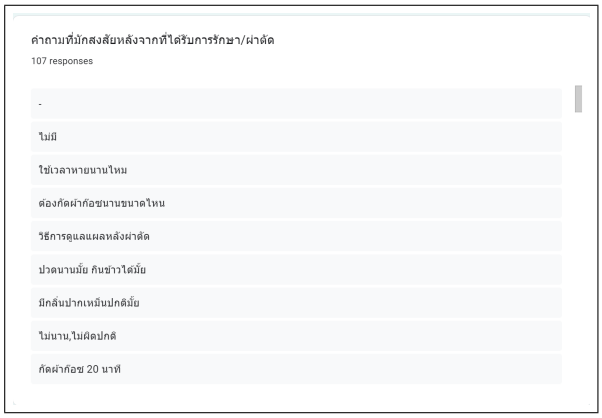

Figure 4.9 Post-Treatment Frequently Asked Questions

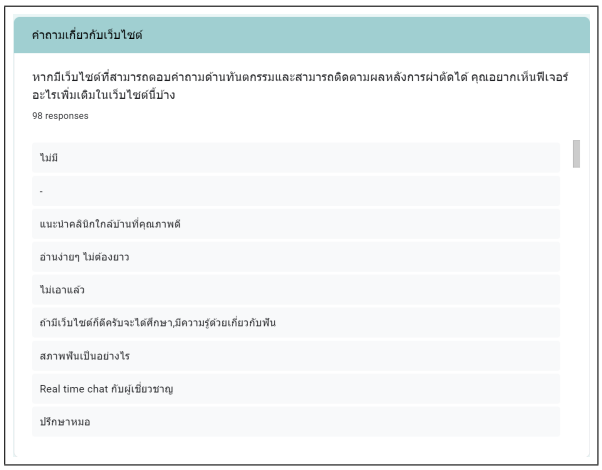

Figure 4.10 Recommendations for Website Development and Features

4.2 Follow-Up Procedure Interview

Since the follow-up process is one of the project's main features, we must examine every important aspect in order to emphasize the post-surgery follow-up in the context of dental healthcare, understand the importance of comprehensive patient care, as well as the details of the follow-up process. This will allow us to imitate the actual medical staff procedure. This section explains how we conducted interviews with the dental clinic's medical staff in order to gain important insights into the techniques used for post-surgery tracking.

4.2.1 Interviewing Dental Clinic Around the University

To gain an insight and understand post-surgery follow-up procedure, we have first conducted an interview at the dental clinic around the university. The interview question include question such as ขั้นตอนการติดตามอาการผู้ป่วย, โดยปกติแล้วจะทำการโทรติดตามอาการคนไข้กี่ชั่วโมงหลังผ่าตัด, คำถามที่มักจะถามผู้ป่วยตอนติดตามอาการ, คำถามที่ผู้ป่วยมักจะถามกลับมา. After these interviews, we have gained invaluable insights and a deeper understanding of the follow-up procedures, enhancing our research with firsthand perspectives on patient care in the post-surgical phase within the local dental healthcare landscape.

4.2.2 Interviewing and Survey at Faculty of Dentistry at Chulalongkorn University

According to the important requirement for an in-depth understanding of the practicalities involved with the follow-up procedure, we needed to familiarize ourselves with the patient's involvement following surgery. This includes an in-depth investigation of complexity of questions, symptom assessment, patient interaction during the follow-up phase, and response to particular concerns. Regarding the complexity of these interactions, we think it is important to have discussions and obtain advice from professionals, especially those who have experience with the follow-up procedure, and patient communication.

In order to capture the view of the expert and match our project with the actual demands of both medical professionals and patients, we conduct an on-site observation and interviews at the Faculty of Dentistry, Chulalongkorn University.

Figure 4.11 Our team and the call-center representative

The call-center representative works at the OPD Instant Clinic's call center. The department is in charge of answering questions and helping out OPD patients.

Figure 4.12 Working environment of the OPD Instant Clinic's call center

The OPD Instant Clinic's call center is following-up with their patient a day after the surgeries.

Figure 4.13 Conversation with the nurse who is experienced in the patient follow-up process

The follow-up process usually happens three days following a patient's discharge. The nurse will follow-up with the patients and give them advice if needed.

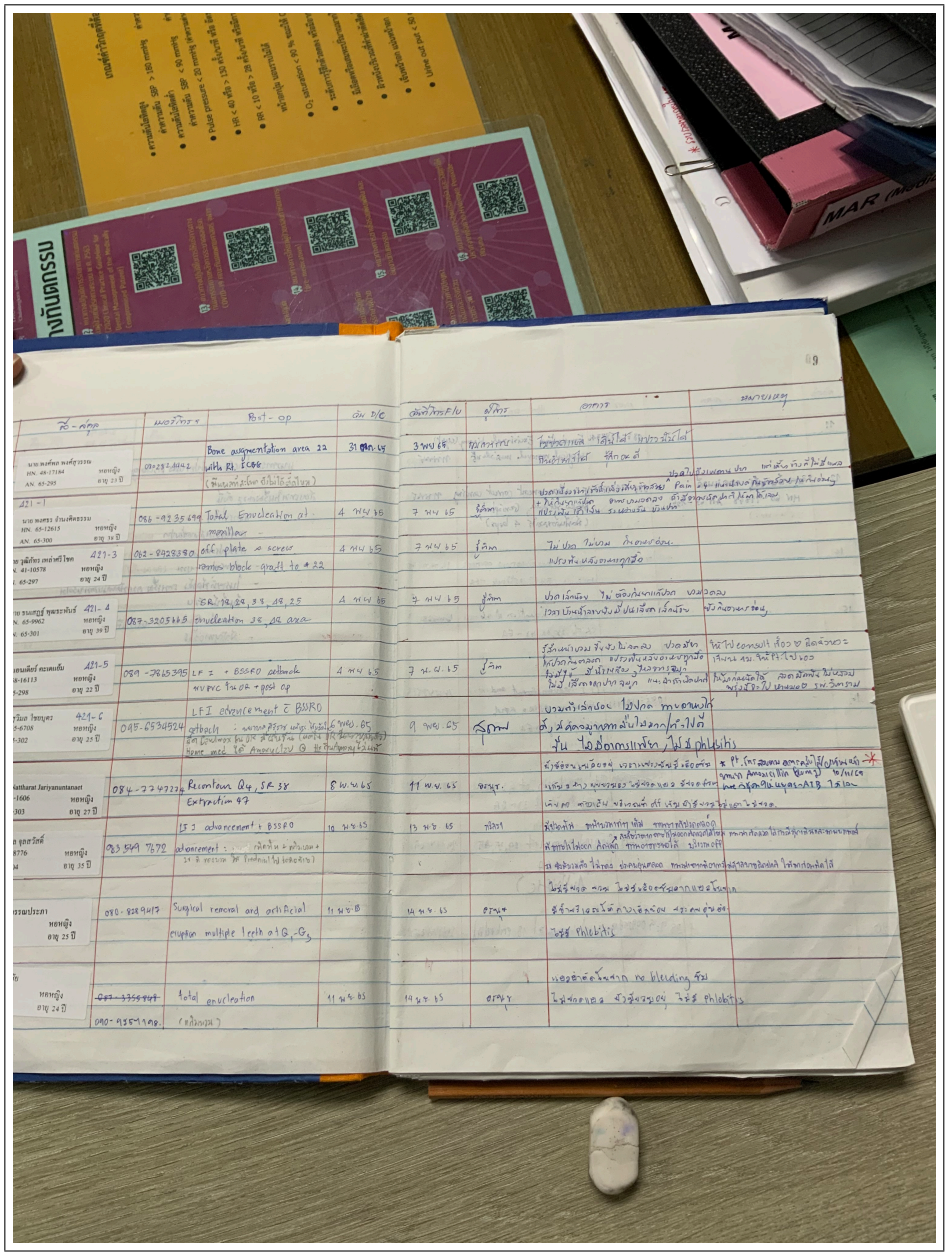

Figure 4.14 Document that the nurse has documented patient information during follow-up sessions

The nurse records details such as the operation, discharge date, follow-up date, contact person, symptoms, and any additional notes. This approach is a comprehensive and accurate way of tracking patient data gathered during follow-up calls.