UTHM DENTAL APPOINTMENT SYSTEM WITH ROLE-BASED ACCESS CONTROL (RBAC) FOR UTHM HEALTH CENTER

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A project report submitted in partial fulfilment of the requirement for the award of
the Bachelor of Computer Science (Information Security) with Honours

Faculty of Computer Science and Information Technology
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AUGUST 2025

I hereby declare that the work in this Report is my own except for quotations and summaries which have been duly acknowledged

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DEDICATION

To my family,

who with love and effort have accompanied me in this journey, without hesitating at any moment to see my dreams come true, which are also their dreams.

ACKNOWLEDGEMENT

ABSTRACT

The UTHM Dental Appointment System is an innovative solution designed to enhance the management of dental care appointments at University Tun Hussein Onn Malaysia's health center. This web-based system aims to streamline scheduling processes, reduce manual errors, and ensure timely dental appointments for students and staff. Currently, the manual appointment system results in inefficiencies, such as scheduling appointment conflicts, long wait times, and increased administrative burdens. It also exposes sensitive data to potential security risks due to the use of physical records. The development of this system follows the agile methodology, which ensures continuous improvements and stakeholder involvement throughout the process. The system integrates advanced technologies, such as Role-Based Access Control (RBAC) and End-to-End Encryption (E2EE), to safeguard patient data and optimize access controls. A part of that, UTHM Dental Appointment System also utilizes MySQL as its database for securely storing patient records and appointment data, while the front-end is developed using HTML for structure and design, and Java and PHP are employed for back-end functionalities and system logic to ensure a seamless and secure user experience. By automating appointment scheduling, notifications, and record-keeping, the system eliminates overlapping appointments and reduces administrative workload. It also provides actionable insights for resource allocation, ultimately contributing to better dental care for the university community.

ABSTRAK

Sistem Temu Janji Pergigian UTHM merupakan satu penyelesaian inovatif yang direka bentuk untuk meningkatkan pengurusan temu janji penjagaan pergigian di Pusat Kesihatan Universiti Tun Hussein Onn Malaysia. Sistem berasaskan web ini bertujuan untuk memudahkan proses penjadualan, mengurangkan kesilapan manual, dan memastikan temu janji pergigian dapat dilakukan tepat pada masanya bagi pelajar dan staf. Pada masa ini, sistem temu janji secara manual menimbulkan pelbagai ketidakcekapan seperti konflik penjadualan, masa menunggu yang lama, serta beban kerja pentadbiran yang meningkat. Selain itu, penggunaan rekod fizikal turut mendedahkan data sensitif kepada risiko keselamatan. Pembangunan sistem ini menggunakan metodologi Agile yang memastikan penambahbaikan berterusan dan penglibatan pihak berkepentingan sepanjang proses pembangunan. Sistem ini juga mengintegrasikan teknologi terkini seperti Kawalan Akses Berasaskan Peranan (RBAC) dan Penyulitan Hujung-ke-Hujung (E2EE) untuk melindungi data pesakit dan mengoptimumkan kawalan akses. Di samping itu, sistem ini menggunakan MySQL sebagai pangkalan data untuk menyimpan rekod pesakit dan data temu janji dengan selamat. Antara muka hadapan dibangunkan menggunakan HTML untuk struktur dan reka bentuk, manakala Java dan PHP digunakan bagi kefungsian belakang dan logik sistem untuk memastikan pengalaman pengguna yang lancar dan selamat. Dengan mengautomasi penjadualan temu janji, pemberitahuan, dan penyimpanan rekod, sistem ini dapat menghapuskan pertindihan janji temu serta mengurangkan beban pentadbiran. Ia juga menyediakan pandangan yang berguna untuk pengagihan sumber secara lebih efektif, seterusnya menyumbang kepada peningkatan kualiti penjagaan pergigian bagi komuniti universiti.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER ONE

INTRODCUTION

1.1 Project Background

University Health Center's, of University Tun Hussein Onn Malaysia (UTHM) provides many types of services such as dental examination and consultation, medication and dental check-ups, dental X-ray examinations, dental treatments and fillings, dental scaling, oral health education, root canal treatments (specific cases), tooth extractions (front and molar teeth), and minor dental surgeries such as operculectomy for certain surgical cases. The process was majorly manual made where patients had to actually visit the clinic, fill out paper forms, and these were later processed, stored, or managed manually by the administrative staff. [1]. This meant a whole lot of time and resources being wasted hence prone to human error, misplacement of records, or even scheduling conflicts. Large amounts of paperwork and files would make it hard to retrieve information, particularly during peak hours of appointments. Moreover, the lack of a proper digital system rendered it more difficult to track appointment histories or to monitor data usage, and consequently, longer waiting times, misallocation of resources, and tardy service delivery.

Besides, the manual system did not support proper security of sensitive patient information [2]. Physical records might have gotten into the hands of unauthorized personnel, lost, or damaged, risking patient privacy. Recognizing these issues, UTHM Dental Appointment System with RBAC is proposed to modernize the scheduling process through an automated and secure web-based platform for dental appointments. This solution would foster operational efficiency and bring data security to a new level, thereby allowing UTHM Health Center to provide better and more secure dental services to students and staff.

1.2   Problem Statement

The UTHM Health Center currently use a process that is manual to manage the dental appointment processes, which limits its users' efficiency and effectiveness. To store patients' dental appointment information and histories, dentists and staff use paper forms. It is challenging to keep track of previous records using this paper-based method, particularly when working with a large patient population. Additionally, storing dental appointment data on paper presents security problems since unauthorized people might easily accessed, misplaced, or modified by unauthorized individuals. Sensitive dental appointment data may be vulnerable to identity theft, illegal access, and information manipulation in the absence of appropriate security measures.

To address these issues, the UTHM Dental Appointment System with Role-Based Access Control (RBAC) was developed. This web-based system allows only registered users patients, dentists, and staff to securely access the platform. All dental records are stored in a centralized database, enabling authorized users to efficiently retrieve and update information while preventing unauthorized access. RBAC limits data access based on user roles, reducing the risk of misuse or tampering. Security features like access control and encryption further protect patient data and enhance trust in the university's dental services.

1.3   Objective

The objective of this project are:

    i.   To design a secure web-based UTHM Dental Appointment System with RBAC.

    ii.   To develop the proposed system using Java, HTML, PHP and MySQL.

    iii.   To test the functionality and usability of UTHM Dental Appointment system with RBAC.

1.4   Project Scope

Table 1.1 shows systems of UTHM Dental Appointment System with Role-Based Access Control (RBAC) for UTHM Health Center where each module serves a specific purpose to ensure smooth and secure operation.

Table 1.1: System Function Module List

Module	Description
User Authentication Module	Provides a secure login interface with role-based access control, ensuring that only authorized users can access specific parts of the system. Users are required to
Patient Management Module	Allows dentists to access patient records, view appointment histories, and review treatment plans. This module provides dentists with essential information to prepare for consultations.
Appointment Scheduling Module	Offers an intuitive interface for students to book and cancel appointments. Students can view available time slots, choose a convenient time, and receive confirmation for their appointment.
Notifications Module	Sends automated alerts and reminders to patients regarding upcoming appointments or any changes in schedule. Notifications are sent via email to help students keep track of their appointments.
Reporting Module	Generates detailed reports for administrative staff, showing appointment trends and service utilization. Staff can use these reports to analyse system performance and improve service quality.
Dashboard Module	Provides a central overview of key system metrics, such as daily appointments and usage statistics. It displays real-time data, helping administrators monitor the system's overall performance and keep track with the appointments.
Login Registration Module	Manages the registration process for new users, including students and staff, dentists, and administrative staff. Users are required to submit necessary information, and system administrators assign roles and permissions based on user type.

To solve the inefficiencies and security issues in the present manual system, the UTHM Dental Appointment System with Role-Based Access Control (RBAC) For UTHM Health Center is suggested and built, as shown in Table 1.1. To guarantee that only verified users may use the system, patients must register as new users. This procedure is managed by the Login Registration Module, which allocates responsibilities and permissions according to user types. Dental records are therefore securely kept in a centralized database, reducing the possibility of unauthorized access, and can be updated and reviewed by staff members and dentists using the Patient Management Module. By limiting access to sensitive information according to user responsibilities and preventing unwanted changes, RBAC lowers the possibility of information tampering. Additionally, to protect patient information and increase user confidence in the university's healthcare services, cutting-edge security methods including data encryption and access control mechanisms are used. These enhancements also provide more individualized care delivery, effective resource allocation, and more intelligent healthcare planning.

Dentists, administrative staff, students, university workers, and IT personnel are among the system's main stakeholders. Administrative personnel supply the necessary resources for scheduling and patient data administration, while dentists offer their perspectives on service and time management. Through the Appointment Scheduling Module, the main users are staff and students which provide input on how accessible and easy it is to make appointments. IT staff oversee managing the system's technological advancement and seamless implementation, making sure that features like User Authentication, Notification, Reporting, and Dashboard operate efficiently and safely. This cooperative approach guarantees that the system satisfies all users' practical demands in addition to technical and security requirements.

1.5   Expected Result

The University Health Center is expected to effectively develop and implement a dental appointment management system at the project's final analysis, called the UTHM Dental Appointment System with Role-Based Access Control (RBAC). By providing a user-friendly through the web interface that enables users to book, cancel,

view and delete dental appointments from any place at any time, the system aims to improve the overall appointment experience for both staff and students. By eliminating the necessity for physically presence throughout the booking process, this feature guarantees flexibility and ease. It is also expected to reduce the staff's workload and time spent on managing appointments manually.

A real-time appointment scheduling module that gives access to staff schedules, services options, and available time slots will be included into the system. With this feature, patients can make informed decisions when booking appointments, as they will be able to view all relevant service descriptions, availability windows, and appointment history. This transparency is expected to empower users to select the most convenient options while also improving the overall resource allocation at the dental clinic. Additionally, a notification module will send automated reminders via email which helping users getting notify of the appointment details status and remember their upcoming appointments. This is expected to reduce no-show rates and improve the efficiency of dental service delivery.

Technically, the system stores appointment data in a secure centralized database, enabling quick access for authorized users. RBAC ensures only users with appropriate roles can access or modify sensitive data, while End-to-End Encryption (E2EE) protects data during transmission. These features enhance privacy, security, and user trust. Additionally, a reporting module offers insights into system usage and appointment trends, supporting better planning and service improvement. Overall, the system aims to provide a secure, efficient, and user-friendly dental appointment experience.

1.6   Importance Of Project

There are several significant advantages that can be gained from the implementation of the UTHM Dental Appointment System with Role-Based Access Control (RBAC) at the UTHM Health Center. Firstly, the primary advantage is the improvement of convenience in appointment management. By implementing the integration of an online scheduling system, students and staff can easily book, view, or cancel their dental appointments at any time without the need to physically visit the clinic. This

self-service feature empowers users to manage their appointments more efficiently, reducing the workload on administrative staff. Furthermore, the system provides real-time availability of appointment slots, allowing users to view time, date, and service availability instantly.

The second advantage is the enhancement of operational efficiency. Through integration with a centralized secure database and automated scheduling system, all appointment records are synchronized, making it easier for administrative staff and dentists to manage appointment and treatment sessions. Changes such as rescheduling or cancellations are automatically reflected in the system and linked to the admin's calendar. In addition, automated reminders are sent to patients via email to notify them about registration details, appointment status verification and upcoming appointments, reducing the chances of missed appointments. This allows the staff to stay organized and focus more on patient care rather than on managing manual paperwork or follow-ups.

The third advantage involves the reduction of human error. Since the appointment system automates most of the appointment and notification processes, it minimizes errors such as double bookings, incorrect time slots, or forgotten reminders. Previously, staff were responsible for handling appointments manually, which often led to confusion, delays, and inconsistencies. With this system, all actions are tracked and validated, ensuring accurate scheduling and timely reminders, which contribute to a more systematic and reliable service environment.

Lastly, the system significantly enhances the security and confidentiality of patient information. In manual system, dental records and appointment data were handled using physical forms, which exposed them to risks such as unauthorized access, loss, or damage. With the implementation of Roled-Based Access Control (RBAC), End-to-End Encryption (E2EE), Password Hashing, Input Validation, Database Authorization, Email Notification and Two-Factor Authentication (2FA), data is securely stored in an encrypted digital database. This layered security approach ensures that all patient records remain confidential, reducing the risk of data breaches and strengthening user trust in the university's healthcare services.

1.7   Report Organization

This report is organized into six chapters, starting with Chapter 1, which provides background information on the project, highlights the main problems with scheduling dental appointments by hand, and explains the goals, scope, anticipated results, and importance of the suggested system. In-depth reviews of relevant technologies and systems are given in Chapter 2. In addition to highlighting security aspects like encryption, password hashing, input validation, and two-factor authentication, it looks at current dental appointment platforms. Additionally, it examines the function and application of Role-Based Access Control (RBAC) and assesses a number of existing systems to demonstrate the necessity of the suggested remedy.

The Agile technique is used in Chapter 3 to describe the system development process, covering every stage from planning to review. Chapter 4 covers the design architecture, flowcharts, database structure, user interfaces, and functional and non-functional needs of the system. In addition to presenting the findings of system testing, Chapter 5 emphasizes the deployment of important features, such as security elements like RBAC. Chapter 6 concludes with a summary of the overall results, an assessment of the system's advantages and disadvantages, and suggestions for future development.

CHAPTER TWO

LITERATURE REVIEW

2.1   Introduction

Explanation about UTHM Dental Appointment System in 2.2. With overview of the current system is explained in section 2.2.1. Security measures are discussed in this chapter in section 2.3. Authentication of system is examined in section 2.4. In section 2.5, role-based access control is discussed in this section. Hashing algorithm is discussed in section 2.6. In section 2.7, data management are explained in this section. Along with that, in section 2.8 is the comparison between three existing systems and proposed system. Lastly, in section 2.9 is the chapter summary.

2.2   Dental Appointment Systems

The purpose of dental appointment systems is to make it easier for patients to book, view, and keep track of their appointments. Both patients and staff save a great deal of valuable time due to these solutions, which lessen the burden of manual tasks like paperwork and phone calls. Previous appointment systems relied on manual tasks like creating timetables in hardcopy or utilizing rudimentary spreadsheets. In addition to being extremely time-consuming, this approach was more vulnerable to errors, such as scheduling appointments around the same times and lead to data loss. This is because these factors can affect patient accessibility and dental student learning outcomes which is essential for dental clinics that trying to maximize appointment scheduling strategies to comprehend them [4]. Using a computer, online systems allow users to make appointments at any time and at anywhere. As an outcome, the patients can review the time slot availability and change their appointments without being required to call or physically visit the center and this system allows dentists to focus

on clinical duties while providing patients with insights into their appointments plans and histories [5].

Computerized systems focus a significant value on reliability and security in addition to convenience. These technologies provide patients more control over their dental health by enabling them to actively manage their schedules and monitor their dental history [6]. They use authentication processes to ensure that only individuals with permission, including employees and patients, are allowed access. To protect sensitive information, they use passwords, one-time passcodes, or even role- based access. Additionally, these systems implement security measures like encryption to shield patient data from online threats and illegal access. By reducing errors, saving time, and implementing reliable and secure technology, dental appointment systems enable better appointment scheduling and improve healthcare services. Figure 2.1 shows the manual appointment form that currently used by the university health's center.

Figure 2.1: Manual Appointment Form

2.2.1 Overview of UTHM Dental Appointment System

University Health Center's present manual appointment procedure has security issues and inefficiencies that may be resolved with the UTHM Dental Appointment System with Role-Based Access Control (RBAC). Several problems with the current dental appointment system impact patient record accuracy as well as access to dental care.

The dental clinic at UTHM continues to rely mostly on manual or just partially computerized appointment scheduling techniques. It is usually necessary for patients to make appointments by calling the clinic or by physically visiting. These appointments are then manually entered by clinic employees using spreadsheets or printed forms, a procedure that is prone to human error and can result in scheduling conflicts and duplicate reservations.

Additionally, appointment histories and patient data are frequently kept in paper-based files, which increases the possibility of document loss and makes record retrieval time-consuming. Another factor contributing to patient annoyance is the absence of an easily navigable online booking system. Patients must confirm appointments over the phone or in person if there is no real-time visibility of available time slots, which might result in inefficiencies and possible misunderstandings.

The UTHM Dental Appointment System addresses these constraints by introducing a digital method that gets beyond manual methods' scalability problems. Manual appointment scheduling gets more inefficient as the patient data expands, frequently leading to missed appointments and delays, especially when reminders are given over the phone or verbally. It shows that the appointment scheduling systems influence the performance and efficiency of service-oriented organizations [7].

Features like digital alerts by email, computerized scheduling, and real-time appointment slot availability are all integrated into the new system. The UTHM Dental Appointment System improves accessibility, reduces human error, and streamlines administrative procedures to increase patient satisfaction and operational efficiency.

2.3   Security Measures

Dental appointment systems must have robust security measures in place to safeguard private patient data, stop illegal access, and guarantee privacy laws are followed. These systems handle extremely private information that has to be communicated and maintained securely, such as appointment history and personal information. A variety of cutting-edge security methods are used to preserve system integrity and data confidentiality. The next section provides explanation regarding these security measures more in depth.

2.3.1 End-to-End Encryption (E2EE)

End-to-End Encryption (E2EE) is to make any information that traverses between the two parties safe. For example, patient and dental care system. It is a process of changing the data into an unreadable structure (encryption) while it is on its way out-of-origin and change it back readable (decryption) only when arrives at destination. To put it simply, even if someone tries to listen in on that conversation in transit, they will have no idea what they are saying. It is important for dental appointment system because data there are highly sensitive such as appointment history, personal information, location and appointment details. If an individual uses an online booking system to schedule a dental appointment and provides their appointment history, an E2EE ensures secrecy and safety from start to end. This high level of protection is the absolute need for trust and compliance with privacy laws. The application of E2EE not only protects personal health records but also facilitates interoperability among various dental system stakeholders, thereby improving the overall efficiency of dental appointment scheduling and management [8].

2.3.2 Password Hashing

One important security method for safeguarding user credentials in online applications is password hashing. It transforms a plain-text password into a hash, which is a fixed-length, irreversible string [9]. Hashing is a one-way function, which means that the original input (password) cannot be recovered from the hash, in contrast to encryption. Because plain-text password storage in a database presents a significant security risk, hashing is crucial. All user credentials are immediately visible to attackers who manage to access the database. The technology guarantees that even if the database is compromised, the real passwords will not be revealed because it only stores hashed passwords. Because of its built-in salting mechanism, cost factor that can be adjusted, and security, modern hashing algorithms like BCRYPT are very popular. Figure 2.2 shows that the system password hashing is implemented using PHP's built-in password_hash() function with the BCRYPT algorithm.

```
48        $password_hash = password_hash($password, PASSWORD_BCRYPT);
49
50  ∨     try {
51  ∨         $stmt = $pdo->prepare("INSERT INTO signup (username, email, student_staff_id, password_hash, role)
52                             VALUES (:username, :email, :student_staff_id, :password_hash, :role)");
53  ∨         $stmt->execute([
54             ':username' => $username,
55             ':email' => $email,
56             ':student_staff_id' => $student_staff_id,
57             ':password_hash' => $password_hash,
58             ':role' => $role
59         ]);
```

Figure 2.2: Password hashing

In this project, the password_hash() function with the BCRYPT algorithm is used to securely hash user passwords, which ensures that even if the database is compromised, the original passwords remain protected. The hashed password is stored in the database using a prepared SQL INSERT statement. The prepared statement includes named placeholders and uses the execute() method to bind user input values, such as username, email, student_staff_id, password_hash, and role. This approach not only secures passwords through hashing but also prevents SQL injection attacks by properly handling user input.

2.3.3   Input Validation

The process of verifying that user-provided data is correct, secure, and follows standard standards prior to processing or storage by a system is known as input validation. In addition to eliminating mistakes and safeguarding online applications against typical security concerns like SQL injection and cross-site scripting (XSS), it is essential for preserving data integrity [10]. Both client-side (like JavaScript) and server-side (like PHP) input validation should be used in a secure online application.

In this project, input validation is an essential stage in the user registration process that guarantees that data supplied is safe, correct, and comprehensive before it is entered into the database. Using PHP's filter_var() function, the system verifies that the email is formatted correctly and that all required fields such as the username, email, password, and patient ID are filled in. To improve account security, passwords must also adhere to specific standards, including having a minimum length or containing

unusual characters. Figure 2.3 shows the input validation that implemented in the system.
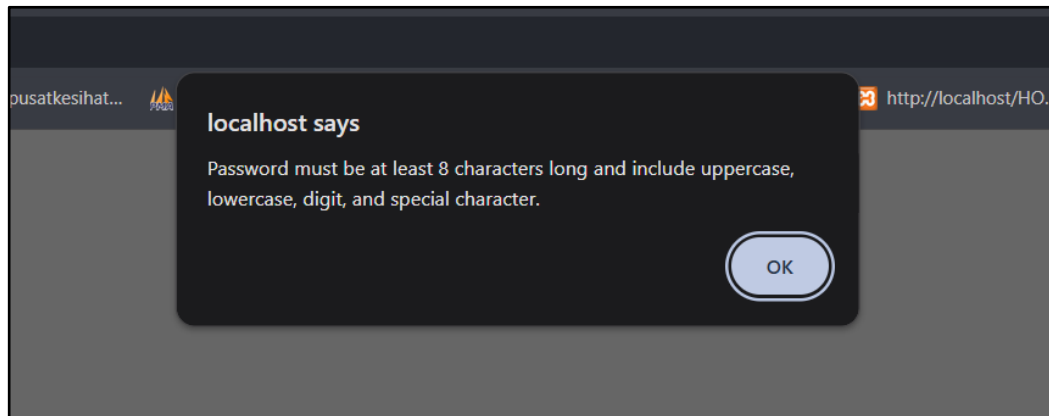
Figure 2.3: Input Validation

This project's input validation is essential to ensuring that only secure, well-formatted, and clean data enters the system. The program preserves data integrity, guards against malicious attacks, and enhances user experience and security by employing prepared statements and verifying inputs prior to database operations.

2.3.4   Database Security

Users' access and manipulation of the database is restricted by database authorization, a security measure. It guarantees that, according to their designated responsibilities, only authorized users can carry out particular operations like reading, adding, updating, or deleting data. By assigning roles such as admin, staff, or student upon user registration and limiting the actions that each position is allowed to take within the system are how database authorization is accomplished in this project. This is in line with the ideas of Role-Based Access Control (RBAC), which limits access to specific database activities based on the role of the user [11]. For example, an admin may have full access to all appointment history, while a staff member can view and update only their assigned appointments, and a student can only access their own booking details.

2.3.5 Email Notification

Email notification is an essential feature in this project to enhance communication between the system and its users. It is used to automatically notify users about important actions such as appointment confirmations, approvals, or rejections [12]. This not only improves user experience but also adds a layer of professionalism and reliability to the system. In this project, email notifications are implemented using the PHPMailer library, which allows the application to send emails through Gmail's SMTP server in a secure and structured way. The email setup includes specifying the SMTP host, enabling authentication, providing a Gmail address and app-specific password, and configuring the port and encryption method (TLS). The setFrom() and addAddress() functions define the sender and recipient, while Subject, Body, and AltBody allow customization of the email content in both HTML and plain-text formats.

The email logic is placed within the PHP block that handles the booking or admin update. It ensures that the email content dynamically reflects the user's information and current appointment status. This implementation not only strengthens system interactivity but also promotes transparency and professionalism in managing dental appointments. Figures 2.4 to 2.7 shows the registration confirmation, appointment approved, appointment received and appointment rejected.
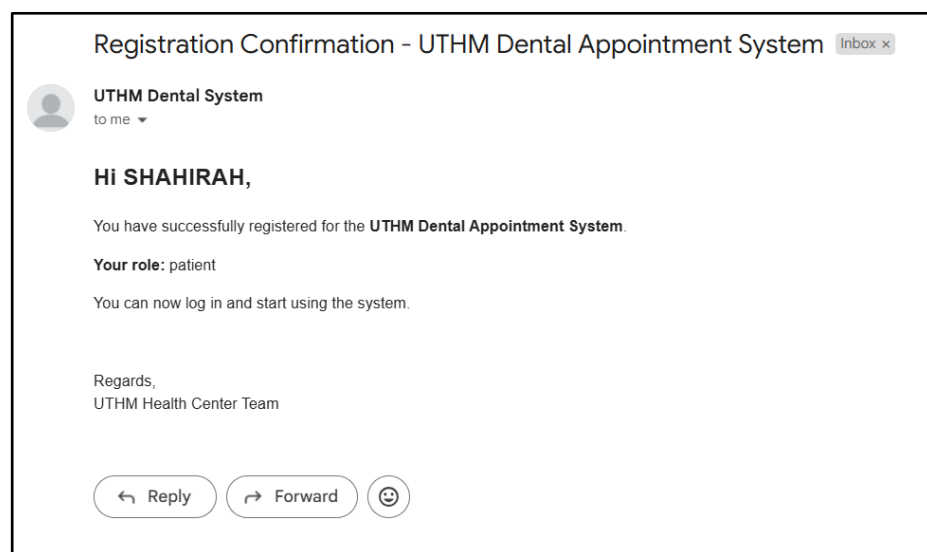
Figure 2.4: Registration Confirmation
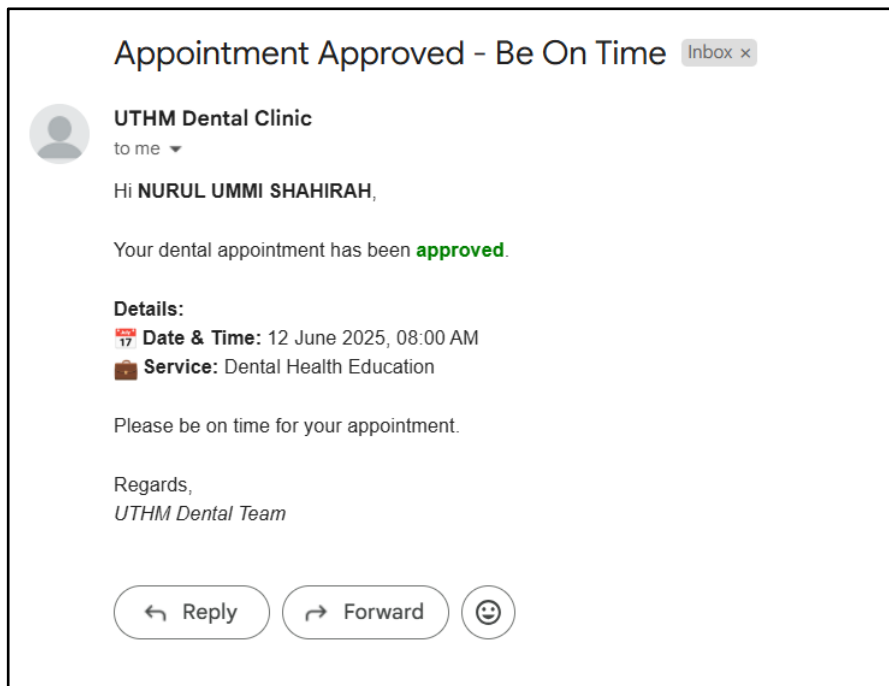
Figure 2.5 Appointment Approved

Figure 2.6: Appointment Received
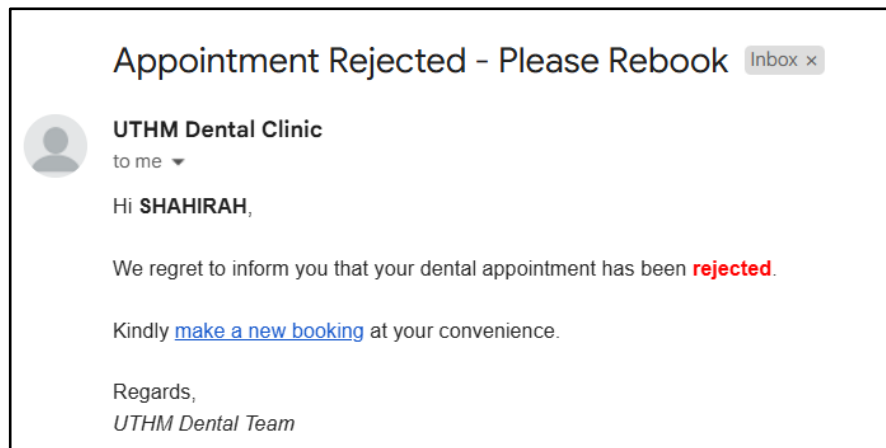
Figure 2.7: Appointment Rejected

2.3.6 Two-Factor Authentication (2FA)

It includes an additional layer to verify the login credentials for security reasons. A user might be prompted to provide a password, something they know and also have a one-time passcode sent on their phone, something they have. This ensures that, even in the unlikely event of password compromise, unauthorized access is still unlikely without the second factor. 2FA enhances dental systems security by minimizing the possibility of data breaches, along with protecting sensitive patient information. 2FA also requires users to provide two distinct forms of identification before gaining access to their accounts, significantly reducing the risk of unauthorized access that can occur with single-factor authentication methods, such as passwords alone [13].

Implementing 2FA in this project significantly improves login security and aligns with best practices for protecting user accounts in modern web applications. It is especially useful in role-based systems where users have different access levels, making it harder for attackers to exploit privileged accounts. Figure 2.8 shows the push notification after successful signup.
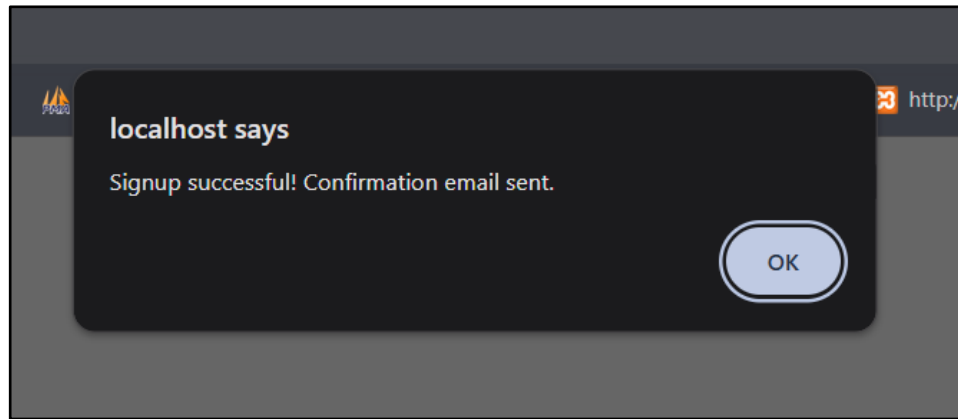
Figure 2.8: Push Notifications

2.4   Role-Based Access Control (RBAC)

The implementation of RBAC in dental appointment system settings, including dental practices, is particularly advantageous due to its scalability and flexibility, allowing for easy adjustments as staff roles change or as new users are added. Role-Based Access Control (RBAC) has become a critical approach to security issues in dental system and has allowed the safeguarding of sensitive information pertinent to patients. With RBAC, users are put into groups based on their role functions, such as dentist, administrative staff, or patient. Each role is assigned specific permissions that limit how much data a user can view or what parts of the system the user can use[14] . For instance, a dentist can have access to the records of the patients' medical history, while a receptionist sees the appointment schedule. Such separation reduces the risk of unauthorized accidental or intentional disclosure, with minimal compliance in regulations about privacy of data, hereby assuring the confidentiality of patients Implementing RBAC helps secure critical data in UTHM Dental Appointment System by ensuring that users have access only to the information they need to perform their work.

2.4.1 Importance of RBAC in dental system

Role-Based Access Control (RBAC) is crucial in dental system as it ensures that information confidentiality is only accessible to authorized individuals based on their specific roles. By assigning permissions based on roles rather than individual users, RBAC reduces the complexity associated with access control, thereby facilitating easier administration and maintenance of security policies.

In a dental system, users such as dentist, staff, administrative staff, and patients require access to different types of information to perform their tasks effectively. A part of that, a dentist may need access to detailed dental history, while administrative staff might only need appointment schedules. By assigning permissions based on roles, RBAC prevents unnecessary and unauthorized access to critical information, reducing the risk of data breaches and misuse. These features ensure that sensitive operations, such as authorizing the treatment of patients and kept securely patient information, are not concentrated in the hands of an individual. This helps reduce the risk of fraud or error. RBAC not only enhances security but also streamlines workflows by allowing users to access only the information necessary for their responsibilities, ensuring a balance between functionality and data protection. Figure 2.9 shows the role-based access control (RBAC) used in the system.
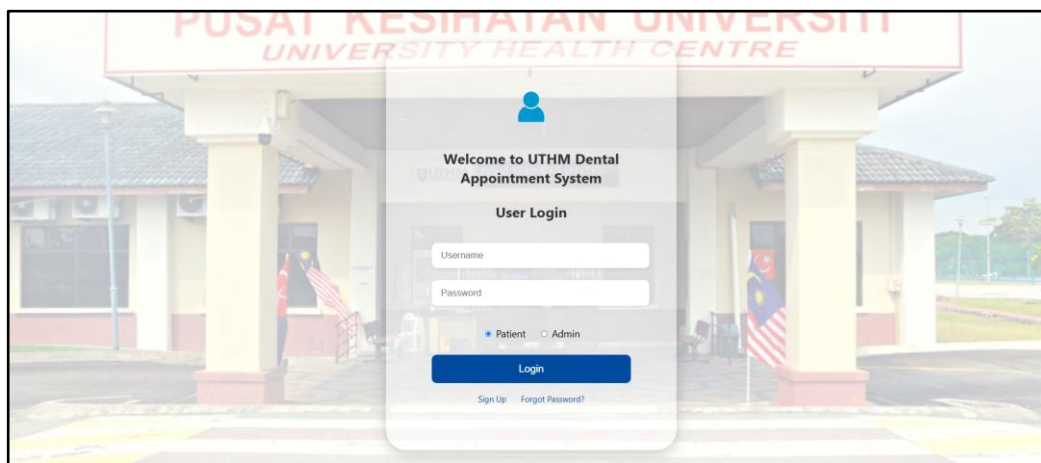

Figure 2.9: Role-Based Access Control

2.4.2 Implementation of RBAC

This project uses the basic security architecture known as Role-Based Access Control (RBAC) to control user permissions and safeguard sensitive actions according to user roles. RBAC is essential to the dental appointment system created for the UTHM Health Center since it guarantees that users may access only the data and features that are pertinent to their duties. Admin, staff, and student are among the several user roles that the system defines, and each has varying levels of access. For instance, administrators may handle user accounts, accept or reject appointments, manage appointments, and see system reports with complete authority. Patients can only schedule appointments, see their personal appointment history, and get alerts at this time.

Implementing RBAC helps maintain data confidentiality, operational integrity, and system accountability. It prevents unauthorized access to patient records or administrative functions by ensuring users cannot perform actions outside their assigned roles. Moreover, this approach simplifies permission management, especially in systems with growing user bases, by assigning roles rather than configuring permissions individually. In the backend, user roles are stored during the registration process and checked during login to redirect users to their appropriate dashboards and restrict access to specific pages or functions. This structure enhances the overall security posture of the dental system. Figure 2.10 shows the implementation of role-based access control (RBAC) in the coding section.


```php
106     if ($user && password_verify($password, $user['password_hash'])) {
107         $_SESSION['username'] = $username;
108         $_SESSION['user_role'] = $user['role'];
109         echo "<script>alert('Login successful! Welcome, " . $user['role'] . "'); window.location.href = 'dashboard.php';</script>";
110     } else {
111         echo "<script>alert('Invalid username or password.'); window.history.back();</script>";
112     }
113
114 } elseif (isset($_POST['action']) && $_POST['action'] === 'access') {
115     if (!isset($_SESSION['user_role'])) {
116         die("<script>alert('Access denied. Please log in.'); window.location.href = 'login.html';</script>");
117     }
118
119     $required_role = $_POST['required_role'];
120
121     if ($_SESSION['user_role'] !== $required_role) {
122         die("<script>alert('Access denied. You do not have the required permissions.'); window.history.back();</script>");
123     }
124
125     echo "Access granted. Welcome, " . $_SESSION['username'] . ".";
126 }
```

Figure 2.10: Role-Based Access Control

2.5   Database Management System (DBMS)

A Database Management System (DBMS) is integral to managing data collections, providing the means for storing, modifying, and extracting information securely and efficiently [15]. Database is the collection of data or information which is organized to allow easily access and manipulate by users. Database is organized into tables where each table has a number of records that represent real world objects. Fields are organized in records where data items are used to specify a characteristic of the record. It also can be defined as a collection of programs that lies between users and database so that users can create and maintain the database. A DBMS allows users to easily manipulate the tables. It also allows users to retrieve data from a table.

DBMS is useful when it comes to data loading which enable data loads faster without writing programs. Data loading is the process of copying and loading data or data sets from a source file, folder or application to a database or similar application. DBMS also provides backup that enables to store the data to help in cases of crashes and disasters. Recovery utility of DBMS allows to track the data back even though the data is lost. DBMS can act as monitoring tools that monitors the performance of the database. File reorganization utility provides the mechanism to reorganize the file into different file of organization to improve efficiency of data performance.

2.5.1   Secure Database Management System

Database management security concerns the protection of patient data within a dental facility. UTHM Dental Appointment System used MySQL as the database platform to securely store and manage data for the system. RBAC is a widely recognized access control mechanism that assigns permissions to users based on their roles within an organization, thereby enhancing security and operational efficiency in database management systems. Some of the methods employed to prevent hacking include data encryption, frequent update of security patches, and intrusion detection systems. This will prevent data loss in the event of hardware failure or other emergencies. It is also

important that dental systems audit database activities from time to time to enable the detection of and response to unauthorized access or other anomalies. By prioritizing secure database management, dental organizations can maintain patient data confidentiality, integrity, and availability.

2.6   Review of Existing Systems

There are three existing systems that will explained in this section. In this section 2.6.1, it reviewed about Artizen Dental System while in section 2.6.2 it reviewed about Dental Appointment System UTEM. Furthermore, Dental Clinic Management System is reviewed in section 2.6.3. These three systems are used as reviews to make a comparison of the differences between the three existing systems and proposed system.

2.6.1   Artizen Dental System

The dental appointment system is integrated with modern features, ensuring the operation of effectiveness and security. It has a user-friendly interface that is responsive and cross-device-compatible, ensuring smooth interactions among patients and staff. Booking an appointment on the website becomes easy for the patient which creating, rescheduling, and cancelling an appointment is possible. It gives dentists and administrators secure access to patient records, ensuring updates and management are carried out correctly with the utmost privacy due to RBAC, where users access data based on their roles. Security is further enhanced with two-factor authentication, 2FA, and end-to-end encryption, E2EE, protecting sensitive information from unauthorized access. Figure 2.11 shows the homepage of Artizen Dental System.
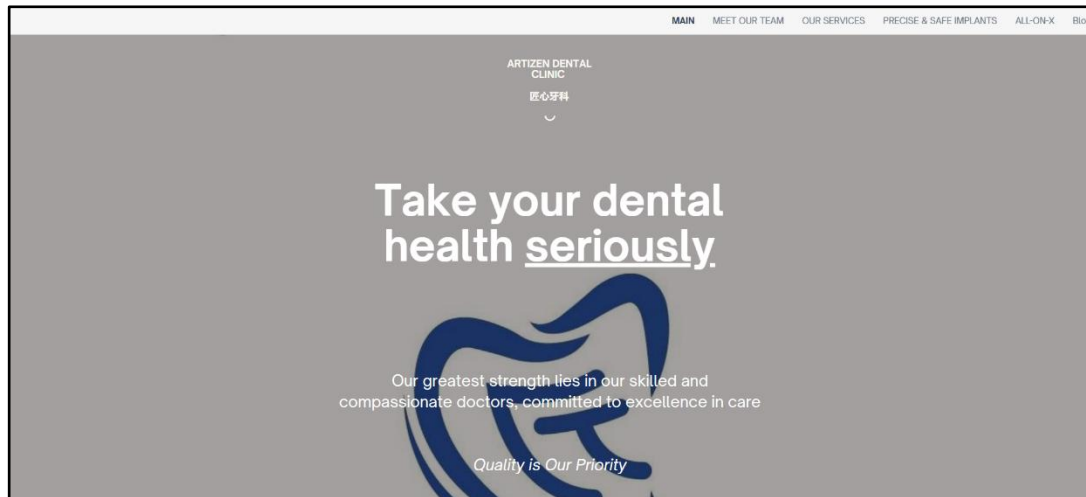
Figure 2.11: Homepage of Artizen Dental System

The system also supports customization for dental services, enabling the tailoring of workflows for treatments, and ensures timely communication through user notifications for reminders and updates. Online appointment management enables the clinic staff to oversee and optimize scheduling, avoiding overlaps and ensuring smooth operations, which leads to better efficiency and patient satisfaction. Figure 2.12 shows the booking appointment page of Artizen Dental System.

Figure 2.12: Booking Appointment of Artizen Dental System

The Artizen Dental website presents a clean, professional, and user-friendly interface that effectively guides users to book an appointment through offline

communication. The layout is visually balanced, with key contact details prominently displayed on the left and a welcoming image of the dentist on the right, which adds a personal and trustworthy feel. The use of recognizable icons next to the addre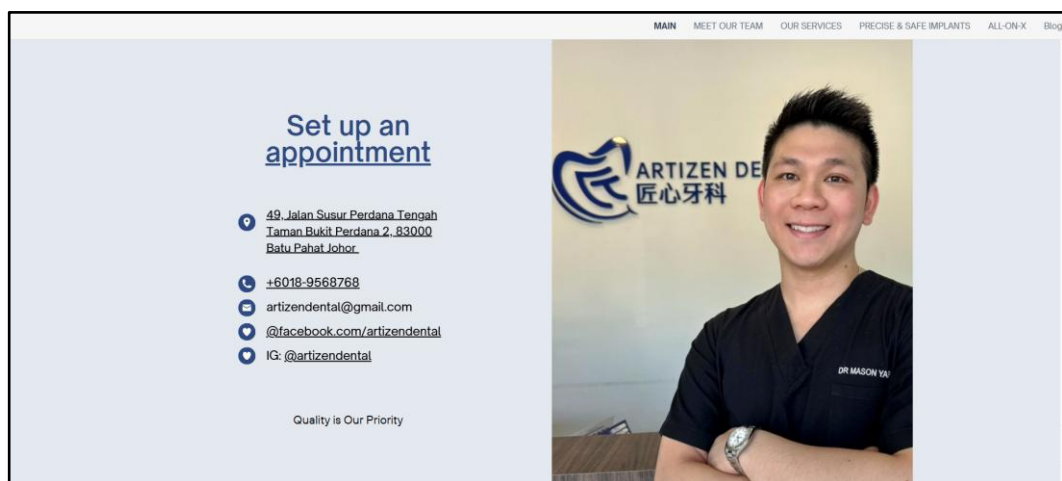ss, phone number, email, and social media handles improves readability and quickly informs users of available contact options. The bold call-to-action "Set up an appointment" draws attention without overwhelming the viewer, and the consistent color scheme and font styling enhance the overall aesthetic. Despite the absence of an online booking form, the intuitive UI ensures users can easily find the information they need to reach out via phone, email, or social media, creating a smooth and accessible appointment setup experience.

2.6.2   Dental Appointment System UTEM

The UTeM Dental Clinic's online appointment form, created with Jotform, is the system that is linked. It enables patients to electronically enter their appointment information, including their name, contact information, chosen time and day, matric/staff ID, and the kind of dental care they need. The form probably integrates with database records and email alerts, giving staff or students an easy-to-use method of making appointments. The database is securely stored because this system is used online booking system. It also implements role-based access control as a part of security measures of the system and ensuring users can only access information necessary for their roles [16].

The UTeM Dental E-Appointment system presents a clean, modern, and user-friendly interface that prioritizes clarity and simplicity. From a UI/UX perspective excluding the form functionality and the design emphasizes well-organized content, clear labels, and logical grouping of information such as personal details, appointment preferences, and dental services. This layout helps reduce user confusion and cognitive load. The consistent use of fonts, spacing, and alignment creates a visually appealing structure, while the minimalistic and clutter-free design enhances focus. Institutional branding elements like color schemes and logos contribute to a trustworthy and professional appearance. Additionally, the responsive layout ensures the system is

easily accessible and making the overall experience smooth and inclusive for all users. Figure 2.13 shows the booking appointment page of UTEM's dental appointment.
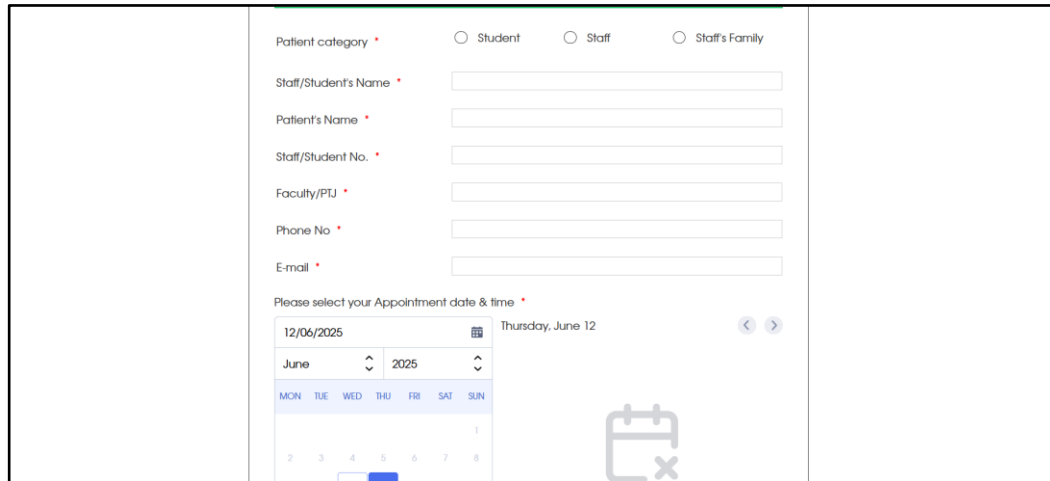

Figure 2.13: Booking Appointment of Dental Appointment UTEM

A seamless and easy-to-use user experience is provided by the system's presentation, which demonstrates sound UI/UX techniques even without assessing the form functionality itself. Even people with low technological expertise may easily navigate it because to its design, which promotes efficiency and confidence.

2.6.3 Dental Clinic Management System

Dental clinic management system is important to overcome the problems in a clinic such as storing patient's dental record and appointment booking. Thus, this system was developed to store patient's dental record in a database to allow dentist to trace past treatment of a patient. It was to ensure there is no error occur during the treatment. Furthermore, notification reminder is implemented in this system to remind the patient about their scheduled appointment. It was to ensure that the patient would not miss their appointment with the dentist. This system is specially designed to improve the clinic services and to ensure that the operation will run smoothly. Dental clinic management system was developed by using the Visual Studio 2010, Net Framework

4.0 and SQL Server 200. It is a standalone application which it does not connect to any network. Therefore, it can make the computer more secure.

There are two users that can access dental clinic management system which are clinic's staff and patient. The system consist of computerized and systematic patient's record, treatment record details and appointment scheduling. Thus, it will give benefits to staff and patient to use the system. The patient's treatment module will allow the dentist to view and update the patient's dental record and the treatment while appointment schedule can help the staff to send reminders to the patient for their followings treatment that has been made by the dentist. As for the appointment schedule, only the staff can view, update and delete the information. The staff will send reminder to patient's mobile phone number. Dental clinic management system database does have access control that allows only authorized user to view the data. This is to protect the data from being stolen or exposed to unauthorized users.

2.6.4 Comparison of Existing Systems with Proposed System

Table 2.1 presents a comparison between three existing dental appointment systems and the proposed UTHM Dental Appointment System with Role-Based Access Control (RBAC). This comparison highlights key features such as security, user accessibility, data management, and system functionality. While the existing systems may offer basic appointment scheduling or limited access control, the proposed system is designed specifically to meet the needs of UTHM Health Center by providing enhanced security features like RBAC, Two-Factor Authentication (2FA), and centralized data storage. These additions not only improve user role management and data protection but also ensure the system is more efficient, scalable, and tailored to the university's workflow and privacy requirements.

Based on the observation of the comparative study in Table 2.1 with the features that each application offers, the proposed system application able to provide most of the basics functions comparing to other systems. Furthermore, proposed system implements system security while most of other applications does not.

Table 2.1: Comparison between existing systems with the proposed system

Features	Artizen Dental Clinic	Dental Appointment System UTEM	Dental Clinic Management System	Proposed System
Platform	Web-based	Web-based	Desktop Application	Web-based
Appointment Booking	Yes	Yes	Yes	Yes
Patient Record Access	No	Yes	Yes	Yes
Role-Based Access Control (RBAC)	No	Yes	Yes	Yes
Two-Factor Authentication (2FA)	No	No	No	Yes
End-to-End Encryption (E2EE)	No	No	No	Yes
Customization for Dental Services	No	Yes	Yes	Yes
User Notifications	Yes	No	Yes	Yes
Online Appointment Management	Yes	No	Yes	Yes

2.7   Chapter Summary

This chapter reviewed the existing systems and technologies related to the development of the UTHM Dental Appointment System. It pointed out the various challenges and limitations regarding traditional manual appointment systems, which include inefficiencies, lack of security, and administrative burdens. Overall, the findings from this review provide a basis for the proposed system to meet the specific needs of UTHM's dental services and provide a secure, user-friendly, and efficient system.

CHAPTER THREE

METHODOLOGY

3.1   Introduction

This chapter presents the methodology used in the system. Agile is a popular software development methodology that advocates for an iterative approach in terms of work done and flexibility to the changing requirement. There are six steps of iterative agile methodology that are requirement phase, system design, development, testing, deployment and review. Requirement phase is discussed in section 3.2.1 which examines the system requirement. The layout design and database design of the system is explained in system design in section 3.2.2. development is described in section 3.2.3. Functionality testing is clarified in testing as shown in section 3.2.4. Next, section 3.2.5 presents deployment which explained the maintenance of the system. Lastly, 3.2.6 explained the review of the system.

3.2   Agile Methodology

Agile methodologies focus on flexibility and continuous improvement, which are paramount in dentalcare environments characterized by rapid changes and varying patient needs [17]. This modified version has the most attractive aspect is that it enables the phases to overlap when needed, unlike in a pure waterfall model where no overlapping was allowed. Figure 3.1 shows the graphical representation of agile methodology which consist of six steps which are requirement, system design, development, testing, deployment and review.
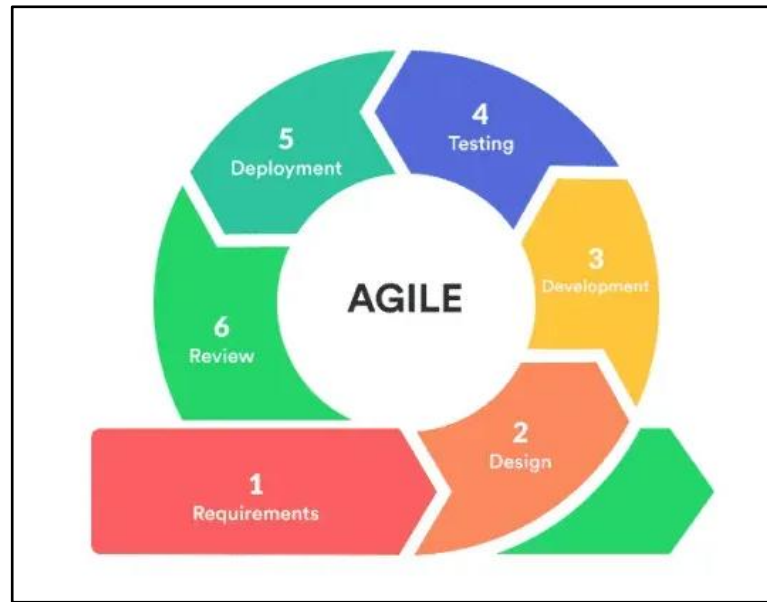
Figure 3.1: Agile Methodology

3.2.1 Requirement Phase

In this phase, the information is gathered by reviewing existing system and by gathering information from university health center. There are four problems that can be analyse from existing system and problems that happened to the dental clinic. The first problem by analysing existing system is that most dental record are stored in database with single authentication. The dental record can be seen straight away if hackers gain the username and password to view it. The second problem that is encounter by the dental clinic is the appointment is managed manually. The third problem is the dental appointment system which are made via instant message, phone call and walk in. Identity theft can occur if the patient does not have proof to show their booking confirmation. Lastly, the fourth problem is that the data is not protected. Therefore, the system will be easily compromised or hacked. There are six modules which are register module, login module, patient information module, dental record module, dental appointment module and report. In addition, there are three security that are needed in the proposed system which are authentication, password hashing and system security which is RBAC to store confidential information.

Table 3.1 shows the requirement of hardware and software to develop the proposed system. Table 3.1 shows the hardware and software required for this project.

Table 3.1: Hardware and software requirement

Ittems	Requirements
Hardware	- Laptop 1GB of hard disc - Minimum of 4GB of RAM Intel (R) Celeron® CPU N2940 @ 2.25GHZ
Software	- Microsoft Windows 11operating system - Visual Studio Code - Xampp
Programming Language	PHP, HTML,JavaScript,HTML,CSS
Database	MySQL

Hardware required is laptop which consist of 1GB of hard disc, minimum 4GB of RAM, Intel (R) Celeron® CPU N2940 @ 2.25GHZ. As for software, this project required Microsoft Windows 11 operating system, visual studio code and xampp while the programming language and database used are PHP, HTML, JavaScript and MySQL.

3.2.2 Design

In this phase, database design, class design and user interface design are carried out. For database design, the database structures are designed where database tables such as admin, dentist, patient, and appointment. Entity relationship was drawn so that the database can run smoothly. User interface design is important to make sure the system is convenient for users. In terms of this proposed system, the user interfaces are designed and to be implemented in this system which allow dentists to view, insert, update, delete dental records of a patient and stored in secure database. Patients is allow to book, view and cancel book appointment where the confidential information will be stored in secure database. Lastly, test plan is designed in this proposed system.

There are four categories of test plan which are user interface testing, system functionality testing, security requirement testing and input validation testing. By doing this, errors can be discovered easily so that debugging process can be conducted to ensure the efficiency of the proposed system.

3.2.3 Development

Accordingly, the development phase was implemented by building the core system in iterative phases. For instance, individual phases would focus on developing functionality such as secure appointment scheduling, role-based access, and user authentication mechanisms. The development team delivered functional modules in stages, starting with basic features like user registration and appointment management, and then advancing to more complex ones such as patient record security and notification systems. At the end of each phases, the modules were reviewed and tested, thus enabling the team to take up every issue before proceeding to the next iteration. This iterative approach ensures incremental evolution of the system with reduced risks and enables continuous improvement.

3.2.4 Testing

An essential step in the system development process is testing, which makes that the system functions properly, safely, and effectively before it is formally launched. In order to verify that the constructed dental appointment system satisfied all functional, security, and usability criteria outlined in the project scope, it underwent extensive testing throughout this phase.

Functional testing was carried out during the project's testing phase to ensure that every module operated as planned. This involved testing essential functions including user administration, notice delivery, and appointment scheduling. To evaluate the efficacy of security measures incorporated into the system, such as Roled-Based Access Control (RBAC), End-to-End Encryption (E2EE), Password Hashing, Input Validation, Database Security, Email Notification and Two-Factor

Authentication (2FA), security testing was also conducted. To guarantee the protection of private patient data, these tests were essential.

After development was finished, user acceptability testing was also conducted on the system. The purpose of this stage was to confirm that the system fulfilled the goals and anticipations of the stakeholders and users. To evaluate the system's overall usability and performance in practical situations, a sample of users examined the system's features and functions and provided input. This procedure assisted in verifying that the finished system satisfies the project's functional criteria as well as user demands.

3.2.5 Deployment

The UTHM Dental Appointment System was launched during the deployment phase at the UTHM Health Center in a controlled setting. Training sessions were held with healthcare personnel prior to the formal deployment to make sure they were familiar with the features of the system, including scheduling appointments, authorizing requests, and securely storing patient information. In order to minimize operational disruptions and increase user confidence, these workshops were essential.

In the initial deployment, real-time testing in a live setting with real users was the main focus. In order to find technical flaws, usability problems, and opportunities for improvement, administrative staff and patients' input was aggressively solicited throughout this period. A number of improvements were performed in response to this feedback in order to clarify the user interface, boost system performance, and make sure role-based access control (RBAC) was operating as intended. An excellent basis for long-term use was established by this iterative process, which helped guarantee that the system functioned safely and efficiently in the real healthcare environment. The deployment, in summary, was a crucial stage in moving from development to actual usage. It confirmed the system's operation in actual use and emphasized how crucial ongoing user input is to enhancing system dependability. Early problem solving through controlled rollout allowed the team to guarantee a more seamless adoption process and increased customer satisfaction.

3.2.6   Review

The final phase focused on reviewing the system's performance post-deployment. Feedback was collected from users, including students and staffs, dental staff, and IT personnel, to assess the system's strengths and identify areas for improvement. A post-deployment evaluation report was prepared, highlighting the project's successes and detailing any adjustments needed for future updates. Continuous monitoring processes were implemented to ensure the system remained efficient, secure, and responsive to the needs of its users. This phase emphasized the importance of long-term maintenance and iterative updates to sustain the system's effectiveness over time.

3.3   Project Planning

Project planning was a fundamental part of developing the UTHM Dental Appointment System, ensuring that each phase of the project was carried out efficiently and within the expected time frame. The system was developed using the Agile methodology, which emphasizes flexibility, collaboration, and iterative progress. Agile project planning involves breaking the development process into smaller, manageable cycles called sprints, where specific features or modules are developed, tested, and refined based on ongoing feedback. This approach allowed the development team to adapt quickly to changes, continuously improve the system, and ensure that each component such as appointment booking, role-based access, and security features was implemented effectively. By planning and executing the project in stages, Agile ensured that the final system met user requirements, maintained quality, and stayed aligned with the overall project goals.

Table 3.2 shows the project plan for the UTHM Dental Appointment System is structured into six different phases. The project follows a structured development lifecycle with defined phases. In the Requirement Phase, the focus is on outlining project tasks, deliverables, and milestones to establish clear system requirements. During the Designing phase, the system's workflows and user interfaces are planned, resulting in mockups and design documentation. The Development phase involves the actual implementation of the system's core features, followed by the Testing phase,

where functionality and usability are assessed, and any issues are addressed. Once tested, the system is deployed to production in the Deployment phase, making it operational for users. Finally, the Review phase evaluates the system's performance, gathers user feedback, and identifies any areas for future improvement. Each phase builds on the previous one, ensuring a systematic and thorough approach to project delivery.

Table 3.2: Project Planning

Phase	Task	Output
Requirement Phase	Define tasks, output, and milestones.	A clear outline of project goals, specific tasks, output, and timelines. This includes detailed specifications for the system's requirements.
Designing	Design system workflows and user interfaces.	Visual representations of workflows, user interface designs, and detailed mockups. The design phase will focus on how users interact with the system
Development	Implement core system features.	A functional system with all core features implemented according to the design and requirements. The system is built and integrated with essential components.
Testing	Test system functionality and usability.	A report on testing results, identifying bugs, usability issues, and verifying the system meets all functional requirements The system istested for errors, security flaws, and user experience.
Deployment	Deploy the system to production.	A fully operational system deployed in a live environment, available for use by the intended users.
Review	Evaluate system and gather feedback.	A final evaluation report with user feedback, system performance, and suggestions for improvements. This includes an analysis of system effectiveness and future improvements.

Figure 3.2 shows the Gantt Chart diagram that presents the project timeline, which involves six successive phases which planning, design, developing, testing, deployment, and review. The project timeframe runs from October 2024 to January 2025, slightly overlapping the period of design phase, October 2024 to December 2024. Development will range from December 2024 to March 2025, while testing will range from March to April 2025. The Deployment will fall between May and June 2025, while the Review is scheduled for July 2025. The bar chart shows the current time in June 2025 and thus allows for good tracking and resource allocation.
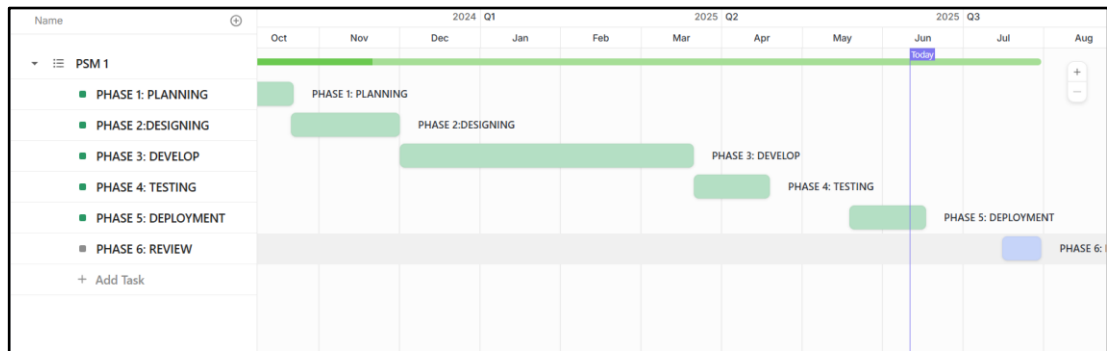
Figure 3.2: Gantt Chart

In conclusion, the Gantt chart effectively outlines the project's timeline and phases, providing a clear visual representation of the development process from planning to review. It highlights key overlaps and transitions between phases, ensuring that time and resources are allocated efficiently. With the current progress marked in June 2025, the chart confirms that the project is in the deployment stage and approaching the final review phase. Overall, the Gantt chart has proven to be a valuable project management tool, supporting effective tracking, coordination, and timely delivery of the UTHM Dental Appointment System.

3.4 Chapter Summary

This chapter outlines the methodology and planning approach for developing the UTHM dental appointment system using agile methodology, chosen for its flexibility, iterative process, and stakeholder involvement. The project was executed in six phases which requirements, designing, development, testing, deployment, and review. These phases ensured incremental development, and continuous improvement. Planning focused on defining goals, scope, and timelines, while the design phase prioritized secure and user-friendly architecture using prototypes. The development phase involved building core modules like appointment management and RBAC in sprints, followed by rigorous testing for functionality, security, and usability. Deployment introduced the system with training and adjustments, and the review phase evaluated system performance for future updates.

CHAPTER FOUR

SYSTEM ANALYSIS AND DESIGN

4.1   Introduction

The general system architecture for the UTHM Dental Appointment System, which uses RBAC in Section 4.2, is explained in this chapter. Functional, non-functional, user, software, and hardware requirements are all included in the discussion of system requirements. The system analysis is explained in Section 4.3, with a focus on the structured approach. Structured English, process specifications, level 1 diagrams, context diagrams (level 0), and entity relationship diagrams (ERD) are all included in the Data Flow Diagram (DFD). The system design, including the flowchart, is explained in detail in Section 4.4. Section 4.5 presents the structure and data dictionary and discusses database design. The interface design, including menu and screen design, system navigation, and web page project (if relevant), is covered in Section 4.6. Lastly, the chapter summary is provided in Section 4.7.

4.2   System Requirements

This study highlights the importance of user-centered design in scheduling systems and outlines functional criteria that enhance user engagement and experience two factors that are crucial for appointment systems [18]. The features and prerequisites required for the creation, implementation, and functioning of the UTHM Dental Appointment System Using Role-Based Access Control (RBAC) are outlined in the system requirements. To meet the needs of patients and dentalcare professionals, the system needs to have a flexible appointment scheduling feature. The requirements are separated into five main categories which are hardware, software, non-functional, functional, and user requirements.

4.2.1 Functional Requirement

Table 4.1 shows the functional requirement of UTHM Dental Appointment System With Role-Based Access Control (RBAC) For UTHM Health Center.

Table 4.1: Functional requirement

Module	Functionalities
Appointment Scheduling Module	- Allows patient to book, view, and cancel appointments.
	- Displays available time slots to choose a convenient time.
	- Sends confirmation for scheduled appointments.
Patient Management Module	- Enables dentists to access patient records and appointment histories.
	- Assists in reviewing treatment plans for consultations.
Notifications Module	- Sends automated reminders and alerts for upcoming appointments or schedule changes.
	- Notifications are sent via email to keep students informed.
Reporting Module	- Generates detailed reports for administrative staff.
	- Reports include appointment trends, service utilization, and patient record.
Dashboard Module	- Supports analyzing system performance to improve service quality.
	- Provides an overview of key system metrics such as daily appointments and usage statistics.
	- Displays real-time data to help administrators monitor system performance and health.
Login Registration Module	- Manages user registration processes for new users.
	- Facilitates the creation of secure user accounts for accessing the system.

Table 4.1 discusses the functional requirements for the UTHM Dental Appointment System using role-based access control (RBAC). The system consists of several modules which user authentication, appointment scheduling, patient management, notifications, reporting, dashboard, and login registration. The login registration module allows patients to register as new users, while dentists are registered by the admin only. Once registered, users can access the system through the

user authentication module by entering valid usernames and passwords. Invalid input triggers system alerts to ensure security. While the patient management module enables dentists to update patient dental records, which are stored securely. Patients can view their updated records via this system. The appointment scheduling module allows patients to book, view, or cancel appointments. Upon successful booking, patients receive an email as confirmation. Moreover, the notifications module ensures automated alerts and reminders for appointments or changes in schedules via email. The Reporting Module provides role-based access to system reports which admin can view full reports of patient information, dentists can view complete reports of patient dental records, and patients can view their own detailed dental records. Lastly, the dashboard module offers a centralized, real-time view of key metrics, such as daily appointments and system performance, to help administrators monitor overall system health and functionality.

4.2.2   Non- Functional Requirement

Non-functional requirements outline the behavior and performance of the system, emphasizing quality aspects that guarantee the application's overall efficacy, security, and maintainability. These specifications are necessary for the UTHM Dental Appointment System with Role-Based Access Control (RBAC) to enable day-to-day operations at the UTHM Health Center. The system must provide good performance by responding promptly, especially during high-traffic periods such as semester registration or appointment peak times. Security is a top priority, necessitating the usage of secure user authentication, data protection, and robust access control using RBAC to stop unwanted access. Emphasis is also placed on usability; both staff and students should find the system's interface to be clear and simple to use. Furthermore, dependability guarantees that the system will continue to operate steadily and without frequent malfunctions or breakdowns. Scalability is thought to facilitate future growth or interaction with other institutional systems, and maintainability guarantees that updates or debugging of the system may be done with little interruption. These important characteristics are outlined in further detail in Table 4.2.

Table 4.2: Non-functional requirement

Non-Functional Requirement	Description
Availability	- The system must be available 24/7 to support continuous access for patients, dentists, and admins.
	- Downtime for maintenance or updates system
Security	- Implements role-based access control (RBAC) to restrict unauthorized access to sensitive information. - User credentials are securely stored using encryption techniques. The system must enforce strong password policies.
Usability	- The interface must be user-friendly and intuitive for patients, dentists, and administrators. - - New users should be able to navigate the system with minimal training.
Maintainability	- The system should allow for easy updates and maintenance with minimal disruption to users. - Proper documentation must be provided to support system enhancements or troubleshooting.
Reliability	- The system must ensure data integrity and consistency across all modules. - Backup mechanisms should automatically save system data daily to prevent data loss.
Compliance	- The system must comply with data privacy regulations to protect patient personal information -.All system logs and activities must be auditable for security reviews.

Table 4.2 outlines the non-functional requirements for the UTHM Dental Appointment System using role-based access control (RBAC). The availability requirement ensures the system operates 24/7, providing continuous access for patients, dentists, and administrators, with minimal downtime for maintenance or updates. The security requirements emphasize the implementation of role-based access control (RBAC) to restrict unauthorized access to sensitive data. While, user credentials are securely stored using encryption techniques, and the system enforces strong password policies while limiting login attempts to three retries for added security.

The usability requirement ensures the system is user-friendly and intuitive for patients, dentists, and administrators, with minimal training required for new users. For maintainability, the system is designed to support easy updates and maintenance

without disrupting users, and proper documentation is provided to aid troubleshooting and enhancements. Next, the reliability requirement focuses on maintaining data integrity and consistency across all modules. Backup mechanisms automatically save system data daily to prevent data loss. Finally, the compliance requirement ensures the system adheres to data privacy regulations to protect patient information. All system logs and activities are auditable for security reviews.

4.2.3   User Requirement

User requirements describe the specific needs, expectations, and interactions that users have with the system. These requirements focus on what the system should allow users to do, based on their roles and responsibilities. In the context of the UTHM Dental Appointment System with Role-Based Access Control (RBAC), user requirements are crucial to ensure the system delivers practical and relevant functionality to each user group, including students, staff, dentists, and administrators.

Every user group has different requirements. In addition to choosing their desired time slot and dental service, students must be able to register, log in, and follow the status of their appointments. Additionally, they must be able to examine their past appointments and get timely email notifications about any changes to their reservations. However, in order to examine and manage appointment lines, verify patient attendance, and update service records, dental professionals need access. In order to be ready for every consultation, dentists might also need to review patient appointment information and treatment categories in advance.

These requirements are gathered through observation, interviews, and feedback from the stakeholders to ensure that the system aligns with real-world workflows and operational needs. For example, students need the ability to book and view their appointment status, staff must manage patient queues and services, and admins require full access to user accounts, reports, and appointment approvals.

Table 4.3 shows user requirement of UTHM Dental Appointment System With Role- Based Access Control (RBAC) For UTHM Health Center.

Table 4.3: User requirement

User	Requirement
Patient	- Register as a new user in the system.
	- Log in using valid credentials.
	- Book, view, and cancel dental appointments.
	- Receive appointment confirmation
	- Update apointment information.
	- View dental records and appointment history.
Staff	- Register as a new user in the system.
	- Log in using valid credentials.
	- Update status and cancel dental appointments.
	- Receive appointment confirmation
	- Update available appointment slot.
	- View dental records and appointment history.
Dentist	- Access patient dental records and appointment details.
	- View patient dental records.
	- View patient treatment history and generate reports.
Admin	- Manage user registration for dentists.
	- View and manage all appointment schedules.
	- Generate detailed reports for system performance and dentist activities.
	- Ensure system data integrity and compliance with regulations.

Table 4.3 outlines the user requirements for the UTHM Dental Appointment System utilizing role-based access control (RBAC). Patients can register as new users, log in using valid credentials, and manage their dental appointments, including booking, viewing, and cancelling appointments. They also can receive appointment confirmations, update appointment information, and view their dental records and appointment history. Staff members can register as new users and log in securely using valid credentials. Dentists have access to patient dental records and appointment details, including the ability to view patient treatment history and generate reports. They can also manage, and update patient records as needed. Administrators are responsible for managing user registration for dentists, viewing and managing

appointment schedules, generating detailed reports on system performance and dentist activities, and ensuring data integrity and compliance with regulations.

4.2.4 Software Requirement

Table 4.4 shows software requirement of UTHM Dental Appointment System With Role- Based Access Control (RBAC) For UTHM Health Center.

Table 4.4: Software requirement

Software Component	Description
Operating System	- Windows Server for server deployment.
Database Management System	- MySQL to store user, appointment, and patient data.
Web Server	- Apache HTTP Server
Programming Languages	- Frontend: HTML, CSS, JavaScript.
	- Backend: PHP, Java.
Encryption Tools	- SSL/TLS for secure data transfer.
Notifications Service	- Email (PHPMailer) for sending alerts and confirmations.
Browsers Supported	- Google Chrome, Mozilla Firefox, Microsoft Edge,

Table 4.4 presents the software requirements for the UTHM Dental Appointment System, which incorporates role-based access control (RBAC). The system requires a user-friendly interface to support seamless access for patients, dentists, and administrators. It must also be compatible with modern web browsers to ensure easy access and functionality across different devices. The software must

integrate with a database management system (DBMS) to securely store and manage user credentials, dental records, appointments, and treatment history. Additionally, the system should support automated email to keep users informed about appointment confirmations, history and changes. The software must also adhere to industry standards for data encryption and security to protect user privacy and sensitive information.

4.2.5   Hardware Requirement

Table 4.5 shows hardware requirement of UTHM dental appointment system with role-based access control (RBAC) for university health center.

Table 4.5: Hardware requirement

Hardware Component	Hardware Component
Client Devices	- Desktop or laptop computers for administrative staff.
Network Equipment	- High-speed routers, switches, and access points.
Backup Storage	- External hard drives or cloud storage solutions.

Table 4.5 outlines the hardware requirements which requires desktop or laptop computers for administrative staff to manage appointments and user accounts. Patients can access the system using devices, which is desktop or laptop, for booking appointments and viewing records. For network infrastructure, high-speed routers, switches, and access points are necessary to ensure smooth communication and data transfer. Additionally, backup storage should be implemented using external hard drives or cloud storage solutions to securely store critical data

A reliable and safe backup system is required for data security. External hard drives can be used for offline backups, while cloud storage services can be used for remote backups that happen in real time. These backup options are crucial for preventing data loss in the event of hardware faults, cyberattacks, or system failure. For the system to ensure performance, security, and scalability over time, the hardware infrastructure must be properly developed and maintained.

4.3   System Analysis

The UTHM Dental Appointment System's system analysis can be broken down into a number of approaches that aid in defining, visualizing, and improving the system's procedures and structure. These approaches include of Structured English, Context Diagrams, Data Flow Diagrams (DFD), and Process Specification.

4.3.1   Context Diagram

The dental appointment system's system analysis can be broken down into a number of approaches that aid in defining, visualizing, and improving the system's procedures and structure. These approaches include of Structured English, Entity Relationship Diagrams (ERD), Context Diagrams, Data Flow Diagrams (DFD), and Process Specification.

Figure 4.1 shows the context diagram for UTHM dental appointment system with role-based access control (RBAC) for UTHM health center
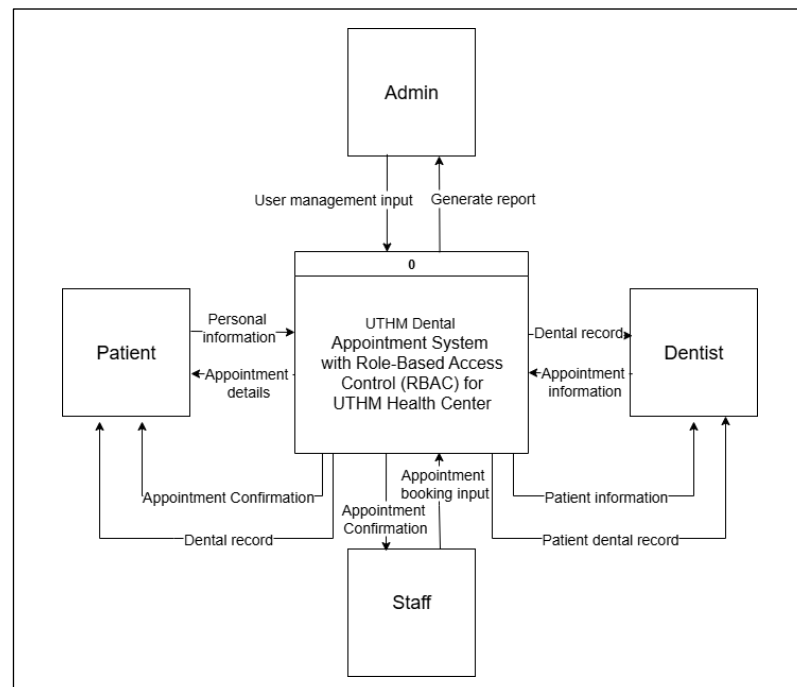
Figure 4.1 : Context Diagram

The UTHM Dental Appointment System using Role-Based Access Control (RBAC) connects four main users which admin, dentists, patients, and staff. Admins are responsible for managing user inputs, registering new dentists, storing their information in the database, retrieving dentist details, and generating reports. Dentists interact with the system by updating patient dental records, retrieving patient information, accessing appointment details, and viewing dental records stored. Patients contribute by providing and updating personal information, booking and managing appointment details, and receiving appointment confirmations. Staff manage appointment bookings by inputting and confirming appointment details while ensuring updates are reflected in the system. The system enables secure data flow and access based on roles, ensuring that each user interacts only with the data and functions relevant to their role, thereby facilitating efficient dental management processes.

4.3.2 Data Flow Diagram (DFD) Level 1

Figure 4.2 shows the data flow diagram Level 1 for the UTHM dental appointment system with role-based access control (RBAC) for university health center. There are four users which Admin, Dentist, Patient, and Staff. The admin can register new dentists and store their information in the database, as well as manage user inputs. Dentists can manage patient dental records by viewing and storing them in the patient table within the database. They can also view patient appointment details for better treatment management. Patients can register by providing their personal information, which is stored in the database. They can retrieve and update their personal information when needed. Additionally, patients can manage their appointments by inputting appointment details and receive appointment confirmations. Staff play a role in managing and confirming appointment information, ensuring the information is updated and accurate within the system. The system ensures secure access and operations for each user based on their roles, maintaining proper functionality and data management.

Figure 4.2: Data Flow Diagram (DFD) Level 1

4.3.3 Structured English

Structured English describes the logic of a system's processes using straightforward and understandable statements. In structured English, the key processes of the UTHM Dental Appointment System using Role-Based Access Control (RBAC) are listed below.

4.3.3.1 User Authentication Process

Figure 4.3 shows the user authentication process is a critical component of the UTHM Dental Appointment System that ensures only authorized individuals are granted access to the system. To log in, users are required to provide valid login credentials, which include a username and password. Upon successful authentication, the system verifies the user's identity and determines their assigned role. Patients can access their personal dashboard, where they can manage appointments and view dental records. Dentists, on the other hand, have permission to manage and update patient dental records, as well as view appointment details. Admins, who have the highest level of access, can control the entire system, manage users, oversee appointments, and generate reports. If a user enters invalid credentials, the system will deny access and promptly notify the user of the unsuccessful login attempt.

```php
106     if ($user && password_verify($password, $user['password_hash'])) {
107         $_SESSION['username'] = $username;
108         $_SESSION['user_role'] = $user['role'];
109         echo "<script>alert('Login successful! Welcome, " . $user['role'] . "'); window.location.href = 'dashboard.php';</script>";
110     } else {
111         echo "<script>alert('Invalid username or password.'); window.history.back();</script>";
112     }
113
114     } elseif (isset($_POST['action']) && $_POST['action'] === 'access') {
115         if (!isset($_SESSION['user_role'])) {
116             die("<script>alert('Access denied. Please log in.'); window.location.href = 'login.html';</script>");
117         }
118
119         $required_role = $_POST['required_role'];
120
121         if ($_SESSION['user_role'] !== $required_role) {
122             die("<script>alert('Access denied. You do not have the required permissions.'); window.history.back();</script>");
123         }
124
125         echo "Access granted. Welcome, " . $_SESSION['username'] -. "!";
126     }
```

Figure 4.3: User Authentication Process

In summary, by guaranteeing that only authorized users may access the system in accordance with their assigned responsibilities, the user authentication procedure is essential to protecting the UTHM Dental Appointment System. By guiding users to functions pertinent to their tasks, role-based access control (RBAC) improves operational efficiency while fortifying security. By restricting unwanted access to sensitive data, this structured access guarantees that administrators, dentists, and patients engage with the system in a safe and orderly way. All things considered, the authentication process is a basic security layer that upholds the system's secrecy, integrity, and usefulness.

4.3.3.2 Appointment Scheduling Process (for patients)

Figure 4.4 shows that Patients can book, view, or cancel dental appointments through the system. When scheduling an appointment, the system checks for time slot availability. If a selected slot is available, the appointment details are saved, and a confirmation, along with a confirmation details, is sent to the patient. If the time slot is unavailable, the system prompts the patient to choose another time. This process ensures an organized and efficient booking system for patients and dentists.

```php
32    // Combine date & time into a valid DATETIME format
33    $appointment_datetime = date('Y-m-d H:i:s', strtotime("$appointment_date $appointment_time"));
34
35    // Validate input
36    if (empty($fullname) || empty($email) || empty($appointment_date) || empty($appointment_time) || empty($service)) {
37        header("Location: BOOKING.html?message=missing");
38        exit();
39    }
40
41    // Prepare and execute insert query
42    $stmt = $conn->prepare("INSERT INTO appointment
43        (role, fullname, patient_id, faculty, phone, email, appointment_time, service, status, created_at)
44        VALUES (?, ?, ?, ?, ?, ?, ?, ?, 'Pending', NOW())");
45    $stmt->bind_param("ssssssss", $role, $fullname, $patient_id, $faculty, $phone, $email, $appointment_datetime, $service);
46
47    if ($stmt->execute()) {
48        // Send confirmation email
49        $mail = new PHPMailer(true);
```

Figure 4.4: Appointment Scheduling Process (for patients)

4.3.3.3 Appointment Update or Cancellation Process

Figure 4.5 shows that patients can update or cancel their dental appointments as needed. When updating an appointment, the system verifies the availability of the new time slot before making changes. If the slot is free, the appointment details are updated, and a new confirmation detail is generated. In case of cancellations, the system confirms the request, removes the appointment record, and notifies both the patient and the dentist about the cancellation.

47

```
13    // Standard working slots
14    $all_slots = [
15        "08:00 AM", "09:00 AM", "10:00 AM", "11:00 AM",
16        "12:00 PM", "01:00 PM", "02:00 PM", "03:00 PM", "04:00 PM"
17    ];
18
19    // Get booked time slots for the date
20    $sql = "SELECT TIME(appointment_time) AS time FROM appointment
21            WHERE DATE(appointment_time) = ? AND status != 'Rejected'";
22    $stmt = $conn->prepare($sql);
23    $stmt->bind_param("s", $date);
24    $stmt->execute();
25    $result = $stmt->get_result();
26
27    $booked = [];
28    while ($row = $result->fetch_assoc()) {
29        $booked[] = date("h:i A", strtotime($row['time']));
30    }
31
32    // Return only available slots
33    $available = array_values(array_diff($all_slots, $booked));
34
35    header('Content-Type: application/json');
36    echo json_encode($available);
37    ?>
```

Figure 4.5: Booking Appointment

4.3.3.4 View and Manage Patient Records (for Dentists and Staff)

Figure 4.6 shows that dentists and staff have role-based access to view and manage patient records. Once authenticated, dentists and staff can access patient dental records, appointment histories, and treatment details. Dentists can also update regarding a patient's treatment. This ensures that patient information is accurate and up to date, facilitating better diagnosis and treatment planning.

```
36    if ($user) {
37        if (password_verify($password, $user['password_hash'])) {
38            // Set all required session variables
39            $_SESSION['username'] = $user['username'];
40            $_SESSION['role'] = $user['role'];
41            $_SESSION['email'] = $user['email'];
42            $_SESSION['patient_id'] = $user['patient_id'];
43            $_SESSION['fullname'] = $user['fullname'];
44
45            // Redirect based on role
46            if ($user['role'] === 'admin') {
47                header('Location: ADMIN.php');
48            } elseif ($user['role'] === 'patient') {
49                header('Location: http://localhost/BOOKING.html');
50            } else {
51                header('Location: LOGIN.html');
52            }
53            exit();
54        } else {
55            echo "<script>alert('Invalid password.'); window.history.back();</script>";
56            exit();
57        }
58    } else {
59        echo "<script>alert('User not found. Please sign up.'); window.location.href='signup.html';</script>";
60        exit();
61    }
```

Figure 4.6: View and Manage Patient Records

48

4.3.3.5 Generate Reports (for Admin)

Figure 4.7 shows that admins are responsible for system oversight and performance analysis. They can generate reports based on various criteria, such as appointment trends, system usage, and dentist activities. These reports help in monitoring the system's efficiency and improving overall performance. Admins can export these reports or use them for decision-making and analysis.

```
10    <a href="export_excel.php" class="btn btn-success mt-3"><i class="fas fa-file-excel"></i> Export to Excel</a>
```

Figure 4.7: Generate Reports (for Admin)

4.3.3.6 Role-Based Access Control (RBAC) Process

Figure 4.8 shows the Role-Based Access Control process ensures that system functionalities are securely segregated based on user roles. Patients can only access appointment scheduling and view their dental history. Dentists can manage patient records and view appointment details. Staff can manage patient records and update appointment details Admins have the highest level of access, including the ability to manage user roles, oversee schedules, and generate system-wide reports.

```
98    } elseif (isset($_POST['action']) && $_POST['action'] === 'login') {
99        $username = trim($_POST['username']);
00        $password = $_POST['password'];
01
02        $stmt = $pdo->prepare("SELECT password_hash, role FROM signup WHERE username = :username");
03        $stmt->execute([':username' => $username]);
04        $user = $stmt->fetch(PDO::FETCH_ASSOC);
05
06        if ($user && password_verify($password, $user['password_hash'])) {
07            $_SESSION['username'] = $username;
08            $_SESSION['user_role'] = $user['role'];
09            echo "<script>alert('Login successful! Welcome, " . $user['role'] . "'); window.location.href = 'dashboard.php';</script>";
10        } else {
11            echo "<script>alert('Invalid username or password.'); window.history.back();</script>";
12        }
13
14    } elseif (isset($_POST['action']) && $_POST['action'] === 'access') {
15        if (!isset($_SESSION['user_role'])) {
16            die("<script>alert('Access denied. Please log in.'); window.location.href = 'login.html';</script>");
17        }
18
19        $required_role = $_POST['required_role'];
20
21        if ($_SESSION['user_role'] !== $required_role) {
22            die("<script>alert('Access denied. You do not have the required permissions.'); window.history.back();</script>");
23        }
24
25        echo "Access granted. Welcome, " . $_SESSION['username'] -. "!";
26    }
```

Figure 4.8: Role-Based Access Control (RBAC) Process

4.3.4 Process Specification : System Architecture

Figure 4.9 depicts the system architecture for the UTHM Dental Appointment System using Role-Based Access Control (RBAC), which is designed to support four main user entities which patient, staff, admin, and dentist. Figure 4.9 shows the process specification of system architecture.
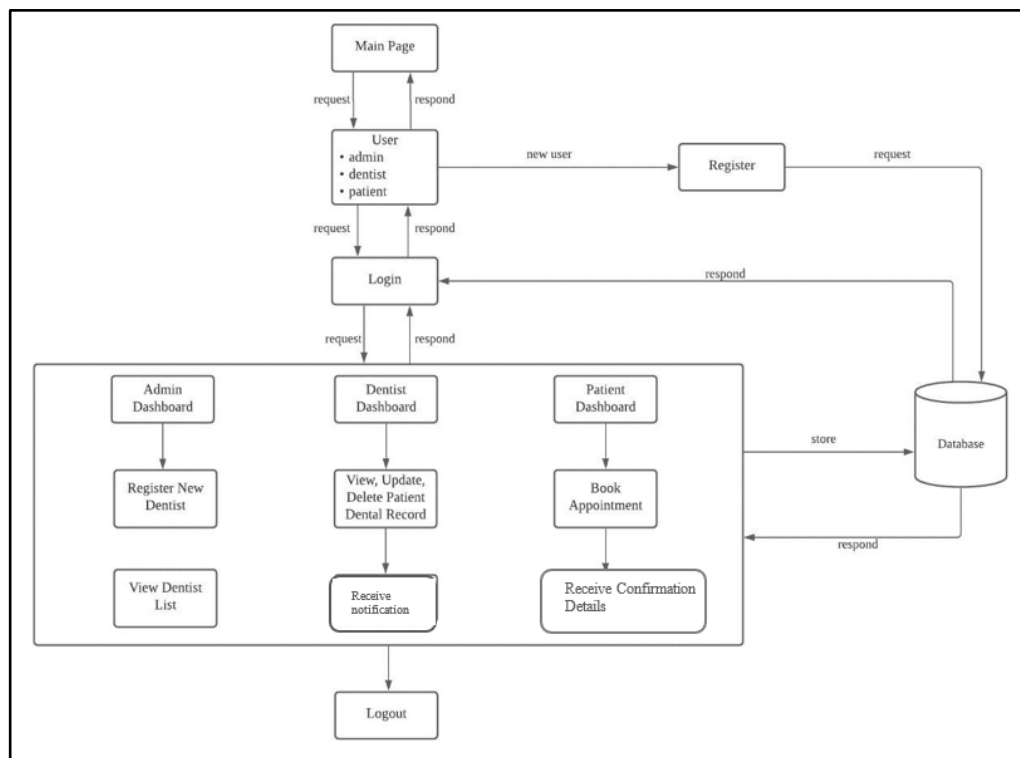
Figure 4.9: Process Specification: System Architecture

Figure 4.9 shows that admin users can log in to manage the system, register new staff or dentists, and view a complete list of registered users. Staff users handle administrative tasks such as managing appointment schedules and updating patient records. Dentists can log in to view appointment schedules and update patient dental records and access patient information. Patients can register as new users, log in to update their personal details, view dental records, and book appointments. Upon booking, patients receive an email notification as confirmation, which stores the details of their appointment. After completing their tasks, all users can log out securely. The system ensures that all data, including user details, dental records, and appointment

information, is securely stored in a centralized database, enabling efficient and secure role-based access across all entities.

4.3.5 Entity Relationship Diagram

Figure 4.10 shows the entity relationship diagram (ERD) for proposed UTHM Dental Appointment System with RBAC. The ERD contains four entities which are admin, dentist, patient, and staff. Admin table are connected to dentist and patient table while dentist table are connected to patient, admin and staff table. As for patient table, it is connected to dentist, admin and staff table. Lastly, staff table is connected to dentist and patient table.
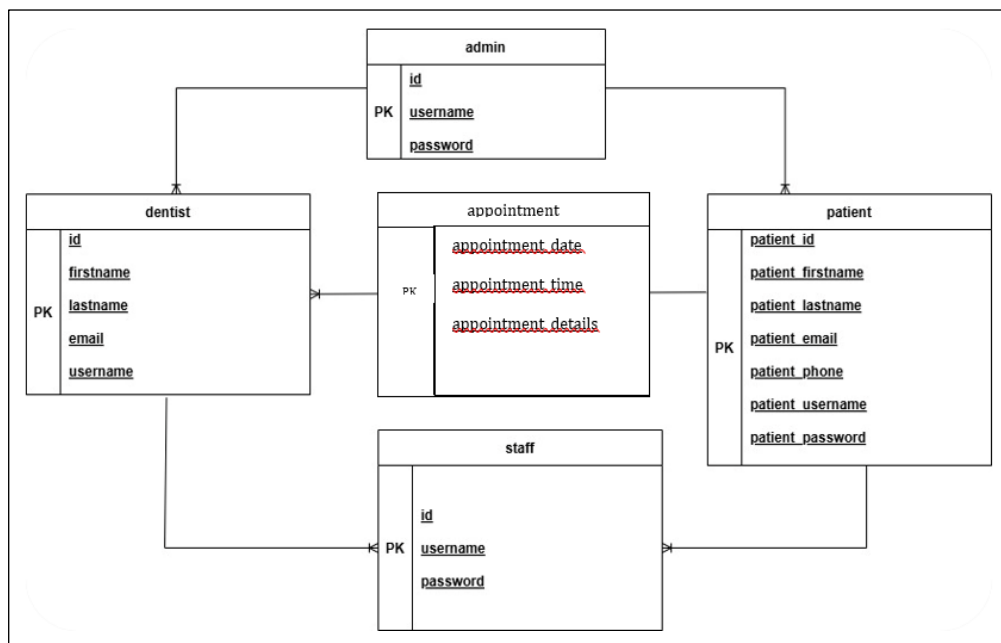
Figure 4.10: Entity Relationship Diagram

4.4 System Design: Flowchart

In this section, flow chart which consist of flow chart for admin, dentist, patient and staff are outlined. Flow chart for admin is discussed in 4.4.1. Section 4.4.2 presents the flow chart for dentist while flow chart for patient is shown in 4.4.3 and lastly section presents flow chart for staff.

4.4.1 Flow Chart for Admin

Figure 4.11 shows the flow chart for admin where it begins with start. Then, if the user is registered user, it will direct to home page for admin. Admin may choose to view dentist list information, register new dentist or view full report of the registered dentist. After all activities are done, admin may logout.
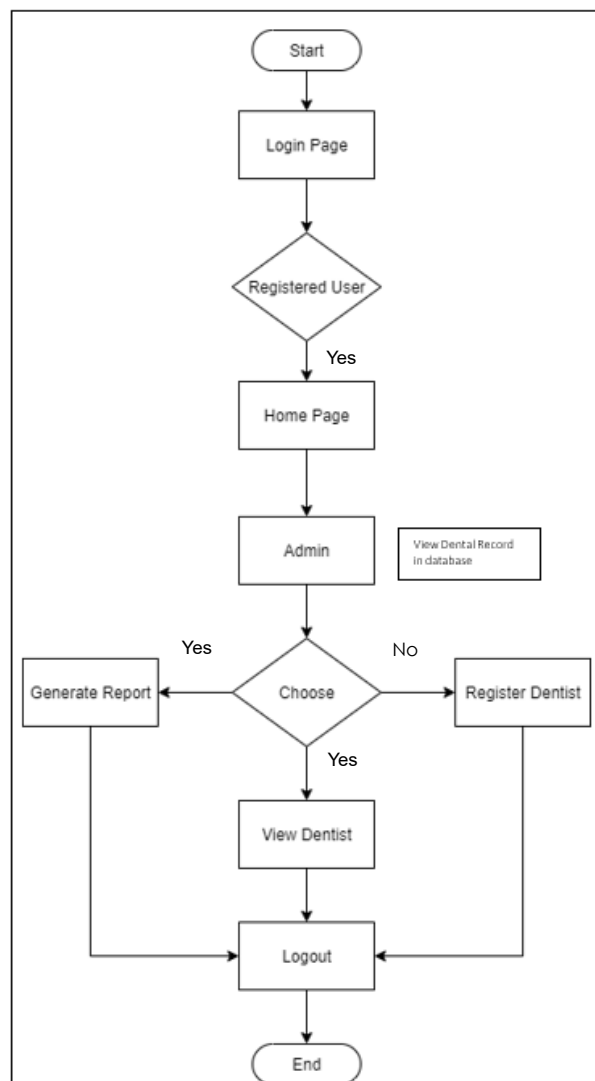
Figure 4.11: Flow Chart for Admin

4.4.2 Flow Chart for Dentist

Figure 4.12 shows the flow chart for dentist where it begin with start then login. If the user is a registered user, it will redirect to dentist home page. Dentist may view patient appointment details and update dental record or view full report. Patient dental appointment and dental record will be stored in database to ensure there will be no modification of data by unauthorized user. As for the report, dentist may view patient full report which are protected by password where it can only be access by authorized user.
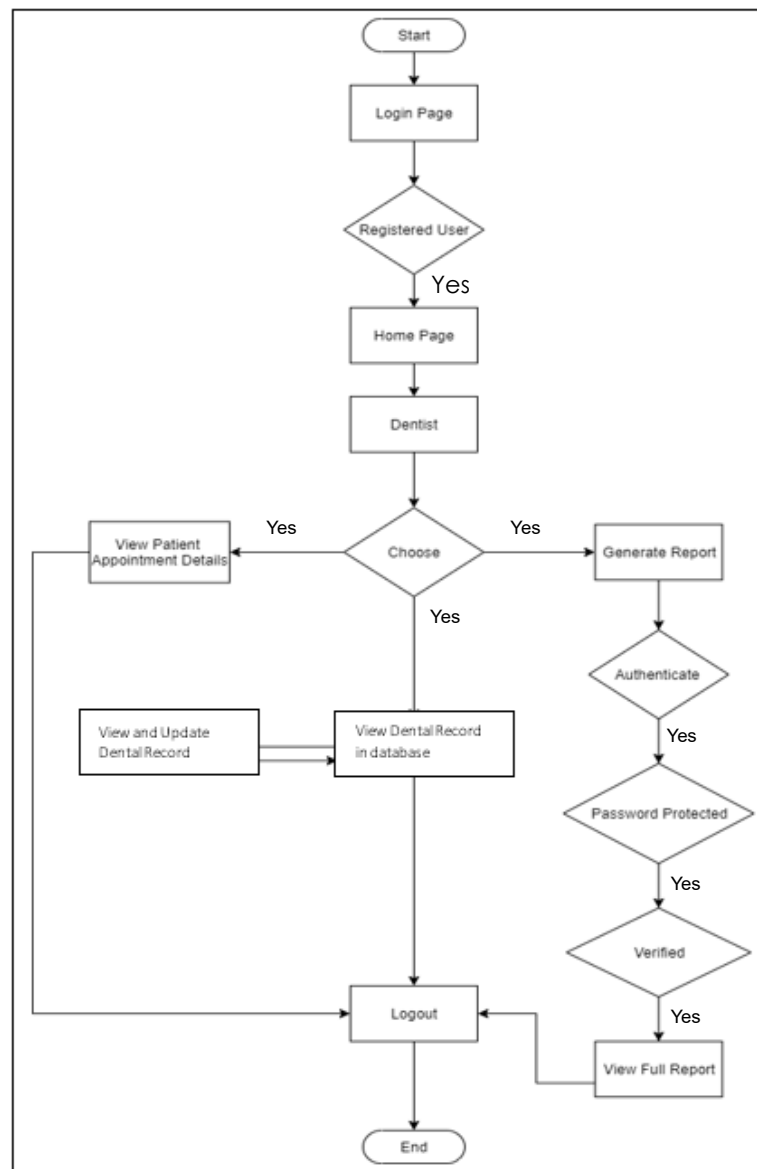
Figure 4.12: Flow Chart for Dentist

4.4.3 Flow Chart for Patient

Figure 4.13 shows the flow chart for patient where it begins with start then login. If the user is registered user, they will redirect to patient home page. However, if they are not registered user, they may register as new user at the register page. After registered, they will direct to login page and login to their account. Once logged in, the user will redirect to patient home page where they may book appointment, update personal information and view full report. Patient may receive booking confirmation in email right after they book the appointment.
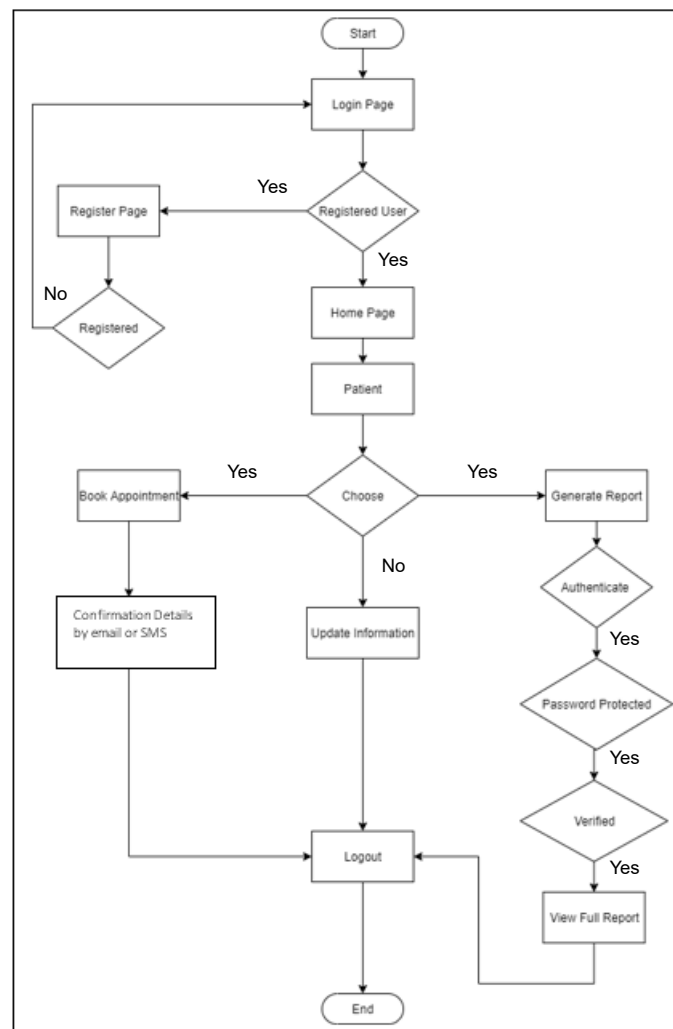
Figure 4.13: Flow Chart for Patient

4.4.4   Flow Chart for Staff

Figure 4.13 shows the flow chart for staff where it begin with start then login. If the user is a registered user, it will redirect to dentist home page. Staff may manage patient appointment details and update dental record. Patient dental appointment and dental record will be stored in database to ensure there will be no modification of data by unauthorized user. As for the report, staff may view patient full report which are protected by password where it can only be access by authorized user. After all the activities are done, dentist may logout.
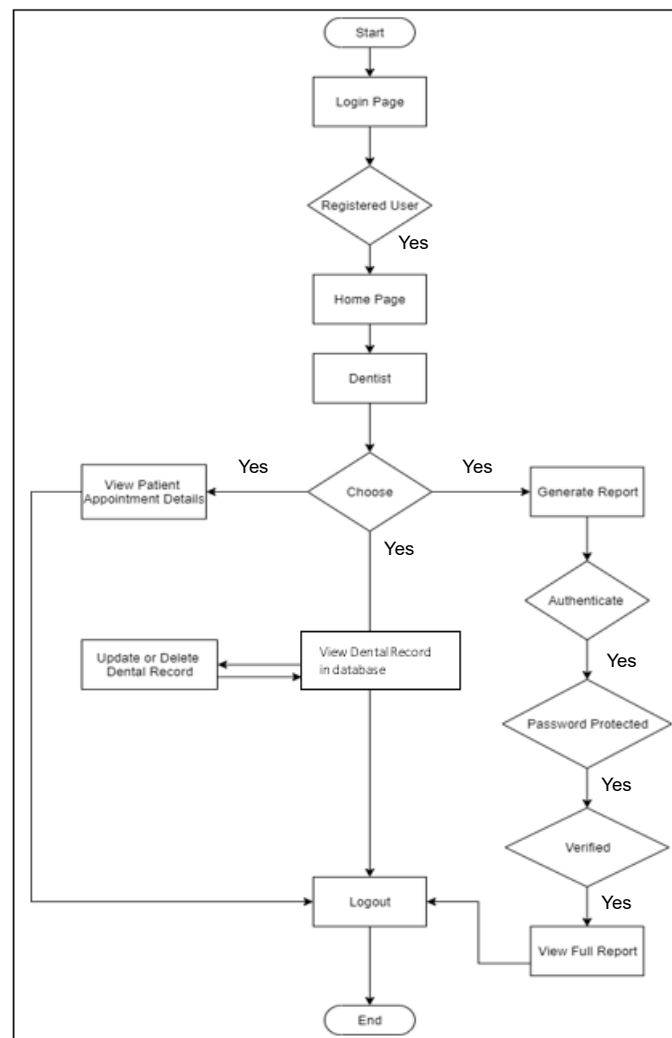
Figure 4.14: Flow Chart for Staff

4.5 Database Design

Schema and database dictionary are represented in the database design. Section 4.5.1 represents the schema. The database dictionary is discussed in section 4.5.2.

4.5.1   Schema

For a UTHM Dental Appointment System with RBAC (Role-Based Access Control), the database schema needs to represent different entities like users, roles, appointments, and permissions, ensuring that access control is enforced based on the user's role. Table 4.6 to 4.12 shows the shcema tables of UTHM Dental Appointment System with RBAC (Role-Based Access Control).

1.   **User Table**

Table 4.6: User table

Field	Data Type	Description
user_id	INT (Primary Key)	Unique identifier for the user
username	VARCHAR(50)	Username for login
password	VARCHAR(255)	Password for authentication
email	VARCHAR(100)	User's email address

2. Roles Table

Table 4.7: Roles table

Field	Data Type	Description
role_id	INT (Primary Key)	Unique identifier for the role
role_name	VARCHAR(50)	Name of the role (Admin, Dentist, etc.)

3. UserRoles Table

Table 4.8: UserRoles table

Field	Data Type	Description
user_id	INT (Foreign Key)	Reference to the user in the Users table
role_id	INT (Foreign Key)	Reference to the role in the Roles table
Primary Key	(user_id, role_id)	Composite primary key to link users and roles

4. Permissions Table

Table 4.9: Permissions table

Field	Data Type	Description
permission_id	INT (Primary Key)	Unique identifier for the permission
permission_name	VARCHAR(100)	Name of the permission (e.g., Manage Users, View Appointments)

5. RoleRPermission Table

Table 4.10: RolePermission table

Field	Data Type	Description
role_id	INT (Foreign Key)	Reference to the role in the Roles table
permission_id	INT (Foreign Key)	Reference to the permission in the Permissions table
Primary Key	(role_id, permission_id)	Composite primary key to link roles and permissions

6. Appointment Table

Table 4.11: Appointments table

Field	Data Type	Description
appointment_id	INT (Primary Key)	Unique identifier for the appointment
user_id	INT (Foreign Key)	Reference to the user (patient) in the Users table
dentist_id	INT (Foreign Key)	Reference to the dentist (user) in the Users table
appointment_date	DATETIME	Date and time of the appointment
status	VARCHAR(50)	Status of the appointment (Scheduled, Completed, Canceled)

7. AuditLogs Table

Table 4.12: AuditLogs table

Field	Data Type	Description
log_id	INT (Primary Key)	Unique identifier for the log entry
user_id	INT (Foreign Key)	Reference to the user who performed the action
action	VARCHAR(255)	Description of the action performed
timestamp	TIMESTAMP	Date and time the action was performed

This schema ensures that users only have access to the features based on their roles and the assigned permissions, enforcing RBAC in the UTHM Dental Appointment System.

4.5.2   Data Dictionary

Table 4.13 until Table 4.16 shows the entity table that represented by attribute name, data type and description

1. Admin entity table

Table 4.13: Admin entity table

Attribute Name	Data Type	Description
Id	int (11)	ID of activity log are auto increment

username	varchar (255)	Username of the admin
password	varchar (255)	Hash key of the password

Table 4.13 shows the admin entity table. There are three attributes which are id, username and password. The primary key for this table is the id.

2. Dentist entity table

Table 4.14: Dentist entity table

Attribute Name	Data Type	Description
id	int (11)	ID of activity log are auto increment
firstname	varchar (255)	First name of the dentist
lastname	varchar (255)	Last name of the dentist
email	varchar (255)	Email of the dentist
username	varchar (255)	Username of the dentist
password	varchar (255)	Hash key of the password

3. Patient entity table

Table 4.15: Patient entity table

Attribute Name	Data Type	Description
patient_id	int (11)	ID of activity log are auto increment
patient_firstname	varchar (255)	First name of the patient
patient_lastname	varchar (255)	Last name of the patient

patient_email	varchar (255)	Email of the patient
patient_phone	varchar (12)	Phone number of the patient
patient_username	varchar (255)	Username of the patient
patient_password	varchar (255)	Hash key of the password
patient_treatment	varchar (300)	Treatment for the patient

Table 4.15 shows the patient entity table. There are nine attributes for this table which are patient_id, patient_firstname, patient_lastname, patient_email, patient_password, patient_teeth_condition and patient_treatment. The primary key for this table are patient_id.

4. **Staff entity table**

Table 4.16: Staff entity table

Attribute Name	Data Type	Description
id	int (11)	ID of activity log are auto increment
firstname	varchar (255)	First name of the dentist
lastname	varchar (255)	Last name of the dentist
email	varchar (255)	Email of the dentist
username	varchar (255)	Username of the dentist
password	varchar (255)	Hash key of the password

Table 4.14 shows the staff entity table. There are five attributes in this table which are id, firstname, lastname, email, username and password. The primary key for this table is id.

4.6 Interface Design

The interface designs of register page and login page are presented in this section. Section 4.6.1 states the register page interface design. The login page interface design is discussed in section 4.6.2. Section 4.6.3 explained about the interface of displaying information.

4.6.1 Register page interface design

Figure 4.15 shows the register page interface design for the proposed system of the dental appointment system with (RBAC). The interface is for the use of first timer of dental management system. Users are required to fill in details such as username, password and email. The function of confirm password is to minimize typing error of their password during the registration process.
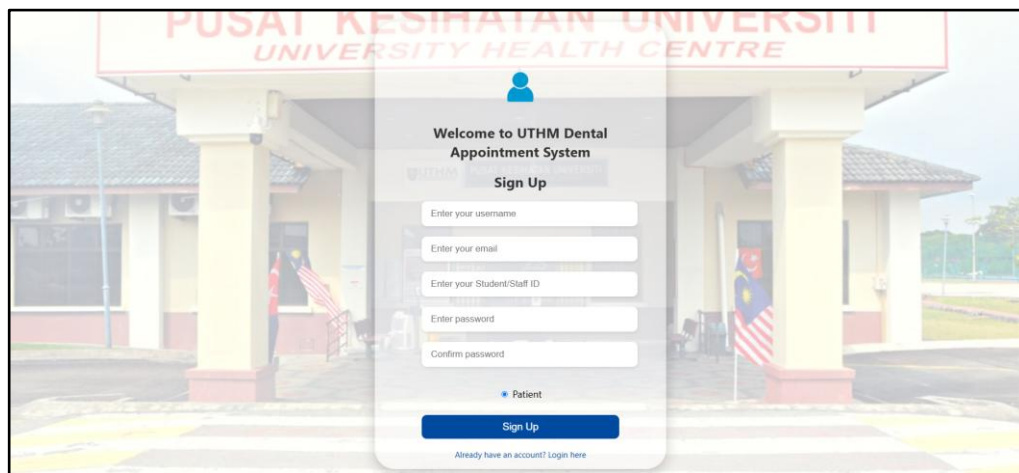
Figure 4.15: Register page interface design

4.6.2 Login page interface design

Figure 4.16 shows the login page interface design. The interface allows users to insert their username and password to login into the system. The input username and

password should be the same as in database. There is also forgot password button for
user to reset their new password
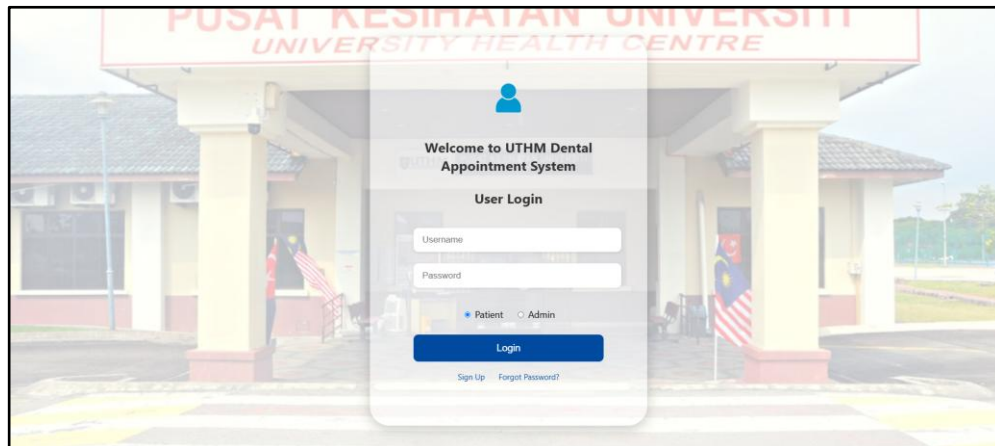
Figure 4.16: Login page interface design

4.6.3   Dashboard design

Figure 4.17 shows the interface design for displaying dashboard page. The interface
design is for user and admin dashboard where it displays dental details and services
that university health center provided to patients.
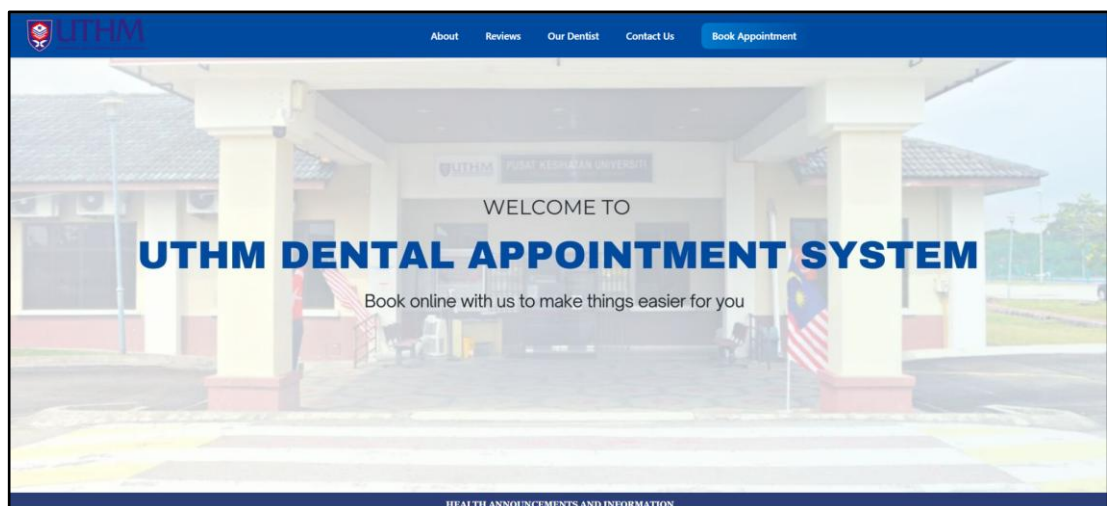
Figure 4.17 : Dashboard Page Design

4.6.4 Admin dashboard design

Figure 4.18 shows the interface design for admin dashboard displaying appointmnet scheduling. The interface design is for admin dashboard where it display todays schedule, todays appointment and remark for admin.
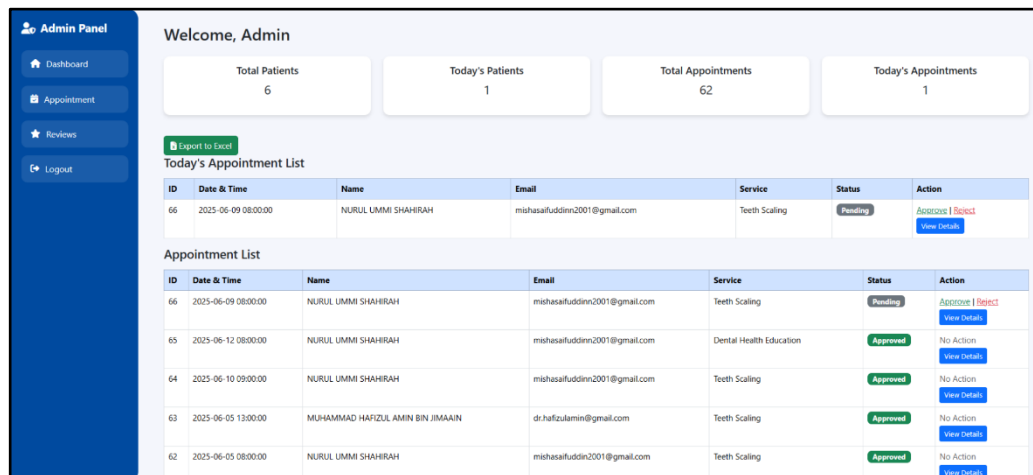
Figure 4.18 : Admin dashboard Page Design

4.6.5 Appointment page design

Figure 4.19 and 4.20 illustrates the interface design for displaying patient appointment details within the user dashboard. This interface plays a crucial role in enhancing the user experience for both patients and administrators by providing quick and organized access to appointment records.For patients, the dashboard displays a summary of their personal appointment history, including key information such as username, email, patient ID, appointment time, and date of appointment. This allows users to conveniently view their past and upcoming appointments in one centralized location, helping them stay informed and better manage their visits. Admins can access and monitor appointment details submitted by users, including filtering by date, status, or user role.

Figure 4.19: Patient Appointment page design

Figure 4.20: Admin Appointment page design

4.7   Chapter Summary

In this chapter, the figures presented clarify and distinguish different interfaces and their functionalities respectively. This helps the proposed system to be designed and developed in a more systematic and comprehensive condition, so the system meets its requirements. The system design incorporates RBAC principles to define user roles and their corresponding permissions

CHAPTER FIVE

IMPLEMENTATION AND TESTING

5.1   Introduction

This chapter outlines the implementation and testing phases of the UTHM Dental Appointment System with Role-Based Access Control (RBAC). Section 5.2 discusses the implementation of the security module, while Section 5.3 covers the implementation of the functional module. Section 5.4 highlights the functional testing performed on the system. Lastly, Section 5.5 summarizes the key points discussed in this chapter.

5.2   Implementation of Security Model

The UTHM Dental Appointment System's security module was thoughtfully created to protect private patient information, provide safe access to system features, and uphold system integrity. Strong and dependable security measures must be put in place since the system manages sensitive data, including personal information, appointment information pertaining to medical conditions, and administrative choices. This module's main goals are to apply access control by restricting user permissions according to their designated roles. For example, enforce authentication by confirming each user's identity before granting access, and maintain confidentiality by making sure that data is only accessible by authorized users. The system incorporates a number of security features to accomplish these objectives.

5.2.1 Implementation of Strong Password Policy

Based on Figure 5.1, the code illustrates the implementation of a strong password policy in the UTHM Dental Appointment System. This policy is enforced during the user sign-up, password change, and password reset processes. The system requires that any password entered must be at least eight characters in length and must include at least one uppercase letter, one lowercase letter, one digit, and one special character. If the password entered does not match the confirmation password or fails to meet the required pattern, the system will trigger an alert and prevent the process from continuing. This validation ensures that all user passwords meet a minimum security standard, thereby strengthening the overall protection of user accounts. Figure 5.1 shows the code for implementing strong password policy.

```
36  if ($password !== $confirm_password) {
37      echo "<script>alert('Passwords do not match.'); window.history.back();</script>";
38      exit();
39  }
40
41  $password_pattern = '/^(?=.*[A-Z])(?=.*[a-z])(?=.*\d)(?=.*[@$!%*?&])[A-Za-z\d@$!%*?&]{8,}$/';
42
43  if (!preg_match($password_pattern, $password)) {
44      echo "<script>alert('Password must be at least 8 characters long and include uppercase, lowercase, digit, and special character.');
45          window.history.back();</script>";
46      exit();
47  }
48
49  $password_hash = password_hash($password, PASSWORD_BCRYPT);
50
```

Figure 5.1: Code for Implementing Strong Password Policy

5.2.2 Implementation of Password Hashing

Figure 5.2 shows the implementation of password hashing using PHP's password_hash() function. In this code, the user's password is securely hashed using the PASSWORD_BCRYPT algorithm before being stored in the database. This ensures that plain-text passwords are never saved directly, enhancing the security of user credentials and protecting them from potential data breaches.

```
49      $password_hash = password_hash($password, PASSWORD_BCRYPT);
```

Figure 5.2: Code for Implementing Password Hashing

67

5.2.3 Implementation of Email Notification

Figures 5.3, 5.4, and 5.5 show the implementation of email notification functionality in the UTHM Dental Appointment System using PHPMailer. Email verification is applied during the user registration process, where a confirmation email is sent to the user's registered email address. The user must click the verification link to activate their account. Additionally, the system sends automated email notifications when a patient books an appointment. The patient receives a confirmation email stating that their request has been received and is under review. Once the admin approves or rejects the appointment, the system triggers a follow-up email to inform the patient of the status. If approved, the email contains appointment details such as date, time, and selected service. If rejected, the patient is advised to rebook through the provided link. This feature ensures clear communication between the clinic and patients while maintaining efficient and secure appointment handling.

```php
// Send confirmation email using PHPMailer
$mail = new PHPMailer(true);
try {
    $mail->isSMTP();
    $mail->Host = 'smtp.gmail.com';
    $mail->SMTPAuth = true;
    $mail->Username = 'mishasaifuddin2001@gmail.com';
    $mail->Password = 'snivvvxnxzjimumw';  // <- Your Gmail app password (NO SPACES)
    $mail->SMTPSecure = 'tls';
    $mail->Port = 587;

    $mail->setFrom('yourgmail@gmail.com', 'UTHM Dental System');
    $mail->addAddress($email, $username);

    $mail->isHTML(true);
    $mail->Subject = 'Registration Confirmation - UTHM Dental Appointment System';
    $mail->Body = "
        <h2>Hi $username,</h2>
        <p>You have successfully registered for the <strong>UTHM Dental Appointment System</strong>.</p>
        <p><b>Your role:</b> $role</p>
        <p>You can now log in and start using the system.</p>
        <br><p>Regards,<br>UTHM Health Center Team</p>";

    $mail->send();
    echo "<script>alert('Signup successful! Confirmation email sent.'); window.location.href = 'login.html';</script>";
} catch (Exception $e) {
    echo "<script>alert('Signup successful but email failed to send. Error: {$mail->ErrorInfo}'); window.location.href = 'login.html';</script>";
}
```

Figure 5.3: Code for Implementing Email Notification of Register

```
if ($stmt->execute()) {
    // Send confirmation email
    $mail = new PHPMailer(true);
    try {
        // Server settings
        $mail->isSMTP();
        $mail->Host       = 'smtp.gmail.com';
        $mail->SMTPAuth   = true;
        $mail->Username   = 'mishasaifuddin2001@gmail.com'; // Your Gmail
        $mail->Password   = 'snivvvxnxzjimumw';                  // Your App Password (NO spaces)
        $mail->SMTPSecure = 'tls';
        $mail->Port       = 587;

            $mail->setFrom('your_email@gmail.com', 'UTHM Dental Clinic');
            $mail->addAddress($email, $fullname); // patient's email

            $mail->setFrom('your_email@gmail.com', 'UTHM Dental Clinic');
            $mail->addAddress($email, $fullname);
            $mail->isHTML(true);
            $mail->Subject = "Appointment Received-Waiting for Approval";
            $mail->Body = " `
                Hi <strong>$fullname</strong>,<br><br>
                Thank you for booking your dental appointment with us. <br>
                <strong>Your request has been received and is currently under review.</strong><br><br>
                <u>Booking Details:</u><br>
                Date: <strong>$appointment_date</strong><br>
                Time: <strong>$appointment_time</strong><br>
                Service: <strong>$service</strong><br><br>
                We will notify you once your appointment is approved or rejected.<br><br>
                Regards,<br>UTHM Dental Team
            ";
            $mail->send();
    } catch (Exception $e) {
        error_log("Email not sent. Error: {$mail->ErrorInfo}");
    }
```

Figure 5.4: Code for Implementing Email Notification of Booking Appointment

```
// Send email
$mail = new PHPMailer(true);
try {
    // SMTP Configuration
    $mail->isSMTP();
    $mail->Host = 'smtp.gmail.com';
    $mail->SMTPAuth = true;
    $mail->Username = 'mishasaifuddin2001@gmail.com'; // Replace with your Gmail
    $mail->Password = 'snivvvxnxzjimumw'; // App Password
    $mail->SMTPSecure = 'tls';
    $mail->Port = 587;

    // Email content
    $mail->setFrom('mishasaifuddin2001@gmail.com', 'UTHM Dental Clinic');
    $mail->addAddress($email, $fullname);
    $mail->isHTML(true);

    if ($status === 'Approved') {
        $mail->Subject = "Appointment Approved - Be On Time";
        $mail->Body = "
            Hi <strong>$fullname</strong>,<br><br>
            Your dental appointment has been <span style='color:green;'><strong>approved</strong></span>.<br><br>
            <strong>Details:</strong><br>
            <strong>Date & Time:</strong> $appointment_time<br>
            <strong>Service:</strong> $service<br><br>
            Please be on time for your appointment.<br><br>
            Regards,<br>
            <em>UTHM Dental Team</em>
        ";
    } else {
        $mail->Subject = "Appointment Rejected - Please Rebook";
        $mail->Body = "
            Hi <strong>$fullname</strong>,<br><br>
            We regret to inform you that your dental appointment has been <span style='color:red;'><strong>rejected</strong></span>.<br><br>
            Kindly <a href='http://localhost/LOGIN.html'>make a new booking</a> at your convenience.<br><br>
            Regards,<br>
            <em>UTHM Dental Team</em>
        ";
    }

    $mail->send();
} catch (Exception $e) {
    error_log("Email could not be sent. Mailer Error: {$mail->ErrorInfo}");
}
```

Figure 5.5: Code for Implementing Email Notification of Appointment status

Figure 5.6 until 5.9 shows the notification email with verification link attached. In the email notification, appointment details and status will be attached.
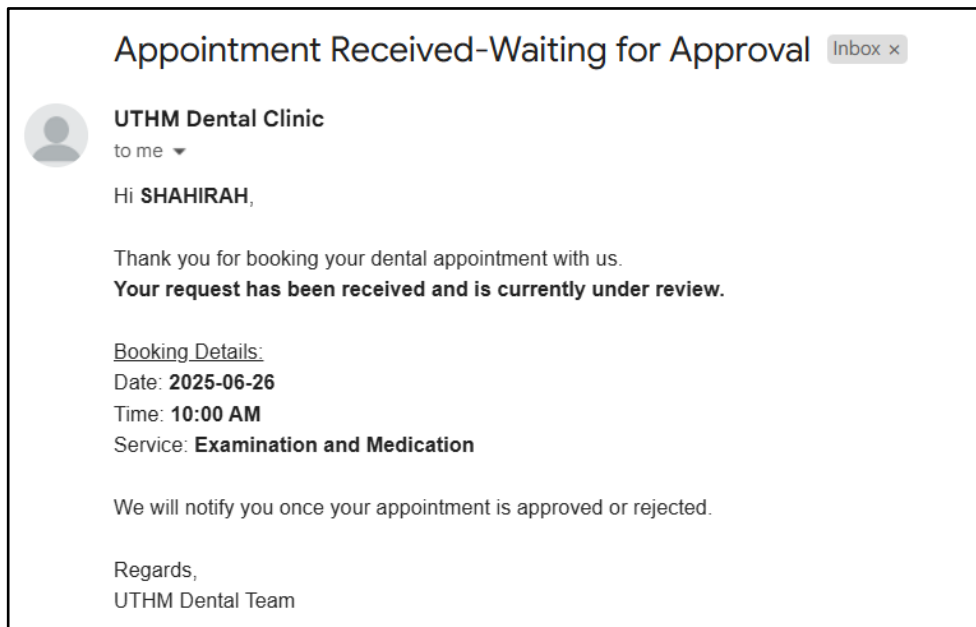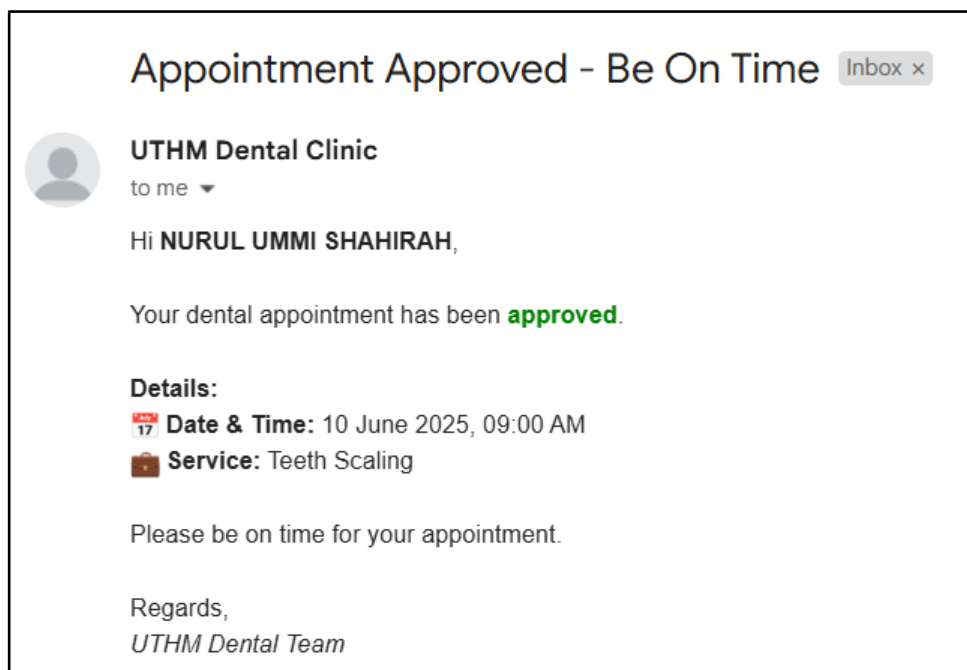

Figure 5.6: Email Notification of Appointment Details
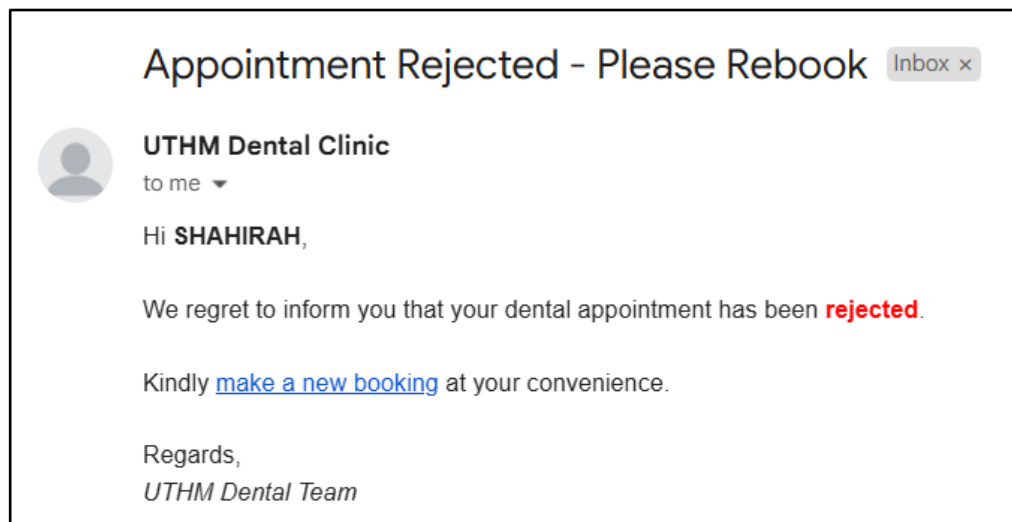

Figure 5.7: Email Notification of Appointment Status
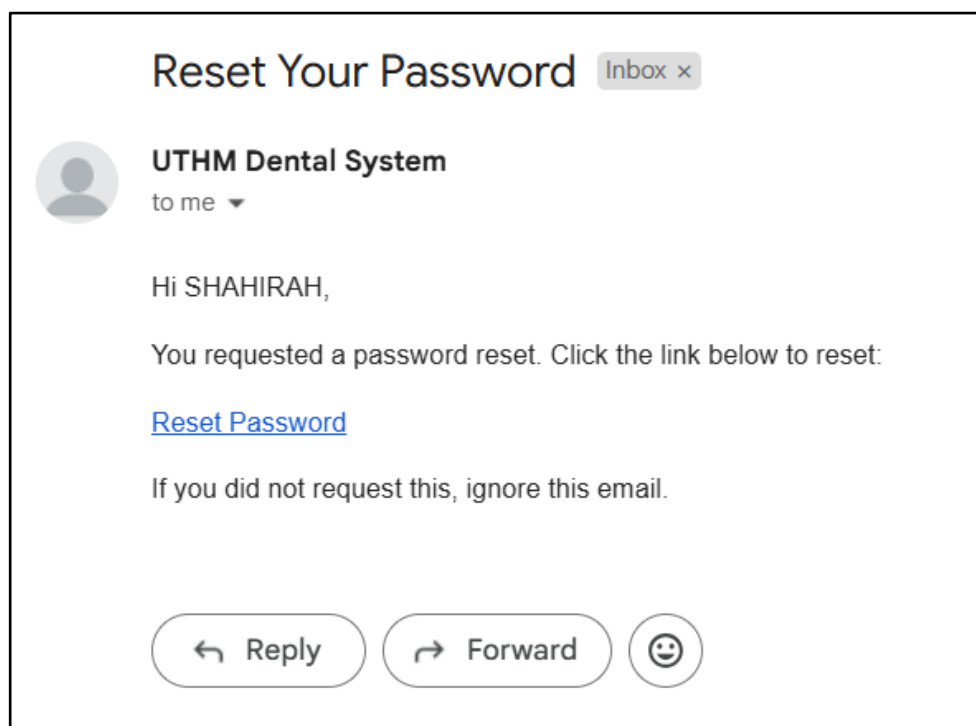
.

Figure 5.8: Email Notification of Appointment Status

Figure 5.9: Email Notification of Forgot Password

5.2.4　Implementation of Role-Based Access Control

Figure 5.10 illustrates the implementation of Role-Based Access Control (RBAC) in the UTHM Dental Appointment System. In this system, users are redirected to different pages based on their assigned roles upon successful login. If the user is an admin, they are redirected to the admin dashboard (ADMIN.php), while patients are directed to the appointment booking page (BOOKING.html). If the role is unrecognized or missing, the system defaults to the login page. This redirection ensures that each user only accesses the modules and functions appropriate to their role, enhancing both usability and security within the system.

```
45          // Redirect based on role
46          if ($user['role'] === 'admin') {
47              header('Location: ADMIN.php');
48          } elseif ($user['role'] === 'patient') {
49              header('Location: http://localhost/BOOKING.html');
50          } else {
51              header('Location: LOGIN.html');
52          }
53          exit();
54      } else {
55          echo "<script>alert('Invalid password.'); window.history.back();</script>";
56          exit();
57      }
58  } else {
59      echo "<script>alert('User not found. Please sign up.'); window.location.href='signup.html';</script>";
60      exit();
61  }
62  }
63  ?>
```

Figure 5.10: Implementation of Role-Based Access Control (RBAC

5.3　Implementation of Functional Module

The UTHM Dental Appointment System's functional module is essential to providing the essential functions and services that underpin day-to-day system operations. It is intended to guarantee that, in accordance with their designated roles, administrators and patients may carry out their respective duties effectively and safely. This module contains all the important capabilities, such as user registration, login, appointment booking, viewing appointment history, acceptance or rejection of appointments, and maintaining user data. Every feature is thoughtfully designed to facilitate a seamless user experience while adhering to the security specifications of the system. Patients

primarily use the booking and personal information modules in this role-specific access implementation, while administrators have access to a wider variety of tools for scheduling and monitoring

5.3.1 Function Modules of All Users

Figure 5.11 displays the login page of the UTHM Dental Appointment System with Role-Based Access Control (RBAC) for the UTHM Health Center. This page serves as the main access point for all users, requiring them to enter a valid username and password to proceed. Once authenticated, users are granted access to specific system functionalities based on their assigned roles either as a patient or an admin. This ensures that each user can only view and perform actions relevant to their responsibilities, enhancing both system security and usability.
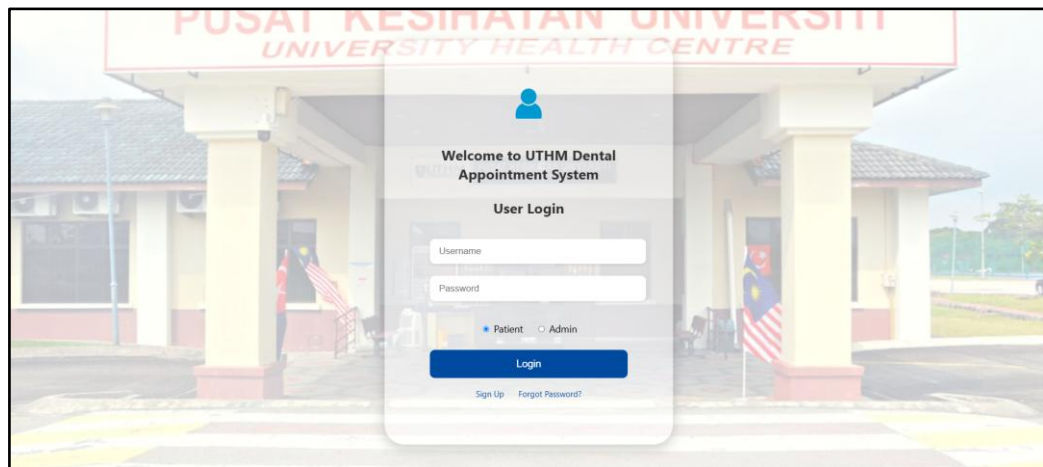
Figure 5.11: Login Page of UTHM Dental Appoinment System with Role-Based Access Control for UTHM Health Center

Figure 5.12 shows the sign-up page of the UTHM Dental Appointment System, which allows new users specifically patients to register for an account. To complete the registration, users must provide their username, email address, Student/Staff ID, and create a password that complies with the system's strong password policy. They are also required to confirm the password to prevent input errors. Once registered, users can proceed to log in and access the system based on their designated role.
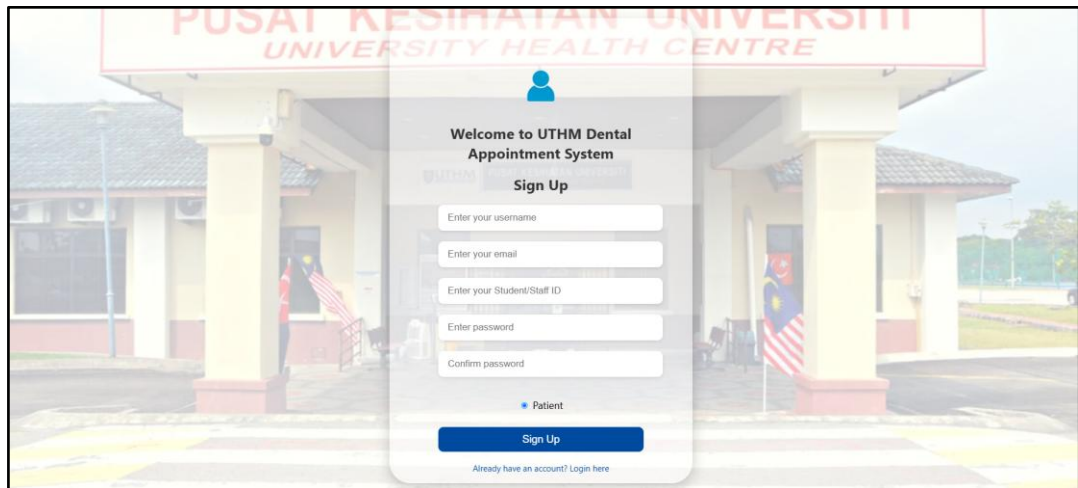
Figure 5.12: SignUp Page of UTHM Dental Appoinment System with Role-Based Access Control for UTHM Health Center

Figure 5.13 displays the "Forgot Password" page of the UTHM Dental Appointment System, which allows users to recover access to their accounts in the event they forget their password. To initiate the reset process, users must enter their registered email address. Once submitted, the system will send a password reset link to the provided email. This feature enhances user convenience and ensures secure password recovery without compromising account safety. It also supports the overall system's commitment to user accessibility and data protection.
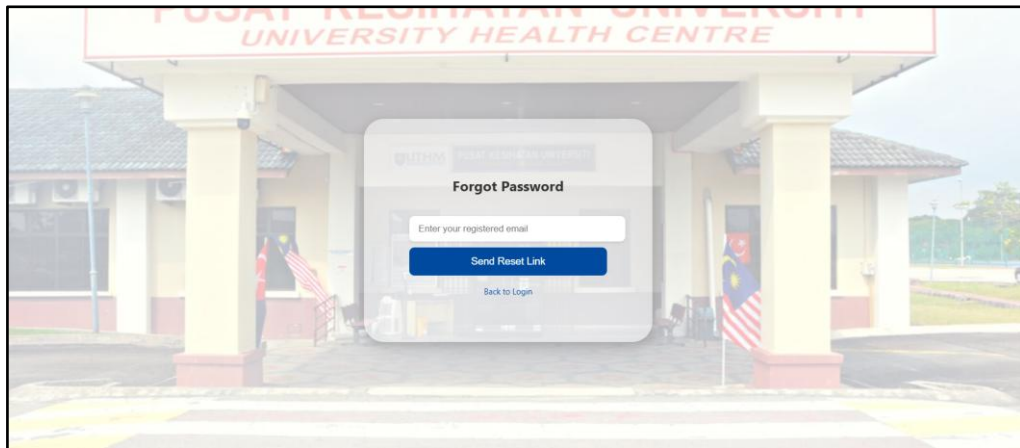
Figure 5.13: Forgot Password Page of UTHM Dental Appoinment System with Role-Based Access Control for UTHM Health Center

Figure 5.14 shows the account management page of the UTHM Dental Appointment System, where users can view their personal information after successfully logging in. The page displays essential details such as the user's full name, email address, student or staff ID, and assigned role in the system. This profile page allows users to confirm their identity and ensures that their account information is accurate. It also includes navigation options like returning to the dashboard or signing out of the system, supporting a user-friendly and secure experience.

Figure 5.14: Account Management Page

Figure 5.15 presents the "Book Your Appointment" form in the UTHM Dental Appointment System, designed to simplify and digitize the appointment scheduling process for students and staff. Users are first required to select their patient category (student or staff), followed by filling in essential personal information such as their full name, matric staff number, faculty or department, contact number, and email address. The form also includes dropdown selections for choosing an available appointment date, time slot, and preferred dental service, helping the system capture all necessary data in a standardized manner. Required fields are clearly indicated with an asterisk to prevent incomplete submissions. Once the form is filled, users can proceed by clicking the "Book Now" button, which will submit their appointment request for review. This form not only enhances user experience through a clean and intuitive layout but also improves the overall efficiency and accuracy of the appointment management process within the university's health center.

5.3.2 Function Modules for Patient

Figure 5.15: Appointment Booking Form

Figure 5.16 displays the "Your Appointment History" page in the UTHM Dental Appointment System, which allows users to view a complete record of their past and upcoming dental appointments. The table presents important details such as the patient's full name, ID number, faculty, phone number, email, appointment date and time, selected service, status of the appointment which approved, rejected, or pending, and the date the booking was created. Overall, this module improves accountability and convenience, ensuring that users remain well-informed of their appointment activities within the UTHM Health Center.

Figure 5.16: Appointment Booking History

Figure 5.17 shows the logout confirmation interface in the UTHM Dental Appointment System. When a user chooses to log out, this prompt appears to confirm their action, helping to prevent accidental logouts. It provides two options: "Yes, Logout" to securely end the session and "Cancel" to return to the system without logging out. This feature ensures that users have control over their session termination, enhances system usability, and adds an extra layer of confirmation to protect against unintentional disconnections especially when handling sensitive appointment or personal data.
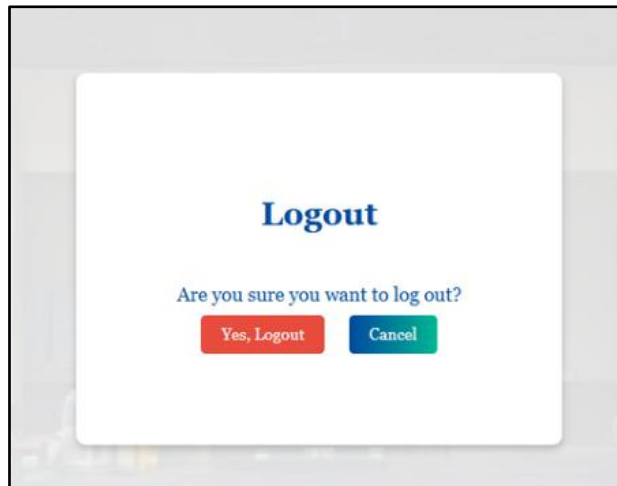
Figure 5.17: Log out page

5.3.3 Function Module for Admin

Figure 5.18 displays the Admin Dashboard of the UTHM Dental Appointment System, which serves as the central interface for administrators to manage the system efficiently. At the top, key statistics are presented, including the total number of patients, today's new patients, total appointments, and today's appointments providing a quick overview of system activity. The dashboard is divided into two main sections: "Today's Appointment List" and the full "Appointment List."
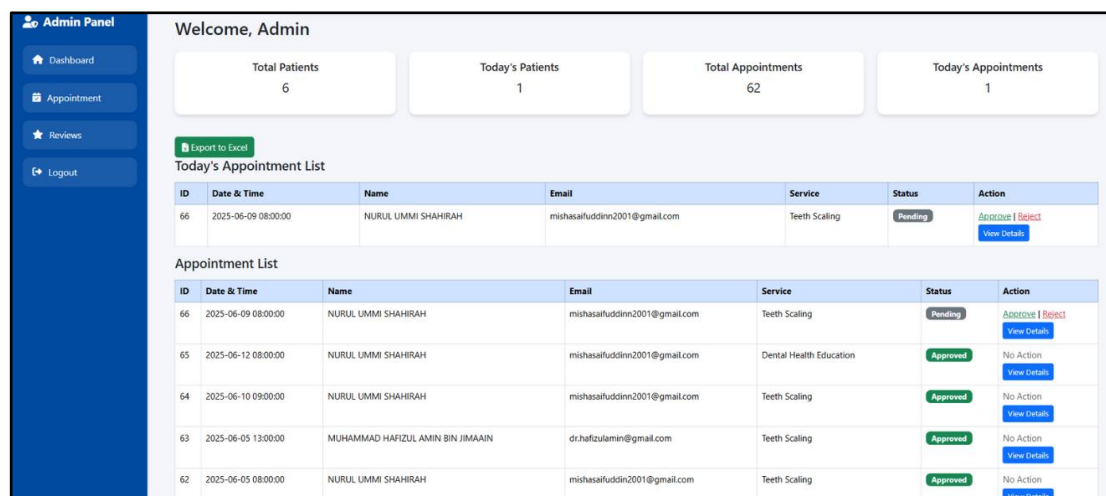

Figure 5.18: Admin Dashboard

The Today's Appointment List highlights appointments scheduled for the current day, allowing the admin to quickly take action by approving or rejecting requests. Each entry shows the ID, date and time, patient's name and email, service requested, current status, and action buttons. The Appointment List below provides a historical view of all bookings in the system, categorized by appointment details and status, including whether an action is required.

Additionally, admins have access to navigation links on the left panel, such as Dashboard, Appointment, Reviews, and Logout. The "Export to Excel" button allows easy data export for reporting and recordkeeping. This dashboard enhances admin productivity by offering an organized, real-time interface to manage dental appointments and monitor overall system usage.

Figure 5.19 illustrates the Appointment Calendar view in the Admin Panel of the UTHM Dental Appointment System. This calendar provides a visual representation of all scheduled appointments for the entire month, making it easier for administrators to track appointment distribution, avoid scheduling conflicts, and manage daily workloads efficiently. Each entry on the calendar includes the service type and the patient's name, allowing admins to quickly review which appointments are set for each day. The calendar supports real-time navigation through previous and upcoming months and includes a "Today" button to return to the current date. This feature improves the overall organization and planning of dental services at the UTHM Health Center by offering a clear and structured overview of the clinic's appointment schedule.
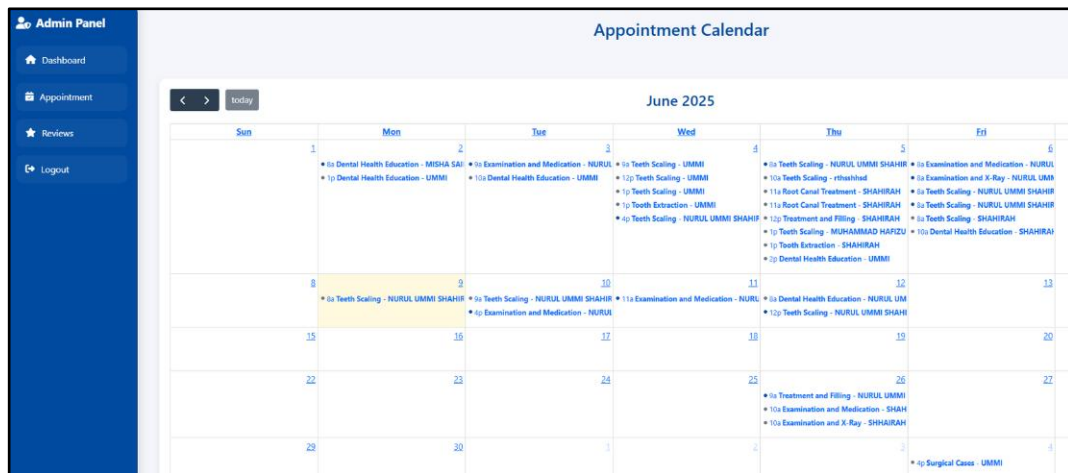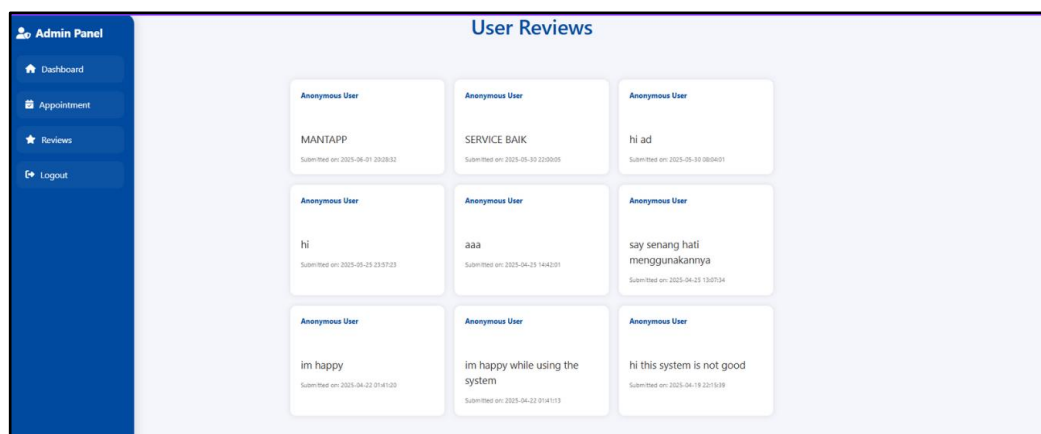
Figure 5.19: Appointment Calendar

Figure 5.20: User Review

Figure 5.20 shows the User Reviews section in the Admin Panel of the UTHM Dental Appointment System. This feature allows administrators to view feedback submitted by users regarding their experience with the system. Reviews are displayed in individual cards and marked as anonymous to protect user identity. Each card includes the comment and the date and time it was submitted. This module provides valuable insight into user satisfaction, highlights areas for improvement, and helps the development team assess the system's usability and effectiveness from the user's perspective. By gathering this feedback, administrators can continuously enhance service quality and user experience at the UTHM Health Center.

5.4   Testing

For testing the appointment management system, two types of test were conducted, which are the system testing and user acceptance testing. The system testing will involve the functional testing, and security tests

5.4.1   Test Plan Result

Table 5.1 shows the result of functional testing while Table 5.2 illustrates the result of security tests. The developed appointment management system was able to pass all the test with expected results.

Table 5.1: Result of Functional Test

Test Case ID	Module	Test Case Description	Expected Output	Actual Output	Status
TC01	Login	Verify login with valid credentials	Redirect to user-specific dashboard	Redirected to correct dashboard based on role	Pass
TC02	Login	Attempt login with invalid credentials	Error message shown	"Invalid email or password" alert displayed	Pass
TC03	Sign Up	Register with valid input fields	Account registered and verification email sent	Registration successful and email received	Pass
TC04	Password Reset	Reset password using registered email	Password reset link sent to email	Email with reset link received	Pass
TC05	Appointment Booking	Submit appointment with all valid details	Booking success message and confirmation email sent	Appointment booked and email received	Pass
TC06	Appointment Approval	Admin approves a booking request	Status updates to "Approved" and email sent to patient	Appointment status updated and email sent	Pass

TC07	Role-Based Redirection	Login and verify redirection based on user role	Redirect to appropriate interface	Patients go to booking, admins go to dashboard	Pass
TC08	View Appointment History	Patient views appointment records	History shown accurately	Appointment details displayed correctly	Pass
TC09	Review Submission	Patient submits a review	Review saved and displayed for admin	Review submitted anonymously and shown to admin	Pass
TC10	Logout	User logs out	Redirect to login and session ended	Logged out and returned to login page	Pass

Table 5.2: Result of Securiy Test

Test Case ID	Security Feature	Test Case Description	Expected Output	Actual Output	Status
ST01	Password Policy	Enter weak password during sign-up	Error message shown and registration prevented	Alert displayed for password strength issue	Pass
ST02	Password Hashing	Check if passwords are stored as plain text	Passwords must be hashed in the database	Passwords stored as hashes using `password_hash()`	Pass
ST03	Email Verification	Register and check verification process	Verification email sent and required to activate account	Email received and account activation required	Pass
ST04	Role-Based Access Control	Attempt to access unauthorized pages	Access denied and redirected to login	Access blocked for unauthorized users	Pass
ST05	Email Notification Security	Booking or status change sends secure email alerts	Proper notification sent without exposing private info	Email sent with appointment info and polite message	Pass
ST06	Form Validation	Submit form with script tags (XSS attempt)	Input rejected or sanitized	Script blocked and form validation triggered	Pass

5.4.2 User Acceptance Form Result

For user acceptance test, there are 5 respondents has been selected to interact with the developed system. The result of user acceptance form has been presented as graphs. There are three graphs has been created

Figure 5.21 shows the result of system functionality test for general module. All the respondents had strongly satisfied that user able to register, login, manage their account and change password.
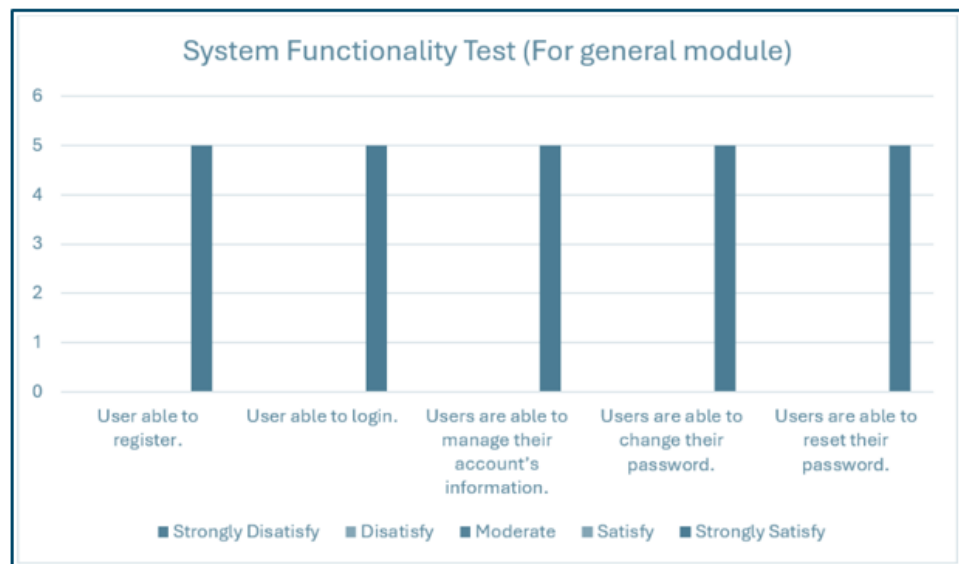

Figure 5.21: Result of System Functionality Test for General Module

Figure 5.22 presents the results of the system functionality test for the Patient Function Module in the UTHM Dental Appointment System. The results indicate that all respondents are highly satisfied with the system's performance. Users are able to access the homepage and view detailed information about the dental services offered by the UTHM Health Center. Additionally, patients can successfully book appointments, view their appointment history, cancel appointments when necessary, and receive timely reminder emails for their scheduled appointments. This confirms that the patient module effectively meets its intended functionality and provides a smooth user experience.
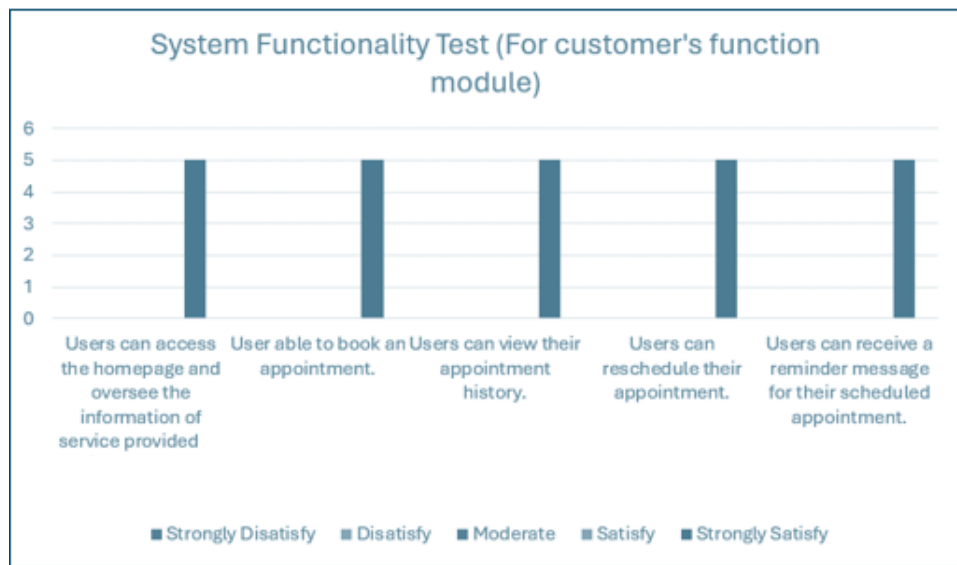
Figure 5.22: Result of System Functionality Test for Customer's Function Module

Figure 5.23 presents the result of security test. Six security elements have been tested and check by the respondents. All the security elements have been tested and passed.
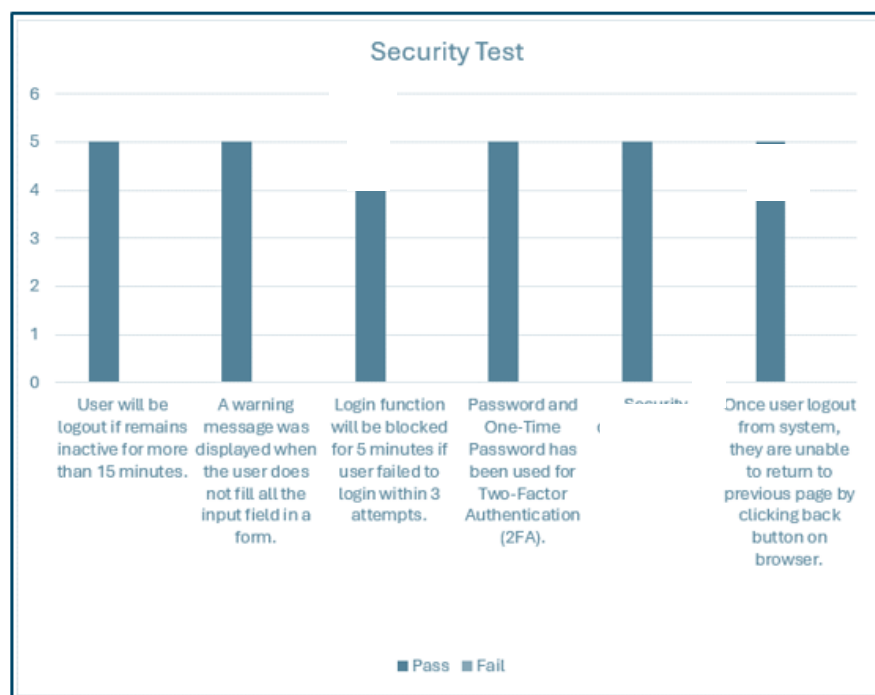

Figure 5.23: Result of Security Test

5.5   Chapter Summary

This chapter has covered in detail how the UTHM Dental Appointment System's security and functional modules are implemented for each category of user. The outcomes of the system's user acceptability testing and test plan were also provided. In organizing dental appointments for the UTHM Health Center, the system's performance, usability, and dependability were highly rated by respondents, and all tests were successfully completed.

CHAPTER SIX

CONCLUSION

6.1   System Development Result

The suggested goals were effectively met in the creation of the UTHM Dental Appointment System with Role-Based Access Control (RBAC). The system has user-specific dashboards, email notifications, appointment scheduling, approval, and a secure login and registration module. Strong password restrictions, password hashing, email verification, and role-based redirection were all skillfully included into the security module. Every module was thoroughly tested and worked as planned, with no serious problems found. Overall, PHP, MySQL, HTML, CSS, and JavaScript were used in the development of the system, which also interfaces with PHPMailer for email correspondence.

6.2   Achievement Overall Objective

The system has successfully fulfilled its main objective, which was to provide the UTHM Health Center with a safe, dependable, and effective dental appointment platform. By allowing staff and students to schedule appointments online, check history, get progress updates, and interact with administrators efficiently, it replaces laborious and traditional methods. Role-based access improves system security and guards against abuse by guaranteeing that only authorized users are able to carry out particular tasks. Additionally, the clinic administration process and user experience are enhanced using automatic email notifications and appointment monitoring.

6.3   Advantages and Disadvantages

The system has a number of benefits. Both administrators and patients may easily utilize its user-friendly interface. Customers no longer need to physically visit the clinic to schedule dental appointments because they may do it online at any time. Password hashing and access control systems are used to ensure security, safeguarding private user information. A clear display of appointment history and dashboards for effective tracking are also available to patients and administrators, and users receive real-time email notifications for booking confirmations and status updates.

The method does, however, have several drawbacks. Due to the lack of a specific mobile application and the fact that it is currently only available through web browsers, mobile users may find it less convenient. Additionally, just one language is supported by the interface, which could not satisfy all users. Email is the only way to get appointment alerts. Last but not least, the admin interface is devoid of sophisticated analytics tools that would facilitate improved performance tracking and decision-making.

6.4   Future Implementation

The system may be further improved in the future by implementing a number of changes. Creating a mobile application to facilitate user access on mobile devices is one suggested improvement. Including two-factor authentication (2FA) would greatly increase user account security. The likelihood that consumers would get timely reminders would rise if SMS alerts were included in addition to emails. Offering a multilingual interface would also help the system better serve users from a variety of backgrounds. Last but not least, adding sophisticated analytics to the admin dashboard would make it possible to track booking patterns, service utilization, and performance indicators more effectively.

6.5   Chapter Summary

In summary, the overall result of the system development and the accomplishment of the project's objectives have been emphasized in this chapter. Along with suggested enhancements for future use, the benefits and drawbacks of the existing system were examined. A major advancement in appointment management, the UTHM Dental Appointment System with Role-Based Access Control offers the UTHM Health Center more productivity, security, and user happiness.

REFERENCES

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APPENDIX A

QUESTIONNAIRE FOR USER ANALYSIS

No	Question	Answer
		Interview Form
1	Can you briefly describe the current manual appointment booking process at UTHM Health Center?	The current appointment booking process is manual, where patients either walk into the clinic or call the reception to book an appointment. The staff records the details on paper or in a spreadsheet. This method often results in booking conflicts, longer waiting times, and difficulties in retrieving patient records.
2	How do patients usually schedule appointments without an online system?	Most patients either visit the dental clinic physically or call during office hours. Appointments are scheduled by the administrative staff based on available time slots and services.
3	What are some common problems faced by patients and staff using the manual system?	Some of the common issues include double bookings, loss of records, limited clinic access during non-working hours, and a lack of real-time updates. Patients also experience difficulty in confirming appointment status.
4	Why is there a need to replace the manual system with an online appointment system?	An online system would reduce human error, enable 24/7 booking access, and provide timely notifications. It also helps the clinic staff manage patient records and appointment status more efficiently.
5	How are patient details currently stored and accessed in the manual process?	Patient details are manually written down or stored in paper-based form. Accessing these records is time-consuming, especially when tracking past appointments or verifying information.
6	Are there any security or privacy concerns with the current manual booking method?	Yes, since records are stored physically or in unsecured digital formats, there is a risk of unauthorized access, loss, or data breach. Manual records are not encrypted or protected by authentication layers.
7	Has the clinic ever faced scheduling conflicts or lost records due to the manual method?	Yes, there have been instances where appointments were mistakenly double-booked or canceled without proper updates. Miscommunication and manual errors often lead to patient dissatisfaction.
8	Would you support the implementation of a digital appointment system in the future?	Yes, a digital system would help improve efficiency, reduce administrative burden, and offer better service to patients. It would also provide a structured and secure way to manage appointments and patient data.

Figure A.1: Questionnaire for User Analysis

APPENDIX B

QUESTIONNAIRE FOR USER ACCEPTANCE TEST

UTHM Dental Appointment System with Role-Based Access Control For UTHM Health Center

This form is deisgned to collect your feedback on the

UTHM Dental Appointment System with Role-Based Access Control For UTHM Health Center. Your honest feedback is crucial in helping us identify area for improvement adn ensure the system meets your needs.

mishasaifuddin2001@gmail.com Switch accounts

Not shared

* Indicates required question

Email *

Your answer

Gender *

○ Male

○ Female

Age *

○ 18 years and below

○ 19 - 23

○ 24 - 29

○ 30 - 35

○ 36 years and above

Are you familiar with the Online Booking System?

○ Yes

○ No

Next   Clear form

Figure B.1: Sample Google Form for User Acceptance Test

Figure B.1: Sample Google Form for User Acceptance Test (Continued)

Users can access the homepage

	1	2	3	4	5	
Stongly Disastify	○	○	○	○	○	Stongly Satisfy

Users able to book an appointment

	1	2	3	4	5	
Stongly Disastify	○	○	○	○	○	Stongly Satisfy

Users can reschedule their appointment

	1	2	3	4	5	
Stongly Disastify	○	○	○	○	○	Stongly Satisfy

Users can receive reminder message for their appointment

	1	2	3	4	5	
Stongly Disastify	○	○	○	○	○	Stongly Satisfy

Back   Next   Clear form

Figure B.1: Sample Google Form for User Acceptance Test (Continued)

Figure B.1: Sample Google Form for User Acceptance Test (Continued)

Figure B.1: Sample Google Form for User Acceptance Test (Continued)

APPENDIX C

INTERVIEW AND SYSTEM TESTING WITH STAKEHOLDER

Figure C.1: System Testing with Dentist of Dental Department UTHM Health Center
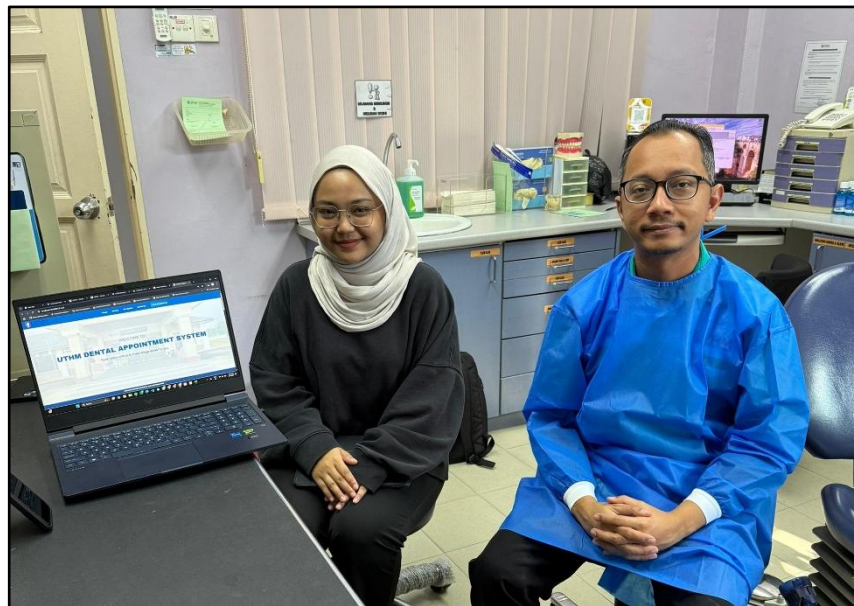

Figure C.2: Final System Presentation to Dentist of Dental Department UTHM
Health Center