Vehicle Maintenance and Service Tracking System

By

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ABSTRACT

This report details the development of the Vehicle Maintenance and Service Tracking System (VMTS), designed to address inefficiencies in traditional vehicle service operations in Malaysia. Manual appointment scheduling, paper-based records, and offline communication methods often lead to errors and delays, which negatively impact customer satisfaction. The VMTS is a web-based solution that automates service bookings, digitizes maintenance records, and provides real-time tracking of service progress, ensuring greater accuracy and convenience for both vehicle owners and administrators. A comparison of existing systems, such as those offered by Toyota Malaysia, Proton ProCare, Audi Malaysia, and Mazda Malaysia, reveals common shortcomings such as the lack of real-time updates and limited customer engagement. To overcome these challenges, VMTS integrates key functionalities such as appointment scheduling, predictive maintenance alerts, automated service reminders, live chat support, feedback and rating systems, and an administrator dashboard with interactive data visualizations. The system was developed using a prototyping methodology, allowing for iterative improvements based on user feedback. The system serves two main user groups: vehicle owners, who can book appointments, track service progress, view historical records, and communicate with service providers; and administrators, who manage appointments, user accounts, services, and feedback through a centralized control panel. This approach ensures the system meets the specific needs of both user groups. The areas of study for this project include Vehicle Maintenance Management and Web Application Development.

Area of Study (Minimum 1, Maximum 2): Web-Based Development, Vehicle Maintenance and Service Management

Keywords (Minimum 5, Maximum 10): Vehicle Maintenance, Service Tracking System, Appointment Scheduling, Web Application, Admin Dashboard, Predictive Maintenance, User Feedback System, Real-Time Monitoring, System Automation

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LIST OF ABBREVIATIONS

VMTS	Vehicle Maintenance and Service Tracking System
ST	Service Technician
FAQ	Frequently Asked Questions
VO	Vehicle Owners
VSMS	Vehicle Service Management System

CHAPTER 1: Project Background

1.1 Introduction

In the rapidly evolving world of transportation, the automotive industry remains a fundamental component of global infrastructure. With the increasing dependence on vehicles for daily commutes, business operations, and logistics, the demand for efficient and reliable vehicle maintenance and service management systems has become paramount [1]. Effective vehicle service management ensures optimal vehicle performance, safety, and longevity by facilitating regular maintenance and timely repairs [2].

Traditional methods of managing vehicle services, such as manual appointment scheduling and paper-based record-keeping, are becoming increasingly inadequate [3]. These outdated approaches are prone to errors, inefficiencies, and delays, leading to dissatisfaction among vehicle owners and operational challenges for service providers [4]. In contrast, modern VSMS, leveraging web-based platforms and advanced database management, offer a comprehensive solution [5]. These systems automate and centralize various aspects of service operations, from appointment bookings to maintenance tracking, inventory management, and customer interactions, significantly enhancing workflow efficiency and service quality [6].

As vehicles become more technologically advanced, the complexity of maintaining them also increases. This evolution necessitates a more sophisticated approach to vehicle service management, one that can keep pace with the growing expectations of customers for transparency, convenience, and high-quality service [7]. The proposed Vehicle Maintenance and Service Tracking System aims to address these needs by providing a robust digital platform that improves the management of vehicle services, ensuring that vehicles are maintained in top condition while delivering a superior customer experience.

1.2 Problem Statement and Motivation

1. Time-Consuming and Difficult-to-Manage Maintenance Records

Traditional methods of managing vehicle service records, such as using paper documents or outdated digital systems, are inefficient and cumbersome [9]. These

systems lead to disorganized records that are hard to access and manage, causing service providers to waste valuable time searching for past maintenance history [10]. This inefficiency not only slows down the service process but also increases the risk of missing crucial maintenance activities. The lack of a streamlined system for managing these records can result in inconsistent service quality, reduced vehicle performance, and a loss of customer trust [11].

2. Failure to make online appointment or manage appointment record

The current system for scheduling vehicle maintenance appointments often falls short of customer expectations. Customers are usually required to call or visit the service centre in person to book appointments, which is both inconvenient and prone to errors. This manual process can lead to issues such as double-bookings, incorrect appointment details, and long wait times. These scheduling inefficiencies frustrate customers and create a negative impression of the service provider, ultimately diminishing customer satisfaction and loyalty [15].

3. Lack of Clear Vehicle Maintenance History Information for ST

Many service centres struggle with inadequate systems for tracking and analysing service maintenance records, which makes it difficult for ST to access clear and comprehensive information about a vehicle's service history. Without easy access to this information, technicians may find it challenging to determine which maintenance services are necessary for a customer's vehicle. This lack of clarity can result in incomplete or inappropriate maintenance being performed, leading to potential issues being overlooked or unnecessary services being recommended. The inability to effectively track and analyse maintenance needs hinders the service provider's ability to offer timely and accurate maintenance, reducing overall vehicle reliability and customer satisfaction [16].

1.3 Project Objectives

1. To enable real-time tracking and updates of appointments.

VMTS will allow user to update their appointment information when the status is still pending. When the appointment is approval, the system will provide users with

immediate access to the latest information regarding their service appointments. By integrating real-time tracking features into the system, users can monitor the status of their appointments from the moment they are submitted until completion. This includes updates such as appointment approval, service start time, progress percentages, and completion status.

The system ensures that users receive timely notifications whenever there is a change in the status or progress of their appointments. This level of transparency not only keeps users informed but also enhances trust and satisfaction by minimizing uncertainty. For administrators, this feature allows efficient management of ongoing services, enabling quick updates and better coordination between service staff and customers. Real-time tracking ultimately improves communication, reduces service delays, and contributes to a more seamless and responsive service experience.

2. To offer an online chat feature for users to receive instant replies or feedback.

This objective aims to enhance communication between vehicle owners and administrators by integrating a real-time online chat feature into the system. The chat functionality allows users to send inquiries, request updates, or raise concerns regarding their service appointments directly through the platform. Administrators can respond promptly, providing immediate support, clarifications, or status updates without the need for phone calls or external communication channels.

By offering instant replies and feedback, the chat system improves user satisfaction, fosters stronger relationships between service providers and customers, and reduces misunderstandings. It also enables administrators to manage multiple conversations efficiently, ensuring that service-related queries are addressed in a timely manner. Overall, the online chat feature contributes to a more responsive, interactive, and user-friendly experience within the Vehicle Maintenance and Tracking System.

3. To maintain and provide access to service history data for both users and administrators to easy tracking and reference.

This objective focuses on ensuring that all completed service appointments and maintenance activities are recorded and stored systematically within the system. By maintaining a detailed service history, the platform enables both vehicle owners and

administrators to easily access past service records for tracking, reference, and verification purposes.

For users, having access to service history allows them to review previous maintenance tasks, understand recurring issues, and plan for future services based on their vehicle's service patterns. For administrators, the service history facilitates better management of customer interactions, helps in monitoring service quality, and supports the generation of reports for operational analysis.

Overall, maintaining comprehensive service history data improves transparency, enhances accountability, and supports informed decision-making for both parties.

4. To provide real-time access to vehicle service status and schedule the required service

The objective of providing real-time access to vehicle service status and the ability to schedule the required service is specifically designed to enhance the administrative capabilities in managing vehicle maintenance through the Predictive Maintenance Dashboard. This feature allows administrators to track and monitor the current status of all ongoing and upcoming vehicle services in real-time.

With the integration of the predictive maintenance functionality, the system continuously monitors vehicle mileage and service intervals, automatically identifying when a vehicle is due for maintenance based on its current mileage and last service mileage. Administrators are given instant access to a real-time dashboard that highlights which services are due, overdue, or approaching. This enables them to make informed decisions about which services need to be scheduled immediately to prevent maintenance delays or issues from escalating.

Administrators can then use the dashboard to schedule the necessary services directly based on the system's recommendations, ensuring that vehicles are serviced at the right time according to the calculated service intervals. The system will automatically flag vehicles requiring urgent maintenance and will display these priority services clearly for the admin to act on quickly.

1.4 Project Scope and Direction

The scope of this project encompasses the design and development of a web-based Vehicle Maintenance and Service Tracking System (VMTS) that supports two distinct user roles: Vehicle Owners (VOs) and Administrators. The system allows VOs to conveniently book service appointments online and modify their booking details prior to approval. VOs can track the status of their appointments in real time and view the service progress through dynamic status updates. They will also receive service reminders when there are updates to the service progress or appointment status. A built-in real-time chat feature enables instant communication with service providers, improving responsiveness and ensuring higher VO satisfaction.

For administrators, the system provides tools to efficiently manage user accounts, vehicle records, and service-related data. It includes functionalities to approve or reject appointments, monitor appointment flow, and send timely reminders for scheduled or overdue services. The system also maintains a comprehensive service history, accessible to both users and administrators, ensuring easy reference and enhancing transparency. Administrators can view the real-time status of all ongoing and upcoming vehicle services, using data-driven insights to make timely decisions and prioritize services.

Additionally, a key feature of the system is the Predictive Maintenance Dashboard, which allows administrators to monitor the health and service needs of vehicles based on their current mileage. The dashboard predicts the required services by calculating the interval between the current and previous mileage, and it automatically assigns services to the Service Required List if the calculated interval meets the necessary service thresholds. This predictive functionality ensures that maintenance tasks are scheduled proactively, helping administrators stay ahead of upcoming services, avoid delays, and reduce the risk of unforeseen vehicle breakdowns.

The overall scope of this project focuses on improving user engagement, streamlining service management, and fostering effective communication through integrated digital solutions. By combining real-time tracking, predictive maintenance, and enhanced administrator tools, the system aims to provide a comprehensive, efficient, and transparent platform for managing vehicle services.

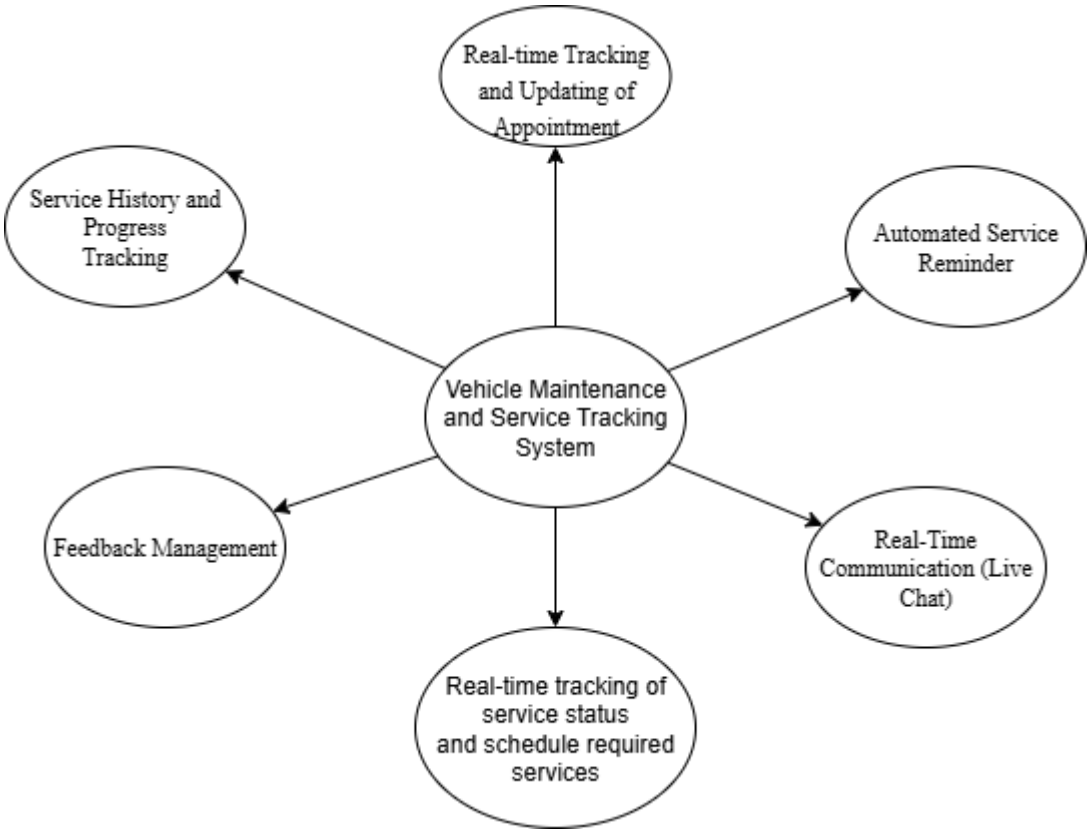


Figure 1.4.1 Project Scope Mind Map

1. Real-time Tracking and Updating of Appointment

The Real-time Tracking and Updating of Appointment feature enables both Vehicle Owners (VOs) and Admins to efficiently manage and monitor appointment records. The system provides VOs with the ability to track their appointments, ensuring they are aware of their scheduled services. Admins have the capability to approve, view, or delete appointment records, offering full control over the appointment management process. Additionally, VOs can update their appointments before they are approved, allowing for flexibility in scheduling changes and ensuring that the system remains responsive to the needs of the users.

2. Service History and Progress Tracking

The Service History and Progress Tracking feature allows both VOs and Admins to monitor the progress of services in real-time. For VOs, this functionality includes tracking the percentage of completion for specific services, helping them stay informed about the status of their vehicle's maintenance. Admins, on the other hand, can update the maintenance progress to ensure that service statuses are accurate and

up to date. Additionally, Admins can view and delete service history records, ensuring that outdated or erroneous data can be efficiently managed. This feature facilitates comprehensive tracking of service history, allowing both VOs and Admins to review past services and track the entire maintenance lifecycle.

3. Real-Time Communication (Live Chat)

The Real-Time Communication (Live Chat) feature enhances the interaction between Vehicle Owners and Admins, enabling two-way communication through an online chat box. This allows VOs to directly communicate with Admins for real-time assistance and updates. The system also allows Admins to select available VOs to initiate or respond to online chats, facilitating immediate problem resolution and improving customer service. This real-time communication tool ensures that any questions or concerns from VOs are addressed promptly, enhancing the overall user experience.

4. Feedback Management

The Feedback Management feature empowers both VOs and Admins to interact with feedback records. VOs have the ability to view and update their feedback, allowing them to express their satisfaction or concerns about the services they have received. Admins can view all feedback records, ensuring that user experiences are consistently reviewed for service improvement. Moreover, Admins have the authority to delete inappropriate or invalid feedback, ensuring that only relevant and constructive comments are retained within the system. This feature ensures that feedback management is transparent and effective, ultimately driving better service quality.

5. Automated Service Reminder

The Automated Service Reminder feature ensures that Vehicle Owners are kept informed about important updates regarding their appointments or service progress. The system will automatically send reminders to VOs when there are updates to the status of their appointments or when the progress of a service changes. This automated feature helps reduce missed appointments, ensuring that VOs stay on track with their scheduled services and remain informed about any changes. By providing timely notifications, this system enhances user engagement and supports a smoother, more efficient maintenance process.

6. To Provide Real-time Access to Vehicle Service Status and Schedule the Required Service

The Real-time Access to Vehicle Service Status and Schedule the Required Service feature is designed to empower Admins with an intuitive and automated way to manage vehicle maintenance. Through this feature, Admins can access real-time updates on the service status of all vehicles, allowing them to track and monitor the maintenance needs of each vehicle efficiently. The system calculates the intervals between the current and previous service mileage, automatically predicting when a service is required. Once the service is identified, the system assigns it to the Service Required List, making it easy for Admins to schedule the necessary maintenance.

The system enhances the scheduling process by providing Admins with proactive service alerts based on predictive data. These alerts indicate when a vehicle is due for maintenance, allowing Admins to prioritize services according to urgency and fleet requirements. This feature ensures that services are scheduled at the right time, reducing the risk of missed services and enhancing the overall efficiency of fleet maintenance management. By streamlining the process, it minimizes administrative workload, improves service planning, and ensures that vehicle owners' needs are met promptly.

1.5 Contribution

This project presents a comprehensive, web-based Vehicle Maintenance and Service Tracking System (VMTS) designed to enhance the overall service experience for both vehicle owners and administrators. The contribution of this project is to provide a web-based system for vehicle owners to conveniently book service appointments and help administrators manage and monitor vehicle service operations online. In addition, the system enables administrators to manage users, services, vehicles, and feedback within a centralized platform. Since the system is implemented in a digital format, the only requirement for users to access the Vehicle Maintenance and Tracking System is an active internet connection on a digital device. With the widespread availability of internet access, users can conveniently interact with the system anytime and anywhere, allowing for flexible service scheduling, live communication, and transparent updates on service progress.

For vehicle owners, the system offers convenient online service appointment booking that can be accessed anytime and from anywhere. It provides real-time updates on appointment status and service progress, promoting transparency and building trust. Users can monitor the progress of their appointments in percentage form and access historical service records for reference. User will also receive notification when the appointment status and service progress were updated. Additionally, a live chat feature enables immediate communication with service providers, ensuring prompt support and feedback.

From the administrator's perspective, the system streamlines service operations through a centralized dashboard that displays key service statistics, appointment distributions, and user insights to support data-driven decision-making. It includes dedicated modules for managing users, services, and vehicle records efficiently. The platform also facilitates the handling of feedback and ratings to assess service quality and customer satisfaction. Moreover, it manages appointment approvals, flags overdue services, and issues timely reminders to maintain a smooth and organized service schedule.

A significant addition to this system is the Predictive Maintenance Dashboard, which provides real-time access to vehicle service status. The dashboard uses predictive analytics to automatically identify when a vehicle is due for maintenance based on mileage data provided by the vehicle owner. By calculating the interval between the current and previous mileage, the system predicts when specific services are required and automatically assigns them to a Service Required List. This helps administrators prioritize services, ensuring that the most urgent maintenance tasks are scheduled promptly. The predictive dashboard also provides administrators with the tools to proactively manage maintenance needs and avoid delays, ultimately reducing the risk of costly repairs.

To enhance monitoring and communication, the system integrates interactive charts and real-time data visualization tools, enabling administrators to assess appointment trends and service performance immediately. Report generation features allow for the export of filtered service history based on specific dates, supporting operational audits and planning. Additionally, the admin-user live chat module ensures prompt handling of user queries, contributing to higher satisfaction and service accountability.

By centralizing key operations and introducing automation across appointment scheduling, progress tracking, and feedback handling, the Vehicle Maintenance and Tracking System significantly improves service delivery, reduces administrative burden, and fosters a stronger relationship between vehicle owners and service providers. This project represents a progressive step towards the digital transformation and modernization of automotive service management in today's tech-driven environment.

1.6 Report Organization

The remaining chapter will show the details of this research. In Chapter 2, some similar systems are reviewed. Features, strengths, and weaknesses from each different similar system had been listed down. In Chapter 2 also included ways to resolve the weaknesses of similar system and a table of comparison between similar systems and proposed system. Methodology, hardware and software used to implement the proposed project, and user requirement been described in Chapter 3. Then, a system design of the proposed system was presented in Chapter 3. In system design included ERD Diagram, use case diagram, use case description, activity diagram and sequence diagram. System architecture diagram and prototype will be resided in Chapter 3. Implementation Issue and Challenges and Project timeline also cover in Chapter 3. Furthermore, Chapter 4 describes preliminary work of the proposed system. Last but not least, Chapter 5 will show the conclusion of the entire project.

CHAPTER 2: Literature Review

In Chapter 2, we will conduct a literature review of existing VMTS. In this review, we found that there are many useful functions and features in the existing systems, such as online appointment booking and providing users with better maintenance service articles.

In order to identify and clarify the basic system requirements and user behaviors that affect the user's perception of the usefulness of the system, we will analyze, evaluate and review similar online VMTS such as Toyota Malaysia, Proton ProCare, Audi Malaysia and Mazda Malaysia. The purpose of conducting a similar system review is to understand the strengths and weaknesses of each online VMTS. In addition, through the literature review, it is possible to find out the features that each similar system lacks, which allows this project to propose more comprehensive features in the system.

Given that our proposed system is a new development, users may initially face challenges in adapting to it. Therefore, the results of this literature review will serve as a reference for enhancing the functionality and usability of the proposed system. This approach will help us better understand the needs and expectations of users, ensuring that the final product effectively meets these needs and improves the overall experience of users when obtaining VMTS.

2.1 Previous Works on Existing VMTS

2.1.1 Toyota Malaysia

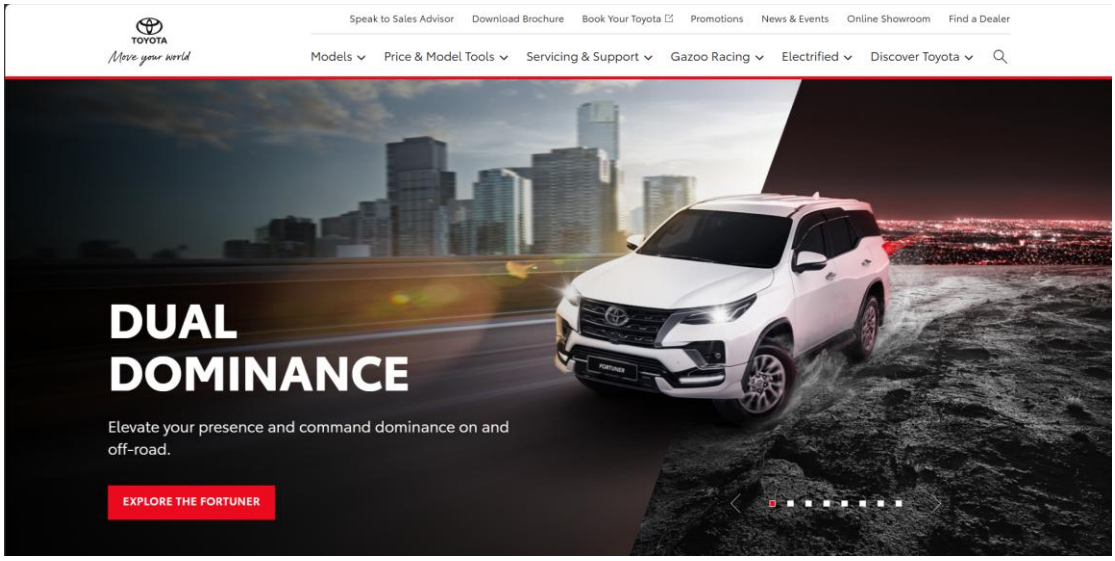


Figure 2.1.1.1 Toyota Malaysia

Toyota Malaysia is a prominent automotive brand known for its extensive range of vehicles and reliable after-sales services. The Toyota service platform in Malaysia is designed to provide comprehensive support to Toyota vehicle owners, ensuring that their vehicles remain in top condition through regular maintenance and timely repairs.

The Toyota Malaysia service platform allows users to book maintenance appointments online, make service inquiries, and access detailed information about various service offerings. The platform aims to enhance customer satisfaction by providing a convenient and efficient way to manage vehicle services. The system also offers customer support through multiple channels, ensuring that users receive assistance when needed [12].

Toyota Malaysia Functions:

Toyota Malaysia offers a range of functions aimed at improving the user experience. The platform allows users to easily locate nearby Toyota dealers and service centers through an interactive dealer locator tool. Additionally, users can download brochures for different Toyota vehicle models, providing them with detailed specifications and features. The website also enables users to view ongoing promotions, special offers, and marketing campaigns, which helps them stay informed about available discounts. For those interested in staying up-to-date with the latest news, Toyota Malaysia offers

a section dedicated to Toyota-related news, updates, and customer stories. Users can also submit inquiries or request assistance from a sales advisor via structured online forms. Furthermore, the platform allows users to compare different Toyota models based on pricing and specifications, making it easier to choose the right vehicle. Lastly, Toyota Malaysia provides comprehensive information about its electrified and hybrid vehicle offerings, catering to the growing demand for environmentally friendly transportation options.

Toyota Malaysia Features:

Toyota Malaysia offers several key features designed to enhance the user experience. The dealer locator tool allows users to search for and locate authorized Toyota dealers and service centers in their area. Users can access downloadable brochures in PDF format for each Toyota vehicle model, providing them with comprehensive details about the vehicles. The website also prominently displays ongoing promotions, campaigns, and featured offers on the homepage, ensuring that users are aware of the latest deals. To keep customers informed, the platform includes sections such as "Toyota Talks" and "News & Events," where users can access news, customer experiences, and automotive articles. Users can send inquiries or sales requests by filling out structured online contact forms, providing a seamless way to get in touch with Toyota representatives. The platform also offers a dedicated section to promote Toyota's hybrid and electrified vehicle technologies. Additionally, users can compare different Toyota vehicle models using an interactive comparison tool, helping them make well-informed purchasing decisions. For easy access to updates, users can connect to Toyota Malaysia's social media platforms, such as Facebook, Instagram, YouTube, LinkedIn, TikTok, and Twitter.

Toyota Malaysia Strengths:

Toyota Malaysia has several strengths that make its platform user-friendly and efficient. The system offers an online payment function, which makes it convenient for users to purchase products without needing to visit physical locations. The platform provides extensive information about Toyota vehicle models, including detailed specifications, design highlights, and downloadable brochures, helping users make informed decisions. The dealer locator tool makes it easy for users to find authorized Toyota service centers and dealerships nearby. Toyota Malaysia also

prominently features ongoing promotional campaigns and special sales offers, making it easier for users to take advantage of discounts. Users can access the latest news, customer experiences, and event updates through sections like "Toyota Talks" and "News & Events." The integrated model comparison tool helps users compare different Toyota vehicle models, ensuring they find the right vehicle. The platform also maintains strong brand visibility through active links to social media platforms like Facebook, Instagram, and YouTube, where users can stay updated. Lastly, the website is designed to be clean, professional, and mobile-responsive, ensuring a smooth browsing experience across all devices.

Toyota Malaysia Weaknesses:

Despite its strengths, Toyota Malaysia's platform has several weaknesses. The platform lacks a personalized user account system, meaning users cannot view their personalized vehicle information or service history through the website. There is also no real-time service progress tracking or appointment status updates available on the website, which could improve transparency for users. The absence of live chat support limits users' ability to instantly communicate with sales or service representatives for assistance. Additionally, the system does not offer online tracking of service history or maintenance records, which are only available via the Toyota MY mobile app. The service appointment booking function is not available directly through the website, as it primarily focuses on vehicle purchase inquiries. The platform also has a limited notification system, as users do not receive automated reminders or service alerts, which could help reduce missed appointments. Lastly, the website does not include a feedback or rating submission feature, making it difficult for users to evaluate and review services directly.

2.1.2 Proton ProCare

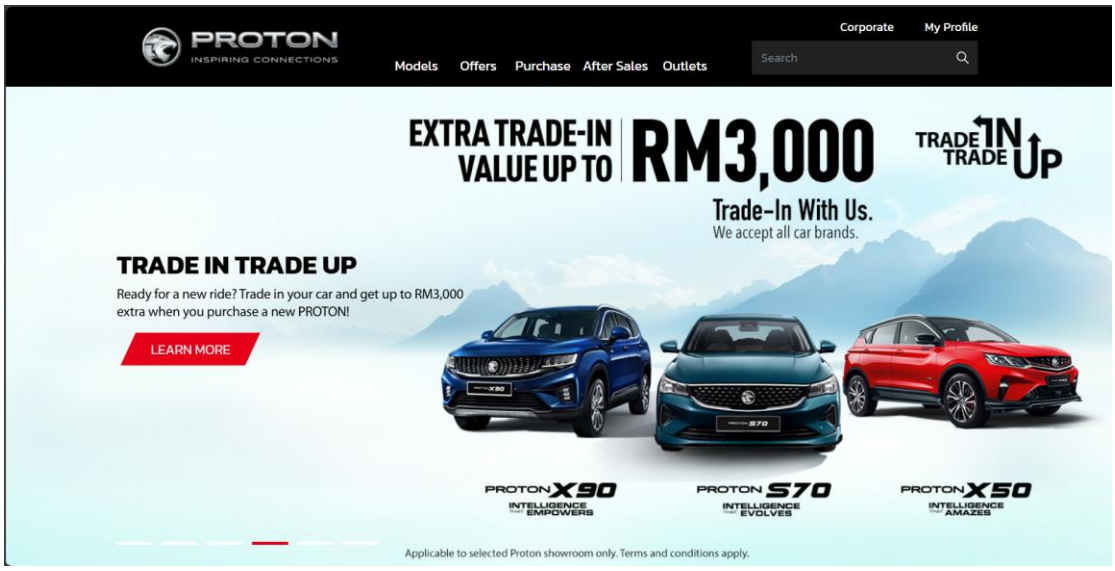


Figure 2.1.2.1

Proton ProCare is an after-sales service program by Proton, a leading Malaysian automotive brand. The ProCare service platform is designed to provide comprehensive maintenance and support to Proton vehicle owners, ensuring their vehicles operate efficiently and safely.

Proton ProCare offers a structured platform that allows users to schedule service appointments, access service records, and obtain detailed information about the maintenance services available. The platform is focused on enhancing customer satisfaction by providing reliable after-sales support and ensuring that vehicles are maintained according to the manufacturer's recommendations [13].

Proton ProCare Functions:

Proton ProCare offers several key functions designed to enhance the user experience for Proton vehicle owners. The platform enables users to easily book vehicle service appointments online, providing a convenient way to schedule maintenance. Users can also locate nearby authorized Proton service centers, ensuring they can access the services they need. Additionally, the platform allows users to view various service options, such as warranty coverage, accessories, and body & paint services, giving them a comprehensive overview of available maintenance services. Users have access to download brochures for vehicles and services, providing them with detailed information to assist in decision-making. The system also facilitates communication

through an online inquiry and complaint submission form, allowing users to easily reach out for assistance. Furthermore, Proton ProCare provides users with access to information about Proton Genuine Parts, highlighting their benefits and importance, as well as detailed maintenance guides through the ProCare section.

Proton ProCare Features:

Proton ProCare is equipped with several useful features to support users in managing their vehicle maintenance. The platform allows users to book service appointments by filling out an online appointment form, streamlining the process of scheduling maintenance. To assist with locating service centers, it offers a dealer locator feature, helping users quickly find authorized Proton service centers based on their location. The website also provides an online brochure downloading feature, which gives users quick access to information about Proton models and services. Users can view detailed information about service maintenance options and Proton Genuine Parts, allowing them to make informed decisions about their vehicle care. Additionally, the system supports customer communication by offering an online inquiry and complaint form, ensuring users can easily ask questions or voice concerns. Proton ProCare also enables users to explore body & paint service options and vehicle accessories, further enhancing the platform's comprehensive service offerings.

Proton ProCare Strengths:

Proton ProCare offers several strengths that contribute to its effectiveness. The platform features a well-organized layout with an intuitive navigation structure, making it easy for users to find the information they need. The simple and efficient layout allows users to quickly book services without unnecessary steps. The platform also includes an FAQ section, providing quick answers to common questions and enhancing the user experience. By centralizing vehicle maintenance, warranty, and after-sales service information, Proton ProCare ensures that users have easy access to all the details they need in one place. The dealer locator helps users find service centers based on their location, improving convenience. Access to Proton Genuine Parts and promotional information builds customer trust and satisfaction. The downloadable brochures further support users in making informed decisions by offering in-depth information about available services and vehicles.

Proton ProCare Weaknesses:

Despite its strengths, Proton ProCare has several weaknesses that limit its functionality. The platform is currently restricted to Malaysian users, which limits its accessibility for Proton owners in other regions. It lacks features for tracking service history or customer feedback, which makes it difficult for users to monitor their past maintenance activities or leave ratings and reviews for services. The absence of multilingual support also poses a barrier for non-Malay or non-English speakers, potentially alienating a broader customer base. Additionally, the system does not include a feedback management feature, preventing users from sharing their experiences and providing valuable insights for service improvement. The lack of service history records means users are unable to track the status or history of their vehicle's maintenance activities online. Another limitation is the absence of real-time customer support chat, making it challenging for users to receive immediate assistance. The system also does not offer real-time tracking of service appointment progress, reducing transparency during the servicing process. Without the ability to track the progress of specific service items, users may find it difficult to understand the current status of their vehicle maintenance.

2.1.3 Audi Malaysia

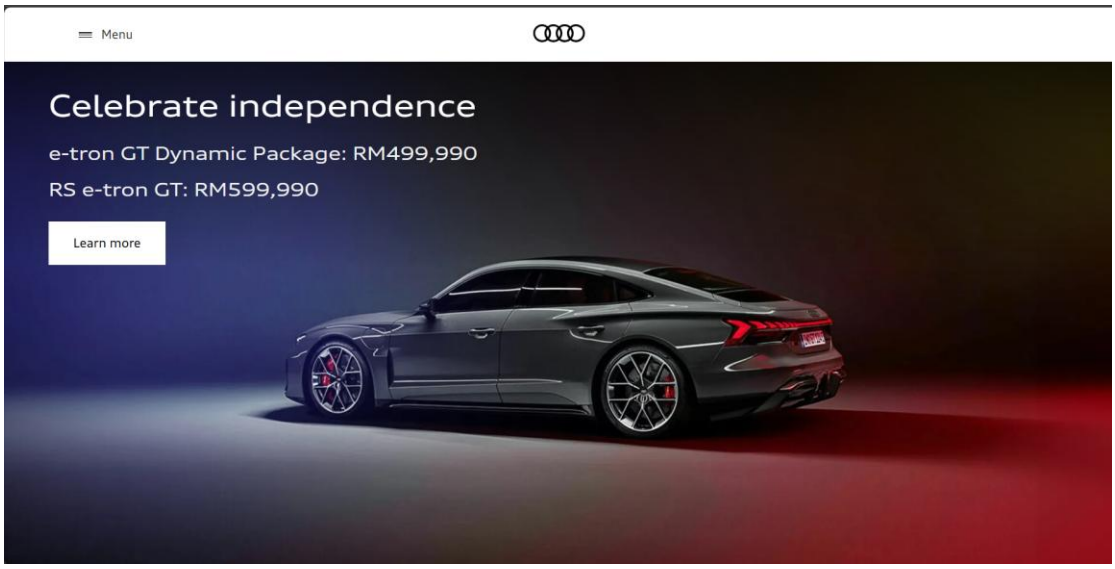


Figure 2.2.3.1

Audi Malaysia is part of the global Audi brand, known for its luxury vehicles and high standards of customer service. The Audi Malaysia service platform is designed to meet

the premium expectations of Audi vehicle owners, providing a range of after-sales services, including maintenance scheduling, service actions, and customer support.

The Audi Malaysia platform offers a premium experience, allowing users to schedule maintenance appointments, access detailed service information, and stay informed about necessary service actions. The platform reflects Audi's commitment to quality and customer satisfaction, ensuring that vehicle owners receive top-notch service that aligns with the brand's luxury image [14].

Audi Malaysia Functions:

Audi Malaysia offers several online features that enhance user engagement and convenience. Users can schedule a test drive for their desired Audi model directly through the platform. The website also provides detailed specifications and information on various Audi vehicles, helping users make informed decisions. In addition, the platform enables users to easily locate nearby authorized Audi dealerships and service centers. It further offers aftersales service details, including information on warranties, and an online contact form to submit inquiries or requests for additional help.

Audi Malaysia Features:

The Audi Malaysia website includes multiple user-friendly features aimed at providing a seamless experience. Users can complete and submit an online form to schedule test drive appointments. Detailed brochures, vehicle specifications, pricing, and features of each Audi model are made available for easy browsing. The platform’s dealer locator tool assists users in finding nearby authorized Audi centers. Users can also access aftersales support details, including service plans, maintenance schedules, and warranty coverage. To facilitate communication, Audi Malaysia includes an integrated inquiry form for users to submit questions and requests.

Audi Malaysia Strengths:

Audi Malaysia’s platform offers a number of advantages for users. One of its key features is the ability to track a vehicle's service status by entering the Vehicle Identification Number (VIN). The site provides a professional presentation of Audi models, including detailed specifications and pricing, ensuring users are well-informed. Additionally, users can easily schedule test drives online, increasing

engagement with the platform. After sales information, such as warranty and service details, is presented clearly, providing valuable insights for users. The dealer locator tool helps users quickly identify nearby authorized Audi service centers. Audi Malaysia's clean and intuitive website design ensures a pleasant browsing experience for users.

Audi Malaysia Weaknesses:

While Audi Malaysia's platform has many strengths, there are also several areas for improvement. The website lacks features like real-time service tracking and customer feedback mechanisms, which could significantly enhance user satisfaction. The platform does not support multilingual content, making it difficult for non-English speakers to navigate the site fully. The absence of an online booking system for service appointments adds inconvenience, as users cannot easily schedule maintenance for their vehicles. Moreover, the lack of a user login or account management feature prevents users from accessing personalized vehicle data or their service history. Additionally, the system does not offer real-time updates on service appointment statuses, reducing transparency for users. Audi Malaysia could also benefit from adding a customer feedback or review system, which would provide valuable insights for service improvements. Lastly, the lack of live chat support means users cannot receive instant assistance when needed, and there are no automated reminders for service appointments, which may lead to missed bookings.

2.1.4 Mazda Malaysia

Figure 2.4

Mazda Malaysia focuses on ensuring the longevity and reliability of its vehicles through a dedicated service platform. The Mazda service platform is designed to provide comprehensive maintenance support to Mazda vehicle owners, helping them keep their vehicles in optimal condition.

Mazda Malaysia's platform allows users to schedule maintenance services, access detailed service records, and receive reminders for upcoming appointments. The platform emphasizes vehicle longevity and reliability, encouraging regular maintenance to extend the lifespan of Mazda vehicles. The user-friendly interface ensures that customers can easily navigate the platform and manage their vehicle services efficiently [15].

Mazda Malaysia Functions:

Mazda Malaysia provides users with a variety of functions designed to enhance their overall experience. The website allows users to easily book service appointments online, making it convenient for vehicle owners to schedule their car’s maintenance. Additionally, users can book test drive appointments for their preferred Mazda models directly through the website. To access personalized services, Mazda Malaysia offers users the ability to register and log in to their Mazda Connect account. Once logged in, users can explore detailed information on various Mazda vehicle models and their specifications. For those seeking assistance, the website also features a tool for

locating authorized Mazda dealers and service centers. Furthermore, users can submit inquiries or request assistance using an online form, ensuring efficient communication with the company.

Mazda Malaysia Features:

The platform includes several key features to improve the user experience. One of the standout features is the integrated online service form, which allows users to schedule their service appointments with ease. Similarly, users can book test drive sessions for their preferred Mazda vehicles directly through the website, providing a seamless experience. The website also supports account registration and login through the Mazda Connect Portal, which gives users access to personalized services. Comprehensive vehicle model information, brochures, and promotional offers are available to users, enabling them to explore Mazda's offerings thoroughly. Additionally, the dealer locator tool assists users in finding nearby authorized service centers and dealers. The online contact form facilitates easy submission of service inquiries or requests for general assistance. Mazda Malaysia also provides vital information regarding 24-hour roadside assistance and warranty programs to ensure customers are well-supported.

Mazda Malaysia Strengths:

Mazda Malaysia offers numerous strengths that enhance the user experience. The website's online service appointment booking system ensures convenience, allowing customers to easily schedule maintenance. The test drive booking feature directly available on the website provides an added convenience for potential buyers. Mazda Connect portal registration enables a personalized experience for users, offering access to tailored services. Comprehensive vehicle model details, including brochures and specifications, allow customers to explore and make informed decisions. The dealer locator tool ensures users can easily find authorized Mazda service centers and dealerships. In addition, the platform provides access to essential customer support services, including 24-hour roadside assistance and warranty programs. Users are kept informed with appointment confirmation notifications, enhancing communication. The website's clean, responsive, and user-friendly design ensures a smooth browsing experience. Furthermore, the live chat feature enables users to connect instantly with Mazda support representatives for real-time assistance.

Mazda Malaysia Weaknesses:

Despite the strengths, Mazda Malaysia's platform has certain weaknesses that could affect user satisfaction. Notably, the platform lacks features for collecting customer feedback and offering real-time service tracking, which could significantly improve the customer experience. It also does not support multilingual options or provide educational content related to vehicle maintenance, which could be helpful for a broader audience. Another limitation is the absence of feedback management features, meaning users cannot submit or track their service experiences. Furthermore, the system does not store or display comprehensive service history records for vehicle owners, which could be useful for users to track past services. The lack of real-time tracking and live updates regarding appointment or service progress is another downside, as customers are unable to see the status of their service. Finally, the absence of a progressive service tracking feature, which would show detailed percentage completion during servicing, limits the platform's functionality in providing transparency for users regarding the service status.

2.3 Recommendation to Improve Similar Systems

Similar Systems	Recommendation to Improve the Systems
Toyota Malaysia	• Implement a user login and personalized dashboard to allow customers to securely access their own vehicle information, view service history, and manage their bookings directly through the web application (similar to the mobile app experience). • Introduce real-time service tracking functionality where users can monitor their service appointment status and service progress online, improving transparency and customer satisfaction. • Enable online service appointment booking directly through the website, allowing customers to schedule maintenance services without requiring dealer follow-up via phone. • Integrate a live chat support feature to offer immediate assistance to users browsing the website,

	improving communication efficiency and user engagement. • Provide automated service reminders or notifications to remind users about upcoming service appointments, service campaign updates, or recall notices. • Allow users to submit feedback and rate their service experiences directly through the website, helping Toyota Malaysia collect valuable customer insights for continuous service improvement.
Proton Procare	• To provide real-time service status updates, allowing users to monitor the progress of their vehicle servicing through the website. • Introduce a service history tracking page that is accessible after user login, enabling users to easily view their past maintenance records for better vehicle management. • Implement a live chat support feature on the website to allow users to receive instant responses from customer service advisors regarding their service inquiries. • Add a post-service feedback and review system to collect customer opinions about service experiences and allow service centers to improve based on real user feedback. • Enable automated notification or email reminders that notify users of updated appointment status or service progress, easy for users to track and monitor the progress has done currently.
Audi Malaysia	• Implement an online service appointment booking system to allow customers to schedule maintenance services directly through the website.

	• Develop a user login and profile management feature, enabling users to view their service history, appointment status, and personalized vehicle information. • Integrate real-time service tracking to allow users to monitor their vehicle's service progress from check-in to completion. • Introduce a customer feedback and service review system to collect valuable insights and improve aftersales service quality. • Add a live chat support feature to provide immediate assistance for customer inquiries and enhance user experience. • Set up an automated email and SMS notification system to remind users of upcoming service appointments and special service campaigns. • Enhance website personalization by displaying recommended services, promotions, or maintenance tips based on the user's vehicle model and service history.
Mazda Malaysia	• Implement a feedback management system to allow users to submit, view, and track their service experiences. • Develop a service history records module to enable users to view complete historical maintenance and service data. • Integrate real-time service appointment tracking to provide users with live updates on service status and progress. • Introduce service progress tracking with detailed percentage completion indicators for ongoing vehicle servicing.

	• Expand the system with multilingual support to cater to a wider range of customers in Malaysia. • Offer predictive maintenance recommendations based on vehicle usage patterns to help customers plan future services better.

Table 2.1 Recommendation to Improve Similar Systems

2.4 Comparison Between Existing System

Functions	Toyota Malaysia	Proton ProCare	Audi Malaysia	Mazda Malaysia	Proposed System
Feedback Management	X	X	X	X	✓
Service History Records	X	X	X	✓	✓
Appointment Booking Function	X	✓	X	✓	✓
Service articles and news	✓	X	✓	✓	✓
Login and Logout	X	✓	X	✓	✓
Customer Support Chat	X	X	X	✓	✓
Service Reminder	X	✓	X	✓	✓
Real-time Tracking and Updating of Appointment	X	X	X	X	✓
Service progress Tracking	X	X	X	X	✓

Table 2.2 Comparison Between Existing System

CHAPTER 3: SYSTEM METHOD/APPROACH

3.1 Methodology

Software Development Life Cycle (SDLC) is the process implemented to plan, develop, and test a software application. Various methodologies can be applied in SDLC depending on the nature and requirements of the project. Among the most popular approaches are the Waterfall Model, Rapid Application Development (RAD), Incremental and Iterative Development, Spiral Development, and the V-Model.

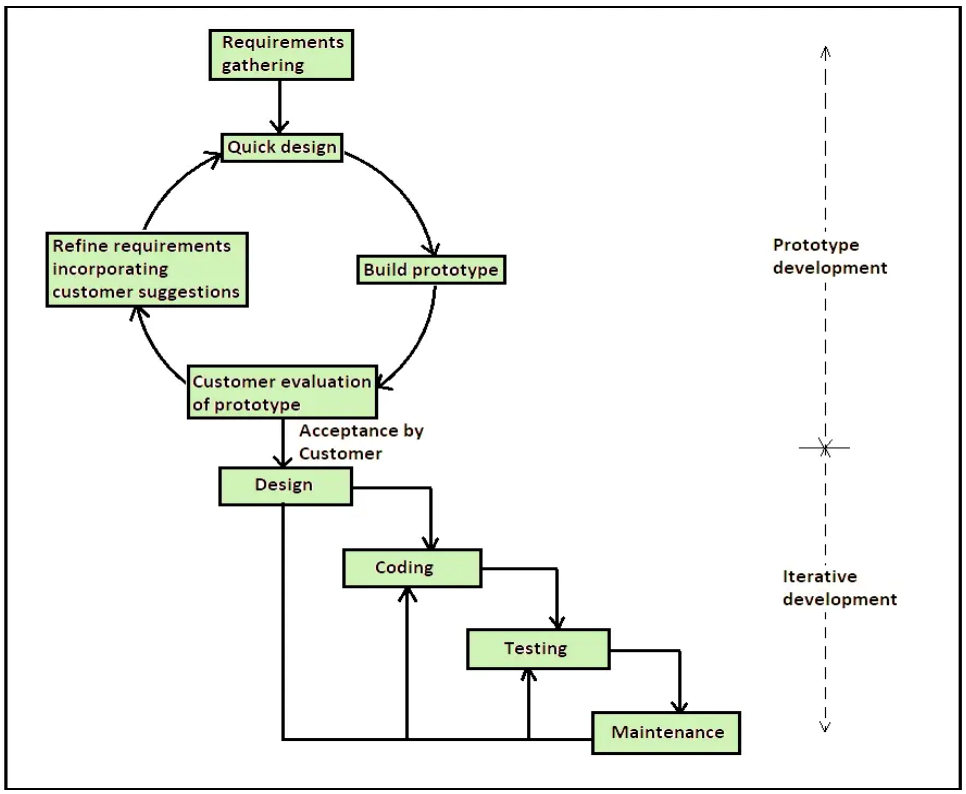


Figure 3.1.1 Prototyping Model [8]

For this project, the Prototyping Methodology is chosen due to its iterative and flexible approach, which is particularly suitable for the development of the Vehicle Maintenance and Service Tracking System (VMTS). This methodology involves building an initial working prototype early in the project, which is then refined based on user feedback and testing. Each iteration of the prototype improves the system's functionality, ensuring that it meets user requirements and project objectives.

CHAPTER 3: PROPOSED METHOD/APPROACH

The first phase of this methodology involves gathering initial requirements from stakeholders, including vehicle owners and administrators. These requirements define the basic features and functionalities needed for the system, such as appointment scheduling, service progress tracking, and communication between users and administrators. A prototype is then developed based on these initial requirements, with core functionalities like service booking and real-time updates included.

Once the prototype is developed, stakeholders, particularly the administrators, evaluate the system's performance and provide feedback. This evaluation allows for a clearer understanding of the system's strengths and areas for improvement. Based on the feedback, the prototype is refined, adding more features or adjusting existing ones to better meet user needs. One such feature that was incorporated after stakeholder feedback is the Predictive Maintenance Dashboard, which helps administrators track vehicle mileage and automatically schedule services based on predicted maintenance needs.

As the prototype evolves, it undergoes continuous testing to ensure its reliability and functionality. This includes testing the accuracy of the predictive maintenance system, ensuring that services are scheduled at the right time based on mileage data. Each iteration of the prototype is tested for both functionality and user experience, and any issues identified are addressed before the next iteration.

With each cycle of refinement, the system becomes more aligned with user expectations and project goals. By the time the final prototype is ready, it ensures that all required features are included, and the system meets both the operational needs of administrators and the usability requirements of vehicle owners. The final system includes automated service scheduling, real-time updates, and predictive maintenance capabilities, which reduce administrative workload and improve the efficiency of vehicle service management.

The Prototyping Methodology proves particularly effective for this project, as it allows for early-stage testing and continuous user feedback. This iterative approach ensures that the VMTS can adapt to changing requirements and effectively integrate new features, such as predictive service scheduling and real-time communication, based on user feedback throughout the development process.

3.2 Timeline

TASK	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
Chapter 1: Introduction														
Project Background														
Problem Statement and Motivation														
Project Objectives														
Project Scope and Direction														
Requirement Gathering														
Refine Project Objective and Project Scope														
Contributions														
Report Organization														
Chapter 2: Literature Review														
Analyse/Review on other websites and system														
Resolve the weaknesses of similar systems														
Compare Similar Systems														
Chapter 3: Methodology and System Design														
Define Methodology														
Determine System Hardware and Software														
Block Diagram														
Use Case Diagram														
Project Timeline														
Future Development Plan														
Chapter 4: Implementation and Testing														
Implementation Module														
Create a Prototype														
Prototype Testing														
Design Poster														
Black Box Testing														
User Testing														
Finalize FYP1 Report														
FYP1 Report Submission														
FYP1 Demonstration														

Task	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
Refinement of Chapter 1, 2, 3														
Overall Refinement of Chapter 1														
Overall Refinement of Chapter 2														
Overall Refinement of Chapter 3														
Project Timeline														
Chapter 5 - Implementation and Testing														
Implementation Module														
Define Technology and Tools Used														
Define Algorithm Used														
Define API Used														
Implementation Issues and Challenges														
Black Box Testing														
User Testing														
Chapter 3 - System Specification														
Analysis														
Design														
System Evaluation/Verification														
Chapter 4 - CONCLUSION AND RECOMMENDATION														
Project Review, Discussions, and Conclusion														
Novelties and Contributions														
Future Work														
Prototype Testing														
Limitation														
Finalise FYP 2 Report														
FYP 2 Report Submission														
FYP 2 Demonstration														

Figure 3.2.1 Timeline

CHAPTER 4: SYSTEM DESIGN

System design is a blueprint that outlines the system architecture, key components and functionalities of the proposed appointment-based recycling system. It focuses on the structure and the operation of the system to ensure it produces the desired system output and is always aligned with project objectives. It provides understanding on how the system interacts between different parts in a real-world condition.

4.1 ERD Diagram

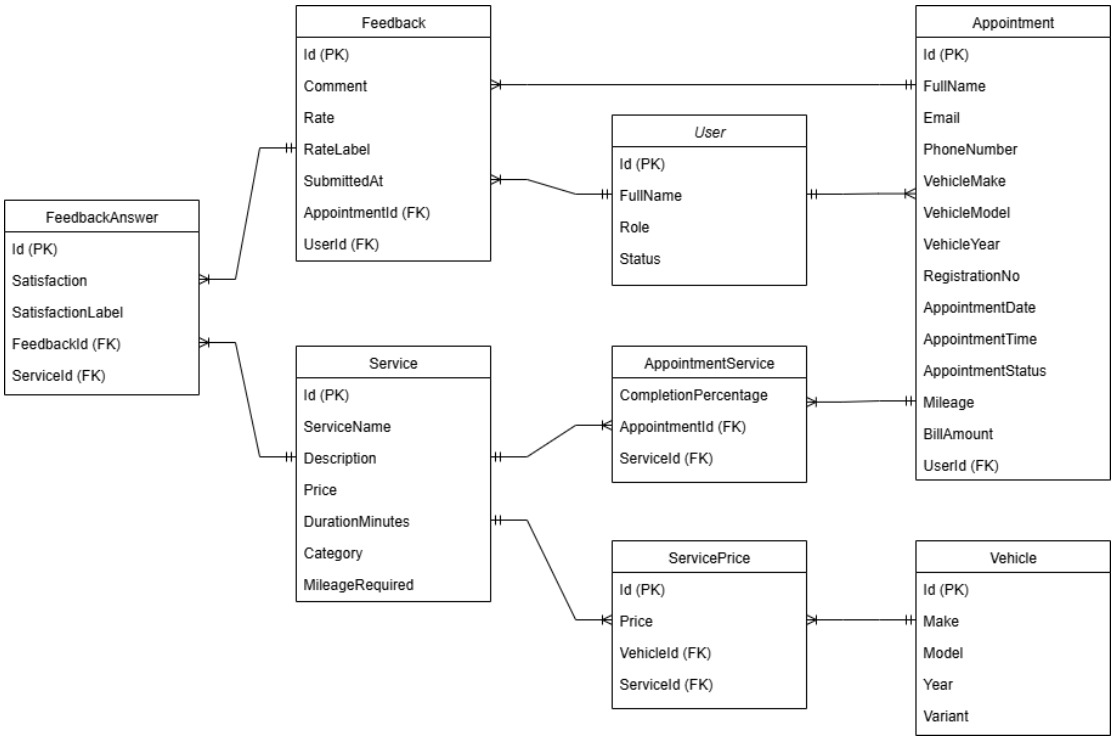


Figure 4.1 ERD Diagram

The Entity-Relationship Diagram (ERD) in Figure 4.1 presents the data model of the proposed Vehicle Maintenance and Service Tracking System (VMTS). It shows how different types of information are structured and linked together, providing a clear picture of the system's data flow. The ERD defines eight main entities: User, Vehicle, Appointment, Service, Appointment Service, Service Price, Feedback, and Feedback Answer.

The User entity represents individuals using the system, storing details such as user ID, full name, email, phone number, password hash, and account creation date. Each user can register multiple vehicles, which are captured in the Vehicle entity. This

includes attributes like vehicle ID, plate number, model, type, and year, with the user ID acting as a foreign key that connects each vehicle to its owner. This establishes a one-to-many relationship between users and vehicles, as well as between users and appointments.

The Appointment entity records all service booking details, including appointment ID, scheduled date and time, pickup address, status (Pending, Completed, or Cancelled), and creation date. Each appointment is linked to one user and one vehicle. When services are added to a booking, the AppointmentService entity captures them, storing the quantity, unit price, and line total. This links each appointment to one or more services, while a single service may appear in multiple appointments.

The Service entity contains information about the services offered, such as service ID, name, description, and estimated duration. Service pricing is managed separately in the ServicePrice entity, which records the cost of a service based on vehicle type and includes start and end dates for price validity. This design supports flexible pricing that can vary across vehicles and over time.

Once a service is completed, users can share their experience through the Feedback entity, which records ratings, comments, and references to the related appointment and user. While a user can submit feedback for many appointments, each appointment can only have one feedback record. To allow for more detailed evaluations, the FeedbackAnswer entity stores responses to individual criteria such as quality or timeliness, with multiple answers linked to a single feedback entry.

Overall, the relationships within the ERD allow each user to own multiple vehicles and appointments, each appointment to involve one or more services, and each service to have multiple price records over time. The feedback system ensures that reviews are both comprehensive and detailed, capturing overall impressions as well as specific service aspects. This organized structure enables the VMTS to efficiently manage all data related to users, vehicles, appointments, services, and feedback in a cohesive and reliable manner.

4.2 Use Case Diagram

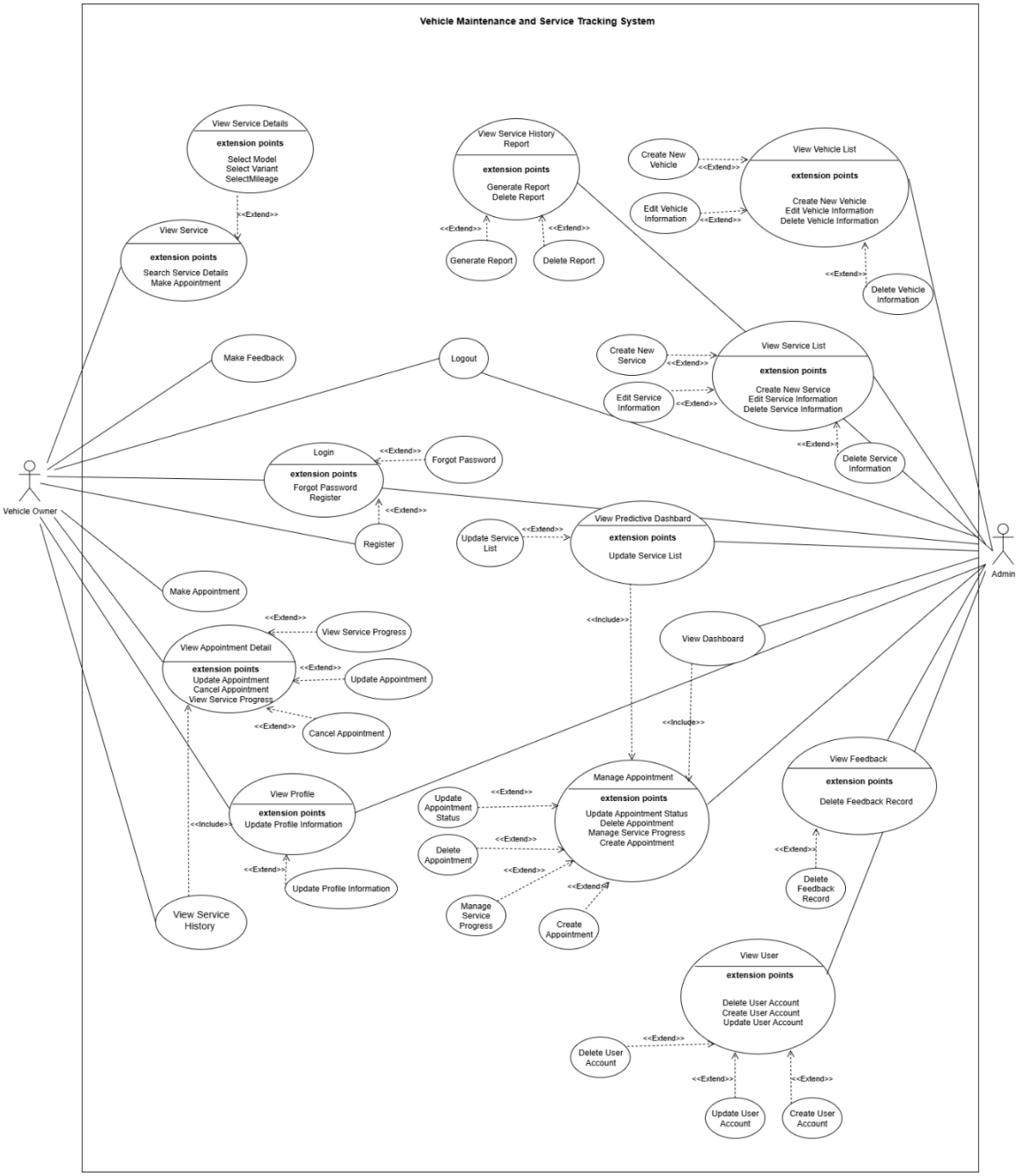


Figure 4.2 Use Case Diagram

The Use Case Diagram in Figure 4.2 illustrates the functional requirements of the Vehicle Maintenance and Service Tracking System by presenting the interactions between the two actors—User and Admin—and the system. Each oval in the diagram represents a specific function that can be triggered by one of these actors. The diagram covers account access, appointment booking and tracking, catalogue and price maintenance, operational dashboards, and feedback management.

Both actors share the same basic access features: Login, Logout, and Forgot Password. Users who do not have an account must Register first and then log in to access member functions. Admin accounts are provisioned by the organization and sign in directly. Each actor can View Profile, where they may update personal information or reset their password.

On the User side, logged-in vehicle owners can View Service and View Service Details (with optional refinement by model/variant/mileage), then Make Appointment for a selected vehicle and time slot. After booking, Users can open View Appointment Detail to Update Appointment, Cancel Appointment, or View Service Progress while work is in progress. Users can also View Service History and, once a job is completed, Make Feedback to rate the service and leave comments.

On the Admin side, day-to-day operations are handled through Manage Appointment, which covers Create Appointment (e.g., phone bookings), Update Appointment Status (in progress, completed, cancelled), Manage Service Progress, and Delete Appointment when necessary. Admin also maintains master data via View Service List (with actions to Create New Service, Edit Service Information, Delete Service Information) and manages pricing through Create Service Price or Update Service List. Vehicle records can be maintained via View Vehicle List (create, edit, delete). For oversight, Admin can View Dashboard and View Predictive Dashboard. Quality and governance are supported with View Feedback (ability to delete inappropriate entries) and View User (create, update, delete user accounts when required).

4.3 Use Case Description

1. View Service

User Perspective – View Service
Name: View Service
Brief Description: To allow users to view the service article and information
Actors: User
Type Include/Extend: View Service Details
Pre-conditions: Service information is stored in the database
Basic Flow 1. Users click on the Services link in the navigation header. 2. System displays service information on service page.
Alternate Flow: **When users click on vehicle brand icon link:** 1. System will redirect user to service details page 2. System will display service details information 3. Users select specific vehicle model, variant, and mileage 4. System will display a breakdown service information including service part description, price, and total price
Exception Flow: Service catalog fails to load
Post Conditions 1. System stores and update the rating and comment in database

Table 4.3.1 View Service Use Case Description

2. Make Feedback

User Perspective – Make Feedback
Name: Make Feedback
Brief Description: To allow users to make rating and comment for appointment that has been completed
Actors: User
Type Include/Extend: -

Pre-conditions: User have appointment with completed status
Basic Flow: 1. Users click on the "Review" link in navigation header of user profile 2. System will display a table of records of appointments 3. Click on the "To Rate" button for appointments that are completed 4. Click to select the number of stars to rate and leave a comment for optional 5. Click "Submit" button to confirm rating 6. System will display success message after submitted. 7. System will refresh the records with newly created rating
Alternate Flow: -
Exception Flow: No completed appointment
Post Conditions 1. System will display service information, parts list, and computed price are displayed.

Table 4.3.2 Make Rating Use Case Description

3. Register

User Perspective – Register
Name: Register
Brief Description: To allow users to register to create an account to access the web application
Actors: User
Type Include/Extend: Log In
Pre-conditions: Users do not have an account
Basic Flow: 1. Users click on the register link in the navigation header 2. Users fill in required information 3. Users click on "Register" button 4. System will validate the received input 5. System checks whether the entered email has existed in the database

6. System stores user input into database 7. System redirects users to login page with a success message
Alternate Flow: **When users click on "Already Have an Account" link:** 1. System will redirect to log in page 2. Users enter their account email address and password 3. Users click on "Login" button with correct input 4. System will receive and validate user input 6. System will redirect users to main page
Exception Flow: 1. Name and email address have existed in database 2. Incorrect user input 3. Invalid name and email address
Post Conditions 1. Users are able to login into their account

Table 4.3.3 Register Use Case Description

4. Login

User, Admin Perspective – Login
Name: Login
Brief Description: To allow users to register to create an account to access the web application
Actors: User, Admin
Type Include/Extend: Forget Password, Register
Pre-conditions: User had registered an account
Basic Flow: 1. Users click on the "Login" link in the navigation header 2. Users enter their registered name and email address 3. Users click on "Login" button with correct name and email address 4. System will receive user input and validate their name and password 5. System will redirect users to main page

Alternate Flow: **When users click on "Forgot Your Password" link:** 1. System will display a reset password form asking users to enter their email address 2. Users fill in their email address 3. Users click on "Send Password Reset Link" 4. System will send a reset password link through users' email 5. System will display a success message to acknowledge users that an email has been sent 6. Users reset their password via the reset password link that is generated by the system 7. System will update the new password in database **When users click on "Register" button:** 1. System will display a registration form 2. Users fill in required information 3. Users click on "Register" button 4. System will receive the user input and validate the input 5. System checks whether the requested email has existed in the database 6. System stores user input into database **7.** System will redirect users to login page and show a success registration message
Exception Flow: 1. Incorrect user input 2. Invalid name and email address 3. Name and email address have been existed in database
Post Conditions: 1. Users able login into their account successfully 2. System updates new password into database when users perform reset password action 3. System stores user input into database and display success message on registration

Table 4.3.4 Login Use Case Description

5. Logout

User, Admin Perspective – Logout
Name: Logout
Brief Description: To allow users to perform logout and erase the sessions
Actors: User, Admin
Type Include/Extend: -
Pre-conditions: User had logged in into their account
Basic Flow: 1. Users click on the "Logout" link in navigation header 2. System will delete his/her session 3. System will redirect users to landing page
Alternate Flow: **-**
Exception Flow: -
Post Conditions: 1. System erases user sessions and redirects to landing page

Table 4.3.5 Logout Use Case Description

6. View Appointment

User Perspective – View Appointment
Name: View Appointment
Brief Description: To allow user to view appointments records
Actors: User
Type Include/Extend: Update Appointment, Cancel Appointment, View Service Progress
Pre-conditions: At least one appointment has been received
Basic Flow: 1. Click on the "Review" link in navigation header 2. System will display appointment record that have been made by users
Alternate Flow: **When users click on "Edit" button:** 1. System will change the input field to be editable

2. Users fill in the input which they wish to update 3. Users click on “Save” button **When users click on “Cancel” button:** 1. System will remove the appointment record in the table and delete the record from database **When users click on “View” button:** 1. System will display the last updated date and time, and maintenance progress of each service has done
Exception Flow: No appointment received
Post Conditions: 1. System will update the database record with validated input

Table 4.3.6 View Appointment Use Case Description

7. View Profile

User, Admin Perspective – View Profile
Name: View Profile
Brief Description: To allow users to view their profile and update the profile information
Actors: User, Admin
Type Include/Extend: Update Profile Information
Pre-conditions: User had logged in into their account
Basic Flow: 1. User and admin click on the “Profile” link in the navigation header 2. System will display profile information on profile page
Alternate Flow: **When users click on “Update Profile” button:** 1. System will change the input field to be editable 2. Users fill in the input which they wish to update 3. Users click on “Save” button **When users click on “Reset Password” button:** 1. System will display a reset password form asking users to enter their email address

2. Users fill in their email address 3. Users click on "Send Password Reset Link" 4. System will send a reset password link through users' email 5. System will display a success message to acknowledge users that an email has been sent 6. Users reset their password via the reset password link
Exception Flow: 1. Incorrect or invalid user input
Post Conditions: 1. System will receive and validate user input to store in database 2. System returns to profile page and prompt success message

Table 4.3.7 View Profile Use Case Description

8. View Service History

User Perspective – View Service History
Name: View Service History
Brief Description: To allow users to view appointment and service history
Actors: User
Type Include/Extend: -
Pre-conditions: User have made appointment
Basic Flow: 1. Users click on the "History" in navigation header 2. System will display a table of records of previous appointments that have been made
Alternate Flow: -
Exception Flow: No appointment made
Post Conditions: -

Table 4.3.8 View Service History Use Case Description

9. View User

Admin Perspective – View User

Name: View User
Brief Description: To allow admin to manage user by adding new user, editing user information or deleting user
Actors: Admin
Type Include/Extend: Update User Account, Delete User Account, Create User Account
Pre-conditions: Admin had logged in into their account
Basic Flow: 1. Click on the "User List" link in navigation header 2. System will display list of existing users in a table
Alternate Flow: **When admin clicks on "Create New User" button:** 1. Admin clicks on the "Create New User" button to add new user 2. A window with a create new user form will pop up 3. Admin needs to fill all required fields 4. Clicks on "Create" button to create a new account for user **When admin clicks on "Edit" button in the staff list:** 1. A window with a edit user form will pop up 2. System will change the input field to be editable 3. Admin fill in the input which they wish to update 4. Click on "Update" button to confirm modification **When admin clicks on "Delete" button in the staff list:** 1. Admin click on the "Delete" button to remove the specific user 2. System will prompt admin whether to continue with the deletion
Exception Flow: Incorrect user input
Post Conditions: 1. System will update the database record with validated input 2. System will return to the staff list and display latest user information

Table 4.3.9 View User Use Case Description

10. Manage Appointment

Admin Perspective – Manage Appointment

Name: Manage Appointment
Brief Description: To allow admin to update appointment status
Actors: Admin
Type Include/Extend: Update Appointment Status, Delete Appointment, Manage Service Progress, Create Appointment
Pre-conditions: At least one appointment has been received
Basic Flow: 3. Click on the "Service Request" link in navigation header 4. System will display appointment records that have been made by users
Alternate Flow: **When admin click on "Edit" button:** 1. System will change the input field to be editable 2. Admin fill in the input which they wish to update 3. Admin click on "Save" button **When admin click on "Delete" button:** 1. System will remove the appointment record in the table and delete the record from database **When admin click on "Manage Service Progress" button:** 1. System will display maintenance progress form for admin to update the progress 2. Admin can input the percentage for each service made by user 3. Click on "Update Progress" button to confirm modification **When admin click on "Create Appointment" button:** 1. System will display the create new appointment form 2. Admin needs to fill all required fields 3. Admin click on "Create" button to add new appointment record
Exception Flow: Incorrect user input
Post Conditions: 3. System will update and store the database record with validated input 4. System will return to the staff list and display latest staff information

Table 4.3.10 Manage Appointment Use Case Description

11. View Feedback

Admin Perspective – View Feedback
Name: View Feedback
Brief Description: To allow admin to view and manage the feedback record
Actors: Admin
Type Include/Extend: Delete Feedback Record
Pre-conditions: At least one feedback has been received
Basic Flow: 1. Click on the "Feedbacks" link in navigation header 2. System will display list of feedback records that have been made by users
Alternate Flow: **When admin click on "Delete" button:** 1. System will remove the feedback record in the table and delete the record from database
Exception Flow: No feedback received
Post Conditions: 1. System will return to the staff list and display latest staff information

Table 4.3.11 View Feedback Use Case Description

12. View Dashboard

Admin Perspective – View Dashboard
Name: View Dashboard
Brief Description: To allow admin to view dashboard with real-time data insight
Actors: Admin
Type Include/Extend: -
Pre-conditions: Admin had logged in into their account
Basic Flow: 1. Click on the "Dashboard" link in navigation header 2. System will display charts with real-time data

Alternate Flow: -
Exception Flow: -
Post Conditions: -

Table 4.3.12 View Dashboard Use Case Description

13. View Service List

Admin Perspective – Service List
Name: Service List
Brief Description: To allow admin to view and manage service list record
Actors: Admin
Type Include/Extend: Create New Service, Edit Service Information, Delete Service Information
Pre-conditions: Admin had logged in into their account
Basic Flow: 1. Click on the "Service List" link in navigation header 2. System will display list of service data on a table
Alternate Flow: **When admin click on "Edit" button:** 1. System will change the input field to be editable 2. Admin fill in the input which they wish to update 3. Admin click on "Save" button **When admin click on "Delete" button:** 1. System will remove the service record in the table and delete the record from database **When admin click on "Create New Service" button:** 1. System will display a create service form for admin to add new service information 2. Admin needs to fill all required fields 3. Clicks on "Create" button to create a new service
Exception Flow: Incorrect user input
Post Conditions:

1. System will update the database record with validated input 2. System will store the new service record into database 3. System will return to the service list and display latest service information

Table 4.3.13 Service List Use Case Description

14. View Vehicle List

Admin Perspective – Vehicle List
Name: Vehicle List
Brief Description: To allow admin to view and manage vehicle list record
Actors: Admin
Type Include/Extend: Create New Vehicle, Edit Vehicle Information, Delete Vehicle Information
Pre-conditions: Admin had logged in into their account
Basic Flow: 1. Click on the "Vehicle List" link in navigation header **2.** System will display list of vehicle data on a table
Alternate Flow: When admin click on "Edit" button: 1. System will change the input field to be editable 2. Admin fill in the input which they wish to update 3. Admin click on "Save" button When admin click on "Delete" button: 1. System will remove the vehicle record in the table and delete the record from database When admin click on "Add New Vehicle" button: 1. System will display add new vehicle form for admin to add new vehicle information 2. Admin needs to fill all required fields 3. Clicks on "Create" button to create a new vehicle record
Exception Flow: Incorrect user input
Post Conditions:

1. System will update the database record with validated input 2. System will store the new vehicle record into database 3. System will return to the vehicle list and display latest vehicle information

Table 4.3.14 Vehicle List Use Case Description

4.4 Activity Diagram

The activity diagram showcases the workflow of activities for every process within the system. It illustrates the flow of control such as the decision points, parallel processes and information flow from users and system perspective towards the performed tasks.

1. Logout

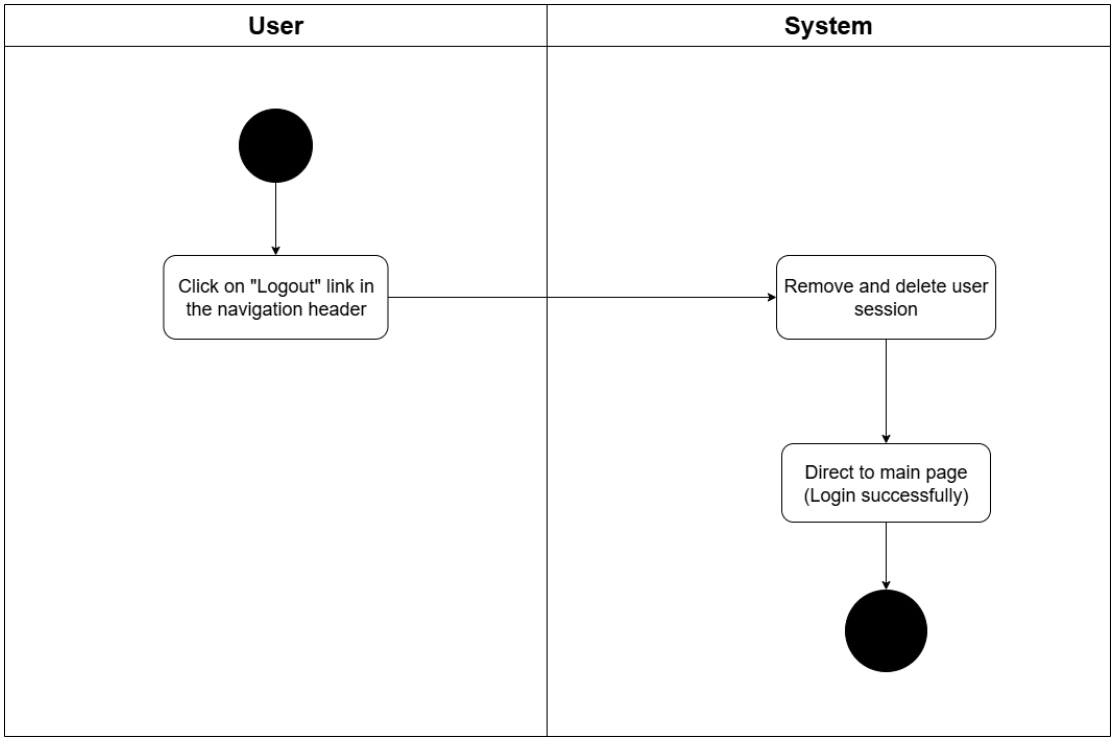


Figure 4.4.1 Logout Activity Diagram

Figure 4.4.1 shows the activity flow of the logout function. This flow is used when an authenticated user wants to exit the system safely. Logging out ensures that the active session is terminated and that protected pages cannot be accessed without signing in again.

To log out, the user clicks the “Logout” link in the navigation header. The system then receives the request and removes the current user session by invalidating the server-side session (and clearing any related cookies/tokens). After the session is deleted, the system redirects the user to the main page and displays a message indicating that the user has been logged out successfully. If the session has already expired, the system performs the same redirect so the experience remains consistent.

2. Register

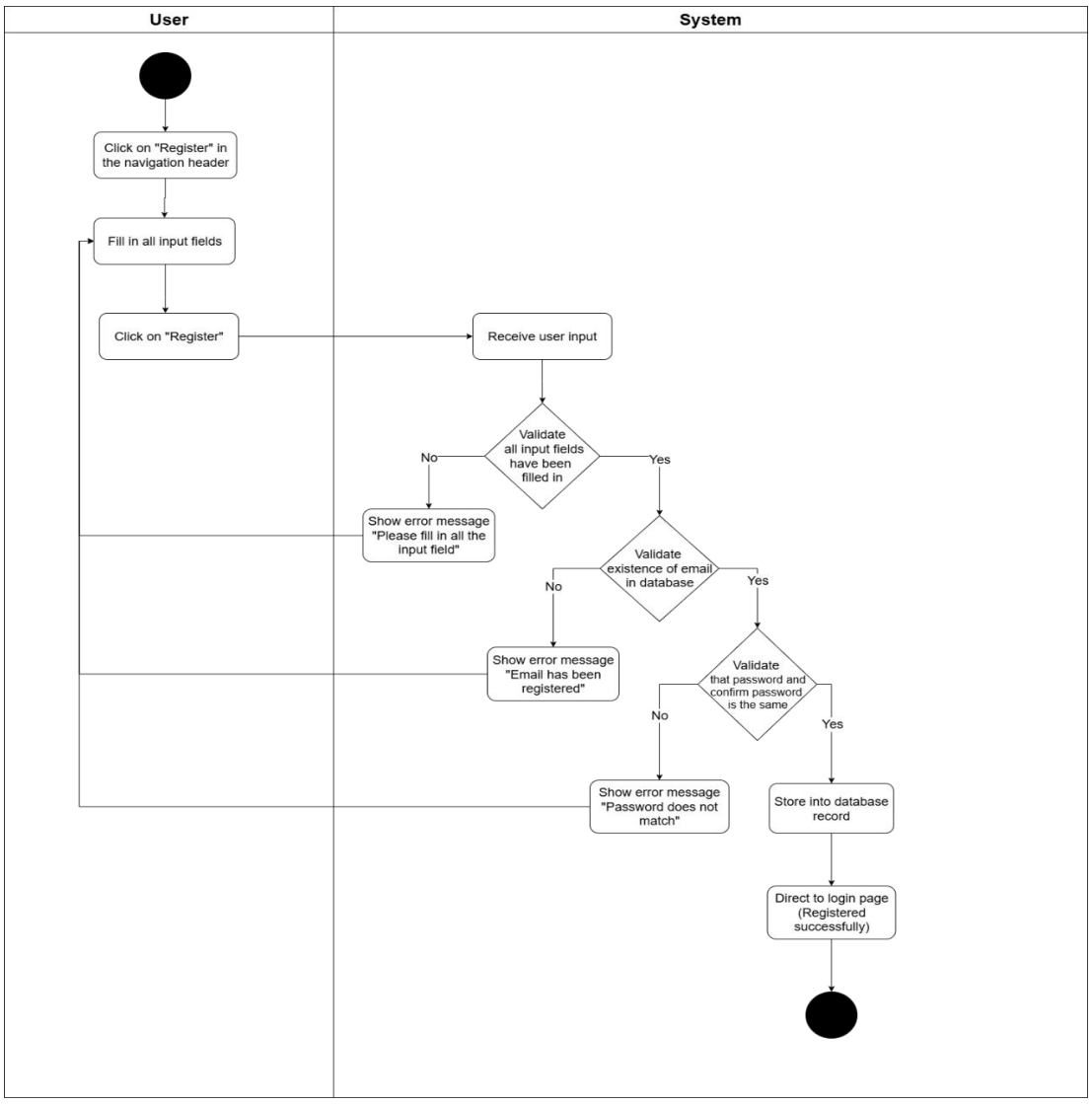


Figure 4.4.2 Register Activity Diagram

Figure 4.4.2 shows the activity flow of the registration function. Users must have their own account to access member features of the website. If a visitor does not yet have an account, they are required to complete the registration process before logging in.

To register, the user clicks the “Register” link on the navigation header and a registration form is displayed. The user fills in all required fields such as name, email, password and confirm password, then clicks “Register” to submit. The system receives the input and performs a series of validations. First, it checks that all mandatory fields are filled in; if not, an error message is shown and the user is returned to the form. Next, the system verifies that the email does not already exist in the database; if the email is already registered, an error message is displayed and the user must provide a different email address. Finally, the system compares the password and confirm-password values; if they do not match, the user is informed and asked to re-enter both fields.

If all validations pass, the system stores the new user record in the database and redirects the user to the login page with a success message indicating that the account has been created successfully. This flow ensures only complete, unique and consistent credentials are accepted, improving data quality and securing access to the system.

3. Login

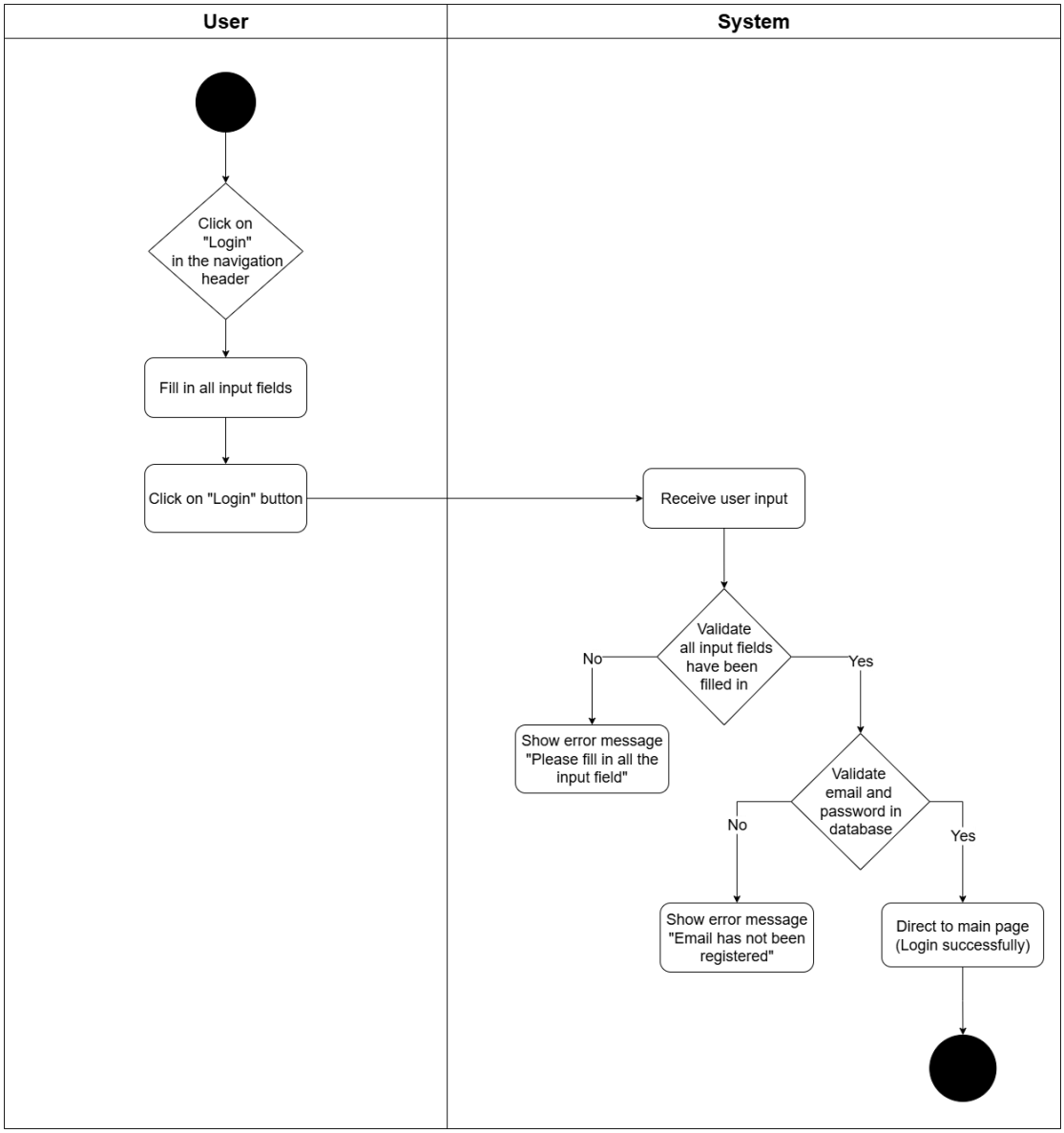


Figure 4.4.3 Login Activity Diagram

Figure 4.4.3 shows the activity flow of the login function. This process allows a registered user to access member features of the website. To begin, the user clicks the “Login” link in the navigation header, enters the required credentials in the login form (email and password), and clicks the “Login” button to submit.

Upon submission, the system receives the user input and performs sequential validation. First, it checks that all required fields are filled in; if any field is empty, the system displays an error message— “Please fill in all the input field”—and returns the user to the form to complete the information. When the form is complete, the system

validates the credentials by verifying the email and password against the database. If the email is not found or the credentials do not match, an error message— “Email has not been registered” (or invalid credentials)—is shown and the user remains on the login page. If the credentials are valid, the system creates the authenticated session and redirects the user to the main page, indicating that the login is successful.

4. View and Update Profile

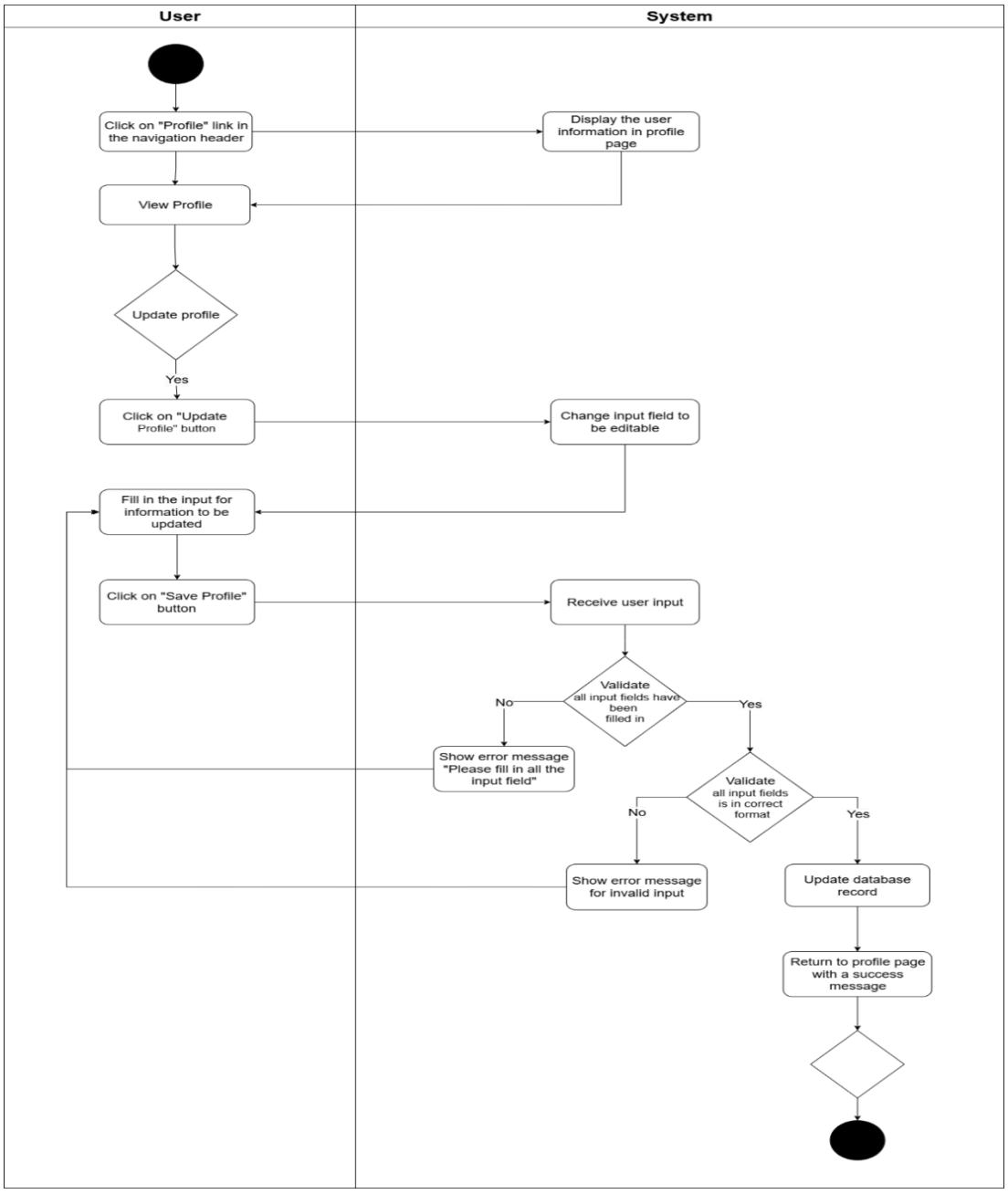


Figure 4.4.4 View and Update Profile Activity Diagram

Figure 4.4.4 shows the activity flow for viewing and updating the user profile. The process begins when the user clicks the “Profile” link in the navigation header. The system loads the profile page and displays the current user information (e.g., name, email, phone). If the user only needs to review details, the flow ends. When the user decides to make changes, they select Update Profile, after which the system switches the fields to editable mode.

The user then enters the new values and clicks “Save Profile.” The system receives the input and performs two levels of validation. First, it checks that all required fields are filled in; if any mandatory value is missing, the system shows an error message—“Please fill in all the input field”—and returns the user to the editable form. Next, it verifies that the data format is valid (for example, email format, phone number pattern, and any length constraints). If a format check fails, an invalid input message is shown and the user remains on the form to correct the values.

If all validations pass, the system updates the user record in the database and returns to the profile page with a success message confirming that the changes were saved. This flow ensures profile information is only changed with complete and correctly formatted data, preserving data quality while giving users direct control over their account details.

5. Make Appointment

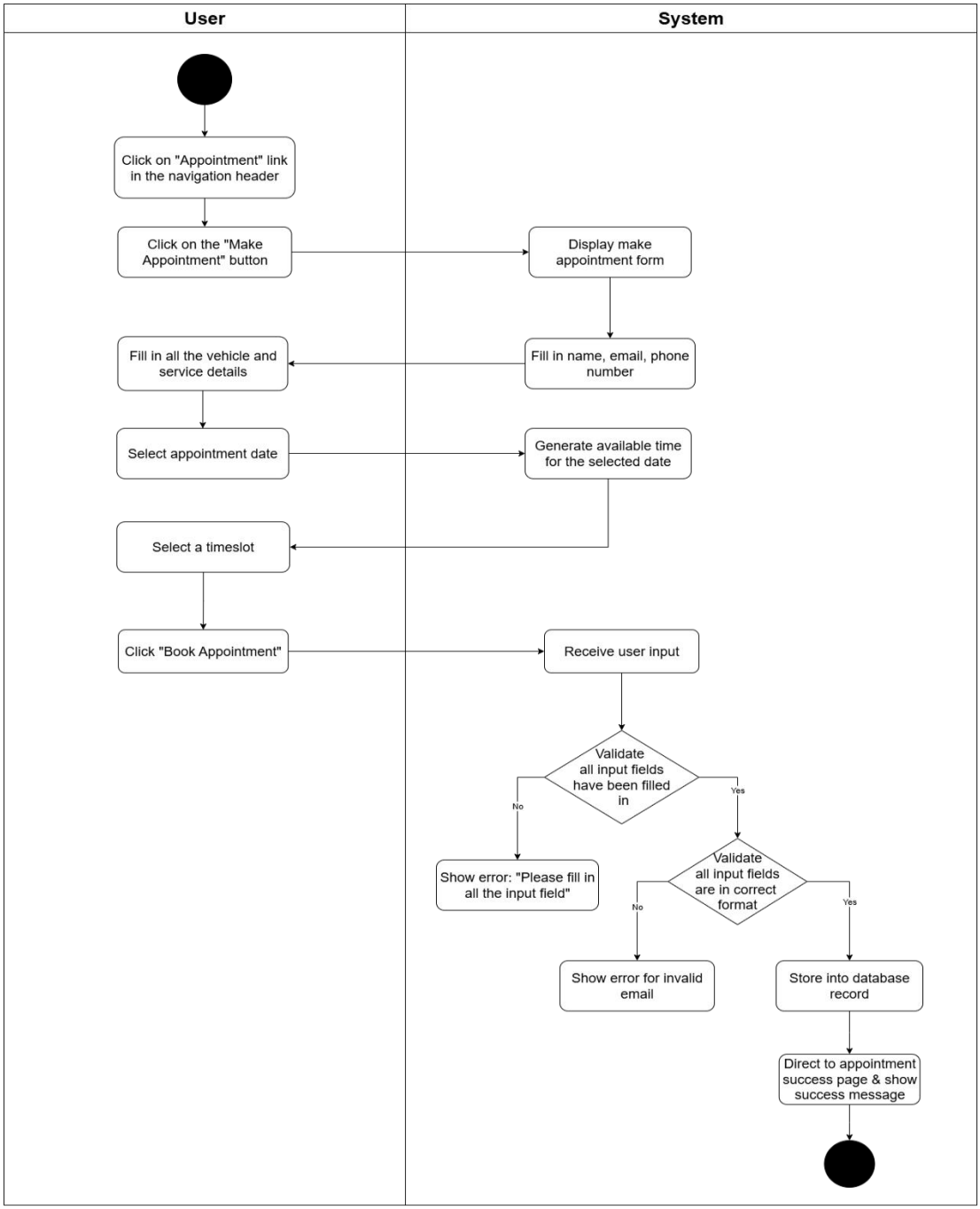


Figure 4.4.5 Make Appointment Activity Diagram

Figure 4.4.5 shows the activity flow of the Make Appointment function. The process begins when the user navigates to the Appointment page and clicks the “Make Appointment” button. The system displays the booking form and pre-fills known contact fields such as name, email, and phone number. The user then completes the required details: vehicle and service information, the appointment date, and an available

timeslot generated by the system for the selected date. After reviewing the inputs, the user confirms by clicking “Book Appointment.”

Upon submission, the system receives the user input and carries out validation in two steps. First, it checks that all mandatory fields have been completed. If any information is missing, an error message— “Please fill in all the input field”—is shown and the user is returned to the form to correct the entries. Second, the system verifies that each field is in the correct format (for example, a valid email pattern). If a format error is detected, an appropriate message (e.g., invalid email) is displayed, and the user must amend the value.

If all checks pass, the system stores the appointment record—including the chosen services and timeslot—in the database. The user is then redirected to an appointment success page where a confirmation message is displayed. This activity ensures that bookings are captured with complete and valid information, that only free time slots are offered, and that the user receives immediate confirmation of a successful reservation.

6. Make Feedback

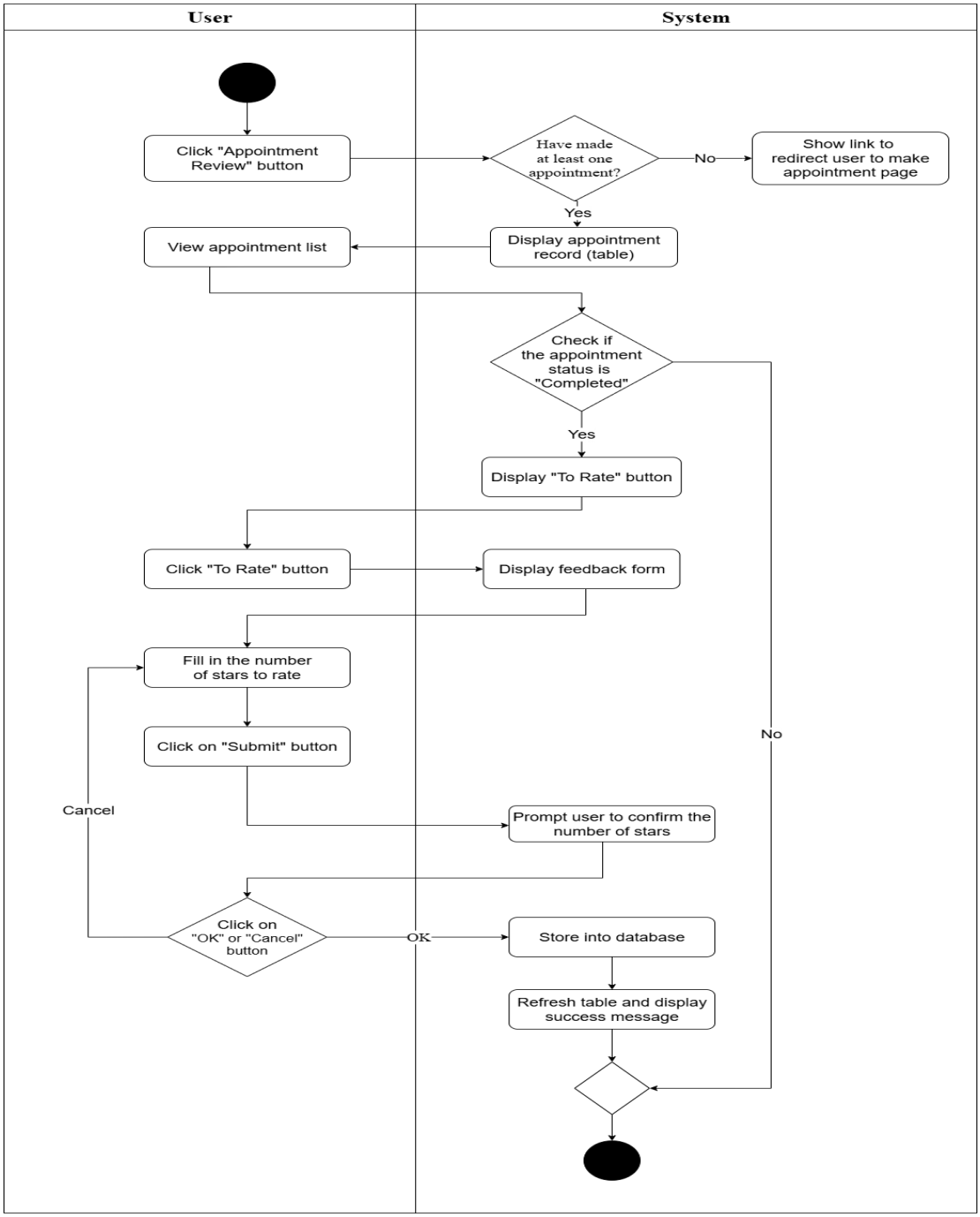


Figure 4.4.6 Make Feedback Activity Diagram

Figure 4.4.6 shows the activity flow of the Make Feedback function. The process begins when the user selects “Appointment Review.” The system first checks whether the user has at least one appointment in the database. If no records exist, the page shows a link that redirects the user to the booking page. If records are found, the system displays the appointment list in a table and checks each record’s status. Only appointments with

status “Completed” are eligible for rating; for those entries the system shows a “To Rate” button.

When the user clicks “To Rate,” the system opens the feedback form. The user selects the number of stars (and any additional comments if available) and then clicks “Submit.” Before saving, the system prompts the user to confirm the selected rating. If the user cancels, the flow returns to the list without change. If the user confirms (OK), the system stores the feedback in the database and refreshes the table with a success message to indicate that the rating has been recorded. This activity ensures that feedback can only be submitted for completed services, prevents accidental submissions through confirmation, and provides immediate visual confirmation after a successful rating.

7. View and Update Appointment

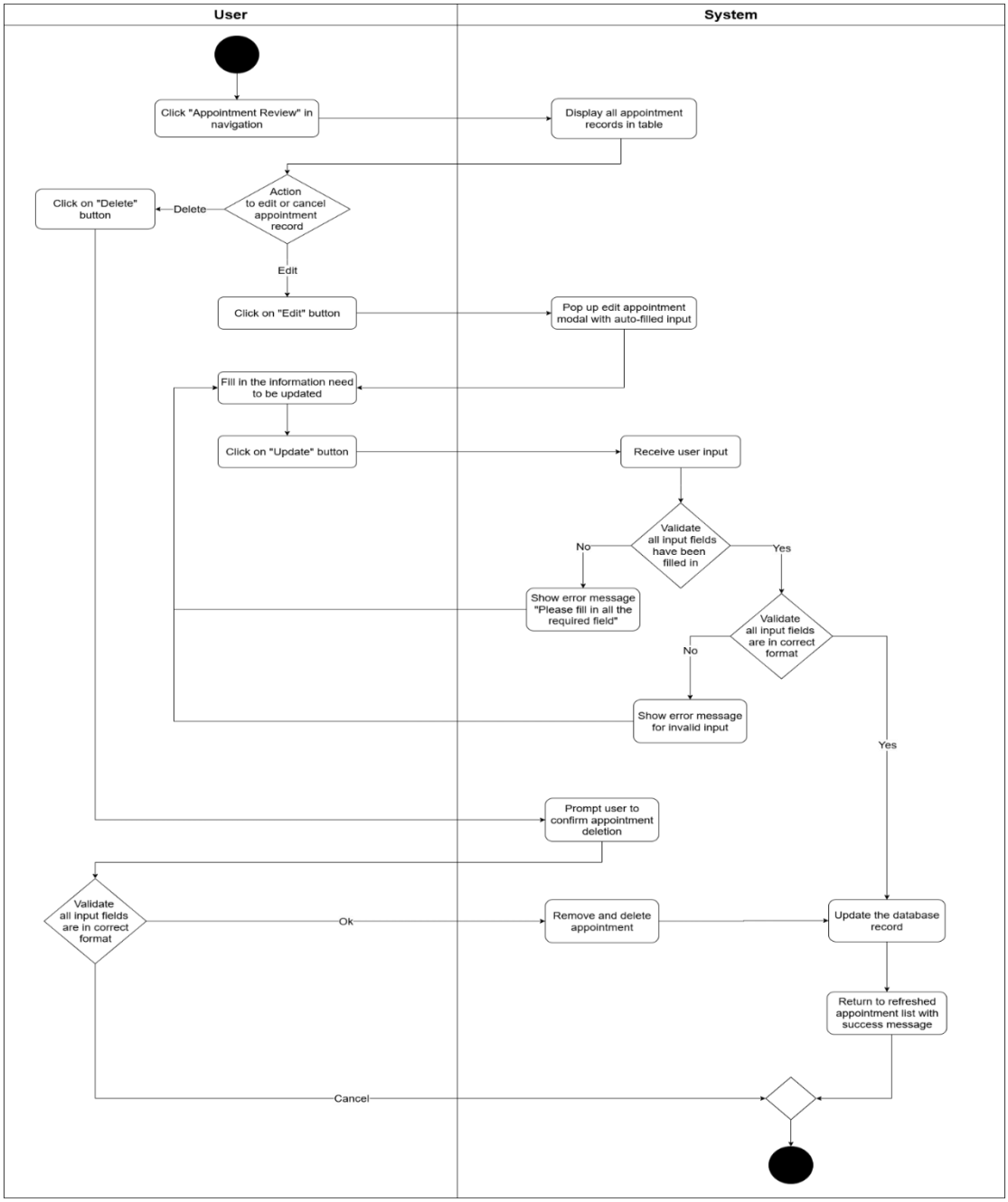


Figure 4.4.7 View and Update Appointment Activity Diagram

Figure 4.4.7 shows the activity flow for viewing and updating an appointment. The process starts when the user clicks “Appointment Review” in the navigation. The system loads the page and displays all appointment records in a table. For each record the user can choose an action: Edit or Delete. If the user selects Edit, the system opens an edit modal pre-filled with the existing appointment details. The user updates the necessary fields and clicks “Update.” The system then receives the input and runs two

validations: (i) all required fields are completed; and (ii) each field follows the correct format (e.g., date/time, contact format). When a check fails, an appropriate error message is shown—such as “Please fill in all the required field” or invalid input—and the user is returned to the form to correct the values. If both checks pass, the system updates the record in the database and returns the user to the refreshed appointment list with a success message confirming that the changes were saved.

If the user selects Delete, the system prompts for confirmation to prevent accidental removal. Choosing “OK” causes the system to remove the appointment and refresh the list with a success message.If choosing “Cancel” leaves the data unchanged and returns to the appointment list.

8. Manage Appointment

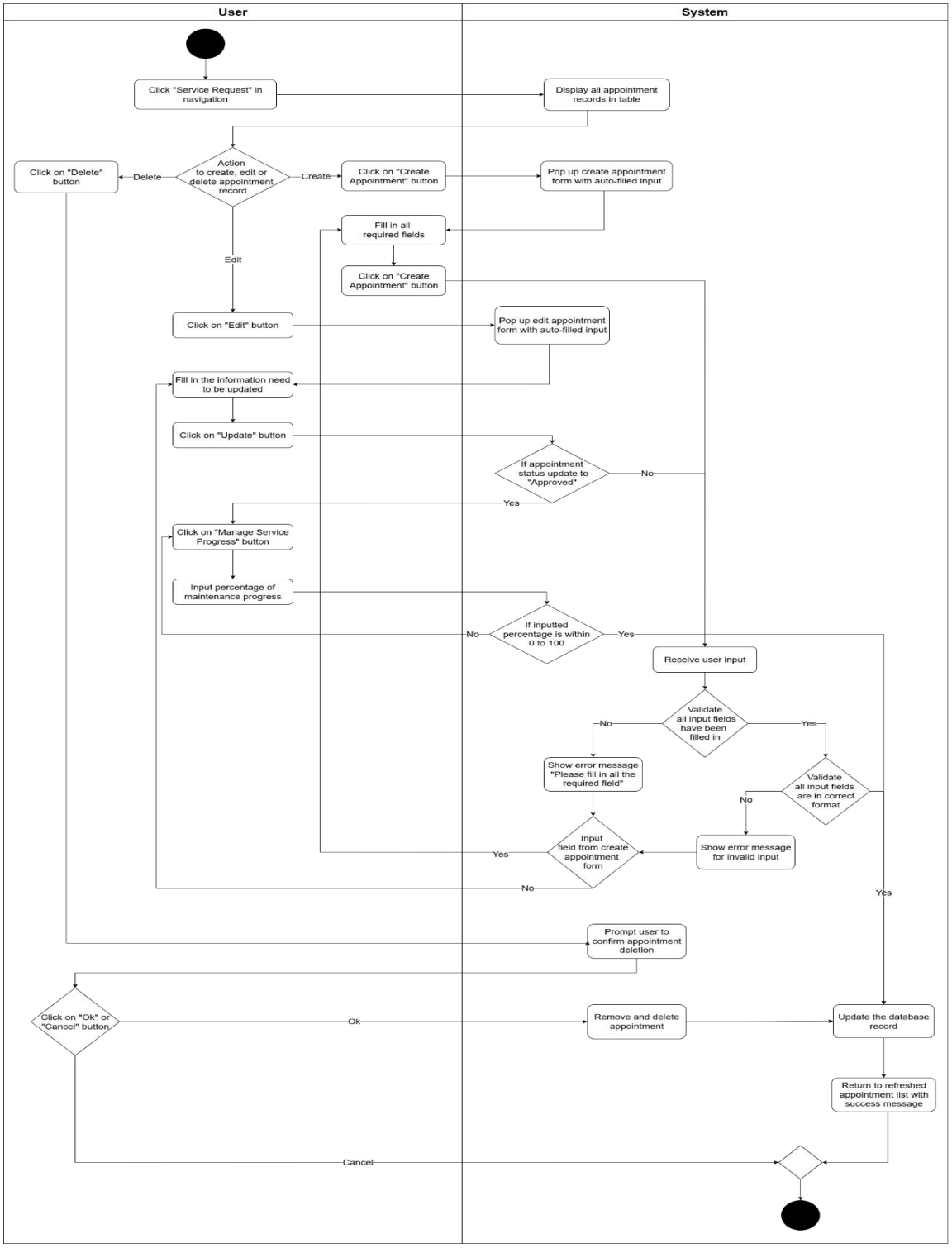


Figure 4.4.8 Manage Appointment Activity Diagram

Figure 4.4.8 shows the activity flow of the Manage Appointment function. This function is used on the administrative page where appointments are created, edited, progressed, or deleted. The flow begins when the user (admin) opens Service Request;

the system displays all appointment records in a table and the admin chooses one of three actions: Create, Edit, or Delete. There is also an operational action to Manage Service Progress for an existing, approved appointment.

For Create, the admin clicks “Create Appointment,” the system opens the create form (with any available fields auto-filled), the admin enters all required details, and clicks “Create Appointment.” The system receives the input and validates it in two stages: (i) all mandatory fields are provided; (ii) each field is in the correct format (e.g., date/time, contact). If a check fails, the system shows an appropriate error message—“Please fill in all the required field” or invalid input—and returns to the form. When validation passes, the system stores the new appointment and returns to the list with a success message.

For Edit, the admin selects a record, and the system opens an edit form pre-filled with the appointment data. After changes are entered and “Update” is clicked, the system performs the same two validations (completeness and format). On success, it updates the database record and refreshes the table with a confirmation message.

For Delete, the system prompts for confirmation to avoid accidental removal. Choosing OK removes the record and refreshes the list; choosing Cancel keeps the record unchanged.

For Manage Service Progress, the admin selects an appointment and clicks “Manage Service Progress.” If the appointment has been approved, the admin can input a maintenance progress percentage. The system checks that the value is within 0–100; out-of-range input triggers an error and the admin must correct it. Valid progress values are saved and the list is refreshed with a success message, giving real-time visibility of job advancement.

9. View and Manage Feedback

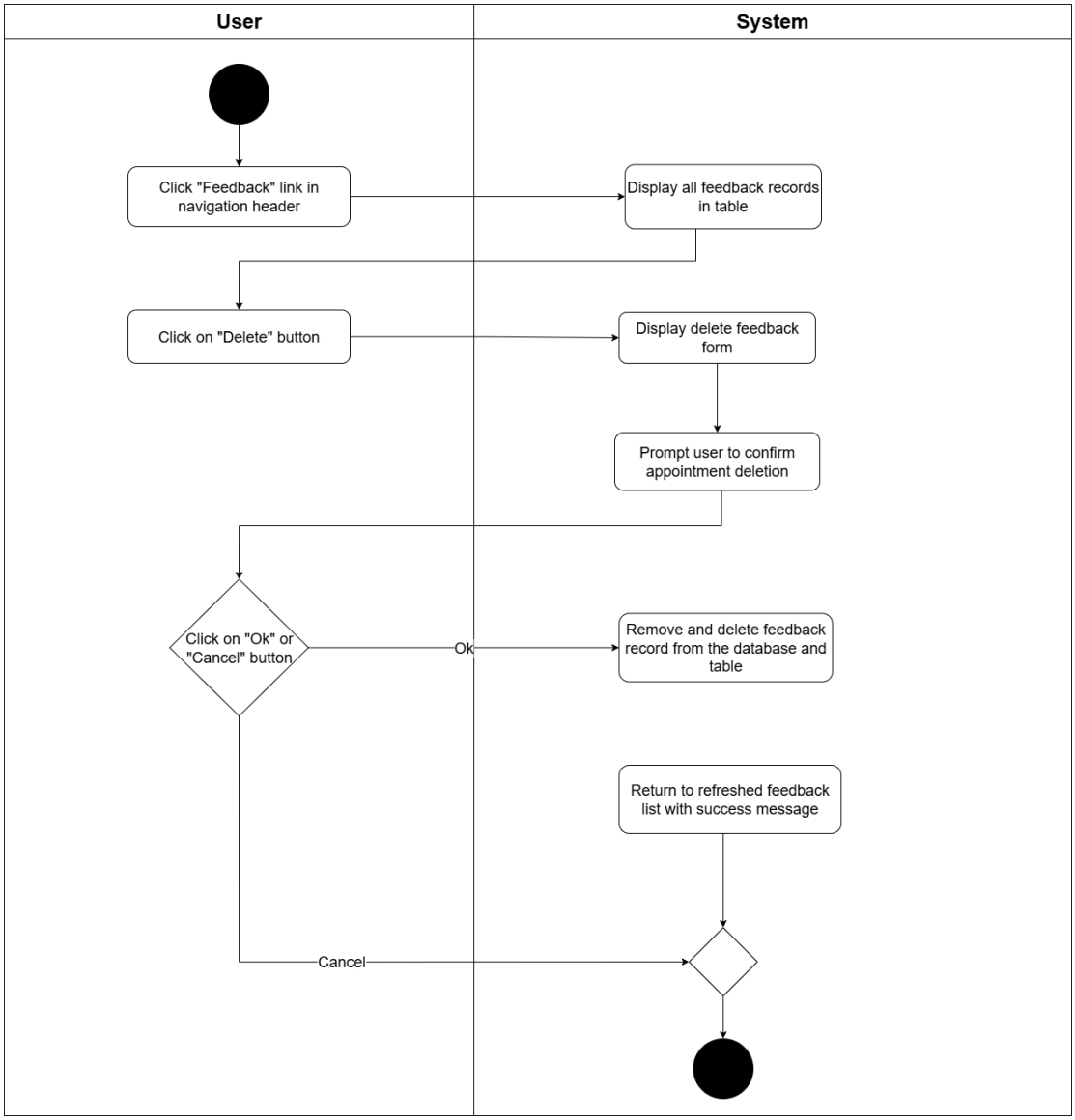


Figure 4.4.9 View and Manage Feedback Activity Diagram

Figure 4.4.9 shows the activity flow for viewing and managing feedback. The process starts when the admin clicks the “Feedback” link in the navigation header. The system loads the page and displays all feedback records in a table. From this list, the admin can choose to remove an entry by clicking the “Delete” button next to the selected record, after which the system opens the delete feedback form and prompts for confirmation to prevent accidental removal.

If the admin confirms (OK), the system removes the feedback record from the database and updates the table. The page then refreshes with a success message indicating that

the deletion has been completed. If the admin cancels, the record remains unchanged and the flow returns to the feedback list.

10. View Service Page

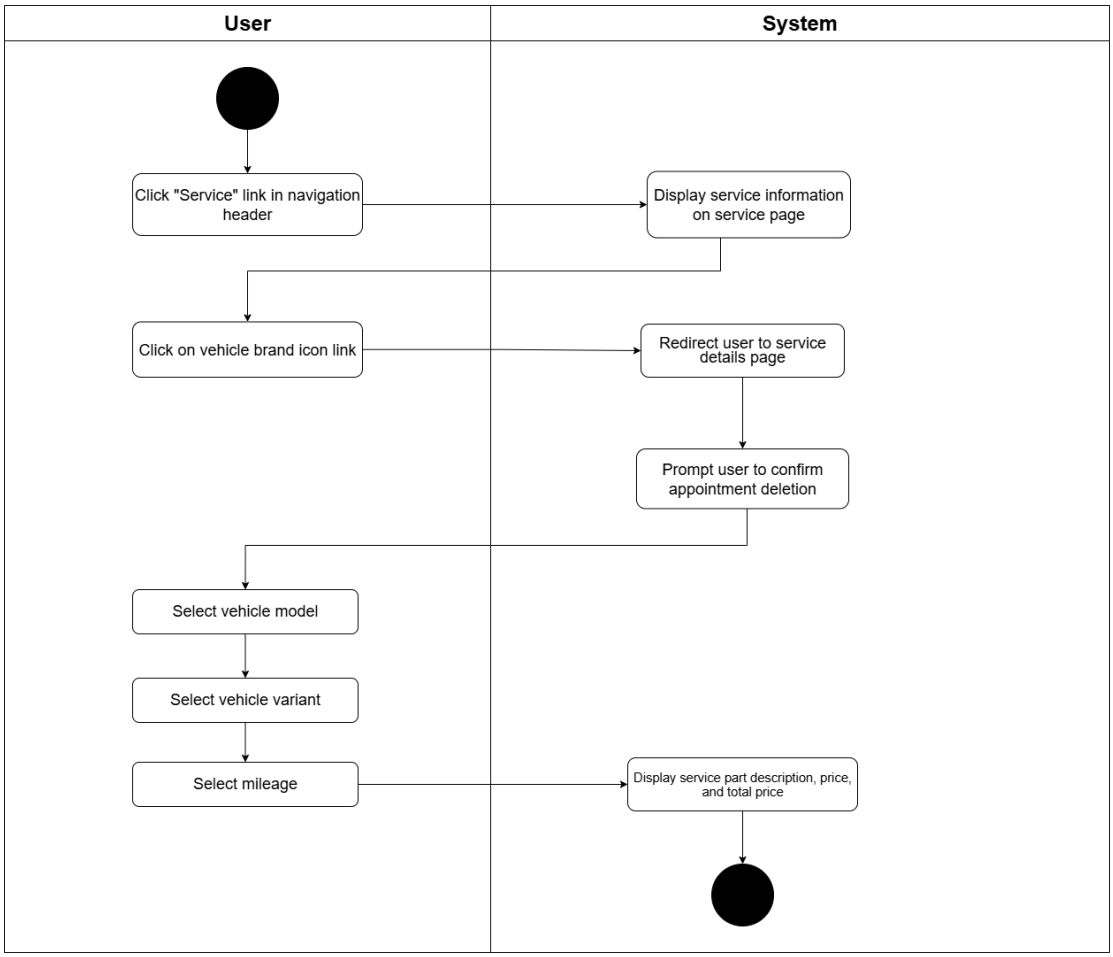


Figure 4.4.10 View Service Page Activity Diagram

Figure 4.4.10 shows the activity flow for viewing the Service page. The process begins when the user clicks the “Service” link in the navigation header. The system loads the Service page and displays general service information (available service types, brief descriptions, and how pricing works). When the user clicks a vehicle brand icon, the system redirects to the Service Details page for that brand.

On the details page the user progressively refines the query by selecting a vehicle model, variant and mileage. Based on these selections, the system looks up the relevant service parts and price rules and then displays the service parts/description, individual prices and the computed total price. This flow lets users estimate costs accurately before

they make an appointment and ensures the price shown matches the specific vehicle configuration.

11. View and Manage Service List

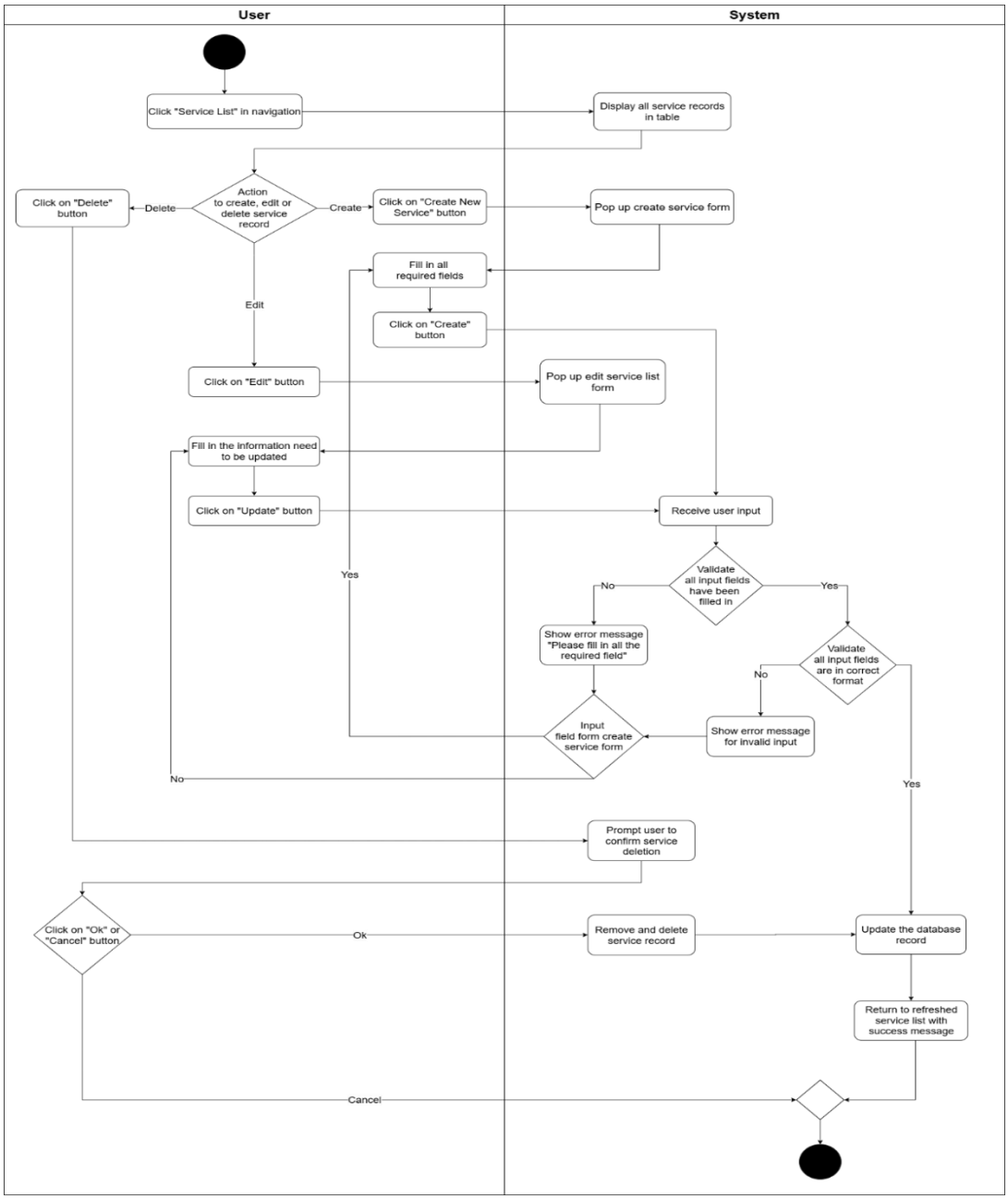


Figure 4.4.11 View and Manage Service List Activity Diagram

Figure 4.4.11 shows the activity flow for viewing and managing the Service List. The process begins when the admin clicks “Service List” in the navigation. The system loads the maintenance page and displays all service records in a table. From this list the

admin can choose one of three actions: Create New Service, Edit an existing service, or Delete a service.

For Create, the admin selects “Create New Service,” the system opens the create form, and the admin fills in all required fields (name, description, duration, etc.). After clicking “Create,” the system receives the input and performs two validations: (i) all mandatory fields are provided; and (ii) every value is in the correct format (e.g., text length, numeric ranges). If a check fails, an appropriate message—“Please fill in all the required field” or invalid input—is shown and the admin returns to the form to correct the values. When the input passes validation, the system adds the new service record to the database and refreshes the list with a success message.

For Edit, the admin clicks “Edit” beside a record and the system opens a pre-filled edit form. The admin updates the necessary fields and clicks “Update.” The system runs the same completeness and format checks; on success it updates the database record and returns to the refreshed list with a confirmation message.

For Delete, the admin clicks “Delete” and the system prompts for confirmation to avoid accidental removal. Choosing OK causes the system to remove the selected service and refresh the

12. View and Manage User

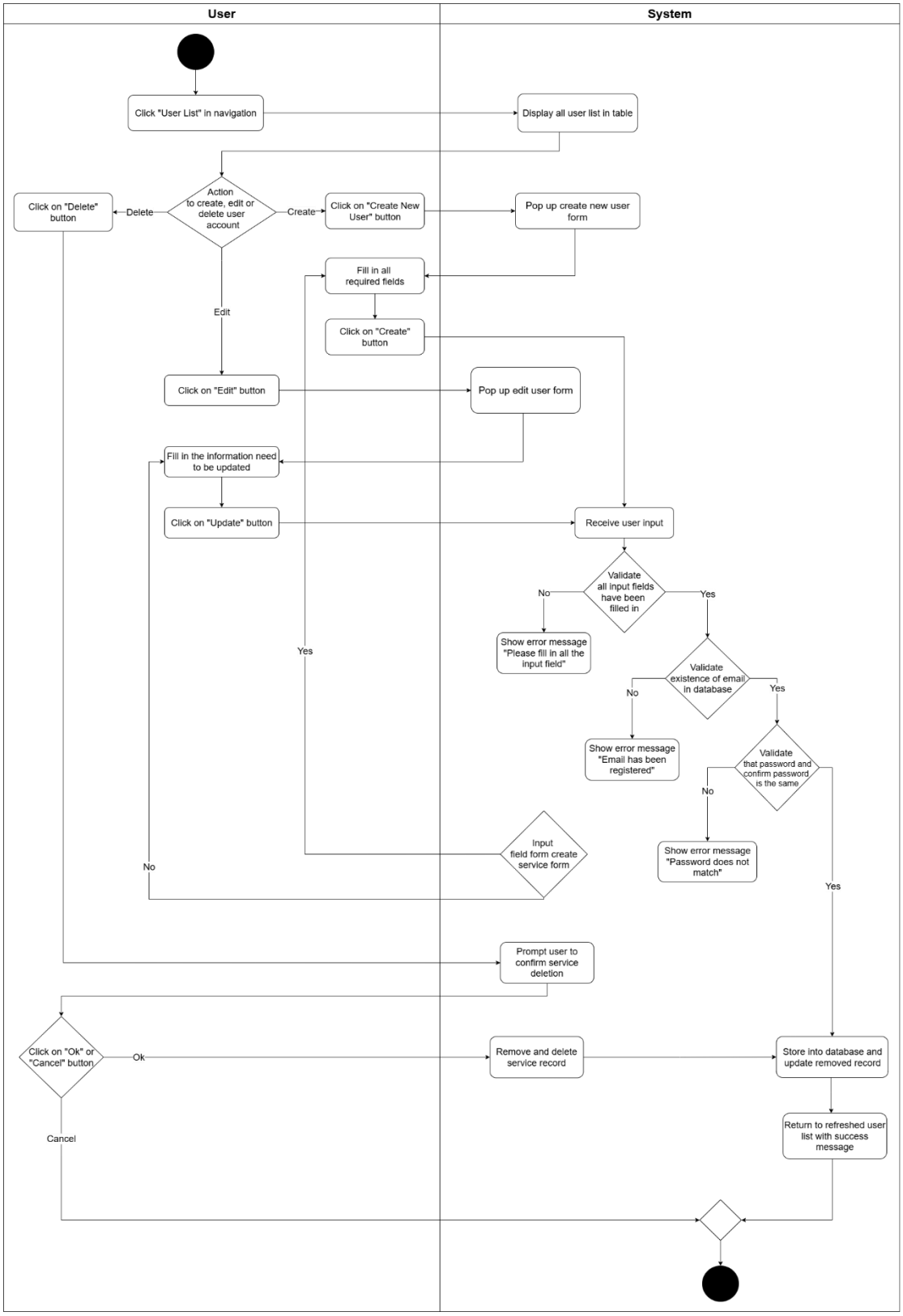


Figure 4.4.12 View and Manage User Activity Diagram

Figure 4.4.12 shows the activity flow for viewing and managing user accounts. The process begins when the admin clicks “User List” in the navigation menu. The system loads the maintenance page and displays all users in a table. From this list the admin can choose to Create, Edit, or Delete a user account.

For Create, the admin selects “Create New User.” The system opens the create-user form, the admin fills in all required fields (name, email, password and confirm password, and any profile details), and clicks “Create.” The system receives the input and validates it in sequence: (i) all mandatory fields are completed; (ii) the email is not already registered; and (iii) password and confirm password match. If any check fails, the system shows a specific error message (e.g., “Please fill in all the input field”, “Email has been registered”, or “Password does not match”) and returns the admin to the form to correct the values. When all validations pass, the system stores the new user record and refreshes the user list with a success message.

For Edit, the admin clicks “Edit” beside a selected user and the system opens a pre-filled edit form. The admin updates the necessary fields and clicks “Update.” The same validations are applied: completeness of required fields, email uniqueness if changed, and password confirmation match if a new password is entered. On success, the system updates the database record and returns to the refreshed list with a confirmation message; on failure, an appropriate error is shown and the admin remains on the form.

For Delete, the admin clicks “Delete” and the system prompts for confirmation to prevent accidental removal. Choosing OK causes the system to remove the selected user record and update the table with a success message; choosing Cancel leaves the dataset unchanged and returns to the list.

4.5 Wireframes

Wireframes provide a foundational blueprint for interface design in the system. It outlines the recycling system design by drafting the structure, layout and every element that will be included in every page of the system. Via the blueprint, it gives an overview to visualize the placement of different elements such as the content, the navigation and the button. This is a crucial step in providing a clearer view on how different actors like user and admin can interact and navigate while using the system. It also ensures that the design of the system is aligned to objectives by considering all of the intended features. This can prevent the system from having boring design which could lead to dissatisfaction and discourage usage.

4.5.1 User Site

The following wireframes illustrate the design and layout of the pages that can be viewed and integrated from user perspective. As the target audience is user, the design focuses on creating an intuitive and user-friendly interface. It will have clear navigation and access to key features so that users can interact easily with the system for intended services.

1. Main Page

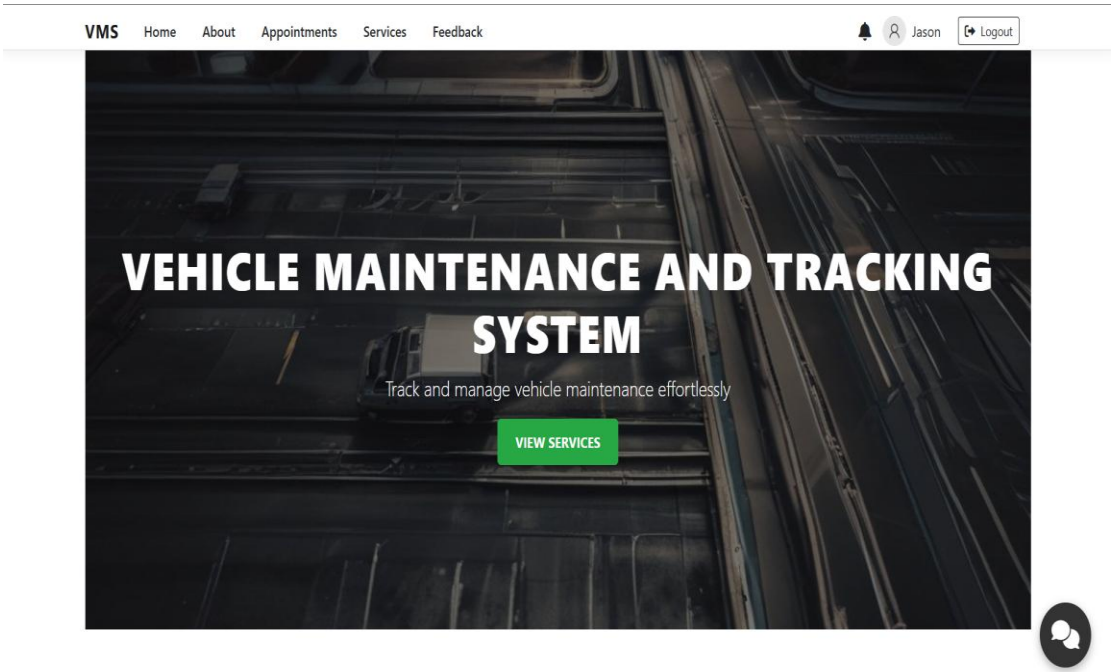


Figure 4.5.1.1 User Main Page Wireframe

2. About Us Page

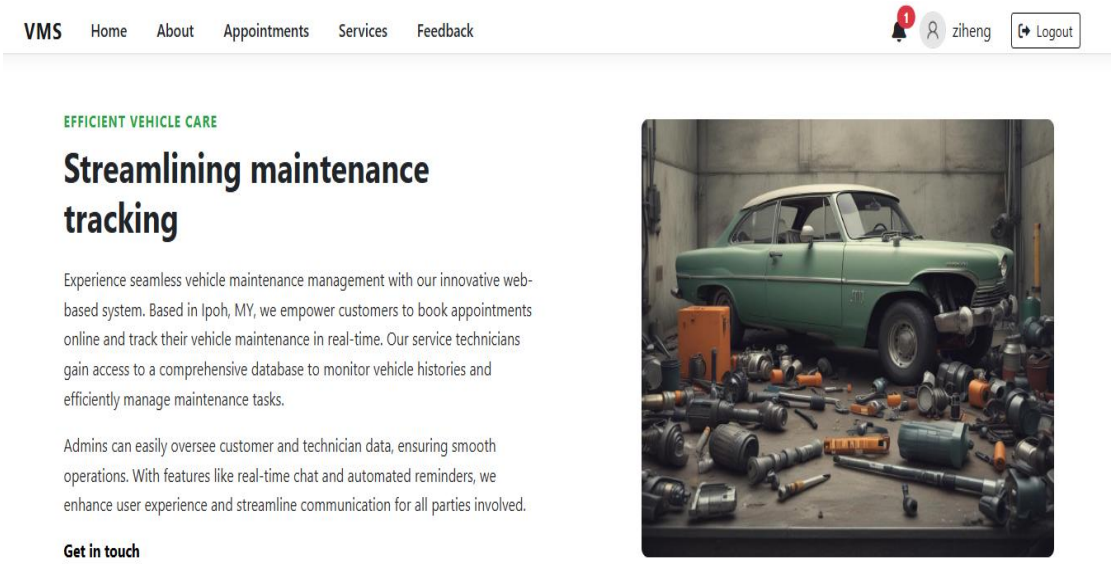


Figure 4.5.1.2 About Us Page Wireframe

3. Login Page

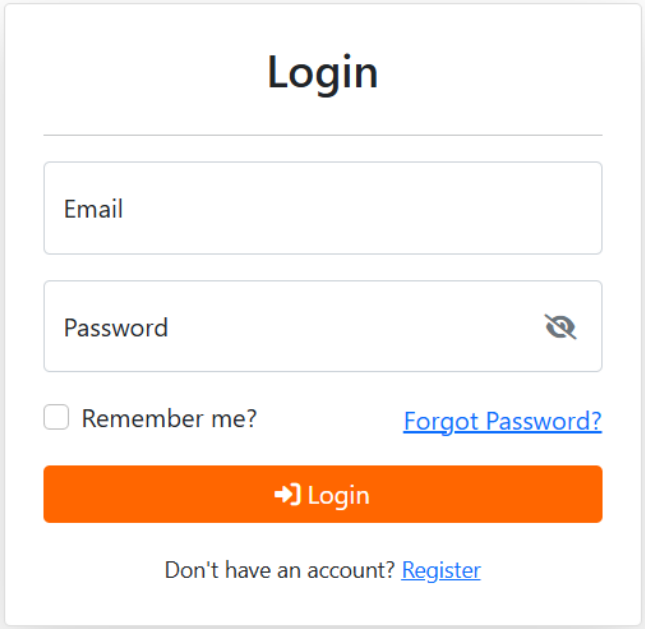


Figure 4.5.1.3 Login Page Wireframe

4. Register Page

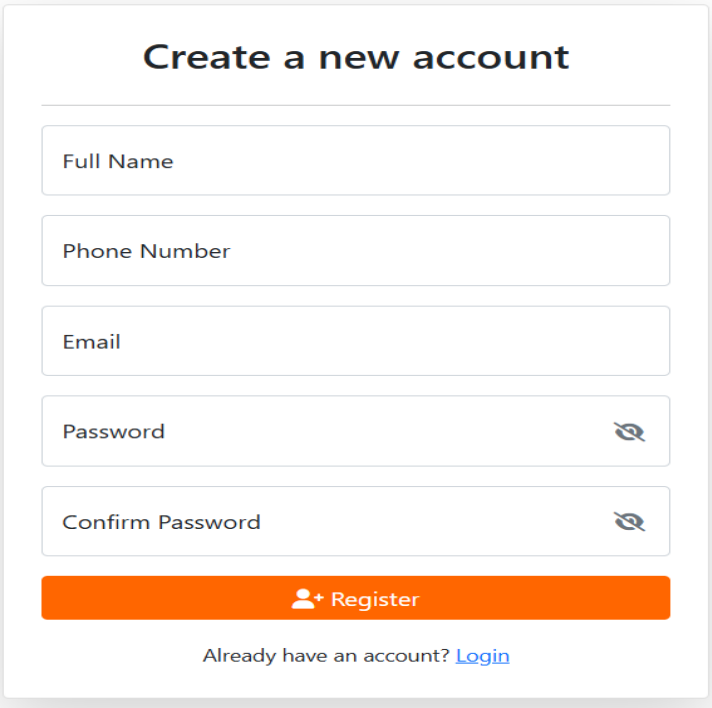


Figure 4.5.1.4 Register Page Wireframe

5. Appointment Booking Page

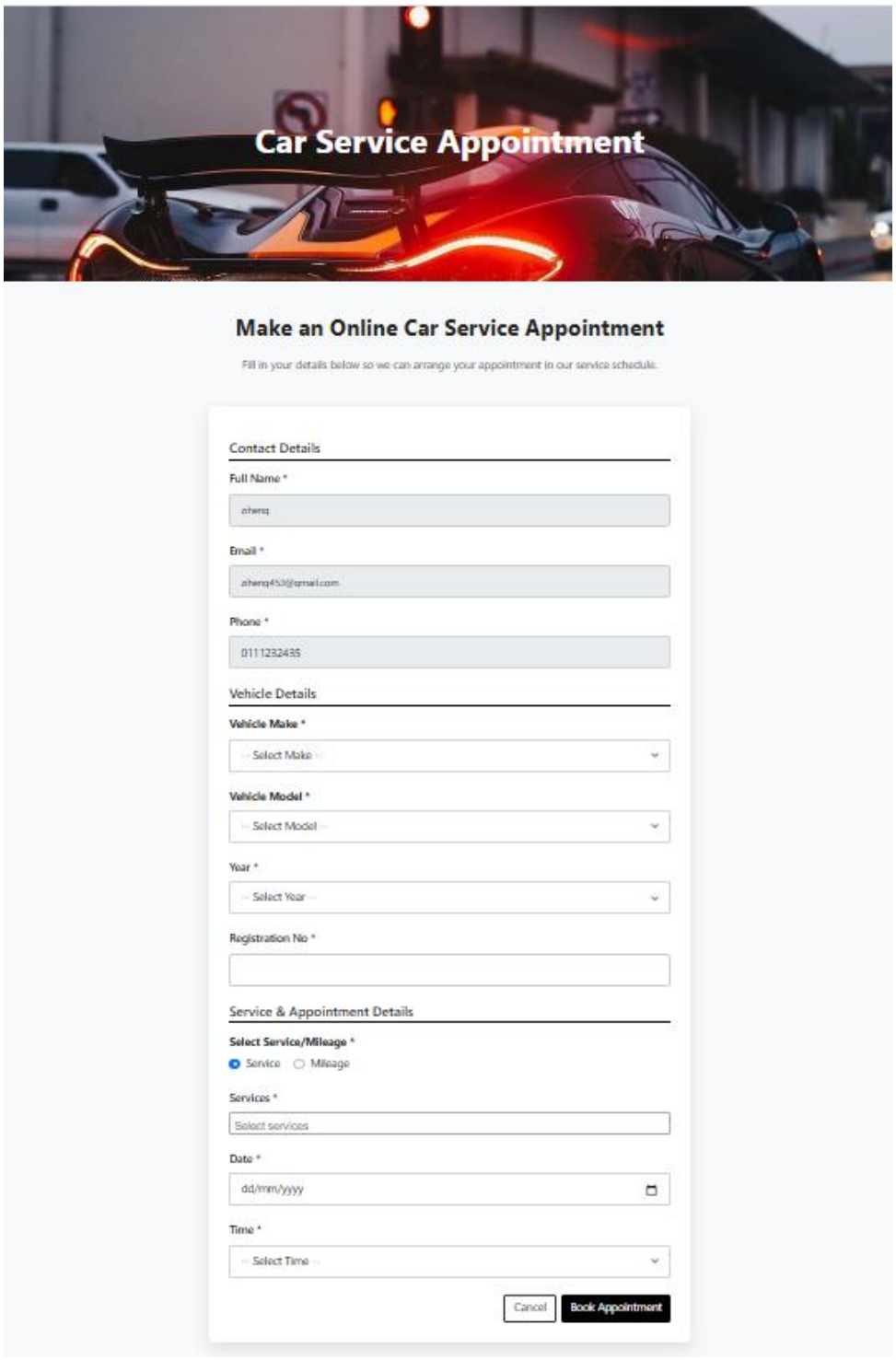


Figure 4.5.1.5 Appointment Booking Page Wireframe

6. Manage User Profile

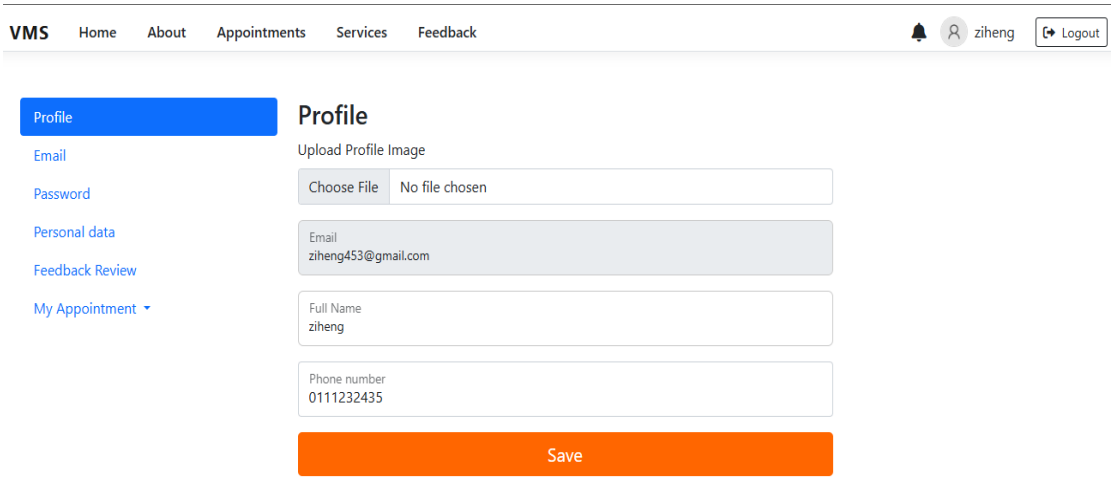


Figure 4.5.1.6 Manage User Profile Page Wireframe

7. Appointment Review Page

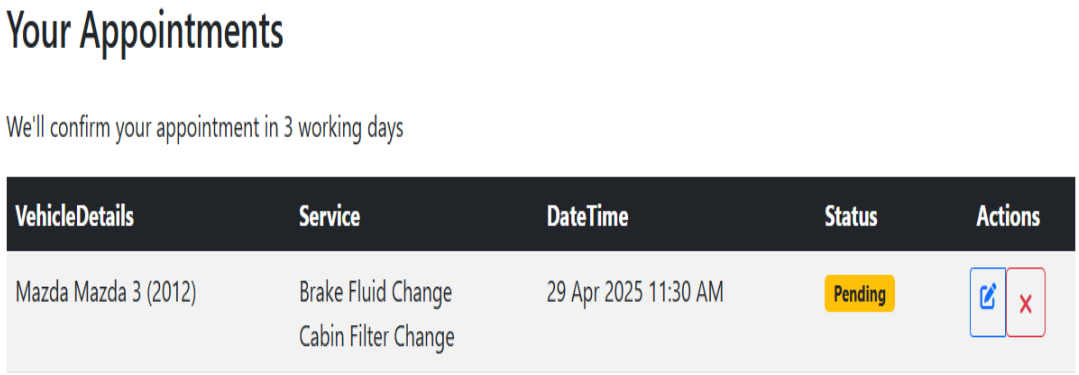


Figure 4.5.1.7 Appointment Review Page Wireframe

8. Update Appointment Page

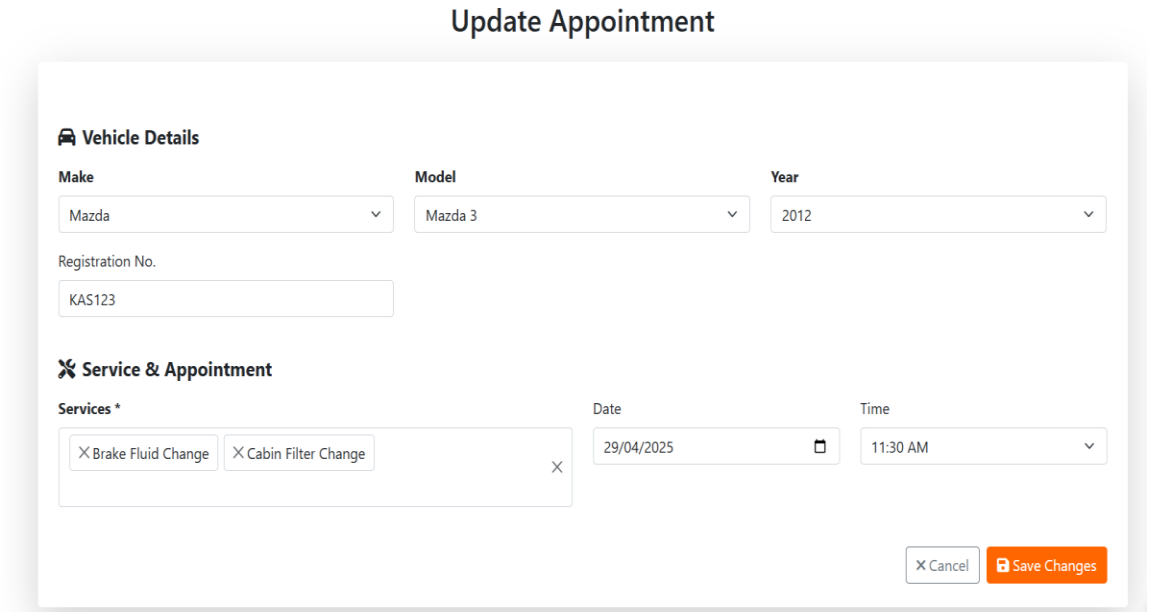


Figure 4.5.1.8 Update Appointment Page Wireframe

9. Service Progress Page

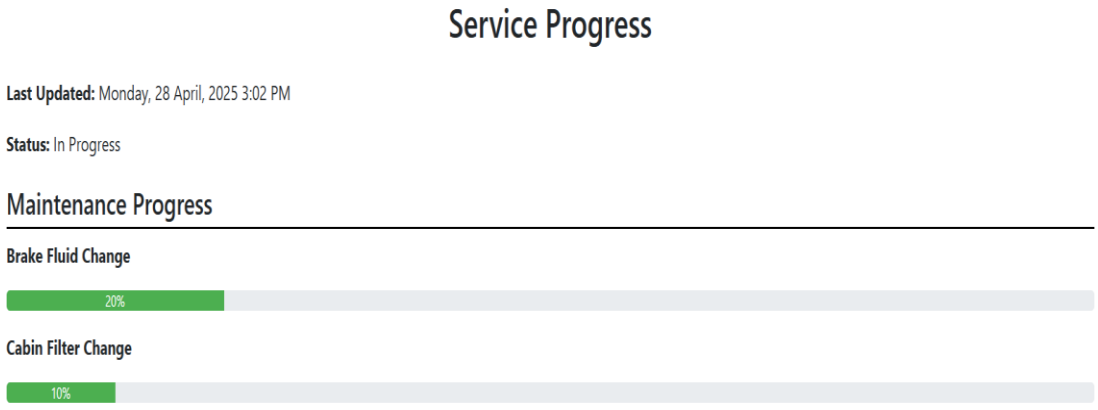


Figure 4.5.1.9 Service Progress Page Wireframe

10. Service History Page

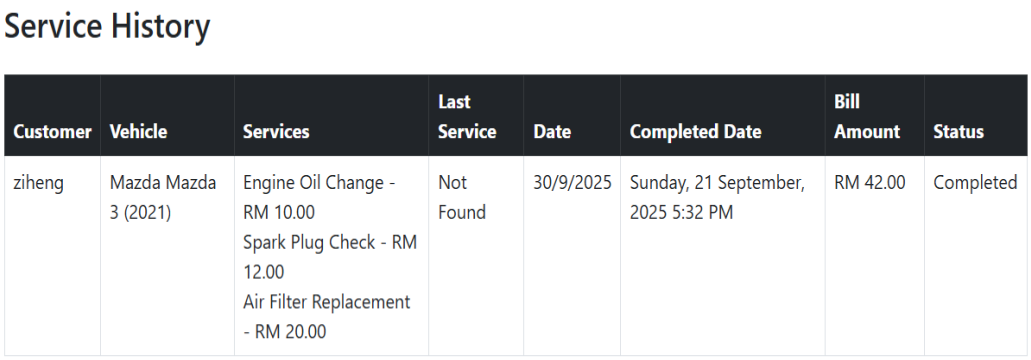


Figure 4.5.1.10 Service History Page Wireframe

11. Services Page

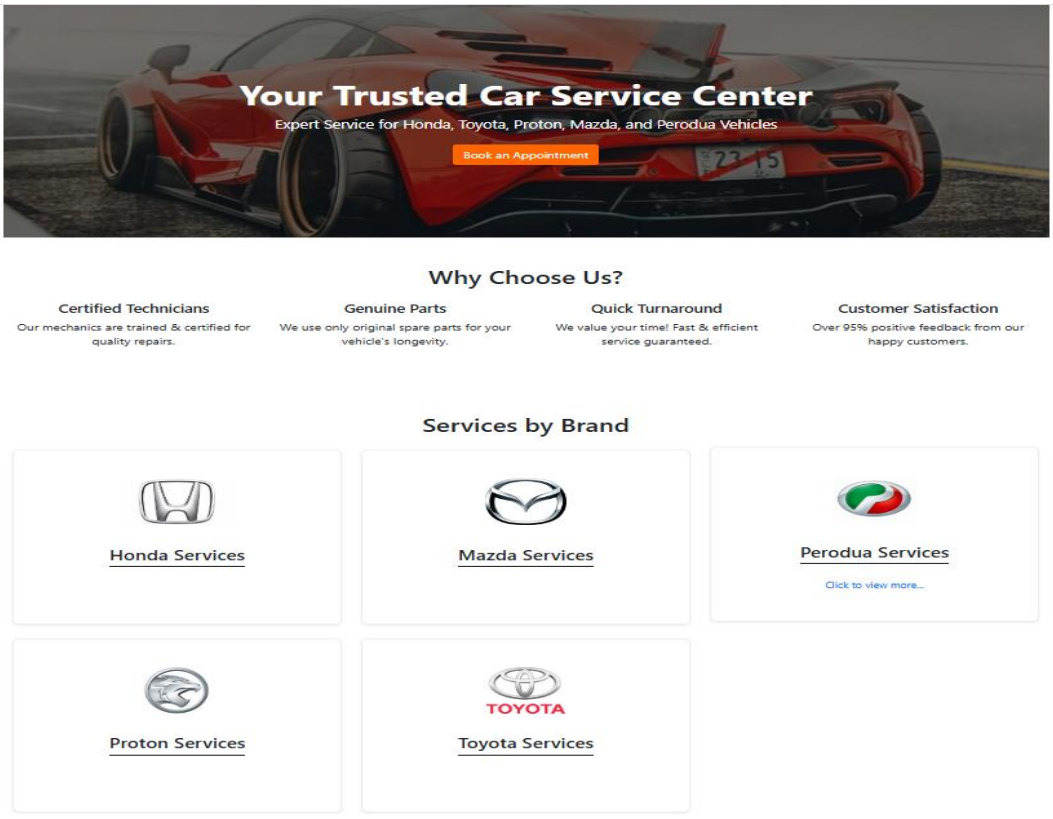


Figure 4.5.1.11 Service Page Wireframe

12. Service Details Page

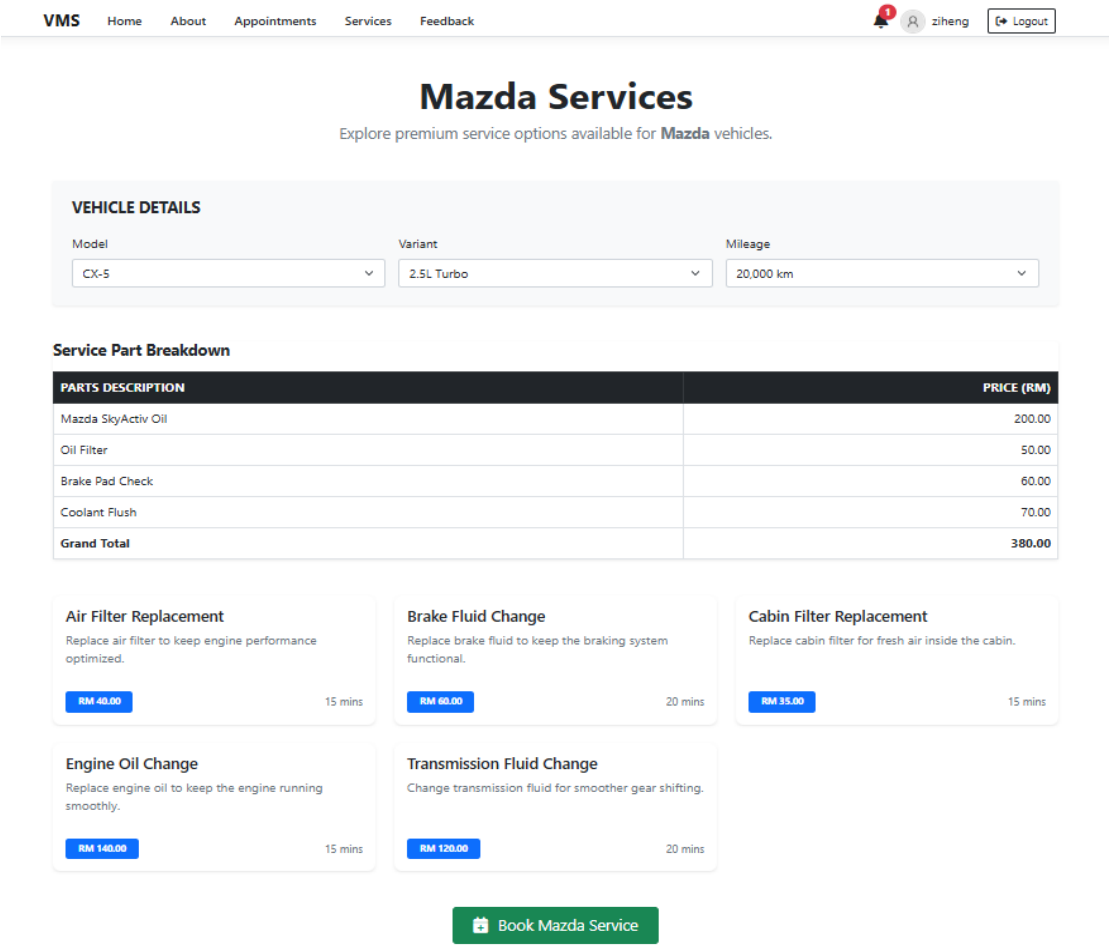


Figure 4.5.1.12 Service Details Page Wireframe

13. Feedback Page

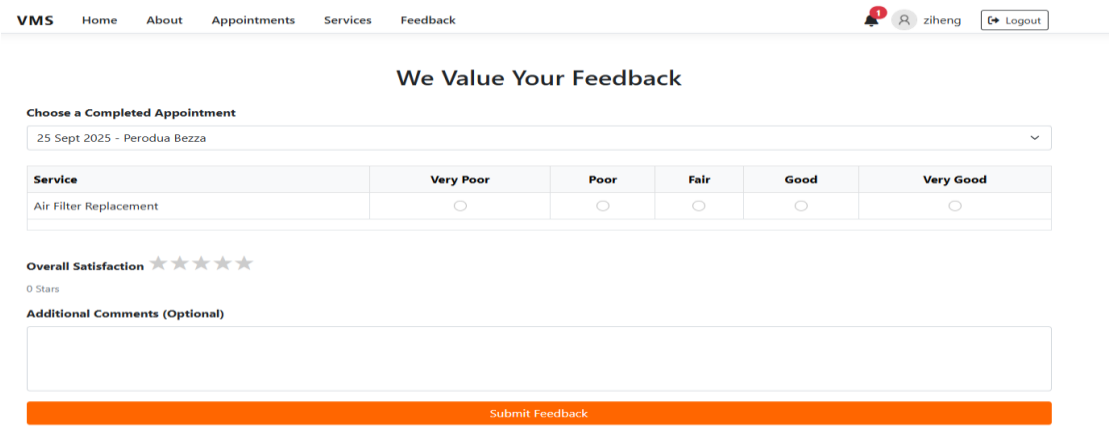


Figure 4.5.1.13 Feedback Page Wireframe

4.5.2 Admin Site

The following wireframes represent the page design that can be viewed from admin perspective. Its design is mainly focus on the functionalities which allowing admin to be able to clearly view the data collected from the users site. The interface is simple and clear so that is will not be messy when receiving huge amount of data. The layout ensures admin can efficiently oversee the platform and handle inquiries.

1. Main Page

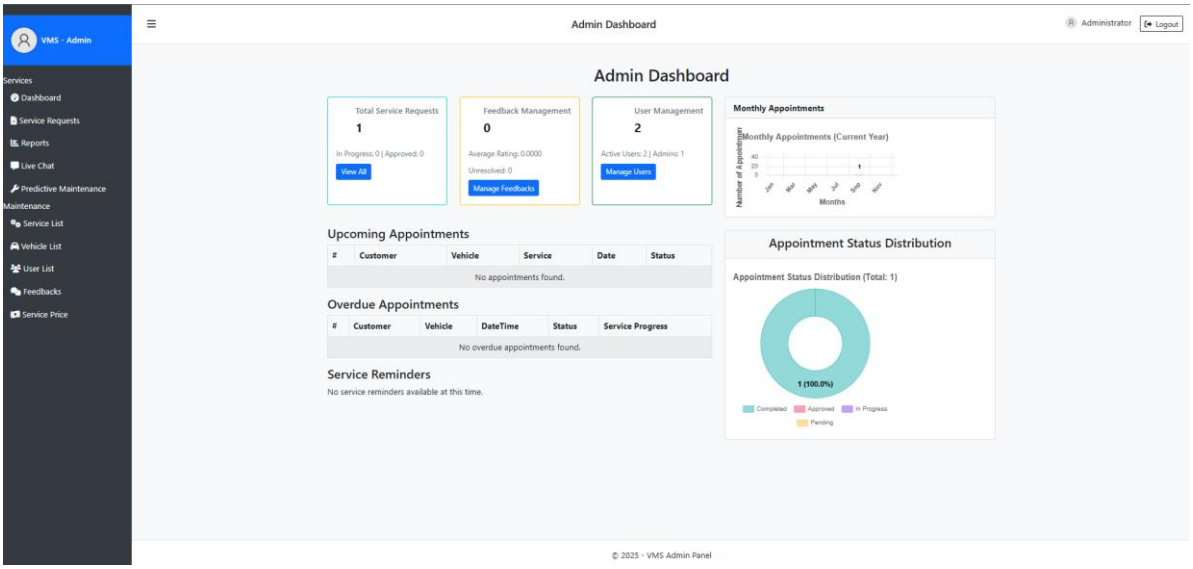


Figure 4.5.2.1 Admin Main Page Wireframe

2. Manage Appointment Page

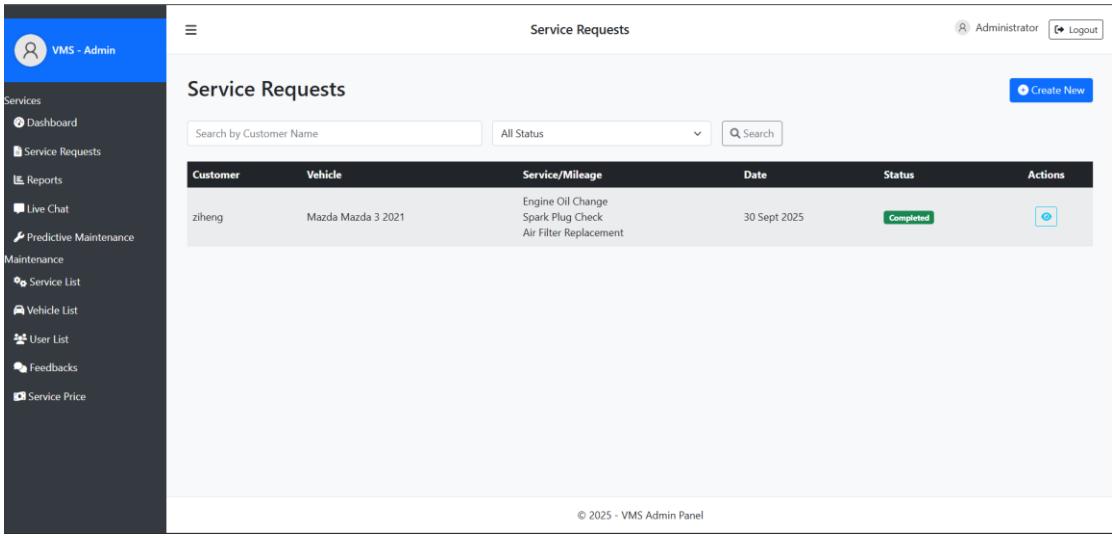


Figure 4.5.2.2 Manage Appointment Page Wireframe

3. Service History Report Page

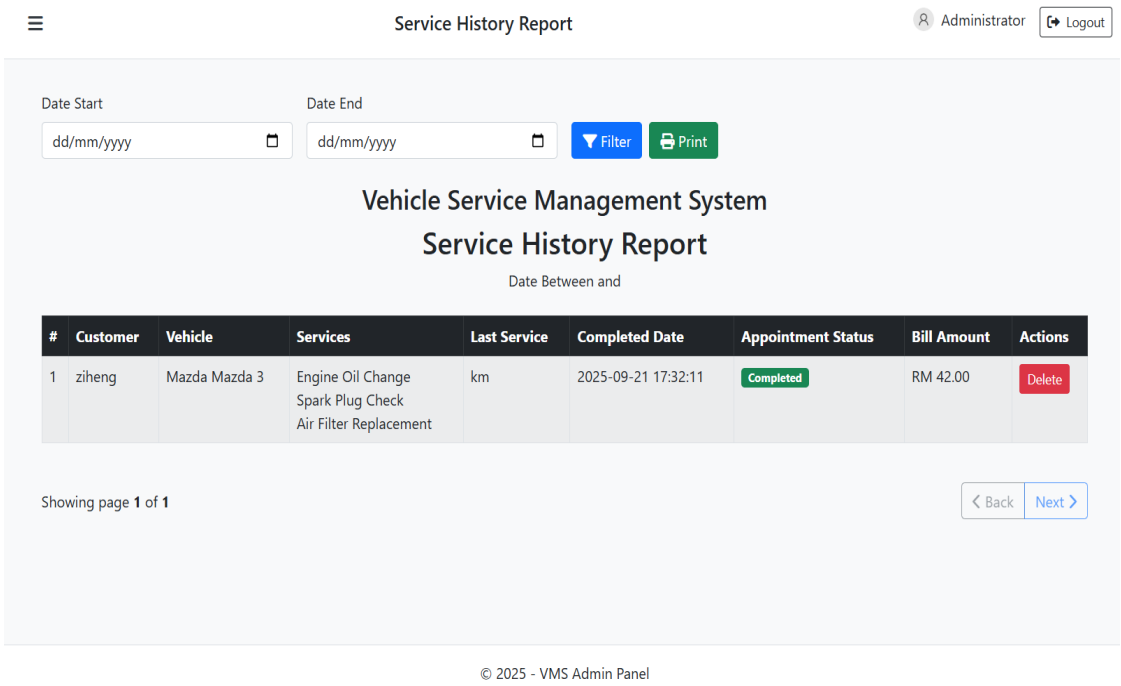


Figure 4.5.2.3 Service History Report Page Wireframe

4. Live Chat Page

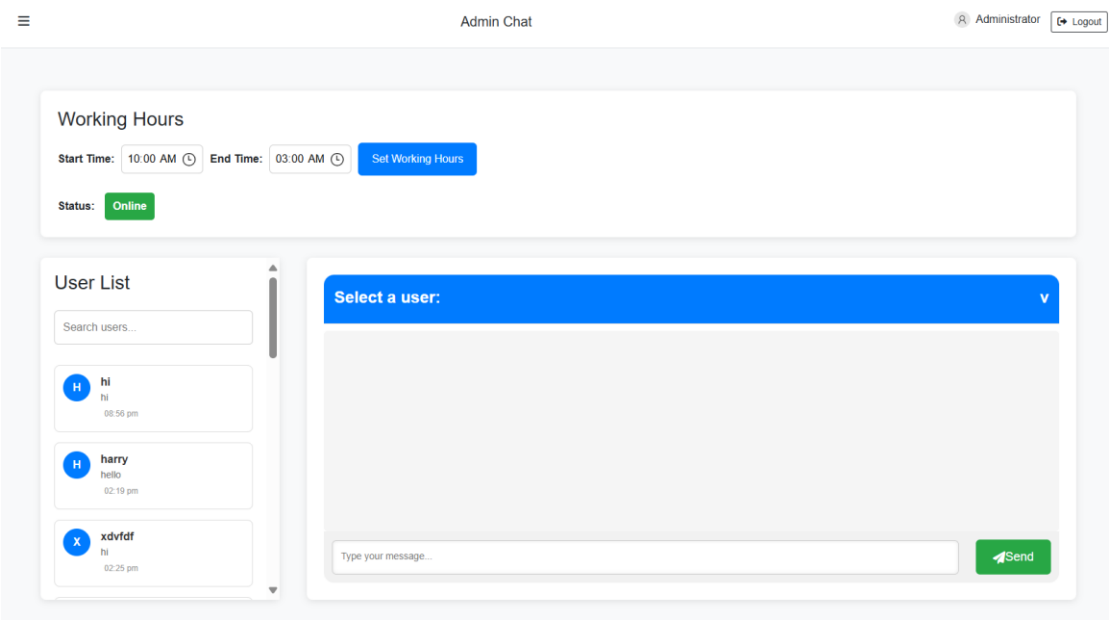


Figure 4.5.2.4 Live Chat Page Wireframe

5. Predictive Dashboard Page

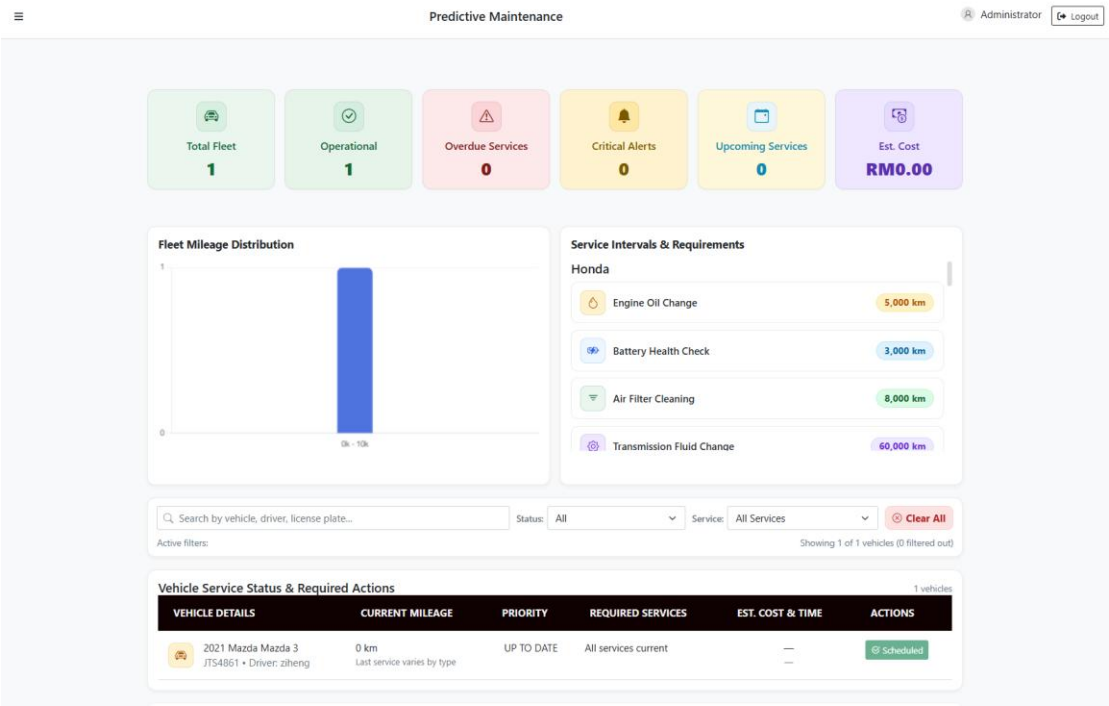


Figure 4.5.2.5 Predictive Dashboard Page Wireframe

6. Service List Page

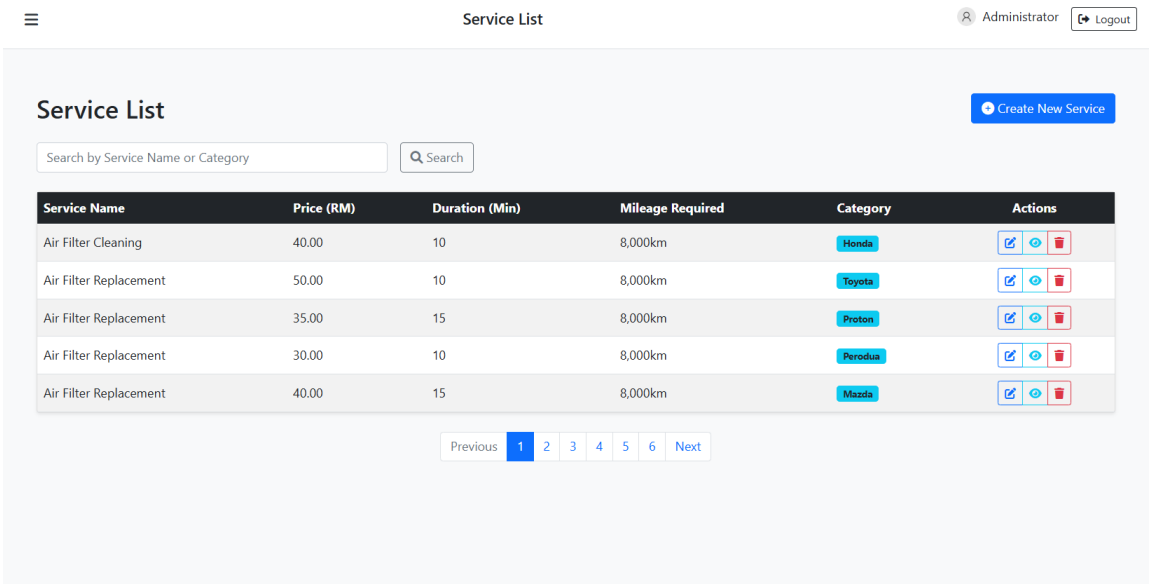


Figure 4.5.2.6 Service List Page Wireframe

7.Vehicle List Page

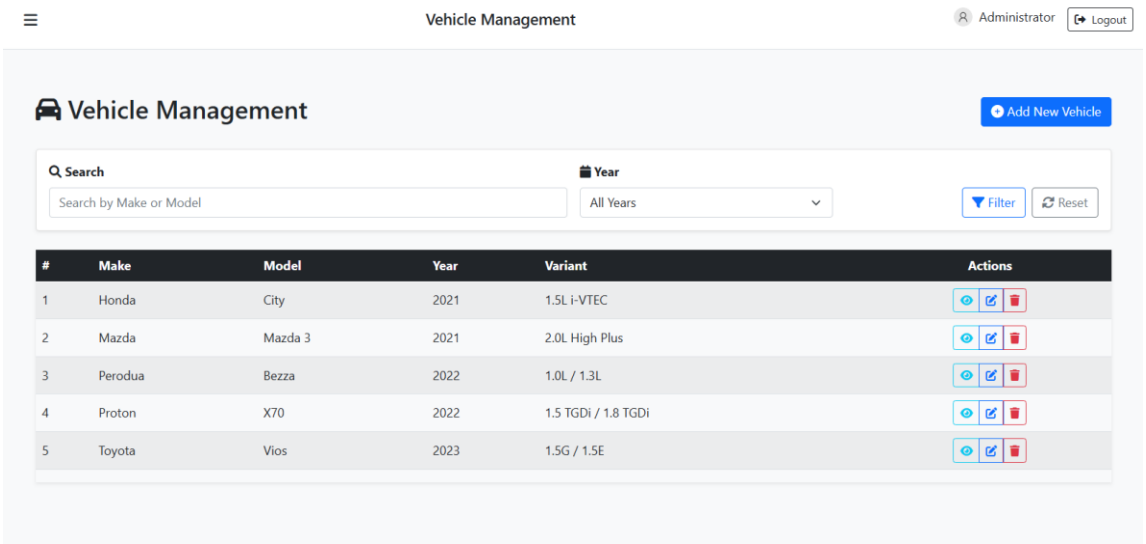


Figure 4.5.2.7 Vehicle List Page Wireframe

8. User List Page

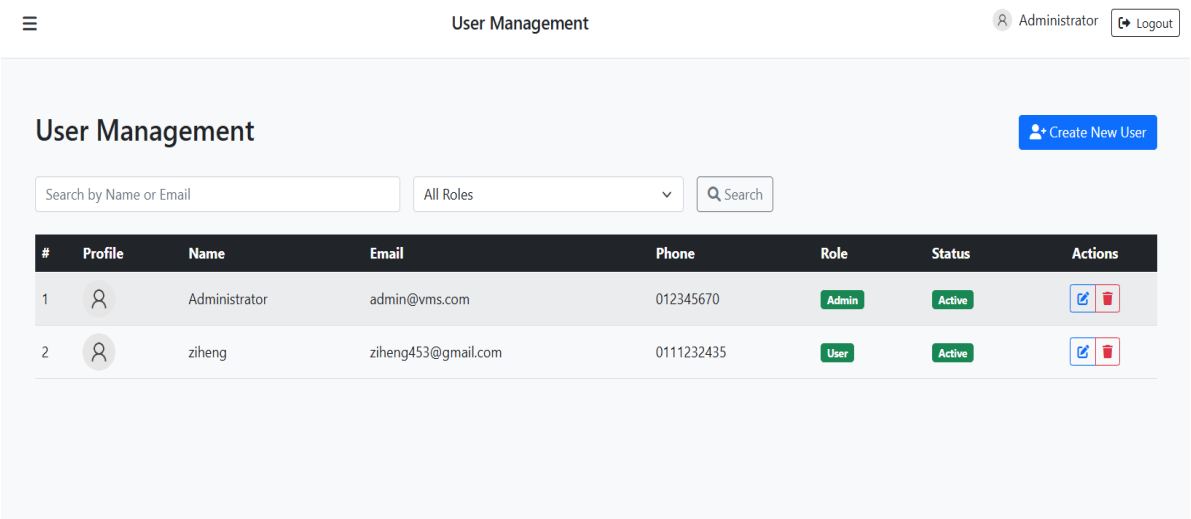


Figure 4.5.2.8 User List Page Wireframe

9. Feedback Page

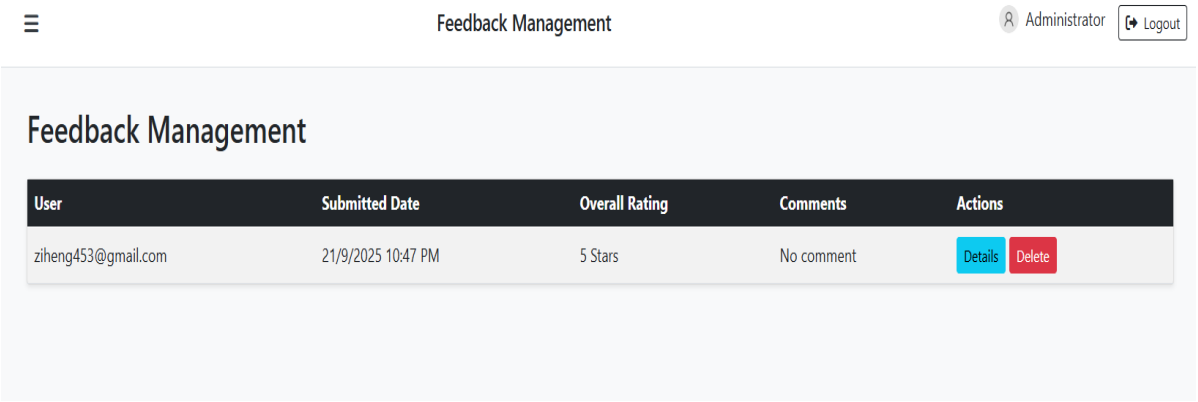


Figure 4.5.2.9 Feedback Page Wireframe

10. Manage Service Price Page

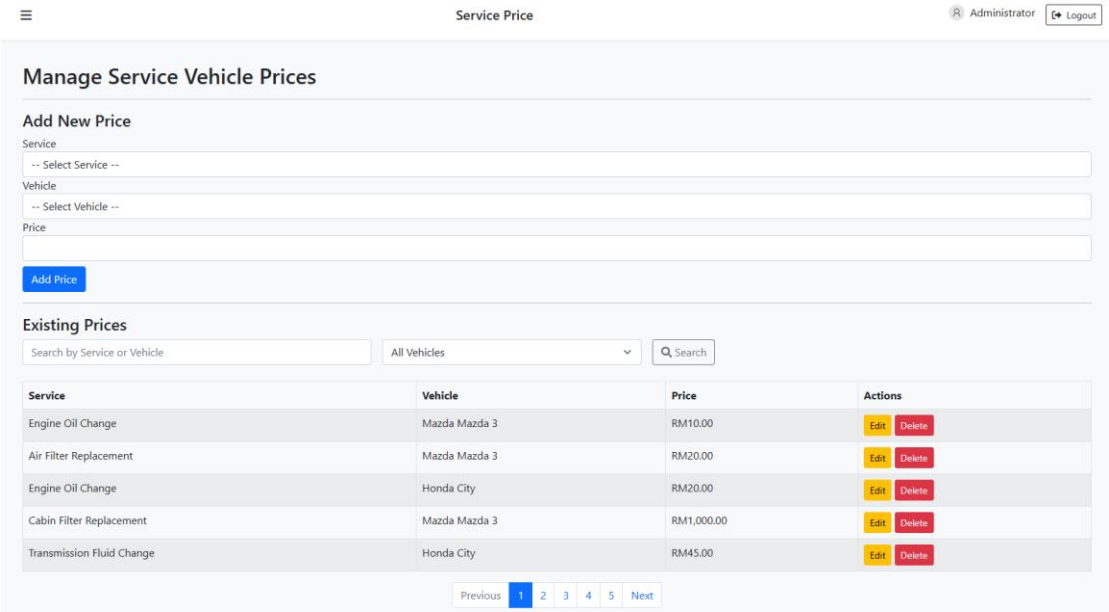


Figure 4.5.2.10 Manage Service Price Page Wireframe

Chapter 5: System Implementation

5.1 Hardware Setup

Hardware	Specifications	Description
Processor	Gen Intel(R) Core (TM) i5-11400H @ 2.70GHz 2.69 GHz	Used for executing and managing the overall performance of the system.
Graphic	NVIDIA GeForce GTX 3060	Used to present graphical content and interface.
Memory	16.0 GB	Used for program storage.
Input Device	Mouse and Keyboard	Used to control for the user during development and program execution

Table 5.1 Hardware Specifications

The hardware required to develop and implement this project consists of a workstation equipped with an Intel® Core™ i5-11400H processor, 16 GB of RAM, and an NVIDIA GeForce GTX 3060 graphics adapter. The CPU provides sufficient processing power for compiling and running the system, while the dedicated GPU supports fluid rendering of the graphical user interface and any visualization required. Standard input peripherals—a mouse and keyboard—are used to operate the development tools and the application under test. This configuration served as the primary development environment and was used to validate functionality and performance throughout the implementation phase.

5.2 Software Requirements

Software	Specifications	Description
Operating System	Windows 10	Used to provide the necessary environment for running the laptop and software programs.
Web Browser	Google Chrome	Used for displaying and testing the system's output during development and use.
Visual Studio	Version 2022	Used for developing and debugging the project.
Front-End Tools	HTML, CSS, Bootstrap, JavaScript	Utilized for creating and designing the graphical user interface of the website.
Back-End Tools	ASP.NET Core, C#	Implements server-side logic, REST endpoints, and business rules.
Database	SQL Server Database	Used to store, manage, and retrieve user data, appointments, and inventory information.

Table 5.2 Software Specification

The software implemented in this project includes Windows 10 as the operating system, which supports the execution of various software programs required for development. Google Chrome is used as the primary web browser for testing and displaying system outputs. Visual Studio 2022 serves as the main development environment, allowing for efficient coding and debugging. The front-end of the system will be developed using HTML, CSS, Bootstrap, JavaScript to create an interactive and user-friendly interface. Server-side functionality is developed with ASP.NET Core (C#), which exposes application services and applies business rules. SQL Server Database will be used to manage and store user information, vehicle maintenance records, and appointment data securely.

5.3 Setting and Configuration

At the beginning of the development phase, the project was implemented on Windows 10 using Visual Studio 2022 as the primary IDE and SQL Server (LocalDB) as the database engine. The application follows the ASP.NET Core MVC structure and uses Entity Framework (EF) Core for data access and schema evolution. As shown in Figure 5.3.1, the database VMS_Data is hosted on SQL Server and contains the operational tables for users, vehicles, appointments, services, prices and feedback, together with the ASP.NET Core Identity tables for authentication.

The database schema was created and maintained through EF Core migrations. After defining the domain entities, an initial migration was scaffolded and applied commands 'Add-Migration InitialCreate' executed in the Package Manager Console and after the new migration was added then execute the command 'Update-Database'. If successful, the data will be updated into database. Figure 5.3.2 lists the migration files used in this project (e.g., updates to ratings, mileage, appointment fee, and status), ensuring that the database stays synchronized with the application model and that structural changes remain traceable.

The web layer is organized around controllers that expose the system's features to users and administrators. Figure 5.3.3 shows the main controllers included in the solution (e.g., AccountController, AdminController, AppointmentController, PredictiveController, ReportController, ServiceController, UserController, and VehicleController). This separation of concerns keeps presentation logic, business rules and persistence cleanly modularized.

Runtime parameters are centralized in appsettings.json. As shown in Figure 5.3.4, the configuration specifies the connection strings for SQL Server, logging levels, Application Insights telemetry, and SMTP e-mail settings used for notifications (host, port and sender identity). Sensitive values such as SMTP credentials are managed outside source control via the Visual Studio User Secrets store during development.

To support development, Visual Studio 2022 was installed with the required workloads and tools. Figure 5.3.5 illustrates key components available in the environment, including SQL Server Data Tools and testing adapters, which streamline building, running and debugging the ASP.NET Core application. Together, these settings and

configurations provide a consistent, reproducible environment for implementing, running and validating the Vehicle Maintenance and Service Tracking System.

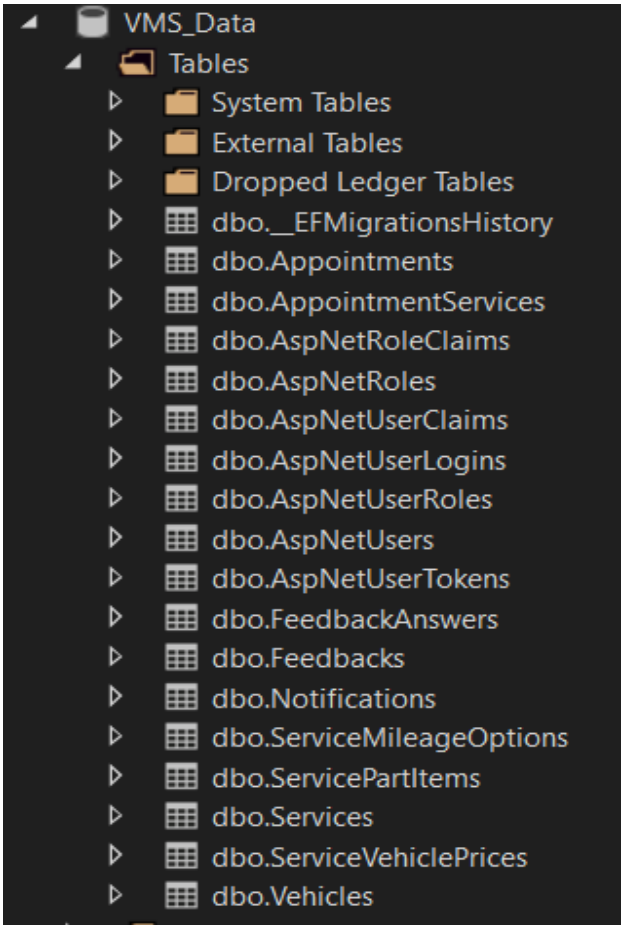


Figure 5.3.1 Database in SQL Server

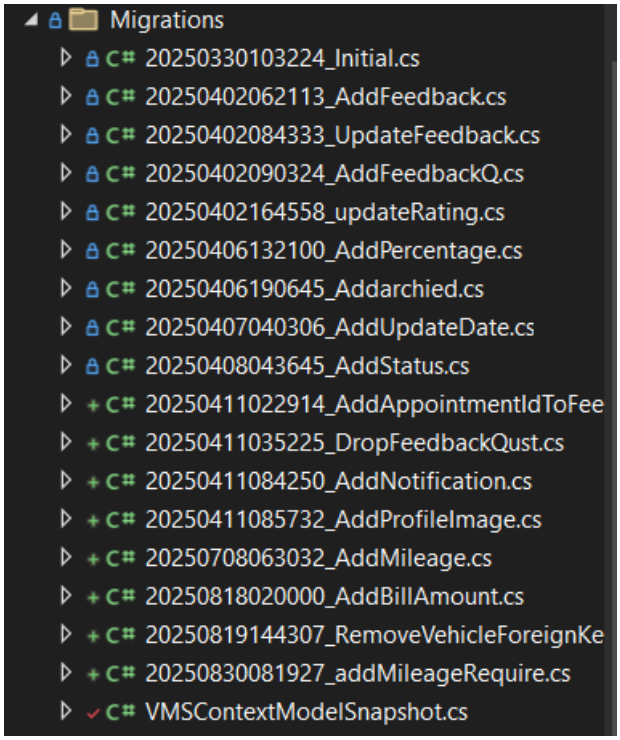


Figure 5.3.2 Migration

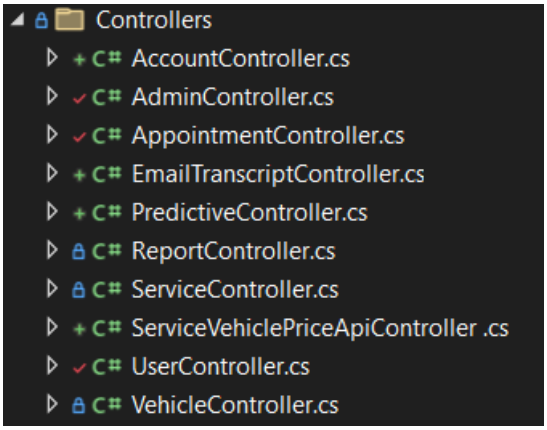


Figure 5.3.3 Controllers

Figure 5.3.4 Application Configuration

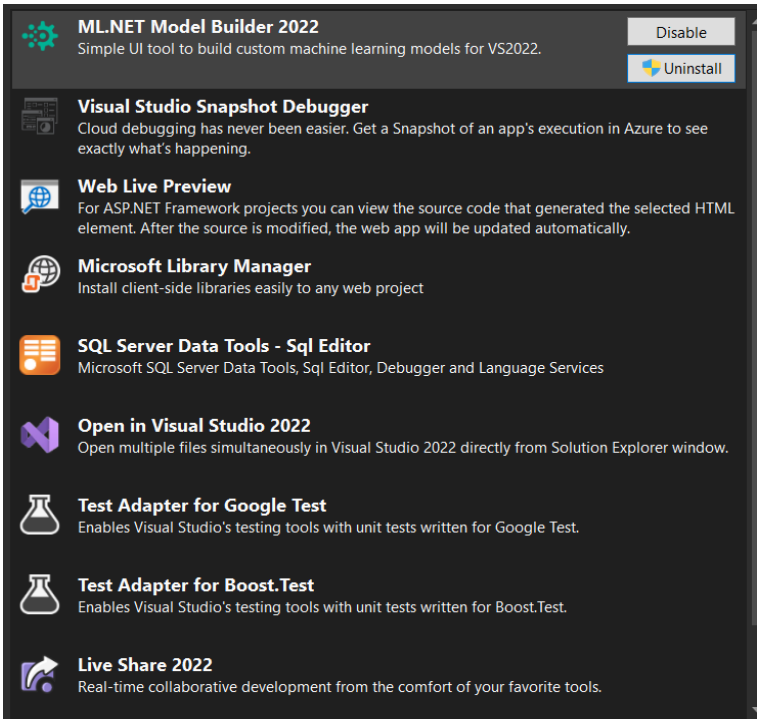


Figure 5.3.5 Extensions

5.4 System Operation

1. Vehicle Owner Main Page

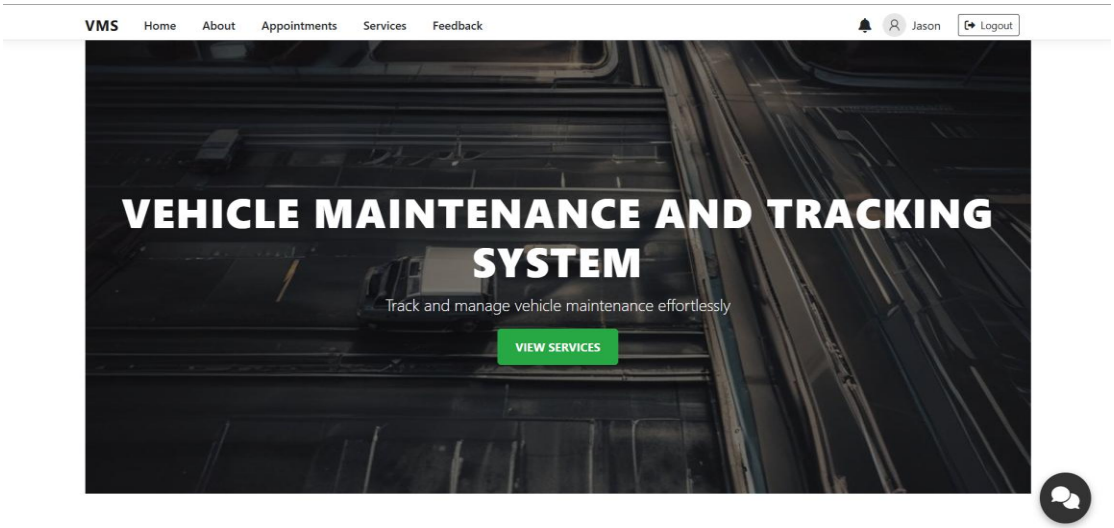


Figure 5.4.1 Vehicle Owner Main Page

When a vehicle owner logs into the system successfully, they are directed to the Vehicle Owner Main Page. This page serves as the dashboard where users can easily access the key features of the system, including viewing services, appointments, and providing feedback. A navigation bar is located at the top, allowing users to navigate seamlessly between different sections such as Home, About, Appointments, Services, and Feedback. Additionally, the page displays a prominent banner that highlights the purpose of the system — managing and tracking vehicle maintenance efficiently. The "View Services" button allows users to quickly explore the services available without navigating through multiple pages.

2. Login Page

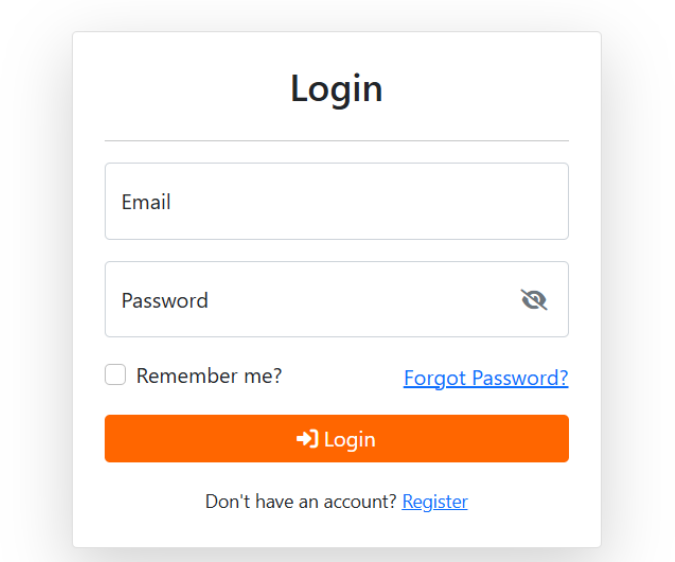


Figure 5.4.2 Login Page

When a user accesses the system, the login page is displayed, prompting the user to input their registered email address and password to authenticate. The form consists of two fields: one for the email and one for the password, which includes a toggle feature to show or hide the entered password for convenience. A "Remember me" checkbox is provided, allowing users to stay logged in if selected. If a user forgets their password, a "Forgot Password?" link is available to redirect them to the password recovery process. Below the login form, there is also an option for users who do not have an account to proceed to the registration page. The login button is prominently styled in orange to encourage users to easily submit their login credentials and access the system.

3. Register Page

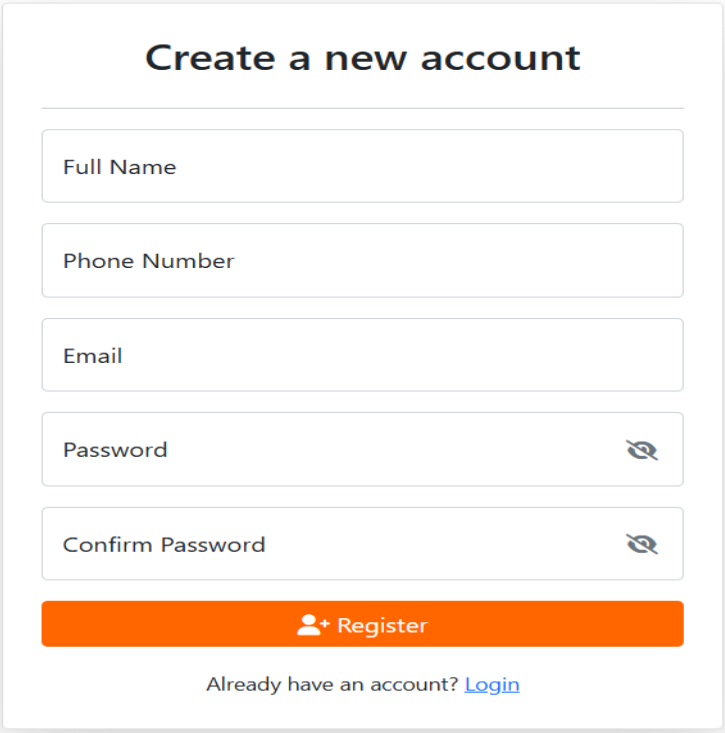


Figure 5.4.3 Register Page

When the user clicks on the Register link located on the login page, the registration form will be displayed. The registration form requires the user to fill in several fields, including full name, phone number, email address, password, and confirmation password. The system will verify that the information entered complies with specific validation rules. The full name field only accepts alphabetic characters and spaces, and the input must not exceed 100 characters. The phone number field must be a valid number between 10 and 15 digits and may optionally start with a plus (+) symbol for international formats. The email address field must match a valid email format to ensure proper communication between the system and the user. Passwords must meet a strong password policy, requiring at least six characters, including one uppercase letter, one numeric digit, and one special symbol. Additionally, the user must re-enter the password in the confirmation password field, and both entries must match exactly to prevent typing errors. If the inputted information is correct and valid, the system will create a new user account and store the information securely. If any validation fails, the system will display relevant error

messages prompting the user to correct the mistakes. This ensures that all registered user data maintains high security and integrity before being saved into the system.

4. Forgot Password Page

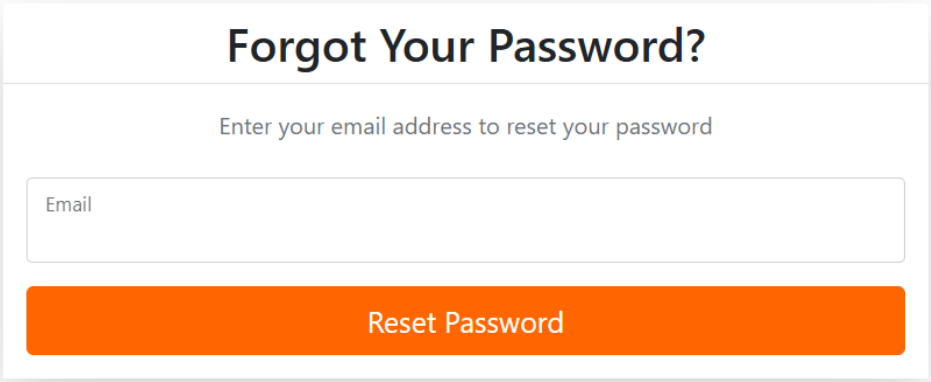


Figure 5.4.4 Forgot Password

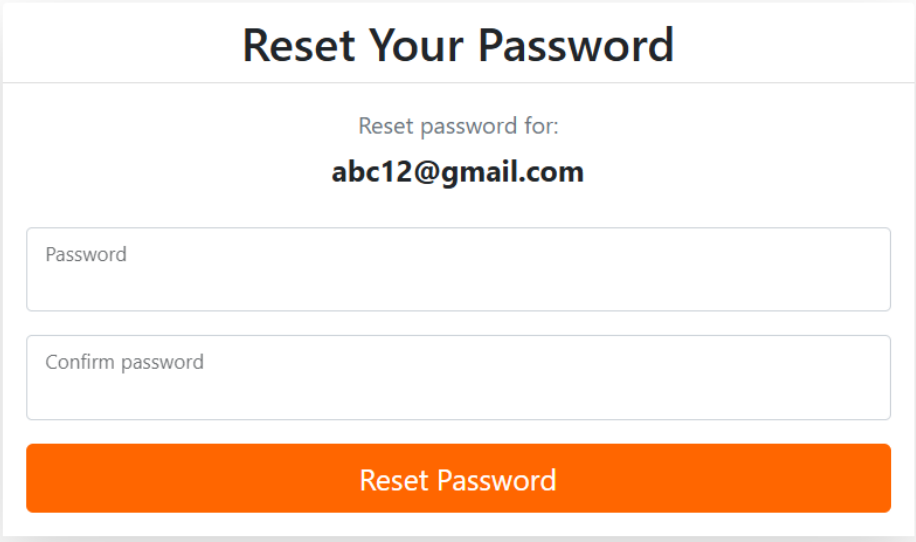


Figure 5.4.5 Reset Password

When a user clicks on the "Forgot Password" link located on the login page, they are directed to the "Forgot Your Password" page. On this page, the system prompts the user to enter their registered email address in order to receive a password reset link. After submitting the form, the system checks if the provided email exists in the database and whether the email address has been confirmed. If the validation is successful, the system generates a secure password reset link and sends it to the user's email. If the email does not exist or is not confirmed, an appropriate error message is

displayed to the user. Upon receiving the password reset email, the user clicks the provided link and is redirected to the "Reset Your Password" page. In this page, the user must input a new password and confirm it by re-entering it in the confirmation field. The system validates that both password entries match and that the new password meets the required security standards, including a minimum length and the inclusion of uppercase letters, numbers, and special characters. If the validation succeeds, the new password is saved, and the user is redirected to the login page along with a success message indicating the password has been reset. This two-step process ensures that the password reset operation is secure, user-friendly, and protects the integrity of user accounts.

5. Appointment Booking Page

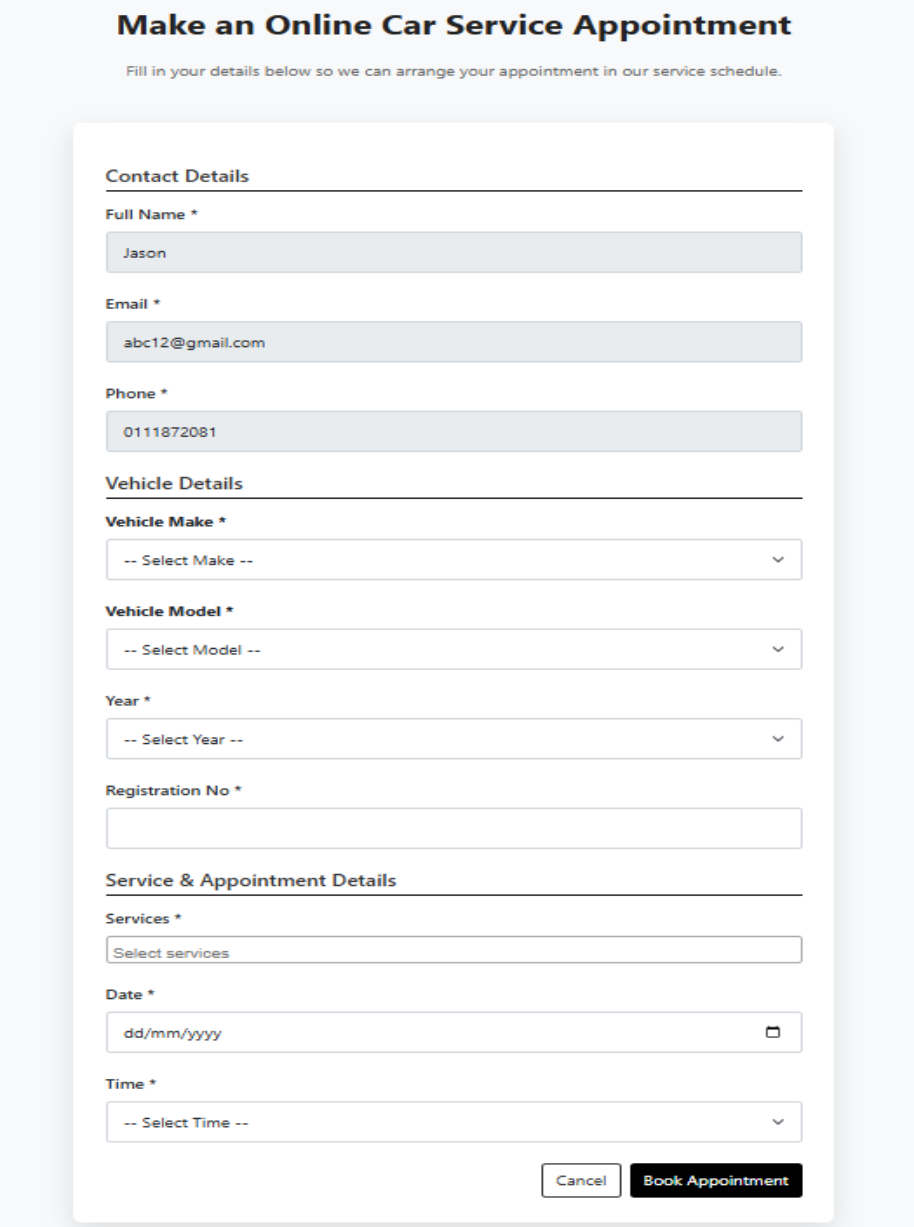


Figure 5.4.6 Appointment Booking Page

When the user navigates to the appointment booking page, they are presented with a form to schedule an online car service appointment. The form is divided into three main sections: Contact Details, Vehicle Details, and Service & Appointment Details. In the Contact Details section, the user's full name, email address, and phone number are pre-filled based on their registered account information, ensuring accuracy and minimizing redundant input. In the Vehicle Details section, the user must select their vehicle's make, model, and manufacturing year from dropdown lists, along with manually entering their vehicle registration number. This ensures the

service center receives precise information about the user's vehicle. In the Service & Appointment Details section, users are required to select the type of service they want to book, pick a preferred date from a date picker, and choose an available time slot from a dropdown menu. All fields marked with an asterisk (*) are mandatory to proceed. Once the user has completed the form, they can either cancel the appointment process or click the "Book Appointment" button to submit their request. The system will then validate the input, ensuring all required fields are properly filled, and save the appointment details to the database. Upon successful submission, a confirmation message will be displayed to inform the user that their service appointment has been successfully booked and recorded.

6. Appointment Review Page

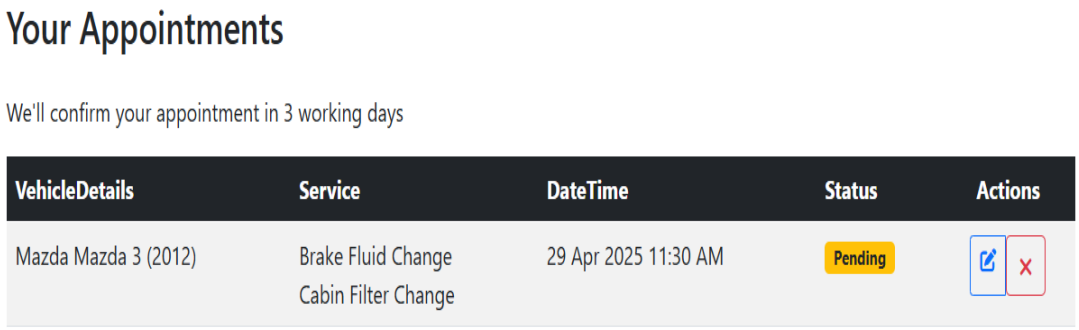


Figure 5.4.7 Appointment Review Page

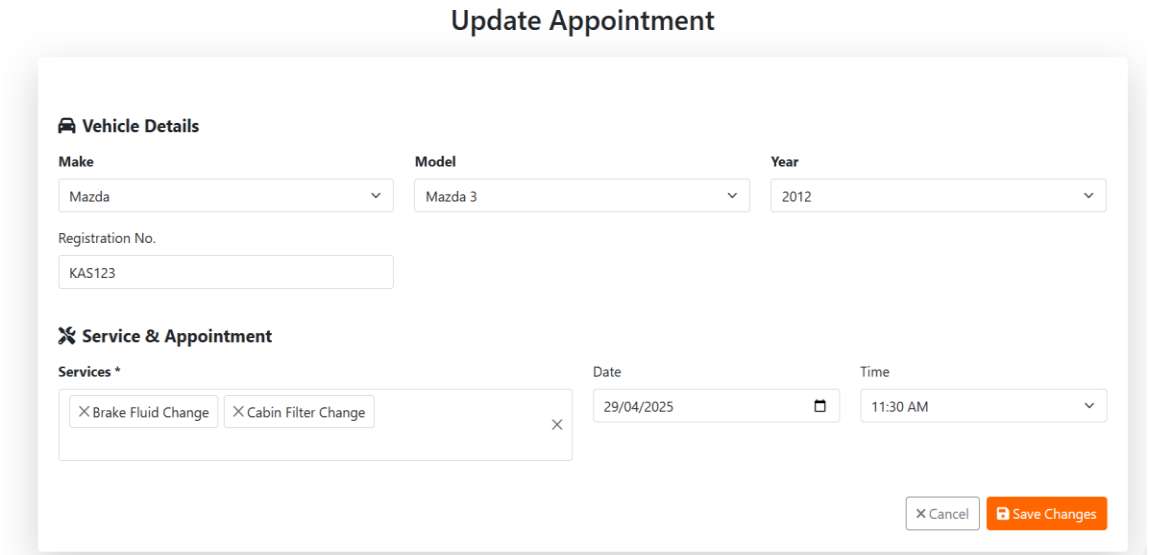


Figure 5.4.8 Update Appointment Page

When the user navigates to the Appointment Management Page, they can view all their previously made appointments in a tabular format. Each row in the table displays the essential details of an appointment, including the vehicle details (make, model, and year), selected service(s), appointment date and time, the current status of the appointment, and available actions. The system informs the user that appointments will be confirmed within three working days after booking. The status field initially displays "Pending" once the appointment is created and will be updated later by the administrator upon approval.

In the actions column, users are provided with two options — Edit and Cancel. When a user clicks on the edit button (represented by the pencil icon), the system will redirect them to the Update Appointment Page. Here, the user can modify the vehicle details, the list of selected services, and the appointment's date and time. All form fields are pre-populated with the current appointment information to ensure a smoother editing experience. Once the user updates the desired information, they can click the Save Changes button to submit the changes. The system will validate the input and save the updated appointment information into the database.

If the user clicks the cancel button (represented by the "X" icon), the system will prompt the user to confirm the cancellation before removing the appointment record. This ensures that accidental deletions are prevented.

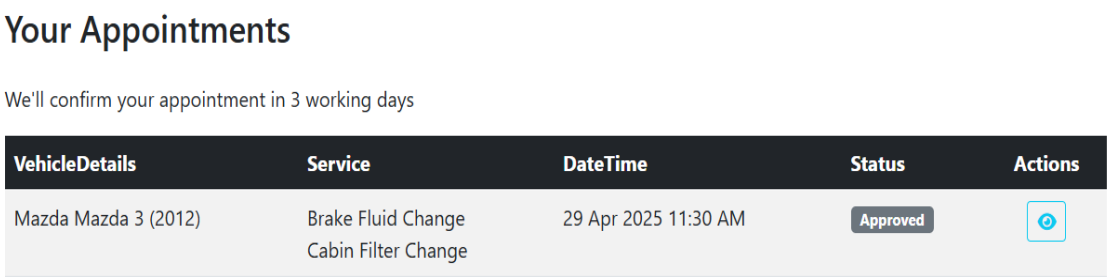


Figure 5.4.9 Approved Appointment Page

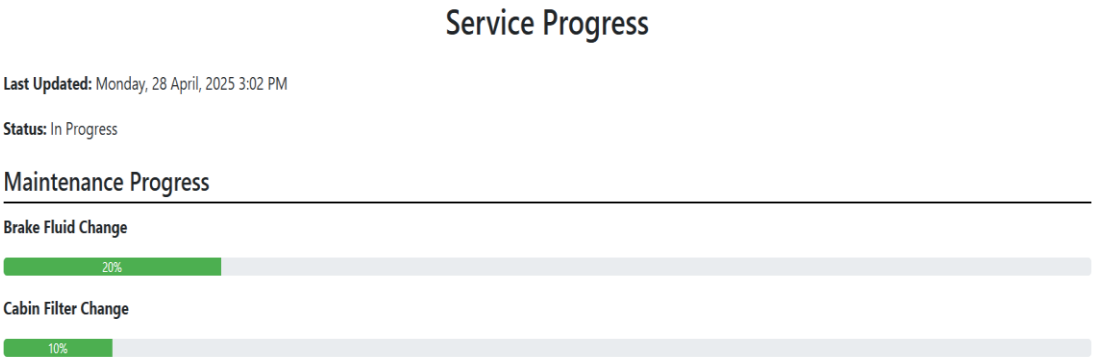
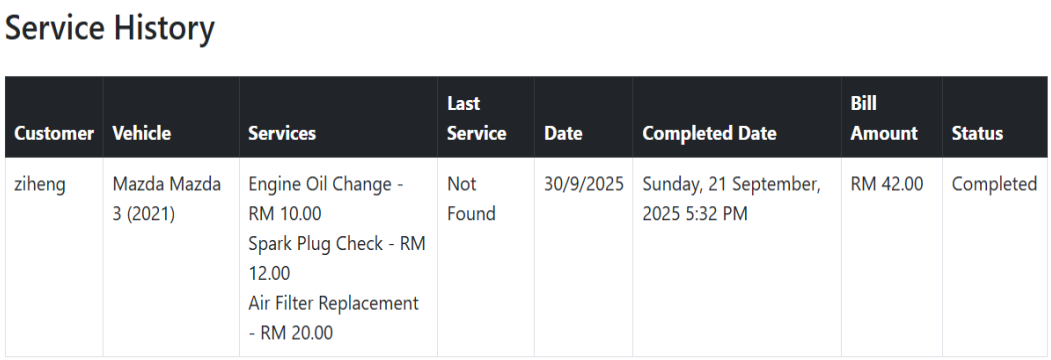


Figure 5.4.10 View Service Progress

When a user's appointment status is updated to Approved, it signifies that the service provider has reviewed and officially confirmed the booking details. In the appointment management page, the status badge will change to display “Approved,” and users will only be allowed to view their appointment details without the option to edit or cancel, ensuring the schedule remains stable and accurate. Upon clicking the view button represented by the eye icon, users are redirected to the Service Progress page. This page shows a detailed status update, including the Last Updated timestamp, which reflects the latest maintenance progress update. The appointment's overall status will be shown as In Progress, and a Maintenance Progress section lists each of the services booked, such as "Brake Fluid Change" and "Cabin Filter Change," each accompanied by an individual progress bar. The progress bars visually represent the completion percentage for each task, updating dynamically as the services are performed. This feature provides users with real-time visibility of their vehicle maintenance status, promoting transparency and eliminating the need for manual follow-up with the service provider. The progress tracking enhances the user experience by ensuring that users stay informed about the ongoing maintenance work until all services are fully completed.



Service History

Customer	Vehicle	Services	Last Service	Date	Completed Date	Bill Amount	Status
ziheng	Mazda Mazda 3 (2021)	Engine Oil Change - RM 10.00 Spark Plug Check - RM 12.00 Air Filter Replacement - RM 20.00	Not Found	30/9/2025	Sunday, 21 September, 2025 5:32 PM	RM 42.00	Completed

Figure 5.4.11 Service History Page

The Service History page lists a customer's past services only after appointment is fully completed. When an admin updates a booking's maintenance progress to 100%, the system automatically sets the appointment status to "Completed" and the record appears here. Each row shows the customer and vehicle, the services performed with their prices, the scheduled date and the actual completion timestamp, the computed bill amount, and the final status.

7. Services Page

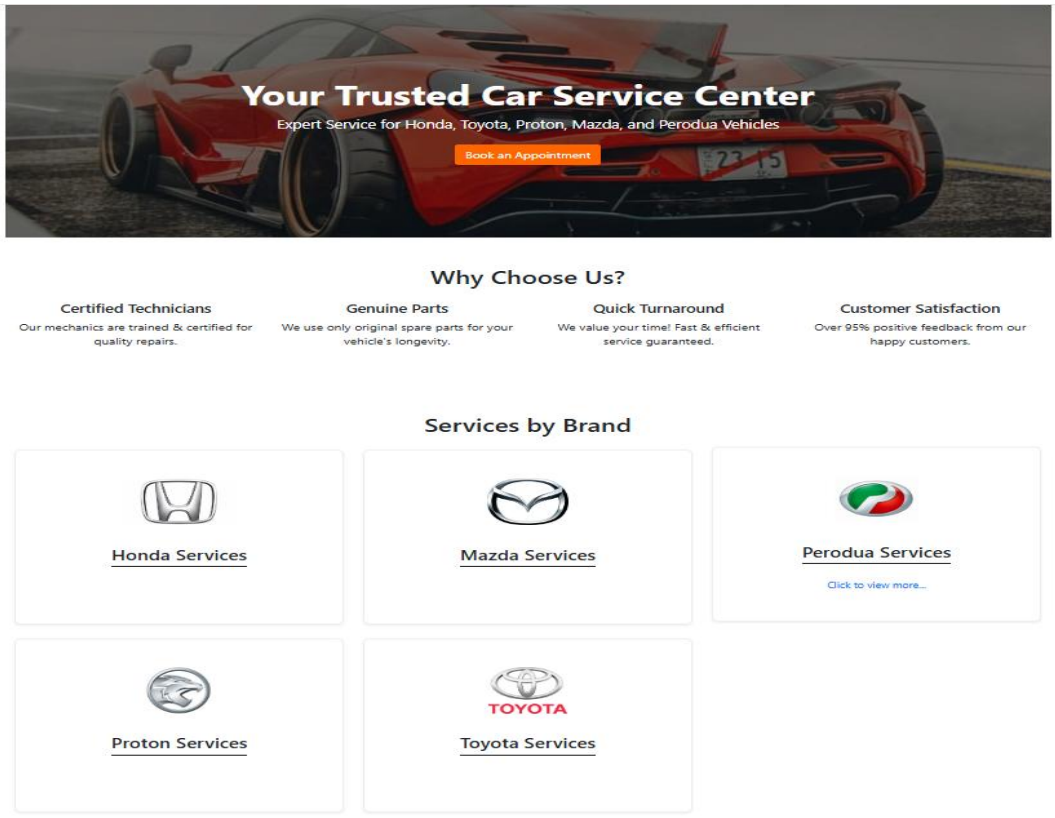


Figure 5.4.12 Service Page

The Service Page provides users with a clear and welcoming overview of the car service center. At the top of the page, a large banner image and a bold heading emphasize the center's branding as "Your Trusted Car Service Center," along with a short description highlighting expertise in handling Honda, Toyota, Proton, Mazda, and Perodua vehicles. A prominent "Book an Appointment" button invites users to easily schedule a service session. Below the banner, the Why Choose Us? section outlines four key advantages: Certified Technicians who are trained and certified for quality repairs, Genuine Parts ensuring only original components are used, Quick Turnaround guaranteeing fast and efficient service, and Customer Satisfaction with a high rate of positive feedback from previous clients. Further down, the page displays a Services by Brand section, where users can quickly select the brand of their vehicle. Each brand — Honda, Mazda, Perodua, Proton, and Toyota — is represented by its logo and a corresponding service link. This brand-based layout improves user navigation, helping vehicle owners easily find specialized services tailored to their car make. Overall, this page is designed for intuitive browsing, promoting user trust and making it effortless to access and book the necessary maintenance services.

8. Admin Dashboard Page

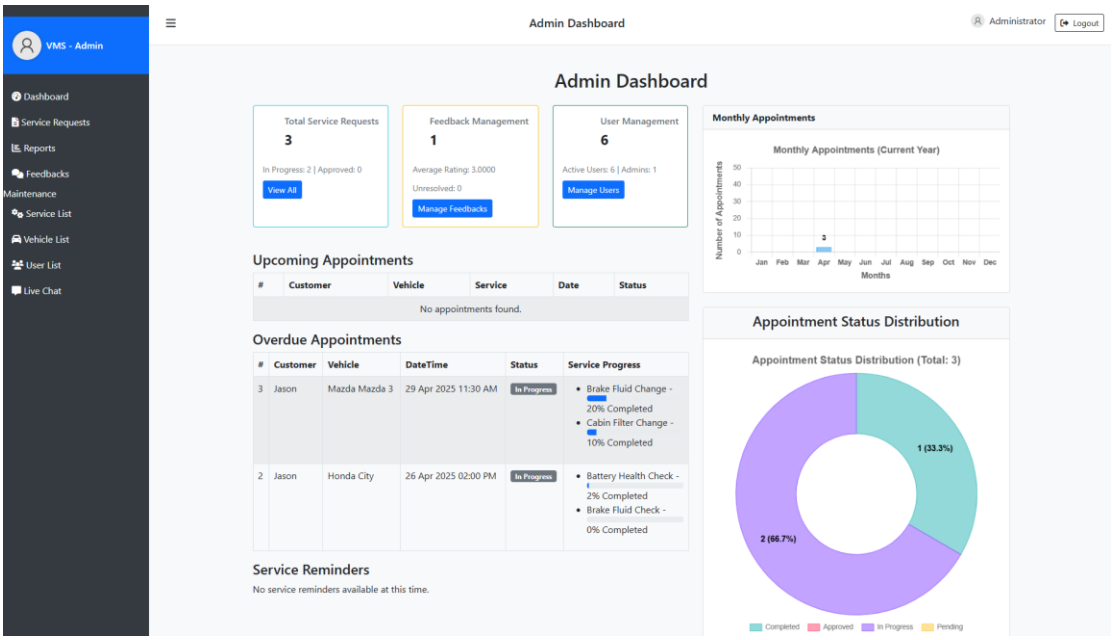


Figure 5.4.13 Admin Dashboard Page

The Admin Dashboard provides a centralized platform for administrators to manage and monitor system activities efficiently. At the top, three key summary cards are displayed, showing the Total Service Requests, Feedback Management, and User

Management modules. Each card provides critical information, such as the number of active service requests, the average feedback rating, and the number of registered users and admins. Quick action buttons allow the admin to instantly view detailed data or manage users and feedback. On the right side, two visual charts are presented: the Monthly Appointments bar chart shows the number of appointments made across each month in the current year, while the Appointment Status Distribution pie chart visually breaks down the total appointments by their status (e.g., Pending, In Progress, Completed). Below the summary, the Upcoming Appointments section lists future service bookings, and the Overdue Appointments section highlights appointments that have passed their scheduled time but are still in progress. In the overdue section, admins can also monitor each service task's completion percentage. Additionally, a Service Reminders area at the bottom reminds the admin about upcoming service deadlines based on the customer's vehicle and appointment schedule. This dashboard design ensures that the admin can quickly identify key metrics, monitor operational flow, and take necessary actions efficiently in a single view.

9. Manage Appointment Page

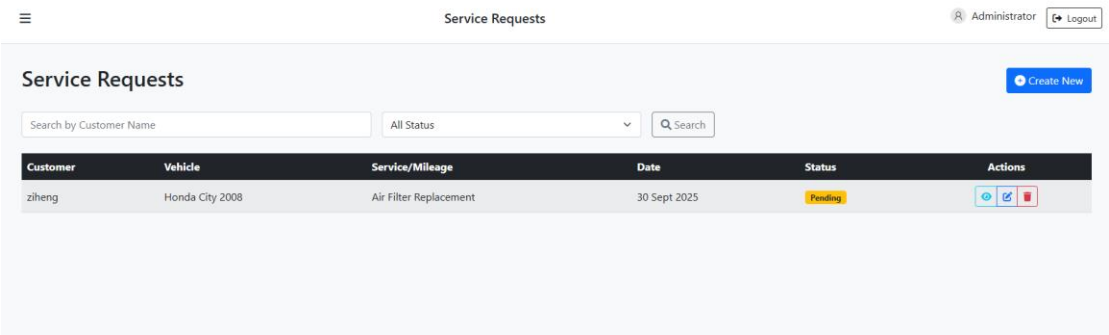


Figure 5.4.14 Manage Appointment Page

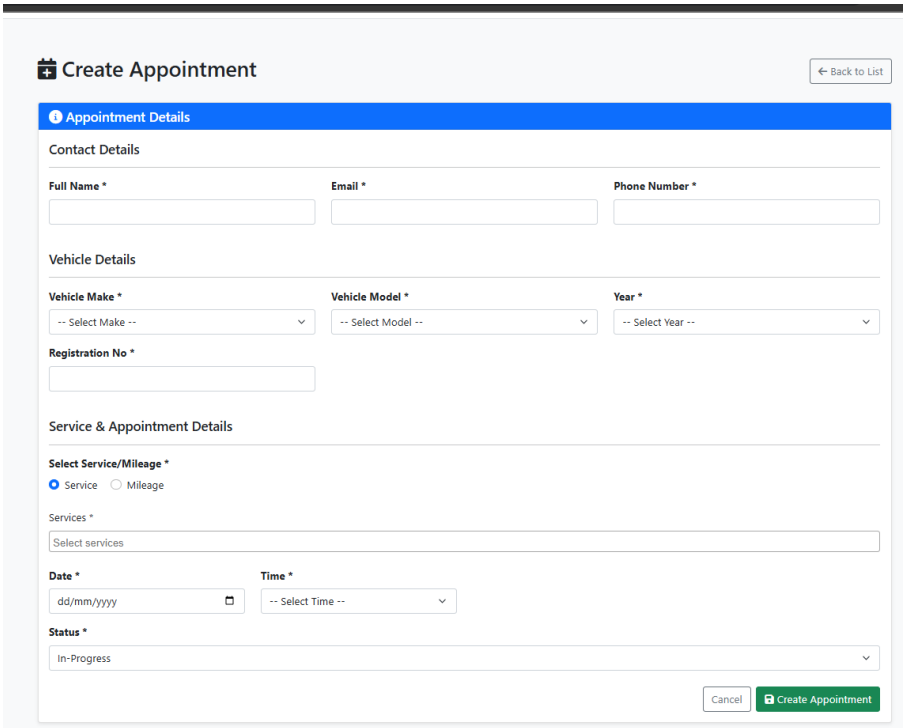


Figure 5.4.15 Create Appointment Page

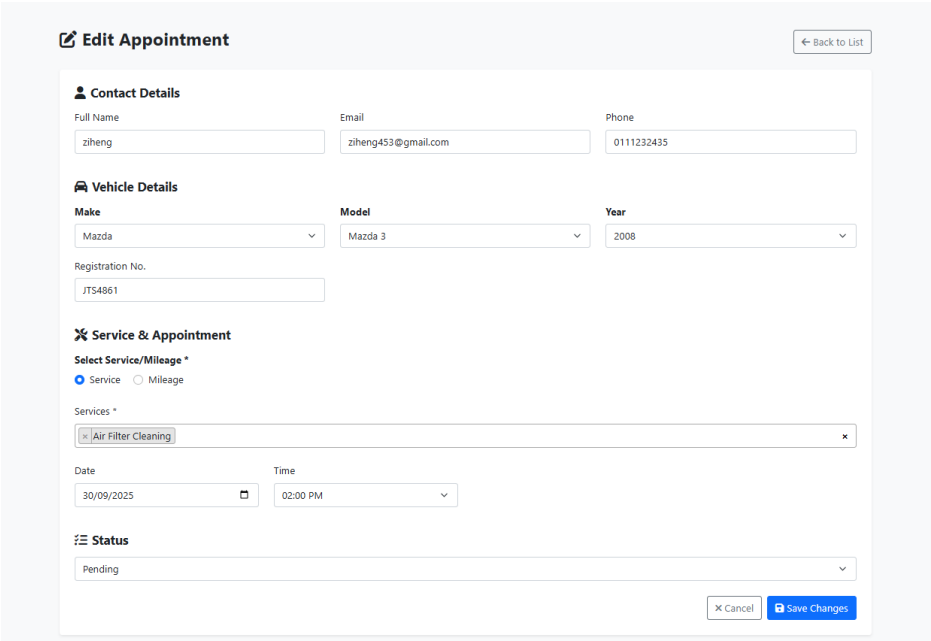


Figure 5.4.16 Edit Appointment Page

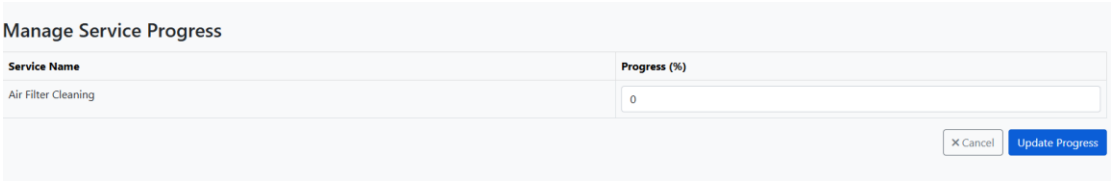


Figure 5.4.17 Manage Service Progress Page

There is a single administrative role responsible for managing customer bookings in the system. The landing page for this role is the Service Requests worklist. Figure 5.4.13 shows the main page, which lists all requests in a searchable and filterable table. For each record, the table displays the customer, vehicle, selected service/mileage, appointment date, and a status badge (e.g., Pending, Approved, Completed), together with an Actions column for quick operations. Administrators may search by customer name, filter by status, view request details, edit or delete a record, and create a new booking for walk-in or phone orders via the Create New button.

When Create New is selected, the system opens the Create Appointment form as shown in Figure 5.4.14. The form collects contact details (name, email, phone), vehicle details (make, model, year, registration number), and service & appointment details (service/mileage selection, services, date and time). Required fields are validated before submission to ensure the record is complete and consistent. If an existing booking needs to be changed, the Edit Appointment page in Figure 5.4.15 is used; previously saved information is auto-filled so that the admin can adjust the chosen services, schedule, or status (e.g., move from Pending to Approved) and then save the updates.

Operational updates are recorded through Manage Service Progress, as illustrated in Figure 5.4.16. Here the admin enters the percentage of work completed for each service line. The system persists progress changes and, once the value reaches 100%, automatically sets the appointment status to Completed. Only completed bookings are published to the customer's Service History page, ensuring that the history contains finished work only while the Service Requests worklist remains the live queue for jobs in progress.

10 Service History Report

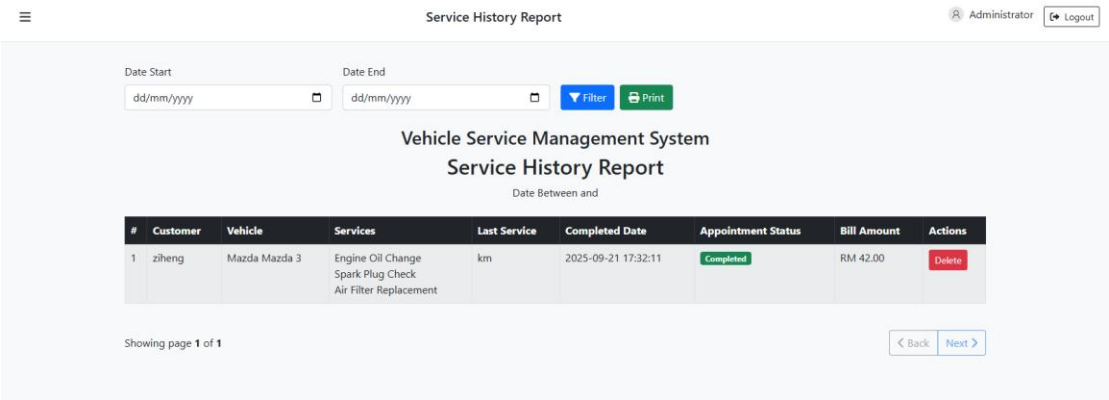


Figure 5.4.18 Service History Report Page

This service history report page is for admin to generates a printable summary of completed appointments within a selected date range. At the top, the admin chooses Date Start and Date End, then clicks Filter to refresh the results or print to produce a hard copy/PDF. The report header ("Vehicle Service Management System – Service History Report") is rendered for printing, followed by a table showing, for each record, the Customer, Vehicle, Services performed, Last Service info, Completed Date timestamp, Appointment Status (badge), and the Bill Amount calculated for that visit. An Actions column allows removal of an erroneous entry (Delete). Pagination controls appear at the bottom when multiple pages of results exist. Only bookings whose status is Completed are included in this report.

11. Live Chat Page

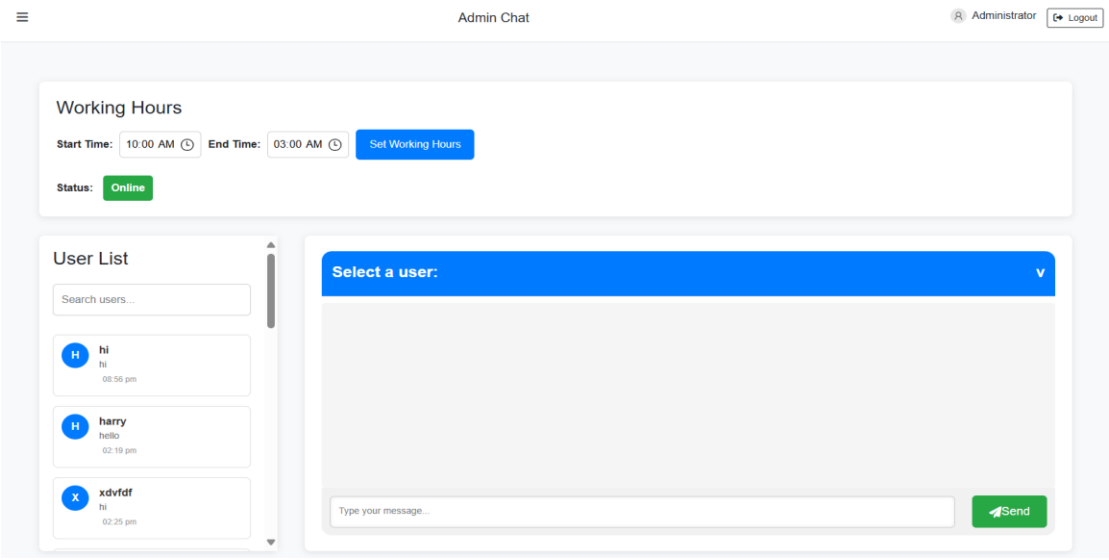


Figure 5.4.19 Live Chat Page

Figure 5.4.16 shows the Admin Chat page that can be accessed from the administrator menu. The top panel allows the admin to configure Working Hours by setting the Start Time and End Time and then clicking Set Working Hours. Based on these values, the system displays the current Status (e.g., *Online*), which informs users when live support is available.

Below, the page is divided into two sections. The User List panel on the left provides a searchable list of users who have initiated a conversation; each item shows the user's name, the latest message snippet and its timestamp. The Conversation panel on the right is used to conduct the chat. The admin selects a user from the list, composes a reply in the message box and clicks Send to deliver the message. Messages are appended to the thread in real time, enabling the administrator to manage multiple user enquiries efficiently while maintaining a record of each dialogue.

12. Predictive Maintenance Dashboard Page

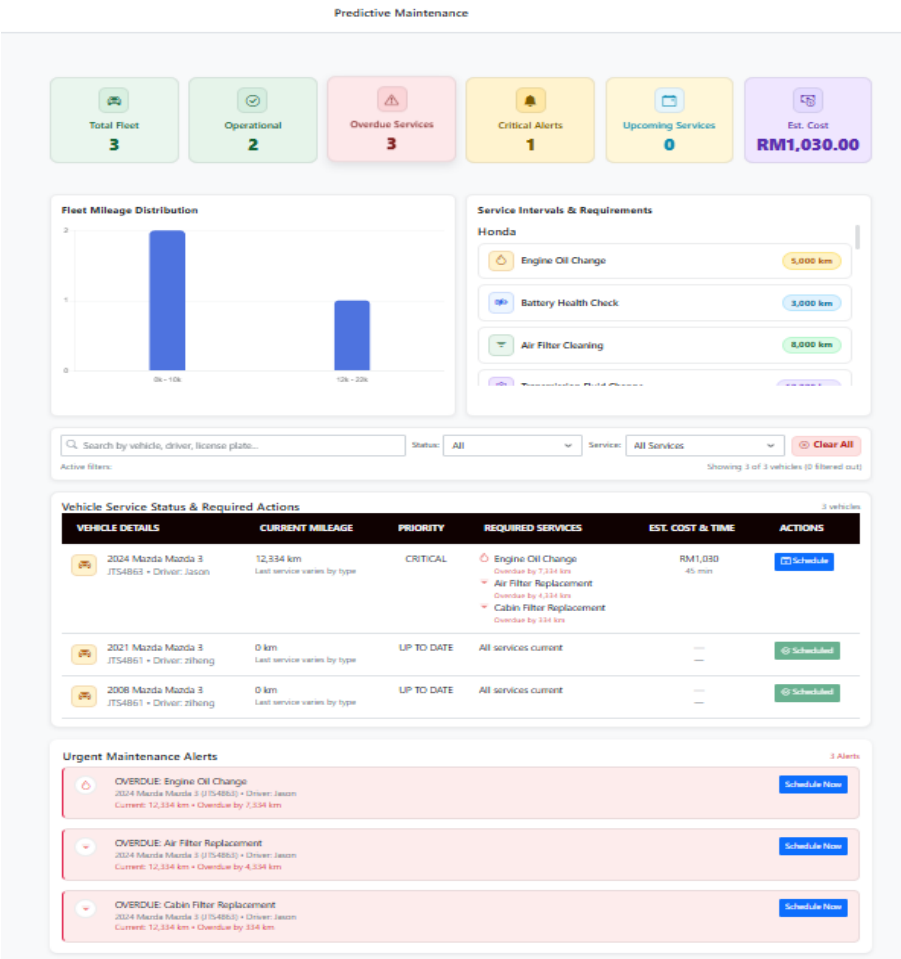


Figure 5.4.20 Predictive Maintenance Dashboard Page

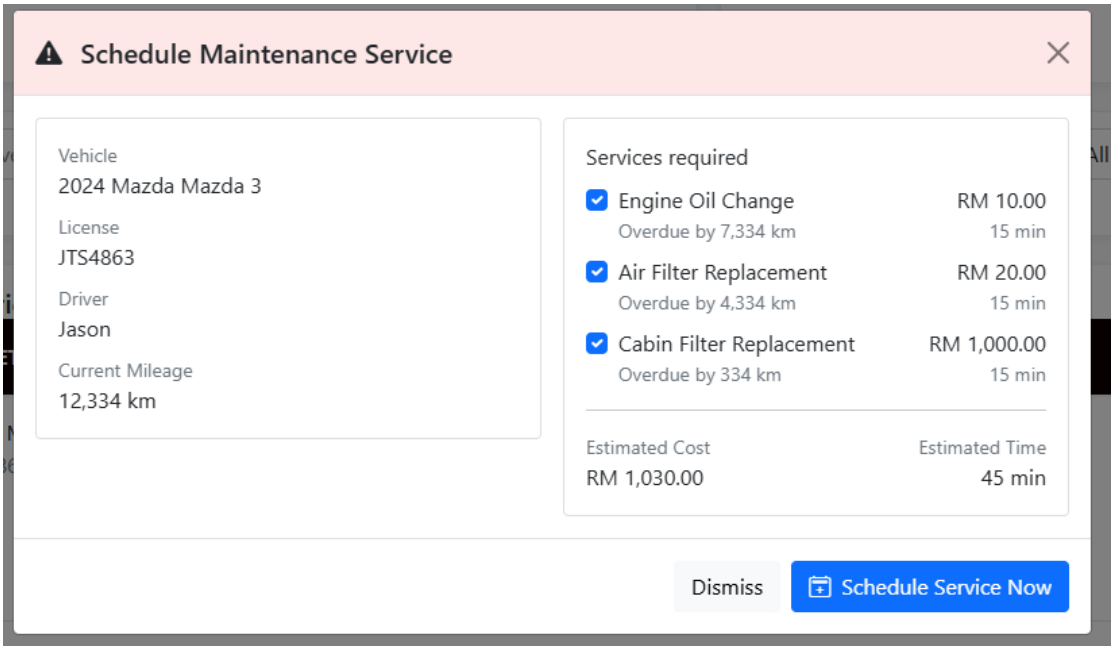


Figure 5.4.21 Schedule Maintenance Modal

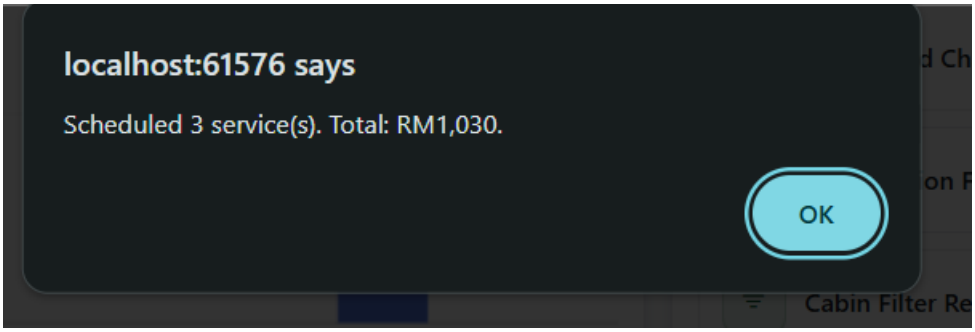


Figure 5.4.22 Success Message

Figure 5.4.17 shows the Predictive Maintenance Dashboard that can be accessed from the administrator menu. The page provides an overview of fleet health with summary cards at the top indicating the number of operational vehicles, overdue items, critical alerts, upcoming services and an estimated cost. Below the summary, a mileage chart and a list of service intervals help the administrator understand usage patterns and recommended maintenance. A searchable and filterable table lists each vehicle together with its current mileage, priority (e.g., CRITICAL, DUE SOON, UP TO DATE), the services required, and an estimate of cost and time. From this table, the administrator can proceed to schedule the suggested work by clicking the Schedule button.

Figure 5.4.18 presents the Schedule Maintenance modal that appears after the administrator selects Schedule for a vehicle. The modal confirms the vehicle details and

displays the set of services that are due. Each service can be selected or deselected, and the system calculates the total estimated cost and time at the bottom of the modal. After reviewing the items, the administrator clicks Schedule Service Now to create the booking.

Figure 5.4.19 shows the success message that is prompted once the booking has been made. The message confirms the number of services scheduled and the total cost. The scheduled job is then added to the service queue and will be tracked through the normal workflow until completion.

13. Service List Page

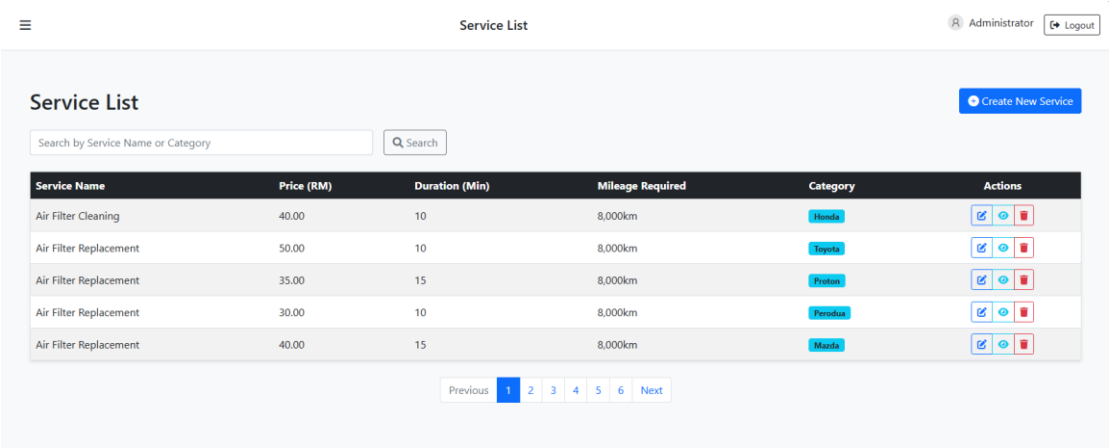


Figure 5.4.23 Predictive Maintenance Dashboard Page

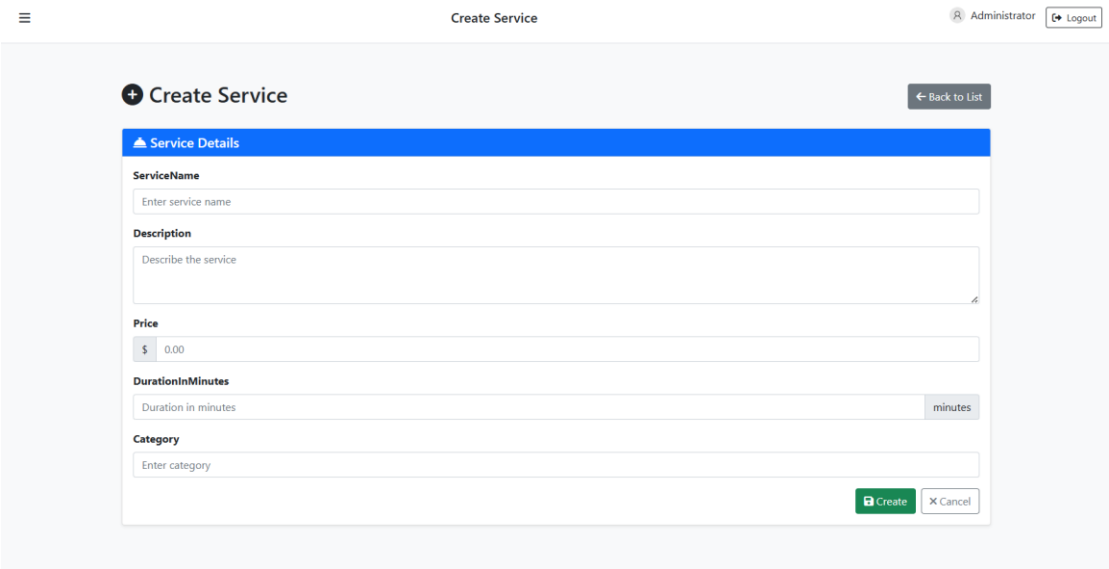


Figure 5.4.24 Create Service Page

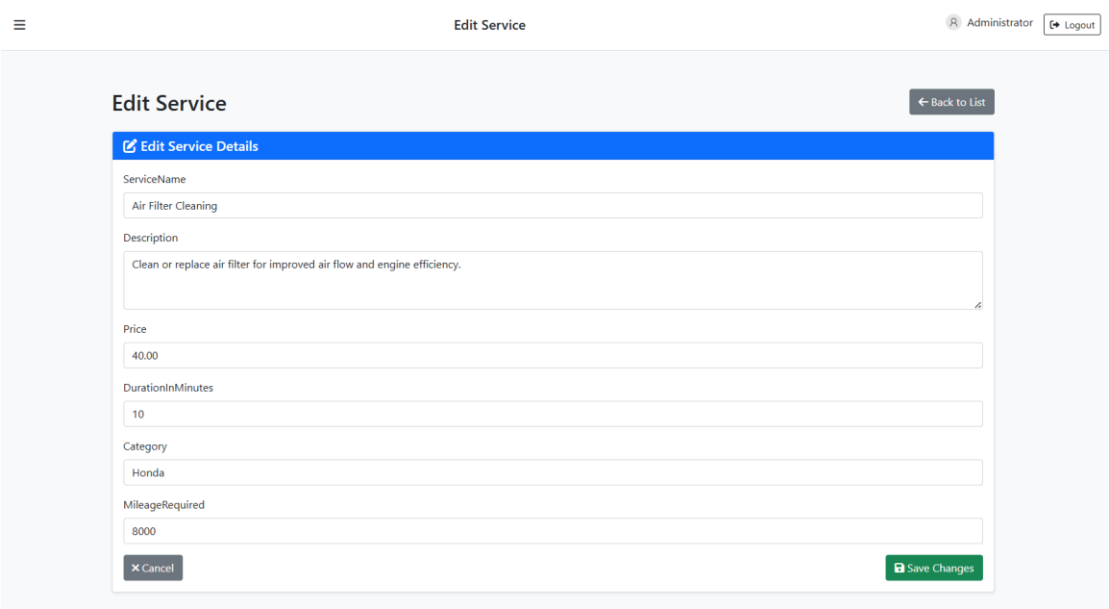


Figure 5.4.25 Edit Service Page

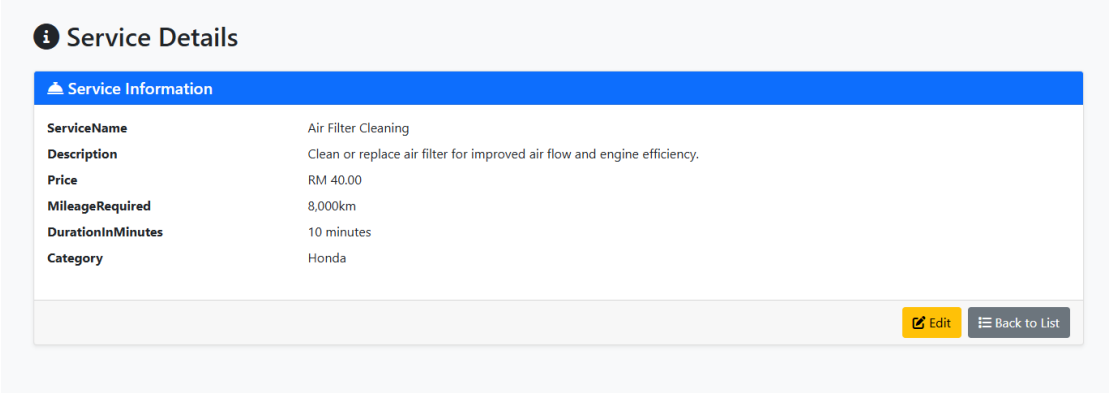


Figure 5.4.26 View Service Page

Figure 5.4.20 shows the Service List page, where the administrator manages the catalogue of maintenance services. A paginated table lists each service together with its price, duration, mileage required, and category, while the search box lets the admin quickly filter by name or category. From here, the admin may open an existing record to view or edit, remove an entry, or click Create New Service to add a new item. When Create New Service is selected, the form in Figure 5.4.21 appears. The administrator enters the service name, description, price, duration, and category; upon clicking Create, the new service is validated, saved, and returned to the list. If an existing service needs changes, the Edit Service screen in Figure 5.4.22 is used; previously saved values are prefilled so the admin can adjust the description, pricing, duration, category, or mileage interval, then Save Changes to update the record. Selecting a service in read-only mode opens Figure 5.4.23, the Service Details view, which summarises the key

attributes and provides shortcuts to Edit or go Back to List. Together, these pages form a continuous workflow for browsing, creating, updating, and reviewing the service catalogue that powers appointments and pricing. Admin also can delete the record by clicking the delete button then te system will display a confirmation form to prompt admin to click “OK” to confirm to delete the information, otherwise it will return to service list page.

14. Vehicle List Page

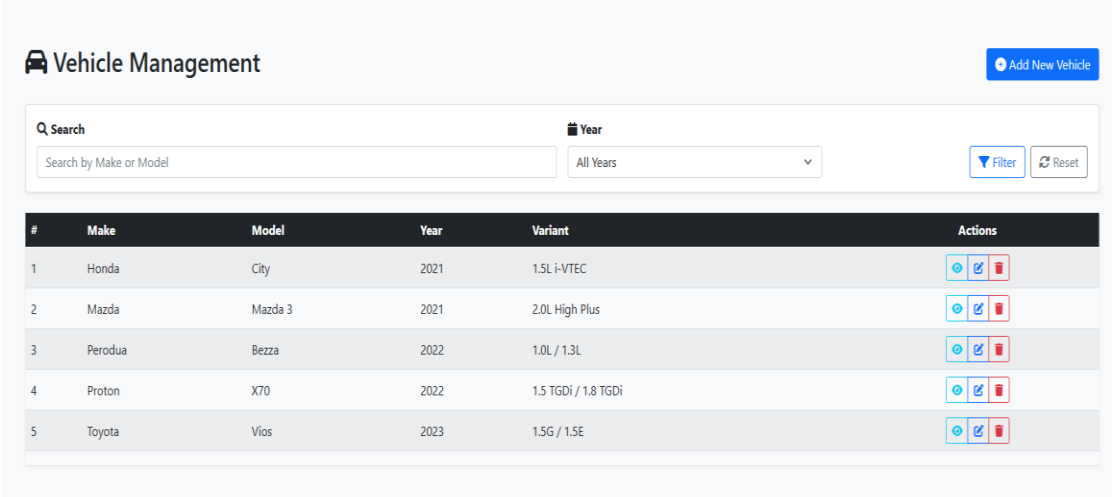


Figure 5.4.27 Vehicle List Page

This vehicle list page is the master catalogue for all vehicle definitions used by the system. At the top, an inline Make/Model search and a Year selector let the administrator quickly narrow the list; the Filter button applies the criteria while Reset restores the full view. The table below presents each record with its Make, Model, Year, and Variant so that similar models can be compared at a glance. A right-aligned Actions column provides one-click controls to view, edit, or remove a vehicle, and the Add New Vehicle button in the header starts a new entry. The layout, control labels, and behaviour are intentionally consistent with the Service List page so that admins do not have to relearn a different pattern.

When Add New Vehicle is selected, the system opens a create form where the administrator enters the vehicle’s make, model, year, and variant (and any other fields configured for the workshop). Required fields are validated before saving. After a successful create, the new vehicle is added to the catalogue and immediately becomes available everywhere it is referenced—such as appointment booking, service-price mapping, and the predictive maintenance dashboard.

Selecting View in the Actions column opens a read-only summary of the chosen record. This is useful for quick confirmation without the risk of accidental edits. From the summary page, the admin can return to the list or proceed to Edit.

Choosing Edit loads the same fields pre-filled. The admin can correct a model name, update the variant, or adjust the year and then Save Changes to persist the update. The list reflects the changes instantly so downstream modules (e.g., service pricing by make/model) remains in sync.

The admin can also click on the delete button on specific record. Once the button is clicked then will display a confirmation form of deletion record and prompt admin to click “OK” to confirm delete the information.

15. Manage User List Page

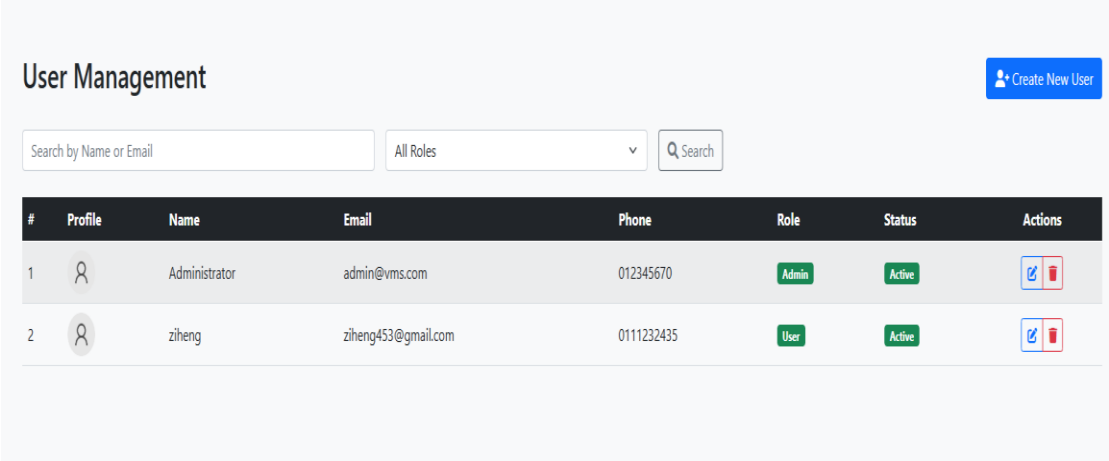


Figure 5.4.28 Manage User List Page

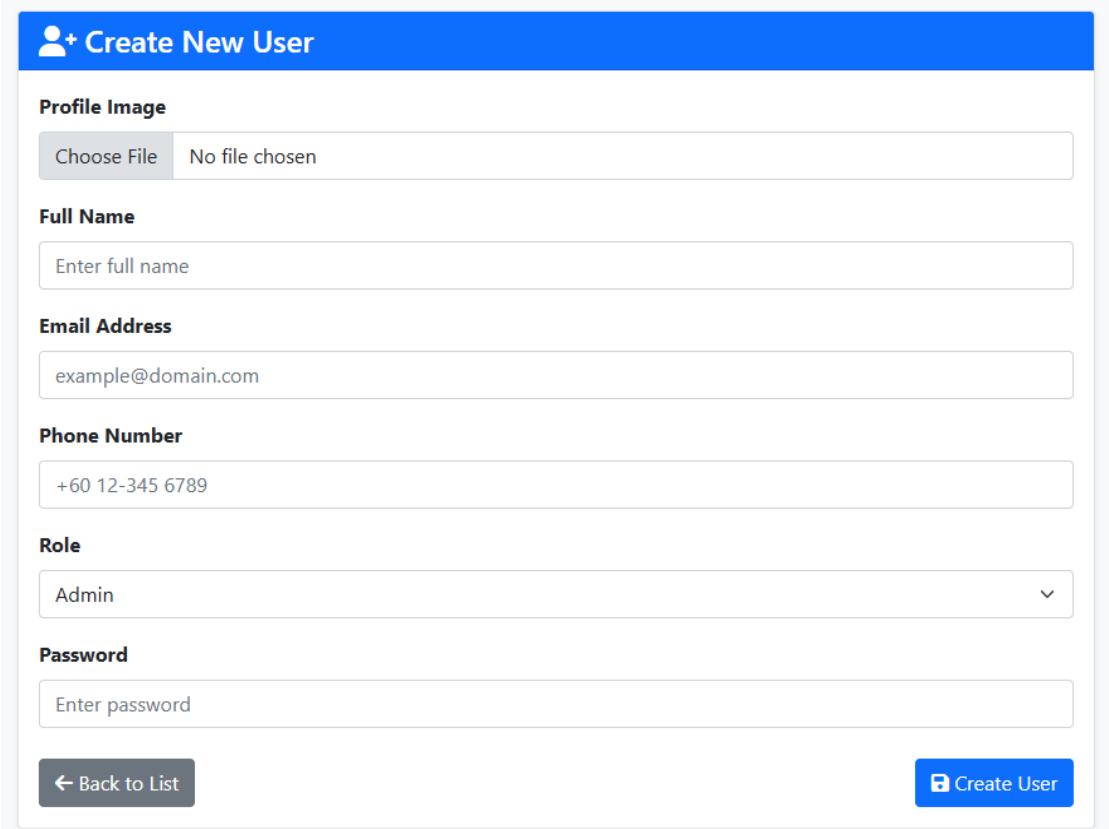


Figure 5.4.29 Create New User Page

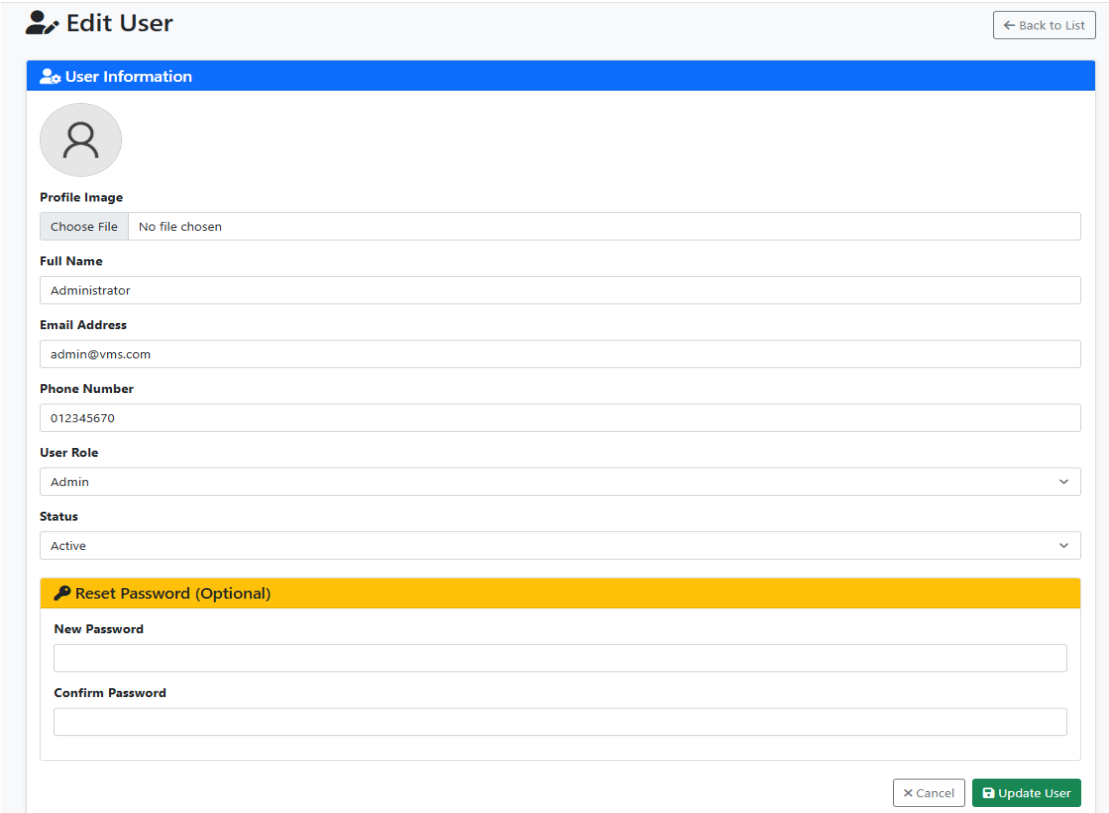


Figure 5.4.30 Edit User Page

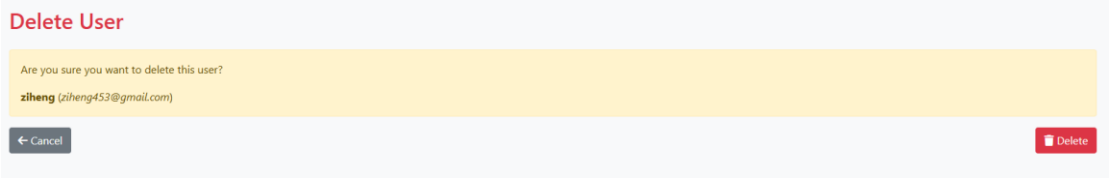


Figure 5.4.31 Delete User Page

Figure 5.4.27 shows the User Management page, which is the starting point for account administration. A searchable and filterable table lists each user together with profile, name, email, phone, role, status, and quick actions. From this page the admin can add a new account, review details, update information, or remove an account that is no longer needed.

When a new user must be registered, the admin selects Create New User and is directed to the form in Figure 5.4.25. The admin enters the full name, email, phone number, role, and an initial password, with an optional profile image. Required fields are validated to prevent mistakes. After choosing Create User, the account is saved and the system returns to the list where the new user appears immediately with the assigned role and status.

If information changes later, the admin opens the Edit User page shown in Figure 5.4.26 All fields are prefilled for convenience so the admin can update the name, email, phone, user role, or account status. A separate section allows a password reset without recreating the account. Clicking Update User saves the changes and refreshes the list so the directory always reflects the latest details.

When an account must be removed, selecting Delete opens the confirmation shown in Figure 5.4.27. The system clearly displays the user's name and email to avoid accidental removal. If the Admin confirms, the account is deleted, and the user loses access immediately. Otherwise, the Admin cancels and returns to the list.

16. Manage Service Price Page

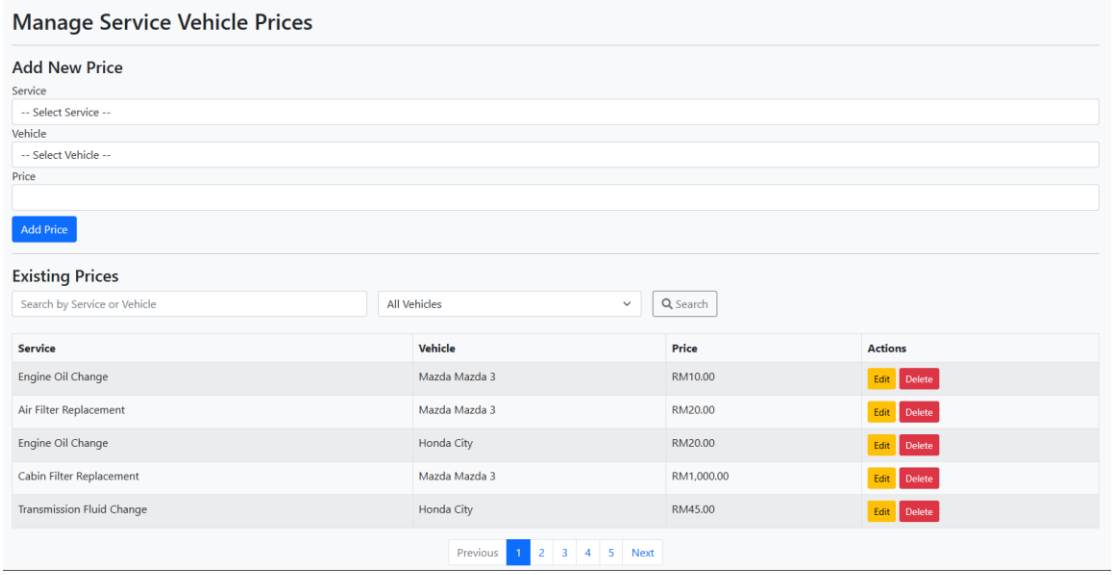


Figure 5.4.32 Manage Service Price Page

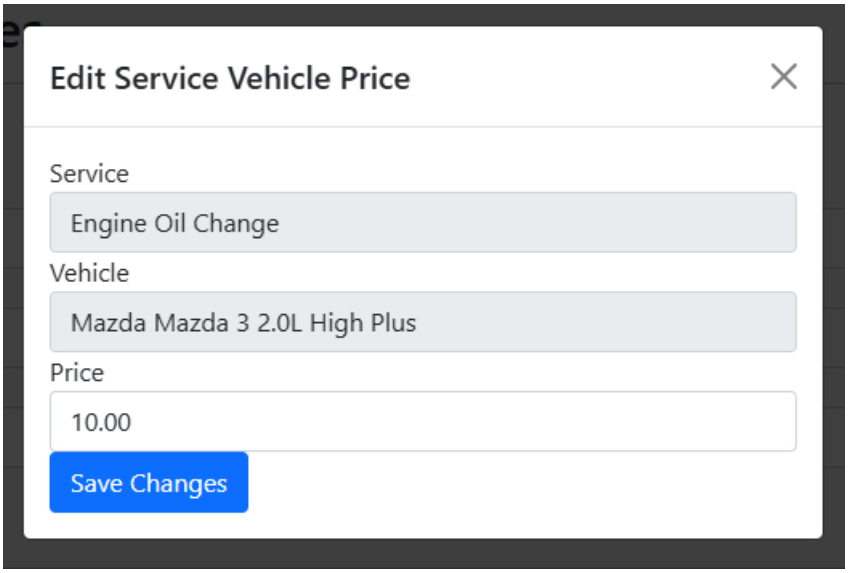


Figure 5.4.33 Edit Service Price Page

Figure 5.4.28 shows the page used by the administrator to maintain the price of each service for a specific vehicle make, model and variant. At the top is a short Add New Price form where the admin selects a Service, selects a Vehicle, and enters the Price, then clicks Add Price to create the mapping. The lower section lists all existing mappings in a searchable and filterable table, with pagination for long lists. This makes

it easy to locate a particular service or restrict the view to one vehicle family before making changes.

For updates, the Edit action opens the modal in Figure 5.4.29. The service and vehicle are shown for context while the Price field is editable. After Save Changes, the table refreshes with the new amount. If a mapping is no longer valid, the Delete action removes it after confirmation so that outdated prices do not appear in bookings. Maintaining these mappings keeps the whole system consistent: appointment bills, the predictive dashboard's estimated costs, and service scheduling all use these service-by-vehicle prices to compute totals accurately.

5.5 Implementation Issue and Challenges

During the development of the Vehicle Maintenance and Tracking System (VMTS), several challenges made the implementation difficult. One of the main issues was managing database updates, especially when modifying or deleting records like appointments and vehicle details. These changes caused errors because the database relationships were not properly set up. This was resolved by fixing the relationships and ensuring that updates were handled correctly to maintain data consistency. Another challenge was related to the Razor code used to display dynamic content. Sometimes, the system failed to render data correctly due to incorrect model bindings, which caused errors. This issue was fixed by reviewing and correcting the Razor code to ensure that the dynamic content was displayed properly. Additionally, there were problems with sending confirmation emails due to incorrect SMTP settings. This caused delays in communication with users. The issue was resolved by adjusting the SMTP settings and adding error handling to ensure emails were sent correctly. These challenges were mainly about managing the database, fixing code errors, and ensuring email functionality worked smoothly.

CHAPTER 6: SYSTEM EVALUATION AND DISCUSSION

System Evaluation and Discussion focuses on the reflection of the project's functionalities, performance, efficiency and overall effectiveness. The chapter included the functional testing with its results that used to verify the expected outcome. Challenges that have been encountered throughout the development phase has been discussed. It also presents a critical analysis on how well the system meets the objectives of the project.

6.1 Testing Setup and Test Result

6.1.1 User Site

No	Test Action	Test Result	Status
1	Register with valid full name, email, phone number, and password	User is successfully registered, and system redirects to the login page with a success message.	PASS
2	Register with duplicate email (already registered)	Registration fails, and an error message is displayed: "Email already registered."	PASS
3	Log in with valid email and correct password	User is successfully logged in, and redirected to the User Main Page.	PASS
4	Log in with invalid email or incorrect password	Login fails, and an error message "Invalid credentials" is displayed.	PASS
5	Log out by clicking the Logout button	User is logged out and redirected to the Login Page.	PASS
6	Reset password with a valid email address (password reset link sent)	System sends a password reset link to the email and displays a success message.	PASS

7	Reset password with an invalid email (email not registered)	Error message displayed: "Email address not registered."	PASS
8	Make appointment by selecting service type, vehicle model, date, and time slot	Appointment successfully created, confirmation displayed with appointment details.	PASS
9	Attempt to make an appointment with missing vehicle details or incorrect date/time	System displays an error message: "Vehicle selection is required" or "Invalid date selected."	PASS
10	View appointment details, update appointment (change time or service type)	Appointment details updated successfully, and changes are reflected on the Appointment Review page.	PASS
11	Cancel appointment before approval (click on the Cancel button)	Appointment status updated to "Canceled", and user receives a confirmation message.	PASS
12	Track service progress for an approved appointment (view real-time updates of each service)	Service progress bar is dynamically updated with completion percentage for each task (e.g., brake fluid change).	PASS
13	Submit feedback after service completion (select rating 1-5 stars and provide comments)	Feedback is successfully submitted and stored in the database with appointment history updated.	PASS
14	View service history (view all completed appointments with vehicle and service details)	Past services are displayed with detailed information (e.g., service type, date, vehicle make/model).	PASS
15	Start live chat with admin (open chat window, send message)	Admin receives the query and replies in real-time, chat history is updated immediately.	PASS

16	Update user profile by modifying email, phone number, and password (validate email format)	User profile updated successfully, new details are saved in the system.	PASS
17	Submit feedback without selecting a rating (empty feedback field)	Error message displayed: "Please select a rating before submitting feedback."	PASS
18	Book an appointment with fully booked timeslot (select unavailable timeslot)	System displays error: "Selected timeslot is unavailable. Please choose another slot."	PASS

Table 6.1.1 Test Case for User

6.1.2 Admin Site

No	Test Action	Test Result	Status
1	Log in with admin credentials (valid email and password)	Admin successfully logs in and is redirected to the Admin Dashboard.	PASS
2	Log in with invalid admin credentials (incorrect email or password)	Login fails, and an error message "Invalid credentials" is displayed.	PASS
3	Create new appointment (admin inputs user vehicle, service type, date, time)	Appointment successfully created in the system and added to the appointment list.	PASS
4	Update appointment status (approve or reject appointment)	Appointment status is successfully updated to "Approved" or "Rejected".	PASS
5	Update appointment details (admin edits service type, date, time)	Appointment details updated, and changes are reflected in the appointment list.	PASS
6	Delete appointment (remove an appointment from the system)	Appointment is successfully deleted, and the system confirms the deletion.	PASS
7	Manage service progress (update progress percentage for each service task)	Service progress is updated in the system, and the percentage of completion is shown.	PASS

8	Create new service (admin enters service name, description, price, duration)	New service successfully added to the service catalog, and details are saved.	PASS
9	Edit existing service (change service name, description, price)	Service details updated successfully in the service catalog.	PASS
10	Delete service (remove service from the system)	Service is removed from the system, and confirmation message displayed.	PASS
11	Add new vehicle (admin inputs make, model, year, vehicle registration)	Vehicle added successfully to the vehicle list and saved in the database.	PASS
12	Edit vehicle details (admin changes make, model, year)	Vehicle details updated successfully, and changes reflected in the system.	PASS
13	Delete vehicle (remove a vehicle from the system)	Vehicle is removed from the database, and the system confirms deletion.	PASS
14	View real-time admin dashboard (overview of appointments, service progress, feedback)	Dashboard shows active service requests, progress, feedback summary, and appointment status.	PASS
15	View feedback (view all user feedback, option to delete inappropriate feedback)	Admin views all feedback and deletes selected inappropriate feedback.	PASS
16	Manage user accounts (create, update, or delete users)	Admin creates, updates, or deletes user accounts successfully, and changes are reflected in the system.	PASS
17	Add service price (admin adds price for service type and vehicle model)	Service price is successfully added for a vehicle and service type combination.	PASS
18	Edit service price (admin updates price for a service type)	Service price is updated successfully, and system reflects the new price.	PASS
19	Delete service price (remove service pricing for a vehicle model)	Service price is removed from the system, and the price is no longer displayed.	PASS
20	View predictive maintenance dashboard (admin views alerts,	Admin views real-time maintenance needs, including	PASS

	upcoming services, and vehicle health data)	alerts and upcoming services based on predictive data.	
21	Generate service history report (filter by date range)	Report is generated showing completed services within the selected period, including details like service type and cost.	PASS
22	Delete service history report (remove generated report)	Report is successfully deleted from the system, and confirmation message displayed.	PASS

Table 6.1.2 Test Case for Admin

6.2 Project Challenges

Throughout the process of delivering the Vehicle Maintenance and Service Tracking System (VMTS), several challenges were encountered. One of the main issues arose with User Authentication and Session Management. The system needed to manage user sessions effectively, particularly when users logged in from multiple devices. This led to challenges related to session timeout, multi-device login prevention, and session consistency across devices. Ensuring secure handling of user credentials was another significant concern, especially when implementing password resets for users who had forgotten their passwords. These issues required careful attention to ensure a seamless and secure experience for all users.

Another major challenge was the development of the Predictive Maintenance Feature. This feature, which calculates when a vehicle is due for maintenance based on mileage and previous service history, faced challenges in terms of data accuracy and predictive algorithm optimization. The system initially struggled with inconsistent mileage tracking, where inaccurate or incomplete data entered by users led to incorrect predictions. This problem required adjustments to ensure that the predictive maintenance logic provided reliable service alerts and minimized the chances of overdue maintenance.

The scalability and database performance of the system also posed significant challenges. As the system was designed to handle an increasing number of users, services, and appointments, database performance became a concern during testing. The system exhibited slow performance when large amounts of data were queried,

particularly when retrieving service history or generating reports. This performance issue threatened to impact the overall user experience, especially as the user base grew.

Finally, real-time communication via live chat presented another challenge. The live chat feature, designed to allow users to interact with administrators in real time, faced issues related to the chat notification system. At times, admins were unaware of incoming messages, leading to delayed responses and poor user experience. The system needed to ensure that messages were delivered instantly, and that admins were notified in real-time of new queries to ensure smooth communication between users and administrators.

6.3 Objectives Evaluation

1. To Enable Real-time Tracking and Updates of Appointments

One of the primary objectives of the system was to allow users to track the status of their service appointments in real time. This objective was successfully achieved. The system provides real-time updates on appointment status, including approval, service start time, progress percentages, and completion status. Both vehicle owners and admins are notified promptly of any status changes, ensuring transparency and improving user satisfaction. The real-time tracking feature was critical in ensuring that users were kept informed throughout the service process.

2. To Offer an Online Chat Feature for Users to Receive Instant Replies or Feedback

The system was designed to provide live chat functionality, allowing users to communicate directly with administrators. This objective was fully realized, as the live chat feature was integrated into the system and allowed both users and admins to engage in real-time conversations. The SignalR technology used for real-time communication ensured that messages were delivered instantly, and users received immediate responses to their queries. The feature contributed to a significant improvement in communication, making it easier for users to get assistance and for admins to manage queries efficiently.

3. To Maintain and Provide Access to Service History Data for Both Users and Administrators

The system aimed to provide a comprehensive service history database, allowing both users and admins to access past service records for reference. This objective was successfully achieved. The system maintains a detailed record of each vehicle's service history, including service type, service date, and completion status. Users can easily review their past services, while admins can monitor service quality and manage service records effectively. The ability to access this service history has proven to be an invaluable feature, contributing to better service management and user convenience.

4. To Provide Real-time Access to Vehicle Service Status and Schedule the Required Service

The fourth objective was to provide real-time access to vehicle service status and schedule necessary services based on predictive maintenance. This objective was met with the introduction of the Predictive Maintenance Dashboard, which allows admins to view and monitor the current status of vehicle services, including upcoming service requirements based on the vehicle's mileage. The system automatically calculates when a vehicle is due for maintenance, helping to prevent missed services and ensure timely repairs. This functionality greatly enhanced the system's operational efficiency and provided admins with real-time data to make informed decisions.

CHAPTER 7: CONCLUSION AND RECOMMENDATION

This chapter summarizes the overall results of the project from the planning phase to the testing phase. It discussed the functionalities, performance, challenges and effectiveness of the implemented system. It also included a few recommendations that can be applied to enhance the system's performance and sustainability in the future.

7.1 Conclusion

In conclusion, the development and implementation of the Vehicle Maintenance and Service Tracking System (VMTS) have successfully met the expected goals of improving the vehicle service management process. Not only has the core functionality been delivered, but several additional features have been integrated to enhance the user experience and overall system performance.

The primary objective of this project was to develop a web-based system that enables vehicle owners to easily schedule service appointments, track service progress in real time, and receive timely notifications. Additionally, the system aimed to integrate live chat support for real-time communication and to provide admins with a centralized dashboard to monitor and manage service requests effectively. The system also aimed to automate service reminders and offer predictive maintenance features based on vehicle usage data.

By the end of the project, multiple functionalities were successfully implemented to ensure the system's efficiency and performance. Users can now book appointments easily, with their current vehicle location automatically set for service pick-up (if location permission is enabled). Real-time updates ensure that users can track service progress dynamically as their appointment progresses. The system also sends automated reminders to users the day before a scheduled service, ensuring they are notified about upcoming appointments. After a service is completed, users are encouraged to provide feedback on their experience, which is then stored in the system for future reference. Additionally, live chat support provides instant responses to user queries, improving overall customer service.

For administrators, the admin dashboard offers real-time statistics monitoring, enabling data-driven decision-making for efficient service management. Administrators can

access appointment details, view user feedback, and manage appointments effectively, ensuring a smooth and streamlined service process.

With the comprehensive features offered by the system, vehicle owners are expected to experience greater flexibility, accessibility, and real-time service tracking, ultimately elevating user engagement and satisfaction. This system is designed to provide a more organized, transparent, and efficient vehicle service management experience, meeting both user and administrator needs.

Despite encountering several challenges during the implementation phase, such as self-learning new technologies, integrating real-time communication systems, and addressing database performance issues, the project successfully addressed these challenges. These issues were overcome through continuous learning, problem-solving, and iterative testing. Moreover, extensive system testing ensured that all functions operated smoothly, leading to the successful delivery of a robust system with the desired functionalities.

7.2 Recommendations

The successful implementation of the Vehicle Maintenance and Service Tracking System (VMTS) has laid a solid foundation for improving vehicle service management. However, there are several recommendations for future development that could further enhance the system and provide even greater value to users.

Firstly, to improve the accuracy of the Predictive Maintenance feature, it is recommended to integrate the system with vehicle telematics systems. These systems automatically track and report real-time data from the vehicle, such as mileage, engine health, and service requirements. By obtaining this data directly from the vehicle, the system can reduce reliance on manual input from users, ensuring that service predictions are more accurate and timely. For instance, when a vehicle's mileage reaches a certain threshold, the system can automatically send maintenance reminders to the user, eliminating the need for manual data entry and making the maintenance process more seamless for the user.

In addition, integrating artificial intelligence (AI) and machine learning into the system could significantly improve its predictive capabilities. AI can analyze a wider range of

factors, including driving patterns, weather conditions, and vehicle performance over time, allowing the system to offer even more refined and personalized maintenance schedules. This would enable the system to make more accurate predictions about when services are due, taking into account individual driving habits and environmental factors. For example, vehicles driven in harsher conditions may require more frequent maintenance, and AI could adjust the service schedule accordingly, providing a more tailored service experience for each user.

Another important recommendation is the integration of an AI-powered chatbot for 24/7 support. This would allow users to access immediate assistance at any time, whether it's in the middle of the night or during weekends when human administrators may not be available. The chatbot could help users schedule appointments, check service status, and answer general maintenance queries in real-time. This would enhance the overall user experience by reducing wait times for support and providing instant responses to common questions, ensuring that users feel supported at all times.

Lastly, introducing a gamified reward system would increase user engagement and encourage users to stay active in managing their vehicle maintenance. By offering users the ability to earn points for tasks such as booking services, tracking service progress, or submitting feedback, the system can create a fun and motivating experience. These points could then be redeemed for discounts on future services, exclusive offers, or badges that recognize user engagement. For instance, users who schedule multiple services within a year could receive a loyalty badge or discounts on their next appointment. This gamification approach not only makes the process more interactive and enjoyable but also encourages long-term use of the system.

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APPENDIX

Poster