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Innovative Smart Parking System for Kluang Mall

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Smart Parking System, License Plate Recognition (LPR), Online Payment, Real-Time Availability, Parking Management, Kluang Mall.

Abstract

This creative Smart Parking System project describes how a solution to reduce parking inefficiencies at Kluang Mall was designed, developed, and assessed. The system was created using a web-based architecture with HTML, CSS, and JavaScript for the front-end, PHP, and MySQL for the back end, and most importantly Python with OpenCV for License Plate Recognition (LPR) to address problems like a lack of real-time availability information, restricted payment flexibility, and ineffective manual management. A comprehensive administrative dashboard for monitoring parking data, payments, and facility status is one of the key features, along with automatic vehicle entrance and departure via LPR, real-time parking spot availability, and secure online payment integration with Stripe. The system's resilience, usability, and secure functioning were confirmed by extensive testing, which included User Acceptance Testing, System Testing, and Security Testing. The findings demonstrate that the created system greatly improves user convenience and operational efficiency, providing a scalable, dependable, and forward-thinking answer to modern parking difficulties.

1. Introduction

In today's rapidly urbanizing world, efficient parking management has become a crucial concern, resulting in congestion, wasted time, and significant annoyance for drivers, especially in commercial districts like Kluang Mall. This article provides a description of an innovative Smart Parking System created as a Final Year Project to alleviate the prevalent parking inefficiencies.[1]

The system uses advanced technology, such as License Plate Recognition (LPR) and a web-based platform, to deliver real-time parking availability information, automate entrance and exit operations, enable convenient online payments, and provide full administrative supervision. This project's development and rigorous testing aim to provide a scalable and dependable solution that considerably improves user convenience and operational efficiency, thereby eliminating identified parking issues and contributing to a smarter urban environment.

2. Literature Review

This section critically reviews present research and solutions in smart parking systems, which include a variety of technology and parking management approaches. It analyses present advancements, their limits, and the precise gaps that the suggested innovative system seeks to fill and better.

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2.1 Smart Parking Systems: Overview and Trends

This article provides a full review of smart parking systems, delving into their basic components, operational principles, and the numerous technologies used to improve parking efficiency. It also looks at current worldwide trends, emphasizing emerging breakthroughs and future directions in the evolution of intelligent parking systems.[2]

2.2 Comparison of the Systems

Table 1 *Comparison of systems*

Feature	Pavillon Mall Parking	KLCC Parking System	Innovative Smart Parking System
Cashless Payment	Yes	Yes	Yes
Ticketless System	No	Yes	Yes
Real-Time Parking Availability	No	Yes	Yes
Vehicle Search (License Plate)	No	No	Yes
Automated Entry & Exit	No	Yes	Yes
Online Payment	No	No	Yes
Real-Time Charge Display	No	No	Yes
Customer Convenience	Moderate	Average	High
Operational Efficiency	Moderate	Average	High
Scalability	Limited	Average	High

This table outlines the key features of three different parking systems: Pavilion Mall Parking, KLCC Parking System, and an Innovative Smart Parking System. It compares them across various aspects such as cashless payment, ticketless operation, real-time availability, vehicle search functionality, automated entry/exit, online payment, real-time charge display, customer convenience, operational efficiency, and scalability. The comparison clearly highlights how the Innovative Smart Parking System offers the most advanced features and highest levels of convenience, efficiency, and scalability.

3. Methodology

The system was developed using the Prototyping Throwaway Model, facilitating iterative refinement through user feedback. Its architecture comprises a web-based front-end (HTML, CSS, JavaScript), a robust back end (PHP, MySQL), and an integrated License Plate Recognition (LPR) module powered by Python and OpenCV. This approach ensured a functional, user-friendly, and technologically advanced parking solution.

3.1 Prototyping Model

The Prototyping Throwaway Model, seen in Figure 3.1, directs the project from planning to testing. Essential steps encompass planning, analysis, design, implementation, and testing, incorporating feedback loops for continuous improvement and modifications.

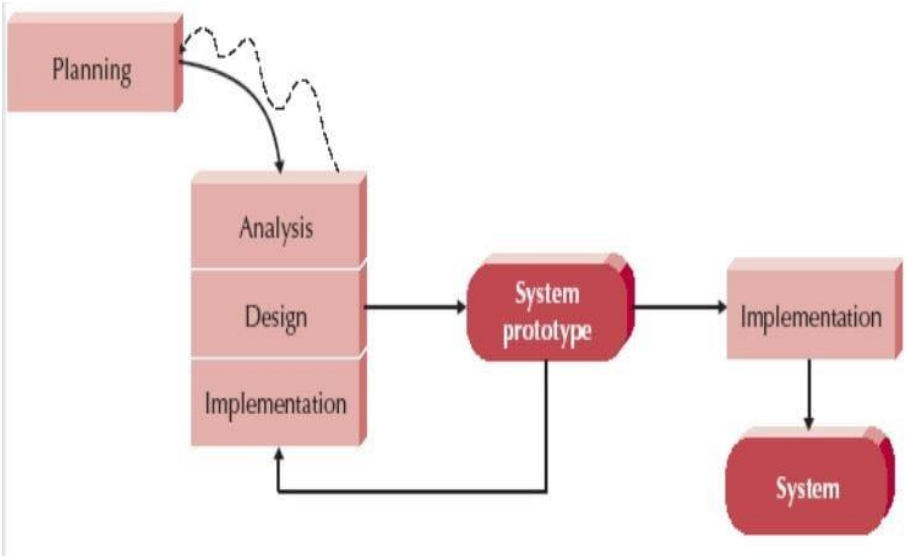

Fig. 1 The Phases of Agile Model

3.1.1 Planning Phase

This initial phase focused on defining the project's scope, objectives, and overall feasibility, establishing a high-level understanding of the Smart Parking System's purpose. It involved preliminary research into existing parking challenges and identifying the core problems at Kluang Mall to be addressed.

3.1.2 Analysis Phase

During this phase, detailed requirements for the system were gathered from both visitor and administrator perspectives, translating needs into specific functional and non-functional specifications. Key processes like vehicle entry/exit, payment workflows, and real-time status updates were meticulously analyzed to inform the system's design.

3.1.3 Design Phase

This phase involved creating the architectural blueprint of the system, including the user interface (UI) and user experience (UX) wireframes, database schemas, and module interactions. Prototypes were developed to visualize key functionalities and gather early feedback, aligning the system's structure with analyzed requirements.

3.1.4 Implementation Phase

The implementation phase translated the approved designs into a working system, involving coding the front-end (HTML, CSS, JavaScript), back-end (PHP, MySQL), and integrating the Python-based License Plate Recognition (LPR) module. This phase focused on building out all functionalities, ensuring robust data handling and seamless module integration.

4. Results and Discussion

The Smart Parking System successfully implemented LPR, real-time updates, and online payments via a web-based platform. Extensive User, System, and Security testing validated its functionality, usability, and robust security. These results confirm the system significantly enhances parking efficiency and user experience at Kluang Mall.

4.1 Requirements Analysis

This section details the comprehensive process of gathering, analyzing, and documenting the functional and non-functional requirements essential for the Smart Parking System's development.

4.1.1 Functional Requirements Analysis

Table 2 Functional *requirement analysis*

Module	**Functionalities**
Entry Management	Handles vehicle entry processes, including License Plate Recognition (LPR) and recording of entry time.
Exit Management	Manages vehicle exit procedures, including LPR for exit and validation of payment status.
Search for Vehicle	Allows users to locate their parked vehicle within the facility using their plate number
Payment Processing	Manages all aspects of parking fee collection, integrating with online payment gateway (Stripe).
Parking Availability	Provides real-time information on the number of available parking spots across different levels.
Admin Dashboard	A centralized interface for administrators to manage parking records, payment transactions, and Parking level Status.
Admin Registration	Facilitates the secure creation and setup of new administrator accounts, including verification processes.

This table, "Functional Requirements Analysis," details the core functions of the system, including entry and exit management, vehicle search, payment processing, real-time parking availability, and comprehensive admin dashboard and registration capabilities.

4.1.2 Non- Functional Requirements Analysis

Table 3 Non-*Functional Requirements Analysis*

Module	**Functionalities**
System Performance	1. The system should handle multiple simultaneous requests without delays. 2. Real-time updates for parking availability should be instantaneous.
Operational Availability	1. The system should operate during the mall's business hours (10 AM to 10 PM) with minimal downtime. 2. Requires a stable and active internet connection for full functionality.
Security	1. Admin registration is restricted to emails with the Kluang Mall domain (e.g., admin@kluangmall.com). 2. Online payment gateway uses encryptions for all transactions to protect sensitive financial data. 3. User and admin data are secured through hashing and access controls
User Interface	1. The UI should be simple, intuitive, and user-friendly for easy navigation. 2. The design must be fully responsive for optimal display on mobile devices, tablets, and desktops.
Data Integrity	1. The system must ensure accuracy and consistency of all parking data (e.g., plate number, location, payment status). 2. Critical data, including parking records and transactions, should be regularly backed up.

This table, "Non-Functional Requirements Analysis," outlines the essential performance, availability, security, user interface, and data integrity requirements crucial for the effective operation of the parking system.

4.2 Unified Modeling Language (UML)

The following UML diagrams demonstrate the design and workflow of the Smart Parking System project. They capture interactions, processes, and key elements of the system, ensuring a comprehensive understanding of its functionality and architecture.

4.2.1 Use Case Diagram

This diagram represents the interactions between the main actors of the system

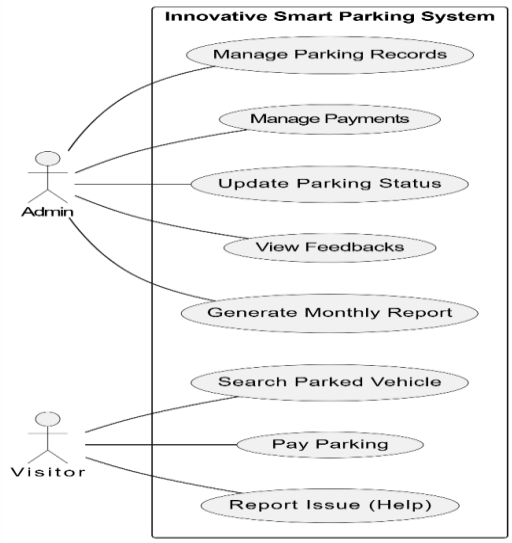

Fig. 2 *Use Case Diagram*

4.2.2 Activity Diagram

This Figure shows the sequence of events with the system.

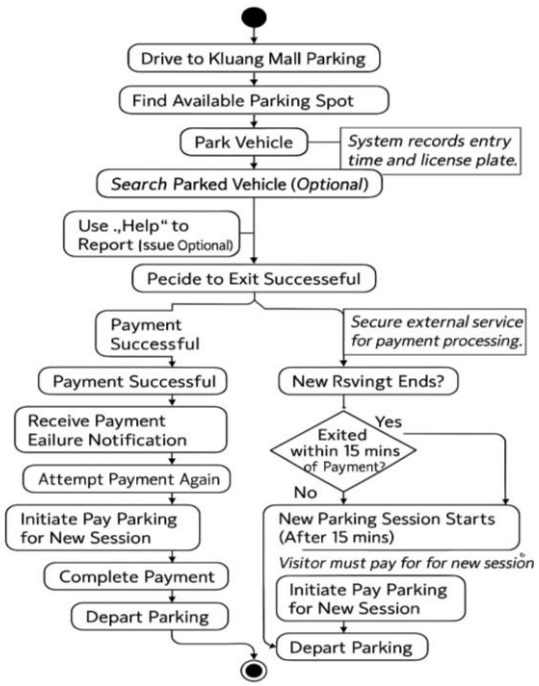

Fig. 3 *User Activity Diagram*

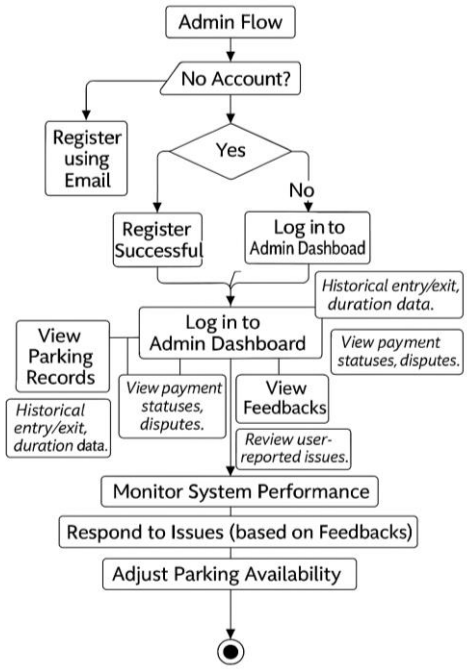

Fig. 4 Admin *Activity Diagram*

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4.2.3 Class Diagram

The class diagram provides an overview of the system's structure

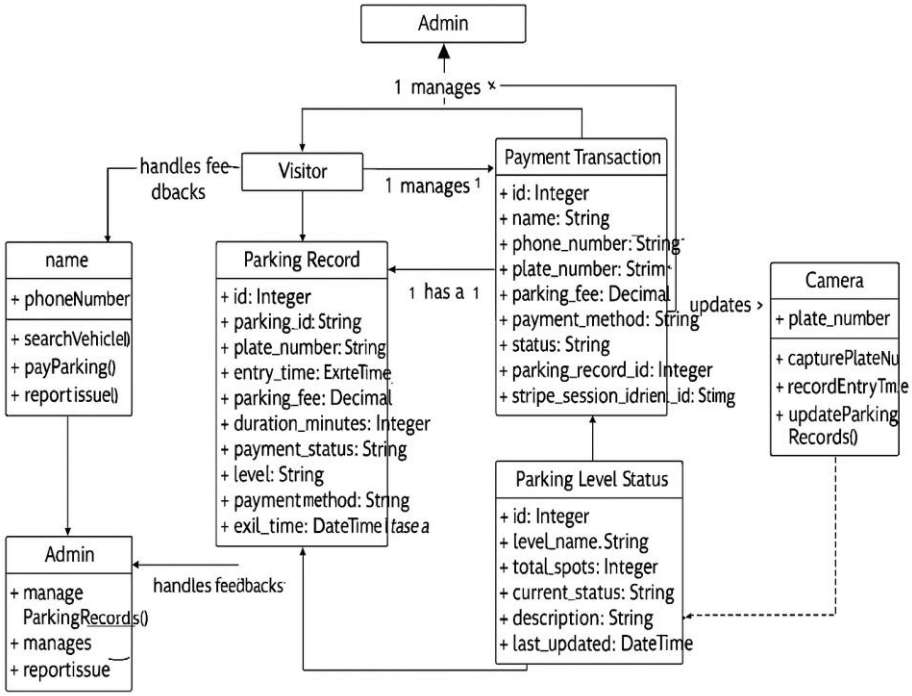

Fig. 5 *Class Diagram*

4.3 Interface Design

This figure illustrates the Home Page of the Innovative Smart Parking System. The homepage serves as the main entry point for users, providing a welcoming and user-friendly interface. Key features displayed include

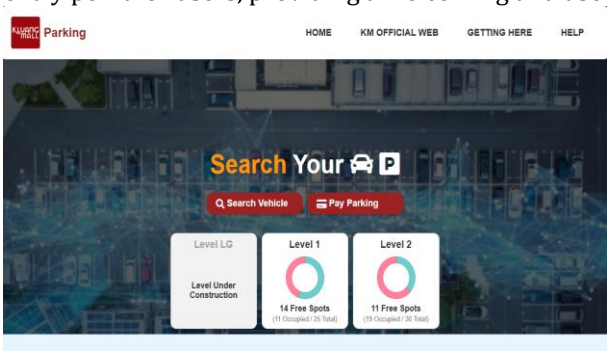

Fig. 6 *Home Pages Buttons and live parking Availably*

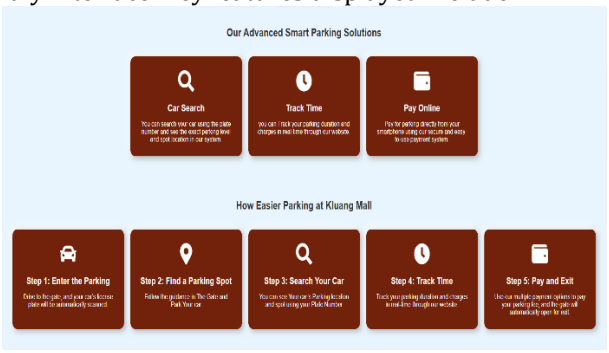

Fig. 7 *Home Page Features*

Fig. 6 and 7 are Home Page Buttons and Features This figure displays the key elements of the home page, including the "Pay Parking" and "Search Car" buttons for quick parking payments and vehicle location. It also features a live pie chart showing real-time parking availability. Additionally, the page includes a box outlining the easy steps to use the Kluag Mall Smart Parking system, helping users understand the simple process of booking and managing their parking spots.

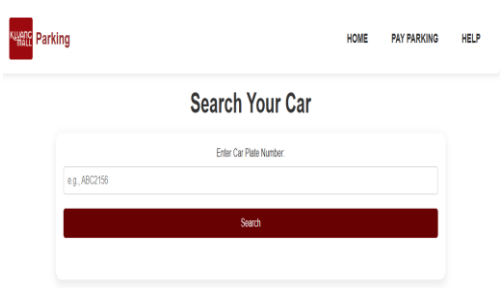

Fig. 8 *Search Car Page*

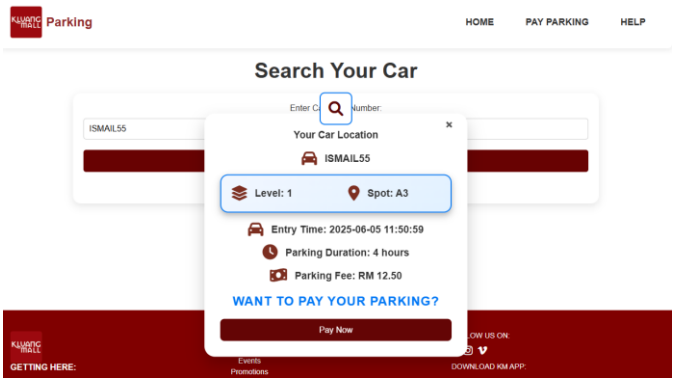

Fig. 9 *Search Car Result box*

Fig. 8: Search Car Page This figure illustrates the "Search Car" page, where users can enter their car details to locate their vehicle. The page provides an intuitive interface to search for cars based on parking location and availability. Fig. 9: Search Car Result Box This figure shows the result box displayed after a successful car search. It includes the car plate number, level and spot or car parked.

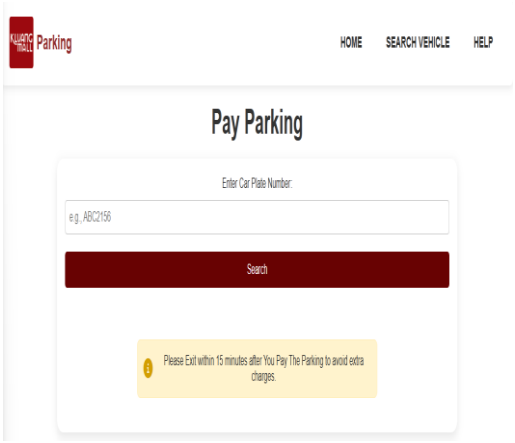

Fig. 10 *Pay Parking Page*

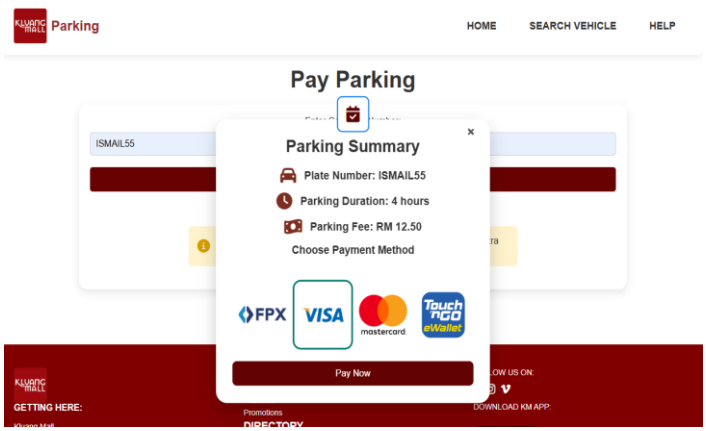

Fig. 11 *Pay Parking Result box*

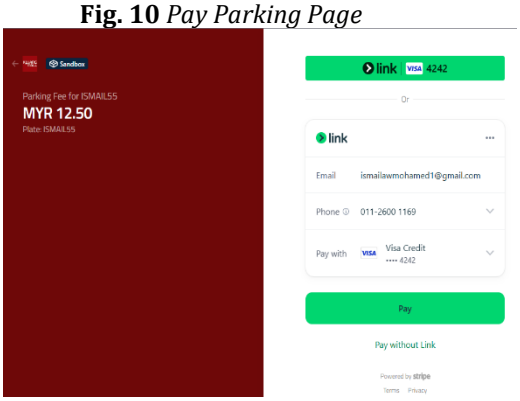

Fig. 12 Pay Parking Page Payment Transaction

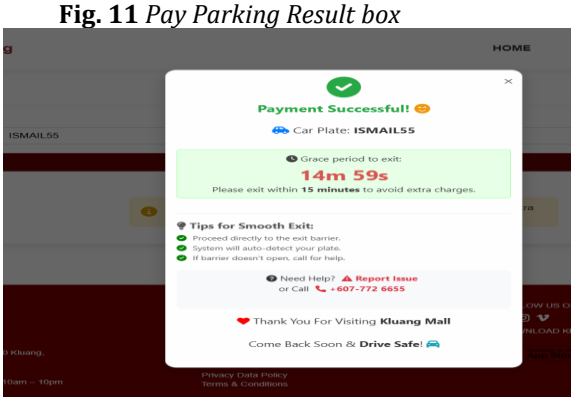

Fig. 13 Pay Parking Page Payment Successful

Fig. 10: Pay Parking Page This figure illustrates the "Pay Parking " page, where users can enter their car Plate Number to see and Pay Parkin. Fig. 11: Result Box. This figure shows the result box displayed after a successful car search. Fig 12: Payment transaction in progress.
Fig 13**:** Payment successful confirmation.

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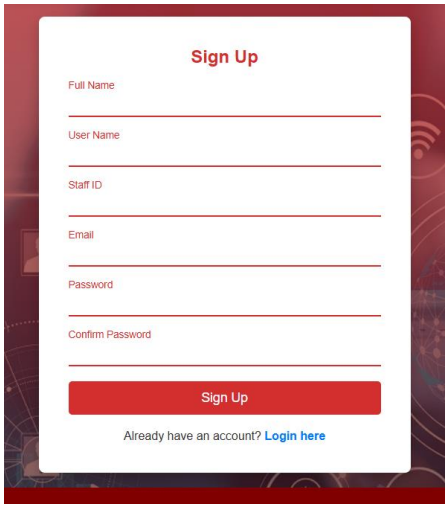


Fig. 14 *Admin Register Page*

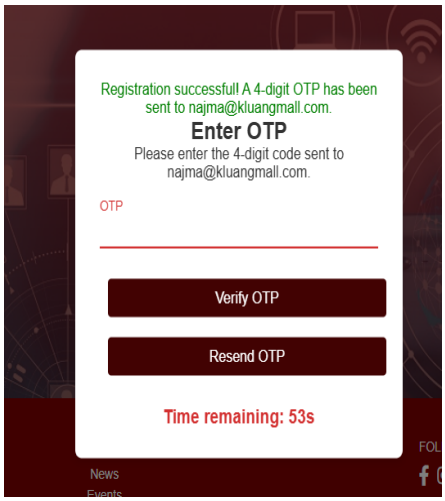


Fig. 15 *OTP Verification*

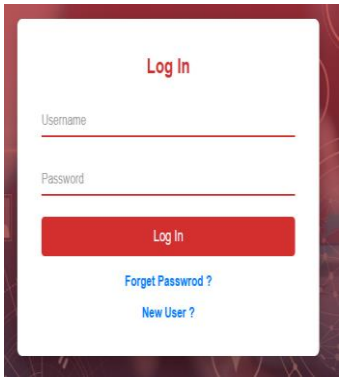


Fig. 16 *Admin Login*

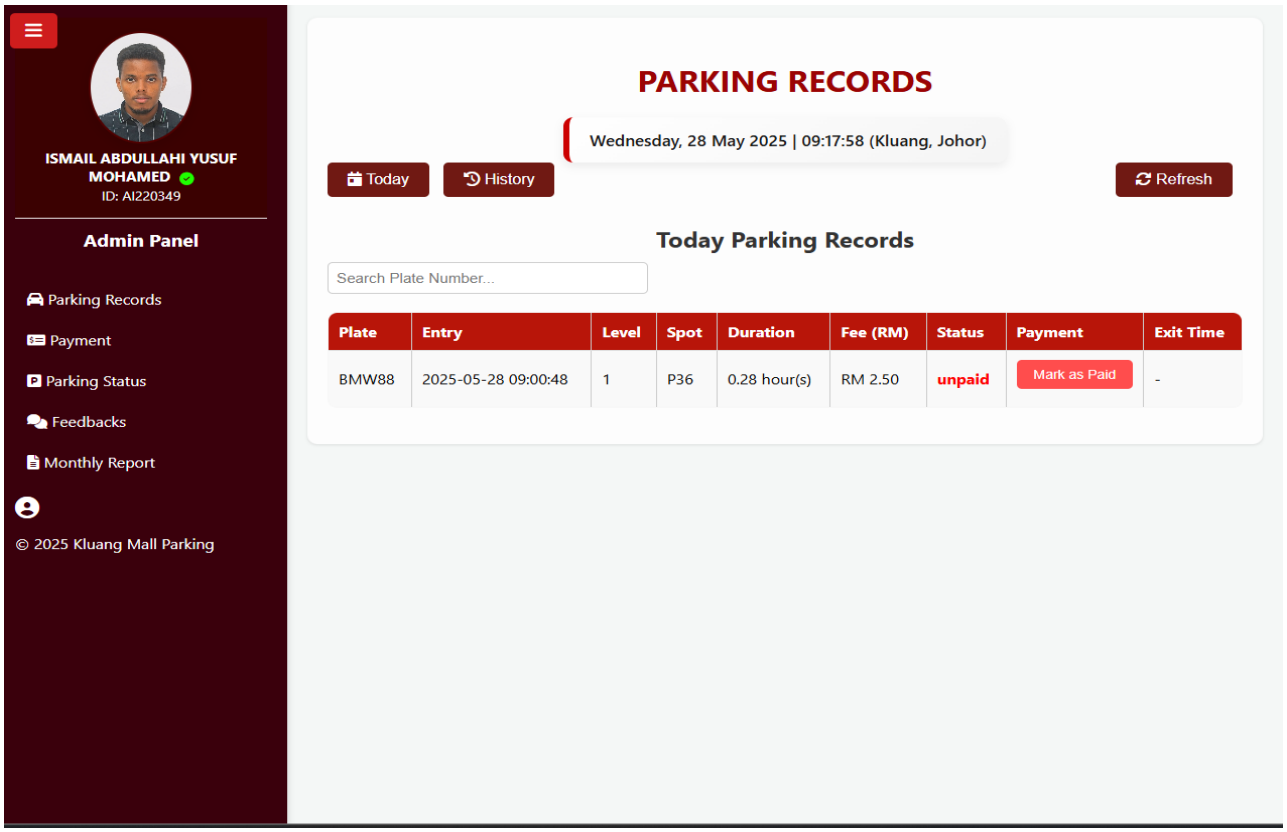
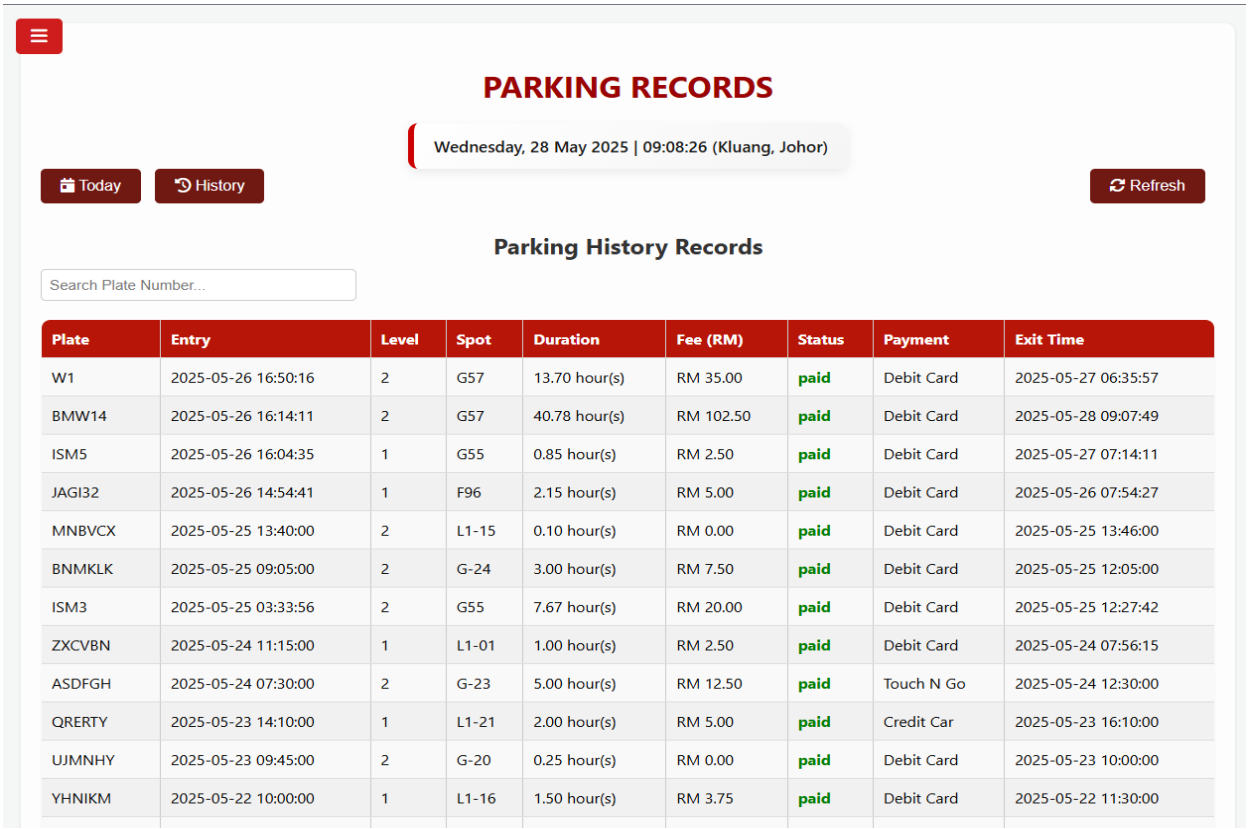


Fig. 17 *Admin dashboard*



PARKING RECORDS

Wednesday, 28 May 2025 | 09:08:26 (Kluang, Johor)

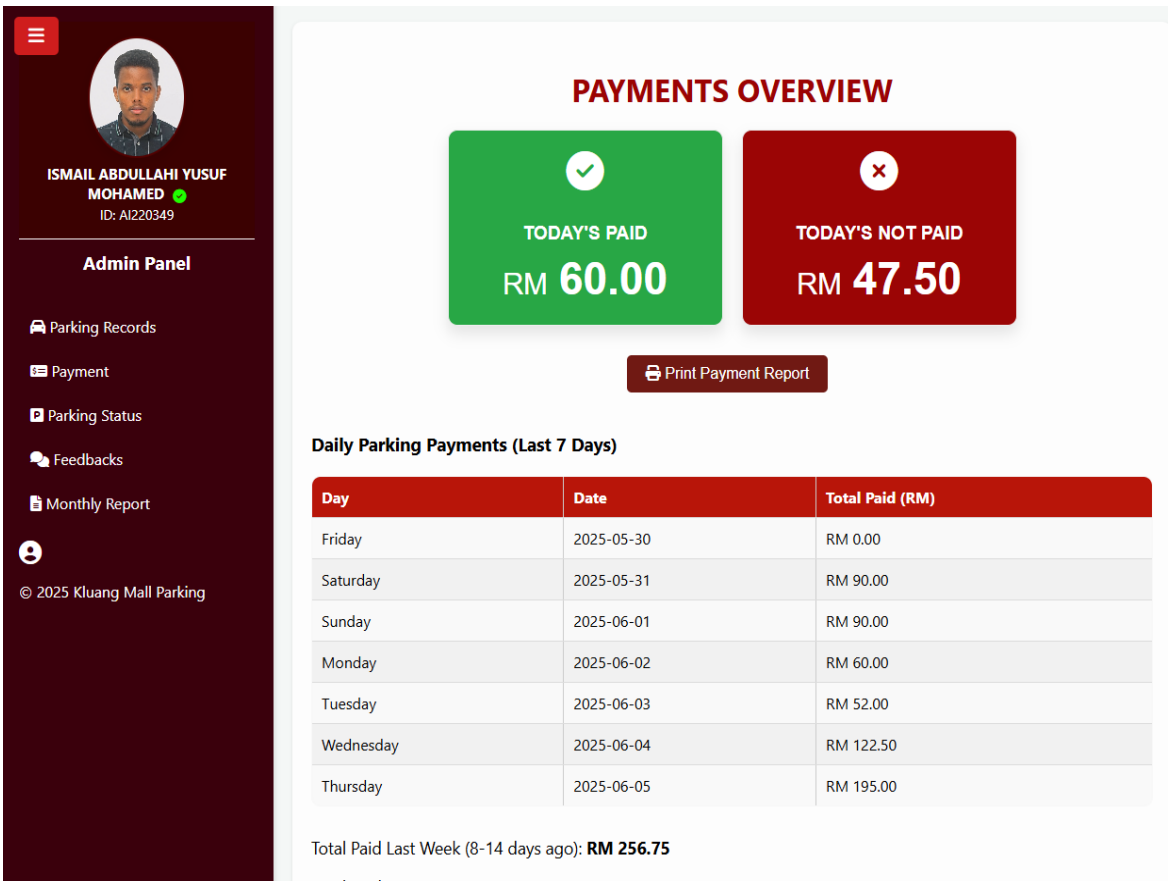
Today | History | Refresh

Parking History Records

Search Plate Number...

Plate	Entry	Level	Spot	Duration	Fee (RM)	Status	Payment	Exit Time
W1	2025-05-26 16:50:16	2	G57	13.70 hour(s)	RM 35.00	paid	Debit Card	2025-05-27 06:35:57
BMW14	2025-05-26 16:14:11	2	G57	40.78 hour(s)	RM 102.50	paid	Debit Card	2025-05-28 09:07:49
ISM5	2025-05-26 16:04:35	1	G55	0.85 hour(s)	RM 2.50	paid	Debit Card	2025-05-27 07:14:11
JAGI32	2025-05-26 14:54:41	1	F96	2.15 hour(s)	RM 5.00	paid	Debit Card	2025-05-26 07:54:27
MNBVCX	2025-05-25 13:40:00	2	L1-15	0.10 hour(s)	RM 0.00	paid	Debit Card	2025-05-25 13:46:00
BNMKLK	2025-05-25 09:05:00	2	G-24	3.00 hour(s)	RM 7.50	paid	Debit Card	2025-05-25 12:05:00
ISM3	2025-05-25 03:33:56	2	G55	7.67 hour(s)	RM 20.00	paid	Debit Card	2025-05-25 12:27:42
ZXCVBN	2025-05-24 11:15:00	1	L1-01	1.00 hour(s)	RM 2.50	paid	Debit Card	2025-05-24 07:56:15
ASDFGH	2025-05-24 07:30:00	2	G-23	5.00 hour(s)	RM 12.50	paid	Touch N Go	2025-05-24 12:30:00
QRERTY	2025-05-23 14:10:00	1	L1-21	2.00 hour(s)	RM 5.00	paid	Credit Car	2025-05-23 16:10:00
UJMNHY	2025-05-23 09:45:00	2	G-20	0.25 hour(s)	RM 0.00	paid	Debit Card	2025-05-23 10:00:00
YHNIKM	2025-05-22 10:00:00	1	L1-16	1.50 hour(s)	RM 3.75	paid	Debit Card	2025-05-22 11:30:00

Fig. 18 *Admin dashboard Parking History Section*



ISMAIL ABDULLAHI YUSUF MOHAMED
ID: AI220349

Admin Panel

Parking Records
Payment
Parking Status
Feedbacks
Monthly Report

© 2025 Kluang Mall Parking

PAYMENTS OVERVIEW

TODAY'S PAID
RM 60.00

TODAY'S NOT PAID
RM 47.50

Print Payment Report

Daily Parking Payments (Last 7 Days)

Day	Date	Total Paid (RM)
Friday	2025-05-30	RM 0.00
Saturday	2025-05-31	RM 90.00
Sunday	2025-06-01	RM 90.00
Monday	2025-06-02	RM 60.00
Tuesday	2025-06-03	RM 52.00
Wednesday	2025-06-04	RM 122.50
Thursday	2025-06-05	RM 195.00

Total Paid Last Week (8-14 days ago): **RM 256.75**

Fig. 18 *Admin dashboard Payment Section*

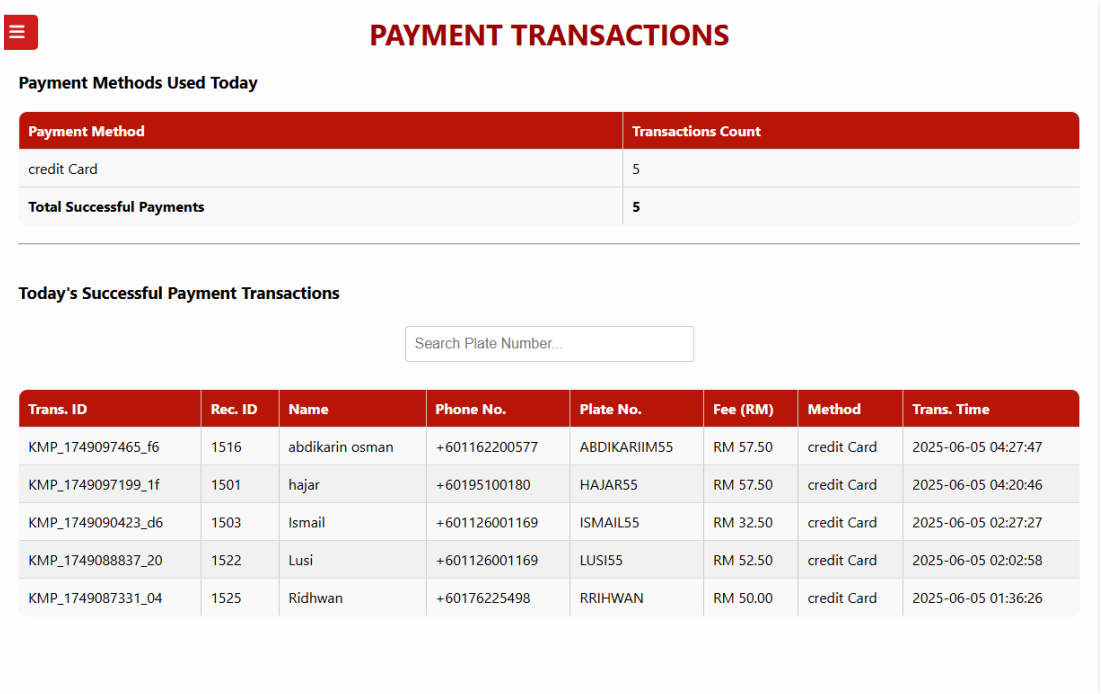


Fig. 19 *Admin dashboard Payment Transaction Section*

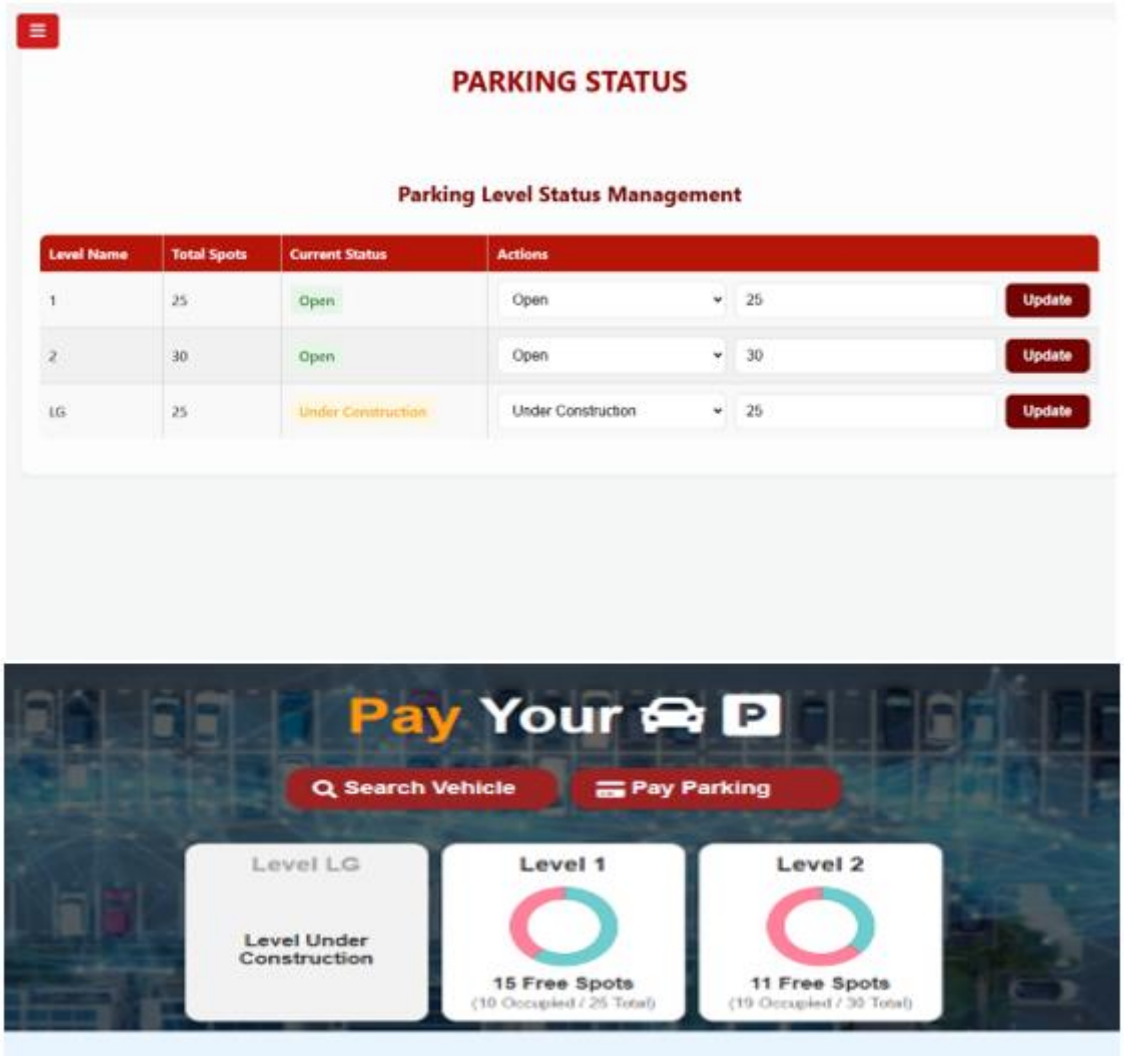


Fig. 20 *Admin dashboard Parking Status Section*

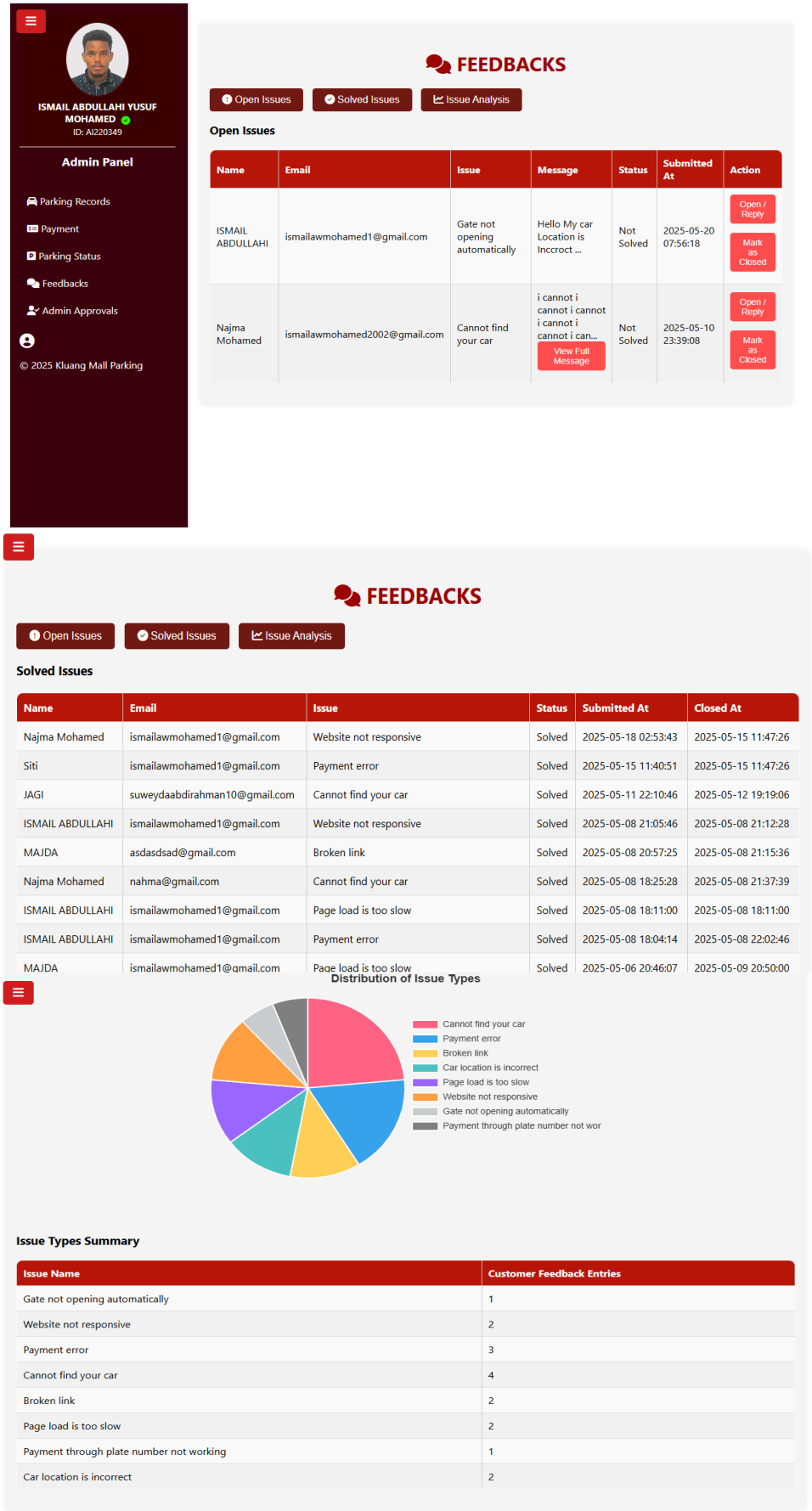


Fig. 21 *Admin dashboard feedback/Issues Section*

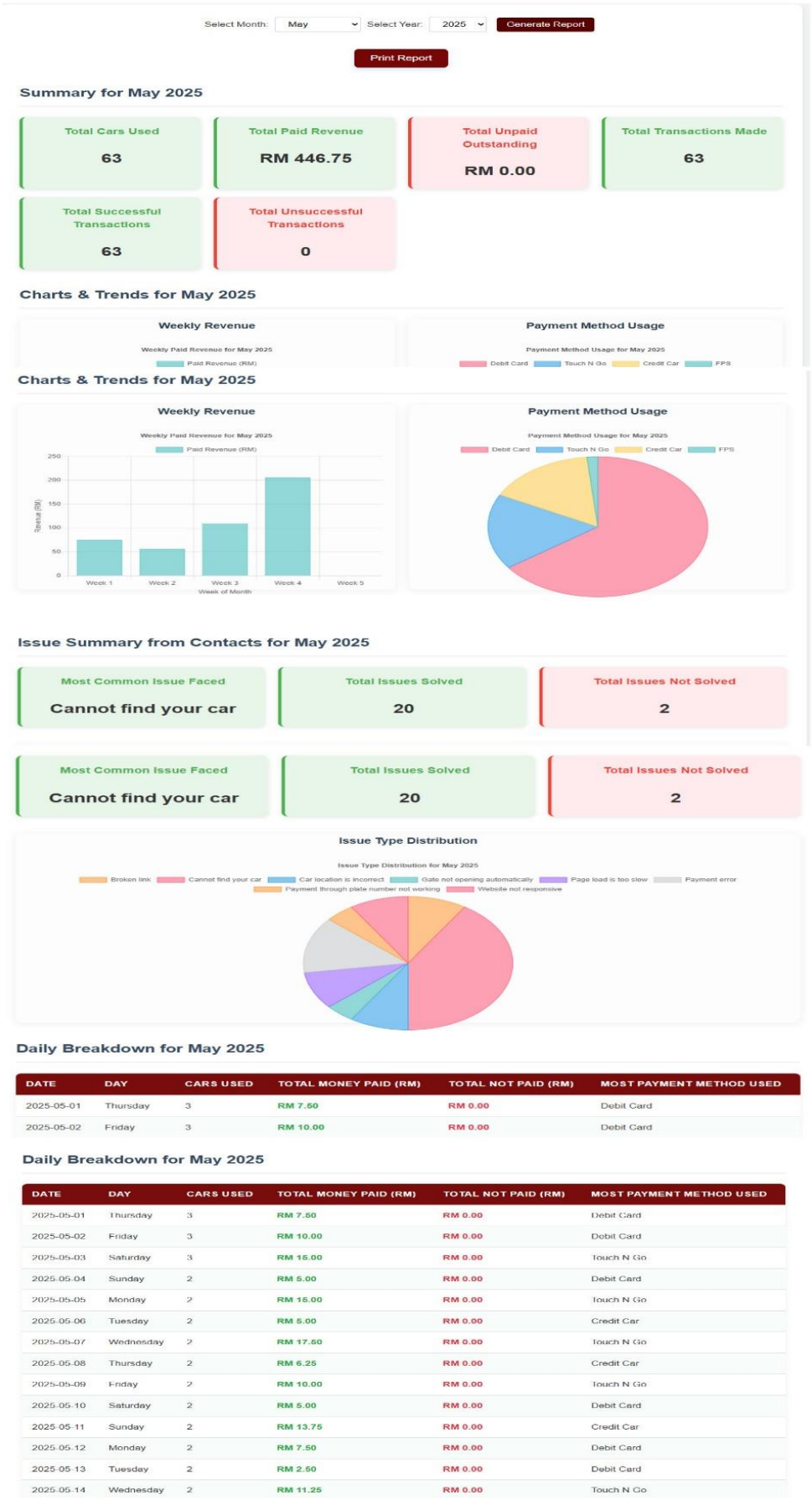


Fig. 22 *Admin dashboard Report Section*

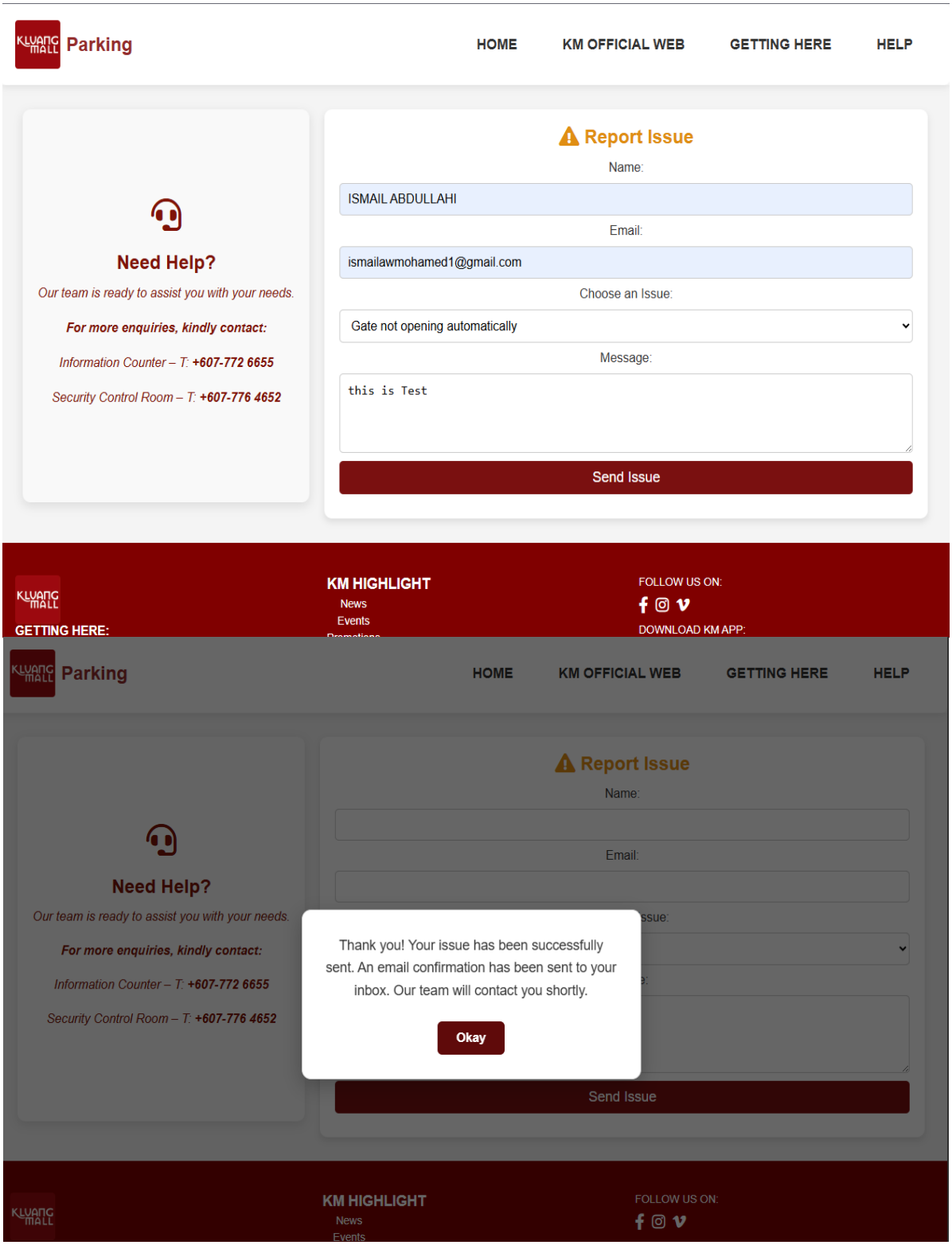


Fig. 23 *Help and Report Issue Page of the Visitor*

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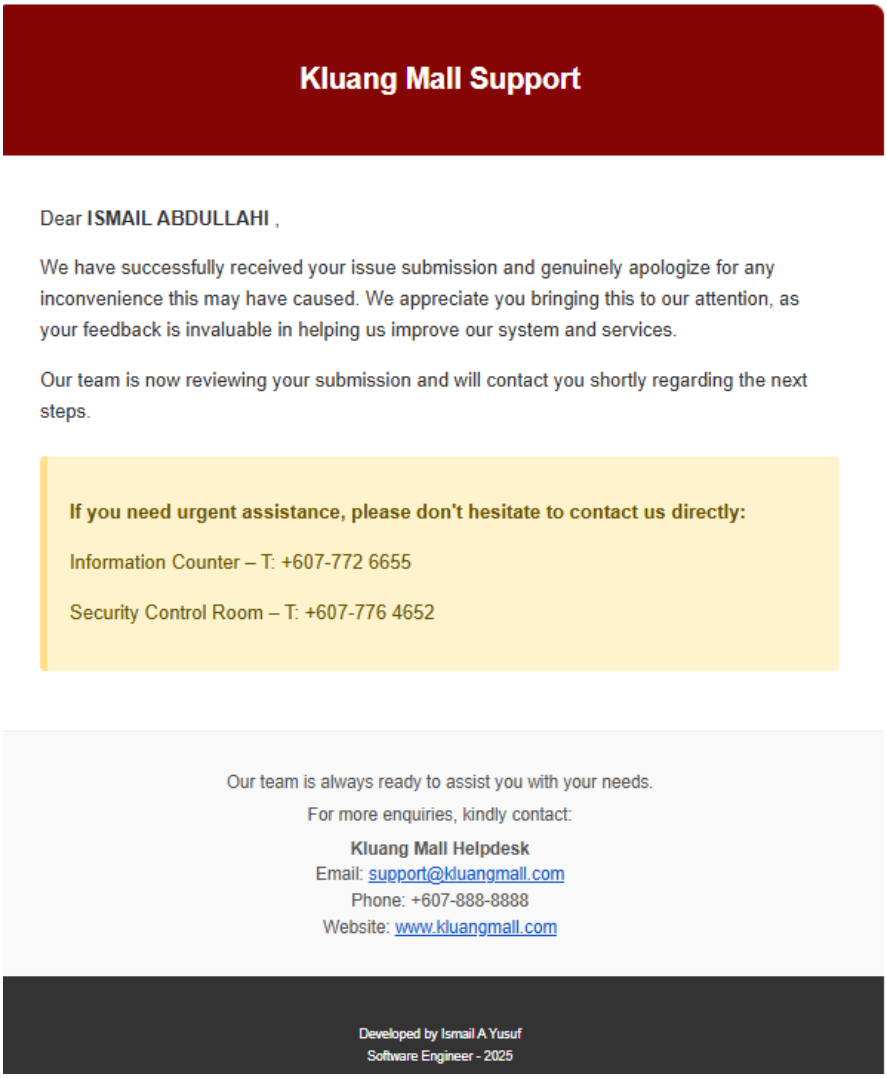

Fig. 24 *Help and Report Issue submission Confirmation Email*

The figures provide a comprehensive visual overview of the Admin Module and Help/Report Issue functionalities within the system. Figure 14 depicts the initial Admin Register Page, followed by Figure 15, which illustrates the OTP Verification process, ensuring secure administrator account creation. Figure 16 then presents the Admin Login interface. Once logged in, administrators are directed to the central Admin Dashboard (Fig. 17), which serves as a hub for various management sections. This includes the Parking History Section (Fig. 18), the Payment Section (Fig. 18), the Payment Transaction Section (Fig. 19), and the Parking Status Section (Fig. 20), all accessible from the dashboard. Furthermore, the dashboard also features a dedicated Feedback/Issues Section (Fig. 21) and a Report Section (Fig. 22) for comprehensive oversight. Finally, the user-facing side is showcased with Figure 23, illustrating the Help and Report Issue Page for visitors, and Figure 24, which shows the Help and Report Issue submission Confirmation Email, demonstrating a closed-loop feedback mechanism for users.

4.4 LPR and Data Input

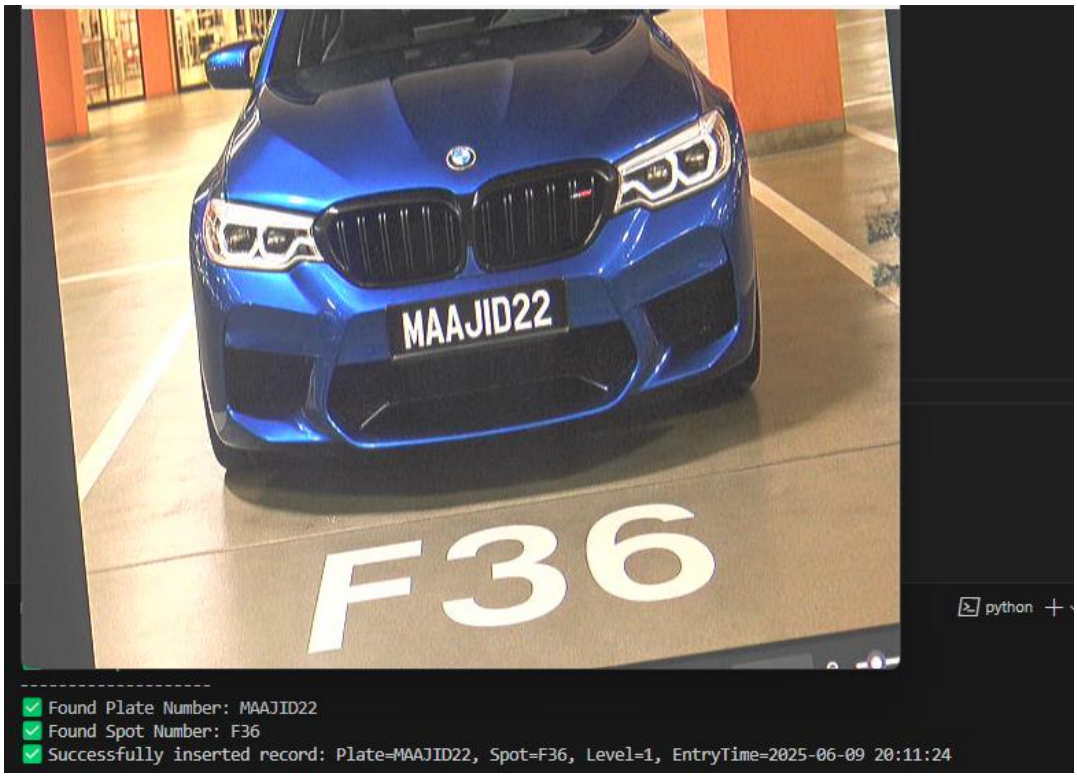

Fig. 24 LPR python Input

Figure 24 illustrates the **Python input** for the **License Plate Recognition (LPR)** system, demonstrating the data or image fed into the Python script for processing and extracting license plate information.

5. Conclusion

This project successfully developed an innovative Smart Parking System to directly address parking inefficiencies at Kluang Mall, a common urban challenge. Through License Plate Recognition (LPR), real-time data, and online payments, the system significantly enhances both user convenience and operational efficiency. Extensive testing comprehensively validated its functionality, usability, and robust security. This proves it's a reliable and effective solution for modern parking management, ready for practical application.

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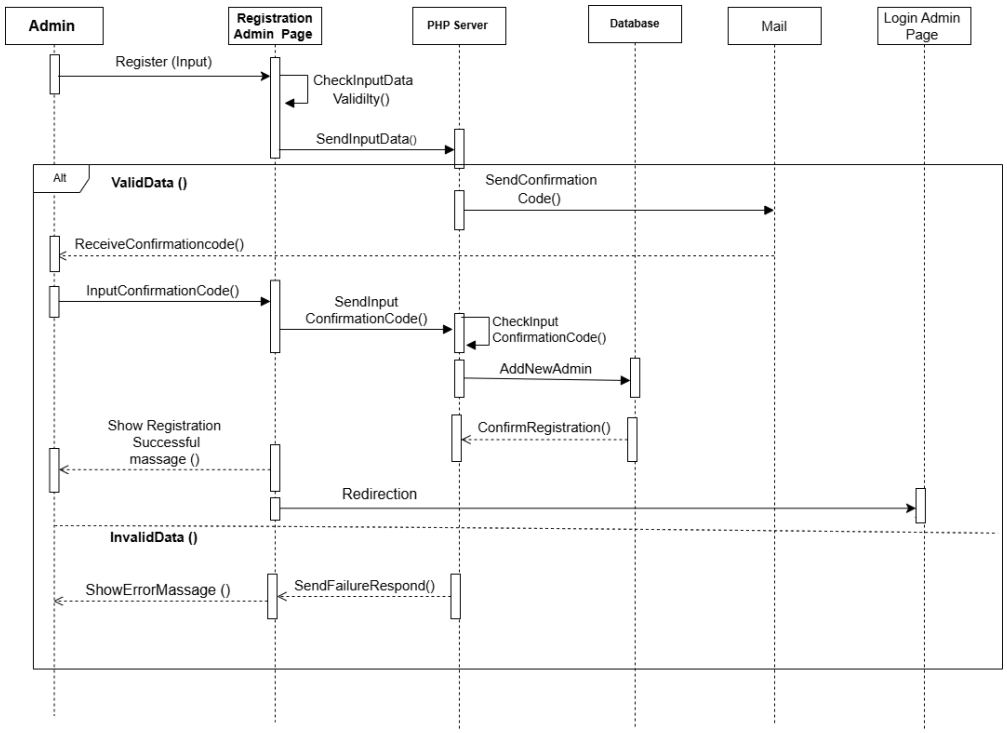
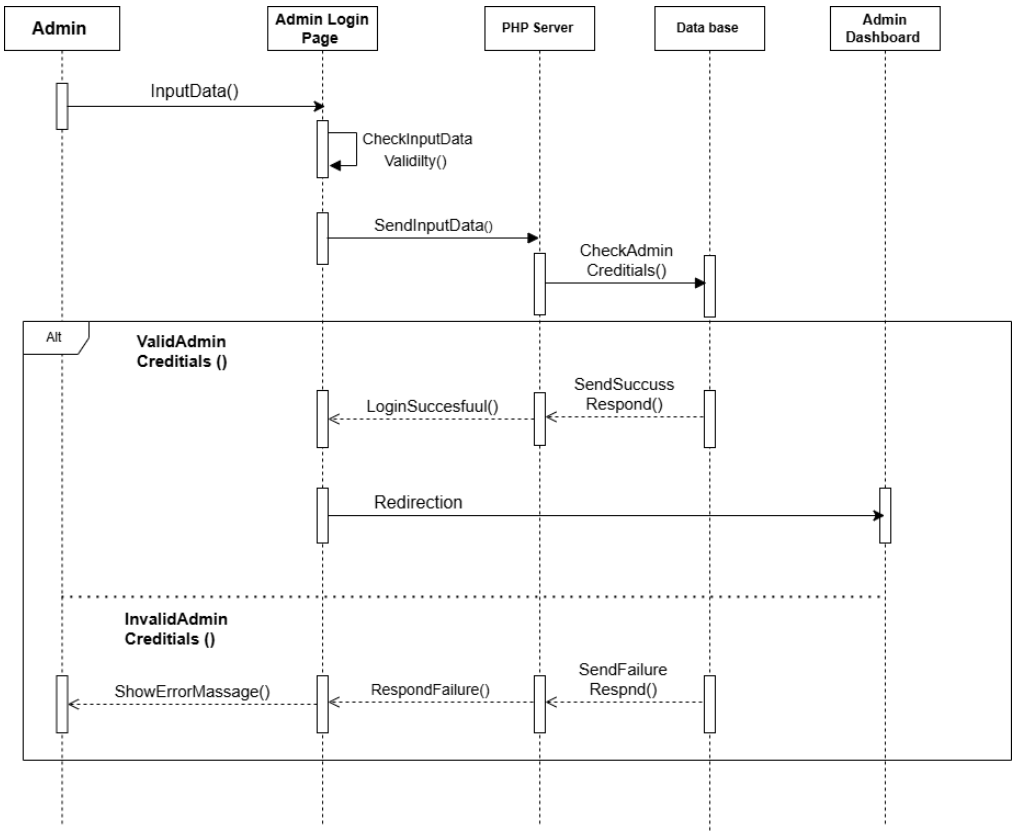
Appendix A: Sequence diagram for each module



Admin Registration Sequence Diagram



Admin Login Sequence Diagram

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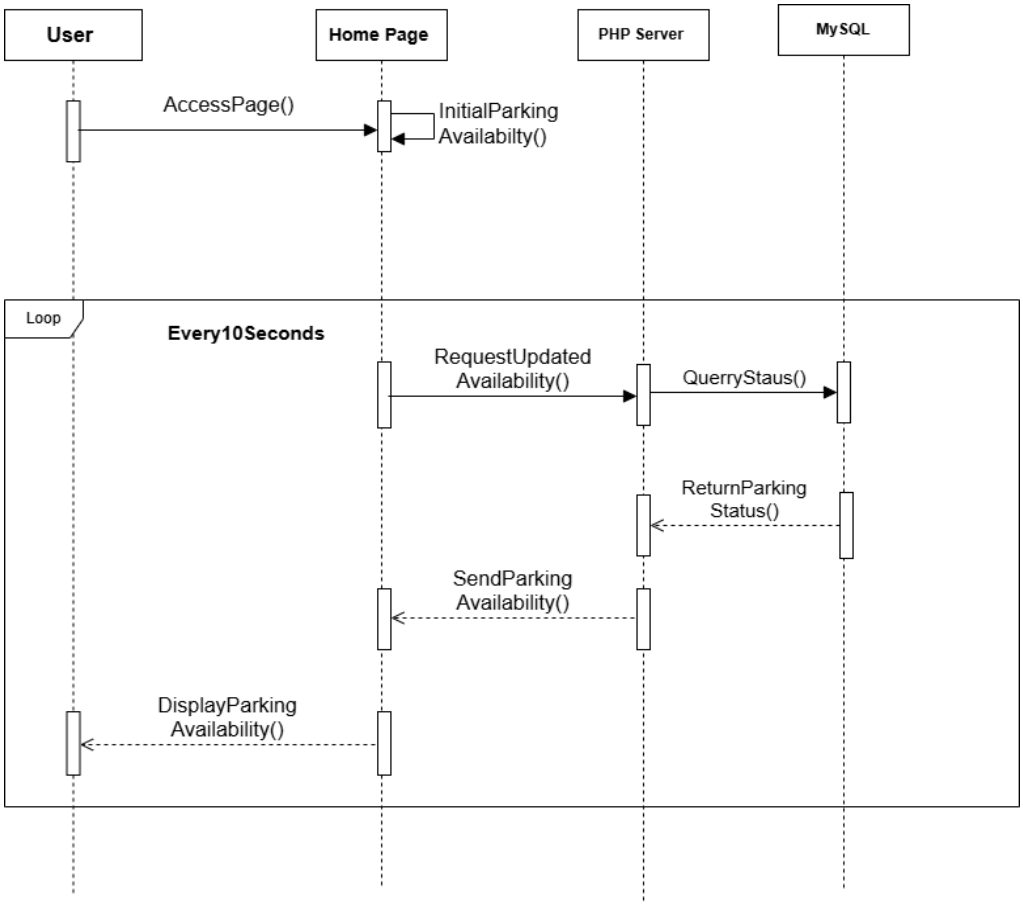
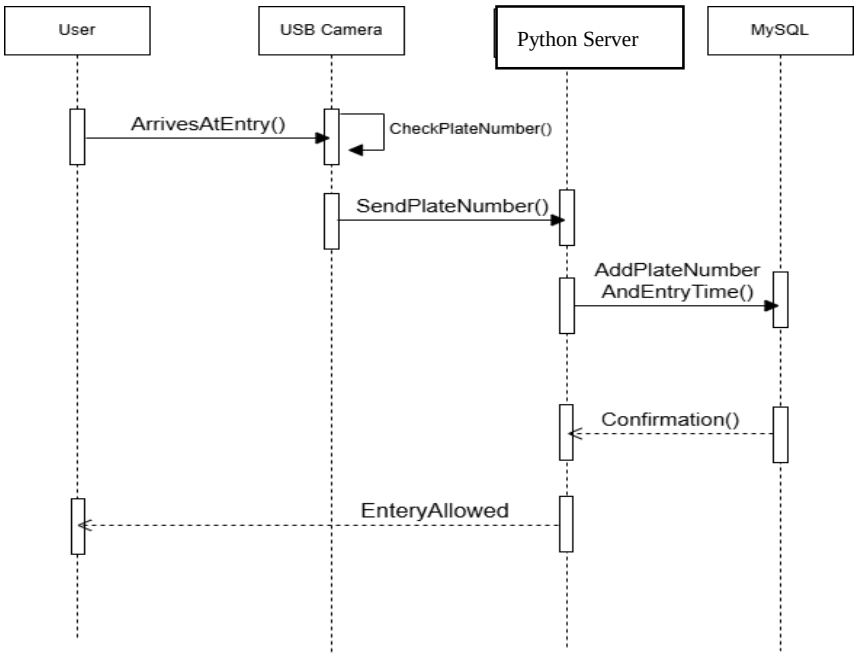
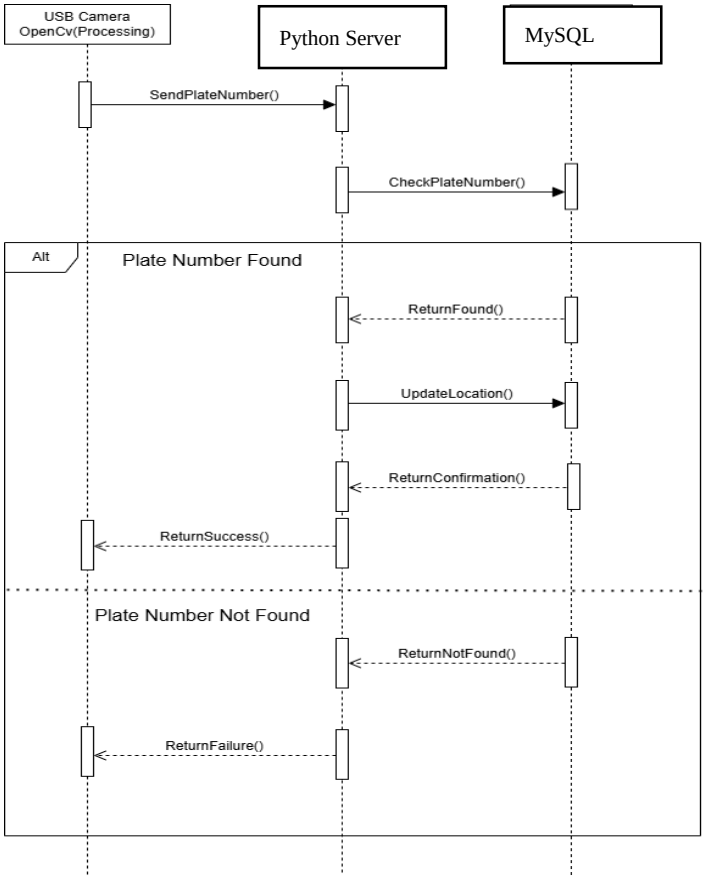


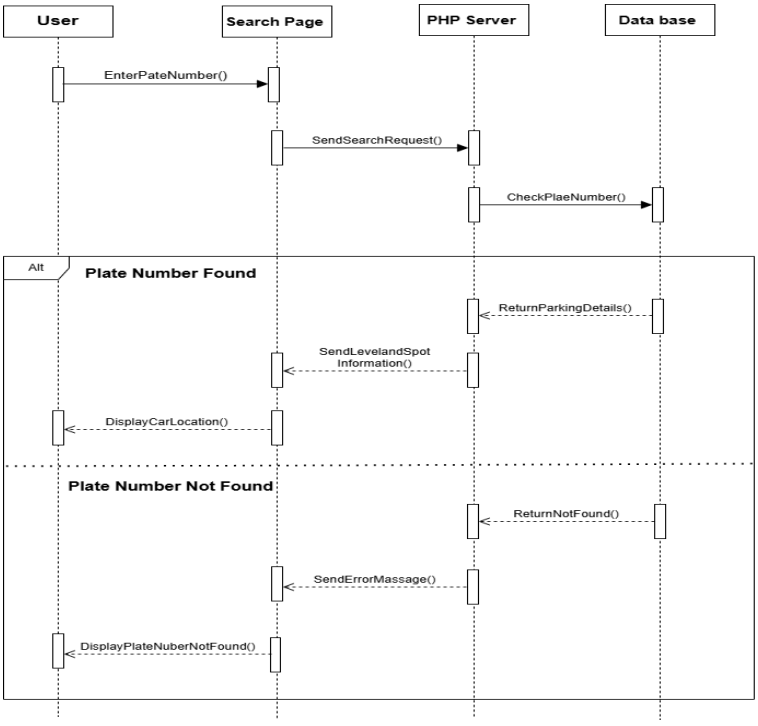
Parking Availability Sequence Diagram



Car Plate Scanning at Entry Sequence Diagram



Car Plate Scanning at Parked Location Sequence Diagram



Car Search Sequence Diagram

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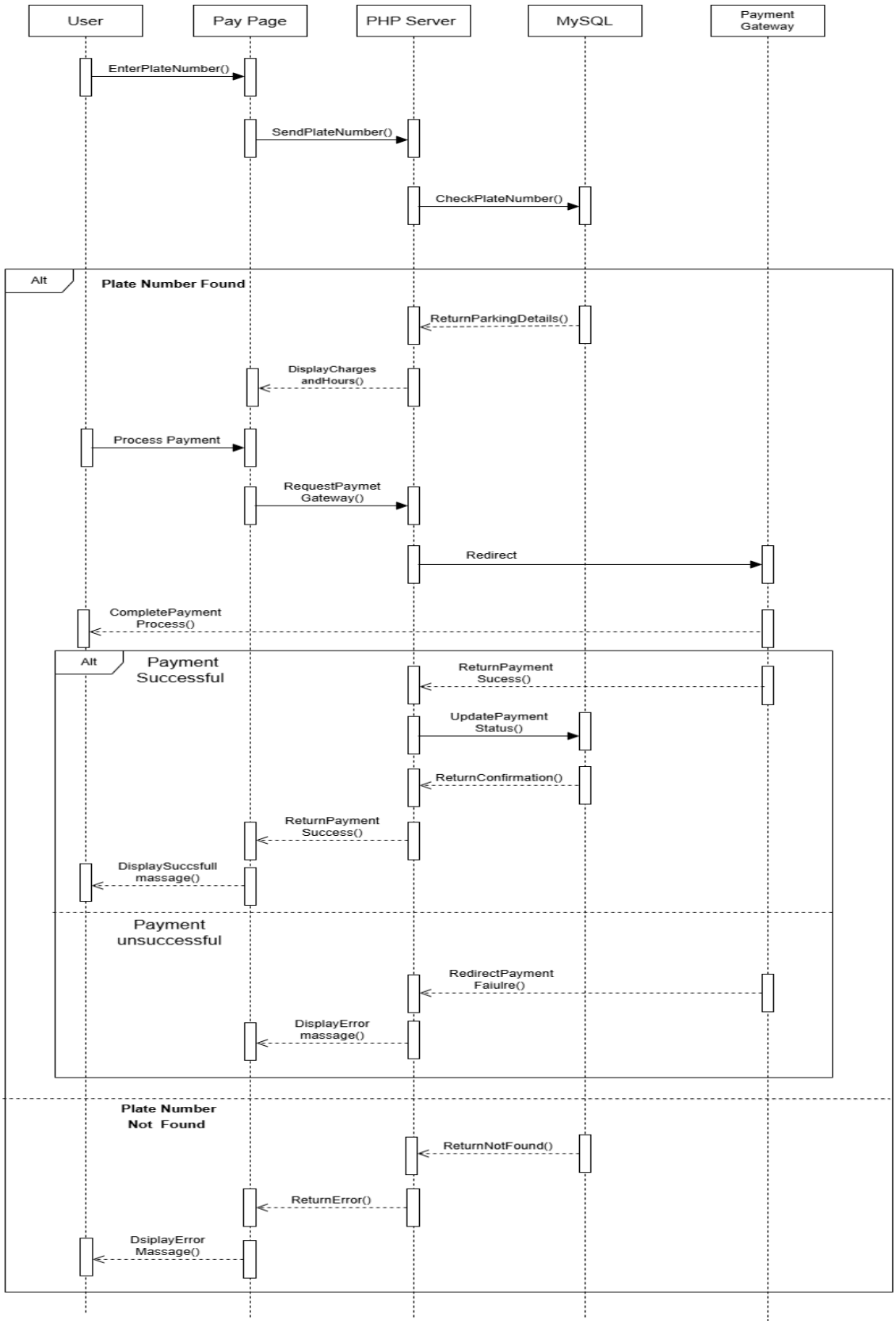
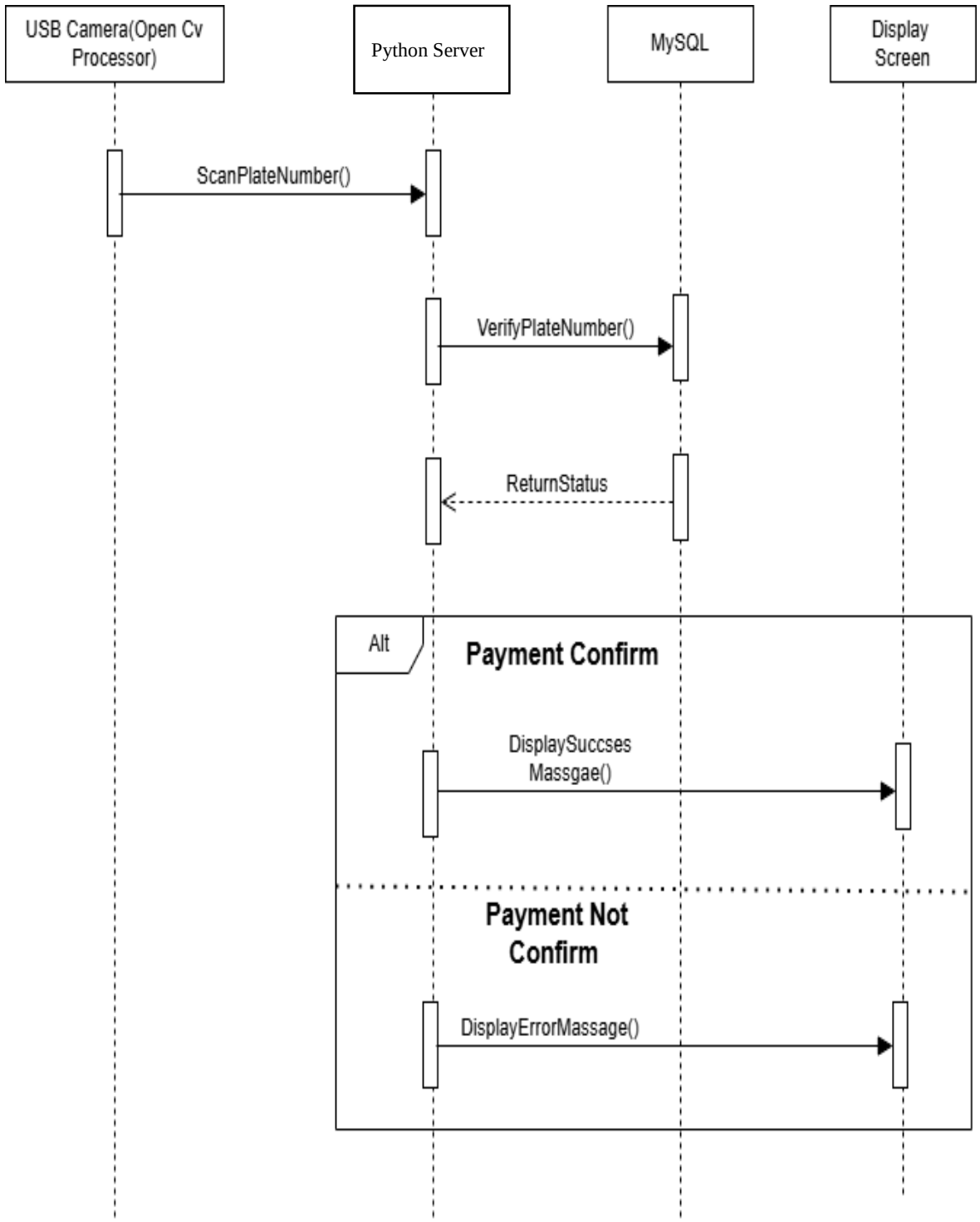


Pay Parking Sequence Diagram



Car Plate Scanning at Exit Sequence Diagram

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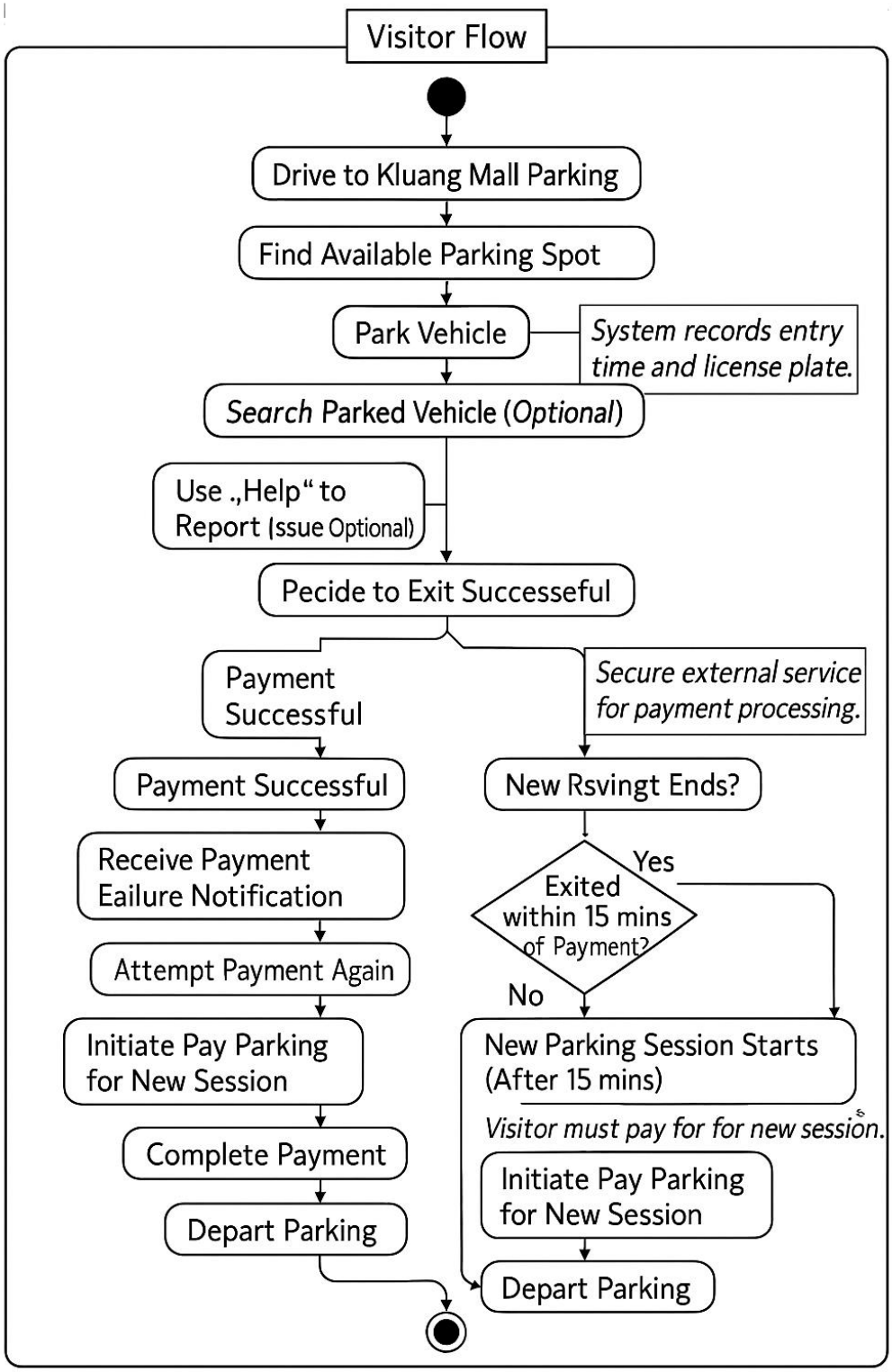
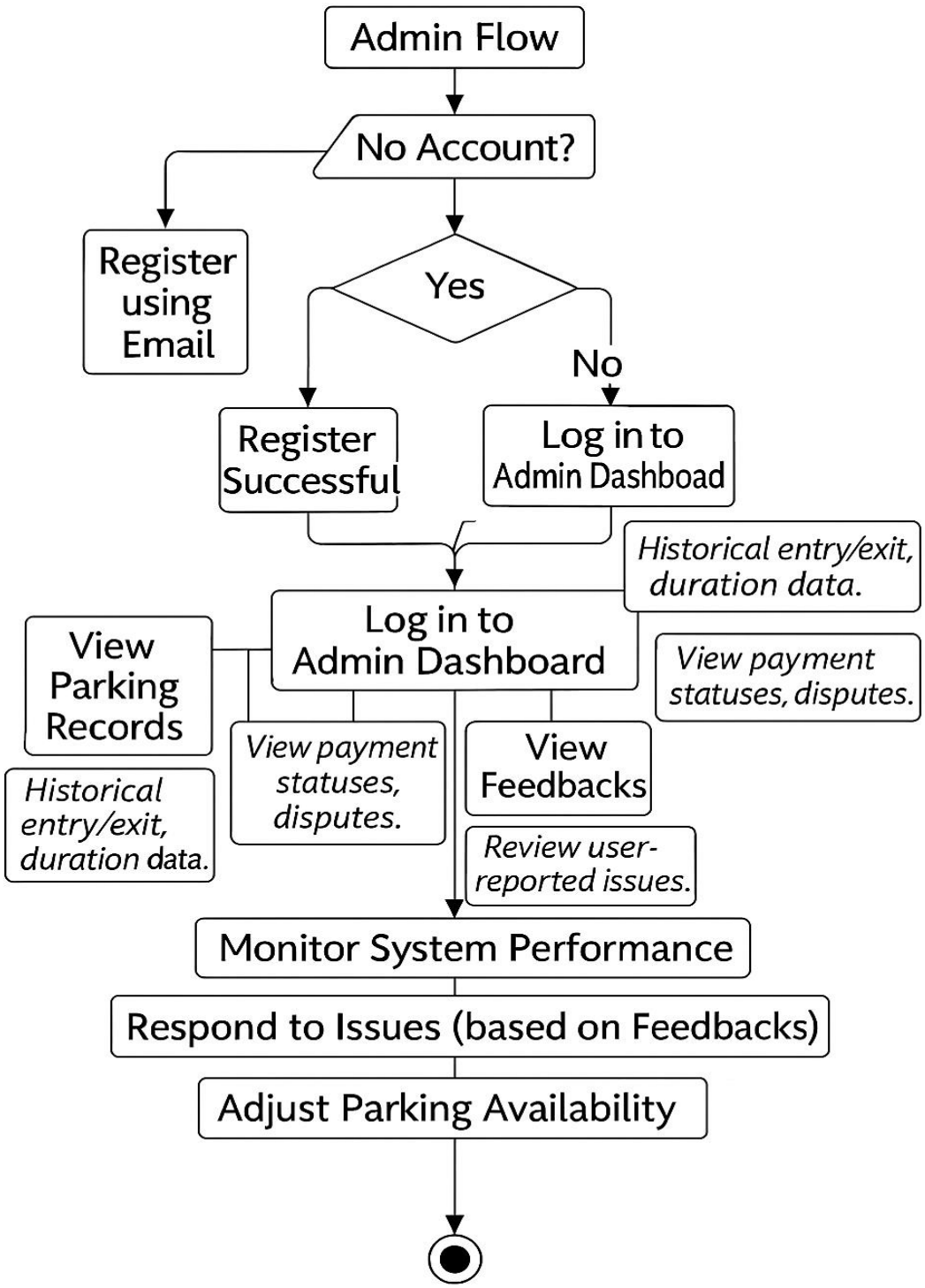
Appendix B: Activity Diagrams



User Activity Diagram



Admin Activity Diagram