Software Engineering Department

ORT Braude College

Capstone Project Phase B

Smart Parking manager

ParkNow

Abstract

The demand for efficient parking management systems has grown significantly, driven by the need to optimize space utilization, reduce congestion, and enhance operational efficiency. This project introduces a smart parking management system designed for administrators, providing real-time simulation of parking lots, automated vehicle tracking, and detailed reporting. By leveraging MySQL for database management and real-time tracking mechanisms, the system ensures seamless monitoring and accurate fee calculations based on parking duration. The core objective of the system is to assist parking administrators in efficiently managing parking spaces by offering real-time visualization of occupancy and automated payment processing. The application enables administrators to monitor vehicle entries and exits, generate comprehensive reports, and optimize space allocation dynamically. Future developments aim to integrate YOLO-based computer vision for automatic empty slot detection using cameras, further enhancing automation and efficiency.

1. Introduction

In contemporary urban environments, the demand for efficient and automated parking management systems has increased significantly. Parking congestion and inefficient space utilization are common problems that lead to traffic delays, environmental concerns, and user dissatisfaction. The need for real-time parking solutions that optimize space allocation, streamline vehicle entry and exit, and automate payment processes is more crucial than ever.

Traditional parking management systems often rely on manual monitoring, leading to inaccuracies in slot availability tracking and delays in payment processing. The emergence of automated parking solutions aims to address these issues by leveraging advanced tracking technologies and database-driven real-time updates. By providing an automated and dynamic approach to parking management, such systems significantly enhance operational efficiency and user convenience.

Beyond the immediate benefits of real-time tracking and automated payments, smart parking management solutions also contribute to broader urban mobility improvements. They reduce unnecessary vehicle circulation in search of parking

spots, minimize human intervention in routine parking operations, and provide administrators with valuable insights into usage patterns and revenue generation. This comprehensive approach fosters a seamless and more intelligent parking experience for both administrators and users.

2. Literature Review

The rapid evolution of smart city technologies has led to various developments in automated parking management systems. Numerous research efforts focus on enhancing parking efficiency through real-time tracking, machine learning-based space allocation, and automated payment processing. This section explores existing solutions, methodologies, and the technological frameworks that drive modern parking management systems.

Several smart parking solutions employ IoT-based sensors to detect available parking slots and update centralized management systems in real time. Others incorporate AI-driven image processing techniques, such as YOLO and OpenCV, to analyze live camera feeds and dynamically identify vacant parking spaces. However, many existing solutions are user-centric rather than administrator-focused, lacking robust tools for comprehensive parking space monitoring and financial report generation.

Our system differentiates itself by prioritizing administrative functionalities. It provides real-time data visualization, dynamic reporting, and an integrated payment system, ensuring that parking lot managers have a complete, automated solution for monitoring and optimizing parking operations.

2. Related Work

The problem of efficient parking management has been a focus of research and development for many years. Numerous studies and projects have attempted to address the challenges associated with urban parking through various

technological solutions. Here, we discuss several notable mobile applications and their limitations, as well as how our project aims to enhance these solutions.

1. **Mobile Applications for Parking Management:** Several mobile applications have been developed to assist drivers in finding available parking spaces.

1.ParkMobile:

ParkMobile is a widely used app that allows users to find, reserve, and pay for parking spaces through their mobile devices. The app is known for its user-friendly interface and extensive coverage in many cities.

Negatives:

Reliability of Data: ParkMobile relies heavily on user-reported data, which can be inconsistent and unreliable.

Availability Updates: The app does not always provide real-time updates on parking space availability, leading to potential frustration for users.

Payment Issues: Some users have reported difficulties with the payment system, including issues with overcharging or payment failures.

2. SpotHero:

SpotHero allows users to search for and reserve parking spaces in advance, often at discounted rates. It is popular for its ability to secure parking spots ahead of time.

Negatives:

Static Data: SpotHero reservations are based on static data that may not reflect real-time changes in parking availability.

Limited Coverage: The app's coverage is limited to certain cities and regions, restricting its usefulness for users in other areas.

User Dependence: Similar to ParkMobile, SpotHero relies on user-reported data for availability, which can be unreliable.

3. Technologies Used in Smart Parking Management

Recurrent Data Processing in Parking Systems Automated parking management relies on real-time data processing to track vehicle movements and optimize space allocation. Similar to recurrent neural networks that process sequential data, smart parking systems must continuously update parking slot availability, monitor vehicle entry and exit times, and calculate fees based on real-time occupancy.

● **Core Components of Parking Data Processing** Smart parking systems consist of several components that work together to manage parking operations efficiently. The **Entry Monitoring System** captures vehicle license plates and assigns available slots using a MySQL database. The **Real-Time Data Tracker** updates the system

continuously, ensuring accurate occupancy status. The **Payment Processing Module** calculates charges based on duration and initiates transactions before vehicle exit.

To enhance efficiency, future implementations may incorporate AI-driven analytics to predict peak usage times and optimize slot allocation dynamically.

● **Output and Application** The final system output provides parking lot administrators with real-time insights into occupancy levels, revenue tracking, and space utilization. The ability to retain and process real-time data enhances operational efficiency and reduces congestion in high-traffic areas.

Real-Time Parking Slot Tracking Using MySQL Database The MySQL database is a robust and scalable solution for managing real-time parking slot availability. It enables efficient tracking of vehicle entry and exit without reliance on external APIs, ensuring minimal latency and secure data management.

The system provides key functionalities such as:

● **Real-Time Slot Availability Tracking:** Updates parking status instantly as vehicles enter or leave.

● **Automated Payment Processing:** Calculates fees dynamically and processes payments before vehicle exit.

● **Multi-Platform Accessibility:** The system is accessible via web and mobile platforms, allowing administrators to manage operations remotely.

Expected Achievements Our project aims to deliver a highly efficient, real-time parking management solution designed to enhance space utilization and streamline parking operations. The system will be accurate, scalable, and user-friendly, offering seamless automation for parking administrators.

By integrating key functionalities, the system ensures that it not only monitors parking activity but also optimizes efficiency through automated tracking and data-driven decision-making. The project aims to create a fully automated solution that

reduces congestion, minimizes manual intervention, and improves the overall parking experience.

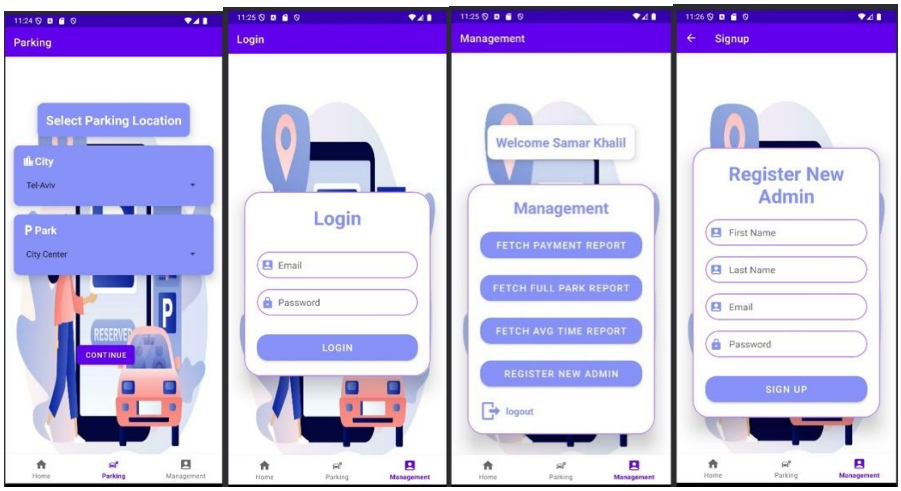
Key Objectives:

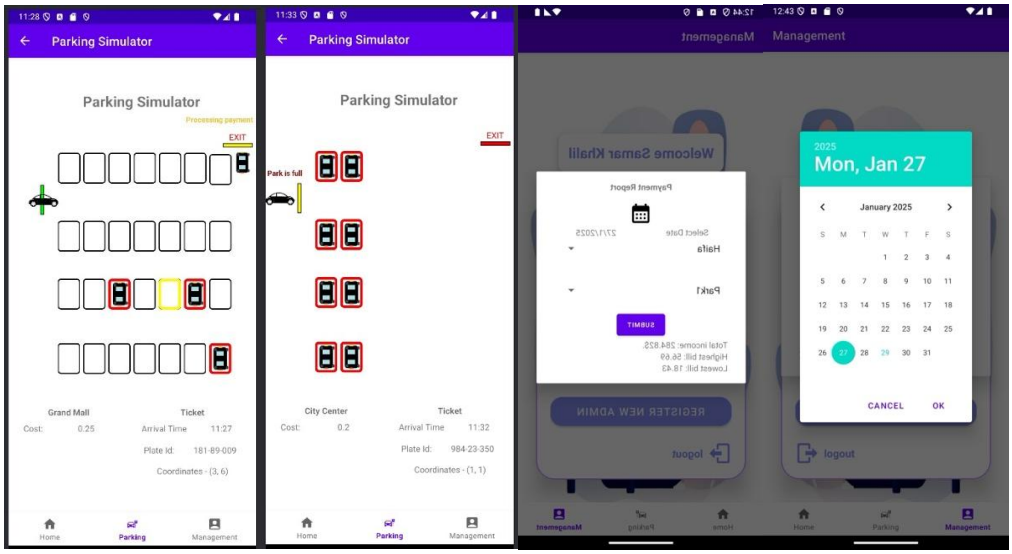
● Developing an intuitive administrator dashboard for real-time monitoring and reporting.

● Utilizing MySQL for dynamic tracking of parking slots and vehicle movements.

● Ensuring real-time processing with minimal latency using server-side optimization.

● Enhancing automation through predictive analytics and AI-driven space allocation in future versions.





Visual representation showcasing the anticipated appearance and functionality of our app

3.1 User-Friendly Interface

We aim to create an intuitive interface that seamlessly displays real-time parking slot availability while offering administrators an efficient dashboard for monitoring parking operations. The interface will include features such as:

- Real-time updates on available and occupied parking slots.
- A graphical representation of parking lot status.
- Access to vehicle entry and exit logs.
- An easy-to-navigate interface with filtering options for reports.

3.2 Real-Time Parking Tracking and Processing

The system will utilize sensors or a counter-based mechanism to monitor vehicle entries and exits in real time. By leveraging MySQL for data storage, the system ensures accurate and immediate updates regarding parking space occupancy. Additionally, the dashboard provides a seamless experience for administrators to track parking activity and generate financial reports efficiently.

3.3 Success Criteria of the Project

● **Accuracy of Parking Slot Monitoring:** Ensures that available and occupied slots are tracked with precision, minimizing errors in space allocation.

● **Efficiency of Processing:** Ensures that updates regarding parking slot occupancy are reflected instantly on the dashboard, allowing for quick decision-making.

● **User Interface Usability:** Features a streamlined and intuitive administrator dashboard that enables easy monitoring of parking activities and reports.

● **Automation and Future Enhancements:** The system will integrate AI-based detection in future versions to improve slot availability tracking using camera-based identification.

● **Positive Administrator Feedback:** Focuses on delivering an effective solution that streamlines parking management, optimizes space utilization, and reduces manual intervention.

4. Engineering Process

4.1 The Process of Crafting Software and Conducting Research

This process consists of two stages:

Stage A – The Design:

● **Researching Parking Management and Automation Needs:** We conducted extensive research on parking automation technologies and their applications. The focus was on identifying key administrator needs, including real-time monitoring, automated fee calculation, and efficient report generation.

● **Exploring Existing Parking Solutions:** We analyzed current smart parking solutions, including IoT-based and camera-based tracking systems, to determine the most effective approach for real-time parking management.

● **Defining Project Requirements and Features:**

We outlined the system's core functionalities, including:

- Real-time tracking of parking slot status.
- Automated fee calculation based on duration.
- A comprehensive administrator dashboard for parking management.

The features were prioritized based on feasibility and their impact on efficient parking operations.

● **Selecting Tools and Technologies:** After evaluating various options, we selected:

- **Frontend:** Android Studio for mobile-based management.
- **Backend:** Eclipse for server-side logic and data processing.
- **Database:** MySQL for real-time storage of parking session details.

● **Designing the System Architecture:**

- **Frontend:** An Android-based mobile application for administrator control.
- **Backend:** Eclipse-based server for handling parking transactions and slot updates. ○ **Database:** MySQL for storing real-time vehicle entry and exit logs.
- **Creating Activity and Use Case Diagrams:** The system's workflows were documented through diagrams to visualize administrator interactions, parking slot management, and payment processing.

Stage B – The Implementation:

● **Developing the Parking Management System:**

Implementing real-time tracking of available and occupied parking slots using MySQL.

Ensuring vehicle entry and exit updates dynamically reflect in the database.

● **Building the Backend Infrastructure:**

Developing REST APIs in Eclipse to facilitate data exchange between the frontend and backend.

Implementing secure transaction handling for payments and reporting.

● **Developing the Administrator Dashboard:**

Creating an intuitive interface to monitor parking availability, generate reports, and process payments.

● **Implementing Real-Time Processing Features:**

Enabling dynamic updates on slot availability and vehicle movements.

Automating fee calculations based on the time a vehicle remains parked.

Future enhancements include AI-powered slot detection using camera-based systems.

● **Gathering Administrator Feedback:** Collecting feedback from administrators to refine system usability, optimize reporting features, and improve automated space allocation.

By prioritizing real-time tracking, automation, and efficiency, this system ensures smooth parking operations while reducing manual workload for administrators.

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● **Gathering Administrator Feedback:**

Collecting feedback from administrators to refine system usability, optimize reporting features, and improve automated space allocation.

4.1.1 Requirements

4.1.1.1 Functional Requirements

● **User Authentication:** The system allows administrators to log in using a username and password. Secure authentication is ensured through industry-standard encryption methods.

● **Parking Slot Management:** The system enables administrators to define parking lot configurations, including total spaces and reserved areas. The system dynamically updates parking availability based on vehicle entry and exit. If the parking lot is full, the system prevents further entries and notifies the administrator.

● **Real-Time Monitoring and Reporting:** The system provides real-time monitoring of occupied and available parking spaces. Reports can be generated for revenue tracking, peak usage analysis, and operational insights.

● **Automated Payment System:** The system calculates parking fees based on the duration of stay. Users must complete payment before exiting the parking lot. Payment logs are securely stored for auditing and financial tracking.

4.1.1.2 Non-Functional Requirements

● **User Interface Usability:** The administrator dashboard is designed to be intuitive, ensuring easy navigation and real-time updates. The system allows administrators to customize report parameters for detailed analysis.

● **System Performance:** The system processes vehicle entry, exit, and payment transactions efficiently, minimizing latency. It ensures accurate tracking of parking slots with minimal data processing overhead.

● **Privacy and Security:** The system securely stores all user credentials, parking logs, and transaction records. Payment transactions are encrypted to protect financial data and prevent unauthorized access.

4.1.2 Deciding Which Technologies We Will Use

● **Parking Slot Management Technology:** ANPR (Automatic Number Plate Recognition): This technology will provide real-time identification of vehicles entering and exiting the parking lot. ANPR cameras will capture license plate numbers, enabling automated tracking and management of parking sessions. This technology will be evaluated for its accuracy, reliability, and performance in various lighting and weather conditions.

● **Database Management:** MySQL: MySQL will be used as the primary database for storing vehicle entry and exit logs, parking slot availability, and payment records. It offers scalability, reliability, and efficient data retrieval for real-time operations.

● **API Integration:** Integration Approach: The system will utilize RESTful API calls to integrate real-time vehicle tracking and payment processing. ANPR cameras will send data to the backend for validation and storage, ensuring seamless communication between components.

● **Data Management:** Cloud-Based Storage: The system will leverage cloud storage for securely maintaining transaction records, reports, and real-time parking updates. This approach ensures data integrity, scalability, and remote accessibility for parking administrators.

● **Summary of Benefits:** By leveraging ANPR technology, MySQL, and cloud-based storage, the system will deliver a reliable, scalable, and efficient solution for parking management. The integration of automated vehicle tracking and real-time data updates will enhance accuracy, reduce manual workload, and improve the overall efficiency of parking operations.

4.1.3 Environments

● **Front-End (UI) Development:** Android Studio: Used for developing the client-side application.

● **Back-End Development:** Eclipse: Used for setting up the server-side infrastructure and backend processing.

● **Database:** MySQL: Chosen for its structured and scalable data management, allowing efficient storage and retrieval of parking records.

● **APIs:**

Custom REST APIs: Developed to facilitate communication between the Android client and the Eclipse-based backend.

● **Deployment Tools:**

Android Studio: Used for deploying and testing the Android client application.

Eclipse: Used for deploying and managing the server environment.

4.1.4 Development Methodology

The dynamic nature of our parking management system led us to adopt the Agile methodology for development. Agile provides an iterative and flexible approach, enabling continuous feedback and adaptation to real-world needs. The development process is structured into iterative sprints, each focusing on refining existing functionalities and adding new features.

In the initial sprint, the team developed a functional prototype that included fundamental parking management features, such as tracking available and occupied spaces and processing vehicle entry and exit records. The first iteration also focused on setting up communication between the Android client and the Eclipse-based server.

Subsequent sprints aim to enhance these functionalities by integrating automated fee calculation, real-time data synchronization, and an administrator dashboard for

viewing parking reports and managing transactions. Each iteration undergoes rigorous testing to ensure system reliability and usability in real-world scenarios.

User feedback is crucial in refining the system, ensuring that features align with administrator expectations. Administrators will evaluate the dashboard and reporting tools, leading to improvements in data visualization, payment processing, and system alerts for full parking lots.

The Agile methodology ensures adaptability to emerging requirements. Future enhancements, such as camera-based slot detection and predictive analytics, will be prioritized in later sprints based on feasibility and impact. By emphasizing continuous improvement and flexibility, Agile development guarantees a robust, efficient, and user-friendly parking management solution.

4.1.5 Challenges

● **Real-Time Processing and Latency:** ○ Ensuring that parking slot updates and payment processing happen with minimal delay is critical for maintaining a smooth user experience. Managing concurrent vehicle entries and exits efficiently remains a challenge, particularly during peak hours.

● **Accuracy of Parking Slot Management:** ○ Maintaining an accurate count of available and occupied slots in real time is crucial, especially when integrating future AI-based camera detection features.

● **Data Privacy and Security:** Securing parking transaction data, including payment records and user credentials, is essential for maintaining user trust and regulatory compliance.

● **Integration with Third-Party APIs:** Dependence on external APIs for payment processing and potential AI integrations introduces reliability risks and service disruptions.

● **Cross-Platform Consistency:** Ensuring smooth operation and UI consistency across different devices, screen sizes, and operating systems remains a technical challenge.

4.2 Product

4.2.1 Software Architecture Diagram

This section outlines the architecture of the Smart Parking Management System, showcasing its components and how they work together to manage parking slot availability, process transactions, and provide real-time monitoring. The system is built as a client-server model, integrating both cloud-based services and a dedicated backend server.

Client App:

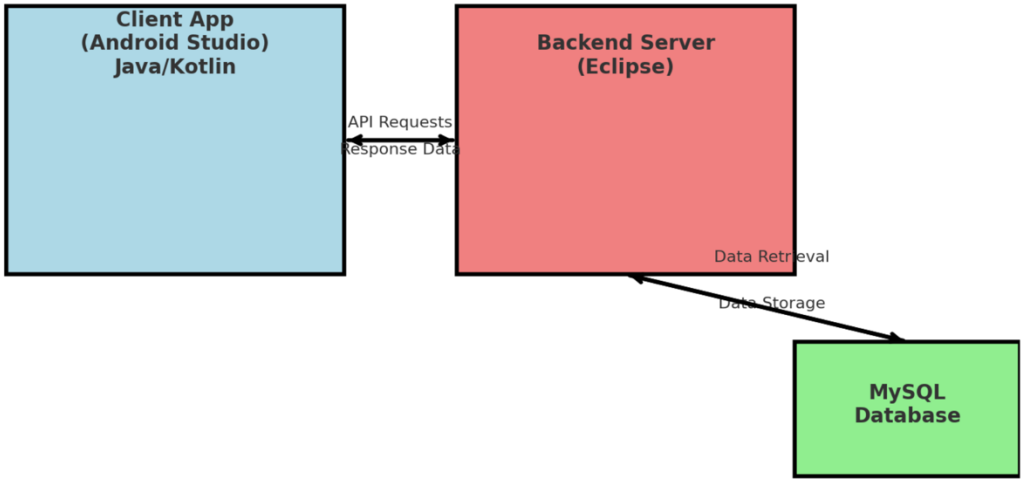
● **Android Studio:** The entire application is developed using Android Studio, ensuring seamless performance and optimization for Android devices.

● **Java:** Handles the app's user interface, logic, and communication with the backend.

● **Native Features:** Android's built-in features, such as GPS and network monitoring, are used to track real-time vehicle movement.

Backend Services:

1. **Eclipse-Based Server:** Handles parking slot allocation, vehicle entry/exit processing, and administrator functionalities. Processes real-time payment calculations and transaction storage.
2. **MySQL Database:** Stores all parking session details, user credentials, and payment records in a structured format.
3. **External APIs:** Future integrations may include AI-powered parking slot detection using camera-based systems. ○ Online payment gateways for seamless transaction processing.



4.2.2 Use Case Diagram

The use case diagram outlines the key functionalities of the Smart Parking Management System:

● **Choose City and Parking Lot:** Allows the administrator to select a city and specific parking area for management. This feature includes an option to check available parking spaces and details of parked vehicles.

● **Check Available Parking:** Provides real-time data on parking slot availability, ensuring that administrators can monitor occupancy and make informed decisions.

● **See Parking Simulator:** A visualization tool that simulates real-time parking activity, displaying vehicle entry, exit, and slot occupancy dynamically.

● **See Vehicle Parking Details:** Enables the administrator to view detailed information about each parked vehicle, including license plate ID, arrival time, and assigned parking slot.

● **Log In:** Authenticates administrators, granting them access to the management dashboard and its functionalities.

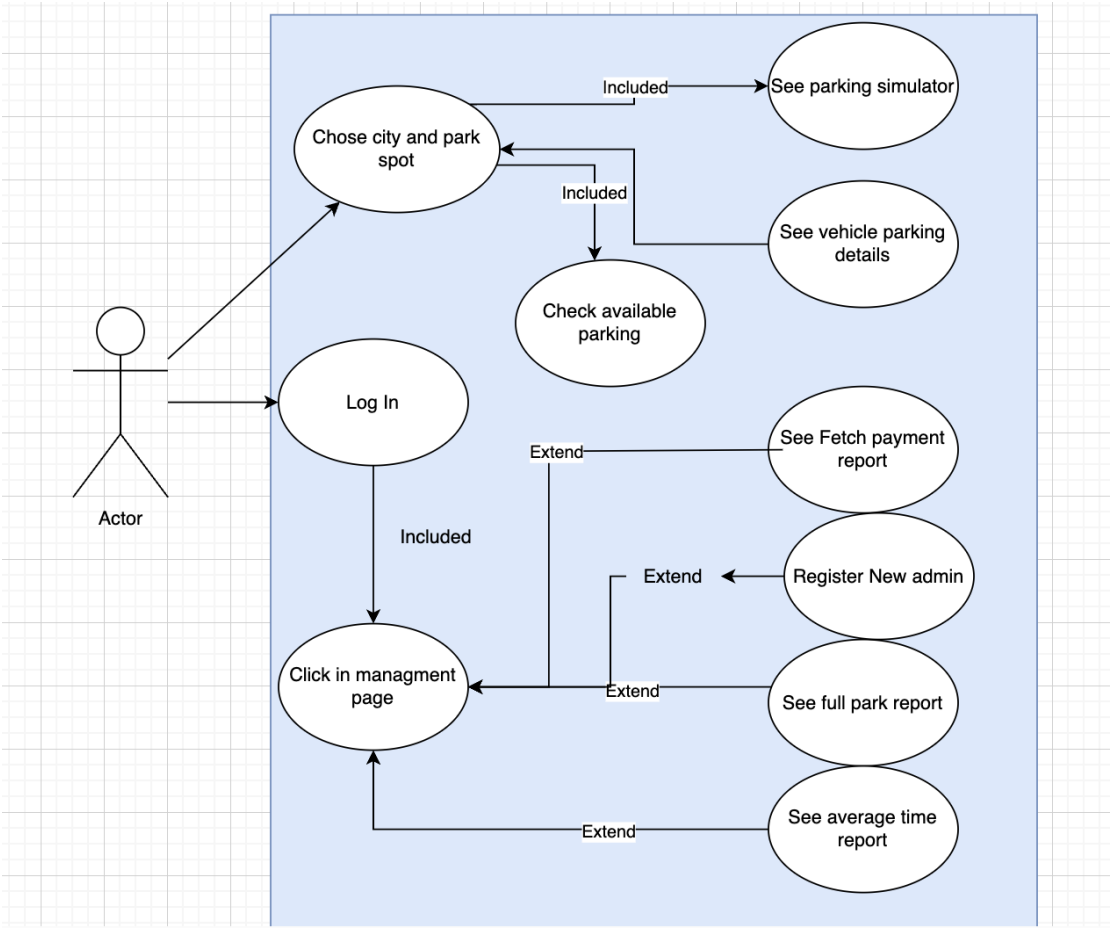
● **Click on Management Page:** Grants access to all administrative controls, including reports and user management.

● **Fetch Payment Report:** Displays detailed transaction history, including payments processed for each parked vehicle.

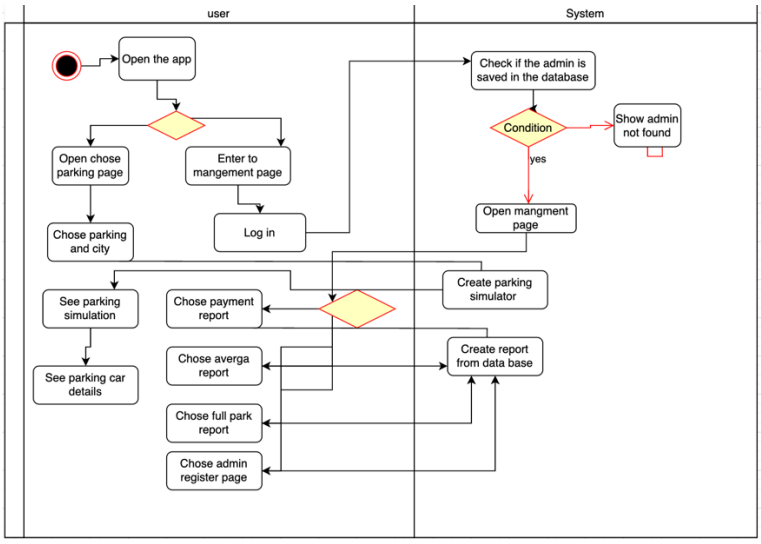
● **See Full Park Report:** Provides comprehensive analytics on parking lot usage, including peak hours and occupancy trends.

● **See Average Time Report:** Shows the average parking duration of vehicles to help administrators optimize space utilization.

● **Register New Admin:** Allows the addition of new administrators with different access levels to manage parking operations more effectively.



4.2.3 Activity Diagram



4.2.3 User Interaction & System Processing

User Interaction:

Opening the App: The administrator starts by opening the app, where they can log in to access parking management features.

● **Choosing an Action:** After logging in, the administrator selects an action: view parking status, generate reports, select parking location and parking name, process vehicle entry/exit, see parking simulation or manage users.

● **Processing Vehicle Entry:** The administrator can register a new vehicle, assigning it a parking slot if available.

● **Processing Vehicle Exit:** When a vehicle exits, the administrator confirms departure, and the system calculates the parking fee.

● **Accessing Reports:** The administrator can generate reports on occupancy rates, revenue, and average parking duration.

System Processing:

● **Updating Parking Availability:** The system updates available and occupied slots based on vehicle entry and exit records.

● **Calculating Fees:** When a vehicle exits, the system calculates the parking fee based on duration and pricing policies.

● **Storing Transactions:** All vehicle entry/exit logs and payments are stored securely in the MySQL database.

● **Real-Time Dashboard Update:** The dashboard provides live updates on parking lot status, ensuring accurate tracking of availability.

Key Features and Flexibility:

● **User Management:** Administrators can add, remove, or update user roles within the system.

● **Automated Fee Calculation:** The system dynamically calculates parking fees and logs transactions for financial tracking.

● **Real-Time Reporting:** Administrators receive live insights into parking occupancy, usage patterns, and revenue.

4.2.4 User-Friendly Interface

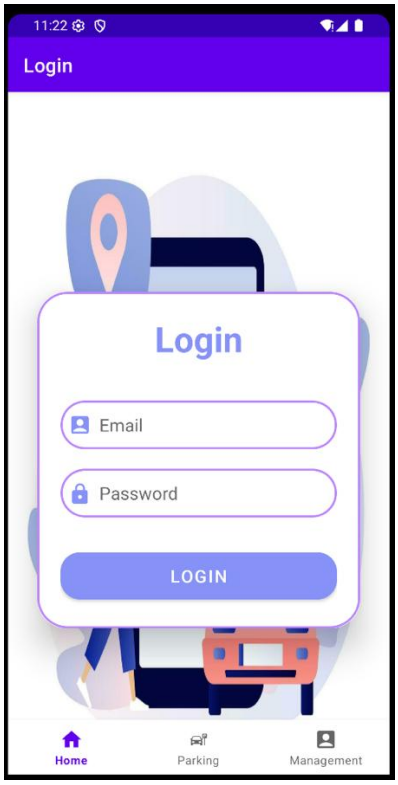
Login Screen This page allows administrators to log in and access the system's functionalities.

● **Login Form:** Administrators enter their username and password to authenticate.

● **Secure Access:** Multi-factor authentication ensures only authorized users access the system.

● **Admin Registration:** System super-administrators can create new accounts for additional administrators.

By ensuring a seamless user experience, the system enhances operational efficiency for parking lot managers, automating key processes while maintaining an intuitive and user-friendly interface.



Parking Location Selection Page

This screen allows the administrator to **select a city and a specific parking lot** before proceeding to manage parking operations.

Key Features:

- **City Selection:**
  - The user can select a city from the dropdown menu. In this example, "Tel-Aviv" is selected.
- **Parking Lot Selection:**
  - Once a city is selected, a second dropdown appears with available parking lots within that city.
  - In the example, the administrator can choose between **City Center, Tel-Aviv University, or Azrieli Mall**.
- **Continue Button:**

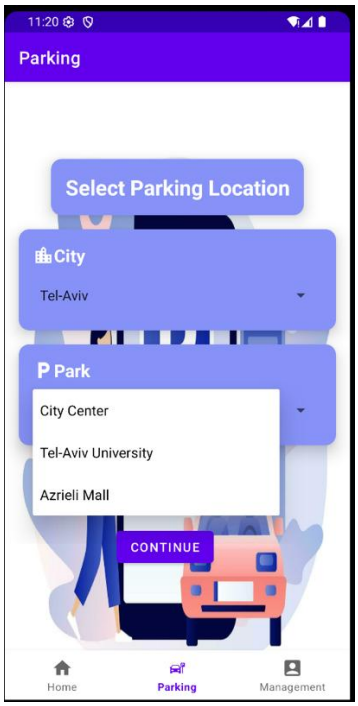
- After selecting both the city and parking lot, the user clicks **"CONTINUE"** to proceed to the parking management interface.

Purpose:

- This page ensures that the system loads the correct parking lot data for tracking occupancy, generating reports, and processing vehicle entries and exits.

User Flow:

1. The administrator selects a **city**.
2. The administrator selects a **specific parking lot** from the dropdown.
3. Clicking **“CONTINUE”** loads the relevant parking simulation and management tools.



Parking Simulator Page

This screen provides a **real-time simulation** of the parking lot, displaying vehicle movements, available and occupied slots, and processing payments for exiting vehicles.

Key Features:

- **Parking Slot Visualization:**
  - The parking lot layout is shown with empty, occupied, and exiting spots.
  - **Occupied parking slots** are marked with **red borders**.
  - **An available slot** is highlighted in **yellow**.
- **Vehicle Entry & Exit:**
  - The system shows a **new car entering** from the left.
  - A **car near the exit gate** is processing payment before leaving.
- **Real-Time Payment Processing:**
  - The text **"Processing payment"** appears at the top, indicating that an exiting vehicle is being charged based on its parking duration.
- **Vehicle Information Display:**
  - **Parking Lot Name:** "Grand Mall"
  - **Cost:** Displays the calculated parking fee (**0.25** in this case).
  - **Arrival Time:** The recorded entry time (**11:27**).
  - **Ticket Number:** A unique ID for the vehicle (**181-89-009**).
  - **Coordinates:** The precise parking location within the lot (**3,6**).

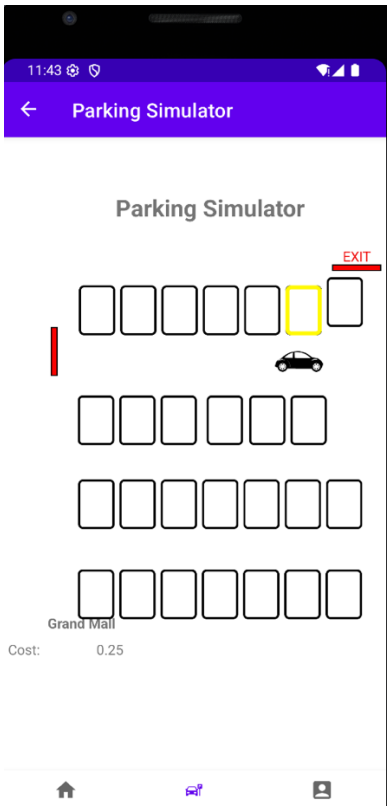
Purpose:

- Allows administrators to monitor the **real-time status** of the parking lot.
- Displays information about **each parked vehicle**, including time of entry and assigned slot.
- Facilitates **automated payment processing** before vehicles exit.

User Flow:

1. Vehicles enter the parking lot automatically and are assigned to an **available space**.

2. When a vehicle **requests to exit**, the system calculates the **parking fee**.
3. Once the **payment is processed**, the vehicle is removed from the parking lot, and the slot becomes **available** again.



Full Parking Lot Alert Page

This screen notifies the administrator that the **parking lot is full**, preventing new vehicles from entering.

Key Features:

- **Full Parking Lot Alert:**
  - A **car at the entrance** is shown with the message **"Park is full"**, indicating no available spaces.
- **Occupied Parking Slots:**
  - All slots are filled, marked with **red-bordered vehicles**.
- **Exit Area:**

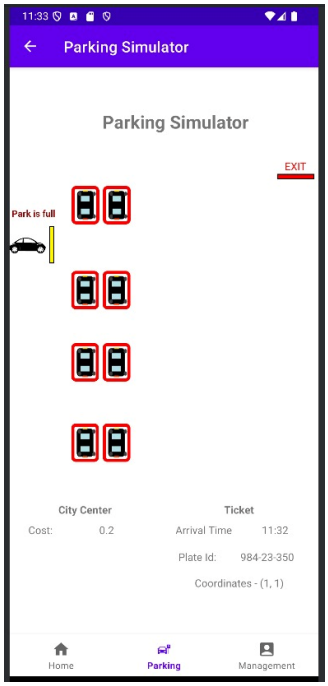
    - The **EXIT** is visible at the top-right, where vehicles leave after payment.
- **Vehicle Information Display:**
    - **Parking Lot Name:** "City Center"
    - **Cost:** Parking fee calculated for this vehicle (**0.2**).
    - **Arrival Time:** The recorded entry time (**11:32**).
    - **Ticket Number:** A unique ID for the vehicle (**984-23-350**).
    - **Coordinates:** The assigned parking location (**1,1**).

Purpose:

- Prevents new vehicles from entering once the parking lot reaches maximum capacity.
- Ensures that the system **dynamically tracks availability** and restricts access accordingly.
- Displays **detailed vehicle information** for reference.

User Flow:

1. A new vehicle approaches the parking lot.
2. The system **checks availability**:
    - If **slots are available**, the car is assigned to a spot.
    - If **no slots are available**, the message **"Park is full"** appears.
3. The vehicle must **wait until a spot becomes free** or **find alternative parking**.



Management Dashboard Page

This screen serves as the **administrative control panel**, allowing the parking lot manager to access reports and manage users.

Key Features:

- **Administrator Welcome Message:**
  - Displays the logged-in administrator's name (**"Welcome Samar Khalil"**), confirming authentication.
- **Management Options:**
  - **Fetch Payment Report:** View transaction history and revenue from parking payments.
  - **Fetch Full Park Report:** Generate a report of parking usage, including entry and exit records.
  - **Fetch Average Time Report:** Analyze the average parking duration for vehicles.
  - **Register New Admin:** Add new administrators to the system for role-based access.

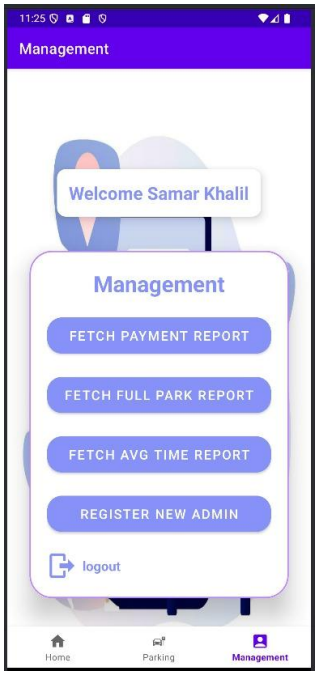
- **Logout Button:**
    - Allows the administrator to log out and return to the login screen.

Purpose:

- Provides a **centralized interface** for managing financial reports, parking statistics, and administrator access.
- Enables **data-driven decision-making** by generating usage and payment analytics.
- Ensures **secure access control**, allowing only authorized administrators to register new users.

User Flow:

1. The administrator logs in and accesses the **Management** tab.
2. They select a report or user management action.
3. The system retrieves and displays the requested information.
4. The administrator can **log out** when done.



Admin Registration Page

This screen allows **administrators to register new admin accounts**, ensuring controlled access to the parking management system.

Key Features:

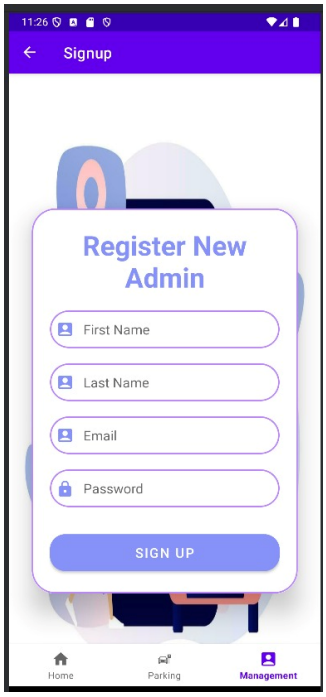
- **Registration Form:**
  - **First Name & Last Name:** The new admin's full name.
  - **Email:** Used for login credentials and system notifications.
  - **Password:** Secure authentication for accessing the management system.
- **Sign-Up Button:**
  - Once the form is completed, clicking **“SIGN UP”** registers the new admin.

Purpose:

- Provides **role-based access control**, ensuring that only authorized personnel manage parking operations.
- Enables **secure authentication** for new administrators.
- Simplifies **adding new admins** without requiring manual database updates.

User Flow:

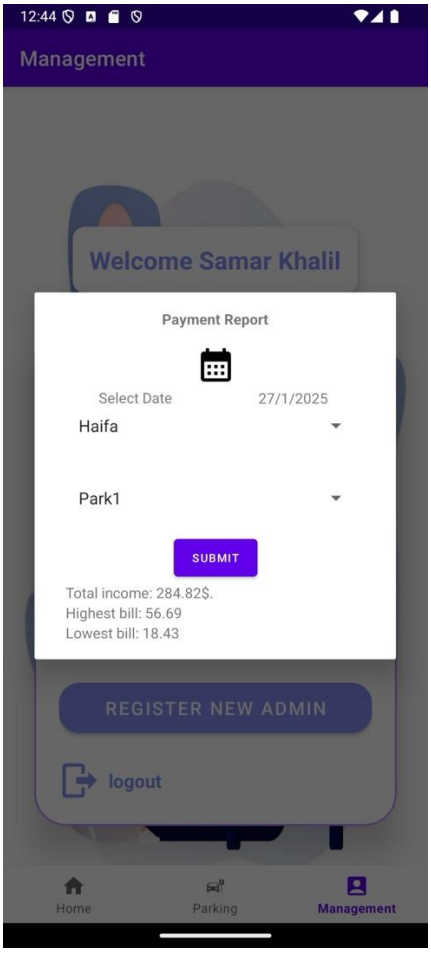
1. The current administrator navigates to the **Management Page** and selects **"Register New Admin."**
2. They fill in the **new admin's details** in the form.
3. Clicking **“SIGN UP”** registers the admin, granting them system access.



Payment Report Page

This page allows administrators to view detailed payment reports for specific parking lots on a selected date.

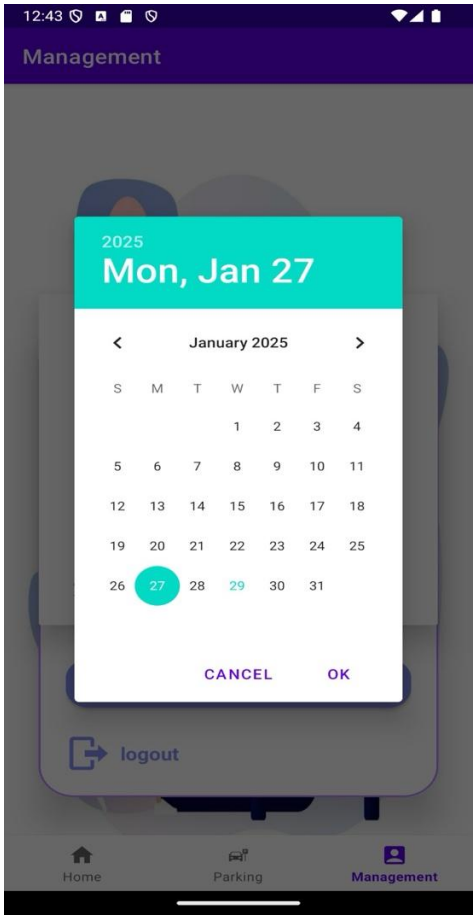
- **Date Selection:** Administrators can select a specific date using the date picker.
- **Location Selection:** The city and parking lot can be chosen from the dropdown menus.
- **Submit Button:** Retrieves the payment report for the selected date and location.
- **Displayed Results:**
    - **Total Income:** Displays the total revenue generated from parking fees on the selected date.
    - **Highest Bill:** Shows the highest individual parking bill recorded.
    - **Lowest Bill:** Displays the lowest parking fee recorded.
- **Functionality:** Used in multiple reports, including payment reports and average parking time reports.



Date Picker Page

This popup allows users to select a specific date for generating reports.

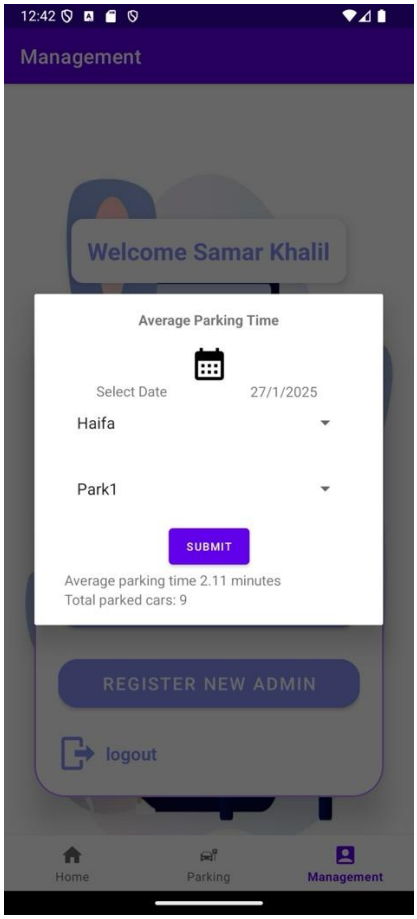
- **Calendar View:** Users can navigate through months and years to select the desired date.
- **OK Button:** Confirms the selected date.
- **Cancel Button:** Closes the date picker without making any changes.
- **Functionality:** Used in multiple reports, including payment reports and average parking time reports.



Average Parking Time Report Page

This page provides statistical data on the average parking duration for a specific location and date.

- **Date Selection:** Users choose the date for which they want to view the report.
- **Location Selection:** Administrators select the city and parking lot from the dropdown menus.
- **Submit Button:** Retrieves the average parking time report based on the selected parameters.
- **Displayed Results:**
    - **Average Parking Time:** Shows the average duration that vehicles stayed in the parking lot.
    - **Total Parked Cars:** Displays the total number of cars that used the parking lot on the selected date.



5. Verification Plan

5.1 Tests

Test Real-Time Parking Slot Update

● **Expected Result:** The system updates available and occupied parking slots in real time with at least 95% accuracy.

● **Measurement:** Compare system updates with actual vehicle entry and exit logs.

● **Explanation:** Ensures that the parking lot status remains accurate at all times.

Test Vehicle Entry Processing

● **Expected Result:** The system correctly registers a new vehicle and assigns an available parking slot.

● **Measurement:** Verify that a new entry is logged in MySQL and displayed on the parking simulator.

● **Explanation:** Ensures smooth vehicle entry processing without system errors.

Test Vehicle Exit and Payment Calculation

● **Expected Result:** The system correctly calculates the parking fee based on duration and ensures payment before exit.

● **Measurement:** Compare calculated fees with expected values based on the configured pricing model.

● **Explanation:** Ensures proper fee calculation and secure payment handling before vehicle departure.

Test Full Parking Lot Handling

● **Expected Result:** When the parking lot is full, the system prevents additional vehicle entries and displays an appropriate alert.

● **Measurement:** Simulate a full parking scenario and verify that new vehicles cannot enter.

● **Explanation:** Confirms that the system enforces capacity limits effectively.

Test Parking Reports Generation

● **Expected Result:** The system generates accurate reports for payments, occupancy, and average parking duration.

● **Measurement:** Compare generated reports with manually recorded parking data.

● **Explanation:** Ensures the correctness and reliability of the reports used by administrators.

Test Administrator Login and Authentication

● **Expected Result:** Only registered administrators can log in, while incorrect credentials are rejected with error messages.

● **Measurement:** Attempt login with valid and invalid credentials to check authentication response.

● **Explanation:** Ensures secure administrator access to the system.

Test Register New Administrator Feature

● **Expected Result:** A new administrator account can be created successfully and stored in the database.

● **Measurement:** Register a new admin and verify the stored details in the MySQL database.

● **Explanation:** Ensures proper role management and controlled system access.

Test Parking Slot Availability Detection

● **Expected Result:** The system accurately updates parking availability when vehicles enter and exit.

● **Measurement:** Verify changes in available slots in real time as vehicles move in and out.

● **Explanation:** Ensures smooth tracking of parking space occupancy.

Test User Interface Responsiveness

● **Expected Result:** The application functions smoothly across different devices and screen sizes.

● **Measurement:** Test UI consistency on various Android devices with different resolutions.

● **Explanation:** Ensures usability and accessibility across different platforms.

Test Logout Functionality

● **Expected Result:** Administrators can log out, and access to the management panel is restricted after logout.

● **Measurement:** Log out and attempt to access restricted pages to confirm logout success.

● **Explanation:** Ensures session security and prevents unauthorized access.

Test Data Storage and Retrieval

● **Expected Result:** Vehicle entries, exits, payments, and reports are stored and retrieved accurately.

● **Measurement:** Compare stored data in MySQL with displayed data in the app.

● **Explanation:** Confirms reliable data storage and retrieval mechanisms.

Test Payment Processing Security

● **Expected Result:** Payments are processed securely, and incorrect transactions are rejected.

● **Measurement:** Attempt various valid and invalid payment transactions and verify system response.

● **Explanation:** Ensures the integrity and security of financial transactions.

Test System Performance Under Load

● **Expected Result:** The system maintains functionality even when multiple vehicles enter or exit simultaneously.

● **Measurement:** Simulate a high-traffic scenario and observe response times.

● **Explanation:** Ensures system scalability and stability under heavy usage.

Test Parking Simulator Visualization

● **Expected Result:** The parking simulator visually updates in real time as vehicles enter and exit.

● **Measurement:** Observe the simulator's accuracy compared to backend logs.

● **Explanation:** Ensures synchronization between the parking visualization and real-time data.

By performing these tests, we ensure that the parking management system operates reliably, efficiently, and securely under various real-world conditions.

5.2 Constraints

1. Hardware Limitations The system’s performance may be affected by the processing power of the administrator’s device. Low-end devices with limited memory may experience delays in loading parking data and generating reports.

2. Network Connectivity As the system relies on MySQL database connectivity and cloud-based storage, poor internet connection may lead to data synchronization issues, delays in report generation, or failures in processing transactions.

3. Environmental Factors Fluctuations in power supply, server downtime, or unpredictable internet failures could affect the ability to manage real-time parking operations efficiently.

4. Data Accuracy The accuracy of parking slot availability and payment calculations depends on the integrity of data received from vehicle entry and exit logs. Any inconsistency in data entry could impact operational efficiency.

5. Compliance with Regulations The system must adhere to data privacy regulations, such as GDPR, to ensure secure handling of payment transactions and vehicle registration data. Compliance requirements may impose additional security constraints on the system.

5.3 Assumptions

1. Consistent Administrator Interaction It is assumed that administrators will operate the system correctly by logging in, monitoring reports, and processing payments as per standard operating procedures.

2. Stable Server and Database Connectivity The system assumes a stable connection between the application and the MySQL database to ensure uninterrupted access to parking records and transaction history.

3. Availability of Parking Sensors or Manual Entry It is assumed that vehicle entries and exits are either detected through sensors or manually updated by administrators to maintain accurate parking slot availability.

5.4 User's Evaluation and Feedback

5.4.1 User Interface Evaluation

● Gather feedback from 10 administrators on the ease of use and clarity of the management dashboard.

● Identify areas for UI improvement to enhance user experience in handling parking operations.

● Some of the key questions: ○ How would you rate the dashboard's clarity and usability? ○ Was navigating between reports and management features intuitive? ○ Were there any functionalities that seemed confusing or difficult to use? ○ What features could improve your workflow as an administrator?

5.4.2 General Feedback Collection

● Collect feedback from 10 administrators regarding the overall effectiveness of the parking management system.

● Gather suggestions for feature enhancements or improvements in report accuracy and system performance.

● Some of the key questions: ○ How effective is the system in managing parking lot operations? ○ Does the system provide accurate and timely parking availability updates? ○ What improvements would you suggest for the payment and reporting functionalities? ○ Are there any additional features that would make parking management more efficient?

By conducting these evaluations, the system can be refined to improve usability, accuracy, and overall efficiency for parking administrators.

6. The Process of Crafting Software

Parking Slot Management System Integration: The system was developed to efficiently track available and occupied parking slots in real time. Vehicles are assigned to free spots upon entry, and their status is updated dynamically in the database.

MySQL Database Integration: A MySQL database was implemented to store vehicle entry and exit logs, payment records, and parking slot availability. This ensures secure and efficient data retrieval for parking administrators.

User Interface Development: Several user-friendly UI components were developed, including:

● **Login and Admin Registration Pages:** Allow administrators to securely log in or create new admin accounts.

● **Parking Management Dashboard:** Provides access to reports, parking lot status, and user management tools.

● **Parking Simulator Page:** Displays real-time visualization of occupied and available parking slots.

Real-Time Parking Management Workflow:

● The system registers vehicle entries, dynamically updating the available parking spots in MySQL.

● Upon exit, the system calculates the parking fee based on the duration of stay.

● Payments are processed, and the parking slot is marked as available for the next vehicle.

Error Management and Feedback:

● Common issues, such as inaccurate slot tracking or incorrect fee calculations, were addressed through thorough testing and debugging.

● Administrators provided feedback on UI improvements, resulting in a more efficient and intuitive parking management system.

Database and Storage:

● MySQL was chosen for its structured approach to handling parking transactions and reports.

● The system ensures quick retrieval of data and accurate synchronization between the UI and backend.

Testing and Refinement:

● Rigorous testing was conducted to verify system performance, accuracy, and reliability.

● Real-world testing scenarios were implemented to ensure the system functions correctly under heavy traffic conditions.

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7. Description of Challenges Faced

During the development and implementation of the parking management system, several technical and operational challenges arose. Below is a detailed account of these challenges and the solutions implemented:

1. Ensuring Real-Time Slot Availability Updates

○ **Challenge:** Synchronizing the database with real-time parking lot activity to prevent inaccurate slot counts.

○ **Solution:** Implemented database triggers and periodic data refresh techniques to ensure accuracy and prevent discrepancies in availability tracking.

2. Implementing Secure Payment Processing

○ **Challenge:** Ensuring that parking fee transactions are correctly calculated and securely processed.

○ **Solution:** Developed a structured pricing model in MySQL, integrating it with secure payment gateways to minimize errors and ensure accurate billing.

3. Handling Full Parking Lot Scenarios

○ **Challenge:** Preventing new vehicle entries when the parking lot reaches full capacity.

○ **Solution:** Implemented a blocking mechanism that prevents new entries once the system detects full occupancy and provides an alert to the administrator.

4. Optimizing System Performance for High Traffic

○ **Challenge:** Ensuring that the system remains responsive when handling multiple vehicle entries and exits simultaneously.

○ **Solution:** Optimized database queries and used caching techniques to reduce load times, ensuring smooth performance even under peak conditions.

By addressing these challenges, we successfully built a reliable and efficient parking management system that provides accurate tracking, real-time updates, and secure financial transactions.

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8. Conclusions

Achievement of Project Goals:

The parking management system successfully meets its primary objectives of providing a real-time, efficient, and user-friendly solution for tracking and managing parking spaces. By integrating a MySQL database, the system ensures accurate vehicle entry and exit tracking, while the user interface provides administrators with an intuitive experience.

The implementation prioritizes automation and accuracy, ensuring that vehicles are correctly assigned to available spots, fees are calculated based on parking duration, and reports are generated efficiently. Challenges such as real-time updates, full parking scenarios, and payment processing were addressed, resulting in a stable and scalable solution. Overall, the system demonstrates its potential to streamline parking operations and enhance administrative efficiency.

Decision-Making Process:

The development process involved making key decisions to optimize efficiency and usability. MySQL was selected for its robust data management capabilities, ensuring structured and secure storage of parking transactions. The parking simulator was designed to provide a clear visual representation of occupied and available slots, helping administrators monitor the system effectively.

When balancing feature complexity with system performance, emphasis was placed on automation and ease of use. These strategic choices enabled the development of a

fully functional application that achieves its objectives while remaining efficient and scalable for parking management.

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9. Overall Effectiveness of the Work

The project effectively achieved its core objectives of providing a real-time parking management system with accurate tracking and reporting. However, certain areas could be improved to enhance its overall effectiveness:

● **Testing in High-Traffic Conditions:** Most testing was conducted in controlled scenarios. Expanding testing to simulate high-traffic conditions could further optimize real-time updates.

● **Enhancing Administrator Feedback Integration:** Gathering more feedback from administrators earlier in the development cycle could have expedited usability improvements.

● **Cross-Platform Optimization:** While the system is functional, additional enhancements could improve performance across different devices and screen sizes.

● **Future Enhancements:** Adding predictive analytics for parking trends and an automated notification system for full parking lots could improve efficiency.

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10. Lessons Learned

During the implementation phase, several adjustments were made compared to the original plan. Initially, a different method for real-time parking tracking was considered, but it proved inefficient in handling high-traffic loads. Instead, the system was optimized with database triggers and structured queries to improve accuracy.

Additionally, early plans included implementing AI-based parking slot predictions. However, due to time constraints, development focused on refining core

functionalities such as real-time tracking, payment processing, and administrative reporting.

This experience highlighted the importance of flexibility in project planning and the need to prioritize essential features to ensure a stable and functional product. Future iterations may include machine learning-based parking predictions and enhanced reporting tools to further improve the system’s effectiveness.

11. Meeting Project Objectives

Overall, we met most of the project objectives set during the planning stage. The core functionalities, including real-time parking management and reporting, were successfully implemented, allowing administrators to efficiently track and manage parking lot operations.

However, some advanced features, such as AI-based predictions and automated notifications, were not implemented as originally planned due to technical constraints and time limitations. Despite these adjustments, the project successfully achieved its primary goal of providing a reliable and efficient parking management solution.

These outcomes demonstrate the project's success in meeting its key objectives while emphasizing the importance of adaptability during development.

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12. User Guide

This section provides clear instructions to help administrators navigate the system and its features, ensuring a smooth experience.

Login Screen: This page allows administrators to log in or register to access the system.

● **Login Form:** Administrators enter their credentials to access the dashboard.

By following this guide, administrators can efficiently manage the parking system and monitor real-time updates.

Parking Location Selection:

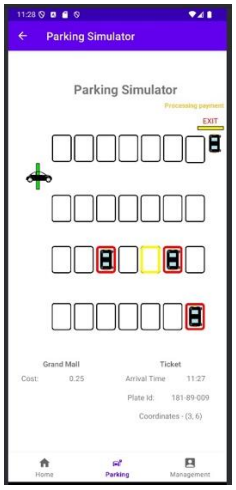
● **City Selection:** Administrators can choose a city from a dropdown list.

● **Parking Lot Selection:** Users select a specific parking facility within the chosen city.

● **Continue Button:** Confirms the selection and loads the parking simulator.

Parking Simulator Page:

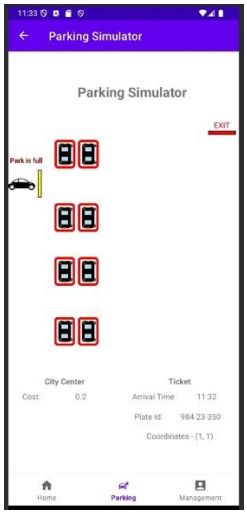
- **Real-Time Visualization:** Displays available and occupied parking slots.
- **Vehicle Entry and Exit:** Vehicles appear dynamically as they enter and leave the parking lot.
- **Clicking in a car** in the parking shows car parking details, car number, parking coordination, arriving time.



● Parking Full Notification:

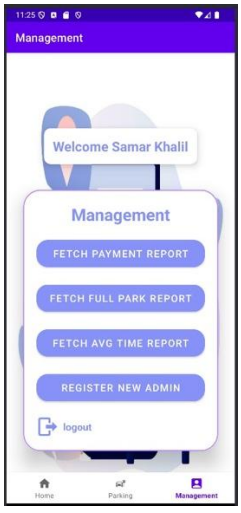
When the lot reaches capacity, a notification alerts the administrator.

- **Payment Processing:** Displays vehicle details, duration, and cost before allowing exit.



Management Dashboard:

- **Fetch Payment Report:** Allows administrators to view all parking payments made.
- **Fetch Full Park Report:** Displays data on the parking lot's occupancy.
- **Fetch Average Time Report:** Shows statistics on the average parking duration.
- **Register New Admin:** Enables new administrators to be added to the system.
- **Logout Button:** Allows the user to securely exit the system.



Admin Registration Page:

- **First Name and Last Name Fields:** Required fields for creating a new admin account.

- **Email and Password Fields:** Ensures secure login credentials for administrators.
- **Sign Up Button:** Completes the registration process and grants access to the dashboard.

Payment Report Page

Purpose:

This page allows administrators to view payment reports for a specific parking lot and date.

How to Use:

1. Select the desired **date** using the date picker.
2. Choose the **city** from the dropdown list.
3. Select the **parking lot** from the available options.
4. Click the **"Submit"** button to generate the payment report.

Important Notes:

- The report will only be displayed if a date and a parking lot are selected.
- The report includes:
    - **Total Income**: The total revenue collected on the selected date.
    - **Highest Bill**: The highest parking fee charged on that day.
    - **Lowest Bill**: The lowest recorded parking fee.

- If no date or parking lot is selected, the report will not generate.

Date Picker Page

Purpose:

The date picker allows administrators to choose the date for generating reports.

How to Use:

1. Tap the **calendar icon** to open the date picker.
2. Scroll through the months and select the desired date.
3. Click **"OK"** to confirm the selection or **"Cancel"** to close without making changes.

Important Notes:

- The selected date is required to generate any report.
- The date picker is used across different reports, including payment reports and average parking time reports.

Full Park Report Page

Purpose:

This page provides detailed insights into the occupancy and peak usage hours of a selected parking lot on a specific date.

How to Use:

1. Select the **date** using the date picker.
2. Choose the **city** from the dropdown menu.
3. Select the **parking lot** from the list.
4. Click the **"Submit"** button to generate the report.

Important Notes:

- The report will not generate unless both a date and a parking lot are selected.
- The report includes:
    - **Total Reports:** The number of reports available for the selected date.
    - **Peak Hour:** The hour with the highest number of parking requests.
    - **Total Occasions:** The number of cars that arrived but found no place.
- If no date or parking lot is chosen, the system will not display any data.

Average Parking Time Report Page

Purpose:

This page provides insights into the average parking duration for a selected parking lot and date.

How to Use:

1. Select the **date** using the date picker.
2. Choose the **city** from the dropdown menu.
3. Select the **parking lot** from the list.
4. Click the **"Submit"** button to retrieve the report.

Important Notes:

- The report will not generate unless both a date and a parking lot are selected.
- The report includes:
    - **Average Parking Time**: The average duration vehicles remained parked.
    - **Total Parked Cars**: The number of cars parked on the selected date.
- If no date or parking lot is chosen, the system will not display any data.

11. Verification

Testing Plan

Since our development process is iterative, we will conduct testing in three key areas: **Real-time Vehicle Tracking, Database Management, and Payment Processing**.

- **Real-time Vehicle Tracking:**
  This module will be tested using simulated vehicle entries and exits to ensure accurate tracking of cars entering and leaving the parking lot. We will conduct unit tests to verify the accuracy of vehicle logs and real-time occupancy updates.
- **Database Management:**
  Functional tests will be performed to validate the integrity of parking records stored in the **MySQL database**. The system will be tested for proper data retrieval, updates, and deletion. Additionally, stress tests will be conducted to assess database performance under high load.
- **Payment Processing:**
  Integration tests will be carried out to verify that the payment system (supporting credit card and mobile payments) processes transactions correctly. The testing will include both successful and failed payment scenarios to ensure reliability.

11. Maintenance Guide

How to Run the Application?

1. **Database: MySQL** – You must execute the provided **SQL file** before starting the server.
2. **Server:** Run the backend server using **Eclipse** in **Java**.

    - Navigate to src/main/MainServer.java and **update** the database **user** and **password** to match yours
    - Run the main server class **MainServer**.java

3. **Client:** Use **Android Studio** in **Java** to run the mobile application.

    - Navigate to app/src/main/java/com/example/parking/client
    - Open **Configs.java**
    - Update the host address (**HOST**) to match the address that your server is running on

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