

Development of a Mobile Application for Parking Registration and Access Management at Systems Plus College Foundation

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ABSTRACT

The increasing need for accessible and technology-assisted parking services in educational institutions highlights the importance of integrating registration, vehicle information management, and access verification into a unified system. This study aims to develop a Mobile Application for Parking Registration and Access Management at Systems Plus College Foundation (SPCF) to provide a more convenient, organized, and efficient approach to parking registration and vehicle access verification. The proposed system will allow authorized students and school personnel to submit and manage personal and vehicle information online, while authorized personnel will be able to review, approve, and manage parking applications through a centralized database. The system will also integrate camera-based license plate recognition to capture and verify vehicle plate numbers against registered parking records, with a QR code serving as an alternative verification method when license plate recognition is unsuccessful. The study will employ a developmental research design using a quantitative approach, with purposive sampling used to choose selected system users and authorized personnel. The system will be developed using the Agile methodology and evaluated through unit testing, integration testing, and User Acceptance Testing (UAT) through pilot testing. A 5-point Likert scale questionnaire based on selected ISO/IEC 25010 software quality criteria, particularly functional suitability, performance efficiency, usability, and reliability, will be used for evaluation. The proposed system is expected to support a more organized parking registration process, centralized record management, and technology-assisted vehicle access verification at SPCF.

Keywords: *Access Management, Centralized Database, Digital Parking Pass, License Plate Recognition (LPR), Mobile Application, Parking Access Management*

SECTION I — INTRODUCTION (THE PROBLEM AND ITS SETTING)

1.1 Introduction

Parking registration and vehicle access management are important processes in educational institutions, yet manual procedures can result in delays, errors, and inefficient record management. Mimbala et al. (2024) reported that the use of pen-and-logbook entries for campus vehicle monitoring was time-consuming and prone to errors, while Moldez (2024) identified inefficiency and user dissatisfaction in an existing university vehicle sticker application system. This study therefore proposes a mobile application that allows authorized users to submit and manage parking and vehicle information online through a centralized system. In line with this, at the campus gate, an installed camera will automatically recognize the vehicle's license plate and verify its registration, payment status, and parking validity against the centralized database. A QR code will serve as an alternative verification method when license plate recognition fails. The proposed system will be developed and evaluated in terms of functionality, usability, reliability, and efficiency to support a more organized and convenient parking registration and access management process at Systems Plus College Foundation.

1.2 Background of the Study

The continuous development of Information Technology (IT) has created opportunities to improve administrative and vehicle management processes in educational institutions. Digital systems can help organize information, reduce manual procedures, and provide more efficient ways of managing registration and access-related activities. According to Mimbala et al. (2024), manual campus vehicle

monitoring using pen-and-logbook entries can be time-consuming, prone to errors, and difficult to maintain, highlighting the need for more efficient approaches to vehicle information management.

The use of digital platforms has also been applied to improve parking and vehicle registration processes. Moldez (2024) developed the UPLB Vehicle Sticker Management System to improve the management of vehicle sticker applications, including registration, payment, appointment scheduling, and monitoring. Similarly, Navalta (2022) developed a Vehicle Monitoring System with QR Code for Don Mariano Marcos Memorial State University North La Union Campus, demonstrating the use of QR technology for vehicle monitoring and verification within an educational institution. These studies demonstrate the potential of digital technologies to support more organized vehicle registration and monitoring processes.

In addition to digital registration and QR-based verification, automatic license plate recognition has been explored as a means of automating vehicle identification and access control. Joaquin et al. (2018) developed a License Plate Recognition System for Adventist University of the Philippines that automatically detected and recognized vehicle plates and stored the information in a database for monitoring at the university gate. This approach provides a basis for using camera-based license plate recognition to reduce manual vehicle verification.

Building on these existing approaches, the proposed study will develop a mobile application for parking registration and access management at Systems Plus College Foundation (SPCF). The system will allow authorized users to submit and manage their personal and vehicle information, while authorized personnel can manage parking records through a centralized database.

1.3 Objectives of the Study

The general objective of this study is to develop a Mobile Application for Parking Registration and Access Management at Systems Plus College Foundation that will provide a convenient, efficient, organized, and secure way for authorized campus users to register their vehicles, manage parking information, and support vehicle monitoring through a camera-based system.

1. To design and develop a mobile application for online parking registration and access management that allows authorized SPCF campus users to electronically submit their personal and vehicle information.
2. To implement features that allow SPCF campus users to update their vehicle and owner information through their accounts, while allowing authorized personnel to review, approve, and manage parking applications.
3. To develop a centralized digital record system for organizing and managing campus users' parking applications, vehicle information, and registration records.
4. To integrate a camera-based vehicle monitoring feature that can monitor vehicles entering and exiting the campus, capture license plate information, and support the identification of registered vehicles for campus safety.
5. To develop a QR code-based alternative for vehicle verification when camera-based license plate recognition fails.
6. To provide authorized personnel with vehicle monitoring information that can help them verify registered vehicles and identify vehicles that are not properly registered or authorized to enter the campus.
7. To evaluate the developed system in terms of functionality, usability, reliability, and efficiency based on the assessment of SPCF campus users and authorized personnel.

1.4 Scope and Limitation of the Study

This study focuses on the development of a mobile application for parking registration and access management at Systems Plus College Foundation. The application is intended for students and authorized school personnel, including teachers, janitors, guards, canteen personnel, and other staff members who are permitted to apply for a parking slot within the institution.

The application will allow applicants to submit their parking registration details online. During the registration process, applicants will be required to provide their name, identification as either a student or school staff member, and a photo of the applicant. They will also provide information about their vehicle, including the vehicle type, such as motorcycle, car, or electric bicycle; plate number; vehicle brand and model; and vehicle color. Applicants will also be required to upload proof of ownership and a photo of the vehicle for verification purposes. The application will support different application types, specifically new applications and renewal applications. Applicants may also indicate whether their parking registration is intended for the entire academic year or for a specific semester only.

The study is limited to students and authorized school personnel of Systems Plus College Foundation who are eligible to apply for or manage parking registration. Individuals who are not students or authorized personnel of Systems Plus College Foundation will not be permitted to register or use the application for parking purposes. The application will also be limited to the online registration and management of parking applications and will not cover the management of parking facilities outside the institution. The system will not determine the physical availability of parking spaces in real time and will not replace the institution's existing parking policies, approval procedures, or physical parking identification requirements. The accuracy of the information and documents submitted

through the application will depend on the applicants and the verification performed by authorized personnel.

1.5 Significance of the Study

The development of a Mobile Application for Parking Registration and Access Management at Systems Plus College Foundation is expected to provide a more convenient and organized approach to the institution's parking registration and management process. The study may benefit the following:

Students and all school staff. The proposed application may provide students and school staffs with a more convenient and time-efficient way to submit parking applications, renew existing applications, and update their personal and vehicle information. By allowing applicants to complete the registration process online, the system may reduce their reliance on physical forms and repeated in-person transactions.

School Personnel. The application may assist authorized school personnel in reviewing, organizing, and managing parking applications and vehicle information through a centralized digital platform. It may help reduce repetitive manual tasks, minimize paperwork, and make parking-related records easier to access and manage.

Systems Plus College Foundation. The study may contribute to the institution's digitalization efforts by providing a proposed system that can support a more organized and efficient parking registration process. The centralized management of parking-related information may also help streamline administrative tasks and improve the accessibility of registration records.

Future Researchers. The study may serve as a reference for future researchers who intend to develop or improve digital systems for online applications, vehicle registration, parking management, or other

administrative processes. It may also provide a basis for future studies that explore additional features, improvements, and technologies that may address the evolving needs of educational institutions.

1.6 Definition of Terms

For clarity and consistency, the following terms and abbreviations are operationally defined according to how they are used in this study:

Access Management - The process of verifying and managing vehicles that are authorized to enter and exit the Systems Plus College Foundation campus through registered parking records and vehicle identification mechanisms.

Authorized Personnel - Designated Systems Plus College Foundation personnel who are permitted to review, approve, manage, and verify parking applications and vehicle access records through the proposed system.

Centralized Database - Digital storage system used to organize and maintain applicants' personal information, vehicle information, parking applications, approval status, payment status, and registration records in one location.

Digital Parking Pass - Electronic parking identification provided by the proposed system that contains a QR code and may be used by authorized personnel as an alternative method of verifying a registered vehicle.

ISO/IEC 25010 - An international software quality model used as a basis for evaluating selected quality characteristics of the proposed system, particularly functional suitability, performance efficiency, usability, and reliability.

License Plate Recognition (LPR) - Technology integrated into the proposed system that uses a camera to capture and recognize a vehicle's license plate number and compare it with registered parking records.

Mobile Application - Software application developed in this study to provide students and authorized school personnel with an online platform for parking registration, management of personal and vehicle information, and access-related verification.

Parking Access Management - System-supported process of determining whether a vehicle has a valid parking registration and is authorized to enter the Systems Plus College Foundation campus.

Pilot Testing - Controlled testing of the developed mobile application by selected intended users to identify functional issues and assess the system's usability, performance, and overall acceptability before final implementation.

QR Code (Quick Response Code) - Two-dimensional barcode generated by the proposed system and associated with a parking record. It may be scanned by authorized personnel to retrieve relevant registration information when license plate recognition cannot successfully verify the vehicle.

User Acceptance Testing (UAT) - Testing process in which selected intended users use and evaluate the developed system to determine whether its functions meet the intended user requirements and are suitable for actual use.

SECTION II — LITERATURE REVIEW

2.1 Introduction to the Review

This section presents a review of related literature and studies that provide the theoretical and empirical foundation for the present research, with particular focus on digital parking registration, vehicle access management, mobile applications, and automated vehicle verification. It discusses existing approaches to parking management, including online registration, centralized vehicle records, license plate recognition, and QR-code-based verification.

Furthermore, the review examines local and international studies related to the use of technology in improving parking registration and access management. These studies are reviewed to identify existing approaches, technologies, limitations, research gaps relevant to the proposed system, and provide a basis for the proposed system and support the development of its conceptual framework and objectives.

2.2 Review of Related Literature and Studies

The increasing advancement of information technology has influenced educational institutions to adopt digital systems for managing administrative and vehicle-related processes. Existing research shows that parking management can benefit from digital registration, centralized records, automated monitoring, and mobile-based services. For instance, Moldez (2024) developed the UPLB Vehicle Sticker Management System to improve vehicle sticker registration, payment, appointment processing, and administrative management. Additionally, Mimbala et al. (2024) developed a web-based vehicle monitoring system for Mindanao State University–Lanao del Norte Agricultural College to address the inefficiencies of manual pen-and-logbook monitoring through QR codes and

SMS notifications. Similarly, Navalta (2022) developed a QR-code-based vehicle monitoring system for Don Mariano Marcos Memorial State University–North La Union Campus. Other Philippine studies have explored related applications, including Maristela et al. (2024), who developed an IoT-based parking and monitoring system for Lyceum of the Philippines University–Batangas; Bisenio et al. (2023), who developed a computer-vision-based smart parking system for Pamantasan ng Lungsod ng Maynila; Cunan et al. (2024), who developed the E-PARK IoT and web-based parking reservation system for Mabalacat City College; Luzuriaga et al. (2025), who developed a QR-based parking occupant management system with AES encryption; and Cunanan et al. (2026), who developed a machine-learning-based smart parking management system. These studies demonstrate the application of digital platforms, QR codes, IoT, and computer vision in Philippine parking and vehicle-management environments.

Furthermore, license plate recognition provides another approach to automating vehicle identification. Joaquin et al. (2018) developed a License Plate Recognition System for the Adventist University of the Philippines that automatically detected and recognized vehicle plates at the university gate and stored the information in a database while Cuartero (2025) developed a university smart parking management system that incorporated image processing for automatic license plate recognition, real-time parking information, reservation, and navigation. These Philippine studies demonstrate the potential of automated vehicle identification within educational institutions. Apart from these local studies, international research has similarly examined license plate recognition and smart parking technologies. Paidi et al. (2018) reviewed smart parking sensors and technologies and identified the use of automated technologies for improving parking management. Arafat et al. (2019) also reviewed license plate recognition techniques and highlighted challenges involving illumination, occlusion, vehicle speed, image quality, and different plate characteristics. Meanwhile, Fahim et al.

(2021) provided a comprehensive review of smart parking systems involving sensors, image processing, mobile applications, web applications, and machine learning. In a related study at Widyatama University, Faza (2020) developed an Android-based smart parking system using QR codes and electronic payment, while Ahmad et al. (2023) developed a university smart parking application integrated with automatic license plate recognition and a database. Clearly, the said studies demonstrate that mobile applications and automated identification can be combined to support parking management.

Thus, more recent studies have further developed automated parking and access-control technologies. For example, Tang et al. (2022) conducted a systematic review of automatic number plate recognition in smart cities and examined its technological development and applications. Similarly, Yu (2023) proposed an edge-cloud-dew architecture for smart parking to maintain license plate recognition and parking operations even when internet connectivity is interrupted. While Safran et al. (2024) developed a multistage license plate recognition approach using YOLO and convolutional neural networks for smart parking environments. But more recently, Ditta et al. (2025) developed an IoT-based smart parking management system using automatic number plate recognition, sensors, and a web-based administrative panel for vehicle identification and parking monitoring. Pradhan et al. (2025) developed an IoT-integrated parking system combining image processing, license plate recognition, sensors, and payment management. A 2025 smart car parking study also combined YOLOv8-based license plate detection, Raspberry Pi, and a web-based reservation system for campus parking. These studies illustrate the increasing use of camera-based recognition, centralized information systems, and automated parking technologies. On the other hand, more recent studies have explored QR-code and computer-vision integration, including Alfajri et al. (2025), who developed an IoT-based smart parking system combining QR codes and OCR-based license plate

recognition, and Md Isa et al. (2025), who examined QR-code-based smart parking access and user interaction. These studies further exhibit the potential of combining automated vehicle identification with digital parking credentials.

Despite the range of existing systems, most studies focus on specific functions such as QR-based identification, parking-space monitoring, online reservation, or automatic license plate recognition. Some systems use QR codes as the primary access mechanism, while others focus primarily on automated plate recognition or parking-space availability. The proposed study differs by integrating these functions specifically for the parking registration and access-management needs of Systems Plus College Foundation. The proposed mobile application will allow authorized users to submit and manage personal and vehicle information through a centralized system. At the campus gate, an installed camera will automatically recognize the vehicle's license plate and the centralized parking database will verify registration, payment status, and parking validity. When the license plate recognition process fails, a QR code from the user's digital parking pass will serve as a fallback verification method. Through this integration of mobile registration, centralized records, automatic license plate recognition, and secondary QR verification, the proposed system seeks to provide a more organized approach to parking registration and vehicle access management at SPCF.

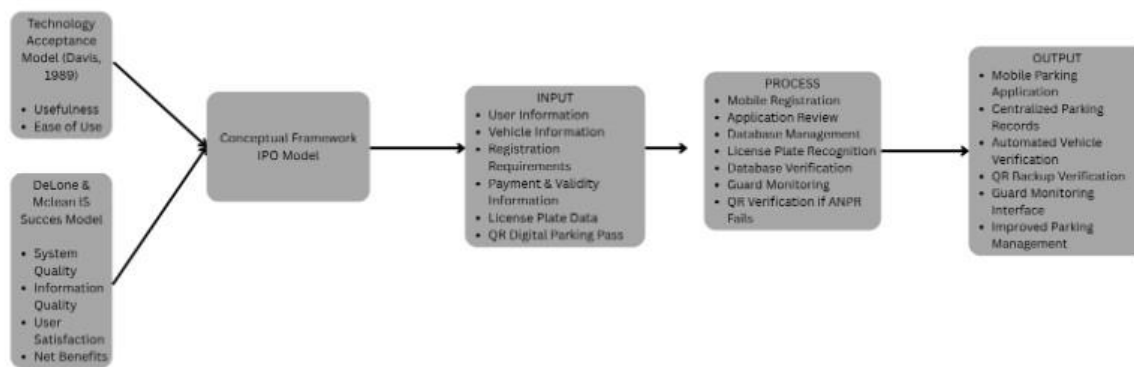
2.3 Conceptual Framework

The study is anchored on the Technology Acceptance Model (TAM) by Davis (1989) and the DeLone and McLean Information Systems Success Model. TAM focuses on the system's usefulness and ease of use, while the DeLone and McLean model emphasizes system quality, user satisfaction, and

benefits. These theories support the development and evaluation of the proposed mobile parking registration and access management system.

The study uses the Input–Process–Output (IPO) model as its conceptual framework. The inputs include user and vehicle information, parking requirements, payment and validity information, and license plate data. The process includes mobile registration, application review, database management, automatic license plate recognition as the primary verification, and QR-code verification as a fallback when license plate recognition fails. The output is a mobile parking system with centralized records, automated vehicle verification, and a guard monitoring interface designed to improve the efficiency of parking registration and access management.

Figure 1. Input-Process-Output Conceptual Framework of the Proposed System



2.4 Synthesis

The reviewed literature and studies show that digital technologies can be applied to improve parking registration, vehicle monitoring, and access management. Existing systems have explored online registration, centralized vehicle records, QR-code verification, and automatic license plate recognition to reduce manual processes and improve the management of vehicle information. Local studies have demonstrated the application of digital vehicle registration and monitoring in educational

institutions, while international studies have further explored automated license plate recognition and smart parking technologies.

Despite these developments, existing systems commonly focus on specific functions such as registration, QR-code monitoring, or license plate recognition rather than integrating these functions into a single mobile-based parking management system. Based on the reviewed literature, the proposed study aims to address this gap by developing a mobile application for parking registration and access management at SPCF. The proposed system will use camera-based automatic license plate recognition as the primary vehicle-verification method, while a QR-code digital parking pass will serve as a fallback when license plate recognition fails. It will also provide centralized parking records and a monitoring interface for authorized personnel. These features are intended to provide a more integrated approach to parking registration and vehicle access management within the institution.

SECTION III — METHODOLOGY

3.1 Research Design

The study will employ a developmental research design using a quantitative approach. Developmental research will guide the design and development of the proposed Mobile Application for Parking Registration and Access Management at Systems Plus College Foundation. The study will focus on developing a system that addresses the identified challenges in parking registration, vehicle information management, and vehicle access verification.

The participants will be selected using purposive sampling, focusing on individuals who are directly involved in or are potential users of the proposed system. These will include selected SPCF students and authorized vehicle owners, as well as security guards or personnel involved in parking and vehicle

access management. Their involvement will provide relevant feedback based on their expected use of the system.

A pilot test will first be conducted with selected participants to identify possible issues and ensure that the proposed system functions as intended. After the pilot testing, a post-evaluation questionnaire will be administered to the participants to quantitatively assess the system based on functionality, usability, reliability, and efficiency. The collected data will then be analyzed using appropriate statistical methods to determine the level of acceptability of the proposed system.

3.2 System Development Methodology

The study will use the Agile development methodology to guide the development of the mobile application. The researchers will develop the system through continuous design, development, testing, and improvement. The application will include online parking registration, personal and vehicle information management, centralized parking records, and camera-based vehicle plate number verification. After development, selected SPCF authorized campus users and personnel will evaluate the system using a structured questionnaire. The collected responses will provide quantitative data for assessing the system's functionality, usability, reliability, and efficiency.

3.3 Requirement Specification and Analysis

The requirement specification and analysis will identify the functional requirements necessary for the development of the proposed parking registration and access management system. These requirements are based on the identified concerns involving long lines, dependence on available personnel, repeated paperwork, difficulty updating vehicle information, and challenges in verifying authorized vehicles.

The proposed system will include the following functional requirements:

1. **Online Parking Registration** – The system shall allow authorized SPCF campus users to submit their personal and vehicle information electronically.
2. **Information Management** – The system shall allow users to update their vehicle and owner information.
3. **Application Management** – The system shall allow authorized personnel to review, approve, and manage parking applications.
4. **Centralized Records** – The system shall organize and maintain parking applications, vehicle information, and registration records.
5. **Camera-Based Vehicle Monitoring** – The system shall capture and recognize vehicle plate information to support vehicle identification.
6. **Vehicle Verification** – The system shall compare captured plate information with registered parking records.
7. **QR Code Verification** – The system shall provide a QR code as an alternative method for verifying authorized vehicles when needed.
8. **Vehicle Monitoring Information** – The system shall provide authorized personnel with information that can help verify registered vehicles and identify vehicles that are not properly registered or authorized.

To represent the system requirements and processes, the researchers may use Data Flow Diagrams (DFDs), Entity-Relationship Diagrams (ERDs), flowcharts, and other appropriate system models. These models will illustrate how information moves within the system, how users interact with the application, and how parking records are organized.

3.4 System Design Specification

This section presents the technical design specifications for the proposed Mobile Application for Parking Registration and Access Management at Systems Plus College Foundation (SPCF). The specifications describe the logical and physical components required for the development and operation of the system. The logical specifications define the user interface, system modules, and processing procedures, while the physical specifications describe the database structure, hardware requirements, and network infrastructure needed to support the system.

3.4.1 Logical Specifications

The application will be developed as an Android mobile application using Native and written in Javascript in Visual Studio Code. Its data will be stored on Firebase free-tier services, which provide the database, user authentication, and file storage for uploaded requirements such as vehicle and registration documents. Authentication will allow campus users (students, professors, and school staff) and authorized personnel to sign in with separate access levels, so users can submit and update their personal and vehicle information while personnel can review and manage applications. The digital parking sticker will be generated using a free QR code library, and personnel will scan it through the phone's camera, using a free scanner library, to retrieve the corresponding parking record and verify the owner's name, user type, vehicle type, plate number, parking access, and sticker expiration date. If the Bluetooth-based recognition is included, Bluetooth Low Energy support in the chosen framework will be used. Version control and collaboration among the four researchers will be handled through GitHub, and design work through free tools such as Figma and draw.io. Testing will be done on the researchers' own Android smartphones, and the system will be evaluated through a survey of campus users and authorized personnel using Google Forms.

3.4.1.1 UI/UX Wireframe Concepts

The application's interface will be logically divided into two primary interfaces designed according to the roles and activities of the intended users:

1. **Campus User Dashboard.** This interface will provide authorized SPCF students and school personnel with access to the parking registration and profile management functions. It will contain a multi-step digital form where users can enter their personal information, identification as a student or school personnel, vehicle information, application type, registration period, and required supporting documents and photographs. Input validation will be incorporated to help ensure that required information is properly entered before an application can be submitted. Users will also be able to view their application status and update eligible personal or vehicle information. Once a parking application has been approved, the dashboard will display the user's digital parking pass containing a QR code that can be used for alternative vehicle verification.
2. **Authorized Personnel/Security Interface.** This interface will provide authorized personnel with access to parking applications, registered vehicle information, and vehicle verification records. The monitoring dashboard will display the results of camera-based license plate recognition and indicate the vehicle's authorization status, such as **Authorized** or **Unauthorized**. The interface will also include a manual QR-code scanning function that authorized personnel can use when the system is unable to successfully recognize the vehicle's license plate.

3.4.1.2 Module Logic and Behavioral Routines

The proposed system will consist of interconnected modules that process parking registration, application management, vehicle verification, and monitoring activities. The major behavioral routines are as follows:

A. User Registration and Authentication Routine.

The system will allow authorized SPCF users to create and access their accounts using the required identification and account information. The system will validate the submitted information and provide access to the appropriate user dashboard after successful authentication.

B. Parking Application Routine.

The user will complete the online parking application by providing personal information, vehicle details, application type, registration period, proof of ownership, and vehicle photographs. The system will validate required fields and store the submitted application in the centralized database. The application will initially be assigned a status for review by authorized personnel.

C. Application Review and Approval Routine.

Authorized personnel will access submitted parking applications through the administrative interface. They will review the applicant's information, vehicle information, supporting documents, and application details. The authorized personnel may approve or reject the application based on the institution's parking requirements. The resulting application status will be stored in the centralized database.

D. Vehicle Information Management Routine.

Authorized users will be able to view and update eligible personal and vehicle information through

their accounts. Updated information will be submitted to the system and reflected in the corresponding records, subject to applicable approval or verification procedures.

E. Camera-Based Vehicle Plate Verification Routine.

When a vehicle approaches the campus entrance or exit, the gateway camera will capture an image of the vehicle and its license plate. The license plate recognition component will process the captured image and extract the recognized plate number. The recognized plate number will then be compared with the registered vehicle records stored in the centralized database. If a matching record is found and the vehicle has valid parking authorization, the system will display an **Authorized** status to the security personnel and record the verification event. If no valid matching record is found, the system will display an **Unauthorized** status and notify the authorized personnel for manual verification.

F. QR Code Alternative Verification Routine.

When the system is unable to successfully recognize a vehicle's license plate, the authorized personnel may use the manual QR-code scanning function. The QR code displayed on the approved user's digital parking pass will be scanned using the authorized personnel's device. The system will retrieve the corresponding parking record and verify its approval and authorization status. The verification result will then be displayed to the authorized personnel and recorded in the verification log.

G. Vehicle Monitoring and Verification Logging Routine.

The system will record relevant vehicle verification activities, including the identified vehicle or captured plate number, verification method, date and time, and verification result. These records

will allow authorized personnel to review vehicle access activities and support the monitoring of registered and unauthorized vehicles.

3.4.2 Physical Specifications

The researchers will develop the application on laptops with at least an Intel Core i5 or AMD Ryzen 5 processor, 8 GB of RAM, and a 256 GB solid-state drive, and will test it on physical smartphones to check the camera, QR code, and Bluetooth functions. Campus users (students, professors, and school staff) need a smartphone with a working camera, Bluetooth capability, an internet connection, and a minimum of 2 GB of RAM and 100 MB of free storage. They use it to submit and update their personal and vehicle information and to display their digital parking sticker with its QR code. Authorized personnel need a smartphone or tablet with a rear camera to scan the QR codes and review applications, along with a reliable internet connection at the campus entrance so scanned codes can retrieve parking records.

3.4.2.1 Data Architecture and Database Schema

The proposed system will use a centralized relational database to store and organize the information required for parking registration, application management, and vehicle verification. The database will maintain relationships between users, vehicles, parking applications, and verification records to support accurate retrieval and management of information.

The proposed database will contain the following major tables:

- **User_Table** – Stores user account and identification information. Suggested fields include User_ID [PK], First_Name, Last_Name, SPCF_Classification, Email, and Password_Hash.

- **Vehicle_Table** – Stores information about vehicles registered by users. Suggested fields include Vehicle_ID [PK], User_ID [FK], Plate_Number [Unique Index], Vehicle_Type, Make, Model, Color, and Registration_Status.
- **Application_Table** – Stores parking application information and its approval status. Suggested fields include Application_ID [PK], User_ID [FK], Vehicle_ID [FK], Application_Type, Registration_Period, Submission_Date, Approval_Status, Reviewed_By, and Payment_Status.
- **Verification_Log_Table** – Stores records of vehicle verification activities. Suggested fields include Log_ID [PK], Vehicle_ID [FK, Nullable], Captured_Plate_Number, Verification_Method, Timestamp, and Verification_Result.

The **User_ID** will establish the relationship between a user and their registered vehicle, while **Vehicle_ID** will connect vehicle records with their corresponding parking applications and verification logs. This structure will allow the system to retrieve a vehicle's registration, approval, payment, and authorization information during the verification process.

3.4.2.2 Hardware and Network Infrastructure

The proposed system will use a three-tier deployment environment consisting of client devices, gateway monitoring hardware, and centralized server infrastructure.

1. **Client Hardware.** Android and iOS mobile devices will be used by authorized SPCF students and school personnel to access the mobile application, submit parking applications, manage information, and view their digital parking passes. Authorized security personnel may also use a compatible mobile device for manual QR-code scanning.

2. **Gateway Monitoring Hardware.** A fixed camera or USB webcam will be positioned at the designated campus entrance or exit to capture vehicle images and license plate information. The camera will provide image input to the license plate recognition component for vehicle identification and verification.
3. **Processing Computer/Server.** A computer or server will process the captured vehicle images, run the license plate recognition component, communicate with the centralized database, and provide verification results to the authorized personnel interface.
4. **Database Infrastructure.** The centralized database will store user information, vehicle records, parking applications, payment and approval status, and vehicle verification logs. For the proposed prototype, SQLite may be used as the database system based on the implementation plan described in Section 3.5.
5. **Network Infrastructure.** The mobile application, processing computer, database, and authorized personnel interface will communicate through the available SPCF network infrastructure. Secure communication protocols such as HTTPS may be used for communication between the application and backend services where applicable.
6. **Software Components.** The proposed vehicle recognition component will use **Python, OpenCV, and Optical Character Recognition (OCR)** technologies to process captured vehicle images and recognize license plate numbers. A **REST API** will facilitate communication between the application or recognition component and the centralized database. The system may also use CSV files and SQL scripts for the controlled import of existing vehicle records when such records are made available and approved by the institution.

3.5 Implementation

The system will be divided into separate components for the mobile application, backend processing, and vehicle recognition. The mobile application will allow authorized campus users to submit parking applications, register vehicles, and update their information. The administrative interface will allow authorized personnel to review applications and manage vehicle records. Python, OpenCV, and OCR will be used to capture and recognize license plate numbers. A centralized SQLite will store user information, vehicle details, plate numbers, application statuses, and parking authorization. A USB webcam connected to an existing computer will capture vehicle images. The ALPR system will compare recognized plate numbers with database records through a REST API to determine whether vehicles are authorized to enter. Unrecognized or unauthorized vehicles will be flagged for manual verification. Existing vehicle records, if available and approved by the institution, will be imported using CSV files and SQL scripts. The system will be evaluated based on recognition accuracy, functionality, usability, reliability, and efficiency.

3.6 Testing and Evaluation

The proposed system will undergo unit testing, integration testing, and User Acceptance Testing (UAT) to ensure that its individual features and integrated components function as intended. Unit testing will assess individual features such as user registration, applicant and vehicle information management, document and photo uploading, parking application submission, license plate recognition, and QR code generation and verification.

Integration testing will verify the proper interaction among the mobile application, centralized database, parking application records, camera-based vehicle monitoring feature, license plate recognition, and QR code verification. The testing will determine whether the system can properly capture and recognize vehicle plate numbers, compare the recognized plate number with registered parking records, and provide appropriate vehicle verification information to authorized personnel.

The QR code verification feature will also be tested as an alternative method when the primary plate-number verification process is unavailable or cannot be used.

User Acceptance Testing (UAT) will be conducted through pilot testing with selected intended users, including students and authorized school personnel, as well as authorized personnel responsible for reviewing parking applications and monitoring vehicle access. The participants will use the proposed system to perform relevant registration, application management, and vehicle verification tasks. Their feedback will be used to identify functional issues and assess the overall usability and performance of the system.

The system will be evaluated using relevant criteria from the ISO/IEC 25010 software quality model, particularly functional suitability, performance efficiency, usability, and reliability, which are aligned with the objectives of the study. A 5-point Likert scale questionnaire will be administered after the UAT/pilot testing to obtain quantitative evaluations from the participants. The collected data will be analyzed using appropriate descriptive statistical methods to determine the users' assessment of the proposed system and identify areas for further improvement.

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