Software Requirements Specification

for

Electric Vehicle Charging Management System

Version 1.0 approved

Prepared by

Group-P

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Revision History

Name	Date	Reason For Changes	Version

1. Introduction

1.1 Purpose

The purpose of this document is to define the software requirements for the Electric Vehicle (EV) Charging Management System. This system aims to facilitate efficient and effective management of electric vehicle charging stations, including user registration, charging session monitoring, billing, and reporting functionalities.

1.2 Document Conventions

Font Style and Highlighting

- The SRS document uses a standard font style such as Roboto ,Times or New Roman with a font size of 12pt for readability.
- Important terms, headings, and subheadings may be highlighted using bold text or underlining for emphasis.
- Code snippets, technical terms, or placeholders for variables may be presented in monospace font to distinguish them from regular text.

Priority Levels

- Each requirement statement is assigned a priority level to indicate its importance and urgency.
- Priority levels are denoted using a numerical scale (e.g., High priority: 8/9, Medium priority: 6/9) to prioritize higher-level requirements over detailed requirements.

Lists and Enumerations

- Requirements, functional descriptions, and system features are listed using numbered lists or bullet points for clarity and organization.
- Enumerations may be used to categorize requirements or specify options within a feature (e.g., Characteristics, Stimulus/Response Sequences).

Technical Terminology and Acronyms

- Technical terms, abbreviations, and acronyms are defined and explained when first mentioned in the document to aid comprehension.
- A glossary (Appendix A) is provided to compile all necessary terms, acronyms, and abbreviations used in the SRS for easy reference.

Section Organization

- The SRS document is organized into clearly defined sections such as Introduction, Purpose, Document Conventions, Intended Audience, Product Scope, References, Overall Description, and other relevant sections.
- Each section has a distinct focus and contributes to a comprehensive understanding of the EV Charging Management System requirements.

1.3 Intended Audience and Reading Suggestions

- **Developers** - This document includes specific technical requirements and system interfaces for developers working on the EV Charging Management System's design, implementation, and testing. They should focus on sections related to functional requirements, system architecture, and interfaces.

- **Project Managers** - They will be responsible for supervising the development process and guaranteeing compliance with project goals and schedules. The areas that deal with the project overview and scope should get their full focus.

- **Users** - The functionality, usability, and operational features of the EV Charging Management System are important to know for end users, such as EV owners and charging station administrators. They should focus on sections related to user requirements, system usage, and interfaces.

- **Testers** - This document contains comprehensive testable requirements and acceptance criteria for the EV Charging Management System. They should focus on sections related to functional requirements, test scenarios, and performance metrics.

1.4 Product Scope

The EV Charging Management System will provide a platform for managing multiple charging stations, enabling users to locate, reserve, and utilize charging services seamlessly. The system will cater to both individual EV owners and fleet operators, offering various features for user convenience and administrative control.

1.5 References

- *ISO 15118: Road vehicles - Vehicle-to-Grid Communication Interface. International Organization for Standardization. Version: 2.0, Date: 2018.* https://www.iso.org/standard/70357.html

- *OCPP (Open Charge Point Protocol). Open Charge Alliance. Version: 2.0, Date: 2020.* https://www.openchargealliance.org/ocpp/

- *GDPR (General Data Protection Regulation). European Union. Date: 2016.* https://gdpr.eu/

- *EV charging Specifications for the user's vehicle. Can be obtained by the relevant manufacturer.*

- *Mast3r. (2019, April 7). Electric car charging on electrical charge station with solar panel renewable eco technologies clean transport. Dreamstime. https://www.dreamstime.com/electric-car-charging-electrical-charge-station-solar-panel-renewable-eco-technologies-clean-transport-environment-care-image144240964*

2. Overall Description

2.1 Product Perspective

The EV Charging Management System will be a standalone web-based application interacting with EV charging stations through APIs. It will integrate with payment gateways for billing purposes and provide a user-friendly interface for both administrators and end-users.

2.2 Product Functions

1. User Registration and Authentication
2. Charging Station Management
3. Charging Session Monitoring
4. Billing and Payment Processing
5. Reporting and Analytics
6. Admin Dashboard

2.3 User Classes and Characteristics

1. Individual EV Owners:

Characteristics

- Occasional or regular users of the charging station network.
- Varied technical expertise levels, ranging from novice to experienced EV owners.
- Require intuitive user interfaces for locating, reserving, and monitoring charging sessions.

Requirements

- Seamless registration and authentication process.
- User-friendly charging station locator with real-time availability updates.
- Ability to view and monitor ongoing charging sessions.
- Secure and convenient payment processing for charging services.

2. Fleet Operators and Managers:

Characteristics

- Manage fleets of electric vehicles for commercial or organizational purposes.Technical expertise may vary among operators, but generally higher than individual owners.
- Require centralized management and monitoring capabilities for multiple charging stations.

Requirements

- Administrative features for managing multiple charging stations and user accounts.
- Advanced reporting and analytics tools for tracking charging usage and optimizing fleet operations.
- Support for bulk charging session scheduling and billing management.

3. Charging Station Administrators:

Characteristics

- Responsible for overseeing the operation and maintenance of individual charging stations.
- Technical expertise varies but generally focused on hardware and infrastructure management.
- Require access to detailed charging station diagnostics and performance data.

Requirements

- Comprehensive charging station management interface for monitoring status, health, and usage.
- Real-time alerts and notifications for critical issues or maintenance requirements.
- Integration with maintenance and support ticketing systems for streamlined issue resolution.

4. System Administrators:

Characteristics

- Responsible for overall system configuration, security, and maintenance.
- High level of technical expertise in system administration and cybersecurity.
- Ensure system reliability, performance, and compliance with industry standards.

Requirements

- Robust system administration tools for user management, access control, and audit trails.

- Implementation of security measures, including encryption, access controls, and intrusion detection.
- Regular system maintenance tasks, such as database backups, software updates, and security patches.

2.4 Operating Environment

The system will operate in a web environment, accessible through modern web browsers on desktop and mobile devices. It will utilize secure communication protocols for data transmission and storage.

2.5 Design and Implementation Constraints

- **Regulatory Compliance** - The system needs to adhere to regulations and guidelines pertaining to data privacy, payment processing, and the infrastructure for charging electric vehicles. Developers are responsible for making sure that laws like GDPR (General Data Protection Regulation) and OCPP (Open Charge Point Protocol).

- **Hardware Limitations** - Hardware constraints pertaining to processing power, memory capacity, and network bandwidth may limit the system's performance. Optimizing software methods and system architecture is necessary for developers to guarantee effective performance on a range of hardware setups.

- **Interface Compatibility** - Power meters, RFID readers, payment terminals, charging stations, and other hardware must all work flawlessly with the system. To promote interoperability, developers must guarantee compatibility with industry-standard hardware interfaces and communication protocols (e.g., OCPP).

- **Specific Technologies** - Developers must adhere to designated technology stacks and development frameworks. In this case MySQL, Express.js, React.js, Node.js, and use approved development tools and methodologies.

- **Security Considerations** - The system must implement robust security measures to protect sensitive user data, payment transactions, and system integrity. Developers must incorporate encryption protocols, access controls, and secure authentication mechanisms to mitigate security risks and vulnerabilities.

- **Scalability and Performance** - Scalability considerations should be taken into account while designing the system so that additional charging stations and users may be added without affecting its functionality. Scalable design patterns, like serverless computing or microservices, are necessary for developers to allow parallel activities and manage growing system loads.

- **Maintenance and Support** - The client's organization may be responsible for maintaining and supporting the delivered software post-deployment. Developers must adhere to design conventions, programming standards, and documentation practices that facilitate ease of maintenance, troubleshooting, and future enhancements by the client's team.

2.6 User Documentation

- **Installation Guide** - Includes a step-by-step guide on proper installation of the system and precautionary guides that needs to be followed. (Provided as a hard copy which is accessible in the website as well)

- **Beginners' Guide** - Includes an overview of the user interface, guide on performing specific functionalities and solutions to frequently raised concerns and issues. (Provided as a hard copy which is accessible in the website as well)

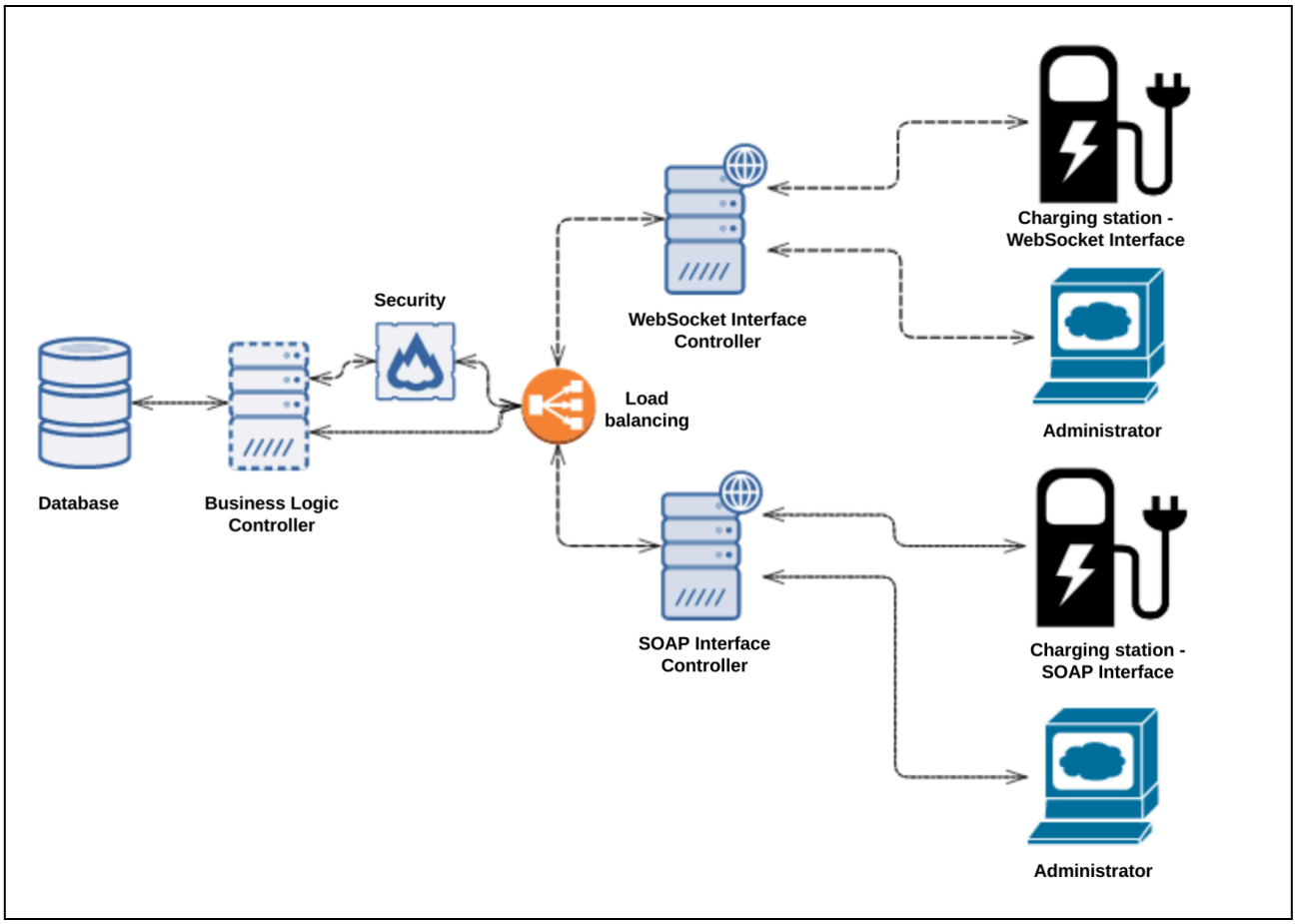
- **Safety and Compliance Documentation:** Safety instructions for users and installers, including guidelines for handling electrical components safely (Provided as a hard copy)

- **Customer Support** - (Online forum to raise concerns and customer support email and contact number)

- **Release Notes** - Documentation highlighting changes, enhancements, and bug fixes in each software release (Released as a soft copy - PDF Document - for each software release)

2.7 Assumptions and Dependencies

1. User's EV has to be compatible with the charging stations.
2. Reliable internet connectivity is available for system operation.
3. Integration with external services (e.g: mapping services for station location) is feasible.
4. Third party components of the system such as the payment gateway are compatible.
5. The system will comply with relevant regulations and standards governing electric vehicle charging infrastructure, data privacy, and payment processing.



3. External Interface Requirements

3.1 User Interfaces

1. User Registration UI
2. Login and Authentication UI
3. Charging Station Locator and Reservation UI
4. Charging Session Monitoring UI
5. Billing and Payment UI
6. Admin Dashboard UI

3.2 Hardware Interfaces

1. Compatibility with EV charging station APIs (e.g., OCPP).
2. Secure data transmission protocols for hardware integration.

3.3 Software Interfaces

- Integration with Payment Gateways (e.g., Stripe, PayPal) for billing.
- Integration with Mapping APIs for location-based services.
- Database management system (DBMS) for data storage and retrieval.

3.4 Communications Interfaces

1. **Web Services Communication**
   - The system shall support RESTful web services for communication with external systems and APIs.
   - Communication between the system and external entities, such as EV charging stations and third-party services, shall utilize HTTP/HTTPS protocols.
   - JSON (JavaScript Object Notation) shall be used as the standard message format for data exchange over web services.

2. **Messaging Protocols**
   - The system shall support messaging protocols, such as MQTT (Message Queuing Telemetry Transport), for real-time communication with IoT devices and sensors within the charging station network.
   - MQTT shall be used for publishing and subscribing to topics related to charging station status updates, alerts, and commands.

3. **Data Transfer Security**
   - All communications between the system components and external entities shall be encrypted using industry-standard cryptographic protocols, such as TLS (Transport Layer Security).
   - The system shall implement secure authentication mechanisms, such as OAuth 2.0, for validating the identity of external systems and users.

4. **Integration with Email Services**
   - The system shall provide email notification capabilities for sending alerts, billing statements, and system updates to users and administrators.
   - SMTP (Simple Mail Transfer Protocol) shall be used for sending emails, and email content shall adhere to standard MIME (Multipurpose Internet Mail Extensions) formats.

5. **Integration with Messaging Platforms**
   - The system shall support integration with messaging platforms, such as SMS (Short Message Service) and push notification services, for delivering real-time notifications to users' mobile devices.

- APIs provided by messaging service providers, such as Twilio for SMS and Firebase Cloud Messaging for push notifications, shall be utilized for message delivery.

6. **Communication Standards Compliance**
   - The system shall adhere to relevant communication standards, such as Open Charge Point Protocol (OCPP) for communication with EV charging stations.
   - OCPP shall be implemented for exchanging operational data, commands, and status updates between the system and charging stations, ensuring interoperability and compatibility.

4. System Features

4.1 Monitoring the Charging Station Network and Detecting Anomalies

1 Description and Priority

This feature involves continuously monitoring the charging station network for any anomalies or issues to ensure smooth operation and timely maintenance.
Priority: High (8/9).

2 Stimulus/Response Sequences

Stimulus: System detects abnormal charging station behavior.
Response: System generates an alert and notifies the maintenance team.

3 Functional Requirements

- The system shall monitor charging station status in real-time.
- The system shall detect abnormal charging patterns and station malfunctions.
- The system shall generate alerts and notifications for maintenance personnel.
- The system shall log all detected anomalies for future analysis.

4.2 Analyzing the Energy Consumption and Optimize the Energy Distribution to Each Station

1 Description and Priority

This feature involves analyzing energy consumption patterns across the charging station network and optimizing energy distribution to ensure efficient charging operations. Priority: High (9/9).

2 Stimulus/Response Sequences

Stimulus: Variations in energy demand across stations.
Response: System adjusts energy distribution to optimize charging.

3 Functional Requirements

- The system shall collect real-time energy consumption data from each charging station.
- The system shall analyze energy consumption patterns and forecast demand.
- The system shall optimize energy distribution to balance load across stations.
- The system shall prioritize charging based on demand and available energy.

4.3 Analyzing Past Charging Data and Make Predictions on the Future Energy Demand

1 Description and Priority

This feature involves analyzing historical charging data to predict future energy demand, facilitating proactive energy management. Priority: Medium (6/9).

2 Stimulus/Response Sequences

Stimulus: Availability of historical charging data.
Response: System generates predictions for future energy demand.

3 Functional Requirements

- The system shall store historical charging data for analysis.
- The system shall use machine learning algorithms to predict future energy demand.
- The system shall provide forecasts for energy consumption and demand spikes.

4.4 User Registration to the System

1 Description and Priority

This feature allows users to register accounts on the system for accessing charging services and managing their preferences. Priority: Medium (5/9).

2 Stimulus/Response Sequences

Stimulus: User initiates registration process.
Response: System prompts user to provide registration information.

3 Functional Requirements

- The system shall provide a user registration interface.
- The system shall validate user-provided registration information.
- The system shall generate unique user IDs and credentials for registered users.

4.5 User Login and Session Management

1 Description and Priority

This feature allows registered users to log in to their accounts securely and manages user sessions during charging sessions. Priority: High (7/9).

2 Stimulus/Response Sequences

Stimulus: User attempts to log in.
Response: System authenticates user credentials and establishes a session.

3 Functional Requirements

- The system shall authenticate user credentials securely.
- The system shall manage user sessions during charging sessions.
- The system shall terminate inactive sessions after a configurable timeout period.

4.6 Locating a Desired Charging Station

1 Description and Priority

This feature enables users to search for and locate nearby charging stations based on their preferences and requirements. Priority: Medium (5/9).

2 Stimulus/Response Sequences

Stimulus: User initiates a search for charging stations.
Response: System displays a list of nearby charging stations.

3 Functional Requirements

- The system shall provide a search interface for locating charging stations.
- The system shall use location-based services to identify nearby charging stations.
- The system shall display charging station details, including availability and pricing information.

4.7 Sending Alerts and Information About Ongoing Charging Session

1 Description and Priority

This feature allows the system to send alerts and notifications to users about ongoing charging sessions and any relevant information. Priority: Medium (6/9).

2 Stimulus/Response Sequences

Stimulus: Charging session initiated or completed.
Response: System sends alert/notification to user's registered device.

3 Functional Requirements

- The system shall send alerts to users upon initiation and completion of charging sessions.
- The system shall notify users about any charging-related updates or issues.

4.8 Payment for the Charging Session

1 Description and Priority

This feature enables users to make payments for their charging sessions securely and
conveniently. Priority: High (8/9).

2 Stimulus/Response Sequences

Stimulus: User initiates payment for a charging session.
Response: System processes payment and updates session status.

3 Functional Requirements

- The system shall provide secure payment processing functionality.
- The system shall support various payment methods, including credit/debit cards and mobile wallets.
- The system shall generate invoices and receipts for completed charging sessions.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

1. The system should handle concurrent user sessions without significant performance degradation.
2. Response times for critical functionalities (e.g., starting a charging session) should be within acceptable limits.

5.2 Safety Requirements

1. The system must ensure that the application provides accurate and reliable information about the nearest charging stations to prevent users from getting stranded due to incorrect data for user safety.
2. Implement a feature that allows users to quickly access emergency services in case of any accidents or emergencies while on their way to or from a charging station.
3. Incorporate route optimization algorithms to suggest the safest and most efficient routes to the nearest charging station, considering factors such as traffic conditions and road hazards.

5.3 Security Requirements

1. Implement secure authentication mechanisms (e.g., OAuth, JWT) for user access.
2. Encrypt sensitive data (e.g., payment information, user credentials) during transmission and storage.
3. Regular security audits and updates to mitigate vulnerabilities.

5.4 Software Quality Attributes

1. Reliability: Consistent performance under varying conditions
   Minimal downtime and error occurrences
2. Usability: Intuitive user interface design
   Clear and concise user documentation
3. Performance: Fast response times
   Scalability to handle increasing user loads
4. Maintainability: Easily modifiable and extendable codebase
   Comprehensive documentation for developers
5. Portability: Compatibility across different platforms and devices
   Easy deployment and installation processes

6. Testability: Comprehensive test coverage
7. Scalability: Ability to handle increasing workload and user base
   Efficient resource utilization and allocation
8. Accessibility: Compliance with accessibility standards (e.g., WCAG)
   Support for users with disabilities or special needs

5.5 Business Rules

1. **User Registration**
   Users of the EV Charging Management System can only be registered by those with working email addresses and personal data. To guarantee data confidentiality and accuracy, verification through email or other authentication techniques could be necessary for registration.

2. **Role-Based Access Control**
   Based on user roles, access to data and system operations is controlled. Standard users (EV owners) have access to charging session initiation, monitoring, and payment operations, while administrators have access to system configuration, station administration, and reporting functions.

3. **Charging Session Authorization**
   Before starting a charging session, EV users need to authenticate both their vehicles and themselves. Misuse of charging facilities or unauthorized access to charging stations is forbidden and may lead to fines or account suspension.

4. **Billing and Payment**
   Tariff rates, energy usage, and session length are some of the variables that go into calculating charging costs. It is the responsibility of the user to pay the charged fees on time, using the authorized payment methods; late payments may result in fines or account limitations.

5. **Station Availability and Reservation**
   Depending on the availability of stations and their preferred timetable, users can schedule charging sessions in advance. Users must respect their reservations within the allotted durations in order to prevent cancellation. Reservation slots are distributed on a first-come, first-served basis.

6. **Maintenance and Service Notifications**
   In order to guarantee the continuous operation of charging stations and the prompt resolution of maintenance issues, administrators get messages regarding maintenance schedules, service alerts, and system updates.

7. **Data Privacy and Confidentiality**
   The system complies with data privacy laws and guidelines that control how user and charging session data are gathered, stored, and used. Measures are in place to protect data integrity and confidentiality, and user agreement is secured for data processing and dissemination.

8. **Compliance with Regulations**
   Regarding data protection, payment processing, and the infrastructure for charging electric vehicles, the EV Charging Management System conforms with all applicable rules and guidelines. To guarantee continuous compliance, any modifications to regulatory requirements are quickly evaluated and system updates are put into place appropriately.

6. Other Requirements

1. **Database Requirements**

A relational database management system (RDBMS) will be used by the EV Charging Management System to store and manage user data, transaction records, charging session logs, and system configurations.
Normalized data structures must be followed while designing database schemas in order to maximize query performance, data consistency, and integrity.
In the event of system failures or natural disasters, the database system must include data backup and recovery techniques to guarantee data availability and integrity.

2. **Internationalization and Localization**

To serve customers from a variety of linguistic and geographic origins, the system will handle different languages and localities.
To enhance usability and accessibility for global users, user interfaces, error messages, and system notifications must be designed and translated into several languages.

3. **Legal and Regulatory Compliance**

The EV Charging Management System must abide by all applicable laws, rules, and industry guidelines pertaining to payment processing, data privacy, and the infrastructure for charging electric vehicles.
Users will receive legal agreements, terms of service, and privacy policies detailing their obligations, rights, and guidelines for using data.

4. **Accessibility Requirements**

The system must comply with accessibility guidelines (such as WCAG) to guarantee fair access and usability for people with impairments.
For users with visual, motor, or cognitive disabilities, user interfaces must include screen readers, keyboard navigation, and other input techniques.

5. **Security and Data Protection**

Robust security measures will be implemented by the system to guard against cyber attacks, unauthorized access, and data breaches, as well as to safeguard user data and financial transactions.
Access restrictions, secure authentication methods, and encryption protocols must be used to protect confidential data and stop data leaks and manipulation.

6. **Integration Requirements**

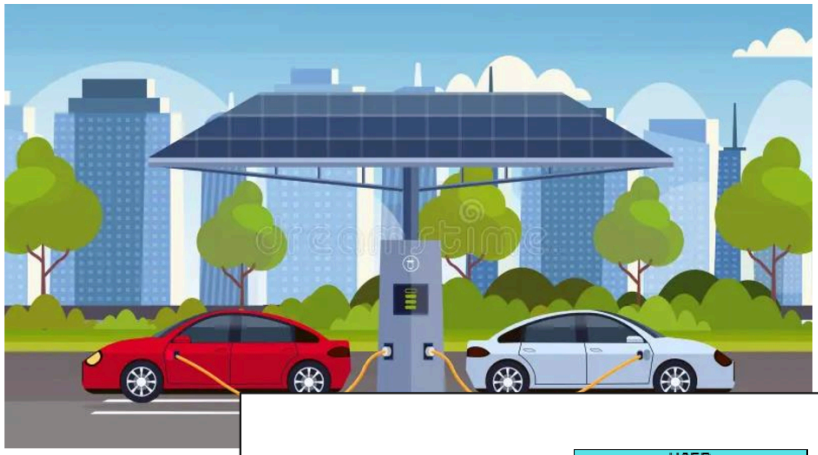
Through common APIs and data exchange protocols, the EV Charging Management System will facilitate integration with third-party systems, including fleet management programmes, accounting software, and energy market platforms.
To enable smooth data exchange and workflow automation, interfaces for web services integration, data import/export, and compatibility with third-party applications must be put into place.

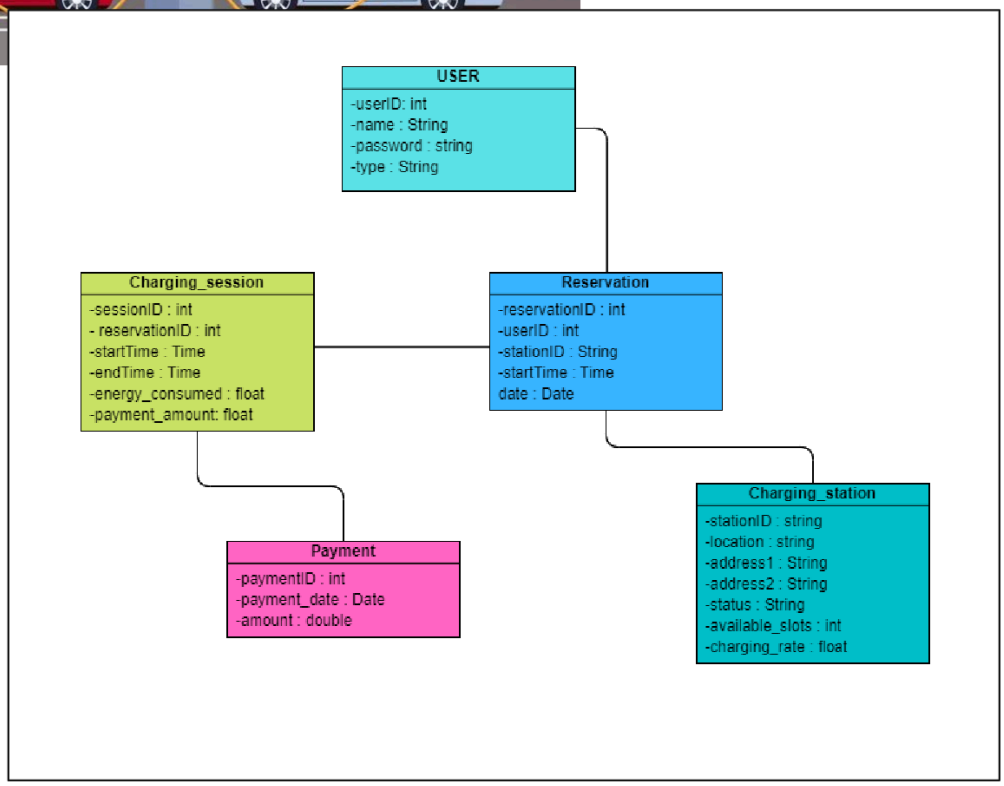
Appendix A: Glossary

- EV - Electric Vehicle
- API - Application Programming Interface
- UI - User Interface
- OCPP - Open Charge Point Protocol
- RESTful - Representational State Transfer
- HTTP/HTTPS - Hypertext Transfer Protocol/Secure Hypertext Transfer Protocol
- JSON - JavaScript Object Notation
- MQTT - Message Queuing Telemetry Transport
- TLS - Transport Layer Security
- OAuth - Open Authorization
- SMTP - Simple Mail Transfer Protocol
- MIME - Multipurpose Internet Mail Extensions
- SMS - Short Message Service
- DBMS - Database Management System
- WCAG - Web Content Accessibility Guidelines

Appendix B: Analysis Models

Class Diagram - EV charging Management System





Appendix C: To Be Determined List

- Payment Gateway Integration Details (TBD)
- Data Backup and Recovery Procedures (TBD)
- User Support and Training Plan (TBD)
- Regulatory Compliance Documentation (TBD)
- Performance Testing Strategy (TBD)
- Internationalization and Localization Requirements (TBD)