A

Mini Project Report

on

VOLTSPHERE: Seamless EV Power Grid

Submitted in partial fulfillment of the requirements for the degree

Second Year Engineering – Computer Science Engineering (Data Science)

by

Kishan Gupta	**23107066**
Shardul Kadam	**23107068**
Hemanshu Ingale	**23107077**
Parth Pawar	**23107048**

Under the guidance of

Dr.Veena Trivedi

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING (DATA SCIENCE)

A.P. SHAH INSTITUTE OF TECHNOLOGY

G.B. Road, Kasarvadavali, Thane (W)-400615

UNIVERSITY OF MUMBAI

Academic year: 2024-25

CERTIFICATE

This to certify that the Mini Project report on **Voltsphere** has been submitted by **Kishan Gupta** (23107066), **Shardul Kadam** (23107068), **Hemanshu Ingale** (23107077) and **Parth Pawar** (23107048) who are bonafide students of A. P. Shah Institute of Technology, Thane as a partial fulfillment of the requirement for the degree in **Computer Science Engineering (Data Science)**, during the academic year **2024-2025** in the satisfactory manner as per the curriculum laid down by University of Mumbai.

Dr.Veena Trivedi
Guide

Prof. Anagha Aher
HOD, CSE (Data Science)

Dr. Uttam D. Kolekar
Principal

External Examiner:
1.

Internal Examiner:
1.

Place: A. P. Shah Institute of Technology, Thane
Date:

ACKNOWLEDGEMENT

This project would not have come to fruition without the invaluable help of our guide **Dr.Veena Trivedi**. Expressing gratitude towards our HoD, **Ms.Anagha Aher**, and the Department of Computer Science Engineering (Data Science) for providing us with the opportunity as well as the support required to pursue this project. We would also like to thank our project coordinator **Prof. Aavani Nair** who gave us her valuable suggestions and ideas when we were in need of them. We would also like to thank our peers for their helpful suggestions.

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Chapter 1

Introduction

"Electric vehicles (EVs) are gaining popularity due to their sustainability, lower environmental impact,and cost-effectiveness compared to conventional fuel-based vehicles. However, EV users face significant challenges, including locating available charging stations, booking charging slots efficiently, and ensuring access during peak hours."

Electric vehicles (EVs) are rapidly gaining traction as a preferred mode of transportation, primarily due to their sustainability, reduced environmental footprint, and cost-efficiency compared to traditional fuel-based vehicles. With growing environmental awareness and government incentives, more consumers are making the switch to electric mobility. However, this surge in EV adoption presents new challenges—most notably, the accessibility and management of charging infrastructure.

EV users often struggle with locating nearby and available charging stations, booking charging slots in advance, and ensuring timely access during peak usage periods. These issues can lead to long waiting times, uncertainty, and inconvenience, ultimately discouraging EV use.

To address these pressing concerns, **VoltSphere** has been developed—a comprehensive, desktop-based **EV Charging Station Management System**. VoltSphere empowers users with a streamlined platform to **search for nearby charging stations**, **view real-time slot availability**, and **secure their bookings in advance**. The system is designed to offer **priority access based on user membership levels**, ensuring a smoother and more personalized charging experience.

VoltSphere is a desktop-based EV Charging Station Management System* designed to help EV users *find charging stations, book slots in advance, and gain priority charging access based on membership levels. The system provides an intuitive and **user-friendly interface* with *real-time updates on slot availability, a color-coded booking system for easy identification, and digital invoicing for transparency*. This project aims to bridge the gap between the increasing number of EVs and the availability of efficient charging station management.

1.1Purpose

The main purpose of **VoltSphere**, a desktop-based **EV Charging Station Management System**, is to provide a centralized and efficient platform for managing electric vehicle charging stations. It enables real-time monitoring and control of charging stations, allowing operators to track usage, manage charging sessions, and optimize station performance. The system also facilitates user and payment management, ensuring seamless transactions and subscriptions for charging services. Additionally, it helps in monitoring energy consumption, providing insights to improve efficiency and reduce operational costs. It also offers data analytics and reporting features, helping operators make data-driven decisions based on usage patterns and financial performance. Furthermore, the system can integrate with smart grids to balance energy distribution and enhance sustainability. Overall, VoltSphere enhances the reliability, and efficiency of EV charging stations while improving user experience and operational management.

1.2Problem Statement

With the rapid adoption of electric vehicles (EVs), the demand for efficient and reliable charging station management has increased. However, existing solutions often lack centralized control, real-time monitoring, and seamless user and payment management, leading to operational inefficiencies, maintenance delays, and poor user experience. Charging station operators struggle with tracking energy consumption, handling faults, and ensuring optimal utilization of resources. To address these challenges, **VoltSphere**, **EV Charging Station Management System**, provides an all-in-one solution for monitoring, managing, and optimizing EV charging stations, ensuring efficiency,and user satisfaction.

1.3Objective

1. To develop a user-friendly system for booking EV charging slots:

The system is designed with a strong focus on user experience. It offers a clean and intuitive interface that allows EV users to easily locate nearby charging stations, view real-time slot availability, and book their preferred time slots with just a few clicks. By minimizing complexity and streamlining the booking process, the platform ensures a smooth and efficient experience for both new and experienced users. Additional features like map integration, search filters, and instant confirmation enhance convenience.

2. To integrate a priority-based membership system for urgent charging needs:

Recognizing that some users may require faster access to charging facilities—such as during emergencies or busy hours—the system incorporates a membership-based priority model. Users can subscribe to different membership tiers (e.g., Basic, Silver, Gold), each offering varying levels of priority.Higher-tier members can reserve slots in advance and gain faster access to stations during high-traffic times,ensuring that urgent charging needs are met without delays.This not only improves service reliability but also rewards loyalusers.

3. To generate digital receipts and maintain charging history for users:

After completing a charging session, users automatically receive a detailed digital receipt, which includes information such as the date, station location, energy consumed, total cost, and payment method. All transaction records and charging sessions are securely stored in the user's account history, allowing them to track energy usage, analyze costs over time, and maintain organized financial records. This feature promotes transparency, builds trust, and is especially useful for fleet managers or business users who need regular.

4. To color-code slot status: Green (Available), Red (Booked), Yellow (Reserved for Members):

To make the interface more intuitive and visually accessible, the system employs a color-coded status system for all charging slots:

• **Green** indicates that the slot is available and open for booking.

• **Red** shows that the slot has already been booked by another user and is currently unavailable.

• **Yellow** designates slots that are reserved specifically for members with priority access, ensuring they are always accommodated.

This visual approach allows users to quickly understand slot availability at a glance, reducing confusion and enhancing the overall booking experience.

1.4Scope

1. Can be applied in public EV charging stations:

The system is specifically designed to be implemented in public EV charging infrastructure such as roadside stations, malls, parking lots, and commercial hubs. It helps regulate user flow, minimize idle time at charging points, and improve overall service efficiency. By managing reservations and slot allocations in real time, it ensures that public charging facilities can handle higher user volumes without chaos or long wait times. This makes it ideal for busy urban locations where demand is high and organization is key.

2. Useful for EV owners, fleet operators, and charging station managers:

The system is versatile and supports the needs of multiple stakeholders:

- EV owners benefit from convenient booking, real-time slot visibility, and access to digital receipts and charging history.
- **F**leet operators can manage multiple vehicles under one account, schedule recurring bookings, and generate detailed reports for business analysis and operational planning.
- Charging station managers gain tools for monitoring usage, identifying peak times, managing memberships, and automating billing, which enhances service delivery and reduces manual workload.

3. Can be extended for mobile application integration in the future:

Though currently developed as a desktop-based platform, the system architecture is adaptable for mobile application development. This future upgrade would enable users to access the platform through smartphones or tablets, enhancing mobility and user convenience. Features like push notifications for slot reminders, QR code check-ins, and location-based station suggestions could be seamlessly added to enrich the user experience and attract a wider audience.

4. Supports both 2-wheeler and 4-wheeler charging at the same station:

The system is built to accommodate various types of electric vehicles, including e-bikes, scooters, cars, and small commercial EVs. It allows for separate or combined slot management for two-wheelers and four-wheelers, ensuring optimal utilization of charging ports. By supporting mixed vehicle types at the same station, operators can cater to a broader customer base and avoid infrastructure duplication, making the station more cost-effective and efficient.

Chapter 2

Proposed System

VoltSphere is a **desktop-based EV Charging Station Management System** designed to provide a comprehensive solution for efficiently managing EV charging stations. The system will enable real-time monitoring and control of charging stations, allowing operators to track energy consumption and ensure seamless operations. It will include user and payment management features, ensuring secure transactions and subscription handling. Additionally, VoltSphere will offer automated maintenance alerts, data analytics, and reporting tools to optimize station performance and enhance decision-making. Integration with smart grids will further improve energy distribution and sustainability. By centralizing management, improving security, and enhancing the user experience, VoltSphere aims to streamline the operation of EV charging stations, reducing downtime and increasing efficiency.

2.1Features and Functionality

1.Slot Booking & Availability:

Users can browse a calendar or time-based interface to view all charging slots in real-time. The system displays which slots are free and which are occupied, allowing users to choose a convenient time in advance.Avoid waiting queues at charging stations.Receive confirmation and reminders for their bookings. This improves the overall user experience and ensures better management of station resources.

2. Membership-Based Priority Booking:

Premium users gain early access to available slots, especially during peak hours, giving them a higher chance of securing preferred time slots before regular users can. This priority access adds value for subscribed members and encourages more users to upgrade.

3.Charging History & Invoice:

The platform keeps a detailed log of each user's past charging sessions, including date, time, location, energy consumed, and cost. Users can also download invoices or receipts for their records or business use, making the process transparent and trackable.

4.Color-Coded Slot Status:

The interface uses a simple color-coding system to indicate slot availability—green for available slots open to all users, red for already booked slots, and yellow for slots reserved exclusively for premium members. This helps users quickly understand slot status and make informed booking decisions.

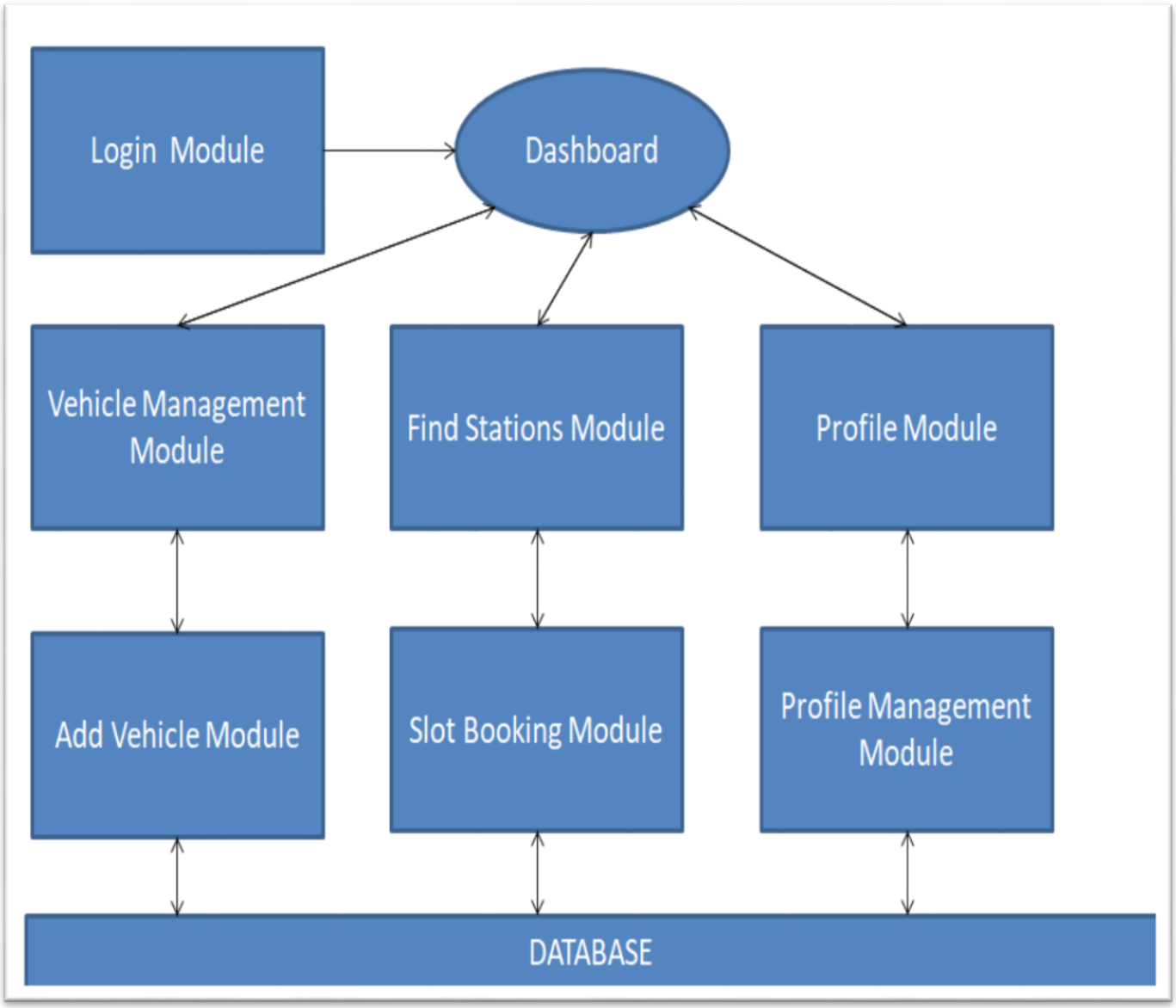


Figure 2.1.: Block Diagram/Architecture of the project

Figure 2.1 represents the architecture of an electric vehicle (EV) charging system application.

- **Login Module**: Authenticates users and gives access to the **Dashboard**.
- **Dashboard**: Central hub that navigates to all major modules.
- **Vehicle Management Module**: Manages user vehicles and connects to the **Add Vehicle Module**, which allows users to register their vehicles.
- **Find Stations Module**: Helps users locate nearby charging stations.
- **Slot Booking Module**: Lets users book charging slots and interacts directly with the **Database**.
- **Profile Module**: Displays user profile, connected to **Profile Management Module** for editing/updating user data.
- **Database**: Central storage accessed by key modules for data persistence.
- Each module is interconnected to provide a smooth user experience for vehicle management, station discovery, booking, and profile handling.

Chapter 3

Project Outcomes

The implementation of **VoltSphere** will result in a highly efficient and intelligent **EV Charging Station Management System** that significantly improves operational management, user experience, and energy optimization. Charging station operators will have access to a centralized platform for real-time monitoring, allowing them to track station performance, energy consumption, and charging sessions effortlessly. The system will streamline user and payment management, ensuring secure transactions, automated billing, and subscription handling, thereby enhancing convenience for both operators and EV users.

By incorporating automated maintenance alerts, VoltSphere will minimize station downtime and reduce operational costs by proactively identifying and addressing issues before they escalate. The integration of data analytics and reporting tools will provide valuable insights into station usage, revenue generation, and energy efficiency, empowering operators to make data-driven decisions for improved business growth.

Furthermore, VoltSphere's integration with smart grids will ensure optimal energy distribution, promoting sustainable energy consumption and reducing the risk of power overloads. The system will also enhance security through robust access control and authentication mechanisms, preventing unauthorized usage and ensuring data protection.

Ultimately, VoltSphere will lead to a **more streamlined, scalable, and user-friendly** EV charging infrastructure. By improving efficiency, reducing downtime, and enhancing customer satisfaction, this system will contribute to the widespread adoption of electric vehicles and support the transition toward a greener and more sustainable future.

To support commercial and fleet operators, VoltSphere will offer analysis, allowing companies to monitor the charging behavior, battery health, and location of their EVs in real time. Customizable access levels and user role management will enable corporate clients to assign permissions and track usage by driver or department.

Chapter 4

Software Requirements

The development of the Expense Tracker app requires a combination of core software tools and libraries that ensure smooth functionality, a user-friendly interface, and reliable data handling. The primary components used are:

- **Python(3.12 version):** Provides the libraries and tools needed for developing the Python-based frontend of the system.
- **Vscode IDE:** Used for writing, testing, and debugging Python code, Vscode offers an integrated environment to streamline development processes.
- **MySQL Database Server:** Manages and stores employee and payroll data, handling SQL queries and transactions for backend operations. **MySQL Workbench:** A graphical tool for database design, management, and maintenance, facilitating schema design and query execution.

Python Libraries Used:

1. **os:** Provides functions for interacting with the operating system.
2. **io:** Helps manage I/O operations in memory.
3. **platform:** Used to access underlying system information.
4. **tkinter / ttk:** For creating GUI elements like windows, buttons, labels, and more.
5. **messagebox, filedialog, colorchooser:** Modules under tkinter used for dialogs and color selections.
6. **mysql.connector:** To establish connection and interact with the MySQL database.
7. **datetime:** Used to handle and format dates for transaction records.
8. **matplotlib.pyplot & FigureCanvasTkAgg:** For generating and displaying data visualizations such as graphs and charts.
9. **reportlab:** Used to generate tables and styled text.
10. **pandas:** Helps in organizing and processing tabular data before export or visualization.

Chapter 5

Project Design

Project design is planning how a project will work before starting it. It involves figuring out what's needed, setting goals, and deciding how to build it. Key parts include figuring out how the system will be set up, how data will be stored, what the interface will look like, how things will work, how to test it, and how to handle any problems.

The project design of our VoltSphere application as shown below:

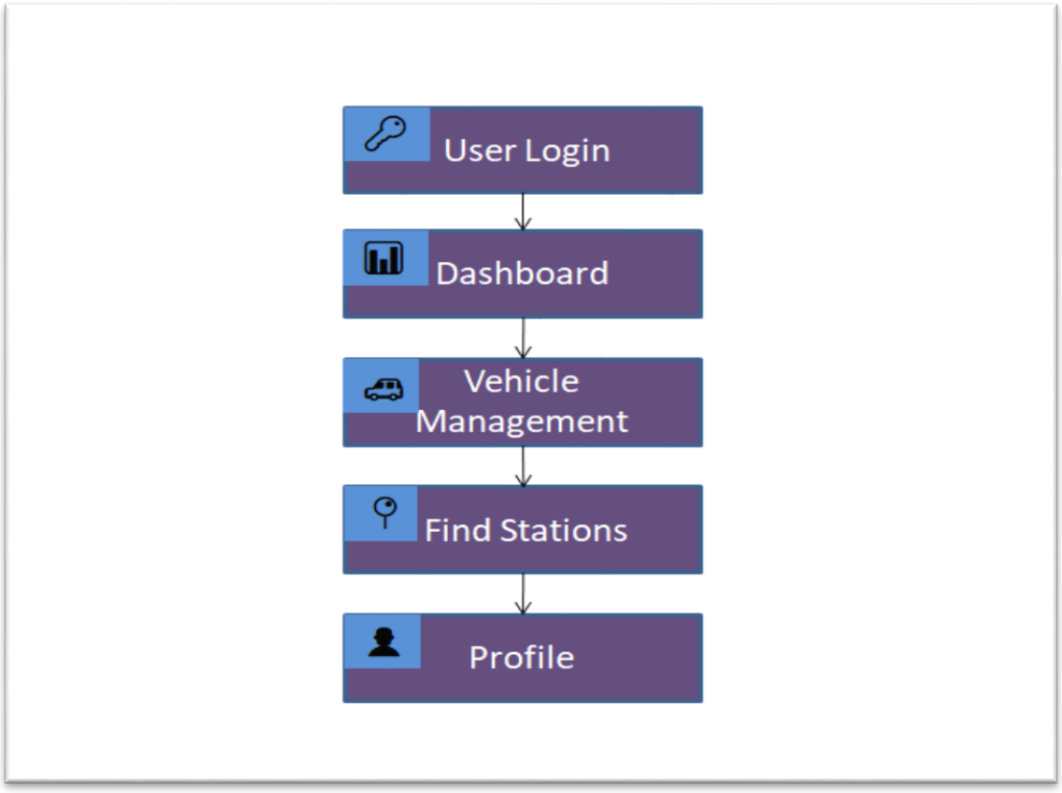


Fig 5.1 Work Flow Diagram

This Fig 5.1 is a workflow diagram outlines a typical user interaction with a system, starting with **User Login**, the necessary initial step for accessing its features, often symbolized by a key icon indicating authentication.Upon successful login, the user is directed to a **Dashboard**,usually represented by a bar graph icon, which serves as a summary or overview of the system's key information and functionalities. From the dashboard, users can then navigate to **Vehicle Management**, indicated by a car icon, where they can manage vehicle-related tasks such as adding, viewing, or editing information.Another option, potentially following vehicle management or as an alternative from the dashboard, is to **Find Stations**,a feature typically represented by a location pin icon, allowing users to locate relevant stations. Finally, the user can access their **Profile**, symbolized by a person's silhouette, to manage their personal information, settings, and account details. This sequential flow suggests a common user journey through the system's core functions.

Chapter 6

Project Scheduling

This Fig 6.1 is Gantt chart that outlines the timeline and task distribution for a project titled "**VOLTSPHERE EV CHARGERING STATION FINDER**," . The project is divided into two main phases: **Project Conception and Initiation** (Phase One) and **Project Design and Implementation** (Phase Two). Phase One includes tasks such as group formation which was done by Kishan Gupta leader of the group sleecting members Shardul Kadam,Parth Pawar and Hemanshu Ingale ,topic confirmation, documentation of the problem, defining the scope, preparing and submitting project proposals, and presenting the finalized proposal.Identifying the functaionalities of this mini project was done by Shardul Kadam.We discussed project topic on paper prototype.The graphical user interface ideas were given by Parth Pawar.Presenataion 1 was presented by all members of the group successfully.Database designing was done by Shardul Kadam and Hemanshu Ingale.Database connective of this projectwas done by Shardul Kadam.Integration of all Modules was done by Kishan Gupta and Parth Pawar.Presentation 2 was presented successfully by all group members. These tasks are scheduled and completed between the weeks of 19-02-25 to 15-03-25. Phase Two includes activities like database design, UI design, community database connectivity, module creation (with frontend and backend), and final presentation. These tasks span from 19-03-25 to 12-04-25. Each task is assigned a specific week and marked with color-coded bars indicating the duration of the task. Additionally, progress is shown as 100% completed for each listed task.This project was made in duration of 12 weeks.

GANTT CHART TEMPLATE

Smartsheet Ti

A Gantt chart's visual timeline allows you to see details about each task as well as project dependencies.

PROJECT TITLE: VOLTSPHERE

PROJECT GUIDE: Dr.Veena Trivedi

INSTUTUTE & DEPARTMENT NAI AP SHAH INSTITUTE OF TECHNOLOGY(CSE-Data Science)

DATE: 10-8-24

WBS NUMBER	TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION(Weeks)	PERCENTAGE OF TASK COMPLETE
1	**Project Conception and Initiation**					
1.1	Group formation and Topic finalization. Identifying the scope and objectives of the Mini Project	Kishan Gupta	1-8-25	1-16-25	1	100%
1.2	Identifying the functionalities of the Mini Project	Shardul Kadam	1-16-25	1-28-25	2	100%
1.3	Discussing the project topic with the help of paper prototype.	Hemanshu Ingale,Parth Pawar,Shardul Kadam	1-28-25	2-5-25	1	100%
1.4	Designing the Graphical User Interface(GUI)	Parth Pawar	2-5-25	2-11-25	1	100%
1.5	Presentation I	Kishan Gupta,Shardul Kadam,Parth Pawar,Hemanshu Ingale	2-11-25	2-17-25	1	100%
2	**Project Design and Implementation**					
2.1	Database Design	Shardul Kadam,Parth Pawar,	2-17-25	3-3-25	2	100%
2.2	Database Connectivity of all modules	Shardul Kadam	3-3-25	3-13-25	2	100%
2.3	Integration of all modules and Report Writing	Kishan Gupta	3-13-25	3-31-25	3	100%
2.4	Presentation II	Kishan Gupta,Shardul Kadam,Parth Pawar,Hemanshu Ingale	3-31-25	4-1-25	1	100%

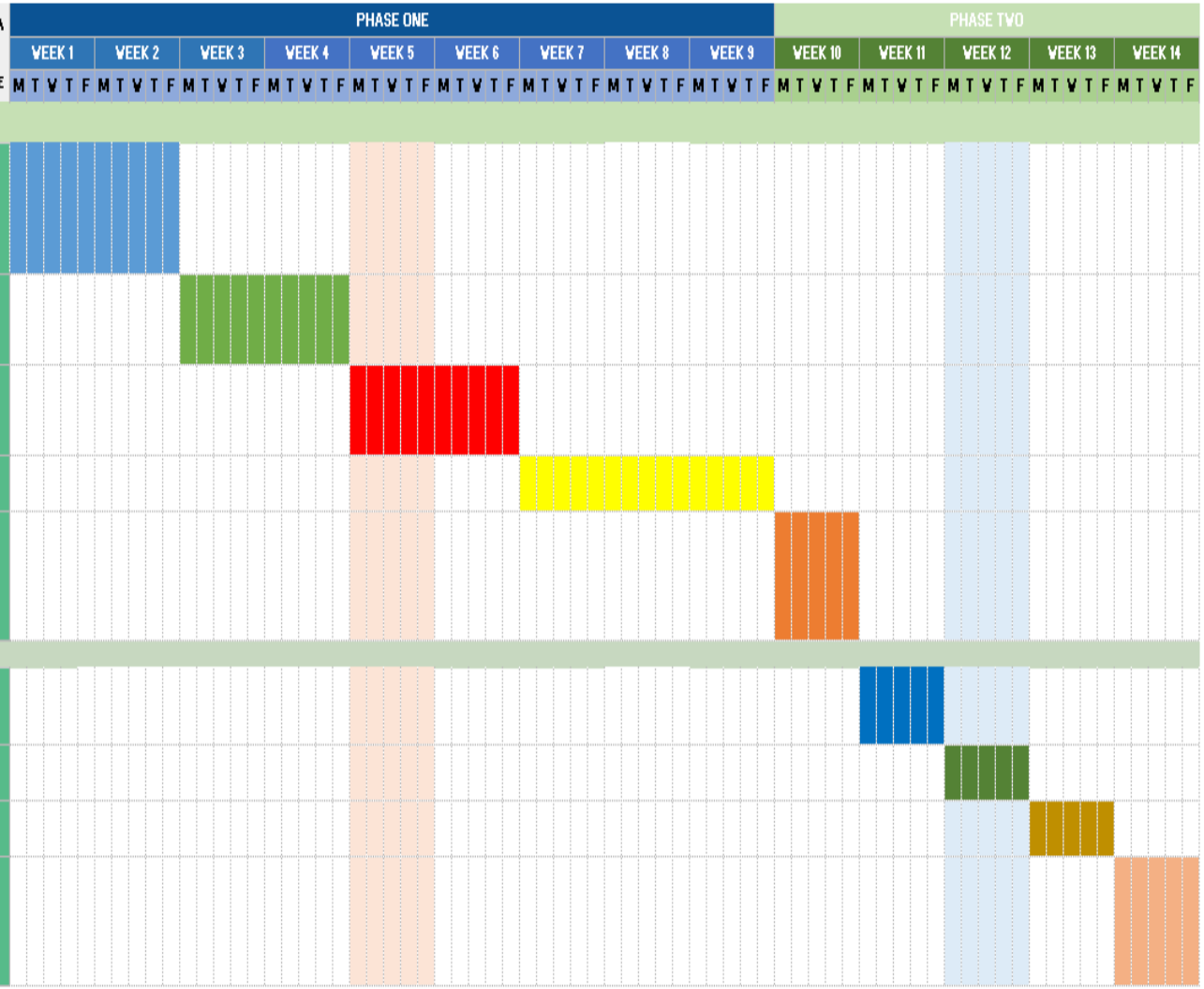


Figure 6.1: Gantt Chart Representing Project Timeline and Task Allocation

Chapter 7

Results

The Voltsphere Application has been successfully developed and tested to meet its intended objectives of allowing users to record, categorize, and manage their daily expenses. Below is a detailed summary of the outcomes observed during the final phase of the project.

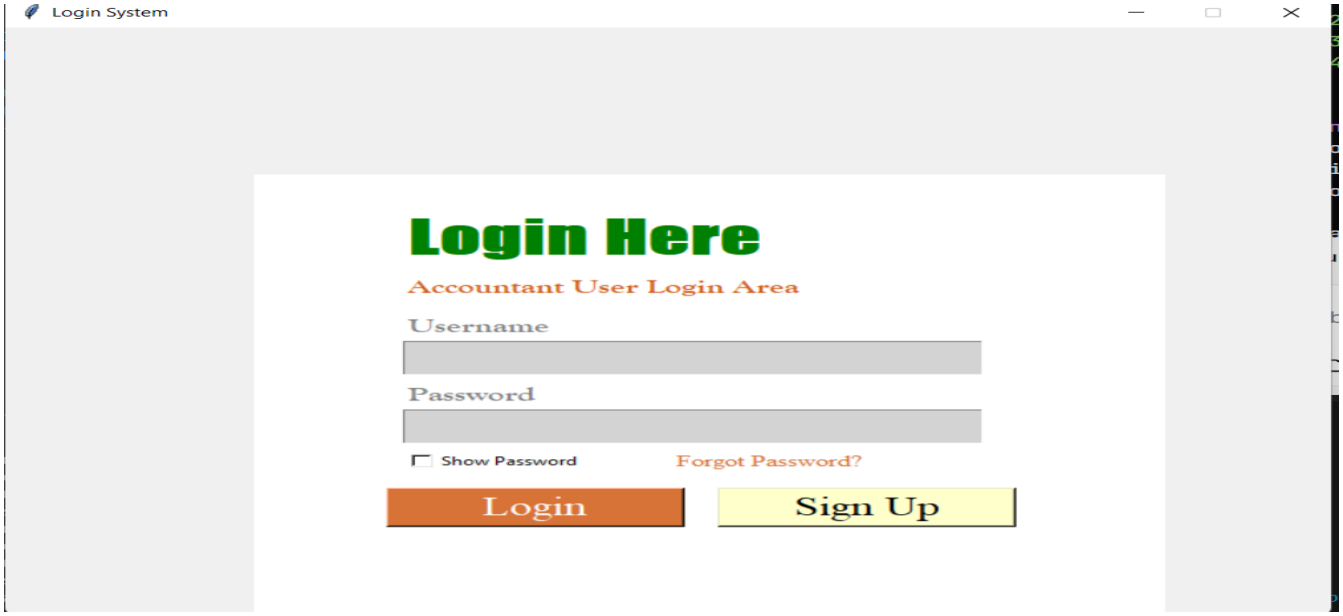


Figure 7.1.: Login page - To take in preregistered users

Fig.7.1 is a login page a secure interface for users to enter their username and password to access the VOLTSPHERE app features with exit button.

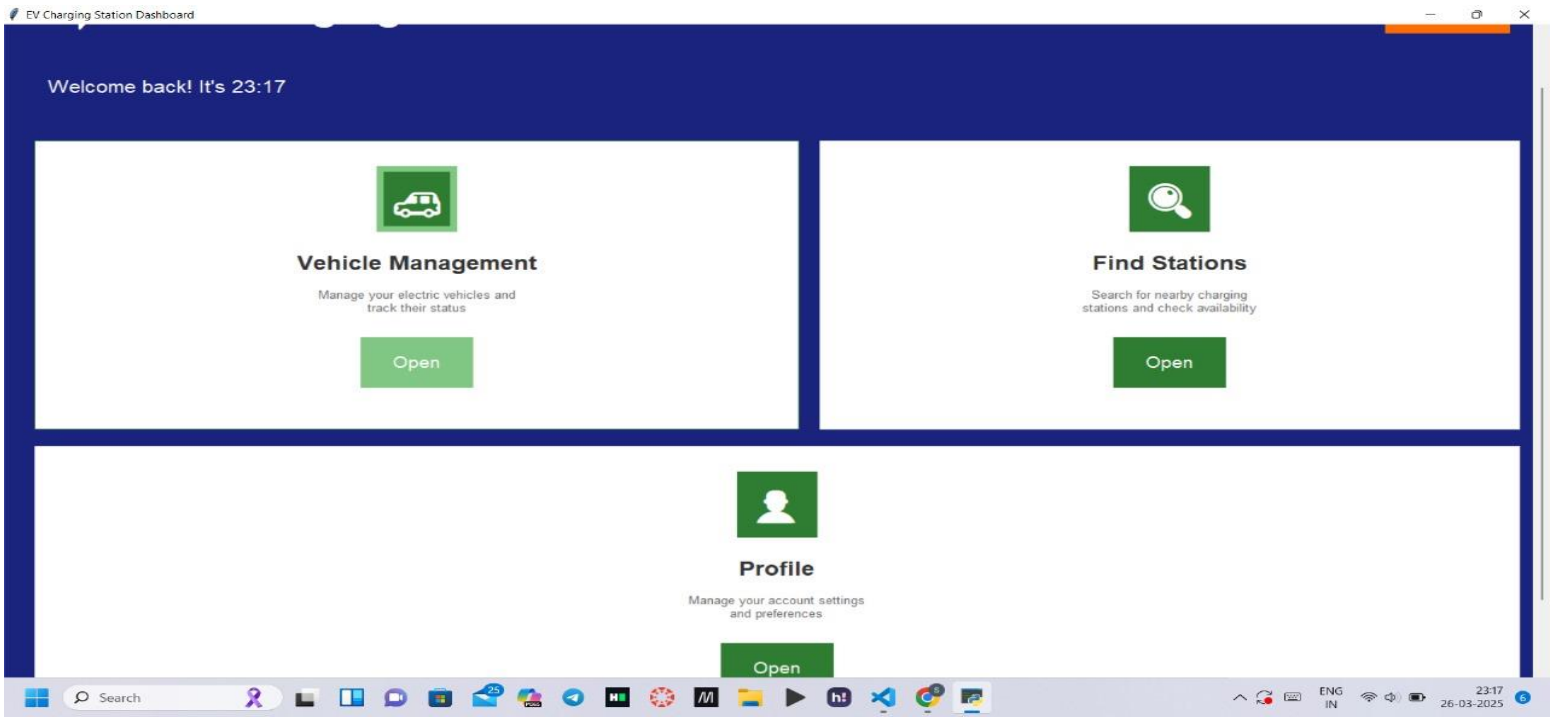


Figure 7.2.: Dashboard page - Interface for vehicle Management,Profile,Find Solution.

Fig 7.2 is of main dashboard offering options for vehicle management, find station,and profile management, allowing users to navigate key functions.

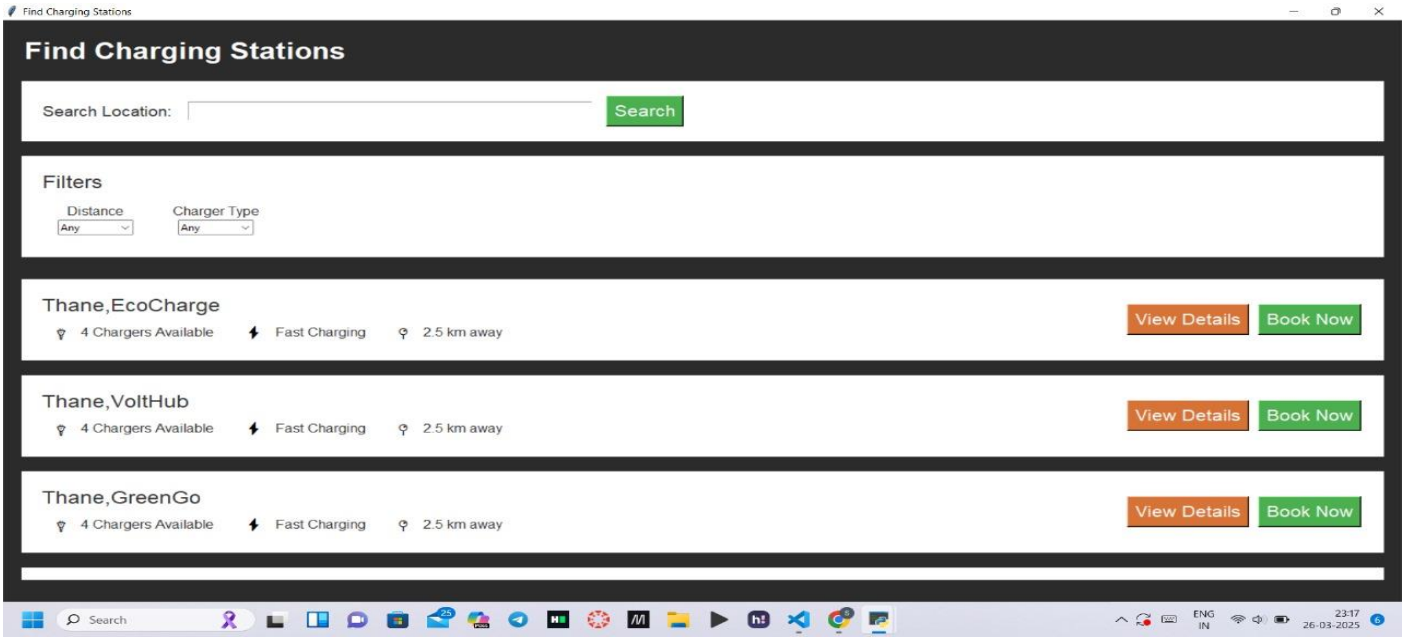


Figure 7.3.: Search page –To find charging stations.

Fig 7.3 is of Search page allow users can serach ev charging station at current location as well as neighbouring ev charging stations locations.

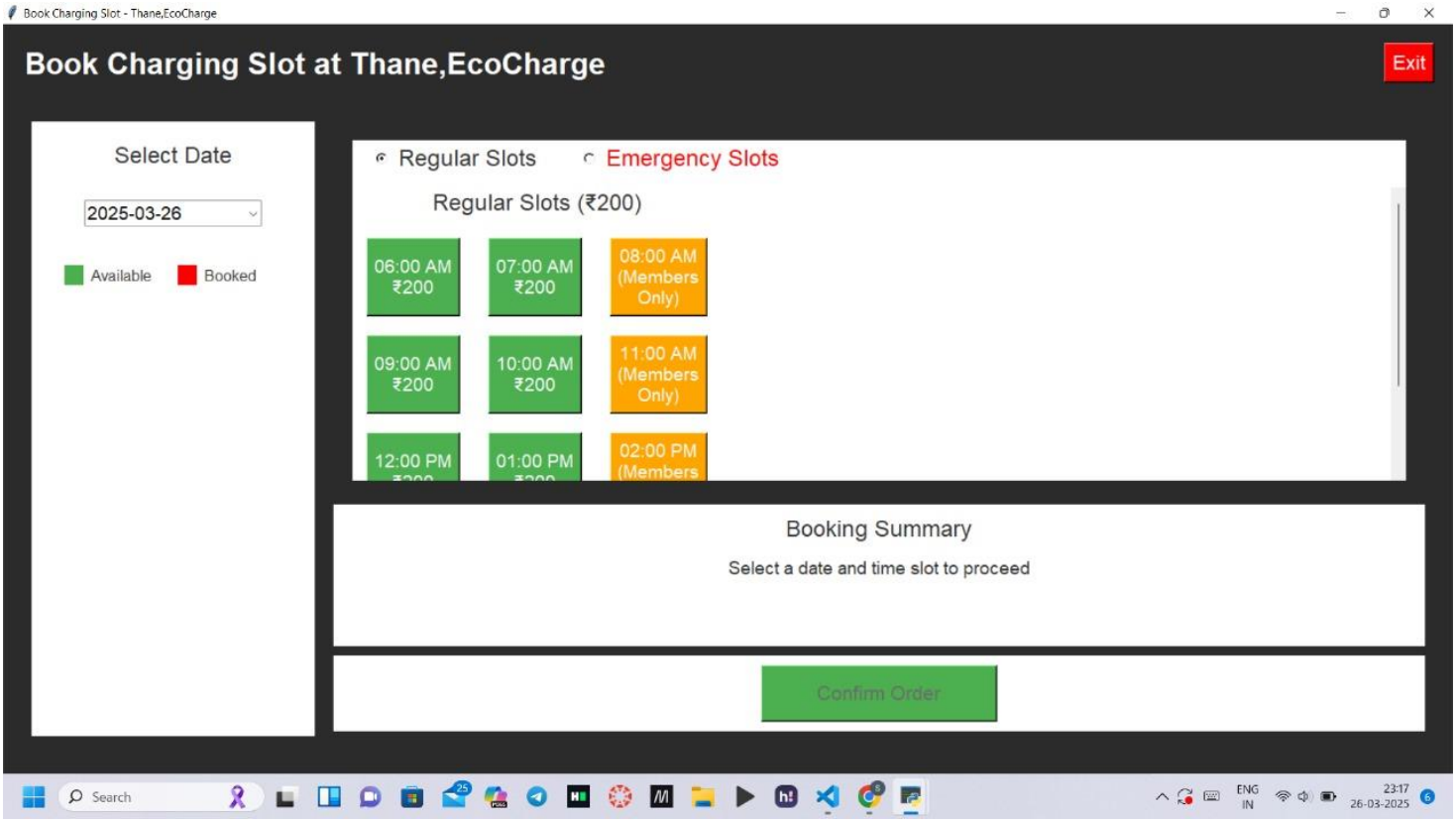


Figure 7.4.: Slot Booking page –To book slot for charging.

Fig 7.4 is of slot booking page enables users to book slots and select time required to charge their vehical. Color-Coded Slot Status green (Available), Red (Booked), Yellow (Reserved for Members).

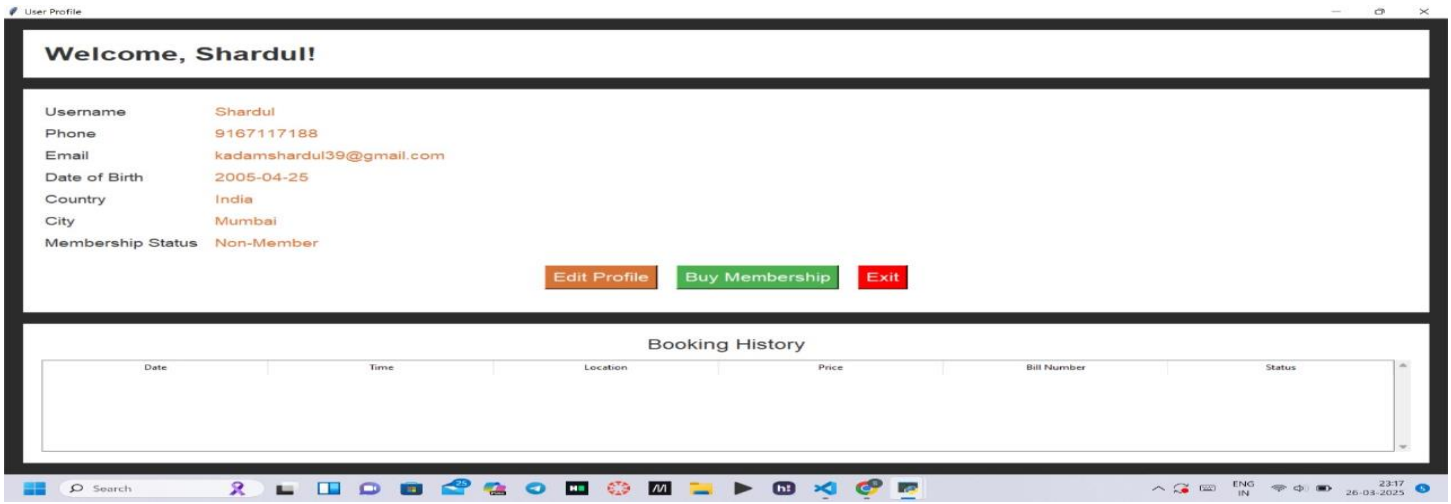
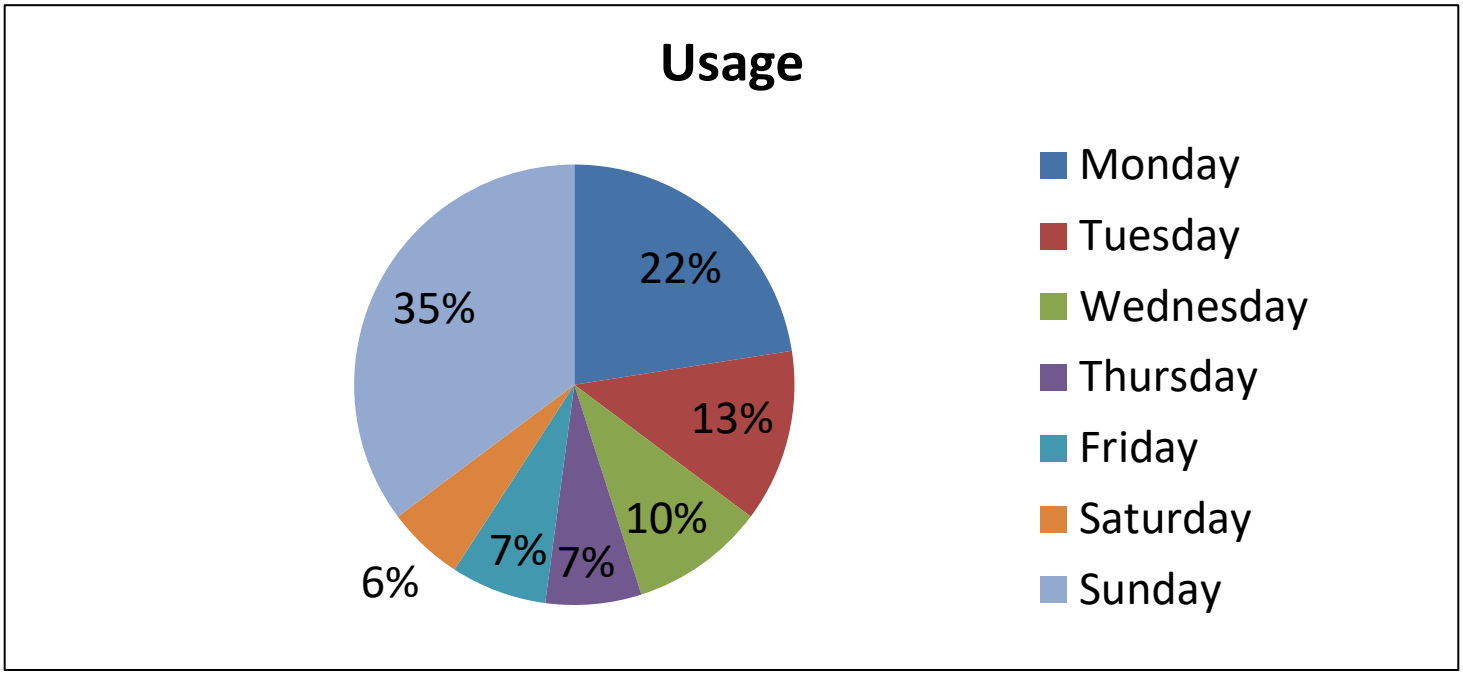


Figure 7.5.: Profile page –To manage user'profile.

Fig 7.5 is of Profile page,this screen allows users to edit and manage their profile as well as an access for subscription of membership.

System Analytics:



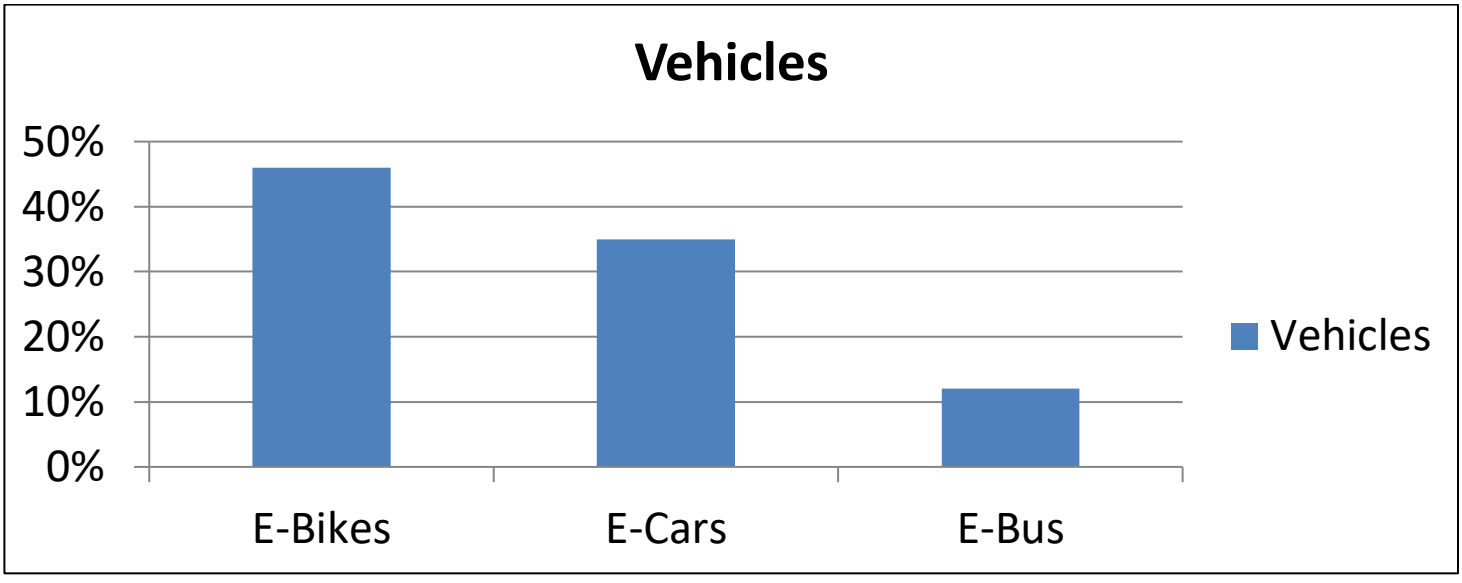
This pie chart titled **"Usage"** shows the percentage distribution of activity or usage across different days of the week. Each slice of the pie represents a day, with the size of the slice indicating the percentage of total usage on that day.

Sunday has the highest usage at 35%, indicating it's the most active day.

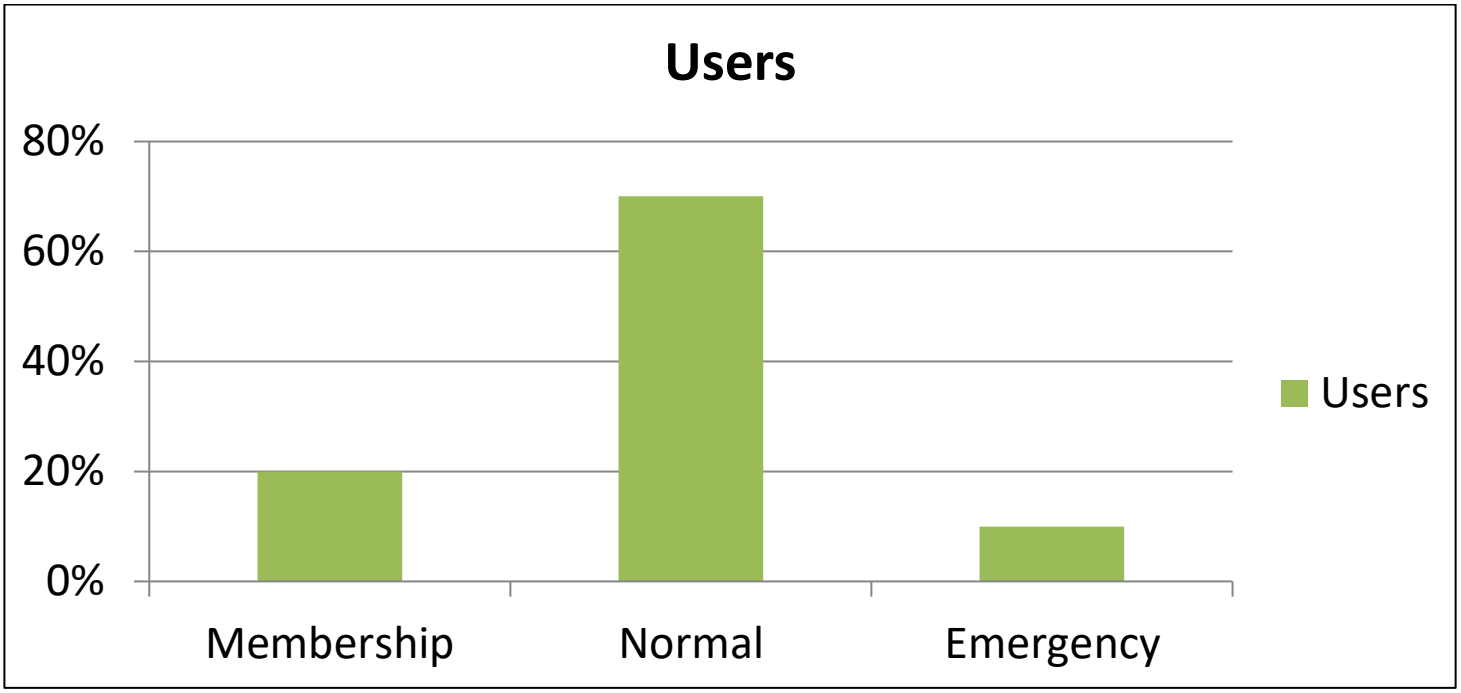
Monday follows with 22%, showing it's also a significant day for usage.

Saturday has the lowest usage at 6%.

Midweek days (Wednesday to Friday) each have moderate and similar usage (6%–10%).



This bar graph titled **"Vehicles"** shows the percentage distribution of three types of electric vehicles: **EBikes, ECars,** and **EBus**. E-Bikes have the highest percentage at around 45%, indicating they are the most commonly used electric vehicle type among the three. E-Cars follow with about 35%, showing significant usage but less than E-Bikes. E-Bus has the lowest share at around 12%, suggesting it is the least used electric vehicle in this comparison.



The bar chart titled "Users" presents a comparison of user distribution across three categories: Membership, Normal, and Emergency. The chart clearly shows that the majority of users fall under the "Normal" category, comprising approximately 70% of the total. "Membership" users represent about 20%, while "Emergency" users make up the smallest segment, around 10%. This indicates that the primary user base is composed of regular or standard users, with fewer individuals requiring emergency access or holding a membership status. The data is visually represented using light green bars, and the percentage scale on the vertical axis ranges from 0% to 80%, helping to highlight the significant gap between the categories.

Chapter 8

Conclusion

The development and implementation of **VoltSphere**, a EV Charging Station Management System, will play a crucial role in addressing the growing challenges of managing EV charging infrastructure efficiently. As the adoption of electric vehicles continues to rise, the need for a robust, centralized, and user-friendly management system becomes increasingly important. VoltSphere provides a comprehensive solution by integrating real-time monitoring, user and payment management, energy consumption tracking, maintenance alerts, and data analytics into a single platform. By enabling charging station operators to monitor and control operations seamlessly, the system ensures improved efficiency, reduced downtime, and optimized energy usage. The inclusion of automated maintenance alerts minimizes operational disruptions and enhances station reliability. Additionally, smart grid integration contributes to a more sustainable.

Looking ahead, VoltSphere is positioned to evolve alongside emerging technologies in the EV and energy sectors. With built-in scalability and modular design, the platform can readily accommodate future advancements such as Vehicle-to-Grid capabilities,predictive analytics, and support for autonomous charging systems. Enhanced interoperability through open APIs will also allow VoltSphere to integrate with city-wide smart mobility solutions, transportation networks, and IoT-enabled infrastructure, fostering a more connected and intelligent urban environment.

From a user standpoint, VoltSphere promotes an intuitive and rewarding experience by offering personalized dashboards, loyalty rewards integration, and eco-friendly driving insights. It empowers users to make informed decisions about their energy consumption while encouraging greener driving habits. For operators, the system opens up new opportunities for business optimization through real-time revenue tracking, usage forecasting, and customizable service models.

Ultimately, VoltSphere is more than just a management tool—it's a foundational pillar for the future of sustainable transportation. By streamlining operations, improving infrastructure resilience, and encouraging innovation, VoltSphere will significantly contribute to accelerating the global transition toward clean energy and smarter cities.

References

1.Indian Electrical and Electronics Manufacturers' Association (IEEMA):

They provide resources on EV charging infrastructure standards, technology, and industry trends in India. https://www.ieema.org.

2.Tata Power EV Charging :

Tata Power is a leader in India's EV charging network. Their platform offers solutions for public and private EV chargers, providing insights local industry landscape. https://www.tatapower.com.

3.Revolt Motors:

Revolt Motors provides electric vehicles and may give you an understanding of how to integrate EVs with charging systems. They have a growing EV infrastructure that could offer insights into your system's integration needs. https://www.revoltmotors.com.

4. EVCHARGE India:

EVCHARGE India is focused on providing end-to-end EV charging solutions. The platform covers station installation, management, and maintenance, which can be a valuable reference for VoltSphere. https://www.evcharge.in.

5. FAME India Scheme (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles):

The FAME scheme by the Indian government incentivizes the adoption of electric vehicles and the installation of EV charging infrastructure. This site provides information on subsidies and government initiatives that you can consider when developing your platform. https://www.dhi.nic.in/fame.

6. Ampere Vehicles:

Ampere is an EV manufacturer in India that could offer insights into the kind of charging infrastructure required for different types of electric vehicles in India, especially in urban areas. https://www.amperevehicles.com.

7. PlugShare:

A comprehensive, crowdsourced data of public, private, and residential charging locations worldwide. It offers real-time availability, user reviews, and photos. https://www.plugshare.com.