VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY
An Autonomous Institute Affiliated to the University of Mumbai
Department of Computer Engineering

Project Report on

EVolve Chargemates: Decentralising EV Station Networks

In partial fulfilment of the Fourth Year, Bachelor of Engineering (B.E.)
Degree in Computer Engineering at the University of Mumbai,
Academic Year 2024-25

Submitted by

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(AY 2024-25)

VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY
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Certificate

This is to certify that ***Vedant Tawade (D17 - C, 65), Soham Tawade (D17 - C, 64), Nikhil Singh (D17 - C, 60), Vedant Pawar (D17 - C, 52)*** of Fourth Year Computer Engineering studying under the University of Mumbai have satisfactorily completed the project on "***EVolve Chargemates: Decentralising EV Station Networks***" as a part of their coursework of PROJECT-II for Semester-VIII under the guidance of their mentor ***Prof. Lifna C. S.*** in the year 2024-25. This project report entitled ***EVolve Chargemates: Decentralising EV Station Networks*** by ***Vedant Tawade, Soham Tawade, Nikhil Singh, and Vedant Pawar*** has been approved for the degree of **B.E. Computer Engineering.**

Programme Outcomes	Grade
PO1,PO2,PO3,PO4,PO5,PO6,PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2	

Date:

Project Guide:

Project Report Approval For
B.E. (Computer Engineering)

This project report entitled ***EVolve Chargemates: Decentralising EV Station Networks*** by ***Vedant Tawade, Soham Tawade, Nikhil Singh, Vedant Pawar*** is approved for the degree of **B.E. Computer Engineering.**

Internal Examiner

External Examiner

Head of the Department

Principal

Date:
Place:

Declaration

We declare that this written submission represents our ideas in our own words, and where others' ideas or words have been included, we have adequately cited and referenced the sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated, or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ACKNOWLEDGEMENT

We are thankful to our college, Vivekanand Education Society's Institute of Technology, for considering our project and extending help at all stages needed during our work of collecting information regarding the project.

It gives us immense pleasure to express our deep and sincere gratitude to the Assistant Professor (**Project Guide**), Mrs. Lifna C. S., for her kind help and valuable advice during the development of the project synopsis and for her guidance and suggestions.

We are deeply indebted to the Head of the Computer Department, **Dr.(Mrs.) Nupur Giri** and our Principal, **Dr. (Mrs.) J.M. Nair,** for giving us this valuable opportunity to do this project.

We express our hearty thanks to them for their assistance, without which it would have been difficult to finish this project synopsis and project review successfully.

We convey our deep sense of gratitude to all teaching and non-teaching staff for their constant encouragement, support, and selfless help throughout the project work. It is a great pleasure to acknowledge the help and suggestions that we received from the Department of Computer Engineering.

We wish to express our profound thanks to all those who helped us gather information about the project. Our families, too, have provided moral support and encouragement throughout.

Computer Engineering Department COURSE OUTCOMES FOR B.E. PROJECT

Learners will be taught,

Course Outcome	Description of the Course Outcome
CO 1	Able to apply the relevant engineering concepts, knowledge and skills towards the project.
CO2	Able to identify, formulate and interpret the various relevant research papers and to determine the problem.
CO 3	Able to apply the engineering concepts towards designing solutions for the problem.
CO 4	Able to interpret the data and datasets to be utilized.
CO 5	Able to create, select and apply appropriate technologies, techniques, resources and tools for the project.
CO 6	Able to apply ethical, professional policies and principles towards societal, environmental, safety and cultural benefit.
CO 7	Able to function effectively as an individual, and as a member of a team, allocating roles with clear lines of responsibility and accountability.
CO 8	Able to write effective reports, design documents and make effective presentations.
CO 9	Able to apply engineering and management principles to the project as a team member.
CO 10	Able to apply the project domain knowledge to sharpen one's competency.
CO 11	Able to develop a professional, presentational, balanced and structured approach towards project development.
CO 12	Able to adopt skills, languages, environment and platforms for creating innovative solutions for the project.

INDEX

LIST OF FIGURES

ABSTRACT

“The increasing adoption of electric vehicles (EVs) requires the development of more accessible and efficient charging infrastructures. The "EVolve Chargemates" app leverages modern technology to create a decentralized EV charging network by allowing homeowners to register their residences as EV charging stations. This app integrates real-time data, smart filters, and navigation to connect EV owners with the nearest available charging station. By utilizing advanced routing algorithms and location-based services, EVolve Chargemates helps optimize the search for charging points and streamlines the entire charging process. The app also empowers homeowners, especially those with solar panels, to monetize their excess energy by becoming EV stations without the need for additional infrastructure. Through this innovative approach, EVolve Chargemates not only addresses the shortage of public EV charging infrastructure but also encourages community participation in sustainable transport solutions. This project sets a new standard in the EV charging landscape, fostering a collaborative and eco-friendly future for urban and residential mobility.”

Keywords: EV, charging, charging infrastructure

Chapter 1: Introduction

This chapter provides an overview of the motivation for selecting this project. It highlights the shortcomings of the current system, outlines the challenges faced by citizens, and concludes by emphasizing the project's significance.

1.1 Introduction

The EVolve Chargemates is a revolutionary platform designed to enhance electric vehicle (EV) charging accessibility by creating a decentralized network of homeowner-listed charging stations, bridging infrastructure gaps, and accelerating EV adoption. Homeowners can register and list their charging stations with details such as charger type, power output, availability, and pricing, encouraging widespread participation. The app features an intelligent search and filtering system, enabling EV owners to locate nearby stations based on distance, availability, speed, pricing, and user ratings. This ensures a quick and efficient selection process. Real-time status updates allow users to check station availability before travelling, while the reservation system ensures drivers secure charging slots in advance, reducing wait times and unnecessary detours. To maintain quality and reliability, a rating and review system lets users provide feedback on their charging experience, helping others make informed choices while encouraging station owners to uphold high standards. Integrated navigation services offer seamless turn-by-turn directions, minimizing route disruptions and enhancing the charging experience. By fostering a community-driven approach, EVolve Chargemates supports EV adoption and promotes sustainable energy practices and collaboration among users. Looking to the future, the platform aims to introduce dynamic pricing based on demand, integrate with renewable energy sources, and establish partnerships with businesses and municipalities to expand the charging network further. Through continuous innovation and community engagement, EVolve Chargemates strives to be a pivotal force in the evolution of electric mobility, reducing carbon emissions and contributing to a greener, more sustainable world. As the network grows, it will drive a significant shift toward environmentally friendly transportation, making EV charging more accessible, convenient, and efficient for users everywhere.

The adoption of electric vehicles (EVs) is hindered by limited charging infrastructure, especially in residential areas. Traditional stations are scarce, inconvenient, and unable to meet rising demand, deterring potential EV owners. A decentralized, community-driven solution is essential to expand the network, making EV charging more accessible and convenient for all users.

EVolve Chargemates enhances EV charging accessibility with location-based search, allowing users to set home and work locations while displaying nearby charging stations on an interactive map with availability markers. Real-time updates ensure users receive live station status, personalized recommendations based on past usage, and push notifications for changes. The app suggests charging spots considering traffic patterns and integrates nearby amenities like cafes for added convenience. Homeowners can register their charging stations, guided through installation if needed, with verification ensuring reliability. A management dashboard enables owners to oversee availability, set pricing, analyze usage statistics, and manage reservations. Integrated maps provide seamless navigation with real-time directions. Secure authentication safeguards user data, while robust storage handles station details, images, and documents. By offering an intelligent, user-friendly platform, EVolve Chargemates simplifies EV charging, fostering a more efficient and accessible charging network.

1.2 Motivation

The rising demand for electric vehicles (EVs), driven by environmental concerns and government incentives, has exposed the limitations of existing EV charging infrastructure. With a growing number of EVs on the road, urban areas are struggling to provide sufficient charging points, leading to long wait times and limited access, especially in residential areas. This shortage hampers the widespread adoption of EVs, which is critical for reducing carbon emissions and promoting sustainable transport.

The motivation behind *EVolve Chargemates* is to address these infrastructure challenges by empowering homeowners to contribute to the EV charging network. By enabling homeowners to register their properties as charging stations, the app aims to decentralize the charging system, reducing pressure on existing infrastructure. This approach not only accelerates the adoption of EVs but also offers homeowners, especially those with solar panels.

1.3 Problem Definition

The current EV charging infrastructure in urban areas is under strain due to the rising number of electric vehicles (EVs), leading to limited access to charging stations, long wait times, and inefficiencies in resource allocation. These challenges are particularly acute in residential areas, where charging options are scarce, limiting the convenience and widespread adoption of EVs. Additionally, the absence of decentralized and easily accessible charging solutions hinders the growth of a sustainable EV ecosystem.

The growing demand for EVs, coupled with the urgent need to reduce carbon emissions, highlights the critical need for a more robust and scalable charging network. The objective of EVolve Chargemates is to create a decentralized platform where homeowners can register their EV charging points, offering a solution to the infrastructure gap. By incorporating real-time data, smart filters, and station management capabilities, the app aims to streamline the charging process for EV owners while empowering homeowners to become part of the charging ecosystem. This approach not only supports the transition to electric mobility but also fosters community-driven solutions to sustainability challenges.

1.4 Existing Systems

Current electric vehicle (EV) charging station systems, such as PlugShare, EZ Charge, and Ather Grid, have made strides in facilitating EV adoption and providing essential charging infrastructure. However, these platforms face several limitations that hinder their effectiveness in offering a seamless user experience and optimal charging solutions.

1) PlugShare:
PlugShare is a widely recognized platform that enables EV drivers to locate charging stations through its interactive map. It offers a comprehensive database of charging locations and features such as user-generated reviews, making it a popular tool among EV users.

2) EZ Charge:
EZ Charge aims to simplify the EV charging process by offering a network of charging stations supported by user-friendly payment options. It focuses on improving accessibility and ease of use for EV drivers.

3) Ather Grid:
Ather Grid is known for providing fast-charging solutions in urban environments, primarily catering to Ather electric scooters. It integrates advanced features like mobile app connectivity and a growing network of fast-charging stations.

1.5 Lacuna of the Existing System

This section presents a comparative analysis of three prominent EV charging applications in India: PlugShare, Tata Power EZ Charge, and Ather Grid. Each system has been evaluated based on its key successes, limitations, and inferred impact on the user experience and EV charging ecosystem.

1**) PlugShare**: Despite its popularity, PlugShare relies heavily on user inputs to report station availability, which can lead to inconsistencies and outdated information. The platform lacks real-time updates and often provides limited details about the operational status of charging stations, causing potential frustration when users arrive at non-functional or occupied chargers.

2**) Tata Power EZ Charge**: The effectiveness of EZ Charge is limited by inadequate regional coverage, particularly in less populated or rural areas. Additionally, the platform's integration with popular navigation systems is not seamless, making it difficult for users to efficiently plan charging stops on longer journeys.

3) **Ather Grid:** Ather Grid's utility is constrained by its limited geographical reach and its focus on Ather vehicles. The platform faces compatibility challenges with a broader range of EV models, reducing its accessibility and usefulness for many EV users outside the Ather ecosystem.

In conclusion, while each of these platforms demonstrates significant contributions to the Indian EV charging landscape, they also reflect the broader infrastructural and interoperability challenges within the sector. PlugShare offers wide accessibility but suffers from data inconsistencies; Tata Power EZ Charge provides strong network reliability within a closed ecosystem; and Ather Grid is effective for brand-specific users in limited regions.

1.6 Relevance of the Project

The EVolve Chargemates app addresses the increasing demand for electric vehicle (EV) infrastructure, driven by the rapid growth of EV adoption and the transition toward sustainable urban transportation. Traditional EV charging networks are limited, often concentrated in specific areas, leaving many regions underserved. This lack of infrastructure leads to "range anxiety" among EV users, limiting the widespread adoption of electric vehicles.

EVolve Chargemates solves this issue by creating a decentralized network of EV charging stations. By empowering homeowners to register their homes as charging points and providing EV owners with real-time access to these locations, the app significantly expands the availability of charging stations. Additionally, the app supports users with features such as location-based station search, smart filters, and journey planning, making EV ownership more convenient and accessible.

The relevance of this project lies in its potential to bolster the EV infrastructure, promote sustainability, and accelerate the shift to clean energy by enabling everyday homeowners to contribute to the charging network without requiring extensive additional infrastructure. This creates an efficient, scalable solution to reduce pressure on existing transport networks and urban resources

Chapter 2: Literature Survey

This chapter reviews existing literature relevant to electric vehicle (EV) charging infrastructure, optimal station placement, and intelligent routing algorithms. The selected studies provide insights into the current status and challenges of EV charging in India, strategies for efficient infrastructure planning, and the role of dynamic and smart routing techniques in enhancing EV usability in urban environments.

2.1 Research Papers :

[1] This paper explores the growing necessity of transitioning to electric mobility in India in response to environmental concerns, fossil fuel depletion, and international commitments such as the Paris Agreement. It highlights how public policy, regulatory frameworks, and public-private partnerships play pivotal roles in facilitating this transition. The paper delves into consumer hesitations, primarily around charging time and range anxiety, and emphasizes the importance of robust charging infrastructure development. It reviews the current status of installed charging stations in India and identifies critical barriers hindering widespread EV adoption. These include infrastructural, economic, and security challenges such as privacy risks, data tampering, and a lack of coordinated frameworks for power exchange and information flow

Inference: The study presents a comprehensive overview of India's readiness and obstacles in adopting EV infrastructure. It underscores the need for integrated planning across the power and transport sectors to ensure secure, scalable, and user-friendly charging networks. The identification of issues such as information asymmetry and the call for vehicle-to-vehicle (V2V) and vehicle-to-charger (V2C) cooperative strategies point toward the future direction of smart and decentralized EV ecosystems in India. These insights are instrumental in shaping policy and technology frameworks to support a sustainable, fully electric mobility future.

[2] This paper surveys various optimization techniques used over the past decade to address the placement and sizing of electric vehicle charging stations (EVCS). It emphasizes the need for strategically located stations to ensure accessibility within driving range, reviewing methods from heuristic algorithms to mathematical models that aim to balance infrastructure cost, grid load, and user convenience.

Inference: The review underscores the importance of intelligent location strategies for enhancing EV usability. For an EV Finder app, these insights can guide the integration of optimized location data, ensuring that users are directed to stations that are not only nearby but also strategically placed to support real-world driving patterns and energy grid stability.

[3] This article by the India Energy Storage Alliance provides an overview of the key components and types of EV charging—AC vs. DC, fast vs. slow charging—and outlines the current ecosystem of EV charging infrastructure in India. It also highlights government initiatives, challenges in standardization, and the growing role of private players in expanding the network.

Inference: This source offers foundational knowledge crucial for designing an EV Finder app tailored to the Indian context. The detailed breakdown of charger types and infrastructure models helps ensure that the app can filter and display compatible charging options based on vehicle type, charging speed preference, and connector standards.

[4] This paper presents an analysis of dynamic routing algorithms designed to adapt to changing conditions in real-time, such as traffic flow or network congestion. It evaluates different algorithmic strategies for maintaining optimal routing performance under fluctuating conditions.

Inference: For an EV Finder app, dynamic routing algorithms can significantly enhance user experience by providing real-time navigation to charging stations based on current traffic and route conditions. This capability can reduce wait times and optimize travel efficiency, particularly in urban environments where road conditions change frequently.

[5] This study compares multiple vehicle routing algorithms with a focus on their application in smart city contexts. It analyzes the trade-offs between algorithm complexity, responsiveness, and real-world applicability, emphasizing the importance of real-time data and predictive analytics for route planning.

Inference: The insights from this comparative study are directly applicable to developing route-planning features within an EV Finder app. By integrating algorithms that prioritize efficiency, adaptiveness, and minimal energy consumption,

2.2 Inferences drawn

EV Charging Diversity and Standards: The transition from traditional to electric vehicles introduces varied charging requirements. Papers highlight the technical distinctions between AC and DC charging and the impact of charger ratings and global standards, suggesting a need for standardized and adaptable infrastructure. Policy and Grid Challenges in India: Research indicates that in India, the EV charging ecosystem is hindered by inadequate coordination with power grids and inconsistent state-wise policy implementations. A unified national policy and better forecasting models are necessary for future scalability. Need for Optimal Station Placement: Efficient charging station deployment remains a critical challenge. The review of optimization techniques emphasizes that without strategic station placement, users may face range anxiety and inefficiencies in energy distribution. Importance of Smart Routing Algorithms: As EV adoption grows in smart cities, real-time traffic-based routing algorithms become essential. Comparative studies reveal that intelligent path planning algorithms can significantly enhance route efficiency and reduce urban congestion

2.3 Comparison with the existing systems

Criteria	Existing Systems (PlugShare, EZ Charge, Ather Grid)	Proposed System (EVolve Chargemates)
Data Integration	Relies mostly on user-generated content and limited network data, causing gaps when stations are offline or outdated.	Integrates real-time status, IoT sensors, user feedback, and crowdsourced reports for full situational awareness.
Real-Time Capabilities	Limited real-time updates; station availability info may be delayed or inaccurate.	Offers live updates on station availability and predictive analytics for better route planning.
Handling of Noisy Data	May suffer from inconsistent or outdated user-reported data, especially in high-traffic areas.	Uses advanced filtering algorithms and validation techniques to enhance data reliability and accuracy.
Scalability	It may be limited to specific regions or compatible only with certain EV models.	Designed to support diverse EV models and scale across urban and rural areas effectively.
Coordination & Communication	Basic user interaction is available; it lacks integrated communication tools among stakeholders.	Provides built-in communication channels for EV owners, station operators, and local authorities.

Chapter 3: Requirement Gathering for the Proposed System

This chapter outlines the detailed functional, non-functional, hardware, and software requirements essential for the successful execution of the **EVolve Chargemates** system. These requirements ensure that all necessary components are in place to achieve the desired outcomes in EV charging accessibility and user engagement.

3.1 Introduction to Requirement Gathering

The proposed system, **EVolve Chargemates**, necessitates a comprehensive set of technical and functional requirements to ensure its successful development and deployment. These requirements are driven by the system's goal to provide real-time access to electric vehicle (EV) charging stations, enhance user experience, and facilitate efficient resource management.

3.2 Functional Requirements

1. **Data Collection and Integration**:
   The system must continuously gather and integrate data from multiple sources, including:
   - **Charging Station Data**: Real-time availability and status of EV charging stations.
   - **User Data**: Information from EV owners and station owners, including preferences and usage patterns.
   - **Location Data**: Geographic data to facilitate navigation and find nearby charging stations.
2. **Data Pre-Processing**:
   The system must pre-process incoming data by:
   - Cleaning and normalizing data to ensure compatibility with the application.
   - Removing irrelevant or noisy data and handling missing values.
   - Normalizing formats for consistent data representation.
3. **AI-based Charging Station Detection and Prediction**:
   The system must use AI models to analyze pre-processed data to:
   - Detects available charging stations based on user queries.
   - Predict optimal charging station locations based on user trends and historical data.

4. **Real-Time Response Generation**:
   The system must generate real-time responses based on user requests, including:
   - Alerts for nearby charging station availability.
   - Recommendations for charging routes and nearby amenities.
5. **Evaluation and Feedback Mechanism**:
   The system must include an evaluation module to assess the accuracy and effectiveness of the responses, providing:
   - Feedback based on user interactions.
   - Continuous improvement through updates and training with new user data.

3.3 Non-Functional Requirements

1. **Performance and Scalability**:
   The system must efficiently handle large-scale data processing, ensuring:
   - Seamless scalability to accommodate increased data input during peak usage times.
   - Minimal performance degradation, especially during high-demand periods.
2. **Reliability and Availability**:
   The system must be highly reliable and available 24/7 to:
   - Ensure continuous monitoring of charging station statuses and user requests.
   - Include fault tolerance and automatic recovery mechanisms to avoid downtime.
3. **Security and Data Privacy**:
   The system must ensure the security of sensitive user data, including:
   - Implementation of encryption and secure access controls.
   - Compliance with relevant data privacy regulations (e.g., GDPR, CCPA) to protect user information.
4. **Usability and Accessibility**:
   The system must be user-friendly and accessible to all users, including:
   - Intuitive interfaces for easy navigation and interaction.
   - Real-time access to critical information, alerts, and recommendations.
5. **Accuracy and Precision**:
   The AI models used in the system must provide high accuracy in:
   - Detecting charging station availability and user needs.
   - Minimizing false positives and negatives to ensure precise and reliable responses.

3.4 Hardware, Software, Technology, and Tools Utilised

Hardware Requirements:

Minimum Requirements:

- **Operating System**:
  - Android: Version 8.0 (Oreo) or higher
  - iOS: Version 12.0 or higher
- **Processor**: Quad-core processor (e.g., Snapdragon 450 or equivalent)
- **RAM**: Minimum 4 GB
- **Storage**: Minimum 64 GB of internal storage
- **Display**: 5.5 inches or larger, HD (1280 x 720) resolution
- **Network**: 4G LTE support for reliable connectivity
- **Battery**: Minimum 3000 mAh for adequate usage time

Software Requirements:

Development Environment:

- **Flutter SDK** (version 3.7.0 or higher): Core framework for building cross-platform mobile applications.
- **Dart SDK** (version 2.19.0 or higher): Programming language used for Flutter development.
- **Firebase**: Backend as a Service (BaaS) for real-time database, user authentication, cloud storage, and hosting.
  - Firebase Authentication: For managing user accounts and login sessions.
  - Cloud Firestore: For storing user data and app state.
  - Firebase Cloud Messaging: For push notifications and real-time alerts.

Data Collection and Integration:

- **HTTP Library**: For making network requests and handling API calls.

Testing and Debugging Tools:

- **Flutter DevTools**: For debugging and performance profiling.
- **Firebase Test Lab**: For testing the app across a variety of devices and configurations.

Development Tools:

- **IDE**: Visual Studio Code or Android Studio with Flutter and Dart plugins installed for a better development experience.

1. **Flutter**: Flutter serves as the core framework for building the EVolve Chargemates app. It enables us to create a seamless cross-platform application that operates efficiently on both Android and iOS devices. With Flutter, we can design a user-friendly and visually appealing interface that enhances the user experience during navigation and interaction with charging stations.
2. **Firebase**: Firebase provides the backend infrastructure for the EVolve Chargemates app. We leverage its services for user authentication, real-time database functionality, and cloud storage. For instance, when users register their households as EV charging stations, their data is securely stored in Firebase, allowing for quick access and updates to charging availability.
3. **Google Maps API**: We integrate the Google Maps API to enhance location-based features within the app. This allows users to visualize charging stations on an interactive map, view navigation routes, and receive directions to their selected charging points.
4. **Dart**: Dart is the programming language used with Flutter, allowing us to develop efficient, high-performance applications.
5. **Cloud Functions**: We implement Firebase Cloud Functions to handle server-side logic, such as processing user requests, sending notifications, and managing data updates in real-time.
6. **RESTful API**: We utilize a RESTful API to facilitate communication between the mobile app and the backend services..
7. **Analytics Tools**: We incorporate analytics tools (like Firebase Analytics) to monitor user interactions within the app. This data helps us understand user behavior, optimize features, and enhance the overall user experience.
8. **Testing Frameworks**: We use testing frameworks, such as Flutter's built-in testing tools, to ensure the app is bug-free and performs well across different devices and operating systems. This includes unit testing, widget testing, and integration testing to maintain high-quality standards.

Chapter 4: Proposed Design

4.1 Block Diagram of the Proposed System

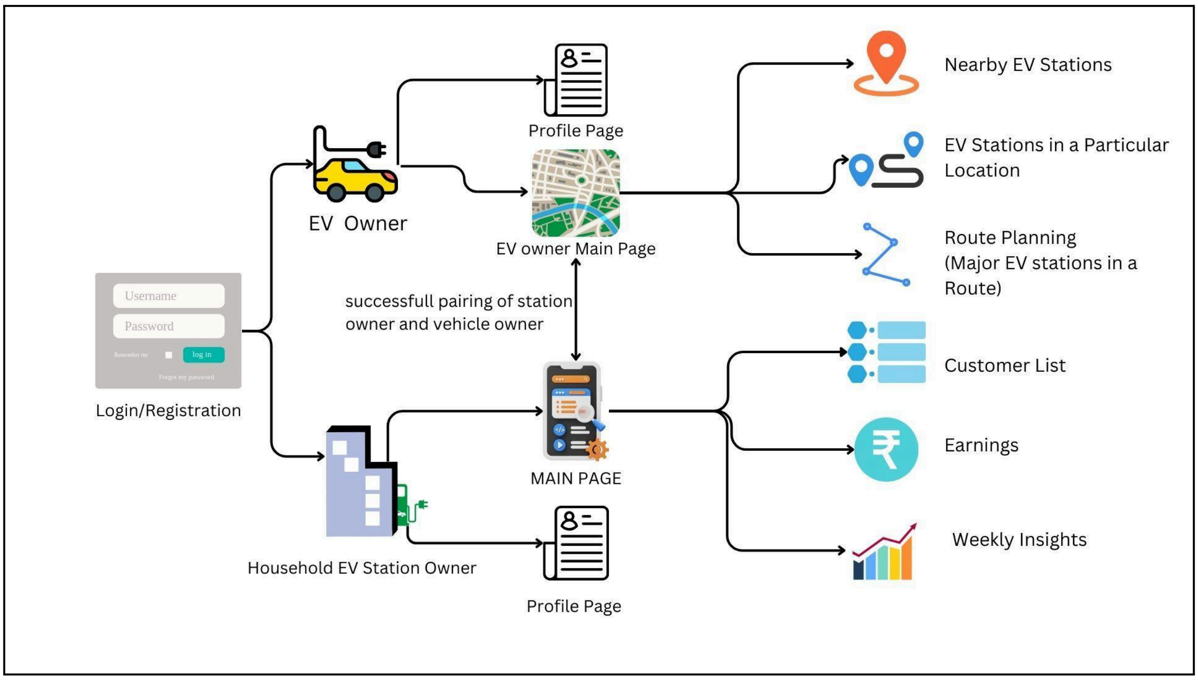


Figure 4.1: Block Diagram

Figure 4.1 illustrates the overall system architecture of the proposed EV Finder Application, delineating the interaction between different user roles—EV Owners and Household EV Station Owners—and the functional components of the app.

(i) The Login and Registration system begins with a Login/Registration module where both EV owners and EV station owners input their credentials and relevant information. For EV owners, this includes personal data, vehicle details, and charging preferences, while for station owners, the data includes station details, charger types, and availability. This input forms the foundation for personalized services and targeted recommendations.

(ii) Profile Pages and Main InterfacesPost-authentication, both user types are redirected to their respective Profile Pages. The EV Owner is directed to the EV Owner Main Page, which aggregates information relevant to their charging needs, such as nearby stations, available stations in specific locations, and route-based charging suggestions. Meanwhile, the Household EV Station Owner accesses a separate Main Page, which focuses on managing station-related operations such as monitoring customer inflow, earnings, and analytics.

(iii) Station Pairing and User Interaction; A core feature is the successful pairing of EV owners with nearby charging stations, facilitated by real-time location tracking and station availability updates. This interaction lies at the heart of the app, ensuring users are seamlessly connected with optimal charging stations based on availability, distance, and preference.

(iv) Key Functionalities for EV Owners; From the EV Owner Main Page, the app provides access to the following features: Nearby EV Stations: Based on GPS data, the app displays a list and map-based visualization of stations within proximity.Stations in a Particular Location: Users can search for stations in specific areas, beneficial for pre-trip planning.Route Planning: Integrates with navigation APIs (e.g., OpenStreetMap) to identify charging stations along the user's route, optimizing for time and convenience.

(v) Key Functionalities for Station Owners;(a)Customer List: Displays a log of past and current users who have accessed their station.(b)Earnings: Tracks revenue generated over time.(c)Weekly Insights: Analytical data summarizing station performance and user engagement, supporting future optimization.

(vi) System Intelligence and Optimization architecture supports backend processing, including data preprocessing, where user and station inputs are cleaned and standardized for accurate system response. The search and filtering mechanisms then match users with relevant stations. Furthermore, real-time updates and a feedback mechanism ensure both data integrity and user satisfaction. Finally, data analysis and optimization modules utilize the collected data to improve recommendation accuracy and support infrastructure planning.

4.2 Modular diagram of the system

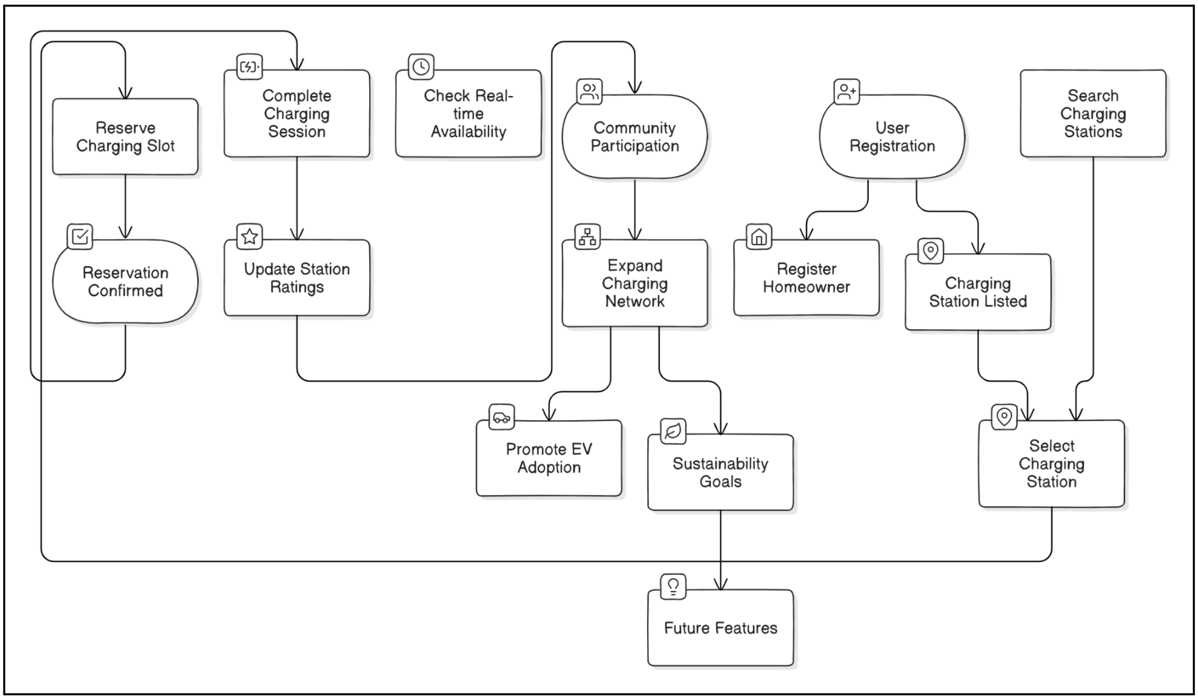


Fig 4. 2: Modular Diagram

Figure 4.2 presents a high-level functional flow diagram illustrating the key steps involved in using the EV Finder app. It outlines how users interact with the system, from registering and reserving a charging slot to contributing to network expansion and future sustainability goals. The flow also highlights how user actions feed into continuous improvement and feature updates.

(i) User Onboarding and Station Listing; In Fig. 4.2, the process begins with User Registration, which acts as the gateway for accessing app features. After registering, a user can either act as an EV driver or a station provider. If a homeowner wishes to share their charging station, they can proceed to Register Homeowner, leading to the Charging Station Listed step, where the station becomes visible in the app's public listings.

(ii)Station Search and Selection; Once registered, users can proceed to Search Charging Stations. Based on their preferences and current location, they can select a Charging Station after reviewing relevant filters such as availability, distance, and charging type.

(iii) Reservation and Charging Process; Upon station selection, users may reserve a Charging Slot, triggering a background check for Real-time Availability. If the slot is available, the system moves to Reservation

Confirmed. After the charging session is completed via the Complete Charging Session node, users are prompted to Update Station Ratings, feeding back into the system to enhance future recommendations.

(iv) Community and Network Growth; A key feature in this system is Community Participation, where users and homeowners can contribute towards the expansion of the Charging Network node. This shared ecosystem not only increases the station base but also helps promote EV Adoption by making EV infrastructure more accessible.

(v) Sustainability and Future Development; The expansion of the network and community engagement supports the Sustainability Goals. Both of these, along with user feedback and network data, drive Future Features, ensuring that the application remains relevant, user-friendly, and aligned with evolving energy and mobility trends.

In conclusion, this diagram illustrates a tightly integrated system that not only facilitates immediate utility for EV users but also builds towards long-term goals such as community-driven growth and environmental sustainability.

4.3 System Design

Data Flow Diagrams [Level 0 & Level 1]

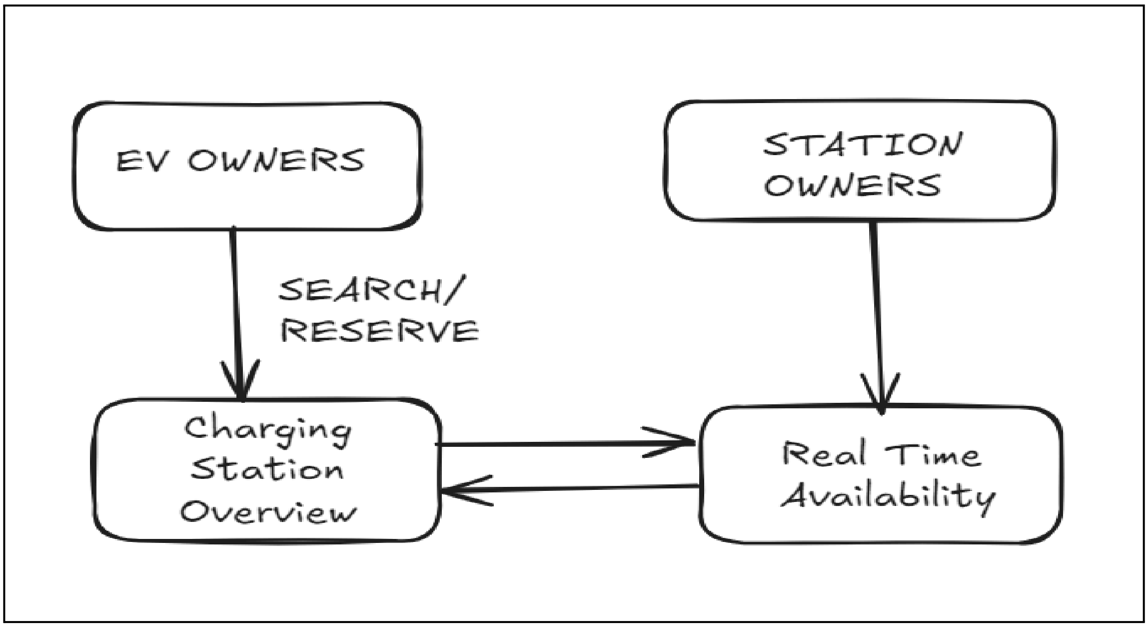


Fig 4.3.(a). Level 0 - DFD Diagram

The **Figure 4.3 (a)** illustrates the overall interaction of the **EVolve Chargemates** electric vehicle charging platform with its external entities. The system receives inputs from **EV Owners**, who search for and reserve nearby charging stations, and from **Charging Station Providers**, who list their household or business charging stations, specifying details such as location, availability, charging speed, and pricing.

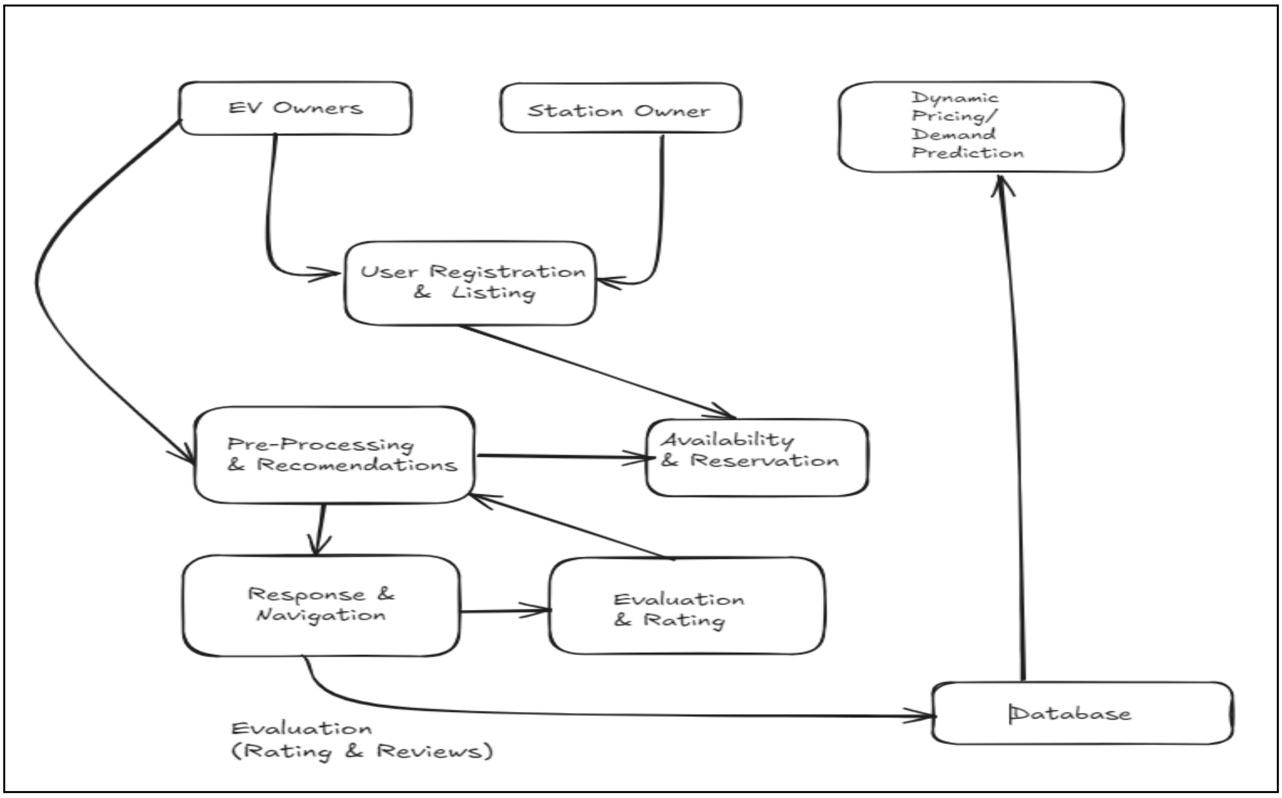
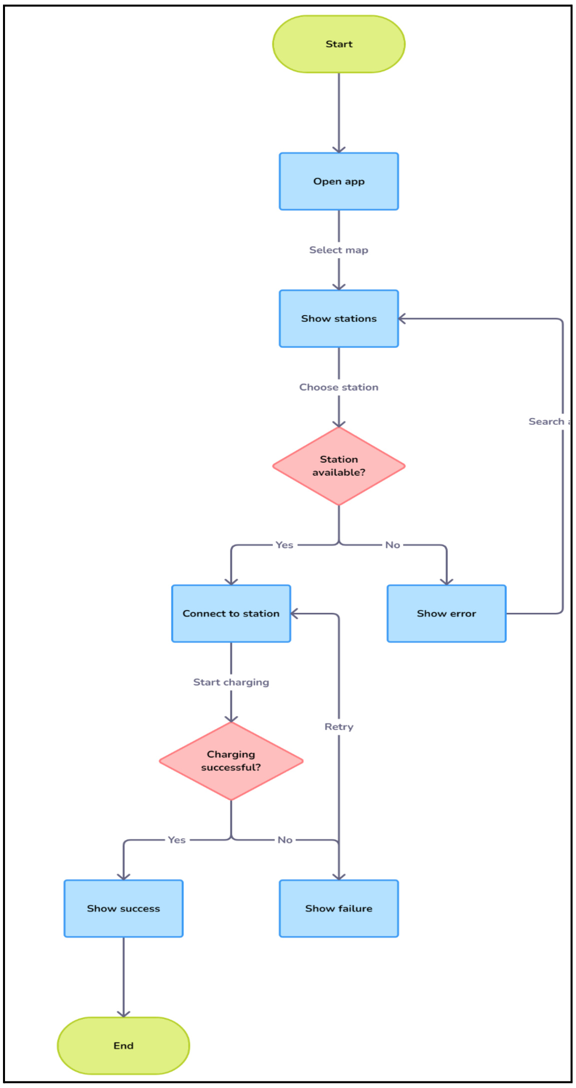


Fig 4.3.(b) Level 1 - DFD Diagram

The **Firgure 4.3. (b) shows the Level 1 Data Flow Diagram (DFD)** for the **EVolve Chargemates** app, it outlines the internal processes and data flow involved in connecting EV owners to available charging stations. The process begins with **EV Owners** searching for charging stations based on specific criteria such as distance, charging speed, and availability. These preferences are sent to the system's filtering and recommendation engine, which processes real-time data on charging station availability, user ratings, and pricing.

4.4 Detailed design (Flowchart)



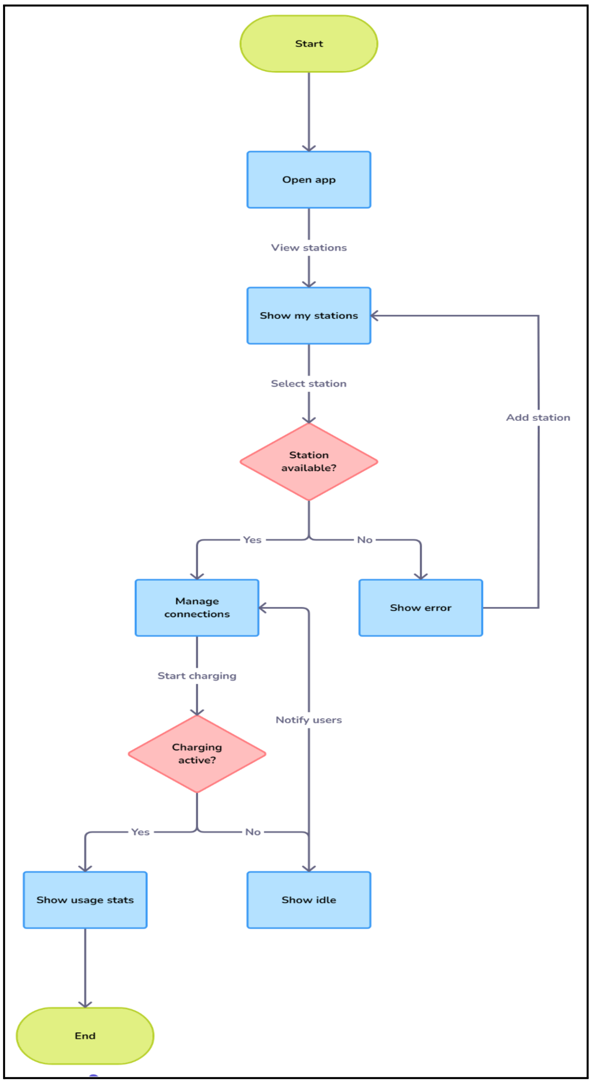


Fig. 4.3.(b).(i). EV OWNER

Fig. 4.3.(b).(ii) STATION OWNER

The **Figure 4.3.(b).(i) and Figure 4.3.(b).(ii)** depicts the high-level process of the EVolve Chargemates system. It begins with users registering on the app to list their homes as EV charging stations(as seen in Fig. 4.3.(b). (ii)), which then flows into two main components: charging station listings management and user search functionality. Homeowners input details about their charging stations, such as charger type, availability, and pricing, while EV owners search for nearby charging stations using filters like distance and charging speed (as seen in Fig. 4.3.(b). (i). Once both components are operational, the system checks the availability of charging stations. If a station is available, the user can reserve a slot, confirming their booking. If no stations are available, the system continues searching for options, creating a continuous feedback loop that ensures users receive timely updates on charging station availability.

4.5 Project Scheduling & Tracking using Timeline / Gantt Chart

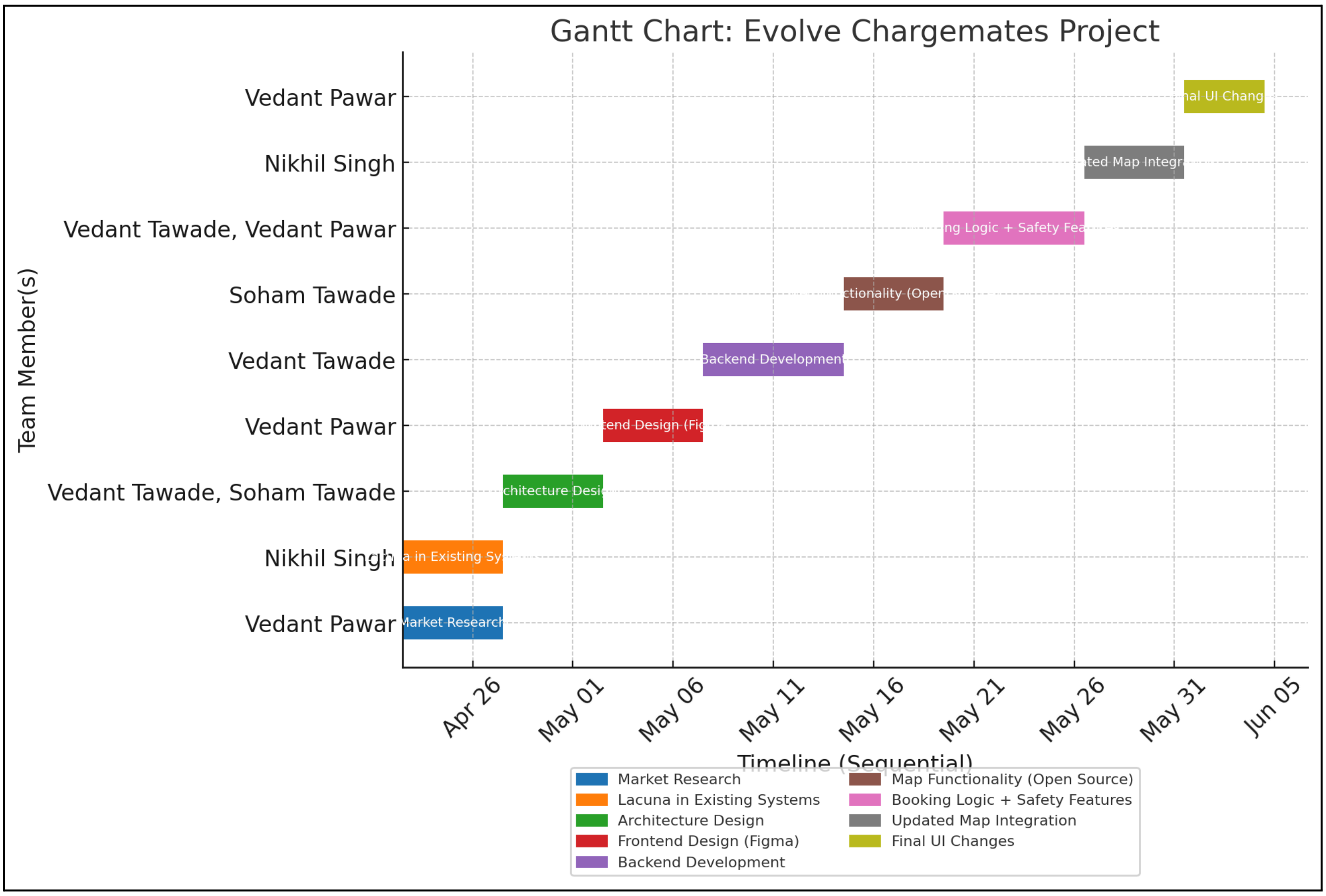


Fig 4.4 Gantt Chart.

The Fig 4.4 illustrates the complete Gantt chart for the technical workflow of the "Evolve Chargemates" project, with each phase represented and color-coded. It begins with Market Research conducted by Vedant Pawar and a Lacuna Analysis of existing systems handled by Nikhil Singh. This foundational research informed the System Architecture Design, carried out by Vedant Tawade and Soham Tawade. The Frontend Design, developed using Figma, was led by Vedant Pawar, followed by Backend Development by Vedant Tawade. Soham Tawade implemented the initial map functionality using an open-source framework, which was followed by collaborative efforts from Vedant Tawade and Vedant Pawar on Booking Logic and Safety Features. Nikhil Singh later updated the Map Integration, and the project concluded with Final UI Enhancements by Vedant Pawar.

Chapter 5: Implementation of the Proposed System

This chapter outlines the implementation strategy adopted for developing the EVolve Chargemates system. It details the methodology followed during development, including the use of geospatial data, clustering, and route optimization techniques. Various algorithms such as Dijkstra's, A*, Bellman-Ford, Floyd-Warshall, Geohashing, and K-Means Clustering are integrated into respective modules to enhance routing efficiency, spatial search, and demand-driven station placement.

5.1 Methodology employed for development

The development of the *EVolve Chargemates* system followed a modular and iterative methodology to ensure scalability, clarity in task distribution, and seamless integration of components. The project began with detailed market research and identification of existing gaps in electric vehicle (EV) infrastructure systems. This was followed by architectural planning that outlined the data flow, user interaction points, and backend requirements. Design thinking principles were applied during the frontend development phase to prioritize user experience, using tools like Figma for prototyping. Backend modules were developed with a focus on data efficiency and real-time communication, using RESTful APIs and database connectivity. A test-driven approach was adopted to validate individual modules before integration. Additionally, open-source tools such as OpenStreetMap were used for map functionalities, while real-time logic for station booking and availability was implemented using graph-based routing algorithms. Collaborative development and version control practices were followed throughout the lifecycle using tools like Git, ensuring effective team coordination and smooth deployment.

5.2 Algorithms for the respective modules developed:

- **Dijkstra's Algorithm:** Dijkstra's algorithm is a graph search algorithm that finds the shortest path between nodes in a weighted graph. It works by maintaining a set of nodes whose shortest distance from the source is known and iteratively selecting the node with the smallest known distance to explore its neighbors. This algorithm is particularly useful for calculating the shortest route in a network of charging stations.
- **A* Search Algorithm:** The A* search algorithm is an extension of Dijkstra's algorithm that uses heuristics to improve efficiency. It combines the actual cost to reach a node from the starting point with an estimated cost to reach the goal (the heuristic). This helps A* to prioritize paths that are

likely to lead to the goal faster, making it ideal for real-time navigation and route optimization in applications like EVolve Chargemates.

- **Bellman-Ford Algorithm:** The Bellman-Ford algorithm is another shortest path algorithm that is capable of handling graphs with negative edge weights. It iteratively relaxes the edges of the graph to find the shortest paths from a single source to all other nodes. This algorithm is useful in scenarios where charging stations might have varying costs or availability based on specific conditions.

- **Floyd-Warshall Algorithm:** The Floyd-Warshall algorithm is a dynamic programming algorithm used to find the shortest paths between all pairs of nodes in a weighted graph. It iteratively updates the distances between every pair of nodes, making it particularly useful for dense graphs where many nodes are interconnected, such as a network of charging stations.

- **Geohashing:** Geohashing is a method of encoding geographic coordinates (latitude and longitude) into a short string of letters and digits. It helps in efficiently indexing and searching spatial data, enabling quick location-based queries in applications like EVolve Chargemates. Geohashing can simplify spatial queries by dividing the area into grid cells, facilitating the search for nearby charging stations.

- **K-Means Clustering:** K-means clustering is an unsupervised machine learning algorithm used to group a set of data points into clusters based on similarity. In the context of EVolve Chargemates, it can be used to analyze user behavior and charging patterns, helping to identify high-demand areas for charging stations and optimize their placement.

Chapter 6: Testing of the Proposed System

6.1 Introduction to Testing:

Testing is an essential phase in software development that verifies the system's functionality, performance, and user interaction. The primary aim of this chapter is to evaluate the key components of the EV Station Booking app by performing various tests to ensure that all features and functionalities perform as expected. These tests focus on the core elements of the system, such as database interactions, API calls, and widget performance, ensuring that the app provides a seamless user experience while maintaining high efficiency and reliability.

6.2 Types of tests considered:

The testing for this project has been divided into three main categories:

1. **Unit Testing – Firebase Data Storage & Retrieval**: This type of testing ensures that the app's interaction with Firebase (data storage and retrieval) is functioning as intended. It covers the core operations of data insertion, validation, and fetching from the Firebase database, ensuring correct data handling.

2. **API Testing – Map APIs**: This test evaluates the API integration for the booking and slot functionality of the app. The goal is to ensure that the system communicates effectively with the external APIs, handles responses accurately, and functions correctly under different conditions (both success and failure scenarios).

3. **Widget Testing – Navigation, Forms**: Widget testing verifies that the user interface elements, such as forms, navigation flows, and dynamic lists, are displayed and behave as expected. This type of test ensures that the app is user-friendly, interactive, and efficient in responding to user input.

6.3 Various test case scenarios are considered:

Test case scenarios are critical to ensure that the system functions correctly in various situations. In this section, we will outline the different test case scenarios considered for each type of testing, addressing the core functionalities of the EV Station Booking app.

1. Unit Testing – Firebase Data Storage & Retrieval

Unit testing ensures that the app's interaction with Firebase is working as expected. Several scenarios were considered for Firebase operations, particularly data storage and retrieval.

Test Scenarios for Data Storage and Retrieval:

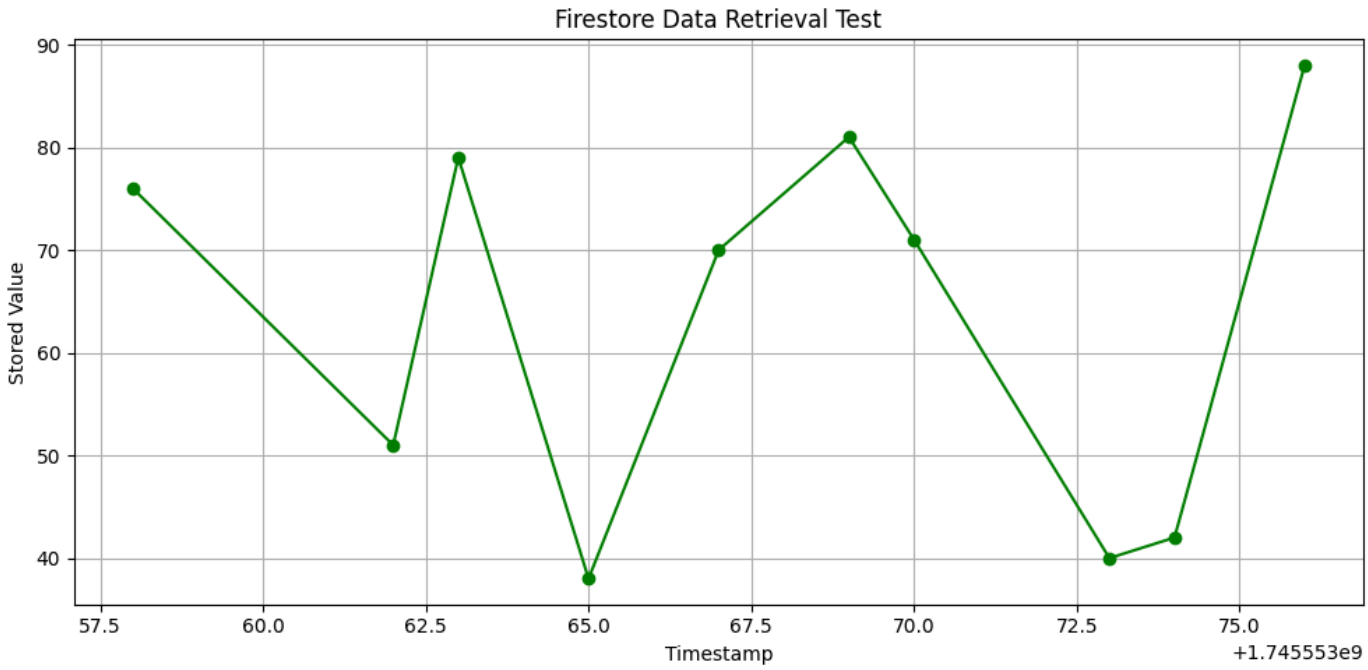


Fig 6.1. Firestore Data Retrieval Test

X-axis (Timestamp): This represents the time at which the data was recorded. These are Unix timestamps, indicating when each data point was stored.

Y-axis (Stored Value): These are the numeric values stored in Firestore.

Green Line with Markers: Each green dot represents a data point that was written to and later read from Firestore. The smooth line connecting the dots shows how values change over time.

The test results validate the reliability and accuracy of Firebase Firestore for storing and retrieving data. The successful storage and retrieval of all 10 values without data loss, corruption, or discrepancies in timestamps demonstrates Firestore's robustness as a NoSQL cloud database. The data points were consistently retrieved in the order they were stored, with fluctuations indicating proper handling of varying data values. This confirms Firestore's ability to maintain data integrity and consistency, making it an ideal choice for applications requiring real-time data synchronization, such as IoT systems or dynamic mobile applications. However, further tests on concurrent writes and read/write latency would provide deeper insights into its scalability and performance under load.

2. API Testing – Map APIs:

API testing ensures the proper integration of map services in the app, focusing on functionalities like slot booking, station details, and location-based data. This testing verifies that the app correctly communicates with external APIs, handles responses, and manages errors.

Fig 6.2: Google Maps API Request Setup with Parameters (Location, Radius, Type)

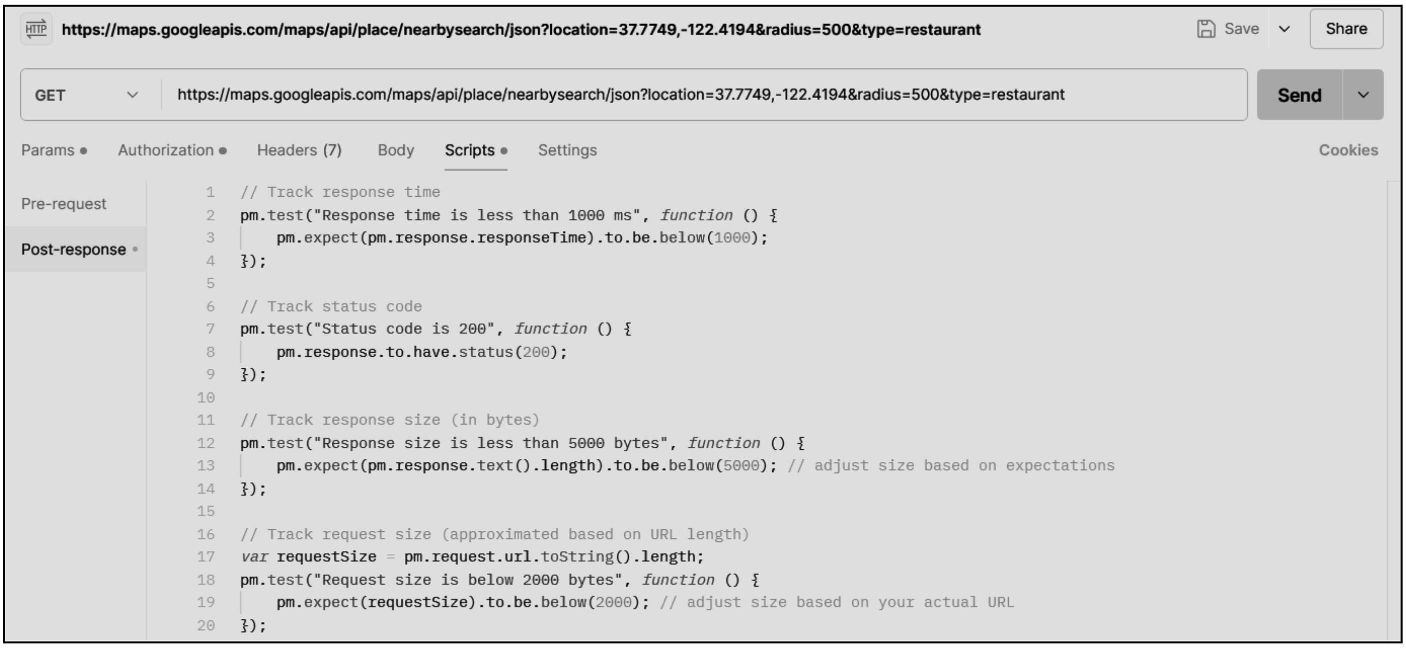


Fig 6.3: Postman Script for API Response Validation and Performance Testing

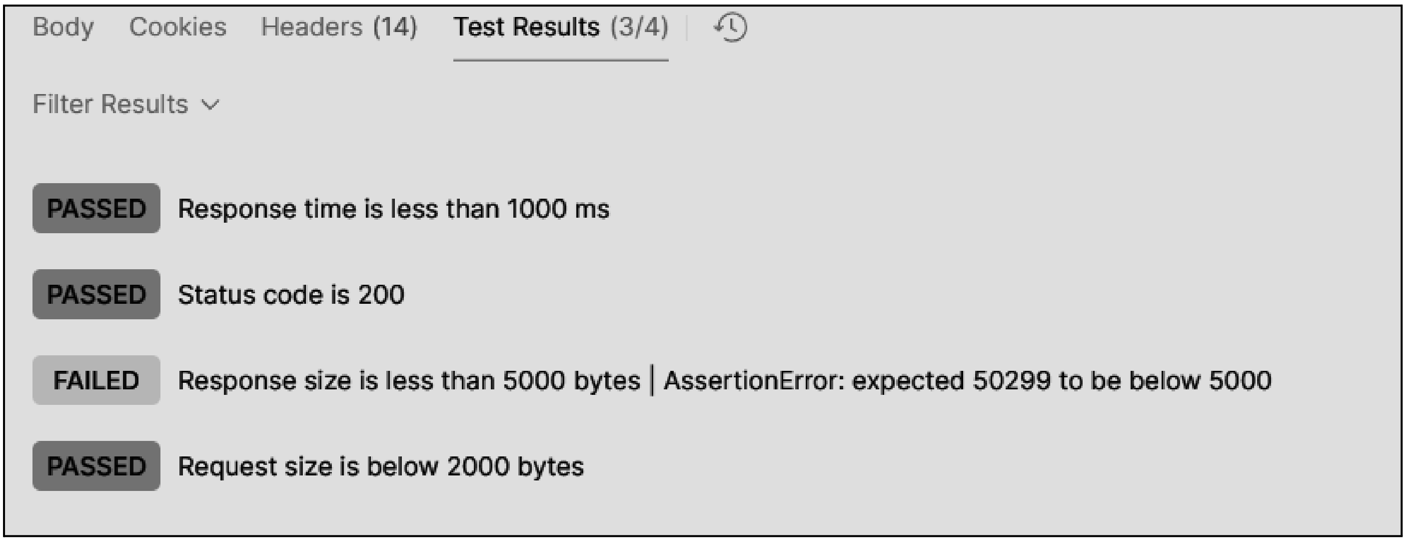


Fig 6.4: API Test Results Showing Response Time, Status, and Payload Size Status

Test Scenarios for Map API Integration:

Verify Successful API Response

This test confirms that the app correctly retrieves data from the map API. The inferences from successful responses show that the app reliably displays slot and station information, enhancing user interaction with accurate and real-time data.

API Error Handling

Testing error scenarios, such as server errors or not found responses, ensures that the app manages failures gracefully. The inferences here suggest that the app's robustness in handling API errors contributes to a smoother user experience, as it provides clear feedback without crashing or disrupting functionality.

API Performance

Assessing the time taken for API calls to return data is essential for ensuring that the app remains responsive, even with a high volume of simultaneous requests. Inferences from performance tests indicate that optimized API response times lead to a faster, more efficient app, improving the overall user experience by minimizing delays.

Validate Data Parsing

Testing the app's ability to correctly parse and display JSON data confirms that it can present the received information in the expected format. The inferences here highlight that reliable data parsing is crucial for displaying consistent and error-free information, which contributes to user trust in the app's data accuracy.

Test API Call with Invalid Parameters

Testing with invalid API parameters evaluates how the app responds to erroneous inputs. The inferences indicate that proper handling of invalid requests prevents the app from crashing, provides users with meaningful error messages, and ensures a stable app performance.

In **Figure 6.2, 6.3, 6.4 using Postman** the Google Maps Nearby Search API test executed successfully with key performance indicators mostly within acceptable limits. The response time was under 1000 ms, the status code returned was 200 (indicating success), and the request size was below 2000 bytes—all of which passed their respective tests. However, the response size exceeded the expected limit of 5000 bytes, clocking in at approximately 50299 bytes, causing that test to fail. This suggests that while the API is responsive and reliable in terms of request handling, the payload size of the response might be large due to the number of nearby restaurants or detailed data returned, which may require optimization or revised expectations.

3. Widget Testing – Navigation, Forms

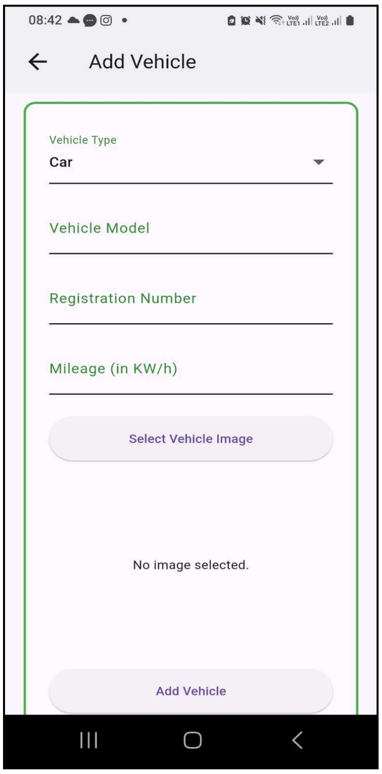
Widget testing verifies that the app's UI components are functioning as expected, including navigation between screens, form validation, and displaying dynamic lists. This type of testing ensures that users can interact with the app smoothly and that the interface behaves as intended.

Chapter 7: Results and Discussions

This chapter presents the **graphical user interface (GUI)** implementation of the EVolve Chargemates application through a series of screenshots. It highlights key modules such as **vehicle registration**, **real-time map interface**, **slot booking system**, and the **deposit payment page**. Each screen is designed to offer a seamless and intuitive user experience, ensuring efficient navigation and interaction across the platform. These visual representations showcase the functional flow and design consistency of the applications.

7.1 Screenshot of User Interface(UI) for the system:

The implementation of the EVolve Chargemates application focuses on providing a seamless and efficient experience for both EV drivers and charging station owners. The system begins with a user-friendly registration process, allowing EV drivers and station owners to create accounts, verify their details, and set up their profiles..



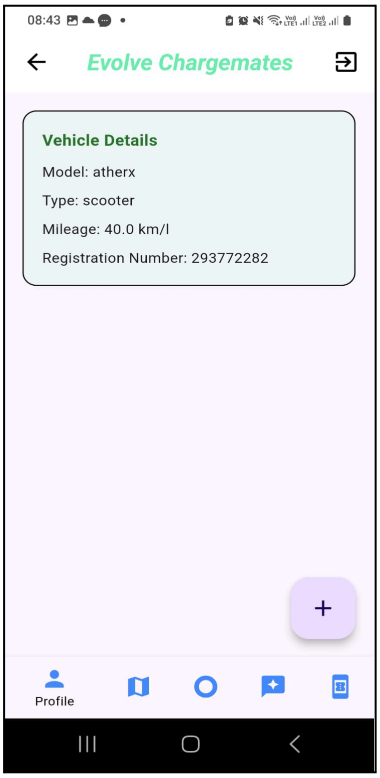


Fig 7.1.(a) Vehicle Registration Page **Fig 7.1.(b)** Details of Vehicle Displayed

Figures 7.1(a) and 7.1(b) illustrate the core components of the vehicle registration and management system within the EVolve Chargemates application.

In Fig. 7.1(a), the Vehicle Registration page is showcased as the entry point for users to personalize their experience. Designed with a clean and intuitive interface, this page prompts users to input essential information about their electric vehicle, such as the vehicle model, mileage (in km/kWh), and registration number. Built-in validation checks ensure accurate and reliable data collection, which is crucial for enabling key features like optimized route planning and station recommendations tailored to the vehicle's range. Upon submission, the information is securely stored and linked to the user's profile.Fig 7.1(b) demonstrates the Vehicle Details display interface, which presents a summary of the registered vehicle's data in an organized and readable format. This screen allows users to view and verify their stored vehicle information at any time, ensuring transparency and easy access. The display page not only supports efficient user interaction but also serves as a foundation for advanced features like real-time energy consumption tracking, performance analytics, and smart charging suggestions.

Fig 7.2.(a) Map Screen

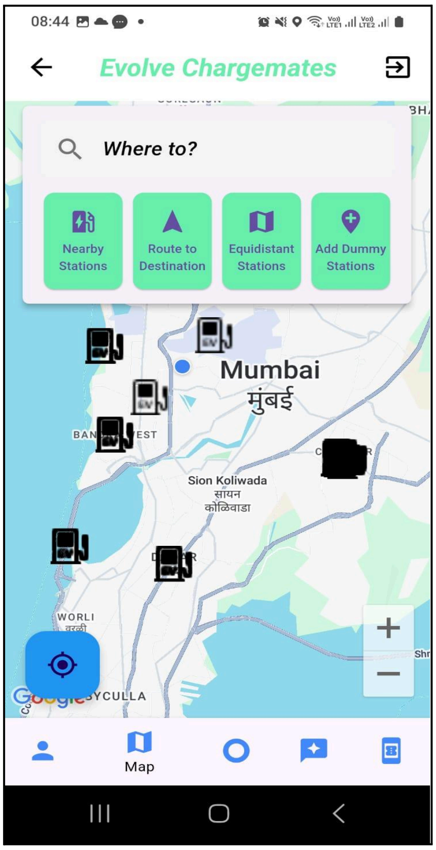


Fig 7.2(b) Display Nearby Stations

Figures **7.2(a)** and **7.2(b)** highlight one of the cornerstone features of the EVolve Chargemates application: the **interactive map interface** and the **dynamic display of nearby charging stations**.

Fig 7.2(a) showcases the **real-time map interface**, which is powered by GPS and integrated with robust mapping APIs. This interactive screen enables users to locate the nearest charging stations based on their

current location, **connector type compatibility**, **availability status**, and **user ratings**. Each charging station is represented with a status indicator that communicates whether the station is **available**, **currently in use**, or **under maintenance**. This ensures users can make quick, well-informed decisions about where to charge. **Fig 7.2(b)** complements this by displaying a **list of nearby charging stations**, filtered and sorted based on proximity, user preferences, and station performance metrics. This screen helps users access important information at a glance, including **distance**, **charging speed**, and **user reviews**, making the selection process seamless.

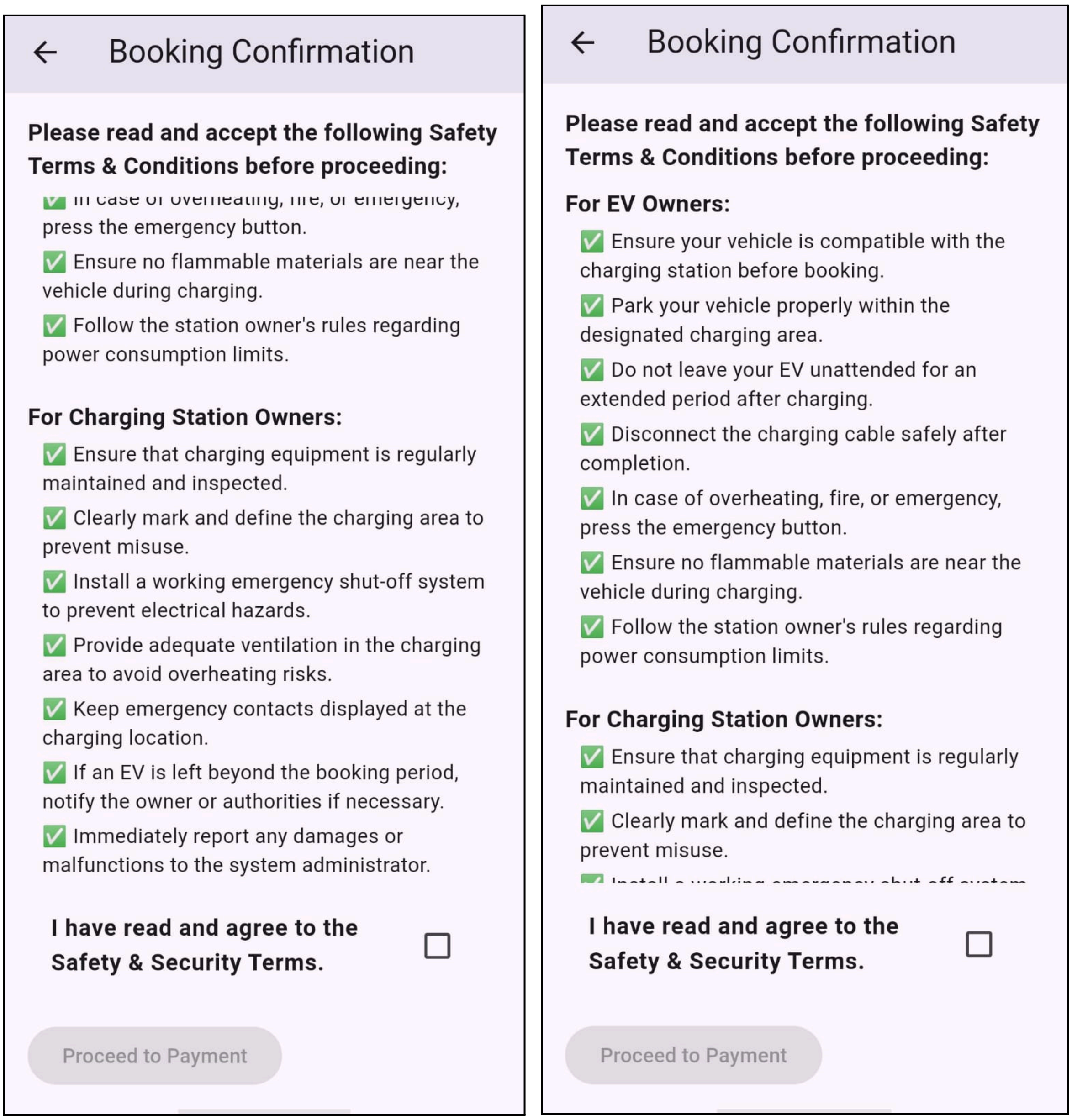
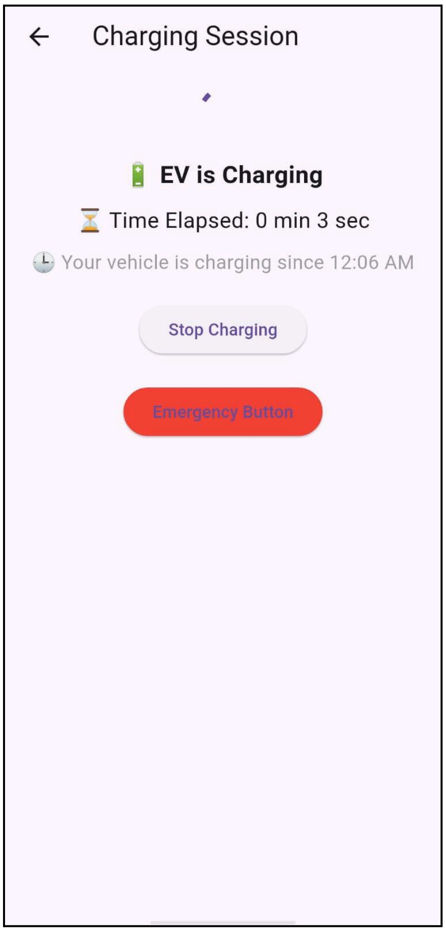
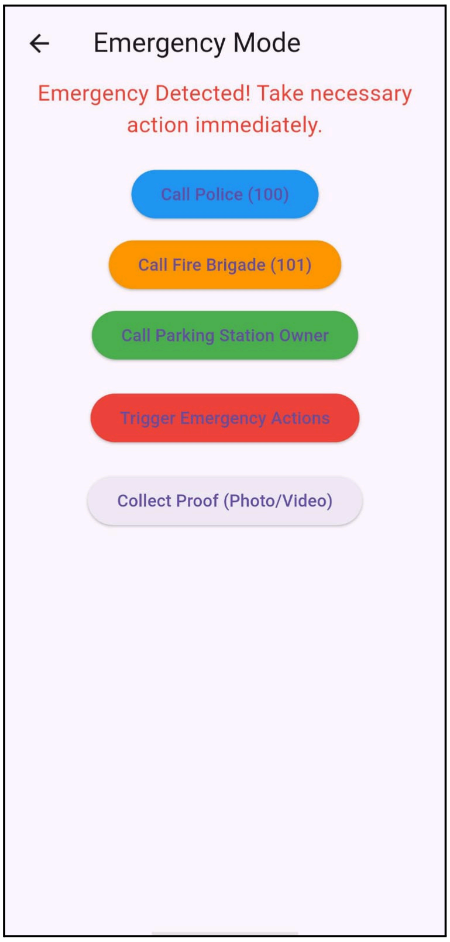


Fig 7.3 Safety Considerations.

In the Fig 7.3, the two images display the **"Booking Confirmation"** screen from an EV (Electric Vehicle) charging application, where users are required to read and accept the **Safety Terms & Conditions** before proceeding with payment. Both screens emphasize responsibilities for **EV Owners** and **Charging Station Owners**. The first image includes guidelines like avoiding flammable materials, following station rules, and emergency protocols. It also highlights the responsibilities of charging station owners, such as maintaining equipment, marking charging areas, ensuring ventilation, and displaying emergency contacts. The second image expands on the first by including additional EV owner duties like ensuring compatibility of the vehicle with the station, parking properly, not leaving the EV unattended, and disconnecting the cable after charging. At the bottom of both screens, users must check a box indicating agreement with the terms to enable the **"Proceed to Payment"** button. The second image provides a more comprehensive list for EV owners compared to the first.



(A)

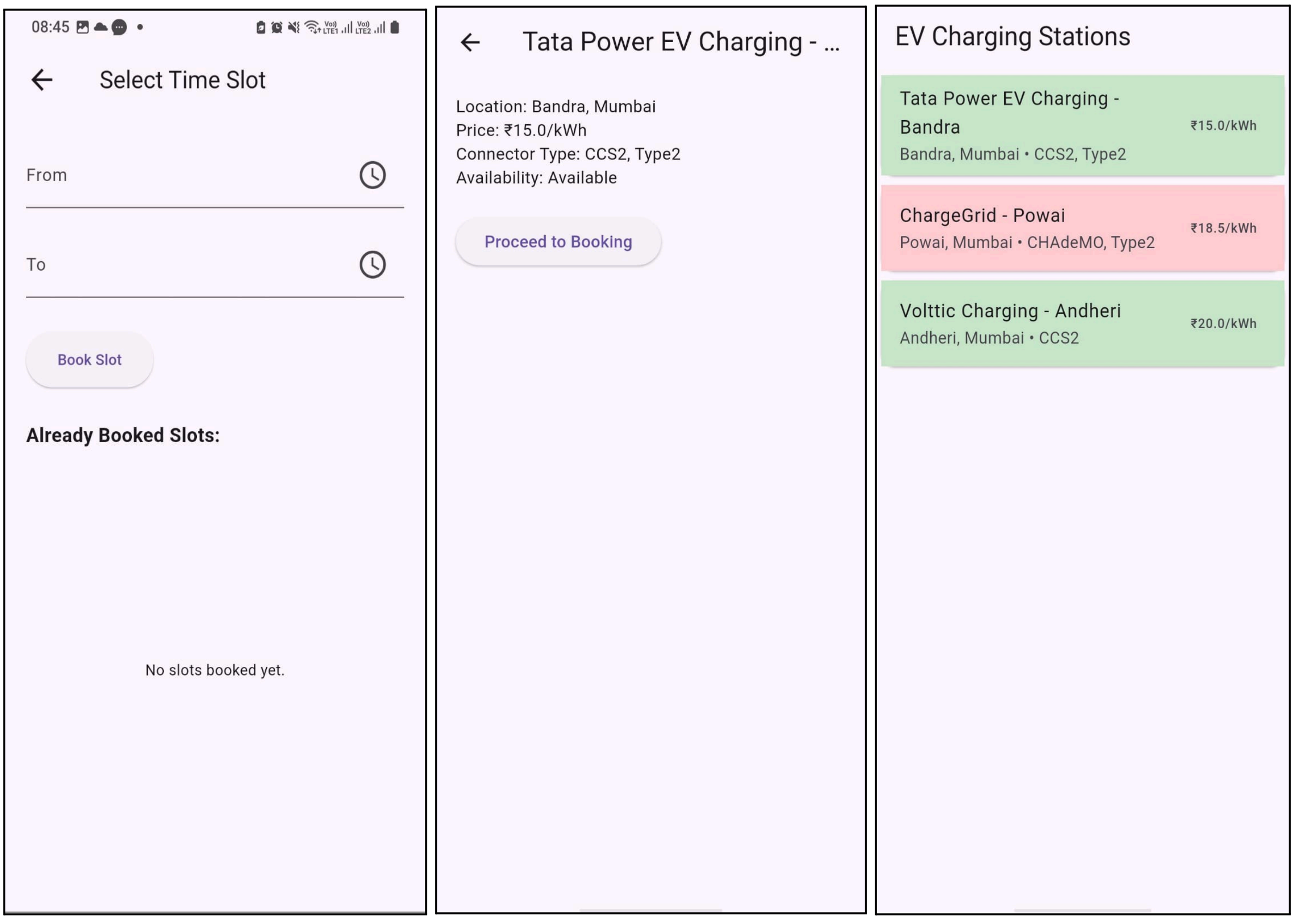


(B)

Fig 7.4 Solution For Emergency

The electric vehicle (EV) charging application includes a well-structured interface for both normal operation and emergencies. During an active charging session, the app displays real-time information such as the current charging status, elapsed time, and the exact time charging began In Fig.7.4 (A). It provides users with two primary options: "Stop Charging" and a prominent red "Emergency Button" for urgent scenarios.

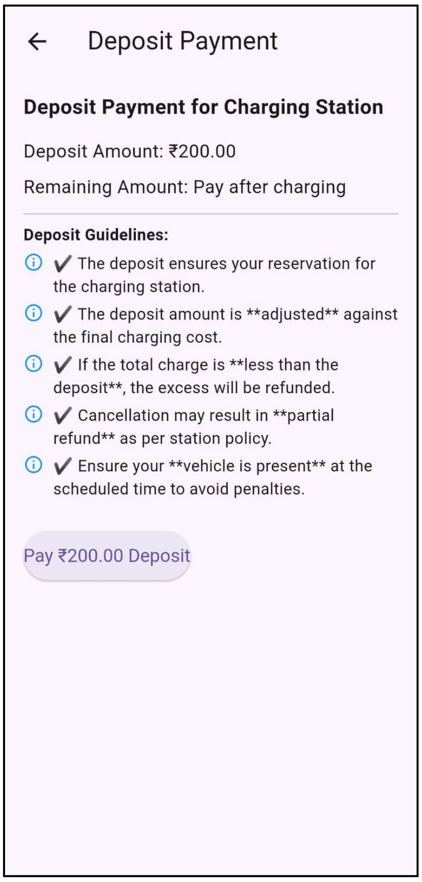
Upon activating emergency mode, users are redirected to a dedicated screen titled "Emergency Mode," which highlights the detection of a critical situation and offers quick-action options. These include direct call buttons for emergency services like police (100) and fire brigade (101) In Fig.7.4 (B), as well as the parking station owner. Additional functions allow users to trigger automated emergency actions and collect photo or video evidence for documentation. This dual-screen interface enhances user safety and system transparency during EV charging.



(A) (B) (C)

Fig. 7.5. Slot Booking

The Fig 7. 5 highlights another key aspect of the application is its **charging slot booking system**, which allows users to **reserve a charging station in advance**. This is particularly useful during peak hours or in densely populated urban areas, where the demand for EV chargers may outstrip supply. By scheduling a time slot, Fig.7.5(A), users can avoid queues and reduce idle wait times, ensuring a smoother charging experience. Notifications and reminders are sent as the reservation window approaches, adding to the convenience. The provided images showcase a user interface design for an electric vehicle (EV) charging station booking application. The Fig 7.5. (A) displays a list of available charging stations in Mumbai, each with details such as the station name, location, supported connector types (e.g., CCS2, Type2, CHAdeMO), and cost per kWh. The stations are visually differentiated using colored cards—green indicating potentially lower cost or higher availability, and red possibly indicating higher rates or lower preference. Fig 7.5.(B) and (C) represent a detailed view of a selected charging station ("Tata Power EV Charging - Bandra"). It provides specific information, including location, price, connector types, availability status, and a prominent “Proceed to Booking” button, streamlining the user’s next action. This UI design supports intuitive navigation and effective decision-making for EV users based on pricing, location, and connector compatibility.



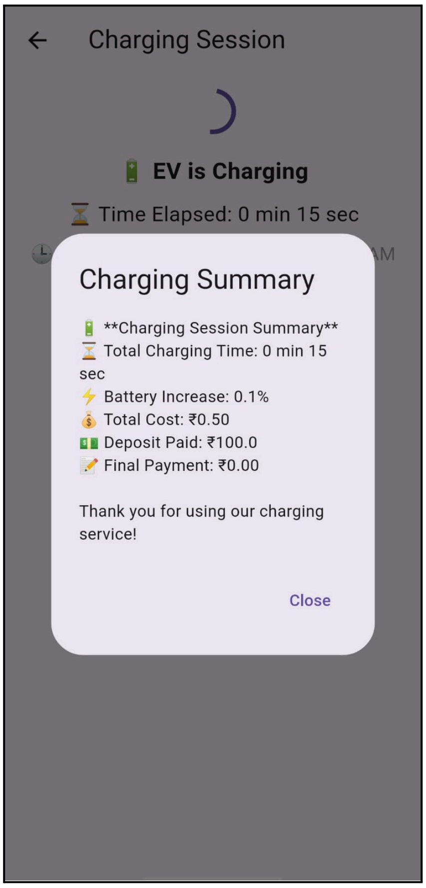


Fig. 7.6 Deposit Payment and Checkout

The Fig 7.6 highlights a mobile application for the electric vehicle (EV) charging station that provides a streamlined and transparent user experience. Before initiating a charging session, users are prompted to pay a refundable deposit (e.g., ₹200.00) to reserve a slot, with clear instructions that the final amount will be adjusted based on actual usage. This ensures commitment and prevents misuse of the reservation system. During charging, the interface displays real-time progress, including the elapsed time and battery status, and provides an option to manually stop charging. Users are informed that stopping the session will trigger a payment request and that restarting would require a new booking. Once the session concludes, a summary screen presents details such as total charging time, battery percentage gained, cost incurred, deposit paid, and any remaining amount due or refundable.

7.2 Performance Evaluation Measures:

Fig. 7.7 Flutter DevTools Dashboard

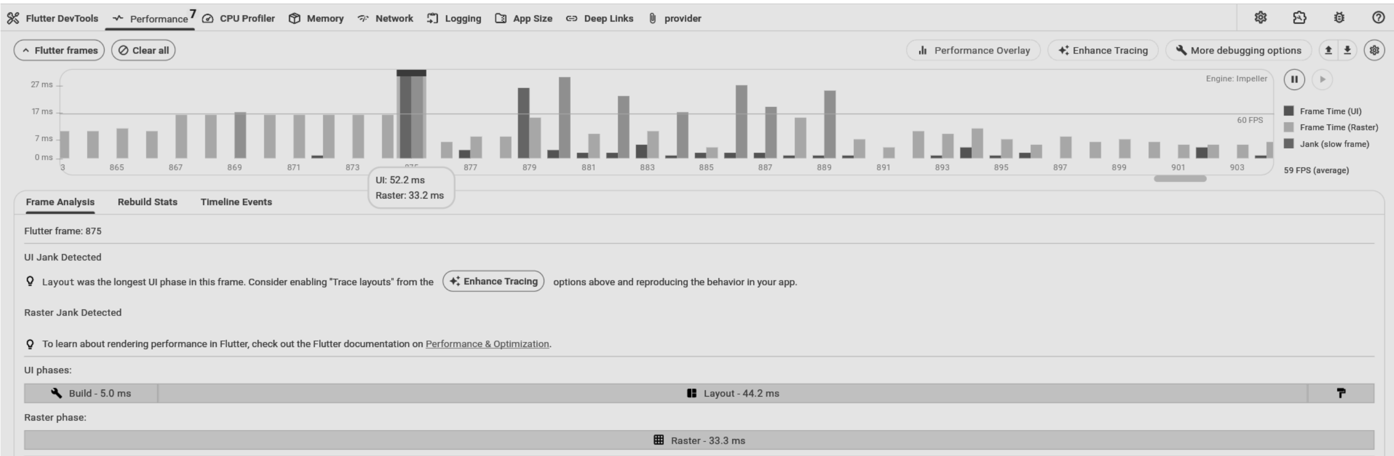


Fig. 7.8 DevTools Performance Analysis

In Fig. 7.8, performance analysis using Flutter DevTools showed a jank frame during the map screen load with UI: 52.2 ms and Raster: 33.2 ms, caused by a long layout phase. All other frames were smooth, indicating overall app performance is stable except during heavy UI rendering.

Fig. 7.9 DevTools CPU Profiler

In Fig. 7.9, the CPU Profiler shows `_drawFrame` and `_beginFrame` consuming over 69% of total time, indicating rendering-heavy operations. Optimizing widget rebuilds and frame drawing can significantly improve startup performance.

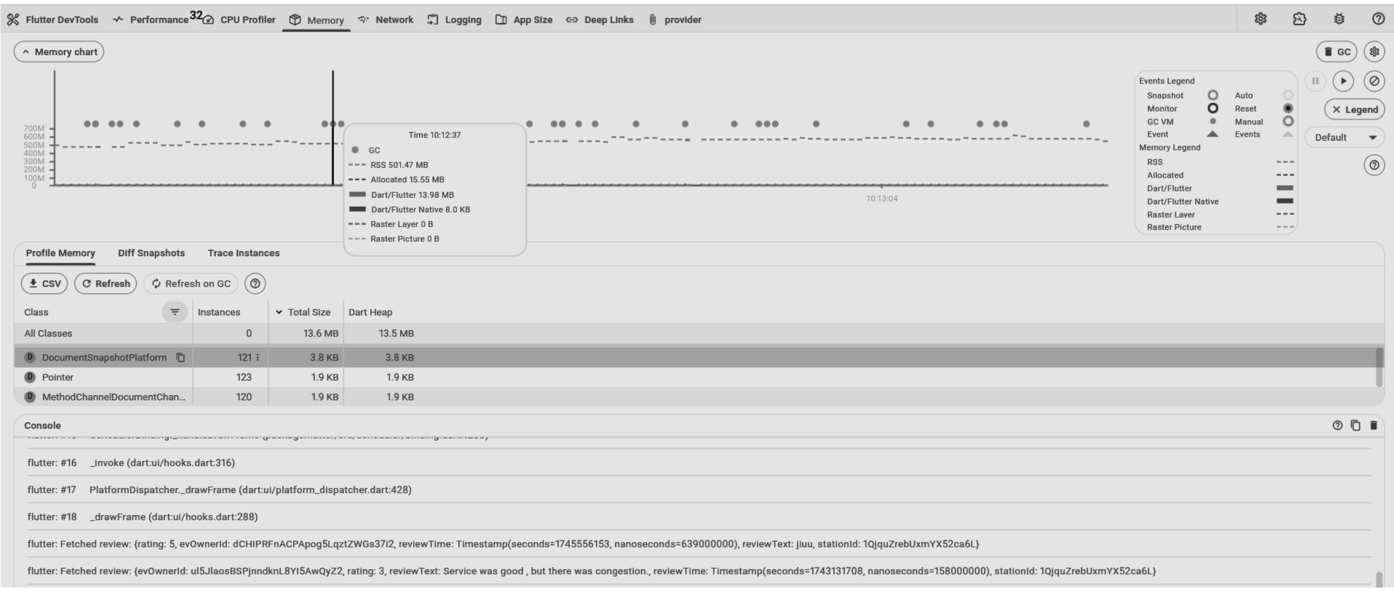


Fig. 7.10 Memory usage monitoring using DevTools

In Fig. 7.10, this Flutter DevTools memory snapshot shows stable memory usage (~13.5 MB Dart Heap, ~501 MB RSS) with efficient garbage collection and no memory leaks. Instances like `DocumentSnapshotPlatform` and `Pointer` have minimal memory impact. Console confirms Firebase data fetches are working; minor UI rebuild optimization may improve performance.

7.3 Input Parameters/Features considered:

- **Performance Metrics:** Frame rendering time, UI thread activity, CPU profiler statistics.
- **Network Metrics:** API response times, data fetch success, network request count and size.
- **Memory Metrics:** Dart Heap size, Resident Set Size (RSS), Garbage Collection (GC) activity, object instance counts (`DocumentSnapshotPlatform`, `Pointer`).
- **Data Handling:** Fetched data structure (e.g., rating, reviewText, timestamp, stationId).
- **Event Monitoring:** GC events, snapshot timings, and manual memory refresh points.
- **Application State:** Real-time memory snapshots during data fetching and UI update

7.4 Inference Drawn:

The performance analysis of the Flutter application highlights a generally stable and optimized system, with a single spike observed during the loading of the map screen. The jank frame caused by the long layout and rendering times (UI: 52.2 ms, Raster: 33.2 ms) indicates that heavy UI components, such as maps or custom layouts, need optimization—possibly through widget tree simplification or asynchronous rendering.

CPU profiler insights revealed that methods like `_drawFrame` and `_beginFrame` dominate CPU usage, consuming over 69% of execution time. This suggests that significant computation occurs during frame rendering, likely due to excessive widget rebuilds or complex visual elements. Reducing rebuilds using efficient state management and widget splitting could lead to performance gains, especially at app startup.

Memory profiling indicates well-managed memory usage, with a Dart heap of ~13.5 MB and total RSS around ~501 MB. No memory leaks were found, and GC activity appears efficient. The instances of key objects, such as `DocumentSnapshotPlatform` and `Pointer,` are limited and lightweight, showing proper handling of backend data.

Network inspection and console logs confirm successful and structured data fetching from Firebase (e.g., rating, reviewText, timestamp, stationId). This validates backend integration and parsing mechanisms. Overall, the app is responsive and performant, with scope for optimization focused on frame rendering and layout efficiency during complex UI transitions.

Chapter 8: Conclusion

This chapter summarizes the outcomes of the EVolve Chargemates project, reflecting on its impact, strengths, and areas for improvement. It highlights how the application addresses key challenges in EV charging infrastructure through innovative community-driven solutions. Additionally, the chapter outlines future enhancements aimed at improving user experience, expanding the network, and integrating sustainable practices

8.1 Conclusion

EVolve Chargemates represents a significant advancement in the realm of electric vehicle (EV) charging by leveraging technology to create a decentralized network of charging stations within communities. The app empowers homeowners to register their residences as charging points, thereby increasing the availability of charging infrastructure and promoting the adoption of electric vehicles. By integrating real-time data collection and mapping capabilities, EVolve Chargemates allows EV owners to locate nearby charging stations effortlessly, ensuring a seamless and efficient charging experience.

The user-friendly interface, coupled with features like reservation systems and feedback mechanisms, fosters engagement and trust within the community. By facilitating direct communication between charging station providers and EV owners, the app enhances collaboration and efficiency in managing the charging network. This connectivity not only improves user satisfaction but also encourages more homeowners to participate in the initiative, further expanding the network.

In addition to improving immediate access to charging stations, EVolve Chargemates aims to contribute to long-term sustainability by promoting the use of electric vehicles and reducing carbon emissions. The app's scalability and adaptability make it suitable for various urban and rural settings, addressing the diverse needs of users across different geographical regions. Ultimately, EVolve Chargemates sets a new benchmark for electric vehicle infrastructure, providing a powerful tool to enhance the accessibility and convenience of EV charging, thereby fostering a more sustainable transportation future..

8.2 Future Scope:

Enhanced User Features and Personalization

Future updates will focus on adding personalized features for users, such as tailored charging recommendations based on individual driving habits and preferences. By utilizing machine learning algorithms, the app will be able to suggest optimal charging times and locations, improving the overall efficiency of the charging process. **Dynamic Pricing and Availability Notifications**

We aim to implement a dynamic pricing model that adjusts charging costs based on demand and time of day. Additionally, users will receive real-time notifications about charging station availability and price changes, ensuring they are well-informed and can make timely decisions regarding their charging needs. **Expansion of the Charging Network**

Efforts will be made to expand the charging network by partnering with local businesses, municipalities, and other organizations. By encouraging more homeowners to list their properties as charging stations, we aim to increase the availability of charging options and support the growing electric vehicle community. **Advanced Analytics Dashboard for Users**

An enhanced analytics dashboard will be developed to provide users with insights into their charging patterns, costs, and overall energy consumption. This feature will empower users to make informed decisions about their electric vehicle usage and contribute to a more sustainable lifestyle. **Integration of Renewable Energy Sources**

Future versions of the app will explore partnerships with renewable energy providers to facilitate the integration of green energy sources into the charging network. This will not only promote sustainability but also offer users the option to charge their vehicles using clean energy**Community Engagement and Gamification** foster a sense of community among users, we plan to introduce gamification elements such as rewards for frequent users and participation in community initiatives. This will encourage more users to engage with the app and contribute to the growth of the EVolve Chargemates network.

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Appendix

List Of Figures:

Project review evaluation sheet

Semester 7 Review 1- 23rd August 2024

Industry/Inhouse: **Project Evaluation Sheet 2024-25** 32 **Class: D17** C

Title of Project(Group no): EVolve Chargemates (Grp No - 32)

Group Members: Vedant Tawade (65), Vedant Pawar(52), Soham Tawade (64), Nikhil Singh(60) D17C

	Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environ ment Friendly (2)	Ethics (2)	Team work (2)	Presentati on Skills (3)	Applied Engg &Mgmt principles (3)	Life - long learning (3)	Profess ional Skills (5)	Innov ative Appr oach (5)	Total Marks (50)
Review of Project Stage 1	4	4	4	2	4	0	2	2	2	3	3	3	4	5	42

Comments: - Every aspect of problem specially wrt houshold charging owner need to be consider (benefit to owner)
- Dataset need to present next Review
→ All Security measure nad tobe conside for Installing charging station what are the prequisite for the same give clarity on that

Yugchhaya Galphat — Name & Signature Reviewer1

	Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environ ment Friendly (2)	Ethics (2)	Team work (2)	Presentati on Skills (3)	Applied Engg &Mgmt principles (3)	Life - long learning (3)	Profess ional Skills (5)	Innov ative Appr oach (5)	Total Marks (50)
Review of Project Stage 1	4	4	4	2	5	2	2	2	2	3	3	3	4	5	45

Comments: ⊛ Focus on prototype. and pitch the idea

Date: 23rd August, 2024

Lifna CS 23/8/24 — Name & Signature Reviewer2

Semester 7 Review 2- 26th September 2024

Industry/Inhouse: **Project Evaluation Sheet 2024-25** 32 **Class: D17** C D17C

Title of Project(Group no): Evolve Chargemates (32)

Group Members: Vedant Pawar (52) D17C, Vedant Tawade (65) D17C, Nikhil Singh (60) D17C, Soham Tawade (64) D17C

	Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environ ment Friendly (2)	Ethics (2)	Team work (2)	Presentati on Skills (3)	Applied Engg &Mgmt principles (3)	Life - long learning (3)	Profess ional Skills (5)	Innov ative Appr oach (5)	Total Marks (50)
Review of Project Stage 1	4	4	5	3	4	2	2	2	2	2	2	2	4	4	42

Comments: Business model can be prepared. detailed comparison study considering different factors.

(Priya R. L) — Name & Signature Reviewer1

	Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environ ment Friendly (2)	Ethics (2)	Team work (2)	Presentati on Skills (3)	Applied Engg &Mgmt principles (3)	Life - long learning (3)	Profess ional Skills (5)	Innov ative Appr oach (5)	Total Marks (50)
Review of Project Stage 1	4	4	4	3	4	2	2	2	2	2	2	2	4	4	41

Comments: ⊛ Complete the implementation c̄ integration c̄ API's
⊛ Get ready c̄ Prototype. before Project Viva

Date: 26th September, 2024

Lifna CS 26/9/24 — Name & Signature Reviewer2

Semester 8 Review 1- 1st April 2025:

Inhouse/ Industry _Innovation/Research:

Sustainable Goal:

Project Evaluation Sheet 2024 - 25

Class: D17 A/B/C

Group No.: 32

Title of Project: Evolve Chargements

Group Members: Vedant Tawade (65), Vedant Pawar (52) (D17C), Nikhil Singh (60), Soham Tawade (64)

Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environment Friendly (2)	Ethics (2)	Team work (2)	Presentation Skills (2)	Applied Engg&Mgmt principles (3)	Life - long learning (3)	Professional Skills (3)	Innovative Approach (3)	Research Paper (5)	Total Marks (50)
4	4	5	3	4	1	2	1	2	2	3	3	3	3	2	42

Comments: ① consider safety measure for home charging station ② 4 1 2 → Improve
proper verification will be required.

Name & Signature Reviewer1 Yugchhaya

Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environment Friendly (2)	Ethics (2)	Team work (2)	Presentation Skills (2)	Applied Engg&Mgmt principles (3)	Life - long learning (3)	Professional Skills (3)	Innovative Approach (3)	Research Paper (5)	Total Marks (50)
4	4	4	2	4	1	2	1	2	2	3	3	3	3	1	39

Comments: ① Productize the Project
② Improve the UI & make the system working

Date: 1st March, 2025

Name & Signature Reviewer 2 Lifna. CS 1/3/25

Semester 8 Review 2- 1st April 2025

Project Evaluation Sheet 2024 - 25

32

Title of Project: Evolve Chargemates - Decentralizing EV Station Networks

Group Members: Vedant H. Pawar (D17C/52), Soham Tawade (D17C/64), Nikhil Singh (D17C/60), Vedant Tawade (D17C/65)

Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environment Friendly (2)	Ethics (2)	Team work (2)	Presentation Skills (2)	Applied Engg&Mgmt principles (3)	Life - long learning (3)	Professional Skills (3)	Innovative Approach (3)	Research Paper (5)	Total Marks (50)
4	4	4	2	3	2	2	2	2	2	3	2	2	2	2	38

Comments:

Name & Signature Reviewer1 (Priya R.L)

Inhouse/ Industry _Innovation/Research:

Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environment Friendly (2)	Ethics (2)	Team work (2)	Presentation Skills (2)	Applied Engg&Mgmt principles (3)	Life - long learning (3)	Professional Skills (3)	Innovative Approach (3)	Research Paper (5)	Total Marks (50)
4	4	5	3	4	1	2	2	2	2	3	3	2	2	02	41

Comments: Installation of EV Station should go with some prerequisite test survey / for approval

Date: 1st April,2025

Yugchhaya Galphat

Name & Signature Reviewer 2