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EcoCharge: A Mobile Application for Real-Time Electric Vehicle Charging Station Location and Reservation System using Flutter and Google Maps API

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Abstract*:* Electric vehicles (EVs) are getting to be increasingly common, which has highlighted the pressing require for a reliable and helpful framework for charging them. Finding available and congruous charging stations is one of the greatest impediments EV clients experiences, which blocks the smooth move to eco-friendly shapes of transportation and includes to run uneasiness. In arrange to bolster the expanding request for EVs and empower their broad appropriation, this issue must be settled.

In arrange to move forward the productivity and comfort of EV utilize, this consider portrays the plan, improvement, and appraisal of an application for finding EV charging stations. The application, which was made with the Vacillate system, gives clients up-to-date data on charging stations in their range by coordination the Google Maps API. In arrange to help clients in making well-informed choices, the app appears comprehensive station information, such as connector sorts, accessibility status, estimating, and operational conditions.

A number of user-friendly highlights, counting filter-based station looks, course arranging with coordinates charging stops, and client announcing for out-of-service stations, are included within the application to advance move forward the client encounter. The interface is made to be simple to utilize, and route is made smooth by intuitively maps. To guarantee the precision and constancy of the data shown inside the app, real-time information is combined from a few sources.

The application's usefulness and client interface were assessed through convenience testing. Concurring to the comes about, clients thought the app was exceptionally user-friendly and compelling. The app encourages a more consistent EV proprietorship encounter by radically bringing down stresses around the accessibility of charging stations. This think about fills a basic framework hole in modern transportation frameworks and progresses clean versatility arrangements.

Keywords*:* Electric Vehicles (EVs), Charging Station Finder, Flutter, Google Maps API, Slot Booking, Real-time Data, Firebase, Sustainable Transportation, Mobile App Development, EV Infrastructure.

I. INTRODUCTION

The global shift toward sustainable transportation has catalyzed the rapid adoption of electric vehicles (EVs), the very factor behind the need to curb carbon emissions, dust, and urban pollution in cities. One major issue with the absence of EV ambiance remains in this acceleration of EV adoption: Charging infrastructure scarce, low-profile, and poorly accessible. Range anxiety, long waiting periods, or idiosyncratic information about charging stations are challenges that make the use of an EV difficult despite its green nature and well-earned performance.

Recognizing the issues, digital solutions commenced to fill the gap that stands between EV drivers and the infrastructure they rely upon. With a rise in their importance came those mobile apps that gave real-time information on charging stations.[6],[7] Such platforms allow users to receive live information on availability of a charging station, charging costs, where one could book a slot, connector types, and navigation to the charging station itself.

They also integrate smart booking confirmations, user ratings, social payments, and other functions to maximize user satisfaction and encourage better infrastructure utilization. In parallel with this, various literatures have stressed the

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importance of optimal charging station placement by noting that chargers must be located strategically to balance demand and supply and to minimize underutilization or congestion. Advanced models using agent-based simulations, geospatial data, and demand-priority algorithms have been solved for addressing such inefficiencies in the distribution of the stations, especially in densely urbanised domains.[10],[11] These models try to reduce the total travel distances of EVs and maximise charging equity among various regions.

This paper details the design and development of a user-centric EV charging station finder application integrated with real-time location services, a booking system, and intelligent navigation. Using a mix of Flutter, Google Maps API, and Firebase, the application provides a scalable and sensitive solution toward a pressing problem. Thus, it is not only an application/technology development but also a step toward sustainable smart urban mobility.

Aiming at infrastructure planning, digital mobility solutions, and the shared economy as well, this study attempts to present integrated solutions through digital platforms that address concrete energy and transport problems. Such a solution clearly fits in the global agenda for green cities and smart transport systems.

II. RELATED WORKS

Numerous tools for adding unique content to Google Maps are available through the Google Maps API, and a variety of web map applications can be investigated using the API. Global positioning systems (A-GPS), the most precise positioning method in mobile location-based services, are adopted by assisted mobile operation companies. This paper presents a solution for a mobile navigation system that enables features like bus line search, Google map browsing and query, quick local positioning on your phone, etc. In this paper, we address the main realization technologies and the technical scheme of the system. [1]

In the modern world, GPS tracking has many applications; it can be used to track children, assets, cars, or any other equipment, as well as spy gear. A portable tracked unit can be located using the system, and the position can be sent to the tracking center. [2]

A portable tracked device that is fastened to a person, car, or other asset and a tracking center that tracks the location of the portable device make up the GPS tracking system. The tracking center, which is merely a personal computer with numerous interface programs to display the location on Google Maps using a free version of Google Maps APIs (application programming interfaces), receives the coordinates from the GPS on the tracked mobile device and sends them to it via GSM modem as SMS.A well-liked UI framework for creating Google mobile apps is called Flutter. In recent years, it has gained popularity. However, when creating their applications, Flutter developers must contend with a state management problem. [3]

Several architectures have been developed to address this issue. This paper suggests a new Flutter architecture that is based on Uncle Bob's Clean Architecture. A Flutter package is used to package and distribute the Flutter Clean Architecture suggested in this paper. By using the package to create a complete application from scratch and recording the procedure, the architecture is tested. [4]

Including runtime checks, known as assertions, in the code to verify assumptions and invariants is a good programming practice. It is said that assertions are frequently most successful when they convey design choices and limitations. In this paper, we present our initial efforts to convert design constraints into assertions for mobile applications. The Object Constraint Language (OCL) is used to formally specify design properties and constraints. Dart, the language used by the Flutter cross-platform framework, is then used to translate these specifications into executable assertions. We take into account different OCL, Dart, and Flutter language and platform-specific features. [5]

In the modern world, every client wants to develop cross-platform mobile applications. Engineers must repeatedly construct the same system for various operating systems (OS). Google offers Flutter as a remedy. It is an open-source SDK for enhancing the most dependable and high-performing mobile applications for Windows, Linux, iOS, Android, and the web. [6]

In contrast to earlier practice, it offers the capability of timely compilation through the use of computer code that incorporates integration during program execution during working hours. [7]

Flutter offers a variety of frameworks and widgets that facilitate code implementation and use. We will talk about Flutter and its widgets in this research paper. Electric vehicle research and development has been pushed as a new technology

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in Indonesia in recent years. To guarantee flexibility, electric vehicle (EV) charging station (CS) infrastructure must be provided. Communicating multiple brands into the central system makes managing the EV charging station difficult. The charging station management system (CSMS) was successfully developed by us. Application development is used to create SONIK (electric vehicle charging operation system), a tool for monitoring and controlling CS in the form of a CSMS application. [8]

Although the number of electric vehicles is generally on the rise, the infrastructure for charging them must also be expanded. New charging station construction causes some issues with electrical networks, particularly in cities. This paper presents a Matlab model of a charging station powered by a DC power supply and classifies the different types of charging stations. [9]

Sharing charging stations is a good way to get electric vehicles charged on a daily basis, but in places with high demand, there aren't enough stations, and in places with lower demand, there are many stations sitting idle. The imbalance between supply and demand is the main cause of the issue. Stated differently, in order to balance supply and demand, we must place the charging stations in the right places. In order to increase the sharing charging level, this study attempts to address the issue of where to find charging stations for public electric vehicles (PUEVs). Mileage, PUEV distribution, and passenger distribution are some of the variables that we take into account when determining the locations of charging stations. In order to reduce the overall vehicle service distance, a Non-deterministic Polynomial (NP) model is created. [10]

By strengthening the constraint for the smallest number of charging stations, this paper optimizes the current location; the suggested model can be applied to the placement of EV charging stations in a densely populated city. Small electric vehicles, or electric cars, were the first step toward electrifying transportation and have recently attracted more and more attention from around the world. [11]

A logical next step in this process appears to be the electrification of commercial vehicles, such as trucks, and in recent years, many commercial vehicle manufacturers have turned their attention to the electrification of medium- and heavy-duty vehicles. We provide a thorough review and analysis of the current literature on commercial vehicle charging in this paper. [12]

III. PROPOSED SYSTEM

In the last decade, major advances have occurred in the domains of electric vehicles and charging technology. Besides emissions reduction, EVs also provide superior power delivery and greater efficiency due to features like regenerative braking, allowing them to recharge on the go. However, with all these advantages, one of the key challenges faced by EV owners is finding nearby charging stations. To help solve this problem, we propose a way to develop an EV charging station finder app with a good user experience that is intuitive and easy to use.

A. Modules

The system is divided into two main modules, each consisting of relevant sub-modules:

1) Admin Module:
Secure login for authentication.
Manage charging stations such as adding, updating, or removing a station.
View user bookings and reservation monitoring:

2) User Module:
Register a new account.
Login to the application securely.
Manage EVs by adding or updating vehicle information.
Search for nearby charging stations according to their location.
View booking details and check reservations

B. Working

The EV Charging Station Finder and Slot Booking Application is designed to make life easier for electric vehicle users. Its goal is simple: help drivers quickly find nearby charging stations, book a slot, and charge their vehicle without hassle.

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The app's working process can be broken down into a few key steps that involve both the user interface and backend systems.

1) How Users Interact with the App

Getting Started:
Users begin by signing up or logging into the app using their phone number, email, or social media accounts. Their credentials are securely managed through authentication services like Firebase or JWT.

Finding Charging Stations Nearby:
Once logged in, the app asks for location access. With this, it uses GPS and mapping tools like Google Maps or Mapbox to display charging stations near the user's current location. The app shows useful station details such as:

Connector types available (like CCS, CHAdeMO, etc.)
Charging speed (slow, fast, super-fast)
Real-time slot availability
Prices
Ratings and reviews from other users

Booking a Charging Slot:
After choosing a station, users can view and book available time slots. The system instantly checks whether that slot is open and confirms the reservation. Users get a notification once the booking is successful.

Getting There and Charging:
The app then provides directions to the selected station using built-in navigation. When the user arrives, they can start charging their vehicle, while the app tracks the session status in real-time.

Making a Payment:
Payments can be made right after booking or after the charging session is complete, through integrated gateways like Razorpay, Paytm, or UPI. Once done, the app logs the session—storing data like charging time, energy used, and payment details—for future reference.

2. How Admins Manage the System
On the backend, the admin panel plays a key role in keeping things running smoothly. Admins can:
Add or remove charging stations
Update charging slot availability
Set or change pricing
Monitor bookings and user activity
They also have access to live dashboards showing real-time usage, popular times, and feedback, helping them make smart decisions for improving the system.

3. What Happens Behind the Scenes
The app's backend handles all the data and real-time communication.[3],[5] Technologies like Firebase or MongoDB store user profiles, bookings, and payment history.[3],[4] Real-time APIs ensure that as soon as a slot is booked or a charging session ends, everyone involved is updated instantly.
If needed, the system can also connect with actual charging stations using OCPP (Open Charge Point Protocol), which lets the app talk to hardware and update live charging status.

4. Notifications and Reminders
To keep users informed, the app sends push notifications for:
Booking confirmations
Payment success or failure
Charging session start or completion
Alerts when a nearby station becomes available
This helps users stay in control without constantly checking the app.
In short, the system works as a smart digital assistant for EV owners. It saves time, reduces uncertainty, and makes the process of finding and using charging stations smooth and predictable. By combining location tracking, real-time data, and secure payments, this app helps support the growing shift to clean, electric mobility.

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C. Features

1)User-centric:
Real-time availability, connector types, charging speeds, and pricing details are displayed to users by the Real-Time Charging Station Locator, which makes use of GPS and mapping services.

2) Advanced Filtering and Search Options:
Users can filter stations using advanced filtering and search options, including charging speed (Level 1, Level 2, DC fast charging), connector type (CHAdeMO, CCS, Tesla Supercharger), availability, and user ratings.

3) Reservation of Charging Slots:
This feature allows customers to book charging slots ahead of time, cutting down on wait times and guaranteeing charging availability when they arrive.

4) User Reviews and Ratings:
Helps others make educated decisions by integrating a community-driven feedback system that allows users to rate and review charging stations.

The system allows the user to manage multiple EVs in the app, search for charging stations in the area, and even pre-reserve a charging slot. The application is designed to support EV drivers by showing real-time information on the availability of charging points nearby, and it is built using Flutter. Once a preferred station is located, the user can check out with a charging slot, ensuring a completely seamless and clean charging experience.

D. Diagrams

1) Use Case Diagram

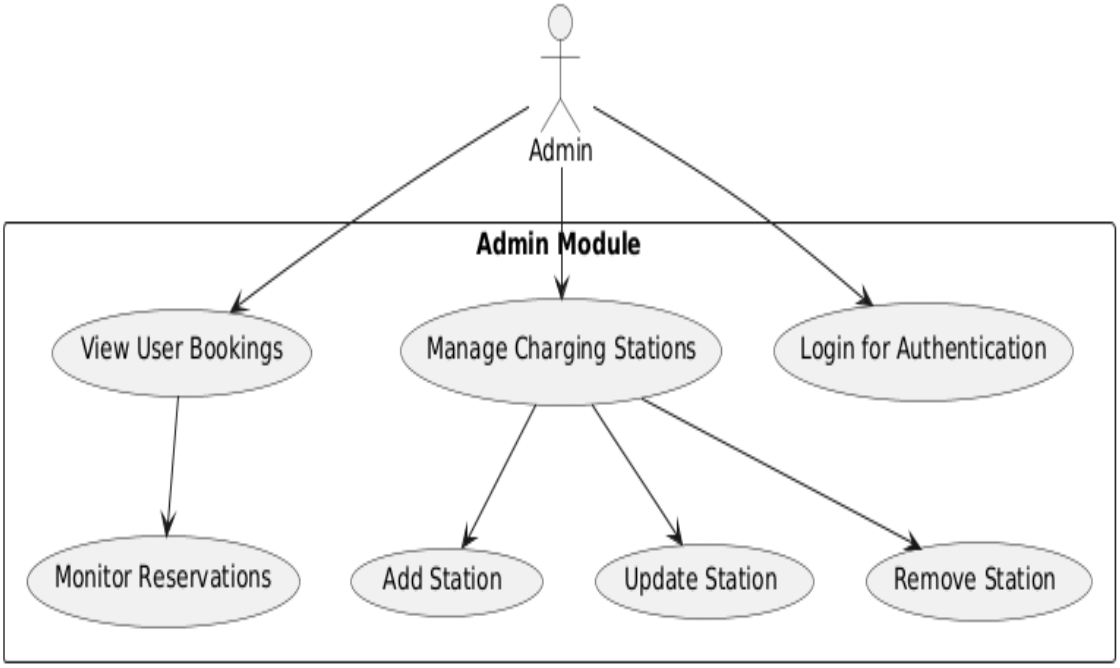

Fig. 1. Use Case Diagram for Admin

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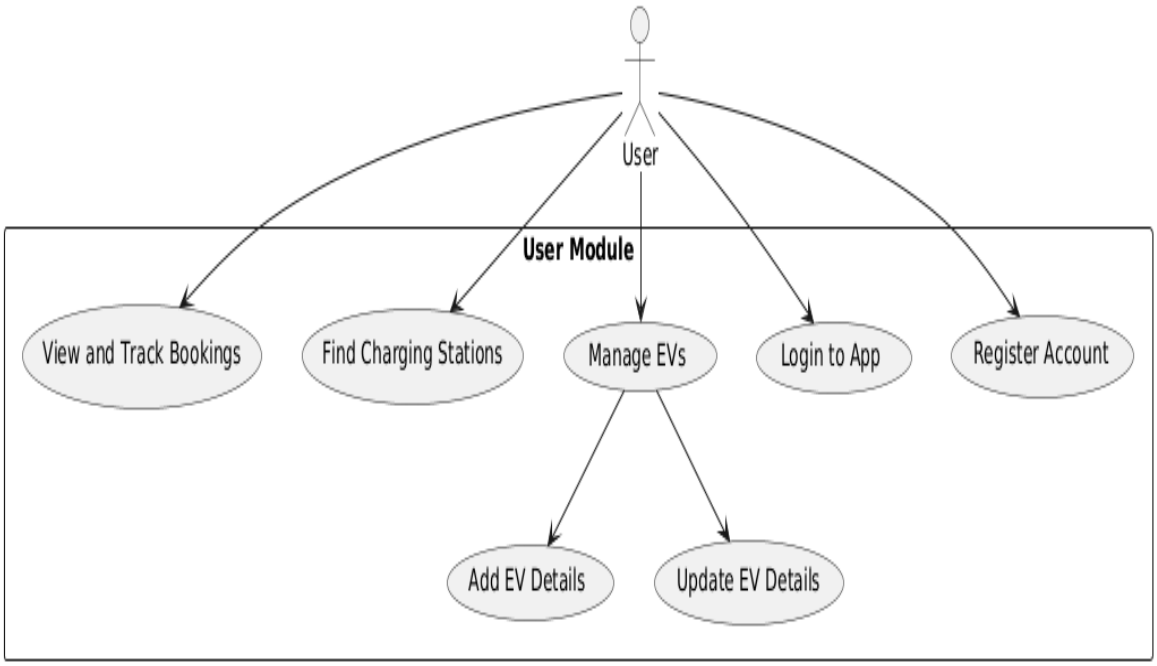

Fig. 2. Use Case Diagram for User

2) System Architecture

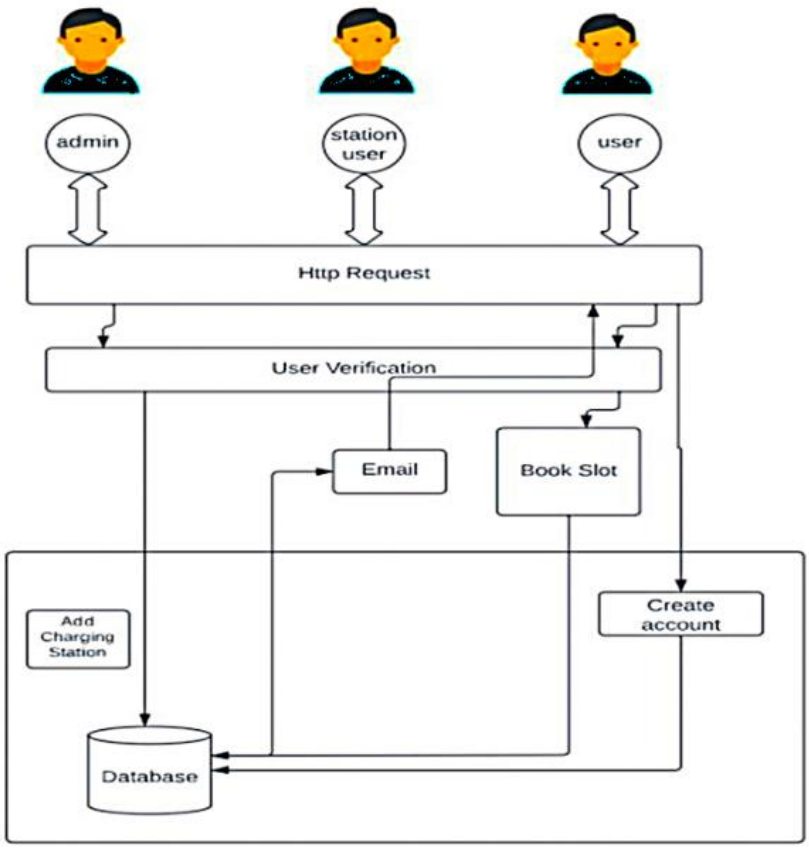

Fig. 3. System Architecture

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3) Sequence Diagram

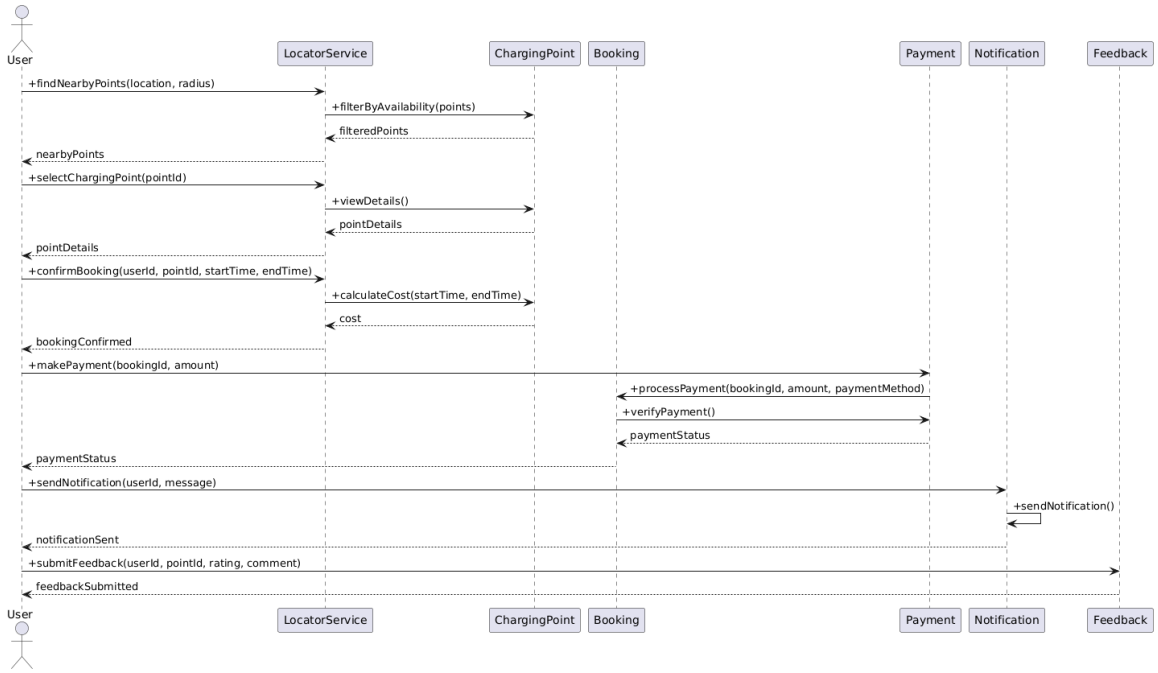

Fig. 4. Sequence Diagram

4) State Diagram

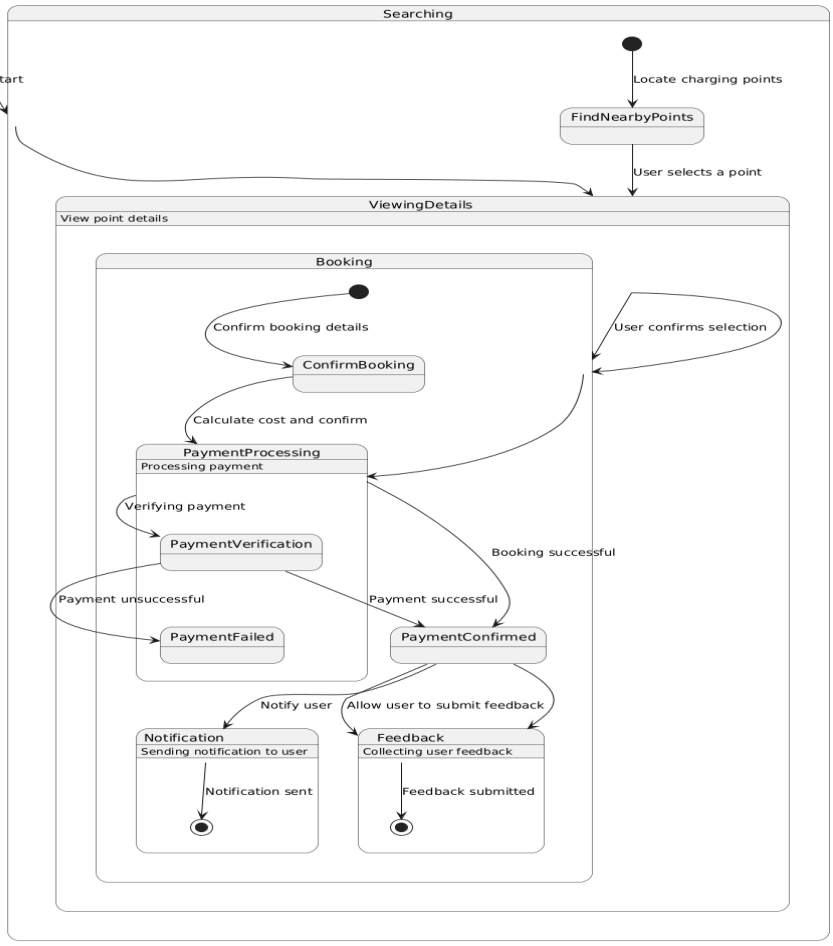

Fig. 5. State Diagram

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5) Deployment Diagram

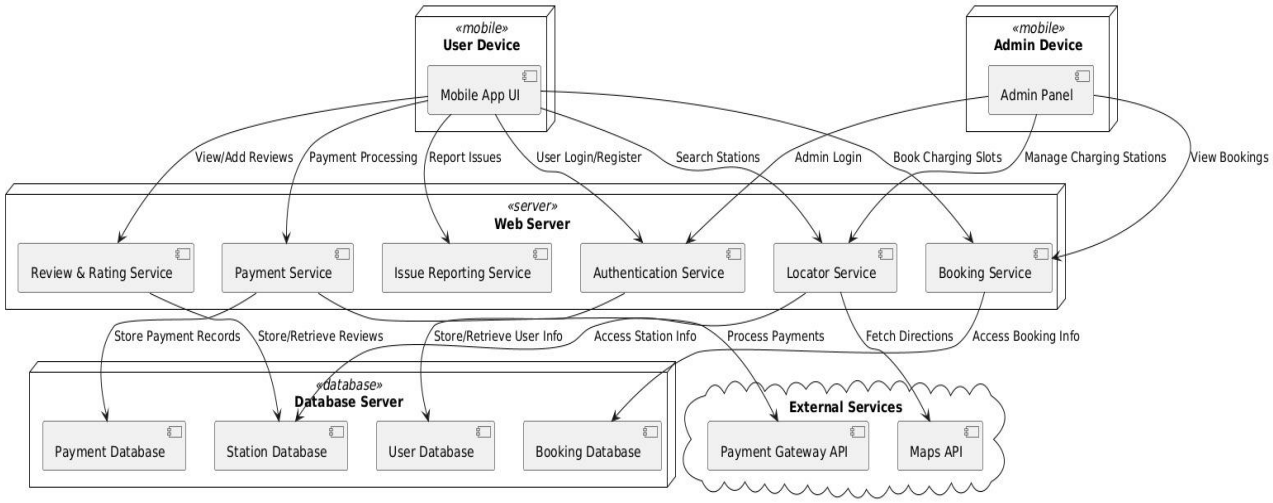

Fig. 6. Deployment Diagram

IV. RESULTS

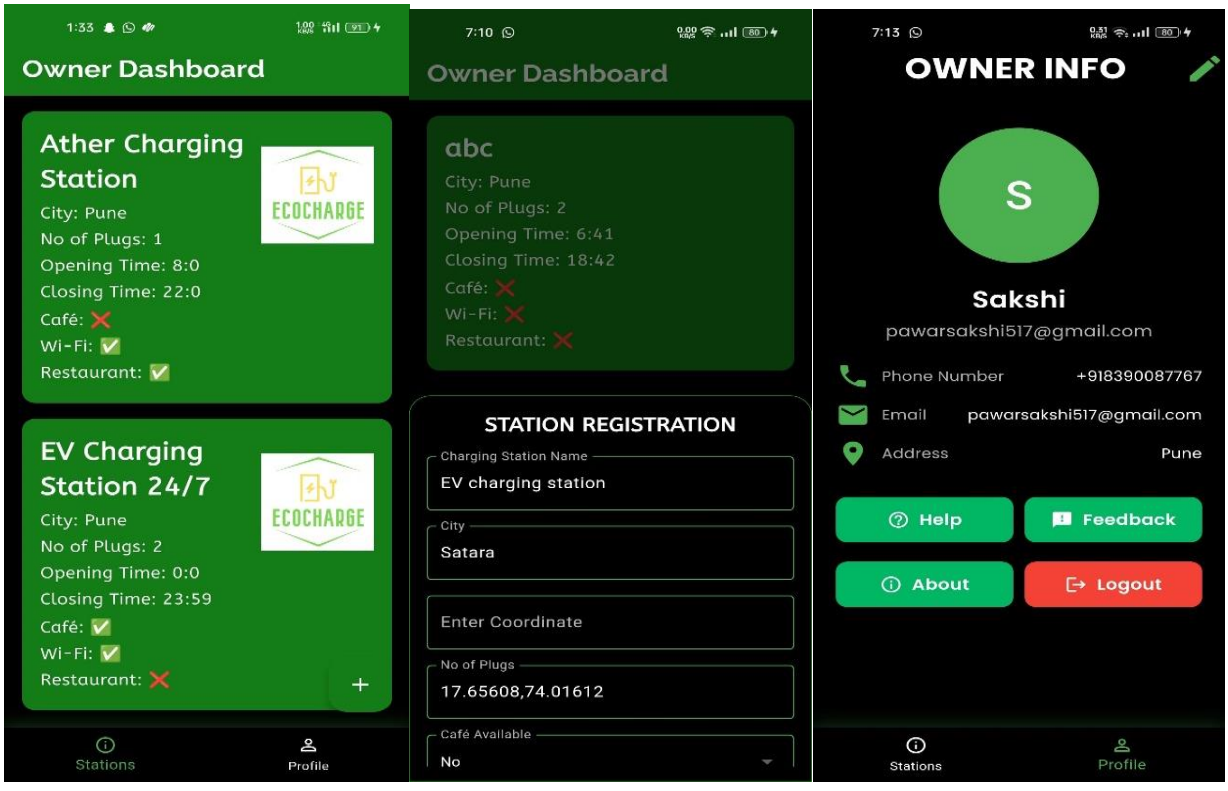

Fig. 7. Owner Dashboards

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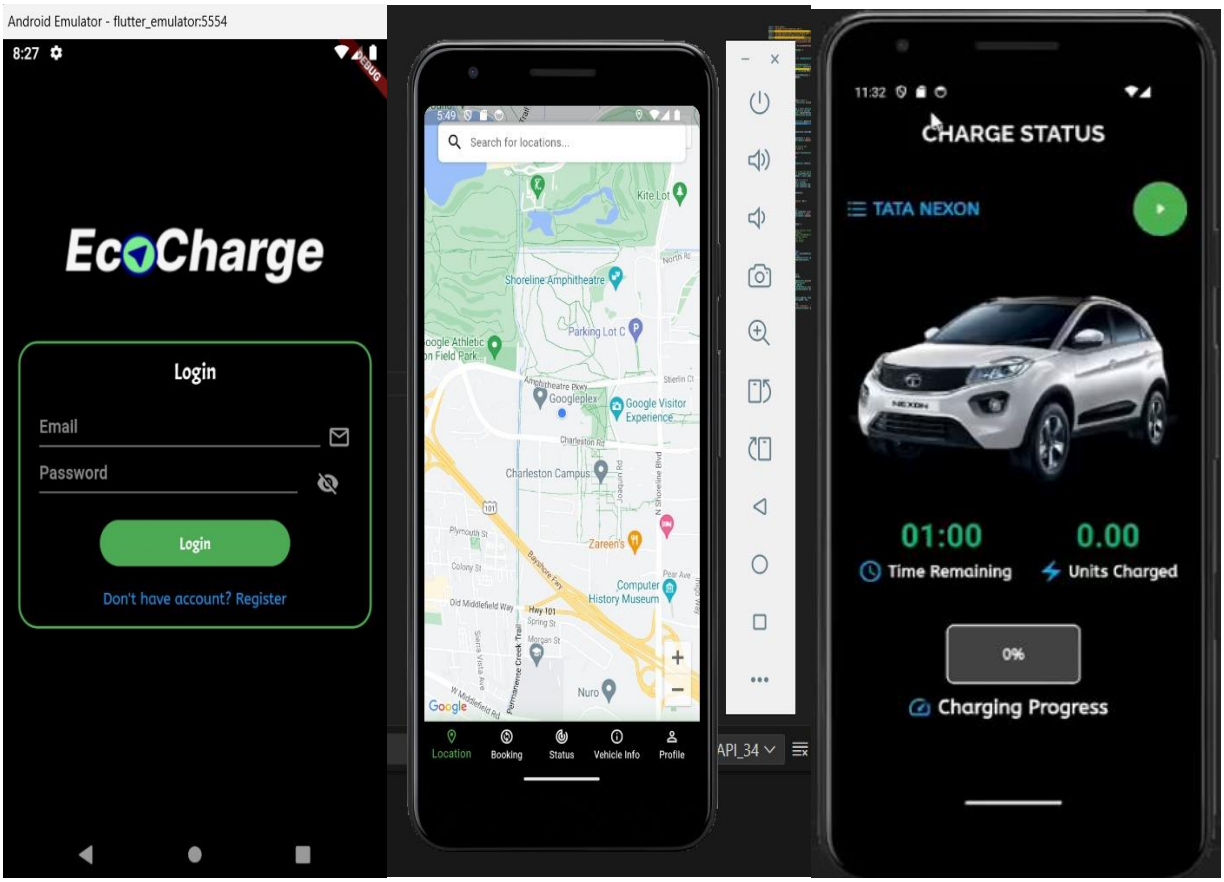

Fig. 8. Login, Landing & Charging Page

V. DISCUSSION

Electric vehicles are becoming a big part of our journey toward cleaner, more sustainable transportation. But while EVs offer clear environmental benefits, they come with a unique set of challenges—especially when it comes to charging. One of the main frustrations for EV owners today is simply finding a charging station that's nearby, available, and compatible with their vehicle. Our project set out to solve that problem in a way that's simple, smart, and accessible.

The app we developed brings together several important features: it helps users find charging stations in real-time, check the types of connectors and speeds available, book time slots, and even pay—all in one place. These features aim to eliminate the stress of running low on charge without knowing where or when you'll be able to plug in. This isn't just about solving a technical problem—it's about creating peace of mind for EV drivers.

On the technical side, using Flutter for the front end allowed us to build an app that works smoothly on both Android and iOS. The backend, powered by real-time databases like Firebase or MongoDB, made it possible to keep users instantly updated about station availability and booking status. Tools like Google Maps added reliable navigation and location tracking, helping users get to the right station quickly and easily.[1],[2]

Beyond helping drivers, this system also offers a lot of value for station operators and city planners.[8],[10],[11] Through the admin dashboard, they can track booking patterns, understand peak usage hours, and gather feedback from users. This kind of data can guide decisions about where to place new stations, how to set pricing, and how to improve the user experience overall.

That said, our system isn't without its limitations. It relies heavily on accurate real-time data from charging stations. If stations don't update their availability properly, it can lead to confusion and frustration for users. Also, while slot booking helps reduce waiting times, it opens the door to issues like overbooking or users not showing up for their slots—something that might need smarter scheduling or a penalty system in the future.

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Another point to consider is the app's effectiveness in less developed or rural areas. Since charging infrastructure is still growing in those regions, users may find fewer stations or limited functionality. Future versions of this system could help address that by identifying underserved areas and recommending them for infrastructure expansion.[11],[12]

Looking ahead, there's a lot of room to grow. We can integrate AI to help with smarter trip planning, allow voice commands, connect the system with smart grids for energy optimization, or introduce dynamic pricing based on demand. These features would take the system from being just helpful to being truly intelligent.

VI. CONCLUSION

As electric vehicles become more common on our roads, the need for reliable and easy-to-use charging infrastructure is growing just as quickly. One of the biggest pain points for EV users isn't owning the vehicle—it's finding where and when they can charge it. This project set out to solve that everyday problem with a simple idea: make it easier for EV drivers to locate nearby charging stations and book a slot, all in one app.

Through this application, we've combined real-time location tracking, smart slot booking, seamless navigation, and easy payments to create a solution that works for both users and charging station operators. Whether someone is on their daily commute or planning a longer trip, the app helps take the stress out of charging.

Technically, the system is built using practical, modern tools—like Flutter for building a smooth cross-platform interface, Firebase for managing live data and authentication, and Google Maps for accurate station tracking. But beyond the tech, what really matters is the experience: helping people save time, avoid frustration, and feel confident about driving electric.

This is just the starting point. There's so much potential to grow—adding features like smarter route planning, personalized suggestions, or integrating with energy providers to optimize charging times. As the EV ecosystem matures, tools like this will play a big role in making electric mobility truly accessible and user-friendly.

In the end, if this app can make someone's day a little easier—or even help more people feel comfortable switching to an EV—then it's already making a difference. It's not just about technology. It's about making cleaner transportation more practical for everyone.

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