Plugpoint Ev Charging Station Finder And Slot Booking System

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***Abstract*—Driven by rising fuel prices, environmental concerns, and government policies supporting green energy, the automotive industry has undergone a significant transformation with the widespread adoption of electric vehicles (EVs) in an era of rapid technological advancement. However, the limited accessibility and availability of public charging infrastructure frequently impedes the convenience of EVs, particularly when traveling between cities. We suggest a thorough and intuitive mobile application created with Flutter and Dart on the Visual Studio Code (VS Code) platform in order to overcome this difficulty. With real-time features like live battery status tracking, suggested routes for travel, and the ability to locate nearby EV charging stations in four major cities, this app is made to help EV users. A clever slot-booking system that lets users reserve charging time slots in advance is one of the main features. A slot is hidden from future users once it is reserved, preventing duplicate bookings and guaranteeing efficient scheduling. The accuracy and security of transactions are improved by integrated QR code-based payment, which is dynamically updated according to the chosen date and time. To handle station data, user reservations, and system updates, the app additionally offers two distinct portals: one for users and another for administrators. Firebase powers the entire backend and facilitates scalable data management, cloud storage, user authentication, and real-time database operations. By combining these elements, the application promotes an engaging online community for EV users and expedites the EV charging process, both of which advance the larger objective of environmentally friendly transportation.**

***Index Terms*—Flutter, Dart, Firebase, Real-time Database, Route Optimization, QR Code Payment, User Authentication, Cloud Storage, Sustainable Transportation, Smart Mobility**

I. INTRODUCTION

Electric vehicles are quickly gaining popularity as the world moves toward cleaner and more sustainable modes of transportation. With rising concerns about environmental pollution and the limited availability of fossil fuels, EVs are now seen as a strong alternative to traditional fuel-based vehicles. To support this shift, both governments and private organizations are actively promoting EV adoption by offering subsidies, raising public awareness, and improving infrastructure. Despite these efforts, a major challenge remains—the lack of a reliable and easily accessible charging network. This is especially problematic in urban areas, where the demand for EVs is growing rapidly.

We have created a clever mobile application that makes it easier to manage and use EV charging stations effectively in order to solve this problem. The application is developed on the Visual Studio Code (VS Code) platform and is constructed using the Flutter and Dart programming languages. Real-time features like route optimization, battery monitoring, and location-based charging station identification are all included. The system's slot booking feature, which enables users to reserve a charging slot in advance, is one of its primary features. To avoid duplicate reservations and scheduling conflicts, a time slot is automatically hidden from other users once it has been reserved.

Accurate and secure transactions are ensured by the app's dynamic QR code-based payment system, which changes based on the time and date selected. The platform has two separate portals: one for administrators and one for general users, and it supports operations in four major cities. Effective station management, slot monitoring, and user analytics are made possible by the admin portal.

Firebase, which offers scalability, cloud storage, secure authentication, and real-time database capabilities, is used to manage all backend services. The application's design, development, and performance results are presented in this paper, highlighting how well it streamlines EV charging processes and improves user experience.

II. LITERATURE REVIEW

Muhammad Shahid Masto [1] explores how thoughtful planning, and recent technological developments can help improve the design and setup of EV charging stations. The paper gives a detailed overview of the current electric vehicle landscape, the challenges of integrating EVs with the power grid, and the strategies for optimal placement of charging facilities. It also highlights past research efforts, technological progress, and the ongoing challenges in standardizing EV charging infrastructure, providing valuable insights for guiding future advancements in this area.

The paper also takes into account factors like grid impact and cost-effectiveness when identifying ideal locations for fast-charging stations. It addresses the challenges associated with EV adoption while also highlighting future developments in the field. These include the integration of renewable energy sources to power charging stations and the potential benefits of vehicle-to-grid (V2G) technologies, where EVs can support the power grid.

Aashish Joshi and K. M. Vishal Somaiya [2] highlight that the limited availability of charging stations is a major reason why many people hesitate to switch to electric vehicles. Unlike fuel stations, EV chargers are not easily found everywhere, leading to concerns about running out of battery mid-journey. In countries like ours, convenience and speed often take priority over environmental concerns. This study focuses on providing a simple and effective solution to improve the reach and availability of EV charging infrastructure.

SITHARA S. G. ACHARIGE 1[3] Because of the quick growth, electric vehicles, or EVs, are expected to play a significant role in the global energy transition in transportation. The planning, operation, stability, standards, and safety of the power grid will all face numerous challenges as a result of high-level EV integration. Therefore, in order to achieve expected charging solutions for EV batteries and to improve ancillary services, the widespread adoption of EVs necessitates research and development of charging systems and EV supply equipment (EVSE). In order to improve desired charging efficiency and grid support, find a remedy for adverse effects, and speed up EV adoption with advanced control strategies, it is critical to analyze the current state of EV charging technologies.

Avinash V. Shrivastav,1Sajidhussain S. Khan [4] The possible need for infrastructure for charging stations (CS) and electric vehicles (EV) is covered in this report, along with the difficulties that the Indian context presents. The Indian electricity market, transmission, and distribution, as well as market processes linked to energy allocation and energy mix, are evolving with increased efficiency and dependability as a result of increased liberalization, privatization, and expansion of distributed and renewable power generation. For the commercial applications of electric vehicles in the current energy market, a systematic analysis of the relevant parameters is carried out.

As part of future smart city initiatives aimed at promoting environmental sustainability, many countries plan to transition to electric transportation systems. This shift will lead to a significant rise in the number of electric vehicles (EVs) in urban areas. Since EV batteries require recharging, charging stations will serve as a key energy source. The strategic placement of these stations is essential—not only should they be evenly distributed across the city to ensure EVs can continue traveling after charging, but they must also be accessible from any location within an EV's driving range. This paper addresses the Electric Vehicle Charging Station Placement Problem (EVCSPP) considering these considerations.

Ali Jawad Alrubaie, Mohamed Salem [6] Globally, electric vehicles, or EVs, are becoming more and more common. Photovoltaic (PV)-powered EV charging has the potential to drastically reduce carbon footprints when compared to conventional utility grid-based EV charging. However, the global adoption of EVs is limited by the lack of charging stations. As EV use rises, more public spaces are installing EV charging stations. However, charging EVs via the current utility grid which is driven by a generating system based on fossil fuels affects the distribution system and might not be environmentally

advantageous. This paper thoroughly examines the current electric vehicle (EV) market, technical requirements, including recent research on different topologies of EV/PV systems, charging infrastructure, and control strategies for EV/PV power management, as well as grid implications, including charging systems for electric vehicles and plug-in hybrid electric vehicles.

Gregory J. Carlton, Selima Sultana [7] Although land use mixing, balanced land uses, and transportation accessibility have all been shown to have a major influence on travel behavior, the EVSE accessibility literature has not looked at this relationship. This study finds 34 locations of spatially clustered level-1, level-2, and DC Fast EVSE charging infrastructure in the Chicago Metropolitan Area using an application of the unsupervised machine learning (ML) clustering algorithm Density-based spatial clustering of applications with noise (DBSCAN). The findings show that charging access is uneven in suburban and ban communities, and that EVSE clustering and the land use regimes that go along with it in the metropolitan area are largely to blame for this discrepancy. Most EVSE clusters are found in isolated commercial developments to the wealthy north and west of the city, and are mainly made up of level-2 charging.

Shubham Mishra, Shrey Verma [9] The world's transportation industry is undergoing a transition, moving from traditional vehicles that run on fossil fuels to vehicles with zero or extremely low tailpipe emissions. A suitable charging station (CS) infrastructure, information technology, intelligent distributed energy generating units, and supportive government policies are needed to facilitate this transition. The purpose of this paper is to discuss the important factors that should be considered when designing the infrastructure for electric vehicle charging stations.

Shubham Mishra, Shrey Verma [10] With the transition from traditional fossil fuel-powered vehicles to zero or ultra-low tailpipe emission vehicles, the global transportation industry is undergoing a period of transformation. Information technology, intelligent distributed energy generating units, supportive government policies, and a suitable charging station (CS) infrastructure are all necessary to facilitate this shift. The goal of this paper is to discuss the important factors that should be considered when designing the infrastructure for electric vehicle charging stations.

III. METHODOLOGY

The development of the Electric Vehicle Charging Station Locator application follows a structured and iterative process. At first, the requirements were gathered. this phase involves analysing the user expectations, real-time charging requirements, and existing disadvantages of the system. Based on the insights, functional and non-functional requirements were defined, accentuating the need for real-time updates, user user-friendly interface, and obtaining slot booking competence. The project is made on a prototype-based model, which allows early testing, customer feedback, and involves the improvement of the application.

In the design phase, systems architecture, user flow, and interaction between the components were prepared, which is outlined with various figures such as Data Flow Diagrams (DFDs) and UML models like use case, activity, and sequence diagrams. The application was made in 2 different modules: user and admin. Users can register, log in, search for nearby charging stations, and book available slots at per convenience. While admins can manage the stations list, availability, and confirm the booking made by the user.

The development of the application was carried out using Flutter as the framework and Dart as the core programming language. Flutter was chosen for its cross-platform capabilities, fast development cycle, and flexible UI design. The application provides users with a list of electric vehicle charging stations across four major cities – Mumbai, Pune, Nagpur, and Nashik. Unlike other similar applications that may offer limited city coverage, our app stands out by supporting multiple cities, making it more versatile and user-friendly. Additionally, the system ensures a smooth and responsive interface, secure user access, and easy navigation to charging station details. This makes our app more accessible and beneficial for a wider audience of EV users.

IV. SYSTEM DESIGN

With Firebase acting as the backend infrastructure, the suggested complaint reporting system is created as a

mobile application for Android. The system is made to make it easy and quick for users to file complaints and for administrators to handle and settle them. The architecture integrates push notification services, secure authentication, real-time cloud databases, mobile frontend development, and image storage using a modular client-server model. The design of the system prioritizes scalability, data security, user accessibility, and real-time responsiveness.

The main user interface is the mobile application, which was created with Android Studio and Kotlin as the programming language. It offers user-friendly screens for administrative controls, status tracking, complaint submission, and user registration. The application securely manages user identities by utilizing Firebase Authentication. Using their email address and password, users can register or log in. Role-based access control determines whether the user interface shows administrative or standard user features.

After being verified, users can use a structured form that is integrated into the mobile interface to file complaints. Among the information gathered by the form are the complaint title, description, location, and, if available, an image that depicts the problem. Each complaint is saved as a document within a complaint collection after being sent to Firebase Firestore, a scalable NoSQL cloud database. User ID, timestamp, current status (such as pending, in-progress, or resolved), priority level, and an optional administrator comment field are among the metadata included in each record. A secure download URL is stored in the Firestore document, and the image is uploaded to Firebase Cloud Storage if the user attaches one.

Administrators are granted privileged access to the same mobile application through the use of Firebase role checks. They can view all incoming complaints on a dashboard and filter or sort them according to status, type, or urgency. After reviewing a complaint, the administrator can change its priority level, add resolution remarks, and update its status. Alongside these updates being written back to Firestore, users receive real-time push notifications through Firebase Cloud Messaging (FCM). By ensuring that users are promptly informed of any changes to the status of their complaint, this improves user engagement and transparency.

Real-time data synchronization is supported by the Firebase infrastructure, allowing for immediate updates on all devices. This is especially helpful for use cases like complaint redressal that call for a timely response and dynamic status tracking. Furthermore, administrators have more authority to handle all complaints, while users can only view and edit their data thanks to Firebase Security Rules. Because Firestore's offline features sync data automatically when the device reconnects to the internet, users can access and submit data even when connectivity is spotty.

By offering a mobile-first interface for filing complaints and tracking them in real time, the implemented system greatly improves user accessibility. Within a single Android application, users can take advantage of easy-to-use form-based input, instant complaint submission, and status tracking. At the same time, administrators have access to a role-based dashboard that makes problem-solving and triage easier. By ensuring that users receive instant push notifications whenever the status of a complaint changes, Firebase Cloud Messaging (FCM) increases transparency and eliminates the need for manual communication. Firebase Authentication's role-based authentication makes sure that complaint data access is suitably limited, protecting user privacy and data integrity.

Additionally, a highly scalable and robust backend solution is offered by using Firebase services, such as Firestore, Cloud Storage, Authentication, and Messaging. All user devices can instantly reflect updates thanks to real-time data synchronization capabilities, and offline persistence makes sure the system keeps working even in the event of sporadic network conditions. The cloud-based and modular architecture supports possible scalability to larger user bases while lowering infrastructure management overhead. In conclusion, by combining cutting-edge mobile application development with cloud-based backend technologies, the suggested system provides a dependable, safe, and effective platform for complaint management.

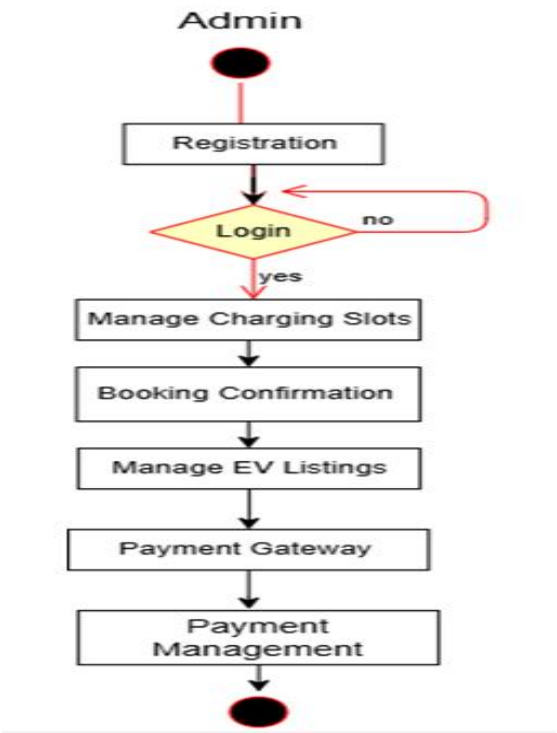

Fig. Admin System Design

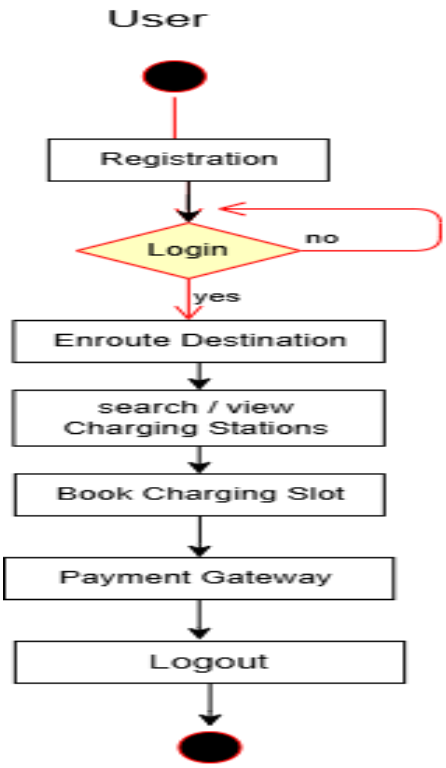

Fig. User System Design

V. RESULT AND DISCUSSION

As per our expectations, the Electric Vehicle Charging Station Locator application was successfully developed and met its desired goals, which provided a smooth and efficient user experience. After the entire completion, the application was tested to ensure validation of its functionalities, overall performance, and usability. Users can register themselves and log in to the application, the system shows nearby charging stations on the basis of current location. Real-time information about charger types, slot availability, and station occupancy is accessible to electric vehicle users.

The slot booking function worked as per the expectations, which allowed users to select a time slot, receive confirmation with navigation assistance. Managing charging station data, booking confirmations, and payment management are backend operations that are efficiently handled by the admin module. Interactions and correct functioning of individual modules are confirmed from unit and integration tests in the testing phase. Under various cases, the overall stability of the application is verified through system testing. Reliability and compliance with specifications of the application are carried out with both black box and white box testing.

The application demonstrated prompt responses to user inputs and searches, with average loading times well within acceptable limits, and performed well as per the user's query. A person with limited technical knowledge can efficiently use the application due to a better user-friendly interface. The application has contributed positively to the growing EV ecosystem and managing electric vehicle charging stations. Also, proved to be a robust solution for addressing the challenges of locating the electric vehicle charging stations.

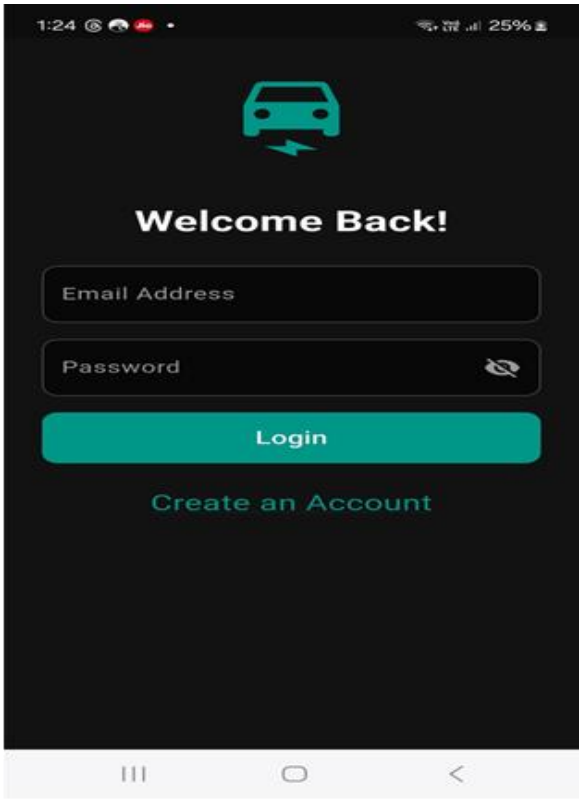

Fig. User Login

Fig. App Display

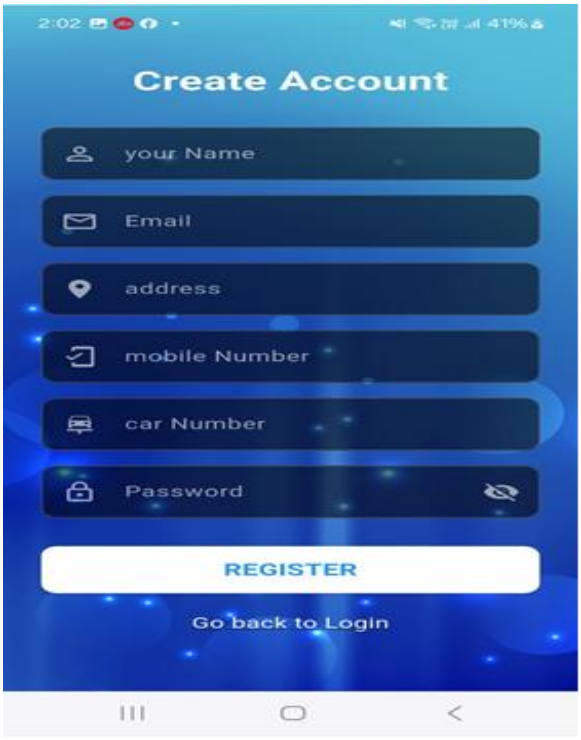

Fig. User Registration

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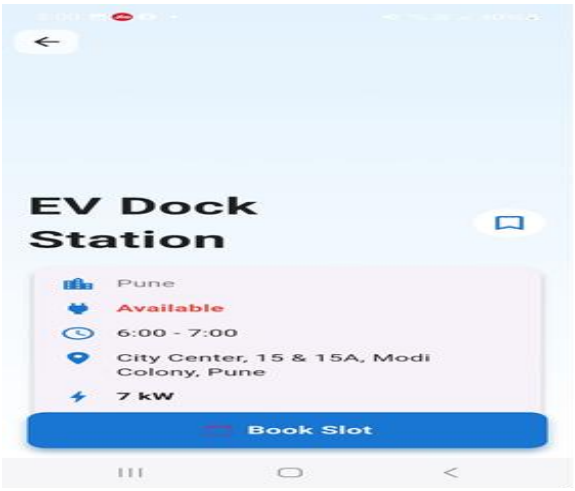

Fig. Station Details

Fig. Book Time Slot

Fig. Admin Portal

Fig. Admin Add/Delete Stations

VI. CONCLUSION

This study offers a clever mobile application as a comprehensive solution to the expanding problems of range anxiety and restricted access to EV charging infrastructure. The application greatly improves the usability and convenience of EVs, particularly when traveling between cities, by incorporating real-time features like battery status monitoring, route optimization, and a location-based EV charging station locator. The dynamic slot-booking system, which enables users to reserve charging slots in advance and automatically hides reserved slots to prevent scheduling conflicts, is one of the app's most notable features.

The system, which updates dynamically according to time and date, guarantees safe and effective transactions through QR code-based payment. Furthermore, robust data management, station monitoring, and analytics are made possible by the dual-portal architecture, which has one portal for administrators and one for regular users. The system is technically sound and prepared for the future thanks to the Firebase-powered backend, which supports scalability, cloud storage, authentication, and real-time database operations.

This work encourages environmentally friendly transportation while also addressing real-world issues

that EV users face. The suggested platform promotes community involvement, improves user experience, and aids in the wider uptake of EVs. Scaling the application and adjusting it to changing infrastructure and technologies will require ongoing development and stakeholder cooperation.

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