IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, May 2025
Impact Factor: 7.67

Enhancing EV Charging Efficiency Through Slot Booking and Occupancy Monitoring

P. S. Sajjanshetti[1], Om Kurkut[2], Sairaj Pawar[3], Sanchet Kuchanwar[4]
Asst. Professor, Department of Computer Engineering[1]
Students, Department of Computer Engineering[2-4]
NBN Sinhgad Technical Institute Campus, Pune, India

Abstract: *The transition to electric vehicles (EVs) is pivotal for diminishing carbon emigrations and minimizing dependence on fossil energies. To support this shift, our Electric Vehicle Station Management System (EVSMS) is designed to enhance the charging experience for both EV druggies and facility personnel. EVSMS enables stoner enrolment, station discovery, and niche reservations, icing a smooth and effective process. A crucial point is real- time residency updates, allowing druggies to check station vacuity and find druthers when demanded. The system also integrates with Google Charts API for flawless navigation, while admin and proprietor dashboards streamline station operation. also, announcements give timely updates on station status and promotional offers, perfecting stoner engagement. By simplifying access to charging structure, EVSMS encourages wider EV relinquishment and contributes to the shift towards green and eco-friendly mobility.*

Keywords: Electric Vehicles (EVs), Electric Vehicle Station Management System (EVSMS), Slot Booking, Map, Chatbot

I. INTRODUCTION

The increasing demand for energy, along with the declining availability of fossil fuels, has generated severe environmental problems such as global warming and high carbon emissions. To address these issues, several countries are adopting regenerative energy and encouraging use of EV as a cleaner alternative to ancestral fuel-based transport. However, as the use of EVs continues to grow, the necessity for an appropriately designed, effective charge system becomes an increasing priority. Without effective management, EV customers may be subjected to long queues, crowded centers, and inconvenience in finding available slots when needed.

To improve these issues, our project introduces the Electric Automobile Station Management System (EVSMS), an internet-based system designed to optimize the administration of EV charging centers. The system makes users locate nearby bays and book slots in advance, ensuring a hassle-free experience. By the incorporation of Google Maps services, customers can conveniently obtain directions to the nearest in stock center. Furthermore, a chatbot feature is included to assist users with booking and general information requests through simple commands. The system also supports multiple modes of payment, ensuring easy and secure transactions.

With the continued evolution of regenerative energy technology, opportunities exist for the integration of solar power and other clean sources of energy into EV charge facilities. By providing a user-friendly, effective charging management framework, this project is part of a larger initiative to support sustainable transport and reduce dependence on hydrocarbon fuels. This article discusses the design, development, and benefits of EVSMS to make EV charging simpler, more efficient, and eco-friendly.

II. MOTIVATION

The use of EV has increased, making a centralized system that connects all EV stations in one place necessary for maintaining a smooth & efficient charging experience. Our system is meant to help EV users easily locate charging bays based on their preferences, making it particularly beneficial for travellers who rely on their EVs for long-distance journeys. By simplifying the search for charging slots, our system makes sure that users can plan their trips efficiently

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, May 2025
Impact Factor: 7.67

and reach their destinations on time without unnecessary delays. To improve user convenience, slot reservations will be confirmed at no extra cost. However, to secure a booking, users will be required to make a partial online payment as a confirmation step. Additionally, our platform allows users to request new charging schedules, helping operators optimize station usage based on demand.

The system also features an interactive map, providing clear directions to the selected charging bays, ensuring users can navigate seamlessly to their chosen location. Moreover, station operators will have access to an intuitive dashboard, enabling them to monitor real-time availability, view reserved slots, and manage station resources more effectively. Our platform is designed specifically as Web-based application, integrating Google Maps API for precise directional assistance. By incorporating time-slot allocation strategies, we ensure that users experience minimal waiting times, making the EV charging process more structured and hassle-free. Through this initiative, we aim to contribute to the advancement of sustainable transportation by providing a well-organized and user-centric charging infrastructure.

III. PROBLEM STATEMENT

The increasing espousing of electric vehicles has highlighted a major challenge the lack of a well-organized and convenient charging accessibility. EV users often face difficulties in locating available charge stations, long waiting times and an inefficient allocation process leading to inconvenience reduced efficiency in EV usage. Without a centralized system to handle recharge station availability, users struggle to plan their trips effectively and station operators face challenges in optimizing resource allocation and managing peak demand. This gap in infrastructure discourages potential EV adopters and slows down the transition towards long lasting mobility.

To overcome these challenges this paper provides an Electric Automobile Station Management System (EASMS) a centralized digital platform that enables users to search charging bays in vicinity, check real-time slot vacancy and book slots in advance. The system integrates Google Maps API for seamless navigation, supports digital transactions for hassle-free payments and provides time-slot allocation strategies to minimize wait times. Additionally, station operators gain access to a dashboard for monitoring occupancy and managing reservations ensuring efficient utilization of resources. By offering a structured and user-friendly solution EVSMS enhances charging accessibility, reduces congestion and promotes the widespread espousing of EVs as a viable alternative to combustion vehicles.

IV. LITERATURE REVIEW

With the growing use of EV, the upsurge of charging slots has become a necessity. Real-time routing, charging slot management, grid incorporation, and renewable energy-based charging system solutions have been the areas of concern in some research.

Mandhare et al. [1] suggested a bookable smart EV charging slot system to minimize lag time and boost the efficacy of recharge points. Their system uses online platforms to facilitate a simple, convenient, and decongested booking process. Tan and Wang [2] suggested a real-time recharging navigation system based on a hierarchical game strategy. The strategy dynamically guides EVs to the immediate fast-charging station/bays with consideration of travel time, charging cost, and station congestion.

Subsequent studies have emphasized cloud and artificial intelligence-powered charging station management methods. Sarika and Shivraj [3] proposed a cloud-based recommendation system for electric automobile charging bays from real-time data to help users find available charging points economically. Bai et al. [4] proposed a dynamic charging demand model to predict charging demand, thereby enabling effective planning and management of charging bays.

Charging point productivity enhancement has been extensively studied. Wang et al. [5] gave a comprehensive overview of various charging dock arrangements, with a focus on the effect on rapid-charging capability. Wang et al. [6] also used the cuckoo search algorithm, boosting the ability of high-voltage motors in charging systems. Yan and Ma [7] also described aleatory planning of EV recharge stations using solar panel battery storage, with a focus on the use of zero-carbon energy resources for sustainable EV charging. Battery consumption habits and grid strength have been a main concern in recent research. Nahmias et al. [8] examined charging points site optimization based on charging habits. Chaudhari et al. [9] suggested an agent-based strategy to predict collective charging habit grid load apportionment. Nissim et al. [10] studied the influence of EV access modes on voltage stability, and the findings enlightened grid

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, May 2025
Impact Factor: 7.67

capacity and distribution network operation. Solar integration has also been of concern. Rallabandi et al. [11] studied current-weakening control strategies for coreless AFPM motor optimization in solar-powered electric vehicles. Hassoune et al. [12] developed a PV-grid hybrid electric automobile charging station based on solar and grid power to enhance efficiency and sustainability.

Overall, these papers are a substantial contribution to the field of EV charging framework study in slot management, real-time guidance, integrating regenerative energy resources, & ensuring grid stability. These results provide the foundation for future innovation in EV charging technology.

V. METHODOLOGY

In the last decade, EV charging technology has seen tremendous progress with increased efficiency and eco-consciousness. Not only do electric vehicles minimize emissions, but they also provide superior power transmission and regenerative braking, which harnesses energy when driving. In spite of these advantages, charging station positions are difficult to find. To overcome this, we designed an EV Charging Station Locator Web-App using Java. The system enables users to maintain their EVs, find charging bays near them, and reserve charging slots in advance, providing a hassle-free and efficient powering experience.

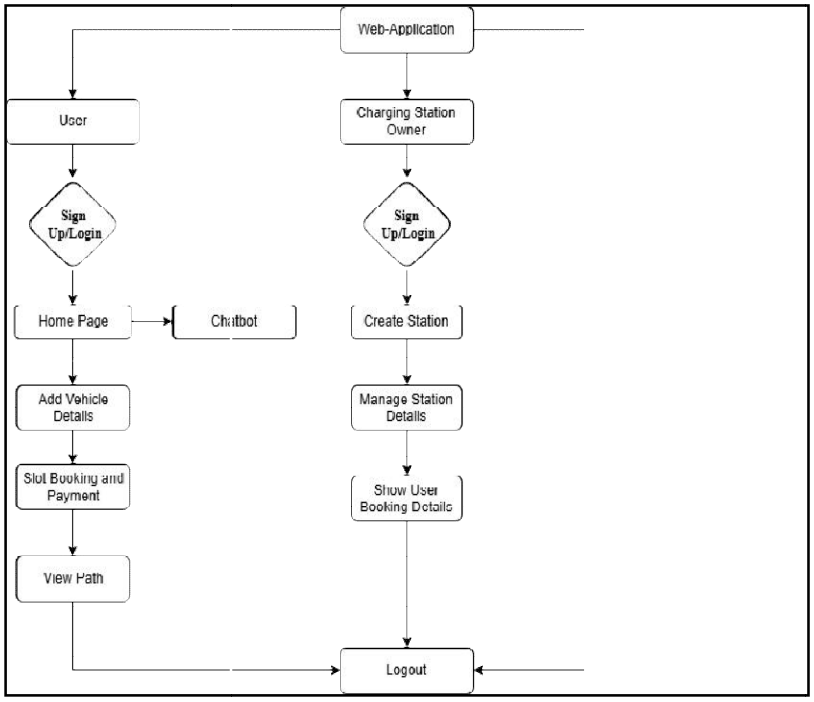

Figure 1: System Architecture

System Architecture:

Users are able to register, update EV information, reserve recharge time slots & view path guidance.

Charging station owners are able to create and update station information and view user bookings.

Administrators manage user and station owner information in order to guarantee system reliability.

There is a chatbot functionality to improve user interaction and a safe logout function to protect data the system ensures effective EV station management and easy charging process.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, May 2025
Impact Factor: 7.67

Modules and Their Description

The system is structured into two key modules, each consisting of multiple sub-modules as outlined below:

User:

User Registration & Login: Allows users to sign up and log in securely.
Manage EV Details: Users can add, update, and manage their EVs.
Search Charging Points: Enables users to find nearby charging station/bays.
Book Charging Slot: Allows users to reserve a charging slot in advance.

EV Charging Station Owner:

Owner Login: Secure authentication for station owners to access their dashboard.
Create Station: Owners can register and set up a new charging station with details like location, capacity, and pricing.
Manage Station Details: Owners can update station data, modify slot availability.
Monitor Slot Booking of Users: Allows owners to view, approve, or modify user bookings in real-time.

Admin:

Admin Login: Secure authentication for the administrator to access the management dashboard.
Manage User Details: Admin can view, update, or remove user accounts and handle any user-related issues.
Manage Owner Details: Admin can register, verify, update, or remove EV station owners from the system.
Review Feedback: Admin can monitor and respond to user and owner feedback to improve the system.

Dijkstra's Algorithm Functionality in the Proposed System:

Graph Initiation: Create a graph showing the charging station network, with each station as a node and edges indicating the connections between stations. Assign weights to edges based on distances or travel times.
Set Initialization: Create an empty set, sptSet (shortest path tree set), to track visited charging bays.
Distance Values: Initialize distance values for all charging bays, setting the distance value of the user's current location to 0.
Main Loop for Path Finding: Continue the following steps until all charging bays are included in the sptSet:
Identify the charging station, u, with the minimum distance value among the remaining unvisited stations.
Add u to the sptSet.
Update the distance values of adjacent charging points to u.
Shortest Path Retrieval: Once the destination charging point is included in the sptSet, modifies the shortest path from the user's present location to the destination charging station.
Iterate Through Computed Path: Go through each charging station in the computed briefest path from the user's position to the desired recharging station.
Slot vacancy check: At each charging station, check the vacancy of slots.
Consider factors such as the number of available slots, charging speed, and any station-specific constraints.
Update path information: Record data about slot availability at each charging point in the computed path for future reference. User Interface: Provide users with an interface displaying the computed shortest path and available recharging bays along the way.
Station Selection: Allow users to select their preferred charging bays from the list of available stations on the computed path.
Booking Request: Upon user selection, initiate a booking request for the chosen charging point.
Slot Confirmation: Confirm the booking and notify the user of the successful reservation.
Time Duration Selection: Allow users to specify the desired time duration for the charging slot reservation.
Reservation Confirmation: Reserve the booked slot for the user for the specified time duration.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, May 2025
Impact Factor: 7.67

VI. RESULTS

The performance of the EVSMS web application was assessed using a series of standard web metrics. These metrics were gathered through either browser-based tools or backend logs. Response time and page load time were measured using Chrome DevTools. Database query time was tracked by recording Java timestamps during database interactions. User satisfaction was evaluated through peer feedback during testing.

Metric	Proposed System (Normalized %)	Existing System (Normalized %)
Response Time (ms)	64.00	85.00
DB Query Time (ms)	52.94	72.00
Page Load Time (ms)	61.11	90.00
User Satisfaction (/100)	80.00	65.00

Table 1: Performance Comparison

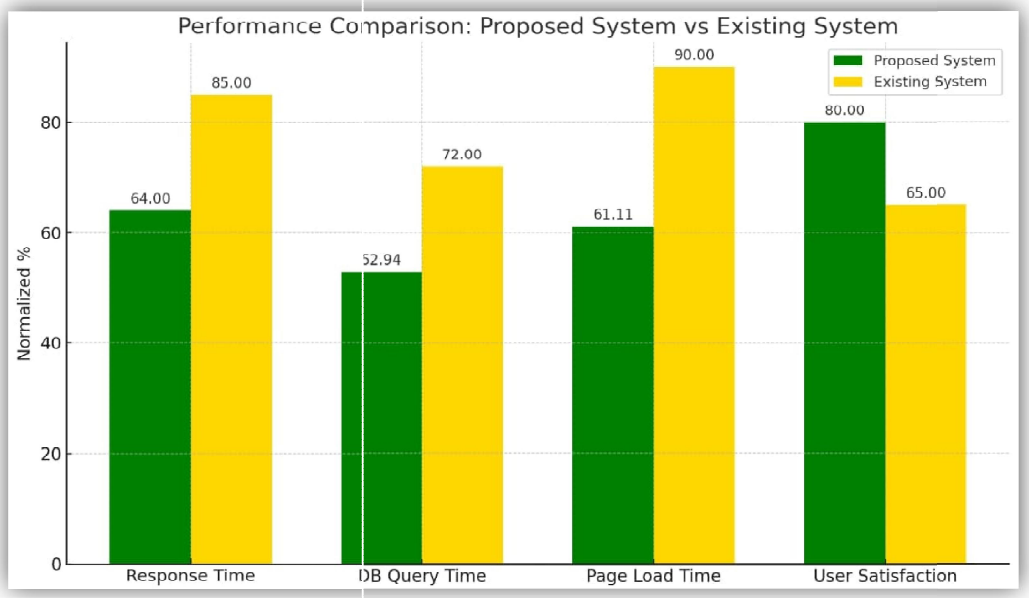

Figure 2: Accuracy Comparison Chart

VII. CONCLUSION

In this study, we have developed a web-based platform aimed at reducing long waiting times at EV charging stations by implementing a pre-booking system. Our approach was shaped by in-depth research, including an analysis of popular EV charging applications in India, a review of user feedback, and a comparative study of existing solutions. Through this research, we identified several common pain points faced by EV users, such as complicated user interfaces, lack of on-the-fly time charging port availability, limited payment methods, absence of user reviews, and difficulties in verifying station operational status.

To address these challenges, we created user-friendly platform which streamlines the charging points reservation process. Our system is designed to be flexible and adaptable, allowing for timely updates in order to increase user experience. By continuously incorporating user feedback, we aim to refine and expand our platform with new functionalities that improve decision-making for EV owners. Future enhancements may include personalized recommendations based on charging points performance, availability trends, and user preferences, ensuring that EV users can make informed choices when booking slots. Through this initiative, we contribute to the development of an

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, May 2025
Impact Factor: 7.67

organized and efficient EV charging ecosystem, promoting smoother adoption of electric mobility and a more sustainable future.

VIII. ACKNOWLEDGMENT

We would like to thank the Department of Computer Engineering, NBN Sinhgad Technical Institute Campus, Pune for the constant support in the field of Research and Development. We are indebted to our mentor, Prof. P. S. Sajjanshetti, who helped in the preparation of this project, for her hearty support, suggestions, and invaluable advice throughout our project work.

REFERENCES

[1]. S. Mandhare, K. Varma, S. Shukla, and P. Bhore, "A Smart EV Charging Slot Booking System," *Vol. 4, No. 4, pp. 3688–3692, Apr. 2023.*

[2]. J. Tan and L. Wang, "Real-Time Charging Navigation of Electric Vehicles to Fast Charging Stations: A Hierarchical Game Approach," *IEEE Trans. Smart Grid, vol. 8, no. 2, pp. 846–856, 2017.*

[3]. S. P. R. and S. P., "Cloud based Smart EV Charging Station Recommender," in *Proc. 2022 IEEE 6th Int. Conf. Renewable Energy Research and Applications (ICRERA)*, Aug. 2022, pp. 26–27.

[4]. X. Bai, Z. Wang, L. Zou, H. Liu, Q. Sun, and F. E. Alsaadi, "Electric vehicle charging station planning with dynamic prediction of elastic charging," *Springer Link*, Nov. 2021.

[5]. Y. Wang, F. Wang, Y. Zhu, Y. Liu, and C. Zhao, "A review on topologies for fast charging bays for electric vehicles," *Springer Link*, 2021.

[6]. L. Wang, H. Guo, C. D. Shaver, and N. Bianchi, "Cuckoo search algorithm for multi-objective optimization of transient starting characteristics of a self-starting HVPMSM," *IEEE Trans. Energy Convers.*, Dec. 2020.

[7]. D. Yan and C. Ma, "Stochastic planning of electric vehicle charging station integrated with photovoltaic and battery systems," 2020.

[8]. D. Nahmias, A. Cohen, and N. Nissim, "Optimal planning of charging station based on discrete distribution of charging demand," 2020.

[9]. K. Chaudhari, N. K. Kandasamy, A. Krishnan, A. Ukil, and H. B. Gooi, "Agent-based aggregated behavior modeling for electric vehicle charging load," 2019.

[10]. N. Nissim, A. Cohen, J. Wu, A. Lanzi, L. Rokach, Y. Elovici, and L. Giles, "Influence of electric vehicle access mode on the static voltage stability margin and accommodated capacity of the distribution network," 2019.

[11]. V. Rallabandi, D. Lawhorn, J. He, and D. M. Ionel, "Current weakening control of coreless AFPM motor drives for solar race cars with a three-port bi-directional DC/DC converter," in *Proc. 2017 IEEE 6th Int. Conf. Renewable Energy Research and Applications (ICRERA)*, Nov. 2017, pp. 739–744.

[12]. Hassoune, M. Khafallah, A. Mesbahi, and T. Bouragba, "Smart topology of EVs in a PV-grid system-based charging station," in *Proc. 2017 Int. Conf. Electrical and Information Technologies (ICEIT)*, Nov. 2017, pp. 1–6