Project Title:

ElectroCharge Pro: Intelligent EV Charging Station Locator and Reservation

Abstract:

The rise in electric vehicles (EVs) necessitates the development of infrastructure to support them, including charging stations. The EV Station Booking project aims to simplify the process of booking and managing EV charging stations. The Electric Vehicle (EV) Station Booking project is a Java-based desktop application developed using JavaFX, the Model-View-Controller (MVC) framework, data structures and MySQL. It serves as a platform for users to book free time slots and manage EV charging stations efficiently. This project will combine real-time data on available EV charging stations with a user-friendly desktop application, enabling EV users to locate nearby charging stations by entering their source and destination location. The slots' availability is then shown, and charging spaces are reserved in advance for the user's convenience.

Introduction:

In the contemporary era where urgent action against environmental concerns and climate change is imperative, electric vehicles (EVs) have emerged as an auspicious mode of transport amalgamating an electric motor. EVs possess the capacity to curtail greenhouse gas emissions and diminish reliance on fossil fuels. Consequently, the global automotive industry has witnessed a paradigm shift towards electric vehicles. However, notwithstanding the manifold merits of electric automobiles, there exist crucial predicaments that impede their widespread adoption. Foremost among these challenges is the issue of accessibility and convenience pertaining to EV charging infrastructure.

In order to facilitate the transition towards electric vehicles, it becomes indispensable to forge an infrastructure-centric towards energy efficiency and user-friendliness for electric vehicle charging. This infrastructure, akin to conventional power plants, represents the vital lifeline of the electric vehicle ecosystem. The pivotal role of enabling access, convenience, and optimization in this procedure cannot be underestimated, as they play a significant role in stimulating consumer engagement with electricity consumption and ultimately mitigating carbon emissions. In this particular context, the indispensable task of establishing a holistic initiative that facilitates the exploration and booking of electric vehicle charging stations becomes imperative to tackle the barriers posed by the electric vehicle charging infrastructure.

Imagine a scenario where a prospective EV owner, eager to embrace a more sustainable mode of transportation, finds their enthusiasm tempered by uncertainty. Questions arise: "Where can I charge my EV? Is there a charging station near my home or workplace? What if I want to embark on a long-distance journey?" These uncertainties can swiftly transform into hesitations and, in some cases, deter individuals from taking the leap into EV ownership. This phenomenon is what experts refer to as "range anxiety," a palpable fear of being stranded with a depleted battery, far from the nearest charging station**.**

For urban EV users, a different set of challenges arises. Charging stations in densely populated areas may be in high demand, leading to long queues and extended waiting times. This not only disrupts the daily routines of EV owners but also exacerbates the frustration of those contemplating EV adoption.

Through real-time data on charging station locations, availability, and status updates, this project intends to eliminate the uncertainties that breed range anxiety. It empowers EV users with the confidence to embark on journeys, secure in the knowledge that they can effortlessly locate charging stations along their route and, if needed, reserve a charging slot in advance.

Literature Review:

The literature review of this project provides an overview of existing research and projects related to user experience, real-time information, and existing projects:

- User perspective on Charging Infrastructure: Research by Hidrue et al. (2016) explores user preferences regarding this type of project. It reveals that users highly value information on charging station availability and preferable booking options to reduce waiting times and uncertainty.

- Real-Time Data for Charging Stations: The work of Hu et al. (2019) emphasizes the significance of real-time data in reducing range anxiety for EV users. Real-time updates on charging station availability and status are crucial to improving user satisfaction and EV adoption rates.

- PlugShare And European Union’s CEF Existing projects: PlugShare is an existing app that provides charging information to EV users while European Union’s CEF aims to develop EV charging infrastructure, providing insights into large-scale infrastructure projects.

Problem Statement:

The adoption of electric vehicles is on the rise due to environmental awareness and improvement and advancement in technology. However, the lack of dependable and user-friendly infrastructure for finding and accessing charging stations continues to be a major obstacle to the mainstream adoption of EVs. This ElectroCharge Pro project will reduce the user's effort through queue management, limited availability information, and efficient trip planning.

Objective:

- Create a user-friendly interface for booking EV charging stations.
- Implement a real-time status update system for available stations.
- Integrate a secure user registration and authentication system.
- Store and retrieve data efficiently using a MySQL database.
- Apply the MVC architectural pattern for code organization and maintainability.

Methodology:

Project Architecture:

- MVC Framework:
  The project employs the Model-View-Controller (MVC) architectural pattern, which separates the application into three interconnected components:

  - *Model*: Contains the business logic and data processing. Algorithms for data manipulation and interaction with the MySQL database are implemented in this component.

  - *View*: Represents the user interface (UI). JavaFX is used for GUI development, enabling the creation of visually appealing and user-friendly screens.

  - *Controller*: Acts as an intermediary between the Model and View. It handles user input, processes requests, and updates the View accordingly.

- Database Integration:
  MySQL is utilized as the backend database to store information about EV stations, user accounts, and booking records. JDBC is employed to establish a connection and perform CRUD (Create, Read, Update, Delete) operations on the database.

Data Structure and Algorithm:

- DATA STRUCTURE:-

Java Collections:

ArrayList<String>: We have used ArrayLists to store lists of strings representing states, cities, and addresses.

These ArrayLists, such as ary, ary2, and ary3, are populated with data and used to initialize the ComboBoxes in the initialize method.

In Combobox we use multiple arrays to store data revalent to the combinations of states, city, address array.

- ALGORITHM:-
  The Model-View-Controller (MVC) framework is not a single algorithm but rather a software architectural pattern used in software development, especially in designing graphical user interfaces (GUIs) and web applications. It is designed to separate an application into three interconnected components to improve code organization, maintainability, and scalability. These components are:

  Model: The Model represents the application's data and core business logic. It is responsible for managing the data, processing it, and responding to requests for information from the View. In the context of algorithms, the Model can encapsulate various algorithms and data structures for data manipulation, processing, and storage.

  View: The View is responsible for the user interface and presentation of data. It receives user input and passes it to the Controller for processing. The View is not concerned with the underlying data or how it is processed. It focuses on displaying the data to the user. Algorithms related to rendering or displaying data can be part of the View.

  Controller: The Controller acts as an intermediary between the Model and the View. It receives user input from the View, processes it, and interacts with the Model to retrieve or update data. It also updates the View with the results of these interactions. The Controller may contain algorithms for handling user input, making decisions, and coordinating data flow between the Model and View.

Project Features

- User Registration and Authentication:
  Users can create accounts and log in securely. Passwords are hashed and stored in the database for enhanced security.

- EV Station Booking:
  Users can search for available charging stations based on location and book them. Real-time status updates ensure that users can view station availability.

- Real-time Status Updates:
  The project provides real-time status updates for EV stations. Users can see which stations are currently available for booking and their waiting times.

- User-friendly Interface:
  JavaFX is used to create an intuitive and visually appealing user interface, enhancing the overall user experience.

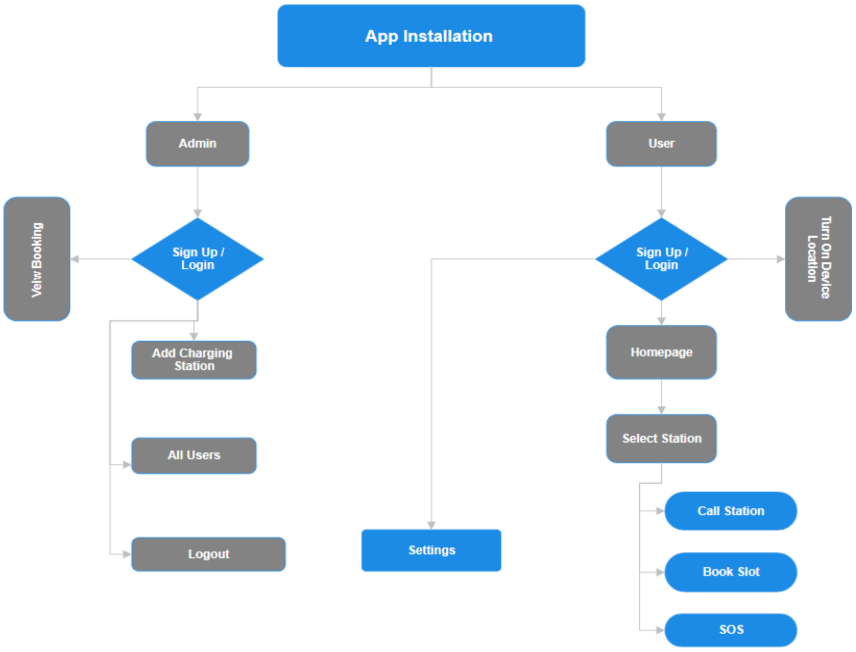
Technical Implementation

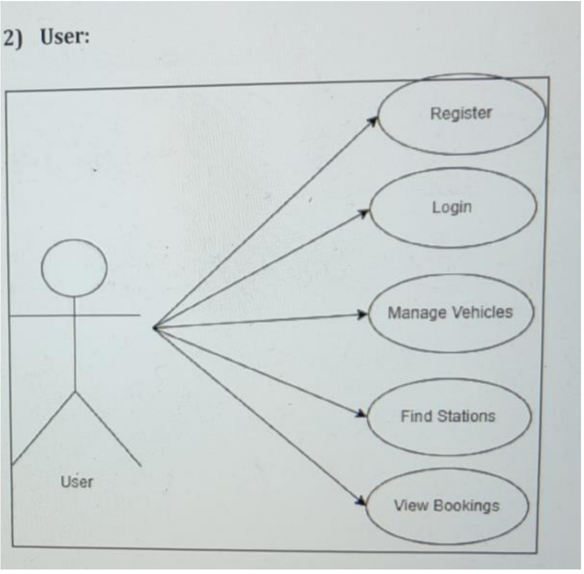
- JavaFX for GUI Development:
  JavaFX is employed to design the user interface, utilizing features like ComboBoxes, TextFields, Buttons, and Alert dialogs to create an interactive and visually appealing frontend.

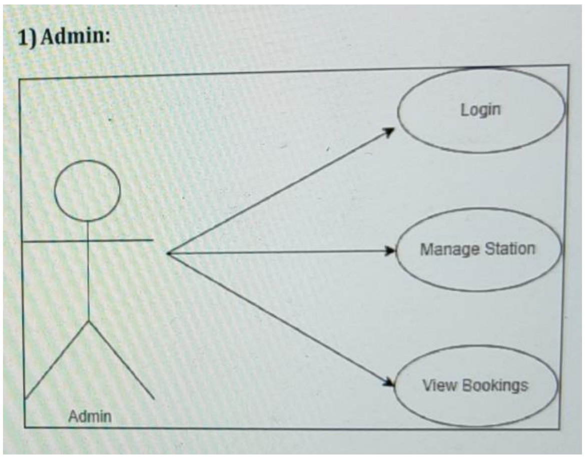
- MySQL Database Integration:
  MySQL is used to store and retrieve data. JDBC is used to establish a connection to the database, execute SQL queries, and handle data retrieval and updates.

- MVC Framework Structure:
  The project follows a well-structured MVC pattern for code organization. Algorithms for data processing and database interaction are contained within the Model, user interface elements are part of the View, and Controller handles user input and updates.

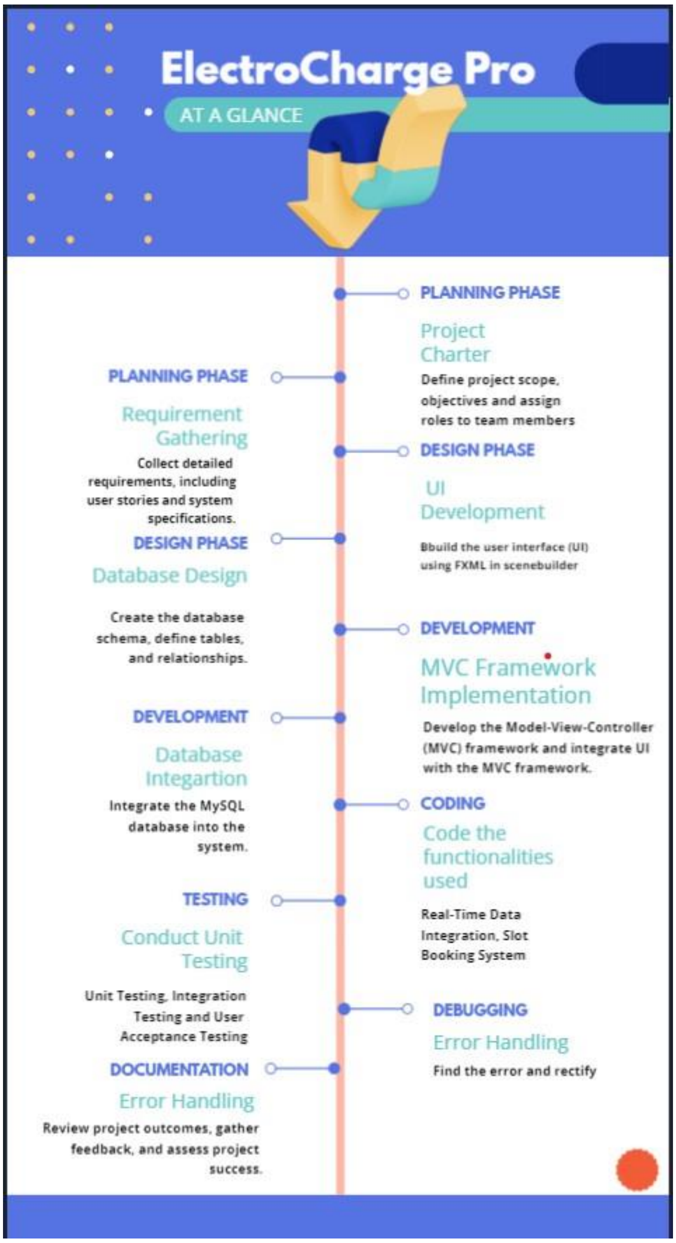
- Data Access and Manipulation:
  Data access and manipulation are performed using PreparedStatement and ResultSet objects. Data validation and error handling are implemented to ensure data integrity and system stability.


App Installation
Admin
User
Veiw Booking
Sign Up / Login
Sign Up / Login
Turn On Device Location
Add Charging Station
Homepage
All Users
Select Station
Call Station
Logout
Settings
Book Slot
SOS


2) User:
Register
Login
Manage Vehicles
Find Stations
View Bookings
User


1) Admin:
Login
Manage Station
View Bookings
Admin

PERT Chart:



ElectroCharge Pro

AT A GLANCE

PLANNING PHASE

Project Charter

Define project scope, objectives and assign roles to team members

PLANNING PHASE

Requirement Gathering

Collect detailed requirements, including user stories and system specifications.

DESIGN PHASE

UI Development

Bbuild the user interface (UI) using FXML in scenebuilder

DESIGN PHASE

Database Design

Create the database schema, define tables, and relationships.

DEVELOPMENT

MVC Framework Implementation

Develop the Model-View-Controller (MVC) framework and integrate UI with the MVC framework.

DEVELOPMENT

Database Integartion

Integrate the MySQL database into the system.

CODING

Code the functionalities used

Real-Time Data Integration, Slot Booking System

TESTING

Conduct Unit Testing

Unit Testing, Integration Testing and User Acceptance Testing

DEBUGGING

Error Handling

Find the error and rectify

DOCUMENTATION

Error Handling

Review project outcomes, gather feedback, and assess project success.

Learnings during this Project:

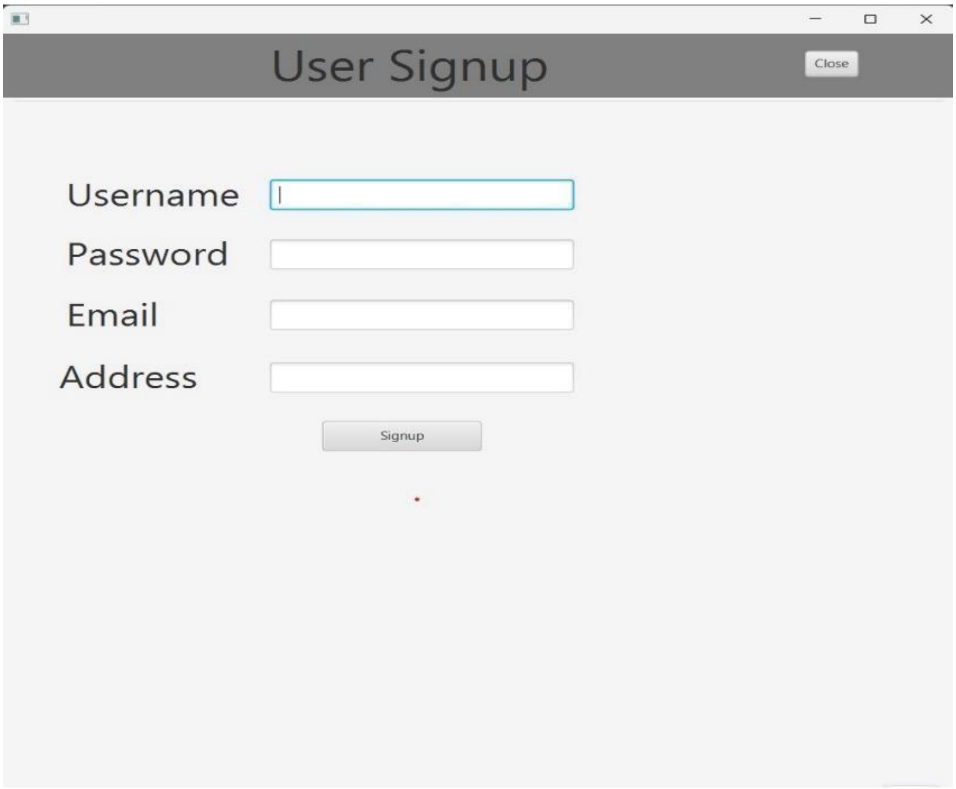
This project has provided valuable insights into GUI design, database integration, data structure, algorithm, and code organization. It helped us to understand in detail the MVC framework and how it is used to build a desktop application. It has also emphasized the importance of user experience in software development.

Result:

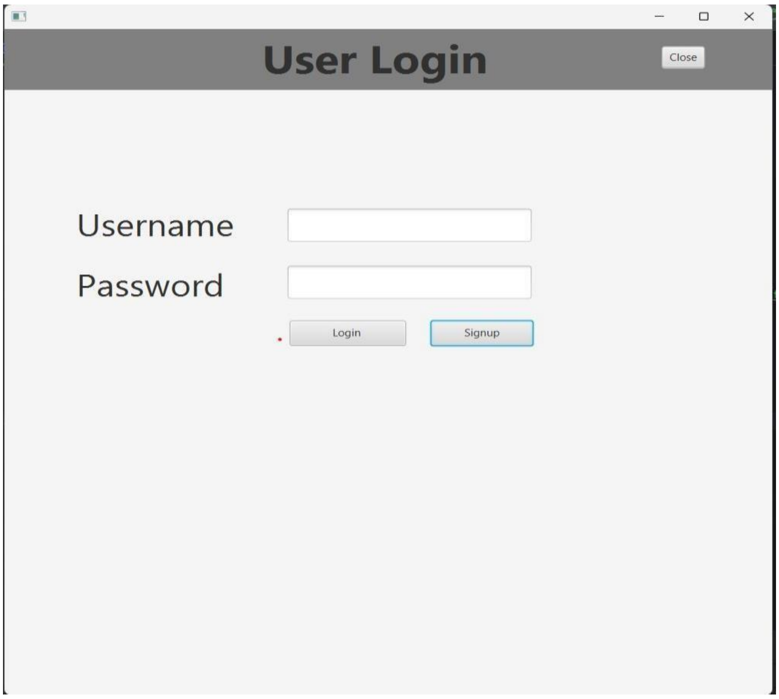
The ElectroCharge Pro will hopefully successfully address the challenges associated with EV charging infrastructure. It will provide EV users with real-time information, enabling efficient trip planning and reducing range anxiety. The slot booking system will provide streamlined access to charging stations, minimizing wait times. Overall, the project will facilitate the widespread adoption of electric vehicles, contribute to environmental sustainability, and simplify the EV charging process.

OUTPUT-

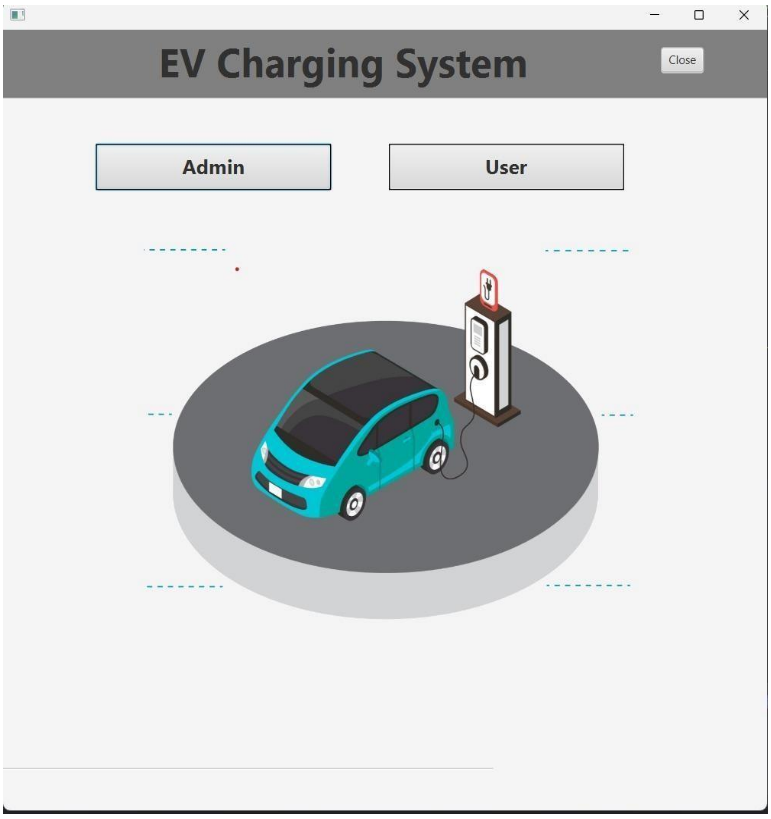
PAGE -1: (Main Page.)



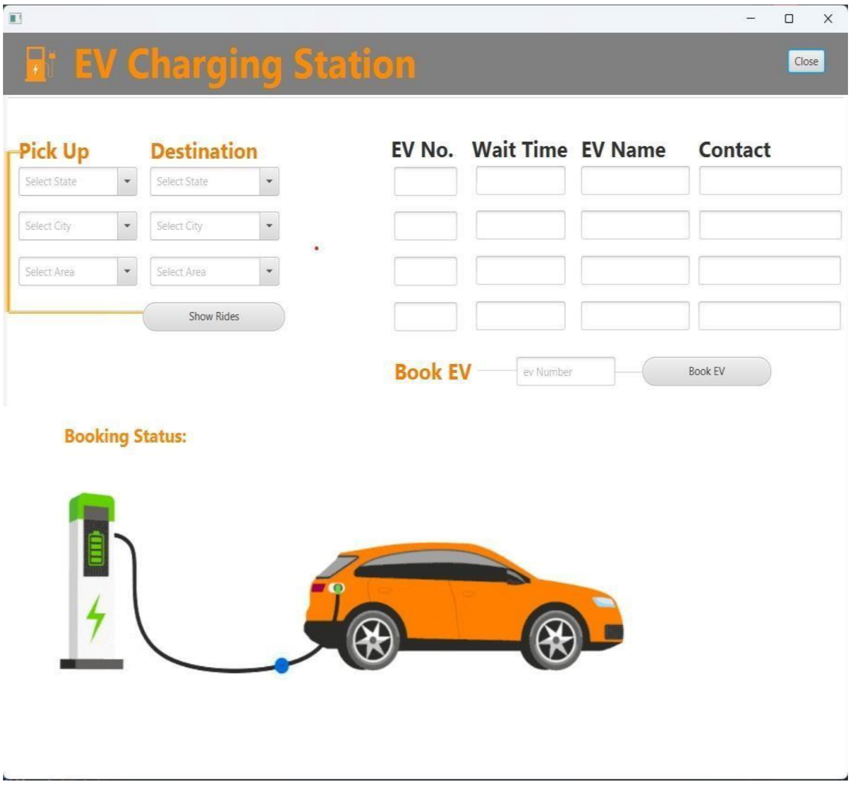
PAGE -2: (Login Page)


User Login
Close
Username
Password
Login
Signup

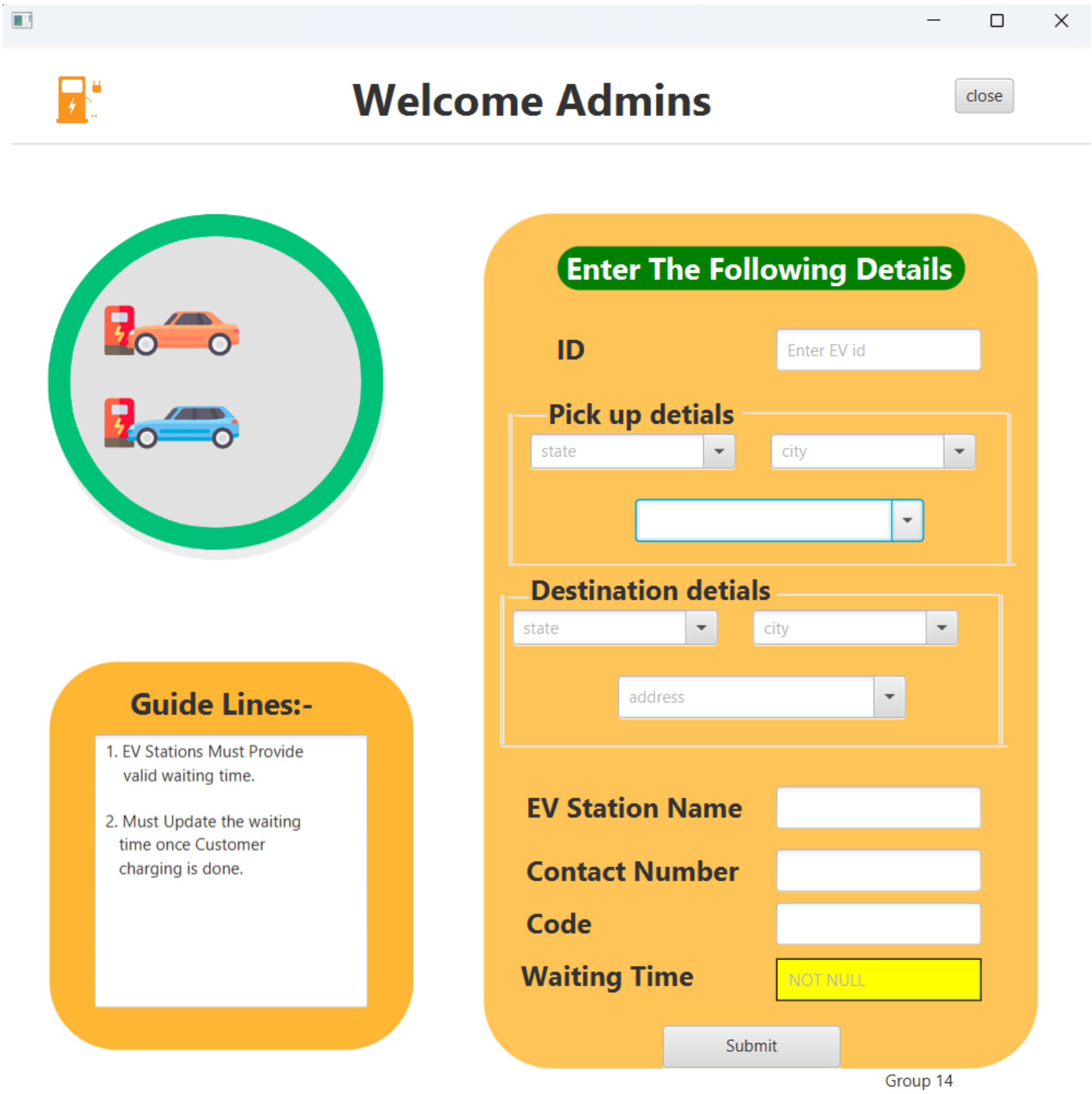
PAGE -3: (Sign-up Page)



PAGE -4: (Booking Page)



PAGE -5: (Admin Page)



Welcome Admins

close

Guide Lines:-

1. EV Stations Must Provide valid waiting time.
2. Must Update the waiting time once Customer charging is done.

Enter The Following Details

ID: Enter EV id

Pick up detials

state | city

Destination detials

state | city

address

EV Station Name

Contact Number

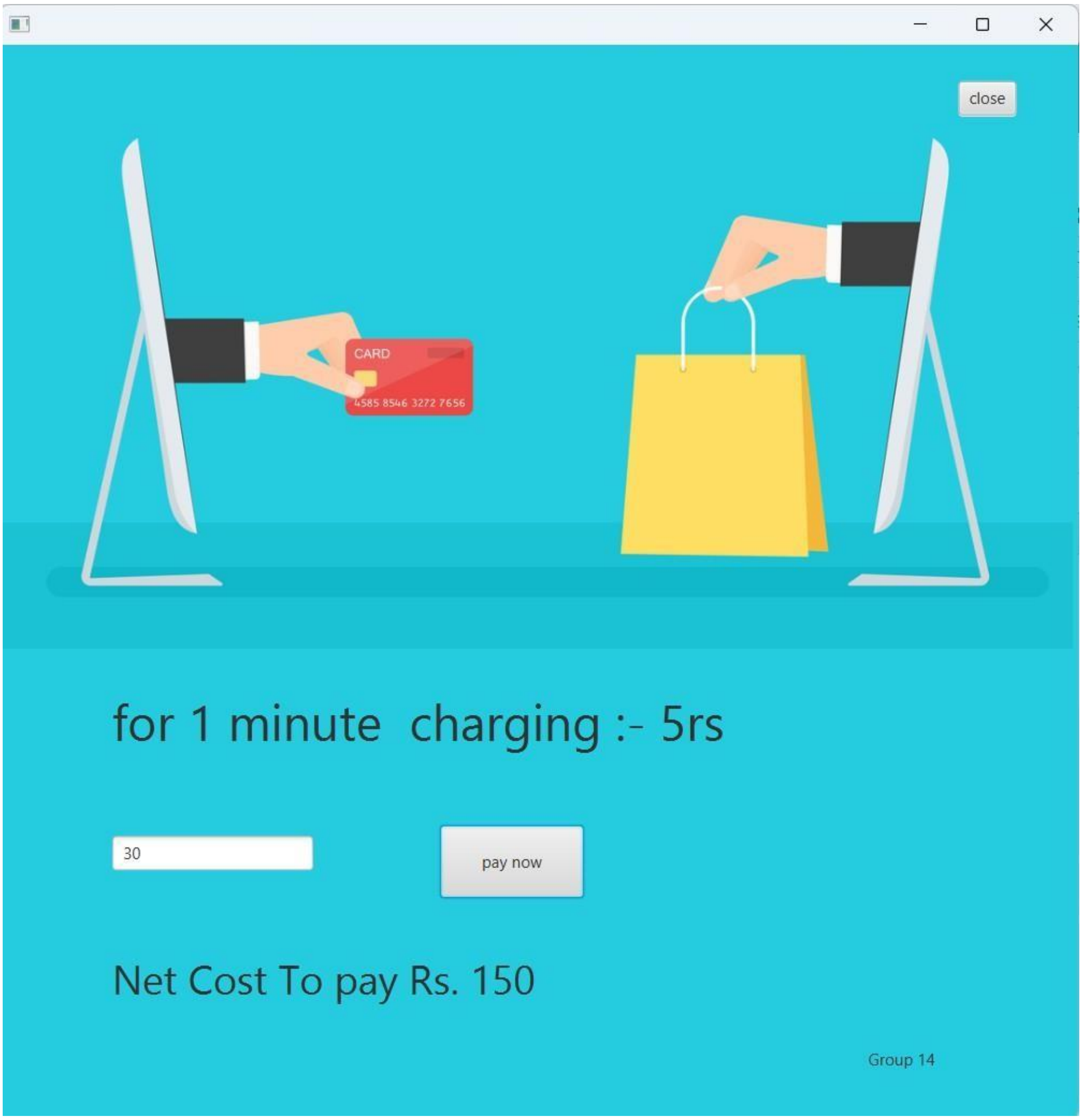
Code

Waiting Time: NOT NULL

Submit

Group 14

PAGE -6: (Payment Page)



for 1 minute charging :- 5rs

Net Cost To pay Rs. 150

References:

- Tushar, Wayes, et al. "Towards a queue management strategy for charging of electric vehicles." 2015 IEEE Power & Energy Society General Meeting. IEEE, 2015. This paper explores the benefits of slot-based reservation systems, which are crucial for efficient charging station management.
- ChargePoint - Official Website: https://www.chargepoint.com/ The ChargePoint network is one of the largest EV charging networks globally, offering insights into successful charging station finder and booking systems.

- PlugShare - Official Website: https://www.plugshare.com/ PlugShare is a popular app that provides comprehensive charging information, showcasing features that can be valuable for reference.