

# PROJECT REPORT

## 1. INTRODUCTION:

### 1.1. Project overview

This project focuses on the development of a visualization tool designed to analyze the performance of electric vehicles (EVs), with particular emphasis on battery charging time and driving range. These two factors represent significant challenges in widespread EV adoption, as they directly influence user convenience and operational efficiency.

### 1.2. Purpose

The primary purpose of this project is to provide electric vehicle (EV) users and stakeholders with data-driven insights into vehicle performance, particularly in relation to charging efficiency and driving range optimization. By transforming raw performance data into interactive visual representations, the tool enables users to better understand how battery capacity, charging duration, and energy consumption patterns affect overall range and efficiency.

## 2. IDEATION PHASE:

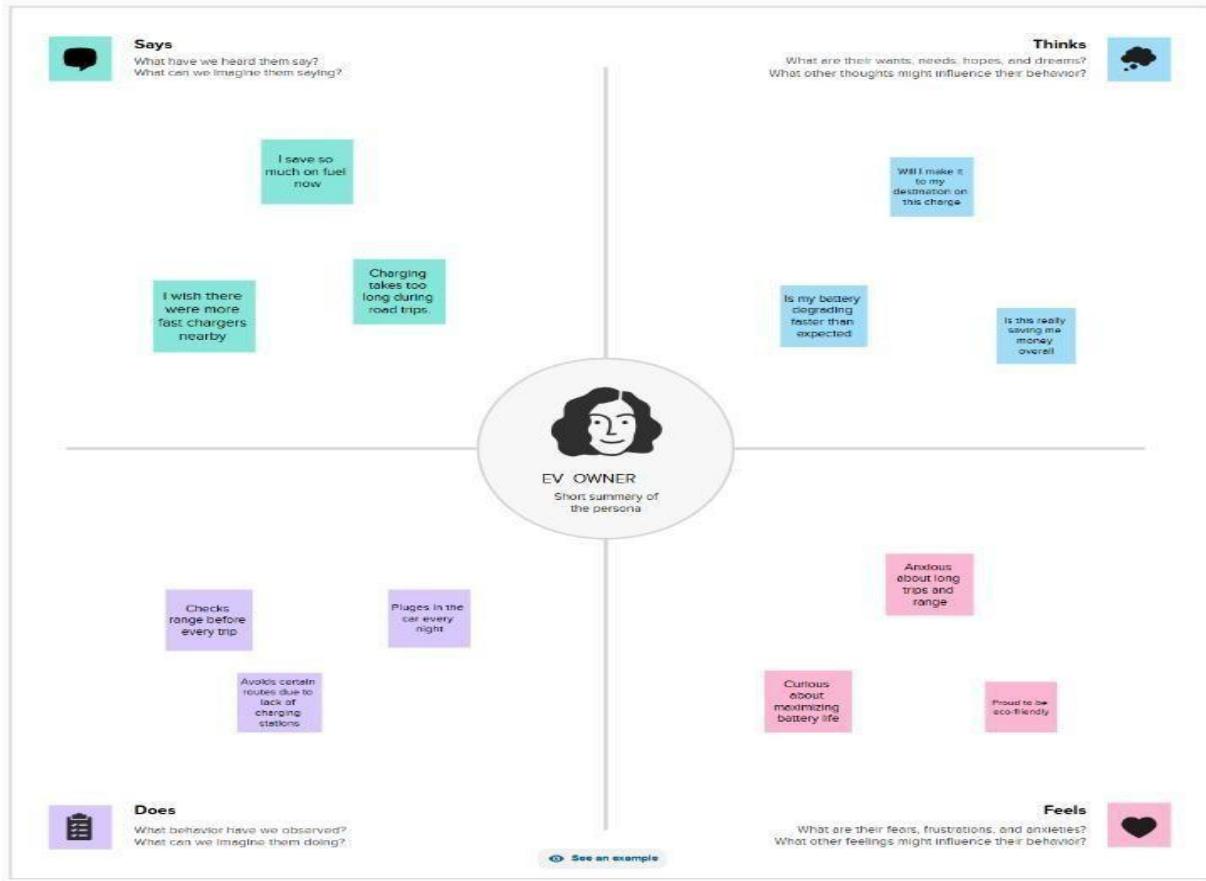
### 2.1 Problem Statement

Despite the growing adoption of electric vehicles (EVs), many users struggle with understanding how far they can travel on a charge and how long it will take to recharge their vehicle. Current EV dashboards often lack intuitive and detailed insights into battery health, charging efficiency, and real-time range predictions. This lack of transparency can lead to inefficient route planning, unexpected battery depletion, and user anxiety—commonly referred to as "range anxiety." There is a pressing need for a user-friendly tool that visually presents essential EV performance data, enabling users to make informed decisions about charging habits and travel plans.

I am	I'm trying to	But	Because	Which makes me feel
I am a small business owner	I'm trying to transfer payments to multiple vendors quickly	But the app only allows one transfer at a time	Because batch payments aren't supported	frustrated and inefficient
I am an electric vehicle owner	I'm trying to plan long road trips confidently	But I struggle to find reliable charging station information	Because current apps don't show real-time charger availability	anxious and frustrated

<b>Problem Statement (PS)</b>	<b>I am (Customer)</b>	<b>I'm trying to</b>	<b>But</b>	<b>Because</b>	<b>Which makes me feel</b>
PS-1	An electric vehicle owner	Plan long road trips confidently	I struggle to find reliable charging station information	Current apps don't show real time charger availability	Anxious and frustrated
PS-2	A small business owner	Transfer payments to multiple vendors quickly	The app only allows one transfer at a time	Batch payments are not supported	Frustrated and inefficient

## 2.2 Empathy Map Canvas



## 2.3 Brainstorming

Step-1: Team Gathering, Collaboration and Select the Problem Statement



## Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

**10 minutes** to prepare  
**1 hour** to collaborate  
**2-8 people** recommended

**Before you collaborate**  
A little bit of preparation goes a long way with this session. Here's what you need to do to get going.  
**10 minutes**

**A Team gathering**  
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

**B Set the goal**  
Think about the problem you'll be focusing on solving in the brainstorming session.

**C Learn how to use the facilitation tools**  
Use the Facilitation Superpowers to run a happy and productive session.  
[Open article](#)

**Define your problem statement**  
What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

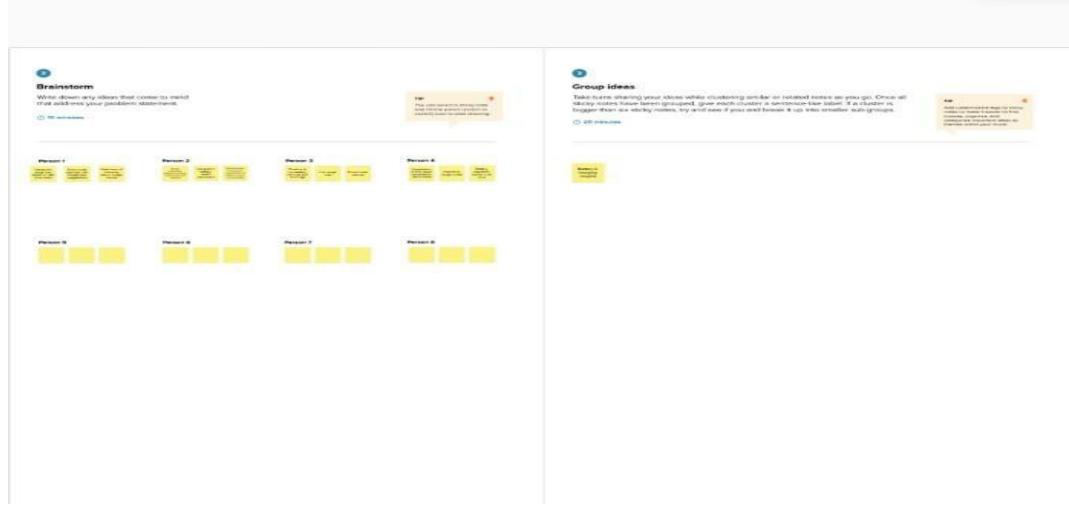
**5 minutes**

**PROBLEM**  
How might we [your problem statement]?

**Key rules of brainstorming**  
To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

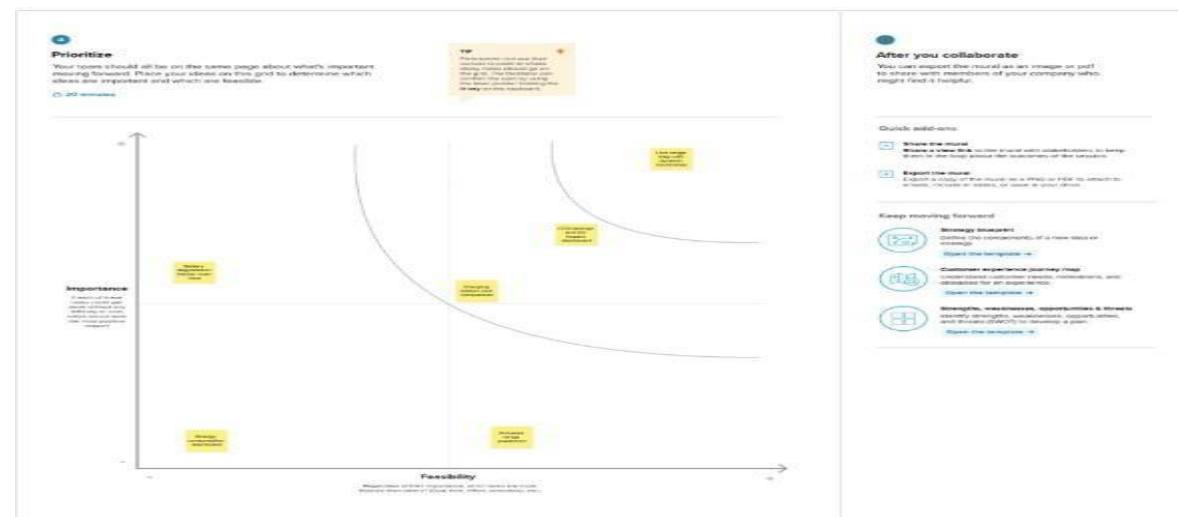
### Step-2: Brainstorm, Idea Listing and Grouping



**Brainstorm**  
Write down any ideas that come to mind. What addresses your problem statement.  
**10 minutes**

**Group ideas**  
Take turns sharing your ideas while clustering similar or related notes as you go. Once all notes have been shared, group every note into a main topic. A cluster bigger than six sticky notes, try and break it up into smaller sub-groups.  
**20 minutes**

### Step-3: Idea Prioritization



**Prioritize**  
Your notes should all be on the same page about what's important and feasible. Place your ideas on this grid to determine which ideas are most important and which are feasible.  
**20 minutes**

**After you collaborate**  
You can expect the results as an image or pdf file to share with members of your company who might find it useful.

**Quick audit-score**

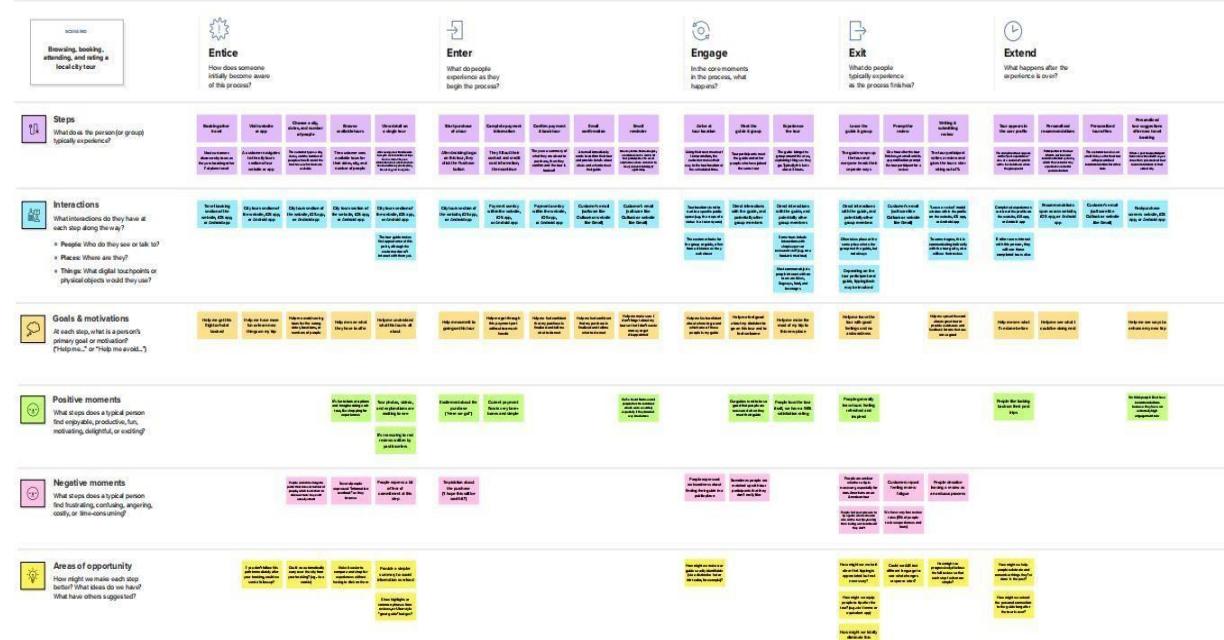
- Share the result:** Write a Value Map, written email with stakeholders, or bring the results to a meeting to discuss the outcomes of the session.
- Export the result:** Export a copy of the results as a pdf or html attachment. Includes a link to the original document.

**Keep working forward!**

- Impact measure:** Define the importance of a new idea or opportunity. [Open the template](#)
- Customer experience journey map:** Understands how users interact, communicate, and engage with an organization. [Open the template](#)
- Strengths, weaknesses, opportunities & threats:** Identify strengths, weaknesses, opportunities, and threats. [Open the template](#)

### 3. REQUIREMENT ANALYSIS

#### 3.1 Customer Journey map



#### 3.2 Solution Requirement

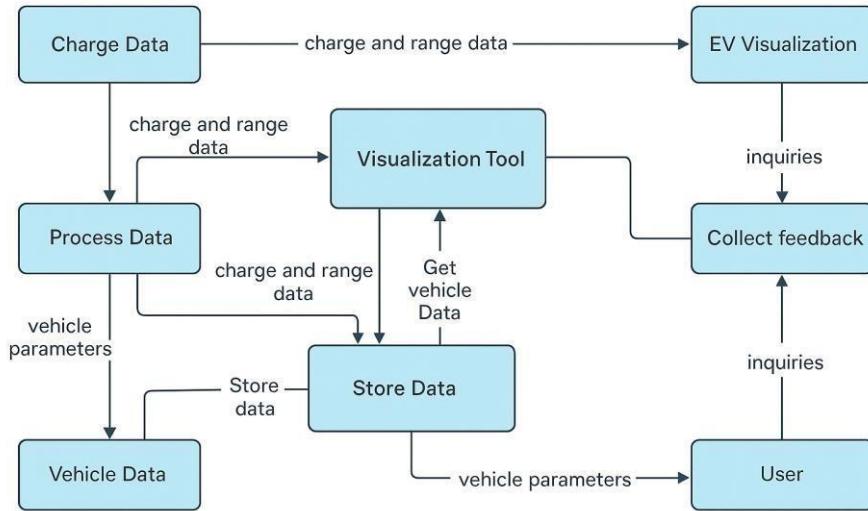
**Functional Requirements:** Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Account Management	Registration through Form Registration through Gmail Registration through Credentials.
FR-2	Vehicle Input Module	Enter battery percentage Input vehicle type/model
FR-3	Range and Charge Analysis	Display estimated range based on input Visualize charge level and consumption trend Suggest optimal charging stations
FR-4	Interactive Map View	Show nearby charging stations Filter stations based on power availability Highlight reachable area on current charge
FR-5	Session History and Reporting	Show previous charge sessions Export usage and performance data
FR-6	Admin Dashboard	Manage station database View user analytics

**Non-functional Requirements:** Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	<b>Usability</b>	The interface must be intuitive for EV users, analysts, and admins, with smooth navigation across modules.
NFR-2	<b>Security</b>	Secure authentication and role-based access must be implemented to prevent unauthorized access.
NFR-3	<b>Reliability</b>	System must provide consistent performance and accurate range estimations during peak usage hours.
NFR-4	<b>Performance</b>	Real-time data updates and visualizations should render within 2 seconds of input for a smooth user experience.
NFR-5	<b>Availability</b>	The system should be operational 99.9% of the time, ensuring accessibility for daily EV planning.
NFR-6	<b>Scalability</b>	The tool should scale to accommodate more users, vehicles, and charging data without performance degradation.

### 3.3 Data Flow Diagram

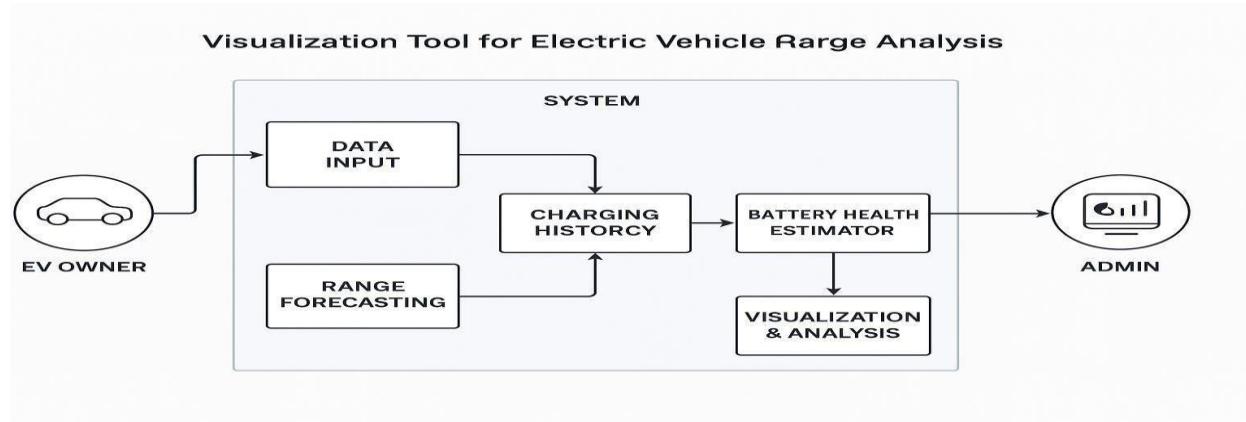


#### User Stories

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
EV Owner (Mobile user)	Account Management	USN-1	As an EV user, I want to register and log in to the app to securely access personalized features	User can create an account and sign in using valid credentials	High	Sprint-1
	Map Visualization	USN-2	As a user, I want to view a map showing nearby charging stations and range zones	Map loads with charging station icons and vehicle range overlay	High	Sprint-1
	Vehicle Charge Analysis	USN-3	As a user, I want to input my vehicle's battery level and get real-time range estimates	System provides accurate range estimates based on battery and driving data	Low	Sprint-2
	Charging History	USN-4	As a user, I want to view my previous charging sessions and performance reports	App displays historical charts and statistics about past charges	Medium	Sprint-2
Admin	Data Management	USN-5	As an admin, I want to upload and manage station data across different locations	Admin panel shows options to add/update station information	High	Sprint-1
	User Monitoring	USN-6	As an admin, I want to monitor system usage and user activity for improvement tracking	Dashboard reports include session logs and activity summaries	Medium	Sprint-3
Data Analyst	Reporting Module	USN-7	As an analyst, I want to generate customized reports based on station usage and range patterns	As an analyst, I want to generate customized reports based on station usage and range patterns	Medium	Sprint-3
Guest User	Demo Access	USN-8	As a guest, I want to explore the tool in demo mode without signing up	Demo mode provides limited but working sample visualizations	Low	Sprint-2

### 3.4 Technology Stack



**Table-1: Components & Technologies:**

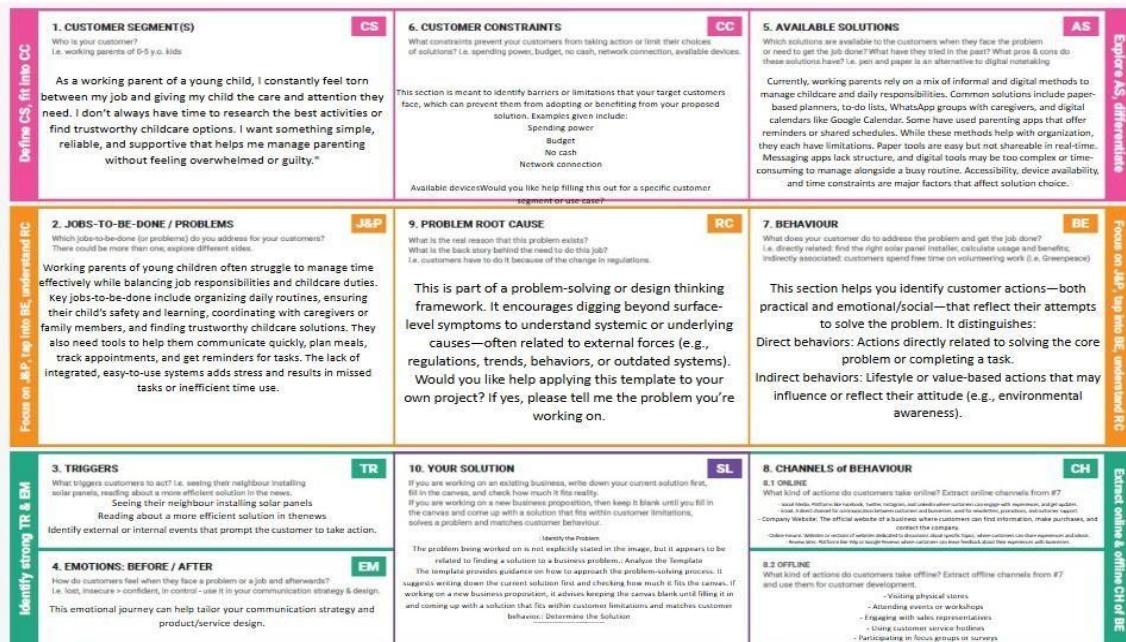
S.No	Component	Description	Technology
1.	User Interface	Provides interactive views for EV Owners, Admins, and Analysts	HTML, CSS, JavaScript, React or Vue.js
2.	Authentication Module	Handles secure login, signup, and role-based access	Firebase Auth, OAuth 2.0, JWT
3.	Vehicle Input System	Allows users to enter battery %, vehicle model, and trip preferences	JavaScript Form Logic, Python Flask API
4.	Range Estimation Engine	Calculates real-time range based on input and terrain data	Python, Pandas, NumPy
5.	Charging Station Mapper	Displays nearby stations and highlights reachable zones.	Leaflet.js, Google Maps API
6.	Charging History Module	Visualizes past charging sessions with analytics	Chart.js, D3.js, MongoDB
7.	Recommendation System	Suggests ideal routes and charging stops	Machine Learning Model, Scikit-learn
8.	Admin Dashboard	Admin access to station management and user analytics	React Admin, Node.js, MongoDB
9.	Database	Stores user data, station info, vehicle profiles	MongoDB, Firebase Firestore
10.	Hosting & Deployment	Runs backend and frontend on scalable infrastructure	Vercel, Netlify, AWS EC2 or Azure App Service.
11.	API Integration Layer	Connects external services like Maps and EV data APIs	REST APIs, GraphQL, Axios.

**Table-2: Application Characteristics:**

S.No	Characteristics	Description	Technology
1.	Performance	Rapid data response for range calculations, map updates, and analytics	Redis Cache, CDN, Async Processing
2.	Maintainability	Easy to update components like maps, APIs, or authentication without affecting the entire system.	Modular Design, Git-based CI/CD.
3.	Scalable Architecture	Ensures the system handles increasing users, stations, and data; follows modular principles for flexibility	Microservices, Docker, Kubernetes
4.	Availability	Stable performance across user scenarios with accurate real-time outputs	Load Balancer (NGINX), Multi-region Hosting (Azure/AWS)
5.	Reliability	Design consideration for the performance of the application (number of requests per sec, use of Cache, use of CDN's) etc.	Automated Testing, Monitoring (Prometheus, Grafana)

## 4. PROJECT DESIGN

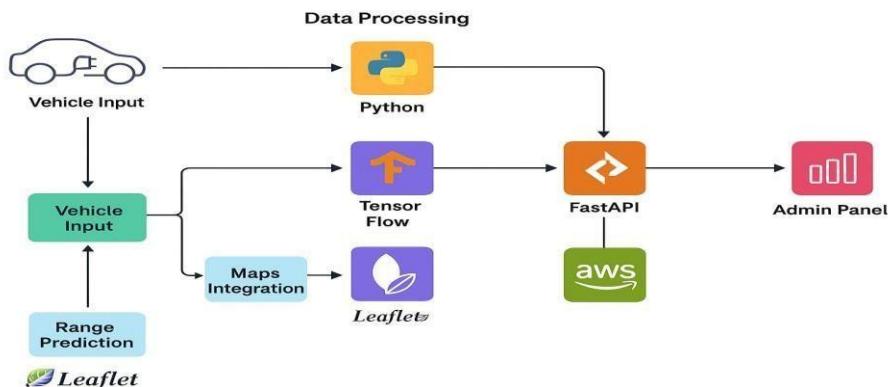
### 4.1 Problem Solution Fit



## 4.2 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Electric vehicle users and manufacturers face challenges in accurately predicting driving range under real-world conditions. Current tools often lack visual clarity and integration of variables such as terrain, temperature, driving habits, and battery health. This project aims to create a tool that visualizes these factors to improve decision-making.
2.	Idea / Solution description	The solution is a web-based visualization and analysis tool that models and predicts EV range based on various user-defined inputs like route elevation, temperature, speed, load, and driving behavior. The tool will integrate mapping APIs, real-time sensor data (optional), and machine learning models to provide personalized range estimations and visual outputs (e.g., range heatmaps, route optimizations).
3.	Novelty / Uniqueness	Unlike standard range calculators, this tool incorporates dynamic visualization with multi-parameter analysis. It also allows users to simulate future trips, compare different EV models, and see the impact of battery degradation over time — features that are often missing in current applications.
4.	Social Impact / Customer Satisfaction	The tool will enhance user confidence in EVs by reducing range anxiety and improving trip planning. It promotes sustainable transport by making EVs more predictable and accessible, indirectly supporting environmental goals and the broader adoption of green mobility.
5.	Business Model (Revenue Model)	Freemium model: basic features for free, advanced simulations and reports (e.g., for fleet owners or dealerships) under a paid subscription. Additional revenue via API licensing for OEMs, automotive portals, and map service providers.
6.	Scalability of the Solution	The tool can scale to accommodate different EV brands and geographies. With cloud-based infrastructure and modular design, it can be expanded to include more datasets (e.g., traffic, real-time weather), support international routes, and integrate with fleet management software.

## 4.3 Solution Architecture



## 5. PROJECT PLANNING & SCHEDULING

### 5.1 Project Planning

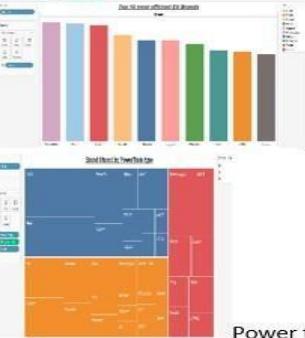
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration & Login	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	4
Sprint-1		USN-2	As a user, I receive confirmation email after registration	1	High	4
Sprint-1	Vehicle Input Module	USN-3	As a user, I can input battery %, vehicle model, and range preference	3	High	4
Sprint-2	Range Estimation	USN-4	As a user, I can view estimated range on a visual map	5	High	4
Sprint-1		USN-5	As a user, I can see alerts when range is critically low	2	Medium	4
Sprint-2	Charging Station Mapping	USN-6	As a user, I can view nearby stations filtered by charger type and availability	4	High	4
Sprint-3	History & Analytics	USN-7	As a user, I can view previous charge sessions with distance and cost data	3	Medium	4
		USN-8	As a user, I can export session summaries for analysis	2	Low	4

**Project Tracker, Velocity & Burndown Chart: (4 Marks)**

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	23 June 2022	23 June 2022	20	29 Oct 2022
Sprint-2	20	6 Days	23 June 2022	23 June 2022		
Sprint-3	20	6 Days	24 June 2022	24 June 2022		
Sprint-4	20	6 Days	24 June 2022	24 June 2022		

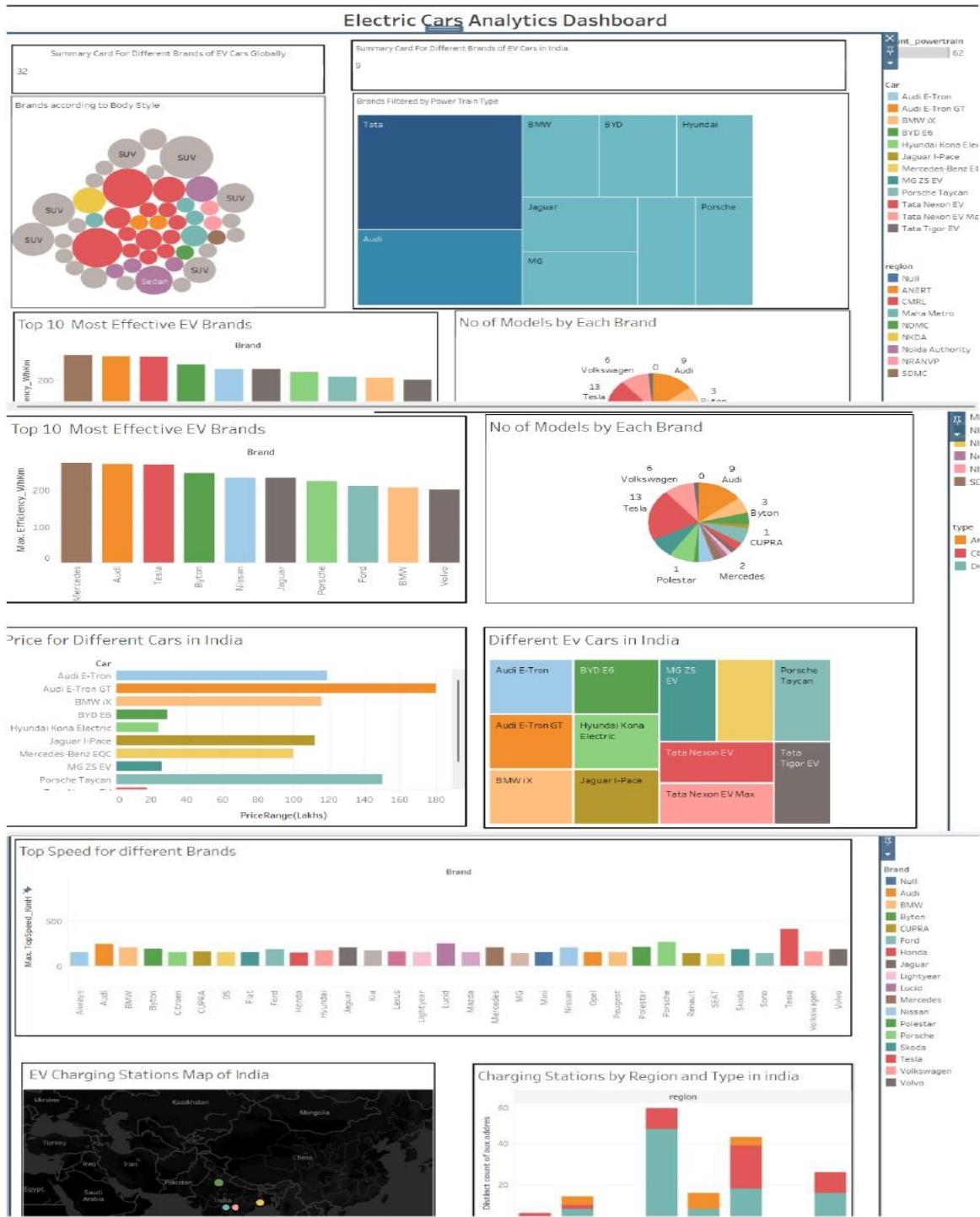
## 6. FUNCTIONAL AND PERFORMANCE TESTING

### 6.1 Performance Testing

S.No.	Parameter	Screenshot / Values
1.	Data Rendered	Cheapestelectriccars-EVDatabase : contains total eleven fields electric_vehicle_charging_station_list : contains total eight fields ElectricCarData_Clean : contains total fourteen fields EVIndia : contains total ten fields
2.	Data Preprocessing	The dataset is already clean and preprocessed. Only combining of all four datasets are done in the data preprocessing phase.
3.	Utilization of Filters	 Brand filter is used for- <b>Top 10 most efficient EV Brands</b>
		 Power train filter is used for- <b>Brand filtered by PowerTrain type</b>
4.	Calculation fields Used	Body style, Car brands in India, Efficiency.
5.	Dashboard design	No of Visualizations / Graphs – A dashboard containing total eleven visualizations.
6	Story Design	No of Visualizations / Graphs -Story design of all eleven visualizations created using the dataset.

## 7. RESULTS

### 7.1 Output Screenshots



## 8. ADVANTAGES & DISADVANTAGES Advantages

- Enhanced User Awareness: Helps users understand charging behavior, energy consumption, and travel planning.

- Customizable Analysis: Allows EV owners to input specific vehicle data for tailored insights.
- Educational Utility: Promotes informed decision-making and environmental consciousness, especially if gamified.
- Accessible Visualization: Transforms complex battery and performance data into intuitive, visual formats.
- Potential for Expansion: Can be integrated with map APIs, real-time charging station data, and IoT inputs.

### **Disadvantages**

- Data Dependency: Accuracy relies heavily on the availability and quality of EV-specific data.
- Device Compatibility: May require optimization for different screen sizes or browser support.
- Scalability Limitations: Handling real-time data for numerous users simultaneously could strain server resources.
- Learning Curve: Users unfamiliar with data dashboards or EV tech may find the interface initially complex.

## **9. CONCLUSION**

The EV Charge and Range Visualization Tool offers a practical solution to one of the most pressing concerns in electric vehicle adoption: understanding and managing battery performance. By transforming complex EV data into accessible visuals, this project empowers users to make confident, informed decisions about their charging habits and travel planning. With customization options, educational potential, and opportunities for future expansion, the tool represents a meaningful step toward enhancing the EV user experience and promoting sustainable mobility.

## **10. FUTURE SCOPE**

The EV Charge and Range Visualization Tool has strong potential for further development and innovation. Here are some directions to expand its scope:

- Real-time Data Integration: Connect with live data sources from EVs or IoT charging stations to offer dynamic, up-to-date insights.
- Route Planning with Charging Stops: Incorporate map APIs to suggest optimal travel routes based on battery range and nearest charging stations.
- AI-Powered Predictions: Use machine learning to forecast battery degradation, energy consumption patterns, and charging time under varying conditions.
- Mobile App Version: Expand accessibility by developing a lightweight, responsive mobile version for on-the-go users.

- Community-Driven Insights: Allow users to share charging experiences, station reviews, and efficiency tips, building a knowledge-sharing ecosystem.
- Gamification Elements: Introduce interactive missions, eco-badges, or progress tracking to boost user engagement and learning, especially in educational contexts.

## 11. APPENDIX

Dataset Link -

<https://drive.google.com/drive/folders/1Rkzdks6Us1Uq2SRB4nxMAb83jN5bpH1>

GitHub-

<https://github.com/Sampath-53/Visualization-Tool-for-Electric-Vehicle-Charge-and-Range-Analysis-by-using-Tableau.git>

Video link-

[https://drive.google.com/file/d/1TLczel1Y\\_bchz87ySVhMyV2RY6ZyXl5I/view?usp=sharing](https://drive.google.com/file/d/1TLczel1Y_bchz87ySVhMyV2RY6ZyXl5I/view?usp=sharing)