PROJECT REPORT

1.INTRODUCTION:

1.1. Project overview

This project centre's on creating a visualization tool for analyzing **electric vehicle (EV)** performance-specifically focusing on battery charging time and driving range. These two factors are known hurdles in EV adoption, so the tool aims to deliver data-backed insights that help EV users optimize their experience.

1.2. Purpose

The primary purpose of this project is to empower electric vehicle (EV) users with datadriven insights into their vehicle's performance—specifically charging efficiency and range prediction. By visualizing key metrics like battery capacity, charge time, and travel range, the tool helps users make smarter, more confident decisions about their EV usage. It also encourages energy-conscious driving habits through awareness and education.

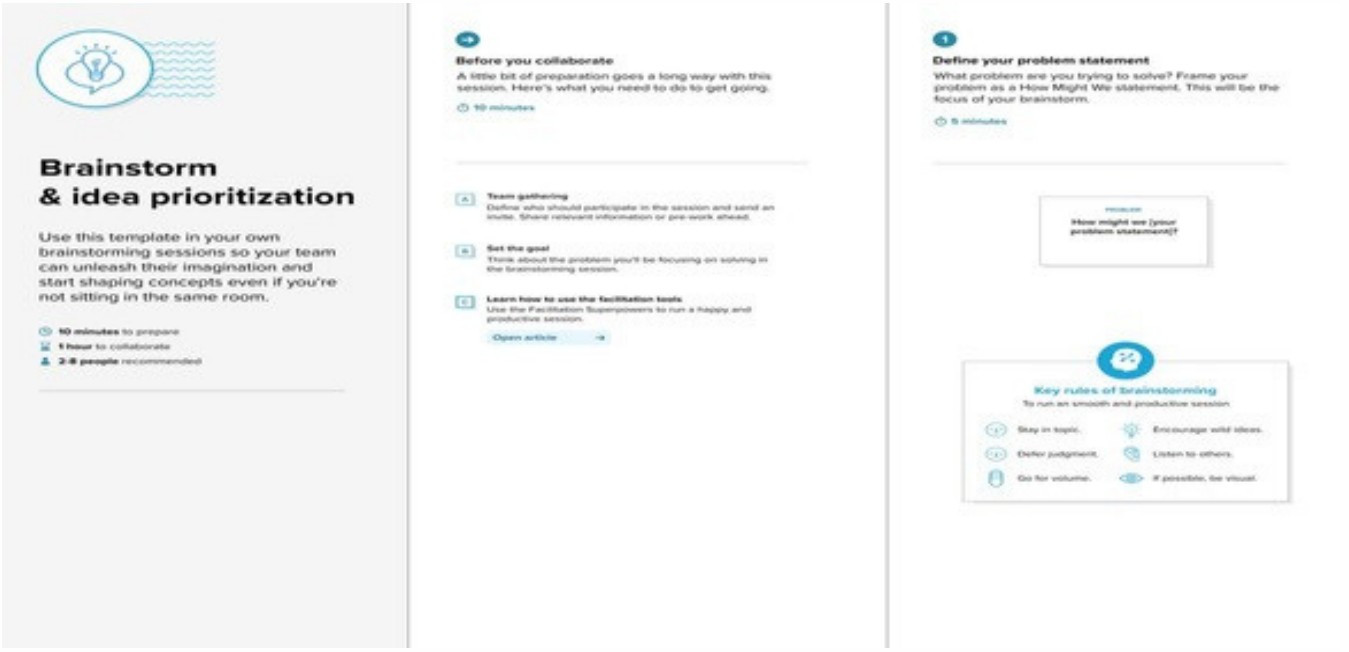
2. IDEATION PHASE:

2.1 Problem Statement

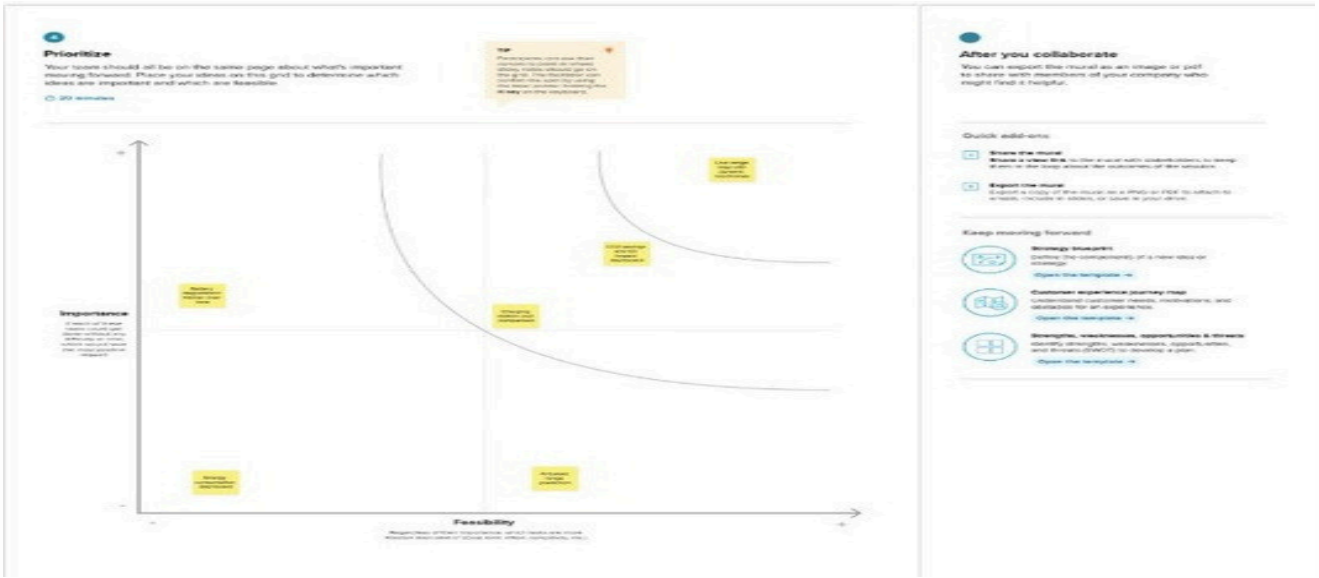
Despite the growing adoption of electric vehicles (EVs), many users struggle with understanding how far they can travel on a charge and how long it will take to recharge their vehicle. Current EV dashboards often lack intuitive and detailed insights into battery health, charging efficiency, and real-time 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.

2.3 Brainstorming

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



Step-2: Brainstorm, Idea Listing and Grouping



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	**Usability**	The interface must be intuitive for EV users, analysts, and admins, with smooth navigation across modules.
NFR-2	**Security**	Secure authentication and role-based access must be implemented to prevent unauthorized access.
NFR-3	**Reliability**	System must provide consistent performance and accurate range estimations during peak usage hours.
NFR-4	**Performance**	Real-time data updates and visualizations should render within 2 seconds of input for a smooth user experience.
NFR-5	**Availability**	The system should be operational 99.9% of the time, ensuring accessibility for daily EV planning.
NFR-6	**Scalability**	The tool should scale to accommodate more users, vehicles, and charging data without performance degradation.

3.3 Data Flow Diagram

3.4 Technology Stack

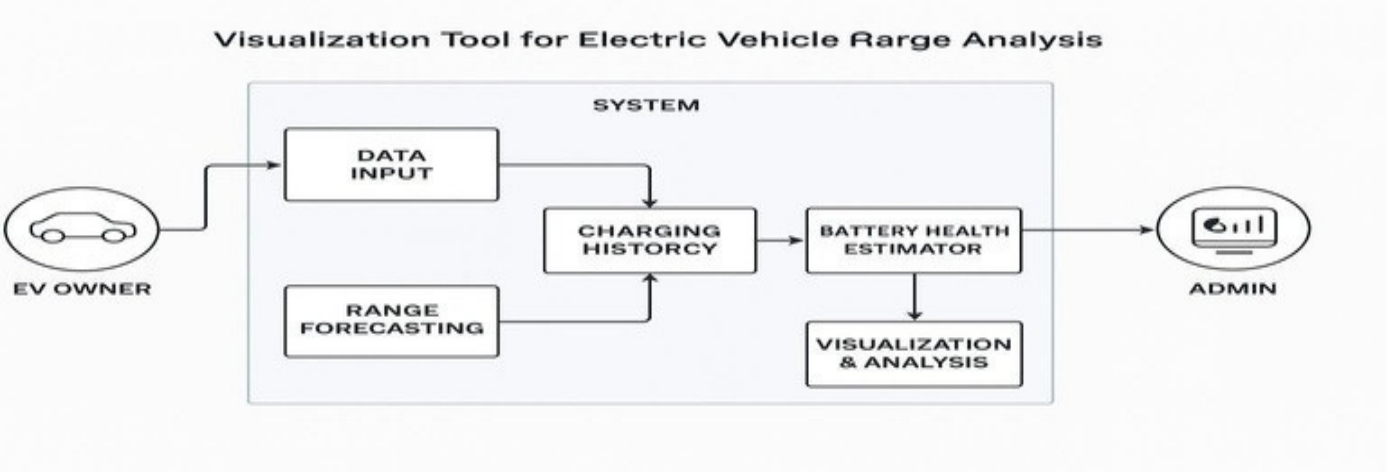


Table-1 : Components & Technologies:

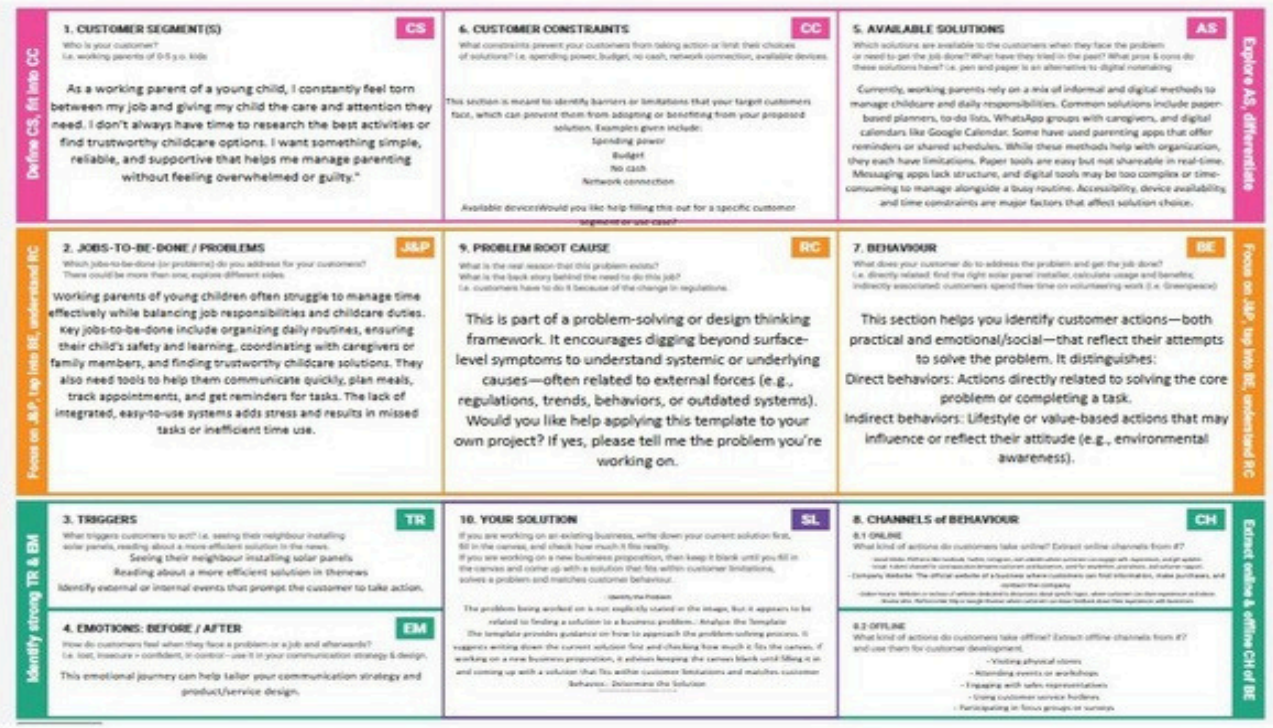
S.No	Component	Description	Technology
1.	User Interface	Provides interactive views for EV Owners, Admins, and Analysts	HTML, CSS, JavaScript, React or Vue.js
2.	Authentication Module	Handles secure login, signup, and role-based access	Firebase Auth, OAuth 2.0, JWT
3.	Vehicle Input System	Allows users to enter battery %, vehicle model, and trip preferences	JavaScript Form Logic, Python Flask AP
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)

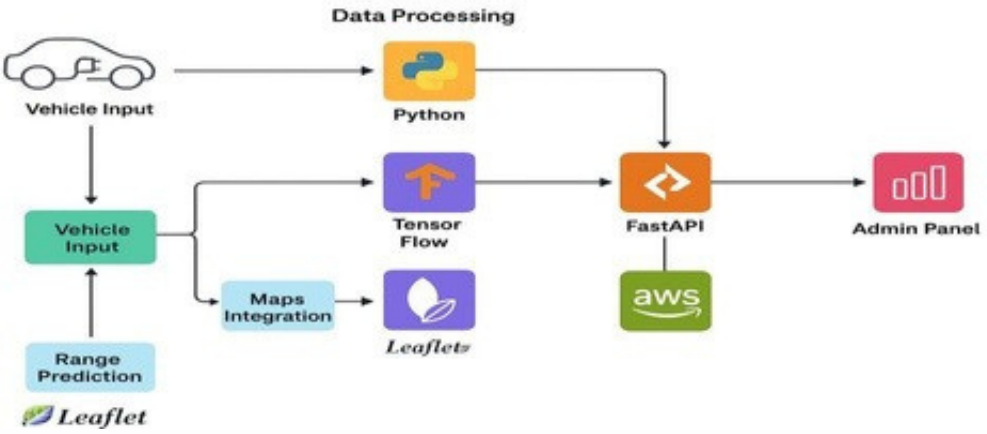
4. PROJECT DESIGN

4.1 Problem Solution Fit



4.2 Proposed Solution

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- **Top 10 most efficient EV Brands**  Power train filter is used for-**Brand filtered by PowerTrain type**
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 EVspecific 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://public.tableau.com/authoring/shaikthasmiya/Dashboard2#1

GitHub – [redacted]

Project Demo Link-

https://drive.google.com/file/d/19Xiix34fVj7GhjvL9RsH-3Mmn8Iff2GI/view?usp=sharing

GitHub - https://github.com/ShaikThasmiya26

2.2 Empathy Map Canvas

Step-3: Idea Prioritization