# 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<br>Registration through Gmail<br>Registration through Credentials. |
| FR-2 | Vehicle Input Module | Enter battery percentage<br>Input vehicle type/model |
| FR-3 | Range and Charge Analysis | Display estimated range based on input<br>Visualize charge level and consumption trend<br>Suggest optimal charging stations |
| FR-4 | Interactive Map View | Show nearby charging stations<br>Filter stations based on power availability<br>Highlight reachable area on current charge |
| FR-5 | Session History and Reporting | Show previous charge sessions<br>Export usage and performance data |
| FR-6 | Admin Dashboard | Manage station database<br>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



Visualization Tool for Electric Vehicle Rarge Analysis
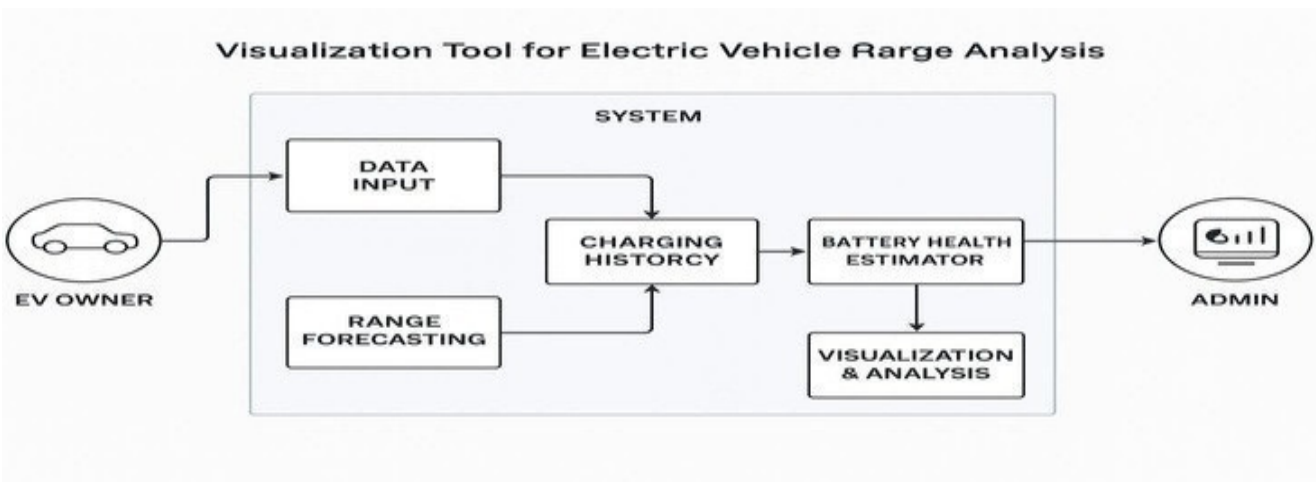
**Table-1 : Components & Technologies:**

| 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
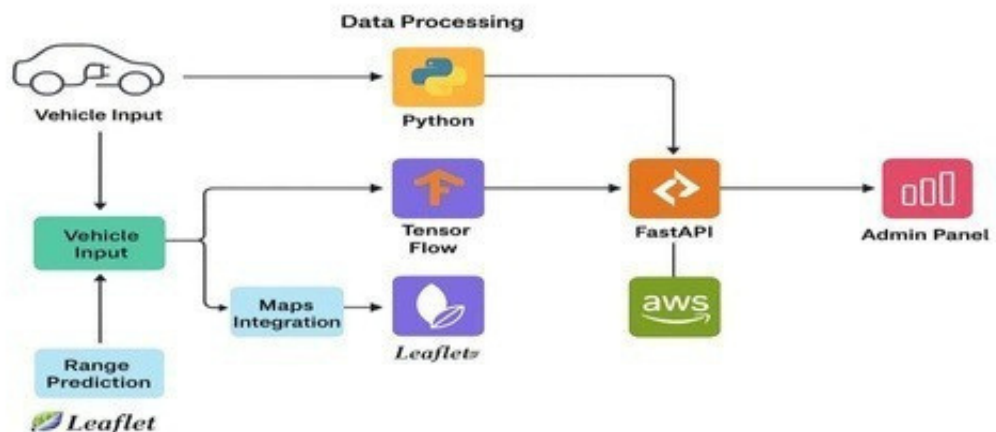


# 5. PROJECT PLANNING & SCHEDULING

## 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<br>electric_vehicle_charging_station_list : contains total eight fields<br>ElectricCarData_Clean : contains total fourteen fields<br>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 | <br>Brand filter is used for- **Top 10 most efficient EV Brands**<br>Power train filter is used for-**Brand filtered by PowerTrain type** |
| 4. | Calculation fields Used | Body style,<br>Car brands in India,<br>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

**7.1OutputScreenshots**

# 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.
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**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 i electric vehicle adoption: understanding and managing battery performance. By transforming complex EV dat into accessible visuals, this project empowers users to make confident, informed decisions about their chargin habits and travel planning. With customization options, educational potential, and opportunities for futur 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

DatasetLink - https://public.tableau.com/views/gollaafreentaj/Dashboard2?:language=en-US&:sid=&:redirect=auth&:display_count=n&:origin=viz_share_link

GitHub –

Project Demo Link-

https://drive.google.com/file/d/19Xiix34fVj7GhjvL9RsH-3Mmn8lff2GI/view?usp=sharing

## 2.2 Empathy Map Canvas

## Step-3: Idea Prioritization