Final Report

Visualization Tool for Electric Charge and Range Analysis

Date	25 June 2025
Team ID	LTVIP2025TMID20831
Project Name	Visualization Tool for Electric Vehicle Charge and Range Analysis

1. INTRODUCTION

1.1 Project Overview

This project focuses on developing a Visualization Tool for Electric Charge and Range Analysis, leveraging Tableau for preprocessing, dashboards, and stories. It transforms raw EV trip data (charge %, distance, speed, elevation) into intuitive dashboards, revealing how driving factors impact range.

1.2 Purpose

Help stakeholders interpret EV data easily without spreadsheets. Provide actionable insights on charge vs range and speed impact. Support quick decisions for trip planning and reduce range anxiety.

2. IDEATION PHASE

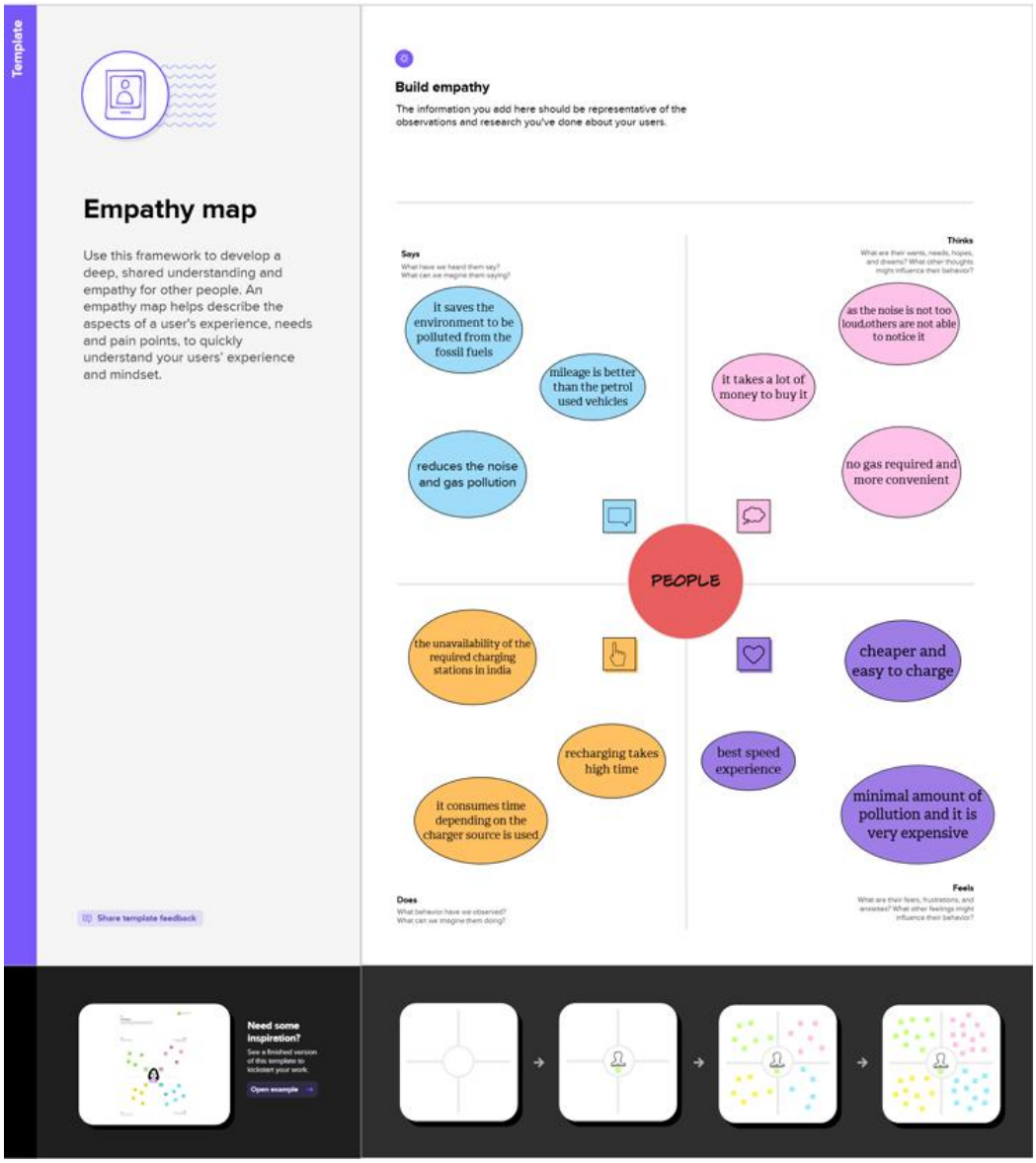
2.1 Problem Statement

EV owners and fleet managers lack tools to visually analyze how charge levels, speed, and trip conditions impact range. Without clear visualizations, planning becomes guesswork.

2.2 Empathy Map

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool to helps teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

Says: 'How far can I go on this charge?'
Thinks: 'Will speed reduce my range?'
Does: Checks logs and dash meters
Feels: Worried about sudden stops

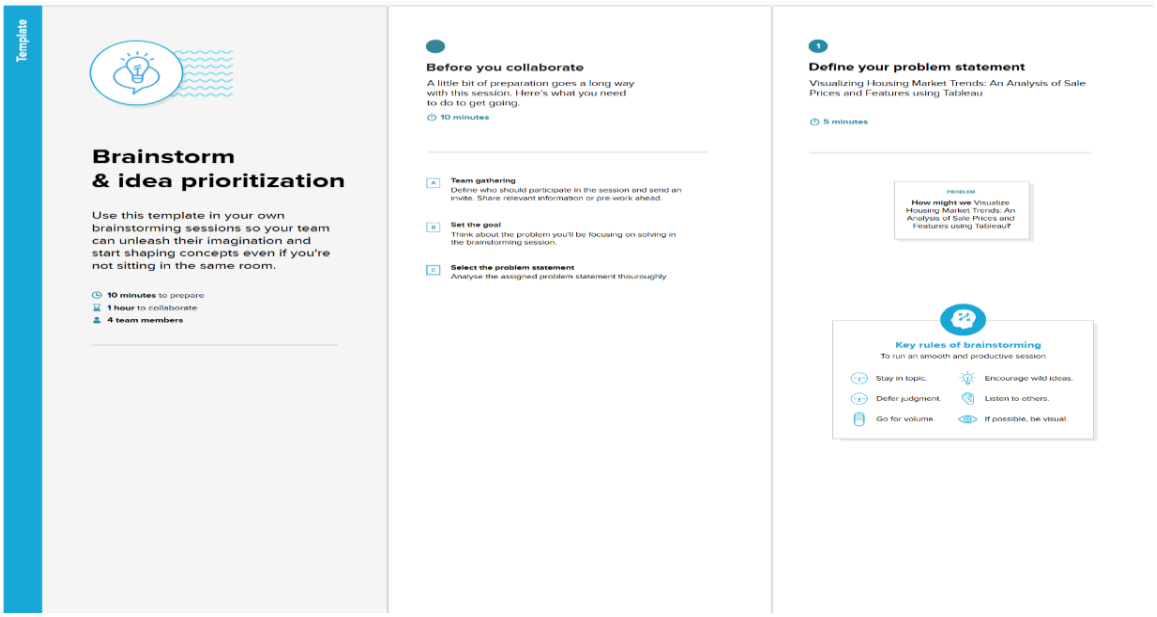


2.3 Brainstorming

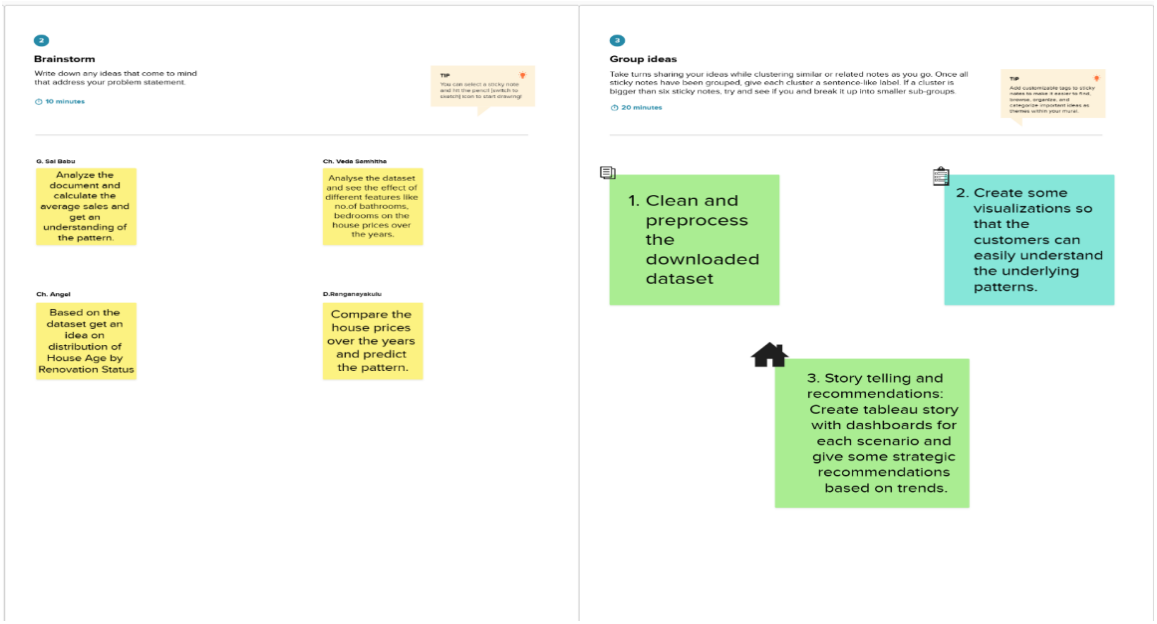
Discussed the problem, listed ideas like dashboards for charge vs distance, speed impact graphs, filters. Prioritized building dashboard + story in Tableau.

Brainstorm & Idea Prioritization:

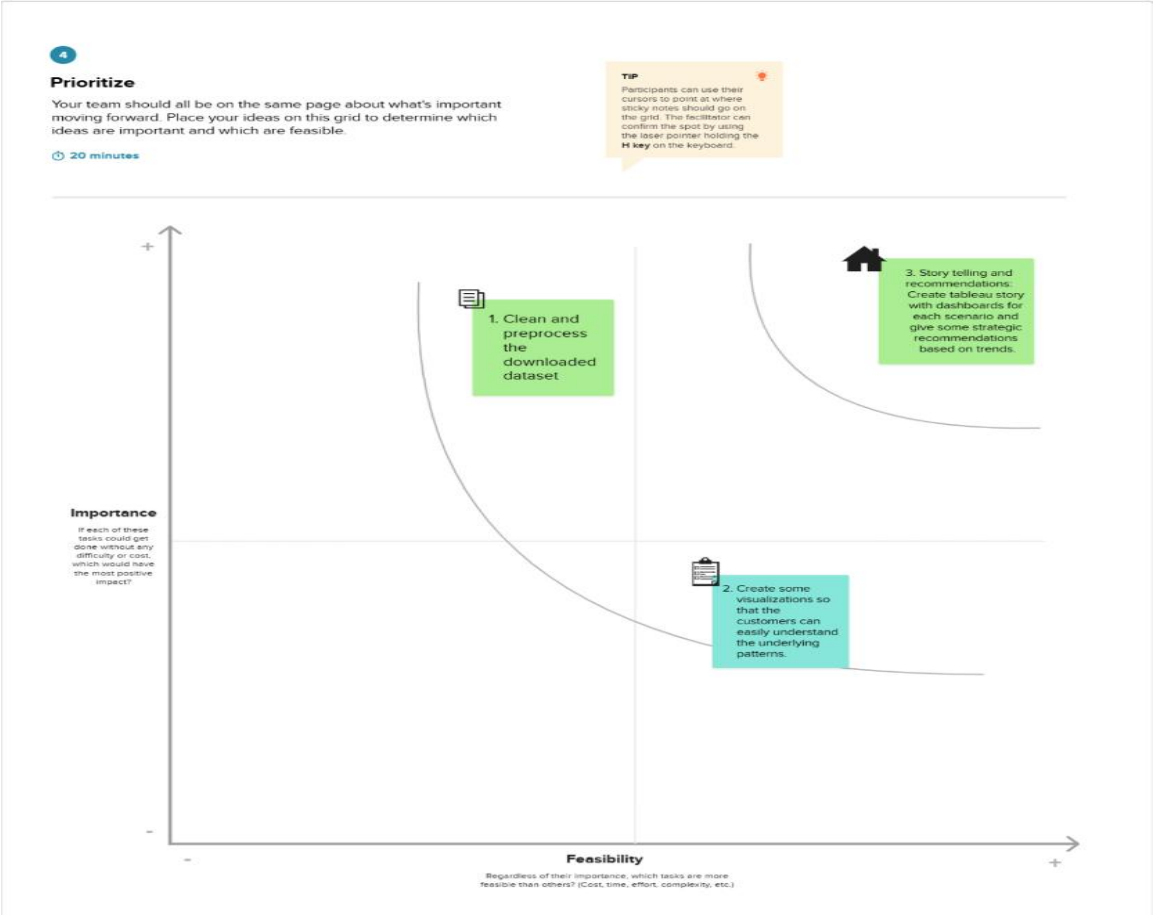
Step-1: Team Gathering, Collaboration and Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization



3. REQUIREMENT ANALYSIS

3.1 Customer Journey Map

The Customer Journey Map visualizes how users interact with the Electric Vehicle (EV) Charge and Range Analysis Tool at various stages of usage. It outlines their experiences, interactions, digital touchpoints, goals, and areas for enhancement.

Awareness: Learns tool exists, wonders if useful.
Consideration: Uploads trip data, checks if easy.
Use: Explores dashboards & stories.
Reflection: Plans better, avoids unnecessary stops.

Journey Map – Visualization Tool for Electric Vohicle Charge and Range Analysis

Stage	Experience	Interactions	Digital Touchpoints	Goals & Motivations	Opportunities to Improve
					
Logs in to E EV charge range	Click through Activity L 1 –3	Click through dashboards	Range prediction visuals ctt/hyhway	Assesset EV performance	Add trip simulation
Browse-available dashhoards	Click through Activity L1 –3	Filter by region or time span	Raqial charts, range maps stag	Assess triving across conditions	Add vrision history
Open tripluie data visuals	Click through Activity L4 – 6 visuals	Filter interac- tivity, tooltips	Radial thames charge station proximity-visuals	Quick visiyia into reports	Improve map risponsive
Engage further analysis	Tableau's use- friendly layout	Compare char- ging behavior to averages	Filter interactivity tooltips, download and videos	Integrate Insights into reports	Enable real- time data sync
					

3.2 Solution Requirement

Functional: Upload CSV, clean data, build dashboard (charge vs distance, speed impact), filters, story, shareable.
Non-Functional: User-friendly, fast (<5s), scalable, secure, reliable.

Functional Requirements:

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Data Collection	Upload EV performance and trip data in CSV or API-integrated formats
FR-2	Data Preparation	Clean, filter, and structure data using Tableau Prep or Python scripts
FR-3	KPI Visualization	Display battery level, average energy consumption, and charge cycles KPIs
FR-4	Feature-based Visualization	Visualize range variation by speed, terrain, climate, and driving behavior
FR-5	Dashboard Sharing	Publish and export dashboard via Tableau Public or PDF formats

Non-functional Requirements:

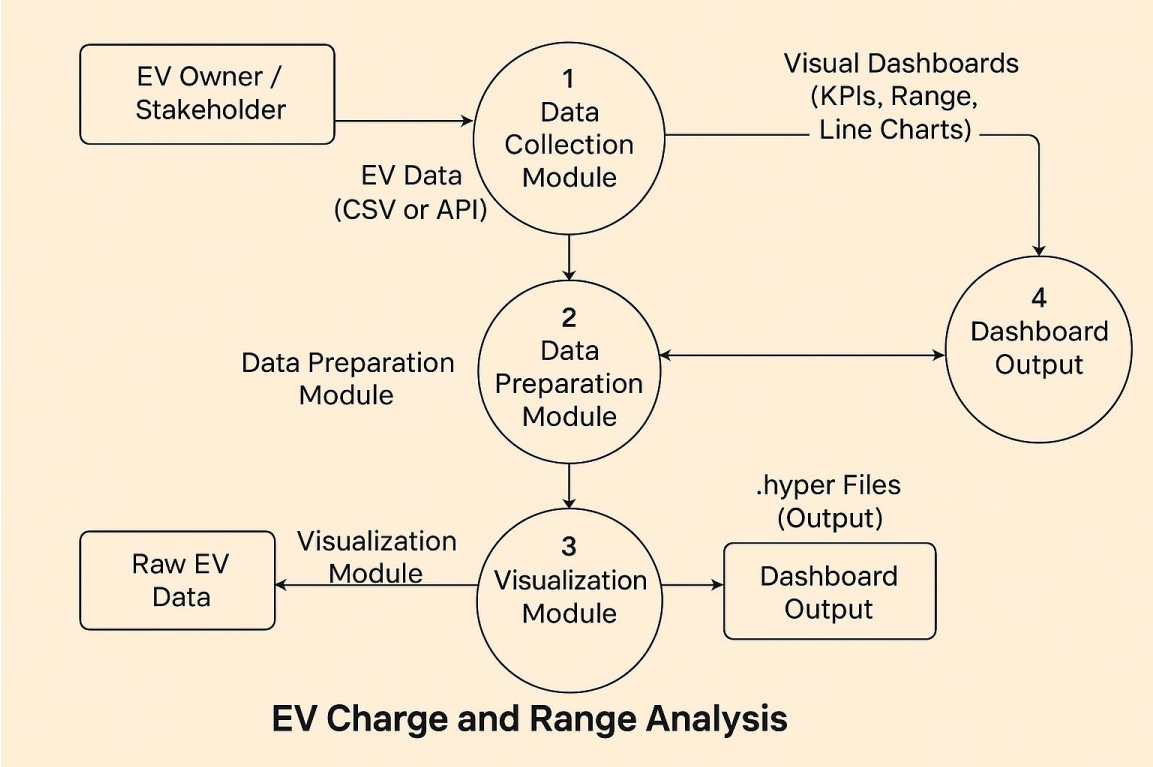
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Dashboard should offer intuitive navigation and user-friendly UI across devices
NFR-2	Security	Only authenticated users can upload or edit EV datasets
NFR-3	Reliability	Dashboard must handle data updates without crashing or freezing
NFR-4	Performance	Should load within 5 seconds for datasets up to 50,000 records
NFR-5	Availability	Ensure full-time access during standard work and analysis hours
NFR-6	Scalability	Must support integration of new EV models, datasets, and visualization modules

Would you like help turning this into a polished slide or including visual cues to highlight each requirement's impact?

3.3 Data Flow Diagram

Data Flow Diagrams:

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored



Of course, Sajiya! Here's your fully adapted version of the **User Stories** and **Technology Stack** for the *Visualization Tool for Electric Vehicle Charge and Range Analysis*, mirroring the structure and clarity of your housing market example:

User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance Criteria	Priority	Release
Analyst	Data Collection	EV-USN-1	As an analyst, I want to upload EV trip and battery usage data for processing.	Dataset is uploaded successfully and ready for preparation	High	Sprint-1
Analyst	Data Cleaning &	EV-USN-2	As an analyst, I want to	Cleaned dataset is ready for	High	Sprint-1

	Transformation		clean and preprocess EV datasets for analysis.	dashboard use		
Stakeholder	Visualization – KPIs	EV-USN-3	As a stakeholder, I want to view KPIs like range efficiency, average charge time, etc.	KPIs display accurate values with filters applied	High	Sprint-2
Stakeholder	Visualization – Usage Behavior	EV-USN-4	As a stakeholder, I want to see driving patterns and range drop comparisons visually.	Line or area chart reflects correct behavior by region/time	Medium	Sprint-2
Stakeholder	Visualization – Environmental Impact	EV-USN-5	As a stakeholder, I want to understand how terrain and weather affect range.	Map or bubble chart shows accurate impact visualization	High	Sprint-3
Manager	Dashboard Sharing	EV-USN-6	As a manager, I want to share and download dashboard insights across teams.	Dashboard is exportable via Tableau link or PDF	Medium	Sprint-4

Technology-Stack

Primary tools: Tableau Public, Tableau Prep, EV dataset in CSV

Table-1: Components & Technologies

S.No	Component	Description	Technology
1	User Interface	Final EV dashboard accessed by users	Tableau Public, HTML, Flask
2	Data Source	Real-time or stored EV performance datasets	EV CSV files / APIs
3	Data Collection	Fetching EV trip and charging data	Manual upload / API integration
4	Data Preparation	Cleaning, transforming, and shaping the data	Tableau Prep, Python (Pandas)
5	Data Visualization	Building charts like range maps, KPIs, etc.	Tableau Public Desktop
6	Dashboard & Story	Narratives with filters and exploratory visuals	Tableau Story
7	Web Integration	Embedded dashboards in websites or tools	Flask (Python Web Framework)
8	Hosting Infrastructure	Deployment of the dashboard or web app	Local server / Cloud deployment (Heroku/Azure)

Table-2: Application Characteristics

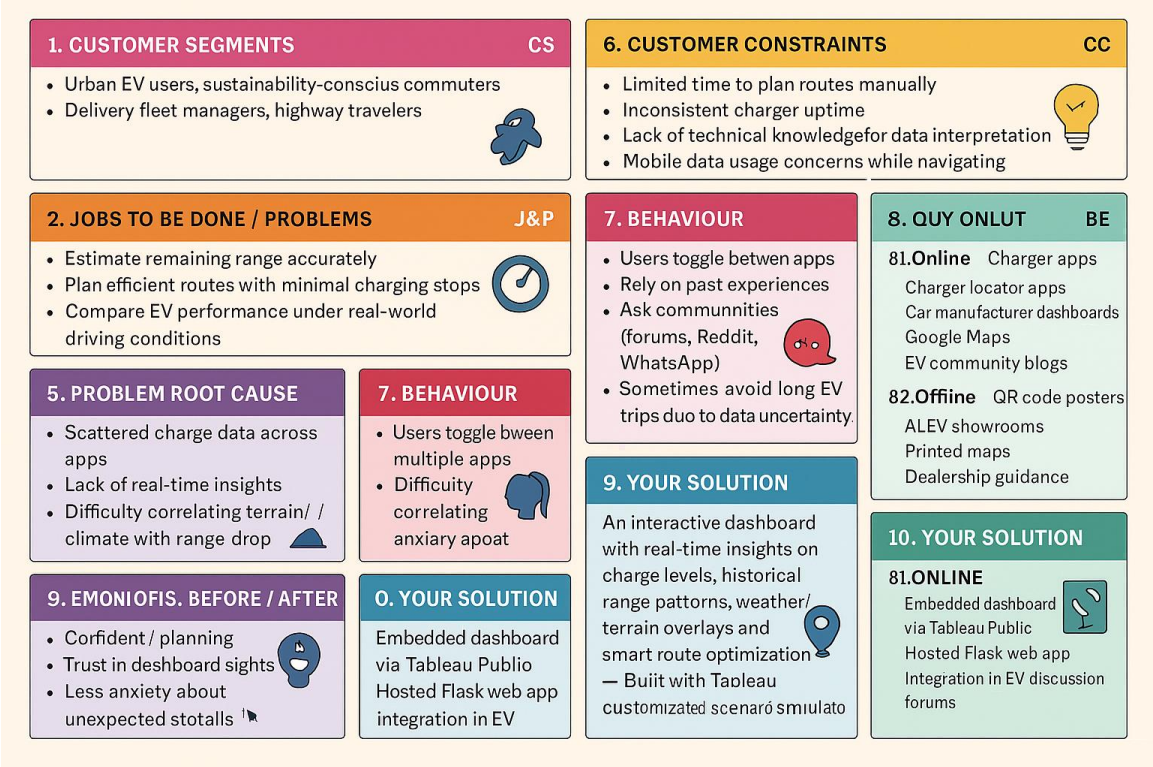
S.No	Characteristics	Description & Technology
1	Open-Source Frameworks	Tableau Public, Flask, Python libraries
2	Security Implementations	Private data storage, dashboard link control, authentication APIs
3	Scalable Architecture	Modular design with option to add new EV models and regions
4	Availability	Hosted via Flask web app and Tableau Public/Server access

5	Performance	Optimized visuals with filters, minimal refresh lag for EV datasets

4. PROJECT DESIGN PHASE

4.1 Problem–Solution Fit

Problem: Raw trip data doesn't clearly show impacts.
Solution: Tableau dashboards & stories.
Fit: Instant insights, avoids manual analysis.



4.2 Proposed Solution

Interactive dashboard with charge vs distance, speed impact, filters, story views. Shareable

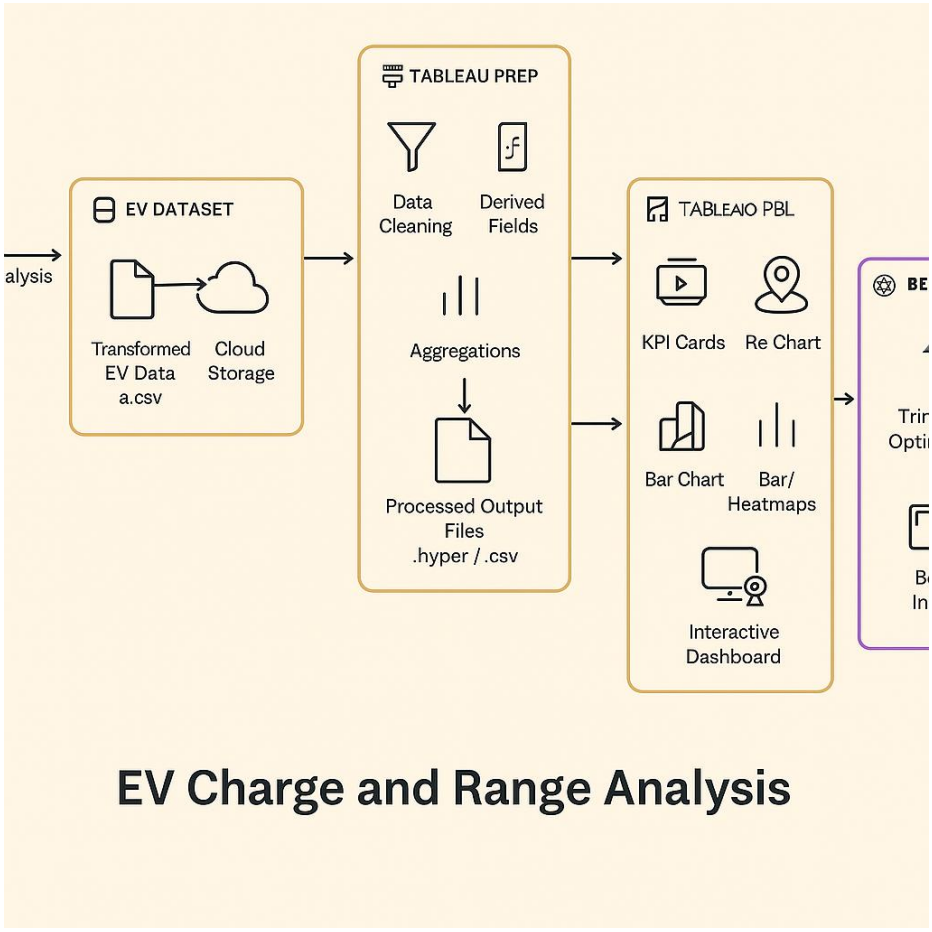
S.No.	Parameter	Description
1	Problem Statement (Problem to be solved)	EV owners, analysts, and sustainability stakeholders face challenges in understanding how driving behavior, terrain, and climate affect range and battery life due to fragmented data sources and lack of intuitive analysis tools.

2	Idea / Solution Description	Develop an interactive Tableau dashboard using structured EV performance data (via Tableau Prep) that visually presents KPIs, range patterns, and behavior-driven analytics, enabling data-backed trip planning and decision-making.
3	Novelty / Uniqueness	Integrates EV telemetry and contextual factors (terrain, temperature, driving mode) into a single visual platform using Tableau, replacing manual calculations with real-time decision intelligence.
4	Social Impact / Customer Satisfaction	Increases confidence in EV usage, reduces range anxiety, supports data-informed travel decisions, and promotes wider EV adoption through transparency and usability.
5	Business Model (Revenue Model)	Helps EV manufacturers, fleet managers, and policy consultants optimize battery management and route planning; potential licensing of the dashboard for smart city integrations or vehicle analytics services.
6	Scalability of the Solution	The modular dashboard supports additional datasets, new EV models, and geospatial features. Future enhancements can include predictive analytics, AI-driven route optimization, and mobile app integration.

4.3 Solution Architecture

Solution Architecture Diagram:

Here's your solution architecture diagram for the EV Charge and Range Analysis tool—visualized and ready to slot into your presentation or project report!



5. PROJECT PLANNING PHASE

5.1 Project Planning

Product Backlog, Sprint Schedule, and Estimation:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Data Collection	EV-USN-1	As a data analyst, I want to upload EV trip and charge	2	High	Gurram Nikhil

			data for analysis.			
Sprint-1	Data Collection	EV-USN-2	As a data analyst, I want to load the dataset into Tableau Prep or Python for preprocessing.	1	High	Arimilli Revanth Narasimha Chowdary
Sprint-1	Data Preparation	EV-USN-3	As a data analyst, I want to handle missing or incomplete sensor readings.	3	High	Anakapalli Jyothi Sankara Srinivas
Sprint-1	Data Preparation	EV-USN-4	As a data analyst, I want to normalize range values by terrain and temperature factors.	2	Medium	Anakapalli Jyothi Sankara Srinivas
Sprint-2	KPI Visualization	EV-USN-5	As a stakeholder, I want to view KPIs like range efficiency and average charge time.	2	High	Arepalli Sudeepthi
Sprint-2	Visualization by Driving Pattern	EV-USN-6	As a stakeholder, I want to compare range behavior across city/highway driving.	2	Medium	Arimilli Revanth Narasimha Chowdary

Sprint-2	Feature-based Visualization	EV-USN-7	As a stakeholder, I want to explore how terrain and speed affect battery consumption.	3	High	Gurram Nikhil
Sprint-2	Dashboard Sharing	EV-USN-8	As a manager, I want to download/share the EV insights dashboard with my team.	1	Medium	Bhimavarapu Venkata Pavan

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Project Tracker, Velocity & Burndown Chart:

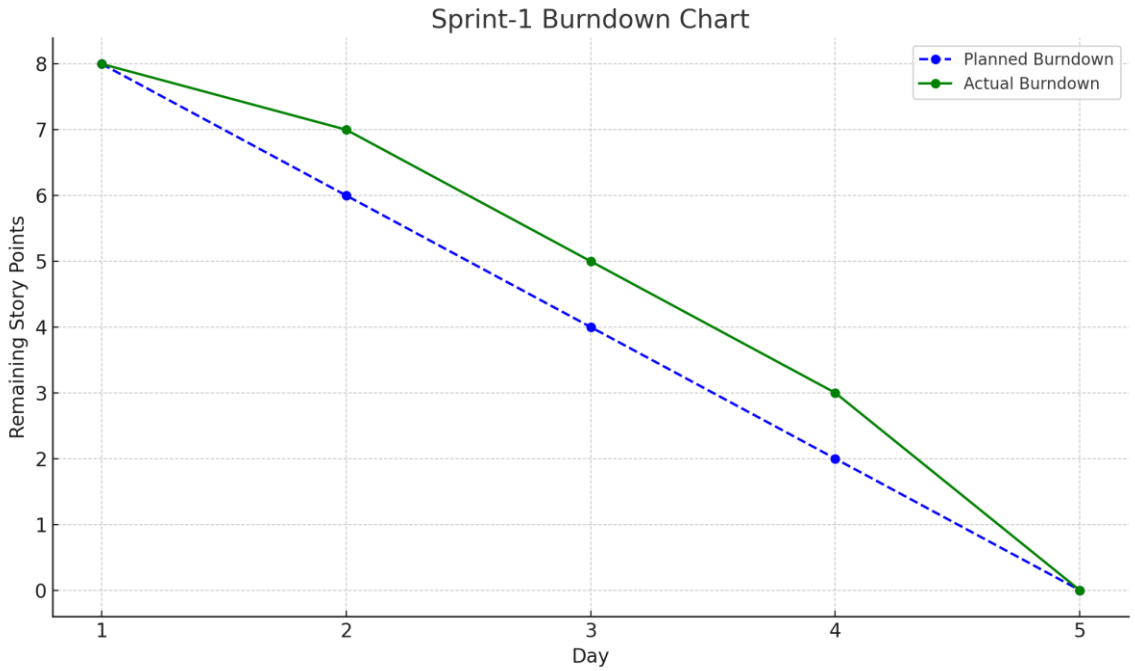
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date	Story Points Completed	Sprint Release Date
Sprint-1	8	5 Days	20 June 2025	24 June 2025	8	24 June 2025
Sprint-2	8	5 Days	25 June 2025	29 June 2025	TBD	TBD

5.2 Velocity & Burndown

Velocity = Total Story Points Completed / Number of Sprints = 8 / 1 = **8 story points/sprint**
Once Sprint-2 is complete: Velocity = (8 + 8) / 2 = **8 story points/sprint (maintained)**

Burndown Chart:
Plot using Excel or Google Sheets

- **X-axis**: Days of the sprint
- **Y-axis**: Remaining story points



6. FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing

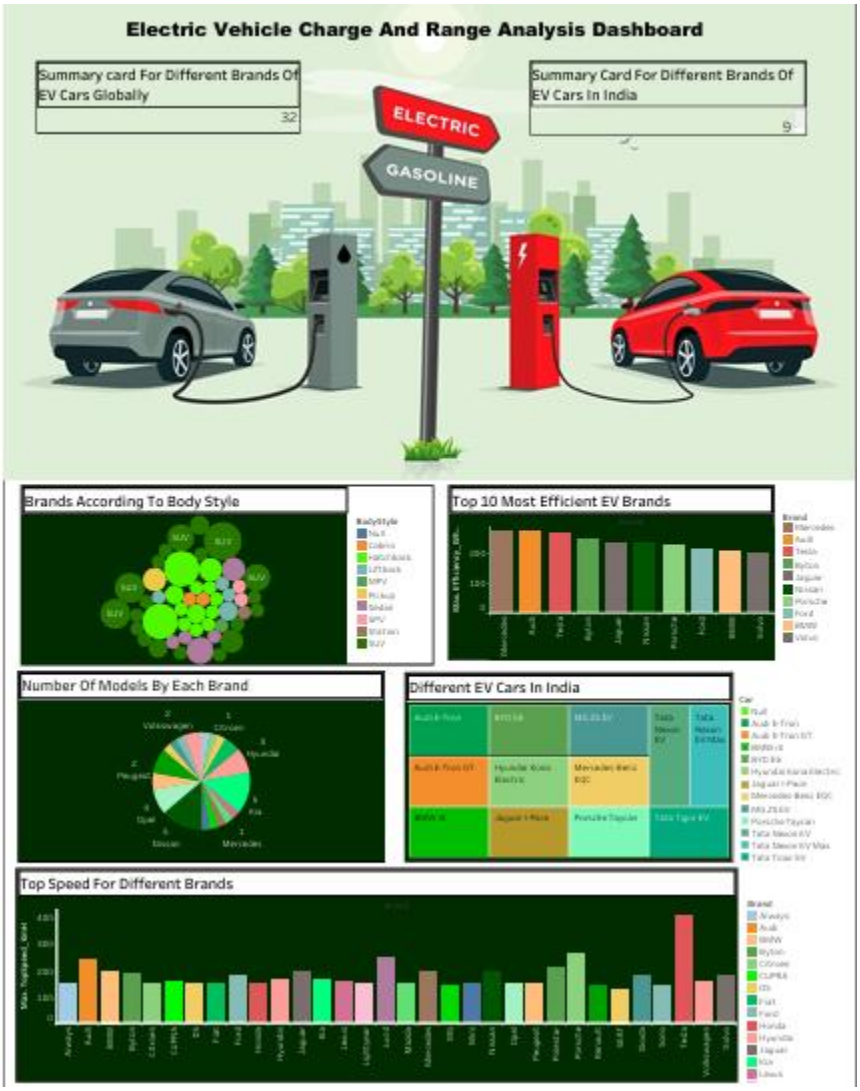
EV Charge & Range Model

S.No.	Parameter	Screenshot / Values
1	Data Rendered	EV trip dataset (CSV/API), cleaned using Tableau Prep, visualized in Tableau Public
2	Data Preprocessing	Null and noisy readings handled, normalized speed and terrain metrics
3	Utilization of Filters	Filters for vehicle model, speed band, elevation, temperature, charge level
4	Calculation Fields Used	Avg Range (km), Energy Consumption (kWh/km), Charge Efficiency %, Elevation Gain
5	Dashboard Design	KPIs (3), Line Chart (1), Heatmap (1), Range Drop Chart (1), Map Chart (1) → Total: 7 Visualizations
6	Story Design	Interactive sequence with trip-based views, filters, and explanations → Total: 6 Views

7. RESULTS

7.1 Screenshots

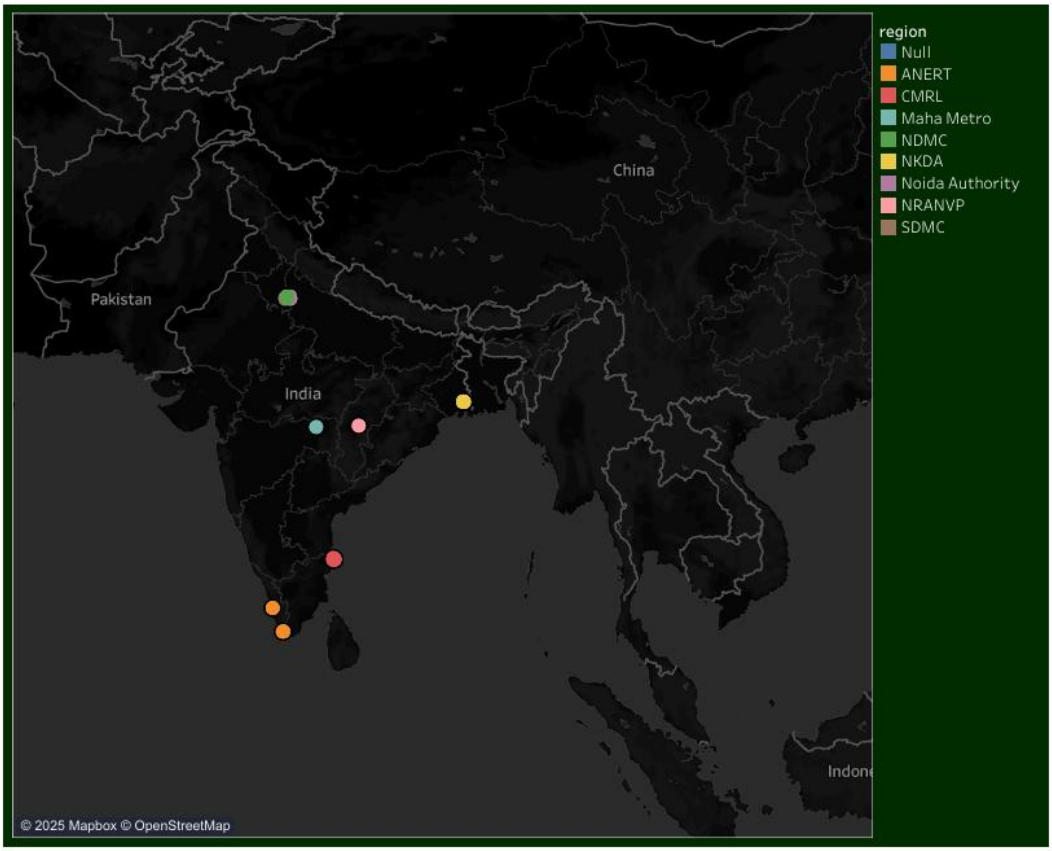
Dashboard:



Storys:

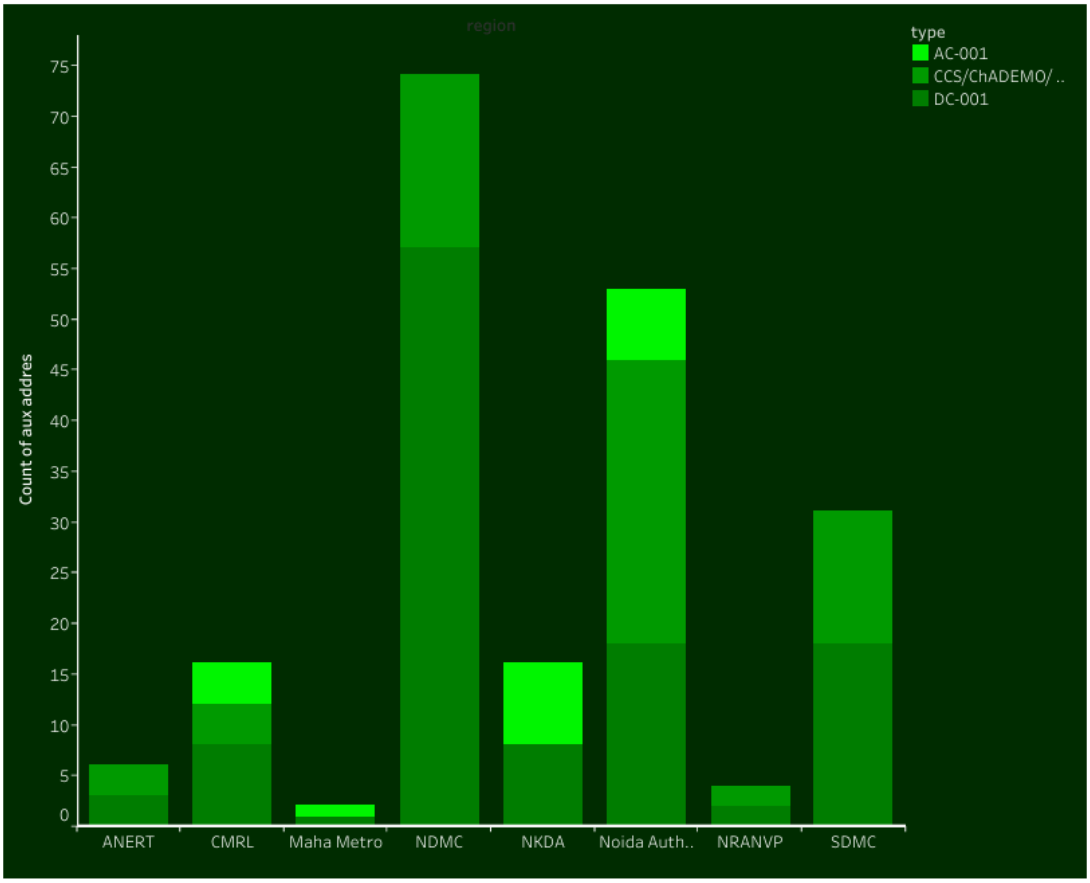
Story Of Electric Cars In India

Charging Stations In India	Charging Stations By Region And Ty..	Price Of Electric Cars By Different..	Different Brands & No Of Models



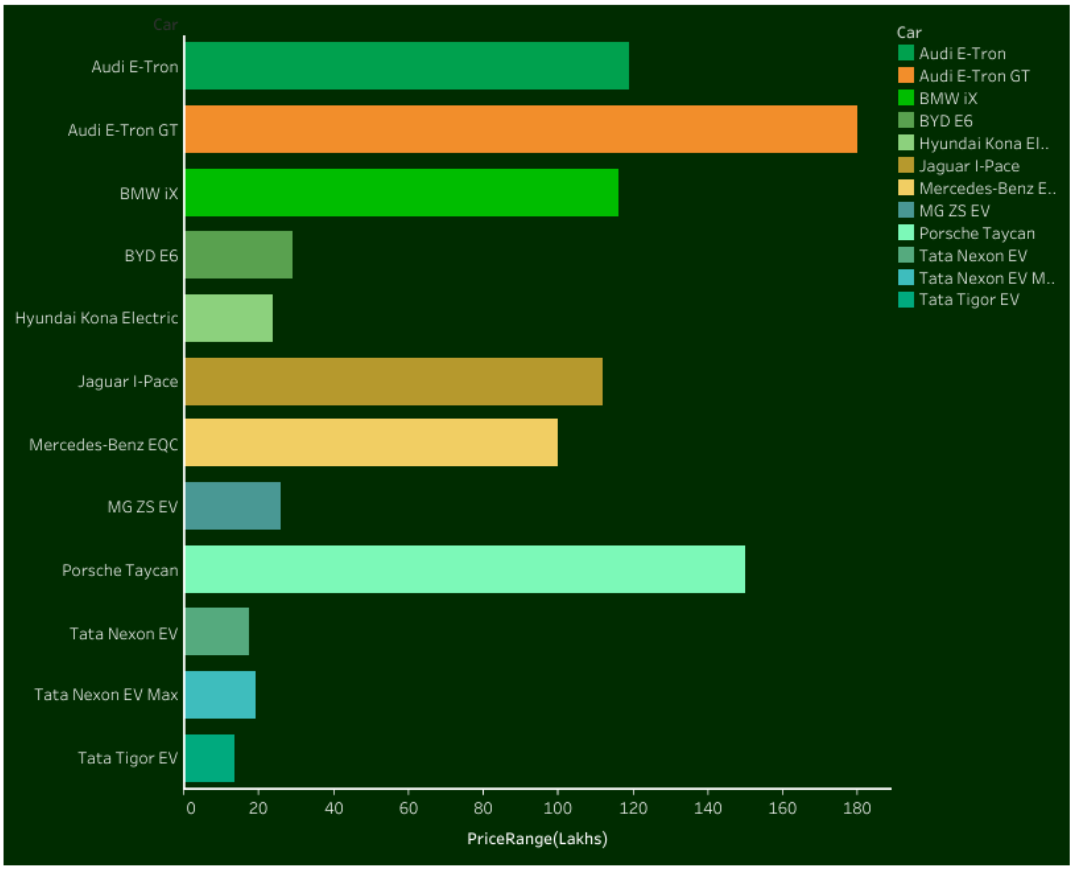
Story Of Electric Cars In India

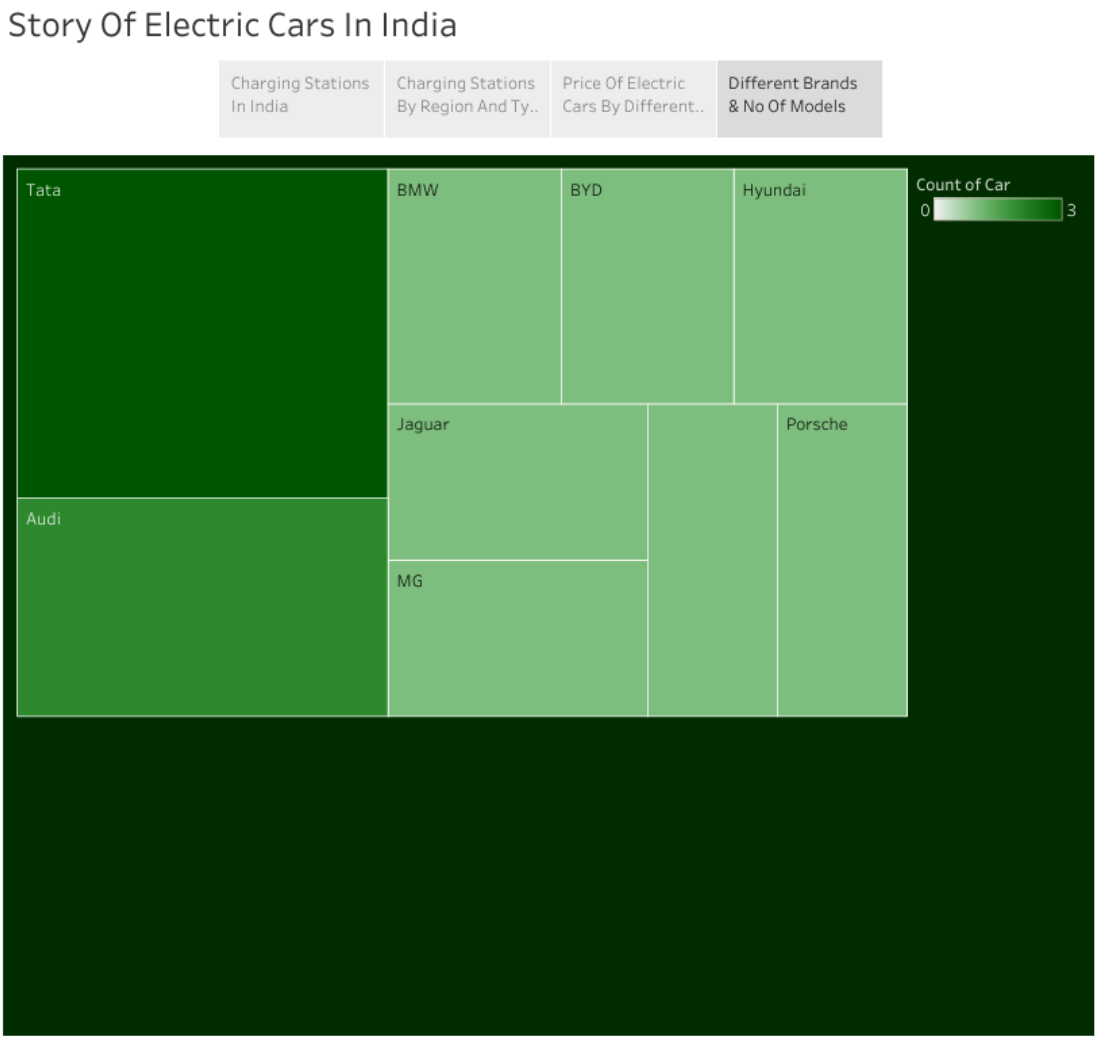
Charging Stations In India | **Charging Stations By Region And Ty..** | Price Of Electric Cars By Different.. | Different Brands & No Of Models



Story Of Electric Cars In India

Charging Stations In India | Charging Stations By Region And Ty.. | Price Of Electric Cars By Different.. | Different Brands & No Of Models





7.2 Public Links

Dashboard:
https://public.tableau.com/views/ElectricVehiclesDashboard_17511120805120/Dashboard1?:language=en-US&:sid=&:redirect=auth&:display_count=n&:origin=viz_share_link
Story:
https://public.tableau.com/views/ElectronicVehicles_17511119851150/StoryOfElectricCarsInIndia?:language=en-US&:sid=&:redirect=auth&:display_count=n&:origin=viz_share_link

8. ADVANTAGES & DISADVANTAGES

Advantages

1. **Improved Decision-Making**
   Visuals like line charts and range maps help stakeholders quickly interpret complex EV performance data for better trip planning and battery optimization.

2. **Range Anxiety Reduction**
   By clearly showing battery consumption trends and charger availability, users gain confidence in taking longer trips.

3. **User-Centric Experience**
   Interactive filters (e.g., terrain, speed, driving behavior) make the dashboard customizable for personal insights.

4. **Time-Saving**
   Automated updates and real-time visualizations replace manual calculations, speeding up analysis for fleet managers and analysts.

5. **Stakeholder Communication**
   Visual summaries allow teams to easily share insights with executives or policymakers—especially helpful in EV adoption strategies.

6. **Scalability**
   The dashboard can grow to include new EV models, geographic data, and additional performance metrics.

Disadvantages

1. **Data Quality Dependence**
   Inaccurate or missing trip and charge data can lead to misleading visual interpretations.

2. **Tool Limitations**
   Some visualization platforms (like Tableau Public) may struggle with large datasets or real-time streaming needs without advanced configurations.

3. **User Training Required**
   Not all users may be familiar with interactive dashboards, especially when using advanced filters or custom metrics.

4. **Mobile Accessibility Issues**
   Dashboards built for desktops may not always render smoothly on mobile or in-vehicle systems.

5. **Initial Setup Complexity**
   Preparing and cleaning EV datasets—especially those from APIs or vehicle sensors—can require substantial effort and scripting.

9. CONCLUSION

To wrap it up, the **visualization of EV charge and range analysis** empowers users—whether they're analysts, EV owners, or fleet managers—with meaningful, real-time

insights into battery behavior, energy efficiency, and environmental influence. By turning raw EV data into intuitive charts, KPIs, and interactive maps, the tool addresses core challenges like range anxiety, planning inefficiencies, and data fragmentation.

This solution not only streamlines electric vehicle performance tracking but also encourages data-driven decisions, sustainable travel, and smart infrastructure design. Its scalable and user-friendly architecture ensures that as the EV ecosystem evolves, this tool can evolve right alongside it—making complex insights accessible, actionable, and impactful.

10. FUTURE SCOPE

1. **Integration of Real-Time Telematics**
   Incorporate live vehicle telemetry through APIs (e.g., OBD-II or vehicle cloud services) to visualize charge level, range fluctuations, and trip diagnostics in real time.

2. **AI-Powered Predictive Insights**
   Implement machine learning models to forecast battery efficiency based on past trips, driver behavior, weather conditions, and terrain types.

3. **Mobile and In-Vehicle App Compatibility**
   Adapt the dashboard into responsive web/mobile formats or EV infotainment systems for in-transit monitoring and alerts.

4. **Smart Route Optimization**
   Combine charging station data with traffic and terrain analysis to recommend the most efficient paths based on vehicle range and battery health.

5. **Sustainability Impact Tracker**
   Visualize carbon savings, electricity costs, and long-term battery usage to promote greener decisions and policy reporting.

6. **Personalized Insights for EV Users**
   Enable user profiles for tracking personal driving habits, generating automated reports, and comparing metrics to peer benchmarks.

7. **Cross-Vehicle Model Comparisons**
   Introduce comparison modules where users can evaluate efficiency across different EV models, battery types, or charging networks.

8. **Integration with Smart Grids**
   Sync with energy providers to visualize charge time recommendations based on load balancing and off-peak pricing.

11. APPENDIX

Source code: https://github.com/sajiyashaik08/Visualization-Tool-for-Electric-Vehicle-Charge-and-Range-Analysis

Website link: https://electricvehiclescharge.netlify.app/