Visualization Tool for Electric Vehicle Charge and Range Analysis

1. INTRODUCTION

1.1 Project Overview

India has the third-largest road network in the world, making the transition to electric mobility a national priority. With rising concerns over urban air quality and global climate commitments, the shift from Internal Combustion Engine (ICE) vehicles to Electric Vehicles (EVs) is gaining momentum. This transition is fueled by government policies, increasing EV model availability, and the urgent need for cleaner transportation.

Multiple stakeholders — including policymakers, technologists, energy authorities, and automotive industries — are now working to accelerate EV adoption by improving infrastructure, enabling data-driven decisions, and removing adoption barriers. This project contributes to that mission by creating a visual analytics tool that empowers users to explore, compare, and evaluate EV models and charging availability in India.

1.2 Purpose

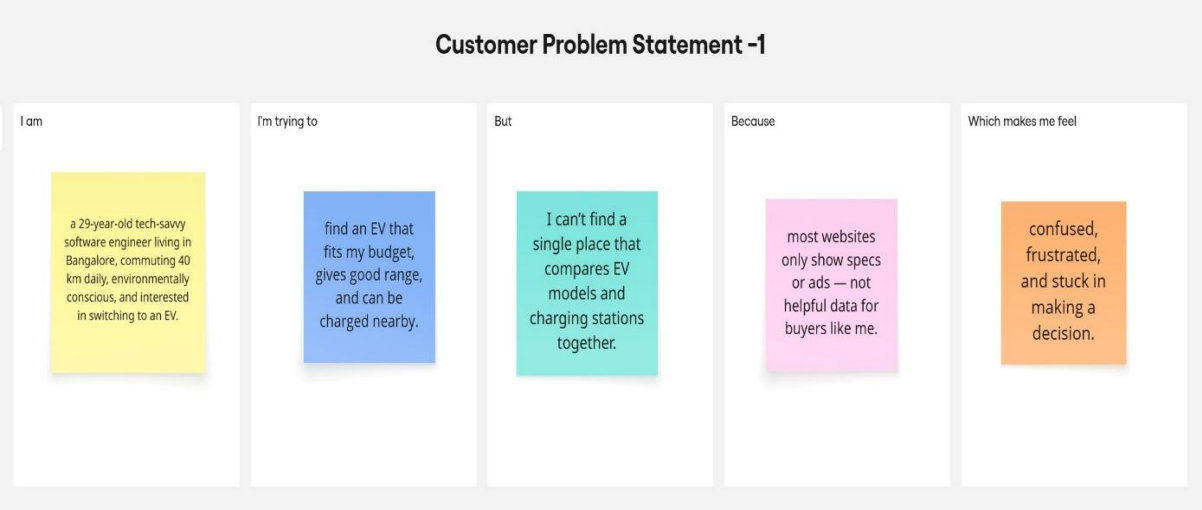
The increasing variety of electric vehicle (EV) models — including passenger cars, buses, vans, and even heavy goods vehicles — marks a major shift in the global transportation landscape. With over 40 highway-capable EV models already available and more set to launch soon, consumers now have more choices than ever before.

Recognizing the rapid growth and opportunities in this space, this project aims to support EV adoption by providing a comprehensive visualization tool. The dashboard helps users explore EV specifications, compare models, and analyze charging infrastructure across regions. By turning complex EV data into easy-to-understand visuals, the tool empowers individuals and stakeholders to make informed, future-ready transportation decisions.

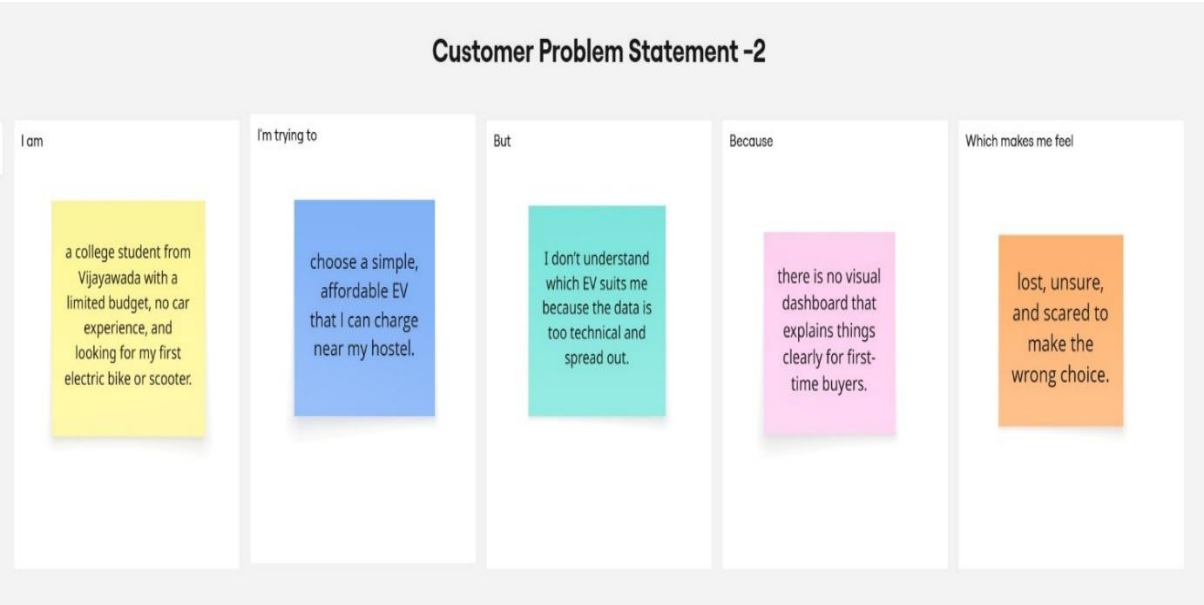
2. IDEATION PHASE

2.1 Problem Statement

Customer Problem Statement-1:



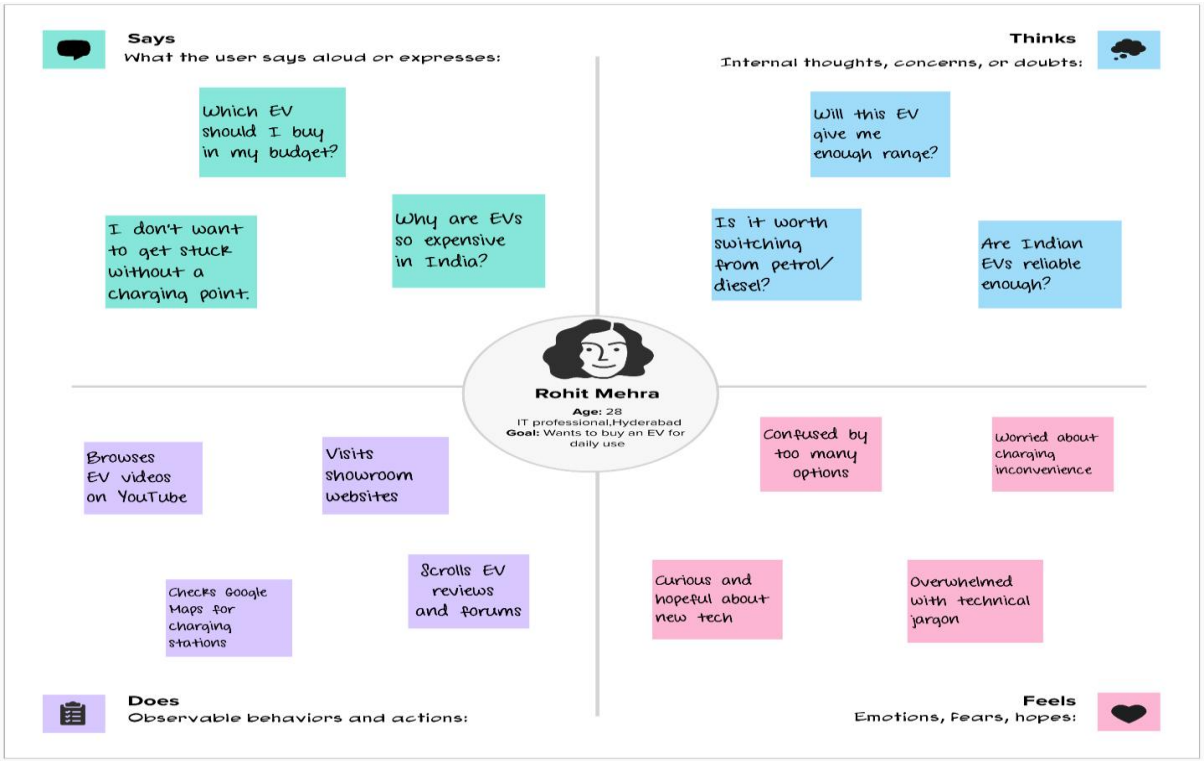
Customer Problem Statement-2:



Problem Statements :

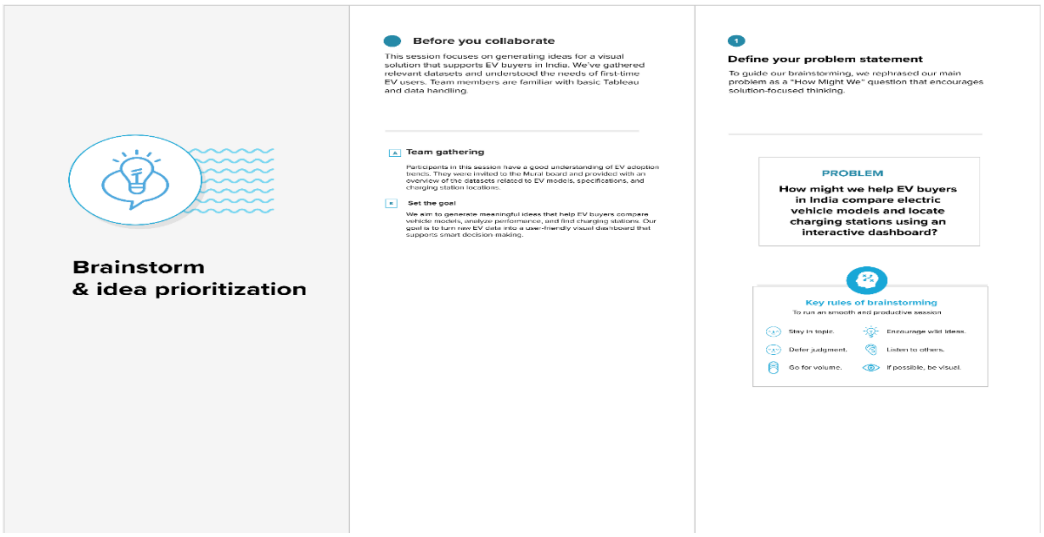
Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	a 29-year-old tech-savvy software engineer living in Bangalore, commuting 40 km daily, environmentally conscious, and interested in switching to an EV.	find an EV that fits my budget, gives good range, and can be charged nearby.	I can't find a single place that compares EV models and charging stations together.	most websites only show specs or ads — not helpful data for buyers like me.	confused, frustrated, and stuck in making a decision.
PS-2	a college student from Vijayawada with a limited budget, no car experience, and looking for my first electric bike or scooter.	choose a simple, affordable EV that I can charge near my hostel.	I don't understand which EV suits me because the data is too technical and spread out.	there is no visual dashboard that explains things clearly for first-time buyers.	lost, unsure, and scared to make the wrong choice.

2.2 Empathy Map Canvas

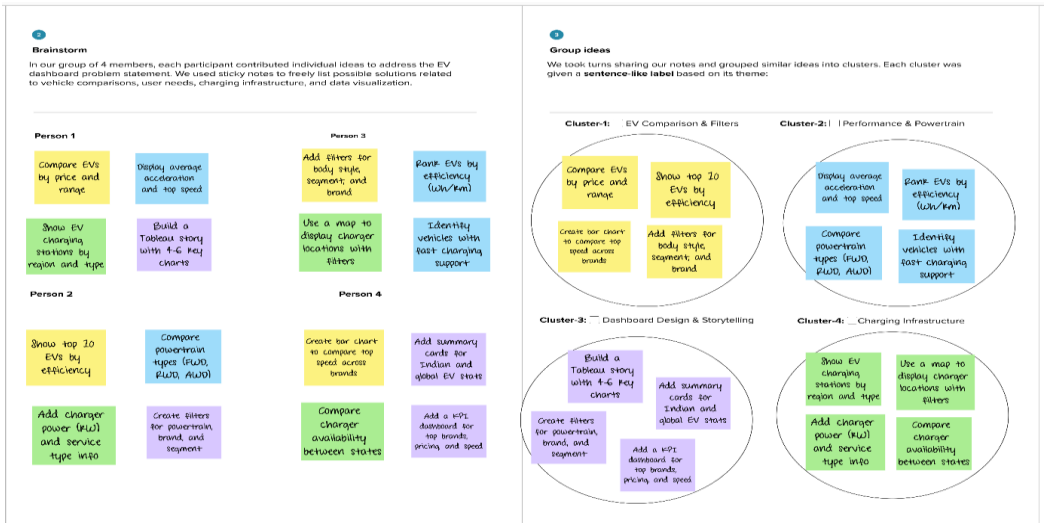


2.3 Brainstorming

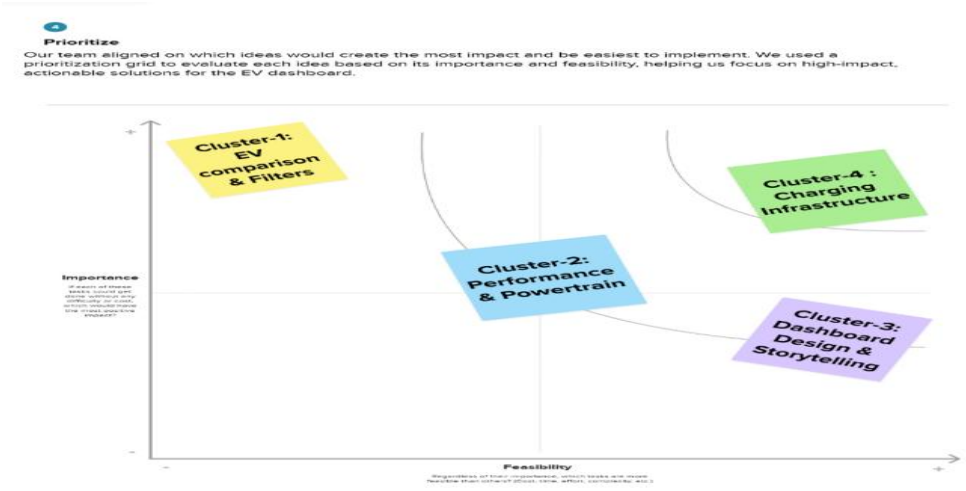
Step-1: Team Gathering, Collaboration and Select the Problem Statement:



Step-2: Brainstorm, Idea Listing and Grouping:

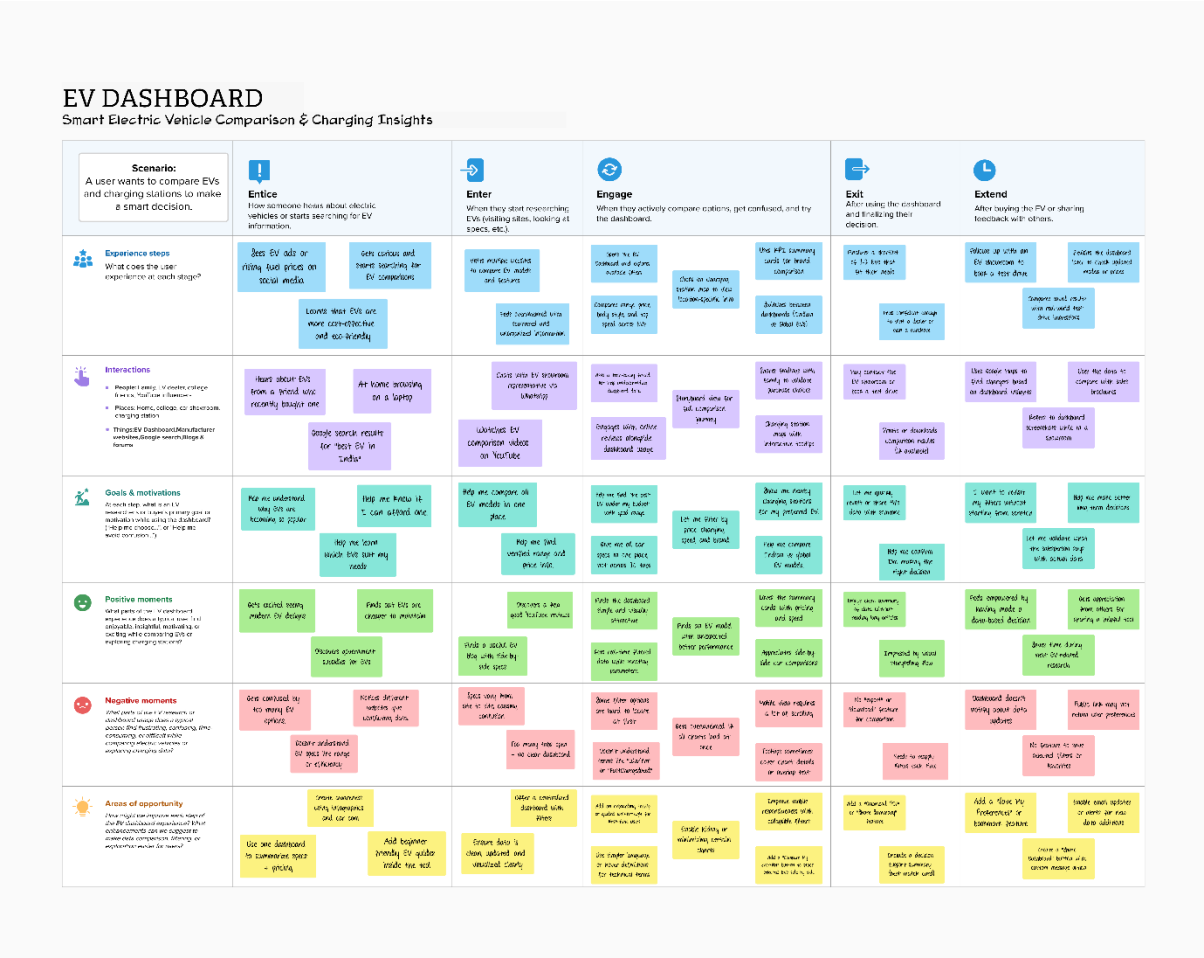


Step-3: Idea Prioritization:



3. REQUIREMENT ANALYSIS

3.1 Customer Journey map



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	**Data Import and Preparation**	Load four EV-related datasets (CSV format) into Tableau. Clean and prepare data for visualizations. Combine relevant fields for a unified view.
FR-2	**Dashboard and Visualizations**	Provide comparative charts (range, price, efficiency, etc.) of different EV models. Map EV charging stations by region and type. Enable filters (brand, powertrain, body style, segment).
FR-3	**KPI Summary Cards**	Display key insights such as average prices, top speeds, number of brands, etc.Include summary cards for India and global EV data.

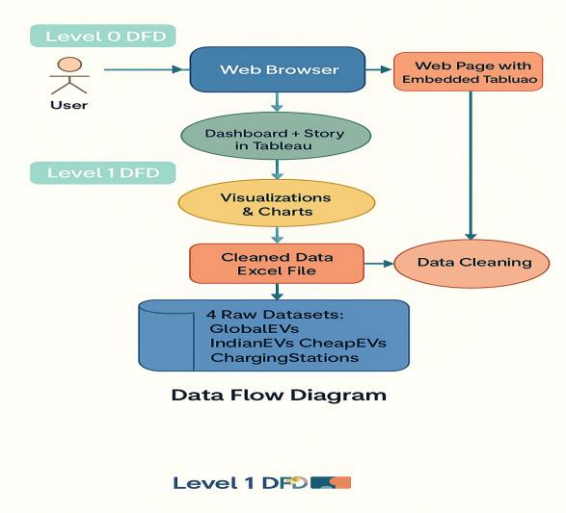
FR-4	**Storyboarding**	Construct a user-friendly story path highlighting dashboard findings. Present data in logical, decision-guiding order.
FR-5	**User Interaction**	Filters and parameters to explore different segments of EV data. Hover/tooltip features to display additional info.
FR-6	**Publishing and Access:**	Publish final dashboard and story to Tableau Public. Generate public share link.

Non-functional Requirements:

Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Dashboard must be user-friendly and intuitive for a non-technical audience.
NFR-2	**Security**	Published dashboard should not expose any sensitive or personal data.
NFR-3	**Reliability**	Dashboard should perform consistently without crashes or data loss.
NFR-4	**Performance**	Load time should be under 5 seconds for average datasets.
NFR-5	**Availability**	Dashboard should be accessible anytime via Tableau Public.
NFR-6	**Scalability**	Solution should handle increased data volume without major redesign.

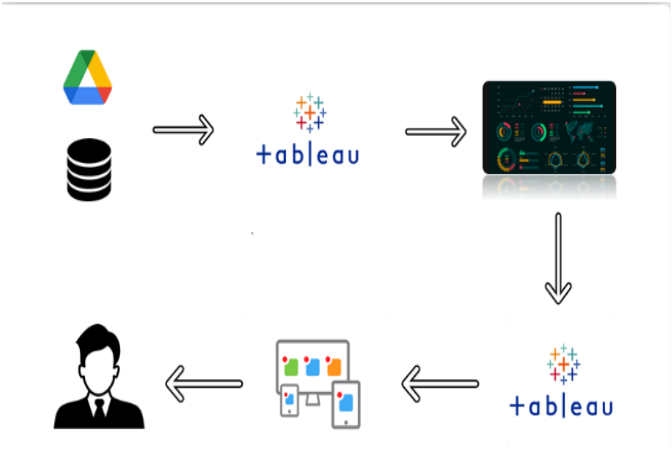
3.3 Data Flow Diagram

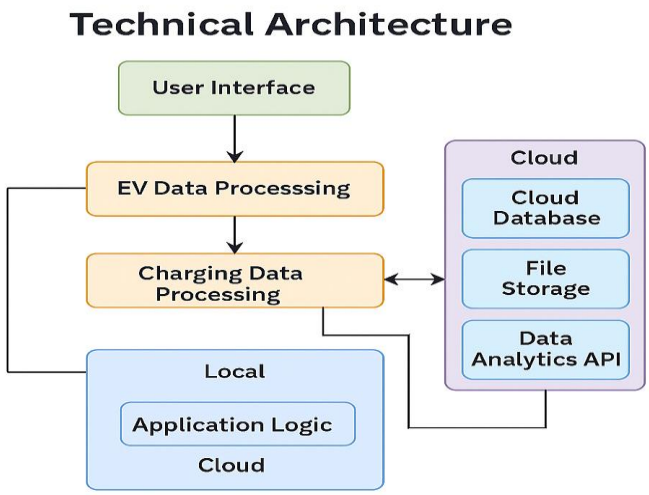


User Stories - EV Visualization Project:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance Criteria	Priority	Release
Customer (Web user)	Data Exploration	USN-1	As a user, I can view global and Indian EV data in one dashboard	I can compare price, range, and features easily	High	Sprint-1
	Charging Station Map	USN-2	As a user, I can view EV charging station locations on an interactive map	I can see location markers and zoom on city-wise regions	High	Sprint-1
	Filtering and Sorting	USN-3	As a user, I can filter EVs by price, range, and segment	Filters apply correctly and update all visuals	Medium	Sprint-2
	Story Dashboard	USN-4	As a user, I can view a visual story comparing Indian vs global EV trends	I can read narrative visual flow embedded into the web app	High	Sprint-2
	Web App Access	USN-5	As a user, I can access the dashboard via a public web page	I can open the webpage and see the Tableau visuals embedded without login	High	Sprint-1
Admin	Data Publishing	USN-6	As an admin, I can publish updated Tableau dashboards and link to the web app	Tableau links are live and reflect changes	High	Sprint-2
Developer	Web Integration	USN-7	As a developer, I can embed Tableau dashboards into a Bootstrap-based HTML page	Embedded dashboard works on different devices and loads fully	Medium	Sprint-2

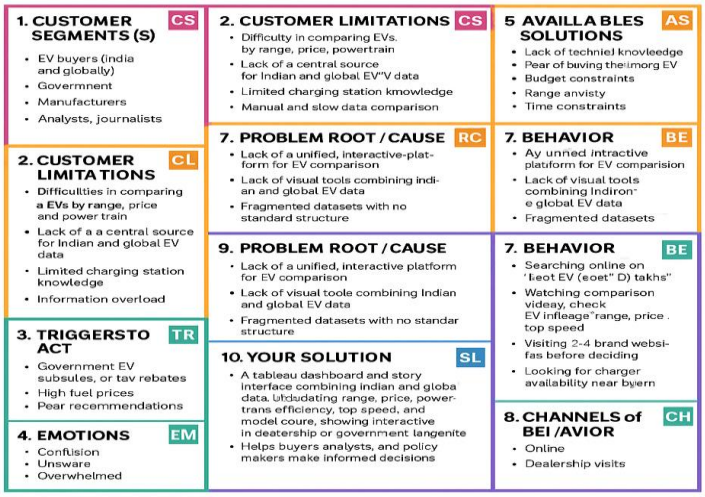
3.4 Technology Stack





4. PROJECT DESIGN

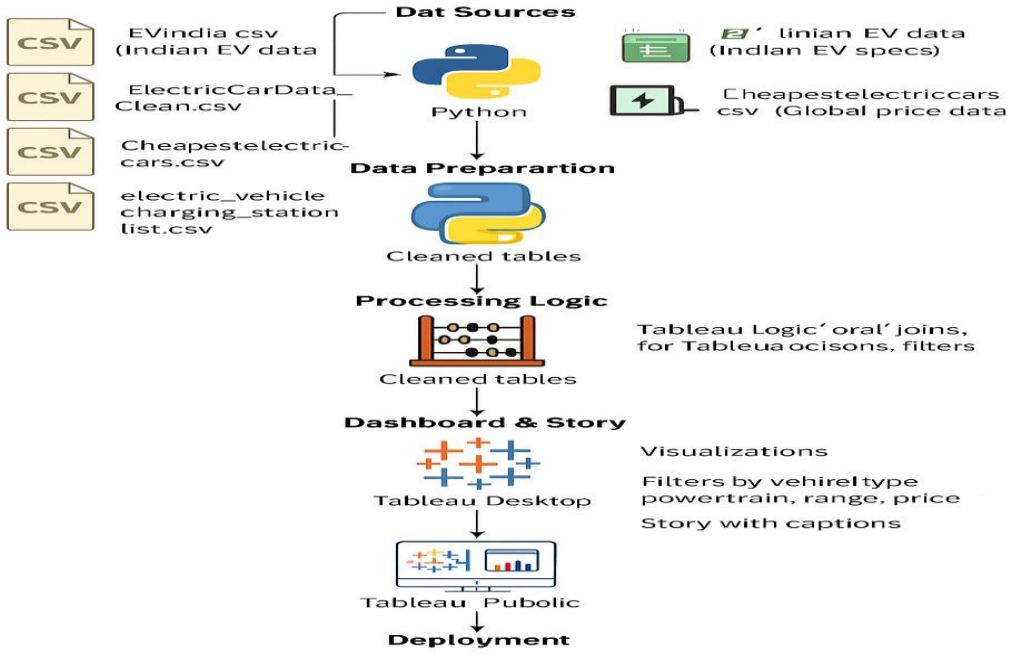
4.1 Problem Solution Fit



4.2 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement	EV buyers and researchers struggle to access centralized, visual comparisons of EVs across price, range, efficiency, and availability.
2.	Idea / Solution description	A Tableau-based dashboard that integrates 4 EV datasets to visualize Indian and global EV data by brand, specs, and charging coverage. Includes filters, KPIs, and interactive stories
3.	Novelty / Uniqueness	Combines India + global EV data in one platform. Visualizes efficiency, range, and charging infrastructure interactively. Includes behavioral insight-based story slides.
4.	Social Impact / Customer Satisfaction	Helps buyers make informed decisions, promotes EV adoption, aids sustainability goals, and supports government/industry awareness.
5.	Business Model (Revenue Model)	Freemium insights. Advanced analytics and brand custom dashboards for manufacturers and state departments. Sponsorship, affiliate leads.
6.	Scalability of the Solution	Add more datasets (real-time charging API, battery health data), include predictive analytics, embed in dealership and government portals.

4.3 Solution Architecture



Solution Architecture and Data flow of the EV Data Visualization Platform

5. PROJECT PLANNING & SCHEDULING

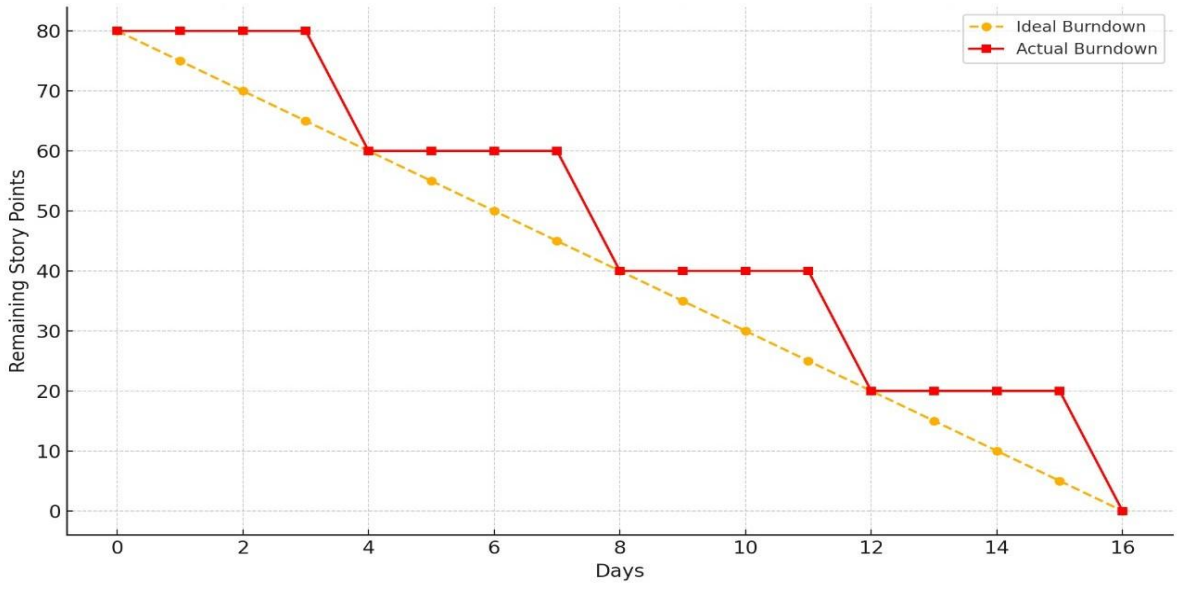
5.1 Project Planning

Product Backlog, Sprint Schedule, and Estimation :

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Data Integration	USN-1	As a developer, I can load and integrate multiple EV-related datasets into Tableau	3	High	Inapakolla Sai Saranya
Sprint-1	Data Preprocessing	USN-2	As a developer, I can clean and format data fields (e.g., city names, range categories)	2	High	Anurag Guptha
Sprint-2	Visual Analysis	USN-3	As a user, I can view EV growth trends using line and area charts	3	Medium	Nadipalli Devakiran
Sprint-2	Visual Analysis	USN-4	As a user, I can compare EV brands by range and cost using bar, bubble, and pie charts	3	High	Adadi Mouli Sri Priya
Sprint-3	Interactive Dashboard	USN-5	As a user, I can log into the application by entering email & password	2	High	Nadipalli Devakiran
Sprint-3	KPI and Comparison Cards	USN-6	As a user, I can navigate story points to understand EV market insights	2	Medium	Inapakolla Sai Saranya
Sprint-4	Storytelling Dashboard	USN-7	As a user, I can navigate a story dashboard that presents insights on EV adoption.	3	High	Adadi Mouli Sri Priya
Sprint-4	Documentation & Testing	USN-8	As a team, we can prepare project documentation and test the performance of visuals.	2	Medium	Nadipalli Devakiran

Project Tracker, Velocity & Burndown Chart:

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	4 Days	31 Jan 2025	03 Feb 2025	20	03 Feb 2025
Sprint-2	20	4 Days	04 Feb 2025	07 Feb 2025	20	07 Feb 2025
Sprint-3	20	4 Days	08 Feb 2025	11 Feb 2025	20	11 Feb 2025
Sprint-4	20	4 Days	12 Feb 2025	15 Feb 2025	20	15 Feb 2025



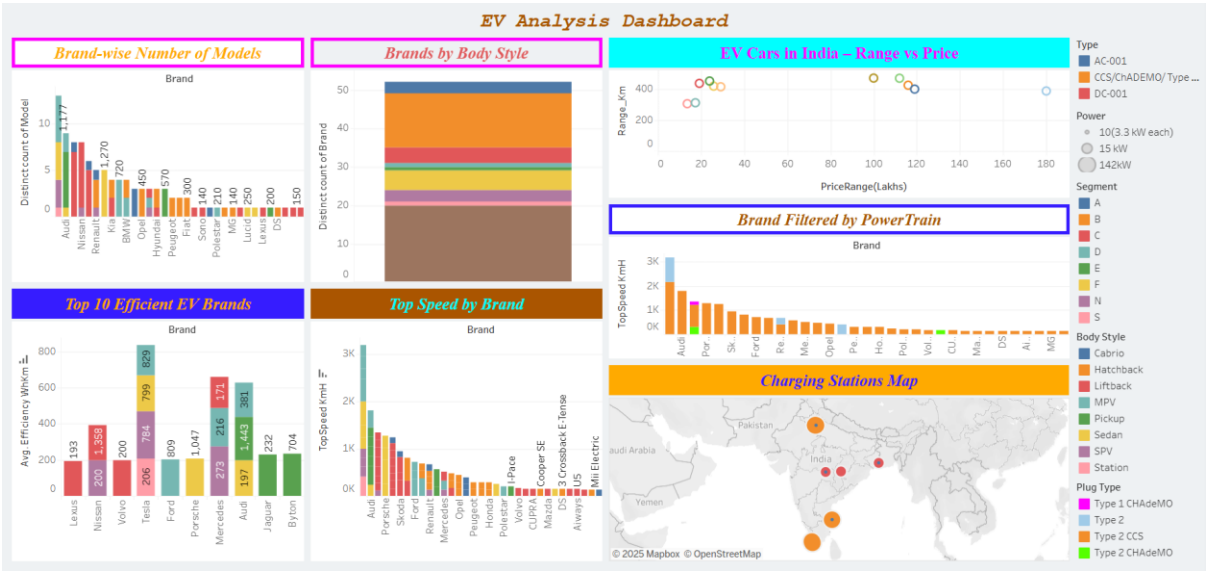
6. FUNCTIONAL AND PERFORMANCE TESTING

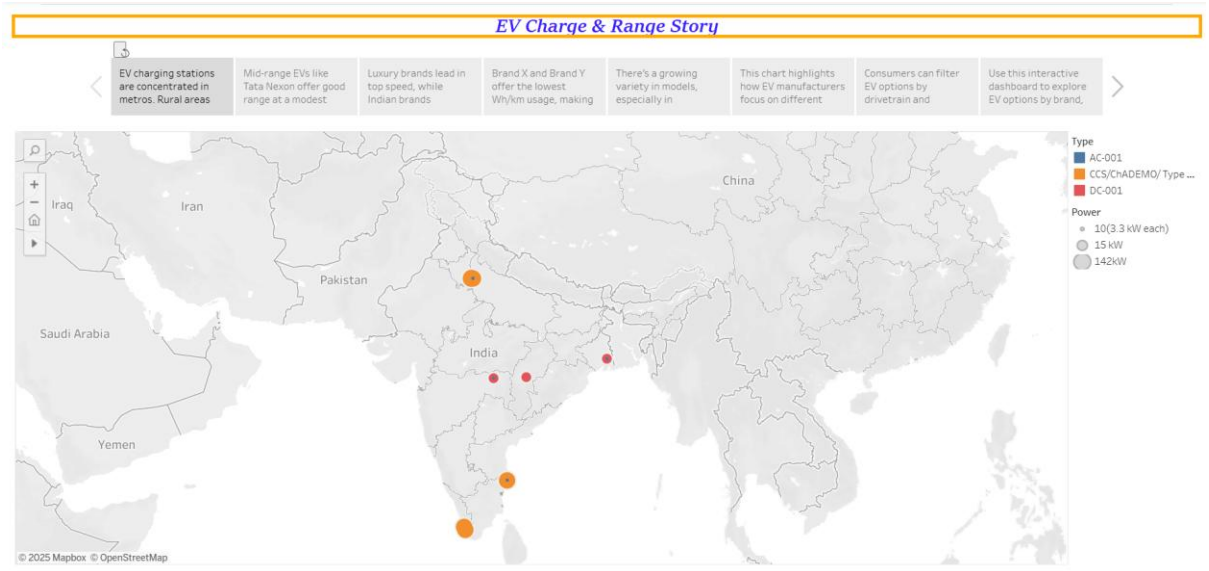
6.1 Performance Testing

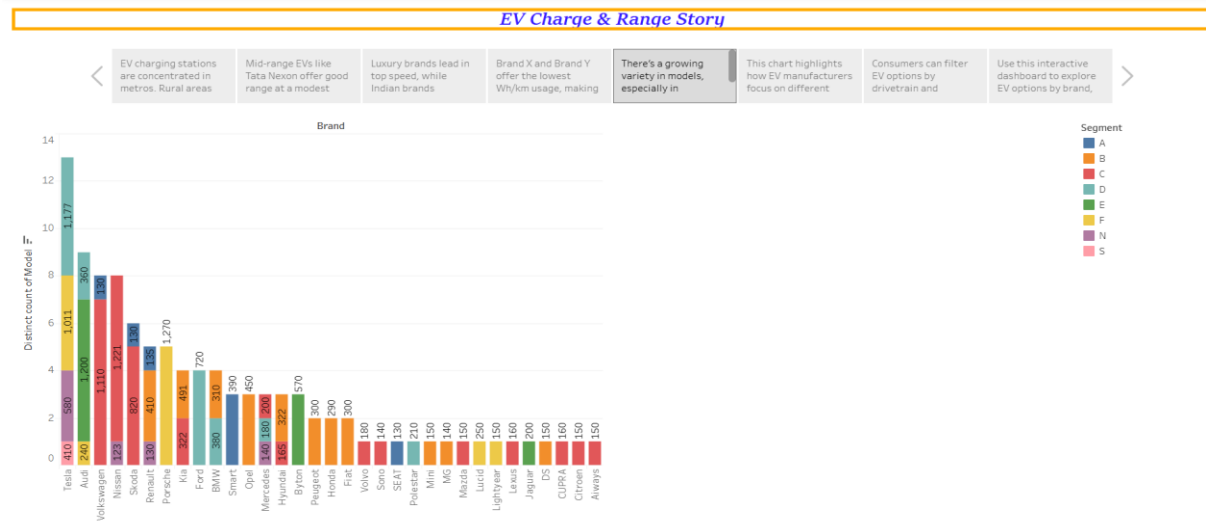
S.No.	Parameter	Screenshot / Values
1.	Data Rendered	**Data from 4 datasets:** • EVIndia.csv • Electric_vehicle_charging_station_list.csv • ElectricCarData_Clean.csv • Cheapestelectriccars-EVDatabase.csv
2.	Data Preprocessing	•Removed null/missing values •Cleaned inconsistent labels (e.g., station types, city names) •Extracted fields like Year, Range Category, City-wise Count
3.	Utilization of Filters	**Applied Filters:** • City • Year • Manufacturer • Charging Type • Range (km) • Price Range
4.	Calculation fields Used	• Total Stations per City • Average Range by Manufacturer • Cost per km • Custom bins for Range and Price
5.	Dashboard design	No of Visualizations / Graphs – 11 • All major charts (Map, Line, Bar, Pie,Bubble,KPI cards, etc.) arranged with interactivity
6	Story Design	No of Visualizations / Graphs -8 • Full walkthrough from EV adoption to charging infra to cost & range analysis • Story points with annotations for better interpretation

7. RESULTS

7.1 Output Screenshots







EV Charge & Range Story

EV charging stations are concentrated in metros. Rural areas | Mid-range EVs like Tata Nexon offer good range at a modest | Luxury brands lead in top speed, while Indian brands | **Brand X and Brand Y offer the lowest Wh/km usage, making** | There's a growing variety in models, especially in | This chart highlights how EV manufacturers focus on different | Consumers can filter EV options by drivetrain and | Use this interactive dashboard to explore EV options by brand,

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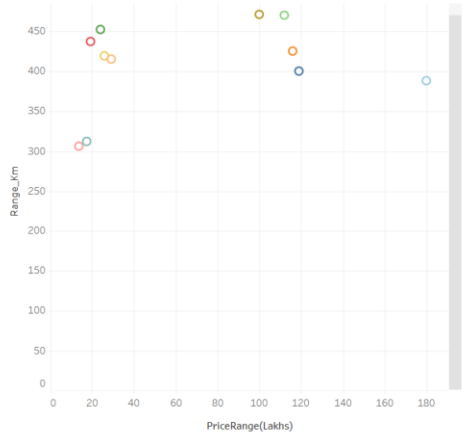

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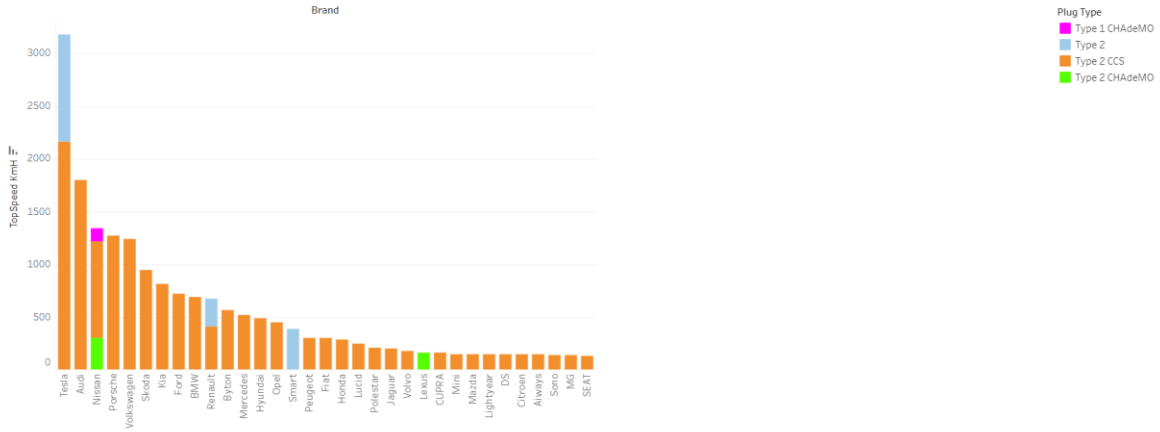

8. ADVANTAGES & DISADVANTAGES

8.1 Advantages of Electric Vehicles

- **Eco-Friendly:** EVs do not burn fuel, so they emit no harmful gases. This helps reduce air pollution and contributes to a cleaner environment.
- **Renewable Energy Source:** Unlike conventional vehicles that rely on fossil fuels, EVs can run on renewable energy sources, helping preserve natural resources.
- **Less Noise and Smoother Motion:** EVs operate more quietly due to fewer moving parts, providing a smooth and noise-free driving experience.
- **Cost-Effective:** Electricity is cheaper than petrol or diesel, and if solar energy is used at home, charging becomes even more economical.
- **Low Maintenance:** With fewer moving components, EVs experience less wear and tear. Maintenance is simpler and more affordable than for ICE vehicles.
- **Government Support:** Many governments offer incentives, subsidies, and tax benefits to encourage the adoption of electric vehicles.

8.2 Disadvantages of Electric Vehicles

- **High Initial Cost:** EVs still have a relatively high purchase price, making them less accessible to some buyers.
- **Limited Charging Stations:** Charging infrastructure is still developing, especially for long-distance travel where stations may not be readily available.
- **Long Charging Time:** Unlike petrol refueling, charging an EV can take several hours depending on the charger type.
- **Limited Model Options:** Compared to ICE vehicles, fewer EV models are currently available with fewer choices for customization.
- **Shorter Driving Range:** Most EVs have a limited range per charge, which can be a drawback for long-distance travel.

8.3 Applications of Data Visualization in the Project

In today's data-driven world, data visualization plays a crucial role in simplifying complex data and delivering insights in an intuitive way. Visual elements like charts, maps, and graphs help users quickly understand trends, patterns, and anomalies in large datasets.

In this project, data visualization is used to help users explore and compare electric vehicles efficiently. For example:

- Visualizing top speed by brand enables customers to clearly understand performance differences.

- Interactive charts and filters allow users to evaluate EVs based on price, range, body style, and charging options.

These insights empower potential EV buyers with accurate, real-time data to make smarter and more informed purchase decisions.

9. CONCLUSION

Electric vehicles represent the future of sustainable transportation. With zero tailpipe emissions, they offer a cleaner alternative to conventional vehicles and play a key role in reducing environmental pollution.

While challenges such as limited range, slow charging, and lack of widespread charging infrastructure remain, the long-term economic and environmental benefits make EVs a viable solution. As fossil fuel prices rise and awareness around climate change grows, the shift toward electric mobility is accelerating.

Governments are providing incentives, and manufacturers are releasing advanced EV models to meet growing demand. Despite current limitations, electric vehicles are expected to dominate the automotive landscape by 2040, driving both innovation and sustainability forward.

10. FUTURE SCOPE

Electric vehicles are poised to become a transformative innovation in the automotive industry. As they produce zero greenhouse gas emissions, EVs are an essential part of the shift toward sustainable transportation and environmental conservation.

Despite current limitations like limited driving range, charging delays, and insufficient infrastructure, the long-term potential of EVs remains strong. As fossil fuel costs continue to rise and environmental awareness increases, EV adoption is expected to accelerate significantly.

By 2040, most vehicles on the road are predicted to be electric. Continued government support, investment in charging networks, and advancements in battery technology will help overcome existing challenges. The ongoing efforts by manufacturers to introduce high-performance EVs further solidify the promising future of electric mobility.

11. APPENDIX

Dataset Link:

https://drive.google.com/drive/folders/1Rkzdks6Us1Uq2SRB4nxMAb83jN5bpHll

Dashboard Link:

https://public.tableau.com/views/EVVisualizationdashboard/Dashboard1?:language=en-GB&:sid=&:redirect=auth&:display_count=n&:origin=viz_share_link

Storycard Link:

https://public.tableau.com/views/Book1_17506991323880/EVChargeRangeStory?:language=en-GB&:sid=&:redirect=auth&:display_count=n&:origin=viz_share_link

GitHub Link :

https://github.com/Saranya2635/Visualization-Tool-for-Electric-Vehicle-Charge-and-Range-Analysis

Project Demo Link:

https://drive.google.com/file/d/11dU2Q4mZtVNrLUuMcmORw3XcNcnDxqQi/view?usp=drivesdk