Final Report

Project Title:

Visualization Tool For Electric Vehicle Charge And Range Analysis

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Interactive Visualization Dashboard for Electric Vehicle Range and Charging Insights: Case Study

1. Introduction

1.1 Project Overview

The growing adoption of electric vehicles (EVs) has highlighted the need for tools that provide better visibility into battery usage, driving behavior, and range estimation. This project focuses on the design and development of an interactive visualization dashboard that enables users—such as EV owners, fleet managers, and infrastructure planners to analyze EV charge levels, driving patterns, and remaining range in a user-friendly and insightful manner.

1.2 Purpose

Visualize key EV performance metrics such as battery charge level, estimated range, energy

consumption, and charging events.

Analyze the impact of driving behavior (e.g., speed, acceleration, terrain) on battery usage and remaining range.

Reduce range anxiety by offering users accurate and real-time insights into vehicle range and charging needs.

Assist in route and trip planning by showing battery status and charging station availability on interactive maps.

2. IDEATION PHASE

2.1 Problem Statement

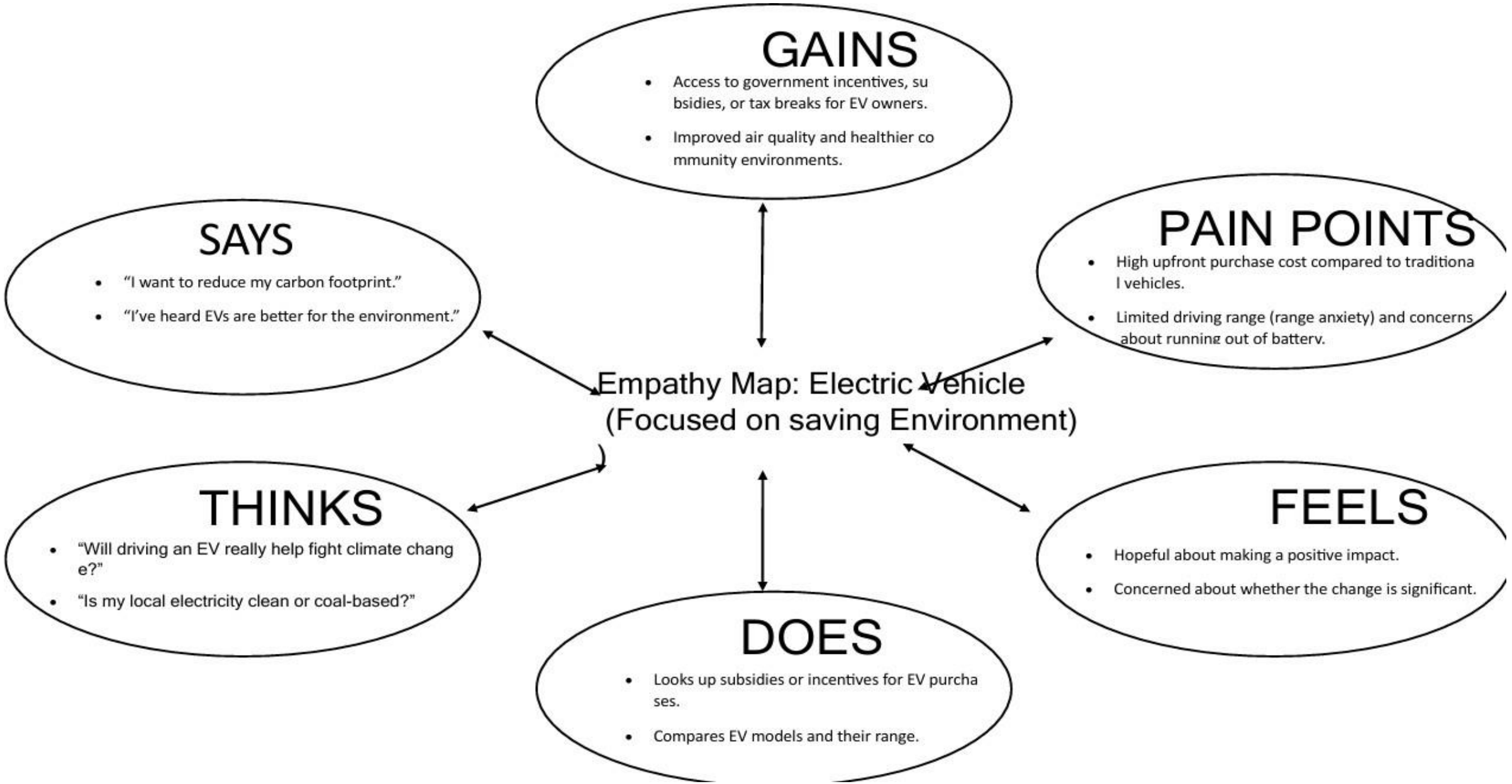
Problem Statement: Electric Vehicle for making sustainable environment

The rapid growth of urbanization and vehicular population in India has significantly increased greenhouse gas emissions, contributing to deteriorating air quality and environmental degradation. Traditional internal combustion engine (ICE) vehicles are a major source of carbon dioxide (CO_2), nitrogen oxides (NOx), and particulate matter, posing severe threats to public health and climate stability.

Electric vehicles (EVs) offer a promising alternative by producing zero tailpipe emissions and reducing dependence on fossil fuels. However, despite their environmental benefits, widespread adoption in Indian cities faces challenges such as inadequate charging infrastructure, high upfront costs, limited public awareness, and range anxiety.

There is a pressing need for sustainable transportation solutions that align with environmental goals and support India's climate commitments. The deployment and effective utilization of electric vehicles can play a pivotal role in reducing the carbon footprint of urban mobility and promoting a cleaner, healthier environment.

2.2 Empathy Map Canva

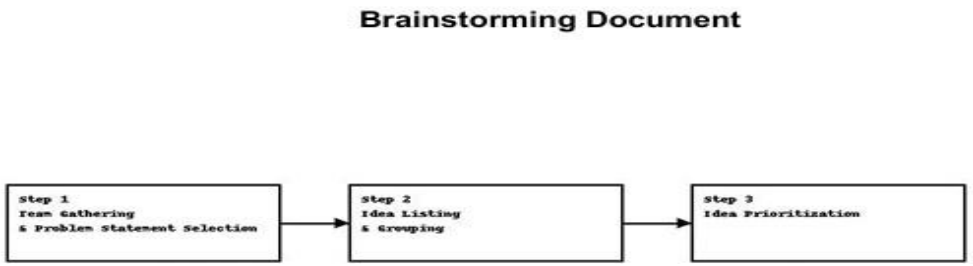


2.3 Brainstorming

Project Overview

Visualization Tool For Electric Vehicle Charge And Range Analysis: As electric vehicles (EVs) become an increasingly vital part of sustainable transportation, understanding battery usage, charge efficiency, and driving range is key to optimizing performance and adoption. This project proposes the development of a dynamic **Visualization Tool for EV Charge and Range Analysis**, aimed at assisting users, developers, and researchers in visualizing real-time and historical EV performance data.

Brainstorming Flowchart



Brainstorming Process

Step 1: Team Gathering and Collaboration -

Form a multidisciplinary team.

- Select a focused problem statement.

Step 2: Brainstorming Idea Listing and Grouping -

Encourage idea generation from all team members.

- Cluster similar ideas into logical groups.

Step 3: Idea Prioritization

- Rank ideas based on impact and feasibility.

- Select top ideas to implement in the project.

Scenario 1: Fleet Manager Optimizing Delivery Routes

A logistics company operates a fleet of electric vans for urban deliveries. The fleet manager uses the visualization tool to monitor each vehicle's battery level, energy consumption patterns, and nearby charging stations. One morning, the tool shows that two vans returning from extended routes have less than 20% battery left, and one is at risk of not reaching the warehouse.

Scenario 2: EV Owner Planning a Long-Distance Trip

n EV owner is planning a weekend getaway across hilly terrain. They use the visualization tool to simulate the trip, inputting route details, estimated luggage weight, and expected weather conditions. The tool calculates how these factors might reduce range and recommends charging stops along the way.

3. REQUIREMENT ANALYSIS

3.1 Solution Requirement

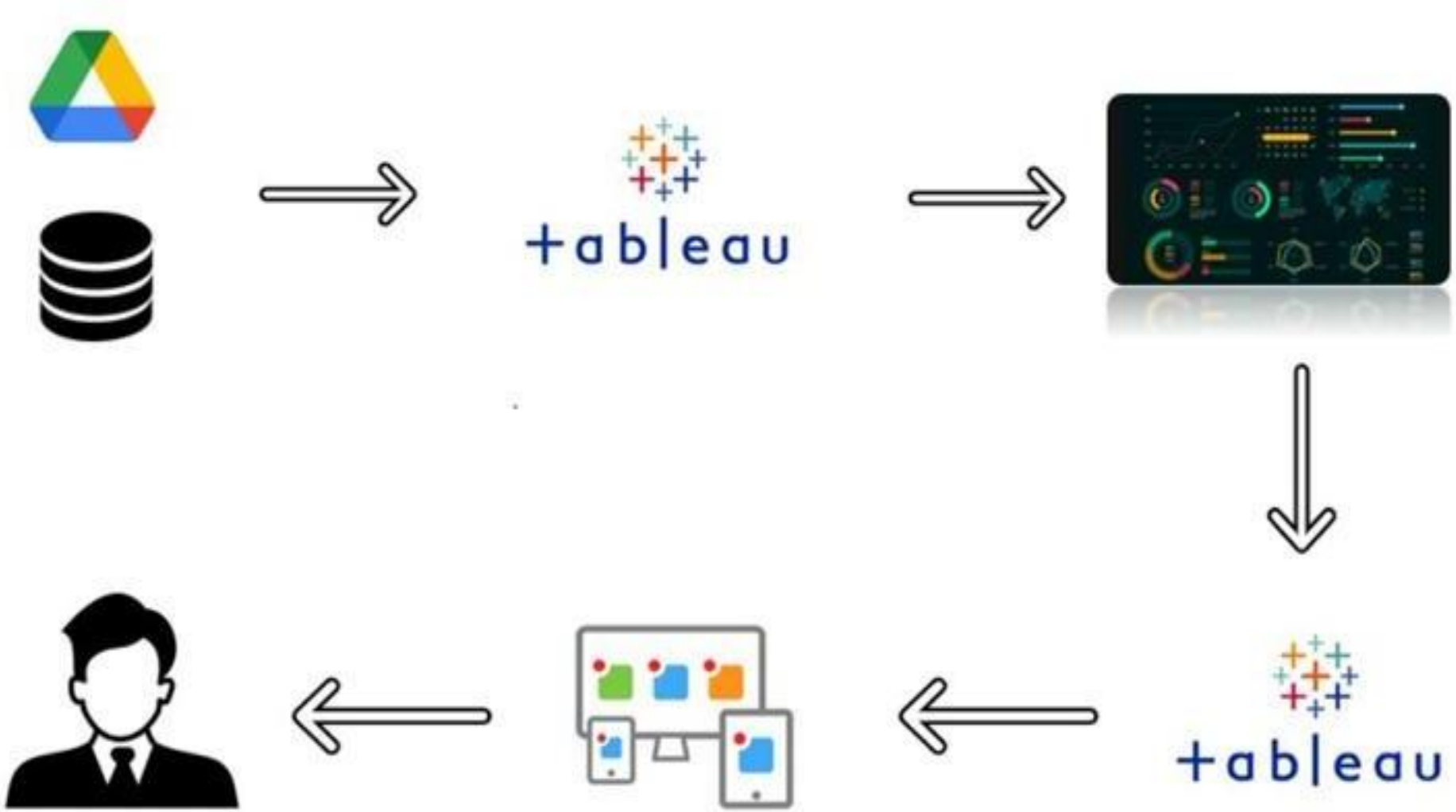
FunctionalRequirement:

1.	**Data Collection Interface**	• Web interface or IoT device integration to collect real time EV data • API integration with EV chargers, fleet management software, or smart grid systems
2.	**Data Storage & Management**	• Centralized cloud based database to store raw EV usage and sustainability matrices • Capability to update records in real time.
3.	**Data Cleaning & Preprocessing**	• Tools or scripts to remove duplicates, handle missing values. • Categorization by Ev types eg:- 2-wheeler, 4-wheeler, commercial
4.	**Interactive Visualization (Tableau)**	• Dashboards showing key matrices like CO2 emissions avoided, battery efficiency, range trends, and energy • Filters by vehicle type, geography, owner profile, and usage type. • Trend analysis,
5.	**Analytics & Insights**	• Pattern recognition (e.g., peak charging hours, drgradation in battery performance). • Group-wise comparison (commercial fleets vs private users, urban vs rural EV users)

Non Functional Requirement :

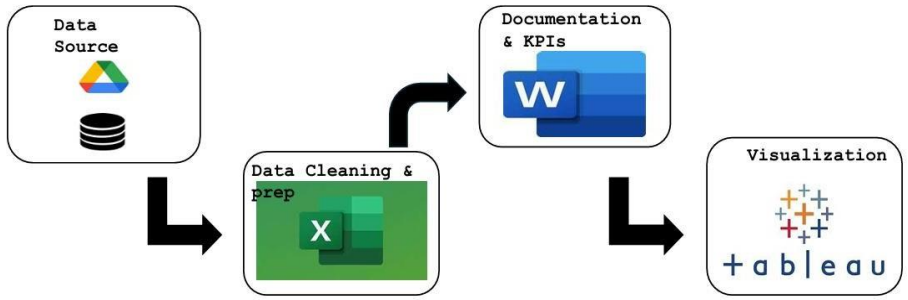
1.	**Scalability**	Should handle data from hundreds or thousands of users at a time
2.	**User-Friendliness**	**Dashboard and reports should be easy to navigate, with minimal training required.**
3.	**Performance**	Fast data processing and dashboard loading, even for large datasets.
4.	**Data Privacy & Security**	• Comply with data protection standards (like GDPR, ISO 27001). • Secure login and role-based access control to location data
5.	**Compatibility**	Should work on various devices (laptops, mobiles) and support data export (PDF, Excel)

3.2 Data Flow Diagram



3.3 Technology Stack

Technical Architecture:



Stage	Tool/Platform	Purpose
1.Data Source	Drive	Source of raw data on EV analysis, preferences, and charging behavior
2.Data cleaning & Prep	Microsoft Excel	- Removed duplicates & nulls - Categorized food types, scores - Created calculated fields and pivot tables
3.Documentation & KPIs	Ms Word/ Google Docs	- Removed duplicates & nulls - Categorized food types, scores - Created calculated fields and pivot tables
4.Visualization	Tableau	- Created dashboards & charts - Built Tableau Stories for insights - Used filters and drill-down for deeper analysis
5.Stroy Telling	Tableau Story	- Presented key findings in narrative format - Used story points for step-by-step flow

4. PROJECT DESIGN

4.1 Problem Solution Fit

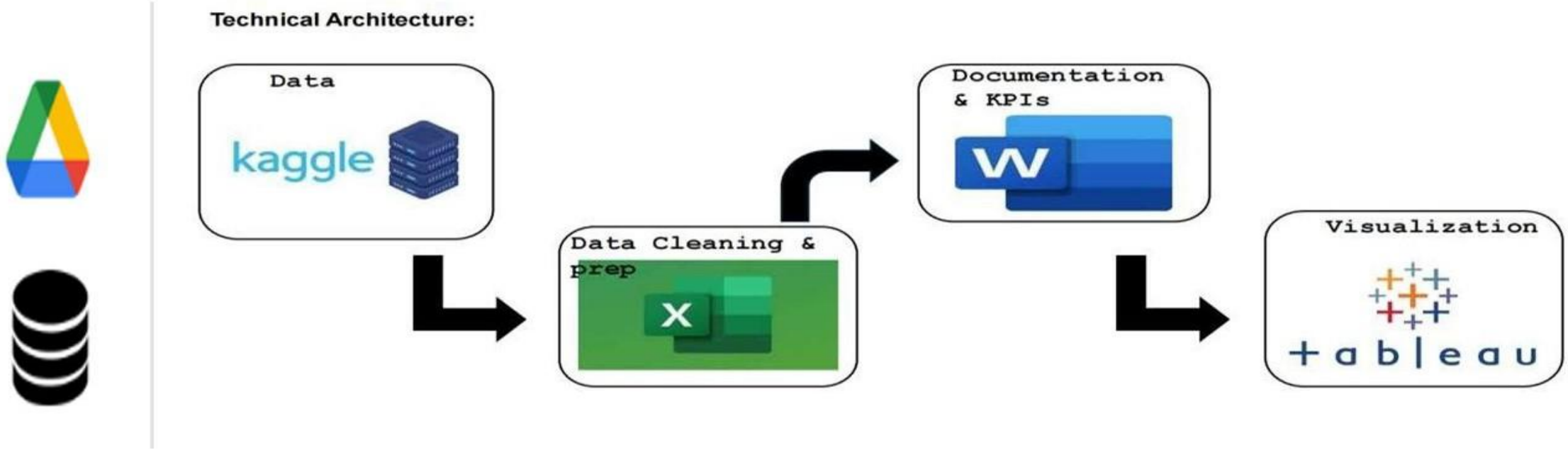
Problem	Solution
1.Lack of sufficient charging infrastructure for EVs	Expand and Upgrade public and private EV charging networks
High upfront purchase cost compared to conventional vehicles	Provide financial incentives,subsidies,and tax benefits to lower cost.
Range anxiety due to limited battery capacity and charging point	Use filtered Tableau views and KPIs to **tailor nutrition strategies** for different demographics.
Limited availability of EV model	Launch awareness campaign

4.2 Solution Architecture

Solution Architecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.



5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning:

Sprint	Functional Requirement	User Story Number	User story / Task	Story point	Priority	Team Member
Sprint-1	Registratation	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	high	
Sprint-1	Login	USN-2	As a user, I can log into the application by entering email & password	1	high	
Sprint-2	Dashboard	USN-3	As a user, I can visualize easily	2	High	
Sprint-1	Public	USN-4				

Project Tracker, Velocity & Burndown Chart:

Sprint	Total Story Point	Duration	Sprint Start Date	Sprint End Date	Story Point Completed	Sprint Realease Date
Sprint-1	20	5 Days	20 June 2025	25 June 2025	20	25 June 2025
Sprint-2	20	5 Days	20 June 2025	25 June 2025	15	25 June 2025
Sprint-3	20	5 Days	20 June 2025	25 June 2025	15	25 June 2025
Sprint-4	20	5 Days	20 June 2025	25 June 2025	20	25 June 2025

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

6. FUNCTIONAL AND PERFORMANCE TESTING

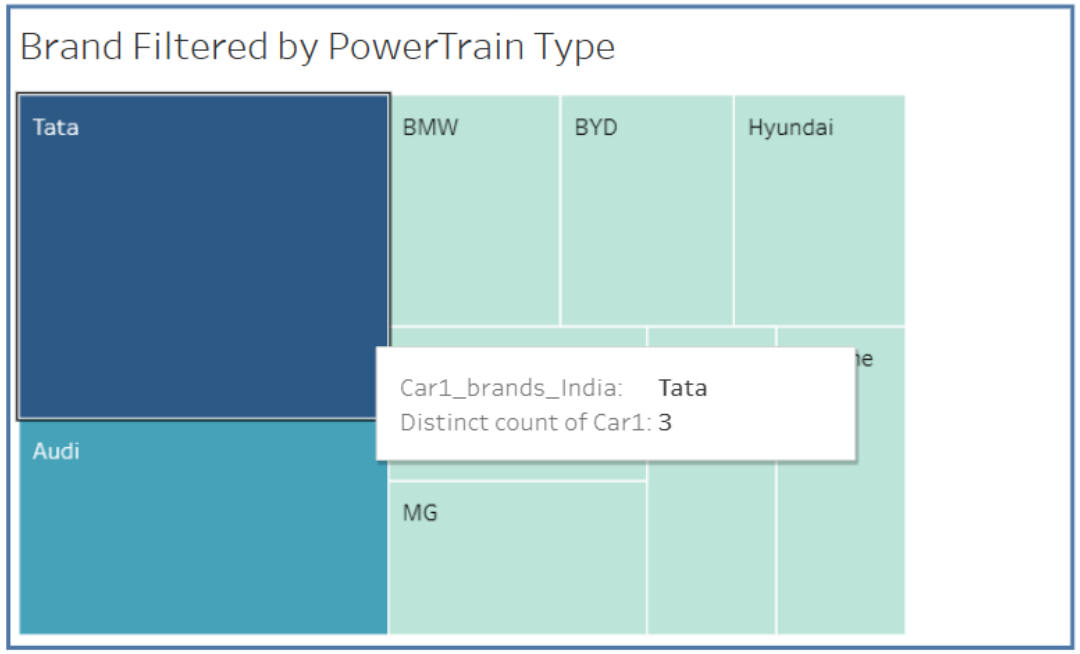
Model Performance Testing:

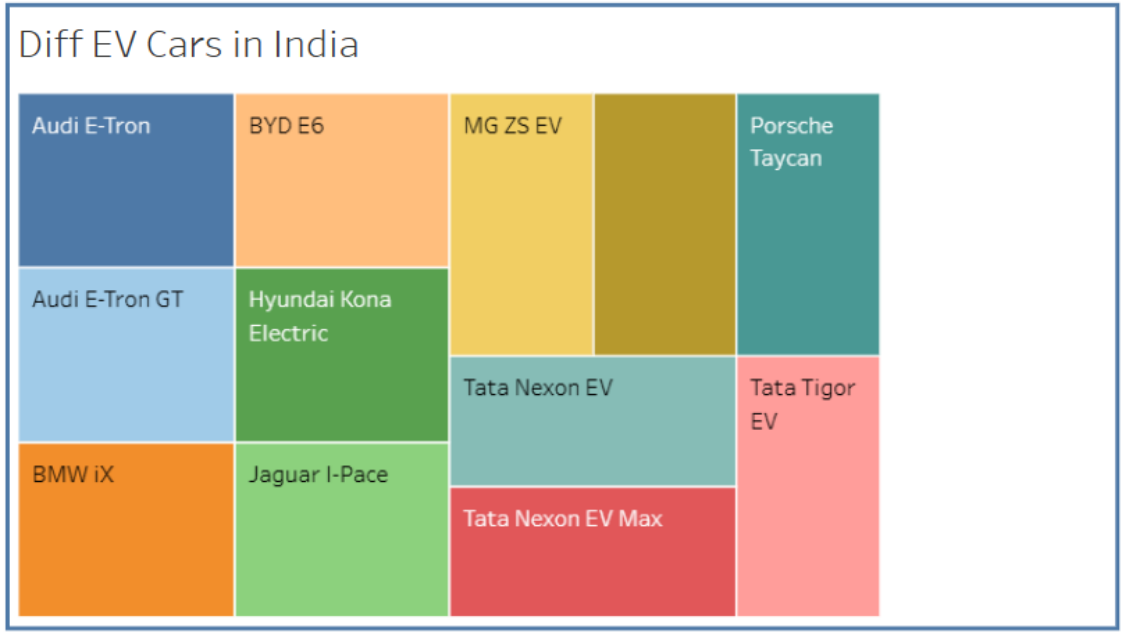
S.NO	Parameter	Screenshot / Values
1.	Data Rendered	18
2.	Data Preprocessing	54
3.	Utilization of Filter	14
4.	Calculation fields Used	10

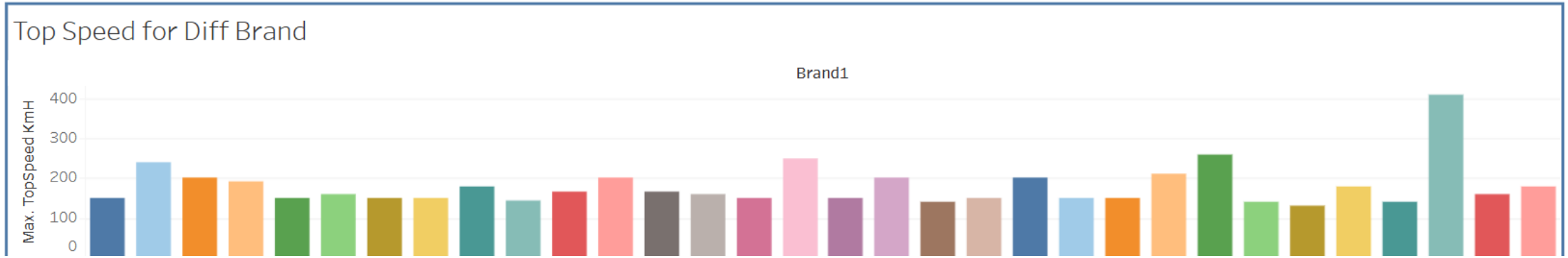
5.	Dashboard design	• No of Visualization / Graphs - GPA Distribution • Diff Brand of EV, globally and in india, brand according to the Bodystyle, Top 10 most efficient brands, Price for different cars in india, No of models by each brands, Brands filtered by powertrain Type, Top Speed of different brands.
6.	Story Design	https://public.tableau.com/app/profile/sai.krishna.bathula/vizzes or https://public.tableau.com/app/profile/sai.krishna.bathula/favorites

7. RESULTS

7.1 Output Screenshots







8. ADVANTAGES & DISADVANTAGE

Advantages:

Environmentally Friendly:

EVs produce zero tailpipe emissions, helping reduce air pollution in cities like Delhi, Mumbai, and Bengaluru.

Lower Running Costs:

Electricity is cheaper than petrol or diesel, and EVs have fewer moving parts, reducing maintenance costs.

Government Incentives:

The Indian government offers subsidies and tax benefits under the FAME II scheme and state-specific policies to promote EV adoption.

Energy Independence:

Reducing reliance on imported crude oil can strengthen India's energy security.

Smooth and Quiet Ride:

EVs provide a quieter driving experience with instant torque and smooth acceleration.

Disadvantages:

Limited Charging Infrastructure

Charging stations are still not widespread, especially in rural or semi-urban areas, leading to range anxiety.

High Initial Cost

EVs generally have a higher upfront cost compared to conventional vehicles due to expensive batteries.

Limited Range

Most affordable EVs have a shorter range per charge, making them less suitable for long-distance travel.

Long Charging Time

Charging an EV typically takes several hours unless using a fast charger, which is still not very common.

Battery Replacement Cost

The cost of replacing EV batteries after several years can be high, which impacts long-term ownership cost.

9. CONCLUSION

Electric vehicles (EVs) present a promising solution for India's transportation future, offering significant environmental and economic benefits. While challenges like limited charging infrastructure, high upfront costs, and range limitations remain, ongoing government support and technological advancements are steadily improving the EV ecosystem. With continued investment and public awareness, EVs have the potential to drive India toward a cleaner, more sustainable mobility landscape.

10. FUTURE SCOPE

- Improved battery technology and fast charging
- Expansion of charging infrastructure

- Integration with renewable energy sources
- Growth in domestic EV manufacturing
- Use of AI and IoT in smart EVs
- Diversification into buses, trucks, and fleets
- Continued government policy support
- Job creation in EV and allied sectors
- Potential for EV exports from India

11. APPENDIX

Tableau Public Link : Tableau Dashboards & Story

Github Link: https://github.com/BathulaKrishna53/Visualization-Tool-For-Electric-Vehicle-Charge-And-Range-Analysis

Video Demo Link : Tableau Demo GoogleDrive

Dataset Link:

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