Final Project Report

Visualization Tool for Electric Vehicle Charge and Range Analysis

Team ID: LTVIP2026TMIDS87959

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Team Member 1: **Palla jaya Prakash Babu**

Team Member 2: **Seeripi Vandana**

Team Member 3: **Nese Anil**

1. INTRODUCTION

1.1 Project Overview

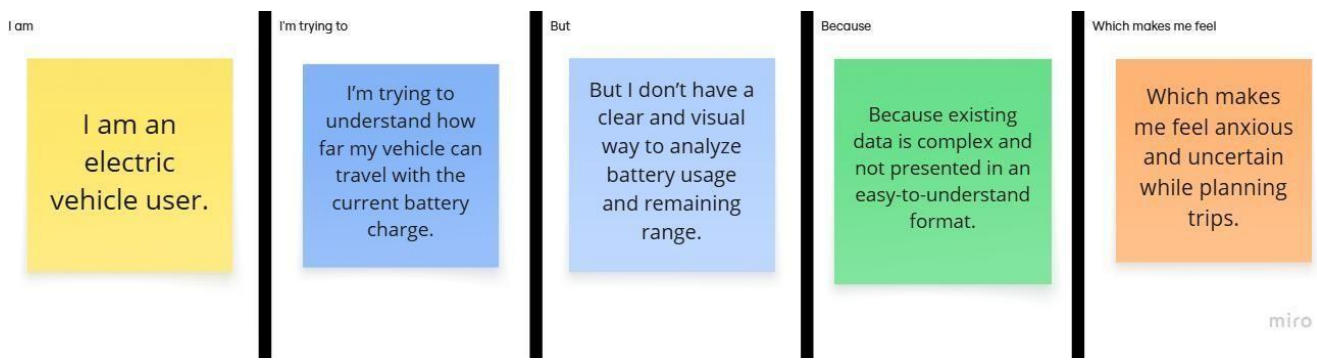
The rapid adoption of Electric Vehicles (EVs) has increased the need for better understanding of battery performance, charging behavior, and driving range under different conditions. This project focuses on developing an interactive Visualization Tool for Electric Vehicle Charge and Range Analysis that helps users analyze and interpret EV charging patterns and range efficiency using data visualization techniques.

1.2 Purpose

The main purpose of this project is to analyze and visualize electric vehicle (EV) charge levels and driving range in an interactive and easy-to-understand manner. The tool helps users make data-driven decisions by presenting complex EV performance data through intuitive visual dashboards.

This project aims to:

1. Monitor battery charge levels and estimate the remaining driving range
2. Visualize EV performance trends such as energy consumption, distance covered, efficiency using charts and graphs.
3. Support EV users and manufacturers in understanding how factors like speed, terrain, and battery capacity impact vehicle range.
4. Improve trip planning and range confidence by helping users predict whether the available charge is sufficient for a planned journey.



2. IDEATION PHASE

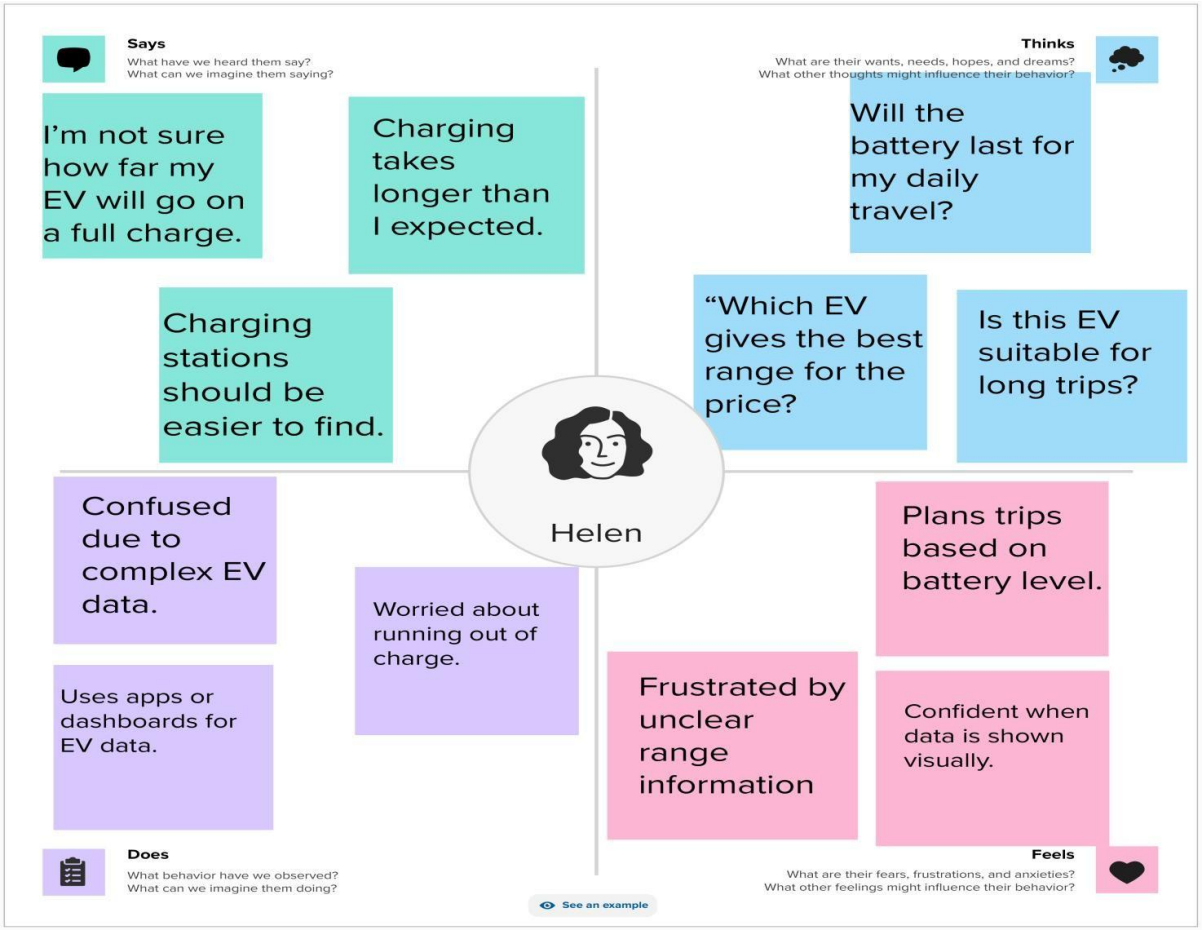
2.1 Problem Statement

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel

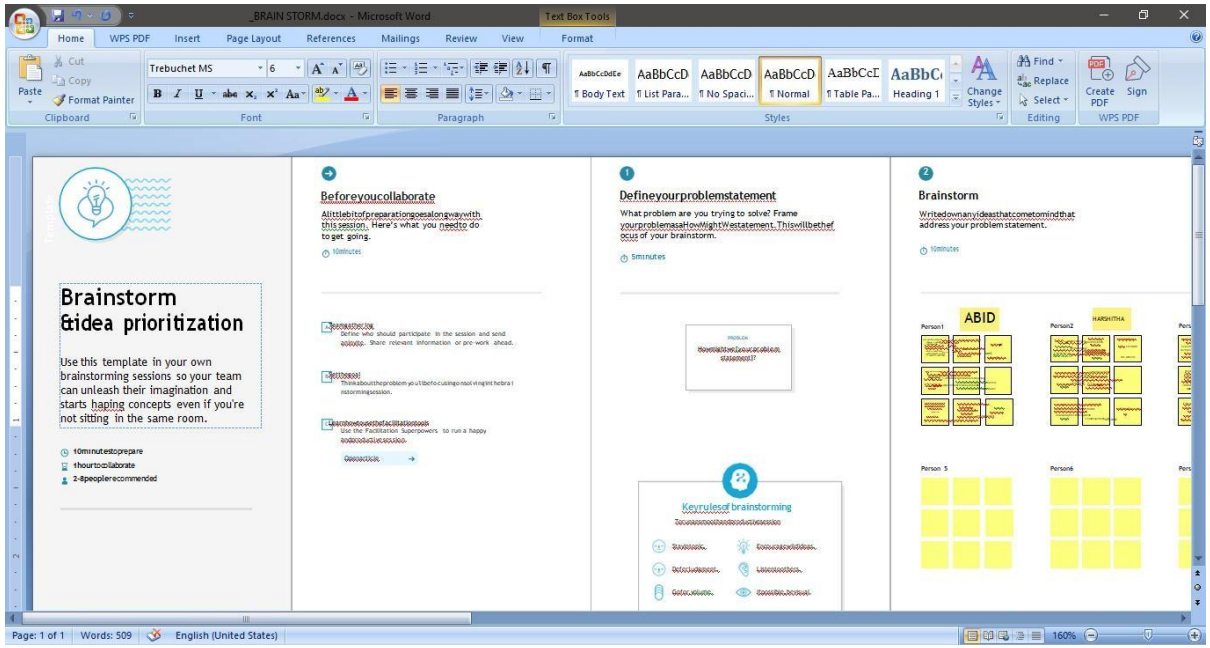
5.

PS-1	Iam an electric vehicle user.	I'm trying to understand how far my vehicle can travel with the current battery charge.	But I don't have a clear and visual way to analyze battery usage and remaining range.	Because existing data is complex and not presented in an easy-tounderstand format.	Which makes me feel anxious and uncertain while planning trips.
PS-2	Iam a fleet manager/ EV analyst.	I'm trying to monitor charging patterns and range efficiency of electric vehicles.	But I lack an interactive visualization tool to compare charge levels, distance covered ,and efficiency.	Because raw datasets and tables do not provide meaningful insights quickly.	Which makes me feel frustrated and inefficient indecision- making.

2.2 Empathy Map



2.3 Brainstorm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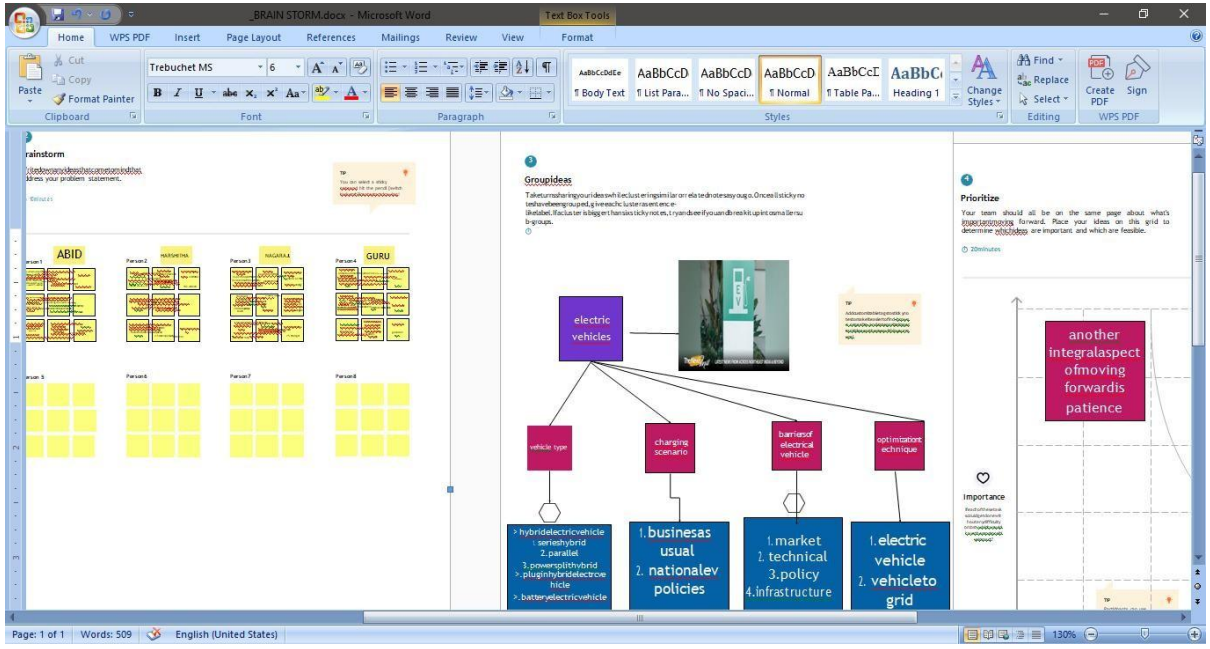
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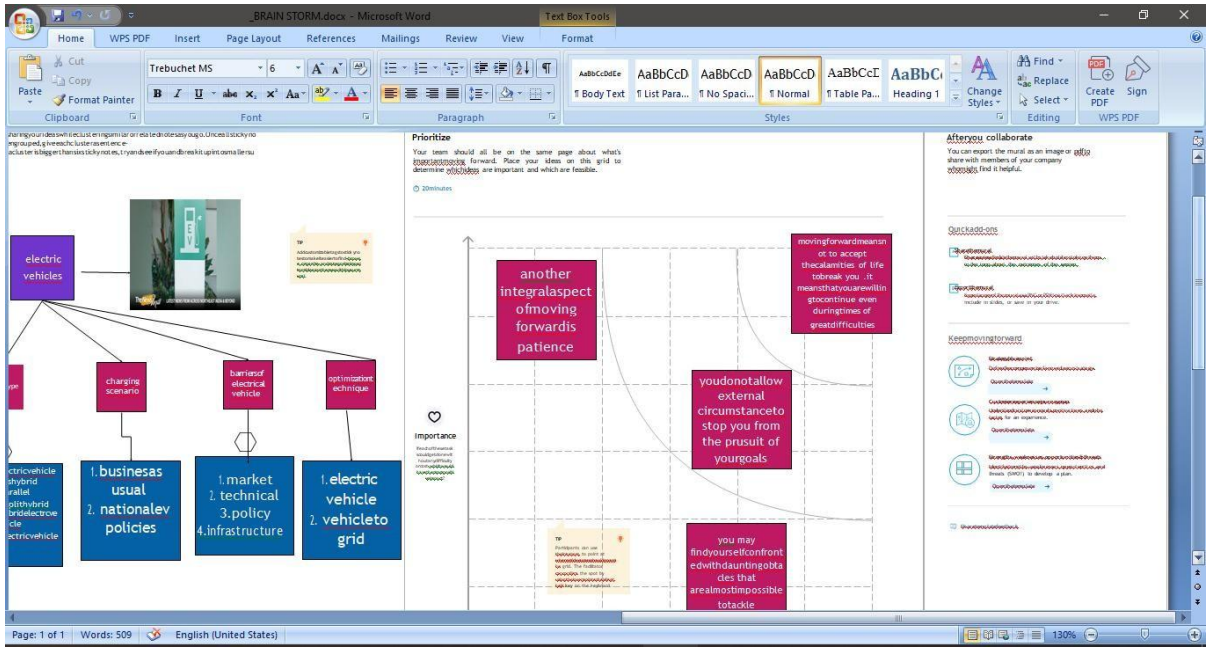
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Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.
20minutes
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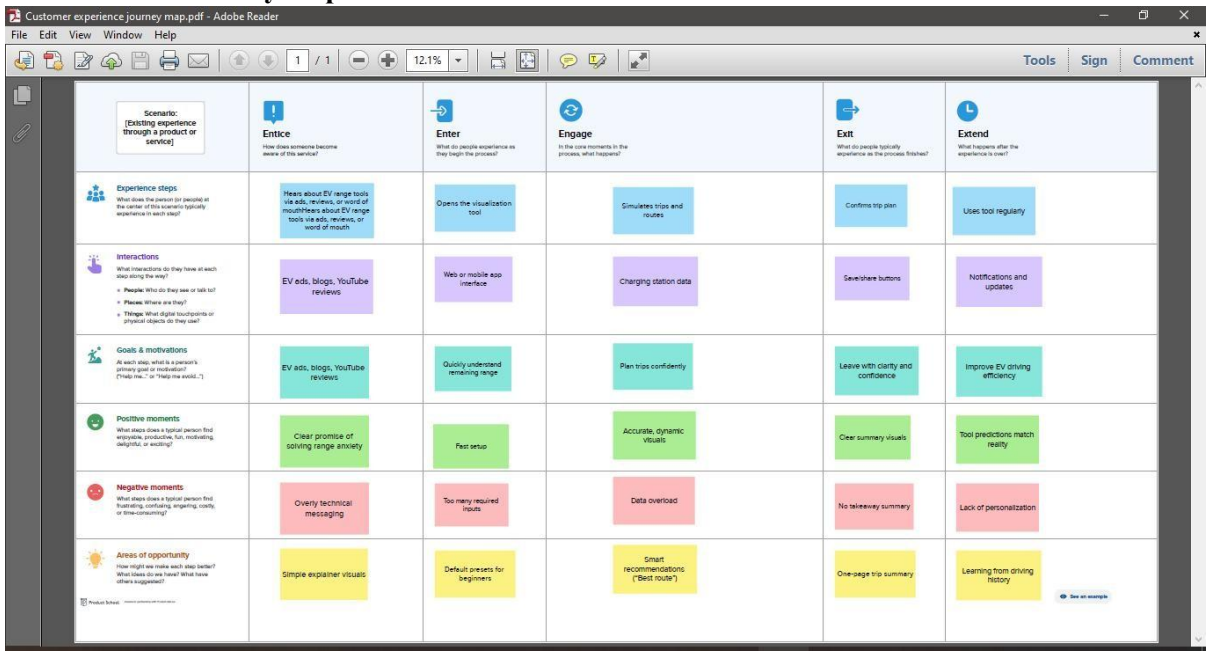
3.REQUIREMENT ANALYSIS

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 Access	User can access the system without login
FR-2	Data Upload	User can view EV data and visualizations
FR-3	Data Visualization	Upload EV datasets in CSV format

FR-4	EV Model Comparison	Display charge vs range charts
FR-5	Filtering Options	Compare EV models based on range, price, and time
FR-6	Charging Analysis	Display charging time and charging efficiency

Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The system should be easy to use and understand for all users
NFR-2	**Security**	Uploaded data should be securely stored and accessed
NFR-3	**Reliability**	The system should provide accurate and consistent results
NFR-4	**Performance**	Visualizations should load quickly without delay
NFR-5	**Availability**	The system should be available whenever the user needs
NFR-6	**Scalability**	The system should handle large EV datasets efficiently

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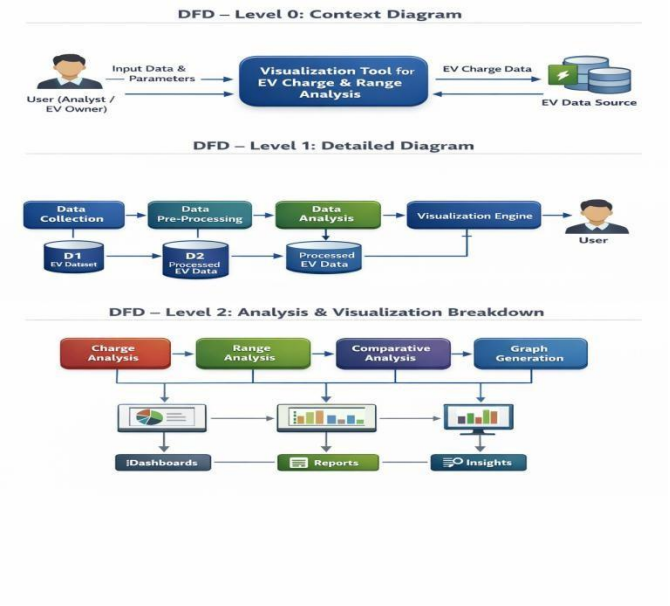
3.3 Data Flow Diagram



User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I want to view electric vehicle data detail	EV data is displayed correctly	High	Sprint-1
Customer (Mobile user)	View EV Data	USN-2	As a user, I want to see charge and range data in charts so that it is easy to understand.	Charts load correctly	High	Sprint-1
Customer (Mobile user)	Data Visualization	USN-3	As a user, I want to compare EV models based on range and price.	Comparison chart is shown	Low	Sprint-2
Customer (Mobile user)	Model Comparison	USN-4	As a user, I want to filter EV data by brand m	Filters work properly	Medium	Sprint-3

Customer (Mobile user)	Filter Data	USN-5	As a user, I want to view charging time	Charging time data is visible	High	Sprint-2
Customer (Mobile user)	Charging Time	USN-6	As a user, I want to analyze range.	Range updates correctly	High	Sprint-4
Customer (Mobile user)	Range Analysis	USN-7	As a user, I want to view charging station	Station data is displayed	Medium	Sprint-3
Customer (Mobile user)	Charging Stations	USN-8	As a user, I want to see EV performance	Dashboard is user-friendly	Low	Sprint-5
Customer (Mobile user)	Performance Analysis	USN-9	As a user, I want a simple and easy-to-use	Performance charts are shown	High	Sprint-4
Customer (Mobile user)	User Interface	USN10	As a user, I want to download visual reports .	Report downloads successfully	Low	Sprint-5

3.4 Technology Stack

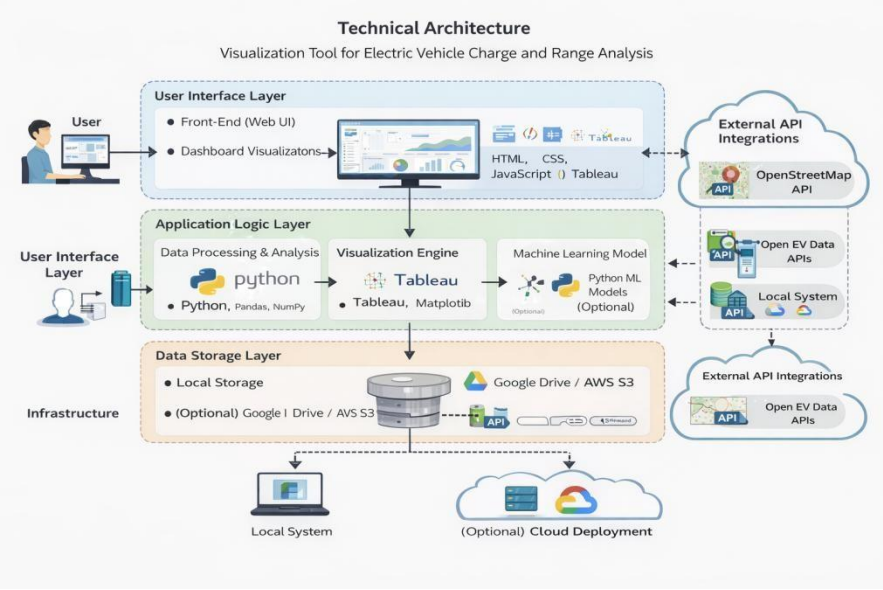


Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	Web interface to view EV charge and range visualizations	HTML, CSS, JavaScript, Tableau
2.	Application Logic-1	Data processing and analysis	Python
3.	Application Logic-2	Data cleaning and transformation	Pandas, NumPy
4.	Application Logic-3	Visualization logic	Tableau, Matplotlib
5.	Database	Storage of EV datasets	CSV Files
6.	Cloud Database	Cloud storage for datasets	. Google Drive
7.	File Storage	Storage of reports and datasets	Local File System
8.	External API-1	EV charging station data	Open EV Data APIs
9.	External API-2	Geographic data for maps	OpenStreetMap API
10.	Machine Learning Model	Range estimation (optional)	Python ML Models
11.	Infrastructure (Server / Cloud)	Application deployment	Local System

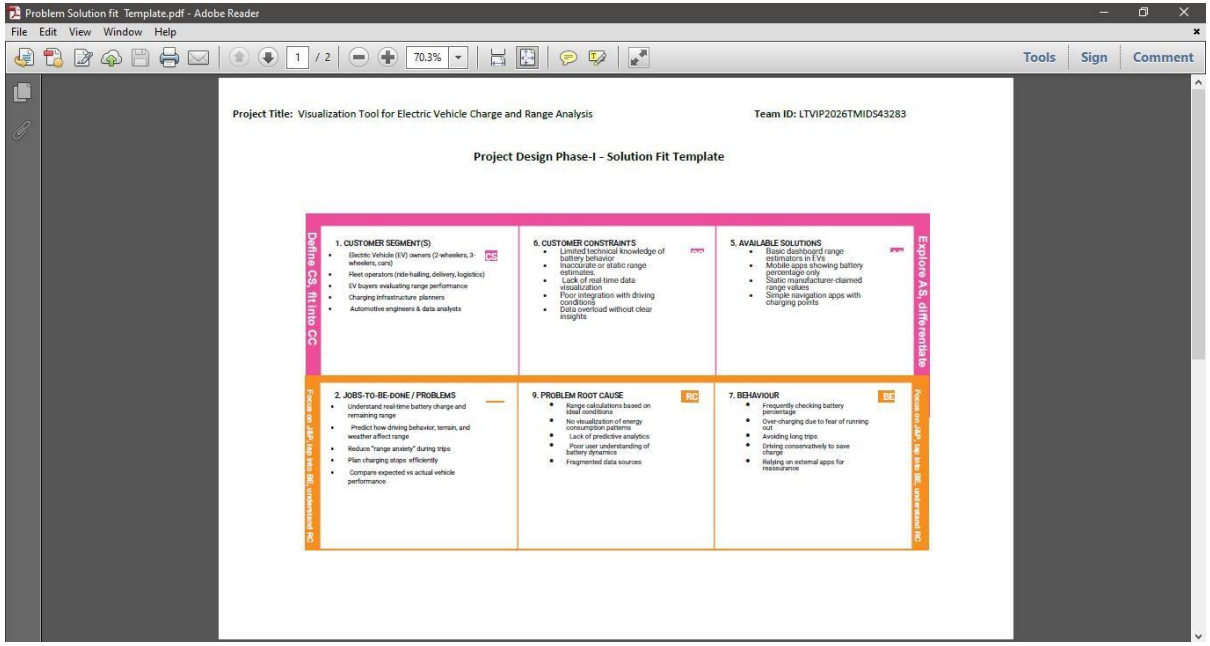
Table-2: Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	Frameworks used for development	Python, Tableau

2.	Security Implementations	Data access control and protection	File permissions, basic encryption
3.	Scalable Architecture	Supports adding more datasets and charts	Modular architecture
4.	Availability	System available during analysis time	Local
5.	Performance	Fast loading dashboards	Optimized queries, caching

4. PROJECT DESIGN

4.1 Problem Solution Fit



4.2 Proposed Solution

6.

S.No.	Parameter	Description

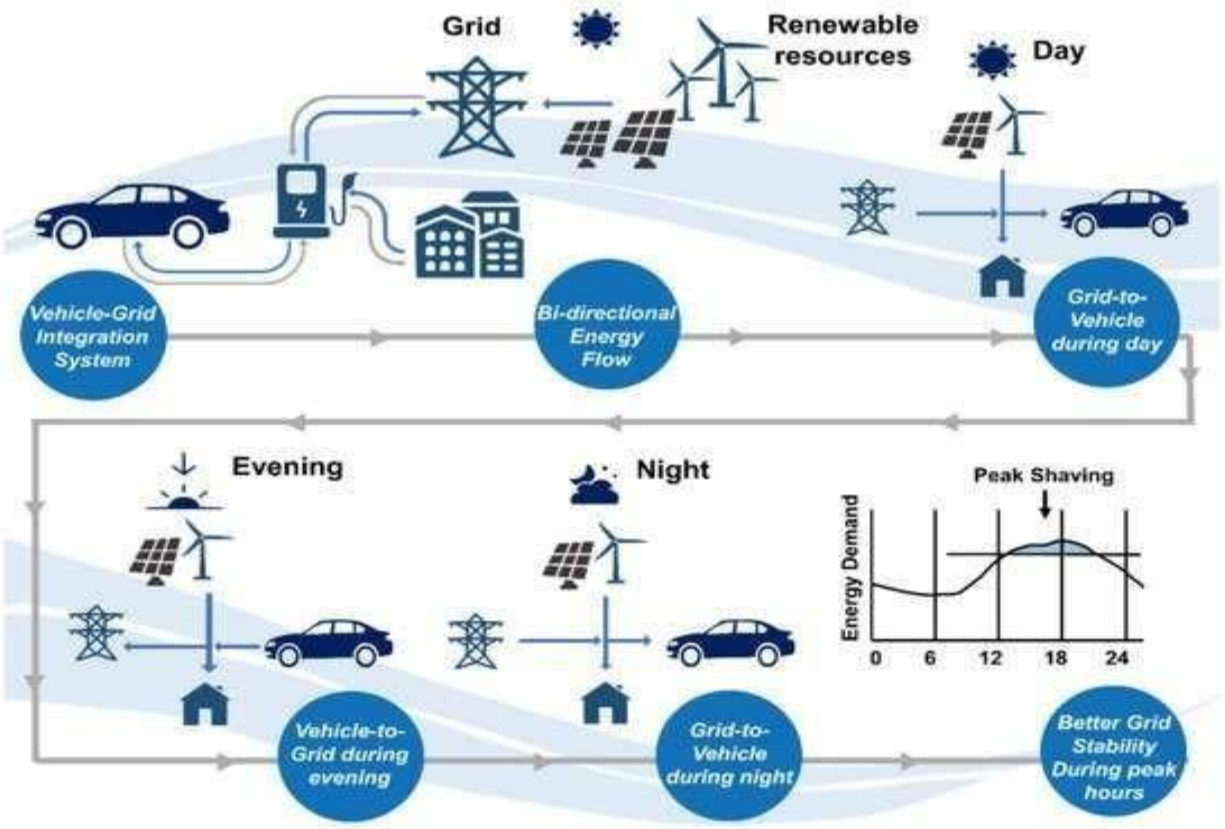
1.	Problem Statement(Problem to be solved)	Electric vehicle users often face difficulty in accurately estimating remaining battery charge and driving range, leading to range anxiety and inefficient trip planning. There is a lack of simple and visual tools to analyze EV charge And range effectively.
2.	Idea/Solution description	The proposed solution is a visualization tool that analyzes electric vehicle battery charge and estimates driving range using vehicle data and driving conditions. The tool presents the results using interactive graphs, charts, and Indicators for easy understanding.

3.	Novelty/ Uniqueness	The system provides real-time visual representation of EV charge and range with condition-based adjustments(city/highway driving), making range estimation more intuitive compared to traditional numeric displays.
4.	Social Impact/Customer Satisfaction	The solution reduces range anxiety, improves confidence among EV users, and promotes wider adoption of electric vehicles, contributing to environmentally sustainable transportation.
5.	Business Model(Revenue Model)	The tool can be offered as a subscription-based service to EV manufacturers, fleet operators, or integrated into mobile applications with Premium analytics features.
6.	Scalability of the Solution	The solution is highly scalable and can be extended to support multiple EV models, realTime sense or data, GPS integration, and large user bases through cloud deployment.

Sprint	Functional Requirement(Epic)	User Story Number	User Story/Task	Story Points	Priority	Team Members

Sprint-1	Data Collection & Input	USN-1	As a user, I want to input EV battery capacity and current charges ot hatI can see remaining	5	High	TM1

4.3 Solution Architecture



5. PROJECT PLANNING

5.1 Performance Testing

			range			
Sprint-1	Data Collection &Input	USN-2	As a user, I want to select vehicle model so that range calculations are accurate	5	High	TM2
Sprint-2	Range Calculation Engine	USN-3	As a user, I want the system to calculate estimated driving range based on charge level	8	High	TM1
Sprint-2	Range Calculation Engine	USN-4	As a user, I want range to adjust based on driving conditions (city/highway)	7	Medium	TM3
Sprint-3	Visualization Dashboard	USN-5	As a user,I want to view charge and range using charts and graphs	10	High	TM2
Sprint-3	Visualization Dashboard	USN-6	As a user, I want color indicators (low/medium/high range)foreasy understanding	10	Medium	TM3
Sprint-4	Reporting &Optimization	USN-7	As a user,I want to compare range across trips and time periods	10	Medium	TM1

Sprint	Functional Requirement(Epic)	User Story Number	User Story/Task	Story Points
Sprint-4	Reporting &Optimization	USN-8	As a user, I want to export range analysis reports	10

7.

Project Tracker ,Velocity & Burndown Chart:(4Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned EndDat
Sprint-1	20	6Days	2February2026	7February2026	18
Sprint-2	20	6Days	9February2026	14February2026	19
Sprint-3	20	6Days	16February2026	21February2026	20
Sprint-4	20	6Days	23February2026	28February2026	20

Velocity Calculation:

Velocity = Total Story Points Completed ÷ Number of Sprints

Total completed story points

18 + 19 + 20 + 20 = ***77 story points***

Number of sprints

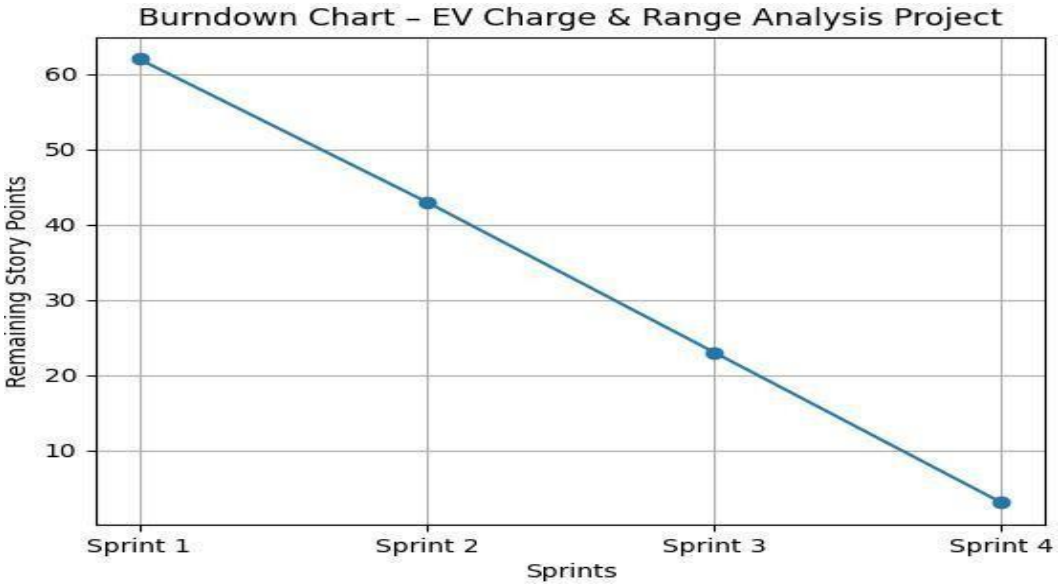
= ***4***

Average Team Velocity:

Average Team Velocity Calculation

Velocity = 77 / 4 = 19.25 story points per sprint

Burn down Chart:



6. PROJECT DEVELOPMENT PHASE

1. Data Connectivity

The data required for this project is collected from publicly available sources and stored in CSV file format.The datasets include electric vehicle specifications and charging station details.These CSV files are directly connected to Tableau for visualization and analysis.

Links of DataSets:

1. https://drive.google.com/file/d/1rMhNvFitXodYzuPbxJ60dy4s2zaYGyR/view?usp=drive_link
2. https://drive.google.com/file/d/1mv1GcOzwShlv4vYyXF82kBfLtZMqIDoN/view?usp=drive_link
3. https://drive.google.com/file/d/1rTANUsWxe2Et5vF6ik0SWjUTUTNoZhP/view?usp=drive_link
4. https://drive.google.com/file/d/1f8hcispK439nJNgcAb13tBEsCx2vTcv/view?usp=drive_link

2. Data Preparation

Data preparation is an important step to ensure accuracy and consistency. The following preprocessing steps were performed before visualization:

- Removed missing and null values
- Removed duplicate records
- Renamed column headers for better understanding
- Converted units such as range(km)and battery capacity(kWh)into standard formats
- Filtered unnecessary attributes
- Checked data consistency and corrected errors

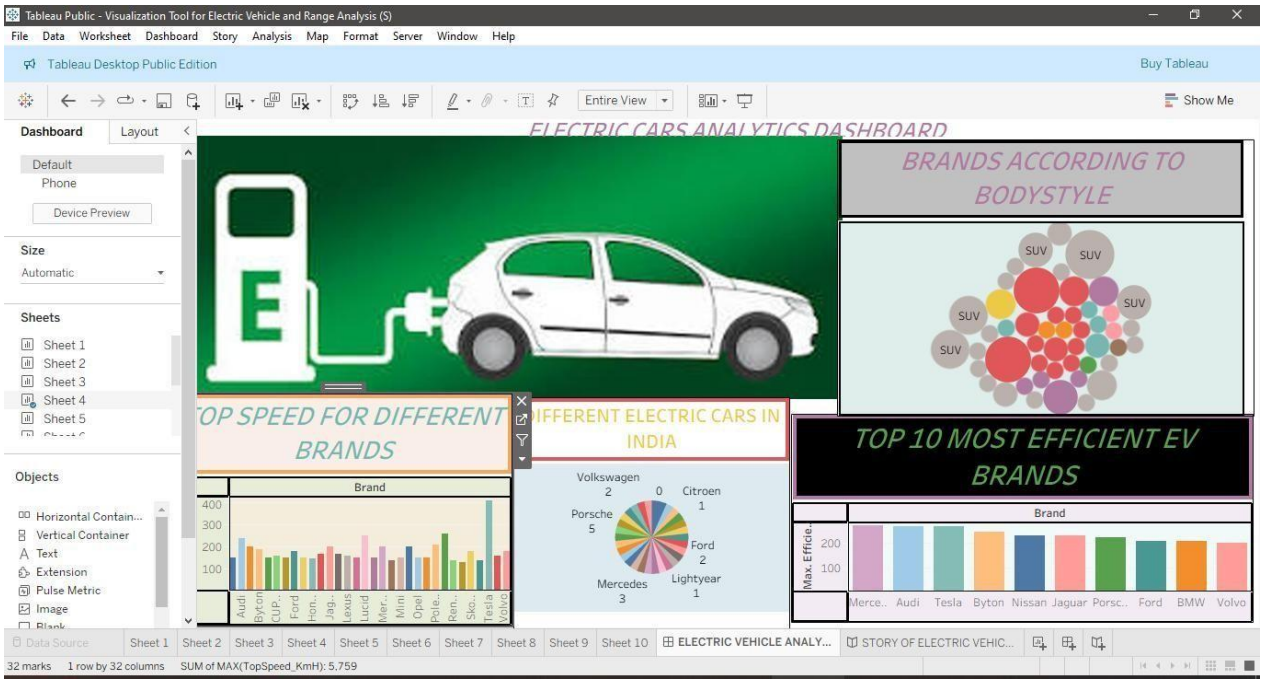
After pre-processing ,the cleaned data was used for creating dashboards and stories.

3. Dashboard

A Tableau dashboard was created by combining multiple visualizations to provide a clear understanding of electric vehicle charge and range analysis. The dashboard includes:

- Comparison of EV range across different models
- Analysis of battery capacity vs charging time
- Distribution of charging stations using map visualization
- Price vs range comparison

The dashboard is interactive and allows users to filter data based on EV model, brand ,and range.

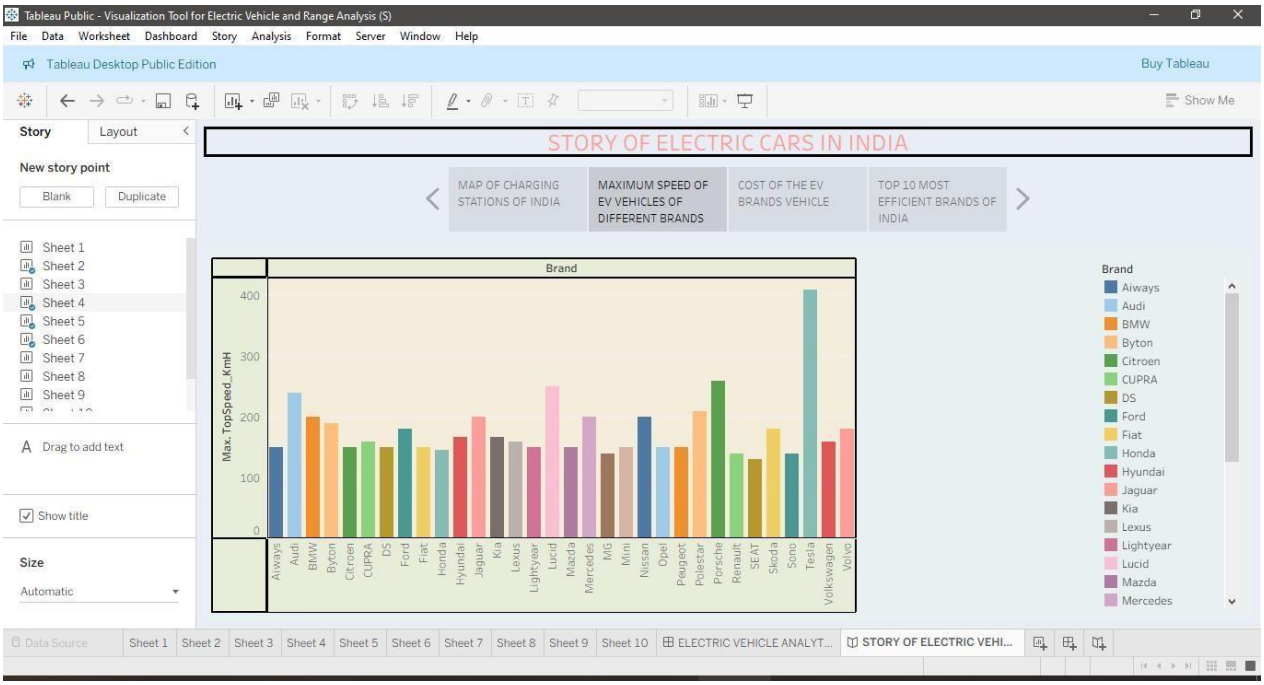


4. Story

A Tableau story was created to present insights in a step-by-step manner.The story consists of multiple story points that guide the user through the analysis:

1. Overview of electric vehicle range
2. Comparison of charging time and battery capacity
3. Availability of charging stations
4. Key insights and observations

The story helps users easily understand trends and make informed decisions.



5. Creativity(Font and Style)

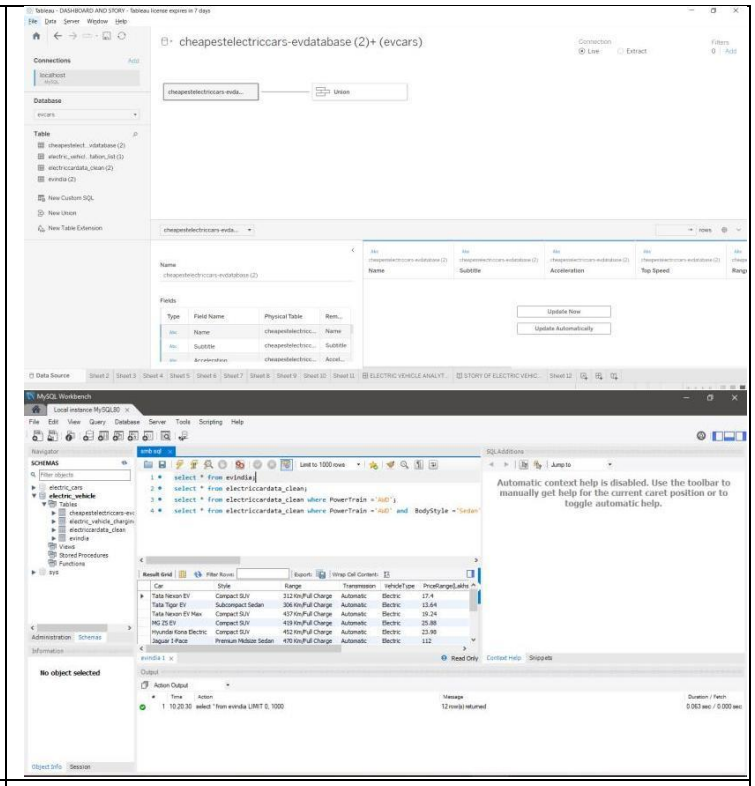
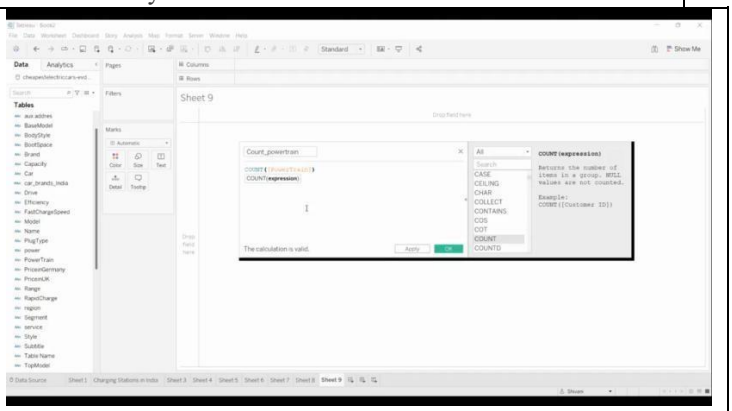
The project document is designed using a clean and professional layout .Consistent fonts ,proper headings, and structured sections are used throughout the document. Visual elements such as charts and dashboards are clearly labeled and aligned. The overall design improves readability and makes the project easy to understand.

- Applied clear headings and sub headings to separate sections
- Used bullet points instead of long paragraphs to improve clarity
- Maintained proper spacing and alignment across all pages
- Used meaningful titles and captions for dashboards and stories
- Applied color themes in dashboards to visually differentiate data categories

7. PERFORMANCE TESTING

Model Performance Testing:

S.No.	Parameter	Screenshot/Values
1.	Data Rendered	

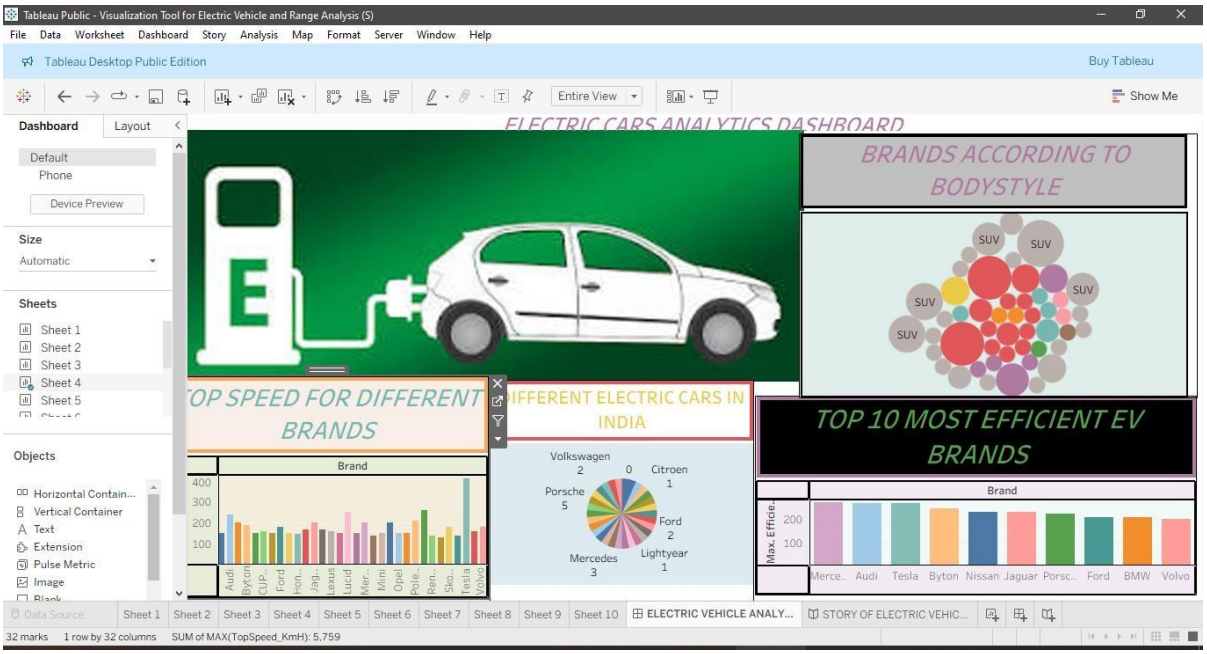
2.	Data Preprocessing	
3.	Utilization of Filters	Filters were used effectively to allow users to interact with the data. Filters such as EV brand, vehicle model, range, battery capacity ,and price range were applied .These filters help users customize the dashboard view and analyze specific electric Vehicle characteristics easily.
4.	Calculation fields Used	
5.	Dashboard design	*The dashboard is designed to be simple, interactive, and user-friendly .Multiple visualizations are combined into a single dashboard to provide a complete overview.* **No. of Visualizations/Graphs:5** ✓ Top speed for different brands ✓ Different electric brands of India ✓ Brands according to body style ✓ Top 10 most effective brands in India ✓ Brands filtered by power train type

6.	Story Design	*A Tableau story was created to present insights in a structured and sequential manner. The story guides users from basic EV range understanding to advanced charge and station analysis, making the insights easy to follow.* **No .of Visualizations/Graphs:4** Story flow includes: • EV range overview • Charging performance comparison • Charging station availability • Final insights and observations

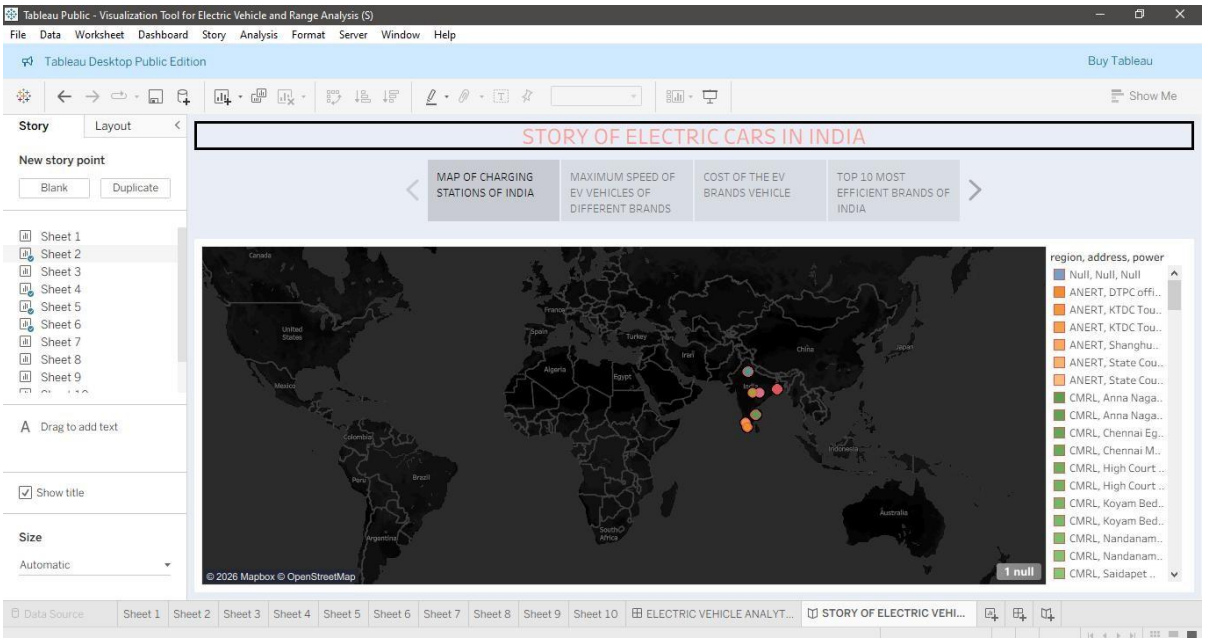
8. Output

Output Screenshots

DASHBOARD SCREENSHOTS



STORY SCREENSHOTS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TOP 10 MOST EFFICIENT BRANDS OF INDIA
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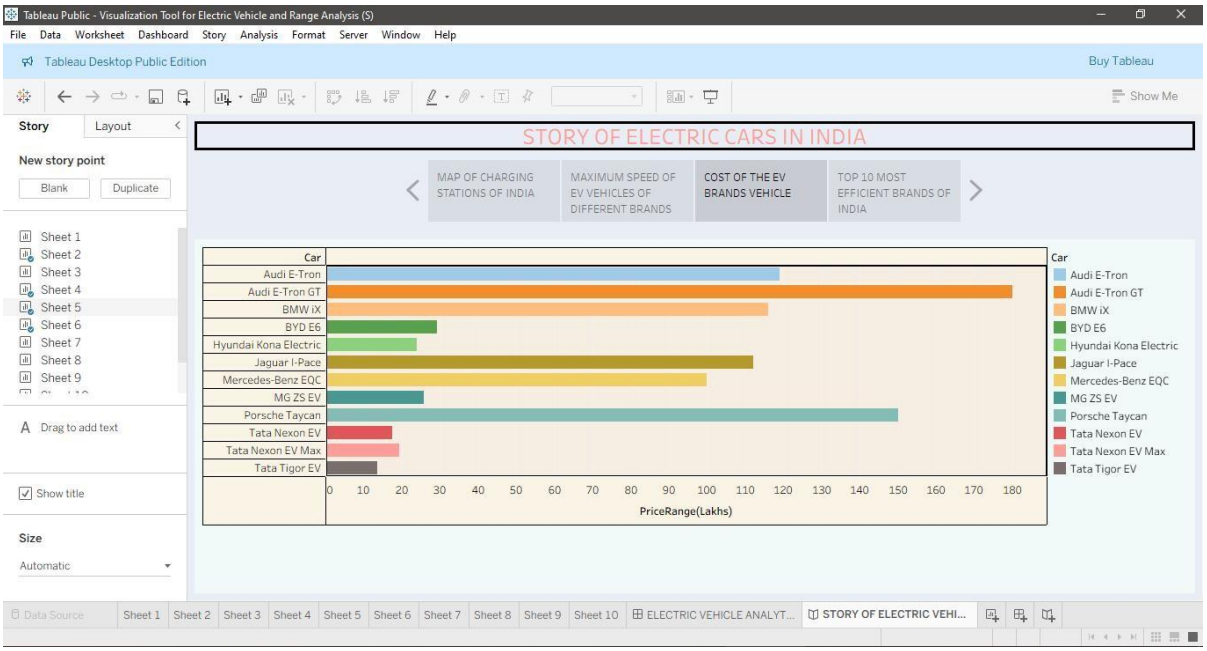
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Audi E-Tron GT
BMW iX
BYD E6
Hyundai Kona Electric
Jaguar I-Pace
Mercedes-Benz EQC
MG ZS EV
Porsche Taycan
Tata Nexon EV
Tata Nexon EV Max
Tata Tigor EV
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Audi E-Tron GT
BMW iX
BYD E6
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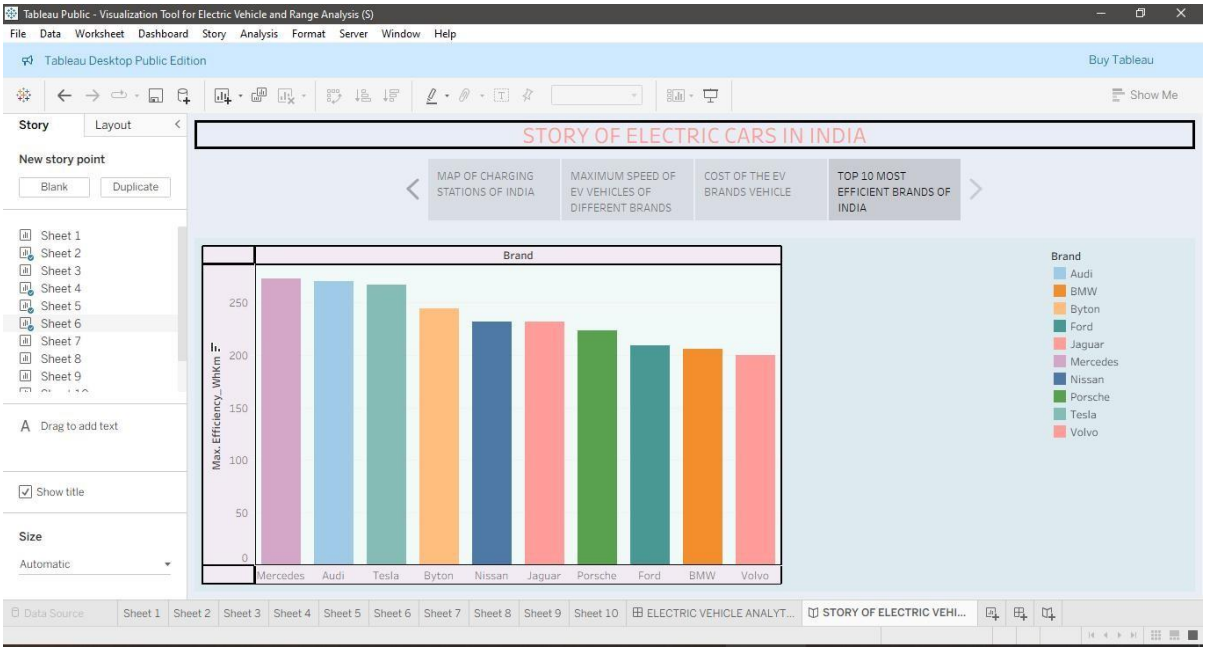
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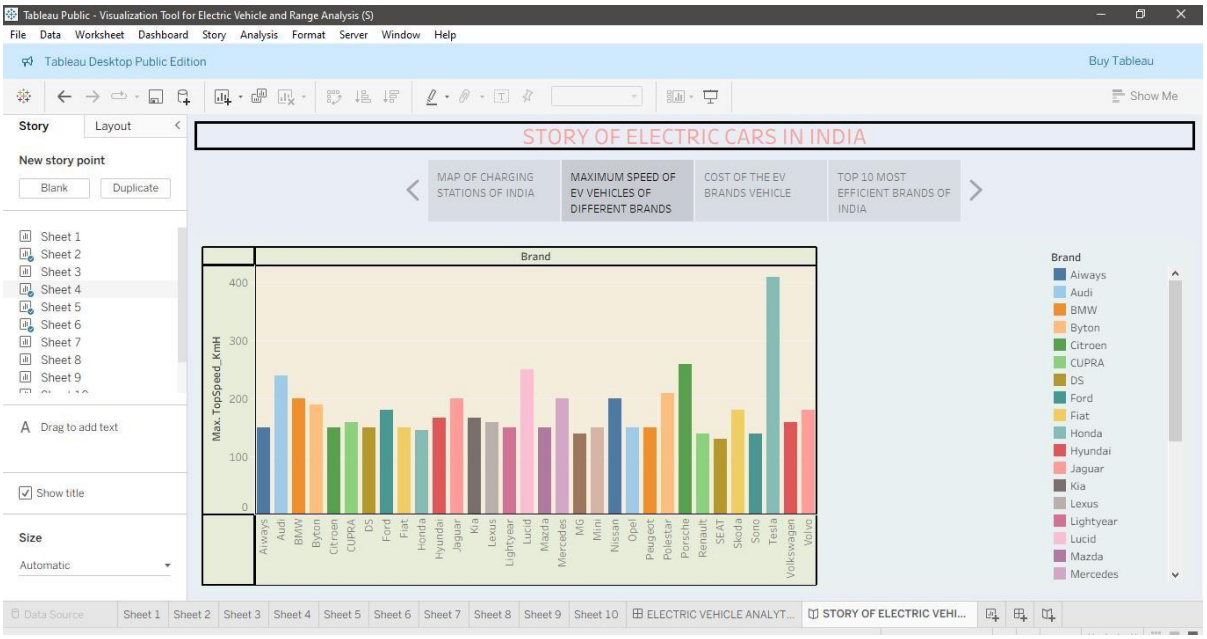
ELECTRIC VEHICLE ANALYT...
STORY OF ELECTRIC VEHI...



9. ADVANTAGES & DISADVANTAGES

Advantages

1. **Improves Decision-Making :**
2. o Visual dashboards make battery charge and range data easy to understand.
   - o Helps users plan trips and charging schedules efficiently.
3. **Reduces Range Anxiety:**
   - o Clear visualization of remaining range builds driver confidence.
   - o Avoids unexpected battery drain during long trips.
4. **User-Friendly Interpretation of Complex Data:**
   - o Converts raw EV data into graphs, charts, and maps.

o Non-technical users can understand insights quickly.

5. **Supports Data-Driven Analysis:**

   - o Identifies usage patterns, efficiency trends, and charging behavior.

   - o Useful for performance evaluation and optimization

Disadvantages

1. **Depends on Data Accuracy**

- Incorrect or incomplete data leads to misleading visualizations.
- Quality of insights fully depends on input data reliability.

2. **Limited Real-Time Capability (Initial Version)**

 Without live vehicle data, analysis is mostly historical or simulated. Real-time integration increases complexity.

3. **Range Prediction Variability**

- Factors like driving style, weather, and terrain may not be fully captured.
- Predictions may differ from actual vehicle performance.

4. **Technical Complexity**

- Requires knowledge of data analytics tools and visualization platforms.
- Maintenance and upgrades may need skilled professionals.

10. CONCLUSION

The Visualization Tool for Electric Vehicle Charge and Range Analysis successfully demonstrates how data visualization can play a crucial role in understanding and optimizing electric vehicle performance. By transforming raw battery and range data into interactive charts and dashboards, the project provides clear insights into charging patterns, energy consumption, and range behavior of electric vehicles.

This tool helps reduce range anxiety by enabling users to monitor battery status and predict driving range more effectively. It supports data-driven decision-making for users, fleet managers, and planners by identifying efficiency trends and potential charging requirements. The project also highlights the importance of analytical tools in promoting efficient EV usage and sustainable transportation.

11. FUTURE SCOPE

1. Real-Time Data Integration

- Connect the tool with live EV sensor data (battery SOC, temperature, energy consumption).
- Integrate IoT devices and vehicle APIs to show real-time charge and range updates.
- Useful for fleet operators and smart city dashboards.

2. AI-Based Range Prediction

- Use machine learning models to predict range more accurately based on:
  - Driving behavior
  - Road conditions
  - Weather and traffic
- Improves decision-making for drivers and reduces range anxiety.

3. Charging Station Optimization

- Integrate charging station availability data**.**
- Visualize: ○ Nearest stations ○ Wait times ○ Fast vs slow chargers
- Helps users plan trips efficiently.

12. APPENDIX

Source Code(Dataset Links)

1. https://drive.google.com/file/d/1rMhNvFitXodYzuPbxJ60dy4s2zaYGyR/view?usp=drive_link
2. https://drive.google.com/file/d/1mv1GcOzwShlv4vYyXF82kBfLtZMqIDoN/view?usp=drive_link
3. https://drive.google.com/file/d/1rTANUsWxe2Et5vF6ik0SWjUTUTNoZhP/view?usp=drive_link
4. https://drive.google.com/file/d/1f8hcispK439nJNgcAb13tBEsCx2vTcv/view?usp=drive_link

GitHub & Project Demo Link

- **Team Leader Github Link**
  https://github.com/Mounika-c824/Visualization-Tool-for-Electric-Vehicle-Chargeand-Range-Analysis
- **Team Member 1 Github Link**
  https://github.com/JAYAPRAKASH-JP-27/Visualization-Tool-for-Electric-Vehicle-Chargeand-Range-Analysis
- **Team Member 2 Github Link**
  https://github.com/Vandana-Seeripi/Visualization-Tool-for-Electric-Vehicle-Chargeand-Range-Analysis.git
- **Team Member 3 Github Link**
  https://github.com/neseanil0001-lab/Visualization-Tool-for-Electric-Vehicle-Chargeand-Range-Analysis-

Project Demo Link:
https://drive.google.com/file/d/1rGtUNUIpi9HOspjMIp_TWRsGX6PhOGhN/view?usp=drivesdk
Project Template Link:
https://drive.google.com/file/d/1NvN64XDPFnKH0YxzQjNUCmZLWfjUHts9/view?usp=drivesdk