Final Project Report

Visualization Tool for Electric Vehicle Charge & Range Analysis

Team ID: LTVIP2026TMIDS47701

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Team Member 2: **Shaik Azmal**

Team Member 3: **Ongole Mounika**

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 datadriven 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.

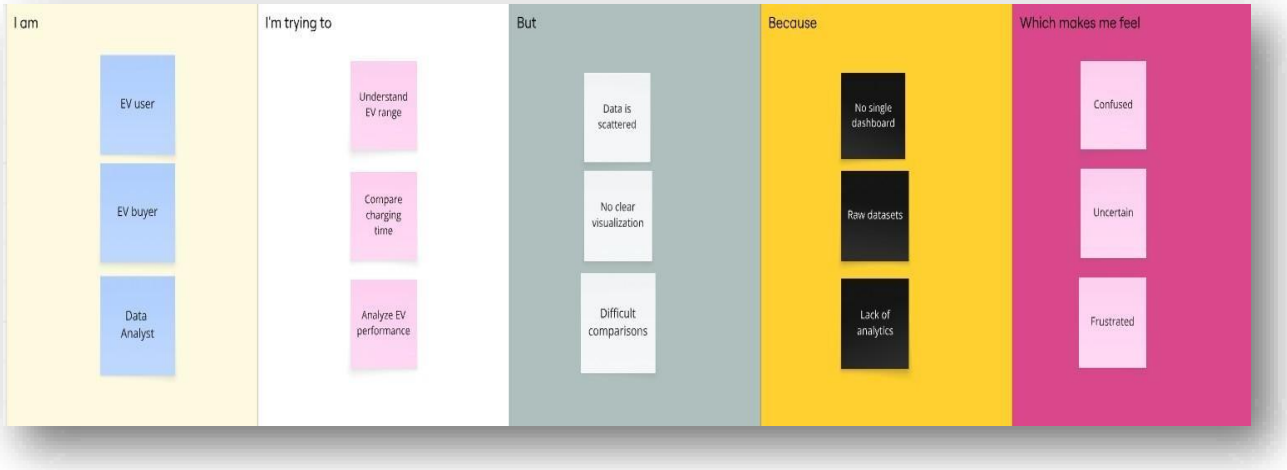
2.Ideation Phase

2.1 Problem Statements

Customer Problem Statement Template:

Create a problem statement to understand your customer's point of view. The Customer Problem Statement template helps you focus on what matters to create experiences people will love. A well-articulated customer problem statement allows you and your team to find the ideal solution for the challenges your customers face.

I am	Describe customer with 3-4 key characteristics - *who are they?*	Describe the customer and their attributes here
I'm trying to	*List their outcome or "job" the care about - what are they trying to achieve?*	List the thing they are trying to achieve here
but	Describe what problems or barriers stand in the way – *what bothers them most?*	Describe the problems or barriers that get in the way here
because	Enter the "root cause" of why the problem or barrier exists – *what needs to be solved?*	Describe the reason the problems or barriers exist
which makes me feel	Describe the emotions from the customer's point of view – *how does it impact them emotionally?*	Describe the emotions the result from experiencing the problems or barriers

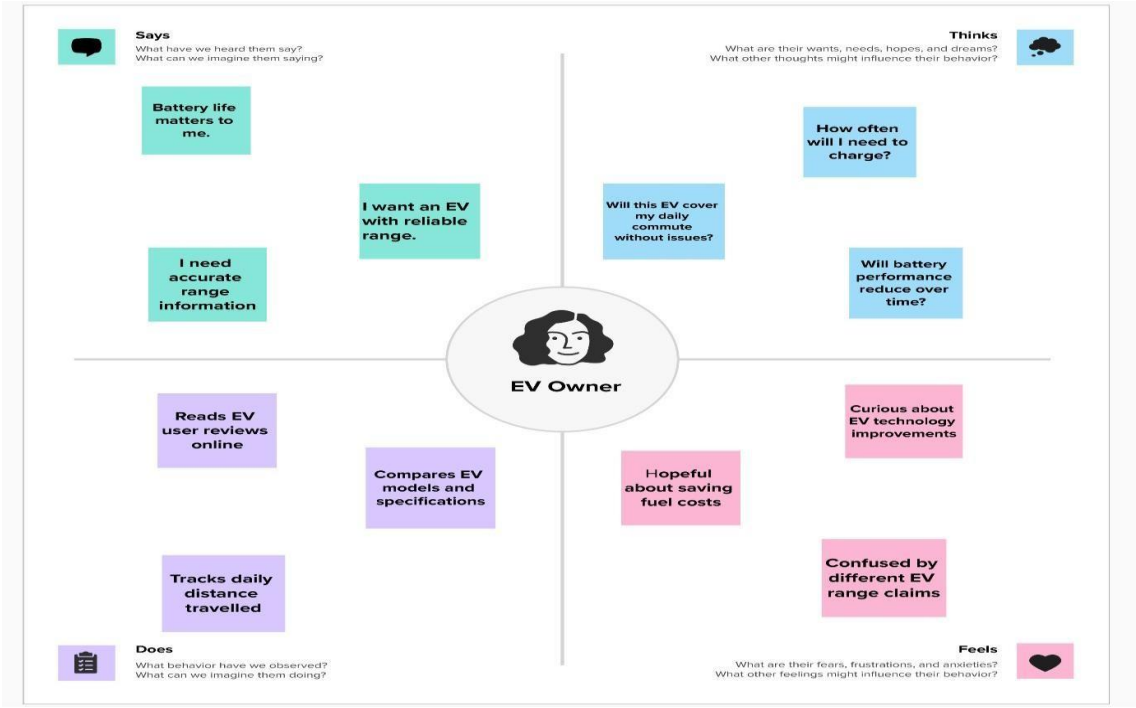


Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel

PS-1	An electric vehicle user.	understand the driving range and charging behavior of different electric vehicles.	understand the driving range and charging behavior of different electric vehicles.	there is no single interactive platform that visualizes EV range and charging data clearly.	confused and uncertain while making decisions.
PS-2	an EV analyst / policy maker.	analyze EV adoption trends, charging infrastructure, and performance metrics.	existing reports lack clear visual insights and comparisons.	raw data is not converted into meaningful dashboards.	inefficient and limited in datadriven planning.

2.2 Empathy Map Canvas:

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' perspective along with his or her goals and challenges.

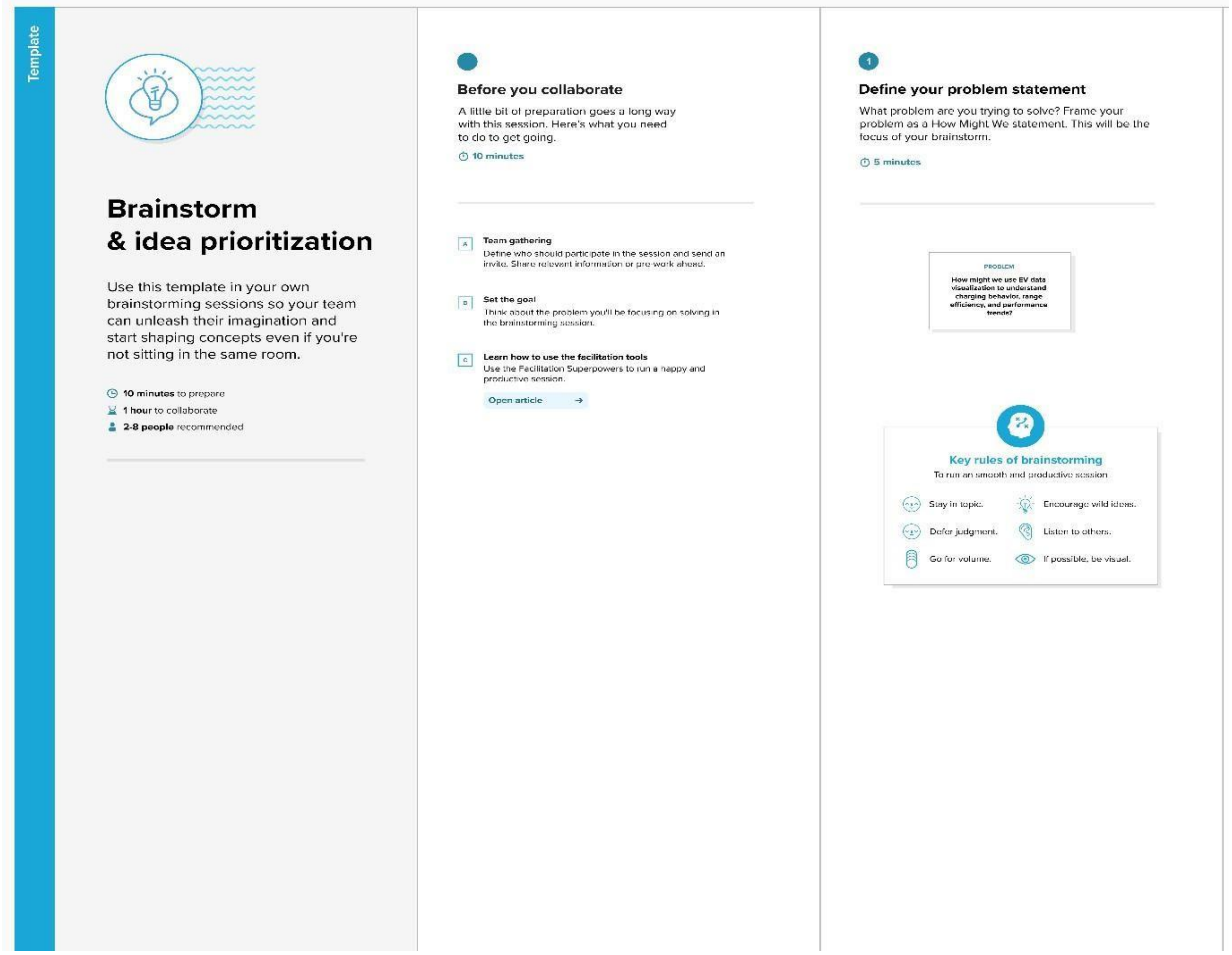


2.3 Brainstorm

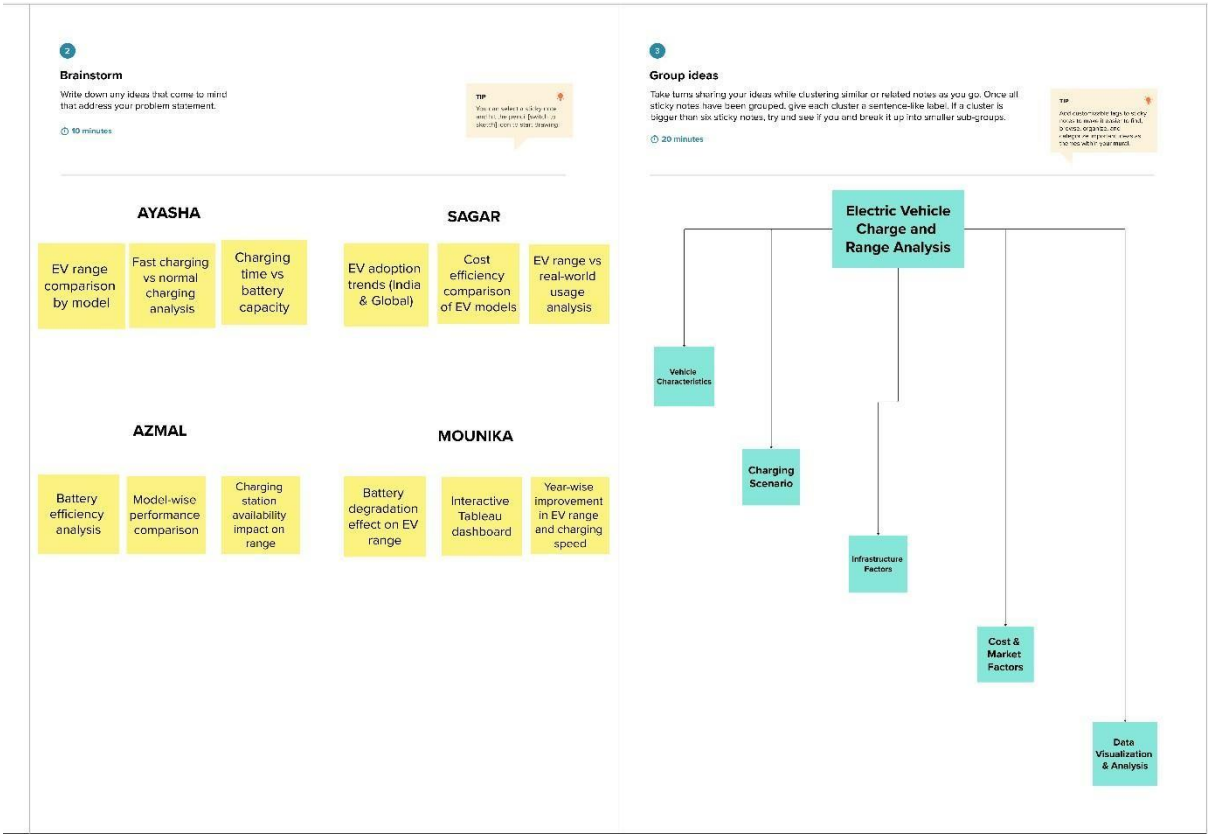
Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative problem-solving process. Prioritization helps in selecting the most impactful and feasible ideas. This approach encourages collaboration, innovation, and structured decision-making to arrive at effective solutions.

This template is used to generate, analyze, and prioritize ideas for building a visualization tool that helps understand electric vehicle charging and range performance using data analytics and dashboards.

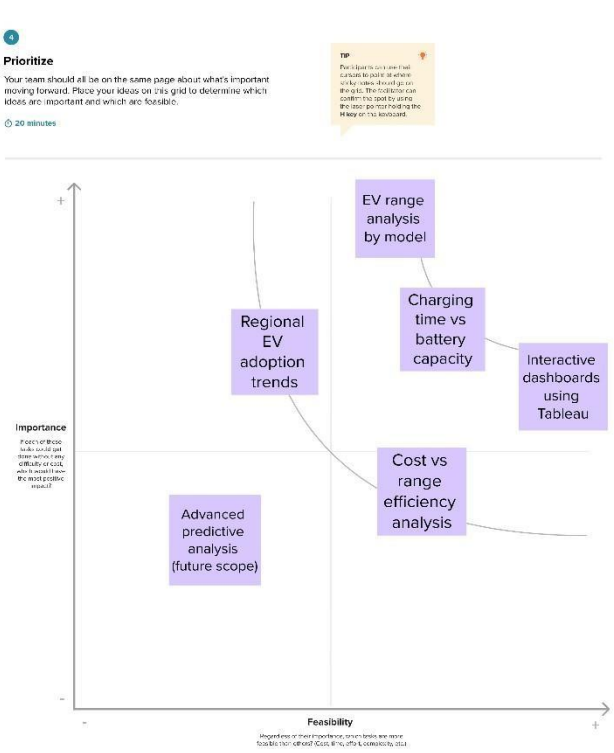
Step-1: Team Gathering, Collaboration and Select the Problem Statement

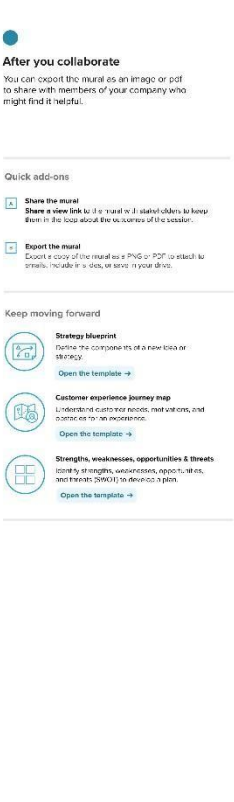


Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization





3.REQUIREMENT ANALYSIS

3.1 Customer Journey Map

3.2 Solution Requirements (Functional & Non-functional)

Functional Requirements:

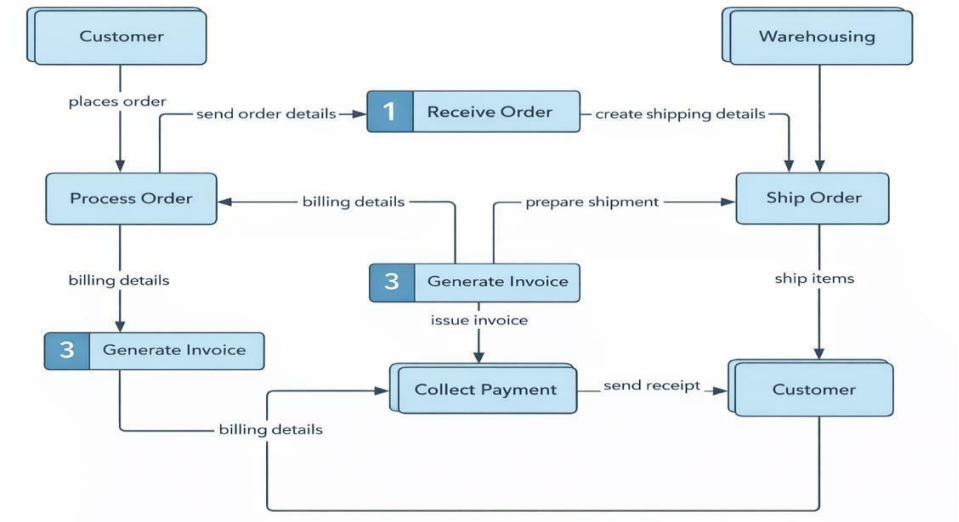
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User Login	Login using email & password Login using Gmail
FR-4	Dashboard Access	View EV range analysis View battery status & charging data
FR-5	Charging Station Information	View nearby charging stations Filter stations by availability
FR-6	Data Visualization	View charts and graphs for EV performance

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 with a simple and intuitive user interface.
NFR-2	**Security**	User data should be protected using authentication and secure access.
NFR-3	**Reliability**	The system should provide accurate EV range and charging analysis without data loss.
NFR-4	**Performance**	The application should load dashboards and analytics within a few seconds.
NFR-5	**Availability**	The system should be accessible 24/7 with minimal downtime.
NFR-6	**Scalability**	The system should support an increasing number of users and EV datasets.

3.3 Data Flow Diagram & User Stories



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 details.	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 model.	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	USN-10	As a user, I want to download visual reports .	Report downloads successfully	Low	Sprint-5

3.4 Technology Stack (Architecture & Stack)

Technical Architecture:

The EV Charge & Range Analysis System follows a three-tier architecture consisting of User Interface, Application Logic, and Database layers. The system collects EV-related data, processes it using analytical logic, and displays insights such as battery status, range prediction, and charging station availability through an interactive dashboard.

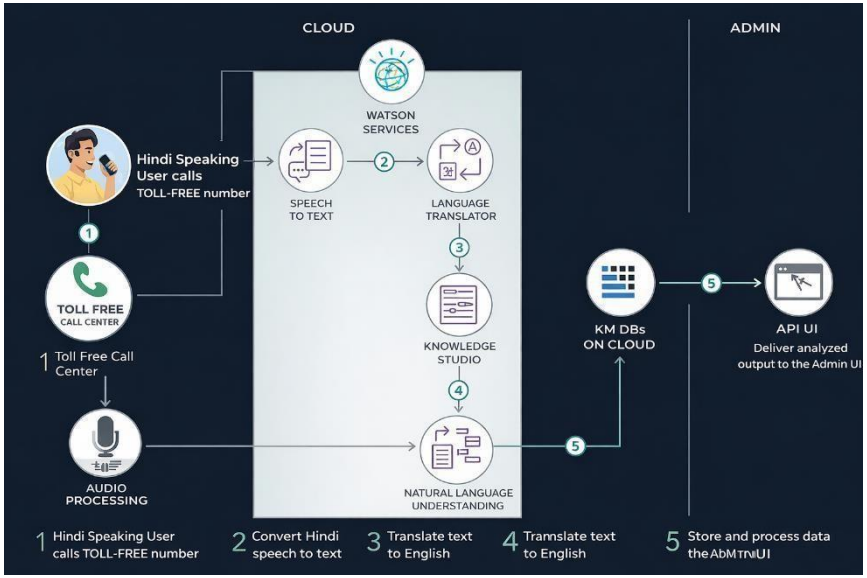


Table-1: Components & Technologies:

S.No	Component	Description	Technology

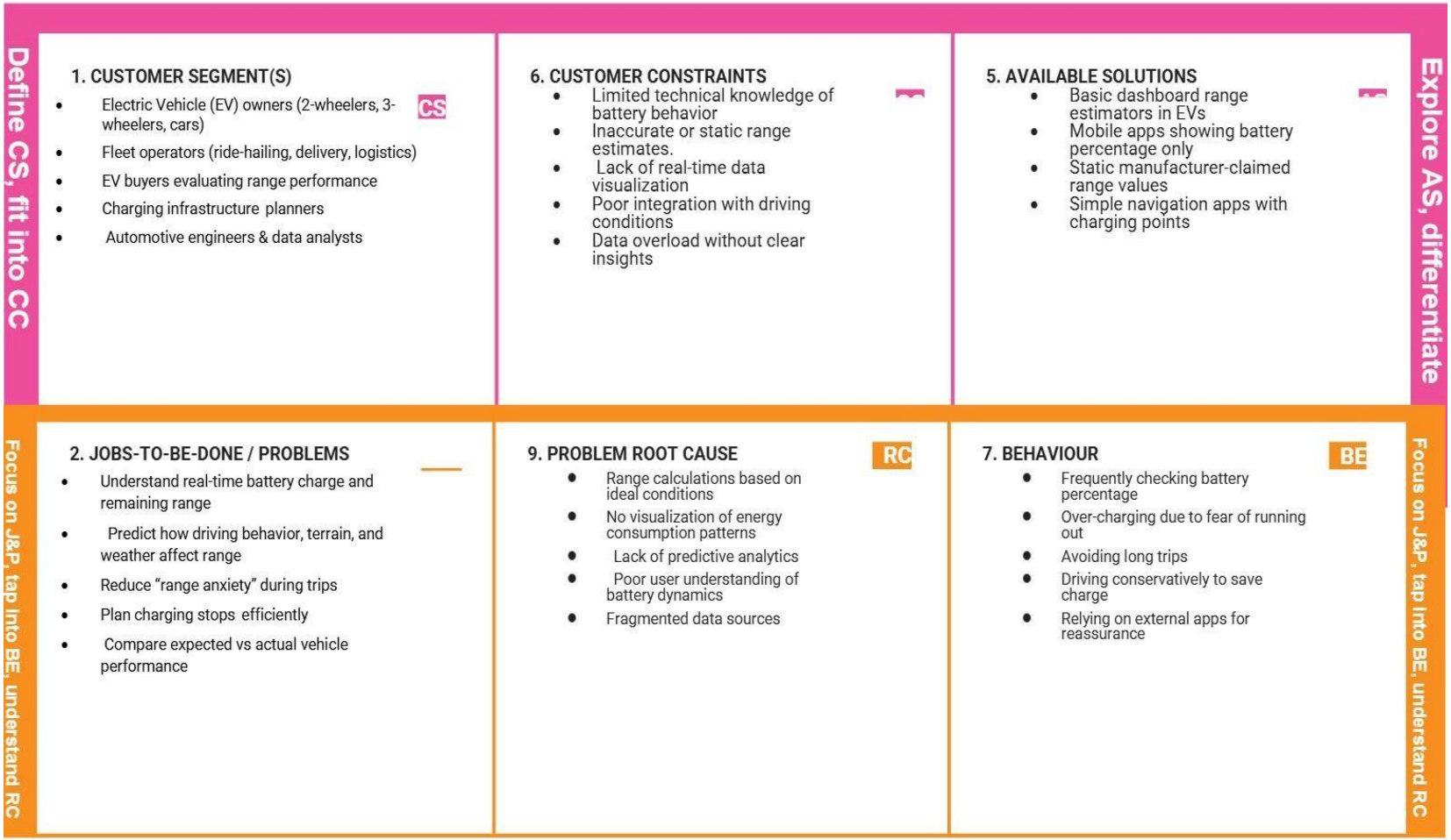
1.	User Interface	Allows users to interact with the application through dashboards and reports	HTML, CSS, JavaScript, React.js
2.	Application Logic-1	Handles user authentication and authorization	Python, Flask
3.	Application Logic-2	Processes EV range and charging data	Python, Pandas
4.	Application Logic-3	Performs data analysis and predictions	Python, NumPy
5.	Database	Stores EV data, user details, and charging station information.	MySQL
6.	Cloud Database	Stores backup and large datasets on cloud	AWS RDS / Firebase
7.	File Storage	Stores CSV files and datasets	Local File System / Cloud Storage
8.	External API-1	Fetches charging station location data	Google Maps API.
9.	External API-2	Fetches EV-related data if required	Open EV API.
10.	Machine Learning Model	Predicts EV range based on battery data	Linear Regression / Scikit-learn.
11.	Infrastructure (Server / Cloud)	Hosts the application and services	Local Server / AWS Cloud.

Table-2: Application Characteristics:

1.	Open-Source Frameworks	System supports increase in users and EV datasets.	Cloud Deployment, Modular Architecture.
2.	Security Implementations	Ensures accurate and consistent analysis results.	MySQL, Data Validation.
3.	Scalable Architecture	Application is accessible anytime.	Cloud Hosting
4.	Availability	Fast data processing and dashboard loading.	Optimized Queries, Caching
5.	Performance	Easy to update and modify system features.	Modular Code Structure

4.Project Design

4.1 Problem Solution fit Template



3. TRIGGERS

- Low battery warning
- Planning a long or unfamiliar trip
- Unexpected drop in remaining range
- Searching for nearby charging stations
- Comparing EV efficiency across routes or vehicles

TR

4. EMOTIONS: BEFORE / AFTER

EM

Before

- Anxiety about reaching destination
- Uncertainty and lack of trust in range estimates
- Frustration due to inaccurate predictions

After

- Confidence in trip planning
- Reduced stress while driving
- Trust in EV performance and data insights

10. YOUR SOLUTION

SL

Interactive visual dashboard showing:

- Battery charge vs distance
- Energy consumption trends
- Predicted remaining range

Real-time data integration (speed, terrain, weather)

- Route-based range forecasting
- Charging station visualization and recommendations
- User-friendly graphs, alerts, and insights

8. CHANNELS of BEHAVIOUR

CH

- In-vehicle infotainment system
- Mobile application (Android / iOS)
- Web dashboard for analytics
- Alerts & notifications
- Navigation and maps integration

4.2 Proposed Solution Template

Proposed Solution Template:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Electric Vehicle (EV) users face range anxiety due to inaccurate charge and range estimation and lack of proper visualization tools to analyze charging behavior and vehicle performance. This makes trip planning difficult and reduces confidence in EV usage.
2.	Idea / Solution description	The proposed solution is a virtualization tool that analyzes EV charging and range data and presents it through interactive dashboards and visualizations. The system helps users understand battery usage, predict driving range, and plan charging efficiently using data-driven insights.
3.	Novelty / Uniqueness	Unlike traditional static range indicators, this tool uses data analytics and visualization to provide deeper insights into EV performance. It combines charge patterns, range prediction, and visual dashboards in a single platform, making EV analysis simple and user-friendly.
4.	Social Impact / Customer Satisfaction	The solution reduces range anxiety, improves user confidence in electric vehicles, and supports ecofriendly transportation. It enhances customer satisfaction by enabling better trip planning and promoting sustainable mobility.
5.	Business Model (Revenue Model)	The platform can follow a freemium model where basic analytics are free, and advanced features are available through subscription. It can also generate revenue through partnerships with EV manufacturers, fleet operators, and charging service providers.
6.	Scalability of the Solution	The solution is highly scalable as it can be extended to support multiple EV models, large datasets, and real-time charging data. It can be deployed across cities and regions with increasing users and EV adoption

4.3 Solution Architecture

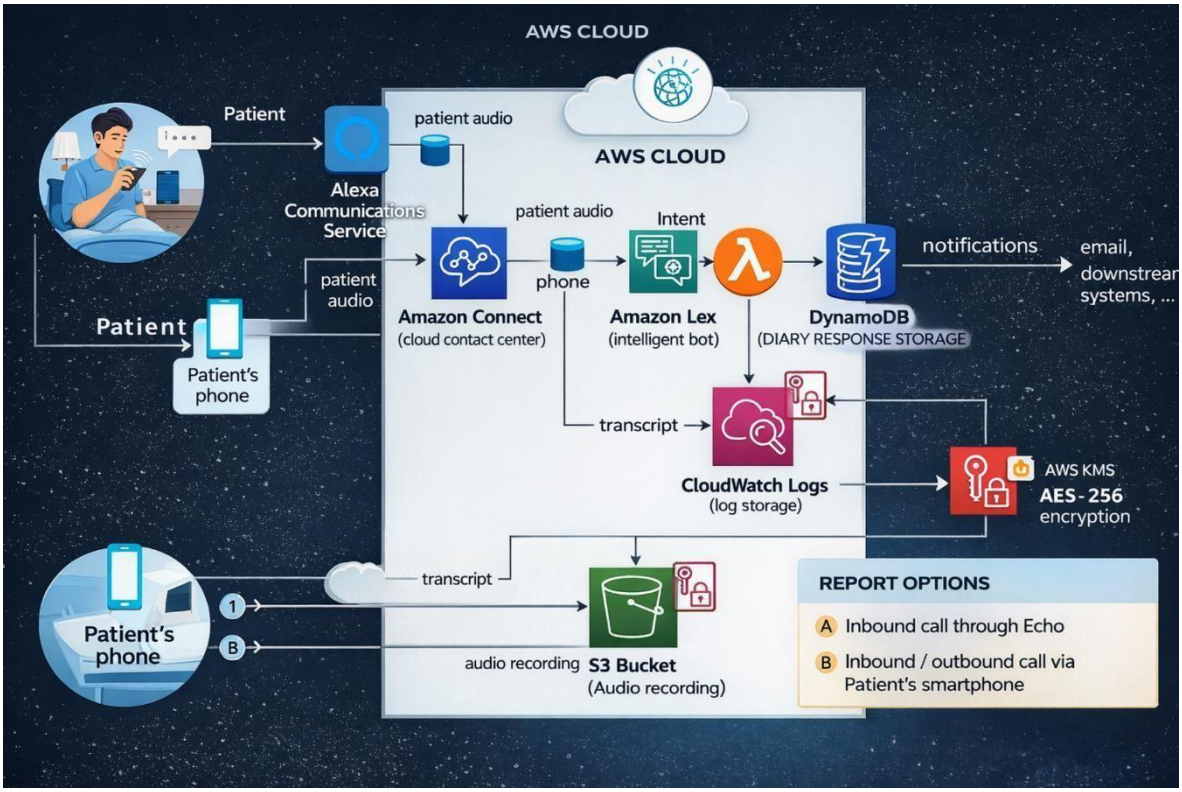
Solution Architecture:

The proposed solution uses a cloud-based, voice-enabled architecture on AWS to collect, process, store, and analyze patient voice responses securely and efficiently. The architecture integrates multiple AWS services to ensure scalability, security, and reliability.

Objectives of the Solution Architecture

- To provide an efficient and scalable architecture for EV charge and range analysis
- To ensure smooth data flow from input to visualization
- To support accurate analysis and decision-making for EV users

Solution Architecture Diagram:



5.PROJECT PLANNING & SCHEDULING

5.2 Project Planning

Product Backlog, Sprint Schedule, and Estimation(4Marks)

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 hatl can see remaining range	5	High	TM1
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

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

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

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**

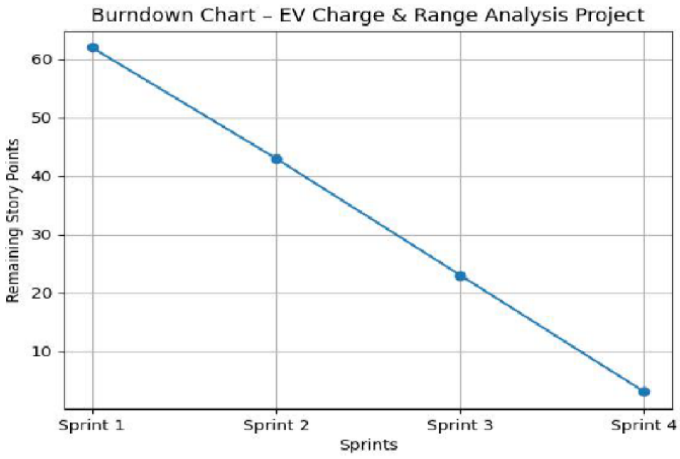
Average Team Velocity

Average Team Velocity Calculation

Velocity = 77 / 4 = 19.25 story points per sprint

Burndown Chart:

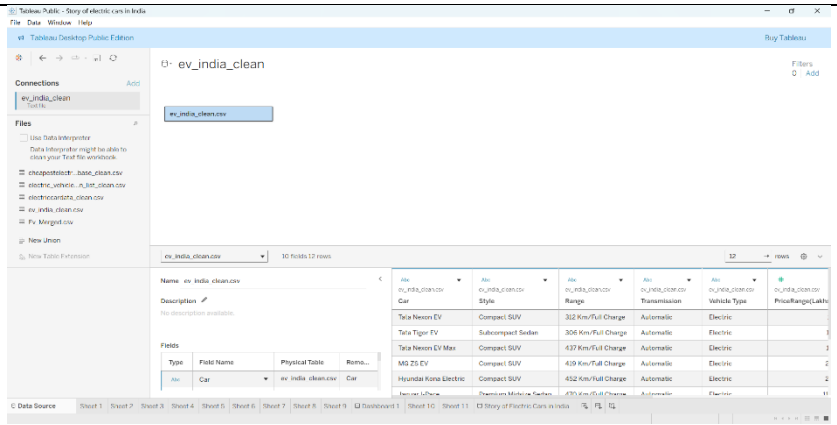
A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

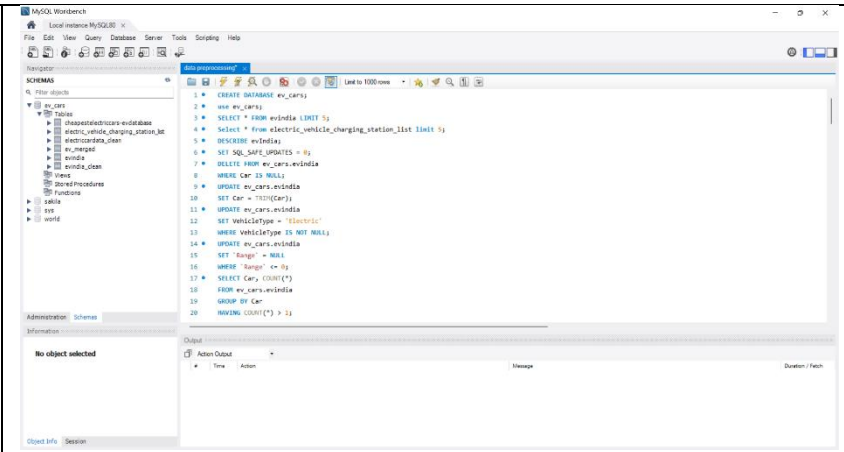


6. FUNCTIONAL AND PERFORMANCE TESTING

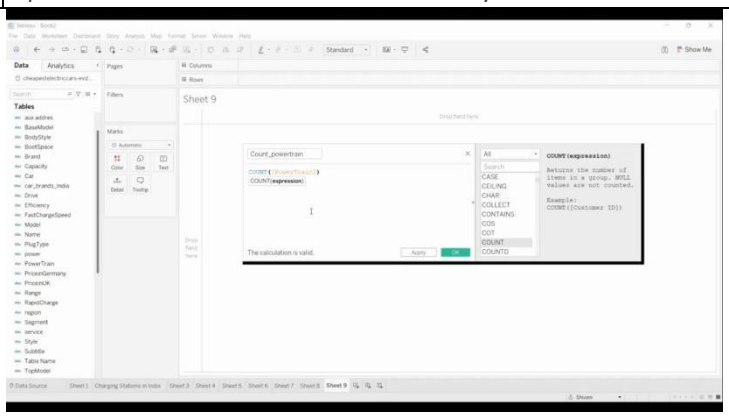
6.2 Performance Testing

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: 9

- ✓ 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 PowerTrain 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.

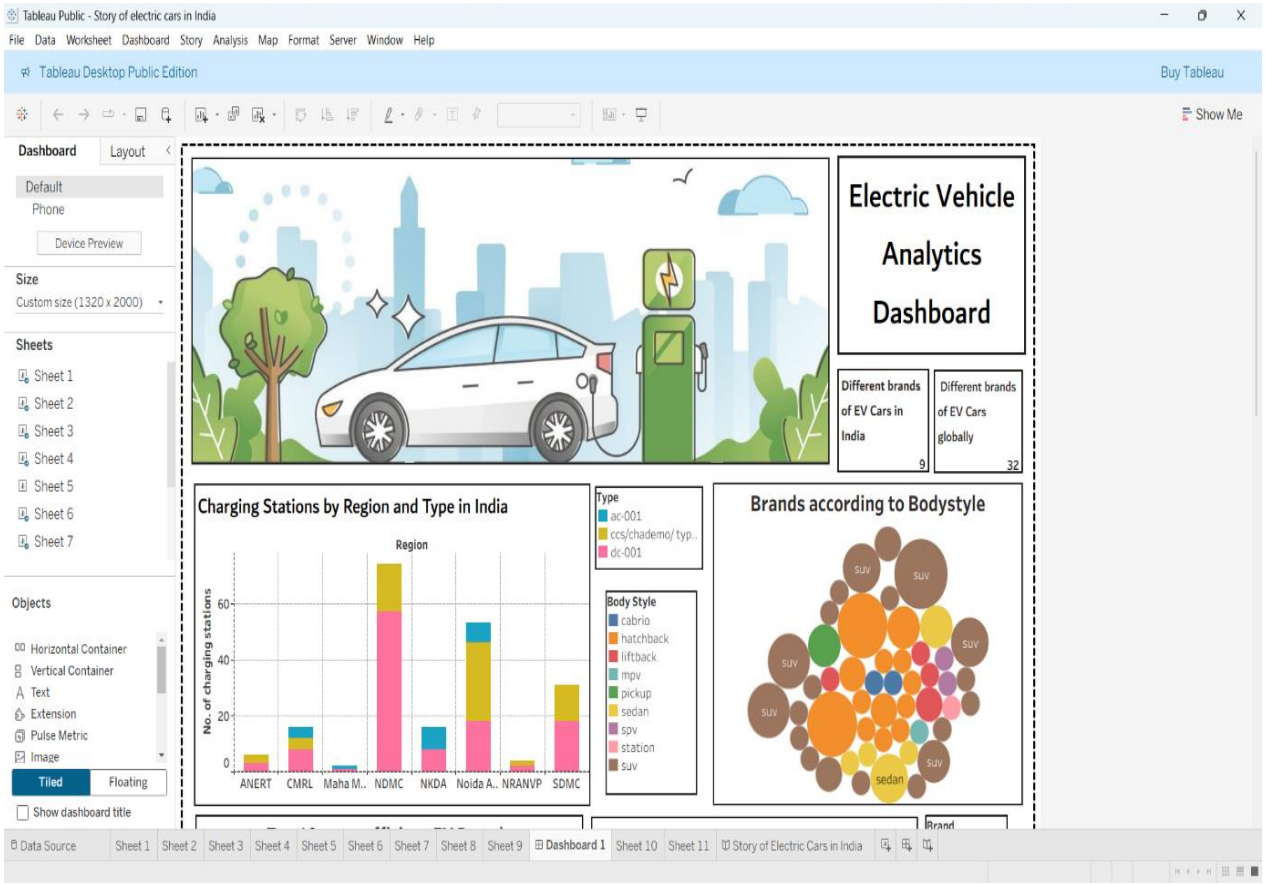
No. of Visualizations / Graphs: 5

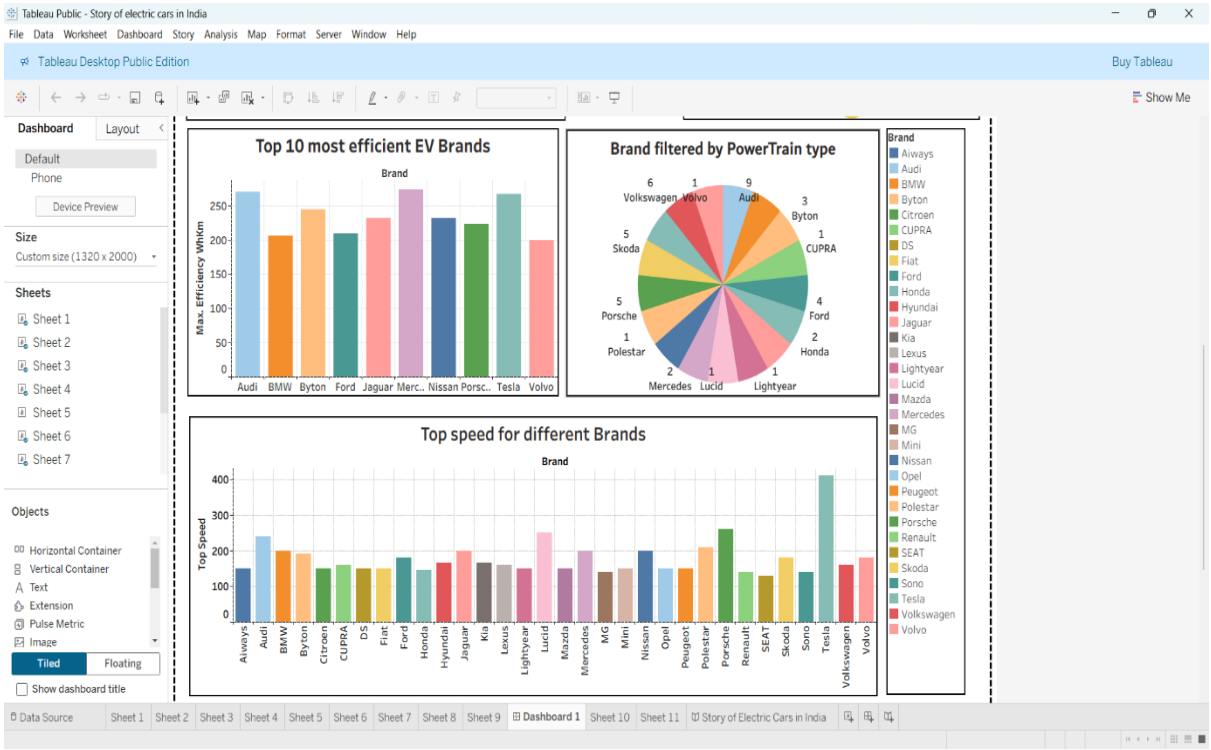
Story flow includes:

- EV range overview
- Charging performance comparison
- Charging station availability
- Final insights and observations
- Brands Filtered by Power Train Type

7. RESULTS

7.1 Dashboard

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Top 10 most efficient EV Brands
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Audi BMW Byton Ford Jaguar Merc.. Nissan Porsc.. Tesla Volvo
Brand filtered by PowerTrain type
Volkswagen 6
Volvo 1
Audi 9
Byton 3
CUPRA 1
Ford 4
Honda 2
Lightyear 1
Lucid 1
Mercedes 2
Polestar 1
Porsche 5
Skoda 5
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BMW iX
Premium Sports Sedan
Porsche Taycan
Premium Midsize Sedan
Jaguar I-Pace
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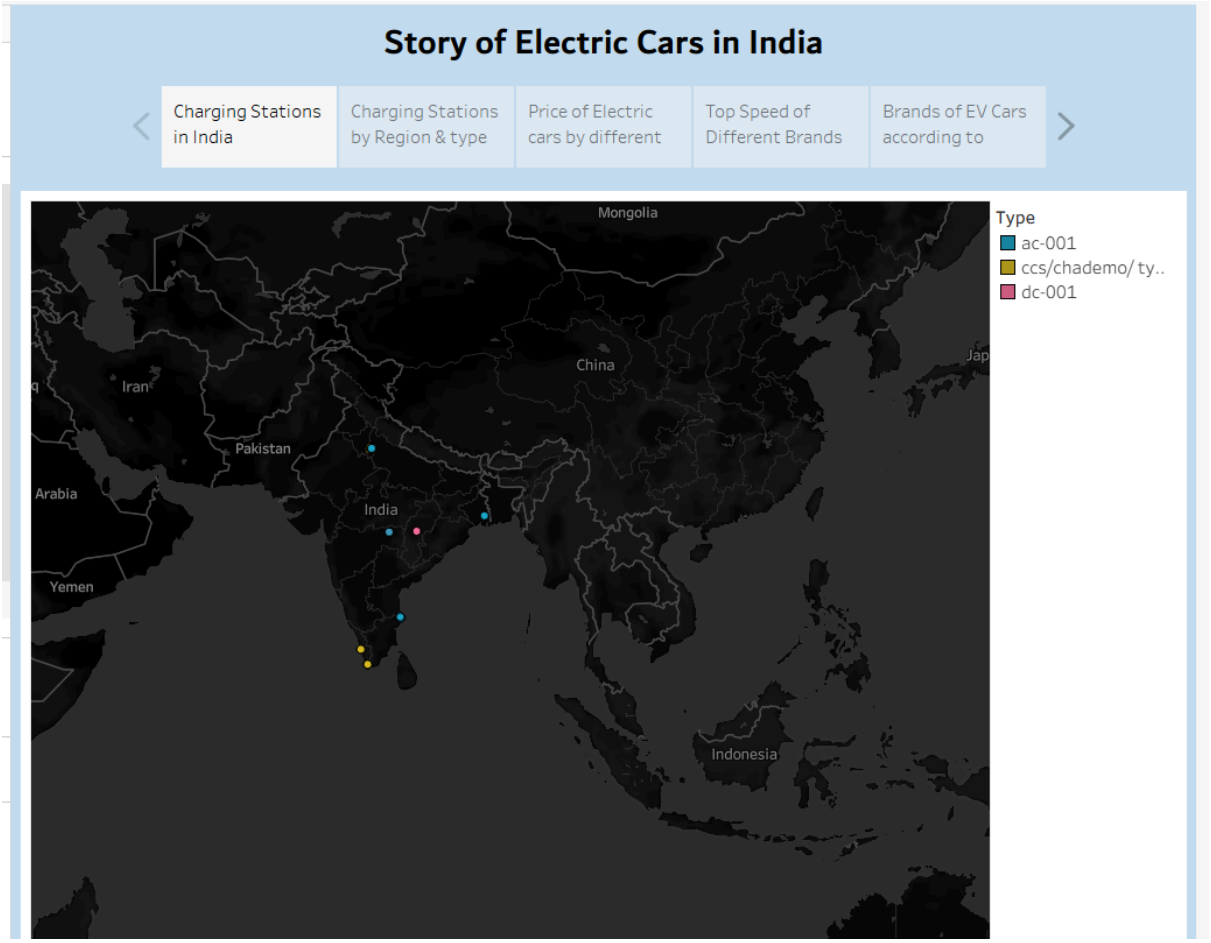
Story of Electric Cars in India

7.2 Story


Story of Electric Cars in India
Charging Stations in India
Charging Stations by Region & type
Price of Electric cars by different
Top Speed of Different Brands
Brands of EV Cars according to
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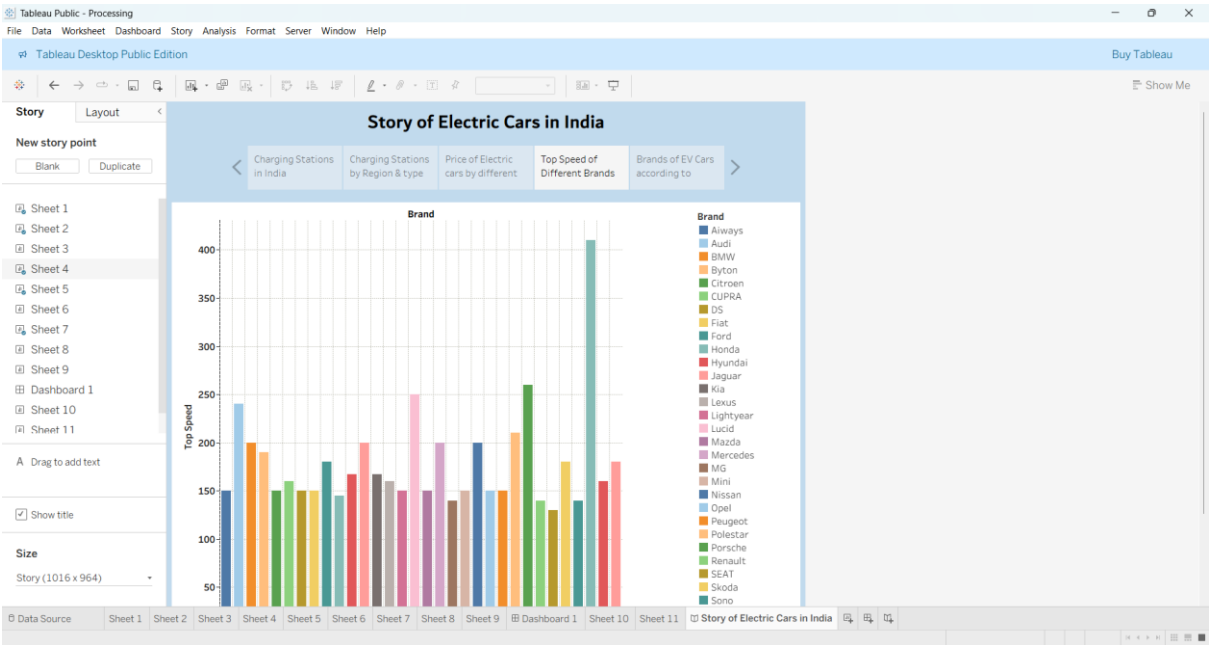
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Charging Stations in India
Charging Stations by Region & type
Price of Electric cars by different
Top Speed of Different Brands
Brands of EV Cars according to
Brand
Top Speed
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350
300
250
200
150
100
50
Aiways
Audi
BMW
Byton
Citroen
CUPRA
DS
Fiat
Ford
Honda
Hyundai
Jaguar
Kia
Lexus
Lightyear
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Mercedes
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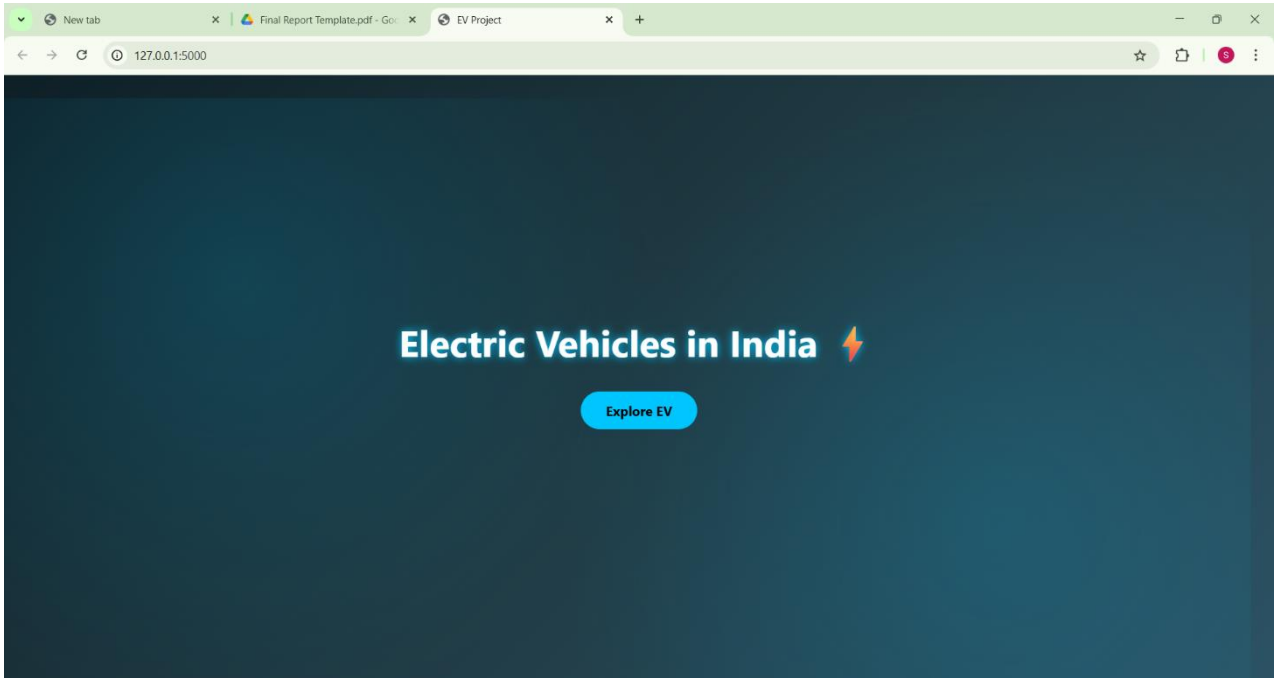
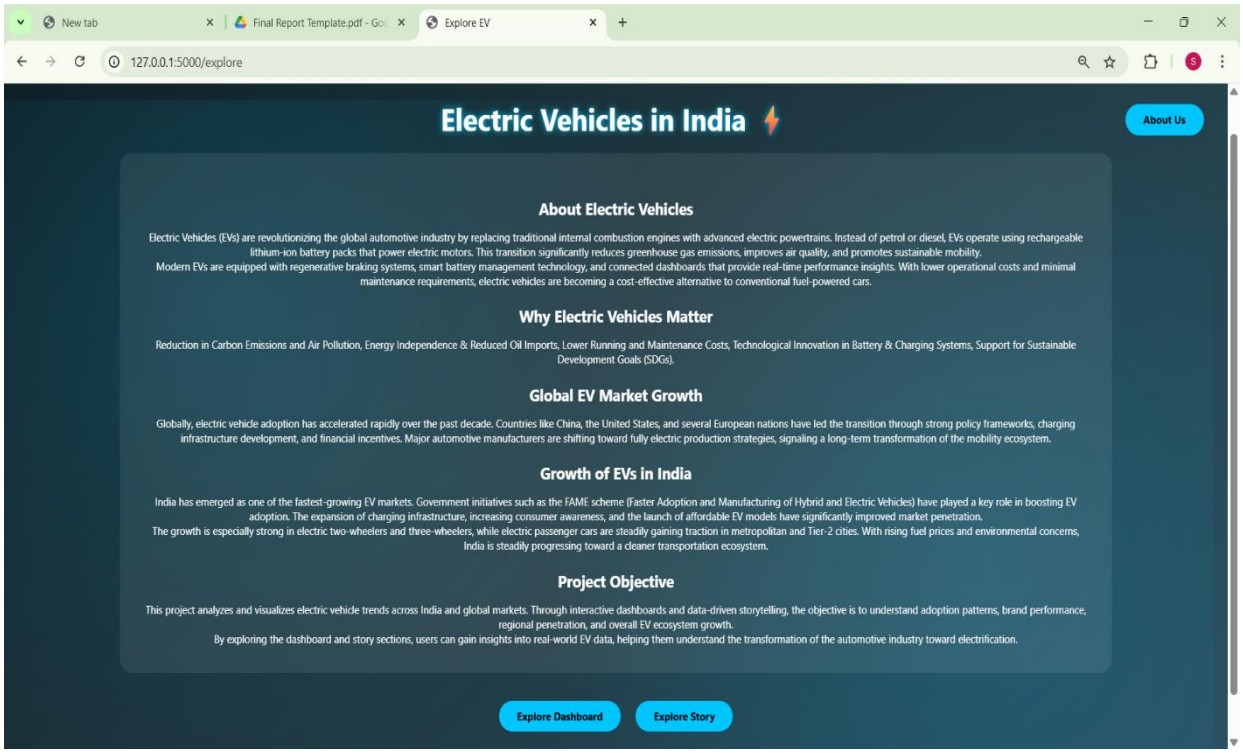
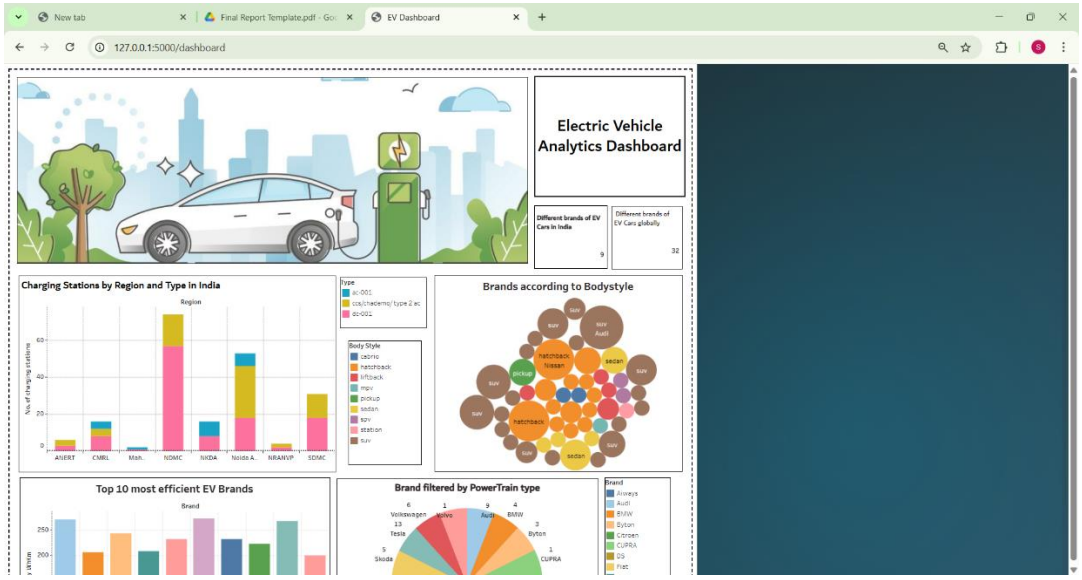
Story of Electric Cars in India

7.3 Web Integration



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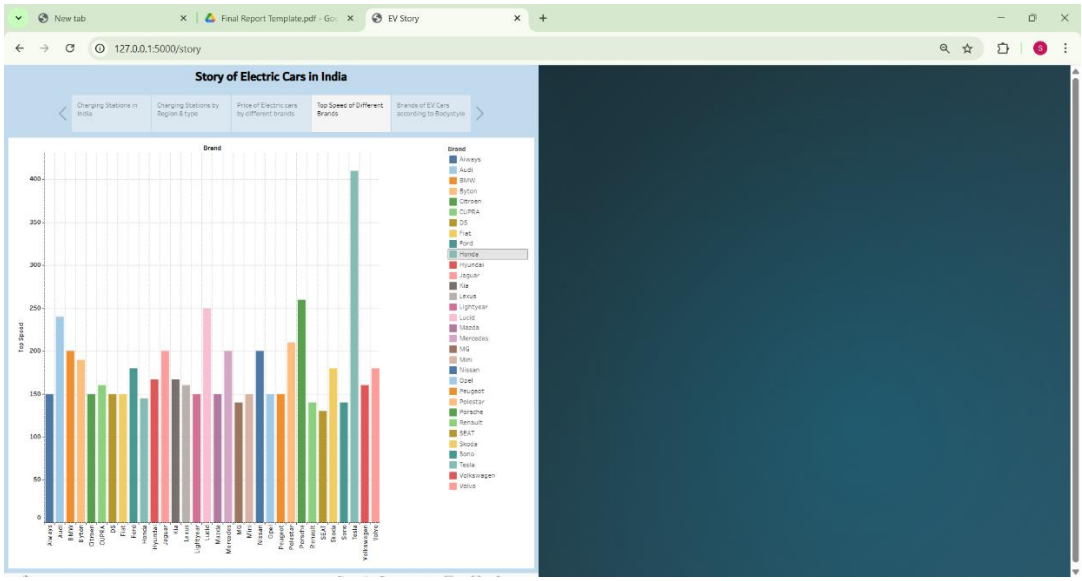
Electric Vehicle Analytics Dashboard
Different brands of EV Cars in India
9
Different brands of EV Cars globally
32
Charging Stations by Region and Type in India
Region
No. of charging stations
ANERT
CMRL
Man.
NDMC
NKDA
Noida A..
NRANVP
SDMC
Type
ac-001
ccs/chademo/ type 2 ac
dc-001
Body Style
cabrio
hatchback
liftback
mpv
pickup
sedan
suv
station
suv
Brands according to Bodystyle
suv
Audi
pickup
Nissan
sedan
hatchback
Top 10 most efficient EV Brands
Brand
y Km/h
Brand filtered by PowerTrain type
6
Volkswagen
1
Volvo
9
Audi
4
BMW
13
Tesla
3
Byton
5
Skoda
1
CUPRA
Brand
Aiways
Audi
BMW
Byton
Citroen
CUPRA
DS
Fiat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EV Story
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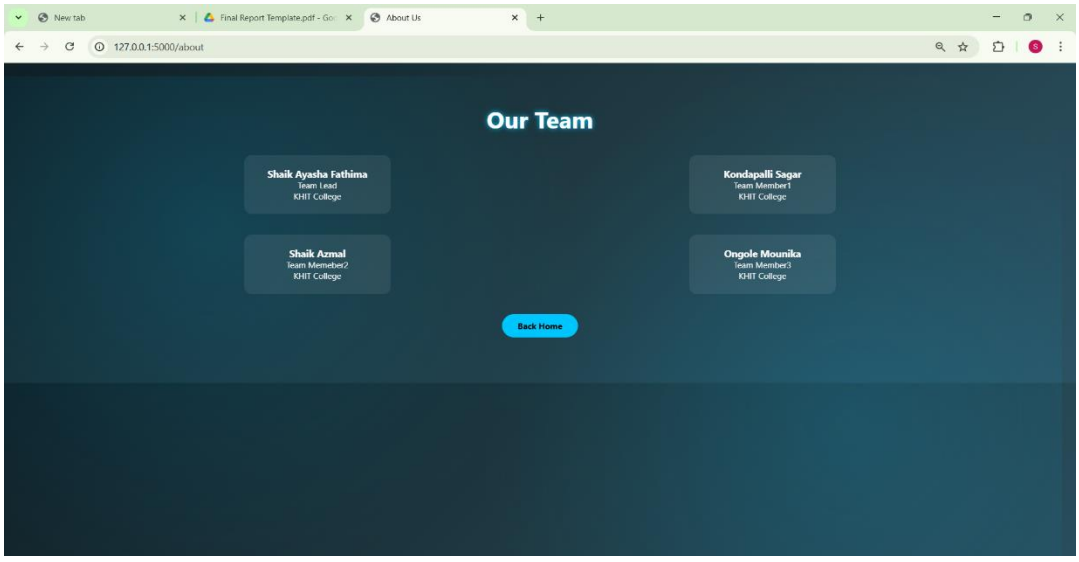
Story of Electric Cars in India
Charging Stations in India
Charging Stations by Region & type
Price of Electric cars by different brands
Top Speed of Different Brands
Brands of EV Cars according to Bodystyle
Brand
Top Speed
Brand
Aiways
Audi
BMW
Byton
Citroen
CUPRA
DS
Fiat
Ford
Honda
Hyundai
Jaguar
Kia
Lexus
Lightyear
Lucid
Mazda
Mercedes
MG
Mini
Nissan
Opel
Peugeot
Polestar
Porsche
Renault
SEAT
Skoda
Sono
Tesla
Volkswagen
Volvo


New tab
Final Report Template.pdf - Go
About Us
127.0.0.1:5000/about
Our Team
Shaik Ayasha Fathima
Team Lead
KHIT College
Kondapalli Sagar
Team Member1
KHIT College
Shaik Azmal
Team Member2
KHIT College
Ongole Mounika
Team Member3
KHIT College
Back Home

8. ADVANTAGES & DISADVANTAGES

Advantages

1. **Improves Decision-Making** ○ Visual dashboards make battery charge and range data easy to understand.
    - Helps users plan trips and charging schedules efficiently.
2. **Reduces Range Anxiety** ○ Clear visualization of remaining range builds driver confidence.
    - Avoids unexpected battery drain during long trips.
3. **User-Friendly Interpretation of Complex Data** ○ Converts raw EV data into graphs, charts, and maps.
    - Non-technical users can understand insights quickly.
4. **Supports Data-Driven Analysis** ○ Identifies usage patterns, efficiency trends, and charging behavior. ○ 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.

9. 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.

10. 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

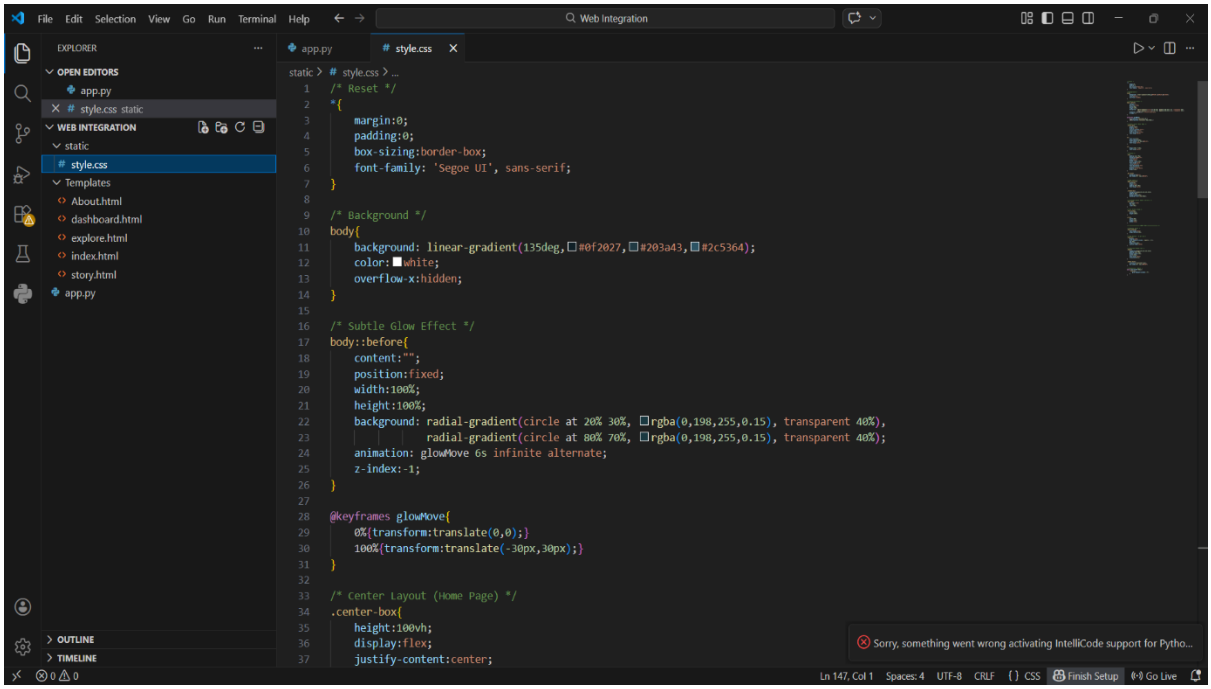
- Use machine learning models to predict range more accurately based on:
  - Driving behavior
  - Road conditions
  - Weather and traffic
- Improves decision-making for drivers and reduces range anxiety.

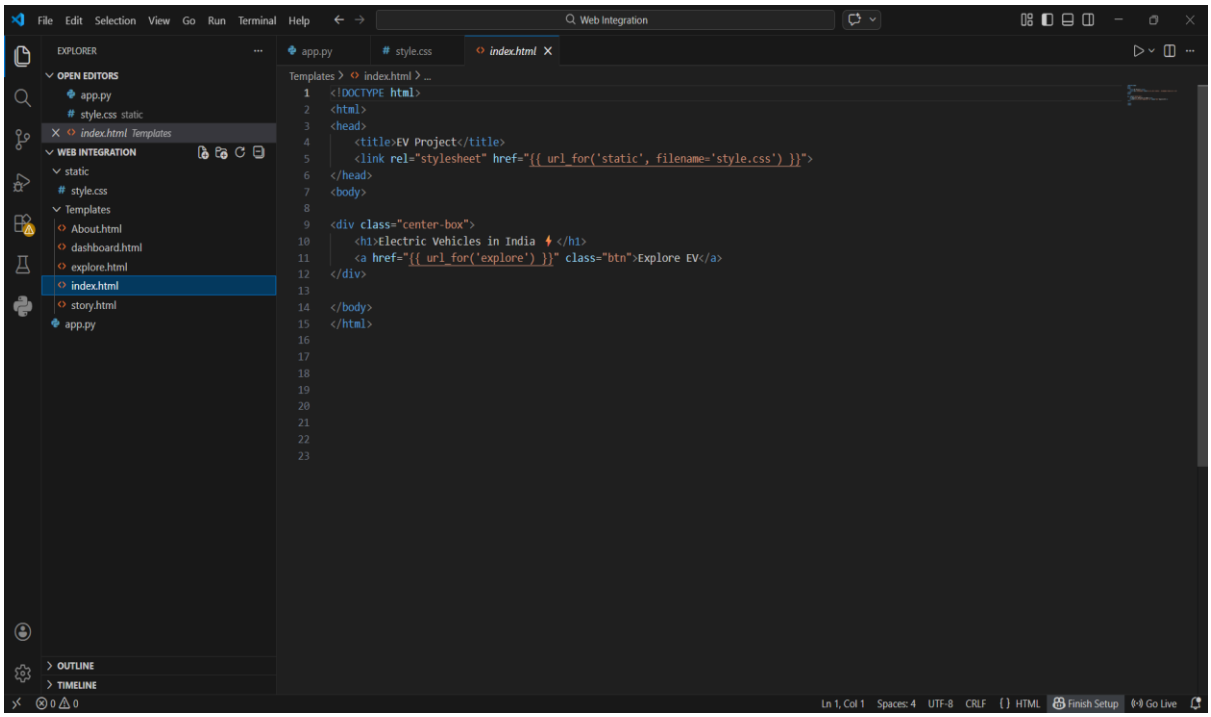
3. Charging Station Optimization

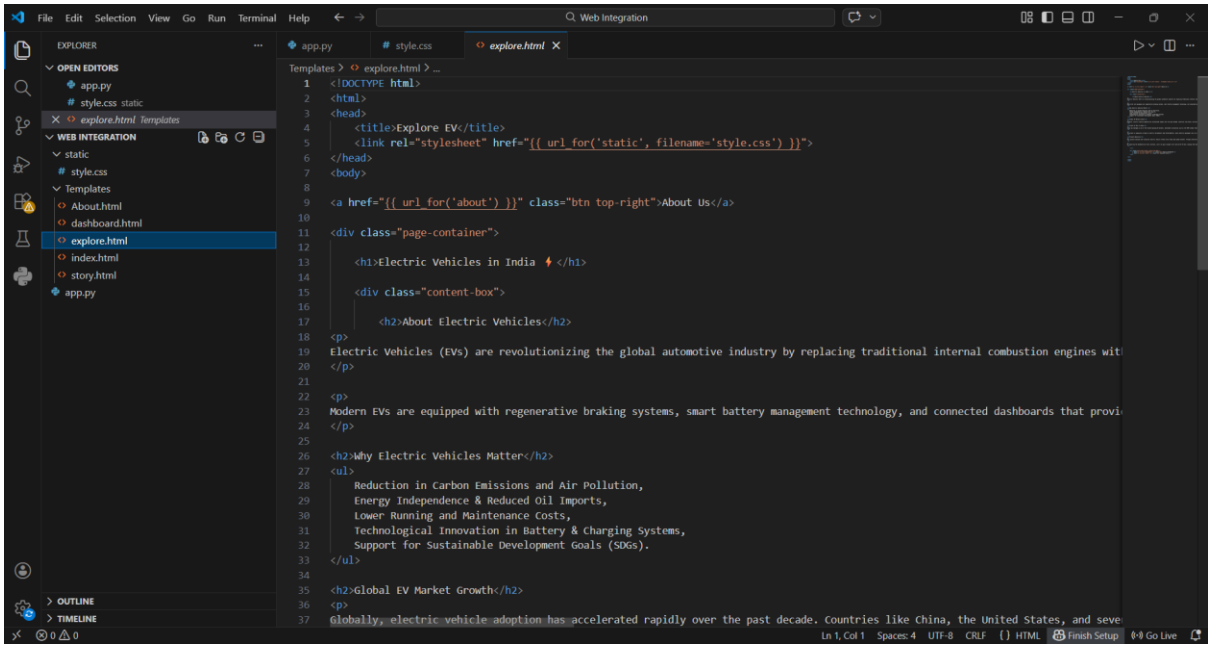
- Integrate charging station availability data.
- Visualize: Nearest stations Wait times Fast vs slow chargers
- Helps users plan trips efficiently.

11.APPENDIX

Source code



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explore.html Templates
WEB INTEGRATION
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Templates
About.html
dashboard.html
explore.html
index.html
story.html
app.py
OUTLINE
TIMELINE
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7 <body>
8
9 About Us
10
11
12
13 <h1>Electric Vehicles in India </h1>
14
15
16
17 <h2>About Electric Vehicles</h2>
18
19 Electric Vehicles (EVs) are revolutionizing the global automotive industry by replacing traditional internal combustion engines wit
20
21
22
23 Modern EVs are equipped with regenerative braking systems, smart battery management technology, and connected dashboards that provi
24
25
26 <h2>Why Electric Vehicles Matter</h2>
27
28 Reduction in Carbon Emissions and Air Pollution,
29 Energy Independence & Reduced Oil Imports,
30 Lower Running and Maintenance Costs,
31 Technological Innovation in Battery & Charging Systems,
32 Support for Sustainable Development Goals (SDGs).
33
34
35 <h2>Global EV Market Growth</h2>
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37 Globally, electric vehicle adoption has accelerated rapidly over the past decade. Countries like China, the United States, and seve
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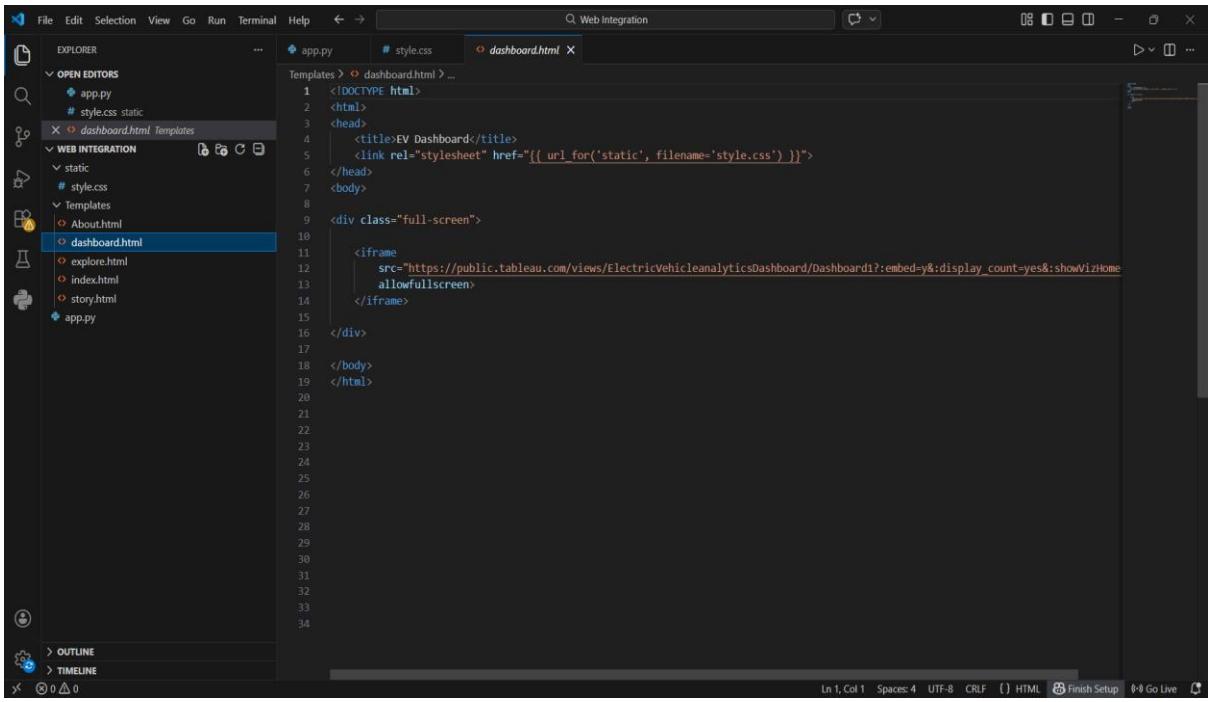
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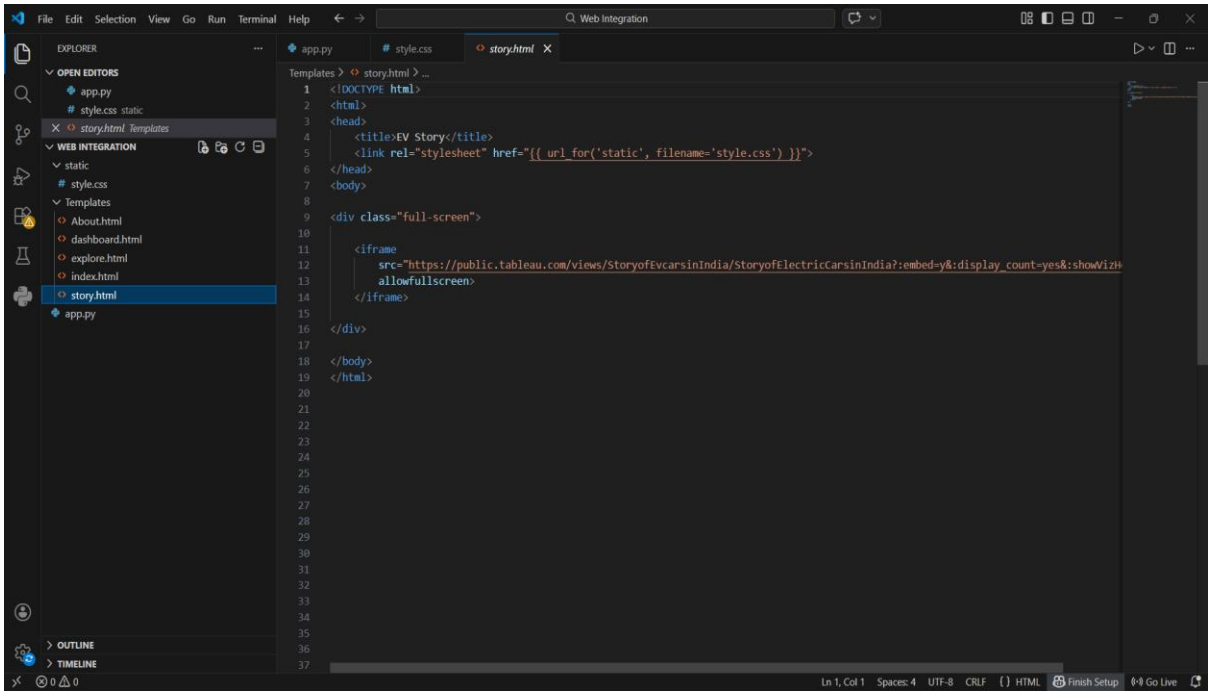
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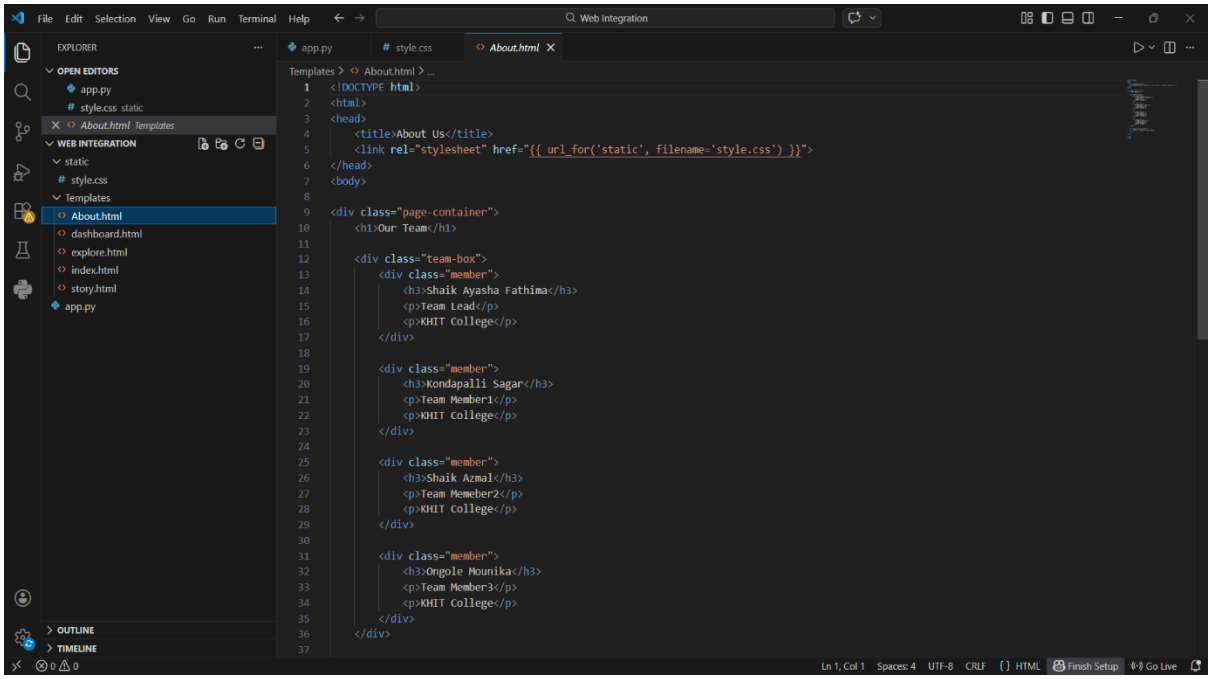
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</head>
<body>

<h1>Our Team</h1>

<h3>Shaik Ayasha Fathima</h3>
Team Lead
KHIT College

<h3>Kondapalli Sagar</h3>
Team Member1
KHIT College

<h3>Shaik Azmal</h3>
Team Memeber2
KHIT College

<h3>Ongole Mounika</h3>
Team Member3
KHIT College

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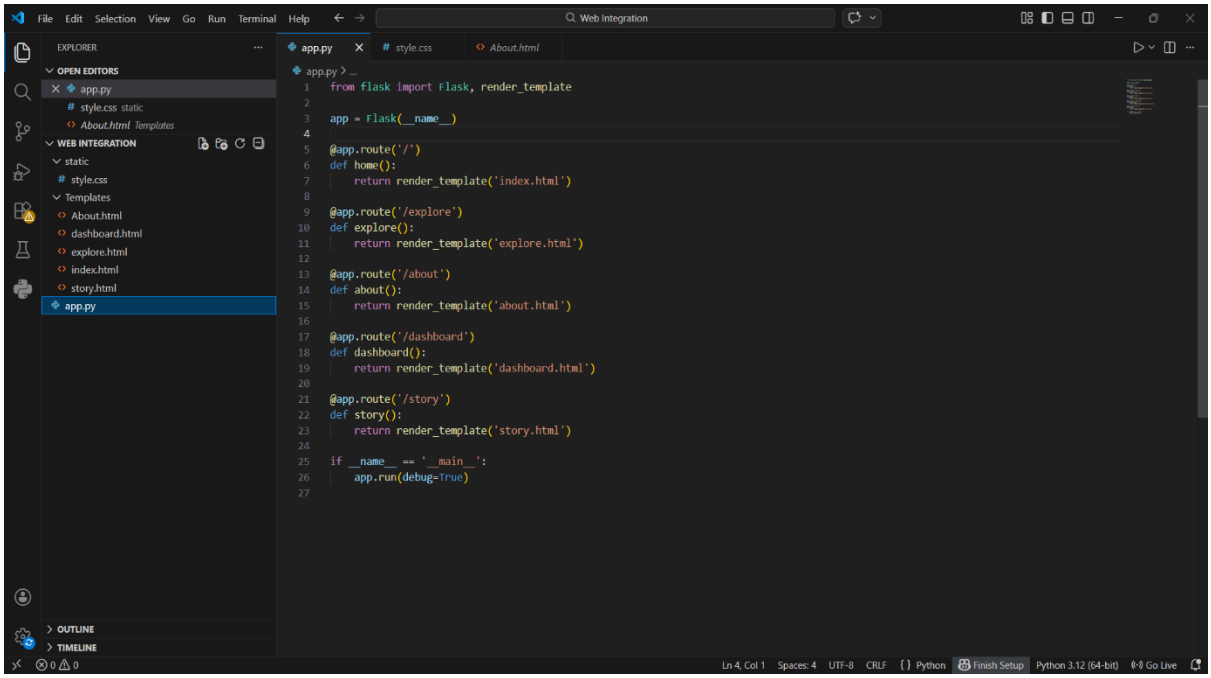

Project Links

Public link of Dashboard:

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

Public link of Story :

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

Demo Video link:

https://drive.google.com/file/d/15aGHrBHkj3RjXQIgyfV_scqYwvfIRp84/view?usp=sharing

Datasets Link:

https://drive.google.com/drive/folders/1Hy6NcdbugtlD3SNQA5aavnAisCJ_1j6?usp=drive_link

GitHub Link:

https://github.com/Ayasha-72/Visualization-Tool-for-Electric-Vehicle-Charge-and-Range-Analysis.git