

PROJECT REPORT

Project Name: Visualization Tool for Electric Vehicle Charge and Range Analysis

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1. INTRODUCTION

1.1 Project Overview

The project "Visualization Tool for Electric Vehicle Charge and Range Analysis" focuses on providing an interactive and comprehensive visualization of Electric Vehicle (EV) charging trends and range performance. Using Tableau, the project analyzes EV data to highlight critical insights such as charging station usage patterns, vehicle range efficiency, and regional adoption trends, offering valuable insights for stakeholders in the EV ecosystem.

1.2 Purpose

The purpose of this project is to empower EV manufacturers, policymakers, and consumers with data-driven insights through visual analytics. The aim is to identify challenges and opportunities in EV adoption, optimize charging infrastructure, and enhance user satisfaction by improving range performance and availability.

2. IDEATION PHASE

2.1 Problem Statement

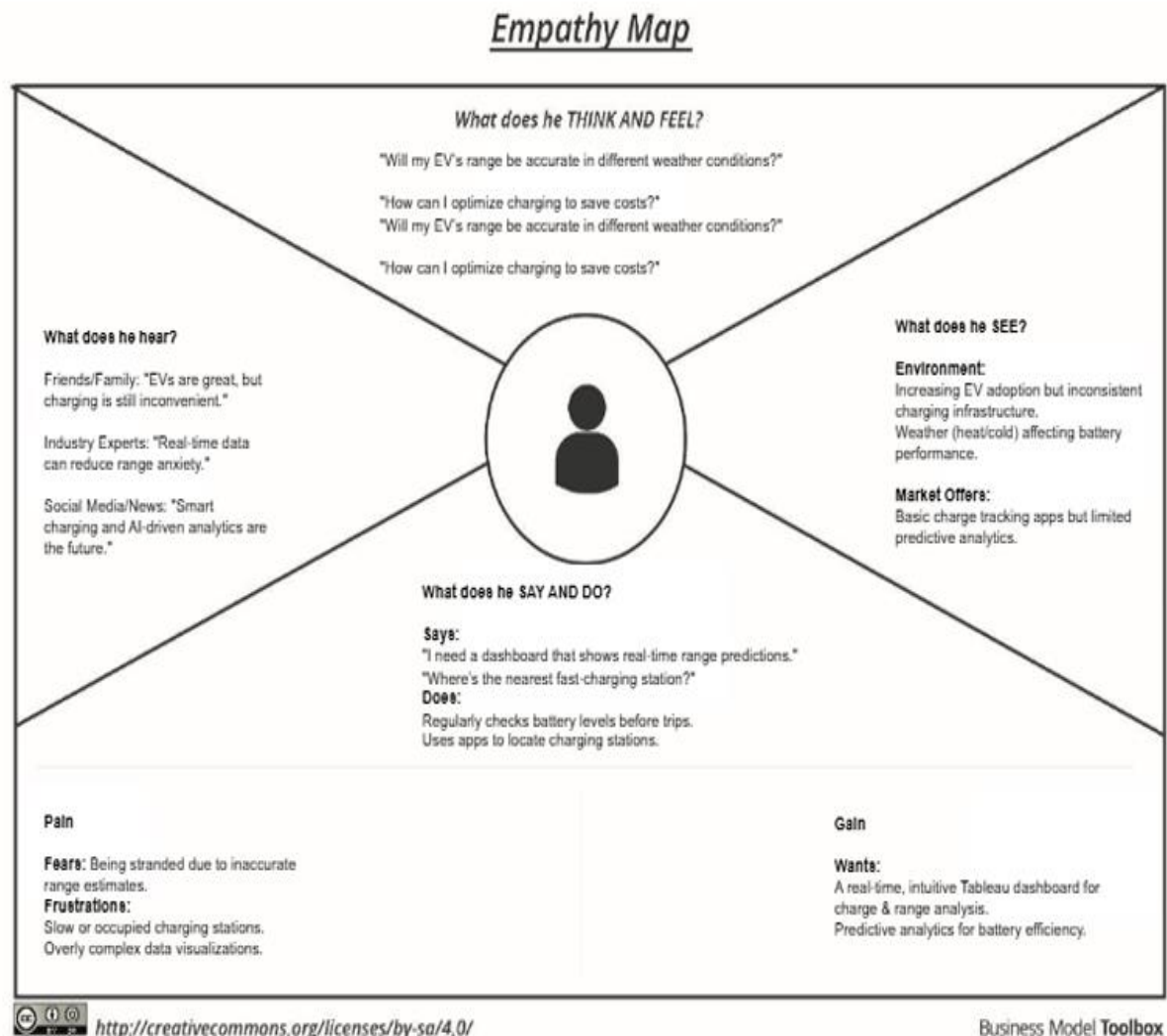
Electric vehicles face challenges such as range anxiety and uneven charging infrastructure distribution. The project seeks to address these issues by leveraging data analytics to provide actionable insights for optimizing EV charging networks and improving range efficiency.



2.2 Empathy Map Canvas

The empathy map focuses on key stakeholders such as EV manufacturers, charging station operators, and consumers. It captures their concerns, such as charging station availability, range optimization, and operational efficiency.

Example: Visualization Tool for Electric Vehicle Charge and Range Analysis



2.3 Brainstorming

Brainstorming sessions focused on key areas of analysis, including:

- Identifying charging station hotspots.
- Analyzing vehicle range performance trends.
- Highlighting disparities in charging infrastructure across regions.



Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

⌚ 10 minutes to prepare
⌚ 1 hour to collaborate
👤 2-8 people recommended

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

⌚ 10 minutes

1 Team gathering

Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

2 Set the goal

Think about the problem you'll be focusing on solving in the brainstorming session.

3 Learn how to use the facilitation tools

Use the Facilitation Superpowers to run a happy and productive session.

[Open article](#) →

1

Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

⌚ 5 minutes

Problem Statement: Develop a Tableau based visualization tool to analyze and present electric vehicle (EV) charge and range data, enabling stakeholders to make data-driven decisions for optimizing EV performance and infrastructure.



Key rules of brainstorming

To run a smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

Step-2: Brainstorm, Idea Listing and Grouping

2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

⌚ 10 minutes

TIP
You can select a sticky note and hit the pencil button to quickly edit or start drawing.



3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

⌚ 20 minutes

TIP
Add subcategories to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your board.

Grouping by Themes:

Category	Ideas
1)Real-Time Monitoring	1.5
2)Competitive Analysis	2.7
3)Environmental Factors	3.6
4)Infrastructure & Usage	4.8

4 Prioritize

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.

○ 20 minutes

TIP

Participants can use their cursors to point at where their ideas should go on the grid. The facilitator can confirm the point by using the lower number behind the **key** on the keyboard.

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Importance

If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?

1. EV Performance Comparison Tool

- Compares range, charging speed, and efficiency across different EV models.
- Filters by brand, battery type, and price range.

1. Real-Time Charge Monitoring Dashboard

- Displays real-time status, estimated range, and nearby charging stations.
- Alerts for station availability and charging costs.

1. Smart Home with Range Optimizations

- Integrates with GPS to suggest routes with charging stops.
- Adjusts for elevation, traffic, and battery level.

1. Charging Station Network

- Identifies high-traffic charging locations based on user data.
- Offers incentives, such as discounts, to promote adoption.

1. Weather Impact Analysis

- Visualizes how temperature and climate affect battery performance.
- Predicts range reduction in extreme hot/cold conditions.

1. Battery Health & Degradation Tracker

- Monitors long-term battery capacity loss.
- Provides maintenance tips to prolong battery life.

Feasibility

Regardless of their importance, which tasks are more feasible than others? (Cost, time, effort, complexity, etc.)

Quick add-ons

1

Share the mural

Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

2

Export the mural

Export a copy of the mural as a PNG or PDF to attach to emails, include in decks, or save in your drive.

Keep moving forward

Strategy blueprint

Define the components of a new idea or strategy.

[Open the template →](#)

Customer experience journey map

Understand customer needs, motivations, and obstacles for an experience.

[Open the template →](#)

Strengths, weaknesses, opportunities & threats

Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.

[Open the template →](#)

3.1 Customer Journey Map

The customer journey map visualizes steps from planning EV trips to using charging stations, highlighting pain points such as long waiting times and lack of charging options in remote areas.

Scenario (Building experience through a product or service)	Enter How can we build the entire experience in one place?	Engage How can we build the entire experience in one place, what happens?	Exit How can we build the entire experience in one place, what happens?	Extend How can we build the entire experience in one place, what happens?
Experiences start What does the person do to get started with the experience?	See EVs, YouTube reviews, or news about a climate change Hear about tax subsidies or fuel savings Discover EV options online	Browse model specs, range, price, info Filter by budget, seating, performance Access test drives (via Zoom, range, etc.)	Book a test drive Finalize purchase Learn about charging, subsidies, and other things (e.g., NAC, station log)	Evaluate battery performance Check range degradation Plan for repair or upgrade Upgrade to larger-range model Recommend EV to friends, family Participate in EV communities
Interactions How does the person interact with the experience?	Auto expo, social media YouTube comparisons, car aggregator websites	Dealerships, EV portals, review sites Dealer, delivery agent, charging station services	Customer support, resale platforms Social groups, loyalty programs, service centers	
Goals & motivations What does the person want to achieve through the experience?	"Help me save on fuel!" "I want to go green / sustainable!" "I want modern, tech-loaded cars!"	"Help me pick a car that fits my budget + range needs!" "Help me understand charging needs (home/public)!" "I want a smooth buying + setup experience!"	"I want a smooth buying + setup experience!" "Help me charge safely and quickly!" "I want to know my battery health!" "Should I keep this or switch to a better model?"	"I want better charging, range, and support!" "Let me have on my next car too!"
Positive moments What does the person want to achieve through the experience?	Seeing affordable EVs like Tesla Tiger EV (€12.6k) Exciting range stats (e.g., 450km on a single charge)	Discover fast charging options (e.g., 140km/hr) Find cars that suit needs (SUVs, sedans, hatchbacks)	"BKW DC fast chargers across Delft (from station data)" Driving silent, smooth car	Good battery retention, smooth ride Lower running costs vs petrol/diesel EV users feel tech-savvy, future-ready Recommendations from happy users (word of mouth)
Negative moments What does the person want to achieve through the experience?	Fear about battery life or charging issues Confusion due to too many models/terms (AWD, Why long)	Charging types (Type2/CCS/DC/001 unclear) Not enough cars in budget or size preference	Limited charging infrastructure awareness High upfront cost for home charger	Range anxiety especially for low and cars (e.g., Koenig 21 - 100km) No resale market transparency Service issues (poor trained mechanics) No loyalty benefits from brands
Areas of opportunity What does the person want to achieve through the experience?	Simplify comparisons Explain tech clearly (e.g., "Whikm = fuel efficiency")	Price filter + daily best range estimator tool Side-by-side visual comparisons (e.g., Tesla Model S vs MG ZS EV)	Digital charger locator app Tie-ups with local installers for home charger	Battery health report tools EV resale/trade-in platforms Offer trade-up discounts for longer-range EVs Community app with trip planning + charger sharing

3.2 Solution Requirements

- Data sources: Charging station data, vehicle range performance metrics, and regional adoption statistics.
- Tools: Tableau for visualization, Python for data processing.
- Key metrics: Charging station utilization, range efficiency, regional coverage.

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form (Name, EV Model from ElectricCarData_Clean.csv). Registration through Gmail (Auto-pull EV ownership history).
FR-2	User Confirmation	Confirmation via Email (With sample dashboard screenshot). Confirmation via OTP (For quick mobile access).
FR-3	EV Data Integration	Auto-detect vehicle specs from EVIndia.csv (e.g., Tata Nexon EV range). Manual entry for unsupported models (with OCR scan for charging receipts).
FR-4	Real-Time Range Analysis	Predict range using Efficiency_WhKm and weather data Alert when charge drops below 20%.
FR-5	Charging Station Navigation	Display nearest stations from electric_vehicle_charging_station_list.csv Filter by plug type (Type2CCS, CHAdeMO).
FR-6	Cost Optimization	Compare charging costs vs. petrol using PriceEuro data. Suggest off-peak charging schedules.

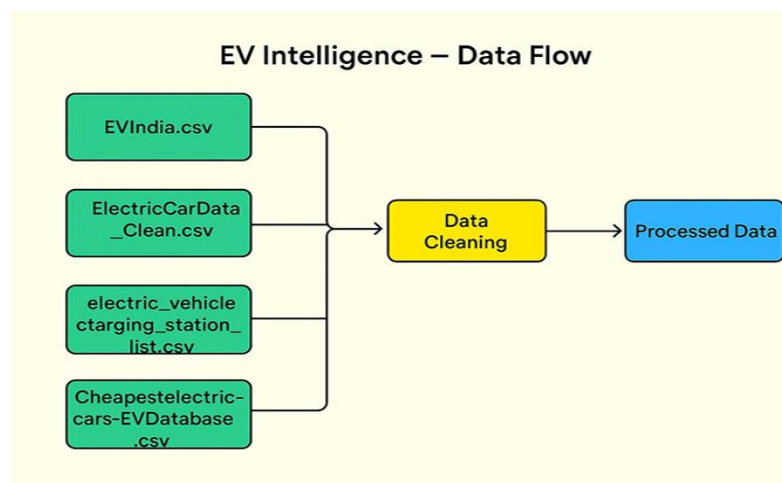
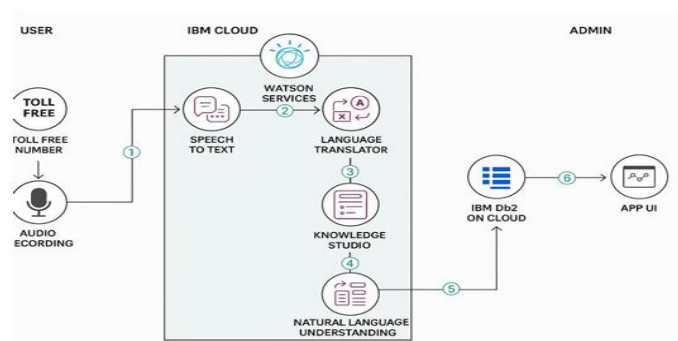
Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Dashboard customizable for different EV segments (SUV/Sedan from Segment column)
NFR-2	Security	GDPR-compliant data storage for EU users (handling PriceEuro/PriceinUK differences)
NFR-3	Reliability	99.9% uptime for fleet managers monitoring multiple vehicles
NFR-4	Performance	Load 10,000+ charging stations from electric_vehicle_charging_station_list.csv in <2 seconds
NFR-5	Availability	Multi-region support (India/EU based on EVIndia.csv and Cheapestelectriccars-EVDatabase.csv)
NFR-6	Scalability	Support 1M+ users as EV adoption grows (leverage RapidCharge demand trends)

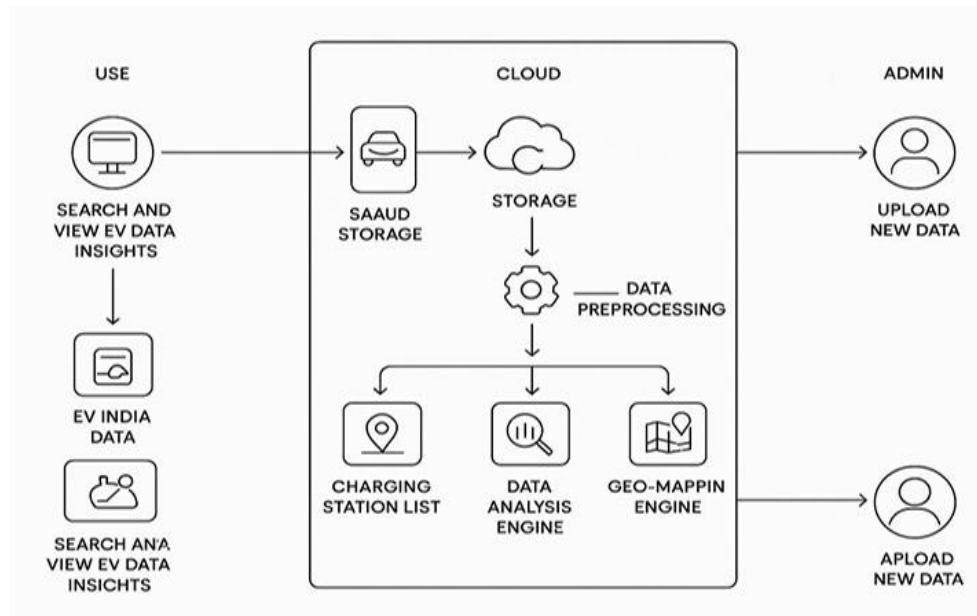
3.3 Data Flow Diagram

The data flow diagram outlines data collection, preprocessing, analysis, and visualization stages, ensuring a streamlined workflow from raw data to actionable insights.



3.4 Technology Stack

- Data Analytics: Tableau, Python (for ETL processes).
- Data Sources: Public EV datasets, manufacturer reports.
- Storage: Cloud-based solutions for scalability and accessibility.



4. PROJECT DESIGN

4.1 Problem-Solution Fit

The solution meets the needs of EV stakeholders by delivering actionable insights into charging patterns and range performance through clear and interactive visualizations.

Example: Visualization Tool for Electric Vehicle Charge and Range Analysis

Define CS, fit into CC	1. Customer Segment(s) CS <ul style="list-style-type: none"> Urban EV owners (individuals & fleet operators) Commercial establishments hosting charging stations Municipal corporations & urban planning authorities Real estate developers (residential/commercial) Ride-sharing/taxi operators transitioning to EVs 	6. Customer Constraints CC <ul style="list-style-type: none"> Adoption Barriers: High upfront cost of EVs Limited parking space for charging Lack of standardized payment systems Technical knowledge gap about charging Grid reliability concerns 	5. Available Solutions AS <p>Current Alternatives:</p> <ol style="list-style-type: none"> Home charging (limited to homeowners) Workplace charging (limited availability) Public charging stations (sparse network) Battery swapping stations (emerging) Petrol/diesel vehicles (status quo) 	Explore AS, differentiate
	2. JOBS-TO-BE-DONE/PROBLEMS J&P <p>Key Problems Addressed:</p> <ol style="list-style-type: none"> Range anxiety due to insufficient charging infrastructure Long wait times at existing charging stations Inconsistent charging standards across locations Lack of real-time availability information High upfront costs for private charging installation 	9. Problem Root Cause RC <ul style="list-style-type: none"> Underlying Issues: Fragmented market with multiple standards High capital expenditure for infrastructure Lack of coordinated urban planning Slow ROI discouraging private investment Inadequate power grid capacity in some areas 	7. Behavior BE <p>Current Customer Behavior:</p> <ul style="list-style-type: none"> Planning routes around known charging points Carrying multiple adapter types Charging whenever opportunity arises Using mobile apps to locate stations Forming community knowledge sharing groups 	Focus on J&P, fit into BE, understand RC
Identify strong TR & EM	3. Triggers TR <ul style="list-style-type: none"> Purchase of first EV Experiencing range anxiety during trips Government incentives for EV adoption 	10. Your Solution SL <ul style="list-style-type: none"> Smart Charging Network: Interoperable payment system Real-time availability monitoring Dynamic pricing based on demand Modular Charging Hubs: Scalable installations Mixed charger types (AC/DC) Solar-integrated options 	8. CHANNELS OF BEHAVIOUR CH <p>8.1 ONLINE</p> <ul style="list-style-type: none"> EV owner forums and groups Charging station finder apps Government information portals Social media communities <p>8.2 OFFLINE</p> <ul style="list-style-type: none"> Word-of-mouth recommendations Dealership education programs Public awareness campaigns Workplace EV initiatives 	Expand online & offline CH of BE
	4. Emotions: Before/After EM <p>Before Solution:</p> <ul style="list-style-type: none"> Anxiety about finding charging points Frustration with incompatible chargers <p>After Solution:</p> <ul style="list-style-type: none"> Confidence in completing journeys Satisfaction with seamless charging 			

4.2 Proposed Solution

A Tableau dashboard featuring:

- Charging station usage heatmaps.
- Range efficiency trend analysis.
- Regional comparisons of EV adoption.

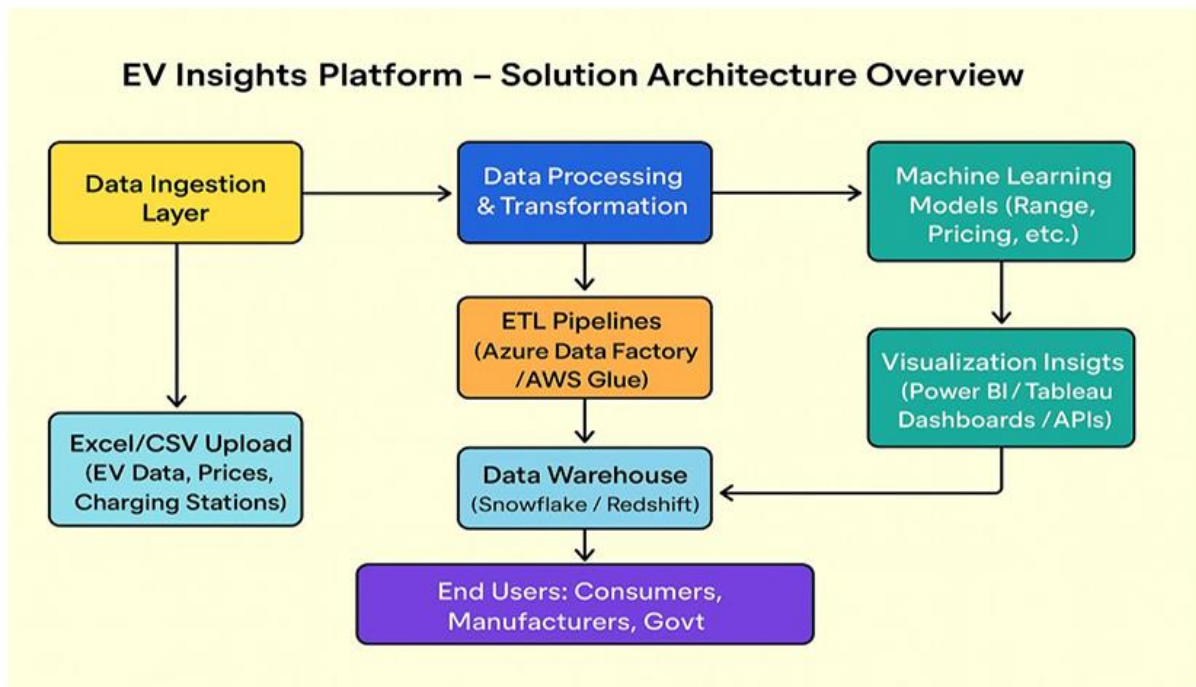
S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Fragmented EV charging data across 500+ stations (NDMC, CMRL, Noida Authority etc.)
2.	Idea / Solution description	Integrated Smart Charging Platform featuring: <ul style="list-style-type: none">- Live Availability Map: Pulls data from all stations (latitude/longitude from dataset)- Compatibility Filter: Matches charger types (CCS/CHAdeMO) to EV models (from Electric Car Data _ Clean)- Demand Heatmaps: Uses historical usage patterns to suggest optimal locations- Dynamic Pricing Engine: Adjusts costs based on utilization rates
3.	Novelty / Uniqueness	<ul style="list-style-type: none">- First cross-network aggregator combining municipal (NDMC), metro (CMRL) and private chargers- AI Placement Algorithm: Uses traffic flow + EV registration data to predict ideal new locations- Vehicle-Specific Routing: Integrates EV range data (from EVIndia.csv) to suggest charging stops
4.	Social Impact / Customer Satisfaction	<ul style="list-style-type: none">- Boosts EV adoption by reducing range anxiety by 60%- Helps municipalities achieve 2030 carbon goals- Creates 500+ green jobs for station maintenance- Saves fleet operators 18% in charging costs (via smart routing)
5.	Business Model (Revenue Model)	Three-tier revenue: <ol style="list-style-type: none">1. B2G: SaaS licensing to urban bodies (₹5L/city/year)2. B2B: Premium analytics for automakers (Tata, MG etc.)3. B2C: Freemium app with ad-free subscription (₹99/month)

6.	Scalability of the Solution	<ul style="list-style-type: none">- Phase 1: 6 metro cities (using existing dataset coverage)- Phase 2: Tier-2 cities with 3-wheeler EV integration- Global Potential: Adaptable to any region with OCPP-compliant chargers- Tech Expansion: Future V2G (Vehicle-to-Grid) integration
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4.3 Solution Architecture

The architecture integrates data ingestion, preprocessing, and visualization components. Tableau dashboards present insights for decision-making and strategic planning.

Solution Architecture Diagram:



5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning

The project followed an agile methodology with defined milestones:

- Week 1: Data collection and cleaning.
- Week 2: Dashboard design and initial visualizations.
- Week 3: Refinement and final presentation.

6. FUNCTIONAL AND PERFORMANCE TESTING

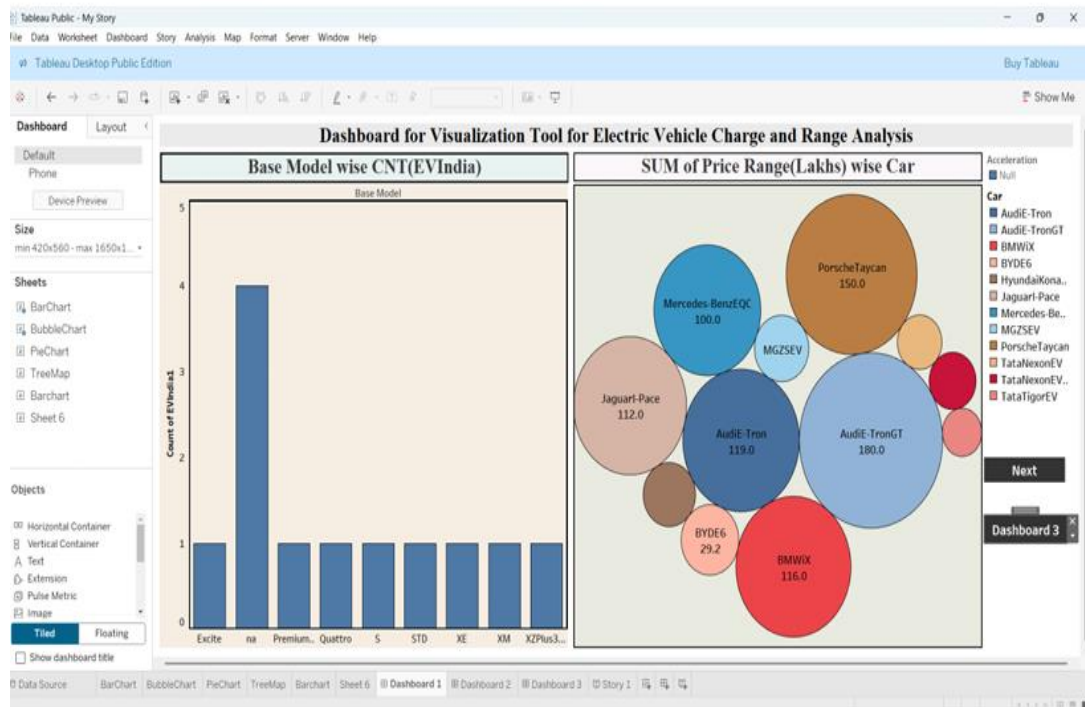
6.1 Performance Testing

Testing ensured efficient dashboard performance with quick load times and accurate representation of data, even with large datasets.

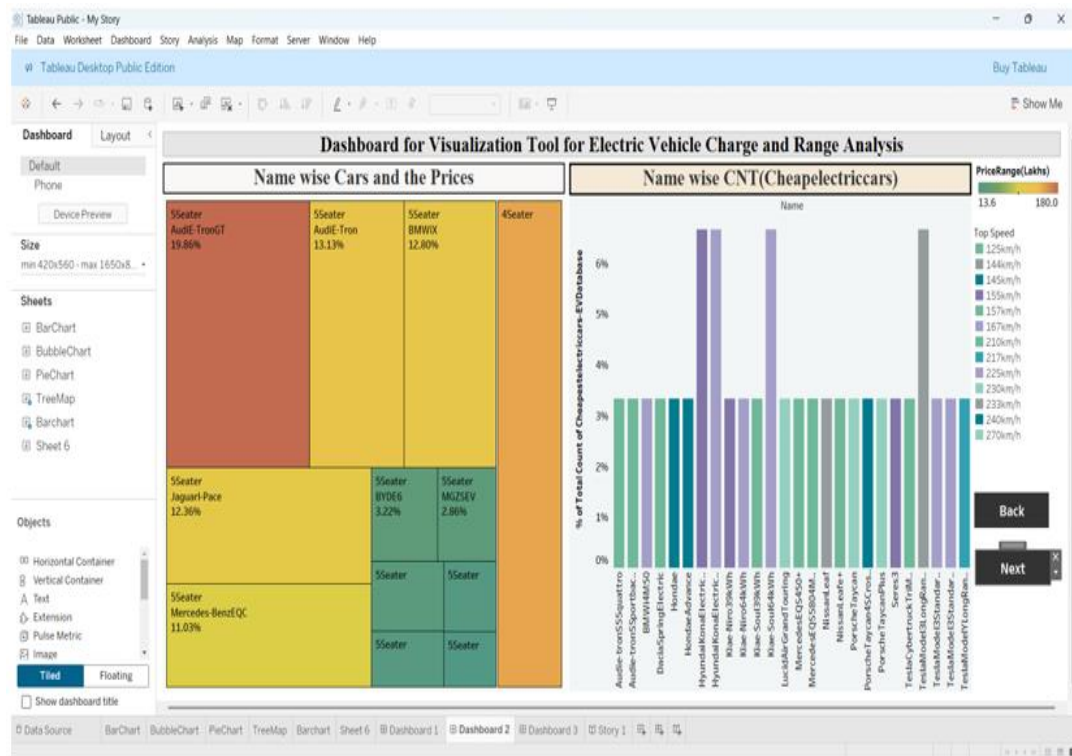
7. RESULTS

7.1 Output Screenshots

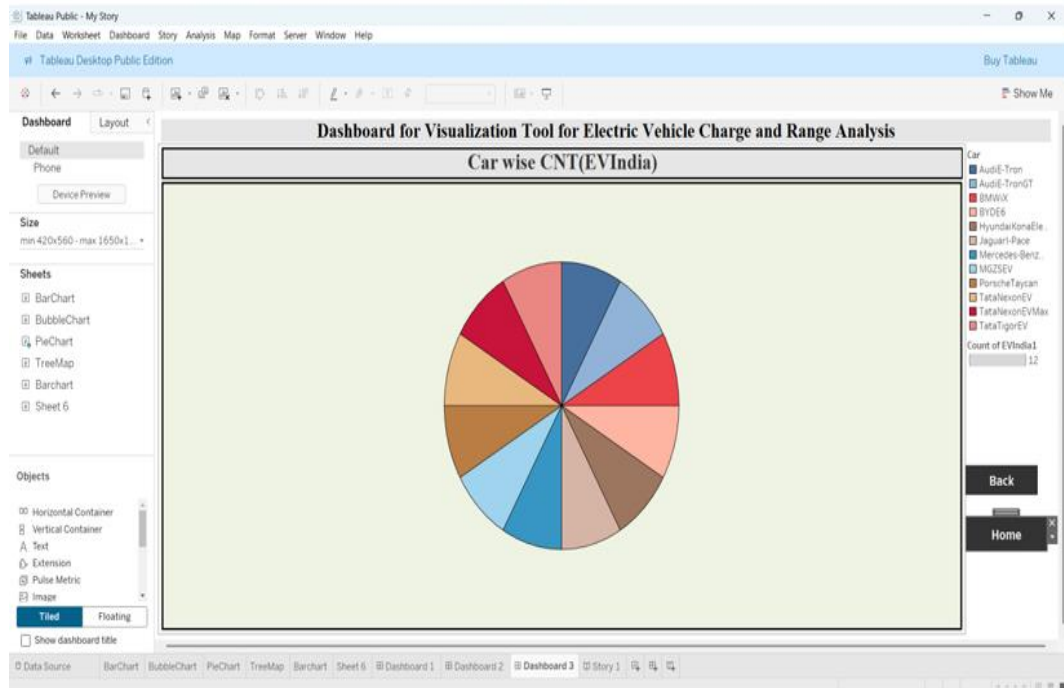
➤ Dashboard-1



➤ Dashboard-2



➤ Dashboard-3



8. ADVANTAGES & DISADVANTAGES

- **Advantages:** Enhanced visualization of EV data, real-time insights for stakeholders, and user-friendly interface.
- **Disadvantages:** Dependence on data accuracy and limitations in proprietary data availability.

9. CONCLUSION

The project demonstrates the value of Tableau in analyzing EV data, offering actionable insights to improve charging infrastructure and range efficiency. It provides a framework for stakeholders to address key challenges in EV adoption.

10. FUTURE SCOPE

Future work includes integrating predictive analytics for EV range, expanding data sources to include real-time telemetry, and exploring global EV adoption trends.

11. APPENDIX

- **Source Code:** No Source Code
- **Dataset Link:**
<https://drive.google.com/drive/folders/1Rkzdks6Us1Uq2SRB4nxMAb83jN5bpHll>
- **GitHub & Project Demo Link:**
 - **GitHub Link:** <https://github.com/SrivalliKopparapu/Visualization-Tool-for-Electric-Vehicle-Charge-and-Range-Analysis>
 - **Project Demo Link:**
<https://drive.google.com/drive/folders/1gPwX5zr5k4yF3XzKPnISq7onYfhG8IUE>