Visualization Tool for Electric Vehicle Charge and Range Analysis

APSCHE Short Term Virtual Iternship Program

Data Analytics with Tableau

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Abstract

The increasing adoption of Electric Vehicles (EVs) has led to a surge in demand for efficient tools that can analyze and visualize EV charging behavior, range patterns, and infrastructure distribution. This project presents a Power BI-based visualization tool designed to simplify the interpretation of complex EV datasets. By transforming raw data into interactive dashboards, the tool enables users—such as vehicle owners, analysts, and policymakers—to explore insights like average range by EV model, usage trends of charging stations, and state-wise station distribution. The tool enhances decision-making in planning, energy management, and sustainable transportation. It demonstrates how data visualization can bridge the gap between data complexity and user understanding, promoting smarter EV ecosystem strategies.

Contents

1. Introduction

1.1 Project Overview

Electric Vehicles (EVs) are rapidly transforming the transportation sector due to their sustainability and efficiency. However, users and analysts often face difficulties in understanding large datasets associated with EV charging patterns and range behaviors. This project, titled "Visualization Tool for Electric Vehicle Charge and Range Analysis," aims to bridge that gap by providing a user-friendly dashboard that simplifies complex EV data through interactive visualizations using Microsoft Power BI. With increasing global attention on green energy and environmental sustainability, this tool enables stakeholders to observe usage trends, station availability, and battery performance for electric vehicles, making it a valuable addition to EV infrastructure development.

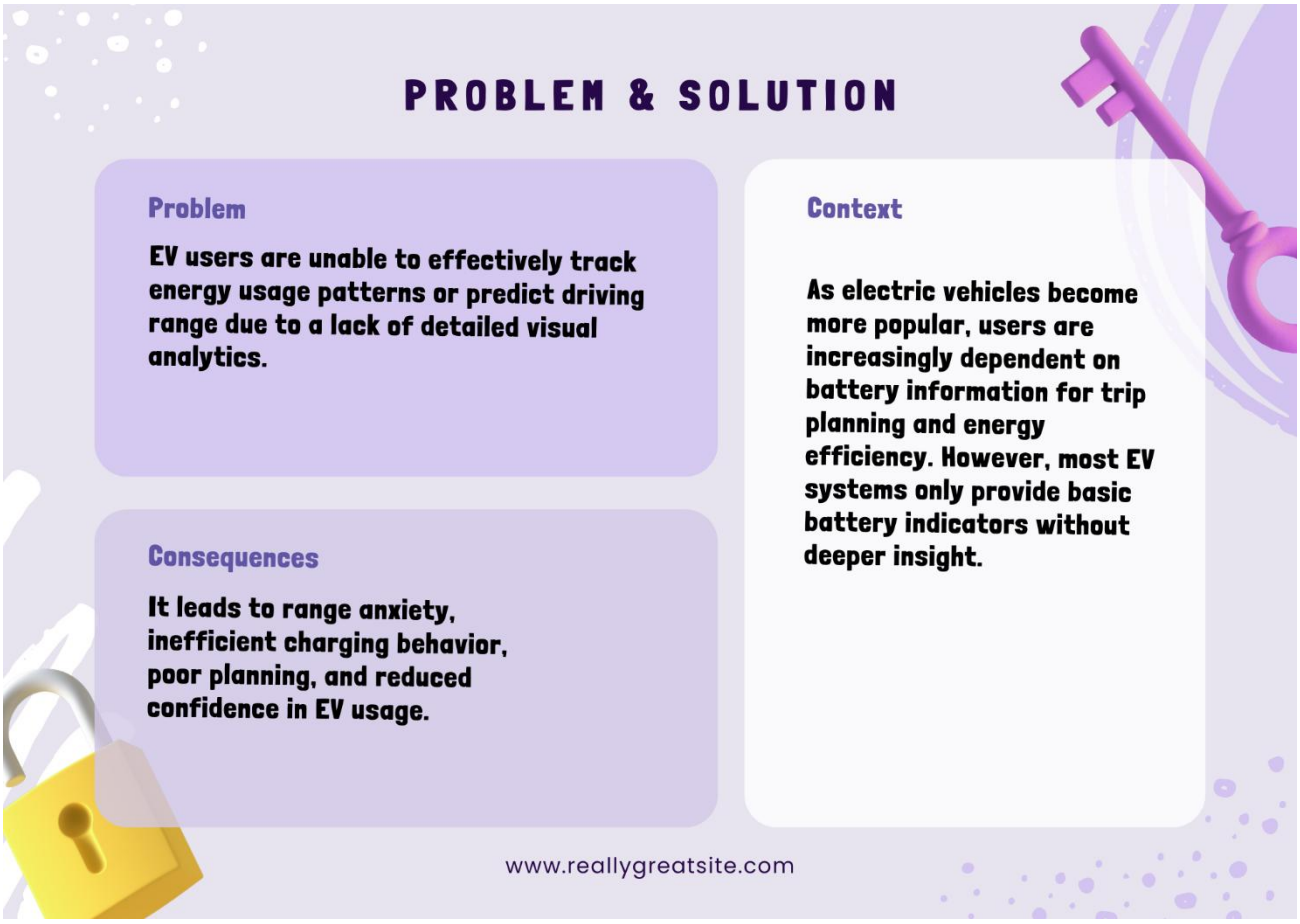
1.2 Purpose

The purpose of this project is to enable various stakeholders—EV owners, infrastructure planners, researchers, and policymakers—to gain actionable insights into electric vehicle charging and range statistics. By converting raw data into visual dashboards, the project provides an analytical tool that supports decision-making and promotes a more efficient and informed EV ecosystem. The visualizations empower users to quickly comprehend data patterns, identify inefficiencies, and contribute to smarter transportation planning.

2. Ideation Phase

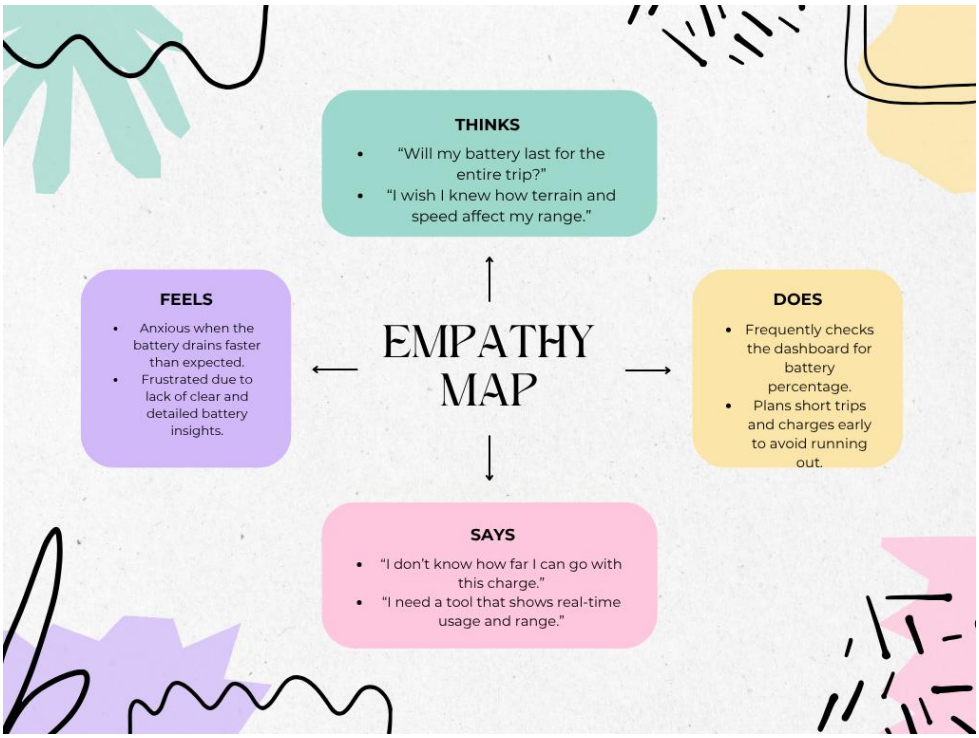
2.1 Problem Statement

As the number of electric vehicles increases, the availability of data is also growing. However, this data is often in unstructured formats, making it hard to derive insights. There is a pressing need for a platform that can visualize this data to help users understand the performance, charging trends, and infrastructure distribution of EVs. The absence of an accessible and interactive tool restricts optimal decision-making and policy formulation, especially in regions where EV adoption is still evolving.



2.2 Empathy Map Canvas

- **Who are we empathizing with?** EV owners, city planners, analysts
- **What do they need to do?** Make informed decisions based on EV data
- **What do they see?** Dispersed and unstructured EV data from multiple sources
- **What do they hear?** Concerns over battery range and station availability, rising user dissatisfaction
- **What do they say and do?** Seek reliable data insights, try third-party mobile apps and maps
- **What do they feel?** Confused, frustrated, often uncertain about charging station accessibility and vehicle performance
- **Pain:** Lack of a centralized, easy-to-use analysis tool
- **Gain:** A clean, interactive dashboard that simplifies insights and supports smarter travel choices.



2.3 Brainstorming

During the ideation stage, multiple features and concepts were discussed, such as:

- Graphs showing charging trends over time to understand usage patterns
- Maps indicating the distribution of charging stations in urban and rural areas
- Charts comparing average range across different EV models and manufacturers
- Filters for analyzing data based on states, vehicle types, station categories, and charging times
- Integrating energy consumption statistics to estimate efficiency
- Adding historical and real-time data comparison options for better analysis.

3. Requirement Analysis

3.1 Customer Journey Map

- **Awareness:** Realization of lack of insight into EV data after experiencing inconsistencies in vehicle range and station availability
- **Consideration:** Searching for tools that offer easy data interpretation and visually rich analytics
- **Decision:** Adoption of this visualization tool for detailed analysis and future planning
- **Experience:** Efficient data-driven decision making through visual insights that are easy to comprehend

3.2 Solution requirement

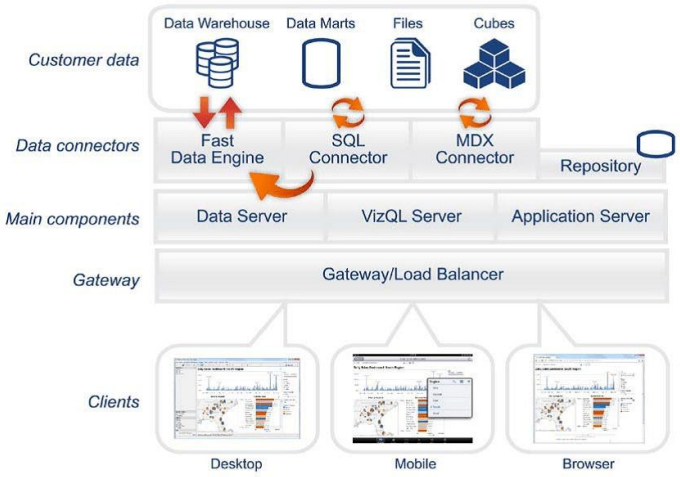
- Datasets related to EV charging sessions, vehicle models, battery range, and station locations
- Power BI platform for building dashboards with interactivity and drill-down features
- Data transformation capabilities using Power Query and DAX for modeling and relationships
- Capability to handle multiple categories and dynamic filters

3.3 Data Flow Diagram

Raw Dataset → Data Cleaning and Preprocessing (Power Query) →

Import into Power BI → Data Modeling → Dashboard Creation →

Insight Generation → Decision Making



3.4 Technology Stack

- **Data Analysis Tool:** Microsoft Power BI
- **Languages:** Power Query (M), DAX
- **Data Source:** Open government portals, Kaggle datasets, industry reports
- **Visualization Features:** Bar charts, line graphs, pie charts, slicers, maps, KPI cards

4. Project Design

4.1 Problem-Solution Fit

The problem of unreadable raw data is addressed through meaningful visualizations. The dashboard provides relevant filters and metrics, which can be easily interpreted by the user. Users can explore insights such as average energy consumed per session, busiest station timings, and EV model-wise performance without any technical expertise.

4.2 Proposed Solution

A set of interactive dashboards created in Power BI that:

- Compare average EV ranges by model and charging behavior
- Show usage statistics of charging stations segmented by state and station type
- Analyze session frequency, session time length, and day-wise trends
- Display geographic distribution of stations on a map interface with filter options

- Allow end-users to filter data based on various fields like location, date, station type, vehicle model, etc.

4.3 Solution Architecture

- Data Collection from open data platforms
- Data Cleaning and Preprocessing in Power BI using Power Query
- Data Modeling using relationships and measures in DAX
- Dashboard Design and layout using visuals and slicers
- Deployment for user interaction and testing for feedback

5. Project Planning and Scheduling

5.1 Project Planning

- **June 14 - June 17:** Data collection and understanding structure of datasets from Kaggle and government portals
- **June 18 - June 22:** Data cleaning using Power Query, building relationships between datasets, deriving calculated columns and measures
- **June 23 - June 25:** Designing visuals, maps, cards, and interactive filters for dashboard views
- **June 26 - June 27:** Performance testing, documentation writing, and final user presentation

6. Functional and Performance Testing

6.1 Performance Testing

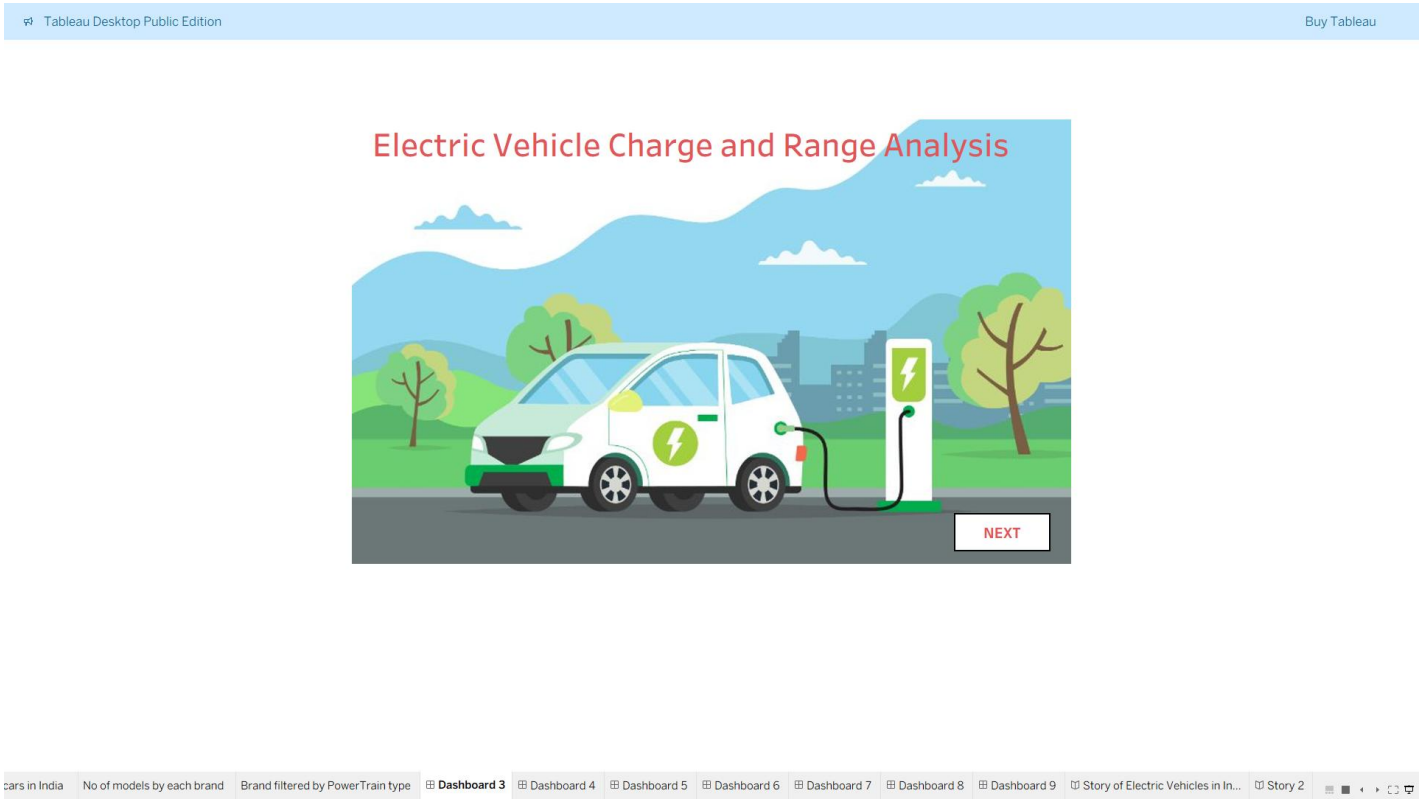
Performance was measured by testing dashboard loading time and responsiveness to filters. Accuracy of visualizations was confirmed by comparing them with raw datasets. Additional testing included:

- Validating filter-based insights
- Ensuring time slicers worked correctly across visuals
- Checking consistency of DAX-based calculated fields
- Testing on different screen resolutions for responsive layout

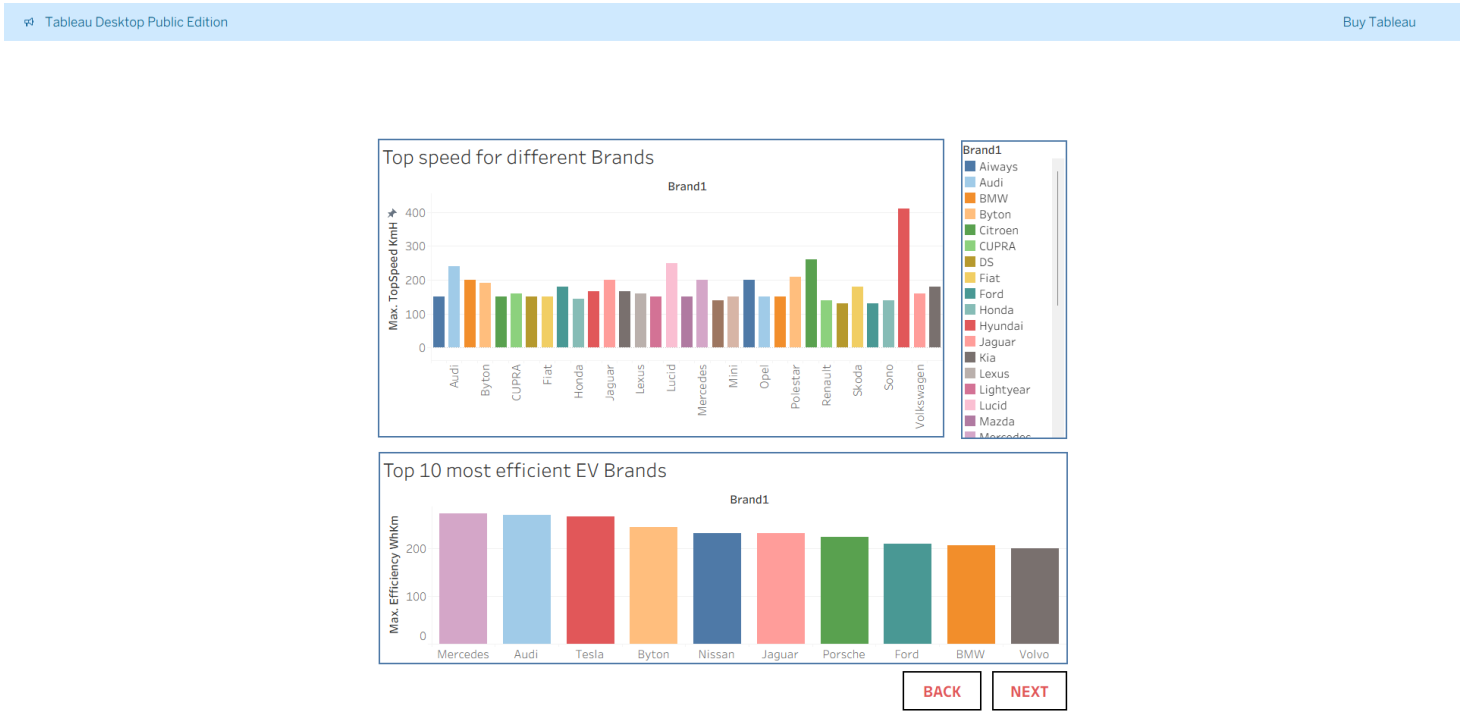
7. Results

7.1 Output Screenshots

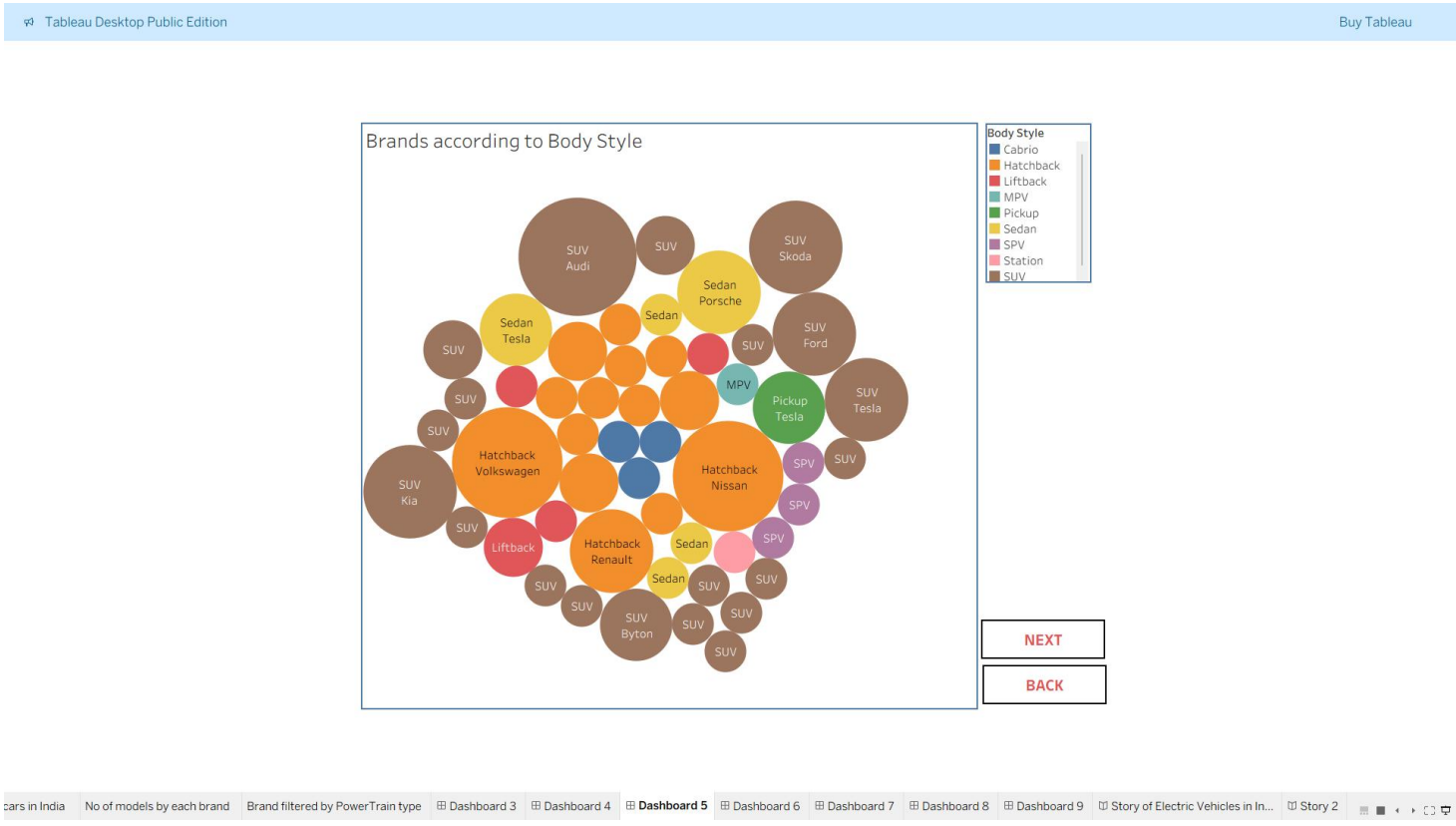
- **Dashboard 1:** Welcome and Introduction Screen



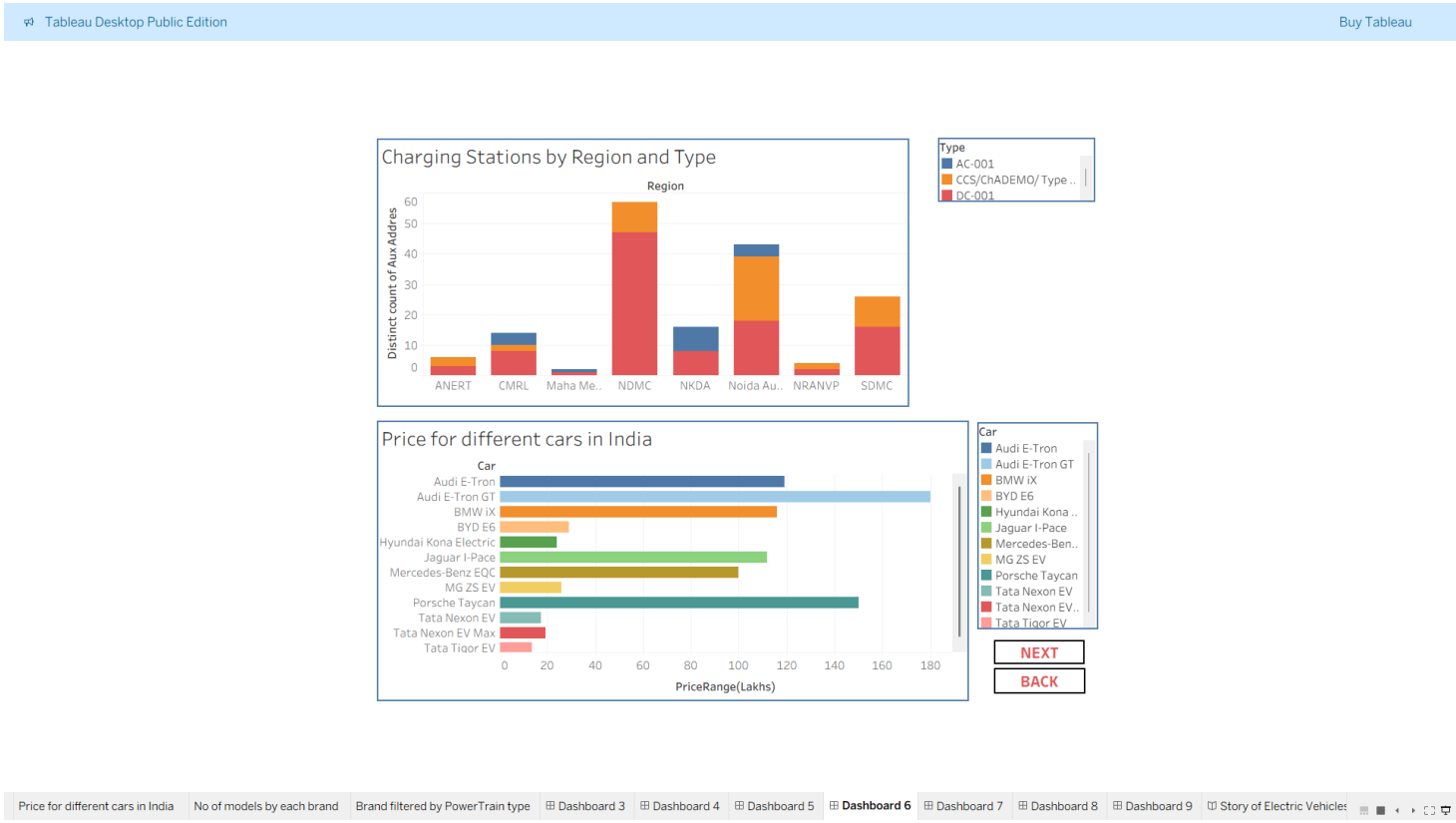
- **Dashboard 2 :**



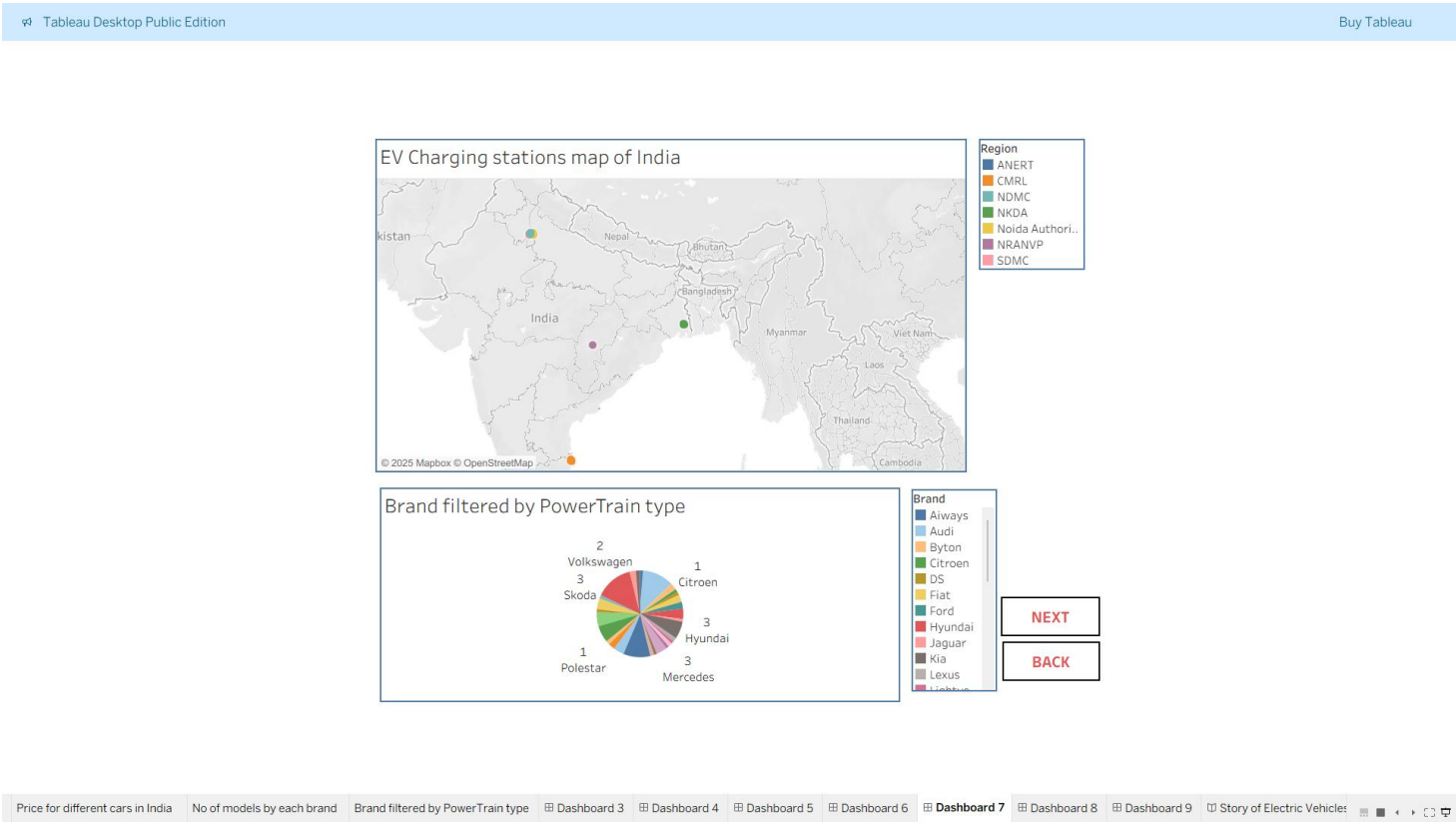
- **Dashboard 3 :**



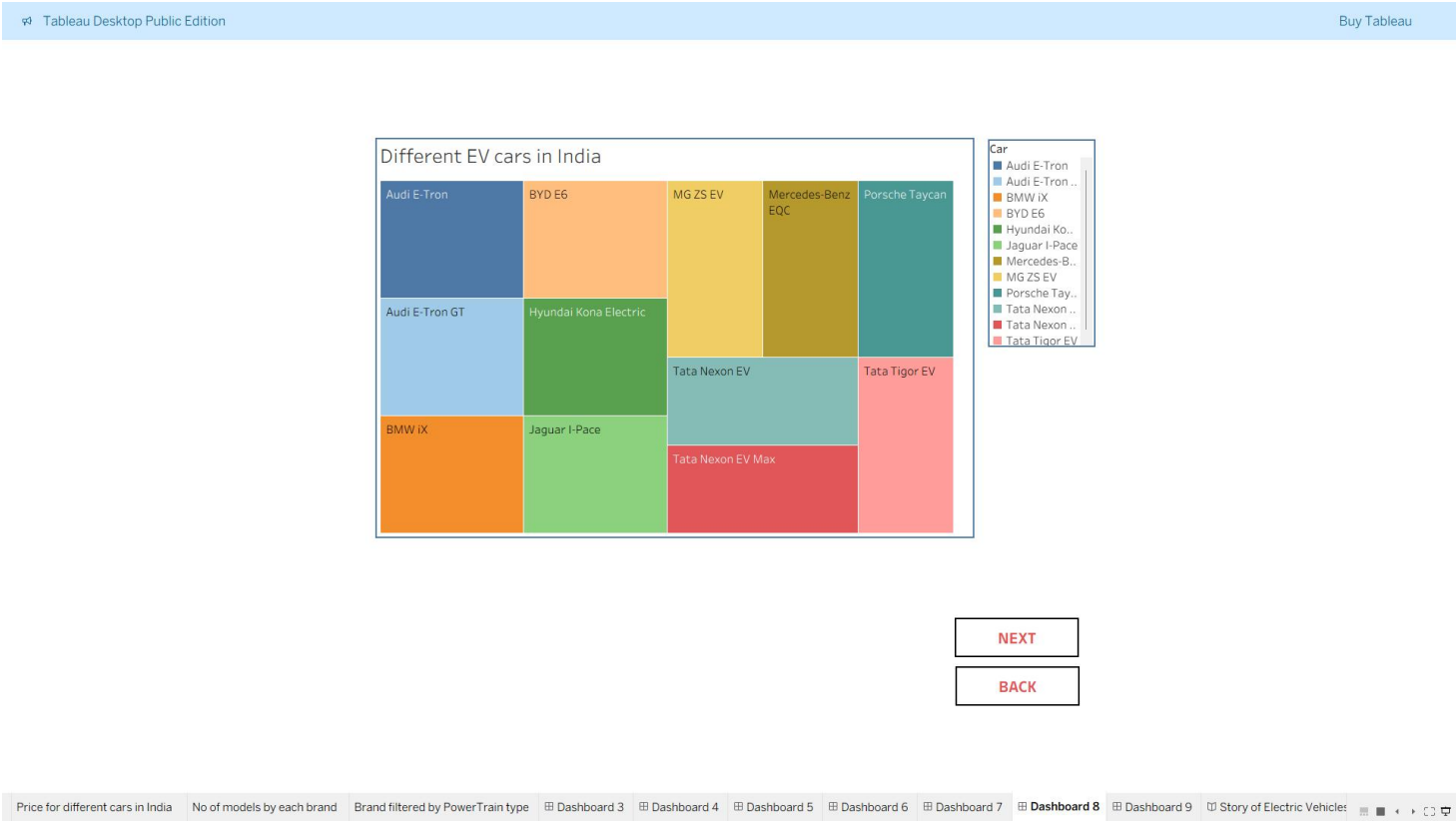
- **Dashboard 4 :**



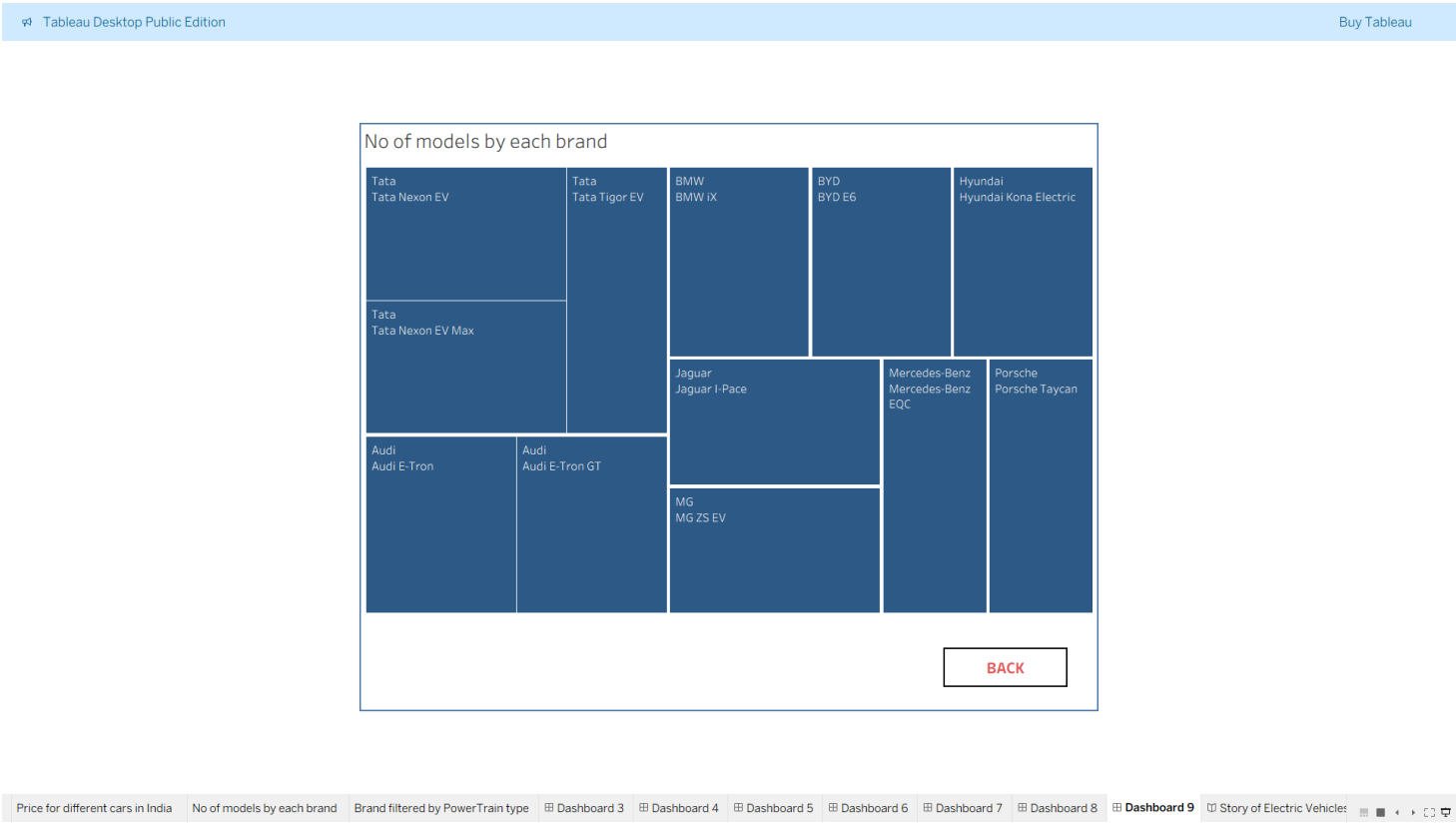
- **Dashboard 5 :**



- **Dashboard 6 :**



- **Dashboard 7 :**



8. Advantages and Disadvantages

Advantages:

- Easy to interpret for both technical and non-technical users
- Fast and responsive interface with rich visual elements
- Supports decision-making using real-world data insights
- Filter and drill-down options for customized exploration
- Enhances user understanding of EV ecosystem behavior

Disadvantages

- Limited by the static nature of the dataset (no real-time updates)
- Requires manual updates for new data inclusion
- Dependent on the quality and completeness of publicly available datasets
- Mobile responsiveness is limited due to Power BI's interface constraints

9. Conclusion

This project successfully demonstrates how data visualization can simplify and enhance understanding of EV charging and range information. The dashboards offer a clear and interactive view of important EV metrics and trends, making them valuable for users and decision-makers alike. Through the use of Microsoft Power BI, this solution bridges the gap between technical data and practical insight, helping shape the future of electric vehicle adoption and infrastructure.

10. Future Scope

- Add real-time data integration using APIs from charging station networks
- Expand coverage to global EV data including commercial fleet usage
- Include battery health and usage efficiency visualizations for better fleet management
- Create a web/mobile app interface using embedded dashboards
- Integrate predictive analytics to forecast station demands and range efficiency

11. Appendix

- **Dataset Link:** https://drive.google.com/drive/folders/1Rkzdks6Us1Uq2SRB4nxMAb83jN5bpHll