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EV Trends and Performance Analysis Using Tableau and Machine Learning

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ABSTRACT: Electric Vehicles (EVs) are becoming increasingly important in achieving sustainable transportation and reducing carbon emissions. However, analysing EV performance, pricing, and infrastructure trends requires effective data analytics techniques. This research proposes a web-based EV analytics system that integrates Machine Learning models with Tableau visualization dashboards to analyse EV market trends and predict vehicle costs and car model.

We collected EV datasets, performs data preprocessing, and visualizes key insights such as brand distribution, price trends, charging station availability, and vehicle performance. A Random Forest Regression model is used to predict EV cost and car model based on features such as range, top speed, battery capacity, and number of seats. The system is deployed using a Flask-based web application that allows users to explore dashboards, view EV trend stories, and predict EV costs and car model dynamically. The results demonstrate that integrating machine learning with interactive visualization tools enhances EV market analysis and supports better decision-making in electric mobility planning.

KEYWORDS: Electric Vehicles, Tableau, Data Visualization, Charging Infrastructure, Dashboard Development, Machine Learning, Random Forest, Flask Web Application, EV Prediction.

I. INTRODUCTION

The global transportation sector is undergoing a major transformation due to increasing environmental concerns and the demand for sustainable energy solutions. Electric Vehicles (EVs) have emerged as an alternative to traditional fossil fuel-based vehicles because they produce lower emissions and reduce dependence on petroleum resources.

However, understanding EV adoption trends requires the analysis of large datasets containing information about vehicle performance, battery capacity, pricing, and charging infrastructure. Traditional analytical approaches are often insufficient to extract meaningful insights from such complex datasets.

This research focuses on building a data-driven EV analytics platform that integrates machine learning predictions with interactive visualization dashboards. The system enables users to analyse EV market trends and estimate EV prices and car model based on vehicle specifications.

II. LITERATURE SURVEY

Several research studies have explored the application of data analytics and machine learning techniques in transportation and electric vehicle markets. Business Intelligence tools such as Tableau have been widely used for analyzing large datasets and presenting insights through dashboards and visual stories.

Previous studies have demonstrated that interactive dashboards help decision-makers understand complex data trends related to sales, pricing strategies, and consumer behavior. Visualization platforms transform raw data into intuitive graphical representations that simplify decision-making processes.

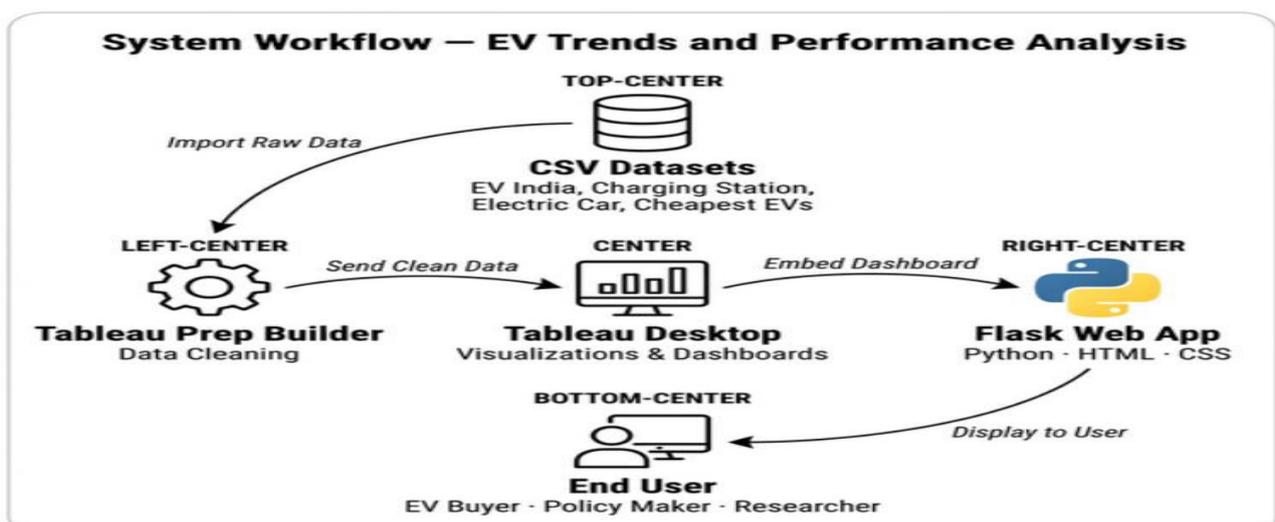
Machine learning models have also been widely used for forecasting and predictive analytics. Regression-based algorithms such as Linear Regression, Decision Tree, and Random Forest have proven effective for predicting numerical outcomes such as product demand, price estimation, and performance forecasting.

Among these models, Random Forest is often considered highly reliable because it combines multiple decision trees to improve predictive accuracy and reduce overfitting.

However, many existing studies focus either on predictive modeling or visualization independently. Few systems integrate machine learning predictions with visualization dashboards in a single platform. This project addresses this limitation by combining machine learning prediction with Tableau visualization in a web-based application.

Technologies Used

Technology	Purpose
Python	Core programming language for ML and backend development
Flask	Web framework connecting ML model with user interface
Scikit-learn	Building Random Forest regression model
Tableau Public	Creating interactive EV data dashboards
Pandas	Data cleaning and preprocessing
NumPy	Numerical computations and feature processing
HTML	Web page structure
CSS	User interface styling
JavaScript	Frontend interactivity
Jinja2	Dynamic HTML rendering
Pickle	Saving trained ML model
CSV Dataset	EV data storage
Tableau Prep Builder	Data cleaning and preparation



III. PROPOSED METHODOLOGY

The proposed system integrates data analytics, machine learning, and visualization tools to analyse EV market trends and predict EV cost and car model.

Data Collection

Four datasets were collected for this project:

- EV India dataset
- EV Charging Stations dataset
- Electric Car Data
- Cheapest Electric Cars dataset

These datasets contain information such as EV price, brand, vehicle type, battery capacity, charging station location, speed, efficiency, and driving range.

Data Preprocessing

Before analysis, the datasets were cleaned and prepared using Tableau Desktop.

Data preprocessing steps include:

- Removing missing values
- Eliminating duplicate records
- Standardizing units (price, speed, range)
- Organizing the dataset into structured format

Data Visualization

Once the datasets are cleaned, they are imported into Tableau Desktop for visualization. Tableau provides powerful tools for transforming raw data into graphical representations.

Different visualization techniques were used in this project including:

- **Bar Charts** to compare EV brands and prices
- **Line Charts** to analyse EV performance trends
- **Maps** to display charging station locations across India
- **Scatter Plots** to study relationships between EV attributes such as efficiency and speed

These visualizations help in understanding patterns and relationships in the EV data.

Dashboard Creation

After creating individual charts and graphs, they are combined into interactive dashboards in Tableau. The dashboard integrates multiple visualizations into a single interface that allows users to analyse EV trends and performance metrics.

The dashboard includes features such as:

- EV brand price comparison
- Charging station distribution map
- Global EV performance analysis
- Efficiency and speed comparison charts

Interactive filters and navigation options are added to allow users to explore the data dynamically.

Machine Learning Model

The system uses a Random Forest Regression model to predict EV prices and car model.

The input features include:

- Top Speed
- Range
- Battery Capacity
- Number of Seats

The Random Forest algorithm constructs multiple decision trees and combines their outputs to produce accurate predictions.

Model Evaluation Metrics

The performance of the machine learning model is evaluated using standard regression metrics:

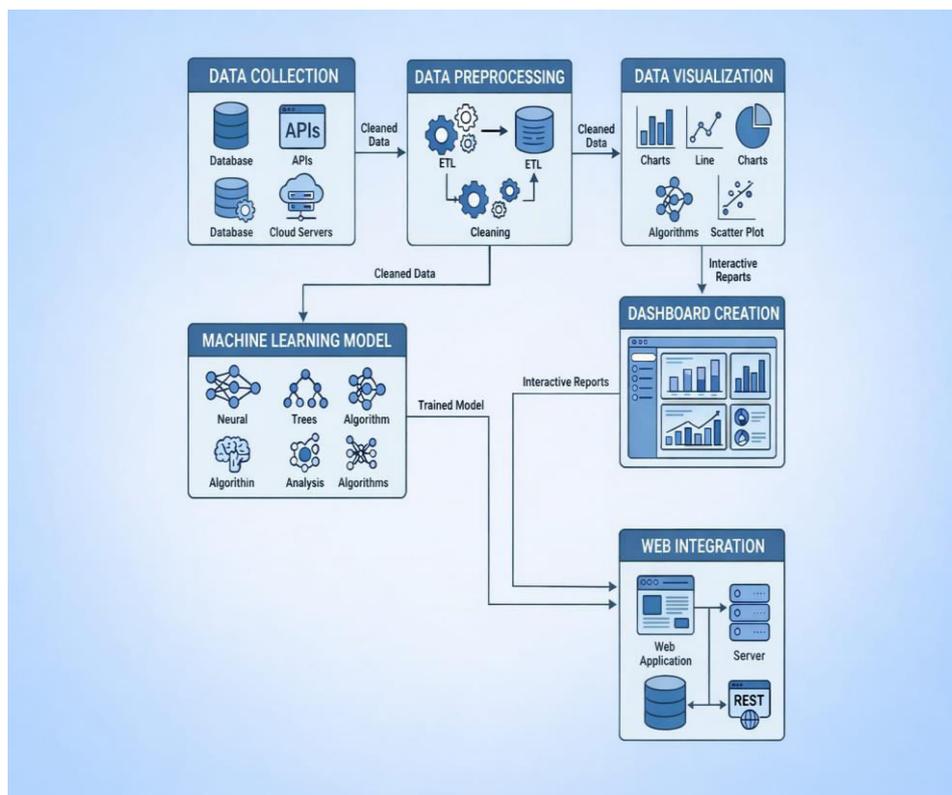
- **R² Score** – Measures prediction accuracy
- **Mean Absolute Error (MAE)** – Measures average prediction error.

Web Integration

In the final stage, the Tableau dashboards are published to Tableau Public and integrated into a web application. The web interface is developed using HTML for page structure, CSS for styling, and Python with the Flask framework for backend functionality.

The dashboards are embedded into the web pages using embed links or iframe integration, allowing users to view and interact with the visualizations through a web browser.

This integration enables users to explore EV data insights and perform predictions within a single web



Methodology Architecture

IV. EXPERIMENTAL RESULTS

The proposed EV analytics system was evaluated using a dataset containing electric vehicle specifications such as top speed, driving range, battery capacity, and number of seats. These features were used to train a Random Forest Regression model for predicting EV prices.

The Random Forest model was trained on the training dataset and evaluated on the testing dataset using standard regression metrics.

Model Evaluation

Evaluation Metric	Description	Model Performance Value
R² Score (R-Squared)	Measures how well the independent variables explain the variation in EV prices.	0.8889 (88.89%)
MAE (Mean Absolute Error)	Measures the average magnitude of prediction errors between actual and predicted EV prices.	4,92,683
RMSE (Root Mean Squared Error)	Measures the average squared difference between predicted and actual values, giving higher weight to large errors.	13,29,900

Feature Importance Analysis

This table presents the key technical variables that have the greatest influence on Electric Vehicle (EV) pricing in the predictive model. The importance of each feature is determined using the Random Forest algorithm, which evaluates how much each input variable contributes to accurate price and car model prediction.

Feature	Impact on EV Price
Battery Capacity (kWh)	High Impact – Primary cost driver of EV price
Range (km)	Significant Impact – Strongly related to battery capacity and vehicle efficiency
Top Speed (km/h)	Moderate Positive Influence – Reflects premium performance characteristics
Number of Seats	Low Influence – Typically standardized across most EV models

Tableau Dashboard Insights

Several key insights were obtained from the Tableau dashboards:

Analysis Area	Key Insight
Brand Distribution	Tata Motors has the highest EV models in India
Price Analysis	Luxury brands show significantly higher pricing
Charging Infrastructure	Charging stations are concentrated in metropolitan regions
Vehicle Performance	Higher battery capacity increases driving range

These visual insights allow users to better understand EV market dynamics.

User Interface Evaluation

The usability and clarity of the web interface were evaluated in this project. The web application provides simple and intuitive navigation, enabling users to easily explore the analysis results. It integrates Tableau dashboards with the machine learning prediction model to present both visual insights and predictive results.

The interactive dashboards display EV trends such as vehicle models, pricing, battery capacity, and driving range, helping users understand EV market patterns. The interface also allows users to enter vehicle features to predict EV price and car model using the Random Forest algorithm.

Overall, the system is user-friendly and interactive, effectively supporting EV data analysis and prediction.

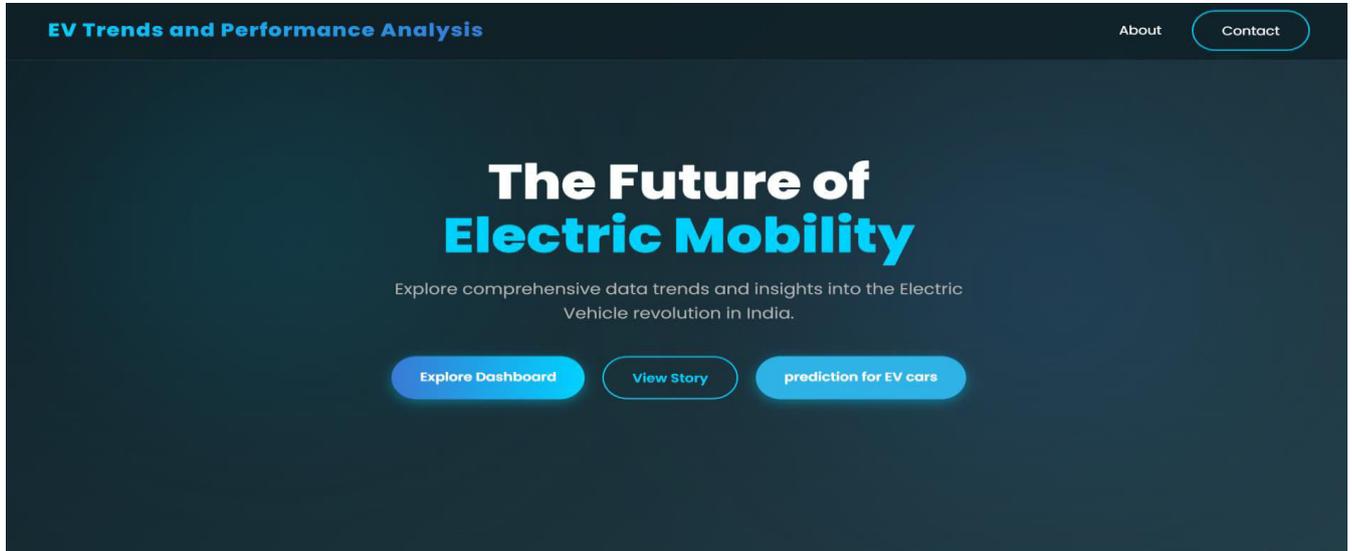


Fig 1: Home Page

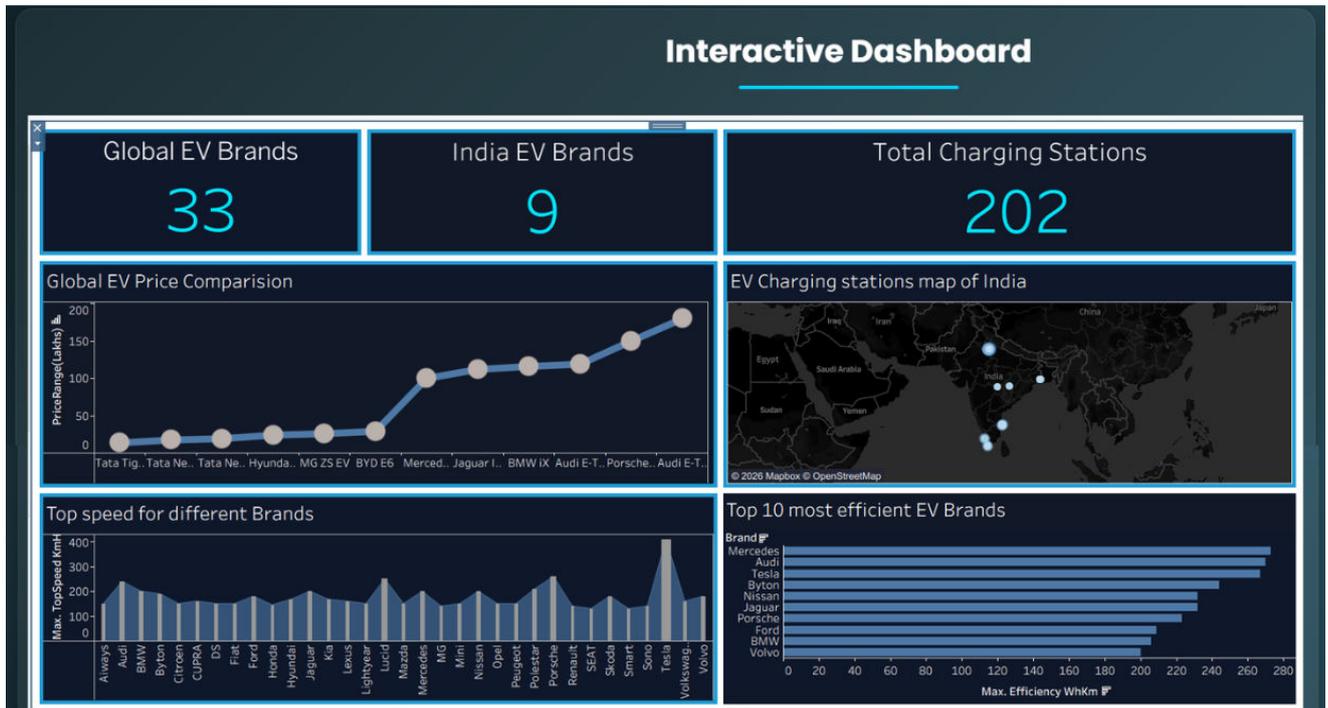


Fig 2: Dashboard Page

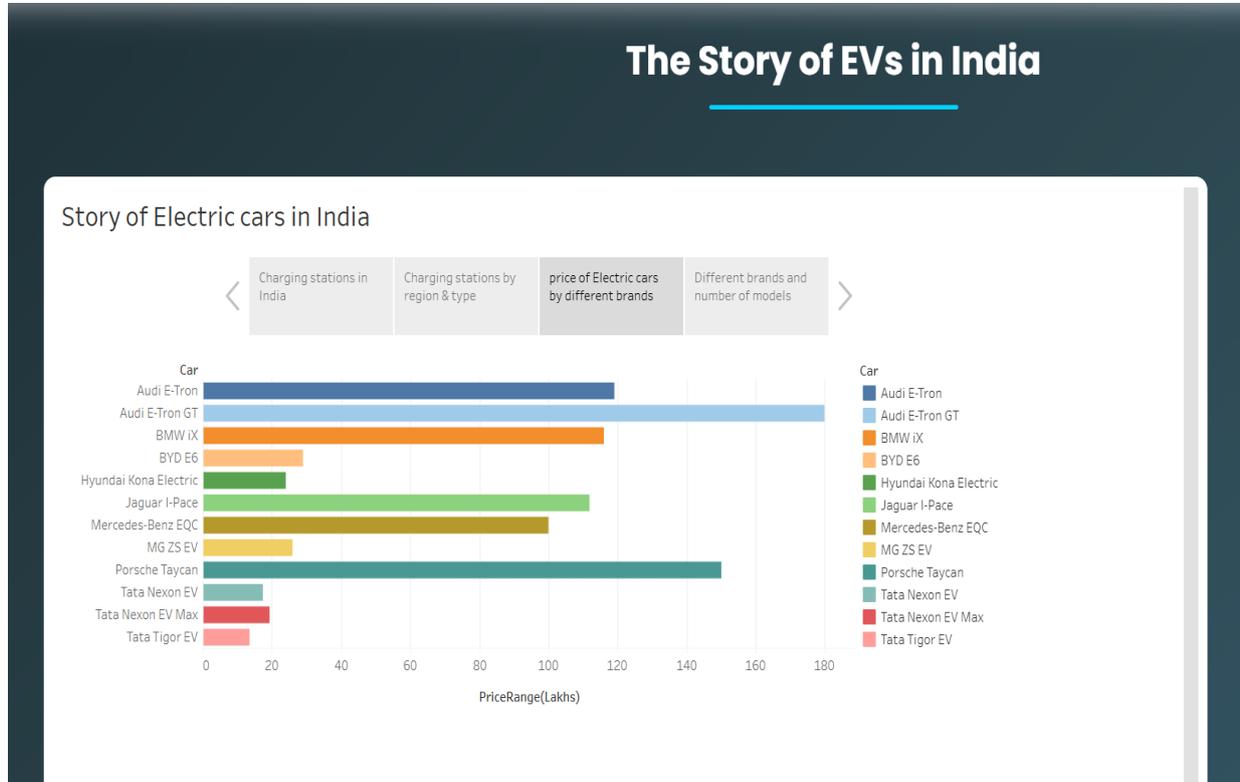


Fig 3: Story Page

prediction for EV cars

Enter your demanded specifications for an Electric Vehicle to predict its estimated Cost and car model.

Range (km):

Top Speed (km/h):

Battery Capacity (kWh):

Number of Seats:

predict

Fig 4: Prediction Page

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The results show that combining machine learning algorithms with visualization tools provides valuable insights into EV market trends.

The Random Forest regression model demonstrated strong predictive performance because it effectively captures complex relationships between vehicle specifications and pricing.

The integration of Tableau dashboards significantly improves the interpretability of the results by presenting insights through interactive charts and visual stories.

This combination of predictive analytics and visualization allows decision-makers to understand EV market trends more clearly and make data-driven decisions regarding EV adoption and infrastructure planning

VI. CONCLUSION

This research presented a data-driven EV analytics system that integrates machine learning prediction with interactive visualization dashboards. The system successfully analyzes EV market trends and predicts vehicle costs based on performance features.

The Random Forest model demonstrated reliable prediction accuracy, while Tableau dashboards enabled clear visualization of EV market insights. The Flask-based web application allows users to interact with the system through dashboards, stories, and prediction modules.

Overall, the project demonstrates the effectiveness of integrating machine learning and visualization tools for analyzing electric vehicle markets.

VII. ACKNOWLEDGMENT

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