

Market Segmentation Analysis of the Indian Electric Vehicle (EV) Market

Submitted by
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Problem Statement

This project focuses on segmenting the Indian Electric Vehicle (EV) market and identifying the most optimal market segments. The goal is to understand key factors such as vehicle type, price, range, battery capacity, and charging time, and to propose actionable strategies based on geographic, demographic, psychographic, and behavioral factors.

Data Collection

The data used in this project was gathered from publicly available sources, including manufacturer specifications and EV market reports. The dataset includes details about various EV models in India, with features such as vehicle type, battery capacity, range, charging time, price, and top speed.

These features provide the foundation for conducting a thorough segmentation analysis to identify key segments in the Indian EV market.

Data Preprocessing

Steps taken to preprocess the raw data:

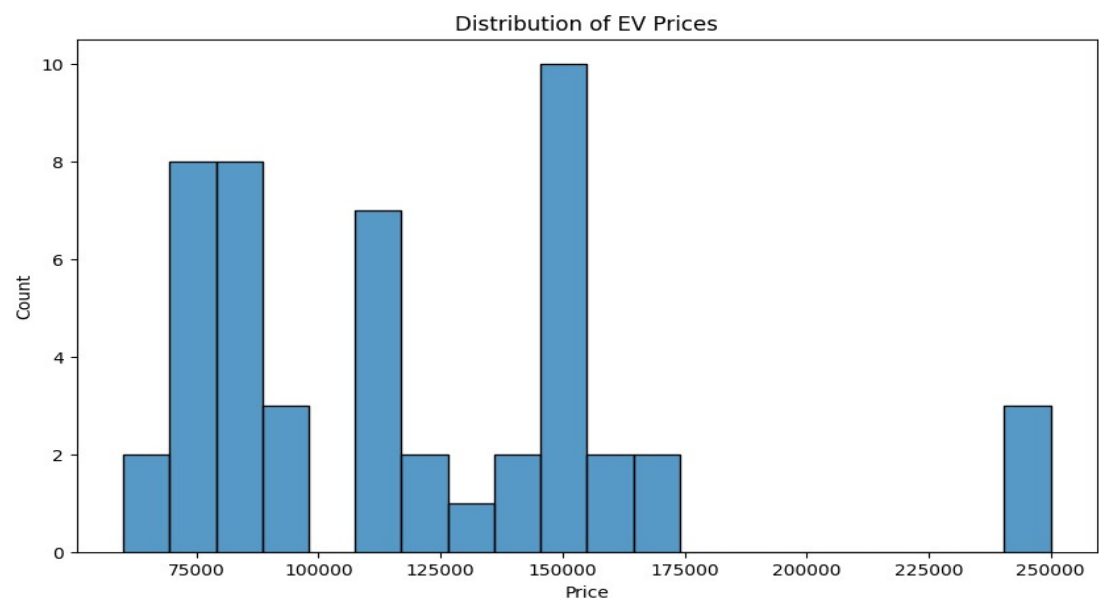
- **Handling Missing Values:** Missing values in key columns like price, charging time, and power were filled with the median value of the respective columns.
- **Data Cleaning:** Unnecessary columns were dropped, and non-numeric data types were encoded appropriately to prepare the dataset for clustering.
- **Standardization:** The numerical features were standardized using StandardScaler to ensure uniformity in scale and avoid bias in clustering.

Libraries Used:

- **pandas:** For data manipulation and processing.
- **sklearn:** For machine learning and preprocessing techniques.
- **matplotlib & seaborn:** For data visualization.

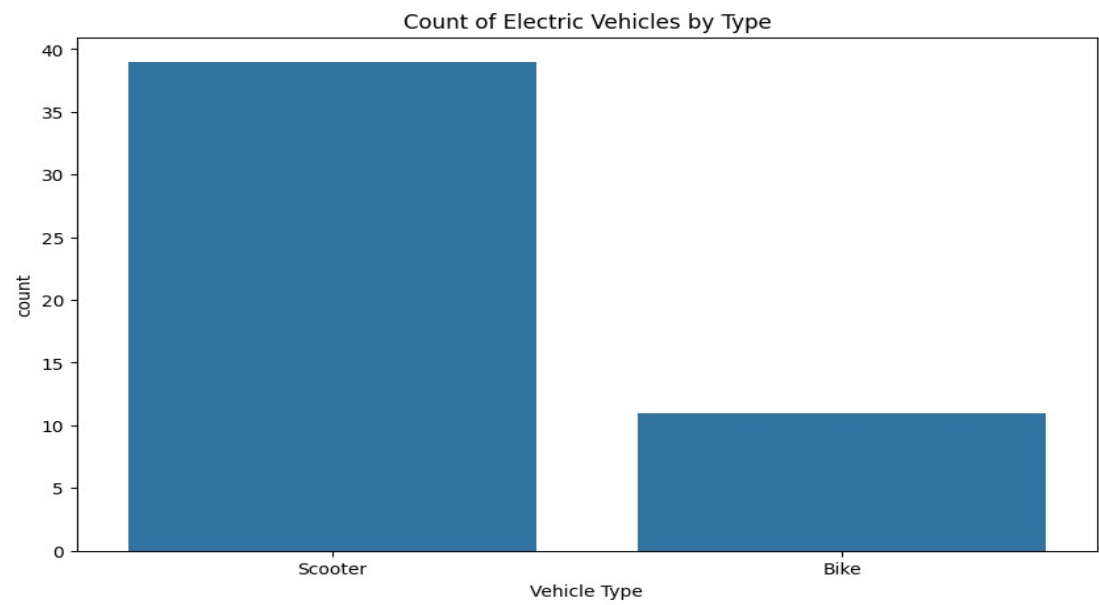
Exploratory Data Analysis (EDA)

Distribution of EV Prices



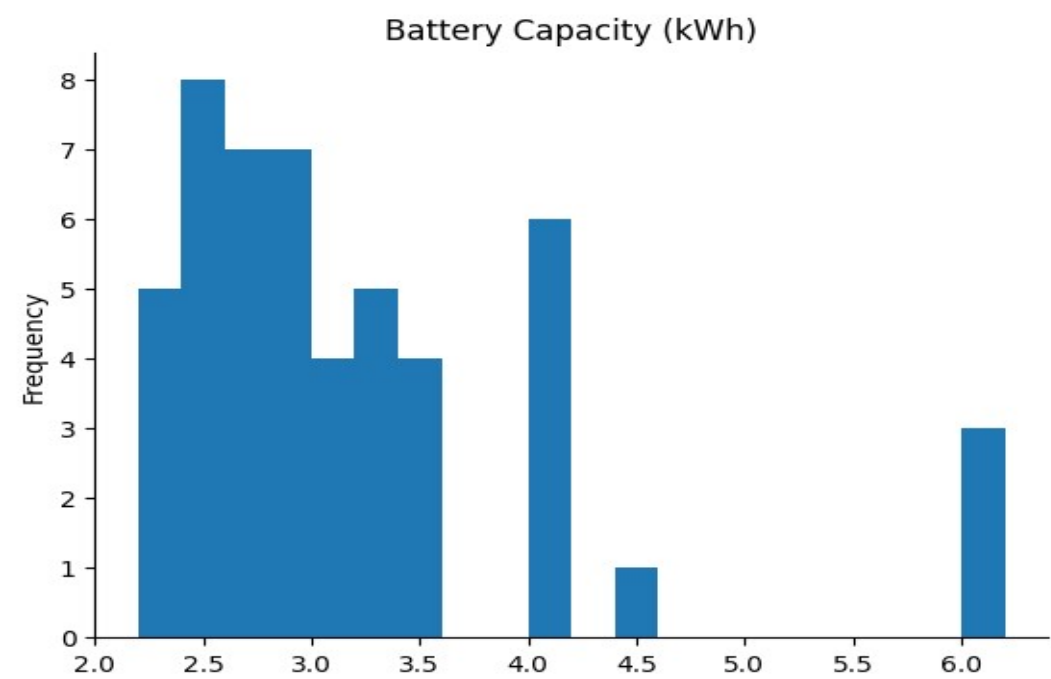
The histogram above shows the distribution of EV prices in the dataset. Most EVs are priced within the lower to mid-range bracket, with a few higher-priced vehicles present. This suggests that the market currently caters primarily to mid-range consumers, with a smaller proportion of premium EVs available.

Count of Electric Vehicles by Type



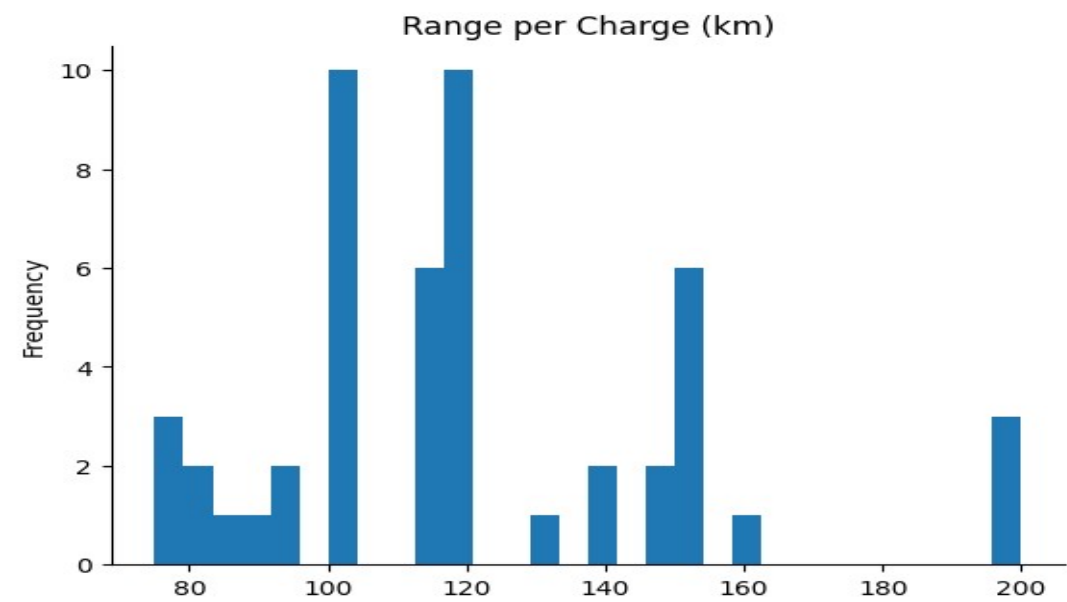
This count plot displays the number of EVs by vehicle type (e.g., scooters, motorcycles, cars). It highlights which types of vehicles are more prevalent in the market, giving insight into consumer preferences and manufacturing focus.

Battery Capacity (kWh)



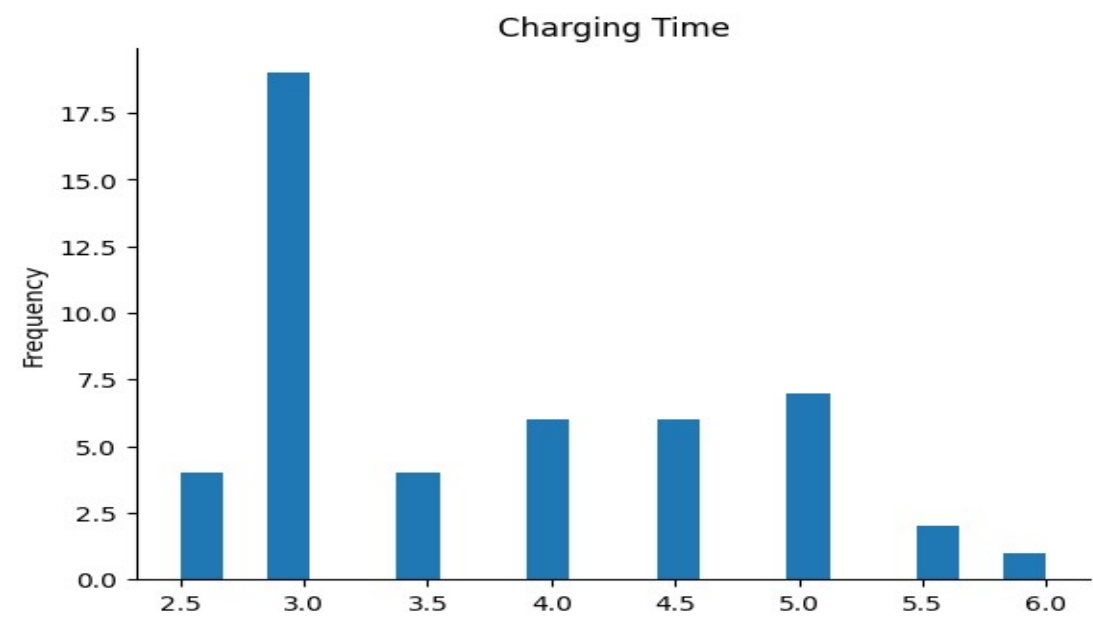
The histogram of battery capacity (kWh) shows that the majority of EVs have capacities between 2 and 5 kWh. This aligns with the range requirements for daily urban commuting, where larger capacities are not as crucial.

Range per Charge (km)



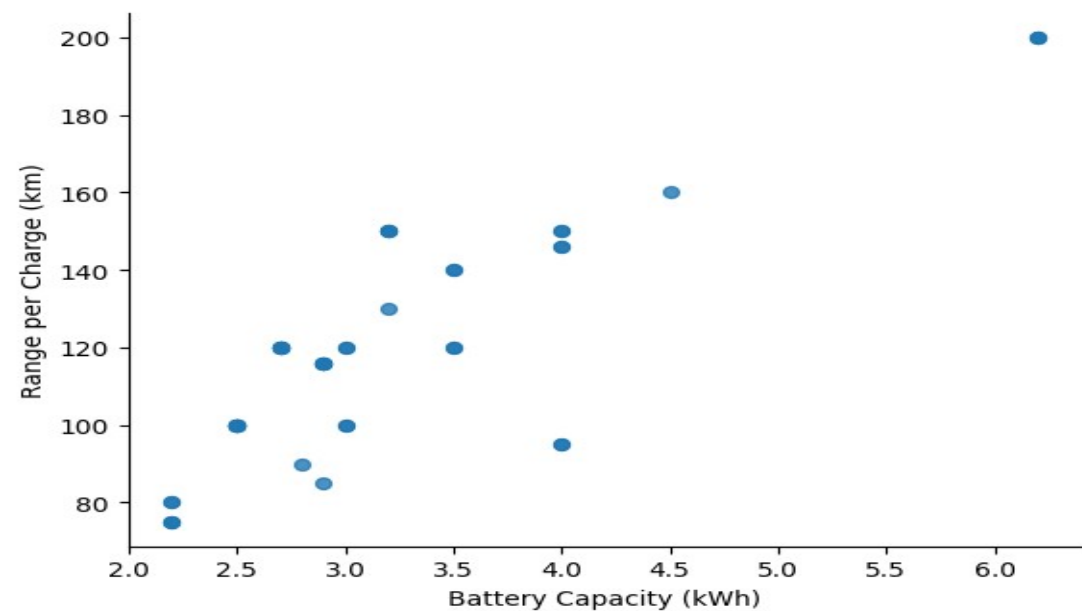
This histogram reveals that most EVs have a range between 50 and 300 km per charge. Vehicles designed for longer trips are relatively few, indicating that the market is currently focused on shorter, city-based travel.

Charging Time



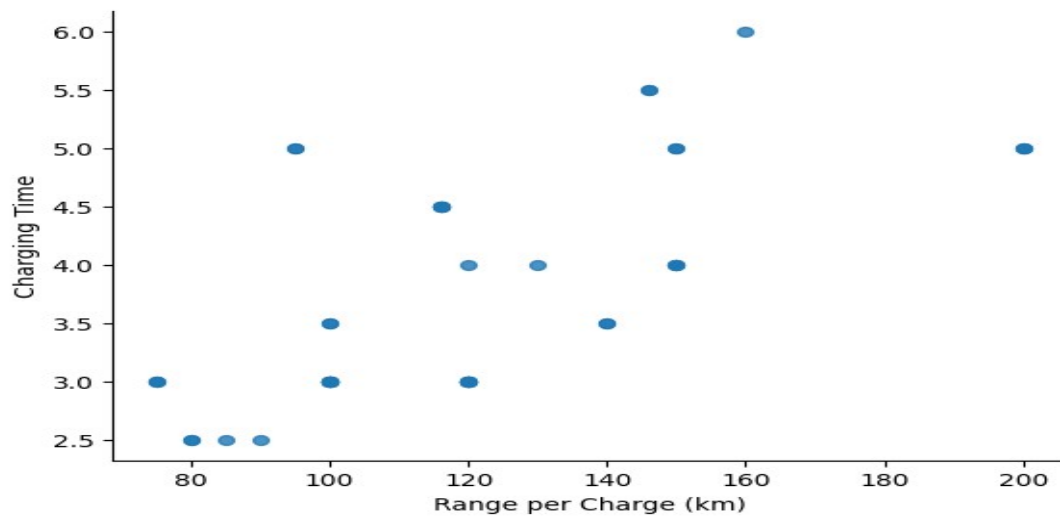
The distribution of charging time demonstrates that a large proportion of EVs have charging times between 2 and 5 hours. This indicates that the market is working to improve efficiency, though faster-charging options are still not widespread.

Battery Capacity (kWh) vs. Range per Charge (km)



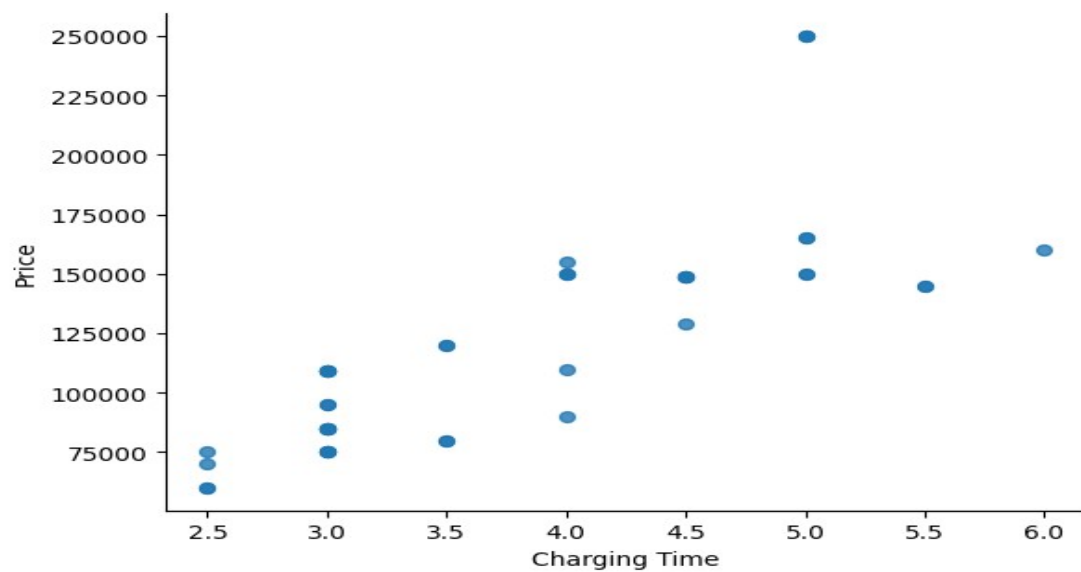
The scatter plot shows a clear positive correlation between battery capacity and range per charge. As expected, larger batteries enable longer travel distances, which is crucial for higher-end vehicles catering to customers seeking extended range.

Range per Charge (km) vs. Charging Time



This scatter plot reveals the relationship between the vehicle's range and its charging time. While longer-range vehicles tend to have longer charging times, there are some exceptions, where advanced battery technology allows for efficient charging even with extended range.

Charging Time vs Price



The scatter plot shows that vehicles with longer charging times tend to be priced lower, while faster-charging vehicles, especially those in the premium segment, command higher prices.

Segment Extraction

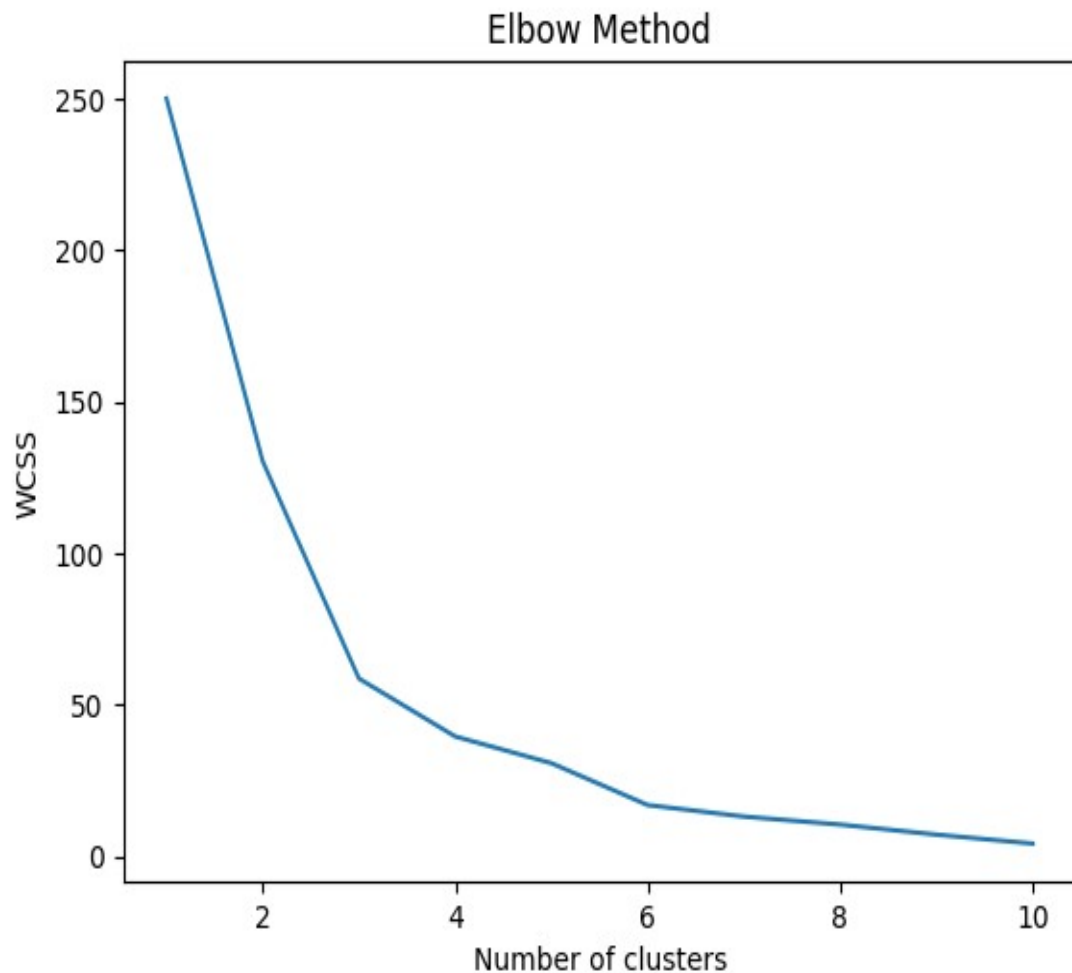
K-Means Clustering

We applied K-Means clustering to segment the market on the dataset based on key numerical features such as battery capacity, range, price, power, and top speed.

Standardization: All features were standardized using StandardScaler.

K-Means Algorithm: The K-Means algorithm was applied to the standardized data to group the vehicles into clusters.

Elbow Method: The elbow method was used to determine that the optimal number of clusters is three. The optimal number of clusters was determined by plotting the sum of squared distances and finding the point where the reduction in distance becomes less significant (the "elbow").



The elbow curve above shows that three clusters is the ideal number, as the reduction in WCSS becomes less significant after three clusters.

Profiling the Segments

After applying K-Means clustering, the dataset was divided into three distinct segments. The table below outlines the key characteristics of each segment:

Feature	Segment (Premium)	1 Segment Range)	2 (Mid- Segment (Budget)	3
Price	High	Moderate	Low	
Range per Charge (km)	Long	Moderate	Short	
Battery Capacity (kWh)	High	Moderate	Low	
Power (HP or kW)	High	Moderate	Low	
Top Speed (km/h)	High	Moderate	Low	

Premium Electric Vehicles:

These vehicles are priced at the high end of the market and offer long-range capabilities, making them suitable for consumers who value performance and luxury. The target audience includes affluent buyers looking for a high-performance vehicle with advanced features.

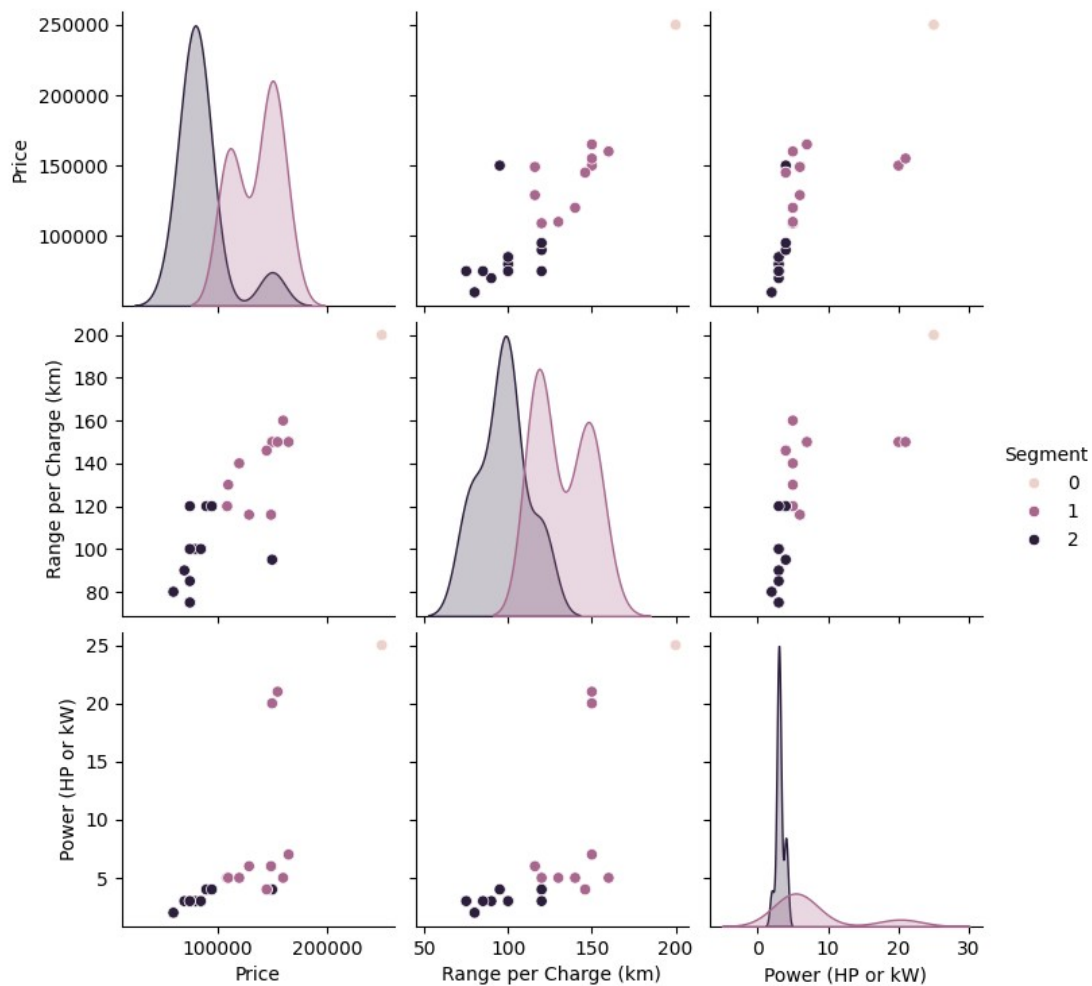
Mid-Range Electric Vehicles:

This segment represents the balance between affordability and performance, offering a practical solution for urban and suburban commuters. These vehicles are competitively priced and provide a moderate range, making them ideal for middle-income families and professionals.

Budget Electric Vehicles:

This segment caters to cost-sensitive customers who are primarily interested in short-distance commuting. These vehicles are priced at the lower end of the market, offering smaller battery capacities and ranges. The target audience includes students, entry-level professionals, and price-conscious consumers.

The pair plot below visualizes the distribution of key features across the three segments. It illustrates how premium, mid-range, and budget EVs differ in price, range, and power.



Selection of the Target Segment

We selected **Segment 2 (Mid-Range EVs)** as the target market. This segment offers the best balance between affordability and performance, making it suitable for a large portion of urban and suburban commuters.

The table below summarizes the characteristics of each segment, aiding in the decision to target the mid-range market:

Segment	Price Range	Range Charge (km)	per Battery Capacity (kWh)	Power (HP Top or kW)	Speed (km/h)
1	High	Long	High	High	High
2	Moderate	Moderate	Moderate	Moderate	Moderate
3	Low	Short	Low	Low	Low

Customizing the Marketing Mix

Product:

We will focus on offering vehicles with efficient charging times, moderate range, and reasonable pricing to appeal to urban and suburban commuters.

Price:

The vehicles will be priced within a moderate range to attract middle-income consumers, offering value for money without compromising on key features.

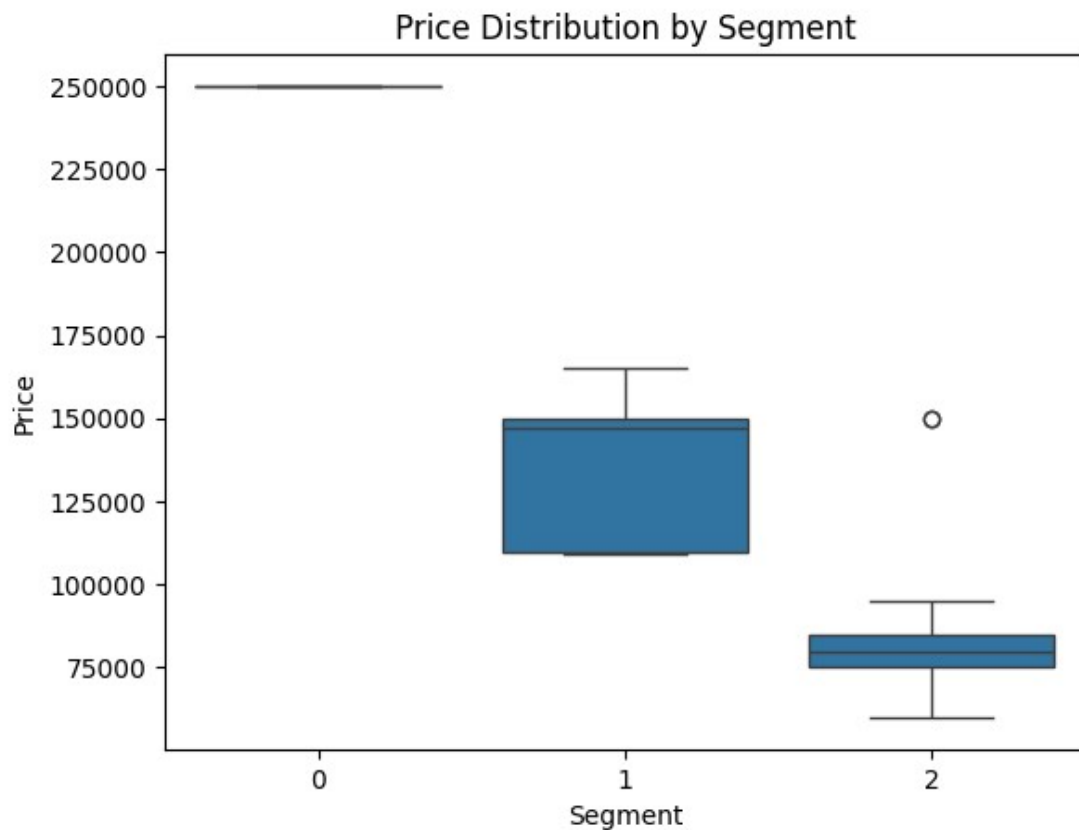
Place:

We will target metro areas with strong infrastructure for electric vehicles, such as established charging stations and government incentives for EV adoption.

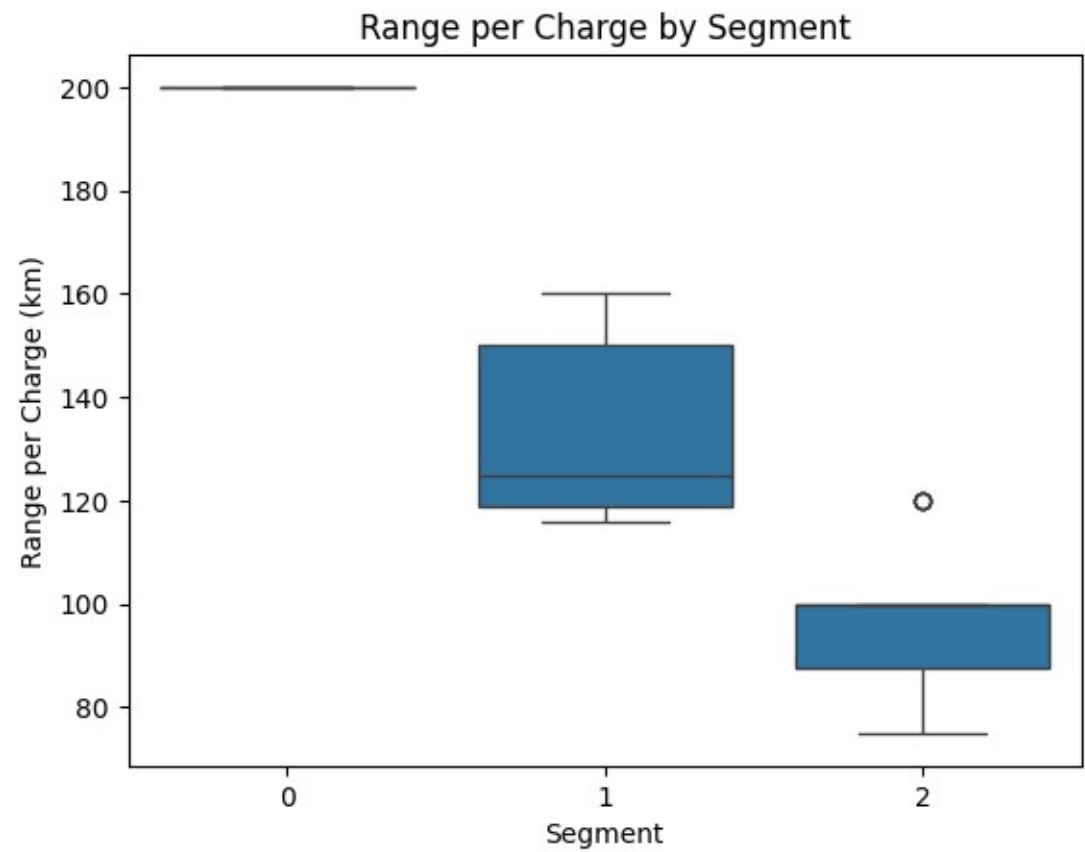
Promotion:

Marketing efforts will highlight government subsidies, long-term savings on fuel and maintenance, and the environmental benefits of switching to electric vehicles.

The boxplot below shows the price distribution across segments, confirming that the mid-range segment offers affordability compared to the premium segment.



The boxplot of range per charge by segment demonstrates that Segment 2 provides a good balance of range, making it ideal for daily commuters.

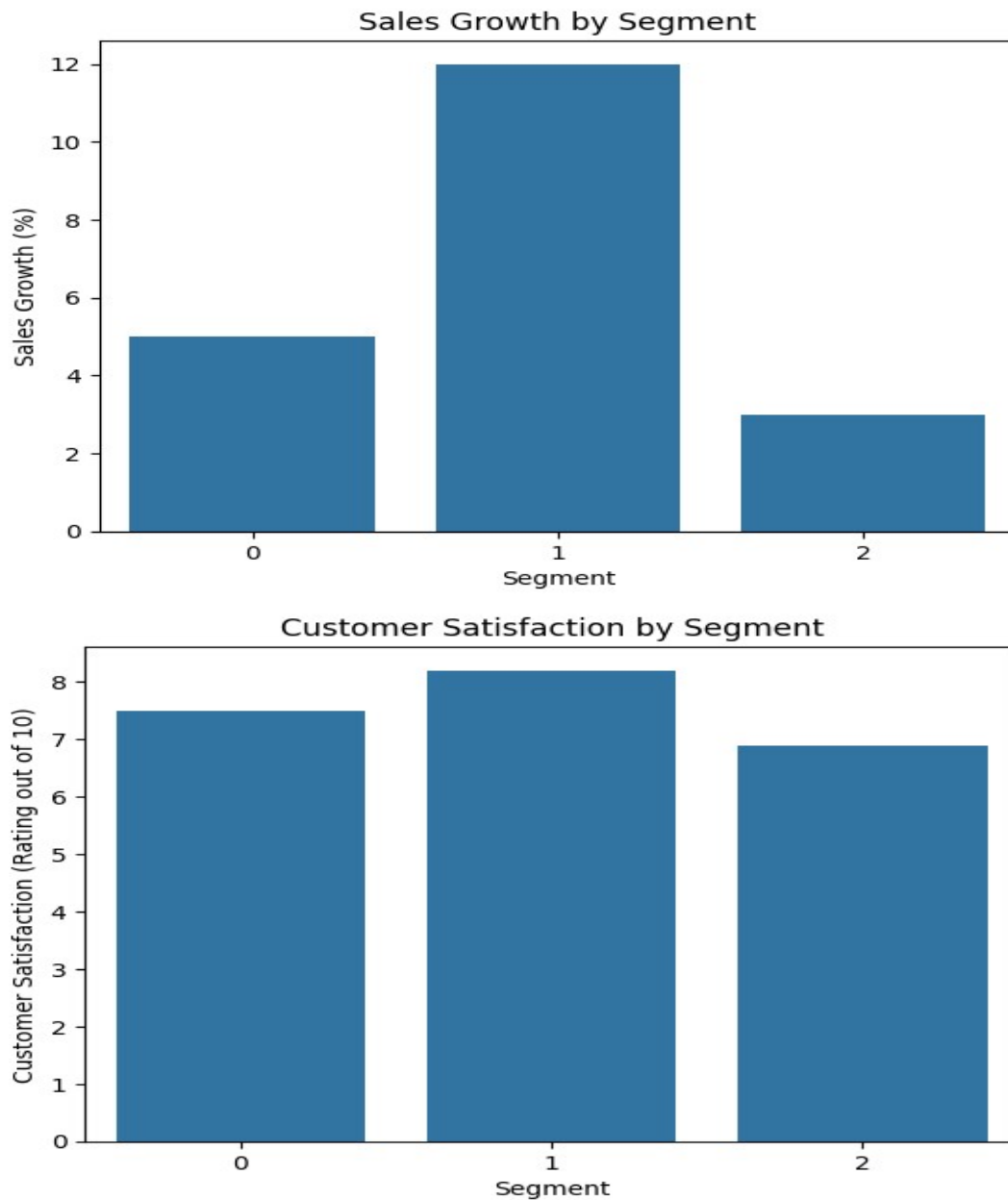


Evaluation and Monitoring

We used mock data to evaluate the performance of each segment. The table below summarizes key performance metrics such as sales growth and customer satisfaction for each segment.

Segment Sales Growth (%) Customer Satisfaction (Rating out of 10)

0	5	7.5
1	12	8.2
2	3	6.9



The barplot above shows that Segment 1 (Premium EVs) has the highest sales growth, but the mid-range segment has a strong customer satisfaction rating.

Potential Sales and Profit

Early Market Strategy:

- **Potential Customer Base:** Estimated 100,000 customers in the early market.
- **Target Price:** ₹1,20,000 (average price for mid-range EVs).
- **Potential Profit:** ₹12 billion in the early market (Potential Customer Base × Target Price).

Conclusion - Optimal Market Segment

This analysis identifies **Segment 2 (Mid-Range EVs)** as the most promising target for market entry. The mid-range segment holds the most potential for growth and offers a balance between affordability and range, appealing to a broad customer base in urban areas. With a moderate price range and competitive features, mid-range EVs are positioned to capture a significant portion of the growing EV market in India.

GITHUB REPO:

<https://github.com/divya9502/EV-market-segmentation.git>