MARKET SEGMENTATION ANALYSIS OF ELECTRIC VEHICLE MARKET IN INDIA

LINK :- GITHUB

Problem Statement

Task is to analyze the Electric Vehicles Market in India using Segmentation analysis and come
up with a feasible strategy to enter the market, targeting the segments most likely to use their
product in terms of Geographic, Demographic, Psychographic, and Behavioral.

In this comprehensive report, we explore the Electric Vehicle (EV) Market in India, analyzing segments such as region, price, charging infrastructure, vehicle type (e.g., two-wheelers, three-wheelers, four-wheelers), retail outlets, manufacturers, body types (e.g., hatchback, sedan, SUV, autorickshaw), safety features, plug types, and more.

Data Collection

Data was extracted from the various websites mentioned below for EV market segmentation.

Link for data extraction:
*   https://pib.gov.in/PressReleasePage.aspx?PRID=1842704
    https://www.ibef.org/blogs/electric-vehicles-market-in-india
    https://evreporter.com/indias-region-wise-ev-market-jan-may-2022/
*   https://www.india-briefing.com/news/indias-ev-manufacturing-capacity-and-market-preferences- progress-25840.html/
*   https://github.com/Marisha18/Market-Segmentation-for-Electric-Vehicles-in-India/blob/main/Market_Segmentation.ipynb
   https://github.com/Ashwini3535/EV-MARKET-IN-INDIA

Exploratory Data Analysis(EDA)

Exploratory Data Analysis (EDA) is a crucial step in the data analysis process, where analysts explore a dataset to understand its main characteristics before applying more formal statistical modeling techniques. EDA involves various techniques that allow analysts to visualize and summarize the data, helping to uncover patterns, spot anomalies, test hypotheses, and check assumptions. It is an iterative process where insights are continuously refined as new questions and patterns emerge from the data.

One of the primary objectives of EDA is to gain insights into the data's underlying structure and variables. Analysts use descriptive statistics, such as measures of central tendency (mean, median, mode) and measures of dispersion (range, variance, standard deviation), to summarize the data. Visual tools, like histograms, box plots, scatter plots, and bar charts, are employed to identify trends, relationships, and outliers. These visualizations help in identifying the distribution of variables and the presence of any skewness or kurtosis that might affect further analysis.

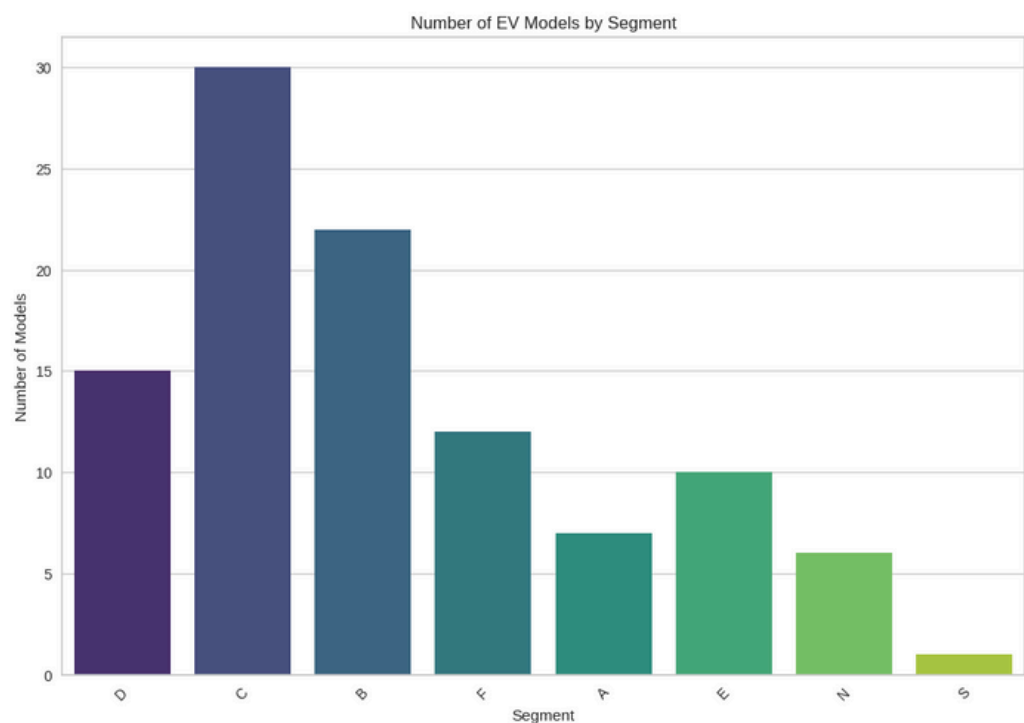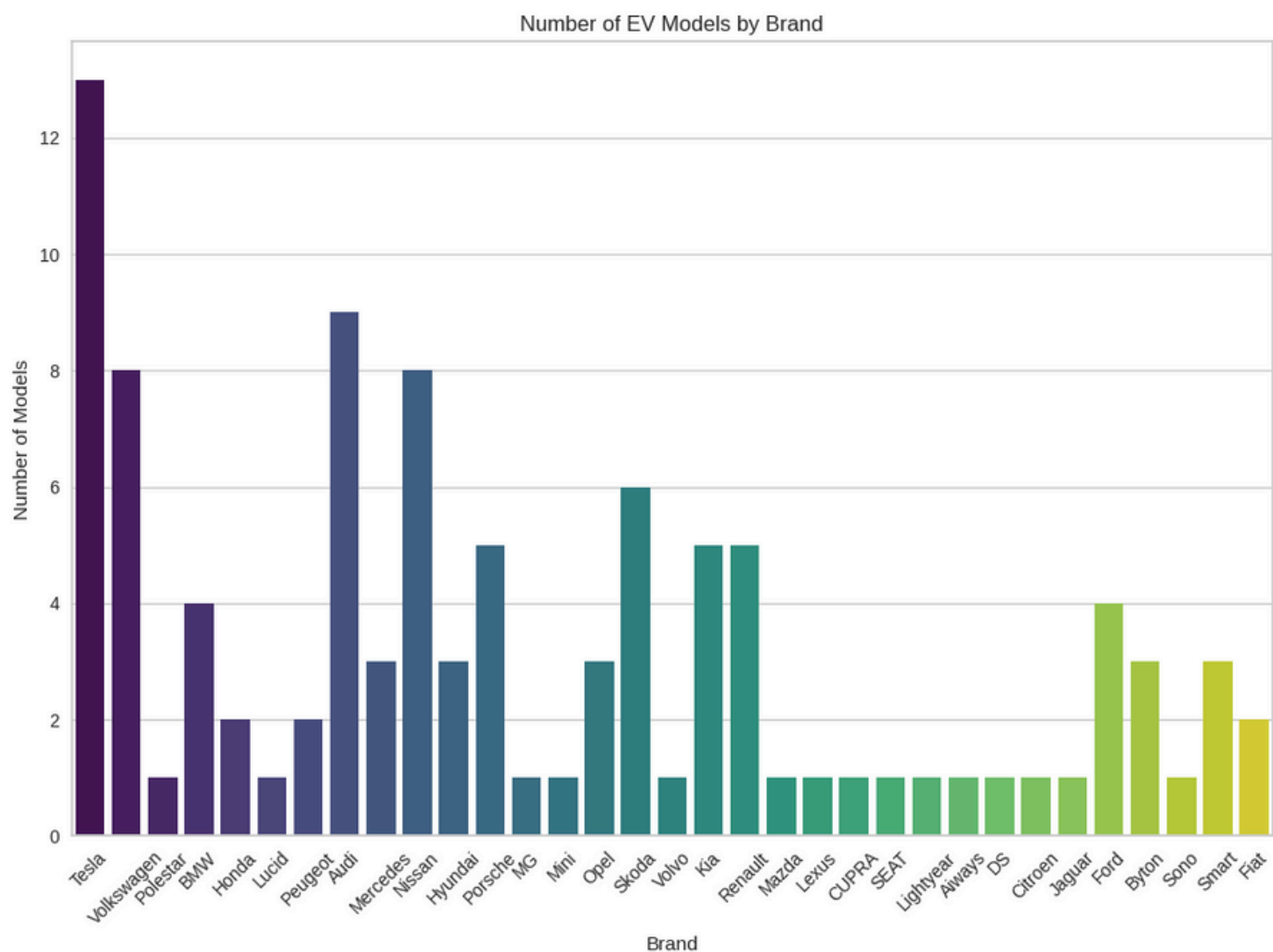Number of Electric Vehicles by State in India
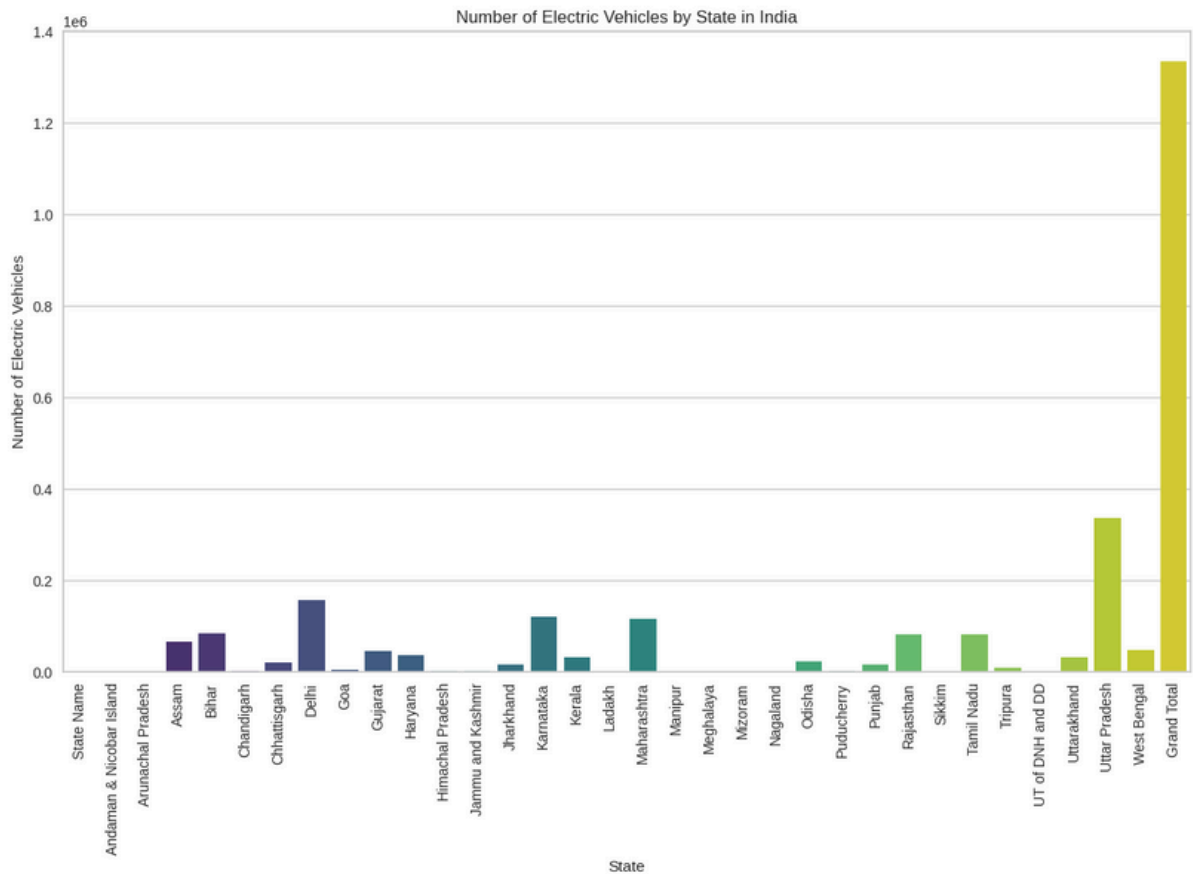
The graph above shows the distribution of electric vehicles (EVs) across various Indian states, illustrating a stark contrast in adoption rates. Uttar Pradesh leads with the highest number of registered electric vehicles, followed closely by Delhi, which ranks second. This data highlights the varying levels of EV penetration, potentially influenced by regional economic conditions, urbanization, specific state incentives, and infrastructure availability for electric vehicles.


Number of Chargers by Region
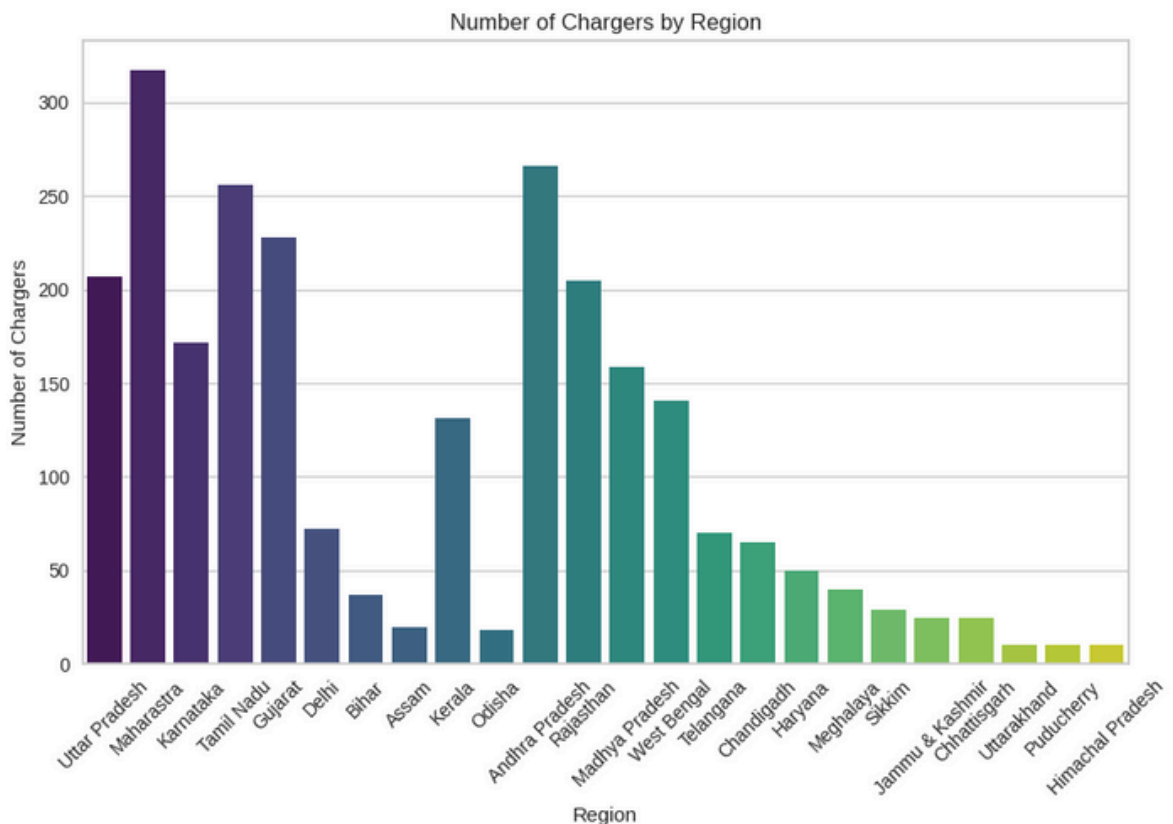
The graph above illustrates the number of electric vehicle (EV) chargers distributed across various Indian states. This visual representation reveals the current state of charging infrastructure, essential for supporting the widespread adoption of electric vehicles. The data shows a significant variation in charger availability, with states like Uttar Pradesh, Maharashtra, and Karnataka leading in numbers, suggesting a higher level of readiness for EV adoption in these regions.

The graph below showcases the diversity of electric vehicle (EV) models offered by various automotive brands. This visualization highlights the range of options available to consumers, indicating the competitive landscape of the EV market. Tesla leads with the highest number of distinct models, followed by Audi and Volkswagen , reflecting their strong positions in the EV sector.

Number of EV Models by Brand


Number of EV Models by Segment

The graph shows the number of electric vehicle models available in different segments. The mid-sized sedan segment has the highest number of models available, followed by the compact sedan segment.
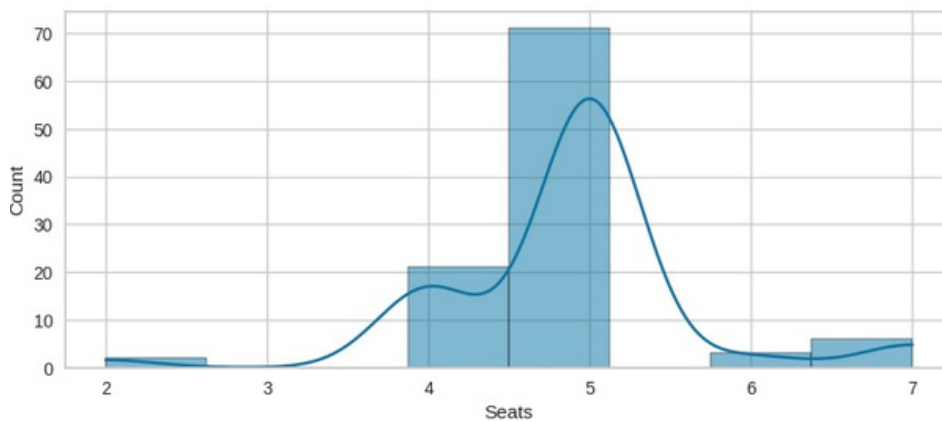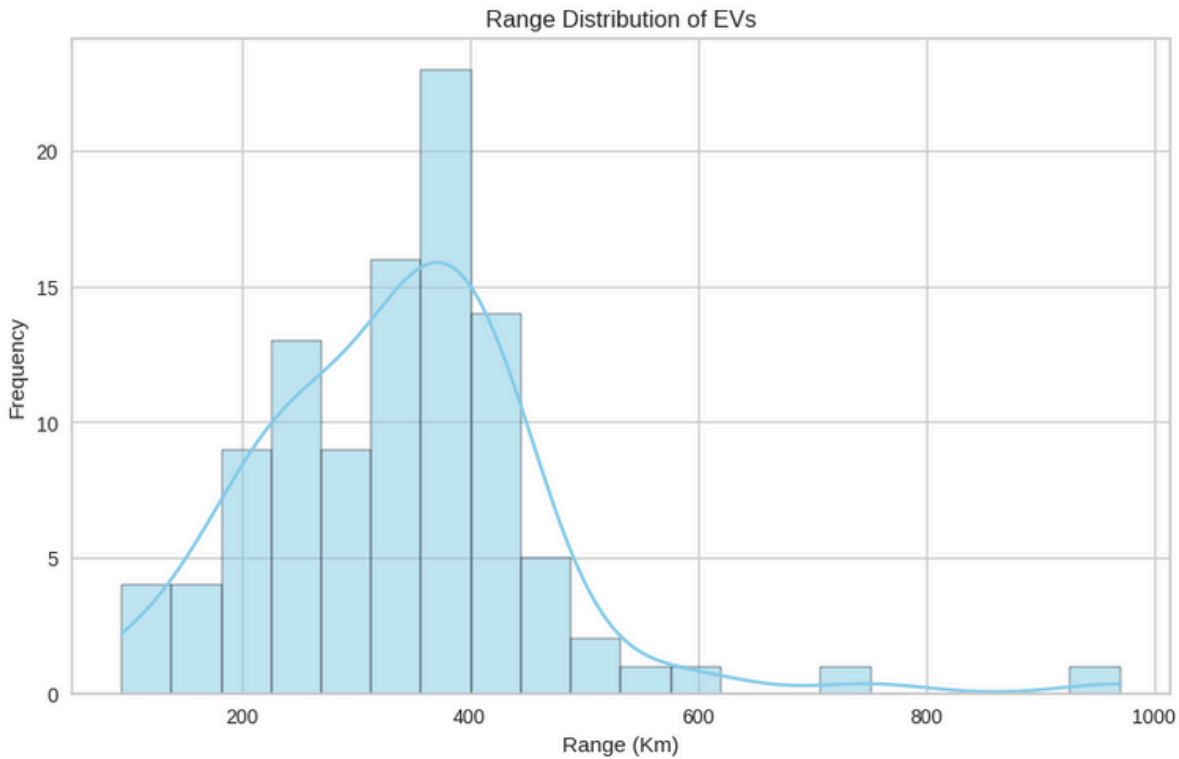
The graph below shows the distribution of electric vehicle prices in Euros. The majority of EVs are priced between 25,000 and 50,000 Euros, with a smaller number of models priced higher or lower.
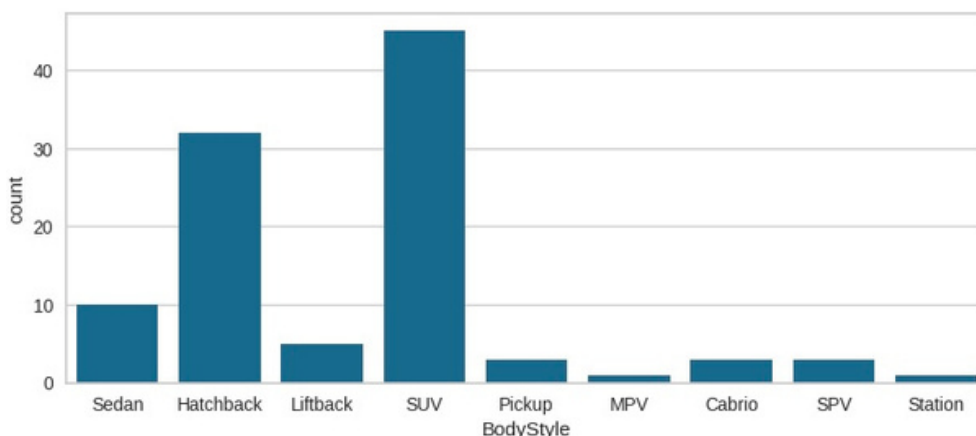

Price Distribution of EVs
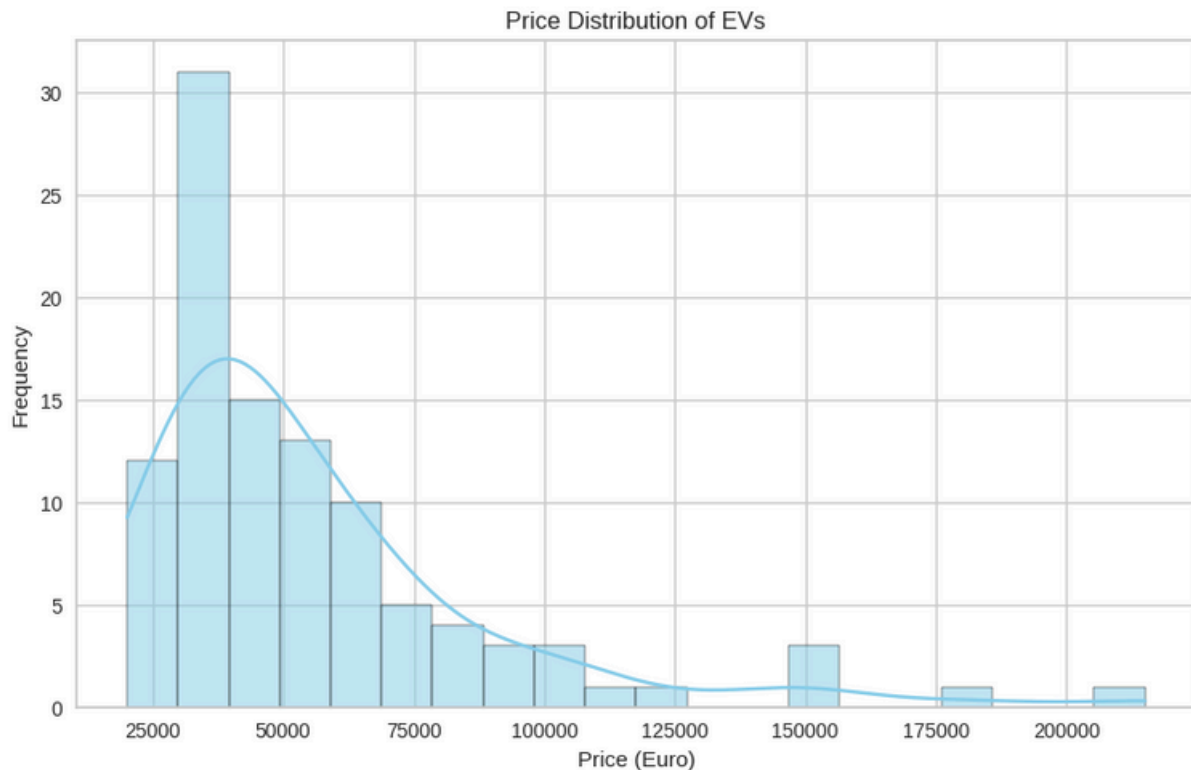
The graph below shows the distribution of top speeds for electric vehicles. The majority of EVs have a top speed between 150 and 200 km/h, with a smaller number of models reaching higher speeds.


Top Speed Distribution of EVs
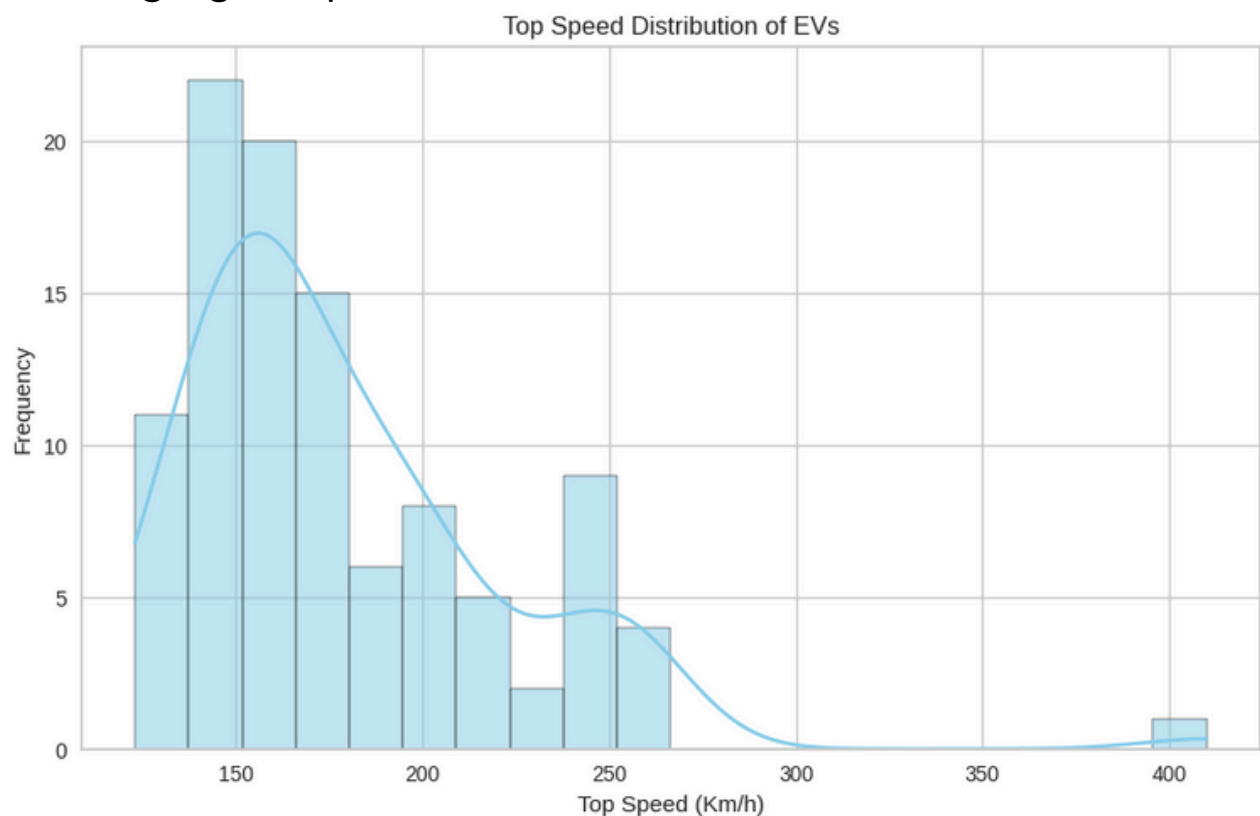
The graph below shows the distribution of electric vehicle ranges. The majority of EVs have a range between 300 and 500 km, with a smaller number of models reaching higher or lower ranges.
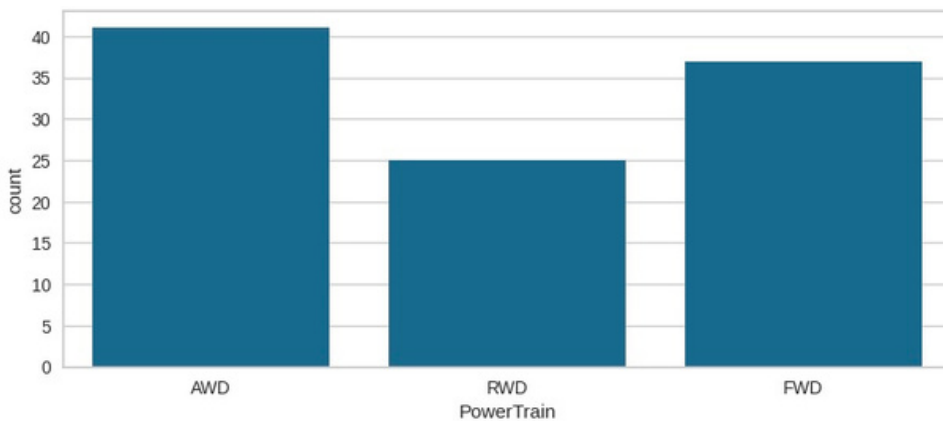

Range Distribution of EVs

The graph shows the distribution of the number of seats in cars. Most cars have 5 seats, with a smaller number of cars having 4 or 6 seats.

The graph shows the distribution of car body styles. SUVs are the most popular body style, followed by hatchbacks and sedans.
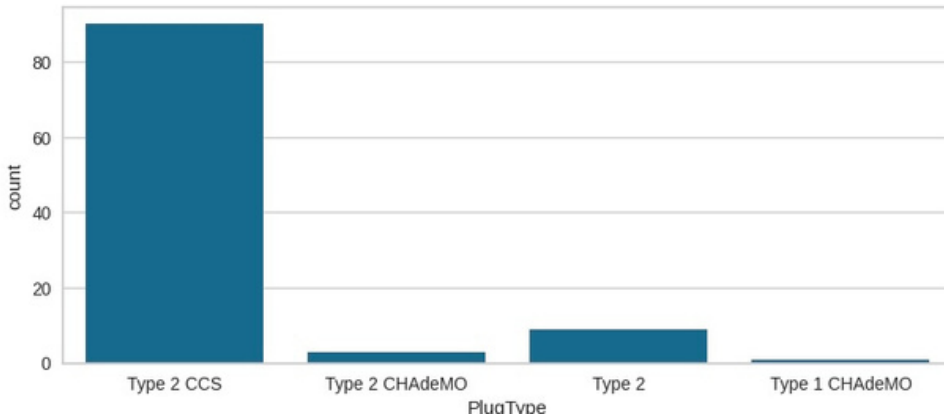
The graph shows the distribution of electric vehicle charging plug types. Type 2 CCS is the most common plug type, followed by Type 2 and Type 2 CHAdeMO. Type 1 CHAdeMO is the least common plug type.
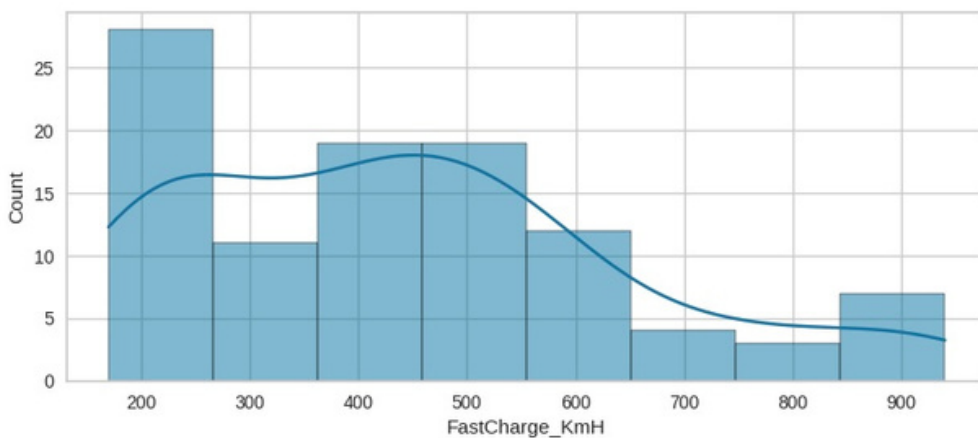

The graph shows the distribution of car powertrain types. AWD is the most common powertrain, followed by FWD and RWD.
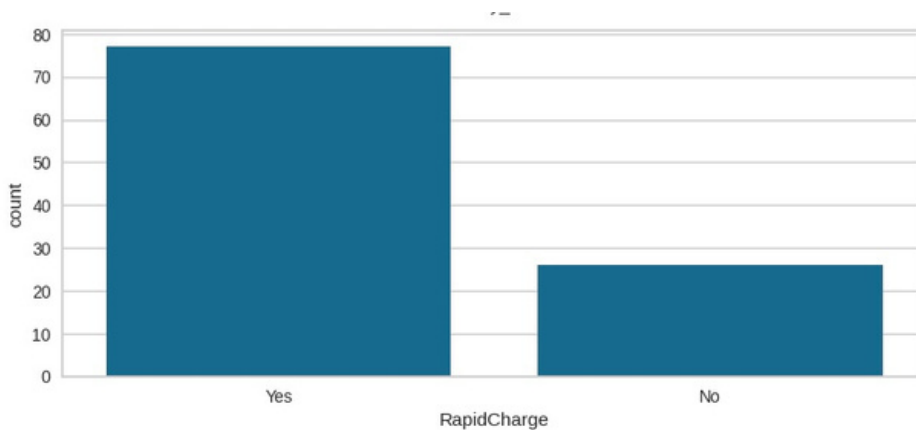
The graph shows the percentage of cars with rapid charge capability. The majority of cars (around 80%) have rapid charge capability, while the remaining 20% do not.
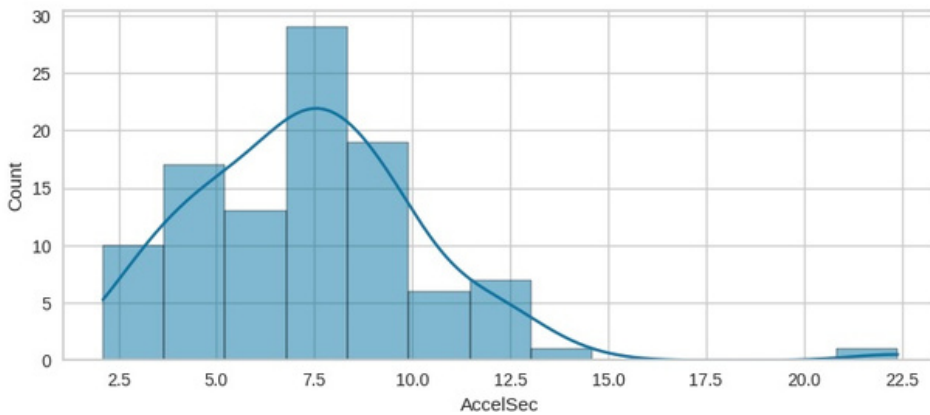
This graph illustrates the distribution of acceleration times (AccelSec) for a dataset. The x-axis represents acceleration time in seconds, while the y-axis indicates the count of occurrences within each time interval.

This graph shows the distribution of fast charge speeds for a sample of electric vehicles. The x-axis represents the fast charge speed in kilometers per hour (Km/H), and the y-axis represents the count of vehicles with that specific charging speed.
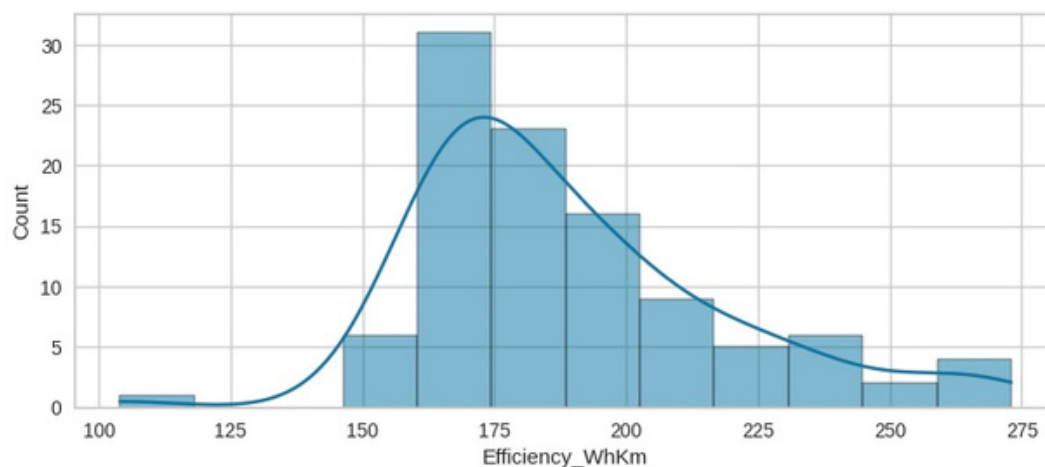
The graph shows the distribution of electric vehicle efficiency in Wh/km. Most EVs have an efficiency between 150 and 200 Wh/km, with a smaller number of vehicles having higher or lower efficiency.

Principal Components Analysis (PCA):

- PCA is a dimensionality reduction technique that transforms the data into a set of uncorrelated variables called principal components. This simplifies the data structure while preserving as much variability as possible, making it easier to identify meaningful segments.

Correlation matrix plot for loadings

PCA Loadings Heatmap
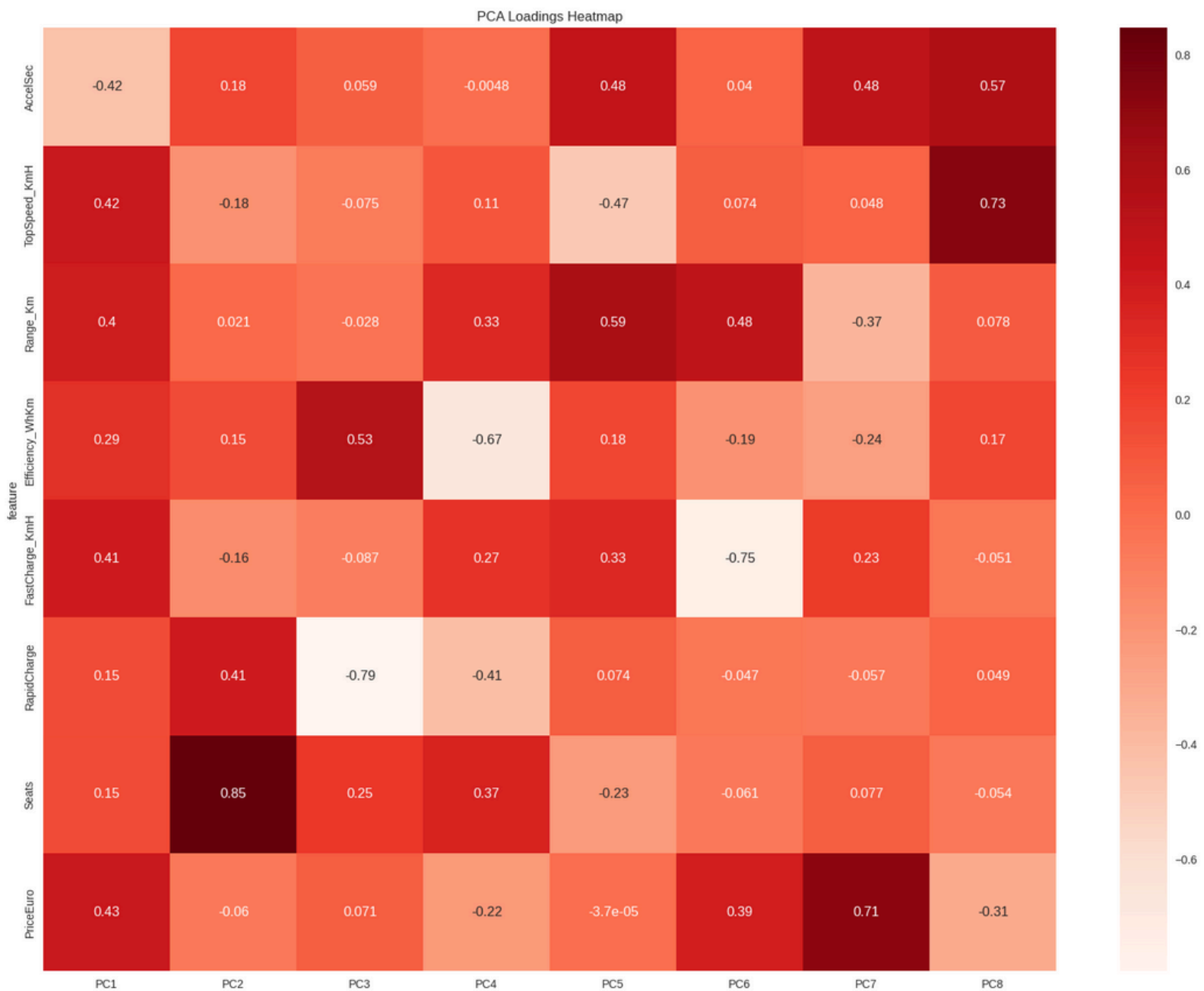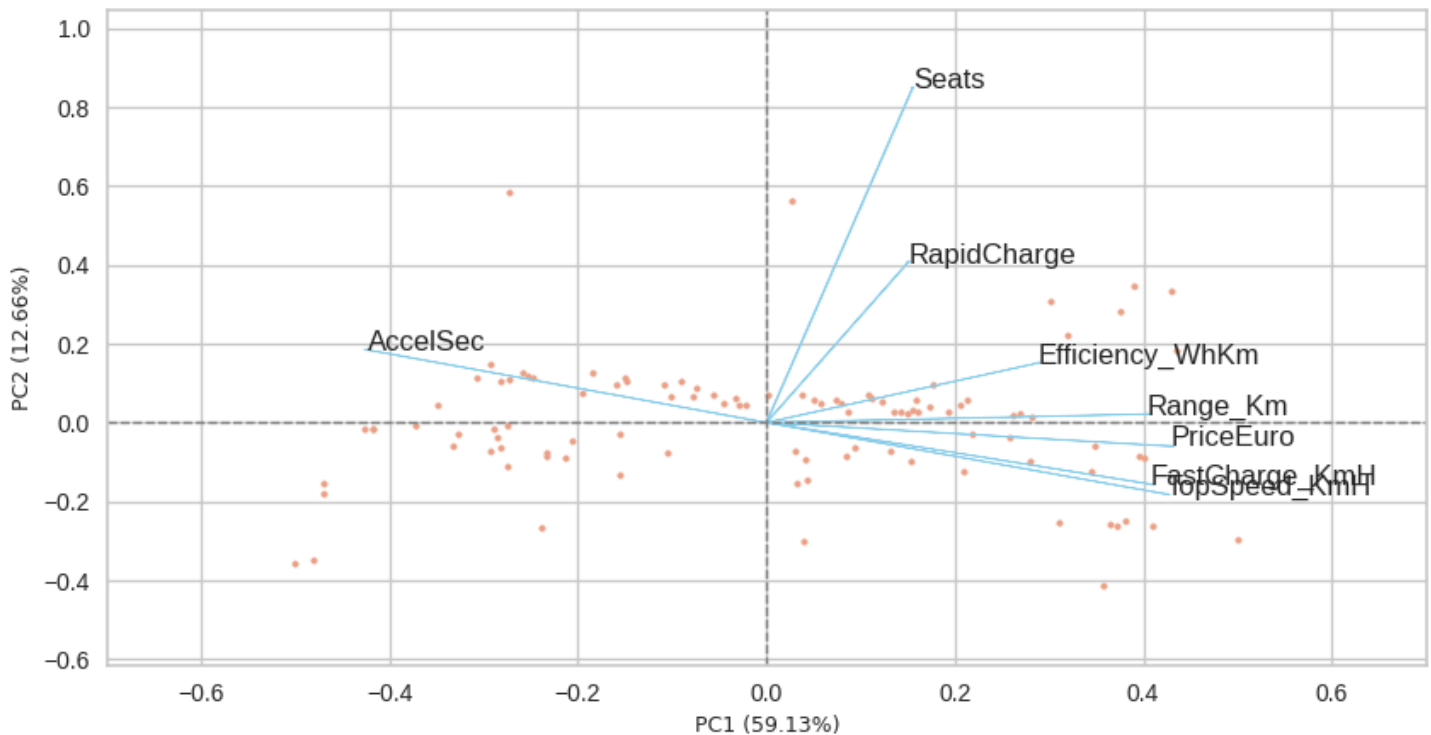
2D Biplot

The biplot visualizes the relationship between electric vehicle characteristics and their projection onto two principal components (PCs) that capture the most variance in the data.

Overall Interpretation:
- The biplot suggests that electric vehicle characteristics can be broadly categorized into two main groups:
  - Performance and size: related to PC1
  - Efficiency and charging: related to PC2
- There is some overlap between these groups, as indicated by the angles between the variable vectors. For instance, vehicles with higher efficiency might also tend to have higher ranges.
- The Biplot also reveals potential trade-offs, such as the negative correlation between price and performance.

Extracting Segments

Elbow Method

As we know in the k-means clustering algorithm we randomly initialize k clusters and we iteratively adjust these k clusters till these k-centroids riches in an equilibrium state. However, the main thing we do before initializing these clusters is that determine how many clusters we have to use.

For determining K(numbers of clusters) we use Elbow method. Elbow Method is a technique that we use to determine the number of centroids(k) to use in a k-means clustering algorithm. In this method to determine the k-value we continuously iterate for k=1 to k=n (Here n is the hyperparameter that we choose as per our requirement). For every value of k, we calculate the within-cluster sum of squares (WCSS) value.

WCSS - It is defined as the sum of square distances between the centroids and
each points.

Now For determining the best number of clusters(k) we plot a graph of k versus their WCSS value. Surprisingly the graph looks like an elbow (which we will see later). Also, When k=1 the WCSS has the highest value but with increasing k value WCSS value starts to decrease. We choose that value of k from where the graph starts to look like a straight line.
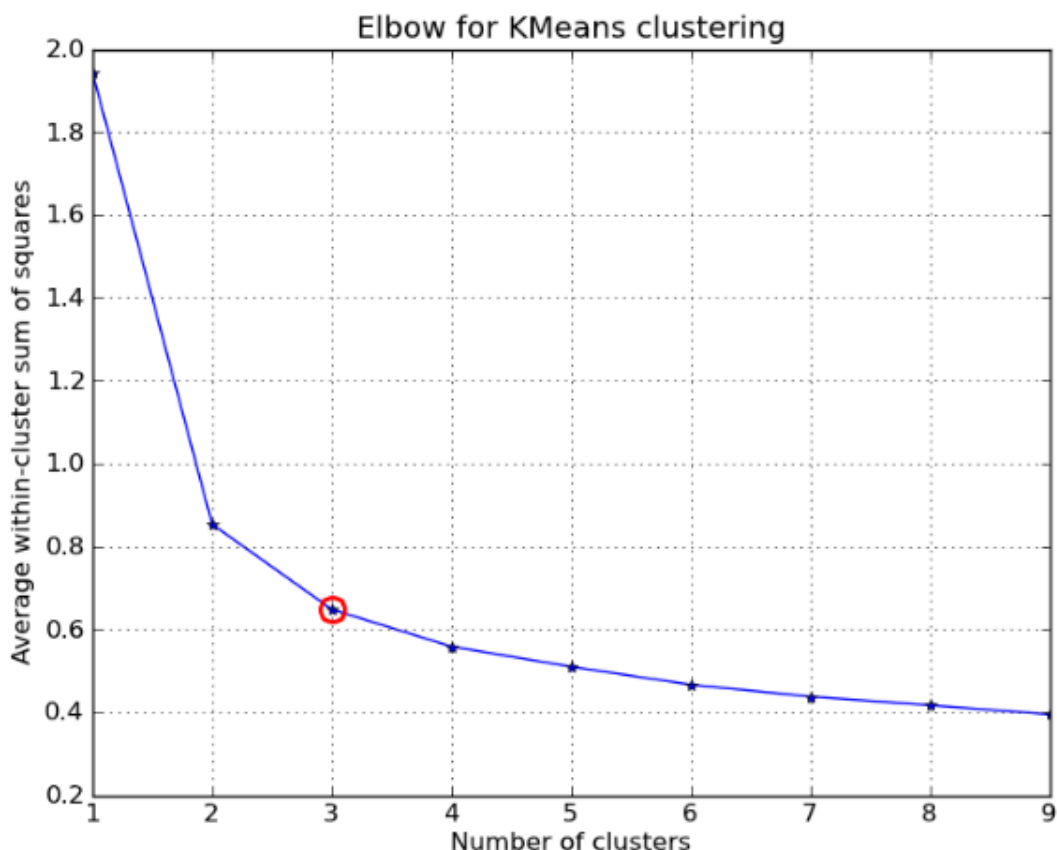
Profiling Segments

Profiling Segments , particularly important when data-driven market segmentation is used. This step involves identifying and understanding the defining characteristics of each market segment.
Objective: The primary goal is to get to know the market segments derived from the data analysis. This includes understanding both individual segment characteristics and how these segments compare to one another.

Describing Segments

Describing Segments is the seventh step, where additional information about the segments is used to develop a complete picture of each segment.
Objective: The goal is to describe the market segments using information not used during the segmentation process. This includes demographic, psychographic, socio-economic variables, media exposure, and specific product or brand attitudes.

Psychographics

This segmentation focuses on a consumer's lifestyle, personality, values, interests, and opinions. It helps companies understand what motivates customers, what they aspire to, and how they perceive themselves. In case of EVs Visual Appeal, Comfort and Value for Money are some of the factors which attracts customer

Customer Rating Distribution

Value for Money Rating Distribution

Visual Appeal Rating Distribution

Comfort Rating Distribution

Count vs Rating of Value for Money, Comfort, and Visual Appeal
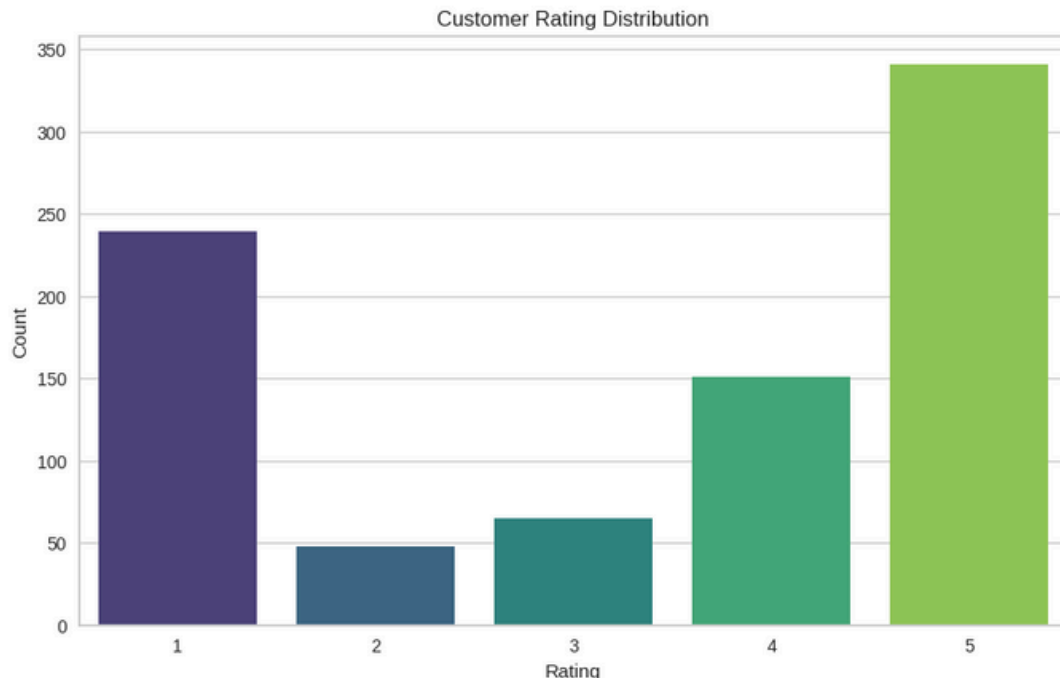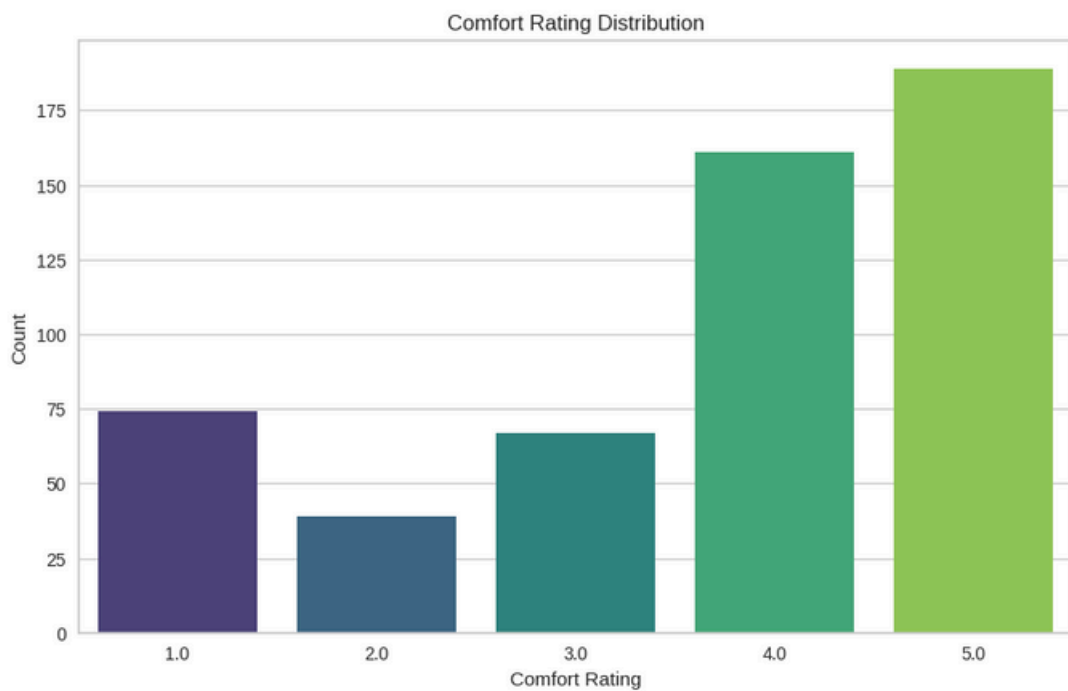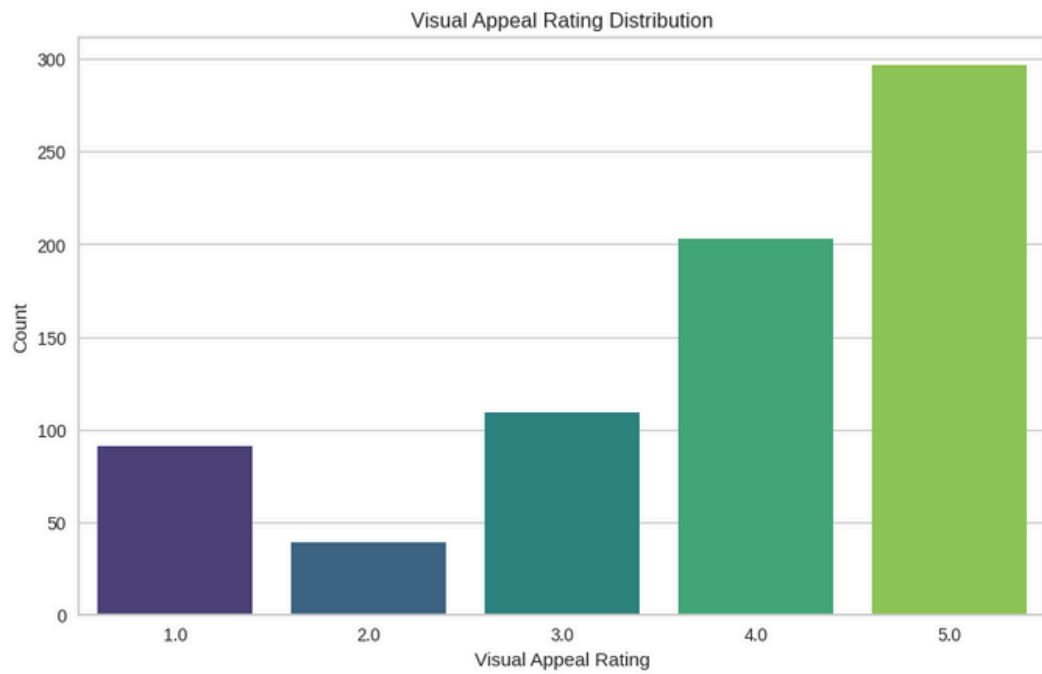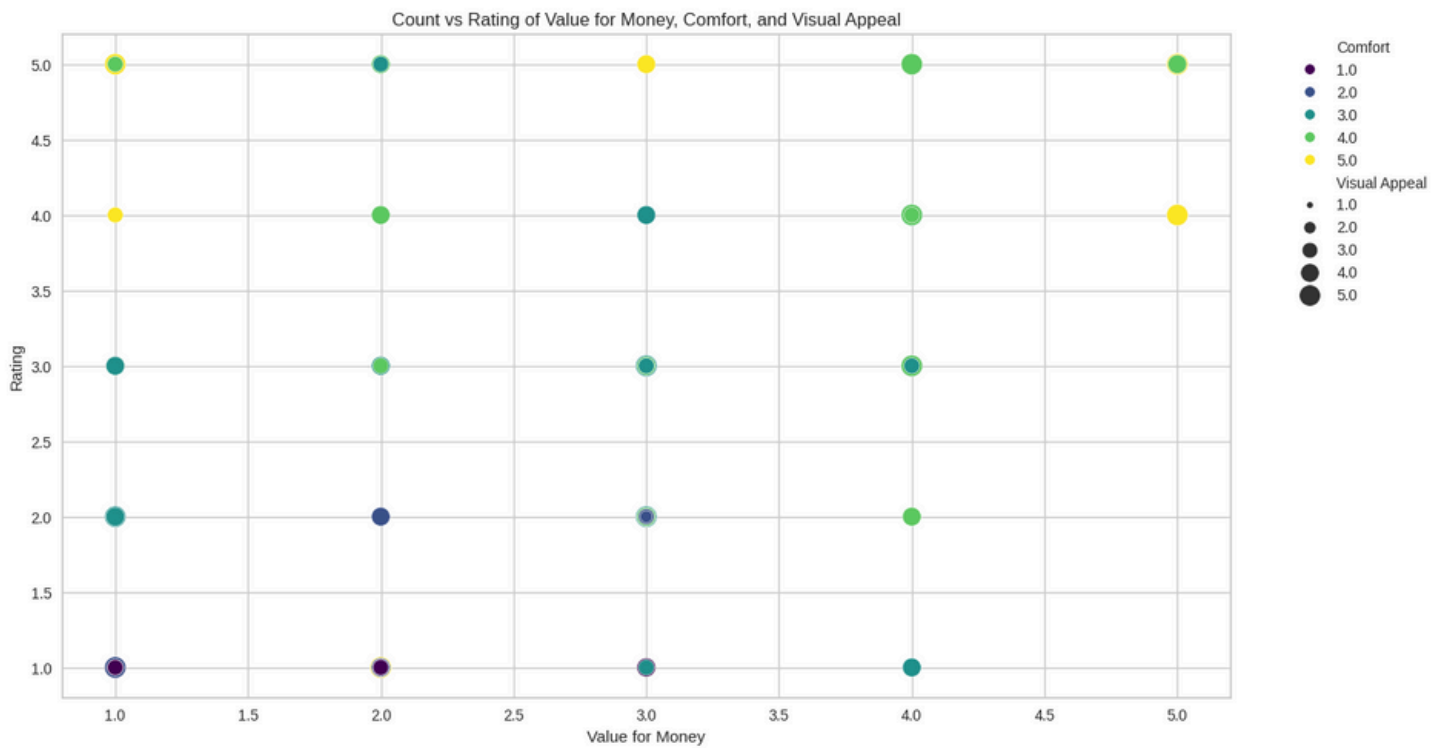
	Value for Money	Visual Appeal	Comfort	rating
Value for Money	1.00	0.74	0.78	0.87
Visual Appeal	0.74	1.00	0.79	0.77
Comfort	0.78	0.79	1.00	0.83
rating	0.87	0.77	0.83	1.00

Major Psychographic Factor

The heatmap shows the correlations between different factors and the overall rating. The key insights are:

- Value for Money: Highest correlation with the overall rating (0.87), indicating it is the most critical psychographic factor influencing user ratings.
- Comfort: Also strongly correlated with the rating (0.83), suggesting that comfort is a significant factor in user satisfaction.
- Visual Appeal: Moderate correlation with the rating (0.77), indicating it is important but less so than value for money and comfort.

Thus, **value for money** is the major psychographic factor affecting overall ratings, **followed by comfort and visual appeal**.
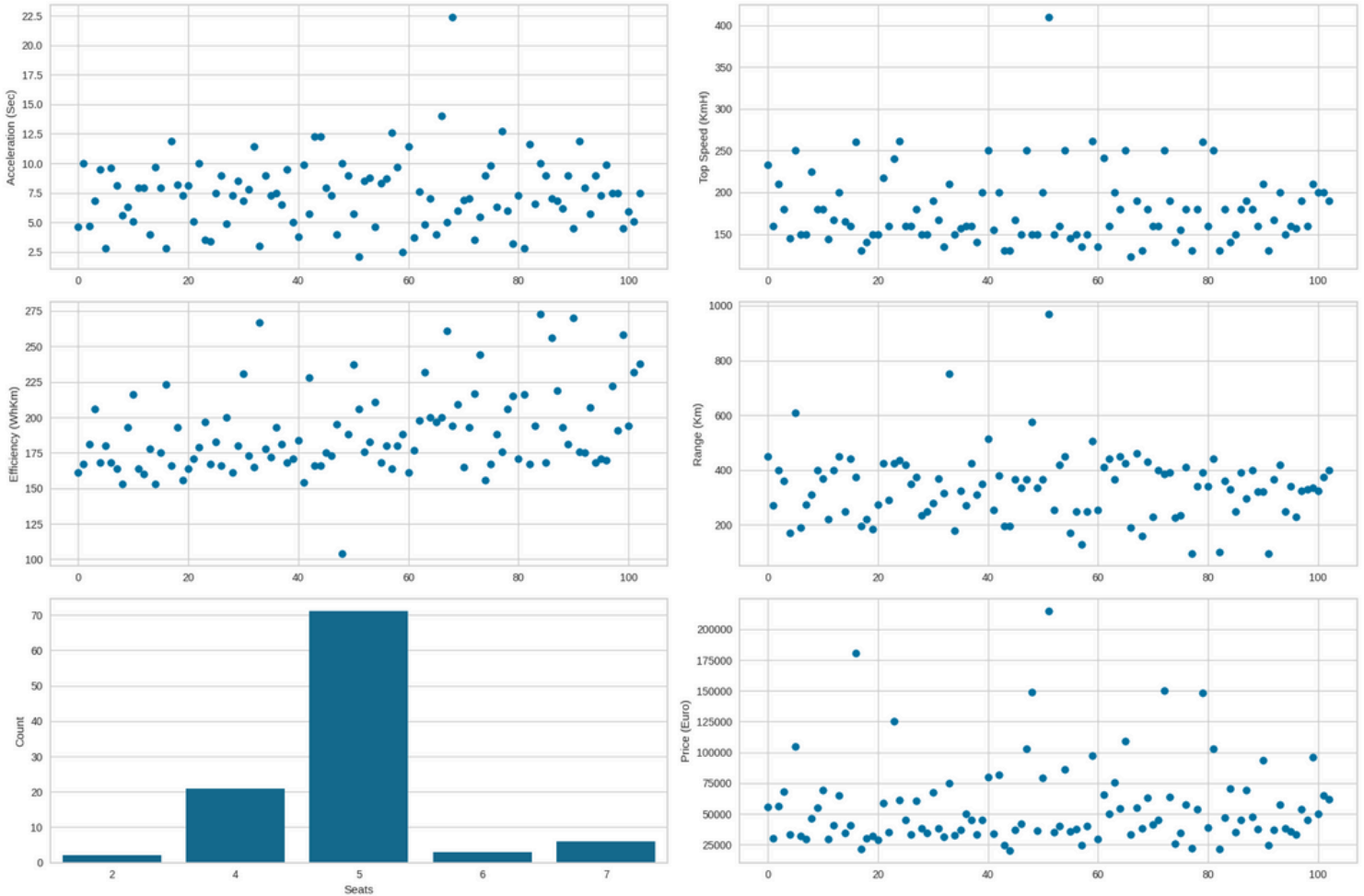
Major Behavioral Factors
1. **Acceleration:**
   - Performance-oriented users prefer lower times.
   - Family vehicles may have higher times but other benefits.
2. **Top Speed:**
   - Appeals to performance enthusiasts.
   - Less relevant for regular users compared to range and efficiency.
3. **Efficiency:**
   - Lower Wh/km indicates better economy and environmental impact.
4. **Range:**
   - Longer range reduces recharging frequency, crucial for long-distance travel.
5. **Seats:**
   - Impacts vehicle suitability (e.g., family vs. sports cars).
   - Predominance of 5-seaters suggests a family-oriented market.
6. **Price:**
   - Major factor influencing affordability.
   - Wide range caters to different budget segments.

Conclusion

The data shows a diverse vehicle market with varying performance, efficiency, range, seating capacity, and price. Most vehicles are family-oriented with 5 seats. Efficiency and price are key factors for most buyers, while performance metrics like acceleration and top speed cater to niche segments.

Geographics

This segmentation divides the market based on geographic location, such as country, region, state, city, or even zip code. Geographic segmentation can be particularly useful when consumer preferences and needs vary depending on location.
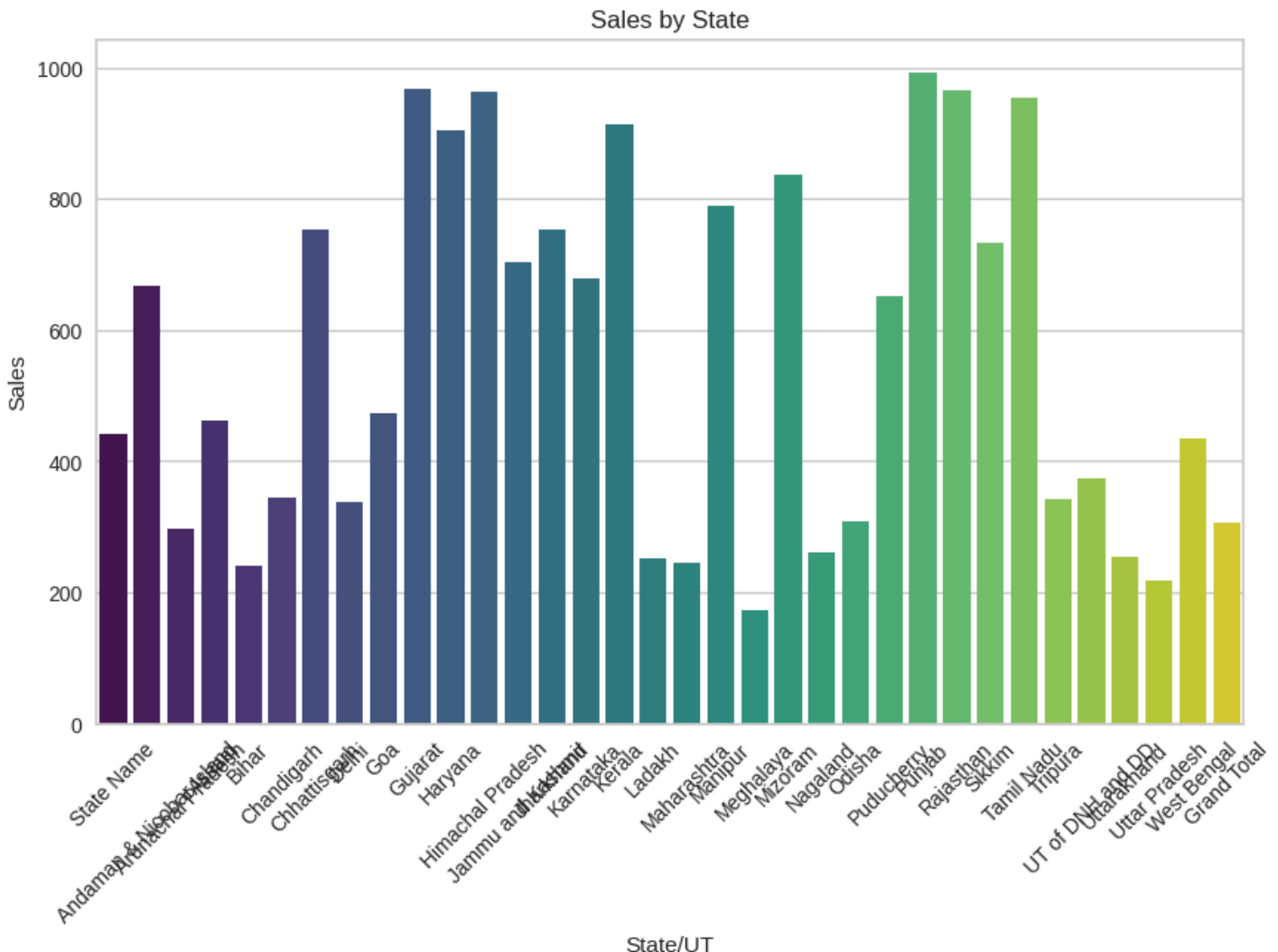
Sales by State

The bar chart shows sales by state, with significant variation across regions. Key points include:

- Top Performers: States like Gujarat, Maharashtra, Rajasthan, and Tamil Nadu have the highest sales, approaching or exceeding 900 units.
- Moderate Performers: States like Haryana, Karnataka, and Uttar Pradesh show moderate sales, around 600 units.
- Low Performers: States like Arunachal Pradesh, Sikkim, and Meghalaya have the lowest sales, around 200 units.

Overall, there is a clear disparity in sales distribution among states, indicating regional preferences or market penetration levels.

Target Segments

The target segment for electric vehicles (EVs) primarily includes family-oriented users seeking 5-seater vehicles. These consumers are cost-conscious, prioritizing value for money and efficiency, while also placing high importance on comfort for a pleasant driving experience. The market strategy should cater to a broad range of price points to appeal to both budget-conscious buyers and those looking for premium options. Additionally, geographically targeted marketing efforts should focus on high-sales regions while simultaneously working to expand reach in underperforming areas. This comprehensive approach ensures the EV offerings align with the needs and preferences of the target audience, driving higher adoption rates and customer satisfaction.

Market Mix

To effectively tailor the marketing mix for electric vehicles (EVs) to suit the identified target segments, adjustments across the 4Ps—Product, Price, Place, and Promotion— are essential. Here's a detailed plan for customizing the marketing mix:

1. **Product**
Adjustments:
- Features:
    - Emphasize family-friendly features like spacious interiors, advanced safety systems, and convenience features (e.g., ample cargo space, child seat anchors).
    - Include technology that enhances efficiency and range, such as regenerative braking and energy-saving driving modes.
- Quality:
    - Ensure high build quality and reliability to boost consumer confidence and perceived value for money.

- Branding:Position the brand as eco-friendly, innovative, and family-oriented.Highlight the cost savings associated with EV ownership (e.g., lower fuel and maintenance costs).
- Packaging:Offer various trim levels to cater to different budget ranges, from basic to premium. Provide attractive financing options and extended warranties.

2. **Price**
Strategies:
- Pricing Tiers: Introduce a range of models with different price points to appeal to both budget-conscious consumers and those seeking premium features.
- Value-Based Pricing:
  - Price the vehicles based on the perceived value, emphasizing long-term savings on fuel and maintenance.
- Incentives and Discounts:
  - Offer government rebates, tax credits, and manufacturer discounts to make EVs more affordable.
- Flexible Payment Plans:
  - Provide flexible financing options, such as low-interest loans and leasing plans, to lower the barrier to entry for consumers.

3. **Place**
Distribution Channels:
- Dealerships:
  - Establish a strong presence in high-sales regions like Gujarat, Maharashtra, Rajasthan, and Tamil Nadu.
  - Ensure that dealerships in these areas are equipped with knowledgeable staff and charging infrastructure.
- Online Sales:
  - Enhance online sales platforms to provide a seamless buying experience, including virtual tours, online financing, and home delivery options.
- Partnerships:
  - Partner with retail chains, malls, and tech stores to set up pop-up showrooms and charging stations.
- Service Networks:
  - Develop an extensive network of authorized service centers to assure customers of reliable after-sales support.

4. **Promotion**
Promotional Activities:
- Advertising:
  - Use a mix of traditional and digital media to reach the target audience, with a focus on family-friendly channels and eco-conscious platforms.
  - Highlight key benefits like cost savings, environmental impact, and advanced safety features.
- Sales Promotions:Run time-limited promotions and incentives, such as free home charging stations with each purchase or trade-in bonuses for old vehicles.

- Personal Selling:
  - Train sales teams to provide personalized consultations and test drives, emphasizing the practical benefits of EV ownership.
- Public Relations:
  - Engage in community outreach programs, sponsor local events, and collaborate with environmental organizations to build a positive brand image.
  - Use social media influencers and eco-advocates to promote the brand and its values.

Summary

By customizing the marketing mix—adjusting product features, adopting strategic pricing, optimizing distribution channels, and tailoring promotional activities—EV manufacturers can effectively meet the specific needs and preferences of their target segments. This ensures a compelling value proposition that resonates with consumers, driving higher adoption and satisfaction rates in the market.

Conclusion

The electric vehicle (EV) industry in India is poised for significant growth in the coming years, driven by increasing demand, investment, and supportive policies. Despite setbacks from the COVID-19 pandemic, the industry is expected to take a substantial leap forward. Here are some key insights and strategic recommendations for companies entering or expanding in the Indian EV market:

Key Insights

- **Post-Pandemic Growth:** The electric vehicle industry has faced challenges due to the COVID-19 outbreak but is set for a remarkable recovery. With the gradual normalization of economic activities and increasing environmental awareness, the demand for EVs is expected to surge.
- **Environmental Impact**: The adoption of EVs will be transformative, offering benefits such as reduced air and noise pollution, decreased reliance on fossil fuels, and significant contributions to India's sustainability goals.
- **Local Manufacturing and Partnerships**: Companies should consider establishing local operations in India through partnerships with domestic firms or by setting up their own manufacturing and development units. This approach can be complemented by importing specific components to balance cost and quality.
- **Growing Market Segments:** There is substantial growth potential in the commercial fleet market, particularly for two-wheelers and three-wheelers, which are ideal for last-mile delivery and urban freight services. Opportunities also exist across the supply chain, including battery production, EV components, and charging infrastructure.

- **Metro City Focus**: Initial business operations should target metro cities, which offer higher demand and better infrastructure for EVs. Once established, companies can expand to other cities within the same states, leveraging insights gained from metro operations and a well-established supply chain network.
- **Investment in Infrastructure**: Significant investment in charging infrastructure is crucial for widespread EV adoption. Companies should collaborate with government initiatives and private enterprises to develop a robust network of charging stations.

- **Government Incentives and Policies:** The Indian government is actively promoting EV adoption through incentives and supportive policies. Companies should stay informed about these policies and leverage them to optimize operations and reduce costs.
- **Training and Workforce Development:** Investing in the training and development of a skilled workforce is essential for the growth of the EV sector. Companies should focus on building expertise in manufacturing, maintenance, and operation of EVs to ensure long-term success.
- **Innovation and Technology**: Continuous innovation in battery technology, energy efficiency, and vehicle design will be key differentiators in the competitive EV market. Companies should invest in R&D to stay ahead of the curve and meet evolving consumer preferences.
- **Sustainability and Corporate Responsibility:** Emphasizing sustainability and corporate social responsibility can enhance brand reputation and consumer trust. Companies should adopt environmentally friendly practices across their operations and engage in community initiatives.

- **Awareness** of the benefits of electric vehicles (EVs) and strategic government promotions can greatly boost their adoption in India. Effective campaigns at airports, bus stations, cinemas, government offices, and public spaces, coupled with print and digital media, can raise awareness. Key consumer benefits include reduced emissions of air pollutants and greenhouse gases, making EVs environmentally friendly. They offer lower running costs than traditional vehicles due to cheaper electricity, making them economical. EVs are perfect for urban areas due to reduced pollution and noise, providing smooth, gearless acceleration and minimal noise except from tires. With a proven global track record, EVs are an ideal choice for modern transportation.

Embrace Change
Drive Electric