Market Segmentation Analysis of Electric Vehicles Market in India

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in partial fulfillment
of Two Month Internship
in
FeyNN Labs: AI for Small Businesses

Code 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 this report, I have analyzed the Electric Vehicles Market in India using segments such as price, wheels, type of vehicles, speed, manufacturers, body type (e.g., Hatchback, Sedan, SUVetc.), plug types, age of customers, income of customers, and much more.

Estimated Market Size

Estimate the number of electric vehicles that will be sold in India in the year 2023.

Taking the top-down approach to our problem

Considering India's population of ~140 cr

Urban to Rural ratio is 70:30 which makes 28 cr Urban

Most rural people do not require vehicles for transport, or majorly they prefer cycles hence dropping their count by 30%.

Breaking the different classes

Poor Class: 30% -> 8.4 cr -> no electric vehicles

Middle Class: 50% -> 14 cr -> 30% buys (either 4-wheeler / 2 wheeler)

Rich Class: 20% -> 5.6 cr -> assuming buys both (4-wheeler as well as 2- wheeler)

Next, calculating households, most families are nuclear nowadays so we can take 3 – 4 people in a family

Households Middle class

14 cr/4 = 3.5*0.3 = 1.05 cr buys — in middle class

Households Rich class

5.6cr/4 = 1.4 cr buys — in rich class

Total: 1.05 cr + 1.4 cr ~ 2 cr total 4 wheeler + 2 wheeler are likely to be sold in India.

(Note: Estimation can include several other factors like GDP of automobile industry, employment rate etc, but here I have used one simple estimation.)

Data Collection

The data used in this project encompassed two distinct datasets: market segmentation, customer segmentation. Each dataset was essential in providing insights and performing analysis.

- Dataset_1
- Dataset_2

ML Techniques Used for Segmentation

In the preprocessing step of this project, I used several data cleaning and transformation techniques to prepare the data for further analysis. The specific preprocessing steps I undertook include:

• Data Cleaning: I addressed any missing or inconsistent data values in the dataset. This involved identifying missing values and deciding on appropriate strategies for handling them, such as imputation or removal. Additionally, I resolved any inconsistencies or errors in the data entries to ensure data integrity.

• Data Type Conversion: As part of the preprocessing, I converted object type variables to float-type variables when necessary. This conversion was necessary for numerical computations and modeling purposes.

• Label Encoding: I utilized Label encoding to transform categorical variables into a numerical format by assigning a unique integer to each category. It transforms categorical labels into a sequence of integers, making it possible to use these variables in machine learning algorithms that require numerical inputs.

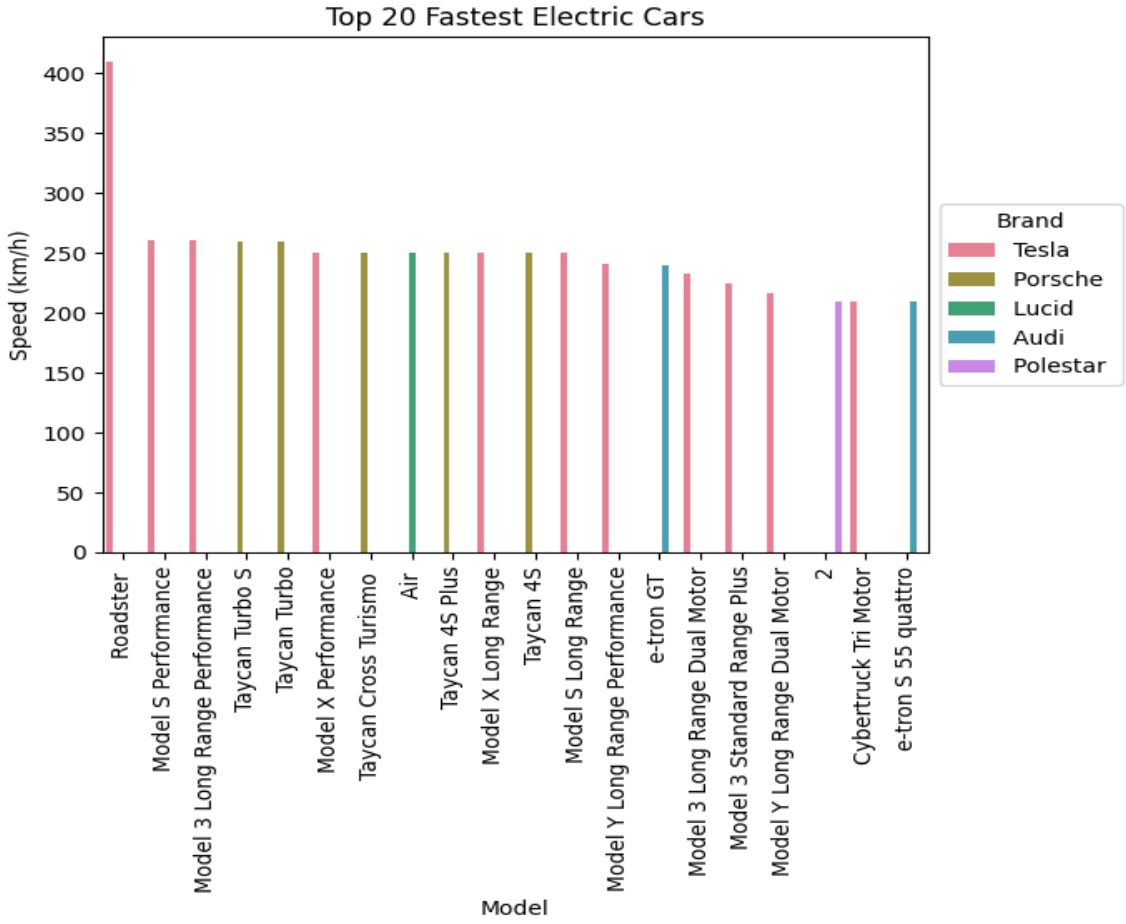
• Scaling: To normalize the numerical variables and bring them to a similar scale, we applied a robust scaler. The robust scaler technique, such as the RobustScaler from scikit-learn, is resilient to outliers and provides robust scaling of the data, making it suitable for handling data with varying scales and potential outliers.

By performing these preprocessing steps, I aimed to ensure data quality, address data inconsistencies, convert variables to appropriate types, handle categorical variables, and normalize numerical data. This prepared the dataset for subsequent analysis, modeling, and interpretation, providing a solid foundation for extracting meaningful insights from the data.

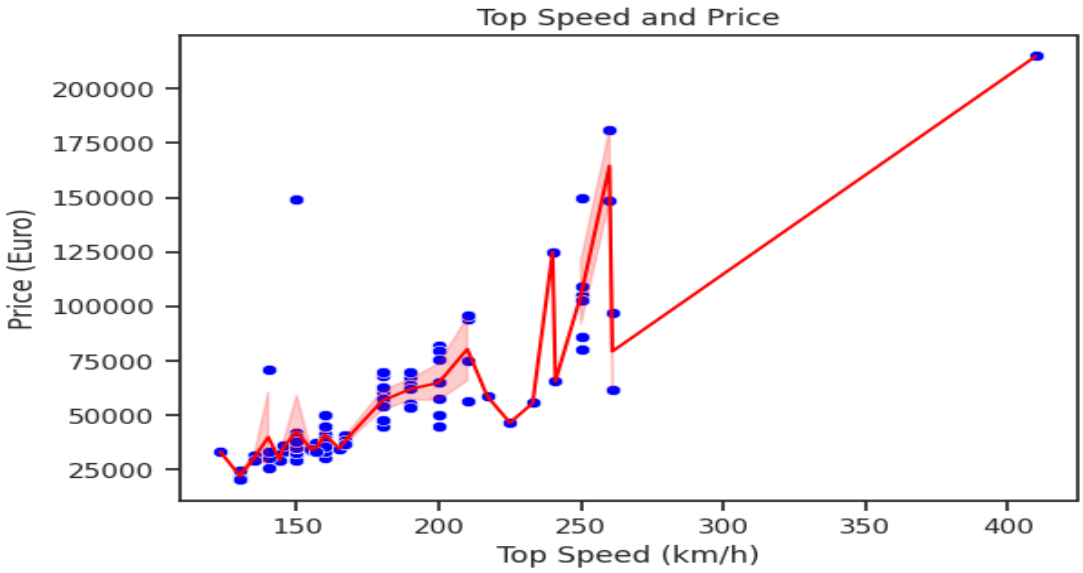
Visualizing Market Segmentation Data

The technique of clearly and meaningfully visualizing market segmentation data is known as visualization. To depict the traits, and behavior of various market segments, charts, graphs, and other visual components are used.

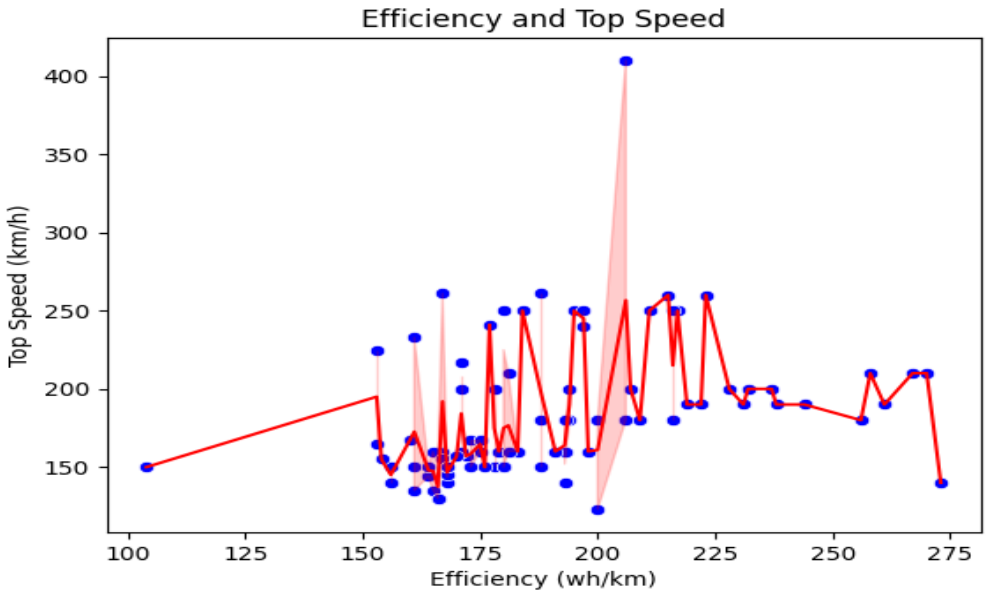
In the global market, speed is a crucial feature for electric vehicles (EVs). The availability of fast and exhilarating experiences in EVs can attract speed enthusiasts, encouraging their transition towards electric mobility.



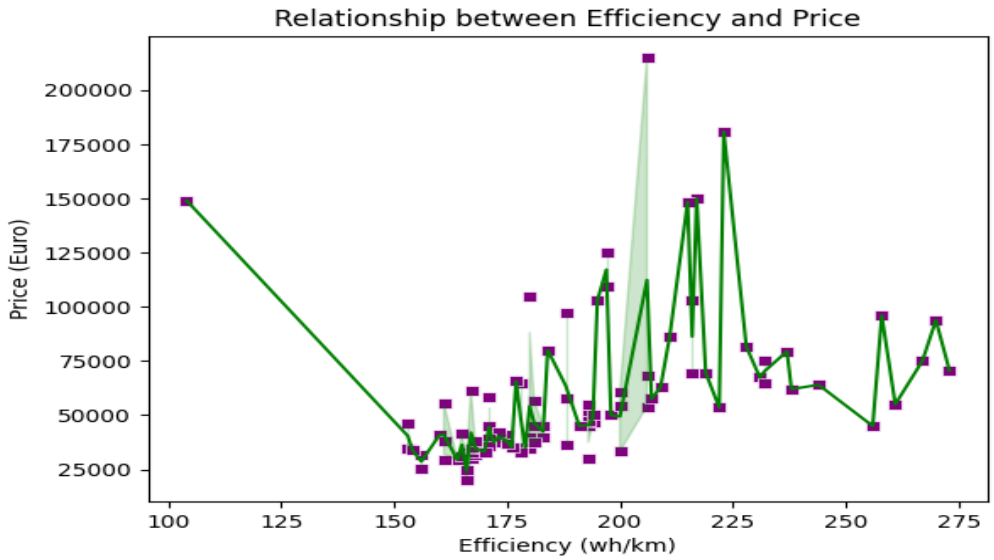
There is often a relationship between top speed and price in electric vehicles (EVs). Higher-priced EV models tend to offer greater top speeds, reflecting advancements in technology and performance capabilities. However, it's important to note that other factors, such as battery capacity and powertrain configuration, also influence top speed, making it a multi-dimensional consideration in the overall EV pricing and performance equation.



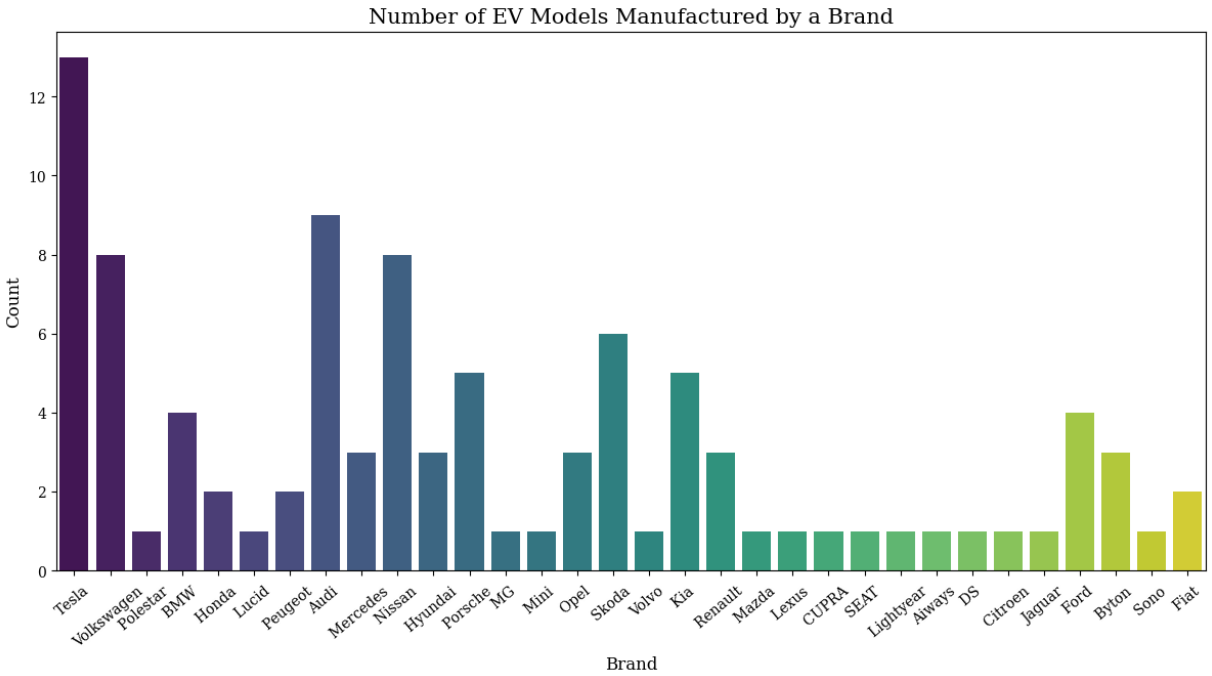
At higher top speeds, a car's economy is often reduced because of increased air resistance and the need for more power to overcome it. As a result, fuel consumption generally increases, resulting in decreased overall efficiency. The trade-off can be mitigated, though, by improvements in engine technology, aerodynamics, and lightweight materials, allowing for increased efficiency even at higher speeds. In order to maximize peak speed and fuel efficiency in modern cars, it is essential to balance aerodynamic design, engine efficiency, and vehicle weight.



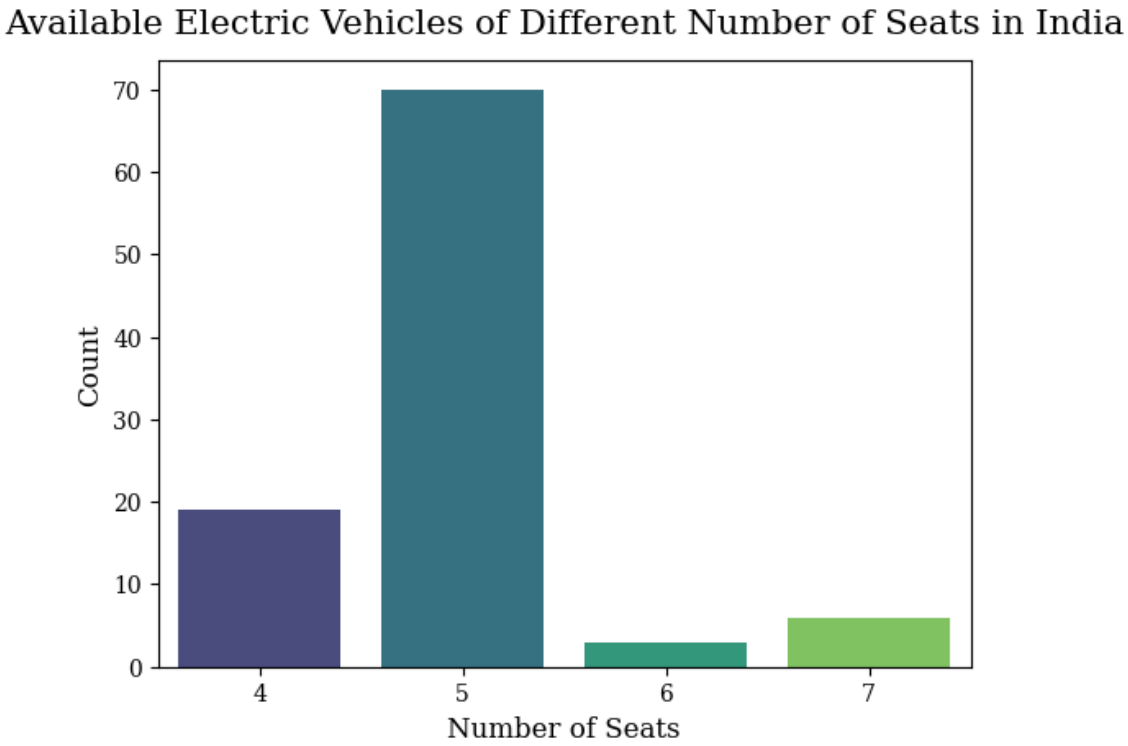
Price and efficiency of a product, like an automobile, are frequently correlated. Due to the use of cutting-edge technologies and materials, more efficient vehicles typically cost more.



Following plot shows number of EV models manufactured by different brands.



EVs with 5 sitters dominate the market while EVs with 6 sitters are less in number.



Employing K-Means Clustering model for Market Segmentation

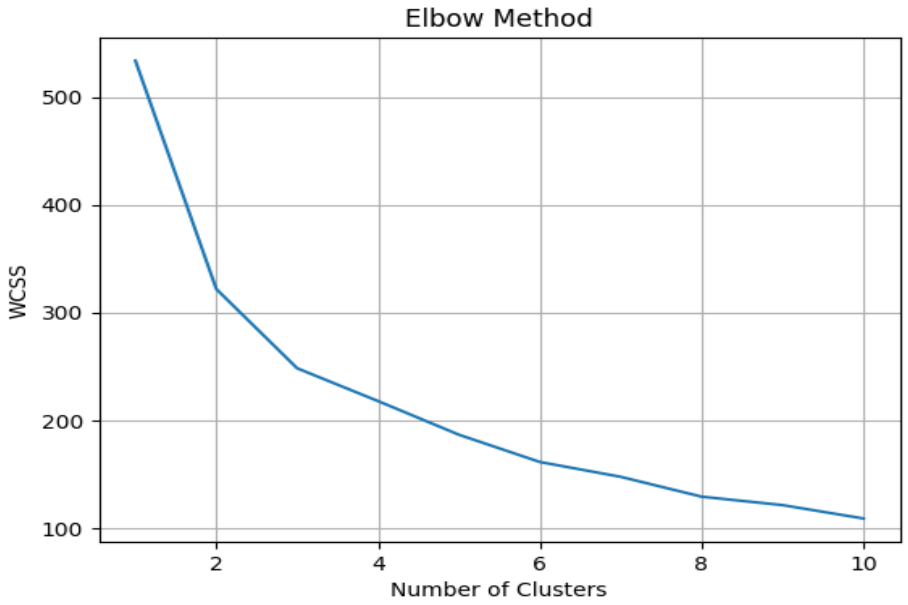
K-means clustering was employed to partition a dataset into K clusters by analyzing data attributes. This method is particularly useful in delineating distinct customer segments within a broader customer base, commonly known as market segmentation.

Using Principal Component Analysis (PCA), nine essential features were extracted from the dataset. PCA effectively captured dataset's variance, enabling a concise representation while retaining critical information.

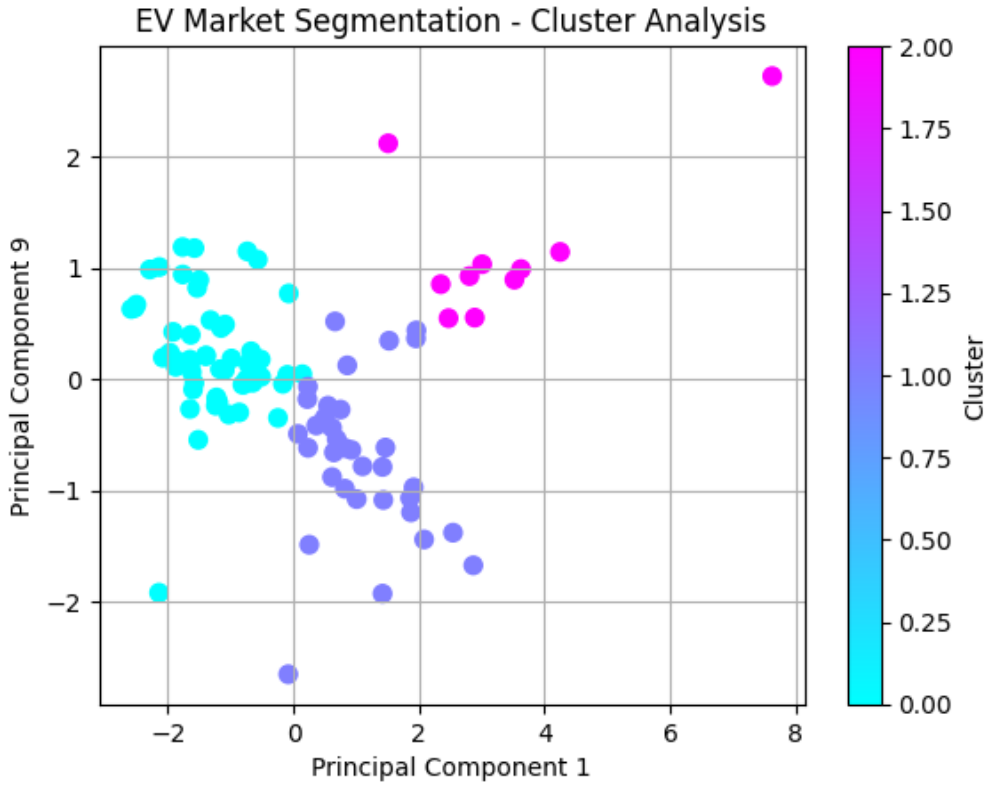
To determine the optimal number of clusters for K-means, the elbow method assessed the within-cluster sum of squares (WCSS). WCSS measures the distance between data points and their assigned cluster centroids, aiding in identifying the most suitable number of clusters for effective segmentation.

Clustering :- It is a technique in unsupervised machine learning that aims to group similar data points together based on their inherent characteristics or patterns. It is used to identify natural groupings or clusters within a dataset without any predefined labels or target variables. The goal of clustering is to maximize the intra-cluster similarity (similarity within a cluster) and minimize the inter-cluster similarity (similarity between different clusters). This allows for the discovery of underlying structures or relationships

in the data that may not be immediately apparent.



Plotting the clusters in PCA space:



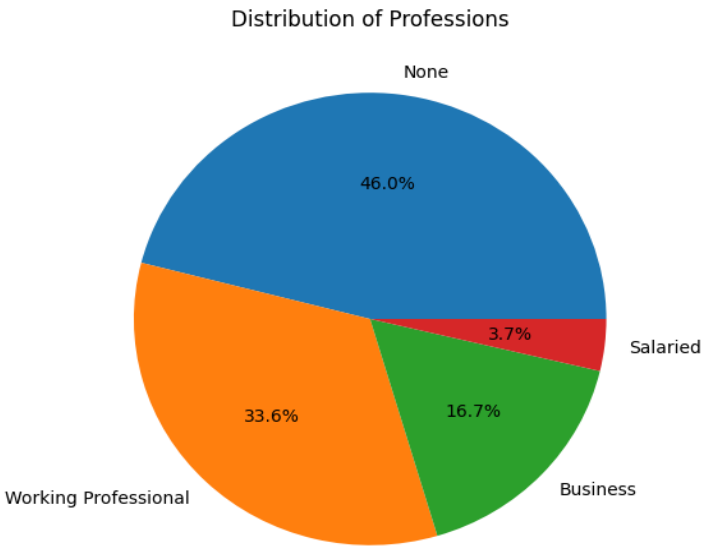
A comprehensive analysis of the clustering results assists EV manufacturers in setting target prices for their vehicles and producing EVs that best suit the market.

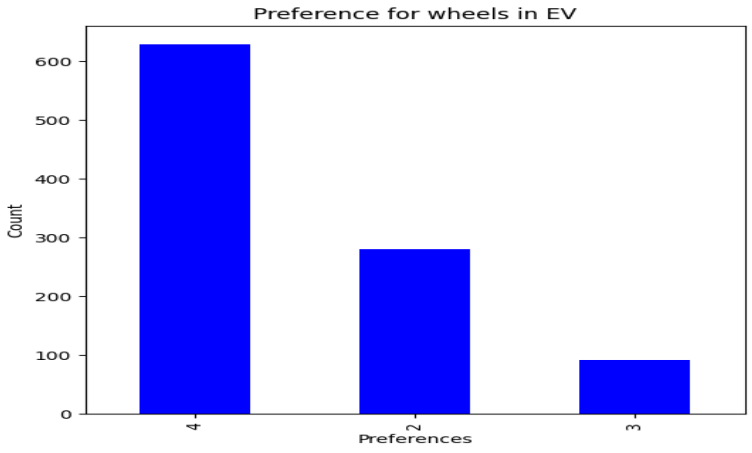
Customer Segmentation Analysis in the Indian Electric Vehicle Market

In order to understand consumer preferences, behavior, and purchase patterns, customer segmentation analysis is used in the Indian electric vehicle (EV) market. By identifying discrete market groups within the EV industry, this analysis makes it possible to develop focused marketing campaigns and unique product lines.

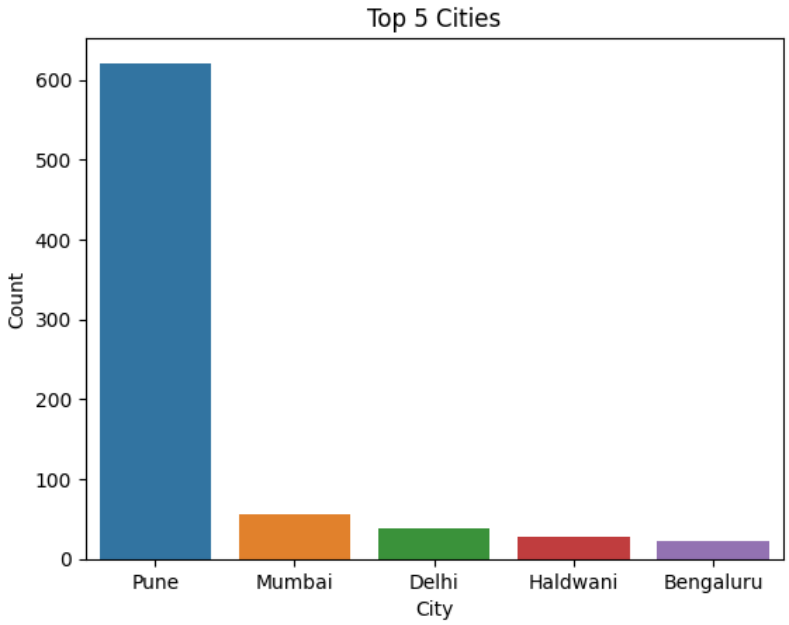
Determining the target market for electric cars (EVs) involves identifying the specific consumer segments most inclined to adopt and benefit from EV technology. This method supports EV manufacturers and marketers in focusing their endeavors on the most advantageous customer base.

The data presented in the following graph is collected from a survey conducted among various individuals, including businessmen, salaried persons, students, and working professionals who are the potential customers of EVs.

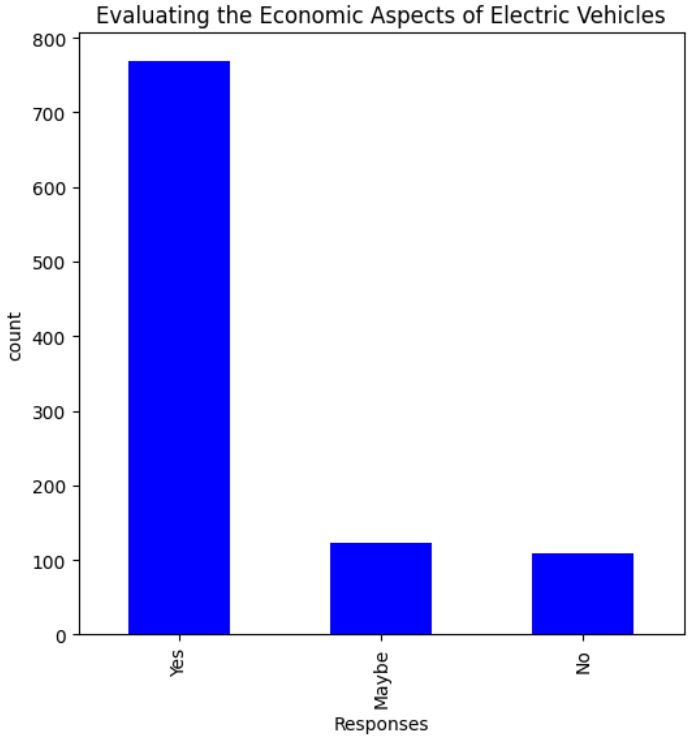




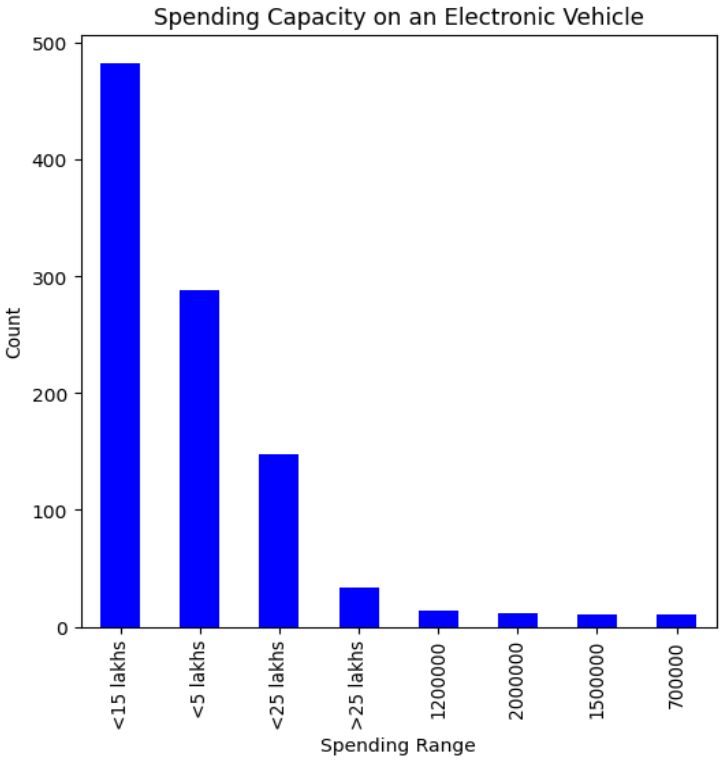
In India, among all the electric vehicles (EVs), four-wheelers are the most demanded, followed by two-wheelers which also have significant demand.



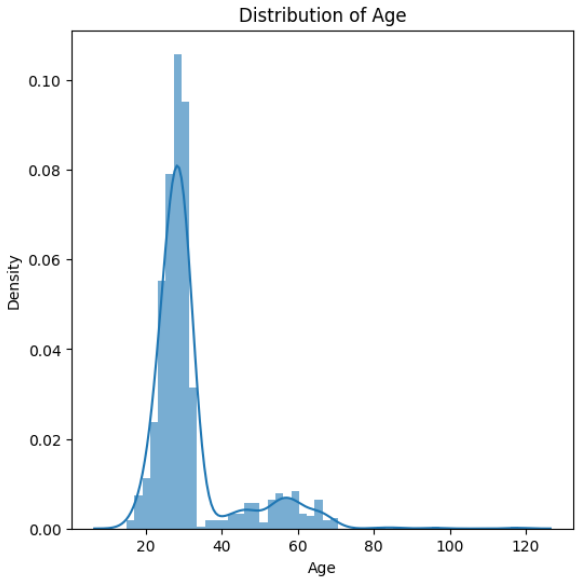
Above plot shows present electric vehicle based on demographics



This plot shows more number of people think that electric vehicles are economical.

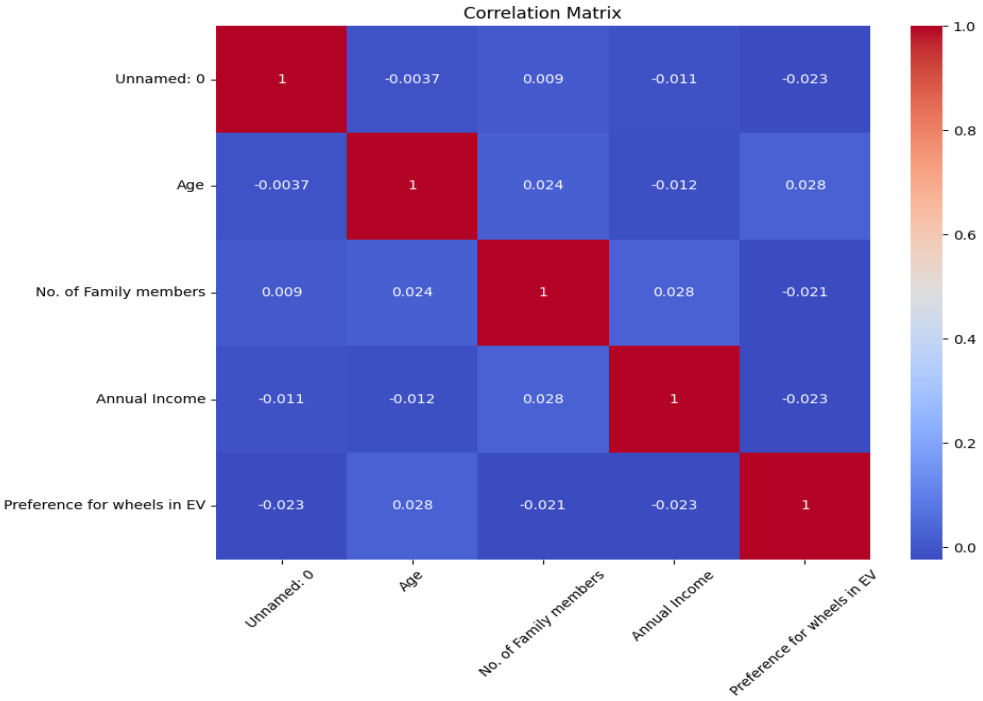


This plot shows that maximum number of people can spend less than 15 lakhs for EVs.

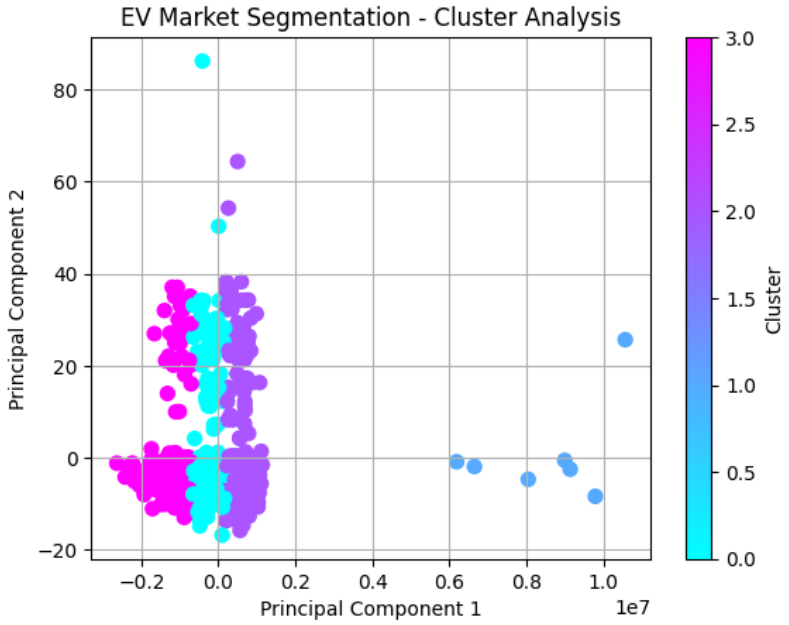


It shows that young Professionals aged between 20 and 35 show a heightened interest in EVs.

Correlations between Several features of customers are given by:



Principal Component Analysis (PCA) is utilized to decompose the data, and subsequently, applying the elbow method determines that the optimal number of clusters for k-means clustering is four.



Segment Extraction

1. EV Market Buying Behavior: -

Age-based Segmentation: Young Professionals aged between 20 and 35 show a heightened interest in EVs.

Income-based Segmentation: Maximum number of people can spend less than 15 lakhs for EVs.

Vehicle Preference: Hatchback and SUV body style EVs are predominant in the market.

Education-based: Individuals with advanced educational qualifications value sustainability and modern technology, indicating a heightened awareness of the benefits of EVs.

2) Comprehensive EV Analysis: -

Drive Type Segmentation: Front Wheel Drive and All Wheel Drive are more preferred

Seating Capacity Segmentation: 5-seater vehicles dominate the market.

Manufacturer-based Segmentation: Tesla dominates the market

Battery Capacity: There's a notable preference for vehicles with higher battery capacities.

Vehicle Speed: Vehicles with an average top speed (150-175 km/hr) are preferred.

Target Market for EVs:

Early Adopters: The initial target market for EVs consisted of environmentally conscious early adopters who were passionate about sustainable transportation. These individuals were willing to embrace new technology and support the transition to electric mobility.

Tech Enthusiasts: EVs appeal to technology enthusiasts who appreciate the advanced features and cutting-edge innovations found in electric vehicles. The integration of smart connectivity, advanced infotainment systems, and driver-assistance technologies in EVs attracts those interested in the intersection of technology and transportation.

Government and Institutional Buyers: Government and institutional buyers, such as government agencies and municipalities, frequently prioritize the adoption of sustainable transportation methods. Procuring electric vehicles for their fleets aligns with their dedication to reducing emissions and showcasing environmental stewardship. This commitment showcases their efforts towards sustainable practices and reinforces their environmental responsibility.

A comprehensive analysis of the clustering results assists EV manufacturers in deciding which customer segment to target first.

Conclusion and Key Insights

In summary, the electric vehicle (EV) market in India is undergoing substantial growth, offering extensive opportunities for stakeholders. Key findings from our analysis include:

- **Growing Adoption**: The steady rise in EV adoption in India is attributed to environmental awareness, strong government backing, and technological advancements. As awareness increases and infrastructure develops further, the market is poised for continued expansion.
- **Policy Backing**: Government initiatives, incentives, and policies significantly drive EV adoption. Sustaining the growth of the EV market necessitates ongoing support through subsidies, tax benefits, and infrastructure enhancements.
- **Environmental Awareness**: Numerous consumers interested in EVs prioritize environmental sustainability due to the absence of tailpipe emissions, significantly reducing air pollution and greenhouse gas emissions. This attribute resonates with individuals striving to minimize their carbon footprint and contribute to a cleaner, eco-friendly future.
-**Infrastructure Advancements**: The expansion and improvement of charging infrastructure play a pivotal role in alleviating range anxiety and fostering widespread EV adoption. Investments in charging stations, fast-charging technology, and standardized networks will expedite market expansion.
- **Government Support**: Several governments offer incentives, such as tax credits, rebates, and grants, to encourage EV adoption. These incentives mitigate initial purchase costs, making EVs more financially appealing to potential buyers.
- **Collaboration and Partnerships**: Collaborative efforts among manufacturers, governments, utility companies, and infrastructure providers are indispensable for EV market growth. Joint endeavors in research, development, and infrastructure expansion will accelerate the transition to electric mobility.

Utilizing these insights empowers stakeholders to seize the opportunities within the Indian EV market. Sustained innovation, supportive policies, infrastructure advancements, and collaborative efforts will pave the way for a sustainable and electrified future in India's transportation sector.

Improvement of the Market Segmentation:
To improve the Market Segmentation Project for the electric vehicle market with additional time and budget for data procurement, consider the following strategies:

Dataset Collection:

1. Expand Data Sources: We can look for diverse data sources such as government databases, industry reports, consumer surveys, social media data.
2. Real-time Data: We can Invest in continuous data streams or real-time analytics to capture evolving market trends and consumer sentiments.
3. Additional Attributes: We can seek specific columns or attributes that could enhance segmentation, such as:

- Geographic Data: We can obtain location-based data to understand regional preferences or infrastructure disparities.

- Consumer Behavior Metrics: We can collect data on user preferences, buying patterns, charging habits, and driving behavior.

- Financial Data: Include data on purchasing power, affordability, and cost-related factors influencing EV adoption.

- Environmental Factors: Acquire information on environmental impact awareness, local policies, and sustainability indices.

Advanced Machine Learning Models:

1. Ensemble Methods: We can utilize ensemble techniques like Random Forests, Gradient Boosting, or AdaBoost to enhance prediction accuracy and robustness in segmentation.
2. Clustering Algorithms: We can explore beyond K-means, such as DBSCAN, Hierarchical Clustering, or Gaussian Mixture Models (GMM), to identify more complex cluster structures within the data.

3. Feature Engineering: We can invest time in feature engineering techniques to create more informative attributes that better capture the essence of market segments.

4. Predictive Analytics: We can apply predictive models like Regression, Time Series Analysis, or Survival Analysis to forecast market trends and future consumer behavior.

Top 4 Variables/features which can be used to create most optimal Market Segments for electric vehicle market:

Determining the most optimal variables/features for creating market segments in the electric vehicle (EV) market involves considering factors that significantly influence consumer behavior, preferences, and market dynamics. While the selection of features can vary based on specific objectives and available data, here are four essential variables that can contribute to creating optimal market segments for EVs:

1. Range/Autonomy: The driving range an electric vehicle can cover on a single charge is a critical factor influencing consumer choice. Segmentation based on range preferences can target different consumer segments, such as daily commuters seeking shorter ranges or long-distance travelers requiring higher ranges.

2. Charging Infrastructure: Access to and availability of charging stations significantly impact EV adoption. Segmentation based on the accessibility and convenience of charging infrastructure can identify segments interested in robust charging networks or those in regions with limited charging facilities.

3. Price/Total Cost of Ownership (TCO): The initial purchase price and overall cost of owning an EV, including maintenance and operational expenses, play a crucial role in consumer decisions. Segmentation by price sensitivity or TCO preferences can target various consumer groups with different affordability levels.

4. Vehicle Type/Segment: Different types of electric vehicles (e.g., sedans, SUVs, hatchbacks, luxury cars) cater to diverse consumer preferences. Segmentation based on vehicle types or segments can address specific market niches and preferences, targeting consumers with distinct lifestyle choices and needs.

These variables provide essential insights into consumer behavior, priorities, and requirements when considering electric vehicles. However, other factors like brand preferences, environmental concerns, incentives, performance specifications, and technological advancements can also be influential and may be considered for a more comprehensive segmentation strategy. The optimal selection of variables depends on the specific objectives of the market segmentation analysis and the availability of relevant data.