ELECTRIC VEHICLE MARKET SEGEMNTATION IN INDIA

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GitHub Link: https://github.com/ananthnani/EV_MARKET_Segmentation.git

Abstract

Market segmentation becomes a crucial tool for evolving transportation technology such as electric vehicles (EVs) in emerging markets to explore and implement for ex- tensive adoption. EVs adoption is expected to grow phenomenally in near future as low emission and low operating cost vehicle, and thus, it drives a considerable amount of forthcoming academic research curiosity. The main aim of this study is to explore and identify distinct sets of potential buyer segments for EVs based on psychographic, behavioral, and socio-economic characterization by employing an integrated research framework of perceived benefits-attitude-intention'. The study applied robust analytical procedures including cluster analysis, multiple discriminant analysis and Chi-square test to operationalize and validate segments from the data collected of 563 respondents using a cross-sectional online survey. The findings posit that the three distinct sets of young consumer groups have been identified and labelled as 'Conservatives', 'Indiffer- ents', and "Enthusiasts' which are deemed to be buddying EV buyers The implications are recommended, which may offer some pertinent guidance for scholars and policy- makers to encourage EVs adoption in the backdrop of emerging sustainable transport market.

Introduction

The electric vehicle (EV) market in India is growing rapidly. In 2022, the market size was valued at USD 2.2 billion and is expected to reach USD 152.21 billion by 2030, growing at a CAGR of 94.4%. The growth of the EV market in India is being driven by a number of factors, including:

- Government incentives: The Indian government has introduced a number of incentives to promote the adoption of EVs, including tax breaks, subsidies, and exemptions from registration fees.
- Rising fuel prices: The rising cost of fuel is making EVs more attractive to consumers.
- Increasing environmental awareness: There is growing awareness among consumers about the environmental benefits of EVs.
- Improved technology: The technology of EVs has improved significantly in recent years, making them more affordable and efficient.

India's EV market is still emerging, but it's experiencing rapid growth. The two-wheeler segment currently leads the market, followed by the three-wheeler segment. The passenger car segment is also expanding quickly and is projected to become the largest segment by 2030.

The expansion of India's EV market is opening up new business opportunities, with rising demand for EV components like batteries, motors, and chargers. Additionally, demand is increasing for EV services, including charging infrastructure and fleet management. The government has set an ambitious target to electrify 30 percent of the country's vehicle fleet by 2030.

Here are some of the key trends that are shaping the EV market in India:

- Rapid Growth of the Two-Wheeler and Three-Wheeler Segments: These segments are anticipated to grow quickly in the coming years, as they represent the most affordable and accessible types of EVs.
- Rising Popularity of Passenger Cars: The passenger car segment is expanding rapidly as consumers become more aware of the environmental benefits of electric vehicles.
- Expansion of the Commercial Vehicle Segment: The commercial vehicle segment is also seeing strong growth, driven by businesses aiming to lower operating costs by transitioning to EVs.
- Advancements in Charging Infrastructure: The development of charging infrastructure is crucial for the EV market's expansion in India. The government is actively working to build this infrastructure, and private companies are also investing in its growth.
- Expansion of the EV Component Manufacturing Industry: The rapid growth of India's EV market is opening new opportunities for businesses involved in EV component manufacturing.

India's EV market is expanding swiftly and holds significant potential. The government is actively encouraging EV adoption, while the private sector is also making substantial investments in this area. This growth is creating opportunities for businesses across various sectors.

Problem Statement

An EV startup is developing electric vehicles (EVs) and is working to determine which vehicle and customer segments to target. While the Indian EV market is expanding rapidly, it remains in its early stages, with multiple segments, each having distinct characteristics. We need to analyze the market to identify the segments most likely to adopt EVs and devise an effective strategy to enter and compete within these segments.

The Indian EV market can be segmented based on the following criteria:

- Vehicle Type: The EV market can be divided into segments including two-wheelers, three-wheelers, passenger cars, and commercial vehicles. In India, two-wheelers are the most popular type of EV, followed by three-wheelers, while passenger cars and commercial vehicles are still in the early stages of development.

- Customer: The EV market can also be segmented based on customer type. Behavioral data about customers can be utilized for effective market segmentation.

Data Sources

To perform the market segmentation for the EV market we will analyze three datasets with the following sources:

- https://www.kaggle.com/datasets
- https://catalog.data.gov/dataset

Analysis of Charging Stations in India

The columns in the dataset are:

- name: The name of the charging station.
- state: The state where the charging station is located.
- city: The city where the charging station is located.
- address: The address of the charging station.
- lattitude: The latitude of the charging station.
- longitude: The longitude of the charging station.
- type: The type of charging station (slow, fast, or ultra-fast)

Data Preprocessing

The following data pre-processing steps using pandas library were done on the dataset:

1. The data had 205 duplicate entries which were dropped from the dataset.
2. Rows with missing values were removed.
3. A new variable charge_speed was created using the type variable.
4. There was some bad data in the latitude and longitude variables which were cleaned.
5. There were some duplicate and incorrect state and city names which were cleaned.

Insights from the Exploratory Data Analysis (EDA)

- The plot shows the distribution of charging stations in India by state. The state with the most number of charging stations is Maharashtra, followed by Delhi and Tamil Nadu.
- The plot shows the distribution of charging stations in India by city. The city with the most number of charging stations is New Delhi, followed by Bangalore , Chennai and Mumbai. We can see that the top 4 cities are metropolitan cities.
- Most of the charging stations in India provide slow charging for the EV. There are very few ultra-fast charging stations.

- Karnataka has the highest number of fast charging stations in india, followed by Haryana and Maharashtra. Bangalore has the highest number of fast charging stations.
- Tamil Nadu and Maharashtra has the highest number of ultra-fast charging stations in india followed by Telangana and Kerala. Hyderabad has the highest number of ultra-fast charging stations.

These findings indicate that the demand for electric vehicles is strongest in India's major metropolitan areas. The Indian government should prioritize the development of charging infrastructure in these regions to facilitate the growth of the electric vehicle market.

Analysis of EV Population Data

The dataset includes the following columns:

- VIN (1-10): The vehicle identification number (VIN) of the electric vehicle.
- County: The county where the electric vehicle is registered.
- City: The city where the electric vehicle is registered.
- State: The state where the electric vehicle is registered.
- ZIP Code: The ZIP code where the electric vehicle is registered.
- Model Year: The model year of the electric vehicle.
- Make: The make of the electric vehicle.
- Model: The model of the electric vehicle.
- Electric Vehicle Type: The type of electric vehicle, such as battery electric vehicle (BEV) or plug-in hybrid electric vehicle (PHEV).
- Clean Alternative Fuel Vehicle (CAFV) Eligibility: Whether the electric vehicle is eligible for Clean Alternative Fuel Vehicle (CAFV) incentives.
- Electric Range: The electric range of the electric vehicle in miles.
- Base MSRP: The base manufacturer's suggested retail price (MSRP) of the electric vehicle in US dollars.
- Legislative District: The legislative district where the electric vehicle is registered.
- DOL Vehicle ID: The vehicle identification number assigned by the Department of Licensing (DOL) of the state of Washington.
- Vehicle Location: The location of the electric vehicle, represented as a point in geographic coordinates.

Data Preprocessing

The following data pre-processing steps using pandas library were done on the dataset:

1. Rows with missing values were removed.

Insights from the Exploratory Data Analysis (EDA)

- The electric vehicle (EV) market in the United States has seen significant growth in recent years, with battery electric vehicles (BEVs) accounting for the majority of EVs sold.
- The number of EVs made in the US has increased exponentially over the past 13 years, with BEVs leading the way. PHEVs have also seen growth, but not as drastic as BEVs.
- Tesla is the leading manufacturer of EVs in the US, accounting for nearly half of all EVs sold since 1997.
- More than 60,000 EVs are eligible for clean alternative fuel (CAF) incentives, while another 60,000 have not yet been researched to determine eligibility.
- Most of the electric vehicles have an electric range that is clustered between 20 to 40 miles and 200 to 250 miles. PHEVs, in general, have a lower range than BEVs.

These findings indicate that the EV market in the US is expanding quickly, with battery electric vehicles (BEVs) at the forefront. Tesla remains the leading manufacturer of EVs in the country, and a considerable number of these vehicles qualify for CAF incentives. However, there is still insufficient data regarding the electric range of many EV models.

Analysis of Indian Automobile Buying Behaviour Data

The dataset includes the following columns:

- Age: The age of the buyer.
- Profession: The occupation of the buyer.
- Marital Status: The marital status of the buyer.
- Education: The highest level of education of the buyer.
- No of Dependents: The number of dependents of the buyer.
- Personal loan: Whether the buyer has a personal loan.
- House Loan: Whether the buyer has a house loan.
- Wife Working: Whether the wife of the buyer is working.
- Salary: The salary of the buyer.
- Wife Salary: The salary of the wife of the buyer.
- Total Salary: The combined salary of the buyer and wife.
- Make: The make of the automobile purchased.
- Price: The price of the automobile purchased.

Data Preprocessing

The following data pre-processing steps using pandas library were done on the dataset:

1. The Wife Working variable had one extra category with only one data point. This category was merged with the Yes category.

Insights from the Exploratory Data Analysis (EDA)

- The salary of the customers is grouped around 1000000 and 2500000 Indian rupees. This suggests that the majority of the customers in the dataset are from the upper-middle class or upper class.

- Wife's salary for most of the customers is zero. For those whose wife is working, the salary is between 500000 and 1500000 Indian rupees.

- The total household salary of the customer is between 1000000 and 3000000 Indian rupees. This suggests that the majority of the customers in the dataset have a comfortable financial situation.

- The price of the cars purchased by the customers range between 500000 and 2000000 Indian rupees. This suggests that the majority of the customers in the dataset have purchased mid-range cars.

- Around 65% of the customers are salaried while 35% have their own business. This suggests that the majority of the customers in the dataset are employed professionals.

- Most of the customers in the dataset are married. This suggests that the majority of the customers in the dataset are in a stable family situation.

- Around 55% of the customers hold a post-graduate degree while 35% have a graduate degree. This suggests that the majority of the customers in the dataset are well-educated.

- Most of the customers have 3 and 2 dependents. This suggests that the majority of the customers in the dataset have young families.

- Around 68% of the customers do not have a personal loan. This suggests that the majority of the customers in the dataset are able to afford the cars they have purchased without taking out a loan.

- Around 61% of the customers do not have a house loan. This suggests that the majority of the customers in the dataset are able to afford to buy a house without taking out a loan.

- Around 52% of the customer's wives are working. This suggests that the majority of the wives of the customers in the dataset are employed.

- Most customers have purchased SUVs and Baleno models, followed by the Creta, while only a small number have opted for luxury vehicles. This indicates that the majority of customers in the dataset are more interested in practical and fuel-efficient cars.

Market Segmentation

We will perform the EV Market Segmentation on the Indian Automobile Buying Behaviour dataset.

Data Preprocessing

The following data pre-processing steps using pandas and sklearn libraries were done on the segmentation dataset:

1. The categorical variables were one-hot encoded using the pd.get_dummies method.
2. The continuous variables were scaled using MinMaxScaler so that their values lie between 0 and 1.

K-Means Clustering

In this analysis, we employ the K-means clustering algorithm to segment car buyers into distinct groups. The K-means algorithm is a straightforward and efficient method for clustering data points into a predetermined number of groups.

The process involves iteratively assigning data points to the cluster with the nearest mean. The algorithm then recalculates the means of the clusters and repeats the assignment until the clusters stabilize.

K-means is effective in uncovering patterns in data that may not be immediately apparent. This algorithm successfully identified the similarities and differences among various clusters, enhancing our understanding of the different types of car buyers.

Elbow Plot

To determine optimum number of clusters, Elbow Plot can be used. In this plot, the number of clusters are on the X-axis and the corresponding within-cluster sum of squares (WSS) are on the Y-axis.
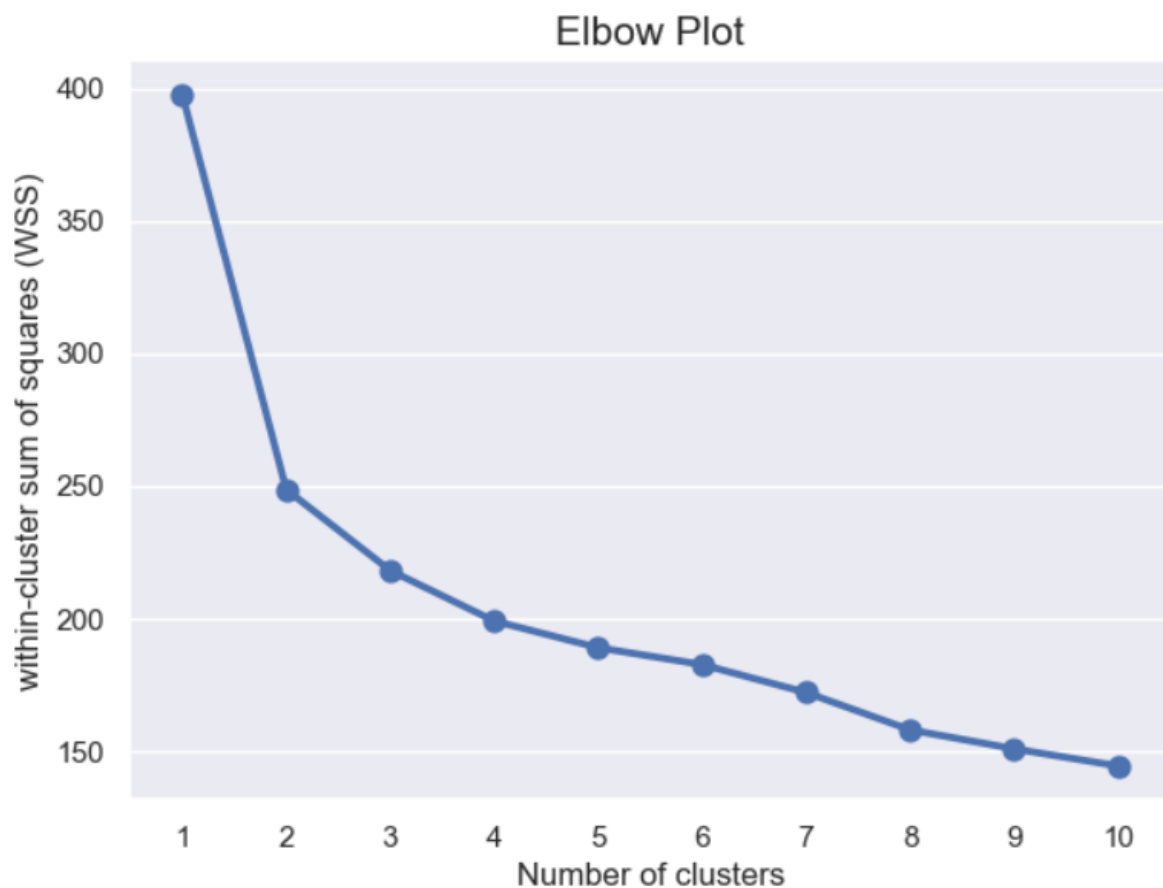

Figure – 1 Elbow Plot

From the above plot we see that, the drop in WSS for clusters 1 to 2 is very large. But, the drop from clusters 2 to 3 is not significant. After cluster 3 the curve gets flatter. Therefore, the plot suggests the optimal number of clusters as 2.

Silhouette Plot

The Silhouette method assesses how closely observations are clustered and the average distance between different clusters. For each observation, a silhouette score is calculated based on the average distance between that point and all other points in its own cluster, as well as the distance between that point and all points in other clusters to which it does not belong.
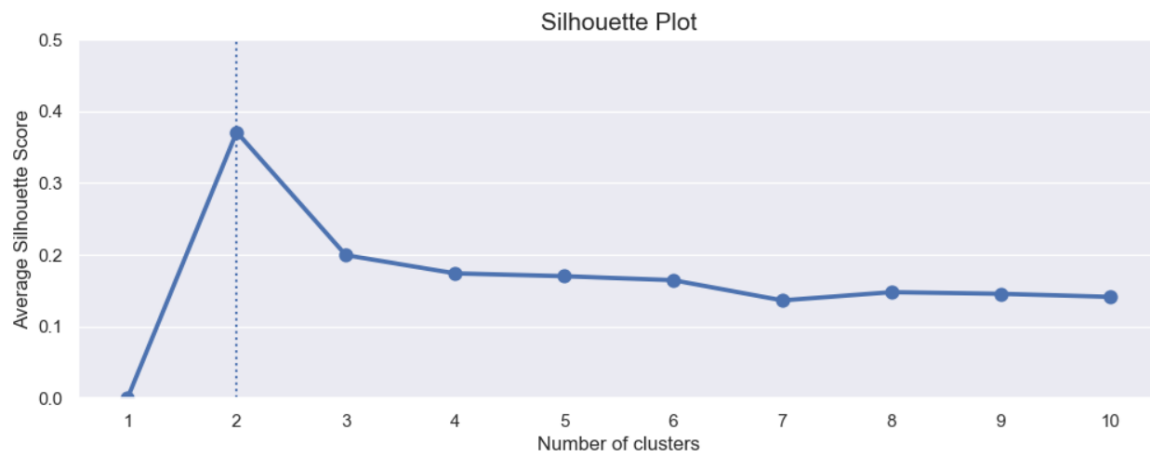
Figure-2 Silhouette Plot

From the above Silhouette Plot, we see that the silhouette score for 2 clusters is maximum. The Elbow method also suggested the optimal number of clusters as 2. Therefore, we choose optimal number of clusters as 2 and perform final segmentation using k equal to 2.

Visualizing the Clusters using PCA

To visualize the clusters, Principal Component Analysis (PCA) was employed to reduce the dimensionality to two dimensions. The scatter plot, which utilizes color coding based on the two cluster labels, is presented below. From the figure, it is evident that the two clusters are well separated from one another, with the yellow cluster containing fewer data points compared to the purple cluster.

Cluster Plot for 2 Clusters

Profiling the Segments

The table below summarizes the two clusters using the variables from the dataset.

Feature	Cluster 1	Cluster 2
Average age	30	40
Most common profession	Salaried	Salaried
Marital status	Single	Married
Level of education	Post Graduate	Post Graduate
Average number of dependents	0	3
Loan type	No loan	No loan
Wife working status	No	Yes
Average salary	1300000	1900000
Average wife salary	300000	600000
Average total salary	1600000	2500000
Most popular make of car	Baleno, Ciaz, Creata	SUV
Average price of car	1100000	1200000

The top 4 variables/features that can be used to create most optimal market segments for the Indian car market are:

- Age: The age of a car buyer serves as a strong predictor of their preferences. Younger buyers tend to seek affordable vehicles, whereas older buyers are more inclined towards pricier options.
- Income: A buyer's income is another key indicator of their preferences. Individuals with higher incomes are generally more capable of affording expensive cars.
- Education Level: The education level of car buyers is also a significant predictor of their needs. Buyers with higher education are more likely to prioritize fuel efficiency and environmental friendliness in their vehicle choices.
- Family Size: The size of a buyer's family can influence their preferences as well. Larger families are typically in search of cars that offer ample space and comfort.

These are just a few variables that can help create market segments within the Indian car market. By carefully considering these factors, car manufacturers can develop products that cater to the diverse needs of different buyer groups.

Conclusion

As shown, the two clusters differ significantly in demographics and purchasing behavior. Cluster 1 consists of younger, less affluent professionals seeking affordable cars, while Cluster 2 comprises middle-aged, affluent professionals interested in more expensive vehicles.

Here are some of the key differences between the two clusters:

- Age: Buyers in Cluster 1 have an average age of 30, while those in Cluster 2 average 40 years old. This indicates that Cluster 1 consists of younger professionals, whereas Cluster 2 includes more experienced professionals.
- Income: The average total salary of the buyers in Cluster 1 is 1600000, while the average total salary of the buyers in Cluster 2 is 2500000. This suggests that Cluster 1 is made up of less well-off professionals, while Cluster 2 is made up of more well-off professionals.
- Car preference: The most popular make of car in Cluster 1 is Baleno, Ciaz, and Creata, which are all relatively affordable cars. The most popular make of car in Cluster 2 is SUV, which are typically more expensive cars.

These differences indicate that the two clusters have distinct preferences in cars. Cluster 1 seeks affordable, reliable, and fuel-efficient vehicles, while Cluster 2 favors more luxurious, powerful cars suited to accommodate their families.

Marketing Mix

The ideal target segment for the EV startup entering the Indian market would include younger, less affluent professionals seeking affordable cars. This segment represents the largest and fastest-growing demographic in the Indian EV market. These buyers tend to be price-sensitive, so the startup should concentrate on providing an affordable electric vehicle that addresses their needs.

The marketing mix for this segment would focus on the following elements:

- Product: The electric vehicle (EV) should be affordable, efficient, and stylish, with a range suitable for Indian driving conditions.
- Price: The EV should be competitively priced compared to other models in the market, while also remaining accessible to the average Indian consumer. Pricing should cater to a broad range of potential buyers.
- Place: The EV should be available at various dealerships across India, particularly in urban and semi-urban areas where demand for EVs is high. These dealerships should also be equipped with charging stations to facilitate easy charging for buyers.

- Promotion: The EV should be marketed through a mix of online and offline channels. Online marketing will help reach a wide audience, while offline marketing will target potential buyers in urban and semi-urban regions. The promotional efforts should emphasize the benefits of EVs, such as their environmental friendliness and affordability.
- People: The EV startup should recruit a team of experienced professionals who are passionate about electric vehicles. This team should have a deep understanding of the Indian market and be capable of developing effective marketing strategies to reach potential buyers.
- Process: The EV startup should implement a smooth and efficient sales process that is easy for buyers to navigate. Excellent customer service should also be provided to ensure buyer satisfaction with their purchases.
- Physical Evidence: The startup should establish a physical presence that aligns with the brand. Dealerships should be well-designed and reflect the company's commitment to quality. Additionally, the EV itself should be attractively designed and meet the expectations of prospective buyers.

This marketing mix would effectively target the desired segment and encourage them to purchase an EV. The startup would need to customize its marketing message to align with the specific needs and interests of this audience. For instance, the message could emphasize the environmental benefits of EVs or highlight the vehicle's affordability.

Additionally, the EV startup should ensure that its vehicles are accessible at dealerships conveniently located for the target segment. These dealerships should be situated in urban and semi-urban areas where the target audience resides and works. Furthermore, they should be equipped with charging stations to facilitate easy charging for buyers.

By following these marketing strategies, the EV startup would be well-positioned to succeed in the Indian EV market.