

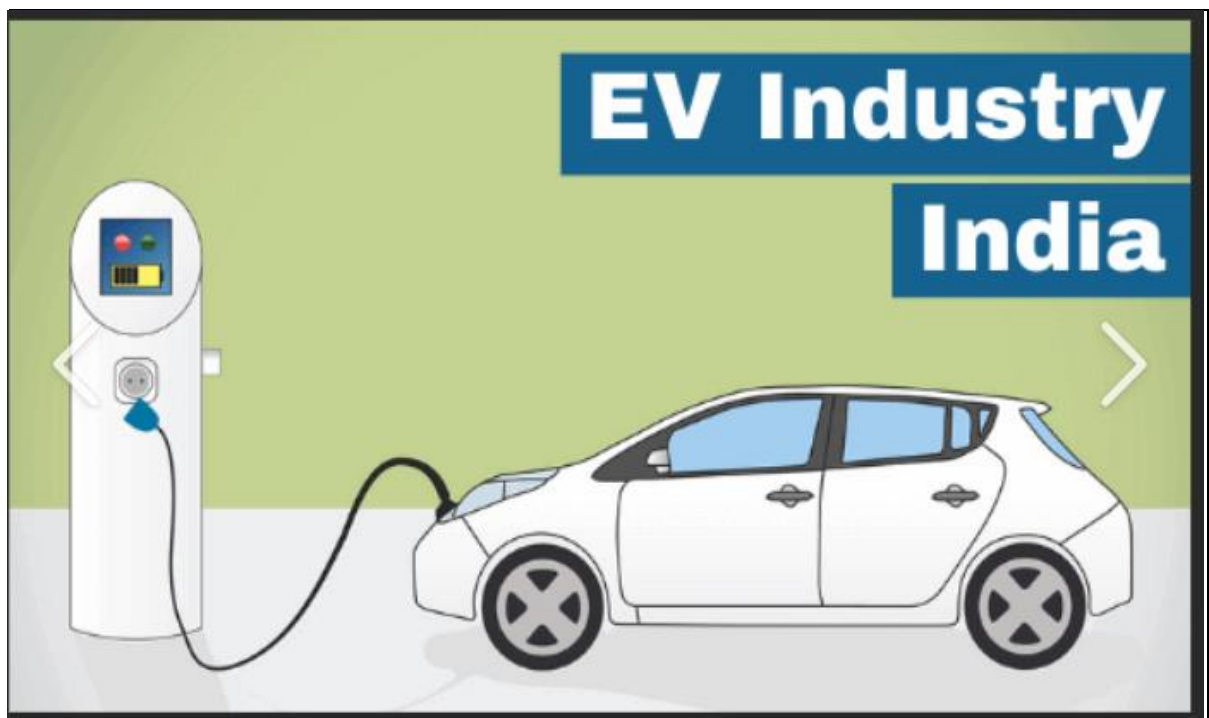
Feynn Labs: Project 2

Link: [GitHub](#)

Market Segmentation Analysis of Electric Vehicles Market in India

Mona Bohra

Date: 21st January, 2024



Electric Vehicle Market Analysis in India

Electric cars are not going to take the market by storm, but it's going to be a gradual improvement.

(Carlos Ghosn)

Problem statement

The task is to conduct a segmentation analysis of the Electric Vehicles Market in India and devise a practical strategy for market entry. The focus is on targeting segments with the highest likelihood of using the product, considering Geographic, Demographic, Psychographic, and Behavioral factors.

The report will delve into segments such as region, price, charging facility, vehicle types (e.g., 2-wheelers, 3-wheelers, 4-wheelers), retail outlets, manufacturers, body types (e.g., Hatchback, Sedan, SUV, Autorickshaw), safety features, plug types, and other relevant factors to inform the market entry strategy.

Fermi Estimation

Wild Guess: Around 8-10% of people will have electric vehicles by the end of 2024 in India.

Employment rate = is the ratio of a number of the available labour force to the population of People in the working age.

We think there are about 1.5 billion Indians in the world. Let's assume that only people over 18 and under 60 work, assuming that they account for around 60% of the population then that would make 0.9 billion Indians in the working class. Out of the 0.9 billion people not all are employed, assuming only 2023 had 45% employment rate which would bring the number around 405 million.

Since not everyone can afford an electric vehicle, let's assume only people above the middle class can afford an electric vehicle, that would be 40 million. Not everyone buys an electric vehicle. Let's assume out of these 40 million only 10 million are willing to buy an electric vehicle.

Variables and Formulas:

Let $E(x)$ be the employment rate of the year x (in %). Let $P(x)$ be the population of the year x .

Let $A(x)$ be the number of available Labor in the year x .

Let r be the ratio of Indians between the ages of 18 and 60 to the total population of India.

$$E(x) = (A(x) * 100) / (P(x) * r)$$

This formula will formulate the Employment ratio for the year x .

Gathering More Information:

Estimation for the population of the year 2022 can be obtained by the increase in population each year

$P(2019) = 1.3676$ billion

$P(2020) = 1.3786$ billion

$P(2021) = 1.39199$ billion

$P(2020) - P(2019) = 11$ million

$P(2021) - P(2020) = 13.39$ million

the mean would be 12.195 million

thus $P(2022) = 1.44185$ billion

assuming $A(x)$ is constant every year = 471,688,990 $r=0.6$ $C=0.75$

$E(2022) = (471,688,990 / (1,441,850,000 * 0.6)) * 0.75$ $E(2022) = 42\%$

Conclusion: Through this analysis, we conclude that by the end of the year 2024, there will be an Employment rate of 42%. That would make 42% of 405 million i.e., 170 million. Out of these 170 million only 10% afford EVs. So around 17 million people will have EVs by the end of 2024".

Keywords: Electric vehicles, Market segmentation, Cluster analysis, Attitude towards electric vehicles, Subjective norms, Adoption intention, Sustainable transportation.

Data Collection

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

Link for data extraction:

- https://drive.google.com/drive/folders/1Yn_0KpPUvPjdNjJe8emy-QsKzqt7aexb
- <https://www.ibef.org/blogs/electric-vehicles-market-in-india>
- <https://www.india-briefing.com/news/indias-ev-manufacturing-capacity-and-market-preferences->
- <https://www.kaggle.com/datasets>
- <https://data.gov.in/>

Columns explanations:

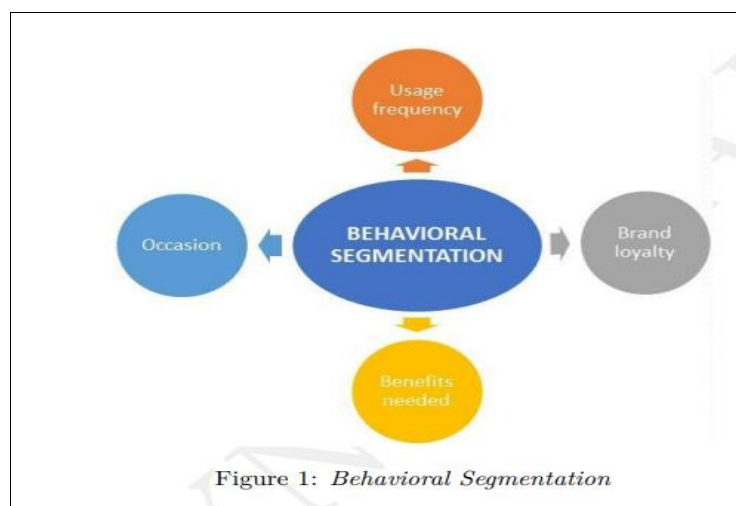
1. 'Brand' tells the manufacturers of electric vehicles.
2. 'model' tells the various of electric vehicles.
3. 'AccelSec', 'Top Speed', and 'Power Train' tell specification about the vehicles.
4. 'Range_km', 'Fast_Charge', 'Plug_type' and 'Bodystyle' tells us about the range of vehicle per full charge, whether fast charging is provided or not, the type of charging plug and the body style of the vehicle respectively.
5. 'Seats' and 'Price' tell about the number of seats available on a vehicle and their price.
6. 'Region' and 'State/UT' tells about the states of India.
7. '2Wheelers', '3Wheelers', '4Wheelers', 'Cars', 'Buses' tell about the type of vehicles in the market.

Market Segmentation

Target Market: The target market of Electric Vehicle Market Segmentation can be categorized into Geographic, Sociodemographic, Behavioral, and Psychographic Segmentation.

Behavioural Segmentation: searches directly for similarities in behaviour or reported behaviour.

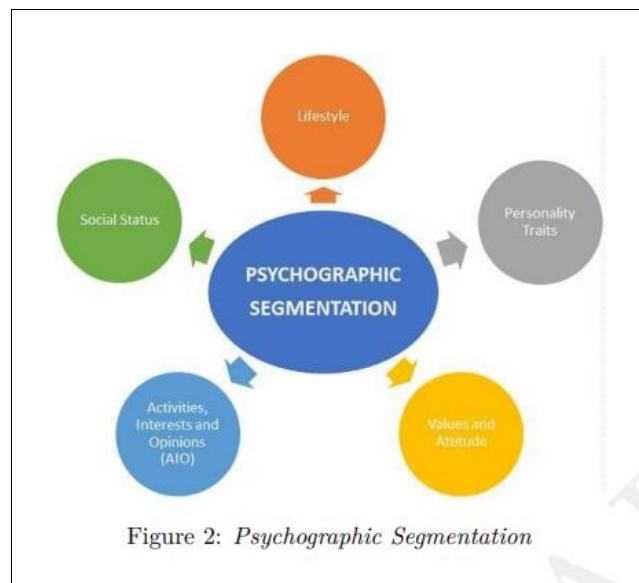
Example: prior experience with the product, the amount spent on the purchase.



Advantage: the very behaviour of interest is used as the basis of segment extraction.

Disadvantage: not always readily available.

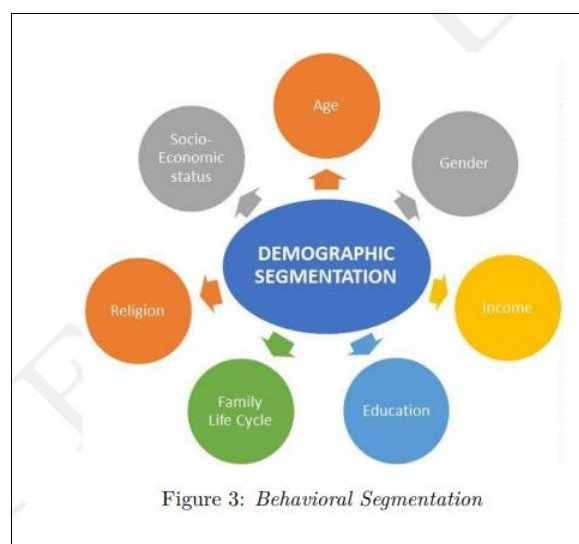
Psychographic Segmentation: grouped based on beliefs, interests, preferences, aspirations, or benefits sought when purchasing a product. Suitable for lifestyle segmentation. Involves many segmentation variables



Advantage: generally more reflective of the underlying reasons for differences in consumer behaviour.

Disadvantage: increased complexity of determining segment memberships for consumers.

Socio-Demographic Segmentation: includes age, gender, income and education useful in industries.



Advantage: segment membership can easily be determined for every customer.

Disadvantage: if this criterion is not the cause for customers' product preferences then it does not provide sufficient market insight for optimal segmentation decisions.

Segment Extraction

The market segmentation approach aims at defining actionable, manageable, homogeneous subgroups of individual customers to whom the marketers can target with a similar set of marketing strategies practice, there are two ways of segmenting the market-a-priori and post-hoc. An apriori approach utilizes predefined characteristics to predefine the segments followed by profiling based on a host of measured variables (behavioural, psychographic or benefit). In the post-hoc approach to segmentation, on the other hand, the segments are identified based on the relationship among the multiple measured variables. The commonality between both approaches lies in the fact that the measured variables determine the 'segmentation theme'. The present study utilizes an apriori approach to segmentation to divide the potential EV customers into sub-groups.

It is argued that the blended approach of psychographic and socioeconomic attributes for market segmentation enables the formulation of sub-market strategies which in turn satisfy the specific tastes and preferences of the consumer groups. Straughan and Roberts presented a comparison between the usefulness of psychographic, demographic, and economic characteristics based on consumer evaluation of eco-friendly products.

They pinpointed the perceived superiority of the psychographic characteristics over the socio-demographic and economic ones in explaining environmentally-conscious consumer behaviour and thus, the study recommended the use of psychographic characteristics in profiling the consumer segments in the market for eco-friendly products. The present study adds perceived-benefit characteristics guided by blended psychographic and socio-economic aspects for segmenting the consumer market.

Implementation

Packages/Tools used:

1. Numpy: To calculate various calculations related to arrays.
2. Pandas: To read or load the datasets.
3. SkLearn: We have used LabelEncoder() to encode

Data Cleaning The data collected is compact and is partly used for visualization purposes and partly for clustering. Python libraries such as NumPy, Pandas, Scikit-Learn, and SciPy are used for the workflow, and the results obtained are ensured to be reproducible.

Data Preprocessing

Steps taken to preprocess the scraped raw data:

1. Ordinal encoded 'PowerTrain'
2. Label encoded 'RapidCharge'
3. Used Label Encoder and Standard Scaler package for preprocessing of the dataset

Exploratory Data Analysis

Exploratory Data Analysis (EDA) is like a deep dive into our dataset, helping us uncover hidden trends and patterns. We used three types of analysis: univariate (looking at one variable at a time), bivariate (considering two variables together), and multivariate (analyzing more than two variables).

Looking at a bar graph, we checked the geographical diversity of our data. It turns out we have the most data from states like Karnataka and Maharashtra, while Sikkim, Meghalaya, Lakshadweep, Ladakh, Dadra and Nagar Haveli and Daman and Diu have the least.

Correlation Matrix:

A correlation matrix is simply a table that displays the correlation. It is best used in variables that demonstrate a linear relationship between each other. Coefficients for different variables. The matrix depicts the correlation between all the possible pairs of values through the heatmap in the below figure. The relationship between two variables is usually considered strong when their correlation coefficient value is larger than 0.7.

Scree Plot: This is a common method for determining the number of PCs to be retained via graphical representation. It is a simple line segment plot that shows the eigenvalues for each PC. It shows the eigenvalues on the y-axis and the number of factors on the x-axis. It always displays a downward curve. Most screen plots look broadly similar in shape, starting high on the left, falling rather quickly, and then flattening out at some point. This is because the first component usually explains much of the variability, the next few components explain a moderate amount, and the latter components only explain a small fraction of the overall variability. The scree plot criterion looks for the “elbow” in the curve and selects all components just before the line flattens out. The proportion of variance plot: The selected PCs should be able to describe at least 80% of the variance.

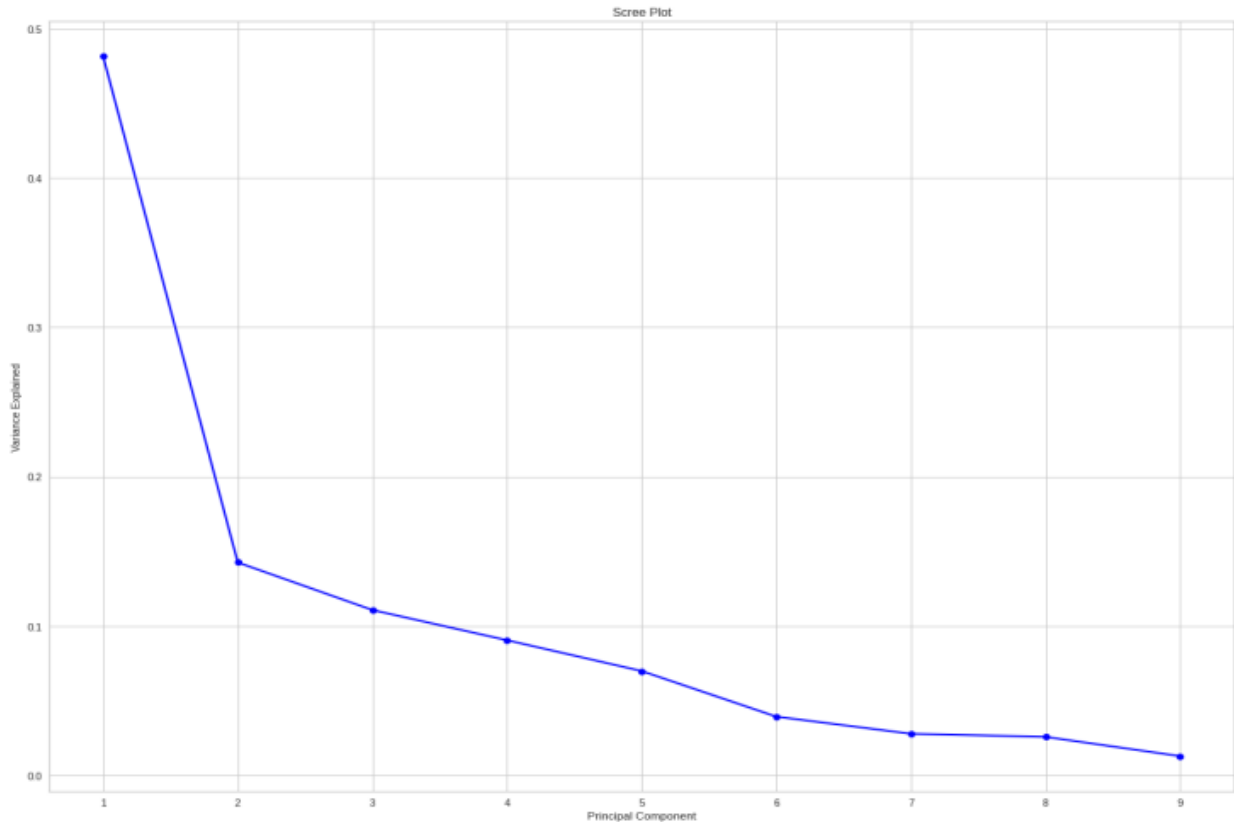


Figure 8: Scree Plot for our Dataset

Extracting Segments

Dendrogram

This technique is specific to the agglomerative hierarchical method of clustering. The agglomerative hierarchical method of clustering starts by considering each point as a separate cluster and starts joining points to clusters in a hierarchical fashion based on their distances. To get the optimal number of clusters for hierarchical clustering, we make use of a dendrogram which is a tree-like chart that shows the sequences of merges or splits of clusters. If two clusters are merged, the dendrogram will join them in a graph and the height of the join will be the distance between those clusters. As shown in Figure, we can choose the optimal number of clusters based on the hierarchical structure of the dendrogram. As highlighted by other cluster validation metrics, four to five clusters can be considered for the agglomerative hierarchy as well.

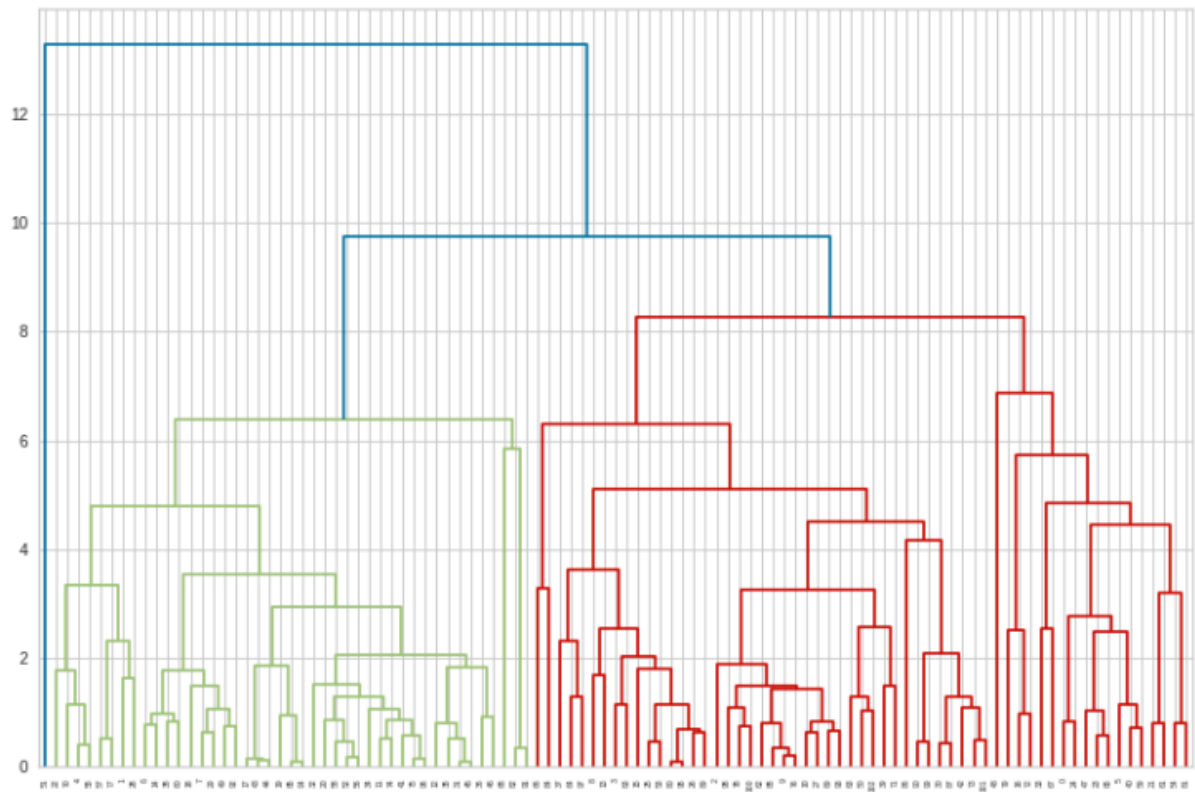


Figure 9: Dendrogram Plot for our Dataset

Elbow Method

The Elbow method is a popular method for determining the optimal number of clusters. The method is based on calculating the Within-Cluster-Sum of Squared Errors (WSS) for a different number of clusters (k) and selecting the k for which change in WSS first starts to diminish. The idea behind the elbow method is that the explained variation changes rapidly for a small number of clusters and then it slows down leading to an elbow formation in the curve. The elbow point is the number of clusters we can use for our clustering algorithm.

The `KElbowVisualizer` function fits the `KMeans` model for a range of cluster values between 2 to 8. As shown in Figure, the elbow point is achieved which is highlighted by the function itself. The function also informs us about how much time was needed to plot models for various numbers of clusters through the green line.

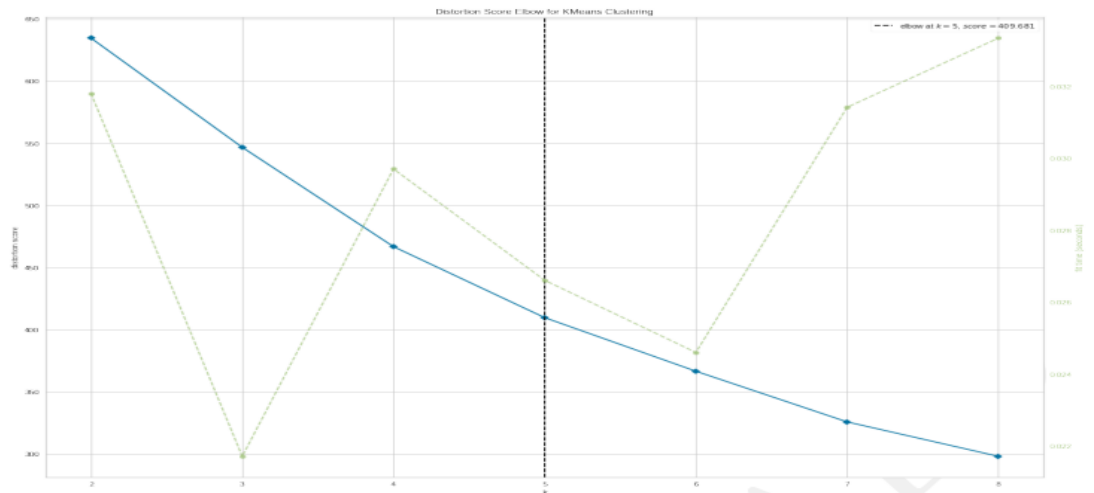


Figure 10: Evaluating the clusters using Distortion

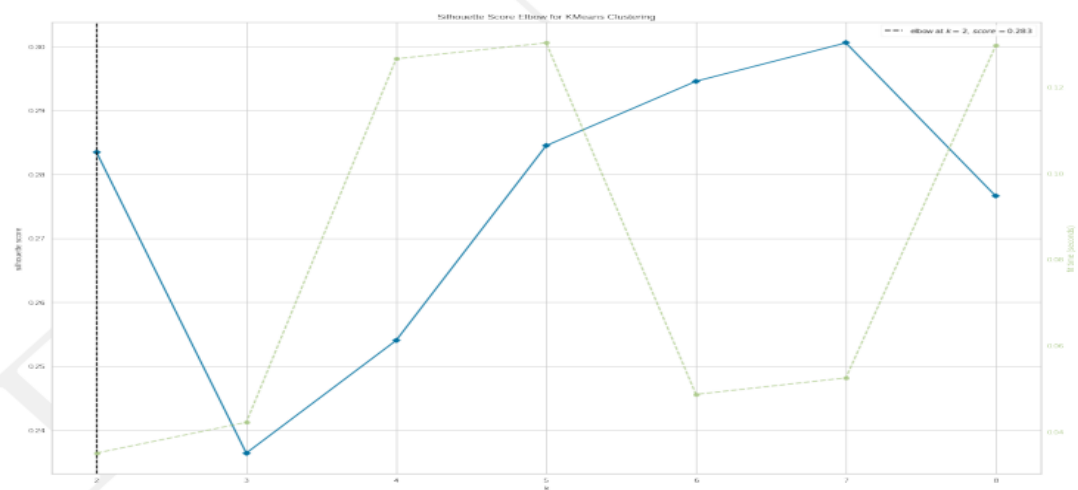


Figure 11: Evaluating the clusters using silhouette

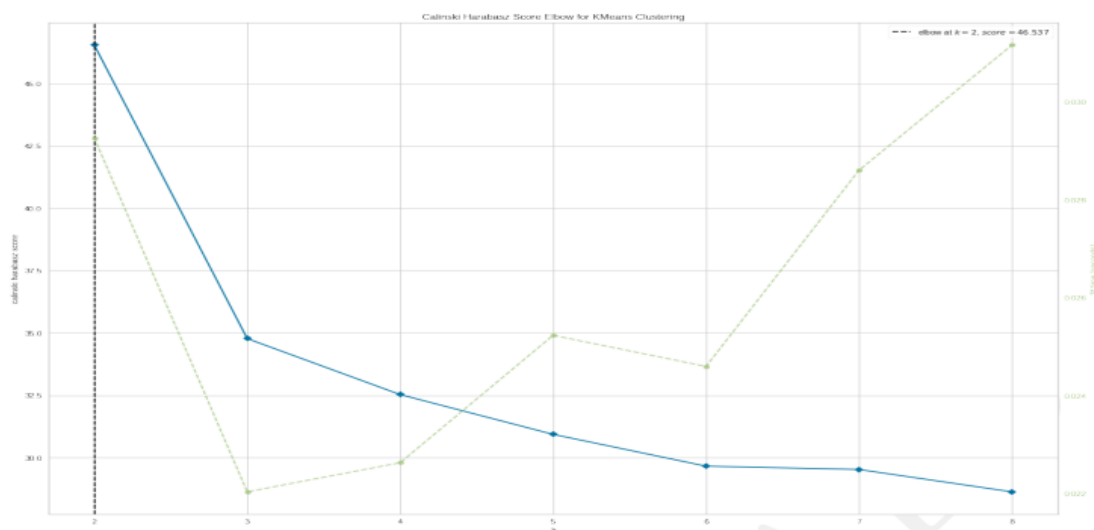


Figure 11 : Evaluating the clusters using calinkiharabasz

Analysis and Approaches used for segmentation

Clustering

Clustering is one of the most common exploratory data analysis techniques used to get an intuition about the structure of the data. It can be defined as the task of identifying subgroups in the data such that data points in the same subgroup (cluster) are very similar while data points in different clusters are very different. In other words, we try to find homogeneous subgroups within the data such that data points in each cluster are as similar as possible according to a similarity measure such as Euclidean-based distance or correlation-based distance. The decision of which similarity measure to use is application-specific. Clustering analysis can be done based on features where we try to find subgroups of samples based on features or based on samples where we try to find subgroups of features based on samples.

K-Means Algorithm

K Means algorithm is an iterative algorithm that tries to partition the dataset into pre-defined distinct non-overlapping subgroups (clusters) where each data point belongs to only one group. It tries to make the intra-cluster data points as similar as possible while also keeping the clusters as different (far) as possible. It assigns data points to a cluster such that the sum of the squared distance between the data points and the cluster's centroid (arithmetic mean of all the data points that belong to that cluster) is at the minimum. The less variation we have within clusters, the more homogeneous (similar) the data points are within the same cluster.

The way k means algorithm works is as follows:

- Specify number of clusters K.
- Initialize centroids by first shuffling the dataset and then randomly selecting K data points for the centroids without replacement.
- Keep iterating until there is no change to the centroids. i.e. assignment of data points to clusters isn't changing.

The approach k-means follows to solve the problem is expectation maximization The E-step is assigning the data points to the closest cluster. The M-step is computing the centroid of each cluster. Below is a breakdown of how we can solve it mathematically,

The objective function is:

$$J = \sum_{i=1}^m \sum_{k=1}^K w_{ik} \|x^i - \mu_k\| \quad (1)$$

And M-step is :

$$\frac{\partial J}{\partial \mu_k} = 2 \sum_{i=1}^m w_{ik} (x^i - \mu_k) = 0$$

$$\Rightarrow \mu_k = \frac{\sum_{i=1}^m w_{ik} x^i}{\sum_{i=1}^m w_{ik}}$$

Applications

K means the algorithm is very popular and used in a variety of applications such as market segmentation, document clustering, image segmentation image compression, etc. The goal usually when we undergo a cluster analysis is either:

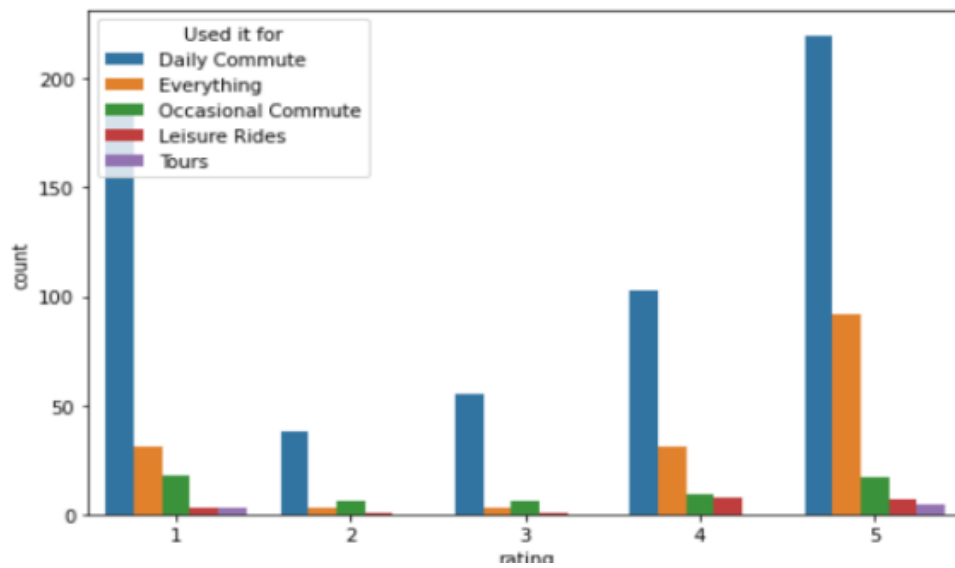
1. Get a meaningful intuition of the structure of the data we're dealing with.
2. Cluster-then-predict where different models will be built for different subgroups if we believe there is a wide variation in the behaviours of different subgroups.

The k-means clustering algorithm performs the following tasks:

- Specify the number of clusters K
- Initialize centroids by first shuffling the dataset and then randomly selecting K data points for the centroids without replacement.
- Compute the sum of the squared distance between data points and all centroids.
- Assign each data point to the closest cluster (centroid).
- Compute the centroids for the clusters by taking the average of all data points that belong to each cluster.
- Keep iterating until there is no change to the centroids. i.e. assignment of data points to clusters isn't changing.

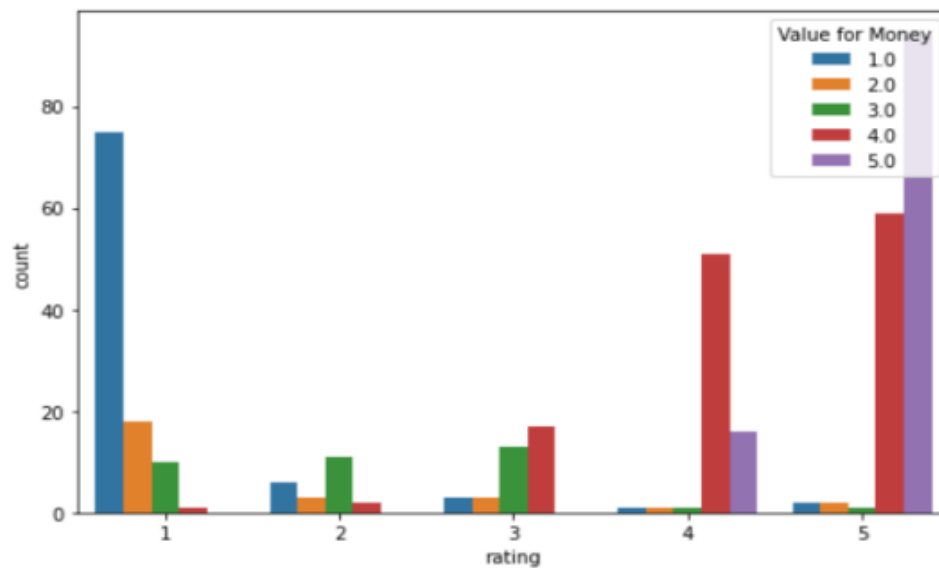
According to the Elbow method, here we take K=4 clusters to train the KMeans model. The derived clusters are shown in the following figure

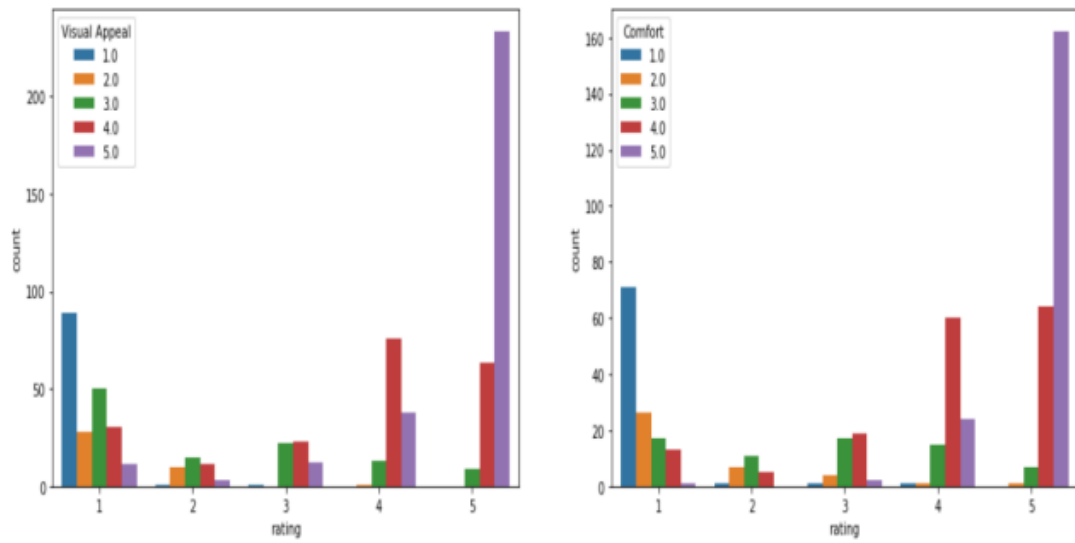
The major use of EVs in India is for daily commutes.



Psychographic Factors

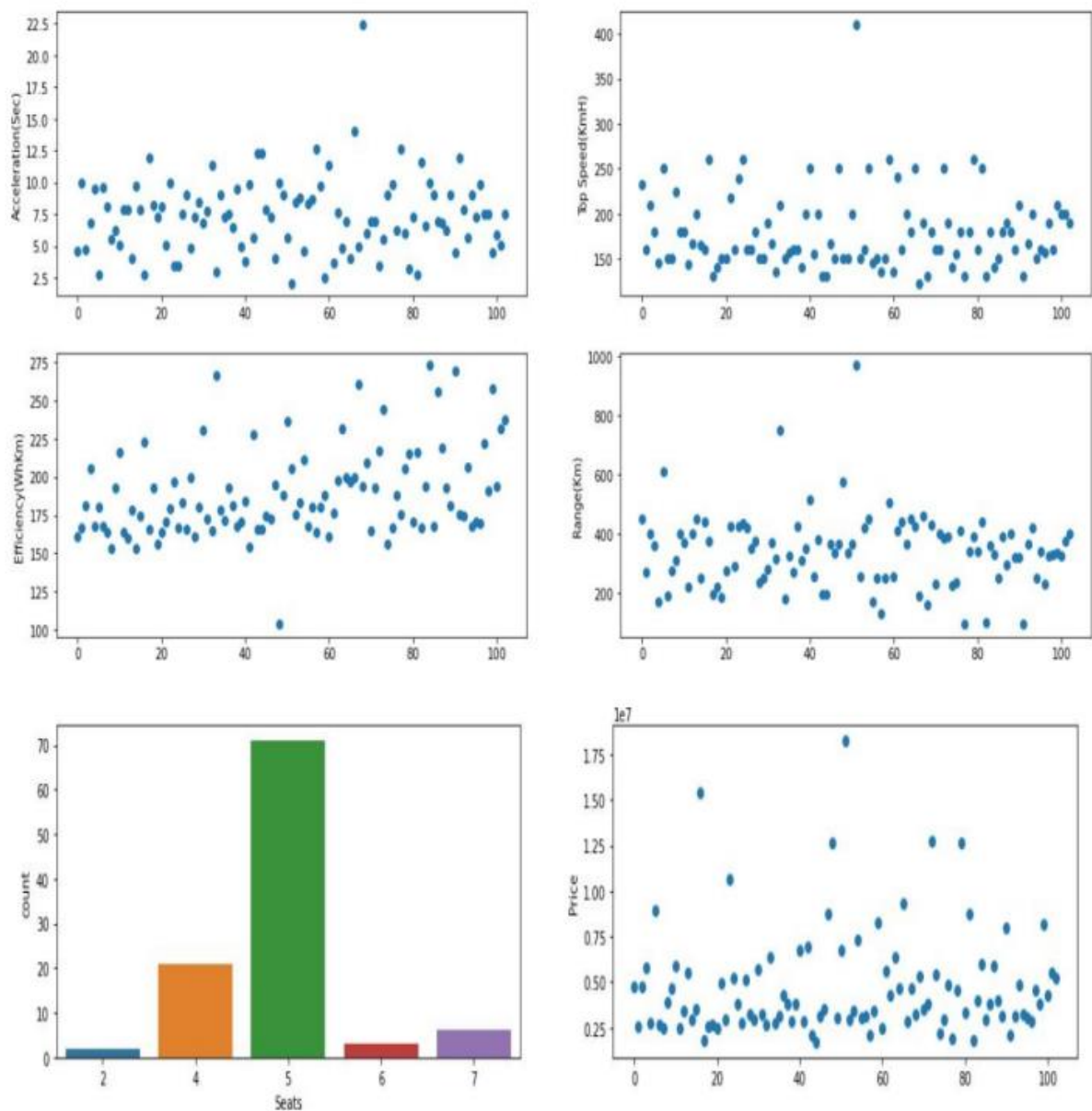
Comfort, Visual Appeal and Value for Money are another key psychological aspect that attract customers.





Major psychographic factors to consider- Values for Money and Comfort.

	Value for Money	Visual Appeal	Comfort	rating
Value for Money	1.000000	0.739205	0.775693	0.868278
Visual Appeal	0.739205	1.000000	0.785004	0.766609
Comfort	0.775693	0.785004	1.000000	0.830538
rating	0.868278	0.766609	0.830538	1.000000



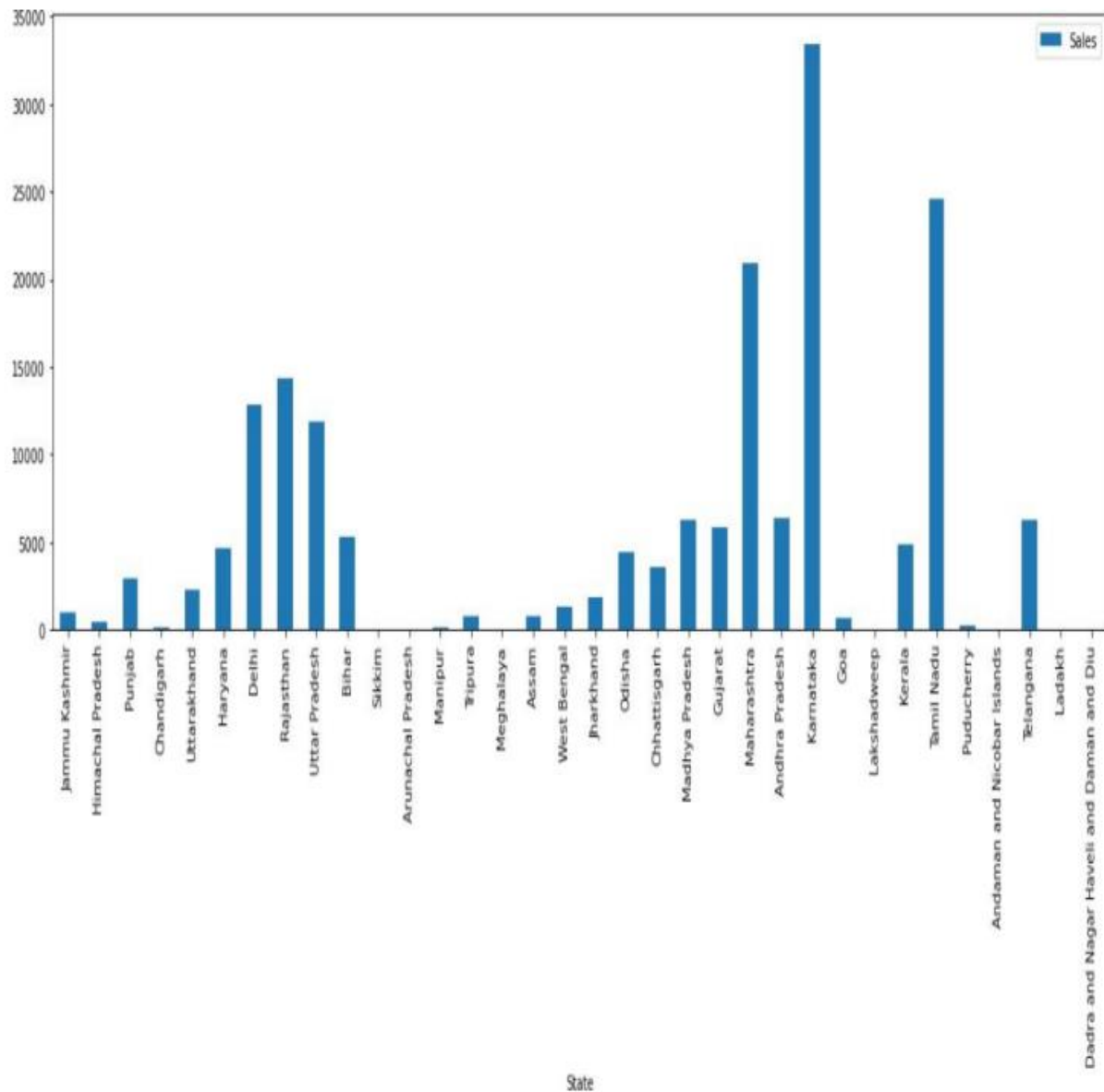
Inferring from the graphs, most of the EVs belong to the 5-seater category. An average price range of 20-30 Lakhs and an Efficiency-high vehicle would do well in the market.

Acceleration seems to matter more than the top speed of the vehicle.

Major behavioural factors to consider – Price, Efficiency, Acceleration

Geographic Factors

The following graph shows the number of sales of EVs in different states.



States like Maharashtra, Karnataka, Tamil Nadu and Rajasthan are good geographic locations to consider for an EV market.

Target Segments

Based on the analysis, the target segment can be narrowed down to EVs having:

1. **Psychographic factors** such as Comfort and Value for Money .
2. **Behavioral factors** such as good Acceleration and viable Price range.
3. **Geographic factors** such as States which are more market-friendly.

In conclusion, the target segment should comprise of EVs having Acceleration of 7.5-10 sec, High in Comfort and Value for Money ratings, have a Price range of 20-30 Lakhs, and be focused mainly on States such as Maharashtra, Karnataka, Tamil Nadu and Rajasthan.

Customizing the market mix



The marketing mix refers to the set of actions, or tactics, that a company uses to promote its brand or product in the market. The 4Ps make up a typical marketing mix -Price, Product, Promotion and Place.

- **Price:** refers to the value that is put for a product. It depends on the segment targeted, the ability of the companies to pay, the ability of customers to pay supply - demand and a host of other direct and indirect factors.

- **Product:** refers to the product being sold – In this case, the service. The product must deliver a minimum level of performance; otherwise, even the best work on the other elements of the marketing mix won't do any good.

- **Place:** refers to the point of sale. In every industry, catching the eye of the consumer and making it easy for her to buy it is the main aim of a good distribution or 'place' strategy. Retailers pay a premium for the right location. The mantra of a successful retail business is 'location, location, location'.

- **Promotion:** this refers to all the activities undertaken to make the product or service known to the user and trade. This can include advertising, word of mouth, press reports, incentives, commissions and awards to the trade. It can also include consumer schemes, direct marketing, contests and prizes.

All the elements of the marketing mix influence each other. They make up the business plan for a company handle it right, and can give it great success. The marketing mix needs a lot of understanding, market research and consultation with several people, from users.

Product Mix

This part of the marketing mix deals with what a company sells. Each group of items a company sells is called a product line. The combination of all these product lines is called the product mix. The product mix reveals how varied a business is, even if it focuses on a specific industry. For example, a car company might have various products like different brands, types, and models of cars.

1. Automobiles
2. Automobile parts
3. Commercial vehicles
4. Financial services

Prices and Pricing Strategies

In this part of the marketing mix, the company focuses on determining the prices for its products. Setting the right price points and price ranges is crucial. It directly impacts how customers perceive the value of the brand and products, especially in markets where people are sensitive to prices. For its cars, the company follows specific pricing strategies to attract customers and drive sales.

1. Market-oriented pricing strategy
2. Premium pricing strategy

Promotional Mix

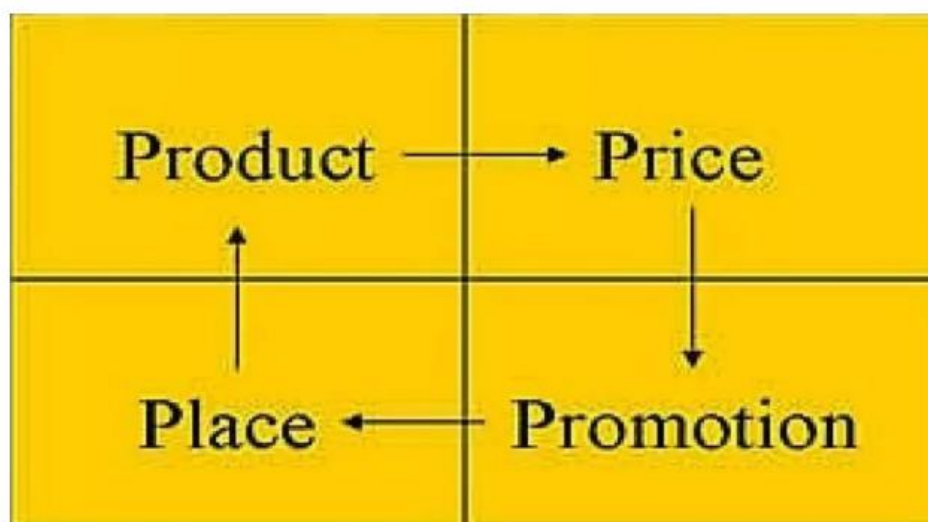
This part of the 4Ps marketing mix focuses on promotional efforts and is often referred to as marketing communications tactics. The collection of these tactics is termed a promotional mix or marketing communications mix. In the automotive industry, the company employs various promotional activities, listed in order of importance, to effectively reach and engage customers.

1. Advertising (primary)
2. Direct marketing
3. Personal selling
4. Sales promotion
5. Public relations

Place/Distribution

In this element of the 4Ps marketing mix, the focus is on the physical or virtual locations where transactions take place. These locations play a crucial role as they help the company connect with its target customers in specific markets. Additionally, these places serve as access points for customers to obtain information and products offered by the automotive business. The distribution of products and services involves utilizing the following locations:

1. Official websites
2. Dealerships
3. Automotive shows and exhibits



Potential Sales in Early Market

In the realm of potential sales in the early market, the acquisition of a vehicle stands out as a significant life achievement for almost everyone. Many customers, often with families, seek vehicles for various reasons such as commuting and schooling. Whether it's a preference for a modern urban loft or a spacious suburban home with a picket fence, the goal is to find a vehicle that feels tailor-made for the family. Our insights come into play here, assisting individuals in discovering the best vehicle at a fixed price tailored to their location and other factors.

Key Focus Points for Electric Vehicle (EV) Development in India:

1. Retrofitting Public Transport to Plug-in Hybrid Electric Vehicles (PHEV):

- A crucial step towards sustainable transportation.
- Balances emissions and reduces infrastructure strain.

2. Government Incentives for EVs:

- Identification of strategic incentives to boost the XEV market.
- Incentives could include subsidies to bridge the cost gap between conventional and electric vehicles.
- Possible benefits like discounts on VAT, registration, and toll plazas to encourage EV sales.

3. Charging Infrastructure Development:

- Develop grid-connected charging stations with moderate tariffs.
- Corporate standalone renewable (solar/wind) charging stations.
- Incorporate charging facilities at petrol pumps, bus stops, and state transport stations.
- Encourage private renewable charging station development.

4. Electrical Propulsion System (EPS):

- Encourage Indian manufacturers to produce EPS locally.
- Develop clear policies supporting the growth of supply, manufacturing, and recycling of propulsion systems.
- Address challenges in the development of cost-effective Li-ion battery technology.

5. Development of Skilled Manpower:

- Focus on certified skilled technicians and professionals due to safety and advanced technology.

6. Awareness and Promotion:

- Raise awareness of XEV benefits through extensive advertising.
- Utilize various channels such as newspapers, magazines, digital media, radio, and TV shows.
- Highlight consumer benefits like environmental friendliness, cost-effectiveness, and suitability for urban use.
- Emphasize smooth acceleration, reduced noise, and proven technology in the global XEV market.

Most optimal Market Segment

Key Insights of the Electric Vehicle (EV) Project:

1. Industry Landscape:

- Presence of numerous EV manufacturing companies in India (e.g., Hero Electric, Tata Motors, Ather Energy, Ashok Leyland, Hyundai Kona Electric, Tesla).
- The anticipated surge in demand with the entry of Tesla, signalling significant growth opportunities.

2. Industry Challenges Post-COVID:

- The EV industry faced challenges due to the COVID-19 pandemic.
- Expectation of a substantial rebound and growth in the coming years.

3. Game-Changing Impact of EVs:

- EV usage is poised to revolutionize environmental impact.
- Contribution to pollution reduction, noise-free transportation, and enhanced post-electric benefits.

4. Local Operations Establishment:

- Consideration for establishing local operations in India.
- Options include partnerships with local companies or setting up independent manufacturing/development units.
- Possible integration with imports of specific components.

5. Growth Opportunities in India:

- Growth expectations are fueled by a burgeoning commercial fleet market for two-wheelers and three-wheelers.
- Focus on last km delivery and urban freight services.
- Identification of opportunities across the EV supply chain, including batteries, components, and charging infrastructure.
- Consideration of machinery, equipment, and skilled workforce for manufacturing plant establishment.

6. Strategic Business Expansion:

- Initial business launch in Metro Cities in India.
- Subsequent expansion to other cities within the same state as the Metro Cities.
- A strategic approach to leverage prior knowledge gained in Metro Cities for seamless expansion.
- Streamlined supply chain network development over time.

7. Future Outlook:

- Acknowledgement of electric vehicles as the future of transportation.
- Emphasis on environmental sustainability with the slogan, "Go Green Go Electric."

In conclusion, the project outlines a comprehensive strategy for navigating the dynamic landscape of the Indian electric vehicle market, anticipating growth, and contributing to a sustainable future.

