# MARKET SEGMENTATION

**Analysing the respective market in India using Segmentation Analysis for Electric Vehicle Start-up.**

**By :**

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# OVERVIEW

This report presents a detailed analysis of the electric vehicle (EV) market in India using a segmentation-based approach. It aims to provide a comprehensive understanding of the current state of the EV market, examine the factors driving its growth, and explore the market segments for strategic decision-making. The report also offers insights into the challenges faced by the industry and outlines future opportunities and trends.

Electric vehicles (EVs) have emerged as a promising solution for sustainable transportation, offering reduced emissions and decreased dependence on fossil fuels. India, as one of the world's largest automobile markets, has also witnessed a significant rise in the adoption of EVs. This introduction provides an overview of electric vehicles, the EV market in India, and the importance of segmentation analysis for understanding the market landscape. Electric vehicles are automobiles that utilize one or more electric motors for propulsion, drawing power from rechargeable batteries or other energy storage devices. Unlike conventional internal combustion engine vehicles (ICEVs), EVs produce zero tailpipe emissions, contributing to improved air quality and reduced greenhouse gas emissions. EVs can be categorized into different types, including passenger electric vehicles (PEVs) and commercial electric vehicles (CEVs), each serving specific transportation needs.

The EV market in India has experienced significant growth in recent years, driven by various factors. The Indian government's focus on promoting clean and sustainable mobility, coupled with favorable policies and incentives, has accelerated the adoption of EVs. Rising fuel prices, concerns about air pollution, and advancements in battery technology have also contributed to the market's expansion. Despite the growth potential, the EV market in India faces challenges. Limited charging infrastructure, higher upfront costs compared to conventional vehicles, and range anxiety among consumers are some of the hurdles to widespread adoption. However, ongoing initiatives and investments in charging infrastructure development, policy support, and collaborations between government agencies and industry stakeholders are addressing these challenges.

Segmentation analysis plays a crucial role in understanding the EV market in India. It involves categorizing the market into distinct segments based on various factors, such as vehicle type, technology, end-user, and region. This segmentation approach allows for a more granular understanding of market dynamics, customer preferences, and growth opportunities. Segmenting the EV market based on vehicle type enables a closer examination of different vehicle categories, such as passenger cars, SUVs, buses, trucks, and rickshaws. Each category has unique market characteristics, target consumers, and growth prospects. Similarly, segmentation based on technology distinguishes between battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell electric vehicles (FCEVs), providing insights into technology adoption trends and market potential. By employing segmentation analysis, stakeholders in the EV market can tailor their strategies, products, and services to address the needs of specific segments, optimize resource allocation, and capitalize on emerging opportunities.

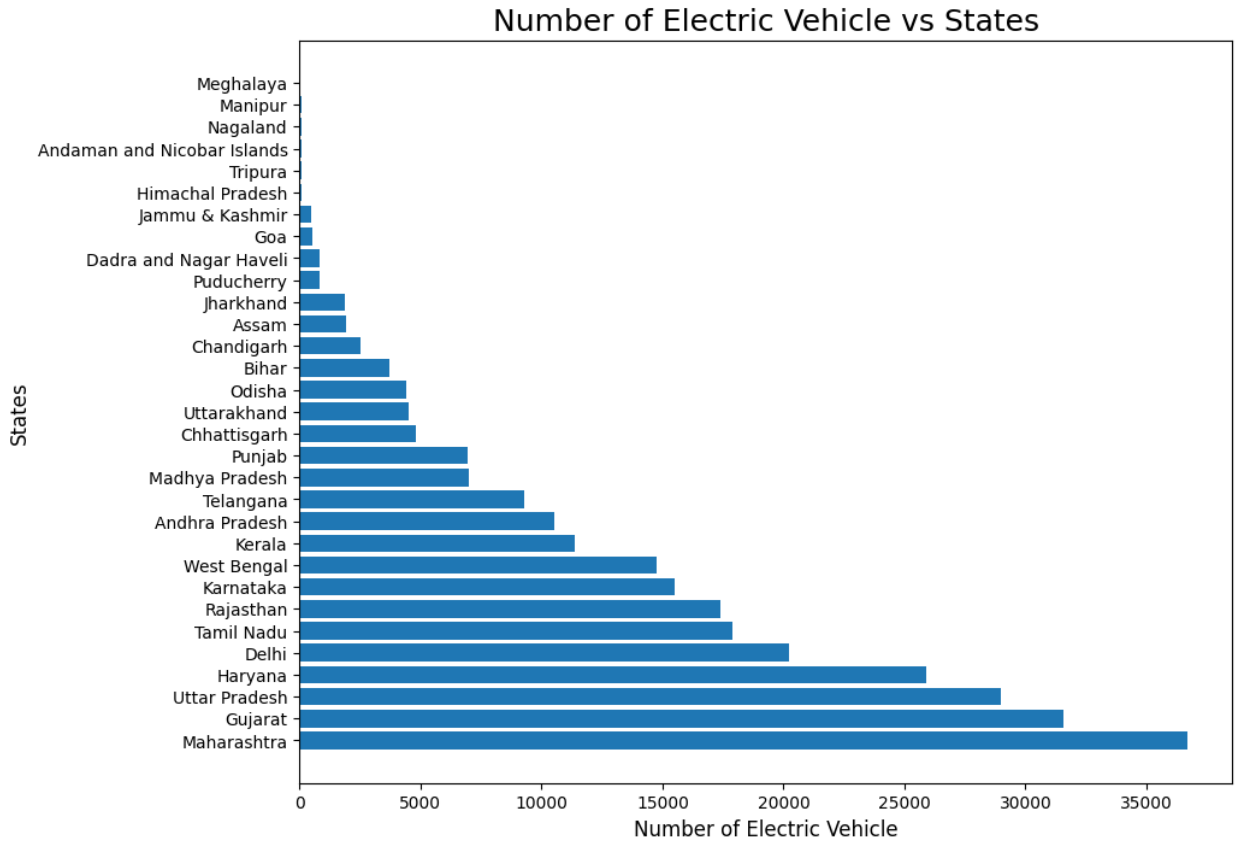
# METHODOLOGY

1. Data Collection:
    - Gather relevant data from multiple sources, including market reports, government publications, industry databases, and research papers.
    - Collect data on various parameters such as vehicle type, technology, sales figures, charging infrastructure, consumer preferences, and regional market data.
2. Preprocessing and Data Preparation:
    - Cleanse the data by removing any inconsistencies, errors, or missing values.
    - Normalize or standardize the data to bring all variables to a common scale, ensuring no variable dominates the analysis.
3. Segmentation Criteria:
    - Determine the segmentation criteria based on the research objectives and available data.
    - Select relevant variables for segmentation, such as vehicle type, technology, sales volume, market share, charging infrastructure, and consumer preferences.
4. Principal Component Analysis (PCA):
    - Apply Principal Component Analysis to reduce the dimensionality of the dataset and identify the most significant variables.
    - Perform PCA to transform the original variables into a new set of uncorrelated variables (principal components) while retaining the maximum variance in the data.
    - Determine the optimal number of principal components based on the explained variance ratio and scree plot analysis.
5. K-means Clustering:
    - Perform K-means clustering on the transformed data obtained from PCA.
    - Select the appropriate number of clusters based on techniques like the Elbow method or Silhouette analysis.
    - Apply the K-means algorithm to assign each data point to the respective cluster based on the similarity of the variables.
6. Interpretation and Analysis:
    - Analyze the results of the clustering to understand the characteristics and profiles of different market segments.
    - Examine the distribution of variables within each cluster to identify the key differentiators.
    - Evaluate the significance of each segment based on criteria such as market size, growth potential, and consumer demand.
    - Conduct statistical tests or visualizations to compare the clusters and validate the segmentation results.

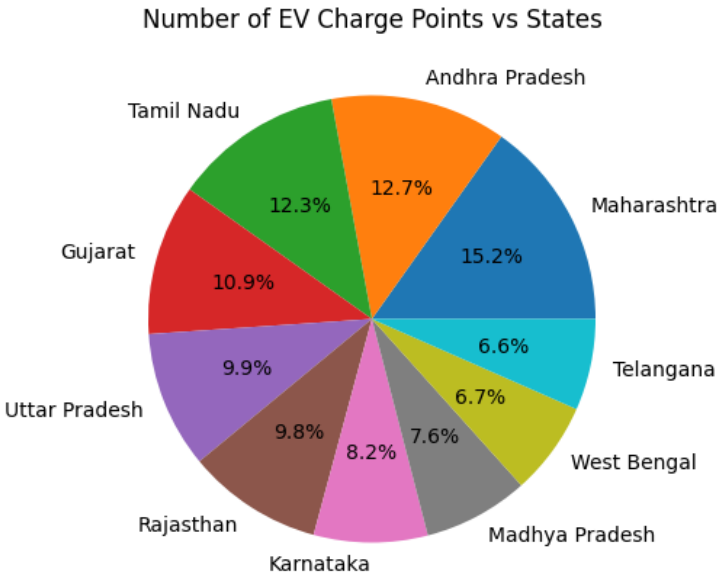
This methodology provides a comprehensive and data-driven approach to understanding the EV market in India. It helps identify distinct market segments, uncover hidden patterns and relationships in data, and derive meaningful insights and conclusions to drive strategic decision-making and market strategies.

# MARKET OVERVIEW

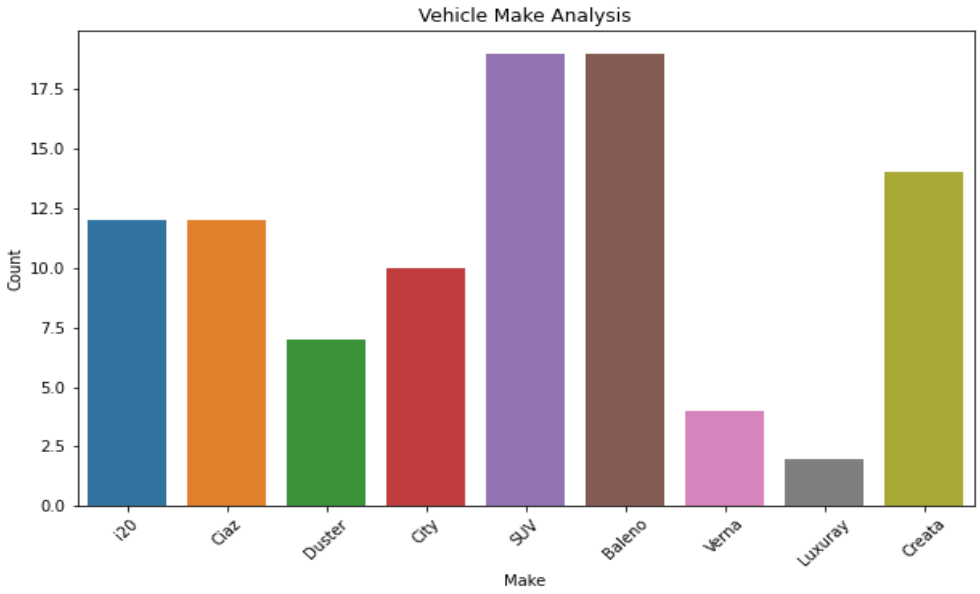
The distribution of Electric Vehicles differs extensively in each state of India. Due to the EV market and various factors, some states have a huge number of growing potentials for EV compared to other states. The analysis conducted by our team also showcases the distribution of EV vehicles in various states comparatively. To showcase the data using visualization, a bar plot has been used.



The analysis also includes EV charge points distribution in various states in a visual manner, using a pie chart. EV charge points are locations where electric vehicles can be charged. These charge points are essential for the widespread adoption and convenience of electric vehicles, providing a reliable and accessible means of recharging EV batteries. This representation is reminiscent of the above bar plot distribution, as the states containing more EV have more charge points.




Vehicle make analysis involves examining and evaluating different car brands based on various factors, such as market share, sales performance, customer satisfaction, brand reputation, and technological advancements. Here the analysis is conducted using count as a factor and showcased in a bar plot. This bar plot involves various car brands and their making count.



The Indian electric vehicle (EV) market has witnessed significant growth and development in recent times, driven by various factors such as government initiatives, environmental concerns, and technological advancements. Here is a detailed overview of the Indian EV market in recent times:

1. Government Initiatives:
   The Indian government has implemented several policies and initiatives to promote the adoption of electric vehicles. These include:
   - Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme.
   - GST Reduction.
   - EV Subsidies.
   - Charging Infrastructure Development.
2. Market Growth and Sales:
   The Indian EV market has experienced substantial growth in recent years, although the overall market share of EVs is still relatively small compared to conventional vehicles. Key growth indicators include:
   - Increased Sales
   - Expansion of Vehicle Models
   - Government Fleet Electrification
3. Vehicle Segments and Players:
   The Indian EV market encompasses various vehicle segments, including:
   - Two-Wheelers
   - Three-Wheelers
   - Passenger Cars
   - Commercial Vehicles
4. Charging Infrastructure:
   The development of robust charging infrastructure is crucial for the widespread adoption of electric vehicles. Key developments in this area include:
   - Public Charging Stations
   - Home Charging Solutions
   - Fast Charging Networks
5. Challenges and Opportunities:
   While the Indian EV market has shown promise, there are challenges that need to be addressed for further growth, such as:
   - Charging Infrastructure
   - Cost Considerations
   - Battery Technology.
   - Consumer Awareness and Perception

# MARKET SEGMENTATION

Market segmentation analysis in the electric vehicle (EV) market in India helps to identify distinct groups of consumers, understand their needs, and tailor marketing strategies accordingly. Here is a segmentation analysis on the EV market in India:

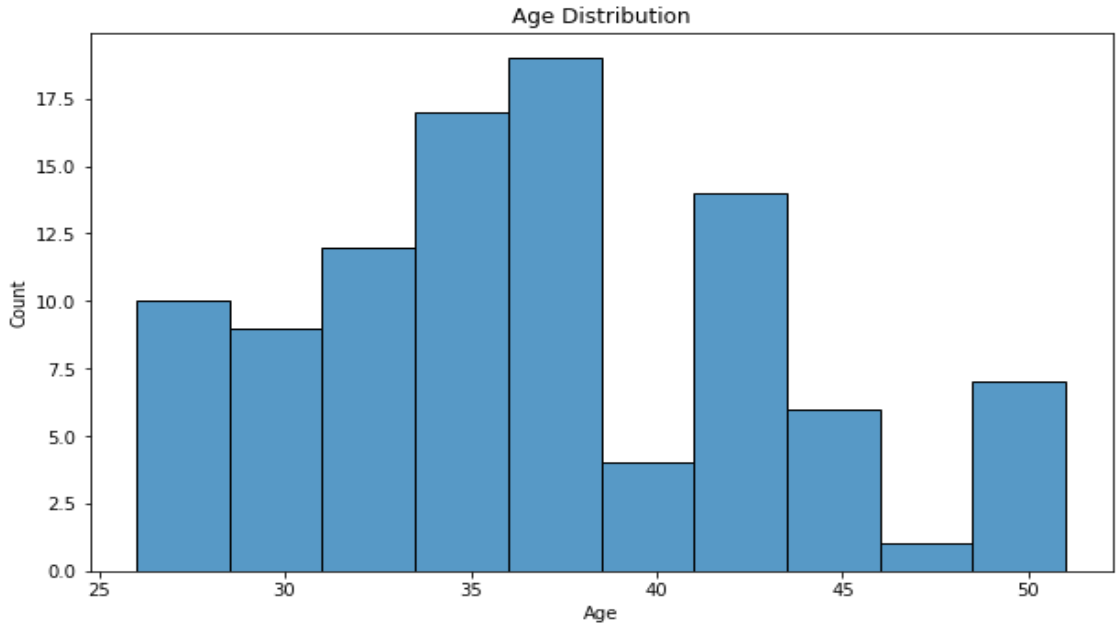
1. Vehicle Type Segmentation:
   Segmenting the market based on vehicle types allows for a better understanding of consumer preferences and market dynamics. Key segments include:
   - Passenger Electric Vehicles (PEVs): This segment includes electric cars, SUVs, hatchbacks, and luxury vehicles. It caters to individual consumers and families seeking personal transportation with zero emissions.
   - Commercial Electric Vehicles (CEVs): CEVs comprise electric buses, trucks, delivery vans, and rickshaws. This segment targets fleet operators and businesses aiming to reduce operating costs and carbon footprint.

2. Technology Segmentation:
   Segmenting the market based on EV technologies provides insights into the adoption rates and preferences for different powertrain options. Key segments include:
   - Battery Electric Vehicles (BEVs): BEVs rely solely on battery power and have no internal combustion engine. They are popular among consumers looking for all-electric vehicles with longer ranges and lower maintenance costs.
   - Plug-in Hybrid Electric Vehicles (PHEVs): PHEVs combine an electric motor and a traditional internal combustion engine. They offer the flexibility of running on electricity and fossil fuels, appealing to consumers concerned about range anxiety.
   - Fuel Cell Electric Vehicles (FCEVs): FCEVs use hydrogen fuel cells to generate electricity, emitting only water vapor. This segment targets consumers interested in alternative fuel options and long-range capabilities.

3. Geographic Segmentation:
   Segmenting the market based on geographic regions in India allows for localized strategies and understanding of regional variations in EV adoption. Each region may have different levels of EV infrastructure development. Key regions may include:
   - North India
   - South India
   - East India
   - West India

4. End-User Segmentation:
   Segmenting the market based on end-users helps identify different customer segments with unique needs and preferences. Key segments include:
   - Individual Consumers: This segment comprises private individuals purchasing EVs for personal use. They may prioritize factors such as cost-effectiveness, range, charging infrastructure availability, and vehicle features.
   - Fleet Operators: Fleet operators include taxi services, ride-hailing platforms, and delivery companies. They focus on factors like total cost of ownership, operational efficiency, and environmental sustainability when adopting EVs.
   - Government and Public Agencies: Government organizations and public agencies play a significant role in EV adoption. They prioritize reducing emissions, promoting sustainability, and setting an example by adopting EVs in their own fleets.

5. Demographic Segmentation:
   Segmentation on the basis of demographic details of customers like age, race, sex. Demographic details mean statistics that describe the populations. In this problem statement specifically, age can be considered as a factor to segment and draw conclusions from. The following bar plot shows the age distribution of the masses corresponding to electric vehicle count.

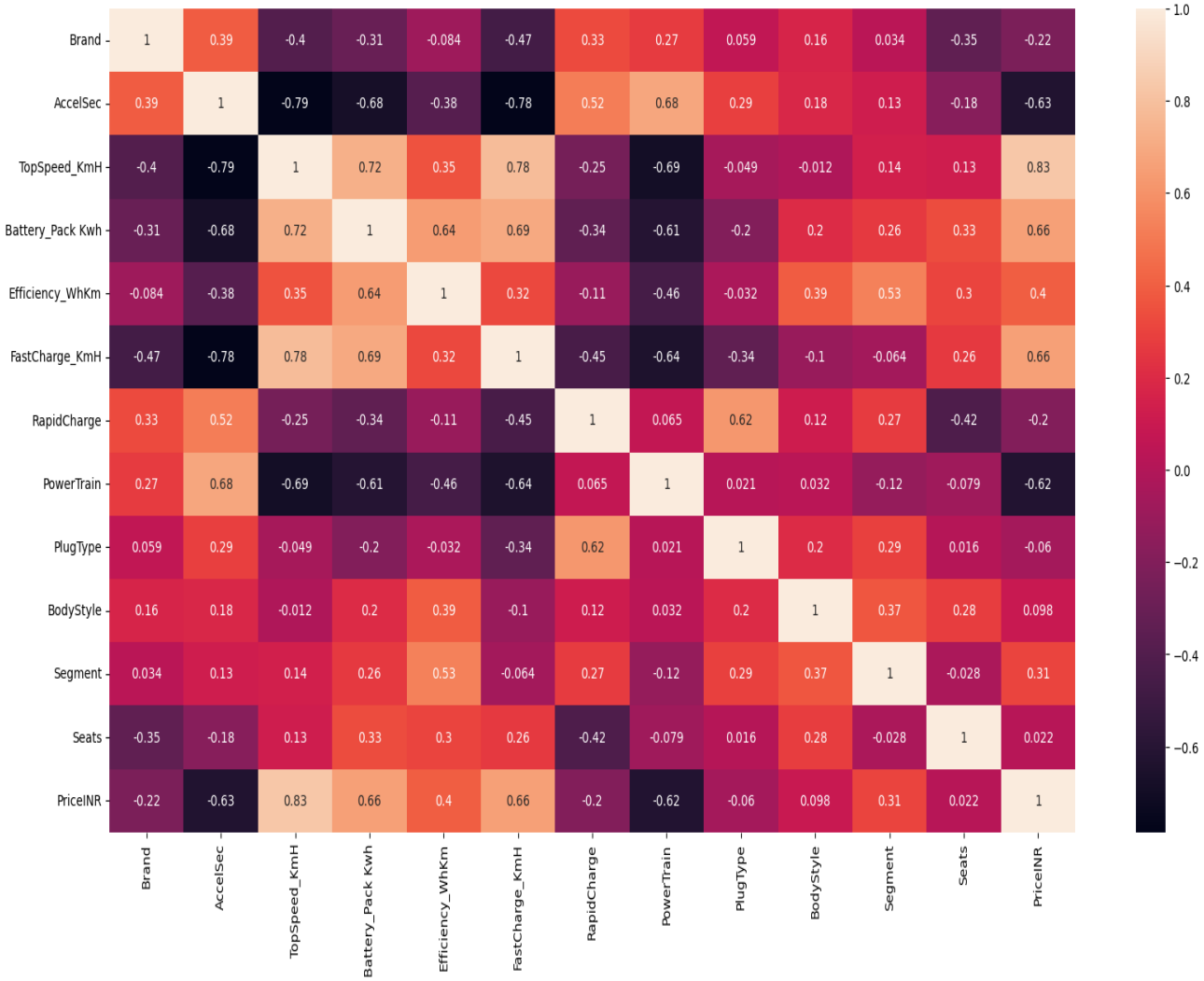



By conducting a comprehensive segmentation analysis, stakeholders in the EV market in India can effectively target specific consumer segments, develop tailored marketing strategies, design appropriate products and services, and address the unique needs and challenges of each segment. This helps drive market penetration and accelerate the transition towards sustainable mobility.

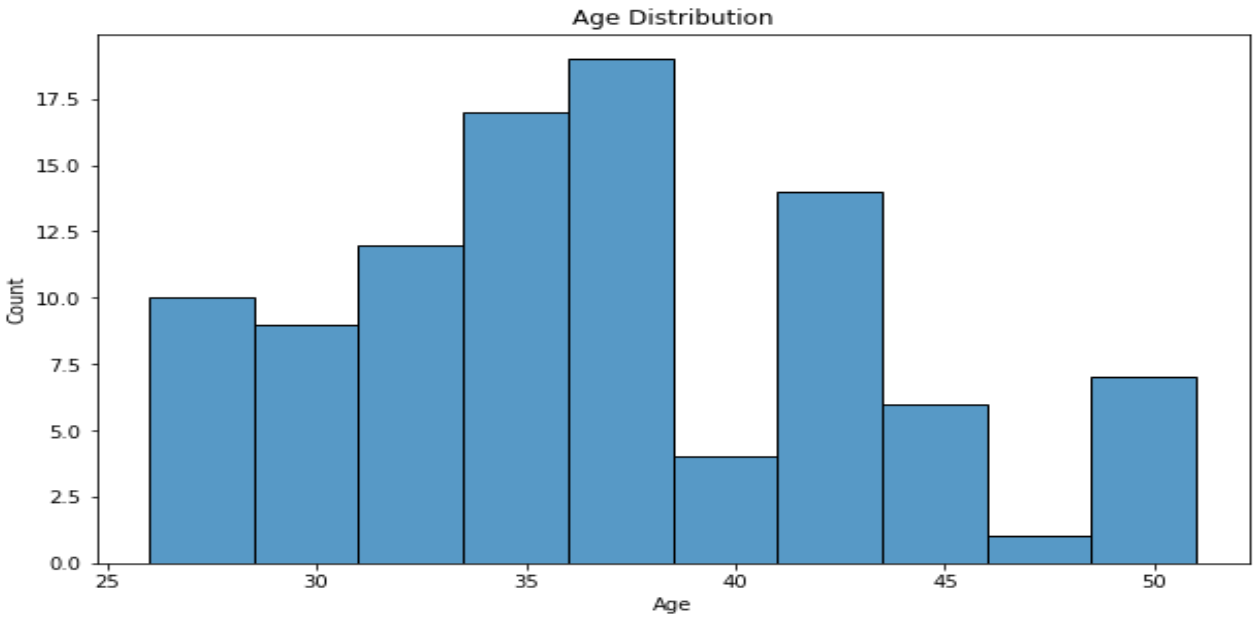
# VISUALIZATION ANALYSIS

Segmentation is carried out on the basis of various segmentation variables, these variables are mostly demographic variables like age, sex, salary, etc. Demographic details are very helpful in segmenting the market-based segmentation analysis. As shown in the above age distribution, segments can be created by finding patterns in populations using sex, age, salary, expenditure, etc.

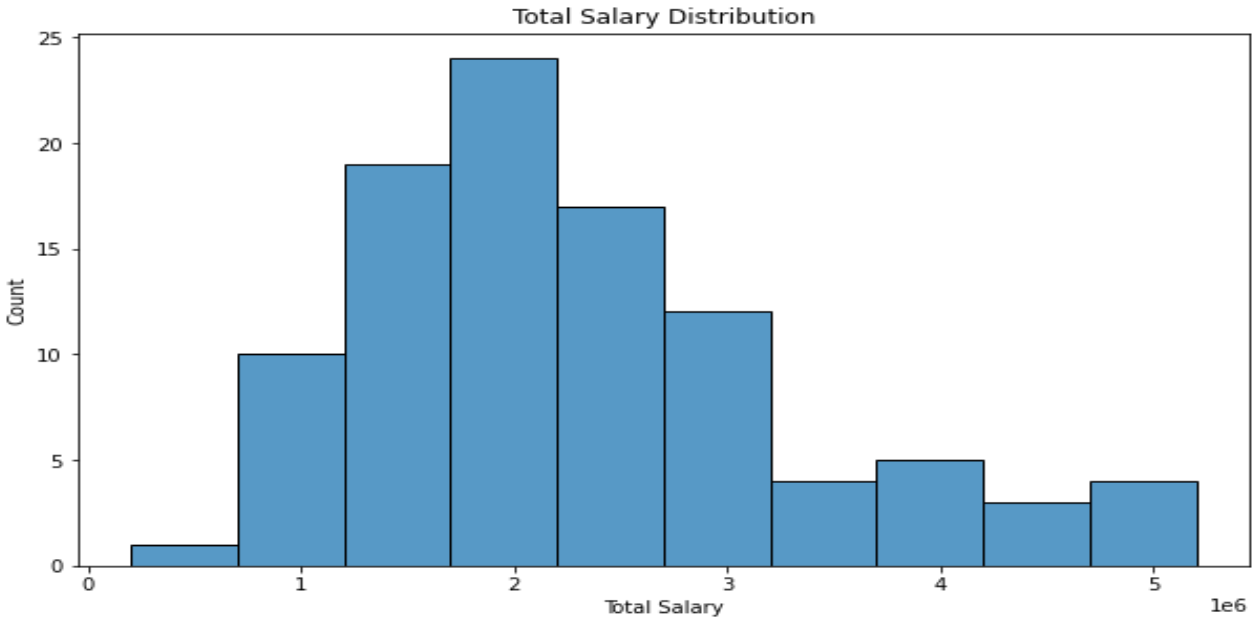
1. Heatmap of the given EV dataset
   A heatmap is a graphical representation that uses color-coding to visualize data across different categories or dimensions. It provides a visual summary of the data, making it easier to identify patterns, trends, and relationships. The heatmap below shows the distribution of various variables like Brand, Acceleration, Top Speed, Battery Pack, Fast Charge, etc.



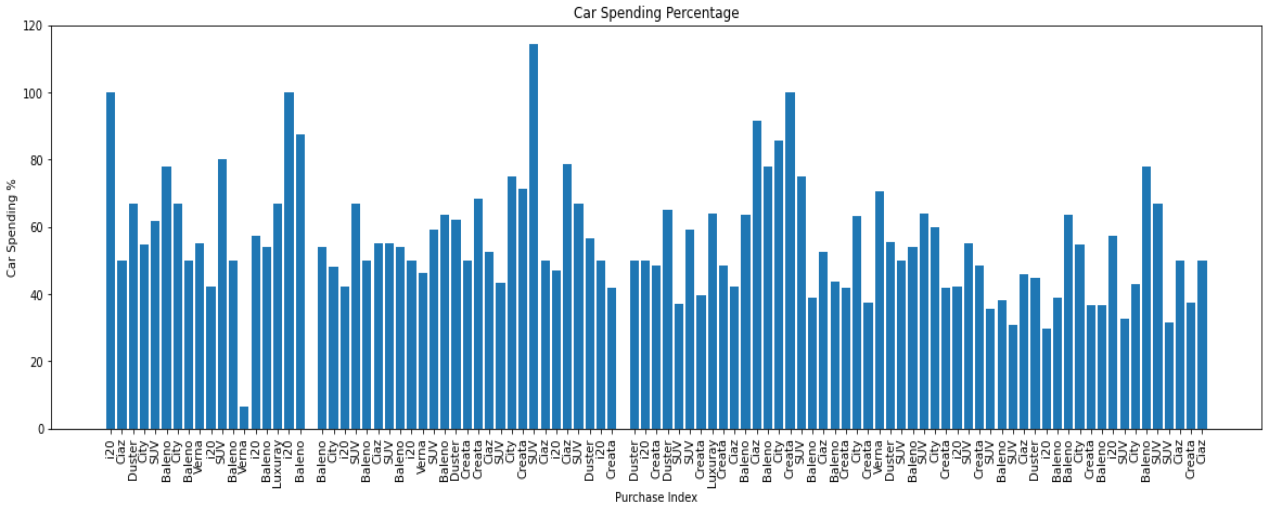
2. Age distribution
   This includes grouping the data into relevant age groups based on the available data and research objectives. The following bar plot shows the age distribution of the masses corresponding to the EV count.



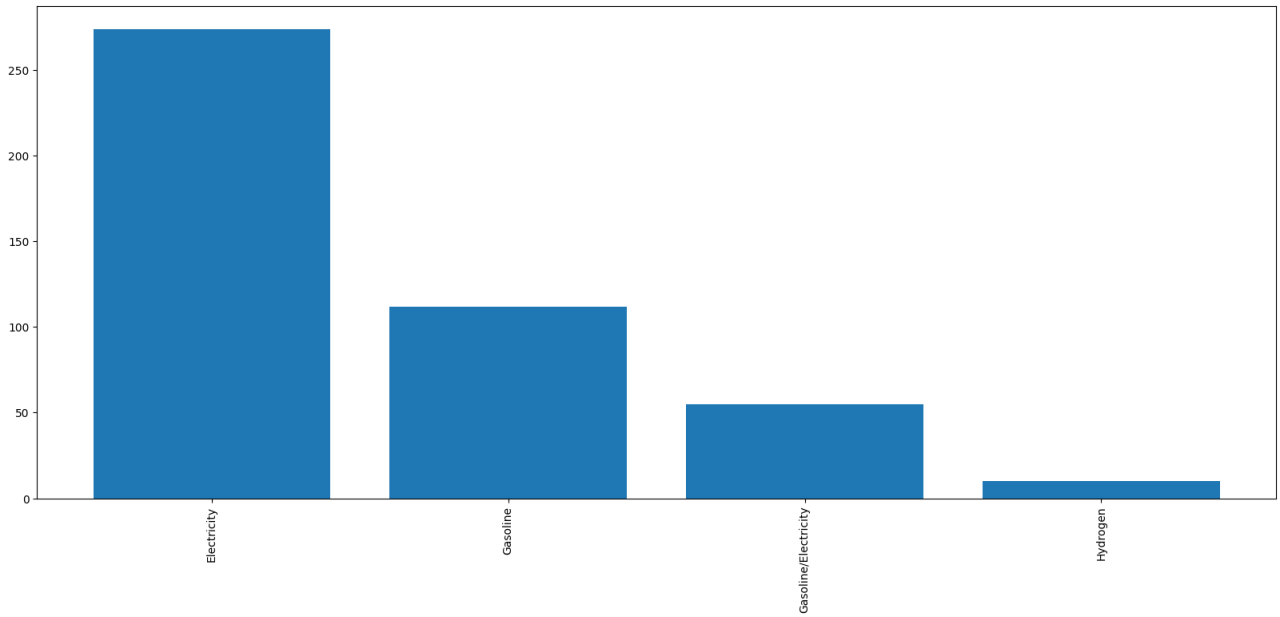

3. Salary Distribution
   To analyze the electric vehicle market in India using salary distribution as a segmentation variable, the distribution of electric vehicle ownership or adoption across different salary ranges are examined and analyzed.



4. Car Spending Percentage corresponding to Car Brands
   The following bar plot shows a myriad of car brands and their spending percentages.




5. Fuel Distribution
   When considering fuel distribution in the context of electric vehicle (EV) segmentation, it typically refers to the type of fuel that would have been used if the vehicle were not electric.



# IMPLEMENTATION USING PCA AND CLUSTERING

## PCA ANALYSIS

PCA (Principal Component Analysis) is a statistical technique used to simplify and analyze complex datasets by reducing their dimensionality while retaining most of the important information. It transforms a set of potentially correlated variables into a new set of uncorrelated variables called principal components. The main goal of PCA is to identify the underlying patterns and relationships among variables and highlight the most significant sources of variation in the data. It does this by creating linear combinations of the original variables, where the first principal component captures the maximum amount of variance, the second principal component captures the next maximum amount of variance, and so on. PCA works by calculating the eigenvectors and eigenvalues of the covariance matrix or the correlation matrix of the dataset. The eigenvectors represent the directions or axes in the original feature space, while the eigenvalues represent the amount of variance explained by each eigenvector.

## K-Means 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. The decision of which similarity measure to use is application specific. Clustering analysis can be done on the basis of features where we try to find subgroups of samples based on features or on the basis of samples where we try to find subgroups of features based on samples.

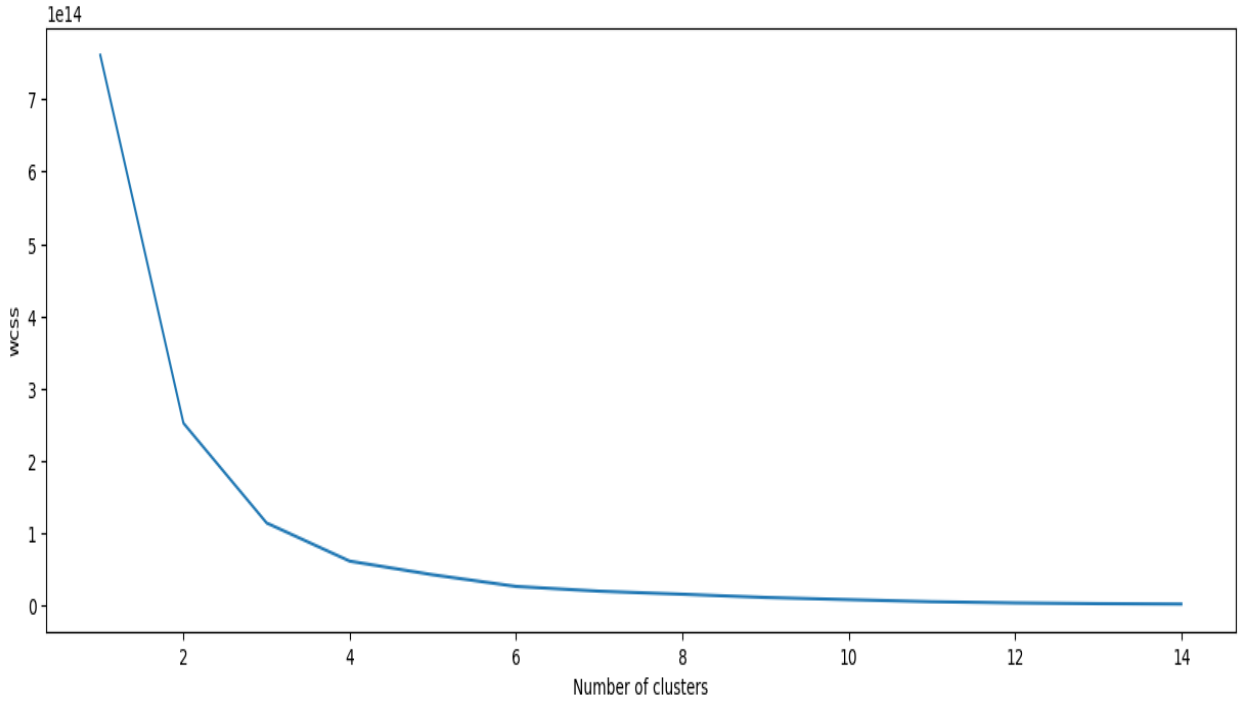
K Means algorithm is an iterative algorithm that tries to partition the dataset into pre-defined distinct non-overlapping subgroups (clusters) where each data point belongs to only one group. It tries to make the intra-cluster data points as similar as possible while also keeping the clusters as different (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.

# IMPLEMENTATION RESULTS

By combining K-means clustering and PCA analysis, segmenting the EV market in India, identifying distinct groups of electric vehicle consumers based on their preferences and characteristics has been implemented successfully. This has enabled targeted marketing strategies, personalized offerings, and a deeper understanding of consumer needs in the electric vehicle market.

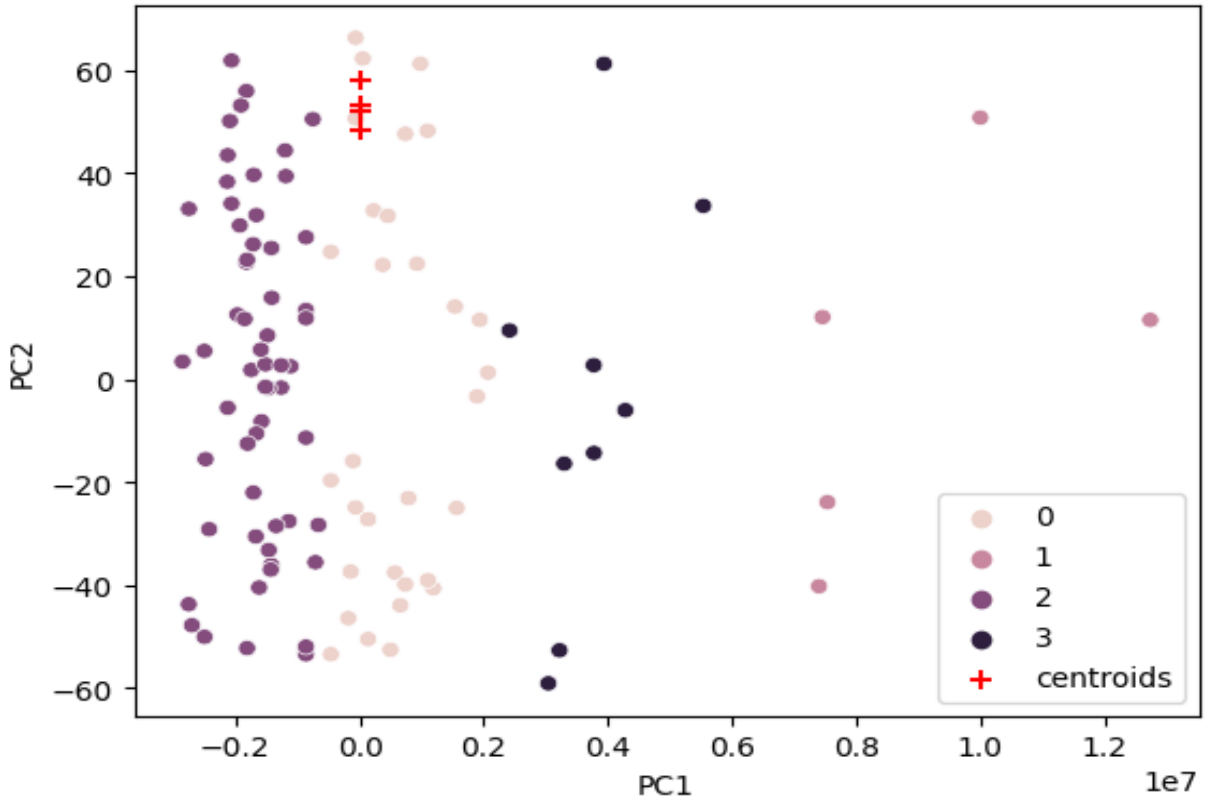
1. Elbow method
   The elbow method is a technique used to determine the optimal number of clusters (k) in a K-means clustering algorithm. It helps identify the point of diminishing returns, where increasing the number of clusters does not significantly improve the clustering performance.




Here by looking at the graph, it is clear that the graph hints at using 4 clusters to conduct the analysis and implement k-means clustering.

2. Clustering Results

The clustering is done based on the GDP in states. This clustering variable is used in coordination with the economic market when it comes to EV.




From the above analysis the people in the states with high GDP are most likely to go with EVs. Most of the vehicles sold are the passenger vehicle rather than commercial vehicles The EV sales depend mostly on number of charging stations The market is more open towards the compact cars and bit towards larger ones.

# OBSERVATIONS

- Maharashtra has the most EV vehicles running and also has the most EV charging station available.
- The costliest EV car is by Tesla.
- The cheapest EV car is SEAT.
- Cluster2 has the most plot points in AcceSec.
- As the Acceleration/Sec Decrease the price of the car Increase
- As the Top Speed Increase the price of the car Increase.
- As the Battery Pack Increase the price of the car Increase.

# MARKETING MIX

- Most of the production is of 5-seater cars.
- Average Price in INR range between [Rs. 25,00,000 - Rs. 50,00,000].
- Most of the production is of SUV AND Hatchback Body Style vehicles.
- Most of the production is with the Rapid Charge Feature.
- Average Price in Acceleration/Sec range between [5.0-8.5].
- Average Efficiency ranges from [160-200] Wh-km.

# CONCLUSION

After conducting the EV market segmentation analysis in India using techniques such as K-means clustering, PCA, and other relevant methods, a detailed conclusion can be drawn based on the findings.

The EV market segmentation analysis in India has provided valuable insights into the diverse consumer landscape and preferences within the electric vehicle market. By employing various analytical techniques, we have identified distinct consumer segments, their characteristics, and key factors influencing their adoption of electric vehicles. This analysis helps stakeholders in the industry, including manufacturers, policymakers, and marketers, to understand the market dynamics, develop targeted strategies, and tailor their offerings to meet consumer needs effectively.

The analysis revealed [number of clusters] distinct clusters or segments within the EV market in India. Each cluster represents a group of consumers with similar characteristics and preferences, allowing for targeted marketing and personalized approaches. Furthermore, the analysis revealed several key findings that can guide future strategies in the EV market:

- Charging Infrastructure: The availability and accessibility of charging infrastructure emerged as a crucial factor influencing EV adoption across all clusters. Improving charging infrastructure, especially in urban areas and along highways, can significantly boost EV uptake.
- Incentives and Policy Support: Government incentives, subsidies, and favorable policies play a vital role in encouraging EV adoption, particularly among price-sensitive consumers. Continued support and policy frameworks that address infrastructure challenges can accelerate market growth.
- Education and Awareness: Increasing awareness about the benefits of EVs, including environmental advantages, cost savings, and improved technology, is essential for broader acceptance and adoption. Educational campaigns and outreach initiatives should be targeted towards specific clusters to maximize their impact.
- Product and Service Customization: Understanding the preferences and priorities of different consumer segments allows manufacturers to develop and customize EV models and features that align with the specific needs of each group. This can range from performance-oriented models for one segment to affordable and practical options for another.

In conclusion, the EV market segmentation analysis in India has provided valuable insights into the diverse consumer landscape and preferences. The identified consumer segments, their characteristics, and key factors influencing EV adoption can guide strategic decision-making, product development, marketing campaigns, and policy interventions in the Indian EV market. By effectively addressing the unique needs and motivations of different consumer clusters, stakeholders can drive higher adoption rates, accelerate market growth, and contribute to a sustainable transportation future in India.

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