MARKET SEGMENTATION

Applying Segmentation Analysis to Analyse the relevant Indian market for the launch of electric vehicles

By :
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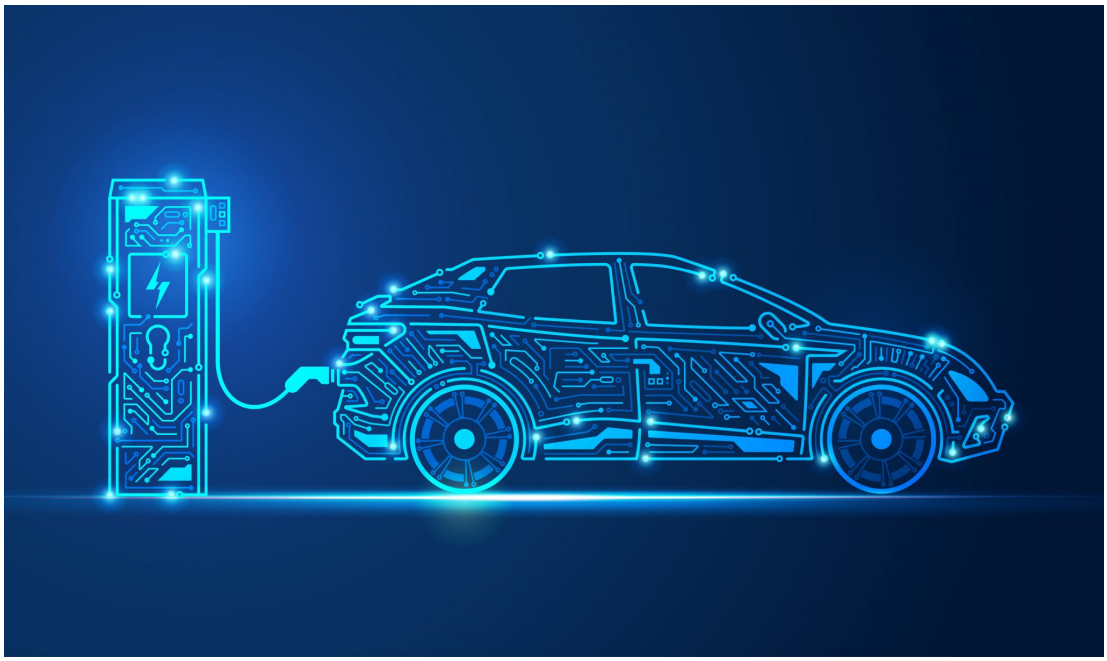


Overview

This study uses a segmentation-based approach to provide a comprehensive analysis of the Indian Electric Vehicle (EV) industry. It seeks to provide a comprehensive understanding of the current state in which the EV market resides, analyse the variables driving growth, analyse market segments for strategic choices The study analyses prospects and emerging trends, and it provides insight into the challenges of the industry.

Electric vehicles (EVs) have emerged as a promising solution for sustainable transportation, reducing carbon emissions and reducing India's dependence on fossil fuels , as one of the world's largest auto markets, has also seen a significant increase in the adoption of EVs. This introduction provides an overview of electric vehicles, the EV market in India, and the importance of segmentation analysis to understand the market scenario.

An electric vehicle is a vehicle that uses one or more electric motors for propulsion , draws energy from rechargeable batteries or other energy storage devices Unlike (ICEVs), EVs eliminate background emissions, helping to improve air quality and air a reduces greenhouse gas emissions EVs can be divided into different categories, including Passenger Electric Vehicles (PEVs) and Commercial Electric Vehicles (CEVs), each Meeting specific transportation needs.

Several factors have led to the expansion of the EV market in India in recent years. Supportive legislation and incentives by the Indian government to promote green and sustainable transport have accelerated EV adoption The market has grown due to rising fuel prices, air pollution concerns and availability of battery technology, While there is scope for expansion, India's EV sector faces constraints.

Barriers to widespread adoption include lack of adequate payment infrastructure, higher prices than conventional vehicles, and customer accessibility problems, however, ongoing services and investments in payment systems, support systems, and partnerships with government agencies. It segments the market based on several criteria such as vehicle type, technology, end-user and region.

This segmentation process provides a deeper understanding of market dynamics, customer preferences and expansion potential. The EV market can be segmented based on the types of vehicles sold, such as passenger cars, SUVs, buses, trucks, rickshaws and each segment has its own target market, growth prospects and market characteristics.

A similar technology-based classification distinguishes battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and electric vehicles that fuel-efficient (FCEVs) network, which determines the market application of the technology. Provides information on power and trends.

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.

METHODOLOGY

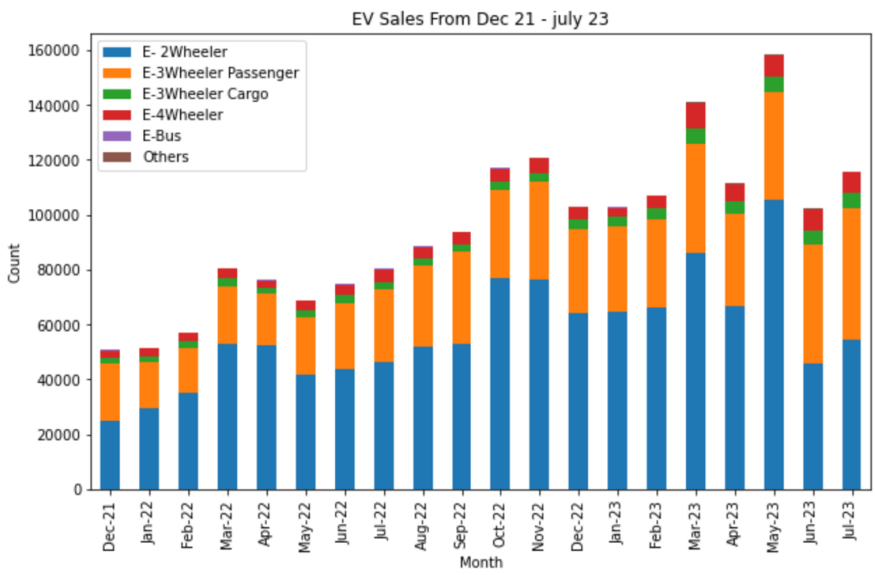
1. Data Collection:
    - Gather relevant data from multiple sources, including market reports, government publications, industry databases, and research papers.
    - Collect data on various parameters such as vehicle type, technology, sales figures, charging infrastructure, consumer preferences, and 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.

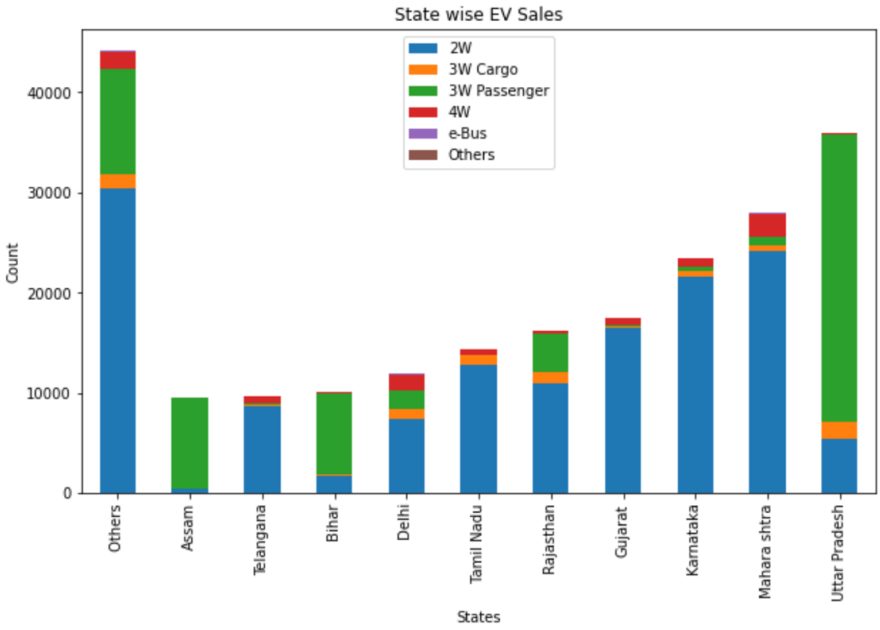
This methodology provides a comprehensive and data-driven approach to understanding the EV market in India. It helps identify distinct market segments, uncover hidden patterns and relationships in data, and derive meaningful insights and conclusions to drive strategic decision- making and market strategies.

MARKET OVERVIEW

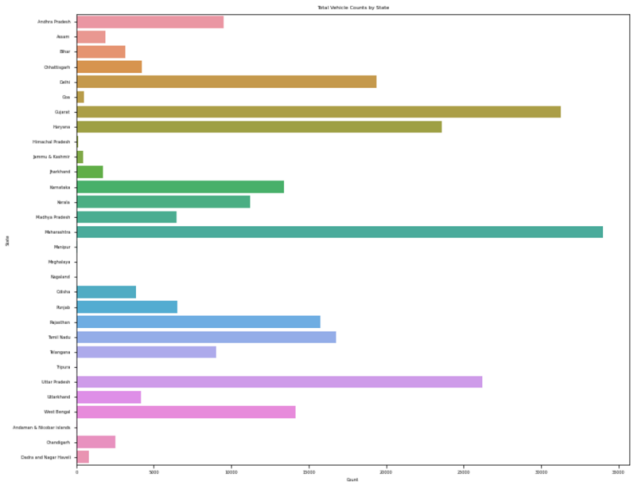
The distribution of Electric Vehicles differs extensively in each state of India. Due to the EV market and various factors, some states have a huge number of growing potentials for EV compared to other states. The analysis conducted showcases the distribution of EV vehicles in various states comparatively.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

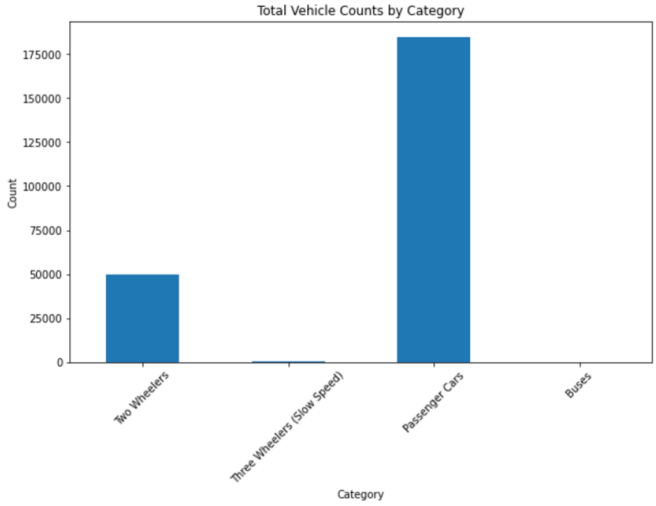
The following plots are analysis done based on first dataset.





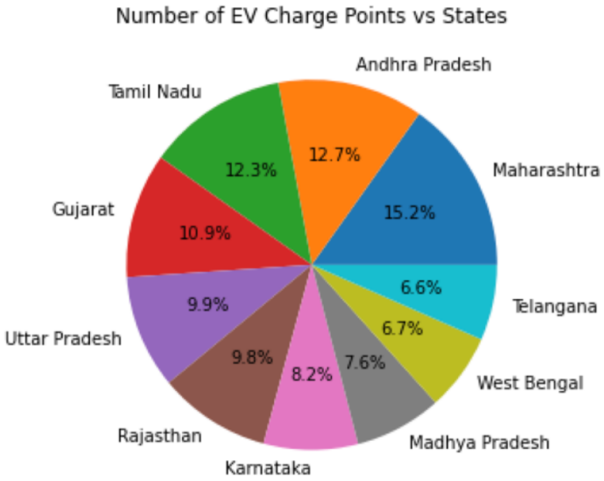
The following plots are analysis done based on second dataset.





From the plots when can clearly say that passenger electric cars are being consumed mostly by States like Maharashtra, Uttar Pradesh and followed by other States at a high rate followed by two wheelers.

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.



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:

Vehicle Type Segmentation:

Segmenting the market based on vehicle types allows for a better understanding of consumer preferences and market dynamics. Key segments include:

1. 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.
2. 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.

Technology Segmentation:

Segmenting the market based on EV technologies provides insights into the adoption rates and preferences for different powertrain options. Key segments include:

1. 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.

2. 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.
3. 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.

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

End-User Segmentation:

Segmenting the market based on end-users helps identify different customer segments with unique needs and preferences. Key segments include:

1. 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.
2. 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.
3. 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.

Demographic Segmentation:

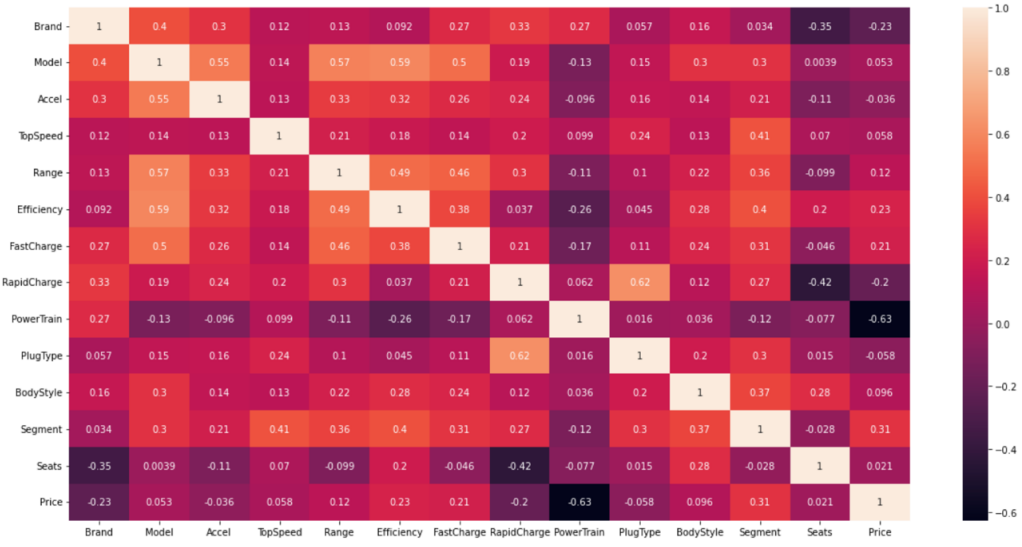
Segmentation on the basis of demographic details of customers like age, race, sex. Demographic details mean statistics that describe the populations. In this problem statement specifically, age can be considered as a factor to segment and draw conclusionsfrom. The following bar plot shows the age distribution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

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.

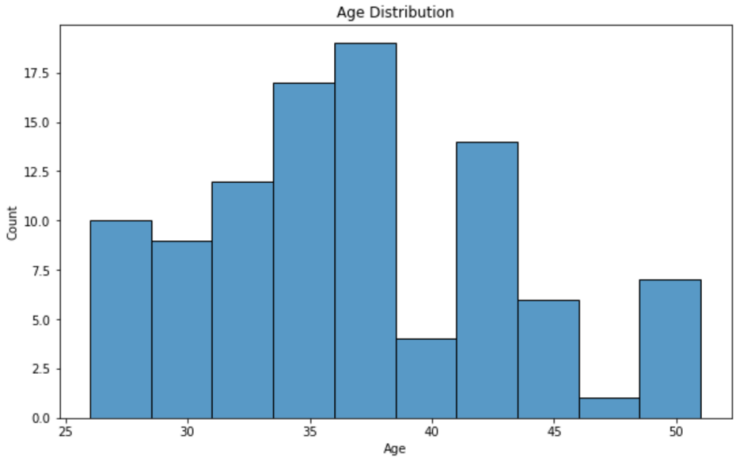
Heatmap of the EV dataset

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.



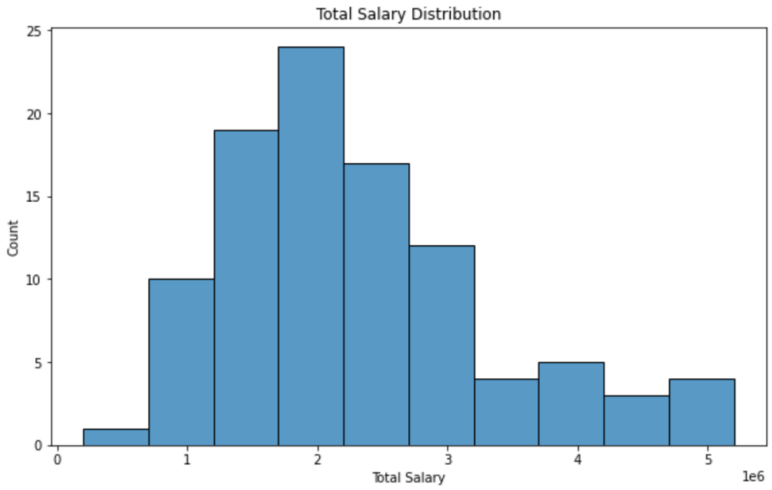
Age distribution

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.

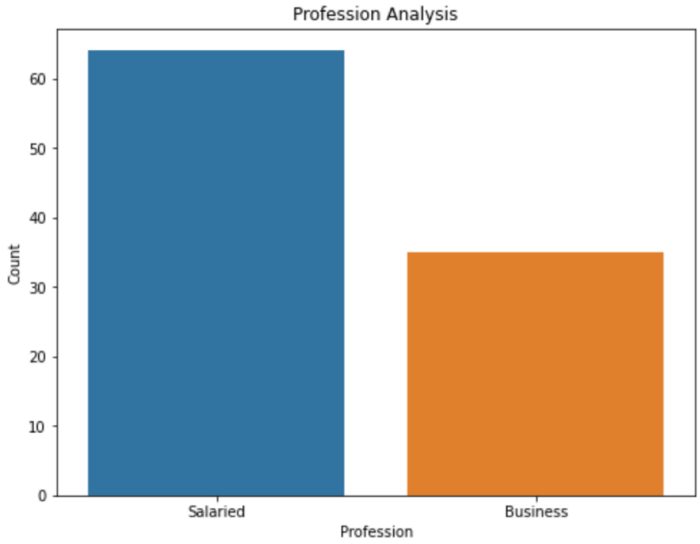


Salary Distribution:

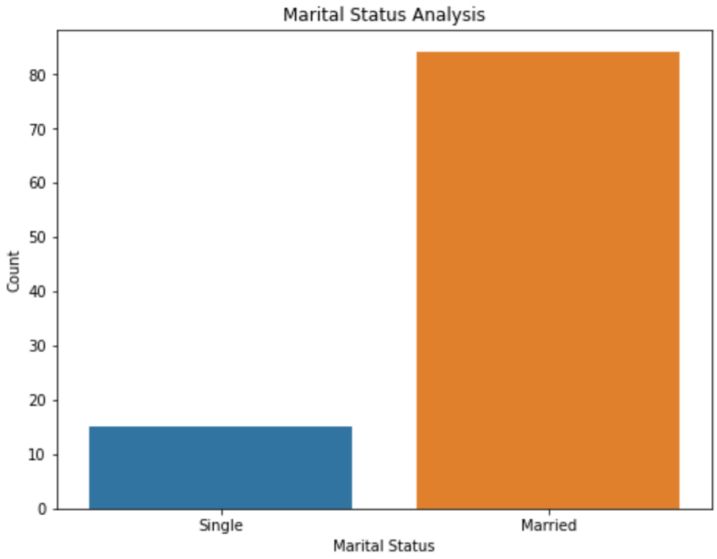
To analyze the electric vehicle market in India using salary distribution as a segmentationvariable, the distribution of electric vehicle ownership or adoption across different salaryranges are examined and analyzed.



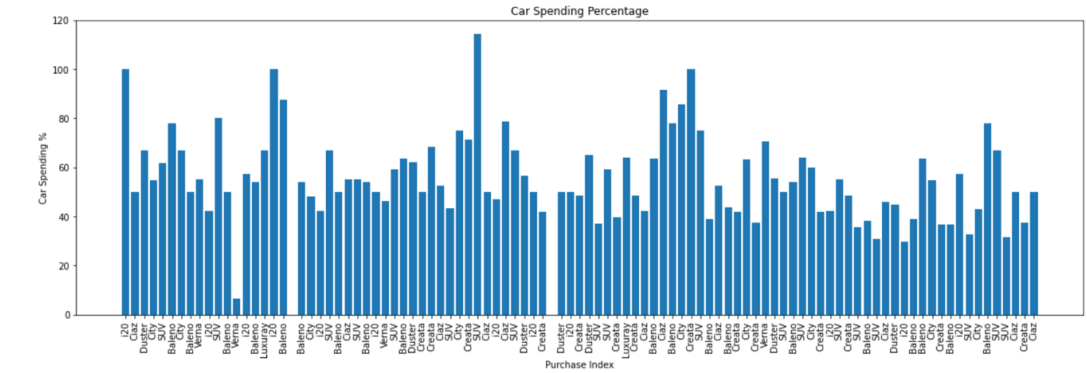
Profession Analysis:

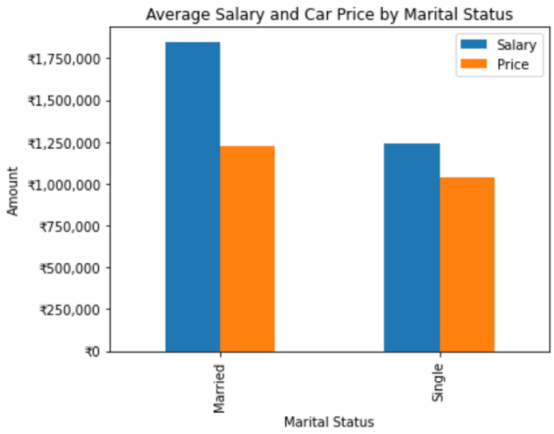


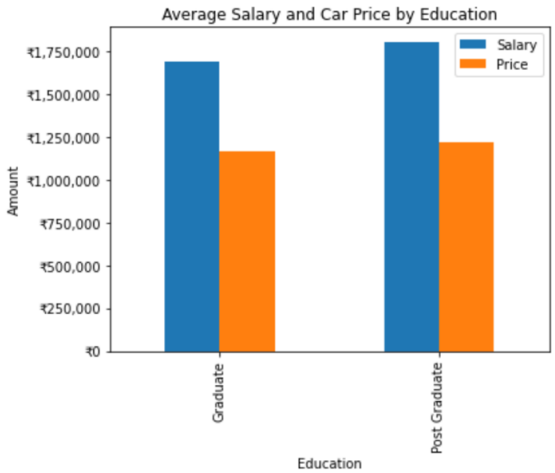
Marital Status Analysis:

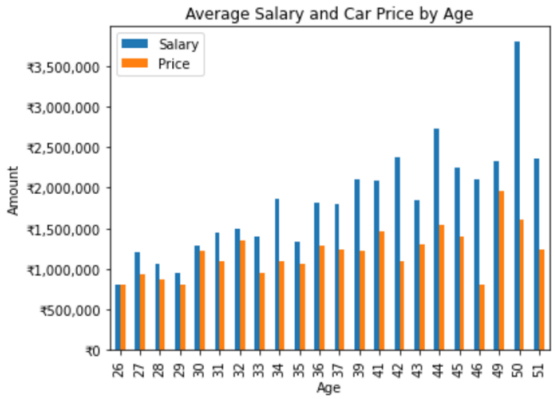


Car Spending Percentage corresponding to Car Brands
The following bar plot shows a myriad of car brands and their spending percentages.









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:

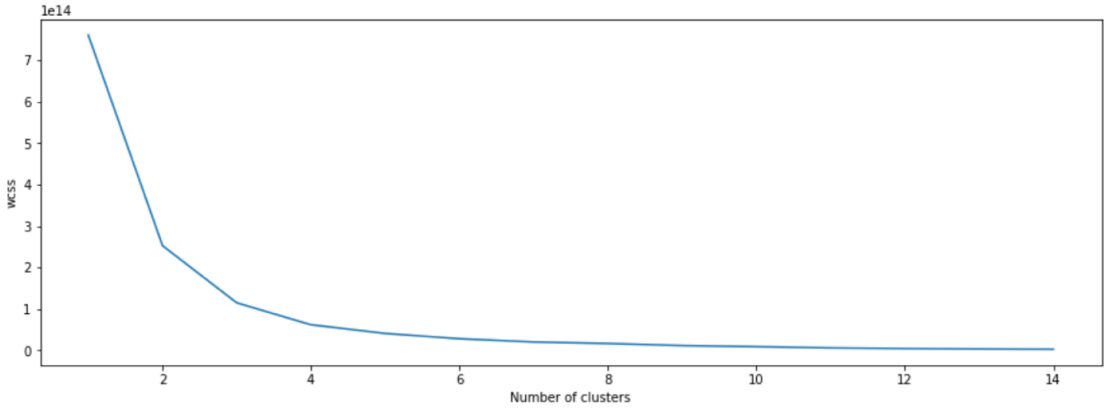
- Specify number of clusters K.
- Initialize centroids by first shuffling the dataset and then randomly selecting K datapoints for the centroids without replacement.
- Keep iterating until there is no change to the centroids. i.e. assignment of data pointsto clusters isn't changing.

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.

The Elbow Method:

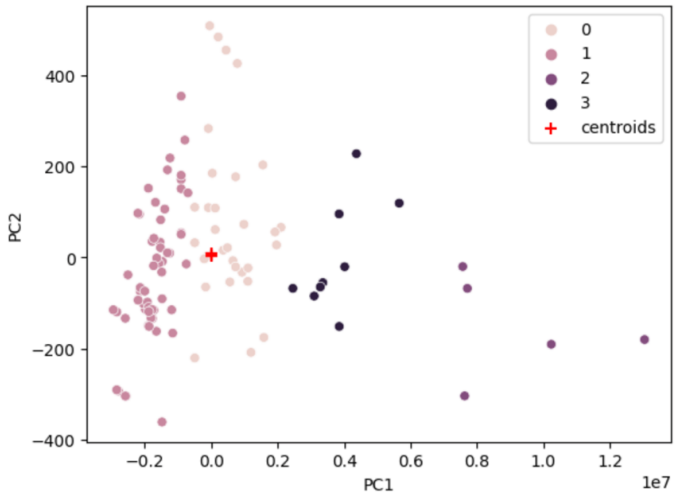
The elbow method is a technique used to determine the optimal number of clusters (k) in a K-means clustering algorithm. It helps identify the point of diminishing returns, where increasing the number of clusters does not significantly improve the clustering performance.



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.

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.

CONCLUSION

Based on the results of the EV market segmentation analysis in India using K-means clustering, PCA, and other related techniques, a valid conclusion can be drawn The analysis of the segmentation of the electric vehicle market in India has shed light on the types and preferences of customers. We used a variety of analytical methods to identify customer segments, characteristics and key factors that led to the adoption of electric vehicles. This research helps business stakeholders, such as manufacturers, policy makers, and marketers, understand market dynamics, develop focused strategies, and adapt them optimizing the supply chain to meet customer desires.

The study identified several clusters or sectors and the number of clusters in the Indian EV market. Each group represents a collection of customers with comparable characteristics and preferences, enabling targeted advertising and personalized strategies. Additionally, the study revealed some key results that could guide future EV market strategies:

• Charging Infrastructure: Across all clusters, the accessibility and availability of charging infrastructure emerged as a critical determinant of EV adoption. The adoption of EVs can be considerably increased by improving the charging infrastructure, particularly in urban areas and along roads.

• Government Incentives, Subsidies, and Favourable Policies: Government incentives, subsidies, and favourable policies are crucial in promoting EV adoption, especially among price-sensitive consumers. Market expansion can be sped up by sustaining support and establishing legislative frameworks that address infrastructure problems.

• Education and understanding: Broader acceptance and implementation of EVs depend on raising public understanding of their advantages, including their environmental benefits, financial savings, and enhanced technology. To have the most impact, educational programmes and outreach programmes should target particular clusters.

• Product and Service Customization: Recognising the preferences and wants of various consumer categories enables manufacturers to create and alter EV models and features that cater to each group's particular requirements. This can range from cost-effective and useful solutions for one segment to models that are performance-oriented for another.

In conclusion, the segmentation analysis of the EV market in India has shed light on consumer trends and prevailing desires. Strategic decision making, product development, marketing strategy and regulatory interventions in the Indian EV industry can be guided by identified customer segments, characteristics and important factors affecting EV adoption can Stakeholders Sustainable Transport India by effectively addressing the specific requirements and motivations of different customer segments be able to support the transition.