Electric Vehicle Market Segmentation Analysis

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Introduction

This report presents the analysis of the Electric Vehicle (EV) market in India using segmentation analysis. The goal is to identify key market segments and develop a feasible strategy for an EV startup to target the segments most likely to use electric vehicles.

Problem Statement

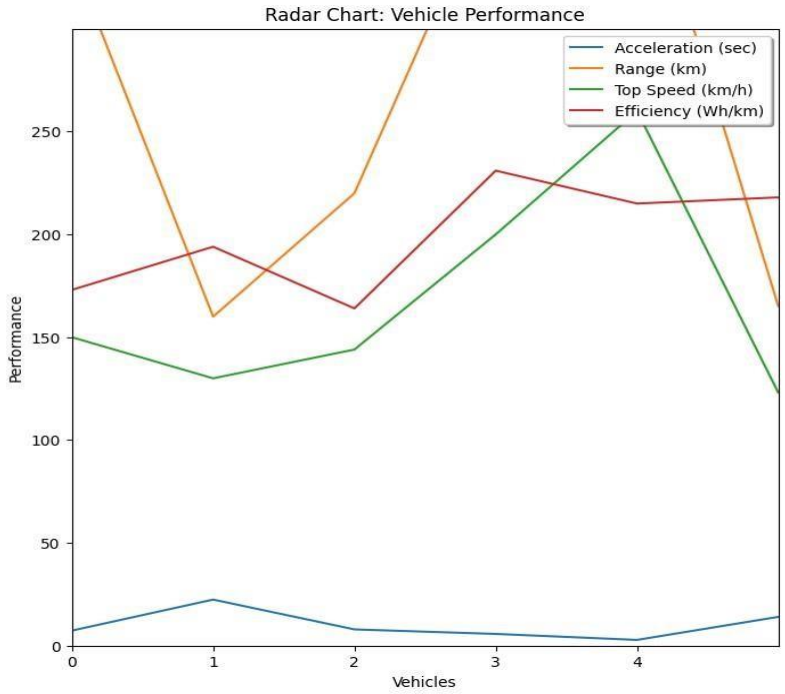
Identify the most feasible segment in the Indian electric vehicle market to target, develop a strategy to enter the market, and determine the type of electric vehicle to develop that meets the needs and preferences of the target segment, in order to successfully establish the startup in the competitive Indian EV market.

Data Sources

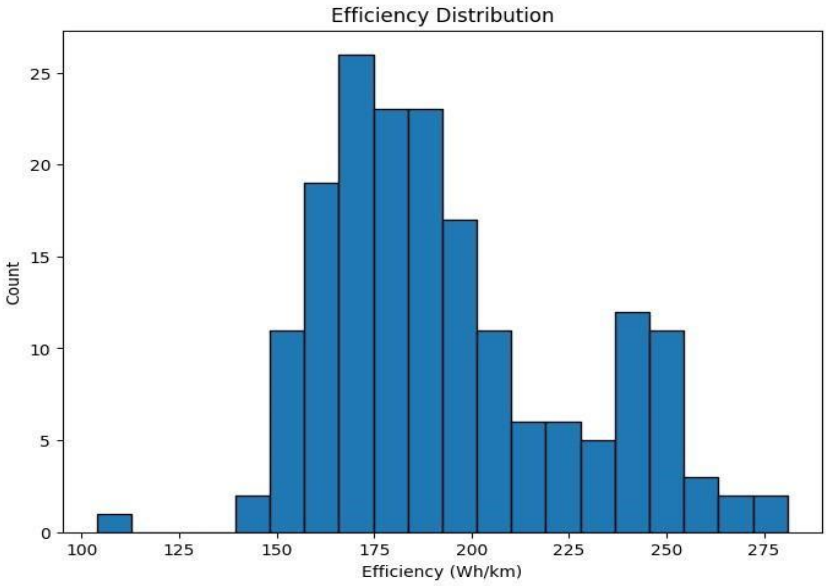
Electric Vehicle Database (Cheapestelectriccars-EVDatabase.csv)

Data Pre-processing

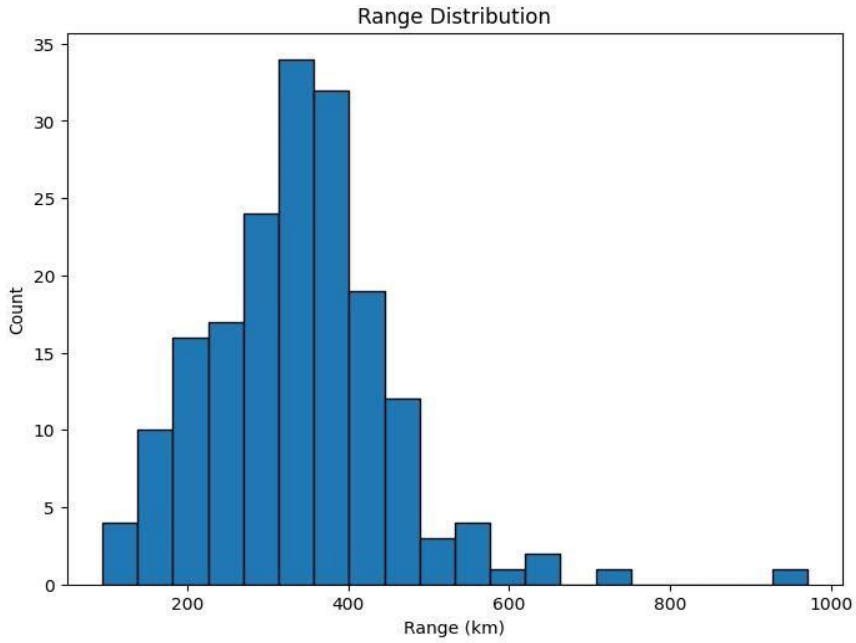
- Import necessary libraries (pandas, numpy, matplotlib, seaborn, scikit-learn)
- Load and clean the dataset (handle missing values, data formatting)
- Split the Subtitle column into two separate columns (VehicleType and BatteryCapacity)
- Convert data types (TopSpeed, FastChargeSpeed, Range, Efficiency, Acceleration) to numerical values
- Scale the data using StandardScaler
- Converted from a string (e.g., '150 km/h') to a float by removing the unit and converting the resulting string to a float using `str.replace` and `astype`.
- Extracted numerical values and converted to floats using `str.extract` and `astype`.

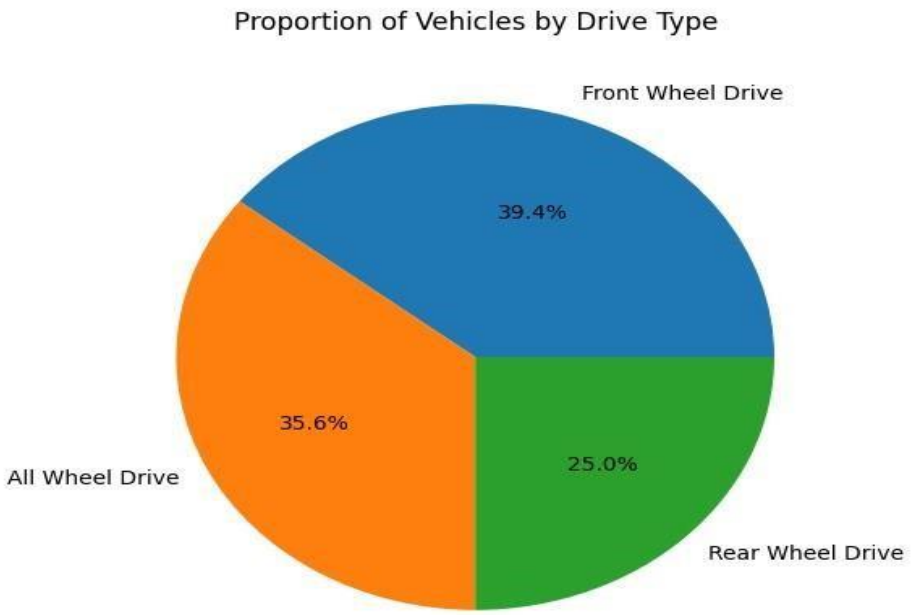


1. The dataset contains a wide range of electric vehicles with varying performance characteristics, including acceleration, top speed, range, and efficiency.
2. The radar chart shows that there is no single vehicle that excels in all performance metrics, indicating a trade-off between different characteristics.
3. In radar axes are typically scaled to a common maximum to allow easy comparison.



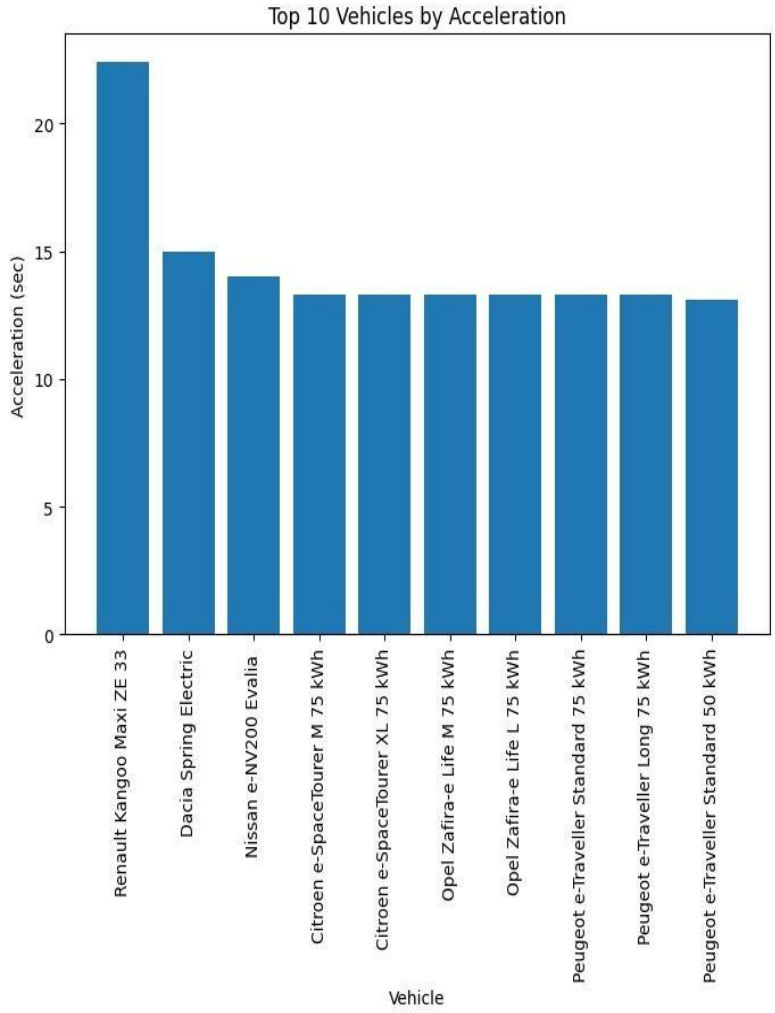
1. The histograms reveal that the distribution of efficiency, acceleration, and range are skewed, with most vehicles having moderate to high efficiency, moderate acceleration, and moderate to high range.
2. The scatter plots show positive correlations between acceleration and top speed, and between range and efficiency, indicating that vehicles with higher acceleration tend to have higher top speeds, and vehicles with higher range tend to have higher efficiency.



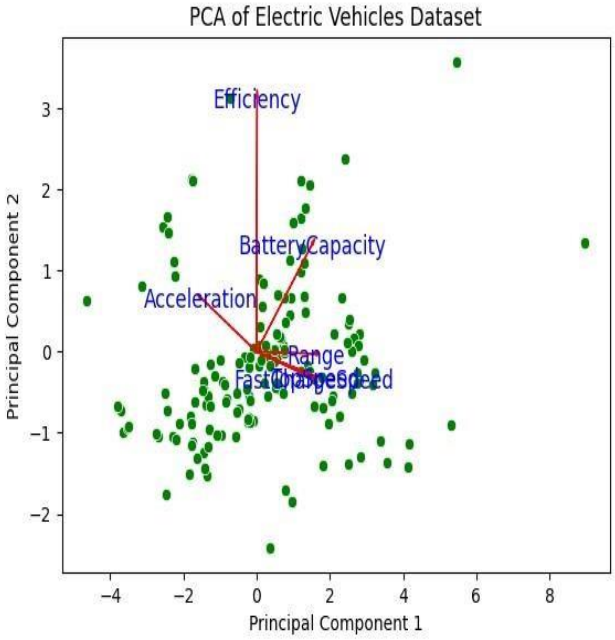


The bar charts show that the top 10 vehicles with the highest acceleration and range are mostly high-performance vehicles, while the top 10 vehicles with the highest efficiency are mostly city cars or compact cars.

The pie chart shows that the majority of vehicles have front-wheel drive, followed by all-wheel drive and rear-wheel drive.

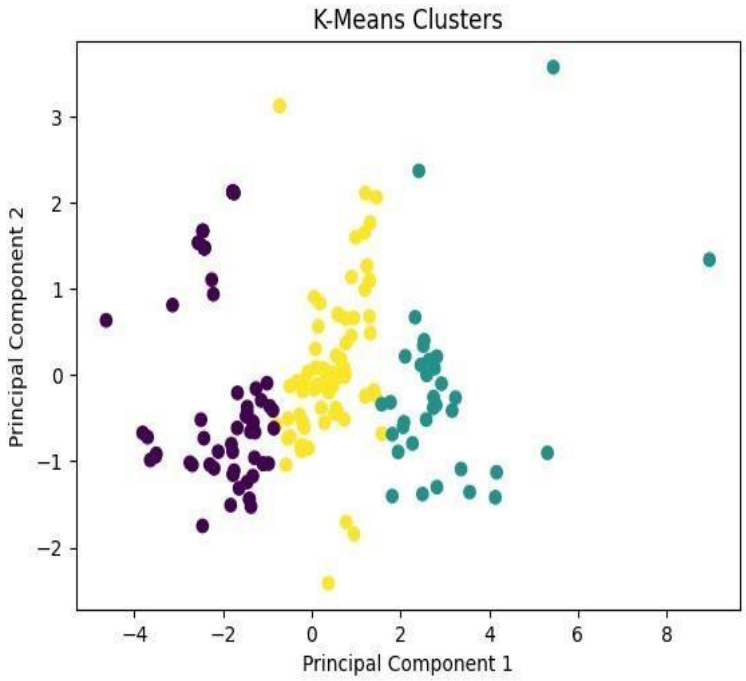


Top 10 Vehicles by acceleration



The PCA analysis reveals that the first two principal components explain a significant proportion of the variance in the data, indicating that the first two PCs capture most of the information in the data.

The scatter plot of the first two PCs shows that the vehicles are clustered into three groups, indicating that there are underlying patterns in the data that can be explored further.



The K-means clustering algorithm identifies three clusters of vehicles with similar performance characteristics, indicating that there are three distinct groups of vehicles in the dataset. The contingency table and mosaic plot show that there is a significant association between drive type and number of seats, with front-wheel drive vehicles having fewer seats than all-wheel drive vehicles.

Key Observations

1. Vehicles exhibit a broad range of acceleration times, indicating significant variability in performance. The majority of vehicles have a range between 200-400 km, suggesting a common target for manufacturers.
2. Most vehicles have top speeds clustered around 150-200 km/h. Efficiency values vary, but the majority of vehicles lie between 150-200 Wh/km, indicating a focus on energy efficiency.
3. Drive vs. Number of Seats giving most configurations are aligned with common seating capacities, indicating standard consumer preferences
4. Through PCA and K-means clustering, we can tailor our products to meet the specific needs of each segment. This segmentation ensures our offerings are highly relevant to different consumer groups.

Overall, our analysis provides a robust foundation for strategic decision-making in product development, marketing, and market positioning. By leveraging these insights, we can ensure our electric vehicles resonate effectively with the target market, driving higher market penetration and customer satisfaction.

Github Link : https://github.com/PritijaBhapkar/EV_Market_Segmentation_Analysis

ELECTRIC VEHICLE MARKET SEGMENTATION ANALYSIS

Gowthami Chunchu

5th July, 2024

Github Link: https://github.com/gowthamich35/Electric_vehicle_MarketSegmentation

Abstract:

This project undertakes a detailed examination of the electric vehicle market in India, emphasizing segmentation based on sales data, consumer feedback, and technical attributes. The research underscores the significant expansion of India's two-wheeler sector, marking it as a key revenue contributor. Through an analysis of behavioral data derived from customer feedback, we performed an extensive market segmentation using the k-means clustering algorithm. This segmentation delineated the market into four distinct groups.

Segment 1, accounting for 39% of the consumer base, emerges as the focal point of our strategic approach. This segment not only represents a significant market opportunity but also aligns perfectly with our business objectives. Our study recommends specific technical specifications for electric two-wheelers that cater to the preferences of Segment 1 consumers.

The proposed specifications, designed to match the needs of this segment, are central to our strategy. Additionally, the pricing structure is carefully positioned around the median market values to ensure both affordability and market competitiveness. This strategic focus on Segment 1, identified as the potential primary customer base, strategically positions our venture within the evolving landscape of India's electric vehicle market.

Introduction:

The electric vehicle (EV) market in India is on a dynamic growth trajectory, driven by increasing environmental awareness, favorable government policies, and technological advancements. Among the various segments within the EV market, the two-wheeler sector stands out due to its significant market potential and widespread consumer adoption. As India moves towards sustainable transportation solutions, understanding the intricacies of this burgeoning market becomes essential for stakeholders aiming to capitalize on its growth.

This study delves into a comprehensive analysis of the electric two-wheeler market in India. By integrating sales data, customer reviews, and technical specifications, we aim to uncover key insights and trends that define this sector. The analysis employs the k-means clustering algorithm to segment the market, providing a nuanced understanding of consumer behavior and preferences.

The research focuses on identifying distinct market segments, each characterized by unique needs and preferences. By examining these segments, we aim to provide actionable insights that can inform product development, marketing strategies, and business decisions. The goal is to align technical specifications and pricing strategies with the demands of different consumer groups, ensuring that the products offered resonate with their intended market.

K-means Clustering:

The k-means algorithm is a widely used clustering technique in data analysis and machine learning, known for its simplicity and effectiveness in partitioning datasets into distinct groups. It operates by initializing a set of k centroids, where k represents the number of desired clusters. The algorithm iteratively assigns each data point to the nearest centroid, forming clusters based on proximity. After assignment, the centroids are recalculated as the mean of all points within a cluster, and the process repeats until convergence, typically when the centroids no longer move significantly. This iterative process aims to minimize the within-cluster variance, resulting in clusters that are as distinct and cohesive as possible.

One of the primary strengths of the k-means algorithm is its computational efficiency, making it suitable for large datasets. However, the algorithm also has limitations. It requires the number of clusters, k, to be specified beforehand, which can be challenging to determine without prior knowledge of the data. Additionally, k-means is sensitive to the initial placement of centroids and can converge to local minima, leading to suboptimal clustering results. Despite these challenges, kmeans remains a popular choice due to its ease of implementation and ability to produce meaningful and interpretable clusters in a variety of applications, from market segmentation to image compression.

Data sources:

The First dataset, extracted from bikewale.com, comprises electric two-wheeler customer reviews, offering vital behavioural and psychographic insights2. These qualitative inputs proved invaluable in understanding customer behaviour.

The second dataset from bikewale.com presents detailed technical specifications and pricing information of electric two-wheelers2. This data allowed us to assess the technical feasibility and price points crucial for our market segmentation strategy.

By integrating these datasets, a robust understanding of the electric vehicle market was developed. Real sales data, customer sentiments, and technical specifics formed the foundation of our analysis, ensuring a data-driven, market-relevant segmentation approach. **Data Pre-processing:(steps and libraries used)**

we will import the libraries for our model, which is part of data pre-processing. The code is given below:

```
import numpy as np import
pandas as pd import
matplotlib.pyplot as plt import
seaborn as sns import missingno
as msno import nltk
from nltk.sentiment import SentimentIntensityAnalyzer
from sklearn.preprocessing import StandardScaler from
sklearn.decomposition import PCA
from sklearn.cluster import KMeans
```

Installed vaderSentiment using:

```
!pip install vaderSentiment
```

- NumPy: Library for numerical operations on large arrays and matrices.
- pandas: Library for data manipulation and analysis.
- Matplotlib: Library for creating static, animated, and interactive visualizations.
- Seaborn: Library for making statistical graphics.
- NLTK: Toolkit for working with human language data (text).
- SentimentIntensityAnalyzer: Class for sentiment analysis in NLTK.
- StandardScaler: Class for standardizing features by removing the mean and scaling to unit variance.
- PCA: Technique for dimensionality reduction in scikit-learn.
- KMeans: Clustering algorithm for partitioning data into clusters.

Interpreting Principal Components:

- Factor loadings help interpret the principal components by showing which features contribute most to each component. A high absolute value in the factor loadings indicates that the corresponding feature has a strong influence on that principal component.

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Visual Appeal	-0.480170	0.117814	0.063320	-0.730598	0.247014	0.105903	0.375474	0.067539
Reliability	-0.494758	0.124910	-0.002776	0.152447	-0.819319	0.060484	0.117211	0.166384
Performance	-0.128721	0.459145	0.574833	-0.005549	-0.019902	-0.025704	-0.288468	-0.598232
Service Experience	-0.486499	0.100691	-0.054176	0.653781	0.470391	0.052432	0.311210	-0.044129
Extra Features	-0.024373	0.519633	-0.364578	-0.023208	0.116821	0.559390	-0.456829	0.246323
Comfort	-0.418255	-0.304266	0.249807	-0.020111	0.172621	-0.296656	-0.623271	0.404238
Maintenance cost	0.005912	0.513208	-0.386495	-0.054822	0.020302	-0.762039	-0.003360	0.055435
Value for Money	-0.309572	-0.351548	-0.563840	-0.107598	-0.046688	0.009572	-0.260855	-0.617065

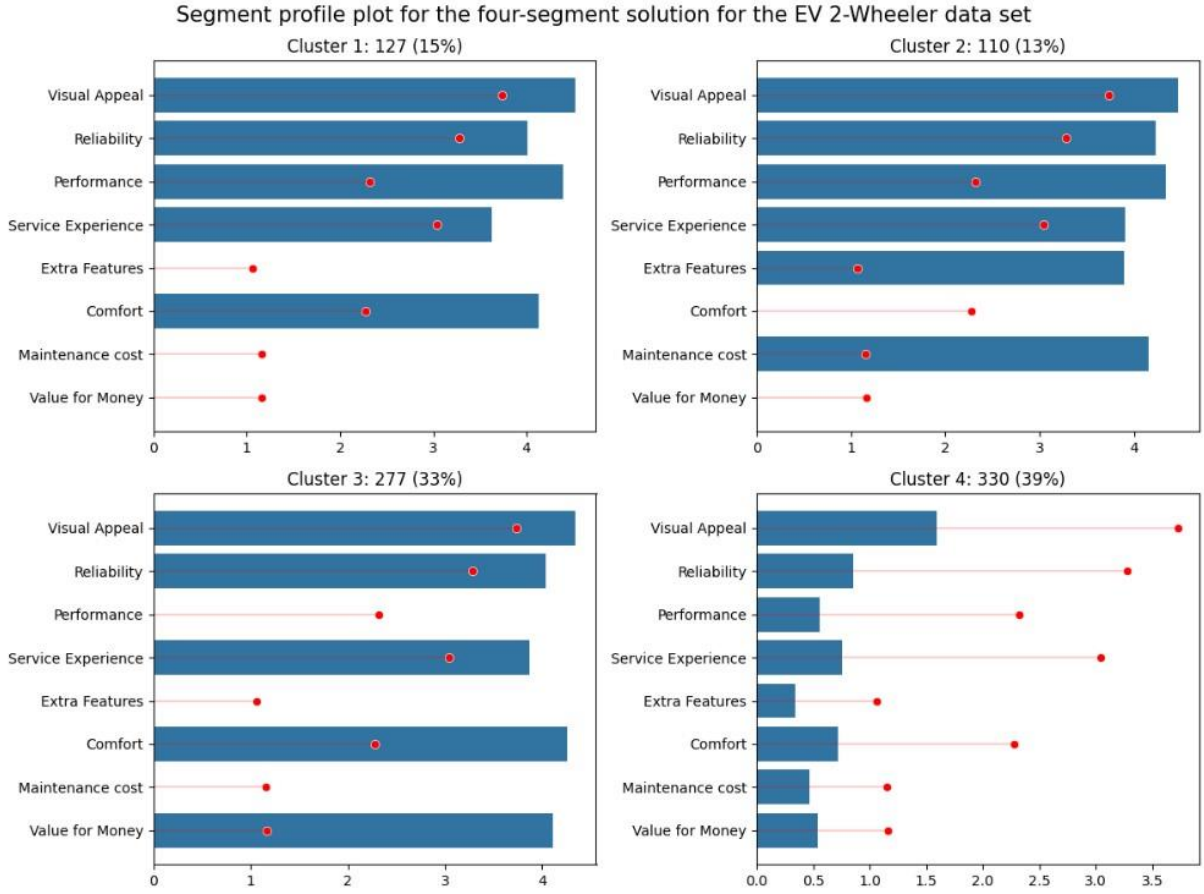
Segment extraction:

To extract the two-wheeler segment, we began by collecting comprehensive sales data, customer reviews, and technical specifications from various sources in the electric vehicle market. This dataset was meticulously cleaned and preprocessed to ensure accuracy and consistency. We then employed filtering techniques to isolate data specific to two-wheelers, distinguishing them from other vehicle categories. By analyzing customer reviews, we identified behavioral variables relevant to twowheeler preferences. These variables, combined with sales data and technical specifications, were used to form a robust dataset, which served as the foundation for our market segmentation analysis using the k-means clustering algorithm.

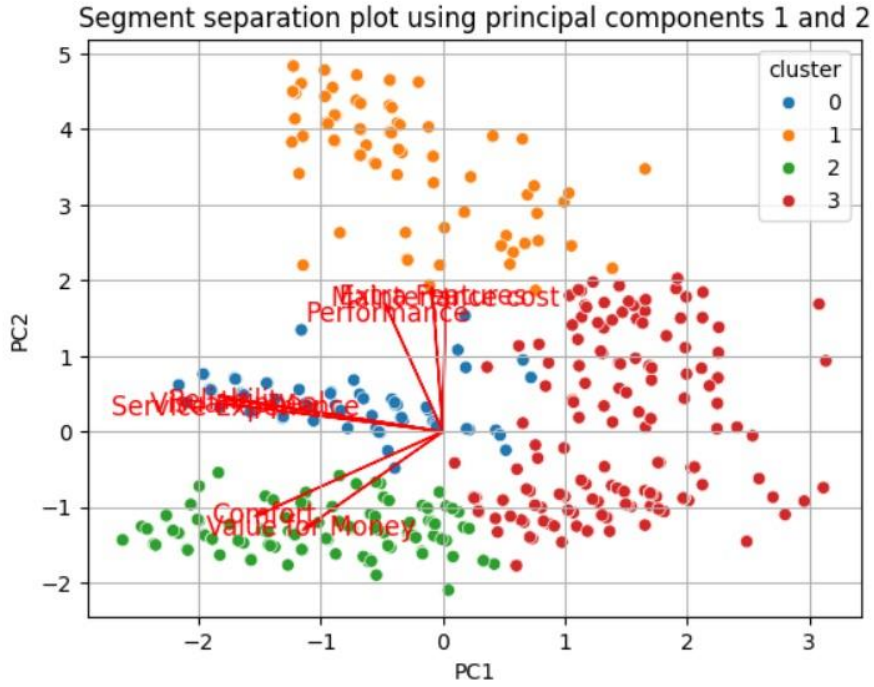
Profiling and Describing Segments:

This section presents a detailed analysis of our consumer segment.

The graph visually captures the diverse perceptions among different segments. Segment 1, representing 15% of consumers, values the electric two-wheeler vehicle for its visual appeal, reliability, performance, service experience, and comfort. Conversely, Segment 2 (39% of consumers) expresses dissatisfaction across all aspects, marking them as the largest but least satisfied group. Segment 3 (33% of consumers) appreciates visual appeal, reliability, service experience, comfort, and notably, perceives a strong value for money. Lastly, Segment 4 (13% of consumers), the smallest segment, values visual appeal, reliability, performance, service experience, extra features, and maintenance cost, showcasing distinct perceptions, particularly on features and costs.

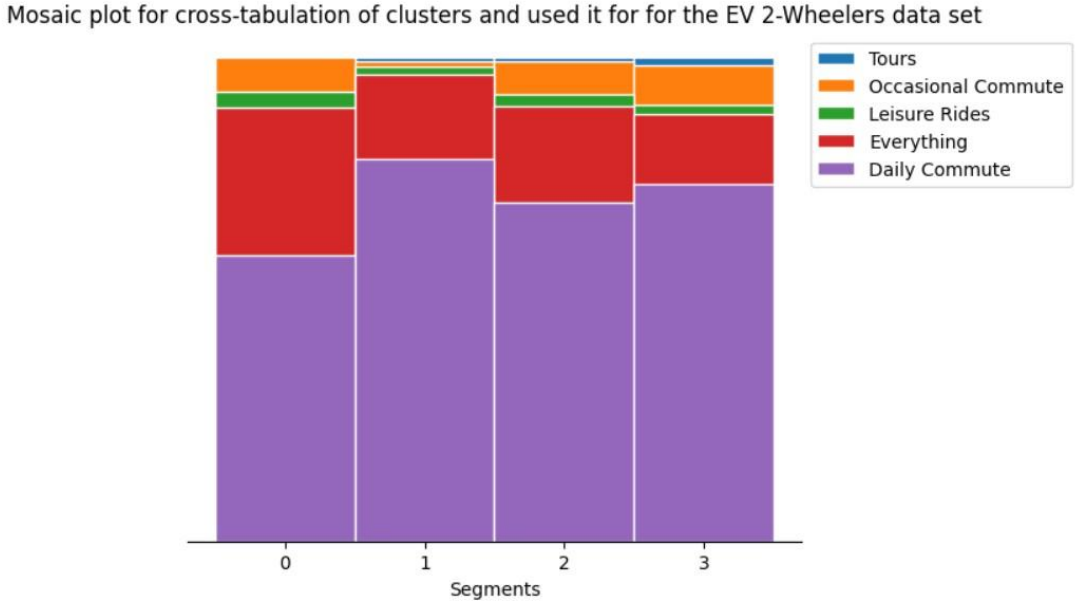


Notably, Segment 2, despite being the largest segment, lacks specific opinions, making them unique in their lack of satisfaction. These detailed insights play a pivotal role in shaping our strategy, ensuring our electric vehicles align precisely with the diverse values and priorities of each segment, thus informing our market offerings accurately.

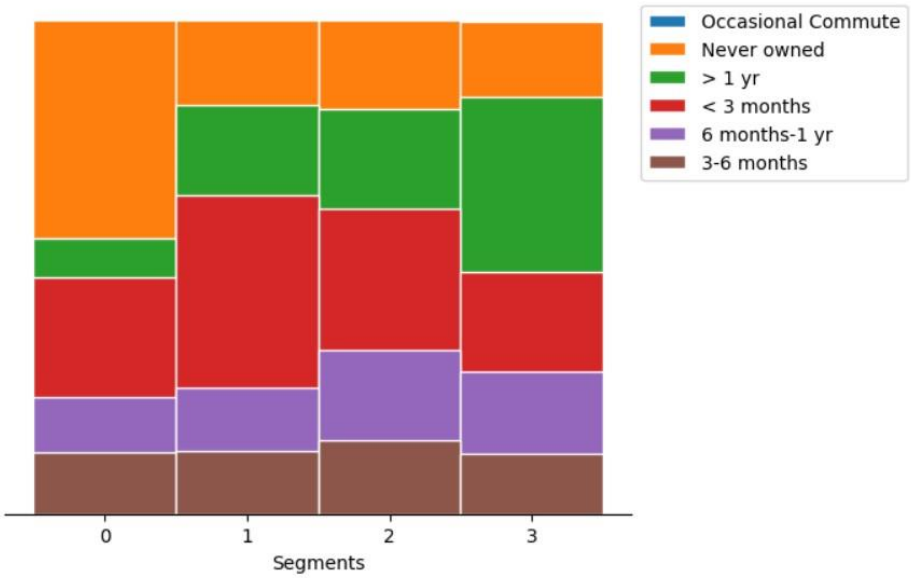


Describing Segments

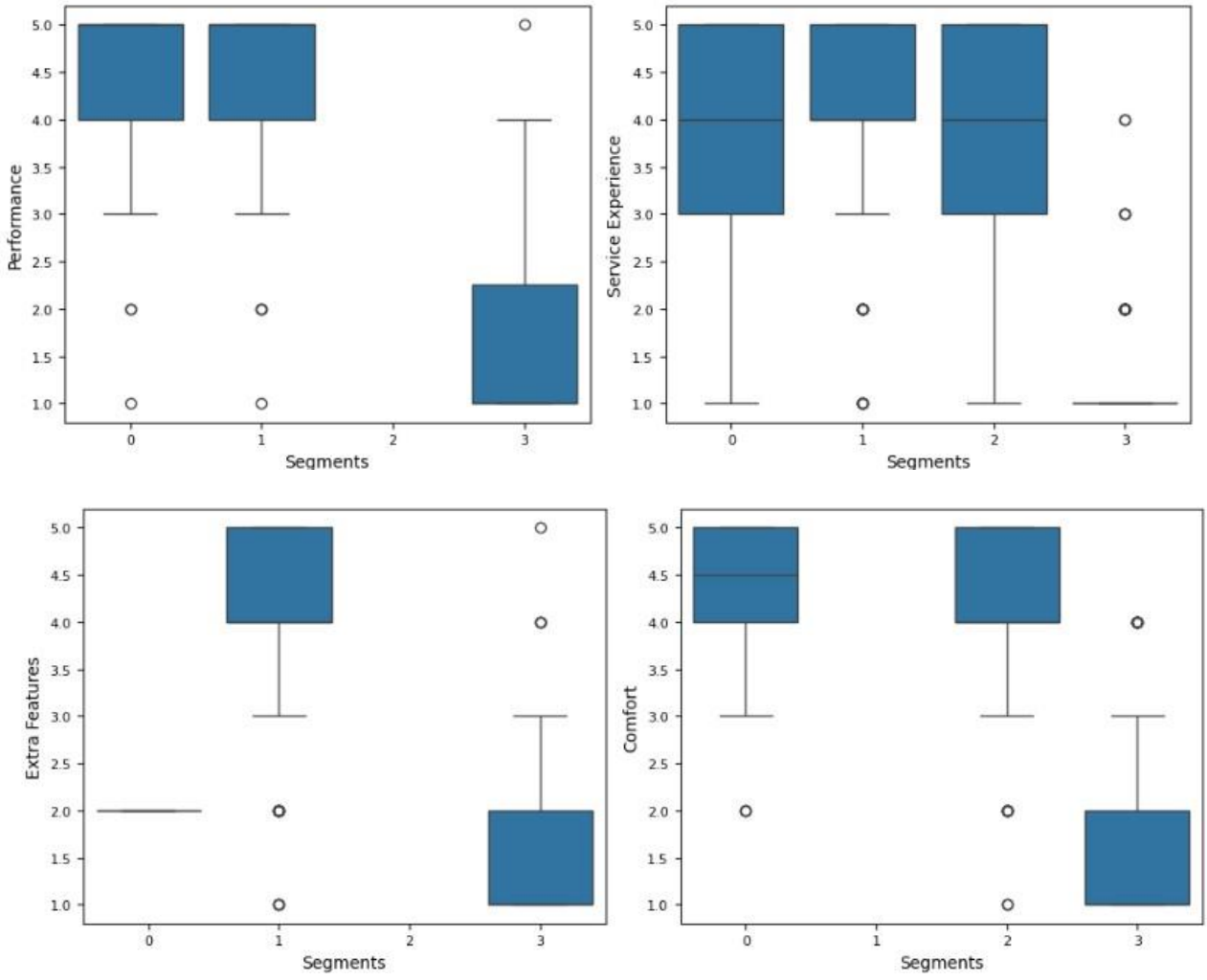
This provides a comprehensive overview based on the insights derived from various mosaic plots and graphical representations. The mosaic plot illustrates that all segments predominantly use electric vehicles for daily commuting, with limited usage for tours, occasional commuting, and leisure rides. In next fig, The plot delineates the ownership duration of electric vehicles among segments. Segment 1 stands out, owning electric vehicles for more than a year, while Segment 1 has no prior ownership experience. Segment 3 members moderately own vehicles ranging from less than 3 months to over a year, and Segment 4 consumers have owned electric vehicles for a few days to less than 3 months.

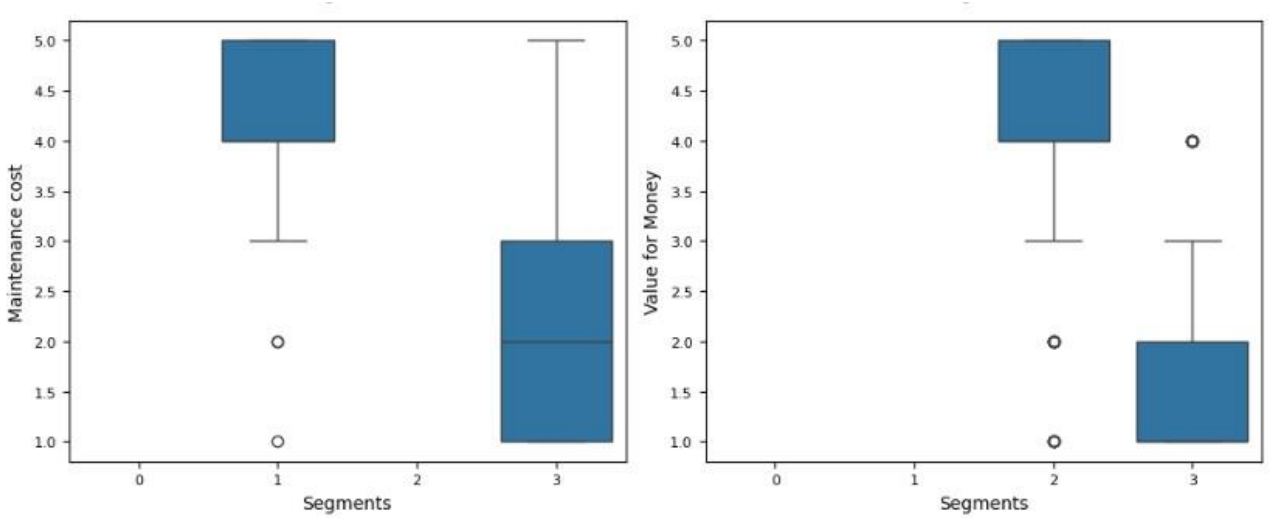


Mosaic plot for cross-tabulation of clusters and owned for for the EV 2-Wheelers data set



Parallel box-and-whisker plot of technical specification of electric vehicle by segment





Selection of Target Segment:

To select the target segment within the electric two-wheeler market, we conducted a detailed analysis using a combination of sales data, customer reviews, and technical specifications.

Behavioral Analysis: Customer reviews were analyzed to identify key behavioral variables and preferences. Sentiment analysis and keyword extraction techniques were applied to understand consumer sentiments and common themes in the feedback.

Clustering with k-means: Using the preprocessed data, we applied the k-means clustering algorithm to segment the market. This involved selecting an appropriate number of clusters (k) based on the data characteristics and using the algorithm to partition the data into distinct groups.

Segment Evaluation: Each resulting segment was evaluated based on its size, growth potential, and alignment with our business objectives. Key metrics such as segment size, average purchase frequency, and customer satisfaction levels were considered.

Target Segment Selection: From the segmented groups, we identified Segment 1, which comprised 39% of the consumer base, as our primary target. This segment was chosen due to its substantial market presence and alignment with our strategic goals.

By focusing on Segment 1, we aim to tailor our product offerings to meet the specific needs and preferences of this group, ensuring a strong market position and customer satisfaction.

Customizing the Marketing Mix:

In our electric vehicle market strategy, customization of the marketing mix is crucial for appealing to Segment 1 and Segment 2, our target segments.

- Product customization involves enhancing features based on specific desires, addressing dissatisfaction points for Segment 1, and emphasizing visual appeal and value for money for Segment 2. Diverse offerings cater to varied tastes and budgets within each segment.
- Price customization includes competitive pricing for Segment 1 and a slightly higher price point for value-added features in Segment 2.

- Promotion customization focuses on targeted advertising and tailored promotional events for each segment's preferences.
- Place customization establishes accessible distribution channels in urban areas for Segment 1 and suburban/semi-urban regions for Segment 2, with a strong emphasis on online presence and customer support.
- People and Process Customization involves training customer service representatives to address segment-specific concerns and ensuring efficient processes for customization requests and service appointments. This tailored approach ensures our electric vehicles align with the distinct needs of Segment 1 and Segment 2, enhancing market relevance and customer preference.

Potential Early Market Customer Base:

To estimate the potential sales and profit in the early market for Segment 1, we first identified the potential customer base within the electric two-wheeler market. Segment 1 constitutes 39% of the consumer base, and assuming the total market size for electric two-wheelers in India is projected to be 1 million units per year during the early market phase, Segment 1 represents approximately 390,000 customers.

Next, we determined the target price range for our electric two-wheelers, which is set between INR 70,000 and INR 90,000 per unit. For calculation purposes, we use the midpoint of this range, INR 80,000 per unit, to estimate potential revenue.

By multiplying the potential customer base (390,000 units) by the target price range (INR 80,000 per unit), we calculate the potential sales revenue to be INR 31.2 billion. This figure represents the total revenue generated from selling electric two-wheelers to the identified Segment 1 customers.

To estimate potential profit, we need to consider the cost of production and associated expenses. Assuming the cost of production and other expenses per unit amount to INR 50,000, the profit per unit is calculated as the difference between the selling price (INR 80,000) and the cost price (INR 50,000), resulting in a profit of INR 30,000 per unit.

Therefore, the potential profit can be estimated by multiplying the number of units (390,000) by the profit per unit (INR 30,000), yielding a total potential profit of INR 11.7 billion. This calculation underscores the substantial profit opportunity that lies within targeting Segment 1 in the early market phase of India's electric two-wheeler market.

Most Optimal Market Segments

Technical specification of electric vehicle two-wheeler for segment 1

Specification	Recommended Range (in INR)
Price	70,688 – 1,29,063
Riding range	89 - 180 km
Top speed	58 - 116 kmph
Weight	76 - 120 kg
Battery charging time	3 - 5 hours
Rated power	1200 - 5500 W

Conclusion:

In summary, our in-depth analysis of India's electric vehicle market led us to identify Segment 1 as the optimal target. With a significant 39% consumer base, this segment represents a substantial market opportunity. By tailoring our electric two-wheeler specifications to meet the preferences of this segment, we ensure our products align seamlessly with the demands of a large customer base. This strategic decision is grounded in a thorough understanding of market segmentation, consumer behavior, and technical specifications. These insights provide a clear direction for our market entry, emphasizing precision and relevance in both product development and marketing strategies. Moving forward, this approach equips us with a solid foundation, ensuring our offerings resonate effectively within India's evolving electric vehicle landscape.

By tailoring our products to meet the specific preferences of this segment and maintaining a competitive price range, we can ensure high market penetration and customer satisfaction. Additionally, the substantial size and expected growth of this segment align perfectly with our strategic objectives, positioning our venture optimally within India's rapidly expanding electric vehicle market.

Market Segmentation Analysis Report for Electric Vehicle Market in India

By Adarsh Herle

4/7/2024

Introduction

This report presents the analysis of the Electric Vehicle (EV) market in India using segmentation analysis. The goal is to identify key market segments and develop a feasible strategy for an EV startup to target the segments most likely to use electric vehicles.

Problem Statement

As an EV startup, we need to determine the appropriate vehicle/customer space to develop our EVs. This analysis aims to segment the EV market in India and identify the most promising segments for market entry.

Methodology

The analysis involved several steps:

1. Data Collection and Preprocessing
2. Feature Engineering
3. Segmentation Analysis
4. Strategy Formulation

Data Collection and Preprocessing

The dataset used for this analysis, `car details v4.csv`, contains various attributes of vehicles as well as locations. The preprocessing steps included: 1. **Handling Missing Values:**

   - Filling missing values in the "Max Power" and "Max Torque" columns with default values. ○ Splitting the "Max Power" and "Max Torque" columns into horsepower, engine RPM, and torque RPM. ○ Filling missing values in the "Engine", "Length", "Width", "Height", "Seating Capacity", and "Fuel Tank Capacity" columns with mean values.

2. **Data Cleaning:**
   - Removing unnecessary characters (e.g., "cc" from the "Engine" column). ○ Converting data types to appropriate formats for analysis.

Feature Engineering

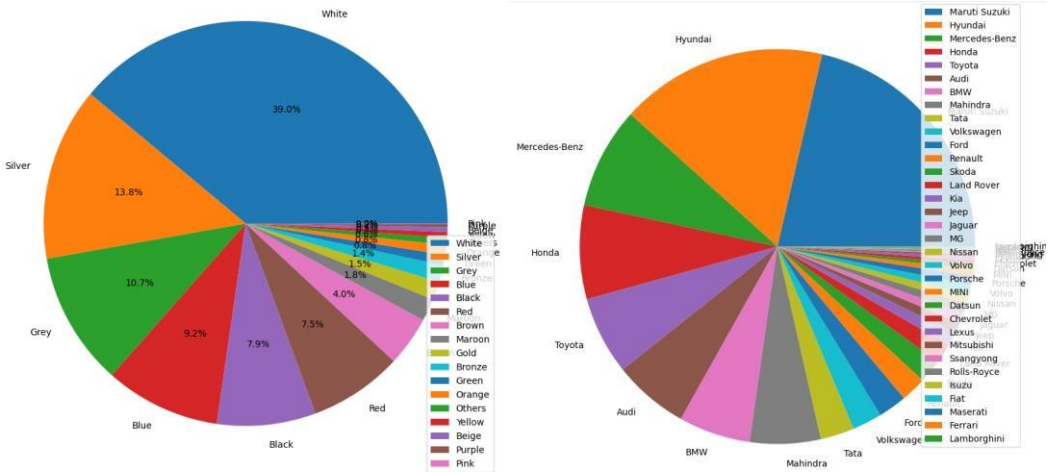
New features were created from the existing data:

- Horsepower and engine RPM from the "Max Power" column.
- Torque power and torque RPM from the "Max Torque" column.

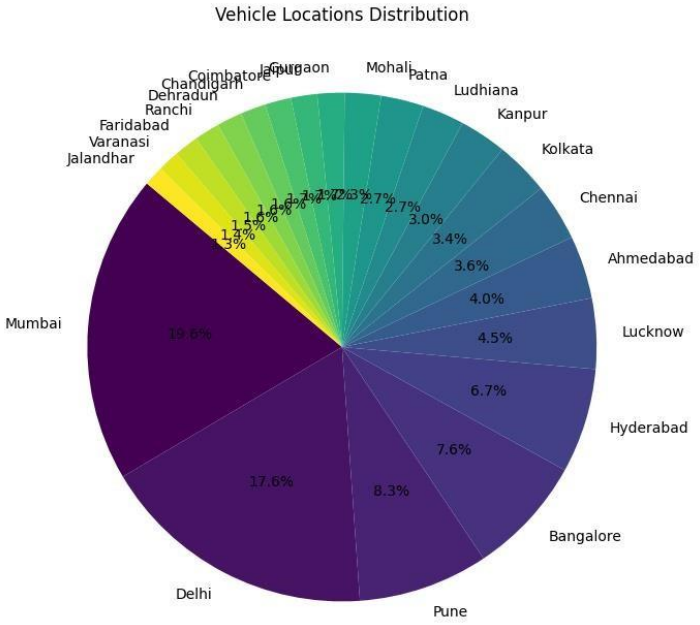
```
df.isnull().sum()
```

```
Make                  0
Model                 0
Price                 0
Year                  0
Kilometer             0
Fuel Type             0
Transmission          0
Location              0
Color                 0
Owner                 0
Seller Type           0
Engine                0
Drivetrain            0
Length                0
Width                 0
Height                0
Seating Capacity      0
Fuel Tank Capacity    0
Horse_power           0
Engine_rpm            0
Torque_power          0
Torque_rpm            0
dtype: int64
```

After doing the visualizations for some features such as colour, make of car, locations, we found white to be the most common colour, Maruti and Hyundai being the most preferred brands, Mumbai and Delhi being the most common locations in terms of car sales.



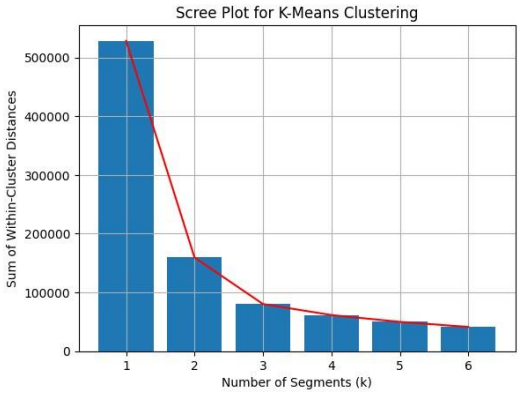
I decided to remove locations that occurred less than 20 times in the dataset so that it becomes easier to interpret.



Segmentation Analysis

It was performed using clustering techniques. The steps included:

1. **Choosing the segmentation variables:**
   - Price, Fuel Type, Location, Transmission, Colour, Seating Capacity.
2. **Mapping:** - Encoding categorical features in the 'dfp' dataframe into numerical values.
   - Dropping the original categorical columns.
3. **Standardization:**
   - Standardizing the data using `StandardScaler` to ensure all features contribute equally to the clustering process.
4. **K-means Clustering:**
   - Determined the optimal number of clusters using scree plot and decided to go with 3.



   - Selecting those relevant features and considering the numerical columns Price and Seating Capacity for clustering.
   - Applying K-means to identify distinct segments within the data.
5. **Principal Component Analysis (PCA):**

- Reducing the dimensionality of the data to visualize the clusters better.

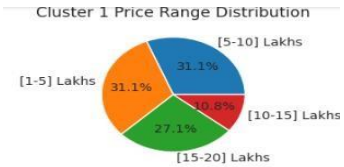
Results

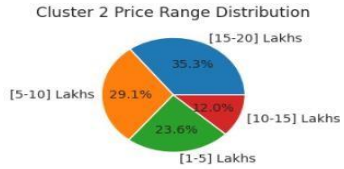
The results of the clustering analysis were visualized using scatter plots and PCA components to illustrate the distribution of vehicles, locations, their features and the prices across different segments.

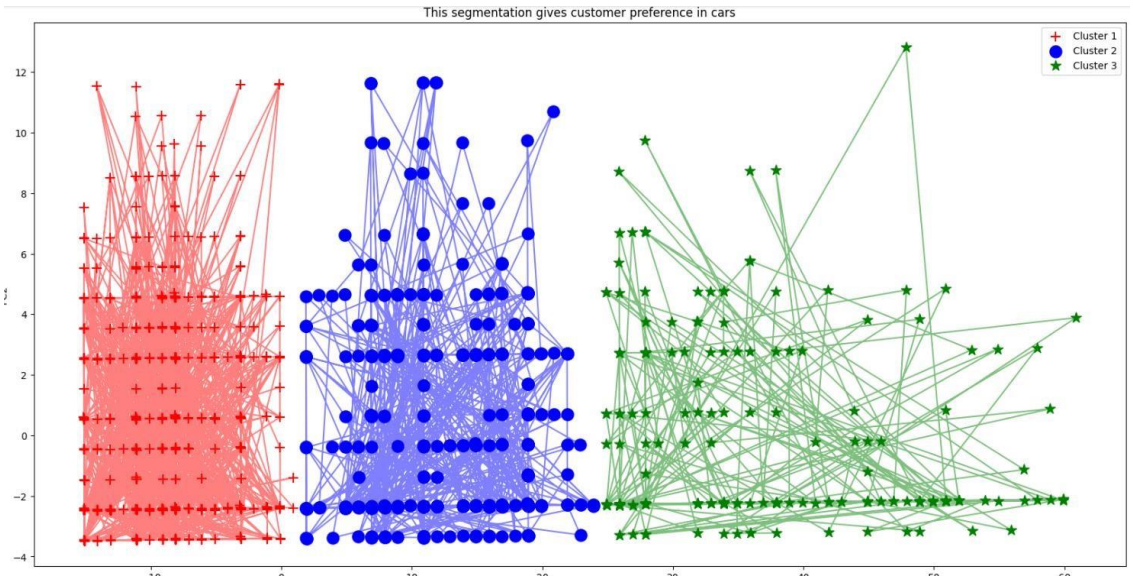
-

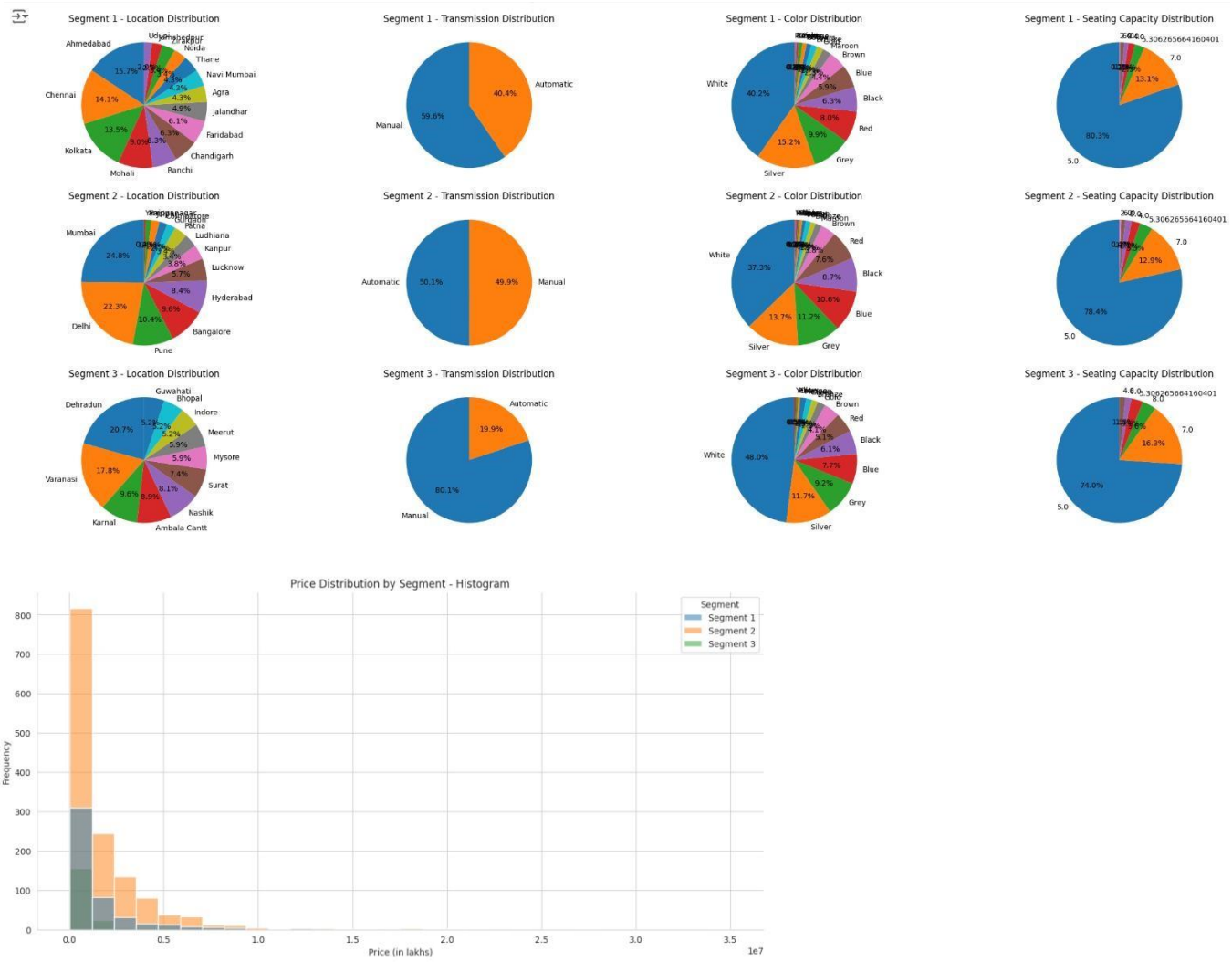
	PC1	PC2	cluster
0	-15.076701	-3.470158	1
1	-14.082128	-2.471317	1
2	-13.085439	-1.461699	1
3	-12.091633	-0.455327	1
4	-11.074272	-3.474851	1
...	...	...	...
2054	31.921551	-2.271444	2
2055	6.918036	-2.365177	0
2056	13.894372	2.667601	0
2057	-10.098212	-2.429481	1
2058	50.920997	-2.180587	2

2059 rows × 3 columns









The histogram plot I plotted shows the distribution of price across three segments.

Key Observations: 2. **Concentration**

at Lower Prices:

- The majority of the prices are concentrated in the lower price ranges, specifically below 0.5 lakhs. This is indicated by the high bars on the left side of the plot.
- Segment 2 (orange) has the highest frequency in the lowest price range.

3. **Overlap Between Segments**: ○ There is an overlap in the price distributions of the segments in the lower price ranges. However, Segment 2 seems to dominate the lower end of the price spectrum.
    - Segment 1 (blue) and Segment 3 (green) also have a presence in the lower price ranges but with lower frequencies compared to Segment 2.
4. **Higher Price Ranges**: ○ As the price increases, the frequency of items decreases sharply for all segments.
    - There are very few items in the higher price ranges (above 1 lakh), and these higher prices are mostly dominated by Segment 2, with some presence of Segment 1.

Insights:

1. **Market Focus**:
    - Segment 2 appears to focus on lower-price, as indicated by the highest frequency in the lowest price range. ○ Segment 1 and Segment 3 have a more diverse distribution but still lean towards lower prices.
2. **Price Distribution**:
    - The data shows a heavy skew towards lower prices, with very few high-priced items across all segments.
    - This could imply that the majority of the market is in the lower price range, which might be a target for competitive pricing or marketing strategies.

Conclusion

Given the price sensitivity of the Indian market, targeting the low-cost segment is crucial. Developing affordable EVs that provide best value for money can capture a significant market share.

Since people prefer a manual white, grey or a silver coloured 5-seater car, if we consider these points, our EV startup can offer vehicles that cater to all 3 types of consumer segments in a price range of 1-10 lakhs which is more affordable for most people and our visualizations also indicate the ideal places for the startup should be in Mumbai, Delhi, Ahmedabad, Chennai, Kolkata and Dehradun.

The Indian EV market presents significant opportunities for growth and expansion. By focusing on these key market segments, developing market-specific EVs, our EV startup can successfully enter and thrive in the market.

Github link- https://github.com/adarsh1102/EV-market-segmentation

MARKET SEGMENTATION

Nagendra N

https://github.com/Nagendrads/EV_Market_Segmentation

Analysing the Electric Vehicle market in India using Segmentation analysis for an Electric Vehicles Startup and coming up with a feasible strategy to enter the market, targeting the segments most likely to use Electric vehicles.

OVERVIEW

More than 90% of vehicles all over the world run on oil, there is a noticeable trend of desire to power vehicles with alternative energy sources. As a result, the subject of electric vehicles (EVs) is gaining popularity. An electric vehicle is one that operates on an electric motor instead of an internal combustion engine, which generates power by burning a mix of fuel and gases. Therefore, an electric vehicle is seen as a possible replacement for the current-generation automobile in the near future. As the problem of rising levels of global air pollution is serious, the use of electric cars can be a response to the achievement of sustainable development goals. With a pressing need for smarter infrastructure and friendlier government policy, electric vehicles have an important role to play in India's energy and mobility markets. In India the current market share of EV/HEV/PHEV is around 0.1%. At present almost all vehicles rely on fossil fuel-based transportation. This pollutes the atmosphere by the emission of greenhouse gases & causes global warming. The Indian transportation sector is growing very fast. The gap between domestic crude oil production and consumption is widening. India is a country which imports around 70% of oil required per year. Hence, there is an urgent need to investigate factors and challenges for the development of sustainable and clean alternatives for transportation systems. Electrified vehicles are one of the promising, clean and sustainable forms of transportation.

The recent scenario of the road transportation sector can be highlighted as:

- Energy consumption: 524 million tons of oil equivalent
- Vehicle to people ratio: 1:56.3
- Per capita energy: 442 kg of oil equivalent
- GHG emissions: 1730 million tons of CO_2 equivalent
- Electric Vehicles sold (2016): 25000 (all) and 2000 (cars)

Unlike other countries the vehicle to people ratio is very high, however, the population is more and emission is high. India stands third with the CO_2 emission of 1.726 billion Metric ton. Hence, there is an urgent need to focus towards EV technology which has the capability towards zero emission for sustainable transportation.

In addition, due to urbanization and decentralization of city areas, a rapid increase in personal vehicles has been observed.

1. 1.EV (Electric Vehicle) /HEV (Hybrid Electric Vehicle) /PHEV (Plug-in Hybrid Electric Vehicle) can be more beneficial for Indian roads due to the following reasons:
2. 2.Hybrid or electric powertrains operate at much higher efficiency at low Indian driving speeds than an Internal Combustion Engine.
3. 3.A higher share of energy per Indian trip is lost in braking, which is almost recovered in a hybrid-electric vehicle (HEV) and EV (Regenerative braking).

4. 4.HEVs and EVs use no fuel during idling and the share of idling time in traffic is much higher in India (than the U.S. & Europe).
5. 5.The average range travelled in India is much smaller than in the U.S. & Europe, making EVs much more feasible and with no range problem with a single charge.
6. 6.Vehicle use and vehicle distance – Urban driving cycle patterns have a frequent start and stop, high traffic benefits to provide high efficiency electric vehicles.

MARKET OVERVIEW

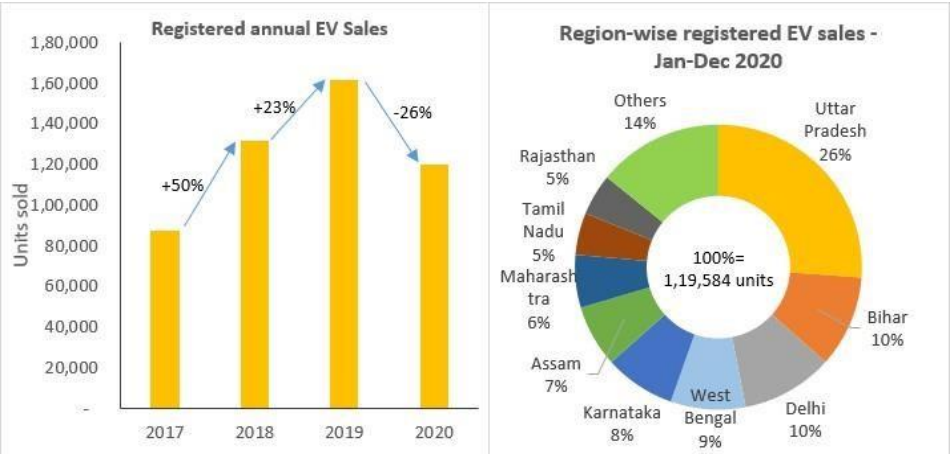
The Indian Electric Vehicle Market is segmented by Vehicle Type and Power Source.

- By Vehicle Type, the market is segmented into Passenger Cars,Commercial Vehicles, and Two- and Three-wheelers.
- By Power Source Type, the market is segmented into Battery Electric Vehicle, Plug-in Electric Vehicle, and Hybrid Electric Vehicle.

Our report mainly focuses on the Indian Electric Vehicle Market segmented by Vehicle Type. However, accessibility to Power Sources for Electric Vehicles affects the market and would be slightly discussed in the report.

The Indian Electric Vehicle Market was valued at USD 5 billion in 2020, and it is expected to reach USD 47 billion by 2026, registering a compound annual growth rate (CAGR) of above 44% during the forecast period (2021-2026).

The Indian Electric Vehicle Market has been impacted by the outbreak of the COVID-19 pandemic due to supply chain disruptions and halt of manufacturing units due to continuous lockdowns and travel restrictions across the country. However, the electric vehicle (EV) market is still in its nascent stage in India. It is expected to grow at a much faster rate during the forecast period due to various government initiatives and policies.



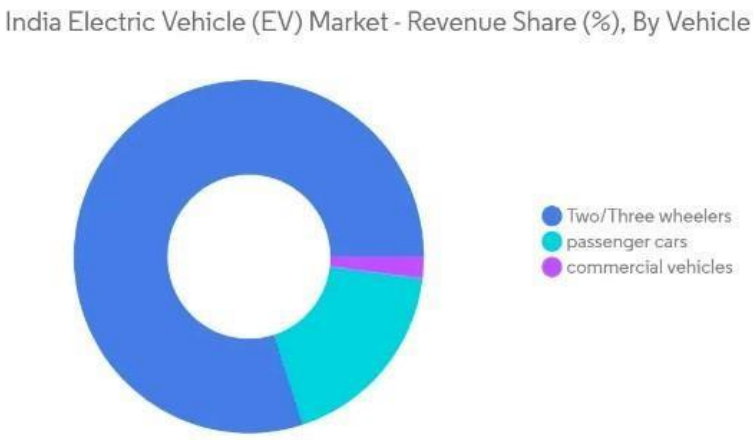
E-commerce companies (Amazon, for example) are launching initiatives to use e-Mobility for last-mile deliveries to reduce carbon footprint. India is experimenting with e-Mobility for public transport, and the country has deployed electric intercity buses across some major cities. In addition, state governments are also playing an active role in the deployment of policies encouraging the usage of EVs.

For instance,

- Kerala aims to put one million EV units on the road by 2022 and 6,000 e-buses in public transport by 2025.

- Telangana aims to have EV sales targets for 2025 to achieve 80% 2- and 3-wheelers (motorcycles, scooters, auto-rickshaws), 70% commercial cars (ride-hailing companies, such as Ola and Uber), 40% buses, 30% private cars, and 15% electrification of all vehicles.

The EV market in India has gained significant momentum after the implementation of the (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India) FAME India scheme with its aim of shifting toward e-mobility in the wake of growing international policy commitments and environmental challenges. Moreover, India offers the world's largest untapped market, especially in the electric twowheeler segment. As 100% foreign direct investment is allowed in this sector, the automatic route market is expected to gain momentum during the forecast period.



MARKET CHALLENGES

The push for electric vehicles (EVs) in India seems to be coming at a rapid pace, but the hype does not seem to match the sales of electric vehicles in the country. The slow progress of EV sales is due to various factors, such as limited options in the passenger car segment, driving range of vehicles, lack of affordability, and lack of charging infrastructure.

Affordability is playing a significant role in hindering the growth of the market studied. India is a pricesensitive country, where the majority of people consider the price of the vehicle first rather than any other factor or aspect. At present, EVs are not affordable for a large section of people who cover a significant sales share of vehicles in the country.

As the electric vehicles market (EVs) in India is at its very nascent stage, the charging infrastructure is also at its minimum, whereas developed countries have well-established charging stations that are more accessible to people for charging their vehicles. Considering the expected increase in the sales of EVs, the development of charging infrastructure becomes very important for the development of a suitable ecosystem. Further, in terms of driving range, very few variants available in the market go beyond 150 km/charge.

OPTIMISTIC GROWTH FOR ELECTRIC BUSES AND TWO WHEELERS VEHICLES

India is also pushing hard for the electrification of buses. Many state governments have already started procuring electric buses from Chinese and local electric bus manufacturers. Many local bus manufacturers who are in collaboration with some Chinese manufacturers are trying to cater to the

rising demand for electric buses in India. With transportation still being a challenge in India, a lot of people in these segments look forward to the two-wheeler industry in India. As a result of the surging pollution, the national government has launched stringent policies to curb vehicular emissions. Furthermore, the availability of a considerable number of electric two-wheeler models, their low cost, as well as their availability as a substitute for conventional fuel-based vehicles. These aforementioned factors are fueling the demand in the Indian electric vehicle market.

MARKET SEGMENTATION

As established in the beginning of this report, the Electric Vehicle market in India has just started to gain momentum, there are not a lot of statistics to provide an insight on Electric Vehicles consumers. So we changed our approach and we have collected consumer data on existing fuel-based vehicles and we would perform simple behavioral and demographic analysis on this data and try to understand the market. Next, for geographic analysis we have used some state-wise statistics to understand which region is most likely to be a good market for which type of Electric Vehicle.
Following this analysis, we can understand important attributes of the segment we aim to target and use them for market segmentation using model-based algorithms.

BEHAVIOURAL AND PHSYCOGRAPIC ANALYSIS

Behavioral Segmentation is a form of customer segmentation that is based on patterns of behavior displayed by customers as they interact with a company/brand or make a purchasing decision. It allows businesses to divide customers into groups according to their knowledge of, attitude towards, use of, or response to a product, service or brand. Psychographic segmentation approach involves an understanding of a consumer's lifestyle, interests, and opinions. We have combined the two types of analysis because a consumer's lifestyle, interests and opinions are mirrored in their purchasing behavior. The dataset we have used is a survey of people who own particular brands of fuel-based vehicles and it contains some basic information such as their age, salary, loan status, marital status, number of dependents, education, occupation and the make of their car and its price.
The violin plot below gives us some insight on the relation between the segmentation and descriptive variables in our data.

Observartions:

- Age: Younger consumers purchase less expensive vehicles. This can be explained simply as they have lesser dependents, lesser income and are single, and so they don't have both the option and the need to buy more expensive vehicles.
- Number of Dependents: Greater number of dependents makes the consumer buy a vehicle with more seats and so they tend to prefer SUVs.
- Salary: If you overlap the normalized salary plots with price plot, you would observe the median of salary violin plot matches that of the price of the vehicle indicating a very direct relationship, which makes sense asmost people would buy vehicles they can afford.

DEMOGRAPHIC ANALYSIS
Demographic segmentation groups customers and potential customers together by focusing on certain traits such as age, gender, income, education, occupation and family status. Demographic segmentation is based on the assumption that consumers in the same demographic group will have similar needs. Demographic customer segmentation helps organizations to develop market outreach

for better marketing strategies. When an organization looks at the demographic segmentation, it focuses on the people who are most likely to buy a product. This helps in identifying the target market.

Observation from the distribution plot:

- People between the age group of 25 to 50 constitute most of the consumer market.
- Most people having an average total salary of around 30 lakh INR tend to purchase vehicles more.
- Most people spent around 10 to 20 lakh INR for vehicles.

GEOGRAPHIC ANALYSIS

It is a component that competently complements a marketing strategy to target products or services on the basis of where their consumers reside. Division in terms of countries, states, regions, cities, colleges or areas is done to understand the audience and market a product/service accordingly. Here we have made divisions in terms of states and union territories in India.

For geographic analysis we used state-wise sales of different types of Electric Vehicles dataset which would help us understand our target region. Based on the type of electric vehicle, states with higher numbers of electric vehicles can be targeted as people in these states are more likely to purchase them. Depending on the type of Electric Vehicle the startup comes with, it can target that particular state. What is important to consider is that for most of these electric vehicles that market would be a fairly developed city in that state, because consumers should be willing to purchase the electric vehicle and factors like cost versus average consumer income and the resources to charge the EV (e.g. Charging Stations) and being able to maintain it are important.

APROACHES USED FOR SEGMENTATION

To perform market segmentation, we are using the population behavioral study where 100 people out of the entire population are selected and data relevant to our goal which is to know about the automobile purchase capability is noted. Since we are trying to find the ideal target segment for market penetration, we will classify the market into various segments. There are 2 general ways for classification: common sense classification and data-driven classification. Here we will be implementing one of the data-driven classification (i.e., K-Means Clustering).

ALGORITHM: K-MEAN CLUSTERING

K-means clustering is a type of unsupervised learning, which is used when you have unlabeled data (i.e., data without defined categories or groups). The goal of this algorithm is to find groups in the data, with the number of groups represented by the variable K. The algorithm works iteratively to assign each data point to one of K groups based on the features that are provided. Data points are clustered based on feature similarity. The results of the K-means clustering algorithm are:

- The centroids of the K clusters, which can be used to label new data.
- Labels for the training data (each data point is assigned to a single cluster) The 'means'

in the K-means refers to averaging of the data; that is, finding the centroid.

The steps followed by the K-Means Clustering are :

1. Specify the desired number of segments k.
2. Randomly select k observations (consumers) from data set X and use them as the initial set of cluster centroids C = {c1, . . . , ck}.

3. Assign each observation xi to the closest cluster centroid to form a partition of the data, that is, k market segments S1, . . . ,Sk where

$$\mathcal{S}_j = \{\mathbf{x} \in \mathcal{X} | d(\mathbf{x}, \mathbf{c}_j) \leq d(\mathbf{x}, \mathbf{c}_h), \quad 1 \leq h \leq k\}$$

This means that each consumer in the data set is assigned to one of the initial segment representatives. This is achieved by calculating the distance between each consumer and each segment representative, and then assigning the consumer to the market segment with the most similar representative.

1. Recompute the cluster centroids (segment representatives) by holding cluster membership fixed, and minimizing the distance from each consumer to the corresponding cluster centroid.
2. Repeat from step 3 until convergence or a pre-specified maximum number of iterations is reached. This is when the stepwise process of the partitioning algorithm stops and the

$$\mathbf{c}_j = \arg\min_{\mathbf{c}} \sum_{\mathbf{x} \in \mathcal{S}_j} d(\mathbf{x}, \mathbf{c}).$$

segmentation solution is declared to be the final one.

TARGET SEGMENT:

The younger population is more likely to purchase products with new technology, especially Electric Vehicles as they are aware of the environmental benefits and would like to bring that change, but our report showed that younger population buys less expensive vehicles and so Electric Vehicles not being affordable can be a downside. It is then suggested to target a segment which is still eager to try new technologies but financially well enough to be able to afford Electric Vehicles. These people are likely to be in an age-group of 30 to 40 years.
People from urban cities with available infrastructure and education about technology and its benefits will tend to purchase electric vehicles more.
People who are married and who have dependents are more likely to go ahead and purchase a vehicle and so they could be targeted.
Average salary of people who buy vehicles is around 30 lakh and the most purchases for automobiles lies in the range 10-20 lakh and lesser for two-wheelers. These aspects need to be kept in mind too.

MARKET MIXING:

Setting prices for our products is both an art and a science. Most importantly, you must know and understand your cost of production. From there you can adjust based on product characteristics, a specific pricing strategy, customer price sensitivity, customer values, and other factors. Marketing Mix helps understand what our product or service can offer to our customers and helps plan a successful product offering. Helps with planning, developing and executing effective marketing strategies. Help determine whether your product or service is suitable for your customers.

PRODUCT

The type of product would obviously depend on the EV Startup, but throughout our analysis we figured that for India it is best to enter the market with two-wheelers because the most automobile marketshare is of two-wheelers. Most people would purchase a two-wheeler because it is cost effective, and the current infrastructure would support that.

Another type of product EV Startup can look into is public transport vehicles, because the current government policies are supportive for revamping public transport to electric-based engines.

PRICE

Affordability is a major issue with the growth of Electric Vehicles. It is important to keep in mind that in order to appeal to the consumers, the company's product has to be cost effective to both purchase and maintain. The product's price should ideally range between 10 to 20 lakh, as most people would make a purchase in this range.

PLACE

Infrastructure is another important aspect that has to be kept in mind while creating any product and launching it. Major urban cities of the country should be targeted as these are the places where infrastructure would support. Another reason for targeting urban cities is that here it is more likely to have an educated population willing to buy Electric Vehicles because they are aware of the environmental benefits. For different types of vehicles, the list of top states which will promise a good market have been given in our geographical analysis.

PROMOTION

Promotion is product dependent. The best possible promotion is to educate people of the benefits of EV/HEV/PHEV over fuel-based vehicles. If the Startup comes up with an affordable product that should definitely be promoted.

REFRENCES:

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- https://www.mordorintelligence.com/industry-reports/india-electric-v ehicle-market
- https://samples.mordorintelligence.com/69655/Sample%20-%20India %20Electric%20Vehicles%20Market%20(2020%20-%202025)%20-% 20Mordor%20Intelligence.pdf
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  https://www.siam.in/statistics.aspx?mpgid=8&pgidtrail=12

DATASETS:

- https://electricvehicles.in/electric-vehicles-sales-report-in-india-2018/
- https://www.kaggle.com/karivedha/indian-consumers-cars-purchasing-behaviour

Market Segmentation Analysis Report for Electric Vehicle Market

Nakshatiraa K N

05/07/2024

Introduction

This report presents an in-depth analysis of the Electric Vehicle (EV) market using segmentation techniques. The objective is to identify key market segments and develop a strategic approach for an EV startup to target segments with the highest potential for EV adoption.

Problem Statement

To maximize market penetration and ensure the success of our EV startup, it is crucial to identify which states and UTs exhibit the highest potential for EV adoption. This analysis aims to segment the EV market based on the given dataset and identify the most promising regions for market entry. By understanding the distribution and characteristics of EVs and non-EVs across different regions, we can tailor our strategy to target the most viable market segments effectively.

Methodology

The analysis was conducted through a multi-step process:

1. **Data Collection and Preprocessing**
2. **Feature Engineering**
3. **Segmentation Analysis**
4. **Strategy Formulation**

Data Collection and Preprocessing

The dataset utilized for this analysis, `EV dataset.csv` ~~(link)~~ includes various attributes of vehicles and their locations. The preprocessing steps comprised:

Handling Missing Values

- Filled missing values in the "Electric" and "Non-electric" columns with the mean values to maintain data consistency.

Data Cleaning

- Removed unnecessary characters from relevant columns.

- Converted data types to appropriate formats for accurate analysis.

Feature Engineering

Several new features were created from the existing data to enrich the dataset:

- **Total Vehicles**: Calculated as the sum of Electric and Non-electric vehicles, providing a comprehensive view of vehicle distribution.

Segmentation Analysis

Segmentation was carried out using clustering techniques to uncover distinct market segments. The steps included:

1. **Choosing Segmentation Variables**: Focused on Electric and Non-electric vehicle counts.
2. **Standardization**: Standardized the data to ensure all features contribute equally to the clustering process.
3. **K-means Clustering**: Applied K-means clustering to identify distinct segments.
4. **Principal Component Analysis (PCA)**: Used PCA to reduce the data dimensionality for better visualization of clusters.

Standardization

The dataset was standardized using `StandardScaler` to normalize the data, ensuring that all features contribute equally to the clustering process.

K-means Clustering

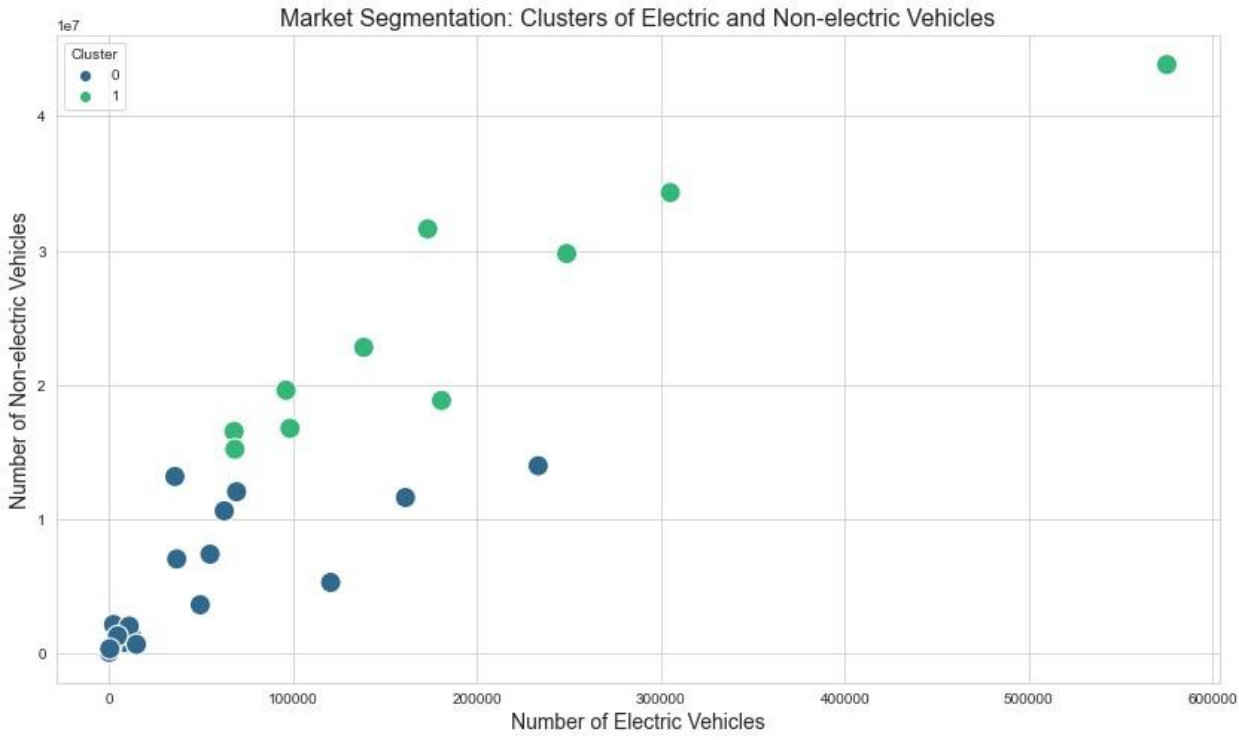
The optimal number of clusters was determined using the elbow method, and K-means clustering was performed to identify distinct segments within the data.

Principal Component Analysis (PCA)

PCA was utilized to reduce the dimensionality of the data, allowing for better visualization of the identified clusters. This technique helped in simplifying the complexity of the dataset while retaining its essential characteristics.

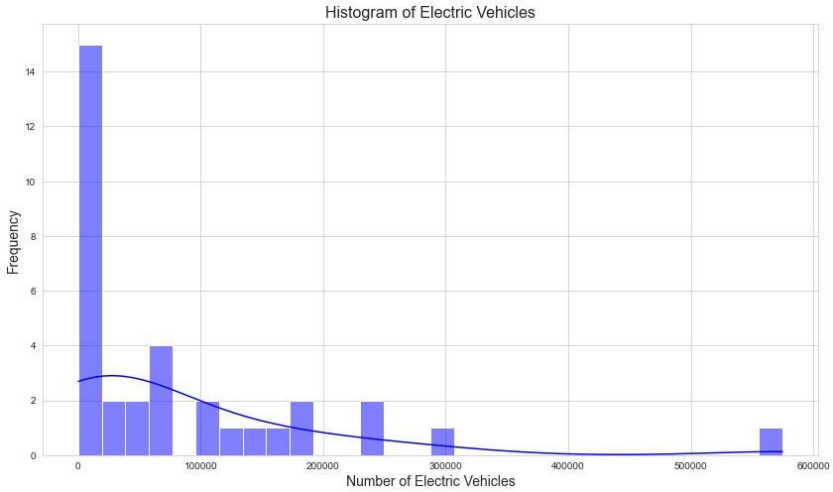
PCA Plot

The PCA plot provides a two-dimensional view of the clusters, making it easier to interpret the relationships between different segments.



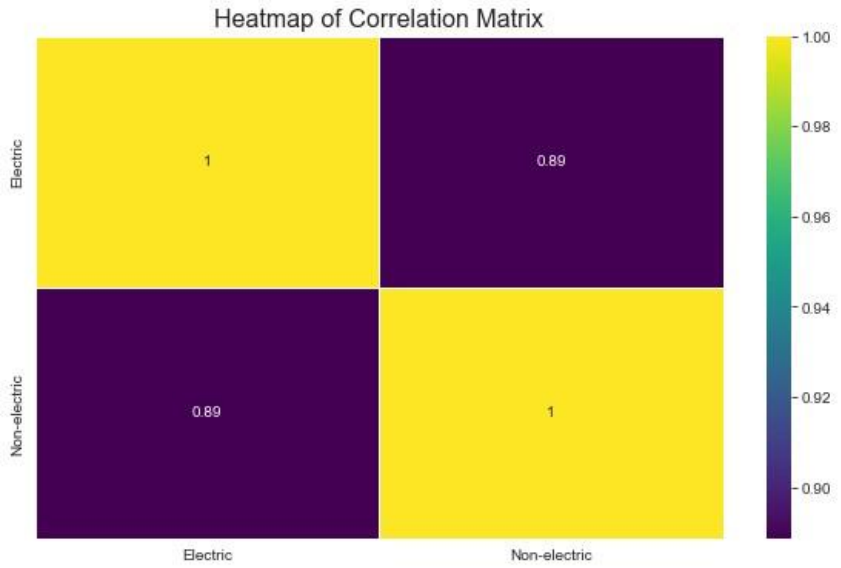
Detailed Analysis and Insights

Histogram



The histogram depicts the frequency distribution of Electric vehicles, highlighting the concentration of vehicles within specific ranges.

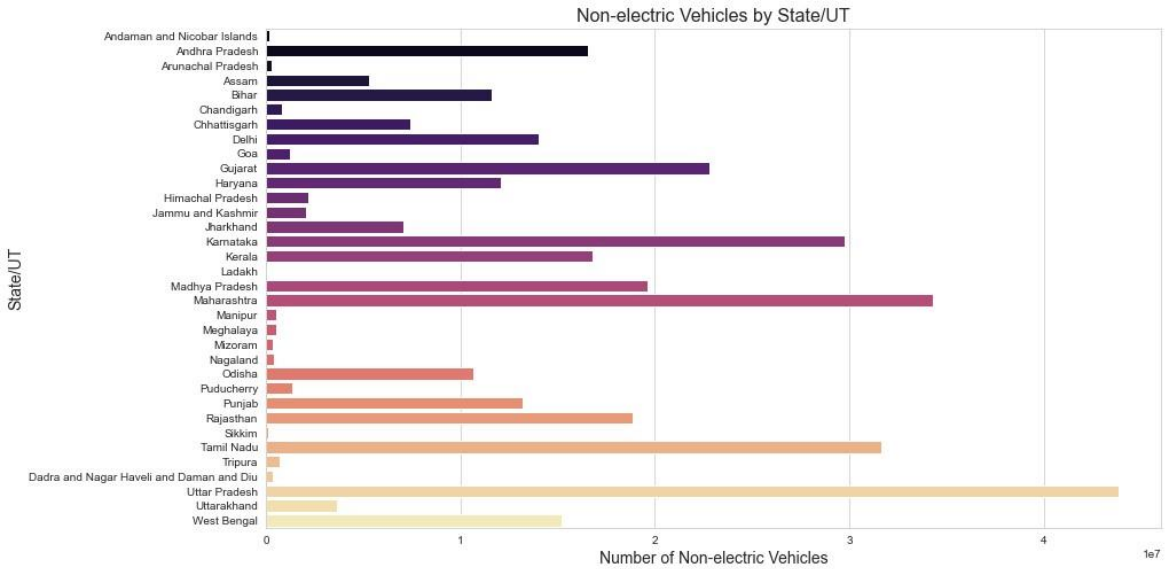
Heatmap

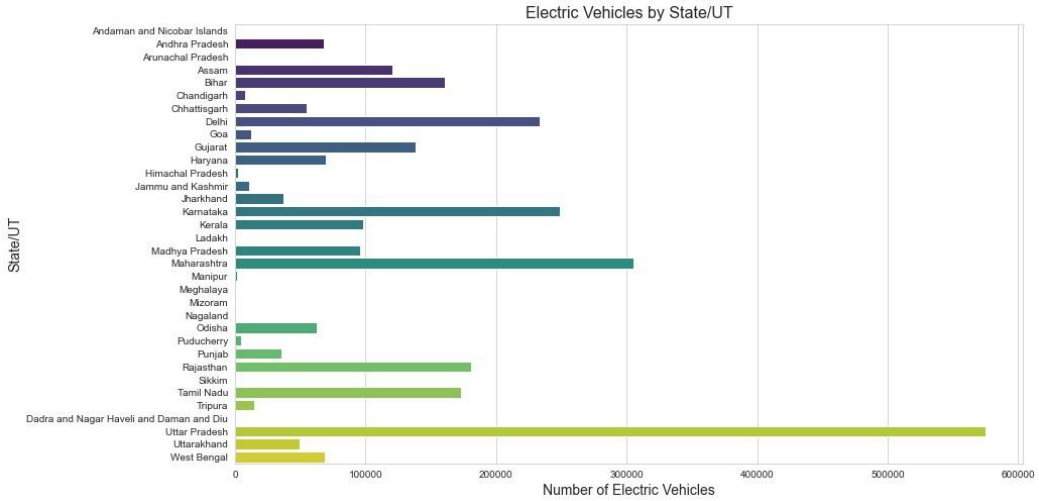


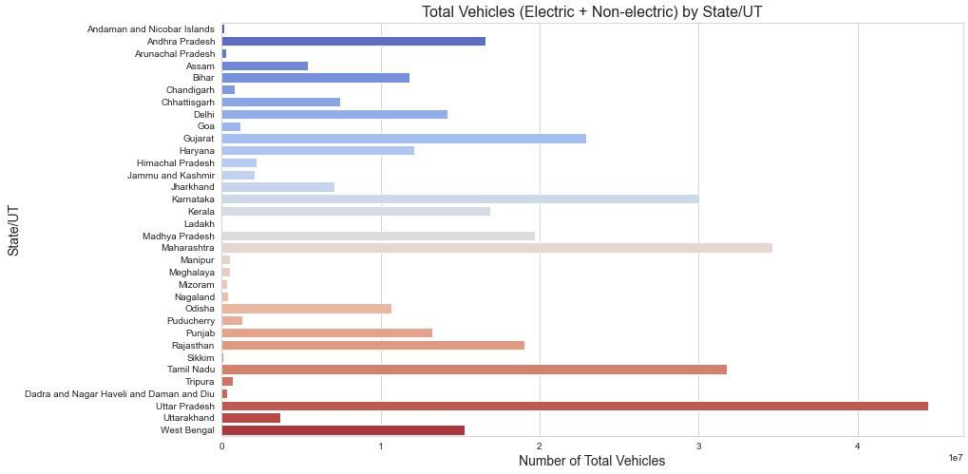
The heatmap shows the correlation between Electric and Non-electric vehicles, offering insights into their interdependencies.

Bar Plot

The bar plot visualizes the total number of vehicles by State/UT, highlighting regions with the highest vehicle counts.







Results

The clustering analysis results were visualized using scatter plots and PCA components to illustrate the distribution of vehicles across different segments. Detailed insights into each segment were derived from the analysis, offering a clear understanding of the market landscape.

Conclusion

The market segmentation analysis reveals distinct clusters of electric and non-electric vehicles. By focusing on these key segments, the EV startup can strategically target the most promising segments for EV adoption. This analysis provides a solid foundation for developing marketspecific EVs and formulating effective marketing strategies.

GitHub Link : [Market_Analysis_Report_Nakshatiraa]

The GitHub links are as follows:

1. Pritija Bhapkar
   https://github.com/PritijaBhapkar/EV_Market_Segmentation_Analysis

2. Adarsh Herle
   https://github.com/adarsh1102/EV-market-segmentation

3. Nakshatiraa K N
   Market_Analysis_Report_Nakshatiraa

4. Nagendra N
   https://github.com/Nagendrads/EV_Market_Segmentation

5. Gowthami Chunchu
   https://github.com/gowthamich35/Electric_vehicle_MarketSegmentation