EV MARKET SEGMENTATION

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Problem Statement:

- Based on Product

  Analyzing data for insights into the most preferred electric vehicle category among EV-2W, EV-3W, EV-4W, and EV Buses based on sales trends and market demand to provide guidance to producers for prioritizing development and marketing in alignment with customer expectations.

- Based on customer

  Analyze data on ratings, visual appeal, reliability, performance, service experience, extra features, comfort, and maintenance cost. Assess the impact of price, riding range, weight, battery charging time on user satisfaction for refining product features and marketing strategies.

Fermi Estimation (Breakdown of Problem Statement)

Determine the anticipated consumer preference hierarchy among Electric Two-Wheelers (EV 2W), Electric Three-Wheelers (EV 3W), Electric Four-Wheelers (EV 4W), and Electric Buses (EV Buses) by the end of 2026 based on the existing data trends.

Variables and Formulas:

- Let (P(x) be the population of the year (x).
- Let (S(x) be the sales trend for the year (x).

Estimation for the Population of 2025:

P(2024) = 1.5) billion (assumed constant growth).

Assumptions:

- Sales trend S(x) remains relatively stable.
- The population P(x) grows steadily.

Anticipated Sales for 2026:

S(2026) = S(2023) + Average Growth Rate

Consumer Preference Hierarchy:

The consumer preference hierarchy will be determined based on the relative sales volumes of EV 2W, EV 3W, EV 4W, and EV Buses.

Factors Influencing Satisfaction and Preferences:

- The impact of key factors such as visual appeal, reliability, performance, service experience, extra features, comfort, maintenance cost, price, riding range, top speed, weight, battery charging time, and rated power on user satisfaction will be assessed based on the trends observed in the existing data.

Conclusion:

By extrapolating existing sales trends and considering the anticipated growth in population, we aim to estimate the consumer preference hierarchy among different electric vehicle categories by the end of 2026. Additionally, the assessment of key factors influencing user satisfaction will guide producers in refining product features and marketing strategies for a more customer-centric approach.

Data Source:

https://www.kaggle.com/code/atom1991/electric-vehicle-market-segmentation/input

Data Pre-processing (Steps and Libraries used)

1.Loaded EV bike data using `pandas`.

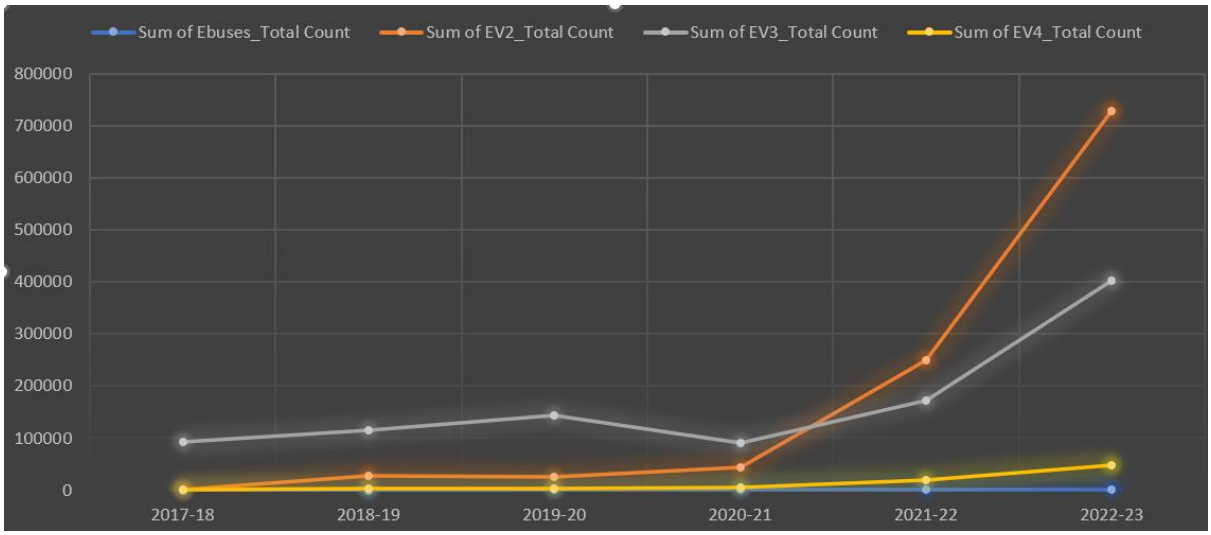
2)Merged two datasets (`data_bike` and `data_model`) on 'Model Name'. Created `new_data` by removing the 'review' column.

3)The `new_data` had missing values which was handled by replacing the missing value with mode values.

4)Exported the cleaned dataset to 'new_data_filled.csv' and performed visualization for data analysis in Excel.

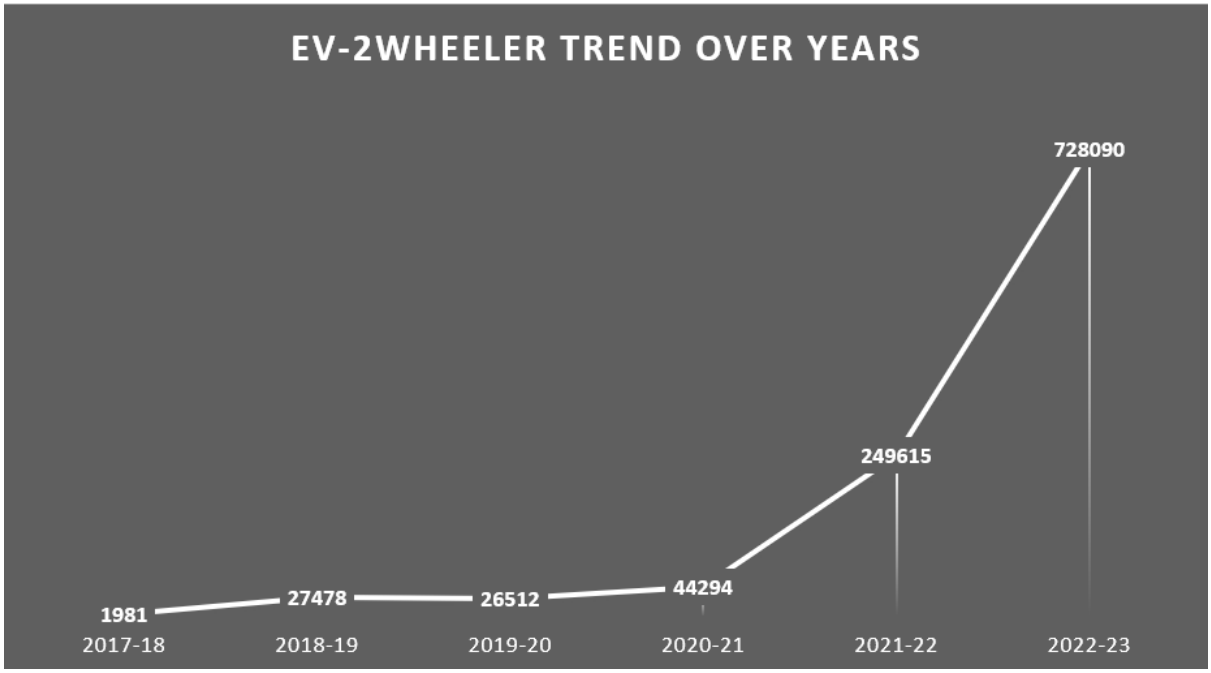
EDA

1)Sales of different EVs over different years



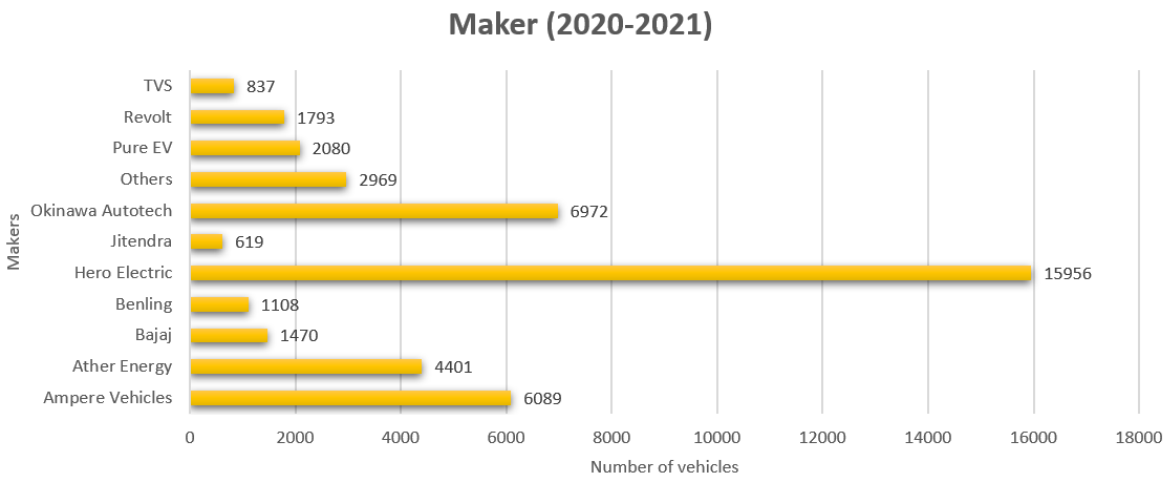
The data shows growth trend for E-2 Wheelers, E-3 Wheelers, and E-4 Wheelers from 2017-18 to 2022-23, with particularly significant increases in sales for E-2 Wheelers in 2022-23.

2)EV-2 Wheeler trend over years



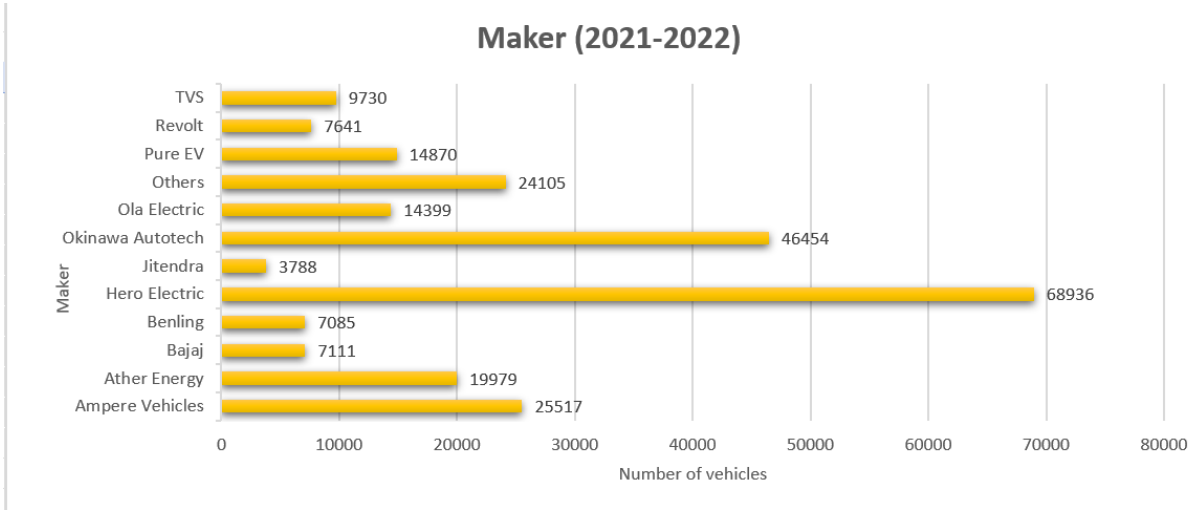
The data indicates a significant upward trend in the sales of EV-2wheeler over the years. Starting from 1981 units in 2017-18, the number of vehicles sold has consistently increased, reaching 728,090 units in 2022-23. This upward trend highlights a substantial growth and adoption of EV2 in the market.

3)Analysis of maker of 2020-2021 for EV 2wheeler



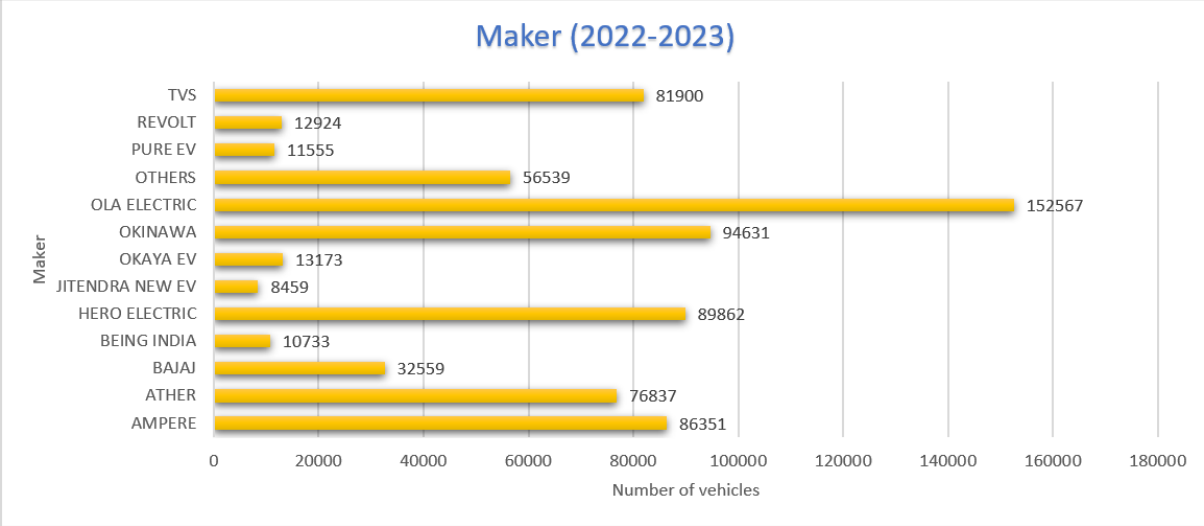
In 2020-2021, Hero Electric led the EV2 market with 15,956 units, followed by Okinawa Autotech (6,972 units) and Ampere Vehicles (6,089 units). Ather Energy, Bajaj, and others also contributed, showcasing a diverse landscape with multiple makers for the EV-2wheeler market.

4)Analysis of maker of 2021-2022 for EV 2wheeler



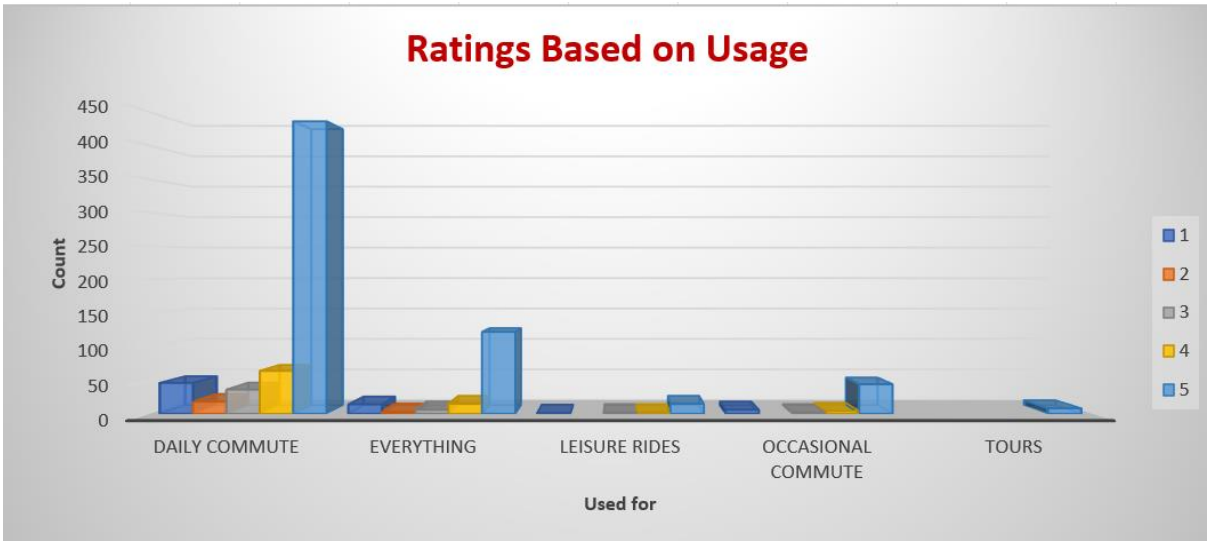
In 2021-2022, Hero Electric led the EV2 market with 68,936 units, followed by Okinawa Autotech (46,454 units) and Ampere Vehicles (25,517 units). Ather Energy, Ola Electric, and TVS also made notable contributions, reflecting a dynamic and competitive landscape.

5)Analysis of maker of 2022-2023 for EV 2wheeler



In 2022-2023, Ola Electric dominated the EV2 market with 152,567 units, followed by Hero Electric (89,862 units) and Ampere (86,351 units). Other major players included Okinawa, TVS, and Bajaj, contributing to a dynamic and competitive landscape in the EV2 segment.

a)Distribution of EV-2wheeler ratings based on usage

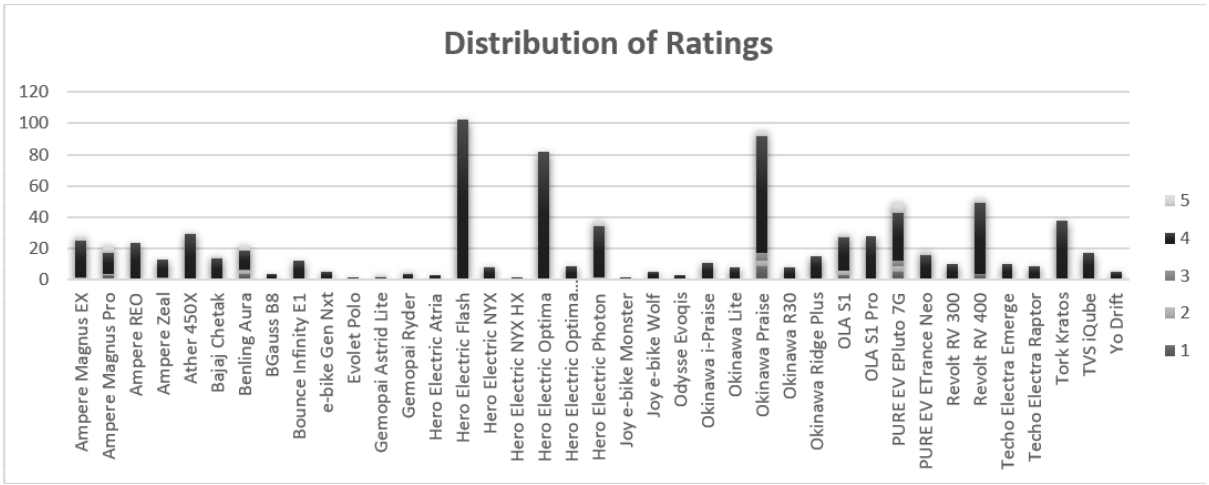


EV2 vehicles tend to receive higher ratings across different usage patterns, indicating a generally positive sentiment among users. Users appreciate the vehicles for daily commutes, various purposes (Everything), leisure rides, occasional commutes, and tours.

b) Distribution of EV-2wheeler Ratings Based on Distance Rode

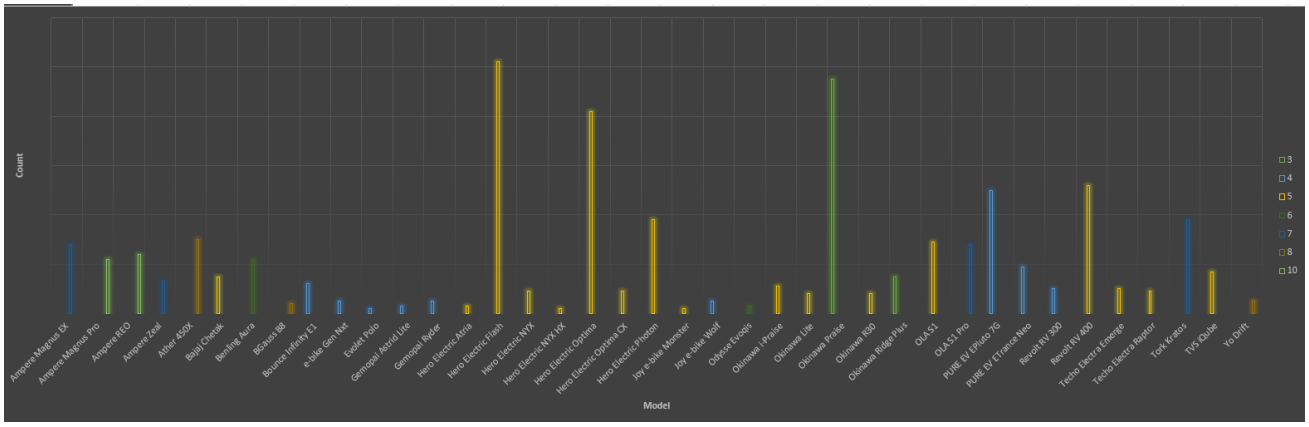
Users across different distance categories generally rate EV-2wheeler positively for comfort, with higher ratings for those who have covered longer distances (> 15000 kms). The single low rating in the "Never owned" category may suggest a specific user experience or preference. The overall trend indicates that users find EV2 vehicles comfortable, irrespective of the distance rode, with higher satisfaction for more extended usage.

c) Distribution of Ratings for EV-2Wheeler Models Based on Value for Money



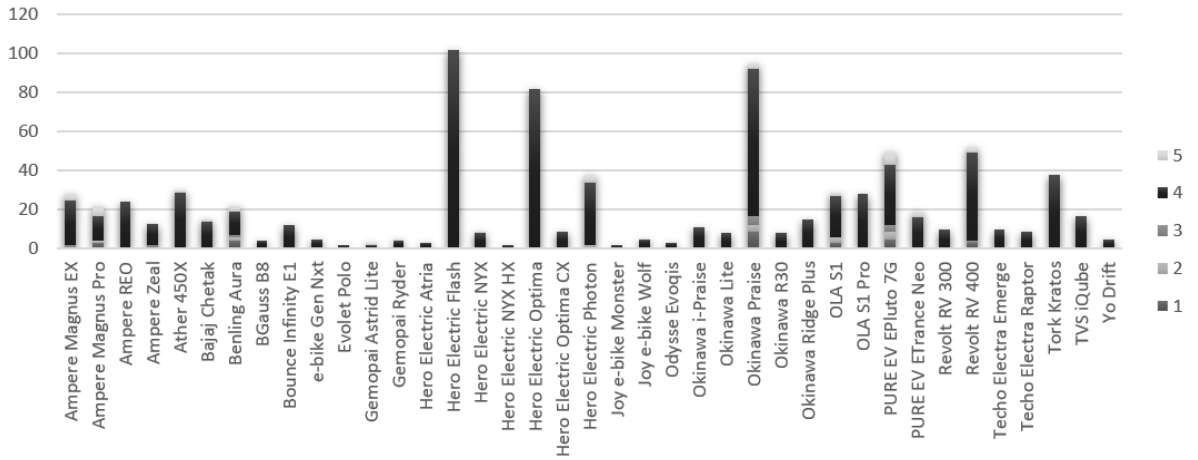
Most EV-2Wheeler models receive positive ratings for value for money, with a notable concentration in the 4 and 5 range. This indicates that users generally perceive these models as providing good value for the money invested.

d) Battery Charging Time Distribution for EV-2Wheeler Models



Notably, Hero Electric Flash has the highest number of votes (102) with a charging time of 5 hours. The comparison indicates that Hero Electric Flash, despite a longer charging time, receives significant user preference, possibly due to other appealing features or factors influencing the voting patterns.

e) Maintenance Cost Distribution for EV-2Wheeler Models

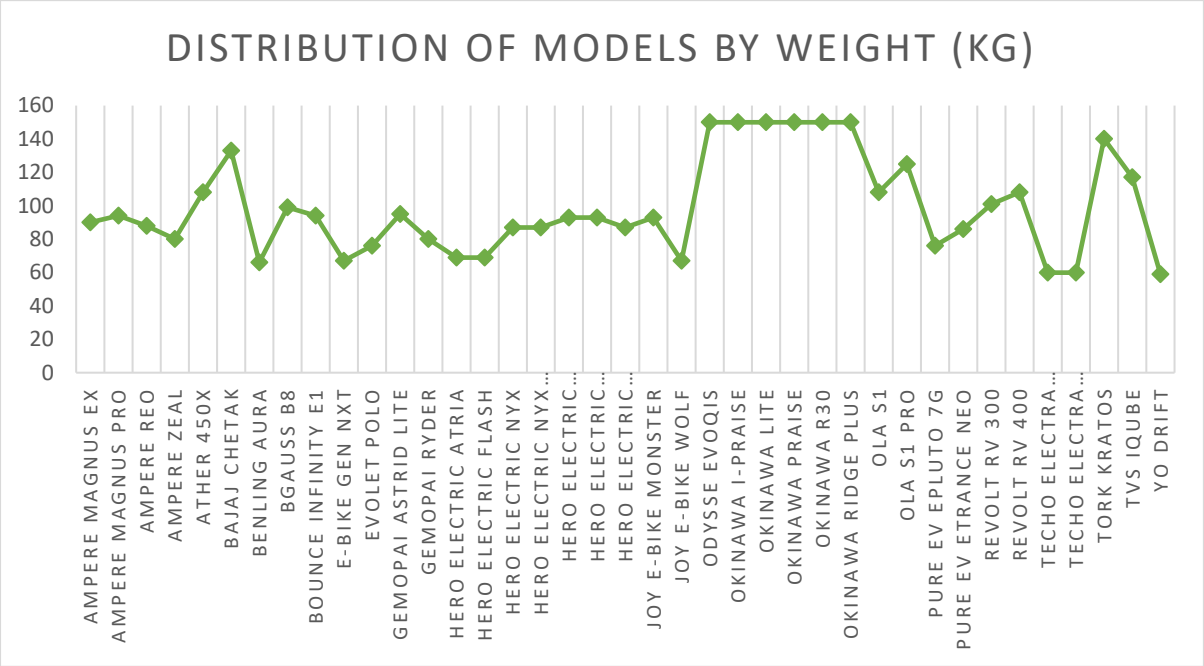


Hero Electric Flash stands out with the highest number of votes (102) and an associated maintenance cost of 5, indicating high user satisfaction with the cost. Okinawa Praise also receives a substantial number of votes (75) with a maintenance cost of 4. Overall, the comparison highlights the influence of various factors on user voting patterns, including perceived value and satisfaction beyond maintenance costs.

f) Comparison of Electric Two-Wheeler Models and Their Maximum Prices

The prices vary across different models, with some high-end models like the "Odysse Evoqis" priced at 171250, "Tork Kratos" at 167844, and "OLA S1 Pro" at 139828. On the more affordable side, we have models like "Hero Electric Flash" at 59594 and "Hero Electric Optima CX" at 106740.It's interesting to note that there is a wide range of prices, suggesting diversity in the electric two-wheeler market, catering to different budget segments. The dataset can be further analyzed to explore trends, compare pricing strategies among different brands, or identify the most popular models based on their pricing and features.

g) Distribution of Electric Two-Wheeler Models by Weight (kg).



The data displays the average weight (in kg) of various electric two-wheeler models. The weights vary across models, showcasing a diverse range in the market. High-performance models like Odysse Evoqis, Okinawa i-Praise, Okinawa Lite, Okinawa Praise, Okinawa R30, Okinawa Ridge Plus, and Tork Kratos exhibit heavier weights, possibly reflecting larger capacities or additional features. In contrast, lighter options such as Techo Electra Emerge, Techo Electra Raptor, and Yo Drift cater to urban commuting preferences. The dataset provides valuable insights into the weight distribution among electric two-wheeler models, offering consumers choices based on their preferences and riding styles.

EV Market Segmentation Introduction:

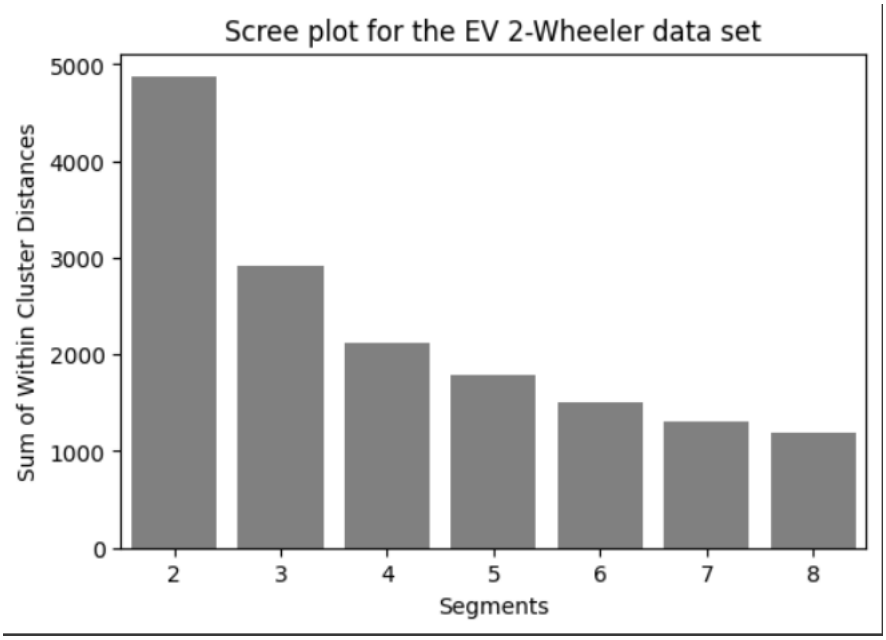
The dataset used for market segmentation analysis sourced from bikewale.com provides a comprehensive overview of electric two-wheeler customer reviews and provides valuable insights. In addition, detailed technical specifications and pricing details are included, allowing for a thorough evaluation of technical feasibility and critical price points essential for forming market segmentation strategies. This diverse dataset serves as the basis for understanding customer preferences and optimizing product positioning in the electric vehicle market.

Segment Extraction (ML techniques used):

Clustering is a widely used analysis technique that divides a set of objects into K clusters such that the sum of the squared distances between the objects and their assigned cluster means is minimized. The purpose is Clustering involves dividing the entire data into groups (also called clusters) based on patterns in the data. Now, to obtain more meaningful clusters, data points from different clusters should be as different from each other as possible. The K-means algorithm uses an iterative approach to find optimal cluster assignments by minimizing the sum of squared distances between data points and their assigned cluster centroids. One of the most common applications of clustering is customer segmentation.

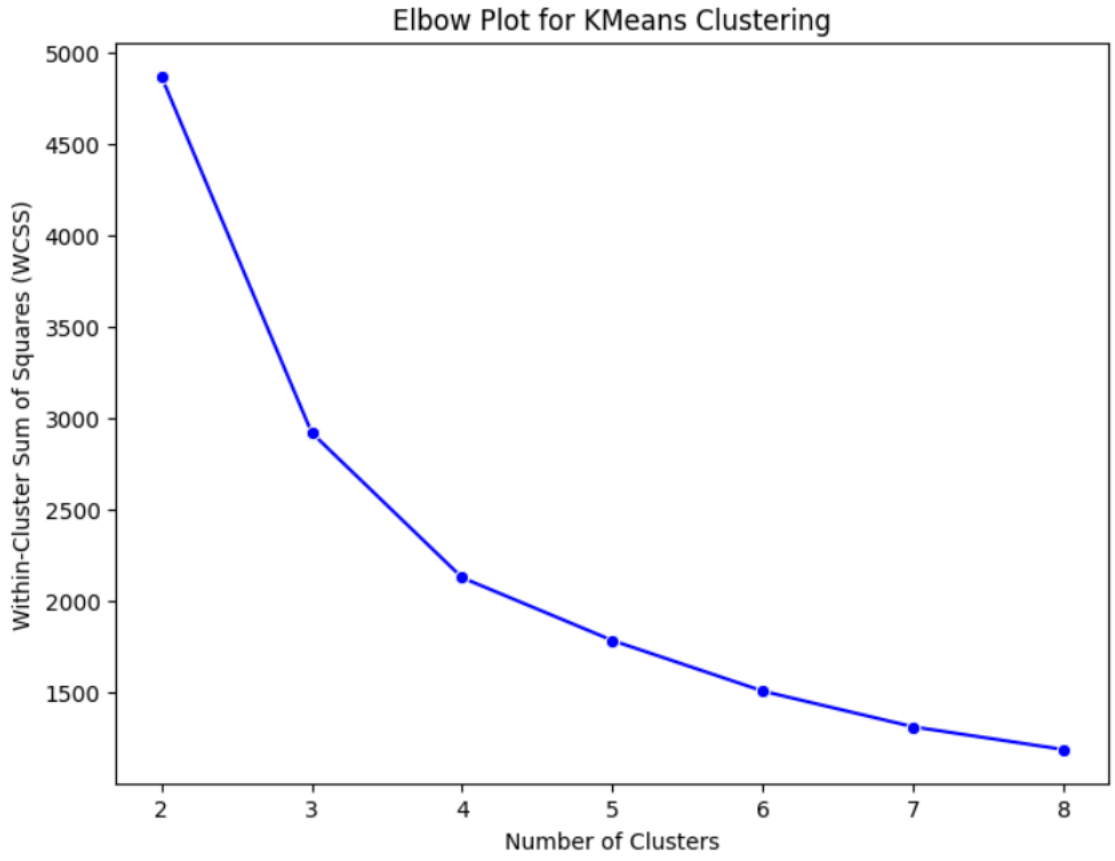
Scree Plot:

scree plot is used to determine the number of factors (or components) to select. It consists of a graph with eigenvalues on the vertical axis and factor numbers (component numbers) on the horizontal axis. Scree plots are useful for visualizing eigenvalues or singular values and can help you decide how many principal components to keep. What we're looking for is an arc or flat bend that suggests a transition from large eigenvalues on the left to very small eigenvalues on the right (scree is loose rock debris at the base of a cliff). In our graph, there is such a curvature between the second and his third element, and it flattens out even more after the third element. This may indicate a two-factor or three-factor solution.



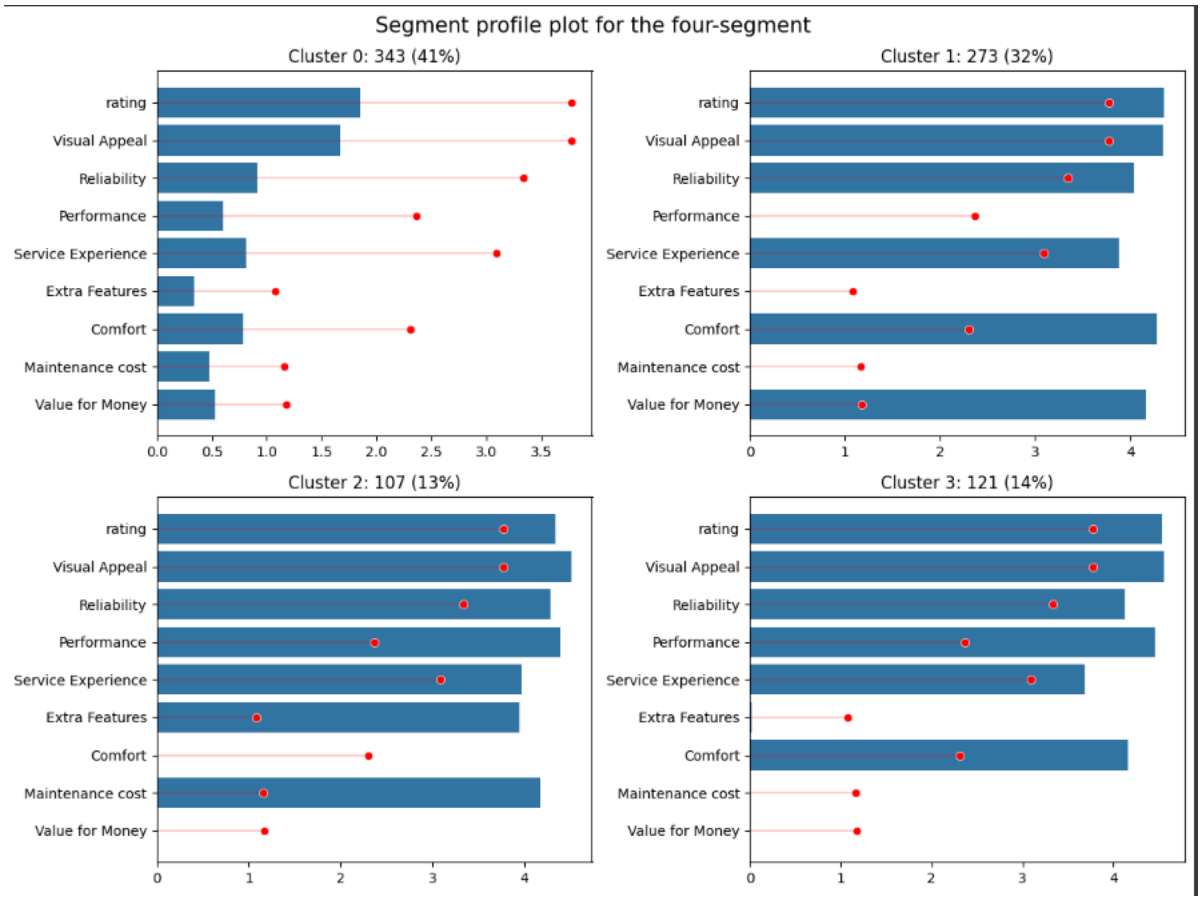
Elbow method:

The elbow method actually varies the number of clusters (K) from 2 to 8. Compute the WCSS (within-cluster sum of squares) for each value of K. WCSS is the sum of squares of distances between each point in the cluster and the centroid. If you graph WCSS with a value of K, the graph will look like an elbow. As the number of clusters increases, the WCSS value starts to decrease. The WCSS value maxes out at when K = 2. If you analyze the graph, you will notice that at point the graph changes rapidly, creating an elbow shape. From this point on, the graph begins to move approximately parallel to the x-axis. The K value corresponding to this point becomes the optimal K value, that is, the optimal number of clusters.



Profiling and describing potential segments:

Profiling segments typically involves analyzing the characteristics of each cluster or segment to understand their unique properties.



Segment Distribution: Segment 0 is the largest group, representing 41% of consumers, but it is characterized as the least satisfied group. Segment 2 and Segment 3 are relatively balanced in size, with 13% and 14% of consumers and Segment 1 represents 32% of consumers , respectively. Segment 2 is the smallest segment, representing 13% of consumers.

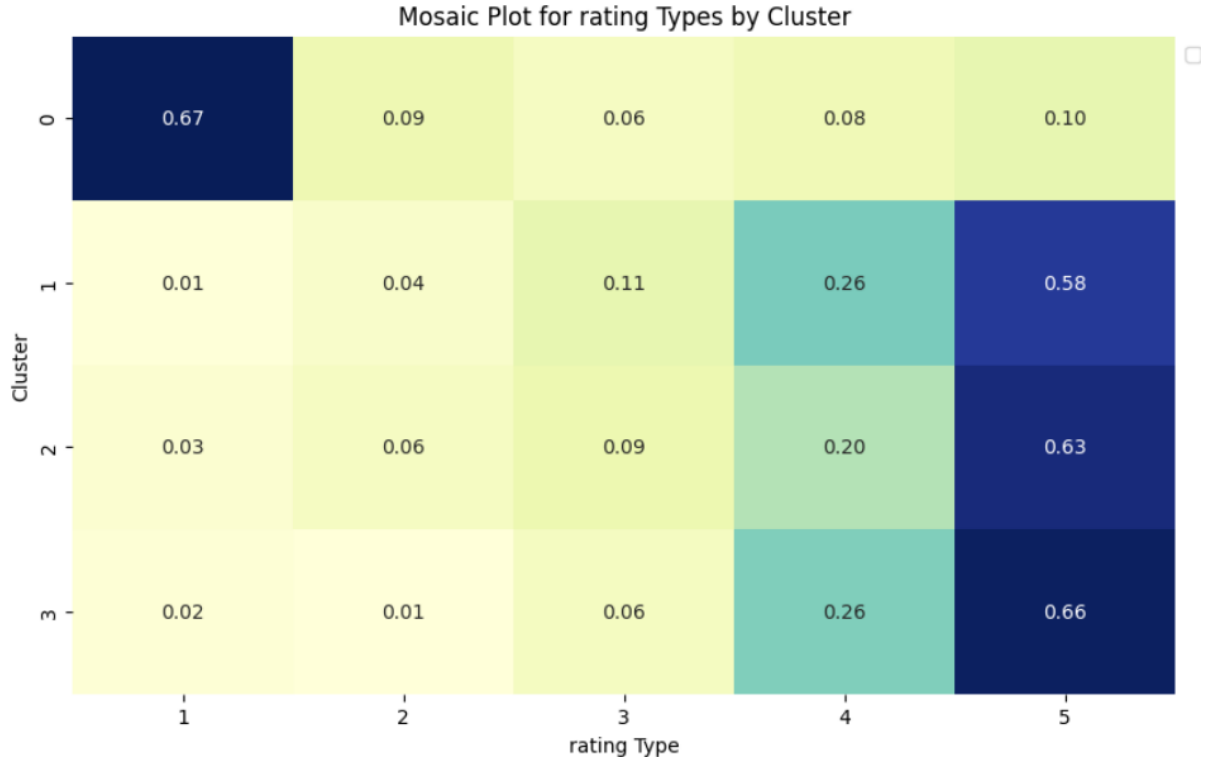
Satisfaction Levels: Segment 0 expresses dissatisfaction across all aspects. This suggests that a significant portion of consumers in this segment may have negative perceptions or experiences related to rating, visual appeal, reliability, performance, service experience, comfort, extra features, maintenance cost and value for money.

Unique Perceptions in Each Segment: Each segment has its unique set of values and priorities. For example: Segment 0 values rating, visual appeal, reliability, performance, service experience, comfort, maintenance cost and value for money. Segment 1 appreciates perceives a strong value for rating and visual appeal, and values reliability, service experience, comfort and value for money. segment 2 stands out for perceiving a strong value for money and performance. This suggests that consumers in this segment not only prioritize certain features but also consider the performance and cost-effectiveness of the product.

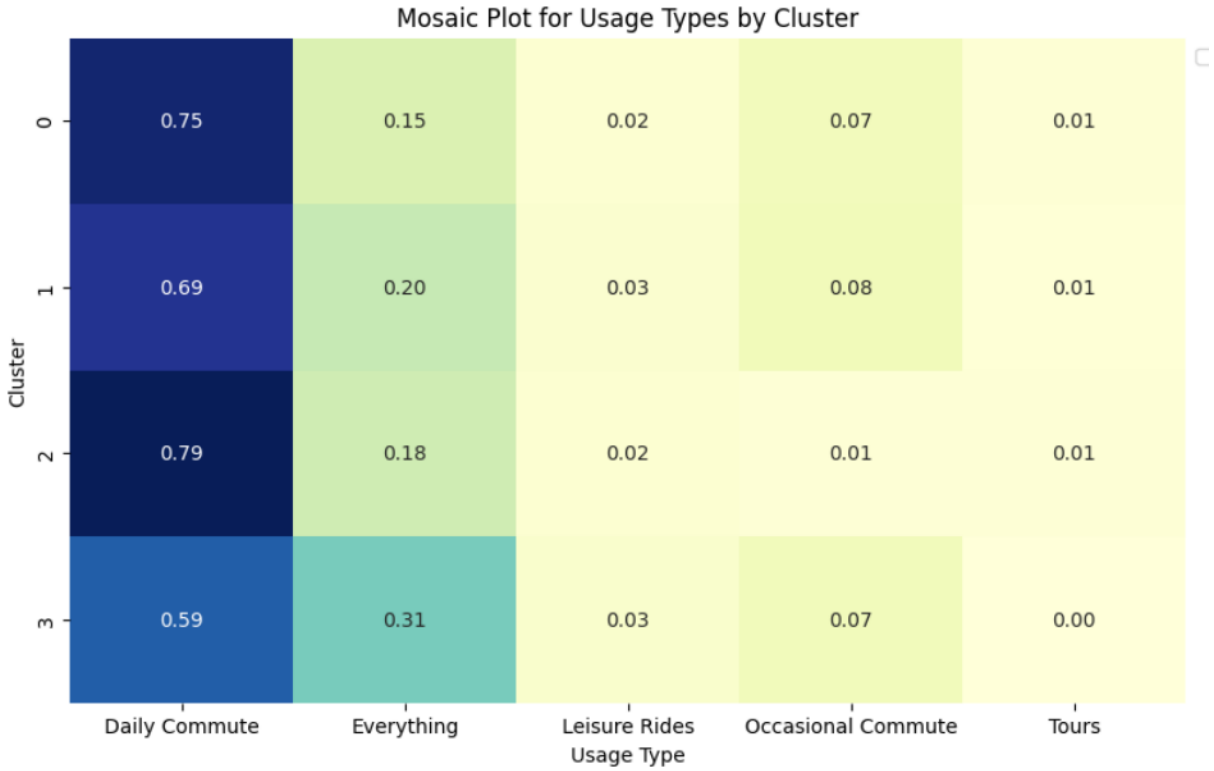
Segment 3 values rating,visual appeal, reliability, performance, service experience and comfort.

Distinct Preferences in Segment 2: Segment 2, the smallest segment, showcases distinct preferences, particularly on features (performance and extra features) and costs (maintenance cost).

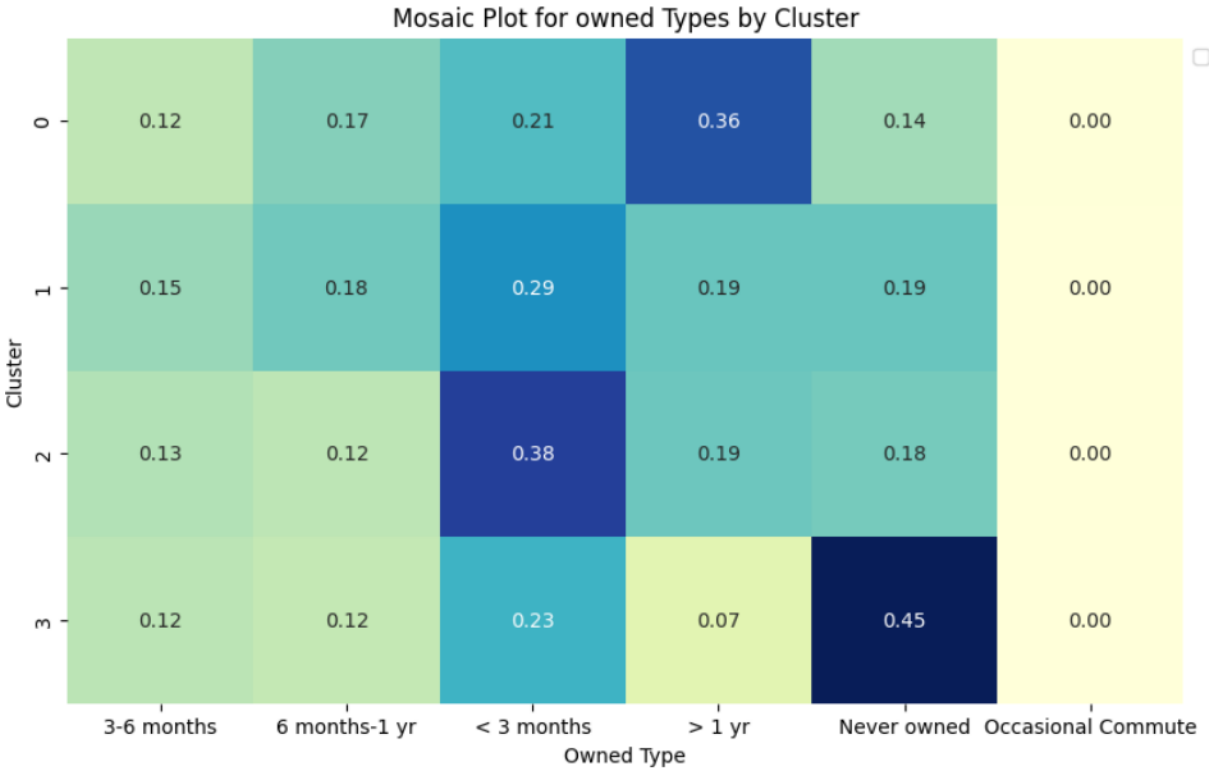
Commonly Valued Aspects: Rating,Visual appeal, reliability, and service experience are valued across all segments. These aspects seem to be universally important to consumers in this context.



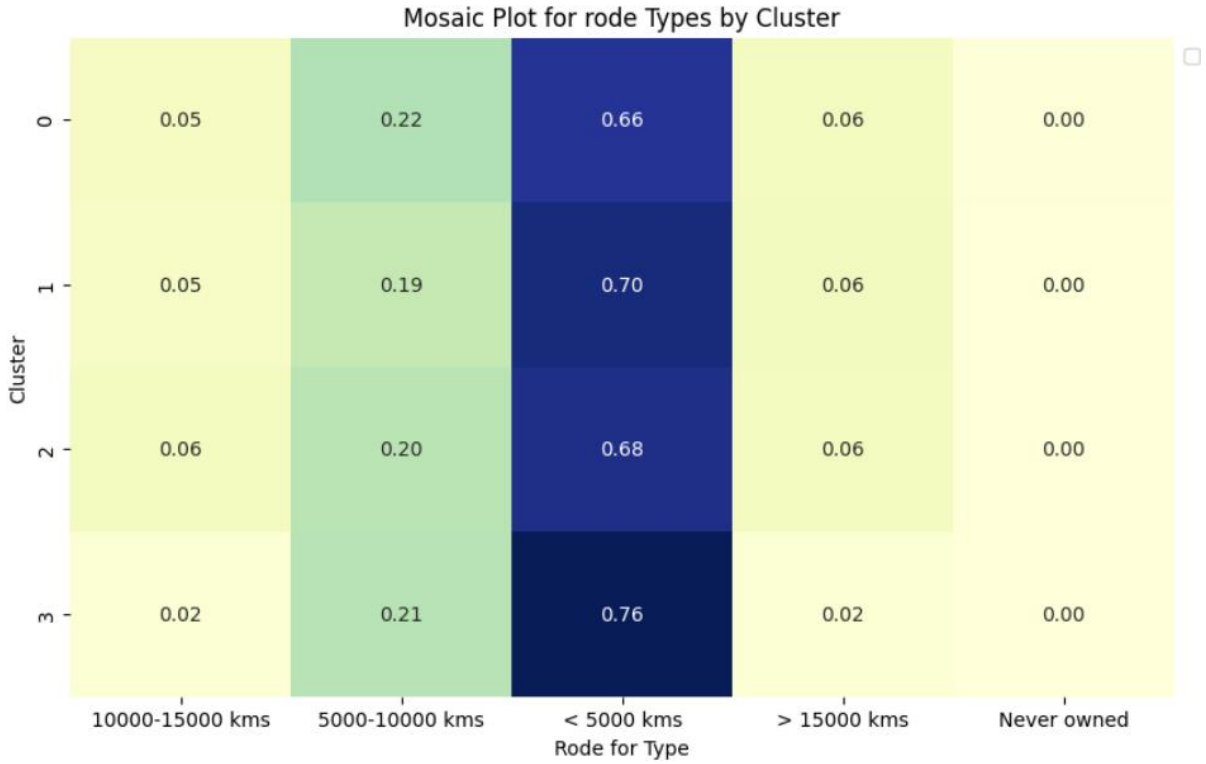
All segments rate the electric vehicles for 5, except segment 0 .



All segments predominantly use electric vehicles for daily commuting, with limited usage for tours, occasional commuting, and leisure rides.



Segment 0 stands out, owning electric vehicles for more than a year. Segment 1 and Segment 2 members moderately own vehicles for less than 3 months, and Segment 3 consumers have never owned electric vehicles.



Above plot depicts that all segments predominantly use electric vehicles for distances below 5000 kms.

Selection of target segment:

Segment 0 (41%), Segment 1 (32%), Segment 2 (13%), and Segment 3 (14%). Segment 0, the biggest however slightest fulfilled, requests changes in different highlights. Particularly, upgrades are required in rating, visual offer, unwavering quality, execution, benefit involvement, consolation, additional highlights, support fetched, and esteem for cash. Whereas common viewpoints like rating, visual offer, unwavering quality, and benefit involvement are generally esteemed over all sections, zones of discontent in Segment pinpoint significant advancement targets. Furthermore, tending to particular desires of Segment 1 (emphasizing rating, visual offer, unwavering quality, benefit encounter, consolation, and esteem for cash) and recognizing the unmistakable inclinations of Segment 2 (prioritizing esteem for cash and execution) are imperative for maintained advertise development. Understanding the preferences and dissatisfaction points of each segment can guide targeted marketing and product improvement strategies.

Customizing the Marketing Mix:

Customizing involves making a strategic approach to address the unique preferences and needs of various consumer segments.

1) Product:

Segment 0: Emphasize plan, unwavering quality, and esteem.

Segment 1: Prioritize cost-effective execution.

Segment 3: Concentrate on unwavering comfort and value for money.

Segment 4: Highlight extra features,cost-effectiveness and value for money.

Potential customer base in the early market

Segment 0 (41%): The largest but least satisfied segment.

Segment 1 (32%): Represents a significant portion of early adopters.

Segment 2 (13%): Smallest, but distinct in preferences.

Segment 3 (14%): Moderate in size, with specific value criteria.

Profit Calculation:

Segment 1 (32%): With 272 members (32% of 845) and a target price range between ₹80,000 and ₹1,50,000, the potential profit can be calculated. For instance, with a target price of ₹1,20,000, the potential profit amounts to ₹34.56 crores.

Segment 2 (13%): Having 110 members (13% of 845) and a target price range of ₹70,000 to ₹1,30,000, potential profit can be determined. For example, with a target price of ₹1,10,000, the potential profit is ₹12.1 crores.

Segment 3 (14%): With 118 members (14% of 845) and a target price range from ₹75,000 to ₹1,40,000, the potential profit varies. For a target price of ₹1,25,000, the potential profit amounts to ₹14.75 crores.

Segment 1, being significant in potential market share, and Segment 3 both contribute to the primary focus for early market penetration efforts due to their substantial profit opportunities.

The MOST OPTIMAL MARKET SEGMENTS to open in the market as per your Market Research and Segmentation

Two key market segments emerge from the analysis: Segment 1, constituting 32% of the market, boasts a large market share, signaling significant profit potential. On the other hand, Segment 3, comprising 14% of the market, presents a distinctive opportunity for substantial profits. These segments represent strategic entry points for maximizing market penetration and capitalizing on the diverse preferences within each group.

Conclusion:

Solution for the problem based on Based on Product

It is evident that the electric vehicle (EV) market is experiencing significant growth across various categories, particularly in the EV-2 Wheeler segment. The sales trends from 2017-18 to 2022-23 depict a consistent upward trajectory, with remarkable increases observed in the EV-2 Wheeler category in 2022-23.Overall, the data suggests a strong preference for EV-2

Wheelers among consumers, with substantial growth potential in this segment. Producers should prioritize development and marketing efforts in alignment with customer expectations, leveraging insights from sales trends and market demand to stay competitive and capitalize on the expanding EV market.

Solution for the problem based on Based on customer

EV2 vehicles consistently receive higher ratings across various usage patterns, indicating a positive sentiment among users. Comfort emerges as a significant factor influencing user satisfaction, with users giving higher ratings, especially for EV2 vehicles, regardless of the distance traveled. This underscores the importance of prioritizing comfort features in electric two-wheeler design and marketing. Furthermore, the analysis highlights the perception of value for money among users, with most models receiving positive ratings in this aspect. Brands like Hero Electric Flash stand out for providing high value despite longer charging times and maintenance costs, suggesting that factors beyond these considerations contribute to user satisfaction. Additionally, the wide range of prices and weights across different models indicates market diversity catering to various budget segments and preferences.

Based on market segmentation analysis

The most optimal market segments for entry into the electric two-wheeler market are identified as Segment 1 and Segment 3, representing 32% and 14% of the market, respectively. These segments offer significant profit potential and present strategic opportunities for maximizing market penetration by aligning product features and marketing strategies with their specific preferences and needs.

In conclusion, leveraging the insights gained from segmentation analysis, targeted marketing, and product customization strategies can help manufacturers effectively navigate the electric two-wheeler market, optimize market entry, and capitalize on diverse consumer preferences to drive business growth and success.

Github Link:

https://github.com/emie44/EV-Market-Segmentation