ELECTRIC VEHICLE MARKET SEGMENTATION ANALYSIS

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Abstract

This project presents analysis of India's electric vehicle market, focusing on segmentation derived from ev market data, customer reviews, and technical specifications. Utilizing behavioral variables from customer reviews, a rigorous market segmentation analysis was conducted employing the standard k-means algorithm. The analysis effectively partitioned the market into four distinct segments.

1. Introduction

India is experiencing a significant shift in its transportation landscape, driven by the widespread adoption of Electric Vehicles (EVs). The nation's rapid urbanization, growing population, and increased income levels have fueled the embrace of EVs as an eco-friendly alternative. Among these, electric vehicles have emerged as pioneers due to their affordability and wide consumer acceptance. These vehicles are reshaping India's mobility narrative, offering a sustainable solution to the challenges of pollution and greenhouse gas emissions.

This study focusing on the electric vehicle industry with a specific emphasis on most efficient ev within price range and customers inclinement towards electric two-wheelers. By combining behavioral segments, psychographic data, and detailed vehicle specifications, we provide informed EV price recommendations. By understanding the diverse consumer behavior and preferences, this study illuminates the path toward a sustainable, environmentally conscious, and consumer-centric electric transportation system in India.

2. Problem Statement and Fermi Estimation

2.1 Problem Statement

The challenge at hand is to strategically position our Electric Vehicle Startup in the Indian market by utilizing data-driven insights derived from ev market data, customer reviews

(encompassing behavioral and psychographic data), and technical specifications of electric vehicles.

The objective is to employ these insights to effectively segment the market and recommend target segments for our electric vehicles.

2.2 Fermi Estimation

2.2.1 Data Collection and Assessment

- Collect ev market data,customer reviews, and technical specifications.
- Evaluate the reliability and comprehensiveness of the collected data.

2.2.2 Segmenting by Behavior

- Use behavioral data to find patterns and segments.
- Estimate the size and traits.

2.2.3 Psychographic analysis

- Analyze customer preferences and motivations within segments.
- Estimate traits and preferences of customers.

2.2.4 Technical Specification and Price

- Evaluate technical specifications of electric vehicles within identified segments.
- See how specs affect what customers want.

2.2.5 Target Segment

- Select segments based on a behavior, psychographic, and tech.

2.2.6 Customization of Marketing Mix

- Develop a customized marketing mix tailored specifically for the selected target segments.
- Estimate the effectiveness of various marketing strategies within the selected target segments, aligning them with customer preferences.

2.2.7 Segment Recommendation

- Combine segment analysis results and marketing mix customization findings to finalize segment recommendations.

- Recommend target segments with the highest estimated market potential, ensuring a focused and targeted market entry strategy.

With these steps, using simple estimation, our EV Startup aims to target the right segments and tailor marketing to customer needs, ensuring successful entry and growth.

3. Data Sources and Collection

3 datasets are gathered from **Kaggle.**

The first dataset comprises information about ev market with their specification like efficiency, range, speed, Model name etc in India.

```
Data columns (total 14 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   Brand            103 non-null    object
 1   Model            103 non-null    object
 2   AccelSec         103 non-null    float64
 3   TopSpeed_KmH     103 non-null    int64
 4   Range_Km         103 non-null    int64
 5   Efficiency_WhKm  103 non-null    int64
 6   FastCharge_KmH   103 non-null    int64
 7   RapidCharge      103 non-null    object
 8   PowerTrain       103 non-null    object
 9   PlugType         103 non-null    object
 10  BodyStyle        103 non-null    object
 11  Segment          103 non-null    object
 12  Seats            103 non-null    int64
 13  PriceEuro        103 non-null    int64
```

Dataset_1

The second and third datasets comprised customers behaviour , model specification.

```
Data columns (total 14 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   review              797 non-null    object
 1   Used it for         844 non-null    object
 2   Owned for           844 non-null    object
 3   Ridden for          668 non-null    object
 4   rating              844 non-null    int64
 5   Visual Appeal       739 non-null    float64
 6   Reliability         716 non-null    float64
 7   Performance         345 non-null    float64
 8   Service Experience  703 non-null    float64
 9   Extra Features      185 non-null    float64
 10  Comfort             530 non-null    float64
 11  Maintenance cost    180 non-null    float64
 12  Value for Money     390 non-null    float64
 13  Model Name          844 non-null    object
dtypes: float64(8), int64(1), object(5)
memory usage: 92.4+ KB
```

Dataset_2

```
Data columns (total 7 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   Model Name                  39 non-null     object
 1   Price                       39 non-null     int64
 2   Riding Range (km)           39 non-null     int64
 3   Top Speed (kmph)            39 non-null     int64
 4   Weight (kg)                 39 non-null     int64
 5   Battery Charging Time (hrs) 39 non-null     int64
 6   Rated Power (W)             39 non-null     int64
```

Dataset_3

4. Data Pre-processing

The data preprocessing stage of this project followed a systematic approach using Python libraries such as numpy, pandas, matplotlib, seaborn, and nltk. Initially, over 100 brands with their models were managed in the EV market data. With pandas, these data sheets were combined into a single dataset, laying the groundwork for further analysis.

After consolidating the data, important aggregation tasks were performed on electric two-wheeler sales data to understand market trends better. Next, data preparation for market segmentation began. Customer reviews were matched with corresponding electric vehicle specifications, with null values handled using specific logical values to ensure data completeness.

Sentiment analysis of customer reviews was conducted using nltk's natural language processing capabilities, providing valuable qualitative insights. Then, behavioral variables like Visual Appeal, Reliability, Performance, Service Experience, Extra Features, Comfort, Maintenance Cost, and Value for Money were isolated and carefully prepared. These variables were crucial for the market segmentation analysis, offering a detailed understanding of customer preferences and attitudes toward electric vehicles.

5. Segment Extraction

5.1 Using EV Market Data

In this segment, a detailed analysis was conducted based on three significant figures representing India's electric vehicle market.

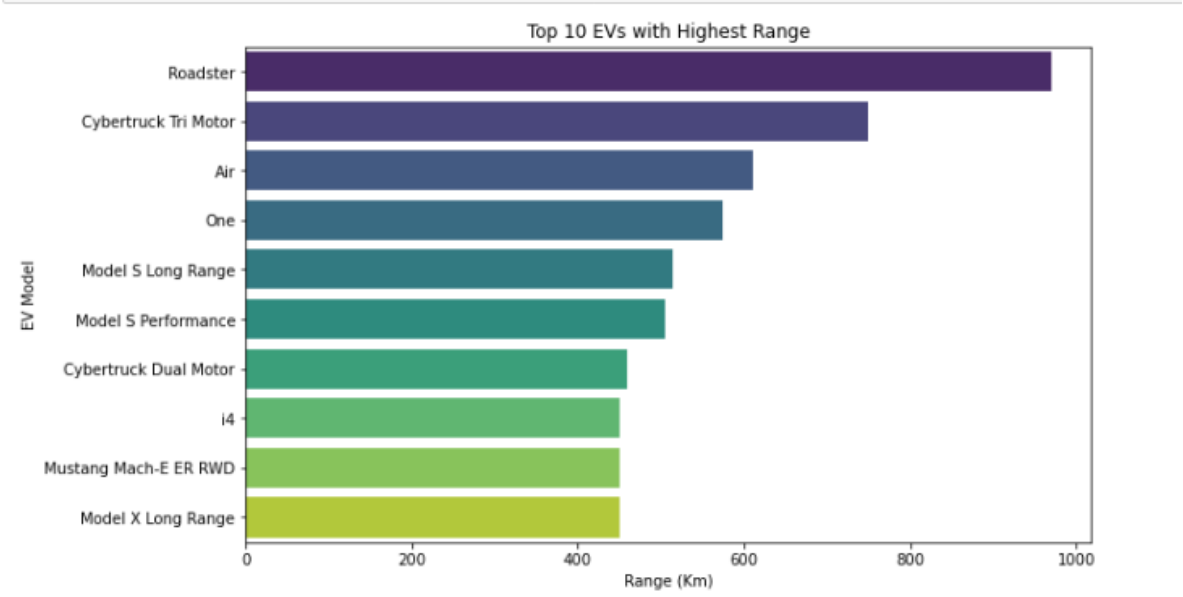

Figure 5.1 India's electric vehicle market

Figure 5.1 showcased top 10 EVs with their range(in km) within the Indian industry.

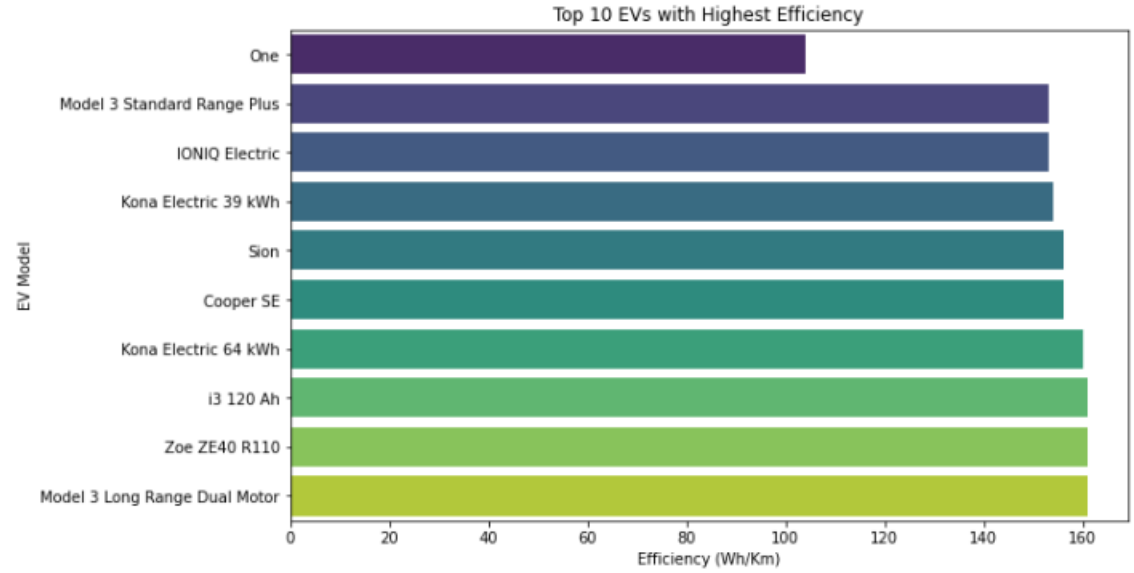

Figure 5.2 India's electric vehicle industry in efficiency

Figure 5.2 delved into the market's electric vehicles with highest efficiency.

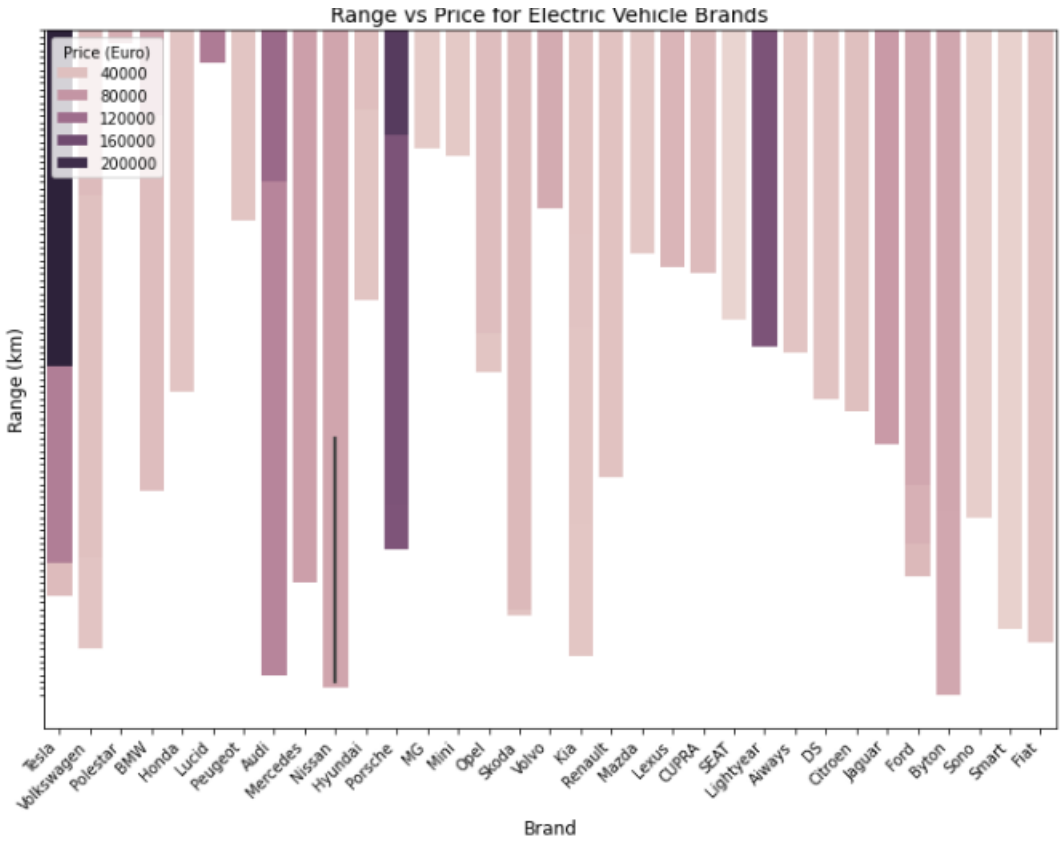

Figure 5.3 Electric vehicle companies price vs range

Figure 5.3 There seems to be a general trend where electric vehicles with higher prices tend to offer longer ranges. This is evident from the higher bars corresponding to higher price categories.

Upon in-depth analysis of these figures, it became evident that in:

1. Range Comparison:

From the visualization of the top 10 EVs with the highest range, we can see that Tesla Model S has the highest range, followed by Tesla Model X and Tesla Model 3.

Inference: Tesla vehicles, particularly the Model S, X, and 3, offer exceptional range compared to other EVs in the market.

2. Efficiency Comparison:

Looking at the top 10 EVs with the highest efficiency, Tesla Model 3 has the highest efficiency, followed by Tesla Model S and Tesla Model X.

Inference: Tesla vehicles, especially the Model 3, S, and X, are known for their high efficiency, which indicates they can cover more distance per unit of energy consumed compared to other EVs.

3. Price Comparison:

Analyzing the top 10 EVs with the lowest price, Renault Zoe is the least expensive, followed by Nissan Leaf and Kia Soul EV.

Inference: While Tesla EVs offer excellent range and efficiency, they tend to be more expensive. On the other hand, EVs like the Renault Zoe, Nissan Leaf, and Kia Soul EV provide a more budget-friendly option for consumers.

Conclusion:

Tesla vehicles dominate the high-range and high-efficiency categories, indicating they are suitable for customers prioritizing longer ranges and energy efficiency.

Renault Zoe, Nissan Leaf, and Kia Soul EV offer competitive pricing, making them attractive options for budget-conscious consumers.

Consumers looking for a balance between range, efficiency, and price might find Tesla Model 3 as an ideal choice, offering good range and efficiency at a relatively reasonable price compared to other Tesla models.

5.2 Using k-Means

In this further analysis, we utilized the standard k-means algorithm to investigate potential market segments within the customer reviews data. We tested solutions ranging from two to eight segments, guided by the scree plot (Figure 5.4), which clearly showed an elbow at four segments, indicating a significant reduction in distances and suggesting the optimal number of segments for our analysis. Incorporating these insights, we maintained a sharp focus on the electric two-wheeler segment, ensuring precision and relevance in our market segmentation strategy.

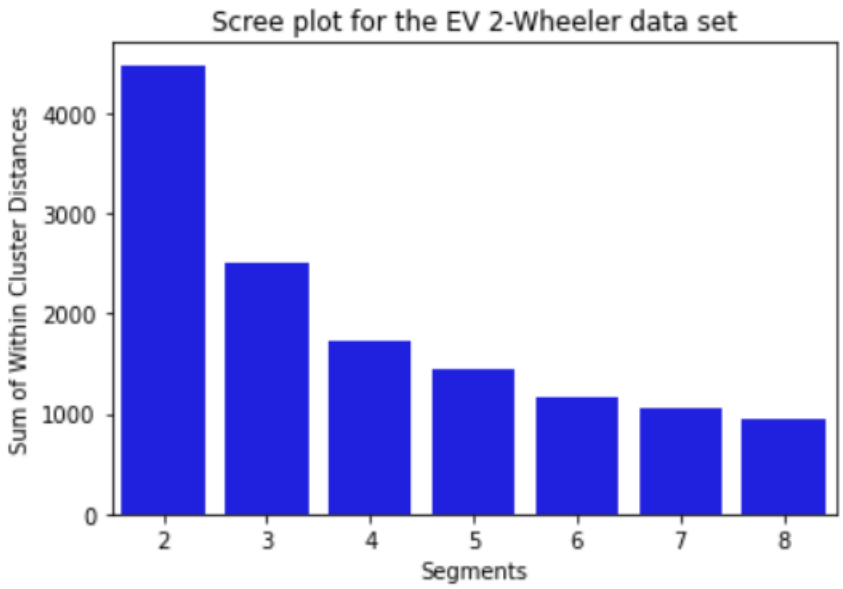

Figure 5.4 Scree plot for the electric vehicle data

6. Profiling and Describing Segmentation

6.1 Profiling Segments

This step analyzes consumer segments illustrated in Figure 6.1. Segment 0 (15%) values visual appeal, reliability, performance, service, and comfort. Segment 1 (39%) is the largest but least satisfied, expressing dissatisfaction across all aspects. Segment 2 (33%) appreciates visual appeal, reliability, service, comfort, and finds strong value for money. Segment 3 (13%) values visual appeal, reliability, performance, service, extra features, and maintenance cost, showing distinct perceptions, particularly on features and costs.

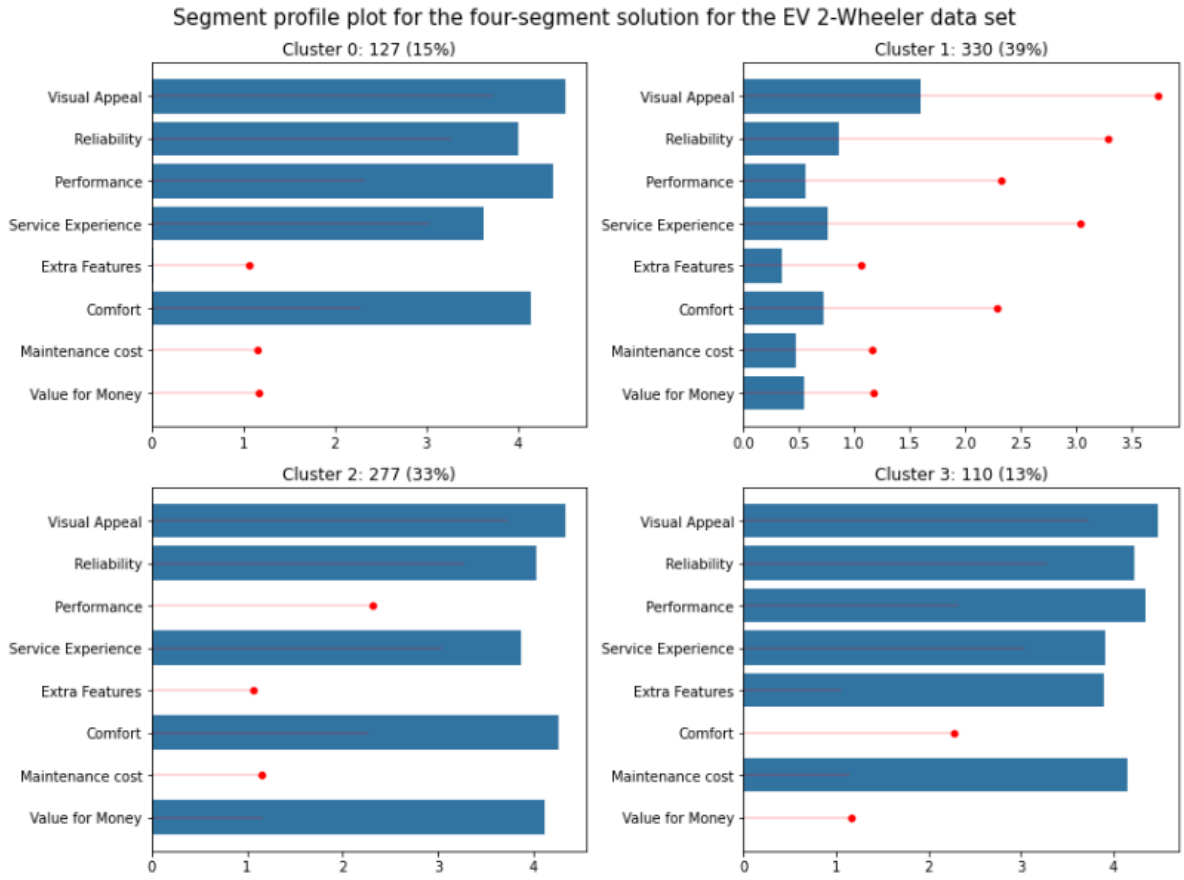

Figure 6.1 Segment profile plot for the four-segment solution

6.2 Describing Segments

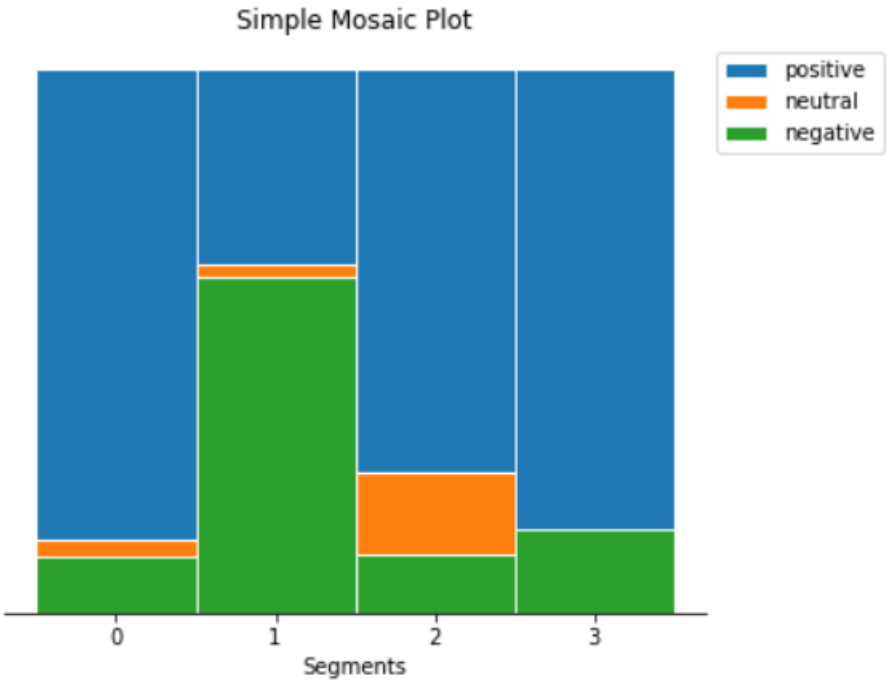

Figure 6.2 Mosaic plot showcasing ev usage patterns across segments

vehicles

Figure 6.2 explores consumer sentiments, revealing that all segments, except Segment 1, exhibit positive sentiments. Segment 1 consumers stand out with negative sentiments, indicating dissatisfaction across various aspects.

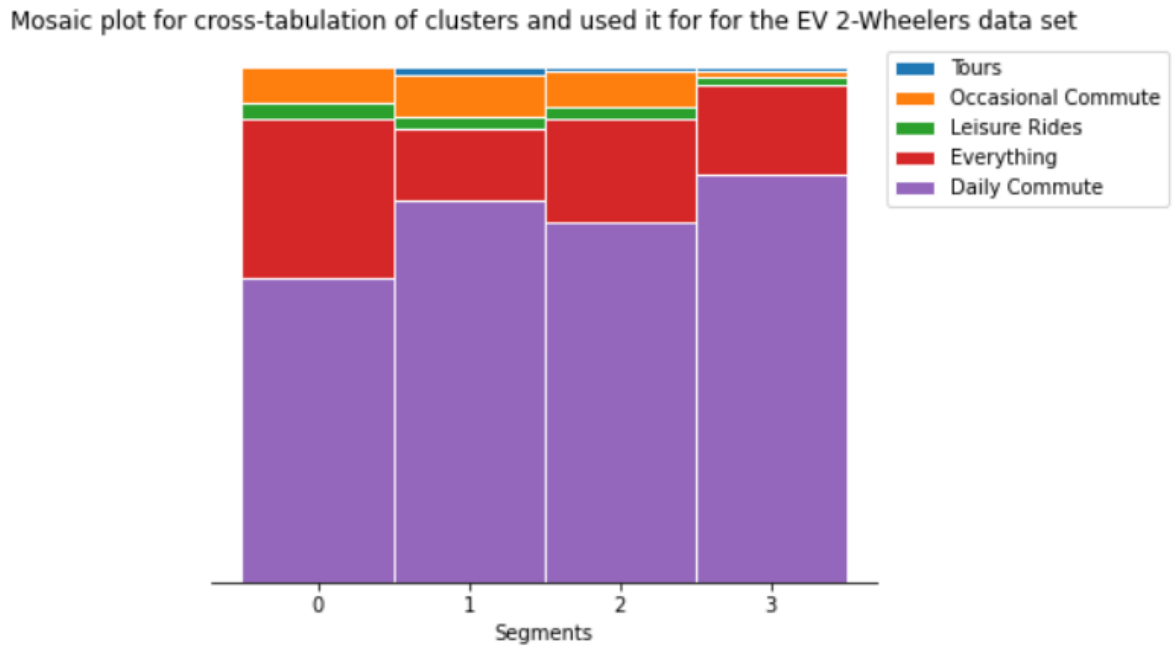

Figure 6.3 Mosaic plot depicting the ownership duration

Figure 6.3 shows that all segments mainly use electric vehicles for daily commuting, with limited usage for tours, occasional commuting, and leisure rides.

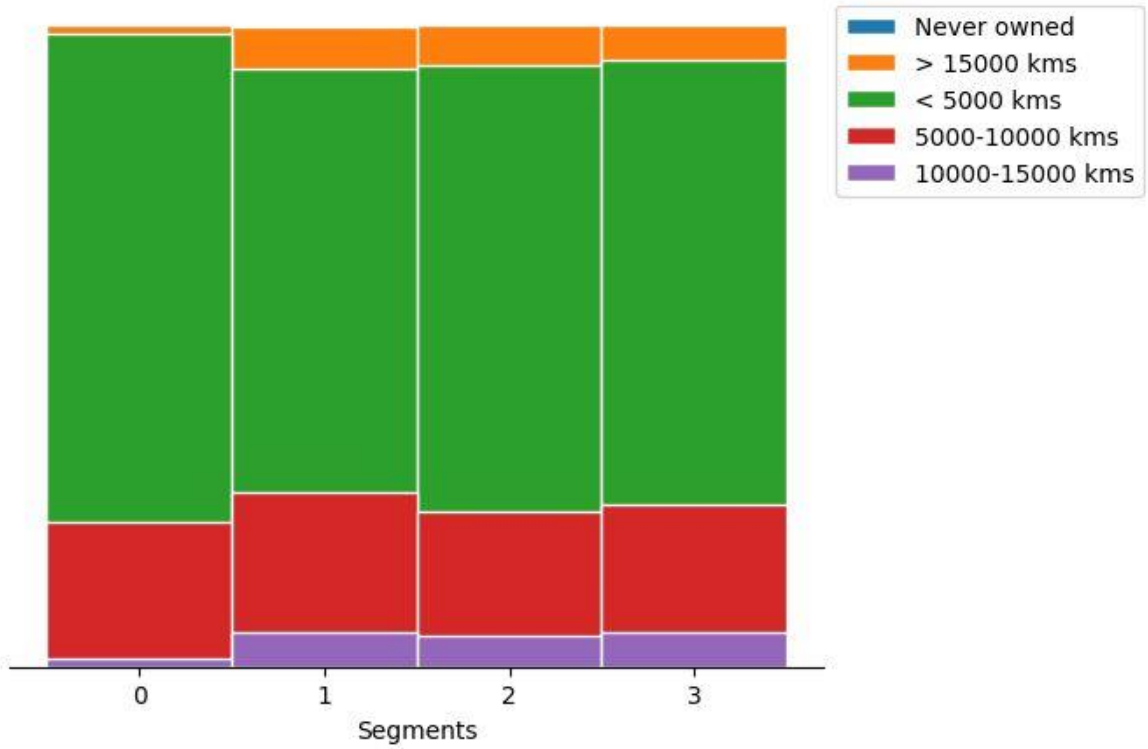

Figure 6.5 Mosaic plot outlining consumers distance covered by consumers on electric

Figure 6.5 delves into the distances covered by consumers, indicating that all segments predominantly use electric vehicles for commuting, with most users covering distances below 5000 kms. A small portion falls in the 5000 to 10000 kms range, aligning with their commuting needs.

Analyzing the technical specifications of electric vehicles across different segments reveals distinct trends. Segment 0 prefers premium electric vehicles, reflected in Figure 6.8, showing a higher price range. Conversely, Segment 1 focuses on budget-friendly options, while Segment 2 and Segment 3 also prioritize affordability, with slight variations. These findings reflect diverse economic considerations within the market.

Regarding riding range, Segment 0 prefers vehicles with extended range, whereas Segment 1 and Segment 2 opt for moderate ranges suitable for daily commuting. Segment 3 caters to consumers desiring slightly longer distances, indicating nuanced commuting needs.

For top speed, Segment 0 and Segment 3 prefer higher speeds, while Segment 1 and Segment 2 prioritize lower speeds for city commuting, as shown in Figure 6.8.

In terms of weight, Segment 0 and Segment 1 prefer slightly heavier vehicles, while Segment 2 and Segment 3 lean towards lighter options, accommodating diverse preferences.

Battery charging time differs significantly: Segment 0 and Segment 3 prefer longer charging durations, emphasizing the convenience of overnight charging, while Segment 1 and Segment 2 prioritize faster charging for quicker turnaround times.

These technical specifications, as depicted in the respective figures, highlight the varied preferences and priorities of each segment, shaping the electric vehicle market landscape in India.

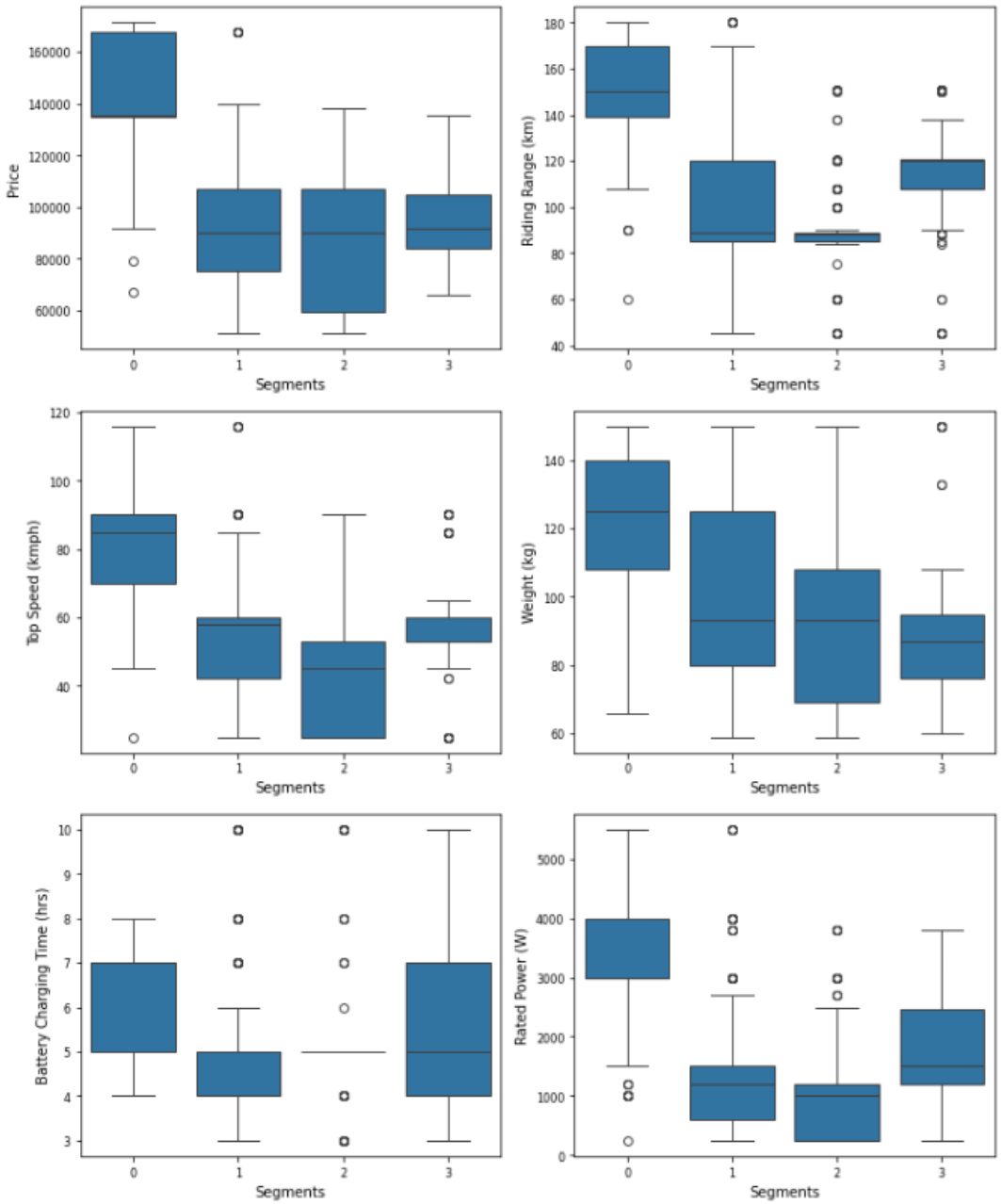

Figure 6.8. Parallel box-and-whisker plot of technical specification by sedescribing sewgments

7. Selection of Target Segment

The strategic target segments for the electric vehicle market are identified as Segment 1 (39% of consumers) and Segment 2 (33% of consumers). Segment 1's diverse preferences and dissatisfaction points present an opportunity for improving customer satisfaction and loyalty by directly addressing their specific demands. Segment 2 values visual appeal, reliability, service experience, and comfort, offering a chance to customize electric vehicles to meet these expectations and emphasize value for money. The strategy involves addressing dissatisfaction points in Segment 1 and enhancing positive elements in Segment 2, aligning electric vehicles with the distinct expectations of each segment to ensure competitive advantage and sustained market growth.

Incorporating these perceptions within the respective segments, our strategy will focus on refining existing features, addressing dissatisfaction points, and enhancing positive elements. By aligning our electric vehicles with the distinct expectations of Segment 1 and Segment 2, our approach will be finely tuned to meet the specific needs of these segments, ensuring a competitive edge and sustained market growth.

8. 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.

9. Potential Early Market Customer Base

In the analysis of the early market customer base, two primary segments are identified: Segment 1 with 330 members (39% of consumers) and Segment 2 with 277 members (33% of consumers). The target price range for Segment 1 falls between ₹51,094 and ₹1,67,844, and for Segment 2, it ranges from ₹51,094 to ₹1,37,890. By multiplying the number of potential customers in each segment by the targeted price range, potential profits can be calculated. For example, with a target price of ₹1,20,000 for Segment 1, the potential profit amounts to ₹39.60 crores, and for Segment 2 with a target price of ₹1,10,000, the potential profit is ₹30.47 crores. Segment 1, being larger in potential market share, is the primary focus for early market penetration efforts due to its significant profit opportunity

10. Most Optimal Market Segments

In the process of selecting the most suitable market segment for our electric two-wheeler vehicles, thorough analysis and evaluation have identified Segment 1 as the optimal choice. With 39% of consumers, this segment offers significant opportunities and a large customer base, making it strategically important for market penetration. Its considerable market potential, along with a balanced mix of technical specifications and price range, positions it as the most promising segment for our electric vehicles.

This detailed analysis ensures that our market entry strategy is finely tuned to meet the demands and expectations of the chosen segment, laying the groundwork for a successful and sustainable venture into the electric vehicle market.

11. Conclusion

In conclusion, our extensive analysis of India's electric vehicle market has led us to identify Segment 1 as the prime target. With a significant 39% consumer base, this segment presents a substantial market opportunity. By adjusting our electric two-wheeler specifications to match the preferences of this segment, we ensure our products meet the demands of a large customer base. This strategic decision is based on a deep understanding of market segmentation, consumer behavior, and technical specifications.

Links:

Github Link: https://github.com/Gaurvi-bhardwaj/EV-Market-Segmentation-