ELECTRIC VEHICLE MARKET SEGMENTATION ANALYSIS

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GitHub Link : https://github.com/tusharpotdar99/Electric-Vehicle-Market-Segmentation-Analysis

Abstract

This project presents a comprehensive analysis of India's electric vehicle market, with a focus on segmentation derived from sales data, customer reviews, and technical specifications. The study emphasizes the robust growth trajectory of India's two-wheeler market, establishing it as a primary revenue source within the broader EV sector. By leveraging behavioural variables from customer reviews, the research conducts a rigorous market segmentation analysis using the standard k-means algorithm, effectively partitioning the market into four distinct segments.

Among these, Segment 1 emerges as the cornerstone of our strategy, representing a substantial 39% of the consumer base. This segment not only offers significant market potential but also serves as the optimal target for our venture. The analysis guides the recommendation of specific electric two-wheeler technical specifications tailored to meet the preferences of Segment 1 consumers.

These recommended specifications, carefully aligned with the demands of this segment, are central to our strategic approach. Additionally, the price range is set to closely match the median values, ensuring both affordability and market competitiveness. This strategic alignment with Segment 1, identified as the potential early market customer base, positions our venture favourably within India's rapidly evolving electric vehicle landscape.

Problem Statement

The challenge at hand is to strategically position our Electric Vehicle Startup in the Indian market by leveraging data-driven insights derived from sales data, customer reviews (encompassing both behavioural and psychographic data), and technical specifications of electric vehicles. Our objective is to use these insights to effectively segment the market and identify optimal target segments for our electric vehicles. By doing so, we aim to tailor our offerings to meet the specific needs and preferences of these segments, ensuring a competitive edge and successful market entry.

Data Sources and Collection

For this project, data was gathered from three distinct sources:

Sales Data: The primary dataset, obtained from the Society of Manufacturers of Electric Vehicles, spans from 2017 to 2023 and catalogues sales figures of electric two-wheelers, three-wheelers, four-wheelers, and buses. This dataset provides a comprehensive view of market trends and customer preferences over time, serving as a critical foundation for understanding the market landscape.

Customer Reviews: The second dataset, extracted from bikewale.com, comprises customer reviews of electric two-wheelers. These reviews offer vital behavioural and psychographic insights, providing qualitative data that helps in understanding customer behaviour, preferences, and pain points.

Technical Specifications: The third dataset, also from bikewale.com, presents detailed technical specifications and pricing information for electric two-wheelers. This data allows us to assess the technical feasibility of various models and determine price points that are crucial for our market segmentation strategy.

By integrating these datasets, we developed a robust understanding of the electric vehicle market. The combination of real sales data, customer sentiments, and technical specifics forms the foundation of our analysis, ensuring a data-driven and market-relevant segmentation approach.

Data Pre-processing

The data pre-processing phase of this project involved a systematic approach, leveraging Python libraries such as NumPy, pandas, matplotlib, seaborn, and nltk to ensure data integrity and readiness for analysis.

Sales Data Handling:

1. The primary task was to manage the sales data, which was initially distributed across 10 separate sheets in Excel format. Using pandas, these data sheets were merged into a unified dataset, providing a comprehensive foundation for subsequent analysis.
2. A key focus was placed on ensuring the accuracy of electric vehicle maker names. This was achieved through meticulous replacement operations, where inconsistencies and variations in naming were corrected to maintain uniformity.

Data Aggregation:

1. After consolidating the data, essential aggregation operations were performed specifically on the electric two-wheeler sales data. This step provided a detailed perspective on market trends and helped in understanding the overall market dynamics.

Data Preparation for Market Segmentation:

1. The customer reviews and responses were merged with the corresponding electric vehicle technical specifications, creating a comprehensive dataset that combined qualitative and quantitative information.
2. To maintain data integrity, null values were handled using specific logical values, ensuring that the dataset was complete and ready for analysis without introducing biases or gaps.

Sentiment Analysis:

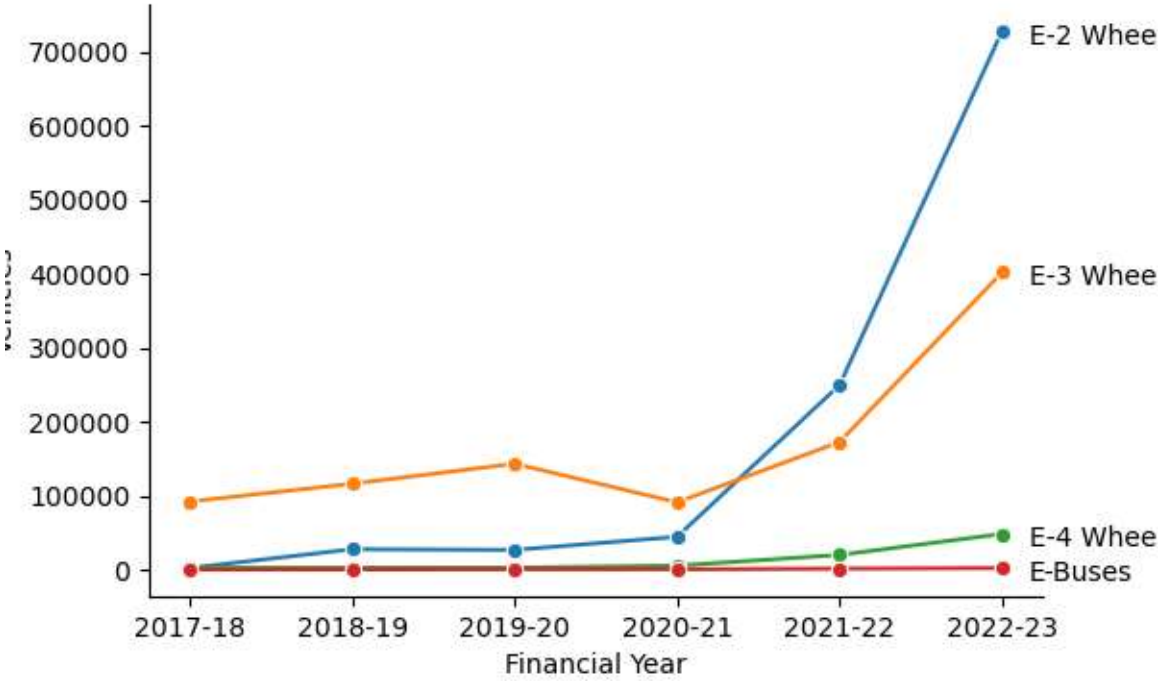
1. Sentiment analysis of customer reviews was conducted using the natural language processing capabilities of nltk. This analysis provided valuable qualitative insights into customer sentiments, revealing attitudes and emotions that influenced purchasing decisions.

Behavioural Variable Isolation:

1. Behavioural variables such as Visual Appeal, Reliability, Performance, Service Experience, Extra Features, Comfort, Maintenance Cost, and Value for Money were isolated and meticulously prepared for analysis. These variables were fundamental in laying the groundwork for the market segmentation analysis, providing a nuanced understanding of customer preferences and attitudes toward electric vehicles.

This comprehensive data pre-processing phase ensured that the datasets were clean, accurate, and ready for the subsequent market segmentation analysis, ultimately enabling a data-driven approach to understanding and targeting the Indian electric vehicle market.

Segment Extraction
Using Sales Data



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

Figure 5.1 showcased the remarkable growth trajectory of India's two-wheeler market in 2023, underscoring its leading position within the industry.

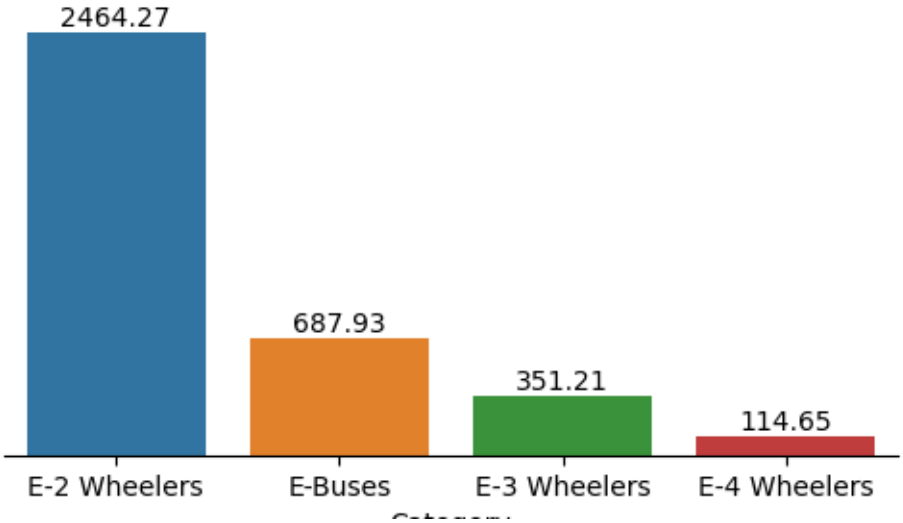
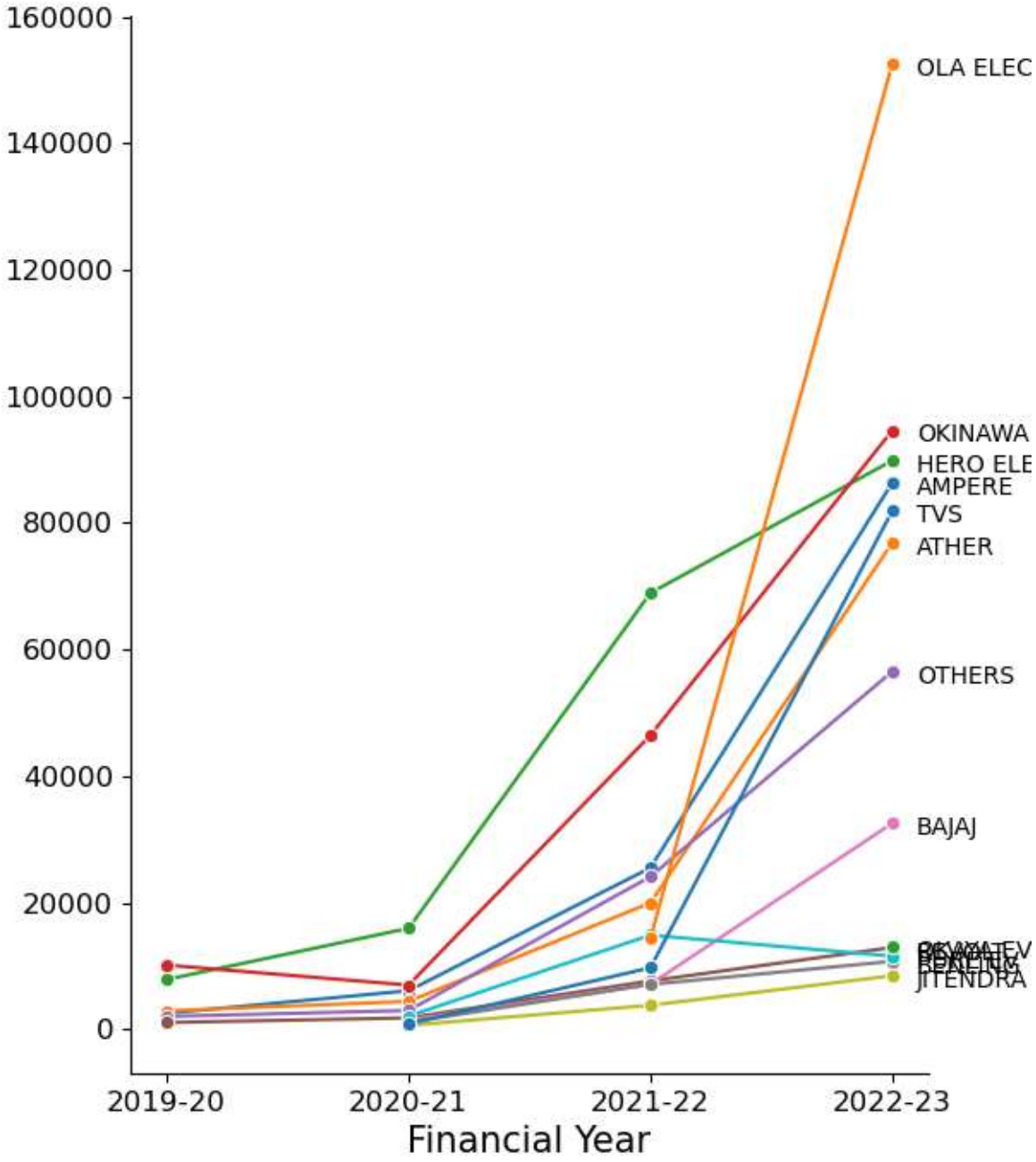


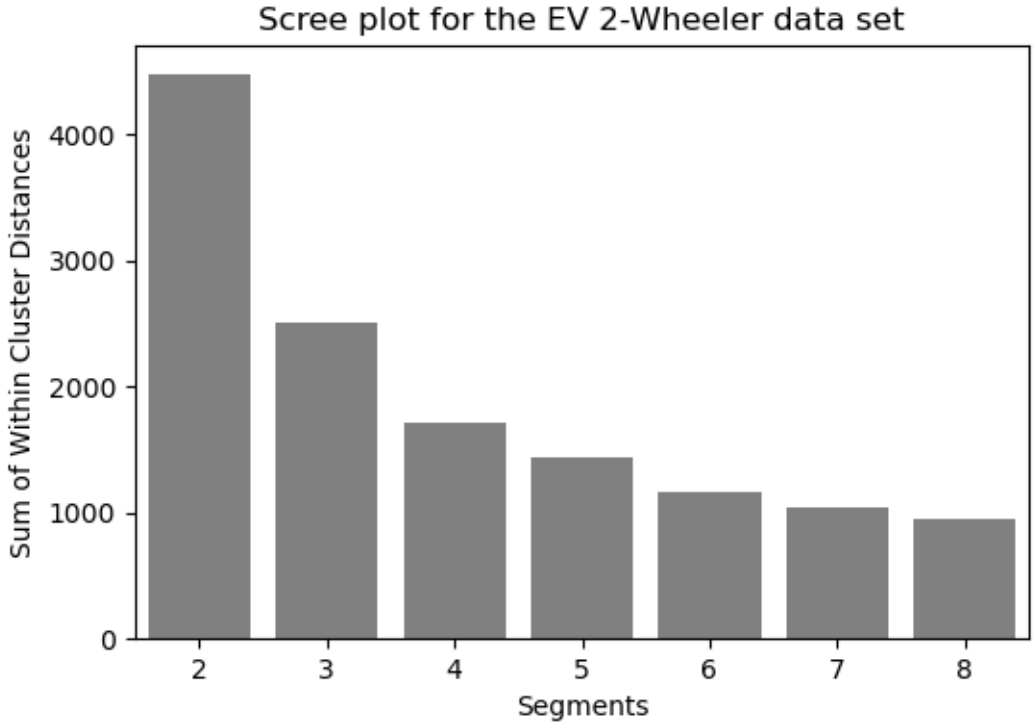
Figure 5.2 delved into the market's financial perspective, representing the industry's total value in crores. Notably, two-wheelers emerged as the primary revenue generators, highlighting their economic significance.

Figure 5.3 honed in on specific electric two-wheeler companies, with Ola Electric emerging as the market leader in 2023, illustrating industry leadership and market competitiveness.



Upon in-depth analysis of these figures, it became evident that the electric two-wheeler segment was the most promising area for our detailed study. The robust growth, revenue dominance, and market leadership collectively indicated its prominence and potential, making it the ideal focus for our detailed study.

Using k-Means



In the subsequent analysis, the standard k-means algorithm was applied to explore market segmentation possibilities within the electric two-wheeler customer reviews data. To determine the optimal number of segments, the algorithm was systematically tested across solutions ranging from two to eight market segments.

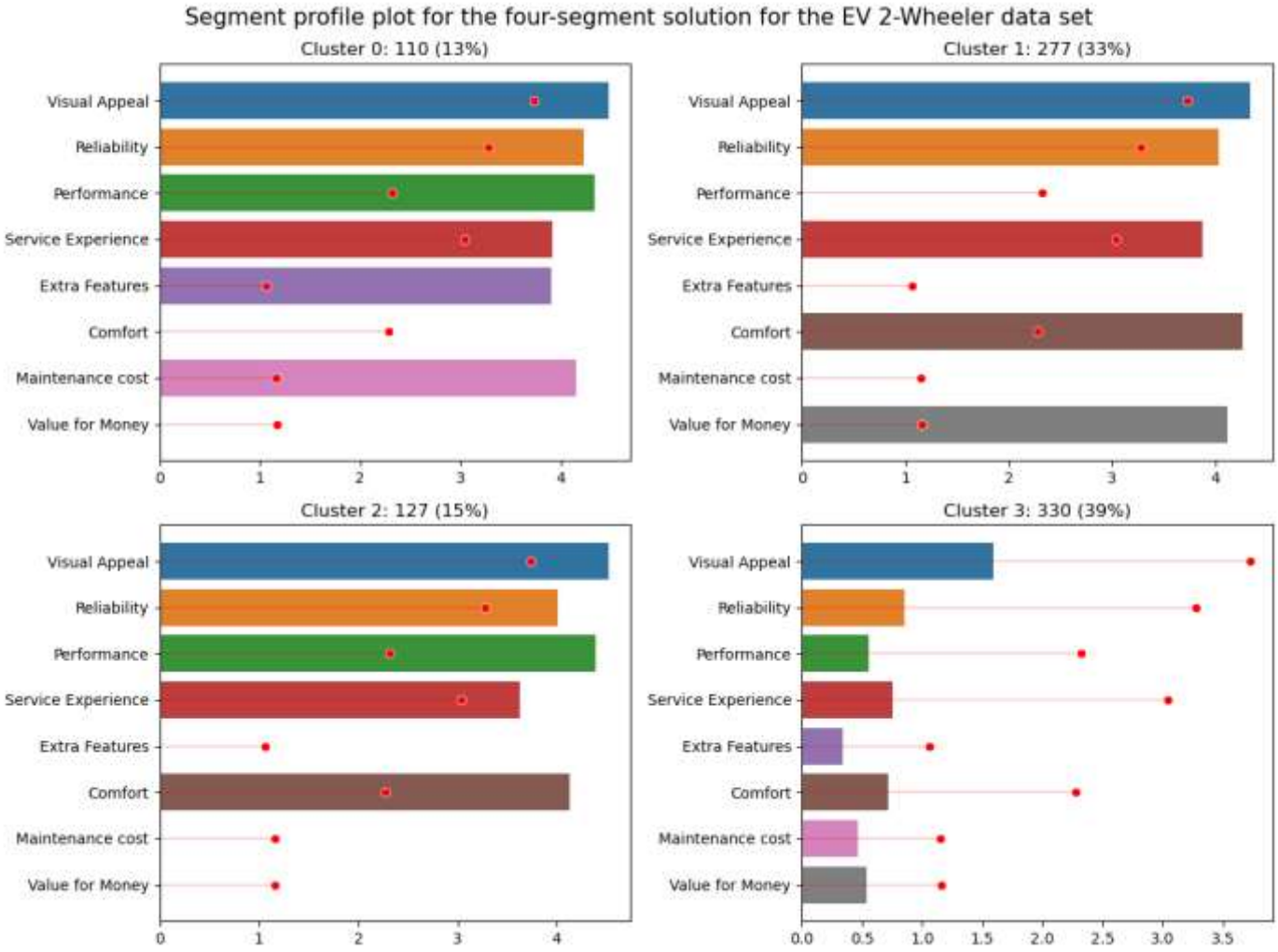
A critical component of the decision-making process was the scree plot (Figure 5.4), which plotted the within-cluster sum of squares against the number of segments. The scree plot revealed a distinct elbow at four segments, indicating a substantial reduction in distances beyond this point. This "elbow" suggested that four segments were the optimal choice for our analysis, balancing the trade-off between complexity and explanatory power.

By incorporating insights from these analyses, our focus remained finely tuned on the electric two-wheeler segment, ensuring precision and relevance in our market segmentation approach. This methodical segmentation allowed us to accurately identify and target the most promising consumer groups within the market, enabling a tailored strategy for product development and marketing.

Profiling and Describing Segmentation

Profiling Segments

Consumer Segment Analysis



This section presents a detailed analysis of our consumer segments, as illustrated in Figure 6.1. The graph visually captures the diverse perceptions and preferences among the different segments, highlighting key insights into the electric two-wheeler market.

Segment 0 (15% of Consumers):

This segment values electric two-wheelers primarily for their visual appeal, reliability, performance, service experience, and comfort. These consumers are likely drawn to vehicles that not only perform well but also offer a visually pleasing and comfortable ride, coupled with dependable service.

Segment 1 (39% of Consumers):

Segment 1 is the largest consumer group, yet it stands out for its dissatisfaction across all aspects of the electric two-wheeler experience. This segment expresses concerns about visual appeal, reliability, performance, service experience, and comfort, marking

it as the most challenging yet potentially rewarding group to address. Improving customer satisfaction in this segment could significantly boost loyalty and market share.

Segment 2 (33% of Consumers):

Consumers in Segment 2 appreciate the visual appeal, reliability, service experience, and comfort of electric two-wheelers. Additionally, they perceive a strong value for money, making them a crucial segment for products positioned as affordable yet high-quality. This segment values a balanced offering that delivers on both aesthetics and practicality.

Segment 3 (13% of Consumers):

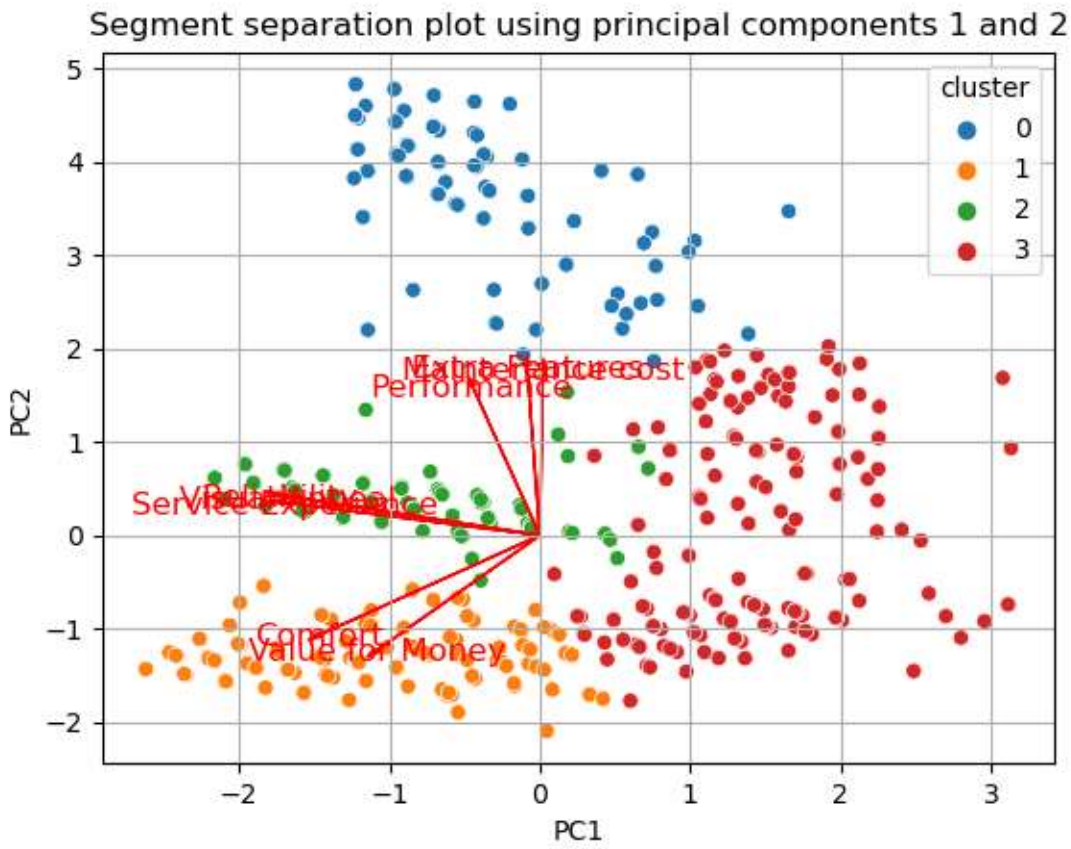
The smallest segment, Segment 3, has distinct perceptions, particularly in terms of features and costs. These consumers value visual appeal, reliability, performance, service experience, extra features, and maintenance cost. Their focus on additional features and the cost of maintenance suggests they seek a more feature-rich and cost-effective vehicle, possibly indicating a preference for vehicles with lower long-term ownership costs.

The accompanying Figure 6.2, which utilizes principal components, further emphasizes the differences among the consumer segments. This analysis highlights the distinct characteristics and perceptions within each segment, offering deeper insights into their unique preferences.

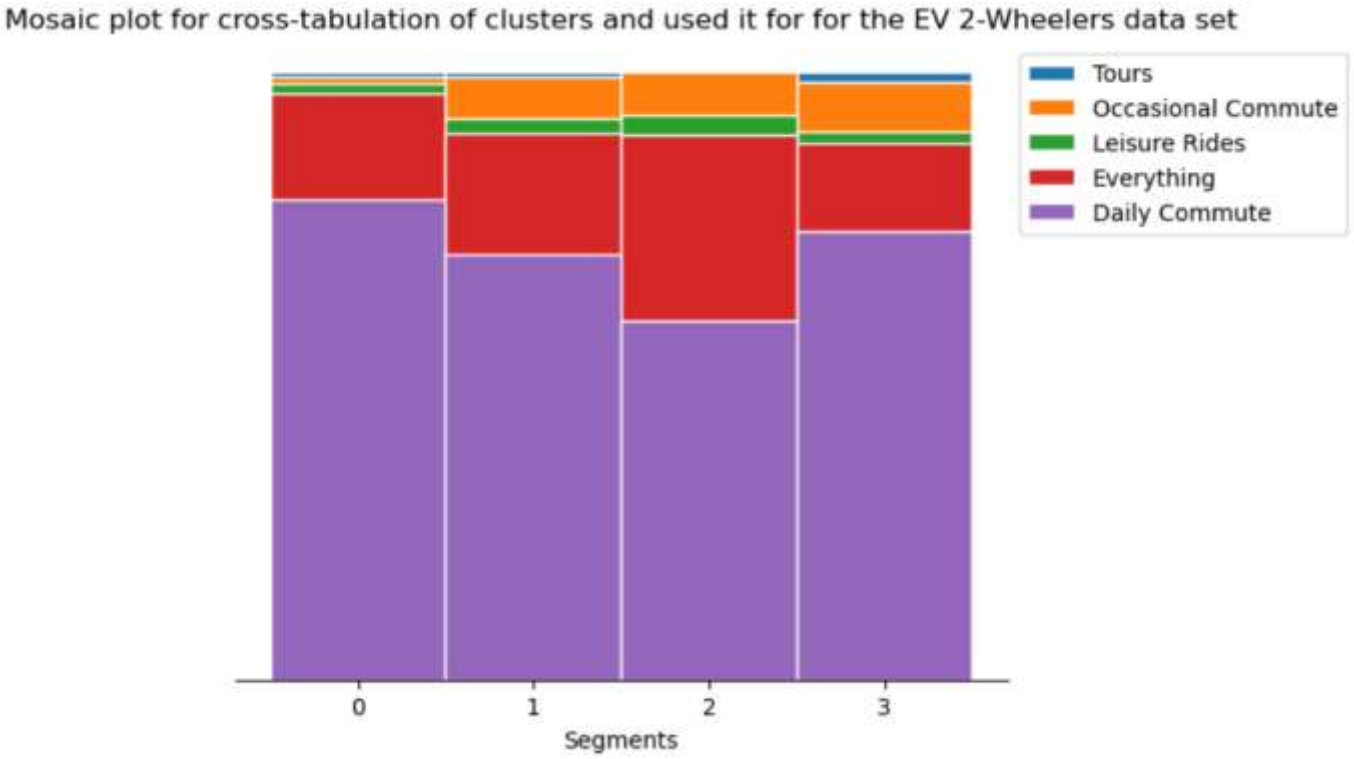
Segment 1:

Despite being the largest segment, Segment 1 stands out for its lack of specific opinions. This segment's overall dissatisfaction across various aspects of the electric two-wheeler experience makes them unique. Their absence of strong preferences suggests that their needs are not currently being met by existing market offerings, making this segment a critical focus for targeted improvements.

These detailed insights, derived from the principal component analysis, play a pivotal role in shaping our strategy. By aligning our electric vehicles precisely with the diverse values and priorities of each segment, particularly the dissatisfaction in Segment 1, we can ensure that our market offerings resonate more effectively with consumers. This approach not only enhances customer satisfaction but also strengthens our competitive position within the electric vehicle market.

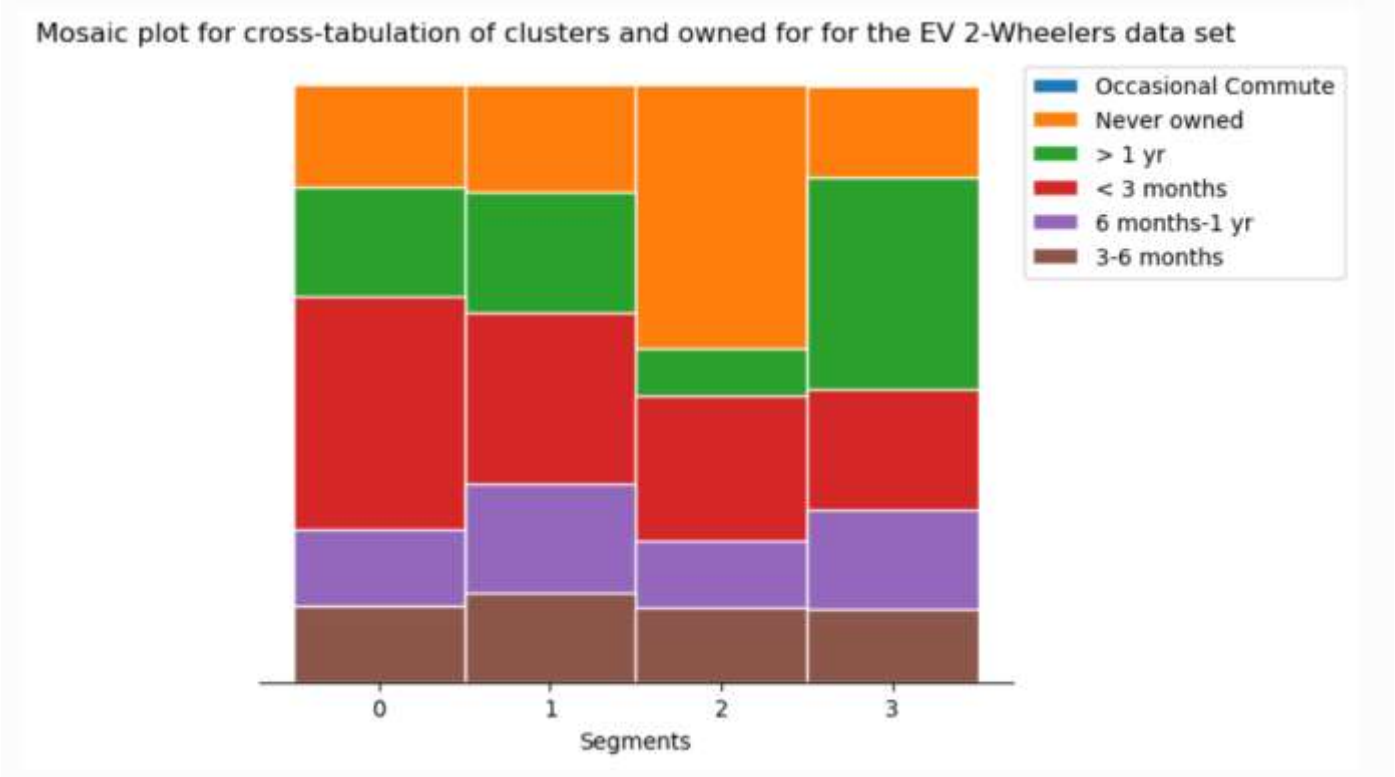


Describing Segments



This section provides a comprehensive overview of consumer behaviour based on insights derived from various mosaic plots and graphical representations.

Figure 6.3: Usage Patterns:



The mosaic plot in Figure 6.3 reveals that across all segments, electric vehicles are predominantly used for daily commuting. This consistent trend underscores the practical role that electric vehicles play in the daily lives of consumers. The plot also shows that there is limited usage for other purposes such as tours, occasional commuting, and leisure rides, indicating that while electric vehicles are favoured for routine travel, they are less commonly used for non-essential trips.

Figure 6.4 provides a breakdown of electric vehicle ownership duration across different segments:

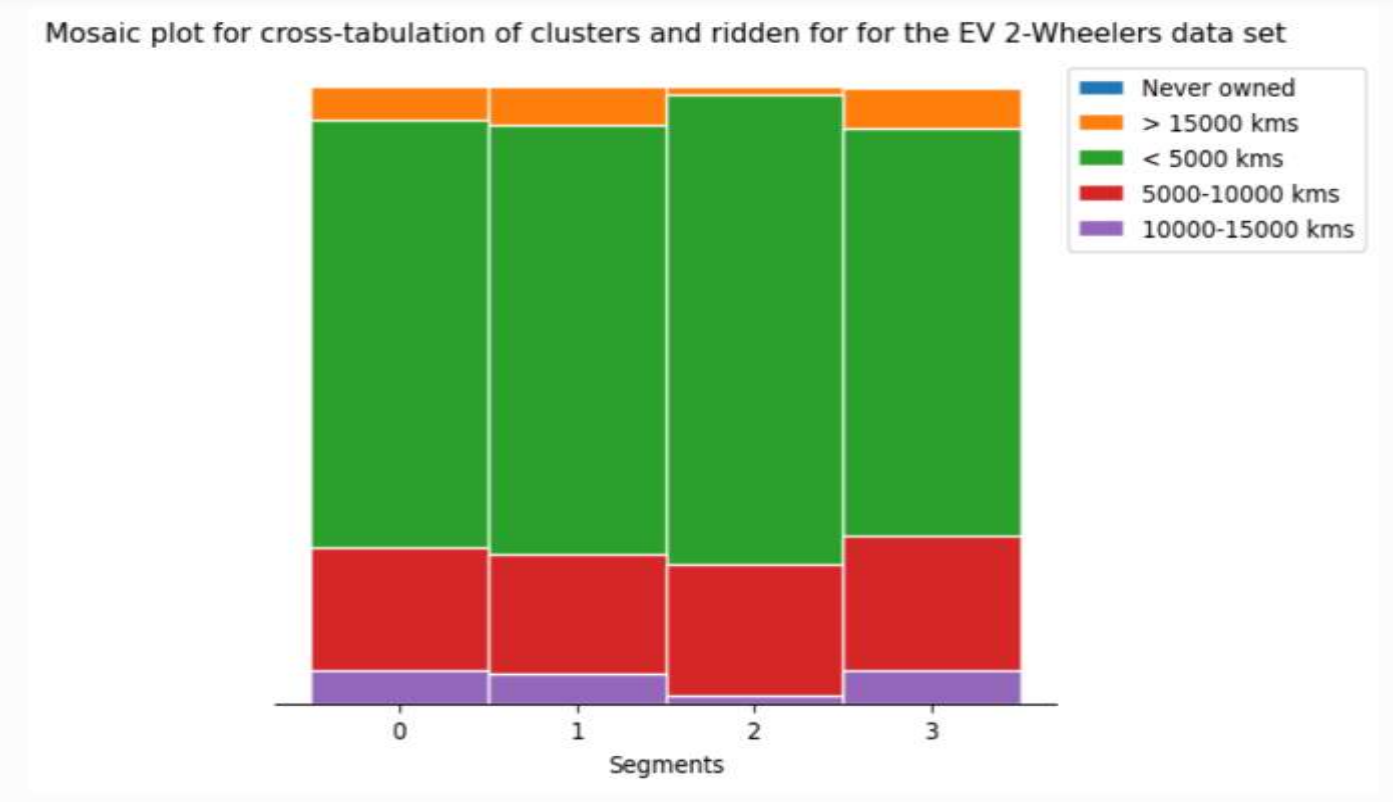
Segment 1 stands out for its long-term ownership, with members having owned their electric vehicles for more than a year. This segment's extended experience with electric vehicles may contribute to their unique dissatisfaction, potentially reflecting unmet long-term expectations.

Segment 0 is characterized by a complete lack of prior ownership experience, suggesting they are new entrants to the electric vehicle market. Their fresh perspective might influence their strong emphasis on visual appeal and comfort.

Segment 2 shows a moderate ownership range, with consumers owning vehicles from less than 3 months to over a year. This segment’s varied experience indicates a balanced mix of new and somewhat experienced users, which aligns with their appreciation of value for money and reliability.

Segment 3 consists of consumers who have owned electric vehicles for a short duration, typically a few days to less than 3 months. Their brief ownership experience might contribute to their focus on extra features and maintenance costs, as they are likely still evaluating their purchase.

Figure 6.5 provides an analysis of the distances covered by consumers using electric vehicles. The key observations from this plot are:



Primary Use for Commuting:

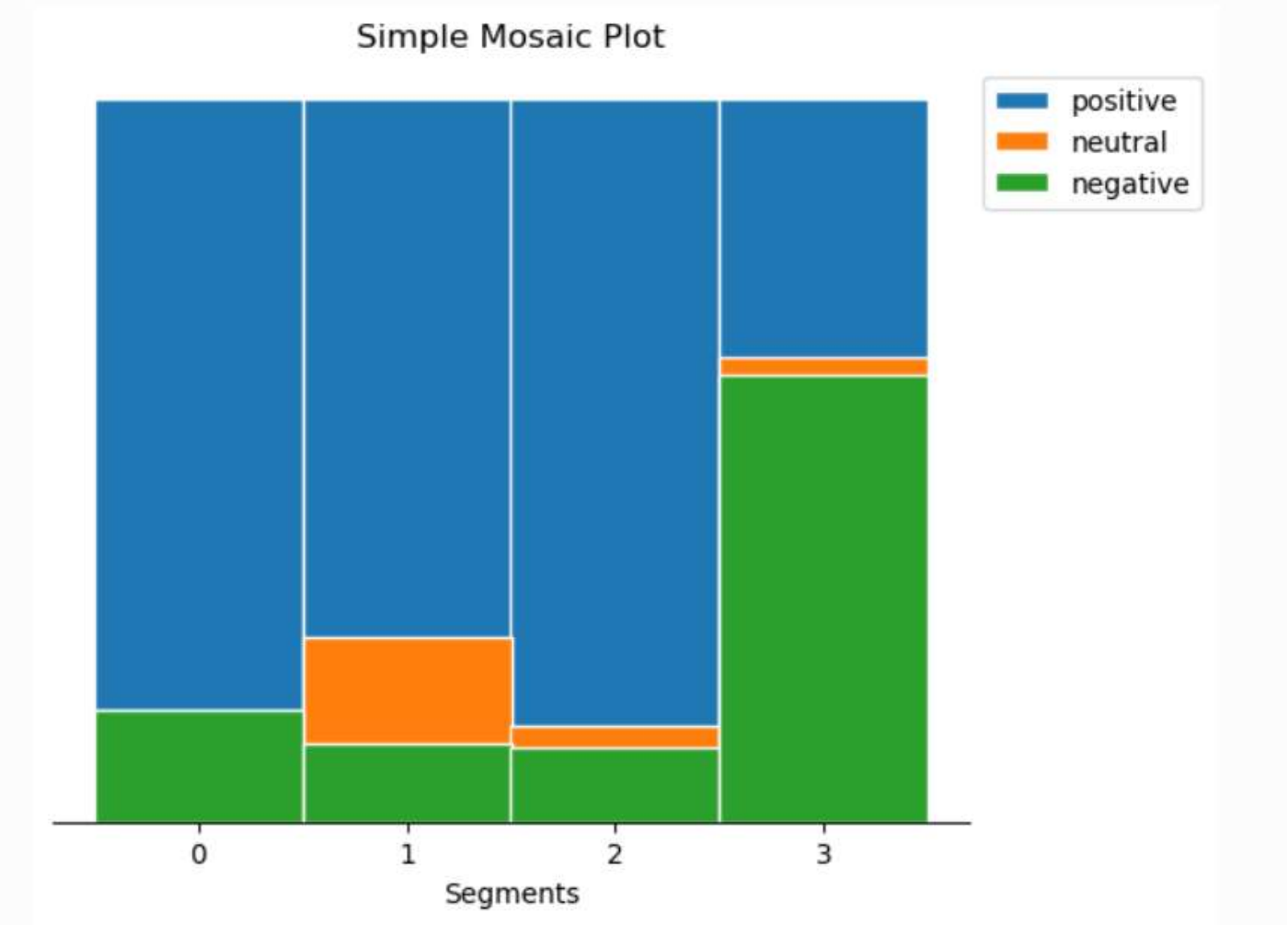
All segments predominantly use electric vehicles for commuting, as indicated by the distances covered. This reinforces the finding that electric vehicles are primarily utilized for daily travel rather than for long-distance journeys.

Distance Range:

The majority of users cover distances of below 5000 kilometres. This suggests that electric vehicles are well-suited to the commuting needs of most consumers, who generally travel shorter distances.

A smaller portion of users falls into the 5000 to 10000 kilometres range. This group represents those who might use their electric vehicles for slightly longer commutes or occasional extended trips, but still within the scope of typical daily use.

These insights into distance coverage help us understand the practical usage patterns of electric vehicle consumers. By aligning our product features and performance metrics with the commuting distances most commonly covered, we can better meet the needs of our target segments and optimize our electric vehicle offerings for the typical usage scenarios they encounter.



Consumer Sentiments and Ratings Analysis

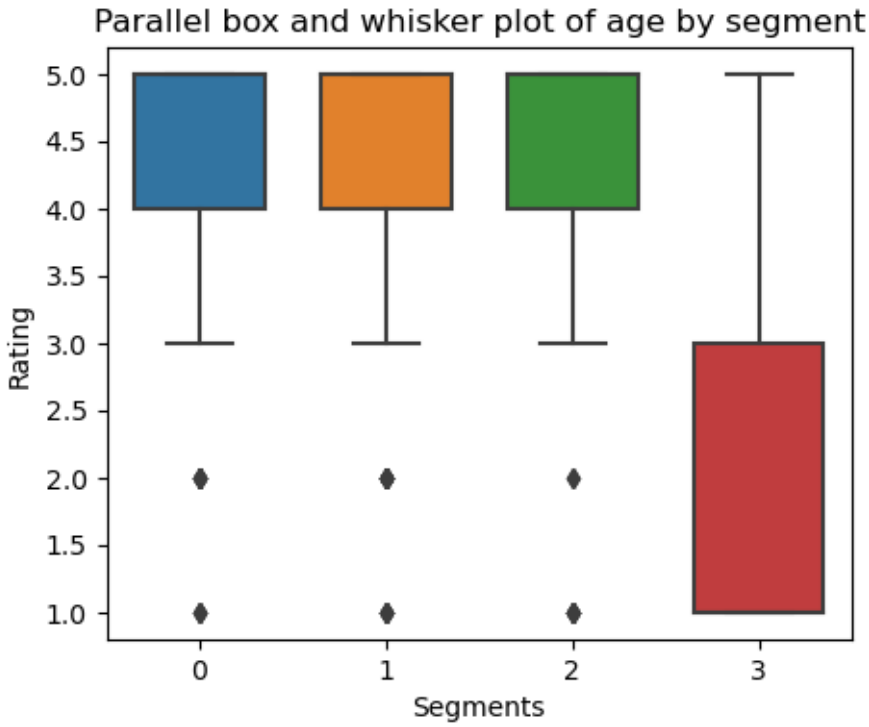
Figure 6.6: Consumer Sentiments

The analysis of consumer sentiments reveals that all segments, except Segment 1, exhibit positive sentiments towards electric vehicles. This indicates that, generally, consumers in most segments are satisfied with their electric vehicles.

Segment 1 consumers are notable for their negative sentiments, showcasing dissatisfaction across various aspects. This segment's overall discontent points to potential areas for improvement and highlights the need for targeted strategies to address their specific concerns.

Figure 6.7: Box and Whisker Plot of Ratings

The parallel box and whisker plot in Figure 6.7 highlights significant differences in average ratings among the segments.



Segment 1 consistently shows lower average ratings, reflecting the dissatisfaction reported in Figure 6.6. This segment's lower ratings across various perceptions underscore the need for a more focused approach to enhance their overall experience with electric vehicles.

These graphical representations provide nuanced insights into consumer behaviours and preferences. The positive sentiments in most segments suggest general approval of electric vehicles, while the negative sentiments and lower ratings in Segment 1 reveal critical areas for improvement. By addressing the specific dissatisfaction points of Segment 1 and leveraging the positive feedback from other segments, we can develop a more tailored and effective strategy for the electric vehicle market, ultimately enhancing overall customer satisfaction and market competitiveness.

Analysis of Technical Specifications Across Segments

Figure 6.8 provides a detailed examination of technical specifications for electric vehicles across different segments, revealing distinct patterns and preferences:

U

Price Range (Figure 6.8 (a)):

Segment 0 showcases a preference for higher-priced, premium electric vehicles, reflecting a focus on luxury and advanced features.

Segment 1 gravitates towards lower-priced, budget-friendly options, indicating a need for affordability.

Segment 2 and Segment 3 also emphasize affordability, with Segment 2 focusing slightly more on cost-efficiency compared to Segment 3.

Riding Range (Figure 6.8 (b)):

Segment 0 stands out with a higher average riding range, suggesting a preference for electric vehicles capable of longer distances, suitable for extended travel.

Segment 1 and Segment 2 focus on moderate riding ranges, aligning with daily commuting needs.

Segment 3 falls between the two, catering to consumers who need a slightly extended range for their commutes.

Top Speed (Figure 6.8 (c)):

Segment 0 and Segment 3 prefer higher top speeds, reflecting a demand for performance and speed.

Segment 1 and Segment 2 prioritize lower speeds, which are more suitable for city commuting and practical everyday use.

Weight (Figure 6.8 (d)):

Segment 0 and Segment 1 Favor slightly heavier vehicles, which may contribute to stability and a more robust feel.

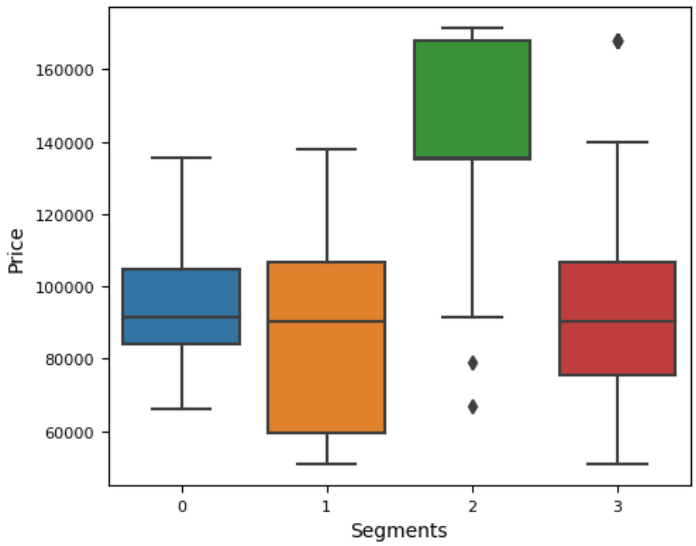
Segment 2 and Segment 3 lean towards lighter options, reflecting a preference for manoeuvrability and ease of handling.

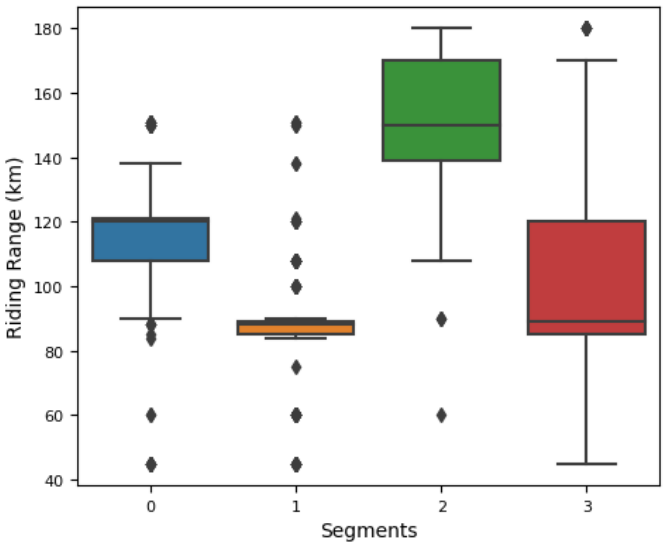
Battery Charging Time (Figure 6.8 (e)):

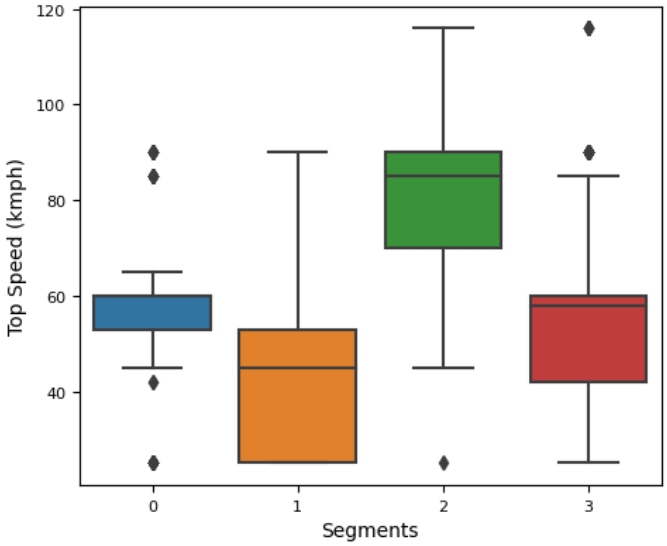
Segment 0 and Segment 3 opt for longer charging durations, indicating that overnight charging is acceptable and convenient for these users.

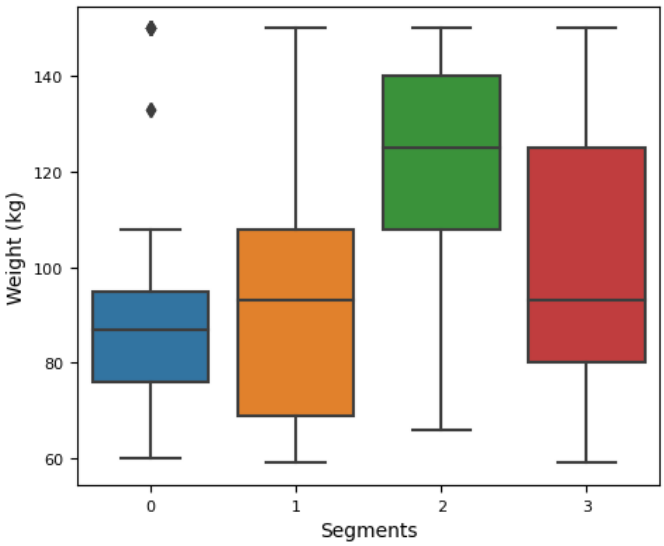
Segment 1 and Segment 2 prioritize faster charging, catering to those who need quicker turnaround times to minimize downtime.

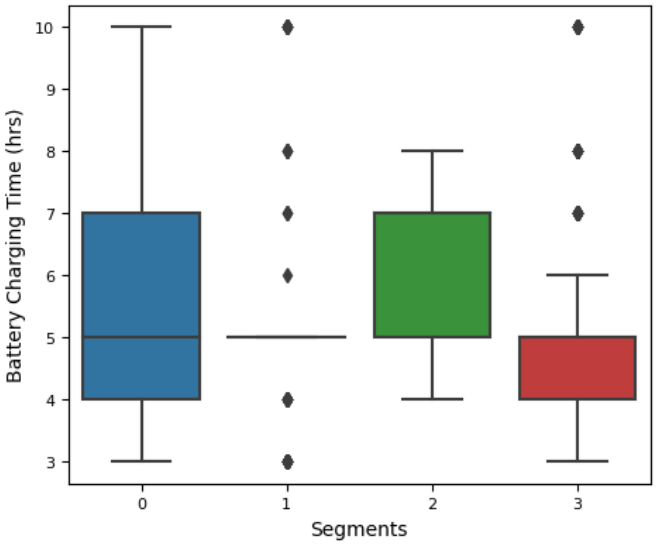
These technical specifications highlight the nuanced preferences and priorities across different consumer segments, shaping the electric vehicle market in India. By understanding these preferences, manufacturers can better tailor their offerings to meet the specific needs of each segment, ensuring a more targeted and effective approach in the competitive electric vehicle landscape.

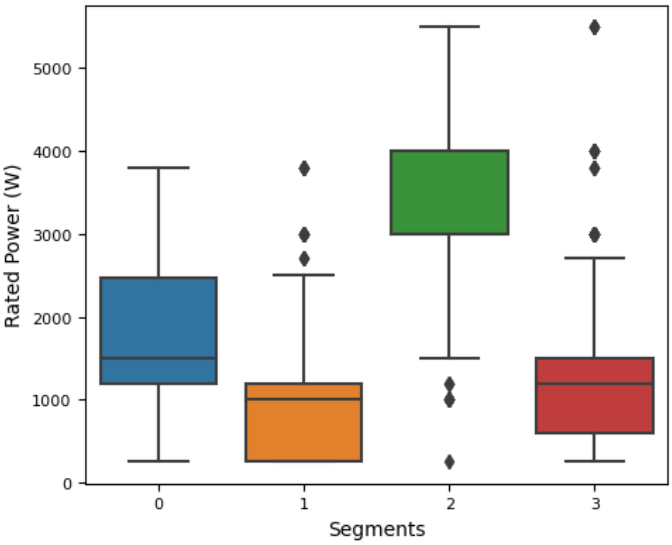

Price
160000
140000
120000
100000
80000
60000
0
1
2
3
Segments


Riding Range (km)
180
160
140
120
100
80
60
40
0
1
2
3
Segments


Top Speed (kmph)
120
100
80
60
40
0
1
2
3
Segments


Weight (kg)
140
120
100
80
60
0
1
2
3
Segments


Battery Charging Time (hrs)
10
9
8
7
6
5
4
3
0
1
2
3
Segments


Rated Power (W)
5000
4000
3000
2000
1000
0
0
1
2
3
Segments

Selection of Target Segment

In selecting our target segments for the electric vehicle market, Segment 1 and Segment 2 emerge as primary focus areas. Here's a strategic overview of these segments:

Segment 1 (39% of Consumers):

Market Size: This segment represents a substantial portion of the market, offering a significant opportunity for growth.

Consumer Insights: Segment 1 displays diverse perceptions and varying sentiments, including dissatisfaction across multiple aspects of electric vehicles. This dissatisfaction indicates specific demands and priorities that need to be addressed.

Strategic Opportunity: By thoroughly understanding and addressing the concerns of Segment 1, such as performance issues, comfort, and value for money, we can enhance customer satisfaction and build brand loyalty. Tailoring our offerings to meet their specific needs and resolving their pain points could transform their experience and potentially convert dissatisfaction into loyalty.

Segment 2 (33% of Consumers):

Market Appeal: Segment 2 presents a compelling opportunity with its significant market share and positive perceptions.

Consumer Insights: This segment values visual appeal, reliability, service experience, and comfort, along with a strong sense of value for money. Their feedback highlights features that are critical to their satisfaction.

Strategic Opportunity: By aligning our electric vehicles with the preferences of Segment 2, we can cater to their specific needs, emphasizing aspects such as design, reliability, and comfort. This approach will help us resonate strongly within this segment and enhance customer satisfaction, reinforcing brand loyalty.

Strategic Approach

Addressing Segment 1:

Identify Dissatisfaction Points: Focus on understanding and resolving specific issues raised by Segment 1, such as performance shortcomings or comfort concerns.

Improve Features: Refine and enhance vehicle features to meet the expectations of Segment 1, addressing their dissatisfaction comprehensively.

Catering to Segment 2:

Enhance Positive Attributes: Build on the strengths identified by Segment 2, such as visual appeal, reliability, and value for money.

Customization: Customize electric vehicles to align with Segment 2's preferences, ensuring that our offerings meet their expectations for service experience and comfort.

Potential Early Market Customer Base

Target Segments:

Segment 1: 330 members (39% of consumers)

Segment 2: 277 members (33% of consumers)

Price Range Analysis:

Segment 1: Target price range between ₹51,094 and ₹1,67,844.

Segment 2: Target price range between ₹51,094 and ₹1,37,890.

Potential Sales and Profit Calculations:

Segment 1:

Target Price: ₹1,20,000

Number of Potential Customers: 330

Potential Profit Calculation:

Potential Profit =330 Customers × ₹ 1,20,000 per vehicle = ₹ 39.60 crores

Potential Profit=330 customers×₹1,20,000 per vehicle=₹39.60 crores

Segment 2:

Target Price: ₹1,10,000

Number of Potential Customers: 277

Potential Profit Calculation:

Potential Profit = 277 customers × ₹ 1,10,000 per vehicle =₹ 30.47 crores

Potential Profit=277 customers×₹1,10,000 per vehicle=₹30.47 crores

Key Insights:

Segment 1 has a larger potential market share and customer base, making it a priority for early market penetration.

Segment 1 offers higher potential profits due to its larger number of customers and broader price range.

Segment 2, while slightly smaller in size, still represents a significant market opportunity with substantial potential profits.

Strategic Implications:

Focus on Segment 1: Given its larger customer base and higher potential profit, Segment 1 is a primary target for initial market entry efforts. Tailoring strategies to address their specific needs and dissatisfaction points can maximize impact and market capture.

Leverage Segment 2: While Segment 2 is smaller, it still offers valuable opportunities. Emphasizing features that resonate with this segment, such as visual appeal and value for money, can help secure a strong position in this group.

By targeting these segments effectively and aligning our pricing strategies with their expectations, we can capitalize on significant market opportunities and drive substantial profits in the early stages of market entry.

Most Optimal Market Segments

In selecting the optimal market segment for our electric two-wheeler vehicles, Segment 1 has been identified as the most promising choice. The analysis highlights Segment 1 as the ideal target for the following reasons:

Segment 1 Overview:

Market Share: 39% of consumers.

Significance: This segment represents a substantial portion of the market, offering significant opportunities and a broad customer base.

Reasons for Choosing Segment 1:

Large Customer Base: With 39% of the market, Segment 1 provides a vast audience for initial market entry and sustained growth.

Substantial Market Potential: The segment’s size and diverse preferences make it a high-potential area for targeting.

Balanced Specifications and Price: Segment 1's requirements align well with a range of technical specifications and price points, making it a feasible and attractive target.

Recommended Technical Specifications for Segment 1:

Specification	Recommended Range
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

Strategic Implications:

Alignment with Segment Needs: The recommended specifications cater to the diverse preferences and requirements of Segment 1, ensuring that our products meet their expectations effectively.

Market Penetration: Targeting Segment 1 with these tailored specifications positions us well within the market, leveraging its substantial potential for a successful entry and long-term growth.

This strategic focus on Segment 1 aligns our market entry strategy with a significant consumer base and ensures our electric vehicles are well-suited to meet the segment's specific needs, paving the way for a successful and sustainable market presence.

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 18 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.