ELECTRIC VEHICLE MARKET SEGMENTATION ANALYSIS

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Introduction

India is experiencing a significant shift in its transportation landscape, driven by the widespread adoption of Electric Vehicles (EVs). Rapid urbanization, a growing population, and increased income levels have fuelled the embrace of EVs as eco-friendly alternatives. Among these, electric two-wheelers stand out due to their affordability and wide acceptance, offering a sustainable solution to pollution and greenhouse gas emissions.

The Indian government's supportive policies have been crucial in this transition, fostering local manufacturing and creating a robust network of manufacturers, dealers, and service providers. By 2023, the electric two-wheeler market in India has reached a pinnacle, reflecting these efforts' success and the growing acceptance of clean mobility solutions.

This project analyses India's electric vehicle market, focusing on segmentation from sales data, customer reviews, and technical specifications. It highlights the robust growth of the two-wheeler market as a primary revenue source. Using behavioural variables from customer reviews, a k-means algorithm segmentation analysis identified four distinct market segments.

Segment 1, constituting 39% of the consumer base, is identified as the optimal target for our venture. This segment represents a significant market opportunity. The analysis recommends specific electric two-wheeler technical specifications tailored to Segment 1 preferences, aligning price ranges with median values for affordability and competitiveness. This strategic focus positions our venture optimally within India's electric vehicle landscape.

By combining behavioural segments, psychographic data, and detailed vehicle specifications, this study provides informed EV price recommendations. It aims to empower consumers, policymakers, and industry stakeholders, illuminating the path toward a sustainable, environmentally conscious, and consumer-centric electric transportation system in India.

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 sales data, customer reviews (encompassing behavioural and psychographic data), and technical specifications of electric vehicles. Our objective is to employ these insights to effectively segment the market and recommend target segments for our electric vehicles.

Data Overview

For this project, data was gathered from three sources.

First dataset, obtained from the Society of Manufacturers of Electric Vehicles, spanning 2017 to 2023, 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.

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

Lastly, the third dataset from bikewale.com presents detailed technical specifications and pricing information of electric two-wheelers. 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

The data pre-processing phase of this project involved a systematic approach facilitated by Python libraries including NumPy, pandas, matplotlib, seaborn, and nltk. The first task was handling the sales data, initially distributed across 10 separate sheets in Excel format. Utilizing pandas, the data sheets were merged into a unified dataset, setting the foundation for subsequent analysis. A key focus was placed on ensuring the accuracy of electric vehicle maker names, achieved through meticulous replacement operations.

Following the data consolidation, essential aggregation operations were performed on electric two-wheeler sales data. This step provided a detailed perspective on market trends. The subsequent phase cantered on data preparation for market segmentation. Customer reviews and responses were merged with corresponding electric vehicle technical specifications. To maintain data integrity, null values were handled using specific logical values, ensuring a complete dataset.

Sentiment analysis of customer reviews was conducted using the natural language processing capabilities of nltk. This analysis provided valuable qualitative insights into customer sentiments. Subsequently, behavioural variables such as Visual Appeal, Reliability, Performance, Service Experience, Extra Features, Comfort, Maintenance Cost, and Value for Money were isolated and meticulously prepared. 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.

Segment Extraction

1. Using Sales Data

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

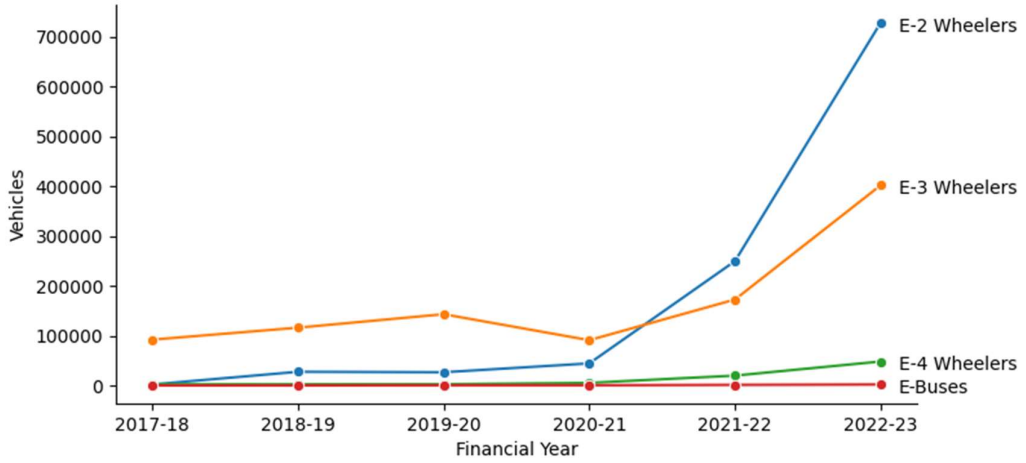

Figure 1. India’s electric vehicle market

Figure 1. shows the remarkable growth trajectory of India's two-wheeler market in 2023, underscoring its leading position within the industry.

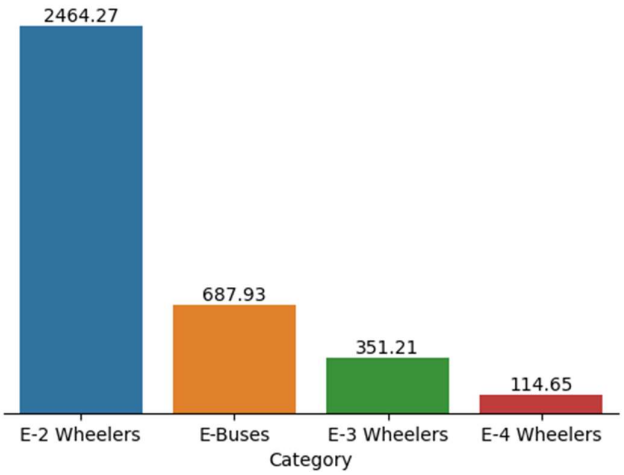

Figure 2. India's electric vehicle industry in crores

Figure 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.

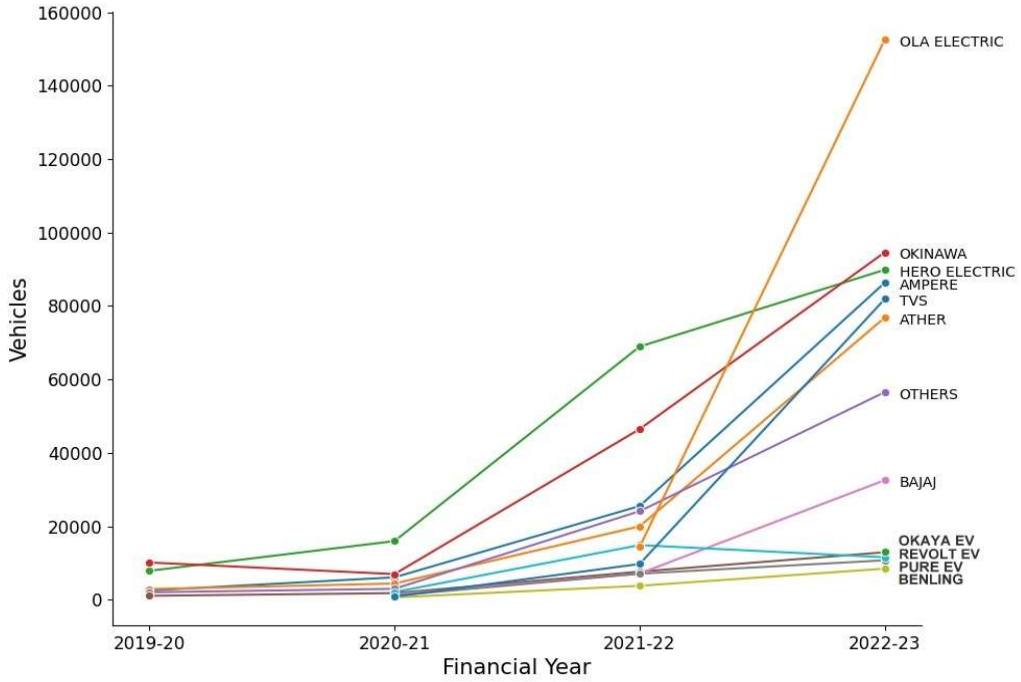

Figure 3. Top electric two-wheeler companies

Figure 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.

2. Using k-Means

In this subsequent analysis, the standard k-means algorithm was applied to explore market segmentation possibilities within the electric two-wheeler customer reviews data. Solutions were systematically tested for two to eight market segments. The decision-making process was significantly guided by the scree plot Figure 4, revealing a distinct elbow at four segments. This marked point indicated a substantial reduction in distances, signifying the optimal number of segments for our analysis. 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.

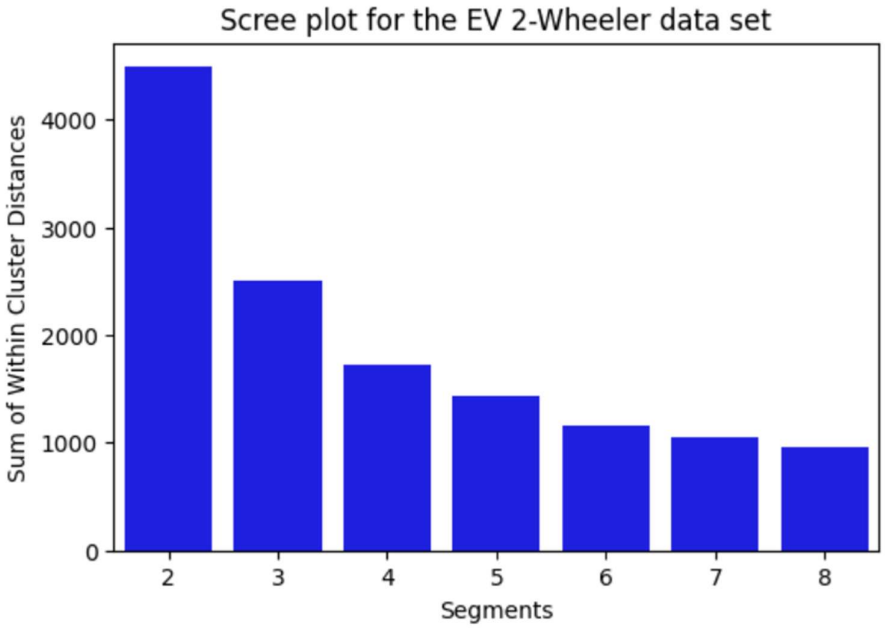

Figure 4. Scree plot for the electric vehicle data set

Profiling and Describing Segmentation

1. Profiling Segments

This section presents a detailed analysis of our consumer segments, as illustrated in Figure 5. The graph visually captures the diverse perceptions among different segments. Segment 0, representing 15% of consumers, values the electric two-wheeler vehicle for its visual appeal, reliability, performance, service experience, and comfort. Conversely, Segment 1 (39% of consumers) expresses dissatisfaction across all aspects, marking them as the largest but least satisfied group. Segment 2 (33% of consumers) appreciates visual appeal, reliability, service experience, comfort, and notably, perceives a strong value for money. Lastly, Segment 3 (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.

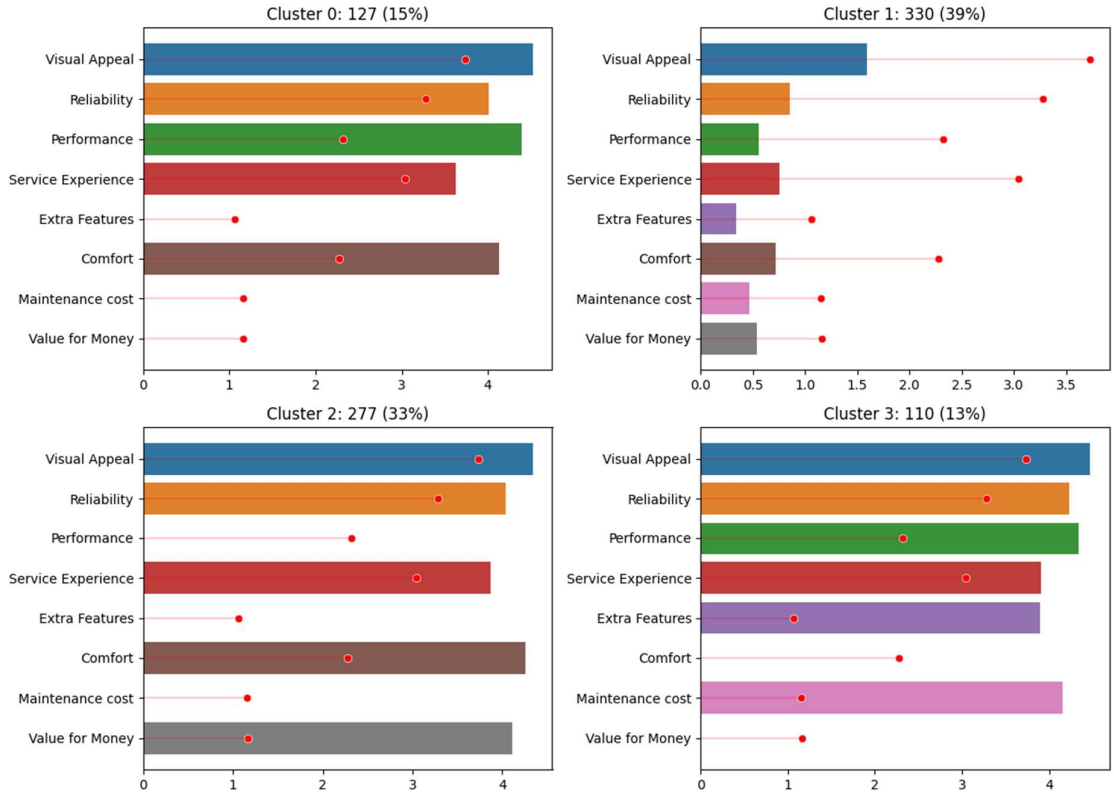

Figure 5. Segment profile plot for the four-segment solution

The accompanying Figure 6, utilizing principal components, further emphasizes these differences. Notably, Segment 1, 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.

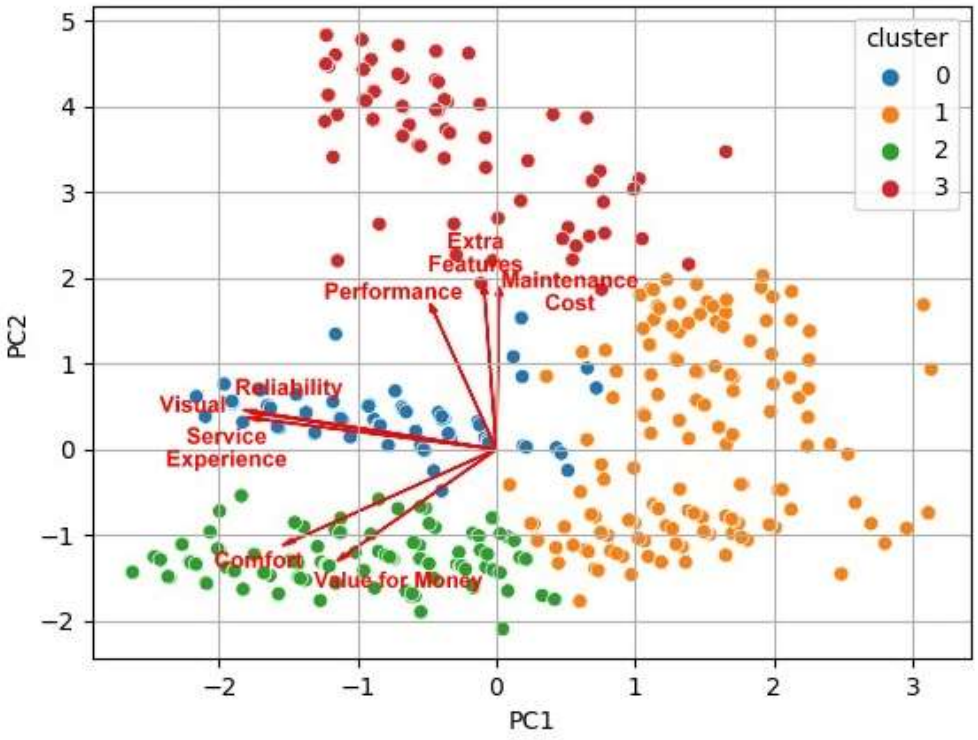

Figure 6. Segment separation plot using principal components 1 and 2

2. Describing Segments

This section provides a comprehensive overview based on the insights derived from various mosaic plots and graphical representations. In Figure 7, the mosaic plot illustrates that all segments predominantly use electric vehicles for daily commuting, with limited usage for tours, occasional commuting, and leisure rides. Moving to Figure 8, 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 0 has no prior ownership experience. Segment 2 members moderately own vehicles ranging from less than 3 months to over a year, and Segment 3 consumers have owned electric vehicles for a few days to less than 3 months.

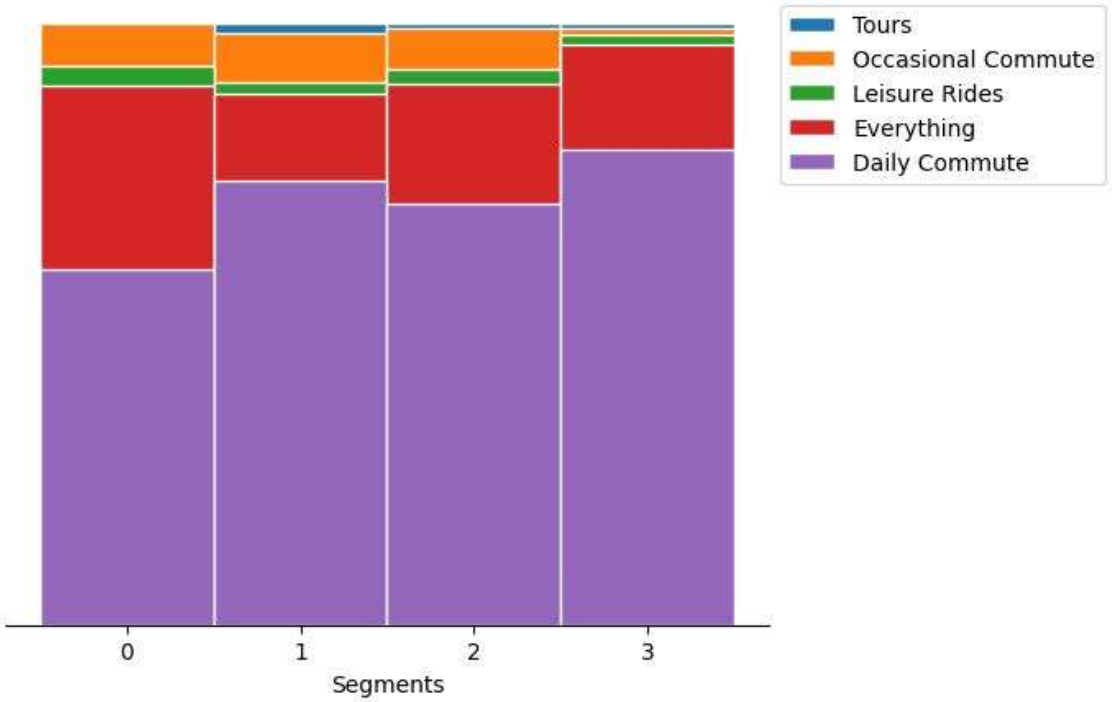

Figure 7. Mosaic plot showcasing electric vehicle usage patterns across segments

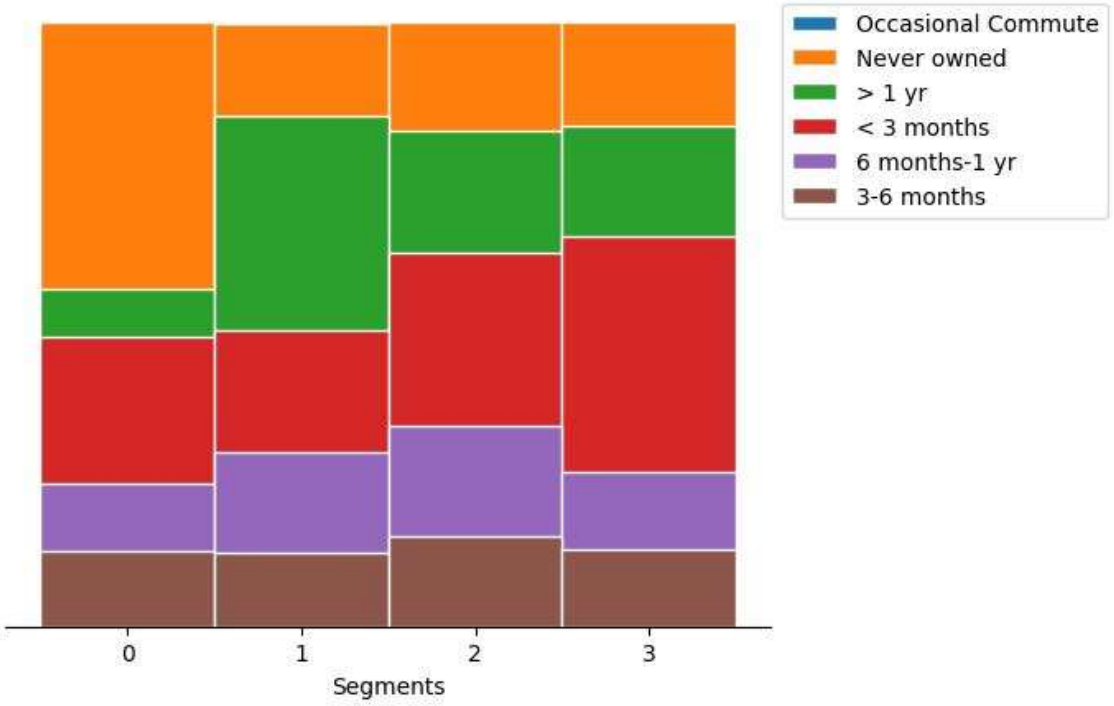

Figure 8. Mosaic plot depicting the ownership duration of electric vehicles across segments

Figure 9. 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.

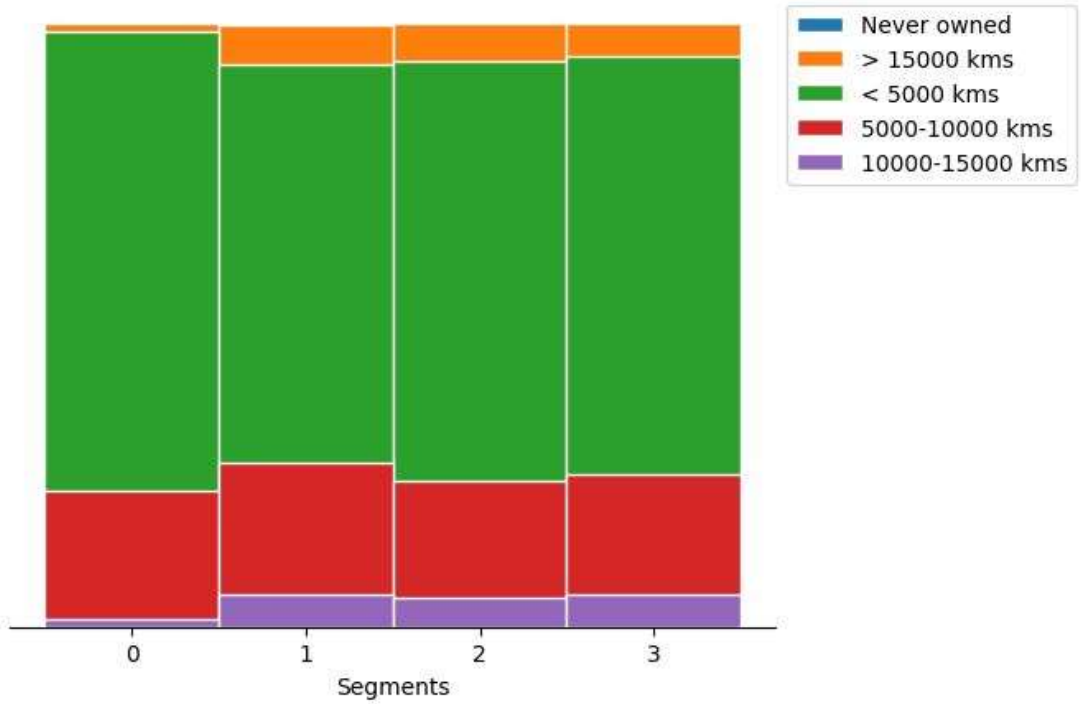

Figure 9 Mosaic plot outlining consumers distance covered by consumers on electric vehicles

Figure 10. 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 11, a parallel box and whisker plot, emphasizes significant differences in average ratings among segments. Specifically, Segment 1 consumers express dissatisfaction across all perceptions, leading to lower overall ratings. These graphical representations offer nuanced insights into consumer behaviours, sentiments, and preferences, guiding our strategic decisions for a more tailored approach in the electric vehicle market.

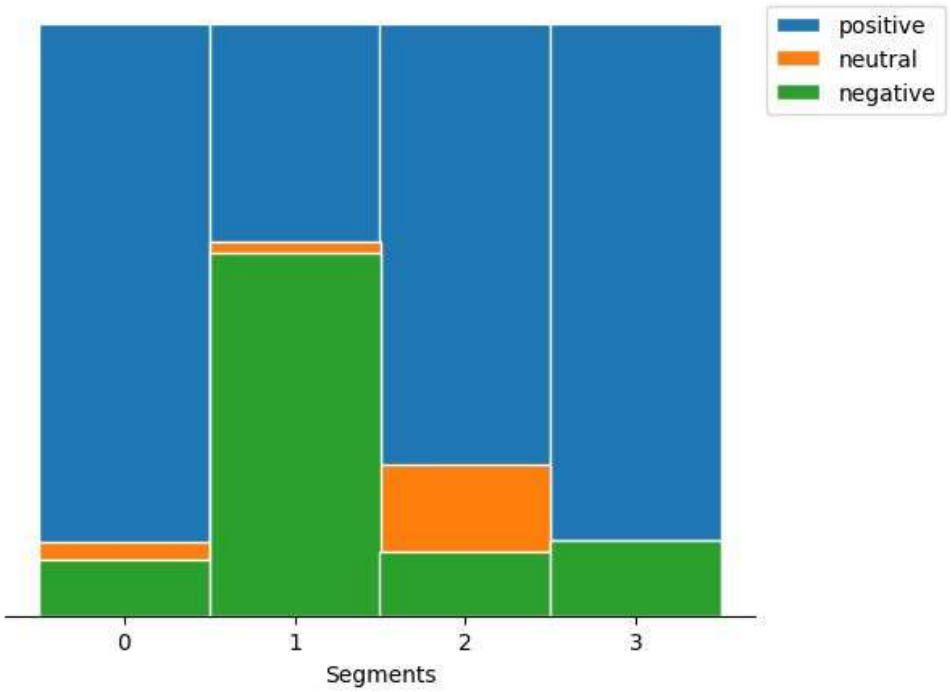

Figure 10. Mosaic plot displaying consumer sentiments towards electric vehicles

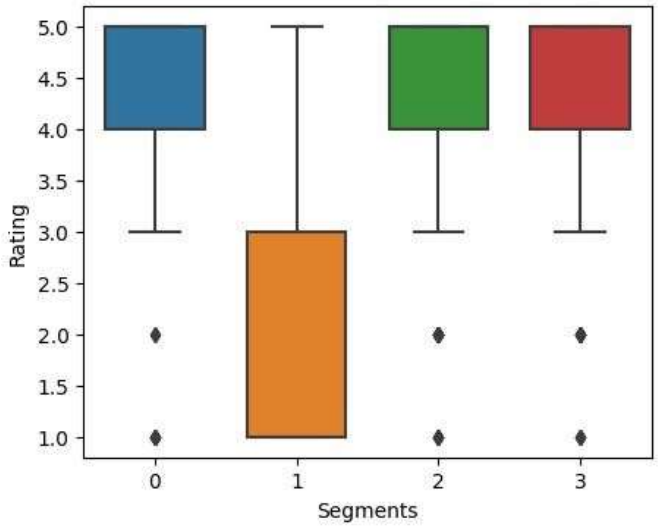

Figure 11. Parallel box-and-whisker plot showcasing consumer ratings across segments

In analysing the technical specifications of electric vehicles across segments, distinct patterns emerge. Segment 0 showcases a higher price range, emphasizing a preference for premium electric vehicles within this group. This is reflected in Figure 12 (a), a parallel box and whisker plot representing the price range. Conversely, Segment 1 exhibits a lower price range, indicating a focus on more budget-friendly options. Segment 2 and Segment 3 also emphasize affordability, albeit with slight differences. These findings align with consumer preferences, highlighting varied economic considerations within the market.

Moving to riding range, Segment 0 stands out with a higher average riding range, suggesting a preference for electric vehicles with extended range, portrayed in Figure 12 (b). In contrast, Segment 1 and Segment focus on moderate ranges for daily commuting. Segment 3 falls between, catering to consumers desiring slightly longer distances, highlighting nuanced commuting needs.

Considering top speed, Segment 0 and Segment 3 opt for vehicles with higher speeds, while Segment 1 and Segment 2 prioritize lower speeds suitable for city commuting. These trends are depicted in Figure 12 (c).

Weight plays a pivotal role, where Segment 0 and Segment 1 Favor slightly heavier vehicles, as represented in Figure 12 (d). Segment 2 and Segment 3 lean towards lighter options, accommodating diverse user preferences for vehicle weight.

Lastly, battery charging time demonstrates a noteworthy difference. Segment 0 and Segment 3 opt for slightly longer charging durations, depicted in Figure 12 (e), emphasizing the convenience of overnight charging. Segment 1 and Segment 2 prioritize faster charging, catering to users seeking quicker turnaround times for their electric vehicles.

These technical specifications, visually represented in respective figures, underscore the nuanced preferences and priorities of each segment, shaping the landscape of the electric vehicle market in India.

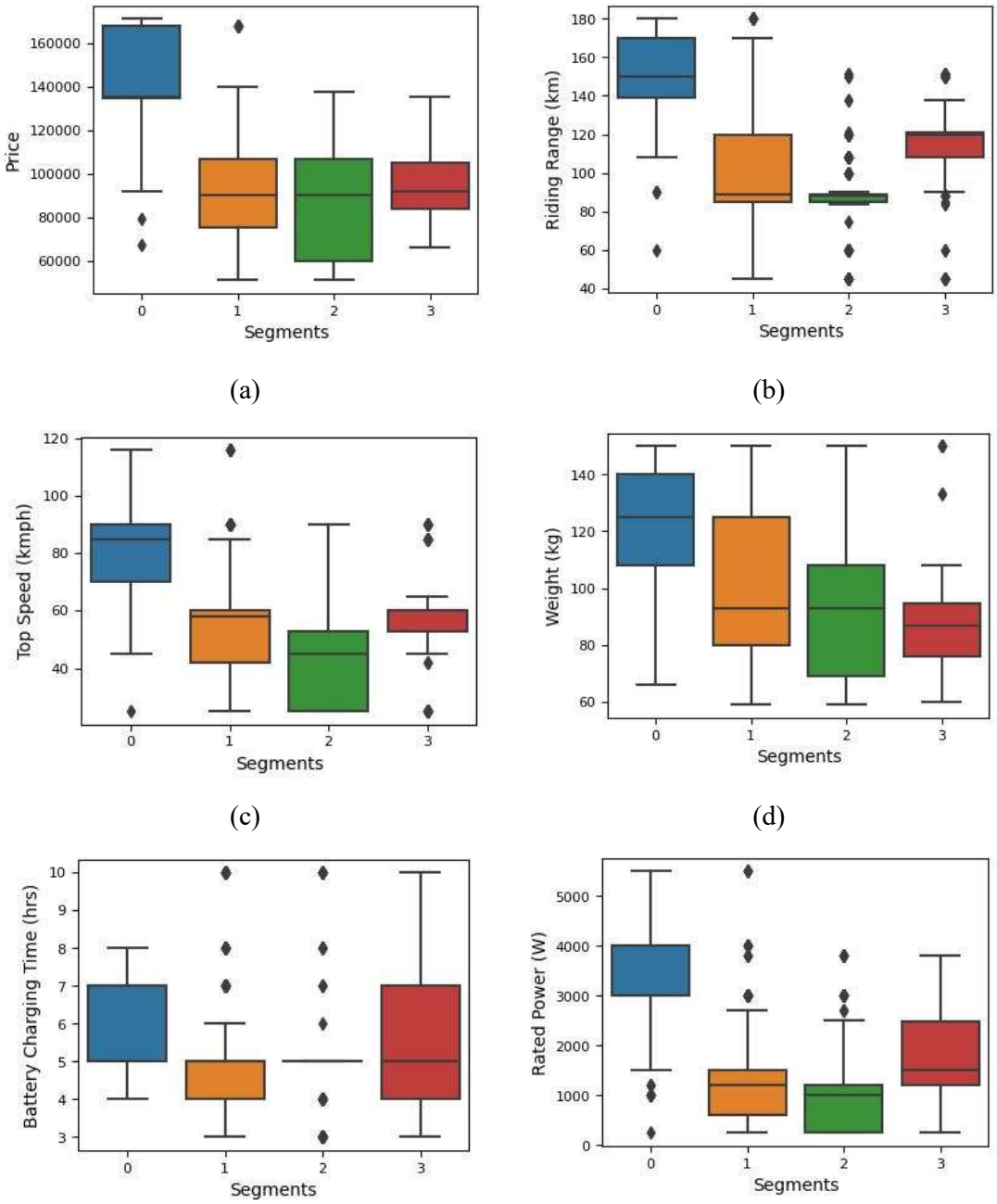

Figure 12. Parallel box-and-whisker plot of technical specification of electric vehicle by segment

Selection of Target Segment

In the strategic selection of our target segment for the electric vehicle market, Segment 1 and Segment 2 stand out as potential focal points. Segment 1, encompassing 39% of consumers, represents a vast market base with diverse perceptions and preferences. This segment's varying sentiments, as revealed through our analysis, signify their specific demands and priorities. Understanding their unique perceptions, such as dissatisfaction across multiple aspects, presents an opportunity. Addressing these concerns directly can lead to improved customer satisfaction and brand loyalty within this significant market share.

Segment 2, comprising 33% of consumers, presents another enticing opportunity. Their distinct perceptions, including valuing visual appeal, reliability, service experience, and comfort, shape their expectations. This segment's feedback provides invaluable insights, aiding in the customization of our electric vehicles to align with their specific perceptions. By catering to their preferences, such as emphasizing value for money, our offerings can create a strong resonance within this consumer group.

Upon careful analysis, Segment 1 offers a unique challenge and opportunity. By comprehensively addressing their dissatisfaction points and crafting electric vehicles that specifically counter these concerns, our strategy can yield remarkable results. Simultaneously, understanding Segment 2's positive perceptions provides a foundation for enhancing these features further, ensuring a positive customer experience and reinforcing brand loyalty.

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.

Most Optimal Market Segments

In the context of selecting the most optimal market segment for our electric two-wheeler vehicles, thorough analysis and evaluation have pointed to Segment 1 as the ideal choice. Representing 39% of consumers, this segment boasts significant opportunities and a large customer base, making it a strategic target for market penetration. Its substantial market

potential, coupled with its balanced blend of technical specifications and price range, positions it as the most promising market segment for our electric vehicles.

The recommended technical specification range for Segment 1, presented in Table 10.1, ensuring alignment with the diverse needs and preferences of the market:

Table 10.1 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

This comprehensive analysis ensures our market entry strategy is finely tuned to cater to the demands and expectations of the chosen segment, setting the stage for a successful and sustainable venture into the electric vehicle market.

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 behaviour, 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.

GitHub Link: https://github.com/Sarweshh/EV-Market-Segmentation-Analysis-in-India