EV SALES MARKET SEGMENTATION ANALYSIS - Aiswarya Sudhir

1. Introduction

In this project, I've undertaken a comprehensive analysis of India's electric vehicle market, with a keen focus on customer segmentation derived from electric vehicle sales spanning from 2020 to 2024 across various states in India. The study delved into both behavioral and geographic segmentation, considering factors such as the states and vehicle categories preferred by customers.

One of the notable findings of the analysis is the robust growth trajectory observed in India's three-wheeler market and the sales of M-cycle/M-scooters. These insights shed light on the evolving dynamics and preferences within the electric vehicle market in India. To deepen our understanding further, I employed behavioral variables from past purchases to conduct a rigorous market segmentation analysis, utilizing the standard k-means algorithm. This analytical approach effectively partitioned the market into two distinct segments, revealing clear differences in customer preferences and behaviors.

By segmenting the market, I gained valuable insights that can inform strategic decision-making for businesses operating in the electric vehicle industry. Understanding the distinct needs and preferences of each segment allows for tailored product offerings and targeted marketing strategies, ultimately driving growth and competitiveness in India's electric vehicle market.

2. Fermi Estimation

2.1 Problem Statement

India's transportation landscape is undergoing a remarkable transformation, primarily fueled by the widespread adoption of Electric Vehicles (EVs). These vehicles are revolutionizing India's mobility narrative by providing a sustainable answer to the pressing challenges of pollution and greenhouse gas emissions.

To tackle the Electric Vehicle Market, we're leveraging data-driven insights derived from comprehensive sales data, encompassing both behavioral and geographical information, alongside technical specifications of electric vehicles. Our objective is to harness these insights to segment the market and identify optimal target segments for our electric vehicles.

By analyzing sales data enriched with behavioral and geographical insights, we aim to uncover patterns and preferences among consumers. Understanding these dynamics will enable us to effectively tailor our offerings to meet the diverse needs of different market segments. Ultimately, our goal is to leverage data-driven decision-making to carve out a strategic position in the Indian electric vehicle market. By identifying and prioritizing target segments based on comprehensive insights, we can maximize our impact and drive sustainable growth for our Electric Vehicle Startup.

In our approach to Fermi Estimation for market segmentation and strategy formulation, we follow a systematic process aimed at leveraging data-driven insights to inform decision-making and maximize market potential for our Electric Vehicle Startup:

2.2.1 Data Collection and Assessment

- Gather Comprehensive Data: Collect sales data, electric vehicle customer reviews, and technical specifications.
- Assess Data Reliability: Evaluate the reliability and comprehensiveness of the collected data to ensure its suitability for analysis.

2.2.2 Segmentation Using Behavioral Variables

- Identify Patterns and Segments: Utilize behavioral data to identify patterns and segments within the customer base.
- Estimate Segment Characteristics: Employ data-driven techniques to estimate the size and characteristics of each segment.

2.2.3 Analysis of Psychographic Data

- Understand Customer Preferences: Analyze psychographic data within each behavioral segment to understand customer preferences and motivations.
- Estimate Psychographic Traits: Estimate the psychographic traits and preferences of customers within each segment.

2.2.4 Technical Specification and Price Analysis

- Evaluate Technical Specifications: Assess the technical specifications of electric vehicles within identified segments.
- Impact Analysis: Estimate the impact of technical features on customer preferences and purchasing decisions.

2.2.5 Target Segment Selection

- Thorough Analysis: Select target segments based on a comprehensive analysis of behavioral, psychographic, and technical factors.

2.2.6 Customization of Marketing Mix

- Tailored Marketing Mix: Develop a customized marketing mix tailored specifically for the selected target segments.

- Effectiveness Estimation: Estimate the effectiveness of various marketing strategies within the selected target segments, aligning them with customer preferences.

2.2.7 Segment Recommendation

- Finalize Recommendations: Combine segment analysis results and marketing mix customization findings to finalize segment recommendations.
- Market Potential Assessment: Recommend target segments with the highest estimated market potential, ensuring a focused and targeted market entry strategy.

By rigorously following these steps and employing Fermi estimation techniques at each stage, our Electric Vehicle Startup aims to make informed decisions, precisely target market segments, and tailor our marketing approach. This strategic approach will enable us to ensure a successful market entry and sustain growth in the competitive electric vehicle market.

3. Data Sources

3.1 https://cleanmobilityshift.com/ev-dashboard/
The data has been downloaded from EV Sales - Statewise

4. Data Pre-processing

Libraries Used:

- Pandas
- Numpy
- Seaborn
- Matplotlib
- Scikit Learn`

Data cleaning was done using pandas functions . unnecessary columns not required for segmentation purposes were removed and the data was further reduced from the year 2020 to 2024 for better analysis results. . To maintain data integrity, null values and duplicate values were handled using specific logical values, ensuring a complete dataset.

	Year	Month_name	Date	State	Vehicle Class	Vehicle Category	Vehicle Type	ELECTRIC(BOV)	Total
12	2022	nov	11/1/2022	Andaman & Nicobar Island	M-CYCLE/SCOOTER	2-Wheelers	2W_Personal	1	386
15	2022	nov	11/1/2022	Andaman & Nicobar Island	MOTOR CAR	4-Wheelers	4W_Personal	1	156
16	2022	nov	11/1/2022	Andaman & Nicobar Island	MOTOR CYCLE/SCOOTER-USED FOR HIRE	2-Wheelers	2W_Shared	5	15
274	2022	dec	12/1/2022	Andaman & Nicobar Island	MOTOR CAB	4-Wheelers	4W_Shared	3	8
276	2022	dec	12/1/2022	Andaman & Nicobar Island	MOTOR CYCLE/SCOOTER-USED FOR HIRE	2-Wheelers	2W_Shared	10	15

Here we can see the number of electric vehicles sold with date and in which state grouped by vehicle category and vehicle class.

5. Segment Extraction

A detailed exploratory data analysis was conducted with the sales data with respect to different states, type of vehicle, category of vehicle and how the sales have increased throughout the years.

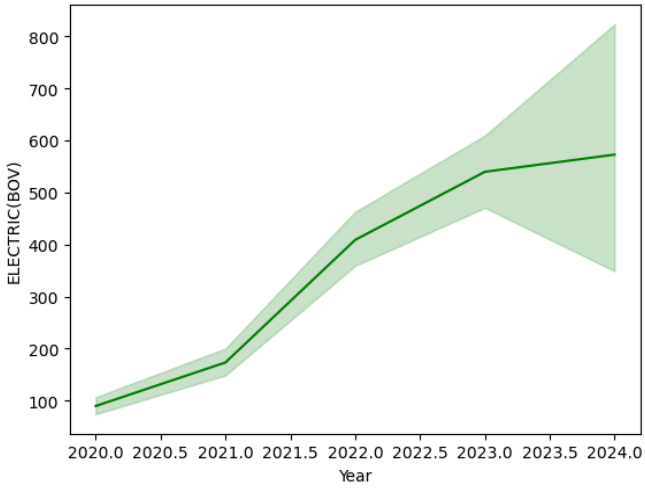


Fig 5.1 : India's Electric Vehicle Market

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

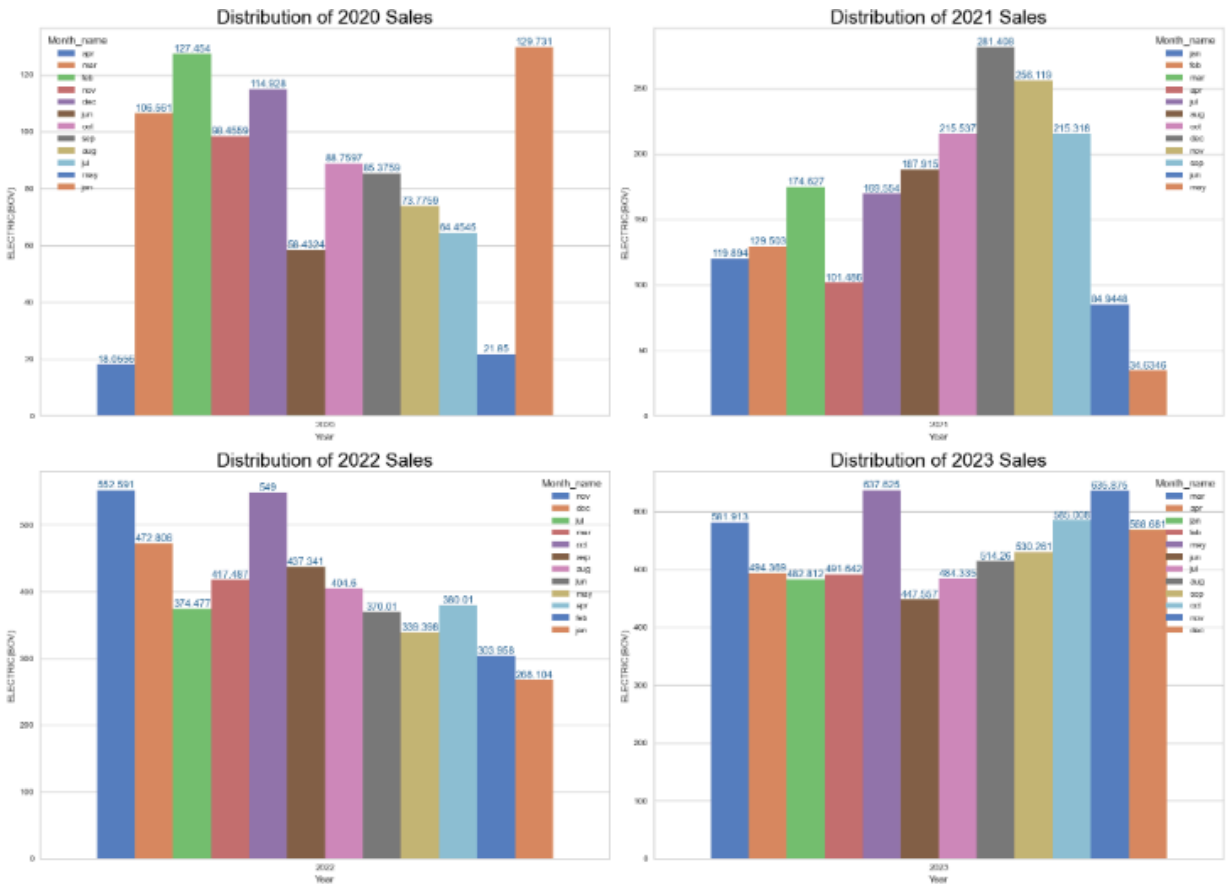


Fig 5.2 : Sales distribution from 2020 to 2023

From the above figure we can see that the number of electric vehicles sold fluctuates from January to December each year and does not remain stable even though the overall sales has increased.

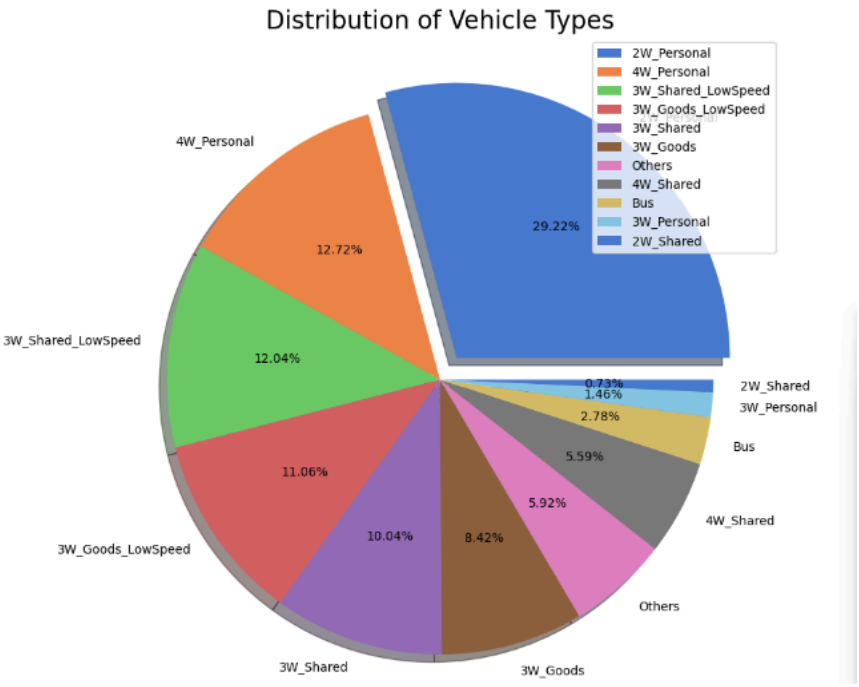


Fig 5.3 : Distribution of Vehicle Types

From the pie chart in fig 5.3 , we can observe that the 2w_Personal is the highest sold vehicle type from 2020 to 2023 followed by 12% of 4W_Personal.

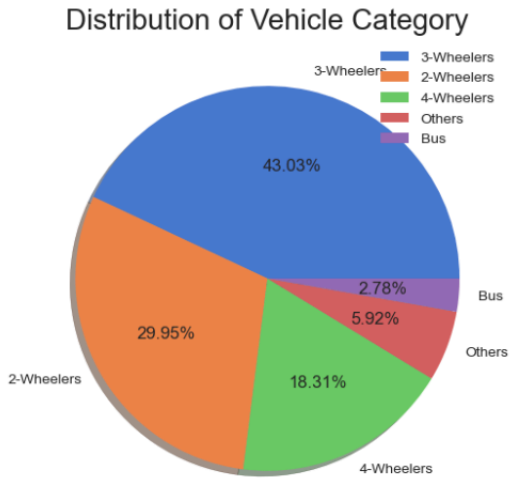


Fig 5.4 : Distribution of Vehicle Category

Fig 5.4, shows that around 43% of the electric vehicles sold were 3-wheelers which was followed by 29% of 2-wheelers.

6. Profiling Segments

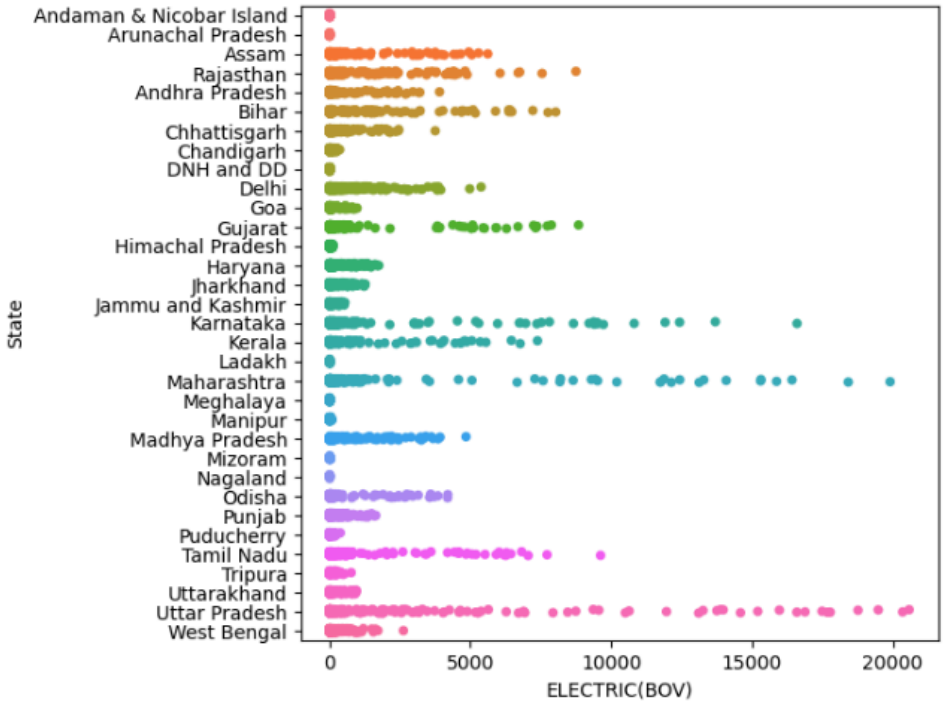


Fig 6.1 : EV sale distribution across states

The highest sales of Electric vehicles were from customers in Uttar Pradesh , which was followed by Maharashtra, Bihar , Karnataka , Tamil Nadu and Delhi as seen from Fig 6.1. Geographic segmentation can be performed using this variable to target effective markets.

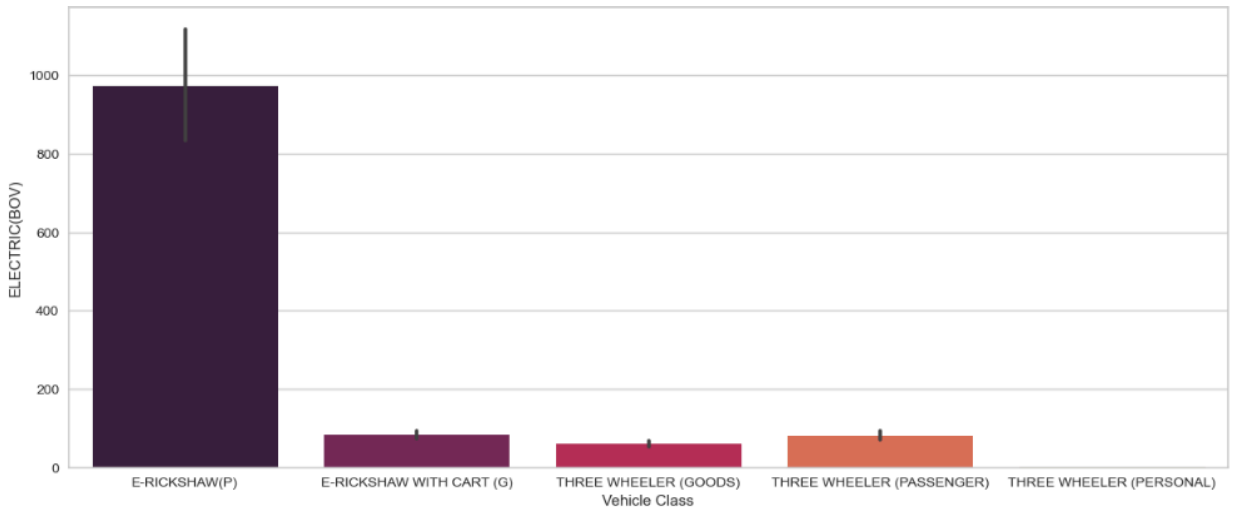


Fig 6.2 : EV sales of 3-wheelers by vehicle class

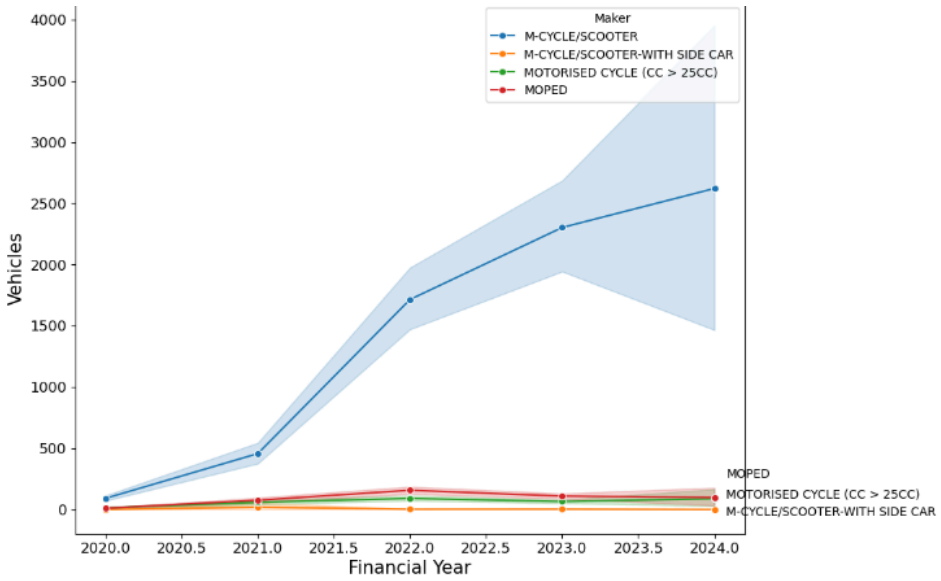


Fig 6.3 : EV sales of 2W_Personal by vehicle class

3-wheelers were the most sold vehicle category as we saw from the pie chart. Among three wheelers , E-rickshaw had the highest sales and was the most preferred by customers as shown in fig 6.2 , hence both vehicle category and vehicle class are important segmentation variables. Similarly 2W_Personal occupied the top position for the most preferred vehicle type and on further analysis we can see from the line plot in fig 6.3 that when the vehicle type is 2W_Personal, motorcycle/scooter had the highest sales throughout that period.

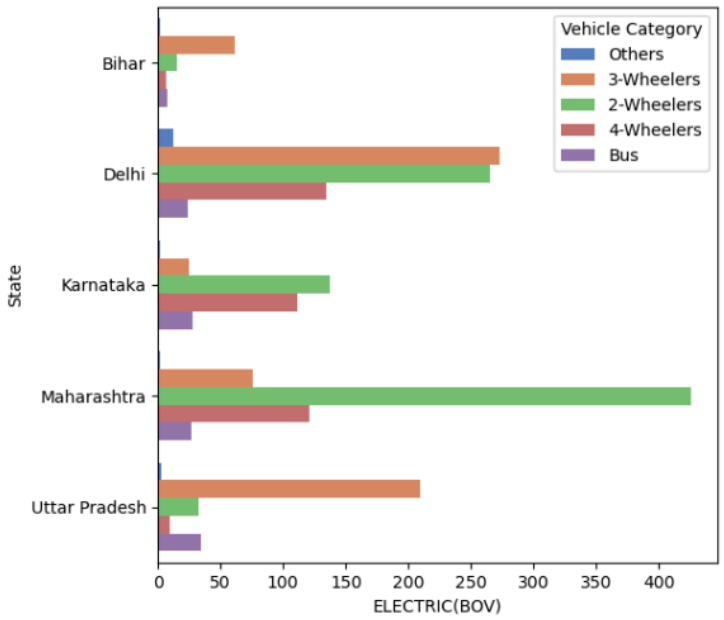


Fig 6.4 : EV sales in states grouped by vehicle category

In this subsequent analysis, the standard k-means algorithm was applied to explore market segmentation possibilities within the electric vehicle sales data. Solutions were systematically tested for two to four market segments. The decision-making process was significantly guided by the elbow method plot, 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 three-wheeler segment, ensuring precision and relevance in our market segmentation approach

The bar graph in figure 6.4 depicts the top 5 states with the highest sales which are grouped by vehicle category. As we can observe , 3-wheelers and 2-wheelers are the most purchased electric vehicles overall in all states, with 3-wheelers sales leading in Delhi and 2-wheeler sales leading in Maharashtra.

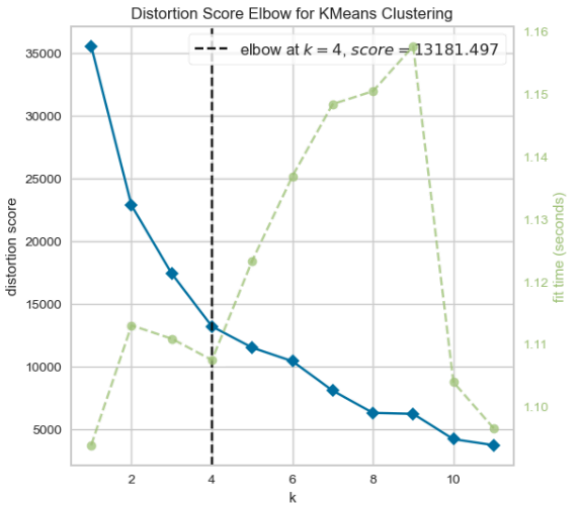


Fig 6.4 : Elbow Method for finding optimal number of clusters

The elbow method graph shows us that the optimal number of clusters required for market segmentation of electric vehicles in India is 4.

Fig 6.5 : Scatter plot for K-Means clustering

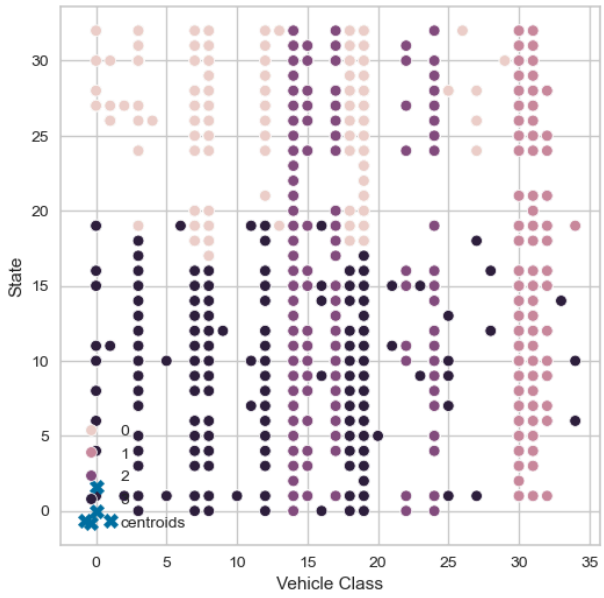
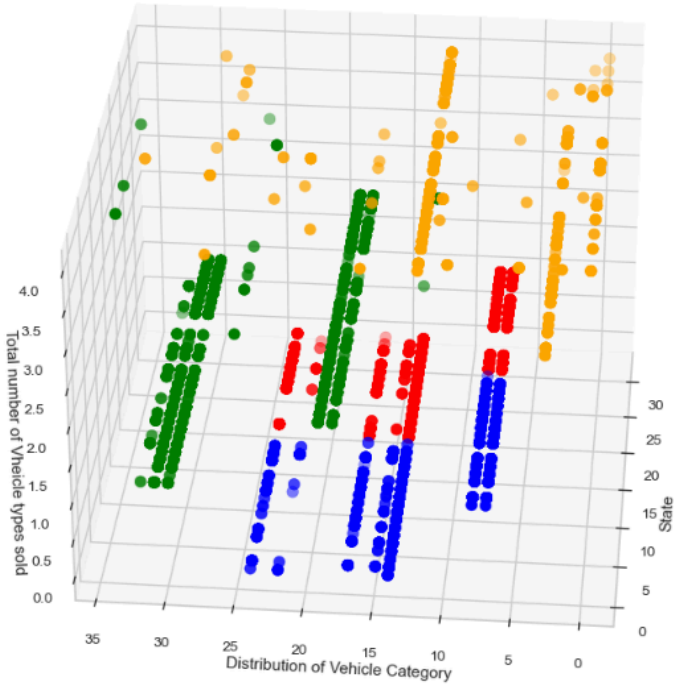


Fig 6.6 : Scatter Plot showing correlation between segmentation variables



We have used K-means clustering for segmentation and the scatter plots shows the further emphasizes these differences and correlation between the 4 segments, 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.

This section presents a detailed analysis of our consumer segments, as illustrated in Figure 6.7. The graph visually captures the diverse perceptions among different segments. Segment 0, representing 21% of consumers, values the electric vehicle sales with correlation to which state it belongs,its vehicle type, vehicle category, vehicle class. Conversely, Segment 1 (20% of consumers) , the smallest segment,expresses a strong value for vehicle class but expresses dissatisfaction across all other aspects, marking them as the largest but least satisfied group. Segment 2 (30% of consumers) appreciates only geographical location and vehicle class, marking them as the largest segment. Lastly, Segment 3 (29% of consumers)maintains a constant value for vehicle type, vehicle category, vehicle class and state showcasing distinct perceptions, particularly on class and type.

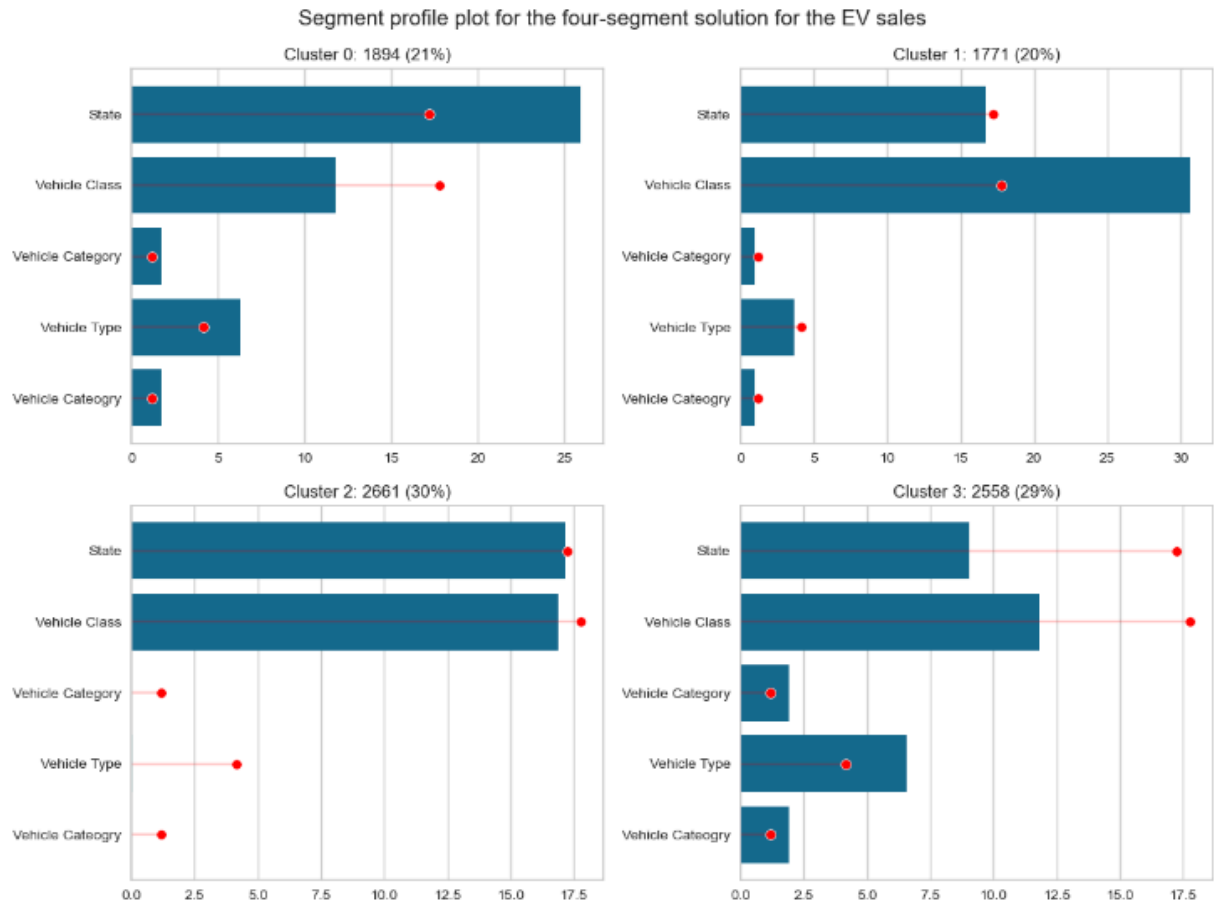


Fig 6.7 : Segment Profiling

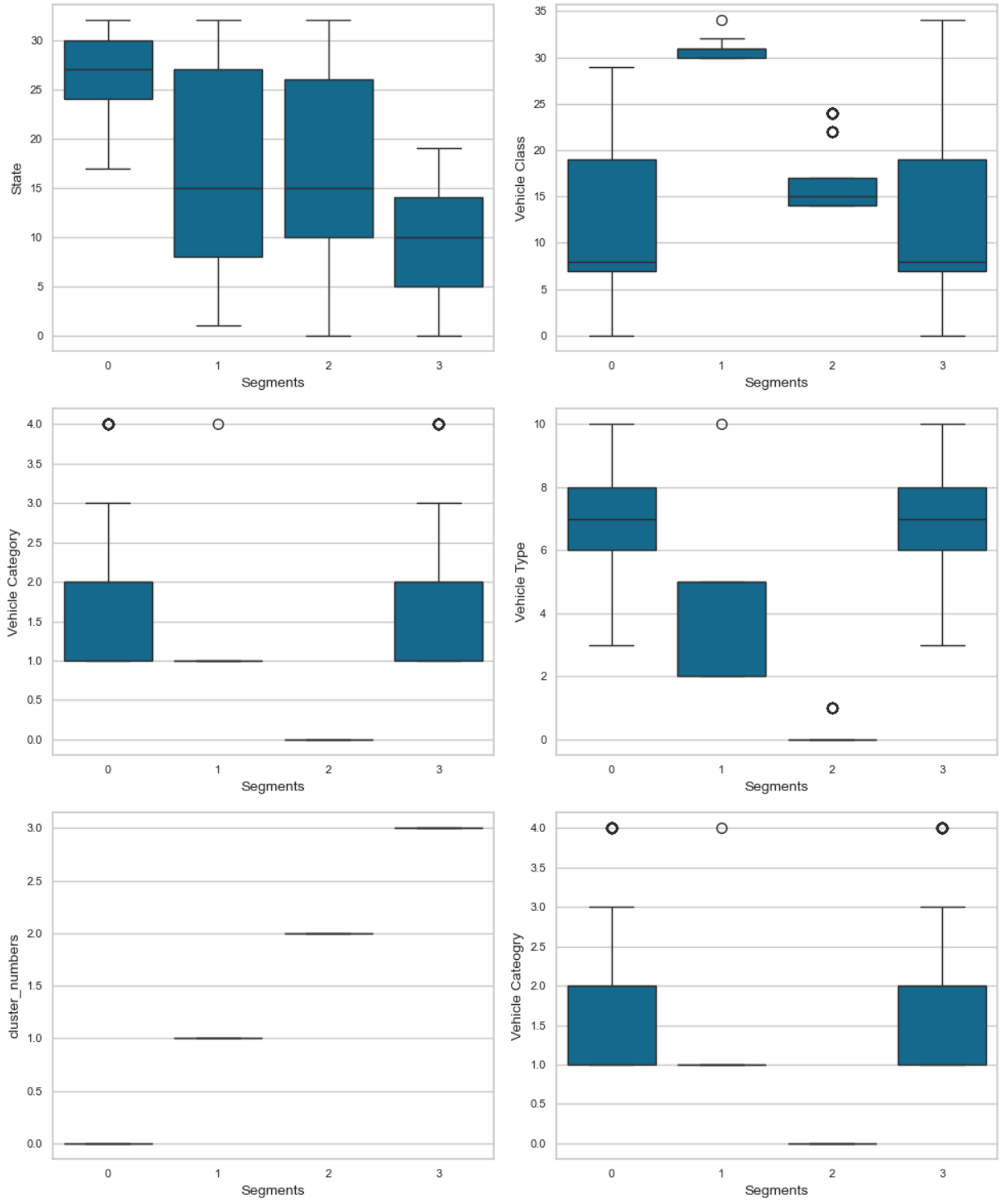


Fig 6.8: Describing Segments

In analyzing the technical specifications of electric vehicles across segments, distinct patterns emerge. Segment 0 showcases a major vehicle class, emphasizing a preference

for vehicle category within this group. Conversely, Segment 1 exhibits a low vehicle category, indicating a focus on vehicle type and states. Segment 2 and Segment 3 also emphasize on state, albeit with large differences. These findings align with consumer preferences, highlighting varied considerations within the market. Moving to vehicle type, Segment 0 and 3 stands out with a higher average, suggesting a preference for electric vehicles with specific class and category. Segment 1 and Segment 3 also focus on moderate ranges for vehicle classes. While Segment 0 and Segment 2 prioritize vehicle class suitable for consumers. Segment 1 and Segment 2 lean less towards vehicle class, accommodating diverse user preferences. Lastly, the states have a stable distribution in all segments with slightly higher levels towards segment 1 and 2. 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.

7. Target Segment

In the strategic selection of our target segment for the electric vehicle market, Segment 0 and Segment 3 stands out as potential focal points. Segment 0, encompassing 21% 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 behavior 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 3, comprising 29% of consumers, presents another enticing opportunity. Their distinct perceptions will shape customer expectations. This segment's sales analysis provides invaluable insights, aiding in the customization. By catering to these sales trends, such as states, preferred vehicle type ,class and category we can create a strong resonance within this consumer group.

Upon careful analysis, both segments offer a unique challenge and opportunity. Understanding Segment 0 and 1'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 Sales in particular states, production of more preferred vehicles, and enhancing positive vehicle types.By aligning our electric vehicles with distinct expectations we can ensure a competitive edge and sustained market growth.

8. **Customizing the Market Mix**

Vehicle type Customization involves introducing more enhanced features in the less preferred categories for electric vehicles and improved productions and flexible pricing structures. Category Customization demands targeted advertising, focusing on reliability and improvements for Segment 0 and 3 , and producing more 2 wheelers and 3 wheelers with more efficiency to further engage these segments effectively.

In terms of Location Customization, we'll establish accessible distribution channels in states with fewer electric vehicles purchased for Segment 0 and 3. Strengthening
our online presence ensures seamless online purchasing experiences, emphasizing virtual showrooms and customer support platforms. Additionally, People and Process Customization
involves training customer service representatives to address segment-specific concerns empathetically. This tailored approach ensures our electric vehicles resonate with the distinct needs of Segment 0 and Segment , fostering market relevance and customer preference.

9. **Optimal Market segments**

In the context of selecting the most optimal market segment for our electric vehicle sales, thorough analysis and evaluation have pointed to Segment 3 as the ideal choice. Representing 29% 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 vehicle specifications and geographic location, positions it as the most promising market segment for our electric vehicles.

The recommended technical specification range for Segment 3, presented in Table 9.1

SPECIFICATION	**RECOMMENDATION**
State	Uttar Pradesh, Maharashtra, Karnataka, Delhi, Bihar
Vehicle Type	2W_Personal, 4W_Personal
Vehicle Class	E-Richshaw , motorcycle/motor scooter
Vehicle Category	2-wheelers, 3 wheelers

10. Conclusion

In this comprehensive analysis of India's electric vehicle market, we've pinpointed Segment 3 as the prime target for our Electric Vehicle Startup. With a substantial 29% consumer base, this segment presents a lucrative market opportunity for us. By aligning our electric vehicle sales with the preferences of Segment 3, we can effectively cater to the demands of a sizable customer base.

This strategic decision is rooted in a deep understanding of market segmentation, consumer behavior, and technical specifications. By leveraging these insights, we're able to make informed choices that ensure our products resonate strongly with the needs and preferences of our target audience.

Moving forward, this focused approach guides our market entry strategy, emphasizing precision and relevance in both product development and marketing initiatives. By staying attuned to the evolving landscape of India's electric vehicle market, we're poised to establish a solid foothold and drive sustainable growth for our Electric Vehicle Startup.

11. Github

https://github.com/Aiswaryasudhir/EV-Sales-Market-Segmentation/