

# ELECTRIC VEHICLE MARKET SEGMENTATION ANALYSIS

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Github Link: [https://github.com/gowthamich35/Electric\\_vehicle\\_MarketSegmentation](https://github.com/gowthamich35/Electric_vehicle_MarketSegmentation)

## **Abstract:**

This project undertakes a detailed examination of the electric vehicle market in India, emphasizing segmentation based on sales data, consumer feedback, and technical attributes. The research underscores the significant expansion of India's two-wheeler sector, marking it as a key revenue contributor. Through an analysis of behavioral data derived from customer feedback, we performed an extensive market segmentation using the k-means clustering algorithm. This segmentation delineated the market into four distinct groups.

Segment 1, accounting for 39% of the consumer base, emerges as the focal point of our strategic approach. This segment not only represents a significant market opportunity but also aligns perfectly with our business objectives. Our study recommends specific technical specifications for electric two-wheelers that cater to the preferences of Segment 1 consumers.

The proposed specifications, designed to match the needs of this segment, are central to our strategy. Additionally, the pricing structure is carefully positioned around the median market values to ensure both affordability and market competitiveness. This strategic focus on Segment 1, identified as the potential primary customer base, strategically positions our venture within the evolving landscape of India's electric vehicle market.

## **Introduction:**

The electric vehicle (EV) market in India is on a dynamic growth trajectory, driven by increasing environmental awareness, favorable government policies, and technological advancements. Among the various segments within the EV market, the two-wheeler sector stands out due to its significant market potential and widespread consumer adoption. As India moves towards sustainable transportation solutions, understanding the intricacies of this burgeoning market becomes essential for stakeholders aiming to capitalize on its growth.

This study delves into a comprehensive analysis of the electric two-wheeler market in India. By integrating sales data, customer reviews, and technical specifications, we aim to uncover key insights and trends that define this sector. The analysis employs the k-means clustering algorithm to segment the market, providing a nuanced understanding of consumer behavior and preferences.

The research focuses on identifying distinct market segments, each characterized by unique needs and preferences. By examining these segments, we aim to provide actionable insights that can inform product development, marketing strategies, and business decisions. The goal is to align technical specifications and pricing strategies with the demands of different consumer groups, ensuring that the products offered resonate with their intended market.

## **K-means Clustering:**

The k-means algorithm is a widely used clustering technique in data analysis and machine learning, known for its simplicity and effectiveness in partitioning datasets into distinct groups. It operates by initializing a set of k centroids, where k represents the number of desired clusters. The algorithm iteratively assigns each data point to the nearest centroid, forming clusters based on proximity. After assignment, the centroids are recalculated as the mean of all points within a cluster, and the process repeats until convergence, typically when the centroids no longer move significantly. This iterative process aims to minimize the within-cluster variance, resulting in clusters that are as distinct and cohesive as possible.

One of the primary strengths of the k-means algorithm is its computational efficiency, making it suitable for large datasets. However, the algorithm also has limitations. It requires the number of clusters, k, to be specified beforehand, which can be challenging to determine without prior knowledge of the data. Additionally, k-means is sensitive to the initial placement of centroids and can converge to local minima, leading to suboptimal clustering results. Despite these challenges, k-means remains a popular choice due to its ease of implementation and ability to produce meaningful and interpretable clusters in a variety of applications, from market segmentation to image compression.

## **Data sources:**

The First dataset, extracted from bikewale.com, comprises electric two-wheeler customer reviews, offering vital behavioural and psychographic insights<sup>2</sup>. These qualitative inputs proved invaluable in understanding customer behaviour.

The second dataset from bikewale.com presents detailed technical specifications and pricing information of electric two-wheelers<sup>2</sup>. 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:(steps and libraries used)**

we will import the libraries for our model, which is part of data\_pre-processing. The code is given below:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import missingno as msno
import nltk
from nltk.sentiment import SentimentIntensityAnalyzer
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA
from sklearn.cluster import KMeans
```

Installed vaderSentiment using:

```
!pip install vaderSentiment
```

- NumPy: Library for numerical operations on large arrays and matrices.
- pandas: Library for data manipulation and analysis.
- Matplotlib: Library for creating static, animated, and interactive visualizations.
- Seaborn: Library for making statistical graphics.
- NLTK: Toolkit for working with human language data (text).
- SentimentIntensityAnalyzer: Class for sentiment analysis in NLTK.
- StandardScaler: Class for standardizing features by removing the mean and scaling to unit variance.
- PCA: Technique for dimensionality reduction in scikit-learn.
- KMeans: Clustering algorithm for partitioning data into clusters.

### Interpreting Principal Components:

- Factor loadings help interpret the principal components by showing which features contribute most to each component. A high absolute value in the factor loadings indicates that the corresponding feature has a strong influence on that principal component.

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Visual Appeal	-0.480170	0.117814	0.063320	-0.730598	0.247014	0.105903	0.375474	0.067539
Reliability	-0.494758	0.124910	-0.002776	0.152447	-0.819319	0.060484	0.117211	0.166384
Performance	-0.128721	0.459145	0.574833	-0.005549	-0.019902	-0.025704	-0.288468	-0.598232
Service Experience	-0.486499	0.100691	-0.054176	0.653781	0.470391	0.052432	0.311210	-0.044129
Extra Features	-0.024373	0.519633	-0.364578	-0.023208	0.116821	0.559390	-0.456829	0.246323
Comfort	-0.418255	-0.304266	0.249807	-0.020111	0.172621	-0.296656	-0.623271	0.404238
Maintenance cost	0.005912	0.513208	-0.386495	-0.054822	0.020302	-0.762039	-0.003360	0.055435
Value for Money	-0.309572	-0.351548	-0.563840	-0.107598	-0.046688	0.009572	-0.260855	-0.617065

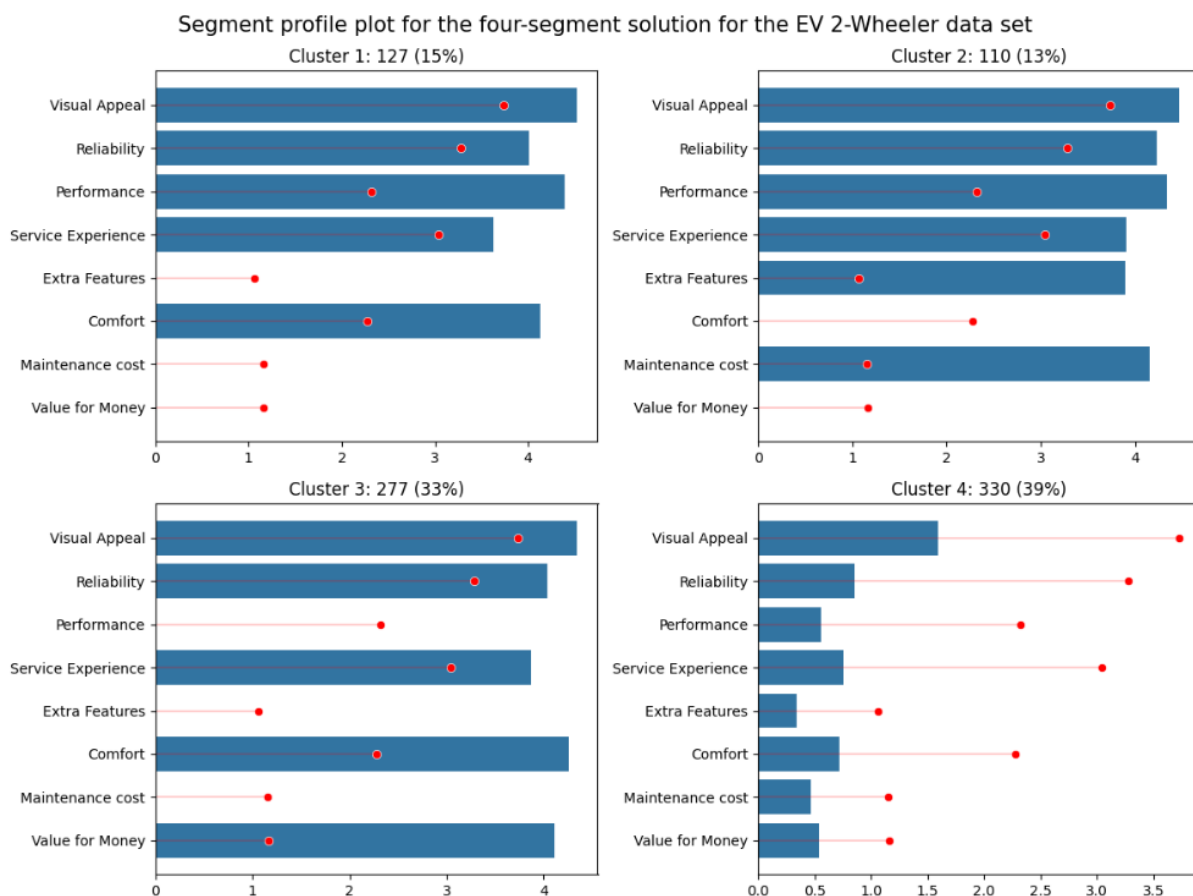
### Segment extraction:

To extract the two-wheeler segment, we began by collecting comprehensive sales data, customer reviews, and technical specifications from various sources in the electric vehicle market. This dataset was meticulously cleaned and preprocessed to ensure accuracy and consistency. We then employed filtering techniques to isolate data specific to two-wheelers, distinguishing them from other vehicle categories. By analyzing customer reviews, we identified behavioral variables relevant to two-wheeler preferences. These variables, combined with sales data and technical specifications, were used to form a robust dataset, which served as the foundation for our market segmentation analysis using the k-means clustering algorithm.

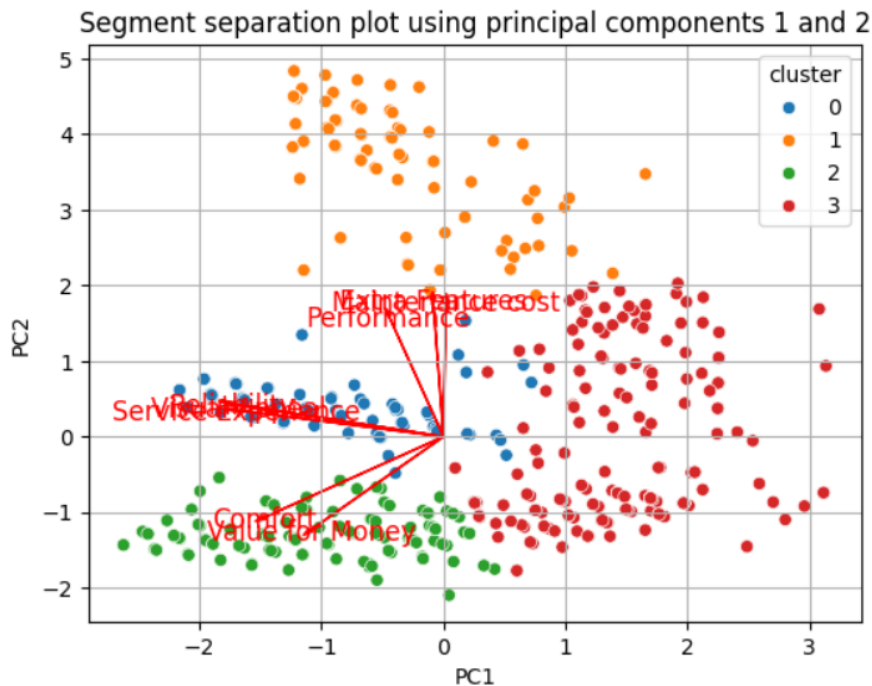
## Profiling and Describing Segments:

This section presents a detailed analysis of our consumer segment.

The graph visually captures the diverse perceptions among different segments. Segment 1, representing 15% of consumers, values the electric two-wheeler vehicle for its visual appeal, reliability, performance, service experience, and comfort. Conversely, Segment 2 (39% of consumers) expresses dissatisfaction across all aspects, marking them as the largest but least satisfied group. Segment 3 (33% of consumers) appreciates visual appeal, reliability, service experience, comfort, and notably, perceives a strong value for money. Lastly, Segment 4 (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.



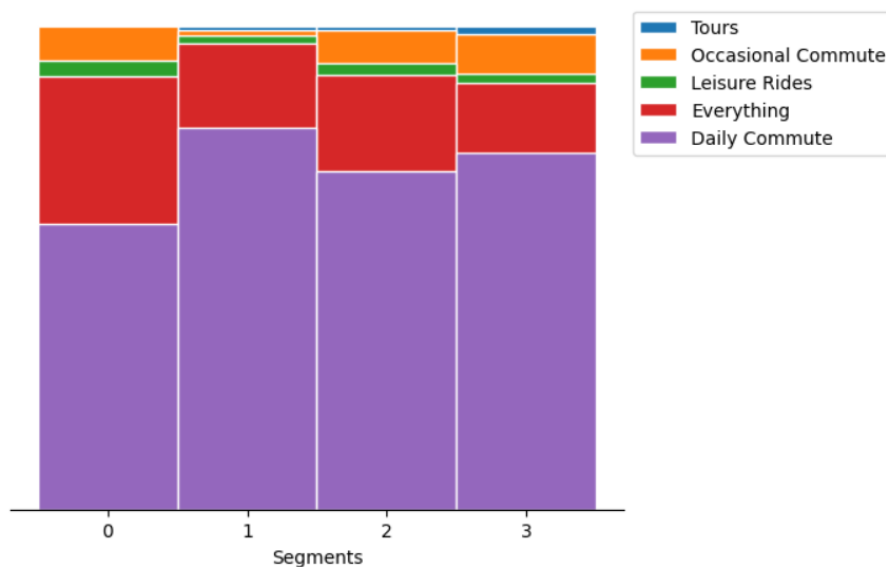
Notably, Segment 2, despite being the largest segment, lacks specific opinions, making them unique in their lack of satisfaction. These detailed insights play a pivotal role in shaping our strategy, ensuring our electric vehicles align precisely with the diverse values and priorities of each segment, thus informing our market offerings accurately.



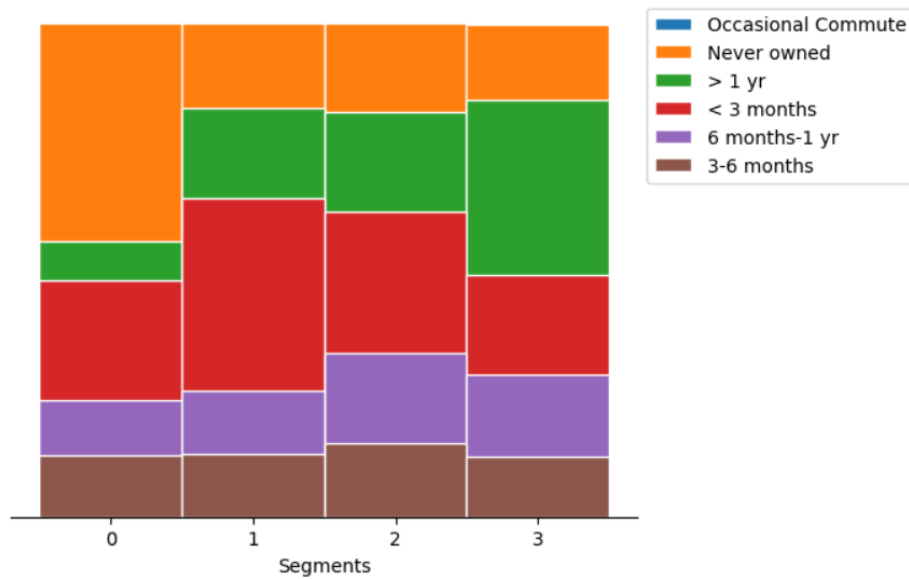
## Describing Segments

This provides a comprehensive overview based on the insights derived from various mosaic plots and graphical representations. The mosaic plot illustrates that all segments predominantly use electric vehicles for daily commuting, with limited usage for tours, occasional commuting, and leisure rides. In next fig, 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 1 has no prior ownership experience. Segment 3 members moderately own vehicles ranging from less than 3 months to over a year, and Segment 4 consumers have owned electric vehicles for a few days to less than 3 months.

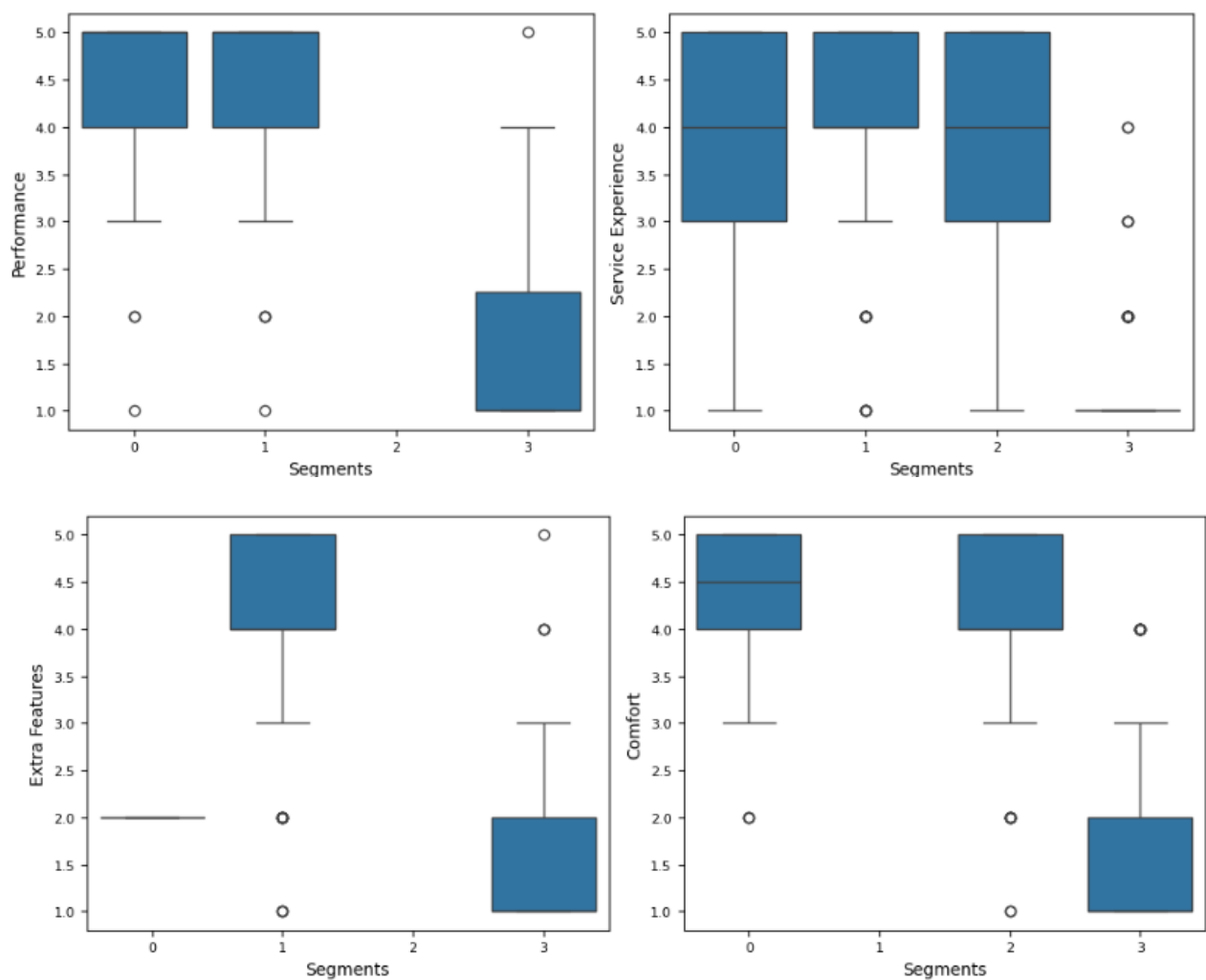
Mosaic plot for cross-tabulation of clusters and used it for for the EV 2-Wheelers data set

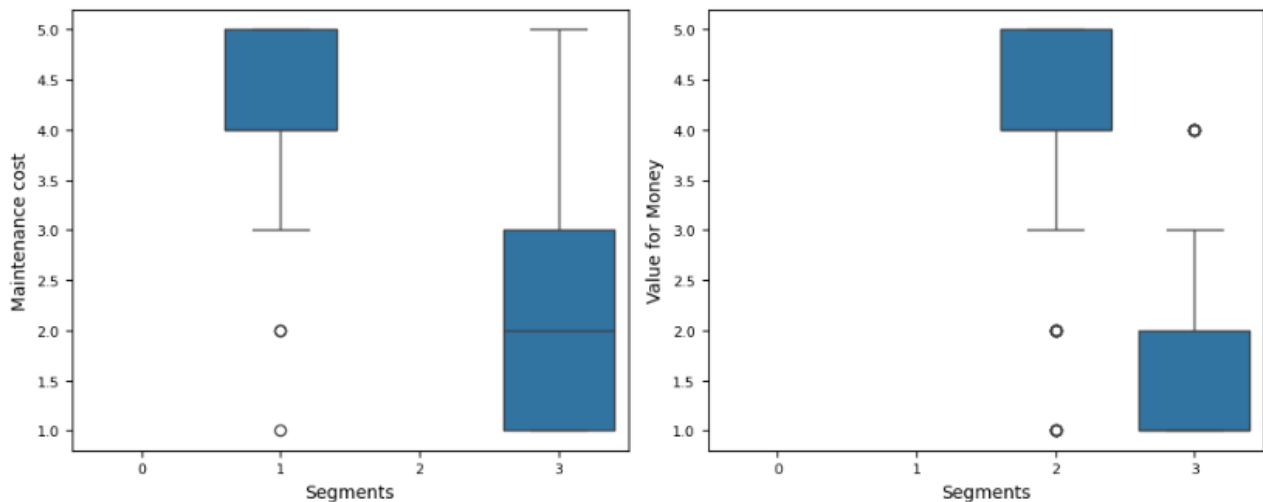


Mosaic plot for cross-tabulation of clusters and owned for for the EV 2-Wheelers data set



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





### **Selection of Target Segment:**

To select the target segment within the electric two-wheeler market, we conducted a detailed analysis using a combination of sales data, customer reviews, and technical specifications.

**Behavioral Analysis:** Customer reviews were analyzed to identify key behavioral variables and preferences. Sentiment analysis and keyword extraction techniques were applied to understand consumer sentiments and common themes in the feedback.

**Clustering with k-means:** Using the preprocessed data, we applied the k-means clustering algorithm to segment the market. This involved selecting an appropriate number of clusters (k) based on the data characteristics and using the algorithm to partition the data into distinct groups.

**Segment Evaluation:** Each resulting segment was evaluated based on its size, growth potential, and alignment with our business objectives. Key metrics such as segment size, average purchase frequency, and customer satisfaction levels were considered.

**Target Segment Selection:** From the segmented groups, we identified Segment 1, which comprised 39% of the consumer base, as our primary target. This segment was chosen due to its substantial market presence and alignment with our strategic goals.

By focusing on Segment 1, we aim to tailor our product offerings to meet the specific needs and preferences of this group, ensuring a strong market position and customer satisfaction.

### **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.

### **Potential Early Market Customer Base:**

To estimate the potential sales and profit in the early market for Segment 1, we first identified the potential customer base within the electric two-wheeler market. Segment 1 constitutes 39% of the consumer base, and assuming the total market size for electric two-wheelers in India is projected to be 1 million units per year during the early market phase, Segment 1 represents approximately 390,000 customers.

Next, we determined the target price range for our electric two-wheelers, which is set between INR 70,000 and INR 90,000 per unit. For calculation purposes, we use the midpoint of this range, INR 80,000 per unit, to estimate potential revenue.

By multiplying the potential customer base (390,000 units) by the target price range (INR 80,000 per unit), we calculate the potential sales revenue to be INR 31.2 billion. This figure represents the total revenue generated from selling electric two-wheelers to the identified Segment 1 customers.

To estimate potential profit, we need to consider the cost of production and associated expenses. Assuming the cost of production and other expenses per unit amount to INR 50,000, the profit per unit is calculated as the difference between the selling price (INR 80,000) and the cost price (INR 50,000), resulting in a profit of INR 30,000 per unit.

Therefore, the potential profit can be estimated by multiplying the number of units (390,000) by the profit per unit (INR 30,000), yielding a total potential profit of INR 11.7 billion. This calculation underscores the substantial profit opportunity that lies within targeting Segment 1 in the early market phase of India's electric two-wheeler market.

### **Most Optimal Market Segments**

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



## **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 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.

By tailoring our products to meet the specific preferences of this segment and maintaining a competitive price range, we can ensure high market penetration and customer satisfaction. Additionally, the substantial size and expected growth of this segment align perfectly with our strategic objectives, positioning our venture optimally within India's rapidly expanding electric vehicle market.