

TARGETED MARKET SEGMENTATION AND ENTRY STRATEGY FOR THE ELECTRIC VEHICLE MARKET IN INDIA

A Data Driven Approach and Report

Submitted by:

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16.09.2024

Abstract

The rapid growth of the Electric Vehicle (EV) market in India presents a significant opportunity for new entrants. This report provides a comprehensive analysis of the Indian EV landscape, utilizing a data-driven approach to identify and target the most promising market segments for an EV startup. By examining geographic, demographic, psychographic, and behavioral factors, the report highlights key trends and opportunities, particularly within the two-wheeler segment. Leveraging extensive datasets and analytical techniques, including Principal Component Analysis (PCA) and KMeans clustering, the report identifies high-income consumers and premium two-wheelers as optimal targets. It outlines a strategic marketing mix to effectively enter the market, emphasizing urban areas with strong EV adoption and affluent customers. The findings offer actionable insights for the startup to navigate and capture a significant share of India's rapidly growing EV market.

1.0 Introduction

The global shift toward sustainable and environmentally friendly transportation has positioned electric vehicles (EVs) as a critical solution for reducing carbon emissions and dependence on fossil fuels. In India, the EV market is rapidly growing, fueled by government initiatives, rising fuel prices, and increasing environmental awareness. With the government's push towards clean energy through programs like the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME), the Indian EV market presents a unique opportunity for startups to capture a significant share.

Our startup aims to develop a strategy for entering this burgeoning market, with a focus on identifying the most promising customer and vehicle segment. The challenge lies in determining which segment of the market – whether it be geographic, demographic, psychographic, or behavioral – is the most feasible to target.

This report utilizes a data-driven approach to perform a comprehensive market segmentation analysis. By examining consumer behaviors and vehicle preferences, the goal is to formulate an optimal entry strategy that will maximize the startup's potential for success in India's evolving EV market.

2.0 Fermi Estimation (Breakdown of Problem Statement)

Our EV startup is looking to enter the Indian market and develop electric vehicles. The challenge lies in identifying the most promising customer and vehicle segments through a detailed segmentation analysis, focusing on geographic, demographic, psychographic, and behavioral factors. Given the varying availability of data across markets, we need to base our analysis on reliable data while applying informed estimates where data is incomplete. This ensures that decisions are both accurate and unbiased.

Here, we will use Fermi Estimation to:

1. Estimate the Potential Market Size

$$\text{Market Size} = \text{Total Population of India} \times \text{Estimated Percentage of Target Customers} \times \text{EV Adoption Rate}$$

This formula helps estimate how many people could realistically adopt electric vehicles in the near future, based on market penetration trends.

2. Estimate the Potential Revenue

$$\text{Potential Revenue} = \text{Estimated Market Size} \times \text{Average Price of Electric Vehicle}$$

This formula gives an approximation of the potential revenue based on the estimated number of customers who might buy electric vehicles and the average price point.

3. Estimate the Early Market

$$\text{Early Market Size} = \text{Total Market Size} \times \text{Percentage of Target Customer Segment}$$

Here, we'll estimate the number of target customers from the total target market, as they are crucial for an early-stage product like EVs.

Key Factors to Consider in Fermi Estimation

- Geographic Factors
- Demographic Factors
- Psychographic and Behavioral Factors

3.0 Data Sources (Data Collection)

Extensive research and data collection was conducted to analyze the Indian EV market. The data was sourced from:

1. Sales Data:

- a. Datasets containing annual EV sales by category:** This dataset provides insights into the sales of different categories of EVs (two-wheelers, three-wheelers, four-wheelers) across various years.

Link to Dataset:

<https://www.data.gov.in/>

https://www.kaggle.com/datasets/srinrealyf/india-ev-market-data?select=ev_sales_by_makers_and_cat_15-24.csv

- b. Dataset containing statewide distribution of EVs:** This dataset provides the geographic distribution of EVs across Indian states. It highlights regions with the highest adoption rates, which can guide geographic targeting.

Link to Dataset:

<https://www.kaggle.com/datasets/sanhitasaxena/indian-electric-vehicle-dataset>

- 2. Consumer Behavior Data:** This dataset contains responses from a survey conducted at two-wheeler EV showrooms in Lucknow, India, between August and December 2023, yielding a total of 1123 responses. The data was collected through a comprehensive questionnaire designed to assess consumers' knowledge, attitudes, and practices regarding EV adoption.

Link to Questionnaire & Dataset:

<https://data.mendeley.com/datasets/9c4brbnms3/1>

- 3. Technical Specifications:** A dataset containing technical specifications of electric two-wheelers, including pricing, mileage, weight, acceleration speed, and top speed.

Link to dataset:

<https://www.kaggle.com/datasets/yashwanthkumarmn/motorcycles-in-india>

In the event of unavailability of proper datasets, the team will ensure decisions remain accurate and unbiased through:

1. **Industry Benchmarks:** Reputable sources like McKinsey, PwC, and government reports (e.g. FAME II) will guide decisions based on established trends and market insights.
2. **Expert Consultations:** Qualitative insights from industry experts, automotive professionals, and local dealerships will compensate for missing quantitative data.
3. **Proxies and Estimations:** Fermi estimation techniques and proxy variables will be used, drawing from similar regions and demographics to estimate missing data.
4. **Primary Research:** Suveys and interviews will be conducted to gather direct consumer input on EV research and market trends.
5. **Data Simulation and Sensitivity Analysis:** Simulated data and sensitivity analyses will help model scenarios and ensure the strategy is robust despite data gaps.
6. **Machine Learning Models:** Predictive models and clustering techniques will be applied to generate insights from available data, allowing informed projections to fill gaps.

3.0 Data Pre-processing (Steps and Libraries Used)

To prepare the data for analysis, the following pre-processing steps were conducted:

1. **Data Cleaning:** Missing values were handled using imputation technique – mean for numerical data.
2. **Standardization:** Key features such as price, mileage, acceleration speed and consumer behavior attributes (K1...K5), (ATT1...ATT5) and (P1...P5) were standardized using `StandardScaler` to ensure uniform scaling before applying Principal Component Analysis (PCA) and KMeans clustering.
3. **Dropping Unnecesary Columns:** Irrelevant rows and columns were removed to streamline the data.

Libraries Used:

- **Pandas:** For data manipulation and handling.
- **Numpy:** For numerical computations.
- **Matplotlib & Seaborn:** For data visualization.
- **Scikit-learn:** For machine learning algorithms including PCA and KMeans clustering.
- **Kneed:** To find the optimal number of clusters using the elbow method.

4.0 Segment Extraction (ML Techniques Used)

4.1 Sales Insights

Based on sales data, the bar graph underscores the significant lead of two-wheelers over three-wheelers and four-wheelers. Two-wheelers not only surpass three-wheelers in sales but also exhibit a considerable gap compared to four-wheelers. This suggests that two-wheelers are an ideal entry point for our startup.

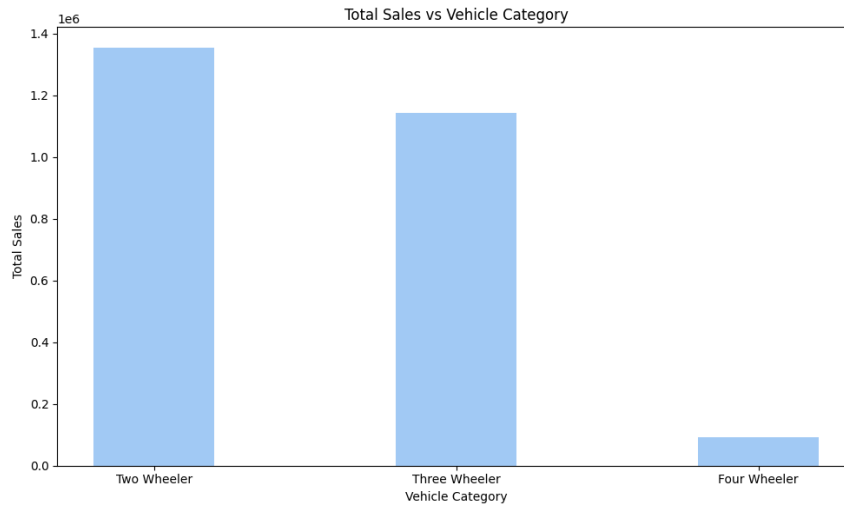


Figure 1: Total sales by vehicle category

Analysis of a second sales dataset, visualized through pie chart, depicted the market share of different vehicle categories, with two-wheelers accounting for 51.6% of the total sales. Three-wheelers followed at 43.8%, while Light Motor Vehicles (LMV) and Multi-Utilit Vehicles (MUV) held a minimal market presence.

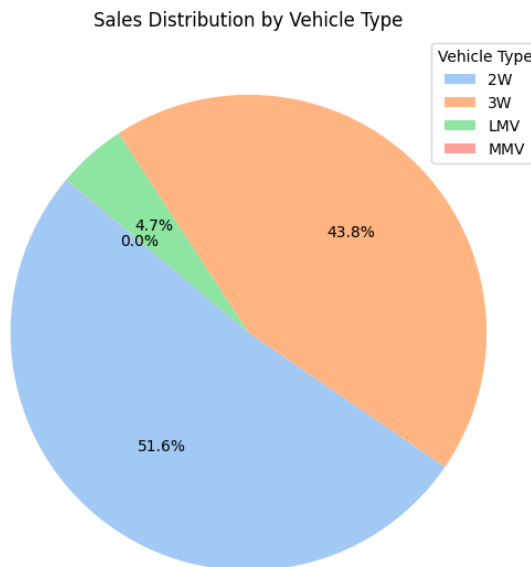


Figure 2: Total Sales Distribution by Vehicle Type

4.2 Geographic Distribution

The sales data analysis also showed that two-wheelers dominate EV sales across most states, with Maharastra, Tamil Nadu, and Uttar Pradesh leading, followed by notable figures from Gujarat, West Bengal, Rajasthan, Punjab, and Haryana. These states, particularly urban areas with favorable EV adoption rates, present the best opportunities for launching the product, given the strong market presence and consumer preference for two-wheelers.

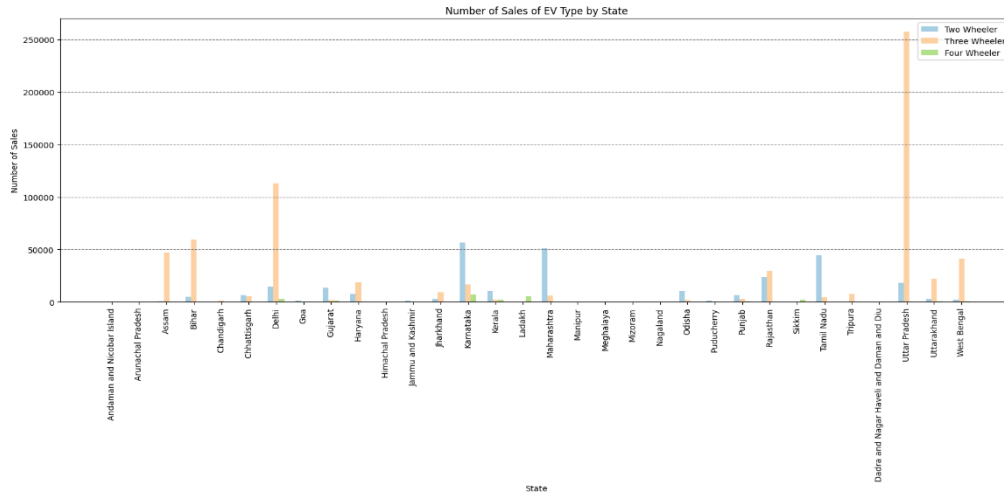


Figure 3: Geographic sales distribution of two-wheelers in India

4.3 Clustering Analysis of Consumer Responses

The research study “Consumers’ Knowledge, Attitude, and Practice: Investigating Electric Vehicle Adoption in the Indian Automobile Sector” collected responses through detailed questionnaire designed to assess various aspects of consumer behaviour towards EVs. The dataset includes responses on demographic information and consumer insights regarding EVs, segmented into Knowledge (K1...K5), Attitude (ATT1...ATT5), and Practice (P1...P5). The objective of the heatmap generated, followed by Principal Component Analysis (PCA) and KMeans clustering was to identify distinct customer segments that could inform targeted marketing strategies for EV adoption.

Link to Questionnaire & Dataset: <https://data.mendeley.com/datasets/9c4brbnms3/1>

4.3.1 Heatmap

To gain a preliminary understanding of the relationships between various factors influencing EV adoption, a heatmap was used to visualize the correlation matrix of the dataset. It served as a key tool for identifying patterns that guided further analysis with PCA and KMeans Clustering.

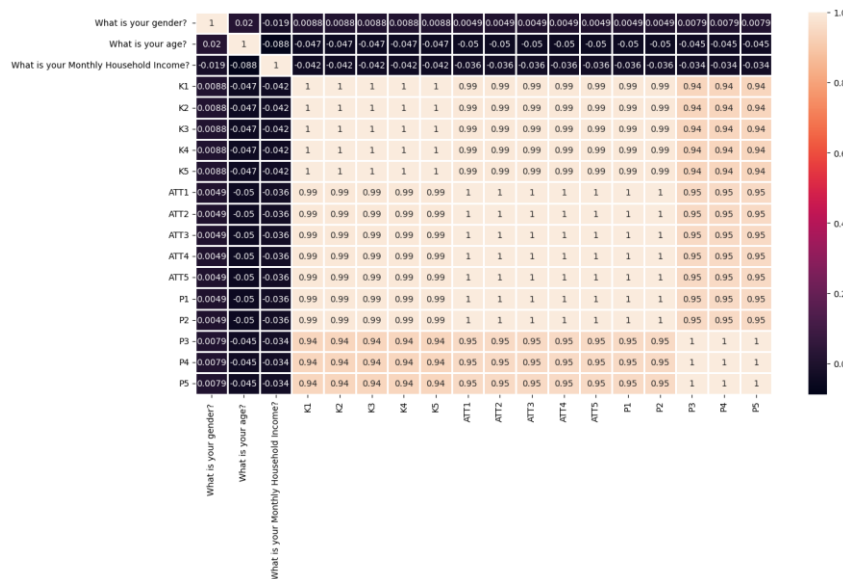


Figure 4: Correlation Heatmap of EV Adoption Factors

Correlation Insights:

1. **Knowledge (K1-K5):** High correlations among knowledge variables indicate that respondents who are well-informed about one aspect of EVs are generally knowledgeable across all aspects. This suggests a unified understanding of EVs.
2. **Attitude (ATT1-ATT5):** High correlations within attitude variables show that those with positive views on one aspect of EVs also tend to have positive views on others. This indicates that a general positive attitude drives agreement across all attitude-related questions.
3. **Practice (P1-P5):** High correlations among practice variables imply that respondents actively involved in one EV-related behavior are likely to engage in other behaviors as well, suggesting cohesive behavior patterns.
4. **Demographics:** Low correlations between demographic variables (gender, age, income) and knowledge, attitude, or practice suggest that these factors do not significantly influence EV-related responses.

The responses in the K, ATT, and P sections are mainly determined by the respondents' personal knowledge, attitudes, and behavior toward electric vehicles, not their demographics.

4.3.2 Principal Component Analysis (PCA)

PCA was utilized to reduce the dimensionality of the data and identify key components that capture the variance in consumer responses. The PCA results showed that the first principal component explained 97.93% of the variance, while the second component explained an additional 1.65%. Together, these two components accounted for 99.59% of the cumulative variance in the data. This analysis revealed that a few principal factors primarily drove differences in consumer attitudes, knowledge, and practices regarding EVs.

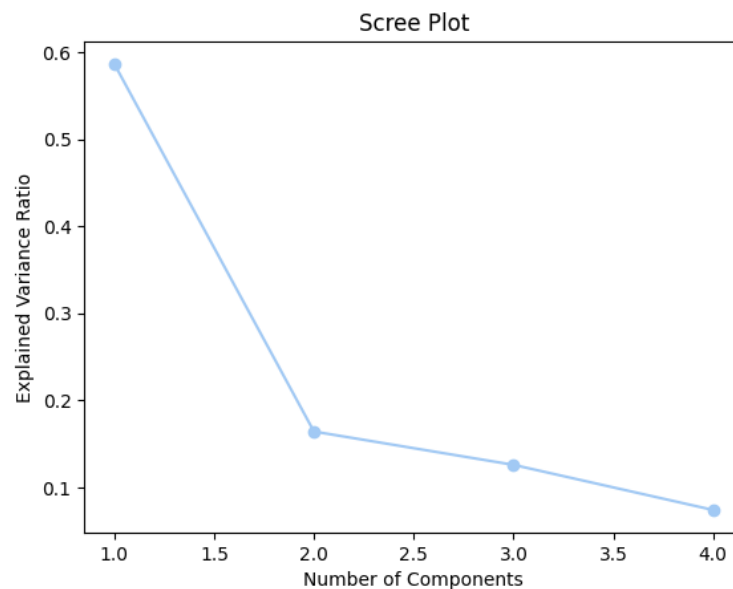


Figure 5: Scree plot showing the variance explained by each PC

4.3.3 KMeans Clustering

KMeans clustering was applied after PCA to group similar customer segments. Using the elbow method, the optimal number of clusters was determined to be three. The results revealed distinct

groups of consumer responses, with points representing individuals and colors indicating their clusters.

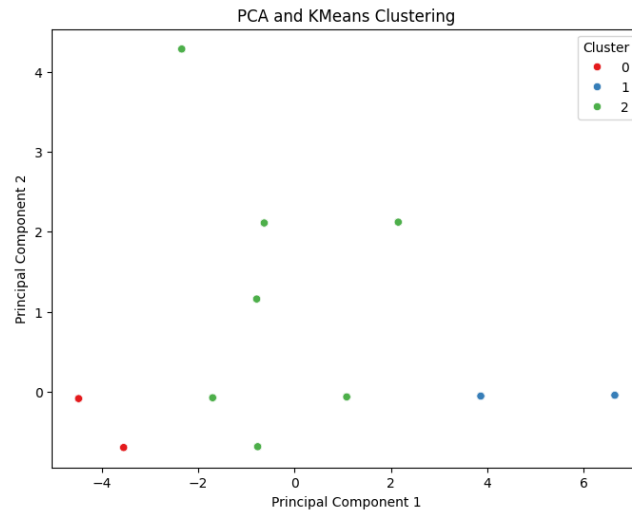


Figure 5: Scatter plot showing EV adoption segments

4.4 Segmenting Electric Two-Wheeler Based on Features: Performance vs. Price

In this analysis, a dataset containing features of electric two-wheelers – price, mileage, weight, acceleration speed, and top speed – was used to segment the market based on performance and pricing factors.

4.4.1 Principal Component Analysis (PCA)

PCA was employed to reduce the dimensionality of the dataset and help summarize the information into key components, capturing most of the variance within the data. The first principal component explained 58.63% of the variance, and the second explained 16.43%, together capturing 75.05% of the total variance. This indicates that these two components effectively reduced dimensionality while retaining most of the key information.

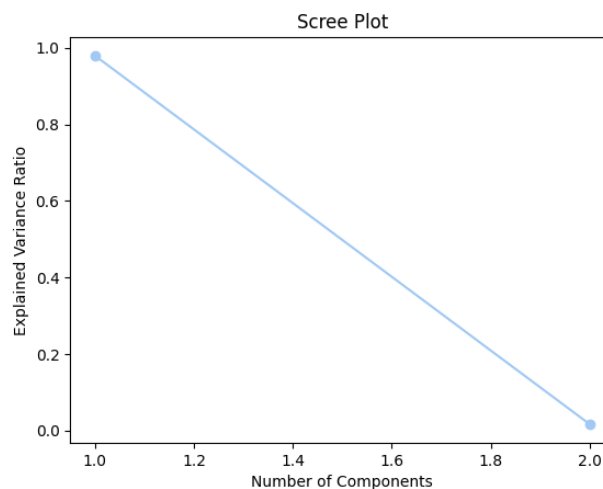


Figure 6: Scree plot showing the variance explained by each PC

4.4.2 KMeans Clustering Analysis

KMeans clustering was applied after PCA to group similar two-wheeler segments. Using the elbow method, the optimal number of clusters was determined to be two. The results revealed distinct groups of electric two-wheelers, with points representing individual vehicles and colors indicating their clusters.

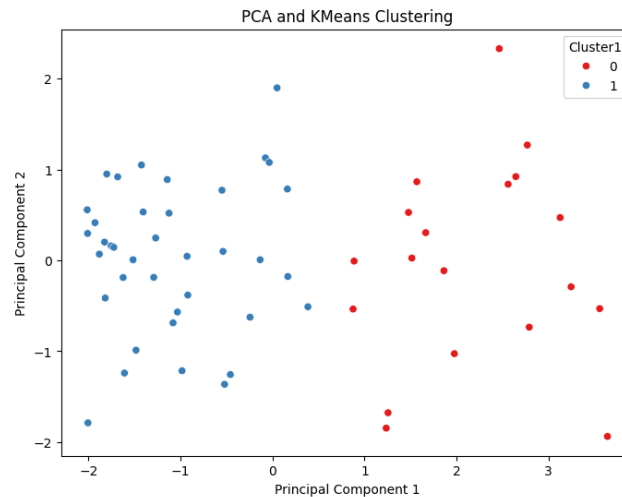


Figure 7: Scatter plot showing two-wheeler segments

5.0 Profiling and Describing Potential Segments

5.1 Cluster Profiling of Consumer Responses

	What is your gender?	What is your age?	\				
Cluster							
0	1.610932	2.308682					
1	1.604317	2.438849					
2	1.627341	2.436330					
	What is your Monthly Household Income?		K1	K2	K3	\	
Cluster							
0	2.440514		4.974277	4.974277	4.974277		
1	2.485612		1.377698	1.377698	1.377698		
2	2.372659		3.539326	3.539326	3.539326		
	K4	K5	ATT1	ATT2	ATT3	ATT4	ATT5 \
Cluster							
0	4.974277	4.974277	5.000000	5.000000	5.000000	5.000000	5.000000
1	1.377698	1.377698	1.377698	1.377698	1.377698	1.377698	1.377698
2	3.539326	3.539326	3.524345	3.524345	3.524345	3.524345	3.524345
	P1	P2	P3	P4	P5		
Cluster							
0	5.000000	5.000000	5.000000	5.000000	5.000000		
1	1.377698	1.377698	1.377698	1.377698	1.377698		
2	3.524345	3.524345	3.389513	3.389513	3.389513		

Figure 8: Cluster Profile

- **Cluster 0 (Higher-Income Segment):**
 - **Demographics:** Young professionals in the ₹5-10 lakh income bracket.
 - **Knowledge:** High awareness of EV technology, government incentives, and infrastructure.
 - **Attitude:** Positive attitude towards EVs, seeing them as environmentally friendly and cost-effective in the long run.

- **Practice:** Active EV users and early adopters, engaged in EV-related practices such as researching and driving EVs.
- **Cluster 1 (Lower-Income Segment):**
 - **Demographics:** Consumers earning less than ₹5 lakhs monthly.
 - **Knowledge:** Limited knowledge of EVs and government policies.
 - **Attitude:** Negative or neutral views on EVs, with skepticism about cost savings and driving experience.
 - **Practice:** Low engagement with EVs, least likely to adopt EVs in the near future.
- **Cluster 2 (Mid-Range Income Segment):**
 - **Demographics:** Middle-range age and income (₹5 – 10 lakhs monthly)
 - **Knowledge:** Moderate understanding of EVs and charging stations.
 - **Attitude:** Positive, but less enthusiastic; recognizes benefits but not fully convinced.
 - **Practice:** Considered EVs but low engagement in information search or usage.

5.2 Cluster Profiling of Two-Wheelers Based on Features

	price	mileage	weight_in_kg	acceleration_speed	\
Cluster1					
0	121758.947368	153.526316	123.263158	4.373503	
1	60177.421053	90.605263	86.421053	7.063092	
	top_speed				
Cluster1					
0	87.631579				
1	38.921053				

Figure 8: Cluster Profile

- **Cluster 0 (Premium Segment):**
 - **Price:** ₹121,758
 - **Mileage:** 153.5 km
 - **Weight:** 123.3 kg
 - **Acceleration Speed:** 4.37 seconds
 - **Top Speed:** 87.6 km/h
- **Cluster 1 (Budget Segment):**
 - **Price:** ₹60,177
 - **Mileage:** 90.6 km
 - **Weight:** 86.4 kg
 - **Acceleration Speed:** 7.06 seconds
 - **Top Speed:** 38.9 km/h

6.0 Selection of Target Segment

Based on the segmentation analysis:

6.1 Target Vehicle Segment

- **Two-wheelers:** Two-wheelers dominate the market, with 51.6% of sales, and have a strong demand in key states. This makes them the ideal segment for the startup's entry into the Indian EV market.

6.2 Target Customer Segment

- **Cluster 0:** Higher-income consumers with high levels of EV knowledge and a positive attitude toward electric vehicle. These individuals are likely to be early adopters and represent a prime market for premium electric two-wheelers.

6.3 Target Two-Wheeler Segment

- **Premium Segment:** High-performance electric two-wheelers, aligned with the needs of higher-income consumers who value features like mileage, speed, and acceleration.

7.0 Customizing the Marketing Mix

To successfully enter the market, the following marketing mix are proposed for the targeted customer and vehicle segment:

1. **Product:** High-performance electric two-wheelers with superior features such as better mileage, faster acceleration, and higher top speed.
2. **Price:** A premium pricing strategy targeting the affluent customers (₹1,00,000 – ₹1,25,000), with value placed on performance and quality.
3. **Place:** Focus on urban areas with developed EV infrastructure, such as Maharashtra, Tamil Nadu, and Delhi NCR. These regions already have high EV adoption rates and government support.
4. **Promotion:** Highlight the long-term cost savings, environmental benefits, and government incentives for early EV adoption in promotional campaigns.

8.0 Potential Customer Base in the Early Market (Business Markets)

To estimate the potential customer base and revenue in the early market, we will apply Fermi Estimation to break down the market into more manageable components.

1. Estimate the Potential Market Size

$$\text{Market Size} = \text{Total Population of India} \times \text{Estimated Percentage of Target Customers} \times \text{EV Adoption Rate}$$

- **Total Population of India:** 1.4 billion people
- **Estimated Percentage of Target Customers:** 5 % (tech-savvy, environmentally conscious individuals with sufficient income).
- **EV Adoption Rate:** 3% (based on current market trends and growing awareness)

Calculation:

$$\text{Market Size} = 1.4 \text{ billion} \times 5\% \times 3\% = 2.1 \text{ million people}$$

This calculation estimates that approximately **2.1 million people** in India could realistically adopt electric vehicles in the near future.

2. Estimate the Potential Revenue

Potential Revenue = Estimated Market Size x Average Price of Electric Vehicle

- **Estimated Market Size:** 2.1 million people
- **Average Price of Electric Vehicle:** ₹1,00,000 to ₹1,25,000

Calculation:

Potential Revenue = 2.1 million x ₹1,25,000 = ₹ 2,62,50,00,00,000 (₹262.5 billion)

This means the potential revenue from the total market, assuming an average price of ₹1,25,000 per EV, could reach **₹262.5 billion**.

3. Estimate the Early Market (Early Adopters and Innovators)

Early Market Size = Total Market Size x Percentage of Early Adopters and Innovators

- **Total Market Size:** 2.1 million people
- **Percentage of Early Adopters and Innovators:** 16% (based on the Technology Adoption Life Cycle)

Calculation:

Early Market Size = 2.1 million x 16% = 336,000 people

This estimation shows that the early market – comprising innovators and early adopters – could consist of approximately **336,000 people**.

4. Estimate the Potential Profit from Early Market

Potential Profit = Potential Customer Base (Early Market Size) x Target Price Range (Average Price of EV)

- **Potential Customer Base:** 336,000
- **Target Price Range:** ₹1,25,000

Calculation:

Potential Profit = 336,000 x ₹1,25,000 = ₹42,00,00,00,000 (₹42 billion)

The potential profit from the early market could be around **₹42 billion**, assuming successful market penetration among early adopters.

9.0 The Most Optimal Market Segments to Open in the Market

Based on the segmentation analysis and available data, the most optimal market segments for entry are:

1. **Geographic Segment:** Urban areas in Maharashtra, Tamil Nadu, and Uttar Pradesh, where EV sales are already high.
2. **Demographic Segment:** Younger, higher-income consumers in the ₹5-10 lakh bracket.
3. **Psychographic Segment:** Environmentally conscious individuals who are early adopters of innovative technologies.
4. **Behavioral Segment:** Consumers who have previously researched and engaged with EV technologies.

10.0 Link to GitHub Profile

All codes and datasets for this analysis are at: [GitHub](#)

11.0 Conclusion

This analysis has provided a detailed understanding of the Indian EV market, focusing on identifying viable market segments and crafting a strategic entry approach. The data-driven insights reveal that two-wheelers, especially premium models, represent the most promising vehicle segment due to their dominant market share and consumer preference. Targeting higher-income consumers with a positive attitude towards EVs is essential, as they are more likely to adopt new technologies and invest in premium EVs. The recommended marketing strategy includes focusing on urban centers with developed EV infrastructure, highlighting the long-term benefits of EVs in promotional events, and setting a premium price point to align with the targeted consumer segment's expectations. The Fermi estimation of market potential and early adopter base further supports the feasibility of this approach, projecting substantial revenue and profit opportunities. Overall, this report equips the startup with a strategic framework to effectively enter and succeed in the evolving Indian EV market.