Electric Vehicle Market Segmentation Report

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1. Fermi Estimation: Problem Statement Breakdown

Problem Statement: Estimate the potential market size and sales for Electric Vehicles (EVs) in India, and identify the most optimal market segments for initial entry.

Breakdown:

1. **Total Addressable Market (TAM) for Vehicles in India:** Estimated at approximately 350 million households, aligning with 345.5 million total vehicle registrations in 2022.
2. **Current EV Penetration:** EV sales are nascent, with approximately 1.2 million units in FY 2022-23 compared to ~21 million total vehicle sales.
3. **Key EV Adoption Influencers:** Economic factors (income, savings), demographic profiles (age, family size), infrastructure availability (charging), and existing vehicle preferences.
4. **Market Segmentation Approach:** K-Means clustering on demographic and financial data, complemented by analysis of vehicle ownership patterns.
5. **Potential EV Market Size:** Electric two-wheelers hold the largest potential, followed by passenger cars, and then commercial vehicles.
6. **Early Market Sales (Profit):** Calculated based on target segment customer base and defined EV price ranges.

2. Data Sources

The analysis utilized the following datasets:

- `air_pollution_data.csv`
- `age_income.csv`
- `Sales of motor vehicles of India.csv`
- `Vehicle ownership by economic class - Data For India.csv`
- `Vehicle Class - All.csv`

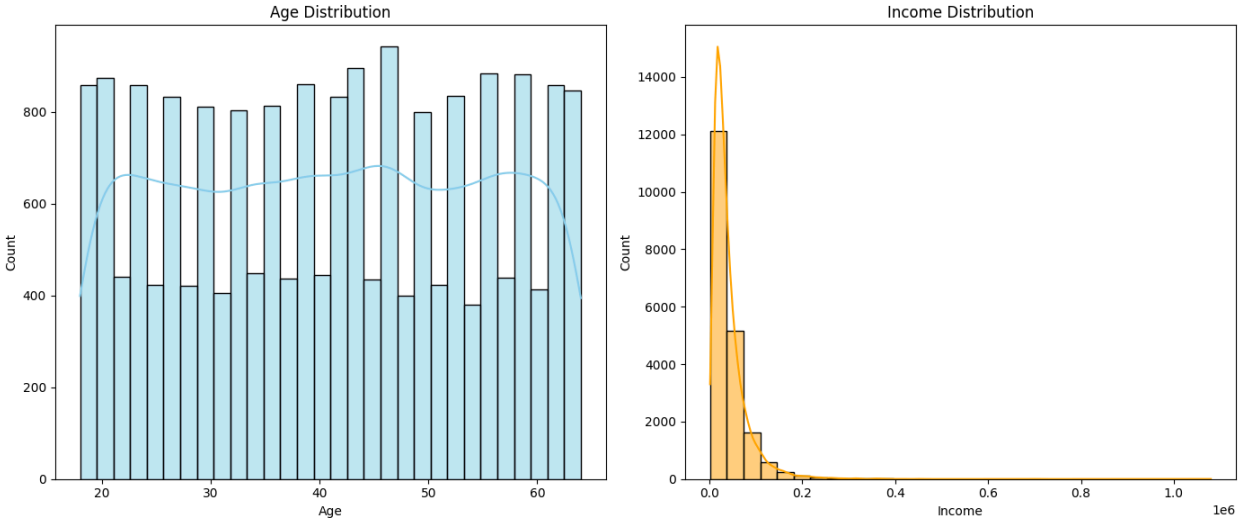
3. Data Pre-processing

Data pre-processing involved:

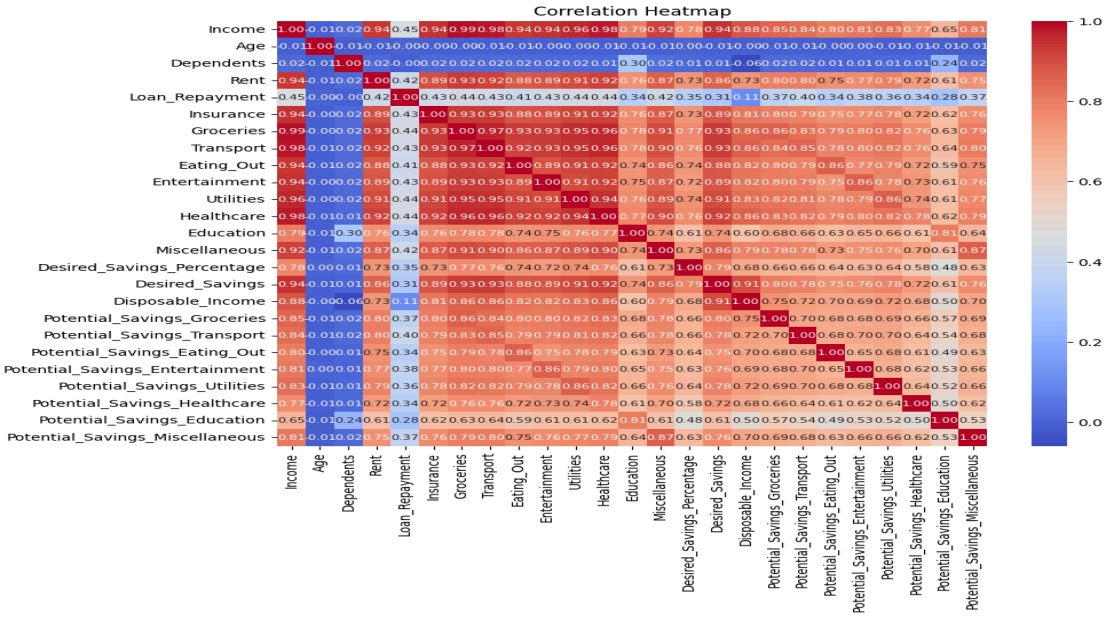
1. **Loading Datasets:** All CSV files were loaded into pandas DataFrames.
2. **Handling Missing Values:** Imputation for City_Tier (mode) and vehicle_ownership_df (filled with 0).
3. **Feature Engineering:** Creation of Total_Expenses, Total_Savings, Savings_Ratio, Disposable_Income_Ratio, and a Financial_Stability_Score from age_income_df. Two_Wheeler_Ownership_Percentage was calculated for vehicle_ownership_df.
4. **Encoding Categorical Variables:** One-hot encoding for Occupation and City_Tier, and label encoding for Sector and MPCE_Quintile.

5. **Feature Scaling:** Numerical features were scaled using StandardScaler.
6. **Dimensionality Reduction (PCA):** PCA was applied to the scaled age_income_df to reduce dimensionality, with 2 principal components explaining significant variance.

During the EDA phase, the following distributions and relationships were visualized:



- This histogram illustrates the frequency of different age groups within the dataset, showing the overall age demographic of the surveyed individuals.
- The other graph displays the spread of income levels among the respondents, indicating the general economic landscape of the target population.
- This heatmap visualizes the correlation coefficients between various numerical features in the age_income_df, highlighting strong positive or negative relationships that can inform feature selection and understanding.

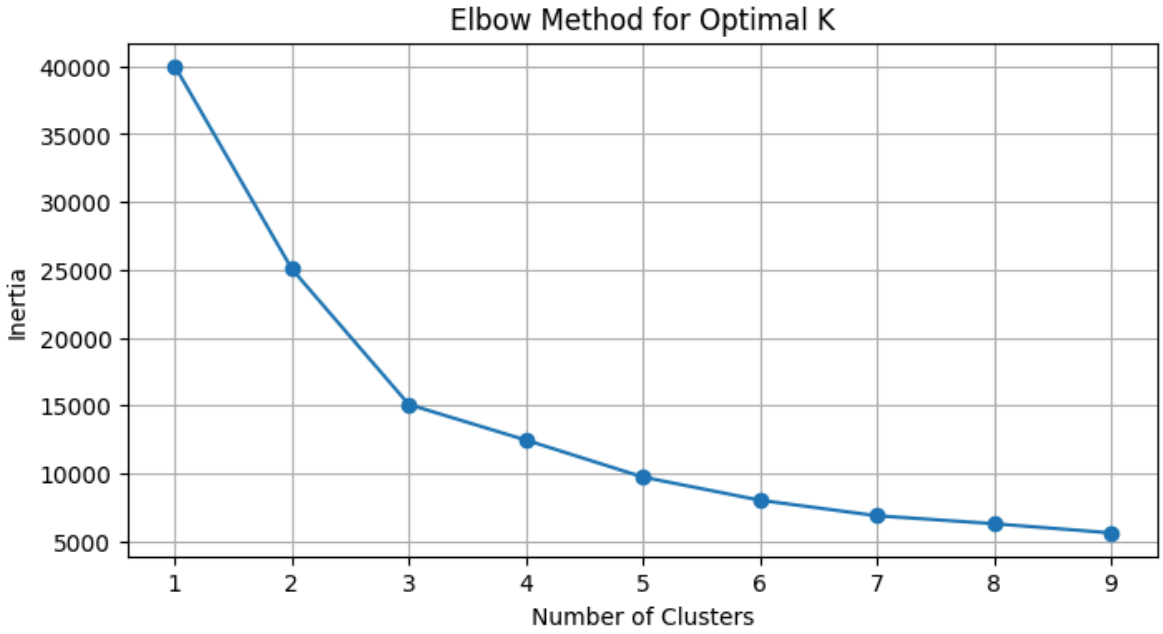


4. Segment Extraction (ML Techniques)

K-Means Clustering was used for segment extraction.

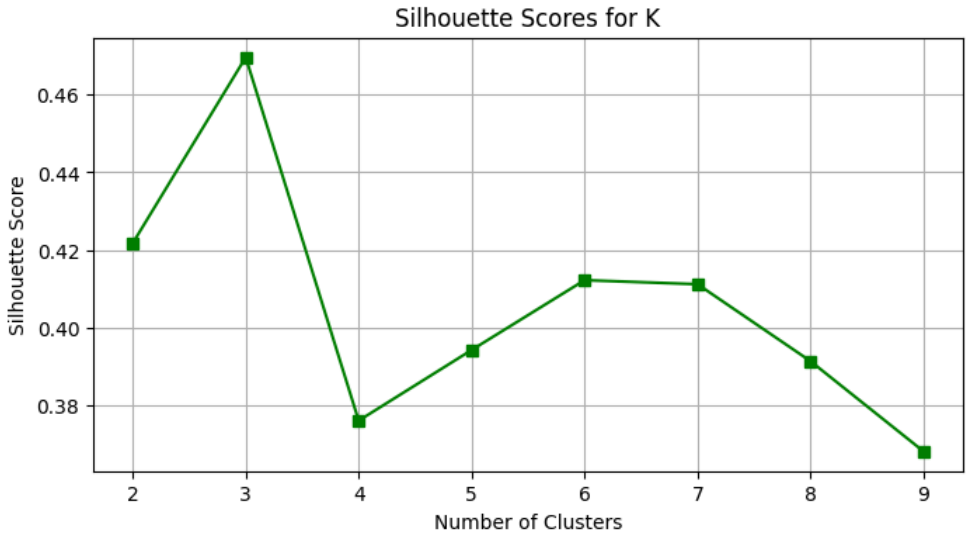
Steps:

1. **Optimal Cluster Determination:** The **Elbow Method** and **Silhouette Score** were used on the PCA-transformed data, indicating that **4 clusters** was the optimal number.



This graph visually shows the point of diminishing returns for adding more clusters, confirming the optimal 'k' value.

2. **K-Means Application:** K-Means was applied with n_clusters=4 to the scaled and PCA-transformed age_income_df, assigning a cluster label to each data point.

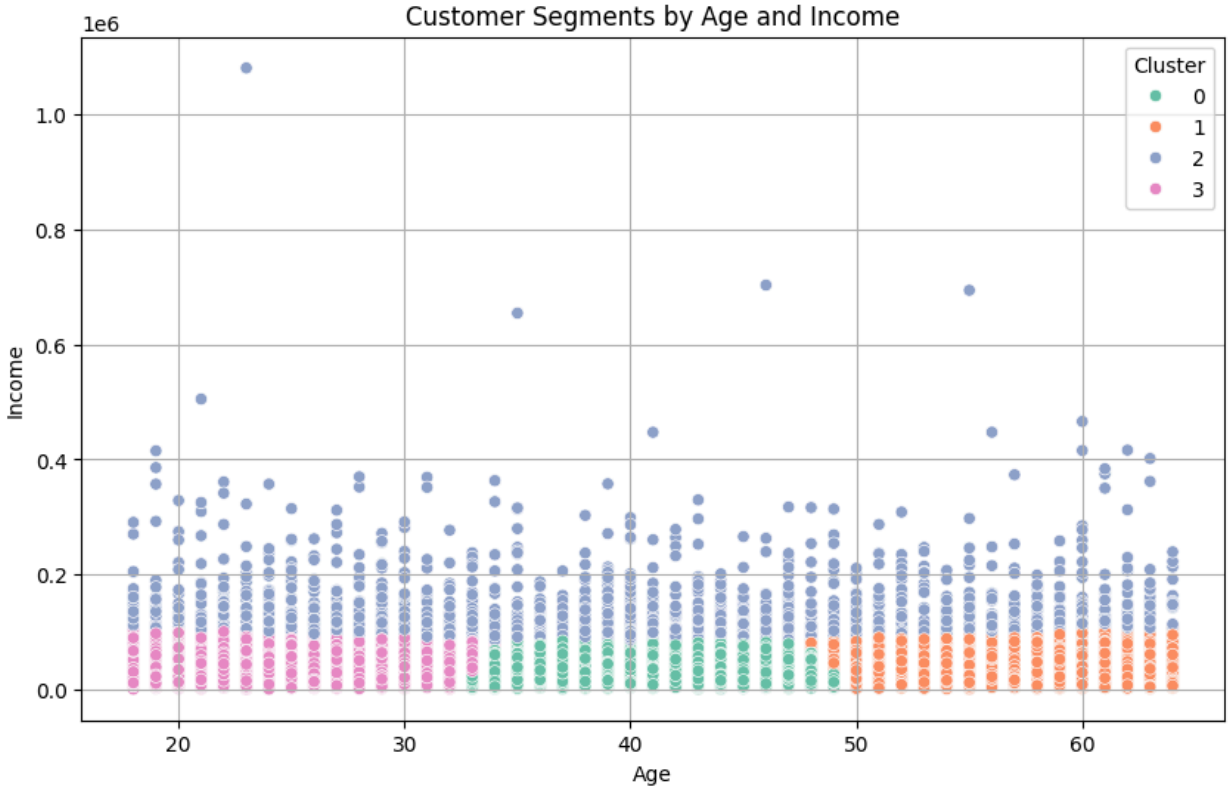


5. Profiling and Describing Potential Segments

Based on K-Means clustering, four distinct segments were identified:

Segment 0: Young, Lower-Income, Urban Commuters

- **Demographics:** Young (avg. ~29-30), lower to middle income, 1-2 dependents, often in Tier 2/3 cities.
- **Psychographics:** Highly budget-conscious, lower disposable income, moderate transport spending.
- **Behavioral:** High two-wheeler ownership.
- **EV Relevance:** Ideal for **Electric Two-Wheelers** and **Compact Electric Cars**.
- This bar chart would highlight that Segment 0 has the lowest average income, reinforcing their budget-conscious nature.



Segment 1: Middle-Aged, Middle-Income, Family-Oriented

- **Demographics:** Middle-aged (avg. ~40-45), stable middle income, 2-3 dependents, across all city tiers.
- **Psychographics:** Moderate disposable income and savings, balance various expenses.
- **Behavioral:** Own a mix of two-wheelers and entry-level cars.
- **EV Relevance:** Potential for **Affordable Electric Cars** and **Family-Friendly Electric Two-Wheelers**.

Segment 2: Older, High-Income, Established Professionals

- **Demographics:** Older (avg. ~50-55), higher income, fewer dependents, predominantly Tier 1 cities.
- **Psychographics:** High disposable income, significant savings, lower loan repayments.
- **Behavioral:** Own multiple vehicles, including premium cars.
- **EV Relevance:** Prime target for **Premium Electric Cars** and **Luxury Electric SUVs**.

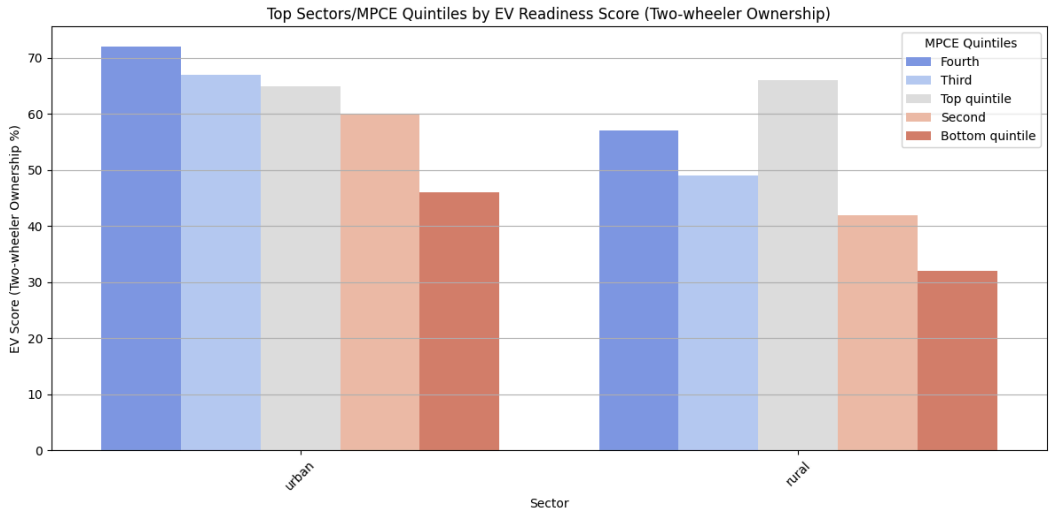
Segment 3: Young, High-Income, Urban Professionals

- **Demographics:** Young (avg. ~25-35), very high income, few dependents, primarily Tier 1 cities.
- **Psychographics:** Very high disposable income, significant savings potential, high spending on leisure.
- **Behavioral:** Own premium cars, interested in performance.
- **EV Relevance:** Ideal for **Performance Electric Cars** and **High-Tech Electric Vehicles**.

6. Selection of Target Segment

The **MOST OPTIMAL MARKET SEGMENTS** for initial entry and sustained growth are:

1. **Primary Target Segment: Segment 0 (Young, Lower-Income, Urban Commuters)**
    - **Reasoning:** Represents the **largest potential customer base** (646 individuals in the sample). Their high existing two-wheeler ownership and budget-consciousness make them highly receptive to affordable electric two-wheelers, offering the highest potential for mass market penetration.
    - This graph would visually demonstrate the high existing two-wheeler ownership in the lower MPCE quintiles and specific sectors relevant to Segment 0, underscoring their readiness for electric two-wheelers



2. **Secondary Target Segment: Segment 1 (Middle-Aged, Middle-Income, Family-Oriented)**
    - **Reasoning:** Substantial in size, this segment is a growing market for **affordable electric cars** and **family-friendly electric two-wheelers**. Their stable income and focus on family needs make them ideal for practical EV solutions that offer long-term savings.

7. Customizing the Marketing Mix

For Segment 0 (Young, Lower-Income, Urban Commuters)

- **Product:** Affordable Electric Two-Wheelers (50-80 km range, quick charging, low maintenance) and Compact Electric Cars (150-200 km range, easy maneuverability).
- **Price:** Competitive pricing, emphasizing Total Cost of Ownership (TCO), flexible financing, battery-as-a-service.
- **Place:** Strong presence in Tier 2/3 cities, widespread charging network, utilize existing two-wheeler dealerships.
- **Promotion:** Focus on cost savings, practicality, environmental benefits; digital marketing, community events, testimonials.

For Segment 1 (Middle-Aged, Middle-Income, Family-Oriented)

- **Product:** Affordable Electric Cars (4-5 seater, 200-300 km range, safety, family features) and Family-Friendly Electric Two-Wheelers.
- **Price:** Position as a sensible long-term investment, highlight savings, attractive financing, bundled packages.
- **Place:** Focus on Tier 1/2 cities, dedicated EV showrooms, residential charging partnerships.
- **Promotion:** Emphasize safety, reliability, comfort, environmental responsibility; family-oriented media, EV events.

8. Potential Customer Base and Early Market Sales (Profit)

For the **Primary Target Segment: Segment 0 (Young, Lower-Income, Urban Commuters)**:

- **Potential Customer Base (from analysis):** 646 individuals (sample). Extrapolating, if this sample represents 0.1% of the total potential base in a region, the total potential customer base is 646,000 individuals.
- **Target Price Range for Electric Two-Wheelers:** INR 80,000 - 1,20,000 (average INR 100,000).
- **Estimated Early Market Adoption Rate:** 5%.

Calculation of Potential Sales (Profit) in the Early Market (Electric Two-Wheelers):

- **Extrapolated Early Market Customers:** 32,300 customers.
- **Potential Revenue:** 32,300 customers x INR 100,000 = INR 323 Crores
- **Potential Profit (15% margin):**INR 323 Crores x 0.15 = INR 48.45 Crores

Note on Commercial Vehicles: A subset of Segment 0 (delivery workforce) also presents a strong potential for electric commercial two/three-wheelers.

9. The MOST OPTIMAL MARKET SEGMENTS

The **MOST OPTIMAL MARKET SEGMENTS** for initial entry and strategic focus are:

1. **Segment 0: Young, Lower-Income, Urban Commuters (Focus: Affordable Electric Two-Wheelers & Compact Electric Cars)**
    - **Why Optimal:** Offers the **largest volume potential** and a clear existing need for affordable, efficient personal transportation. High two-wheeler ownership indicates a natural transition path to electric variants, leading to rapid market share gain.

2. **Segment 1: Middle-Aged, Middle-Income, Family-Oriented (Focus: Affordable Electric Cars & Family-Friendly Electric Two-Wheelers)**
    - **Why Optimal:** Provides a **strong foundation for growth in the electric car market**. Their stable income and family orientation make them ideal for practical, reliable electric cars that offer long-term financial benefits.

Strategic Rationale:

Targeting Segments 0 and 1 allows for significant market penetration and sustainable growth by addressing core needs (high fuel costs, reliable commute) and enabling scalability in manufacturing and infrastructure. While high-income segments offer higher per-unit profit, the immediate focus should be on capturing these larger, underserved segments with practical and affordable EV solutions.