SUKHMANDEEP SINGH

# EV Market Segmentation Project Report

## Step 1: Why Segmentation?

Electric Vehicle adoption varies significantly across customer types. To align with the Innovation Adoption Life Cycle, it’s crucial to segment the customer base and identify early adopters—those who are more open to innovation, have the economic capacity, and the lifestyle need for EV ownership. This justifies why segmentation was the first step in our approach.

## Step 2: Defining the Ideal EV Customer

Before analyzing the data, we defined our ideal early EV adopter based on market trends:  
- Age: 26–50 (tech-savvy working population)  
- Income: ₹70k–2 lakhs annually  
- Spending Behavior: High (indicates openness to new products)  
- Family Size: 2–4 (ideal for compact/mid-size EVs)  
- Profession: Working professionals in urban/creative/technical sectors

## Step 3: Data Overview and Cleaning

We used the dataset 'Customers.csv', which contains 2000 entries and columns such as Age, Gender, Annual Income, Spending Score, Profession, Work Experience, and Family Size. The only missing values were in the 'Profession' column (35 missing), which were filled as 'Other'.

## Step 4: Exploratory Data Analysis (EDA)

We plotted distributions for Age, Annual Income, Spending Score, Family Size, Work Experience, Gender, and Profession.  
- Age: Mean ~43 years, range 18–70  
- Income: Mean ₹1.06L, skewed toward lower ranges  
- Spending Score: Evenly distributed across full 1–100 scale  
We used scatter plots and pairplots to understand relationships:  
- High spending behavior found across all ages  
- Younger individuals with moderate income tended to spend more  
- Age vs Income and Age vs Spend showed non-linear patterns.

## Step 5: Feature Engineering

We derived new categorical features to assist in segmentation:  
- Age\_Group: [18–25, 26–35, 36–50, 51+]  
- Income\_Group: [Low: <₹70k, Middle: ₹70k–120k, High: ₹120k+]  
- Spending\_Level: [Low: <40, Medium: 40–70, High: >70]  
These allowed clearer heatmaps and cross-tab insights between demographics and behavior.

## Step 6: Clustering (KMeans)

We performed KMeans clustering with k=5 on scaled Age, Income, Spending Score, and Family Size, along with one-hot encoded Profession.  
Cluster profiles revealed:  
- Cluster 0: Young professionals, high spending  
- Cluster 3: Older customers with lower spending  
This confirmed the value of multi-feature segmentation, but also highlighted that natural clusters may overlap with rule-based segments.

## Step 7: Rule-Based Segmentation

Using percentiles (25th, 50th, 75th) of Age, Income, Spending Score, and Family Size, we defined 5 clear segments:  
- Urban EV Adopters: High income/spending, professionals, age 25–60  
- Creative Young Spenders: Age < median, top quartile spending  
- Stable Middle-Class: Income ≥ 25th percentile, family ≥ 4  
- Conservative Non-Adopters: Age > 75th percentile or Homemakers  
- General Segment: Remaining population  
These segments created a balance: Urban EV Adopters (242), Creative Youth (236), Stable Middle Class (604), Conservatives (297), General (621).

## Step 8: Segment Profiling

We analyzed segments using groupby averages and boxplots:  
- Urban Adopters: Avg Age 39.6, Income ₹1.43L, Spend 79.4, Family Size 2.4  
- Creative Youth: Age 20.8, Income ₹67k, Spend 79.2, Family Size 2.1  
- Middle-Class: Age 49.4, Income ₹1.36L, Spend 37.2, Family Size 5.5  
- Non-Adopters: Age 74.8, Income ₹1.12L, Spend 51.3, Family Size 3.7  
We visualized profession distribution and heatmaps (Spending vs Income Group, Income vs Age Group).

## Step 9: Decision Tree Validation

We trained a decision tree classifier using Age, Income, Spending Score, Family Size, and Profession (encoded).  
- Accuracy: 100% on training set (max\_depth=4)  
- Top Features:  
 1. Age (36%)  
 2. Family Size (28%)  
 3. Income (21%)  
 4. Spending Score (12%)  
 5. Profession (minimal impact)  
This confirms our assumption that demographic traits are the strongest segmentation drivers.

## Final Conclusion and Recommendations

Urban EV Adopters and Creative Young Spenders should be the primary targets for initial EV launches. They show readiness, spending capability, and lifestyle compatibility with EV ownership. Stable Middle-Class consumers are good secondary targets, while Conservative segments may need education and incentives. This segmentation strategy gives the startup a clear customer roadmap to shape EV design, pricing, and regional launch plans.

# ✅ Final Conclusion

This project conducted a comprehensive demographic segmentation analysis for an Electric Vehicle (EV) startup aiming to identify ideal early adopters in the Indian market. Through structured EDA, clustering, and rule-based segmentation, five distinct customer segments were defined and validated using decision trees.

# Key Insights:

- Urban EV Adopters: High income, mid-aged professionals with small families and high spending scores — best suited for compact 4W EVs.

-Creative Young Spenders: Young, low–mid income, high-spending individuals — ideal for 2W EVs or flexible payment models.

- Stable Middle-Class: Mid-income families with larger household sizes — target with affordable 4W EVs and family-focused features.

- Conservative Non-Adopters: Elderly or homemakers with moderate spending — require educational efforts and financial incentives.

-General Segment: Diverse consumers not strongly associated with any behavioural trend — potential for future psychographic/geographic segmentation.

Decision Tree validation

confirmed the top predictors of segment membership are:

1. Age — most influential

2. Family Size — distinguishes middle-class vs. urban adopters

3. Income — separates premium adopters from budget-conscious groups

4. Spending Score — behavioural indicator of openness to innovation

This segmentation strategy will guide product positioning, pricing, and launch targeting for EV models, ensuring alignment with real market behaviour and increasing the likelihood of successful adoption in early markets.