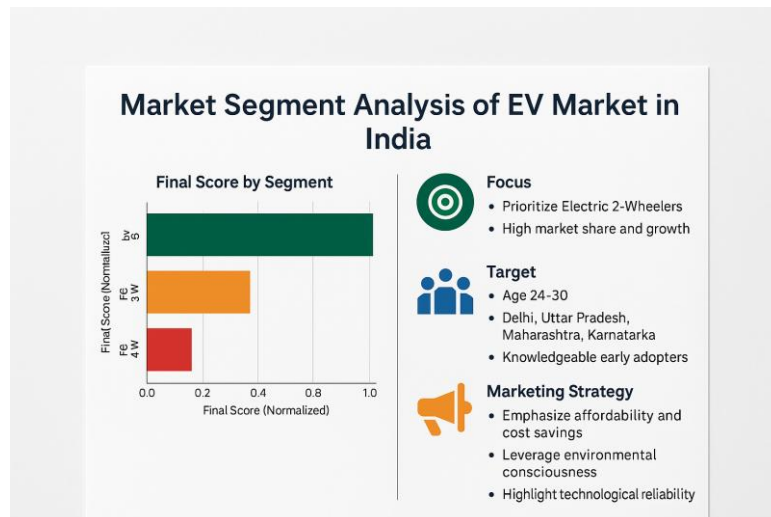


Market Segment Analysis of EV Market in India

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GitHub Link: https://github.com/nushithaitha/EV_Market_Segmentation_Analysis_India.git



Problem Statement:

A new electric vehicle (EV) company wants to enter the Indian market but needs data-driven guidance on which type of EV to manufacture and target 2-Wheeler, 3-Wheeler, 4-Wheeler, or Electric Bus.

To solve this, the company must analyse:

1. Historical EV sales trends in India from 2017 to 2025.
2. Customer segmentation based on demographics, behaviour, eco-consciousness, cost sensitivity, and openness to technology.
3. Market share and growth patterns of each EV type.
4. Targetable customer personas and their preferences.

The goal is to identify the most promising EV segment one with the highest growth, strongest customer demand, and best product-market fit so the company can confidently move forward with manufacturing and go-to-market planning.

Conclusion:

After analysing EV sales trends, customer preferences, and market segmentation data from the three notebooks, the following conclusions were drawn:

1. Electric 2-Wheelers (2W) Are the Clear Market Leaders

- From 2017 to 2025, 2-wheelers consistently account for over 60–70% of total EV sales.
- They also show the highest year-over-year (YoY) growth, especially after 2020.
- This growth is fuelled by:
 - Low cost and easy ownership.
 - Urban adoption among professionals and students.
 - Ease of charging (home/outlet-based).

2. Customer Segmentation Identifies Three Core Segments

Using PCA and K-Means clustering:

- Segment A: Young, urban professionals
 - Tech-savvy, eco-conscious, financially capable.
 - Strong preference for smart 2W or compact 4W EVs.
- Segment B: Budget-focused consumers
 - Motivated by cost savings and government policies.
 - Prefer 2W or 3W EVs (affordable, practical).
 -
- Segment C: Rural or hesitant adopters
 - Limited infrastructure access.
 - Less responsive to tech features.
 - Adoption depends on government or commercial incentives (e.g., buses, fleets).

3. 3W, 4W, and BUS Segments Show Slower or Policy-Dependent Growth

- 3W: Moderate and stable growth, mostly in B2B use (last-mile delivery, auto services).
- 4W: Emerging slowly due to cost and lack of widespread charging infra.
- BUS: Very niche and entirely policy-driven, not viable for private manufacturers without government contracts.

Customer and Vehicle Segmentation Process:

Notebook 1: EV Vehicle Sales Analysis (2017–2025)

This notebook focuses on analysing historical sales data of electric vehicles (EVs) in India to identify which type of EV has gained the most traction over time.

Objective:

To analyse EV sales trends for:

- 2-Wheelers (2W)
- 3-Wheelers (3W)
- 4-Wheelers (4W)
- Electric Buses (BUS)

From the year 2017 to 2025, and determine which category has the highest market growth and share.

Step-by-Step Process

1. Importing Libraries

- Core libraries used:
pandas (data handling), matplotlib and seaborn (visualizations)

2. Loading the Dataset

- CSV file: EV_Sales_Cleaned_Upto_2025.csv
- Contains columns:
 - YEAR, 2 W, 3 W, 4 W, BUS, TOTAL

3. Data Preprocessing

- Converted YEAR column to datetime for easier analysis.
- Extracted the year only from datetime.
- Grouped sales data by year and summed up vehicle counts.

4. Visualizing Total EV Sales by Vehicle Type (Bar Chart)

- Used stacked bar chart to show number of units sold annually for each category.

Insight: 2W dominate the market and grow consistently from 2019 onward.

5. Year-over-Year Growth (%) Calculation

- Computed percentage growth year-over-year for each vehicle category.
- Plotted as line graphs with markers to show growth patterns.

Insight:

- 2W and 4W show consistent growth.
- Buses are unstable.

- 3W is steady but slower.

6. Market Share Analysis (Implied in Visualization)

- Although not directly calculated, market share was interpreted through visual proportions and trends.

Key Takeaways from Notebook (Vehicle Segmentation)

| Metric | Best Performing | Note |
|-------------|-----------------|--------------------------------|
| Total Sales | 2-Wheelers | Highest units sold each year |
| YoY Growth | 2-Wheelers | Fastest growth rate |
| Stability | 2W & 3W | 4W improving; BUS inconsistent |

Notebook (Vehicle Segmentation) sets the foundation by confirming that Electric 2-Wheelers are the strongest segment in both volume and growth, justifying further focus on that category in segmentation and strategy.

Notebook 2: Customer Segmentation (PCA + Clustering)

This notebook performs customer segmentation using unsupervised machine learning techniques to identify target user groups for electric vehicle (EV) marketing and product development.

Objective

To segment Indian consumers based on their:

- Demographics (Age, Gender, Income)
- EV-related perceptions (Tech openness, Eco-beliefs, Infrastructure, Cost concerns, Government Policy, Experience)

So, the company can:

- Tailor its EV product strategy for the most receptive groups.
- Focus marketing on the most high-potential customer personas.

Step-by-Step Process

1. Libraries & Data Preparation

- Libraries: pandas, seaborn, matplotlib, sklearn
- Dataset loaded: Contains customer data

2. Visualization and comparison of the data

3. Feature Selection & Preprocessing

- Chose only relevant numeric features for clustering.
- Normalized the data using StandardScaler to bring all features to the same scale.

4. Principal Component Analysis (PCA)

- Applied PCA to reduce high-dimensional feature space into 2 or 3 principal components.
- Helps visualize clusters and reduce noise in data.

Insight: PCA revealed natural separation of customers into visually distinct groups.

4. K-Means Clustering

- Used the Elbow Method to find optimal number of clusters (typically 3 or 4).
- Applied KMeans clustering and assigned cluster labels to customers.

Insight: Each cluster showed distinct behaviour and attitudes toward EVs.

Key Takeaways from Notebook 2(Customer Segmentation)

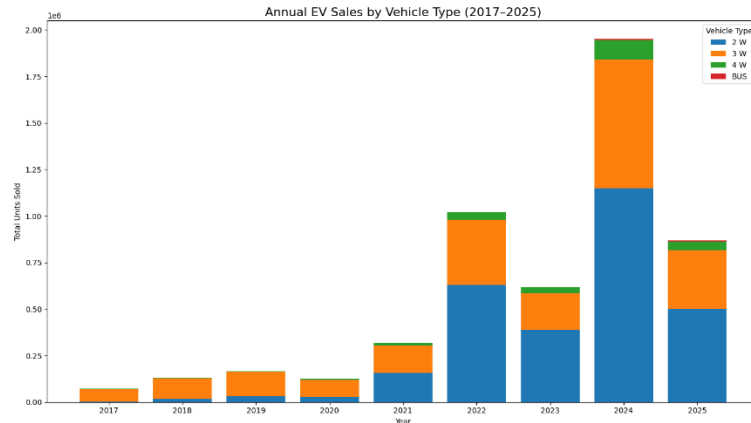
- There is strong product-market fit for EVs in urban millennial and working-class users.
- 2W and affordable 3W are ideal for cost-conscious adopters.
- EV adoption in rural segments is low due to infrastructure and awareness barriers.

This segmentation helps define the right personas for targeting EV products and marketing, enabling focused strategies like:

- Smart scooters for urban professionals
- Subsidy-promoted scooters for middle-class commuters
- Later-stage education/infrastructure for rural areas

Visualized Images:

1. Annual EV Sales by Vehicle Type (2017–2025)



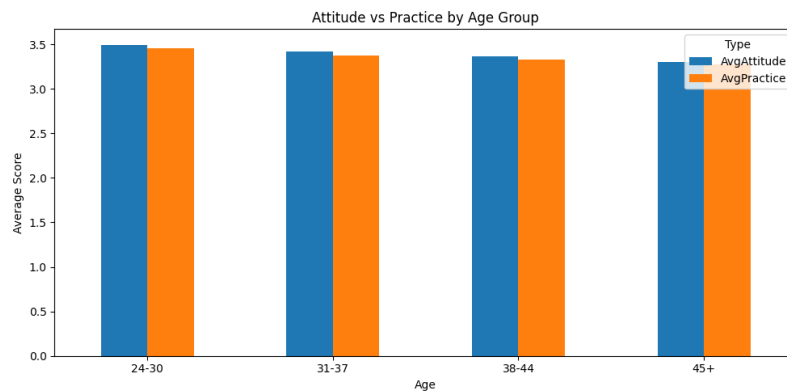
- A stacked bar chart displaying sales trends of 2W, 3W, 4W, and BUS from 2017 to 2025.

Insights:

- 2W (blue) sharply increase after 2021—clearly dominate the EV market.
- 3W (orange) show steady growth, peaking in 2024.
- 4W (green) and BUS (red) have minimal contributions.

Conclusion: Focus on 2W for manufacturing; it's the fastest-growing and most purchased segment.

2. Attitude vs Practice by Age Group



What it shows:

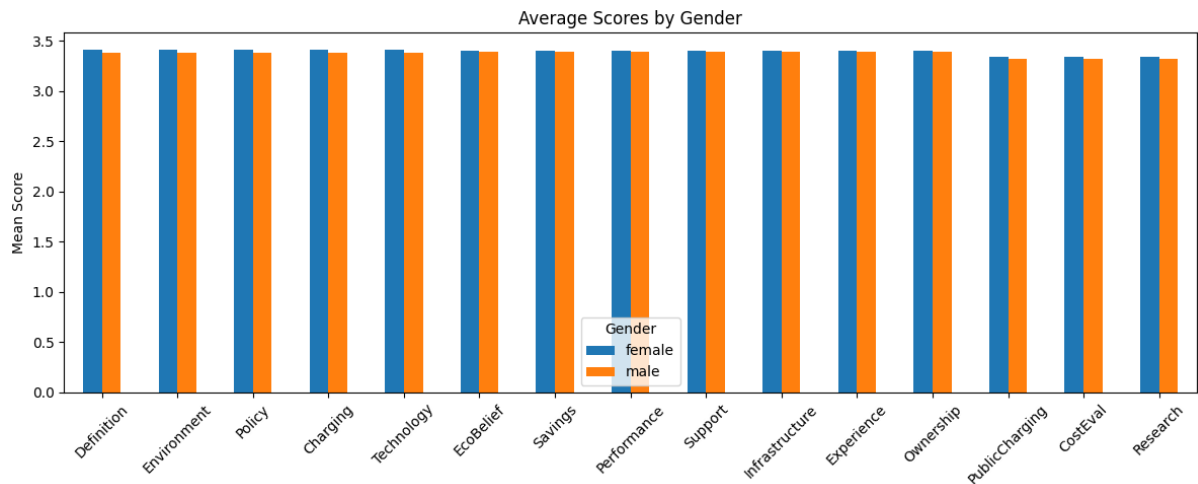
- Compares average attitude score (awareness/interest) vs. actual EV practices (ownership/use) by age groups.

Insights:

- 24–30 age group has the highest attitude and practice alignment.
- Attitude and practice decline with age.

Conclusion: Young consumers not only show interest but are acting on it—ideal target group.

3. Average Scores by Gender



What it shows:

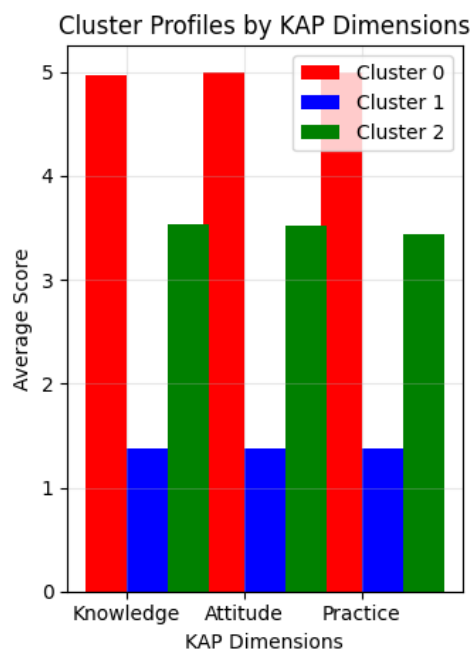
- Average score comparison of EV-related metrics (Environment, Technology, Cost, etc.) for male vs. female.

Insights:

- Both genders score similarly across metrics (~3.3–3.5 average), with females slightly ahead.
- Indicates broad gender-neutral interest in EV adoption.

Conclusion: Marketing need not be gender-segmented; both are equally receptive.

4. Cluster Profiles by KAP Dimensions (Knowledge–Attitude–Practice)



What it shows:

- Average scores of each customer cluster based on:

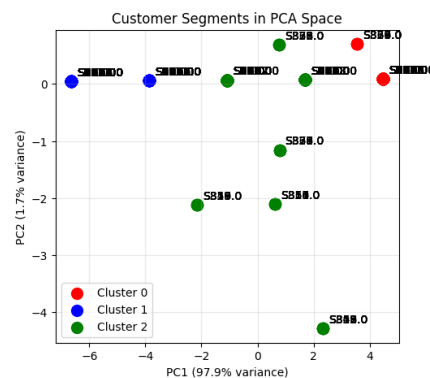
- Knowledge (about EVs)
- Attitude (toward EVs)
- Practice (actual adoption)

Insights:

- Cluster 0 (red): High knowledge, attitude, and practice → ideal EV adopters.
- Cluster 1 (blue): Low across all metrics → not worth targeting yet.
- Cluster 2 (green): Moderate scores → opportunity with awareness and education.

Conclusion: Focus on Cluster 0 for product launch; nurture Cluster 2 with incentives.

5. Customer Segments in PCA Space



What it shows:

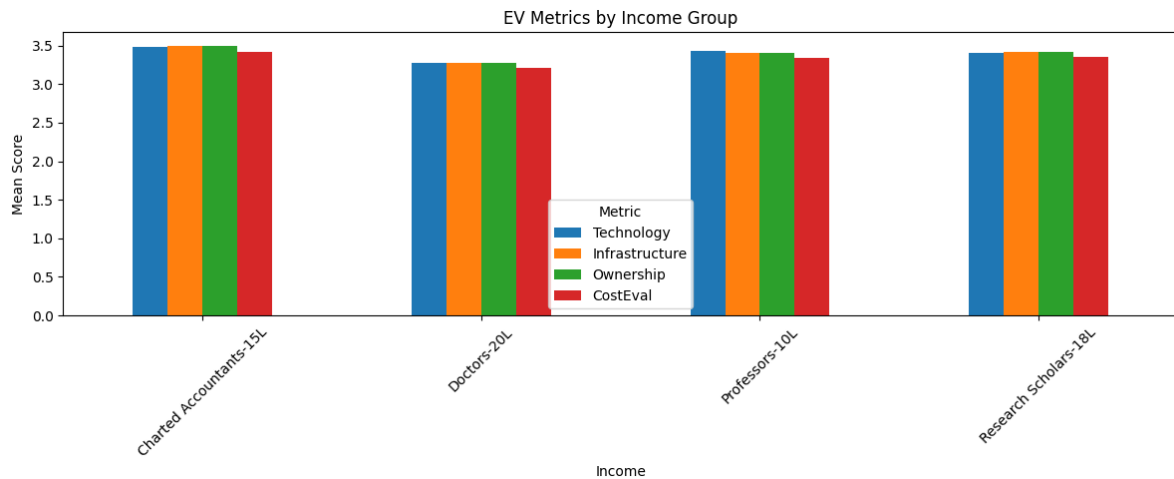
- A PCA 2D scatter plot showing how customer responses cluster into 3 distinct groups.

Insights:

- Customers are clearly separable into 3 behavioral clusters.
- Red = ideal adopters, Blue = low interest, Green = mid-potential.

Conclusion: Validates segmentation—different customer types demand different messaging.

6. EV Metrics by Income Group



What it shows:

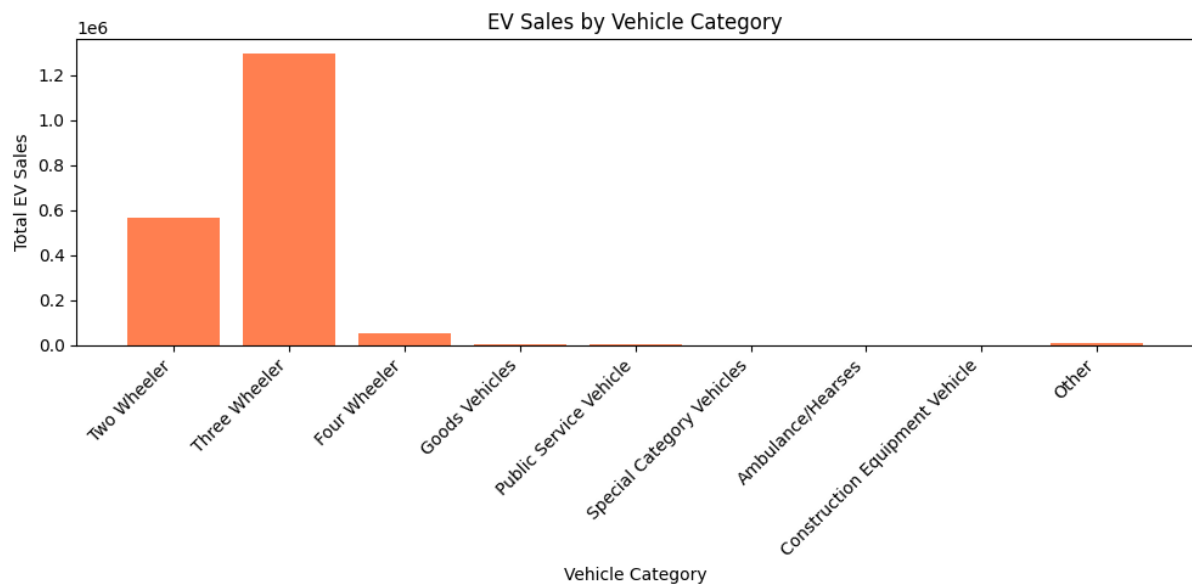
- Comparison of Technology, Infrastructure, Ownership, and Cost Evaluation scores across 4 income groups.

Insights:

- Chartered Accountants & Professors (10–15L income) show high tech/infrastructure expectations.
- Doctors slightly lower on adoption practice despite higher income.

Conclusion: Mid-to-high income urban professionals are ideal launch users.

7. EV Sales by Vehicle Category



What it shows:

- Total EV sales by type (Two-Wheeler, Three-Wheeler, Four-Wheeler, etc.).

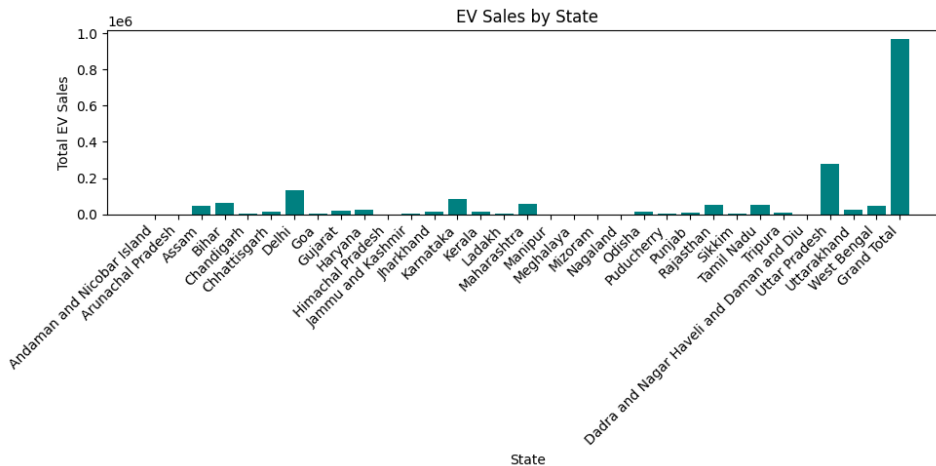
Insights:

- Three-Wheelers slightly lead, followed closely by Two-Wheelers.

- 4W, buses, and others have minimal impact.

Conclusion: 2W and 3W are clearly the most dominant and commercially viable.

8. EV Sales by State (India)



What it shows:

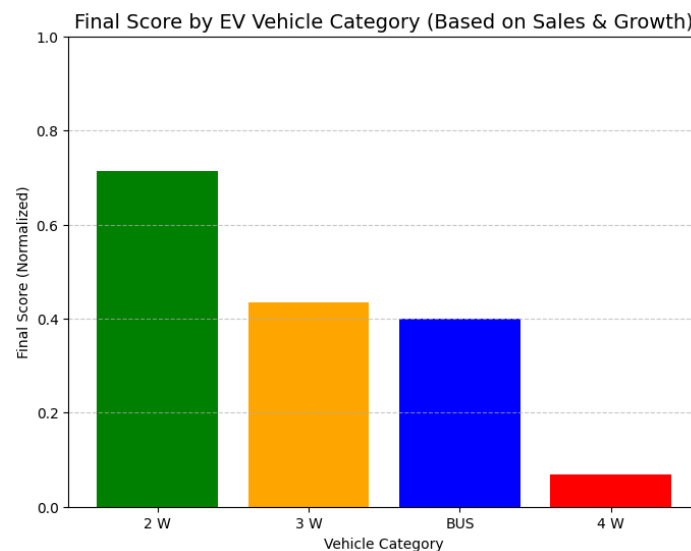
- State-wise EV sales distribution.

Insights:

- Uttar Pradesh, Delhi, Karnataka, Maharashtra show high adoption.
- Tier-1 & Tier-2 states lead in EV penetration.

Conclusion: Best launch regions = Delhi, UP, Karnataka, Maharashtra, Tamil Nadu.

9. Final Score by EV Vehicle Category



What it shows:

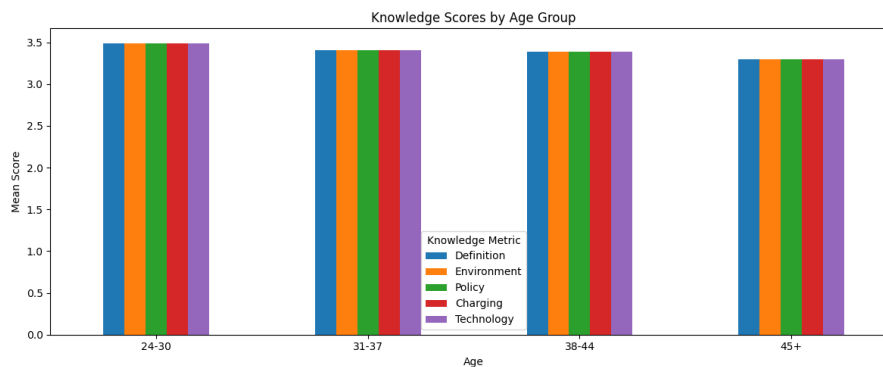
- Normalized score of each EV type based on combined metrics (sales, growth, adoption, etc.).

Insights:

- 2W = highest score (~0.72)
- 3W and BUS ~0.4
- 4W = very low (~0.1)

Conclusion: 2-Wheelers are the best product-market fit for initial investment and launch.

10. Knowledge Scores by Age Group



What it shows:

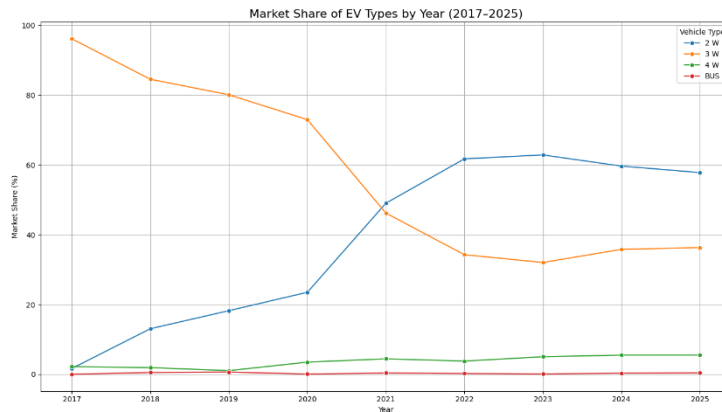
- A grouped bar chart showing the mean knowledge score on five EV-related topics (Definition, Environment, Policy, Charging, Technology) for four age groups.

Insights:

- 24–30 age group shows the highest scores across all dimensions.
- There's a gradual decline in knowledge with increasing age.
- Younger individuals are more informed and better understand EVs' definitions, environmental impact, policy support, and technology.

Conclusion: Educational campaigns and new product marketing should target younger age groups, as they're more receptive and knowledgeable.

11. Market Share of EV Types by Year (2017–2025)



What it shows:

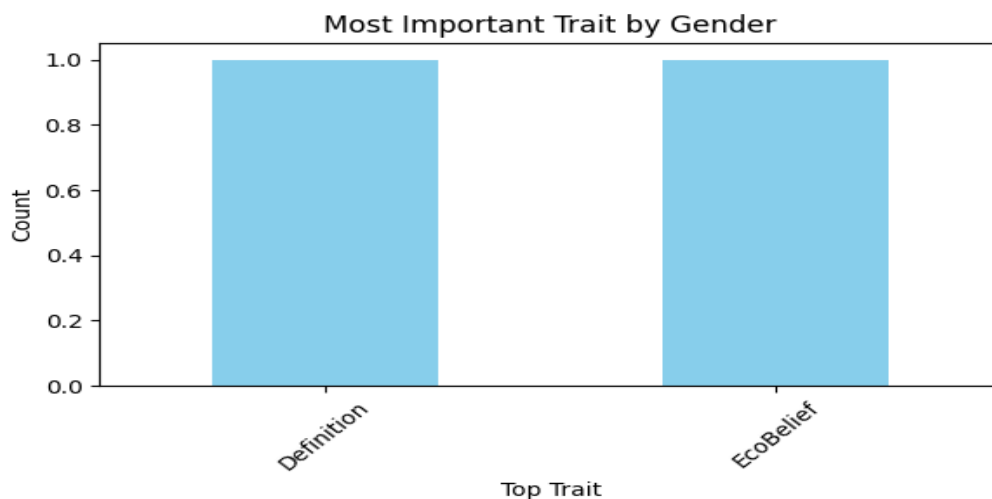
- A line chart tracking the percentage market share of
- each EV category (2W, 3W, 4W, BUS) from 2017 to 2025.

Insights:

- 3W (orange) initially dominated the market but rapidly declined post-2020.
- 2W (blue) saw a massive surge in market share from 2020 onward, surpassing 60% by 2023.
- 4W and BUS maintained very minimal and flat shares.

Conclusion: The 2-wheeler segment is currently the most dominant and sustainable market opportunity.

12. Most Important Trait by Gender



What it shows:

- A simple bar chart displaying which trait (feature) each gender considers most important in an EV.

Insights:

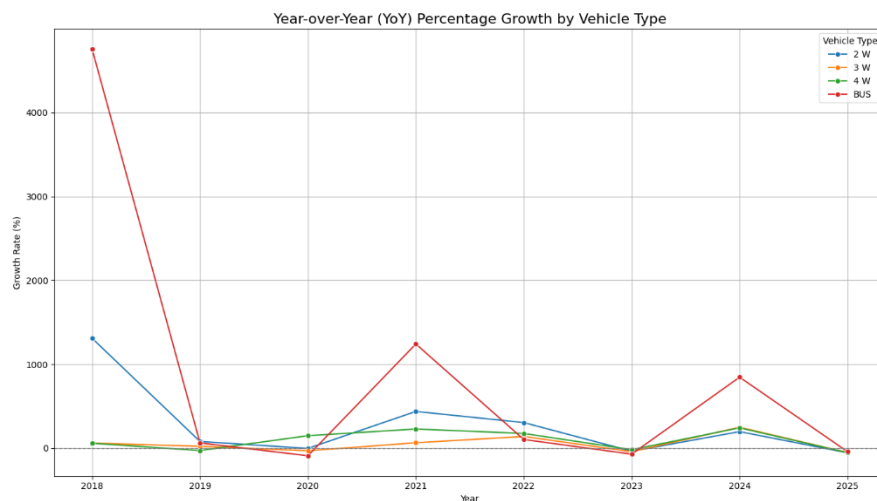
- One gender values “Definition” (clarity about what EVs are).

- The other prioritizes “EcoBelief” (environmental impact awareness).
- Suggests gender-specific value emphasis in perception of EVs.

Conclusion:

- Marketing campaigns should be customized:
 - Males/females (depending on mapping) may prefer clarity and technical information.
 - Others may respond better to eco-conscious branding.

13. Year-over-Year (YoY) Percentage Growth by Vehicle Type



What it shows:

- A line chart showing the year-on-year percentage growth of each EV category.

Insights:

- BUS (red) shows sporadic, extremely high growth due to a low base.
- 2W (blue) exhibits consistent, high growth, especially post-2020.
- 3W and 4W show fluctuating or even negative growth years.

Conclusion:

- 2W is not just high in volume but also stable in growth.
- Buses may show spikes but are unreliable and heavily policy-driven.
- 2W provides sustained growth potential, indicating strong demand maturity.

Solution to the Startup Company:

1. Focus on Two-Wheelers (2W)

- Why?
 - Highest market share since 2021 (crossing 60% in 2023).

- Strongest year-over-year growth trend.
- Preferred in both urban and semi-urban areas.
- Affordable, easier infrastructure demands (charging etc.).
- Action:
 - Prioritize R&D and production for e-scooters and e-bikes.
 - Design models catering to cost-conscious and eco-conscious consumers.

2. Target Age Group: 24–30

- Why?
 - Highest knowledge, attitude, and practice scores related to EV adoption.
 - This group is more receptive to sustainability, technology, and policy benefits.
 - More likely to advocate and influence others (early adopters).
- Action:
 - Digital-first marketing strategy using social media & influencers.
 - Offer student/youth finance schemes, subscription models, and connected vehicle apps.

3. Primary Market Regions

- Top States by EV Sales:
 - Delhi, Uttar Pradesh, Maharashtra, Karnataka
- These states have:
 - High EV penetration,
 - Better charging infrastructure,
 - Favourable state policies.
- Action:
 - Set up initial retail/service networks here.
 - Launch state-specific incentives (e.g., scrappage bonus, exchange offers).
 - Work with local governments on pilot programs.

4. Segment Customers Using KAP Clusters

- Cluster 0 (High Knowledge, Attitude, Practice) is the most EV-ready.
- Cluster 2 is receptive but needs nudges (e.g., cost/infra clarity).
- Action:

- Develop persona-driven campaigns:
 - Cluster 0 → Push performance/features
 - Cluster 2 → Focus on cost-benefits & eco-belief

5. Product & Message Customization

- By Gender:
 - Males may prioritize definition/technical clarity.
 - Females may resonate more with eco-belief and sustainability.
- By Income Group:
 - Charter Accountants & Professors score high across Technology & Ownership metrics.
 - Focus on smart, app-connected, reliable 2Ws.