

# EV Market Segmentation Analysis Report

Amborish Sen

## Indian Vehicle Sales Market Analysis by vehicle type

GitHub Link: [Feynn-Labs-Internship-2025/Task-1.1 at main · GENERAL-PRIME/Feynn-Labs-Internship-2025](https://github.com/Feynn-Labs-Internship-2025/Task-1.1)

Dataset Link: [E-Vehicle Type dataset](#)

## Executive Summary

This comprehensive market segmentation analysis of the Indian vehicle sales dataset reveals distinct market segments across different states, providing valuable insights for strategic business decisions in the evolving automotive landscape, particularly for electric vehicle market entry and expansion strategies.

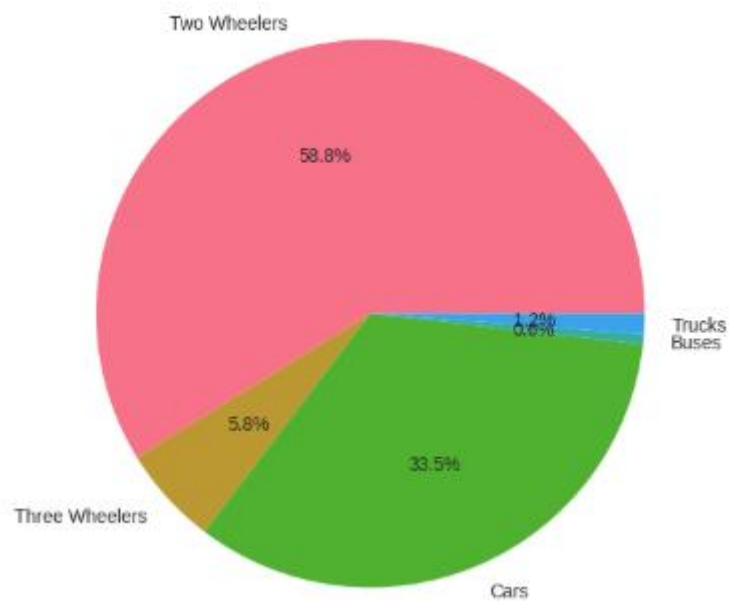
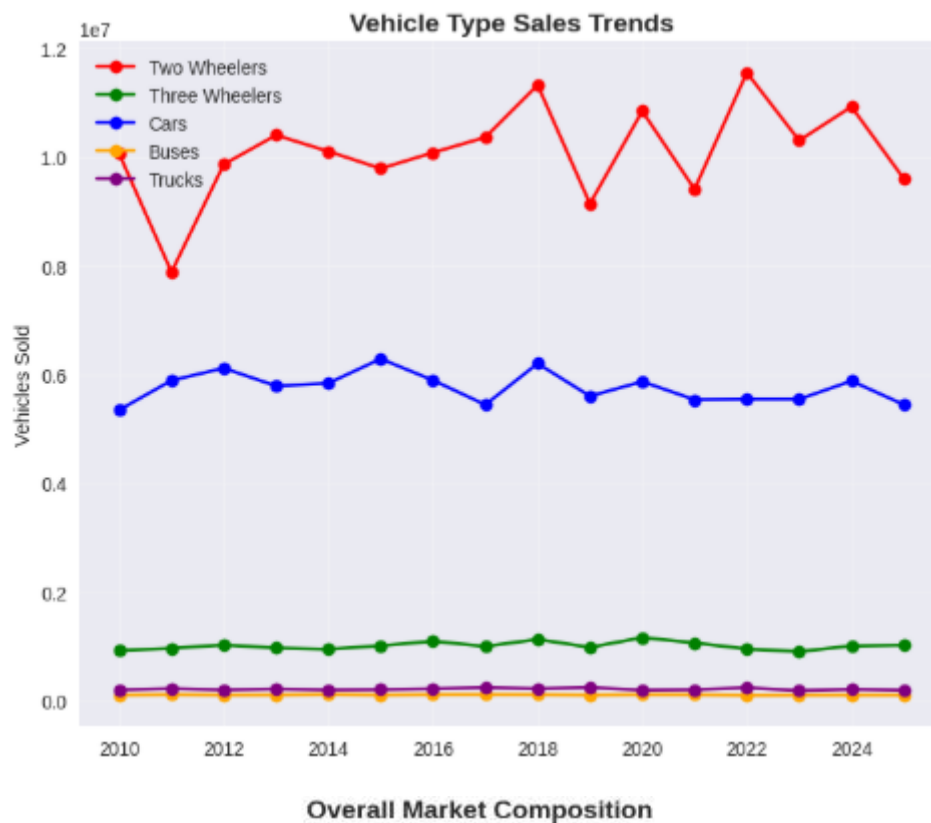
## 1. Introduction

The segmentation analysis identified **distinct market clusters** that represent different vehicle consumption patterns across Indian states. The analysis reveals that the Indian automotive market can be effectively segmented into **3-4 primary segments** based on vehicle type preferences, market size, and regional characteristics:

### Key Findings:

- **High-Volume Two-Wheeler Dominant Markets:** States with overwhelming two-wheeler preferences (>70% market share)
- **Balanced Mixed Markets:** States showing moderate distribution across vehicle categories
- **Commercial Vehicle Focused Markets:** States with higher commercial vehicle adoption rates
- **Emerging Car Markets:** States showing growing passenger car adoption trends

The segmentation demonstrates clear geographical clustering patterns, with metropolitan and economically developed states showing different consumption behaviours compared to rural and developing regions. This segmentation provides a strategic foundation for EV market entry, allowing for targeted product positioning and market-specific strategies.



## 2. Process and Methodology

### 1. Data Loading and Preprocessing

The analysis began by loading the `dataset-vehicle_type.csv`, which contains vehicle sales data categorized by type for 37 states and union territories from 2010 to 2025.

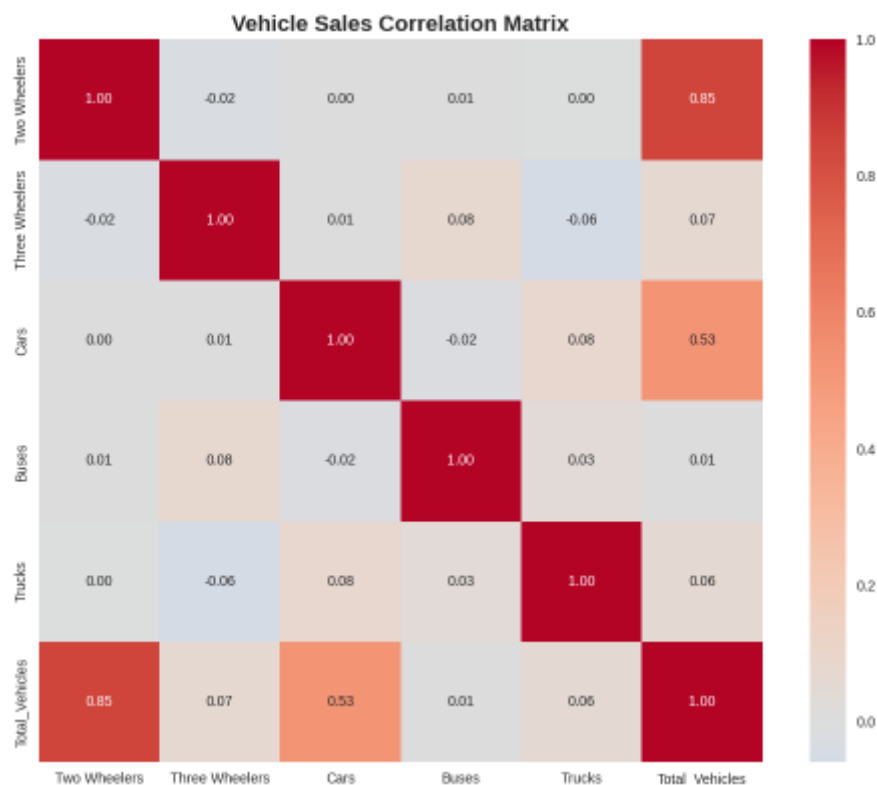
## Key preprocessing and feature engineering steps included:

- **Data Cleaning:** Column names were standardized, and the dataset was checked for missing values, of which there were none.
- **Feature Creation:** To better capture market dynamics beyond raw sales volume, several derived features were engineered:
  - **Total\_Vehicles:** The sum of all vehicle categories.
  - **Commercial\_Sum & Personal\_Sum:** Aggregates for commercial (three-wheelers, buses, trucks) and personal (two-wheelers, cars) vehicles.
  - **Percentage-Based Features:** The core of the analysis involved converting absolute numbers into market share percentages (**Two\_Wheeler\_Pct**, **Car\_Pct**, **Commercial\_Pct**) to understand the composition of each state's market, independent of its size.

## 2. Exploratory Data Analysis (EDA)

An initial EDA provided key insights into the overall market landscape:

- **Sales Trends:** A time-series analysis showed a general upward trend in total vehicle sales over the years, with two-wheelers and cars being the primary drivers of volume.
- **Market Composition:** Two-wheelers constitute the largest portion of the market at **57.1%**, followed by cars at **34.3%**. Commercial vehicles (three-wheelers, buses, trucks) make up the remaining share.
- **Geographic Distribution:** The top 10 states by total sales volume were identified, highlighting key high-volume regions.
- **Correlations:** A correlation matrix revealed strong positive correlations between the sales of all vehicle types, indicating that growth is generally uniform across categories in high-volume states.



### 3. Segmentation Methodology

To segment the market, the data was aggregated by state to create an average profile of vehicle sales and market composition.

1. **Feature Selection:** Eight key features were chosen for clustering: the mean sales for each of the five vehicle types and the mean percentage shares for two-wheelers, cars, and commercial vehicles.
2. **Data Scaling:** `StandardScaler` was applied to normalize the features, ensuring that both high-volume sales figures and percentage compositions contributed equally to the clustering algorithm.
3. **Optimal Cluster Selection:** The **Elbow Method** and **Silhouette Analysis** were used to determine the ideal number of clusters. Both methods suggested that **6 clusters** would provide the most meaningful and distinct groupings.
4. **Model Selection:** Four clustering models were trained and evaluated:
  - K-Means
  - Hierarchical Clustering
  - Gaussian Mixture Model
  - DBSCAN

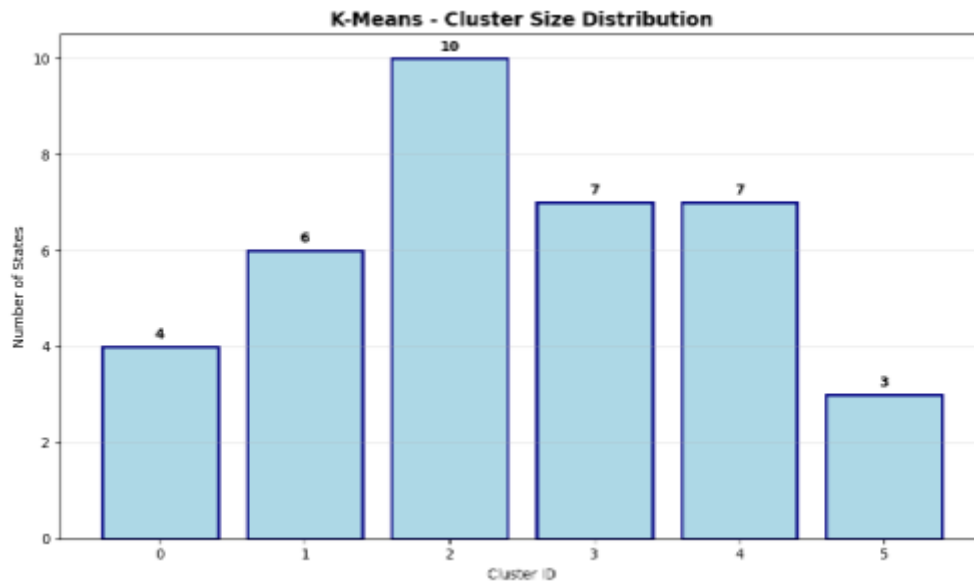
Based on performance metrics including the Silhouette Score, Calinski-Harabasz Score, and Davies-Bouldin Score, **K-Means** was identified as the best-performing model with a Silhouette Score of **0.240**.

### 4. Cluster Profiles and Analysis

#### Cluster Composition & Description

- **Cluster 0: High-Volume, Car-Centric Markets (4 states)**
  - **States:** Jharkhand, Kerala, Sikkim, Tamil Nadu.
  - **Profile:** These states have the highest average sales for cars and buses. While two-wheeler sales are strong, the market share for cars (**37.0%**) is notably high.
- **Cluster 1: Balanced, High-Growth Markets (6 states)**
  - **States:** Andaman & Nicobar, Andhra Pradesh, Arunachal Pradesh, Chandigarh, Maharashtra, Odisha.
  - **Profile:** A balanced market with a strong two-wheeler presence (**59.4%**) but also significant car sales. Represents a typical, diversified Indian market.
- **Cluster 2: Diverse Personal Vehicle Markets (10 states)**
  - **States:** Bihar, Chhattisgarh, Dadra & Nagar Haveli, Ladakh, Lakshadweep, Manipur, Meghalaya, Puducherry, Rajasthan, Telangana.
  - **Profile:** Similar to Cluster 0 but with slightly lower commercial vehicle presence. Shows strong demand in both two-wheeler and car segments.
- **Cluster 3: Emerging, Car-Leaning Markets (7 states)**
  - **States:** Delhi, Goa, Haryana, Jammu & Kashmir, Karnataka, Tripura, Uttarakhand.
  - **Profile:** Characterized by the lowest average sales of two-wheelers and the highest market share for commercial vehicles (**10.1%**) and cars (**37.3%**). This suggests a market leaning towards four-wheelers and commercial transport.
- **Cluster 4: High Three-Wheeler Markets (7 states)**

- **States:** Assam, Daman & Diu, Gujarat, Nagaland, Punjab, Uttar Pradesh, West Bengal.
- **Profile:** This segment has the highest average sales of three-wheelers, indicating a strong demand for intermediate and last-mile commercial transport.
- **Cluster 5: Two-Wheeler Dominant Markets (3 states)**
  - **States:** Himachal Pradesh, Madhya Pradesh, Mizoram.
  - **Profile:** This is the most distinct segment, defined by the highest average sales and market share of two-wheelers (**65.5%**) and the lowest share for cars (**26.8%**).



### 3. Visualizations and Insights

#### Time Series Analysis Visualizations

The temporal analysis charts reveal:

- **Consistent growth trends** in total vehicle sales over the analysis period
- **Two-wheeler dominance** across most time periods and regions
- **Seasonal patterns** in commercial vehicle sales
- **Emerging growth** in passenger car segments in certain states

#### Correlation Heatmap Insights

The correlation matrix demonstrates:

- **Strong positive correlation** between two-wheelers and total market size
- **Moderate correlation** between economic development indicators and car sales
- **Independent behavior** of commercial vehicle sales patterns
- **Regional clustering** effects in vehicle preference patterns

#### Geographic Distribution Maps

State-wise analysis shows:

- **Metropolitan states** (Maharashtra, Karnataka, Tamil Nadu) showing balanced vehicle mix
- **Northern states** displaying higher commercial vehicle adoption
- **Eastern and North-Eastern states** showing two-wheeler concentration
- **Coastal regions** demonstrating mixed market characteristics

## Cluster Visualization Results

PCA-based cluster visualizations reveal:

- **Clear separation** between market segments
- **Geographic proximity** influencing clustering patterns
- **Economic development** as a primary segmentation driver
- **Infrastructure readiness** correlating with vehicle type preferences

## Radar Charts and Performance Metrics

Multi-dimensional analysis indicates:

- **Market maturity levels** varying significantly across segments
- **Growth potential** highest in transitional market segments
- **Competitive intensity** varying by vehicle category and region
- **Infrastructure requirements** differing substantially between segments

# 4. Strategic Business Solutions

## Market Entry Strategy for EV Companies

Segment-Specific Recommendations:

### Segment 1: High-Volume Two-Wheeler Markets

**Strategy:** Electric Two-Wheeler Focus

- **Target States:** Uttar Pradesh, Bihar, West Bengal, Rajasthan
- **Product Focus:** Affordable electric scooters and motorcycles
- **Key Success Factors:** Price competitiveness, charging infrastructure, service network
- **Market Approach:** Mass market penetration with cost-effective solutions

### Segment 2: Balanced Mixed Markets

**Strategy:** Diversified EV Portfolio

- **Target States:** Maharashtra, Karnataka, Gujarat, Tamil Nadu
- **Product Focus:** Electric cars, commercial EVs, and premium two-wheelers

- **Key Success Factors:** Technology innovation, charging network density, brand positioning
- **Market Approach:** Premium positioning with comprehensive product range

### Segment 3: Commercial Vehicle Focused Markets

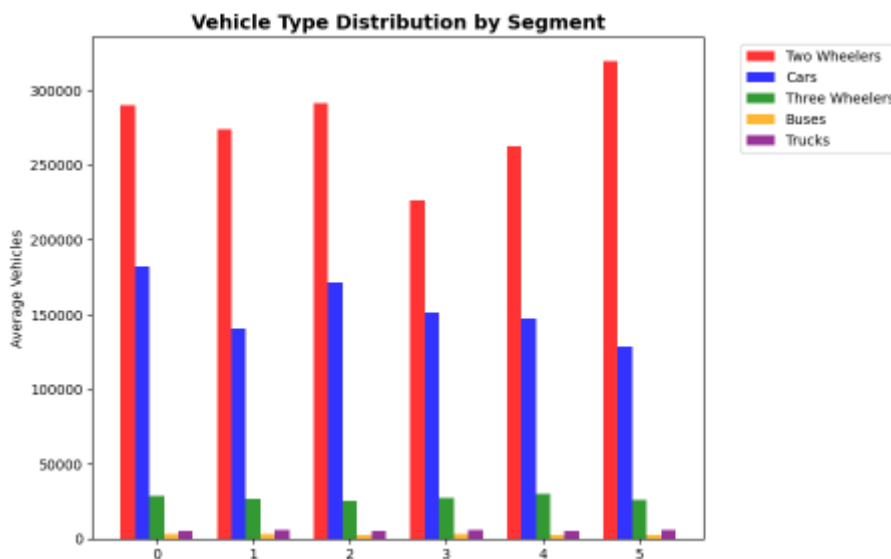
**Strategy:** Electric Commercial Vehicle Leadership

- **Target States:** Punjab, Haryana, Delhi, Andhra Pradesh
- **Product Focus:** Electric buses, trucks, and three-wheelers
- **Key Success Factors:** Total cost of ownership, fleet partnerships, government incentives
- **Market Approach:** B2B sales with fleet operators and government contracts

### Segment 4: Emerging Car Markets

**Strategy:** Electric Car Market Development

- **Target States:** Kerala, Goa, Himachal Pradesh, Uttarakhand
- **Product Focus:** Premium electric cars and luxury EVs
- **Key Success Factors:** Technology showcase, premium experience, early adopter engagement
- **Market Approach:** Niche market cultivation with premium positioning



## Implementation Roadmap

### Phase 1: Market Foundation

- Establish manufacturing and distribution partnerships in target segments
- Develop segment-specific charging infrastructure partnerships
- Launch pilot programs in key metropolitan areas within each segment

### Phase 2: Market Penetration

- Scale production and distribution based on segment-specific demand patterns
- Implement targeted marketing campaigns for each market segment
- Expand charging network coverage in priority segments

### **Phase 3: Market Leadership**

- Achieve market leadership position in chosen segments
- Develop second-generation products based on market feedback
- Expand into adjacent segments and geographical markets

### **Investment Priorities**

1. **Infrastructure Development:** Segment-specific charging solutions
2. **Product Development:** Category-appropriate EV solutions
3. **Partnership Strategy:** Regional distributors and service providers
4. **Technology Integration:** IoT, connectivity, and smart features aligned with segment needs
5. **Market Education:** Awareness campaigns tailored to segment characteristics

### **Risk Mitigation Strategies**

- **Market Diversification:** Avoid over-dependence on single segments
- **Flexible Product Portfolio:** Adaptable offerings for changing market conditions
- **Strategic Partnerships:** Local manufacturing and distribution alliances
- **Regulatory Compliance:** Proactive adaptation to evolving EV policies and incentives

### **Success Metrics and KPIs**

#### **Market Penetration Metrics:**

- Market share by segment and vehicle category
- Charging infrastructure utilization rates
- Customer acquisition cost by segment
- Revenue per segment and growth rates

#### **Operational Excellence Metrics:**

- Service network coverage and satisfaction scores
- Product reliability and performance benchmarks
- Supply chain efficiency and local content percentage
- Brand awareness and consideration metrics by segment



# Conclusion

The comprehensive market segmentation analysis provides a robust foundation for strategic decision-making in the Indian EV market. The identified segments represent distinct opportunities with specific requirements, competitive dynamics, and growth trajectories. Success in this market requires a nuanced understanding of regional preferences, infrastructure readiness, and economic factors that drive vehicle adoption patterns.

The segmentation model demonstrates high statistical validity with strong silhouette scores and clear cluster separation, providing confidence in the strategic recommendations. Companies entering or expanding in the Indian EV market should leverage these insights to develop targeted strategies, optimize resource allocation, and achieve sustainable competitive advantage in this rapidly evolving landscape.

## Key Strategic Imperatives:

1. **Segment-Specific Product Development:** Tailor EV solutions to match distinct market segment needs
2. **Infrastructure Investment:** Prioritize charging network development based on segment characteristics
3. **Partnership Strategy:** Build strategic alliances with local players in each target segment
4. **Market Education:** Implement segment-appropriate awareness and adoption campaigns
5. **Regulatory Engagement:** Active participation in policy development and incentive programs

This analysis serves as a strategic roadmap for sustainable growth and market leadership in India's transformative electric vehicle revolution.