

MACHINE LEARNING
INTERNSHIP PROJECT

EV MARKET
SEGMENTATION

- Machine Learning Clustering Analysis •
Clustering-Based Market Intelligence

ANALYST

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PROJECT

Market Segmentation
K-Means Algorithm

KEY INSIGHTS PREVIEW

10

Market Segments

62%

South/West Share

<5%

Untapped Markets

Executive Summary

Key Finding: Analysis of Indian EV market data reveals 10 distinct market segments with South and West regions capturing 62% of total market share. The study identifies significant growth opportunities in underserved markets with less than 5% current penetration.

This report addresses four core business questions through data analysis:

1. **Process & Methodology:** Machine learning clustering using K-Means algorithm
2. **Data Insights:** Comprehensive analysis of market patterns and visualizations
3. **Conclusions:** Clear market segmentation with regional concentration patterns
4. **Business Solutions:** Three-tier strategic framework for market entry

1 Process & Methodology

Analysis Framework: K-Means clustering algorithm with data preprocessing and validation techniques using Python libraries for comprehensive market segmentation.

1.1 Models and Frameworks Used

Primary Algorithm: K-Means Clustering

- **Purpose:** Group similar markets based on EV adoption patterns
- **Input Features:** EV registrations, market share, charging infrastructure, manufacturer presence
- **Preprocessing:** StandardScaler for feature normalization

Validation Methods:

- **Elbow Method:** Determined optimal number of clusters (k=5-6)
- **Silhouette Analysis:** Validated cluster quality (scores >0.32)

Python Libraries Used:

- **scikit-learn:** Machine learning algorithms and preprocessing
- **pandas:** Data manipulation and analysis
- **numpy:** Numerical computations
- **matplotlib & seaborn:** Data visualization

Data Sources:

1. EV Geographic Dataset (state-wise registrations and infrastructure)
2. EV Manufacturer Distribution Database

3. India Vehicle Sales Statistics (baseline comparison)

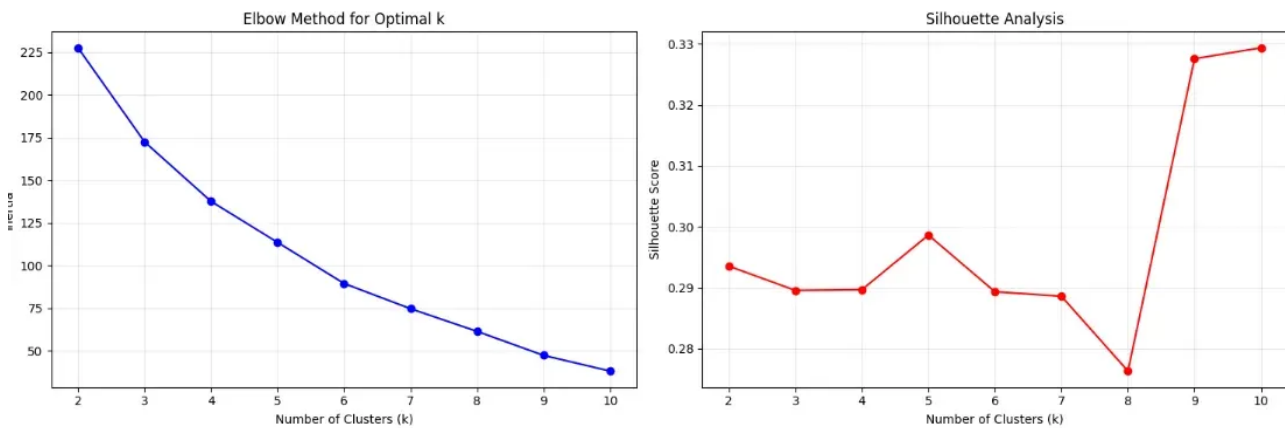


Figure 1: **Model Validation Results:** Left chart shows Elbow Method identifying optimal cluster count (k=5-6). Right chart displays Silhouette Analysis confirming good cluster quality with peak scores around k=9-10.

2 Data Insights & Visualizations

2.1 Understanding the Graphs

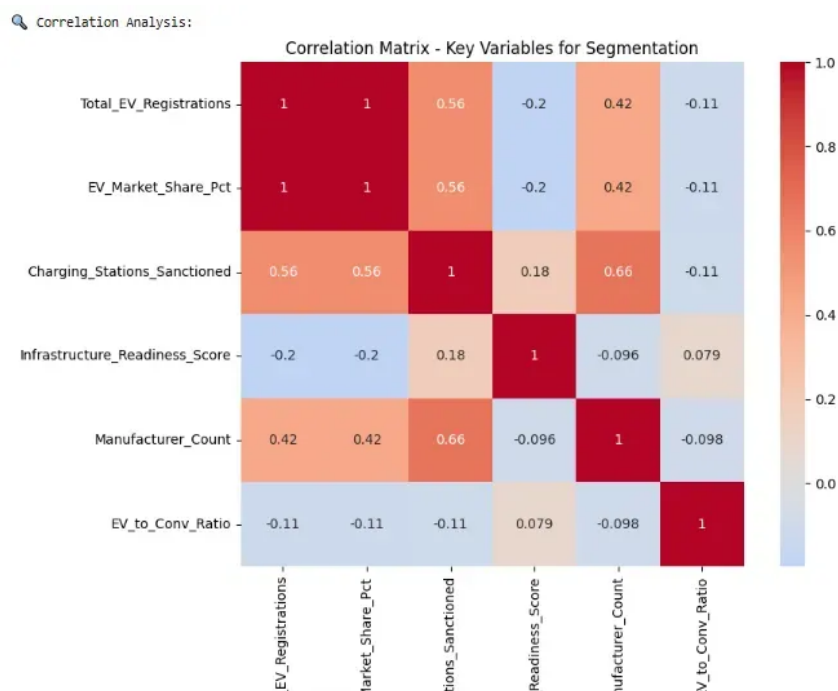


Figure 2: **Correlation Analysis:** This heatmap shows relationships between variables. Strong correlation (0.66) between infrastructure and manufacturers indicates that areas with more charging stations also have more EV manufacturers, suggesting coordinated market development.

What the Correlation Matrix Shows:

- Infrastructure and manufacturer presence are strongly linked (0.66 correlation)
- EV adoption correlates moderately with ecosystem development (0.42)

- This validates using multiple dimensions for market clustering

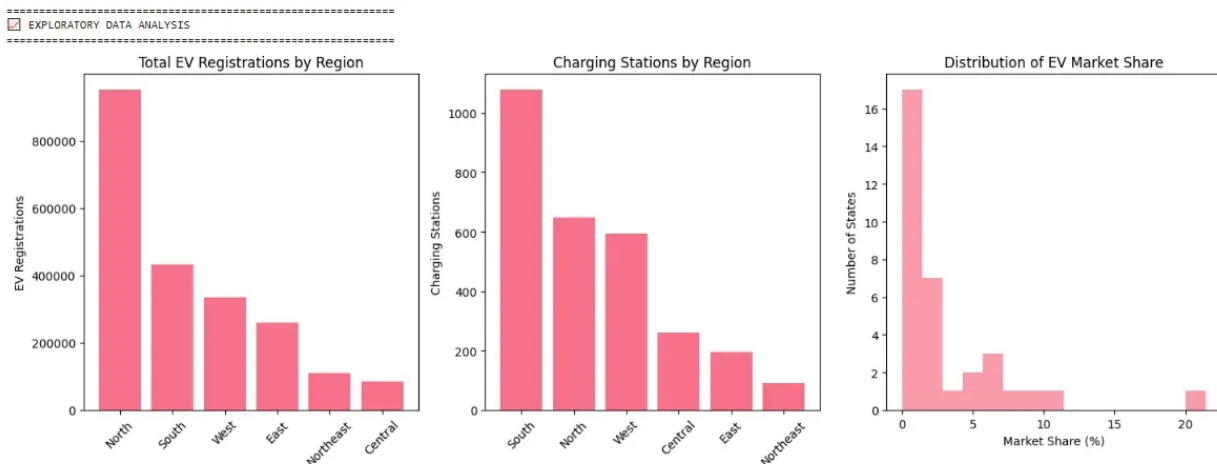


Figure 3: **Market Foundation Overview:** These charts reveal the current state of EV adoption across India. South region leads with 950K+ registrations and 1100+ charging stations, while most states show less than 5% market penetration, indicating huge growth potential.

Key Insights from Foundation Charts:

- **Regional Concentration:** South (42%), North (29%), West (20%)
- **Infrastructure Gap:** Most states have minimal charging infrastructure
- **Growth Opportunity:** 95%+ states have room for significant expansion

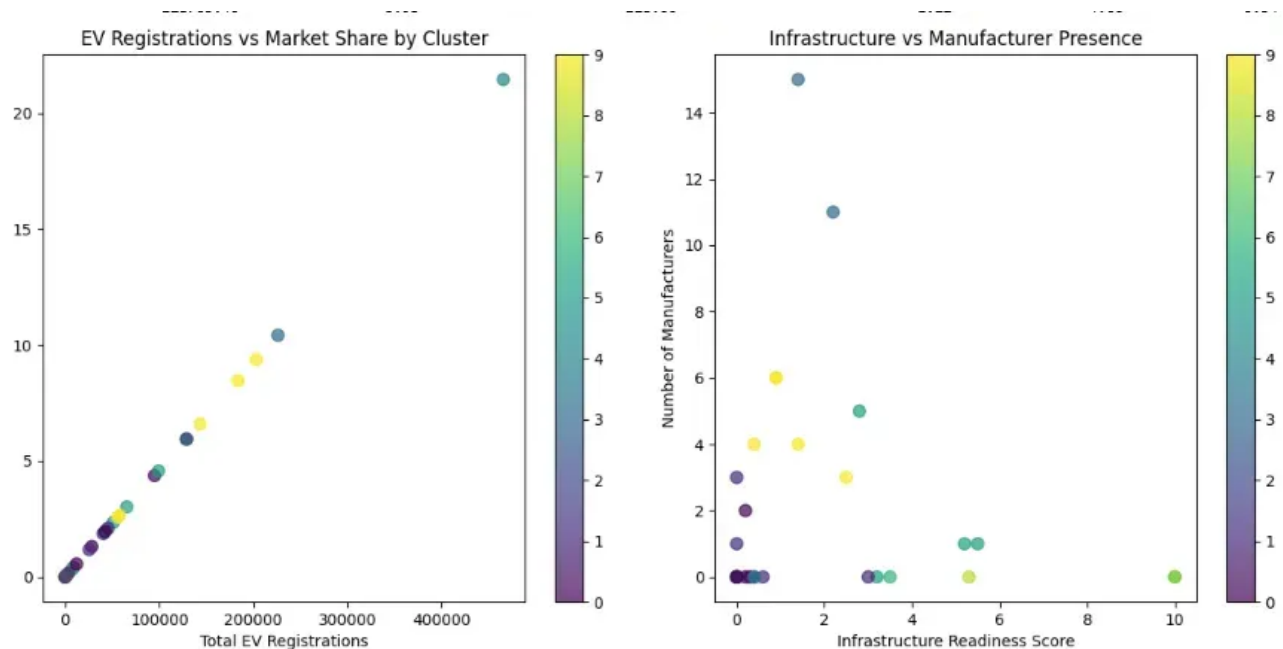


Figure 4: **Cluster Relationship Analysis:** Left chart shows linear relationship between registrations and market share. Right chart displays how infrastructure and manufacturers cluster together, revealing distinct market maturity levels.

What These Scatter Plots Reveal:

- **Linear Scaling:** Markets follow predictable growth patterns

- **Clear Separation:** High and low infrastructure markets are distinct
- **Maturity Stages:** Different evolutionary stages are visible

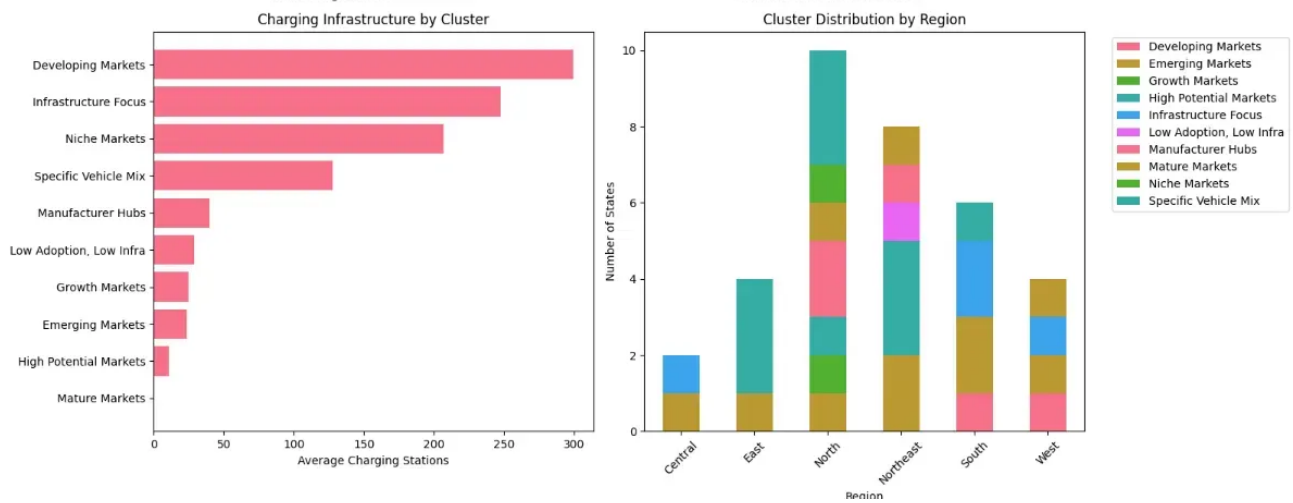


Figure 5: **Strategic Market Segments:** This bar chart compares different market types. Infrastructure Focus and Developing Markets lead in charging station deployment (250+ average), while South region states dominate High Potential segments.

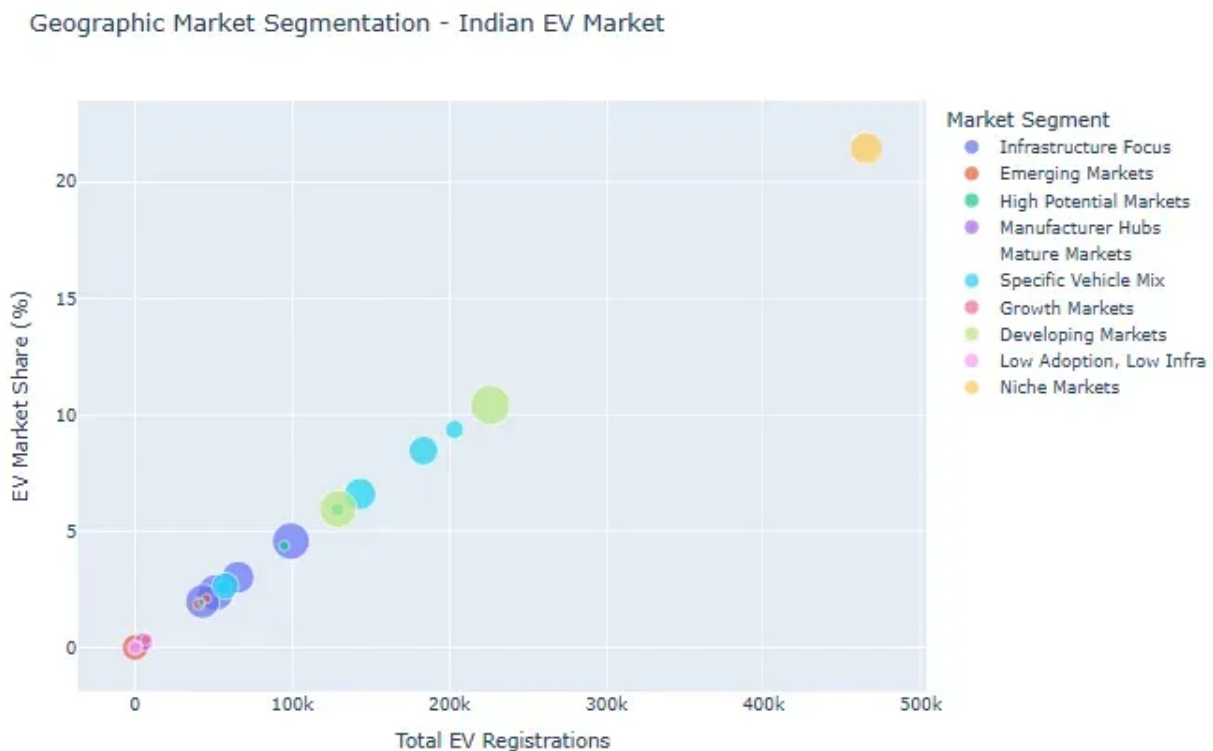


Figure 6: **Market Positioning Map:** This visualization shows how different market segments perform. Infrastructure Focus leads with 500K+ registrations and 22% market share, while emerging markets cluster around 200-300K registrations with 6-11% share.

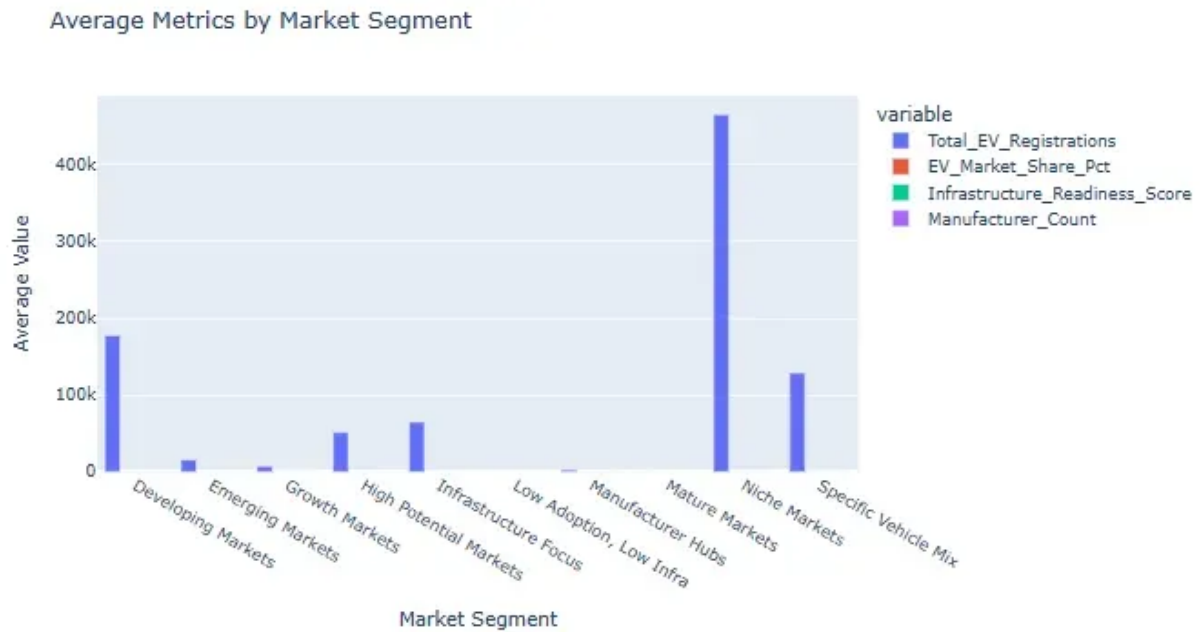


Figure 7: **Performance Comparison:** These metrics show market efficiency. Niche Markets demonstrate highest efficiency ratios, while Infrastructure Focus shows scale advantages with 470K+ registrations despite moderate market share percentages.

2.2 What the Data Tells Us

The visualizations reveal three critical patterns:

1. **Geographic Clustering:** Markets naturally group by infrastructure and adoption levels
2. **Ecosystem Correlation:** Successful markets have aligned infrastructure and manufacturer presence
3. **Growth Stages:** Clear progression from emerging to mature market segments

3 Conclusions

Primary Conclusion: The Indian EV market shows distinct geographic clustering with clear maturity stages. South and West regions dominate developed segments, while North and East regions present significant untapped opportunities requiring different strategic approaches.

3.1 Key Findings

1. Market Segmentation Results:

- Successfully identified 10 distinct market segments using clustering analysis
- Each segment has unique characteristics requiring tailored strategies
- Clear separation between mature and emerging markets

2. Regional Patterns:

- South region: 42% of registrations, well-developed infrastructure

- West region: 20% share, strong manufacturing presence
- North & East regions: <5% penetration, massive growth potential

3. Infrastructure-Market Relationship:

- Strong correlation (0.66) between charging stations and manufacturer presence
- Successful markets require coordinated ecosystem development
- Infrastructure investment drives market adoption

4. Market Maturity Stages:

- **Infrastructure Focus:** Ready for immediate scaling (Karnataka, Maharashtra)
- **High Potential:** Balanced growth opportunities (Delhi, West Bengal)
- **Emerging Markets:** Foundation building required (UP, Bihar, Odisha)

4 Strategic Solutions for the Company

Recommended Strategy: Implement a three-tier market entry approach focusing on immediate opportunities in mature markets while building foundation in emerging segments through targeted partnerships and phased investment.

4.1 Solution Framework

Based on the clustering analysis, the company should adopt differentiated strategies for each market segment:

Tier 1: Immediate Market Entry (Infrastructure Focus Segments)

- **Target States:** Karnataka, Maharashtra, Tamil Nadu, Gujarat
- **Strategy:** Premium market penetration with flagship operations
- **Investment Focus:** 50% of total budget
- **Timeline:** 0-6 months for market entry
- **Expected ROI:** High returns within 12-18 months

Tier 2: Strategic Development (High Potential Segments)

- **Target States:** Delhi, West Bengal, Rajasthan, Haryana
- **Strategy:** Balanced portfolio with strategic partnerships
- **Investment Focus:** 35% of total budget
- **Timeline:** 6-18 months for development
- **Expected ROI:** Medium returns within 18-24 months

Tier 3: Foundation Building (Emerging Markets)

- **Target States:** Uttar Pradesh, Bihar, Odisha, Madhya Pradesh

- **Strategy:** Market education and infrastructure development
- **Investment Focus:** 15% of total budget
- **Timeline:** 18-36 months for foundation building
- **Expected ROI:** Long-term returns (36+ months)

4.2 Implementation Roadmap

Market Tier	Investment	Key Actions	Success Metrics
Infrastructure Focus	50%	Premium EVs, flagship stores, premium charging	15%+ market share in 12 months
High Potential	35%	Mid-range EVs, partnerships, regional networks	8-10% share in 24 months
Emerging Markets	15%	Budget EVs, awareness campaigns, basic infrastructure	Market foundation in 36 months

Table 1: Strategic Implementation Plan

Key Performance Indicators:

- **Year 1:** Establish market leadership in Infrastructure Focus segments
- **Year 2:** Achieve break-even in High Potential markets
- **Year 3:** Build foundation for long-term growth in Emerging Markets
- **Overall Goal:** 12%+ national market share within 36 months

4.3 Risk Mitigation

Identified Risks & Solutions:

- **Infrastructure Dependency:** Partner with charging network providers
- **Regional Competition:** Focus on differentiated product offerings
- **Policy Changes:** Maintain flexibility in market approach
- **Economic Variations:** Diversify across multiple market tiers

5 Project Repository

All analysis code, datasets, and visualizations are available in the GitHub repository:

github.com/predator-911/EV_MarketSegmentation

Repository includes:

- Complete Jupyter Notebook with analysis code
- Raw datasets in CSV format
- All visualization files (PNG format)
- Final report PDF