Electric Vehicle (EV) Market Segmentation and Analysis in India (2001–2024)

By: Aaditya Sinha

---

1. Introduction

Electric vehicles (EVs) are no longer just a futuristic concept. They are actively reshaping the global transportation sector, and India is beginning to embrace this change. With the government pushing for greener alternatives and citizens becoming more environmentally conscious, EV adoption is gaining momentum across the country. However, adoption patterns, infrastructure readiness, and market performance vary significantly by geography.

This project dives deep into EV data collected from 2001 to 2024 and aims to uncover key insights into category-wise trends, state-wise growth, and market segmentation using clustering. The goal is to answer: which states are EV-ready, which ones are lagging, and where should investment go next?

---

2. Objectives

- Analyze historical EV sales data across categories (2W, 3W, LMV)
- Compare EV readiness across Indian states using sales, infra, and production data
- Use clustering (KMeans) to segment states by market maturity
- Visualize trends and segment differences using clear, impactful plots
- Offer actionable insights for policymakers and businesses

---

3. Data & Preprocessing

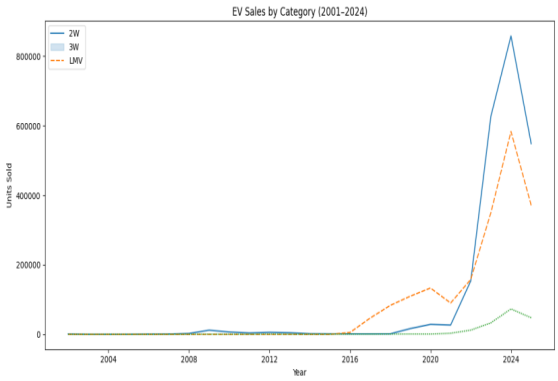
We used six datasets:

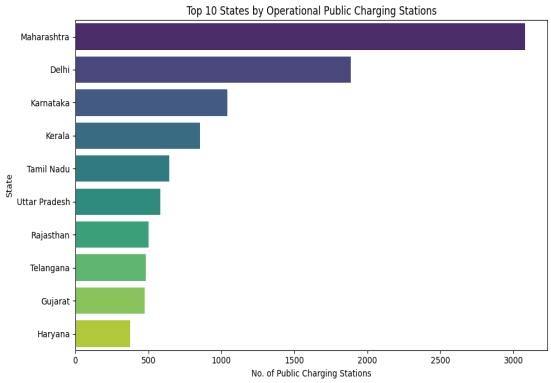
1. EV-Maker-by-Place.csv – Manufacturer distribution by state
2. OperationalPC.csv – Public Charging Station counts
3. Vehicle-Class-All.csv – Registrations by vehicle class
4. ev_cat_01-24.csv – Year-wise category sales
5. ev_sales_by_makers_and_cat.csv – Sales by makers and categories
6. Ev_by_place.csv – State-wise stats: annual sales, market share, production, infra

Preprocessing included**:**

- Removing duplicates
- Cleaning commas from numbers
- Converting columns to numeric types
- Scaling features using StandardScaler
- Label encoding states

This ensured consistent, model-ready data for further analysis.





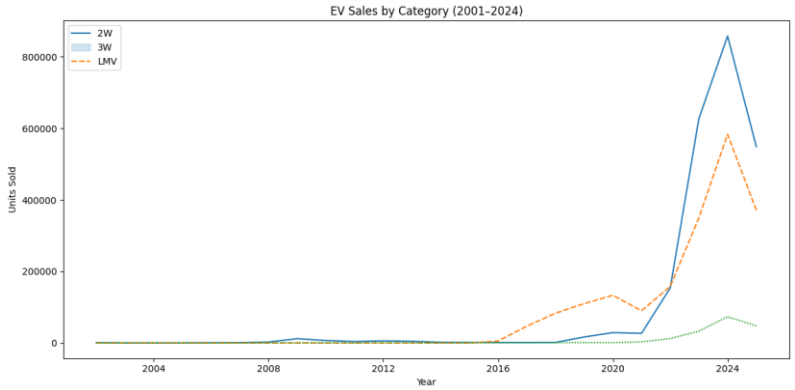
---

4. Exploratory Data Analysis (EDA)

EV Sales Trends by Category (2001–2024)

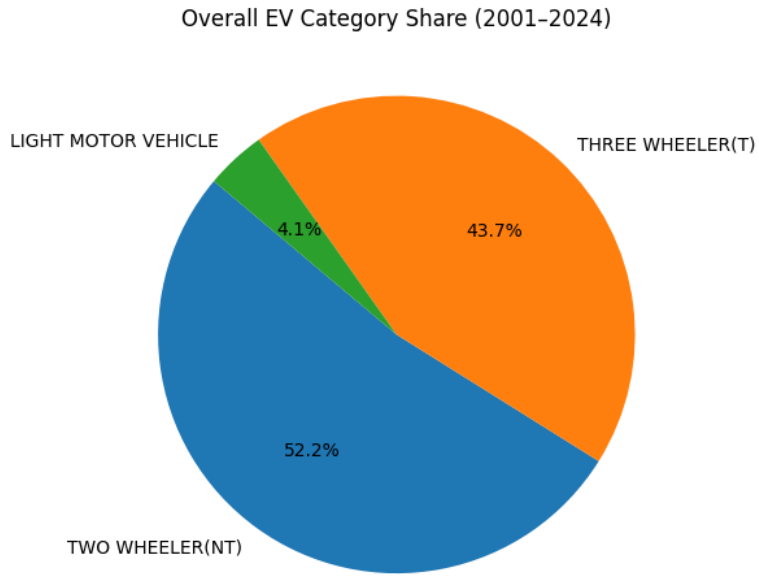
From our visual analysis:

- 2-wheelers dominate the EV market with steep growth post-2018
- 3-wheelers have shown steady uptake in semi-urban and urban delivery services
- LMVs are catching up, especially after 2020 with cars like the Tata Nexon EV



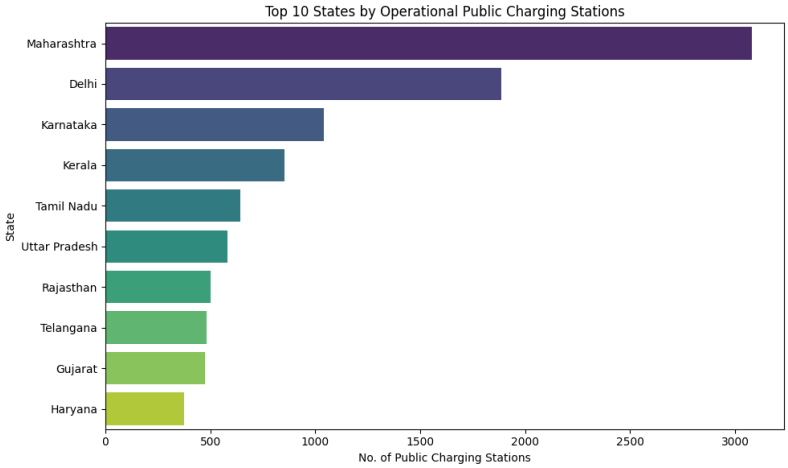
Category-wise Share

We visualized cumulative sales by category using a pie chart. Unsurprisingly, 2-wheelers made up the majority of sales, followed by 3-wheelers, and then LMVs.



Top States by Charging Infrastructure

Bar plots revealed that Maharashtra, Delhi, Karnataka, and Tamil Nadu lead the EV infrastructure push. However, some states like Gujarat punch above their weight by having high EV sales but modest infra.



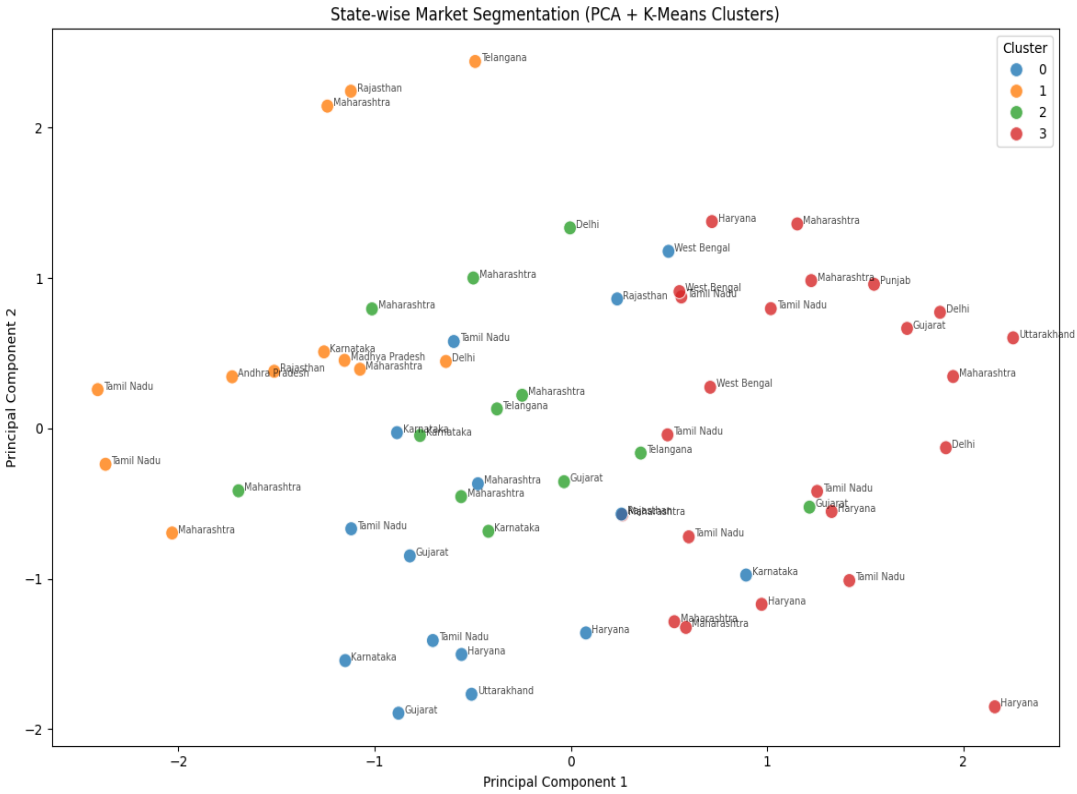
---

5. Clustering & Segmentation

We applied K-Means clustering on 4 features:

- Market Share (%)
- Production Capacity (Units/Year)
- Annual Sales (Units)
- Charging Stations

Using PCA, we visualized the 4D clustering in 2D.

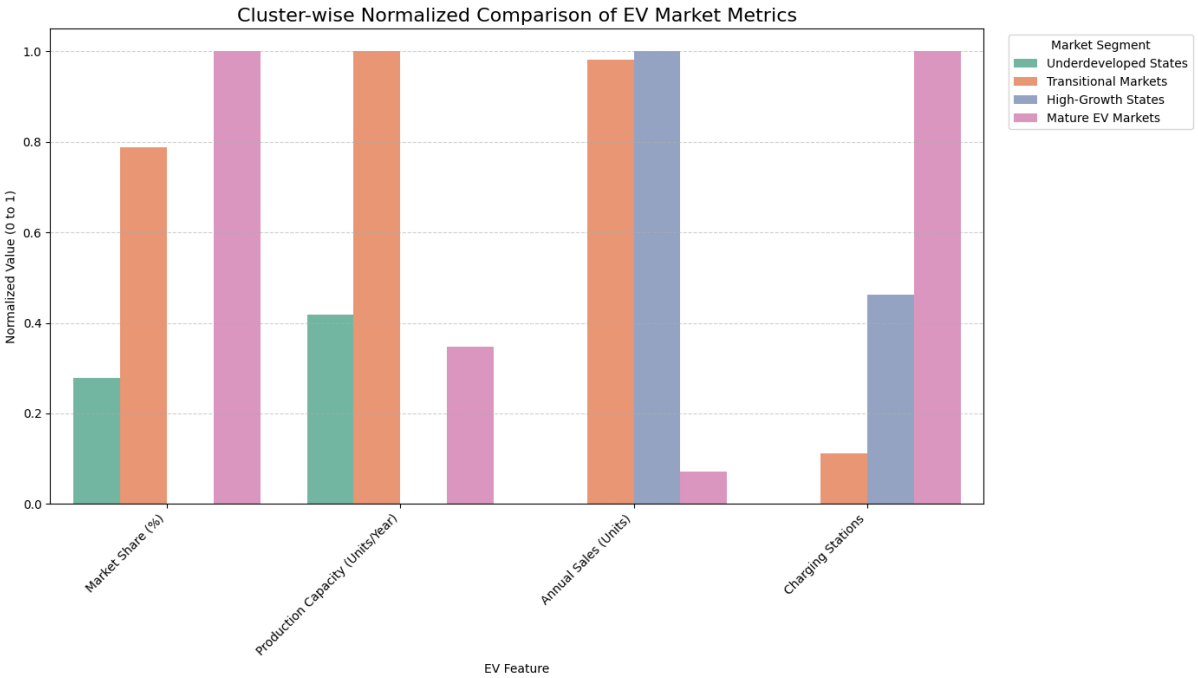


Segment Naming Based on Cluster Characteristics

Cluster	Name	Key Traits
0	Underdeveloped States	Low sales, infra, capacity
1	Transitional Markets	Moderate sales and infra
2	High-Growth States	High sales, growing production
3	Mature EV Markets	High infra, stable performance

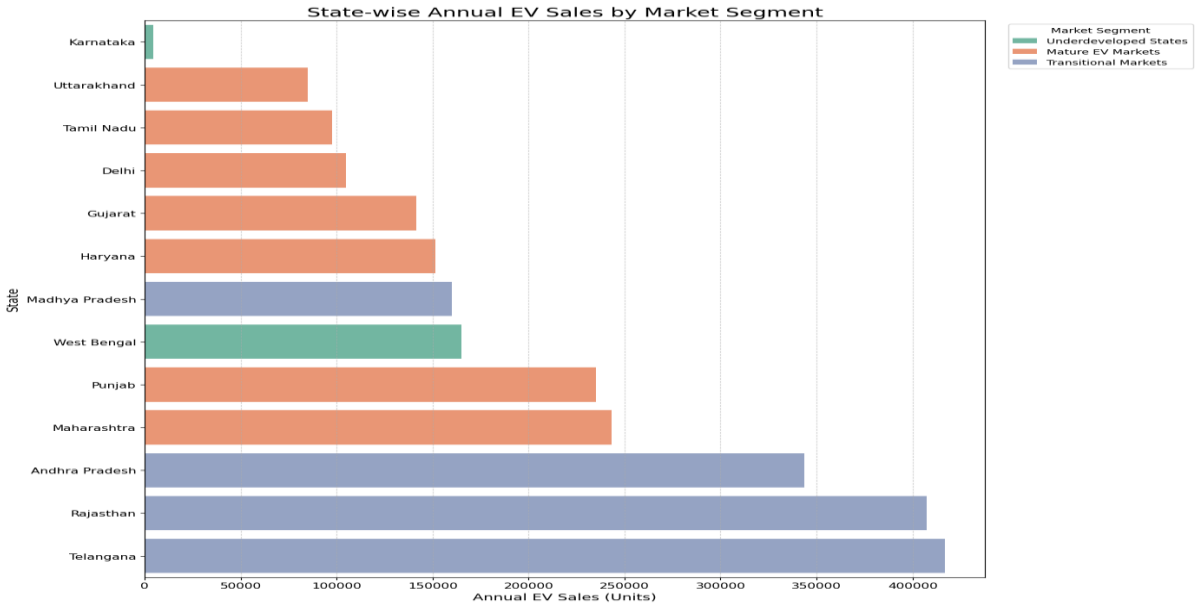
Segment-Wise Averages

Using normalized bar plots, we compared average feature values across clusters.



State-Wise Sales by Segment

We created a horizontal bar chart showing EV sales per state and their respective cluster.



---

6. Insights & Recommendations

Mature Markets (Cluster 3):

- Already well-developed (e.g., Maharashtra, Delhi)
- Focus on ultra-fast charging, battery tech upgrades

High-Growth Markets (Cluster 2):

- Huge sales growth potential (e.g., Gujarat, Karnataka)
- Invest in infra and production scale-up

Transitional Markets (Cluster 1):

- Incentivize infra deployment and awareness campaigns
- Tailored subsidies can push these states toward maturity

Underdeveloped States (Cluster 0):

- Require foundational investment in infra
- Public-private partnerships and rural EV schemes recommended

---

7. Tools Used

- pandas, numpy: data cleaning & manipulation
- matplotlib, seaborn: visualizations
- sklearn: clustering, PCA, scaling

---

8. Conclusion

This EV market analysis presents a data-driven look at how different parts of India are engaging with electric mobility. Using clustering, we created clear market segments to help businesses, policymakers, and investors know where to focus efforts.

States like Delhi and Maharashtra are already leaders, but others like Gujarat and Karnataka are on a steep growth trajectory. Meanwhile, several states still need core infrastructure to kickstart EV adoption.

The road to an electric future in India isn't uniform — but with the right insights, it can be accelerated in all the right places.

GitHub repo - https://github.com/shadyr7/Electric-Vehicle-MarketAnalysis