Market Segmentation Analysis of the Electric Vehicle (EV) Market in India

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Segmentation Based on Vehicle Type

Introduction

The Indian Electric Vehicle (EV) sector is experiencing swift expansion driven by increasing fuel costs, environmental issues, and robust government backing through incentives and regulatory reforms. Nevertheless, the adoption of EVs varies significantly across different categories of vehicles.

Types of vehicles such as two-wheelers, three-wheelers, passenger cars, and commercial vehicles exhibit notable disparities in their adoption rates, affordability, reliance on infrastructure, and consumer interest. It is essential to comprehend these variations for EV manufacturers, policymakers, and investors.

Segmenting the market by vehicle type allows stakeholders to pinpoint high-potential segments, enhance resource distribution, and craft targeted strategies for sustainable development. This report conducts a comprehensive segmentation of the EV market, utilizing vehicle type as the main variable, and is reinforced by data analysis, visual representation, and machine learning-based clustering.

Problem Statement

- ***Identifying High-Potential EV Vehicle Segments***

Despite overall growth in the EV market, manufacturers face challenges such as:

- Uncertainty about which EV vehicle type to prioritize
- Uneven adoption across vehicle categories
- High investment costs with unclear returns

- Infrastructure readiness varying by vehicle segment

The core problem addressed in this study is:

Which EV vehicle type segment offers the best balance of demand, growth, and long-term business opportunity?

- Which EV vehicle type shows the highest demand and growth?
- Which segments are mature vs emerging?
- How can data-driven segmentation help decide product strategy?
- Which vehicle types offer long-term business potential?

Objective

To apply Market Analysis and Machine Learning for:

1. To examine trends in EV adoption across various vehicle categories.
2. To categorize the EV market based on performance metrics of different vehicle types.
3. To pinpoint established, rapidly growing, and emerging segments within the EV market.
4. To offer business recommendations for EV manufacturers based on data insights.

Data Collection

1. **Dataset Sources:**
- https://drive.google.com/file/d/1pUaj35XKjQ3LFL33bDpLrSkxXUpd9wCD/view?usp=sharing
- https://drive.google.com/file/d/12OSGo2GAl46JCy2j1mZDFF-Qq7Qr_4sW/view?usp=sharing

2. **Dataset Description**

Columns present in dataset:

	State	Year	Two Wheelers	Three Wheelers	Cars	Buses	Trucks
0	Andhra Pradesh	2010	171958	20795	151932	4272	6734
1	Andhra Pradesh	2011	187337	21850	107498	3944	9322
2	Andhra Pradesh	2012	379365	5769	214027	2933	6311
3	Andhra Pradesh	2013	153355	44188	234176	3885	7396
4	Andhra Pradesh	2014	308795	32480	176730	3058	8849

Column	Description
Cat (category)	Vehicle Type (e.g., Two-Wheeler, Passenger, Commercial)
Maker	Manufacturer
2015–2024	Annual EV sales

	Cat	Maker	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
0	3W	"VOLVO GROUP INDIA PVT LTD"	0	0	31	12	0	0	0	0	0	0
1	3W	3EV INDUSTRIES PVT LTD	0	0	0	0	0	0	112	390	545	51
2	2W	3GB TECHNOLOGY PVT LTD	0	0	0	1	0	0	0	0	0	0
3	3W	3GB TECHNOLOGY PVT LTD	0	1	1	0	0	0	0	0	0	0
4	3W	3S INDUSTRIES PRIVATE LIMITED	0	0	0	0	48	66	43	68	266	578

Data Preprocessing

The dataset originally had sales data organized in a wide format with yearly columns. To facilitate better analysis,

- The data was transformed into a long format suitable for time-series examination.
- Sales figures were consolidated at the level of vehicle type.
- Any missing values or instances of zero were addressed with caution.
- New features like Total Sales, Average Sales, and Growth Rate were created.

This preprocessing provided clear and consistent data for both visualization and machine learning models.
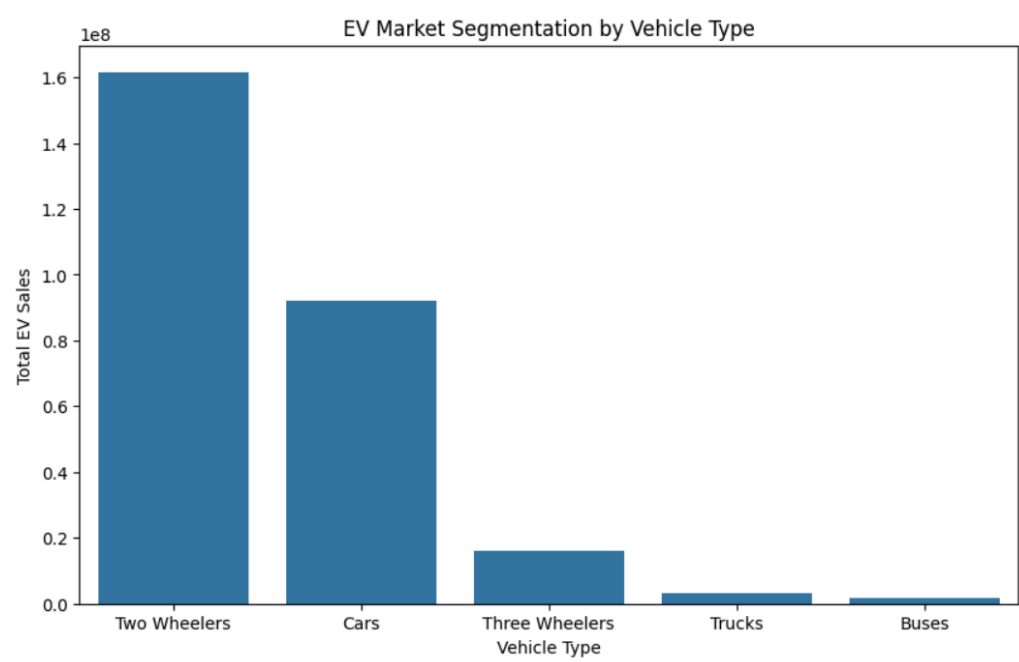
Exploratory Data Analysis (EDA)

- **Market Share by Vehicle Type**

This bar chart represents the **percentage contribution of each vehicle type** to the total EV sales market in India.

Ques - "Which type of EV is selling the most compared to others?"

- A taller bar means **more EVs sold** in that category.
- A shorter bar means **lower adoption** or niche usage.
- Market share reflects **customer preference and affordability**.

Market share analysis shows the percentage contribution of each vehicle type to total EV sales. Vehicle categories with higher market share indicate stronger consumer acceptance and established demand.

Insights:

- Two-wheelers dominate the EV market due to affordability
- Passenger vehicles show moderate share but increasing demand
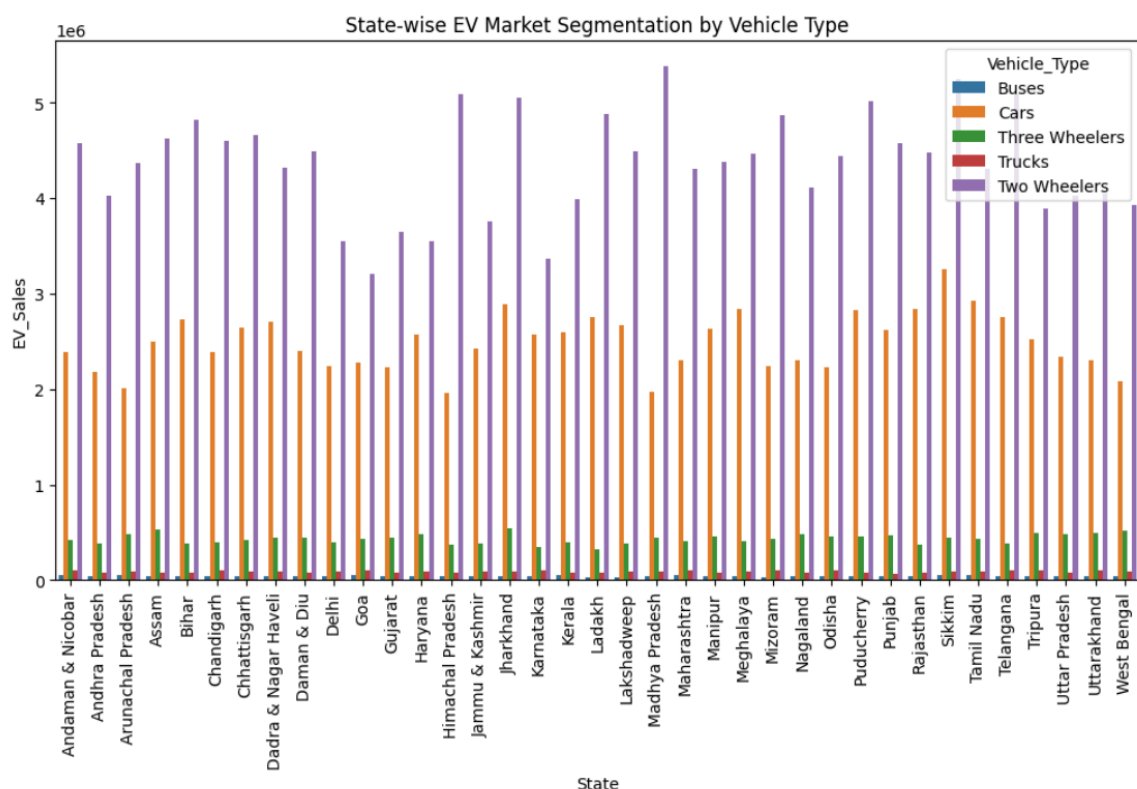- Commercial EVs represent niche but strategic segment

Problem - EV companies often try to invest equally across all vehicle types.

Solution:

However, this graph clearly shows that **not all vehicle types generate equal demand**.

- High market share = **lower risk**
- Low market share = **higher uncertainty but future potential**

● **Geographic Segmentation: State-wise EV Market by Vehicle Type**

This bar chart shows the total number of electric vehicles sold in each Indian state, further divided by vehicle type. Each group of bars represents a state, and different colors indicate different EV vehicle categories.

Which states prefer which types of electric vehicles?

- Taller bars mean **higher EV adoption** in that state.
- Different colored bars show **which vehicle type dominates** in each state.
- States with multiple tall bars indicate **diversified EV adoption**.
- States with only one dominant bar show **vehicle-type-specific demand**.

Insights:

- **Urbanized states** show higher EV sales across multiple vehicle types.
- **Some states strongly favor EV two-wheelers**, indicating affordability-driven adoption.
- **Commercial and passenger EVs** are concentrated in a few economically stronger states.

- Several states show **low overall EV penetration**, reflecting infrastructure or policy gaps.

Problem:

This graph reveals that **EV adoption is geographically uneven**. A vehicle type that performs well in one state may perform poorly in another. Applying the same sales or marketing strategy across all states can lead to poor outcomes.

- Charging infrastructure varies by state
- State-level subsidies and EV policies differ
- Income levels and urbanization are uneven
- Commercial activity is concentrated in specific regions

Geographic segmentation shows that **vehicle-type success depends heavily on location**. EV companies must align their product strategy with state-level demand patterns.

Solutions:

1. **Targeted Product Launch**
   - Launch EV scooters in states with high two-wheeler dominance

Example: EV scooter focus in Karnataka or Delhi

2. **State-Specific Portfolio**
   - Promote passenger EVs in high-income states

Example: Passenger EVs in Maharashtra or Tamil Nadu

3. **Commercial EV Strategy**
   - Focus on logistics-heavy states

Example: EV delivery vans in Gujarat or NCR
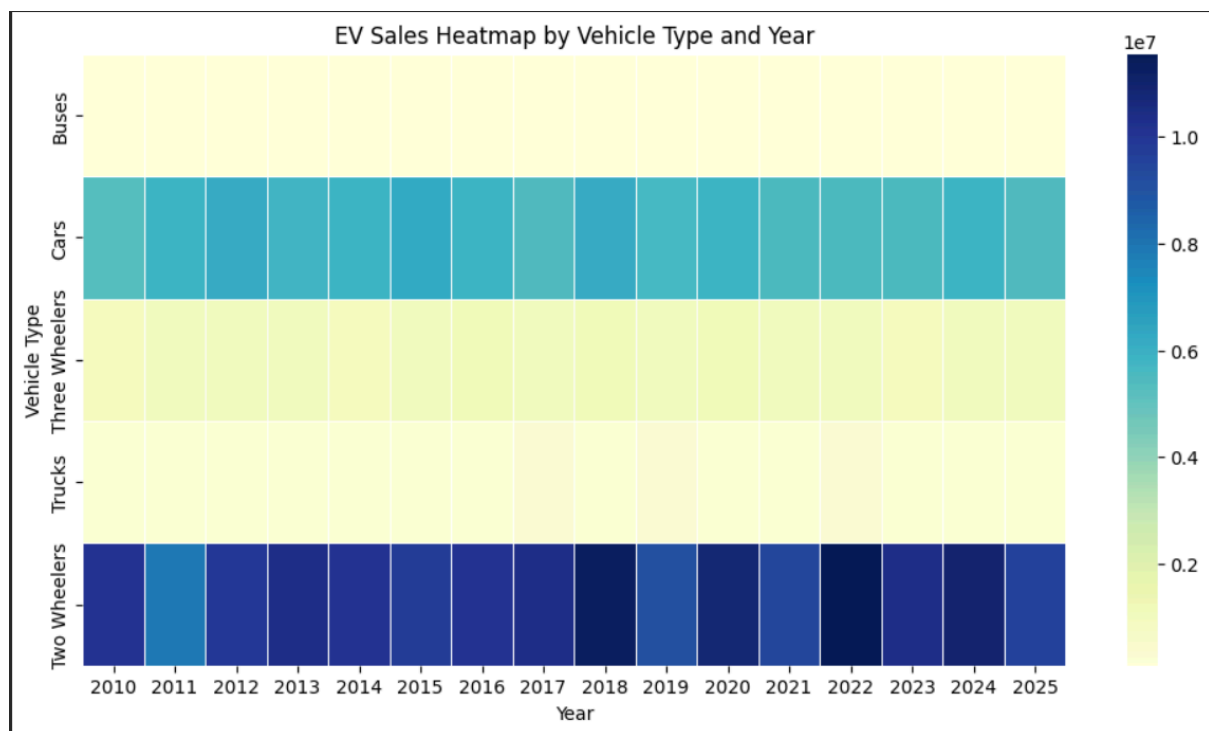
4. Policy-Driven Expansion
- Enter EV-friendly states first
- Align launches with state subsidy programs

Geographic segmentation highlights that EV adoption varies significantly across Indian states and vehicle types. A location-specific strategy is essential for maximizing EV market penetration and minimizing business risk.

● Heatmap – Vehicle Type vs Year

This depicts:
- Dark colors mean people are buying more EVs
- Light colors mean slow adoption
- Sudden dark patches indicate **policy impact or subsidy effect**

The heatmap visually represents EV adoption intensity over time.

Insights:

- Two-wheelers show **early and continuous darkening**
- Passenger EVs darken significantly after 2020
- Commercial EVs show delayed adoption

This is a **time-series analysis**, because:

- Data changes over years
- Trends are observed across time
- Growth patterns are studied longitudinally

Problem: Some EV segments grow only after policy intervention — not organically.

Solution:

- Companies should align product launches with **policy cycles**
- Example: Launching electric autos during subsidy announcements boosts adoption

● Annual Sales Distribution

This graph represents **sales consistency and variability** over multiple years.
- Narrow box → stable demand every year
- Wide box → fluctuating or unpredictable demand
- Dots outside the box → sudden spikes due to policy or incentives
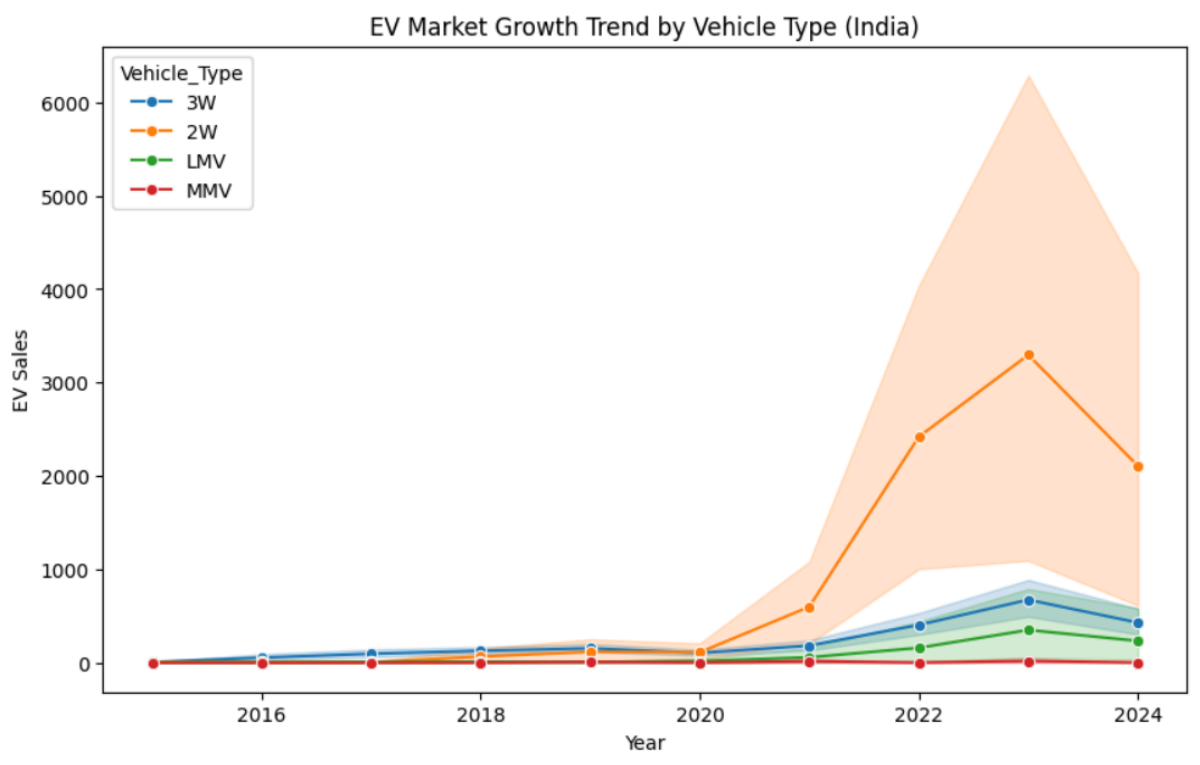
Insights:

- Two-wheelers show **stable and predictable demand**
- Passenger EVs show **gradual improvement**
- Commercial EVs show **high variability**

Problem : Unstable demand makes it risky for companies to invest heavily without government or institutional backing.

Solution:

- Stability is as important as growth.
- Stable segments - suitable for **long-term investment**
- Unstable segments - suitable for **pilot projects and partnerships**
- Example: **EV buses** should be sold through government tenders, not retail sales

EV Market Growth Trend by Vehicle Type (India)

Machine Learning-Based Market Segmentation

● Feature Selection

The following features were used for segmentation:

1. Total EV Sales
2. Average Annual Sales
3. Growth Rate

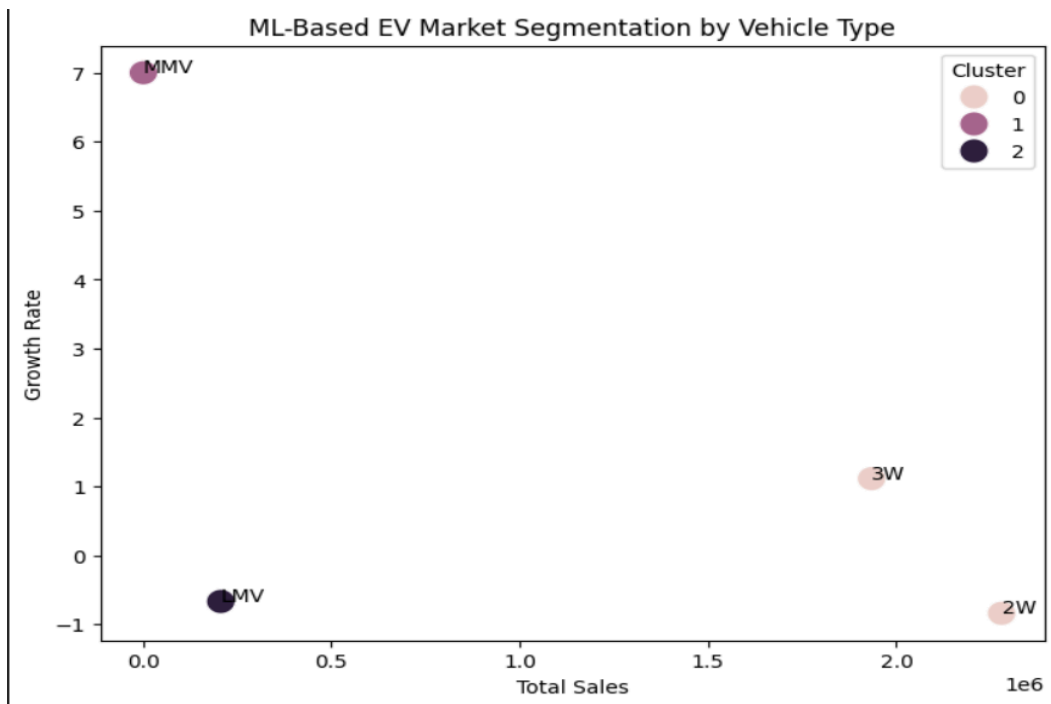These features capture **market size, consistency, and future potential**.

● K-Means Clustering

Why K-Means?

- Unsupervised segmentation
- Groups vehicle types based on similar performance patterns

Process:

- Features scaled using StandardScaler
- Optimal clusters chosen using Elbow Method
- Vehicle types assigned to clusters

ML-Based EV Market Segmentation by Vehicle Type

Machine Learning automatically groups vehicle types that **behave similarly in the market**.

- **Libraries Used**
  - Scikit-learn → KMeans, StandardScaler
  - Pandas → Feature engineering
  - Matplotlib / Seaborn → Visualization

- **Cluster Interpretation**

Cluster	Interpretation
Cluster 0	Mature, high-volume vehicle types
Cluster 0	High-growth, emerging vehicle types
Cluster 0	Niche or low-adoption segments

Insights:

- Mature segments offer stable revenue

- High-growth clusters are ideal for investment
- Niche segments require policy and infrastructure support

Problem: Companies treat all EV segments equally, but ML shows **clear differences in maturity and growth**.

Solution:

- **Mature cluster** → focus on cost optimization
- **High-growth cluster** → invest in R&D and expansion
- **Emerging cluster** → partner with government or fleets

Example:

- Invest aggressively in **EV scooters**
- Expand cautiously in **EV passenger cars**
- Pilot **EV trucks** with logistics companies

Key Findings and Conclusion

Major Findings

1. Two-wheelers form the most mature and dominant EV segment
2. Passenger EVs show strong growth potential with increasing adoption
3. Commercial EVs are emerging but infrastructure-dependent
4. ML-based clustering effectively differentiates market maturity levels

Conclusion

Segmentation based on vehicle types shows that the electric vehicle market is diverse. Various vehicle categories necessitate distinct business approaches. Utilizing data-driven segmentation allows manufacturers to reduce risk and enhance returns.

The EV market in India is highly segmented based on vehicle type. Two-wheelers represent a mature and stable segment with the highest market share, while passenger EVs show strong growth potential. Commercial EVs remain emerging and infrastructure-dependent. Time-series analysis reveals policy-driven growth, and machine learning segmentation confirms that each vehicle type requires a distinct business strategy.

Company Solution

Strategic Actions for an EV Company:

1. **Scale Production**
   - Focus on high-demand vehicle types (EV two-wheelers)

2. **Target Growth Segments**
   - Invest in passenger EV technology and charging partnerships

3. **Reduce Risk in Emerging Segments**
   - Use fleet contracts and government tenders for commercial EVs

4. **Policy-Aligned Launches**
   - Introduce new models during subsidy or incentive phases

Problem

EV companies face uncertainty about **which vehicle type to prioritize**.

Solution Strategy

1. **For Mature Segments (EV Two-Wheelers)**
   - Scale production
   - Reduce costs
   - Improve battery efficiency

Example: Ola Electric expanding scooter manufacturing

2. **For High-Growth Segments (Passenger EVs)**
   - Invest in R&D
   - Partner with charging providers

Example: Tata Motors expanding Nexon EV lineup

3. **For Emerging Segments (Commercial EVs)**
   - Use fleet-based sales
   - Partner with government and logistics firms

Example: Electric buses via state transport tenders

Business Recommendations

- Focus production on **high-growth vehicle segments**
- Maintain efficiency and cost leadership in mature segments
- Invest in charging and logistics infrastructure for commercial EVs
- Align vehicle design with segment-specific consumer needs

Future Scope

- Include pricing, battery range, and charging time data
- Use advanced ML models like Hierarchical Clustering
- Perform demand forecasting using time-series models
- Add geographic segmentation combined with vehicle type

GitHub Link:

https://github.com/disha-katkade/EV-Market-Analysis

Additional datasets

1. https://drive.google.com/file/d/1VG2dQsyG4PDXBp_Xvhba-38N6avcSDTT/view?usp=sharing
2. https://drive.google.com/file/d/1vkmuu_hCZvVewz2PXRaZ-0uQHW4lXvXW/view?usp=sharing
3. https://drive.google.com/file/d/1VdaUOfghuu_RmFpa1wN7HhV9GzjEXbWR/view?usp=sharing
4. https://drive.google.com/file/d/1Exew5RqfoOnp6dQ2b9TK6pbl3aJtdiVY/view?usp=sharing
5. https://drive.google.com/file/d/1mXJhawb4TXlghfC5bXMfbfQKDItmv32J/view?usp=sharing