INDIAN ELECTRIC VEHICLE MARKET SEGMENTATION

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Overview

Analyzing the Indian Electric Vehicle market using market segmentation techniques to help the startup decide in which vehicle/customer space it should develops its EVs and enter the market targeting the segments most likely to use Electric vehicles.

Market Size & Demand

- India has approx. 1.4 billion people and approx. 300 million households.
- Around **90 million households own vehicles**.
- Each year, **approx. 22 million vehicles are sold** in India.
    - **2-wheelers**: 16M
    - **3-wheelers**: 0.6M
    - **4-wheelers**: 3.8M
- EV sales are growing:
    - **2W EVs**: 1 million/year approx.
    - **3W EVs**: 300,000/year approx.
    - **4W EVs**: ~80,000/year approx.

Data Sources

EV_Sales.csv (from Kaggle)

- Contains **year-wise EV sales** by vehicle type (2W, 3W, 4W, buses, etc.)
- Useful for identifying **growth trends**, **market size**, and **vehicle preferences over time**.

EV_Demographic.csv (from data.gov.in)

- Contains **geographic and demographic distribution** of EV registrations/sales
- Useful for analyzing **regional adoption patterns**, **urban vs rural spread**, and **state-level policies/incentives**

Data Pre-processing

Libraries used:

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
```

Loading the Datasets

- Loaded `EV_Sales.csv` and `EV_Demographic.csv` using `pandas.read_csv()`

Initial Exploration

- Used `.info()`, `.head()`, `.describe()` to understand structure, column types, and summary statistics.

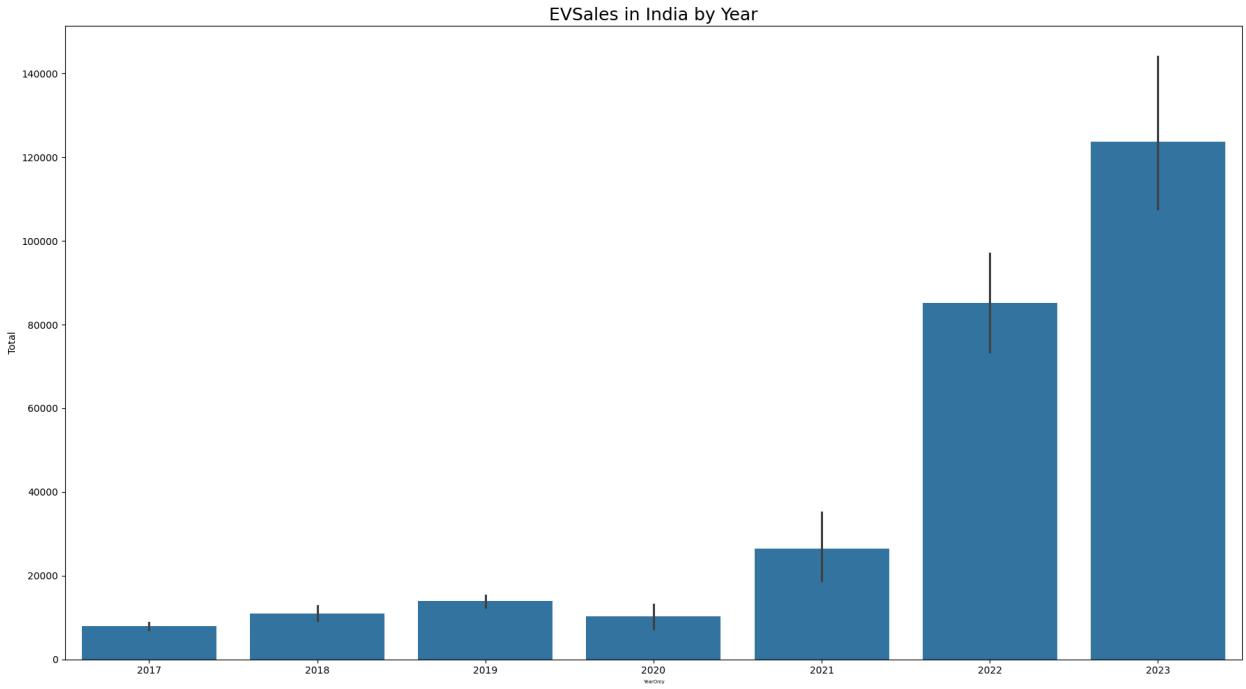
Handling Missing Values

- Identified null or missing entries using `isnull().sum()`
- Removed or imputed missing values as needed

Exploratory Data Analysis

Exploratory Data Analysis (EDA) is the process of deeply examining a dataset to uncover its underlying structure, extract important variables, detect outliers and anomalies, and test assumptions. It serves as a critical step in any data science or analytics workflow, enabling stakeholders to gain insights and make informed decisions based on data.

```
sns.barplot(data=df,x='YearOnly',y='Total')
```

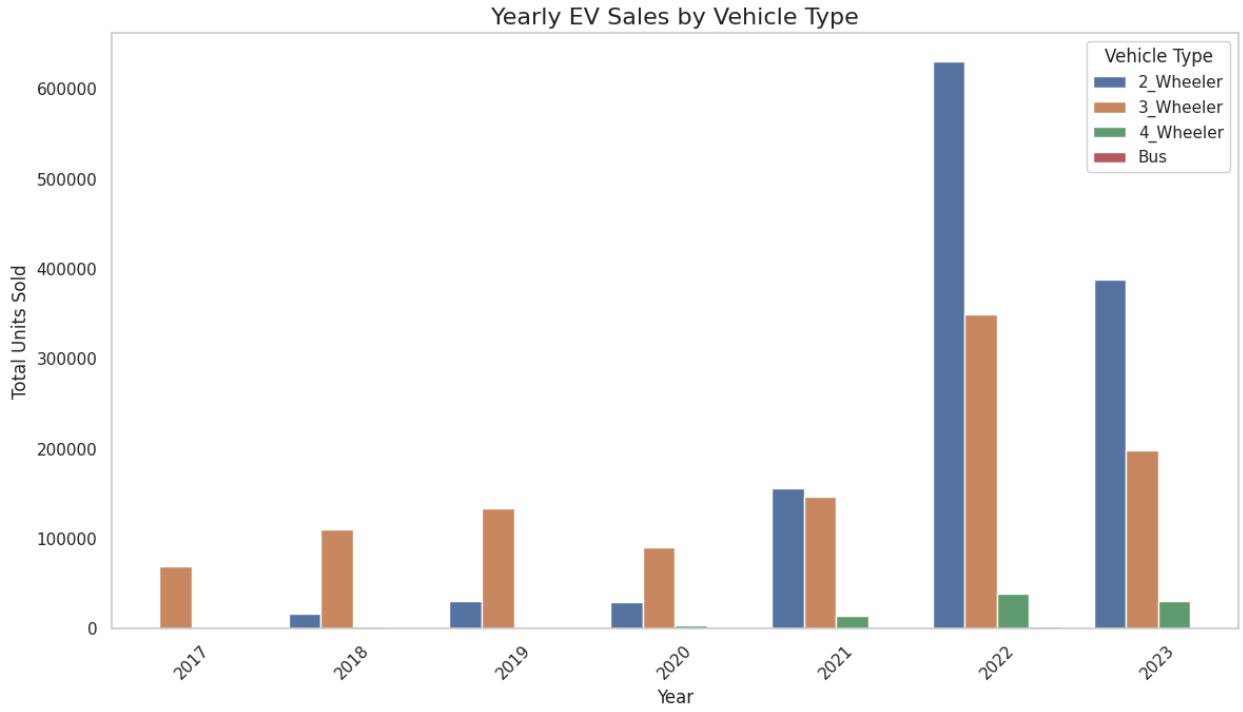


This bar chart presents the **total number of electric vehicles sold across India each year**, spanning from 2017 to 2023.

The graph reveals a **clear upward trend**, indicating that EV adoption has consistently grown over time.
Sales remained relatively low and flat between 2017 and 2019, suggesting that EVs were still emerging in the Indian market.The post-2020 boom indicates that the Indian EV market is no longer in a pilot phase, but entering a high-growth stage.
A startup entering now has the opportunity to ride this wave of market momentum.
The growing sales indicate a favorable environment for new players, especially if the company targets price-sensitive and high-demand segments like 2-wheelers or commercial 3-wheelers.

```
yearly_sales_melted = yearly_sales.melt(id_vars='YearOnly',
var_name='Vehicle Type', value_name='Units Sold')



# Set plot style

sns.set(style="whitegrid")
```

```
# Create bar plot

plt.figure(figsize=(12, 7))

sns.barplot(data=yearly_sales_melted, x='YearOnly', y='Units Sold',
hue='Vehicle Type')

plt.title('Yearly EV Sales by Vehicle Type', fontsize=16)

plt.xlabel('Year', fontsize=12)

plt.ylabel('Total Units Sold', fontsize=12)

plt.legend(title='Vehicle Type')

plt.xticks(rotation=45)

plt.grid(axis='y')

plt.tight_layout()

plt.show()
```



This grouped bar chart displays how sales of different EV vehicle types — **Two-Wheelers (2W), Three-Wheelers (3W), Four-Wheelers (4W), and Buses** — have changed year by year from 2017 to 2023.

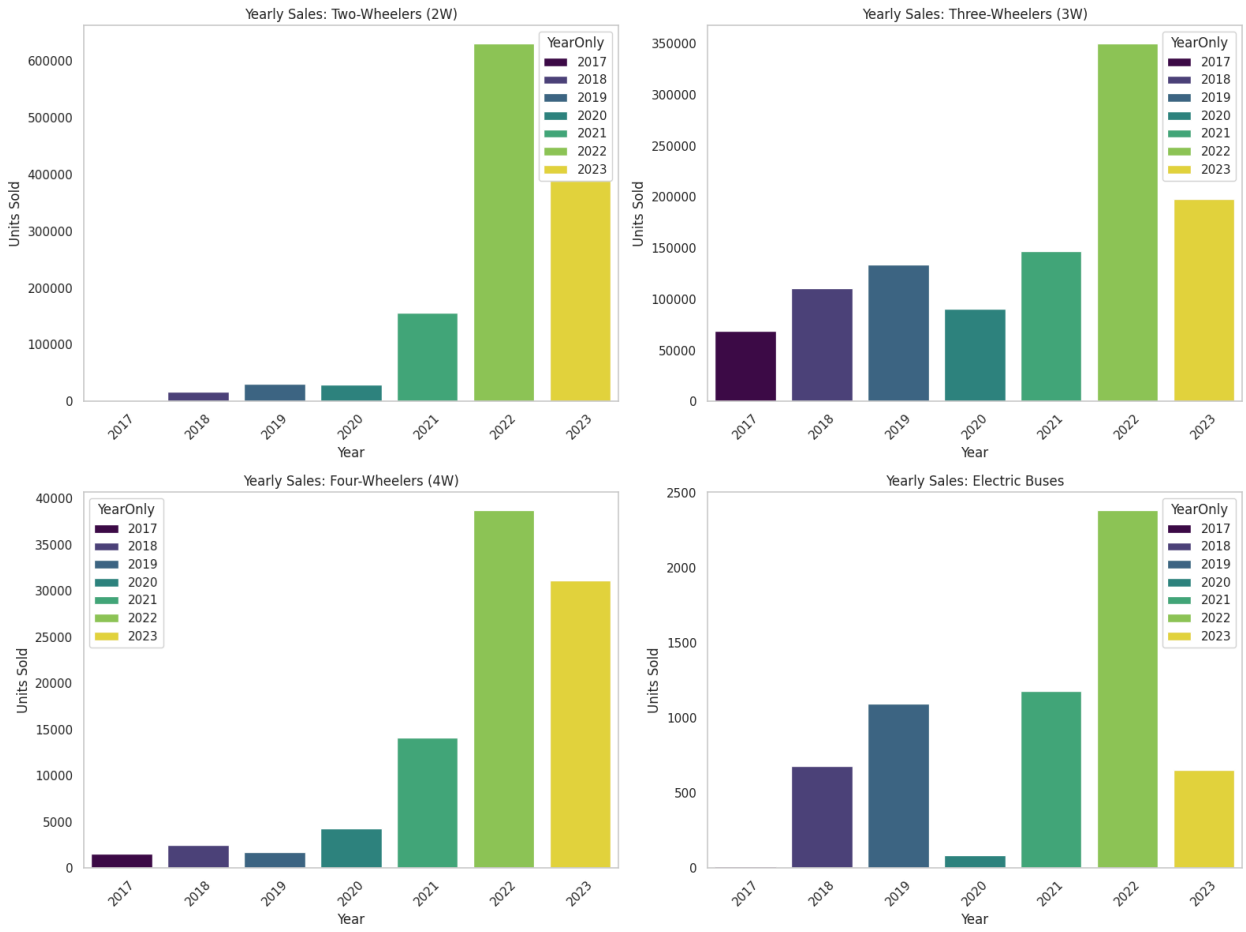
This category consistently shows the **highest sales volume** across almost all years.
The rapid rise after 2021 suggests **strong consumer demand**, particularly in **urban areas** where 2W EVs are seen as affordable, low-maintenance, and ideal for short-distance commuting.

The 3W segment has seen **steady and reliable growth** over the years.

Although still behind 2W and 3W in total volume, 4W EV sales are **increasing gradually** each year.

```
vehicle_types = ['2_Wheeler', '3_Wheeler', '4_Wheeler', 'Bus']

titles = ['Two-Wheelers (2W)', 'Three-Wheelers (3W)', 'Four-Wheelers
(4W)', 'Electric Buses']



# Plot each vehicle type in a separate subplot

plt.figure(figsize=(16, 12))



for i, vt in enumerate(vehicle_types):

   plt.subplot(2, 2, i + 1)

   sns.barplot(data=yearly_sales, x='YearOnly', y=vt,
palette='viridis',hue='YearOnly')

   plt.title(f'Yearly Sales: {titles[i]}')

   plt.xlabel('Year')

   plt.ylabel('Units Sold')
```

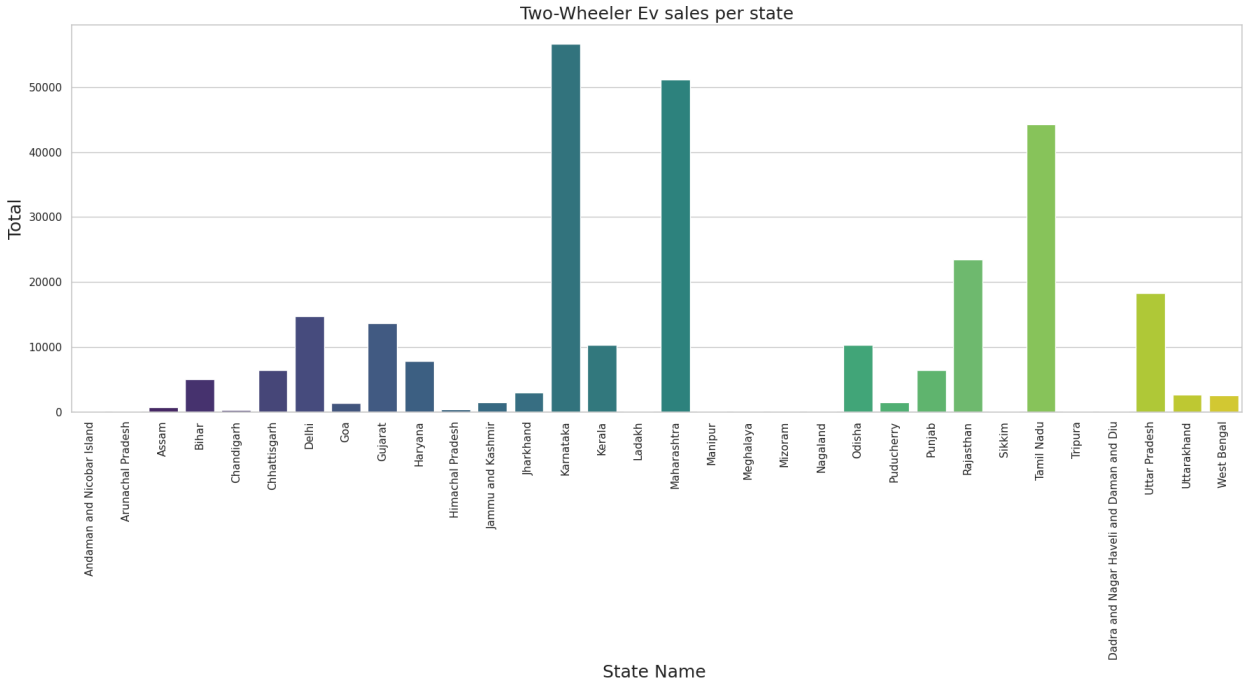
```
    plt.xticks(rotation=45)

    plt.grid(axis='y')



plt.tight_layout()

plt.show()
```



Each subplot breaks down the yearly sales of a specific EV type. This makes it easier to **analyze the adoption trend for each category individually**, without overlap.

EDA for second dataset

```
sns.barplot(data=df,x='State_Name',y='Two_Wheeler',palette='viridis')
```

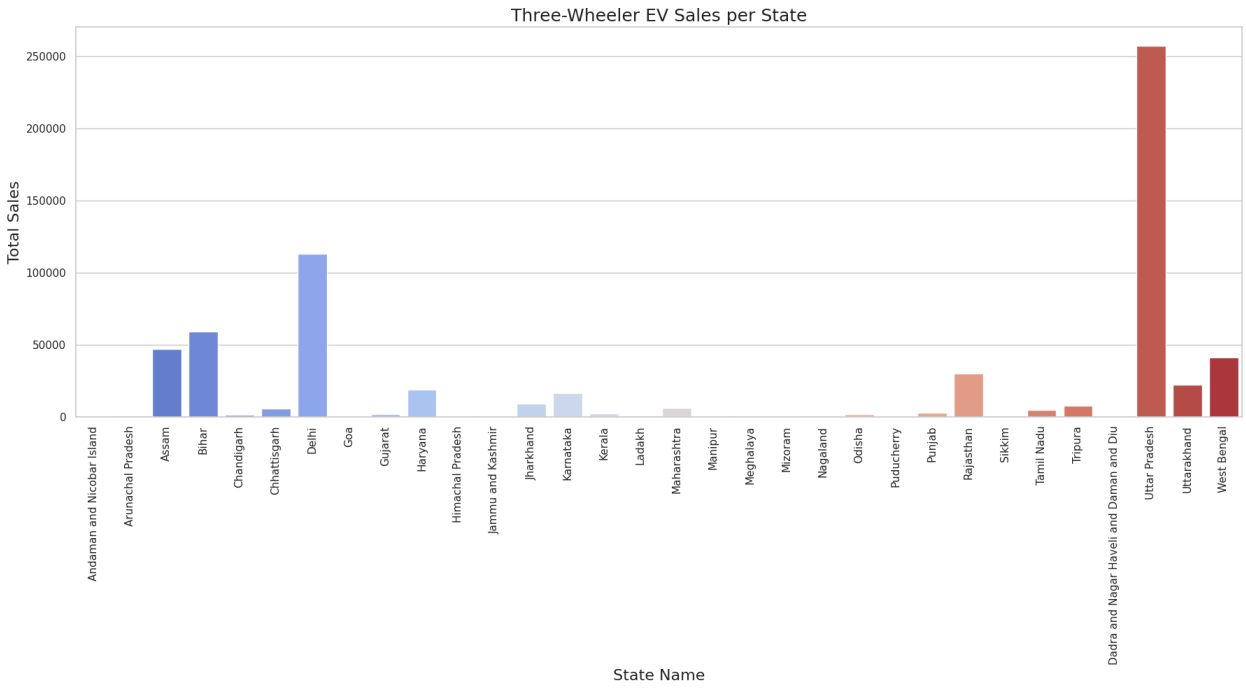


This bar chart shows the **total 2W EV sales across various Indian states**.

Top states like Delhi, Maharashtra, Karnataka, Tamil Nadu, and Gujarat have the highest 2W EV sales.On the other hand, some states with large populations (e.g., Uttar Pradesh, Bihar) have lower EV penetration.Focus marketing on urban Tier-1 cities, then gradually expand to Tier-2 cities in those same states.

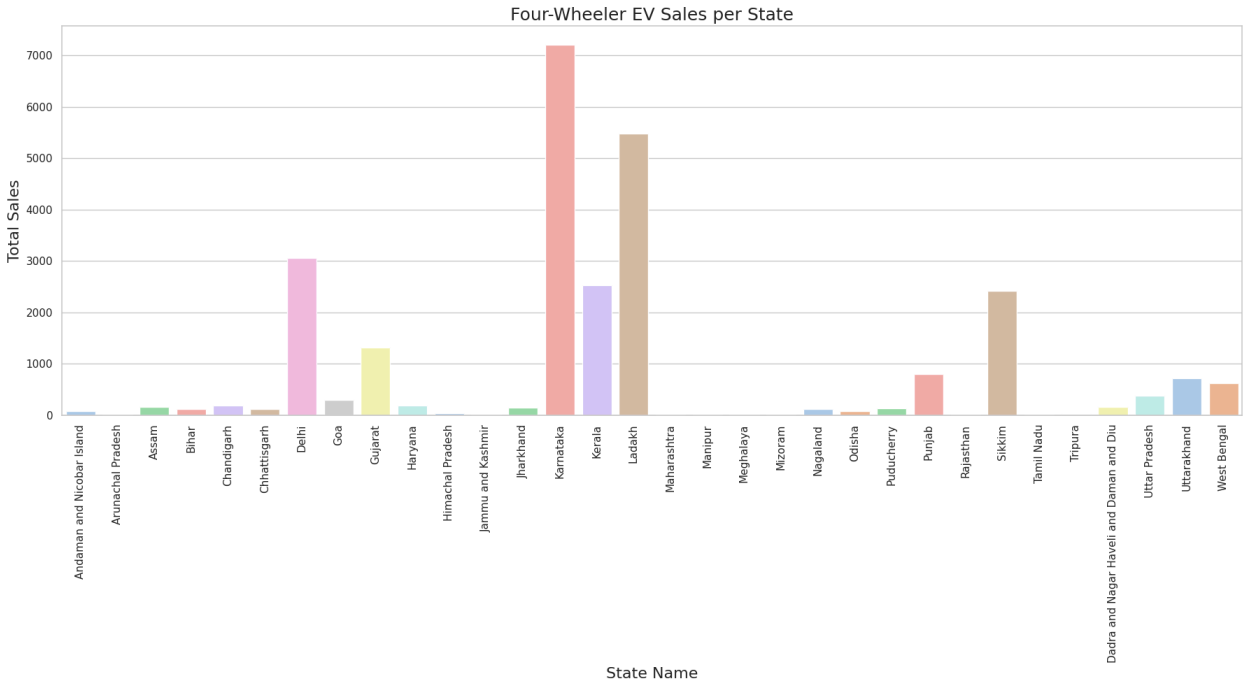
```
plt.figure(figsize=(18, 10), facecolor='White')

sns.barplot(data=df, x='State_Name', y='Three_Wheeler',
palette='coolwarm')

plt.xticks(rotation=90)  # Rotate state names for better readability

plt.title("Three-Wheeler EV Sales per State", fontsize=18)

plt.xlabel("State Name", fontsize=16)
```

```
plt.ylabel("Total Sales", fontsize=16)

plt.tight_layout()

plt.show()
```



Similar to the 2W graph, this one shows **3W EV sales by state**.

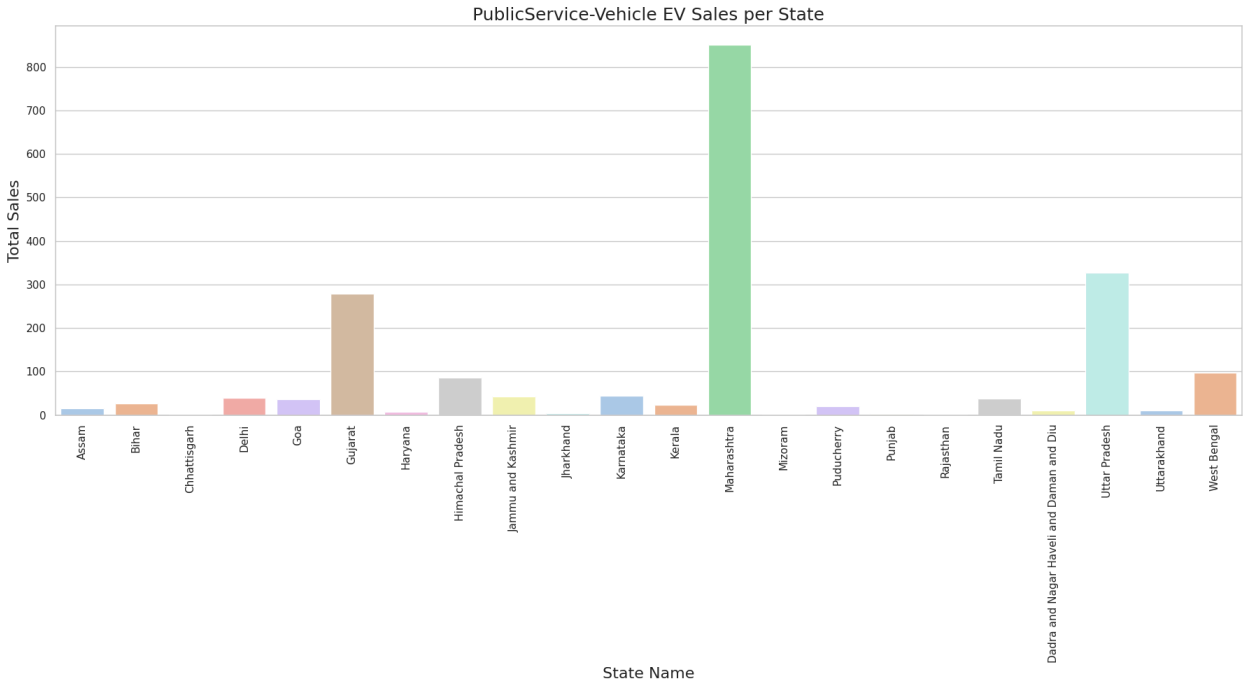
Uttar Pradesh, Delhi, Bihar, and Assam lead in 3W sales.3W EV models should target Tier-2/Tier-3 cities with high population density and low-cost commuting demand. Opportunity to partner with small fleet operators, self-employed drivers, or EV rental companies.



This bar plot displays the number of **Four-Wheeler EVs sold in each Indian state**.

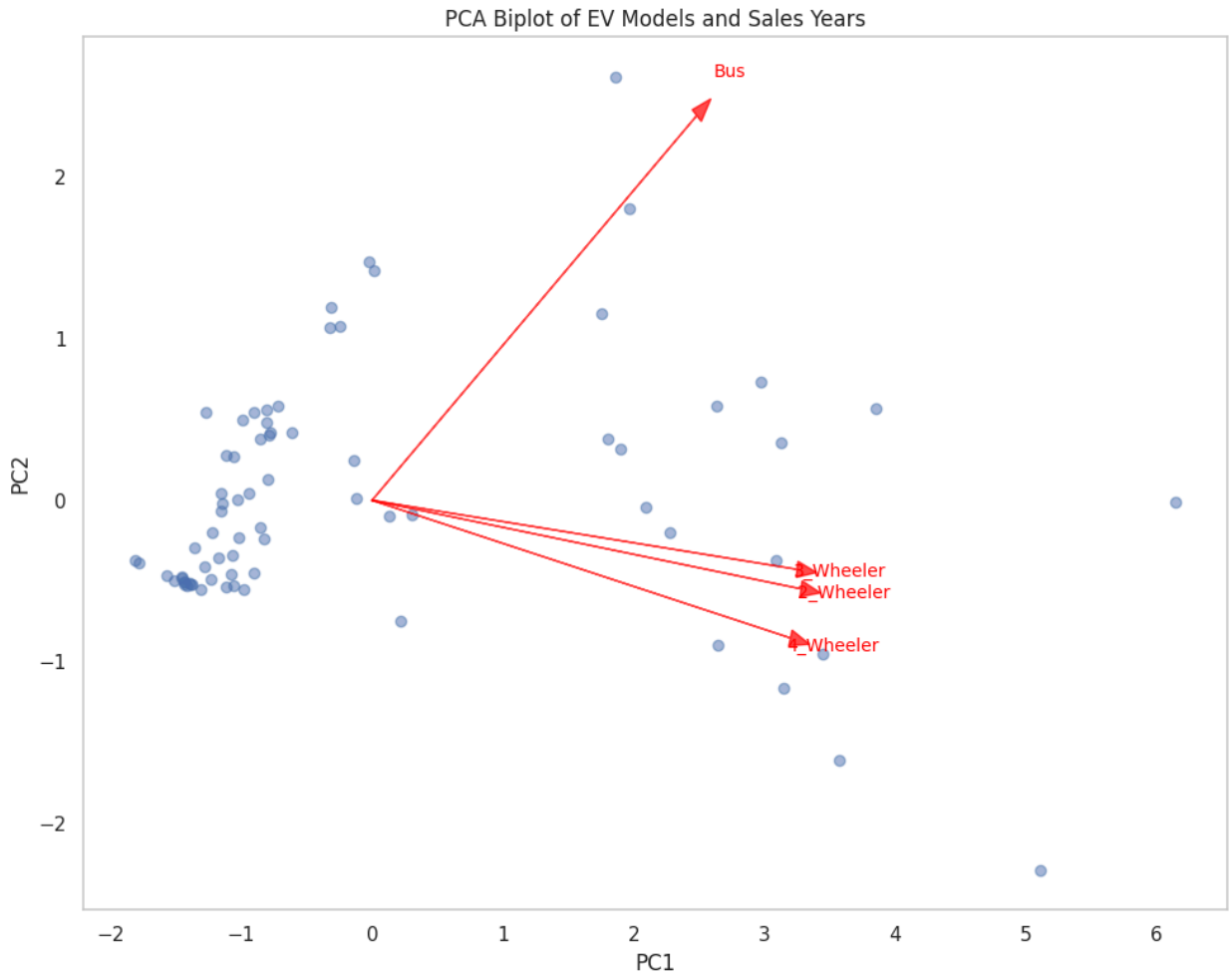
The leading states in 4W EV sales are **Delhi, Maharashtra, Karnataka, Tamil Nadu, and Gujarat** all economically developed and urbanized.States like **Haryana, Kerala**, and **Andhra Pradesh** also show some adoption, possibly due to private and government fleets.

If targeting the **4W EV market**, startups should consider:Focusing on **urban private car owners** or **fleet services,**Partnering with businesses for **electric fleet conversion.**



This bar plot displays the number of **PublicService-vehicle EVs sold in each Indian state**.

SEGMENTATION USING CLUSTERING



To identify meaningful patterns and segment the electric vehicle (EV) market, we applied Principal Component Analysis (PCA) on the dataset comprising EV sales across various categories (Two-Wheelers, Three-Wheelers, Four-Wheelers, and Buses) over different years or regions. The resulting PCA biplot visually reduces the multidimensional data into two principal components (PC1 and PC2), allowing us to understand the structure and correlations between vehicle types.

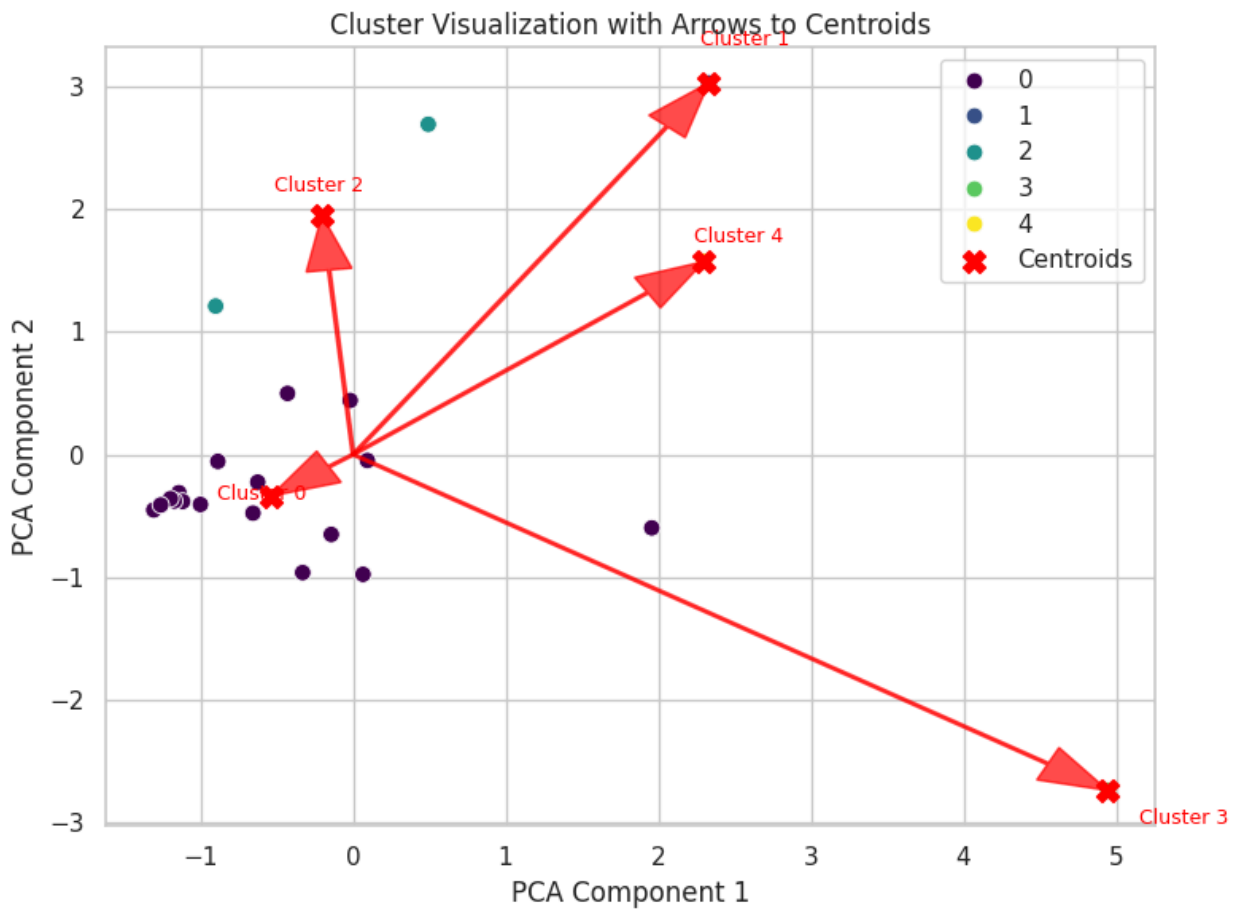
The biplot shows distinct clustering of data points and the influence of each EV category. The arrows representing vehicle types indicate the direction and strength of their influence. Notably, Two-Wheelers, Three-Wheelers, and Four-Wheelers point in a similar direction, suggesting correlated trends—likely driven by private consumers and urban fleet operators. These points cluster on the right side of the plot, representing high adoption zones or recent years with increased market penetration.

In contrast, the vector for Buses points in a different direction, with points along that path forming a separate cluster. This indicates that electric buses follow a different sales trend, driven primarily by government initiatives, public transport policies, and state-level procurements.

This analysis helps clearly segment the market into:

- Personal and fleet-focused segments (2W, 3W, 4W) in urban regions,
- Government/public transport-driven segments (Bus),
- And regions or years with low adoption that fall away from all strong vectors.

From a strategic perspective, this segmentation provides valuable insight for market entry. A startup can initially focus on the high-density clusters (2W/3W/4W) in urban states with proven adoption while preparing long-term plans to collaborate with public authorities for bus deployment in high-potential regions.



To enhance segmentation analysis, we applied **K-Means clustering** to the dimensionality-reduced data (via PCA) to identify distinct EV consumer/vehicle behavior groups. The plot above shows how the data points group into **five clusters** based on similarities in EV adoption characteristics, such as vehicle type usage, sales volume, or demographic-geographic patterns.

Each colored point represents an observation (e.g., state or region), and the red crosses indicate **cluster centroids**, i.e., the "center" of each cluster. Red arrows point from the origin to each cluster centroid, visually illustrating the direction and spread of the clusters in PCA space.

- **Cluster 1** and **Cluster 3** represent **high-value target markets**—urban, incentive-rich zones with early adoption behavior.

- **Cluster 2** provides an opportunity to target **electric logistics or rickshaw markets**, ideal for low-cost, high-volume models.

- **Cluster 0** may require **awareness campaigns or pilot programs** to increase adoption.

- This segmentation enables the startup to **tailor its go-to-market strategy**, choosing entry points based on cluster characteristics rather than treating the EV market as homogeneous.

Customizing the Marketing Mix

1. Product

- **Cluster 1 (Urban High-Adoption Zones):**
  Focus on **sleek, feature-rich 2W and 4W EVs** for personal use. Customers here demand performance, charging convenience, and smart features (e.g., app control, GPS, fast charging). Offer variants catering to both youth and working professionals.

- **Cluster 2 (Three-Wheeler Dominant):**
  Provide **affordable e-rickshaws or commercial three-wheelers** tailored for shared mobility and logistics. Prioritize durability, battery life, and low maintenance. Integrate fleet tracking or B2B service plans.

- **Cluster 3 (Policy-Driven Outliers):**
  Offer **high-capacity vehicles or public fleet options** like electric buses or goods carriers. These markets can benefit from direct collaboration with government or local bodies under PPP or subsidy schemes.

- **Cluster 0 (Emerging Markets):**
  Launch **entry-level 2W/3W EVs** with flexible battery options (swappable vs fixed). Focus on utility and affordability to encourage adoption in low-penetration areas.

2. Price

- **Value-based pricing** in mature urban clusters (Cluster 1) where customers are willing to pay for quality and brand.

- **Cost-efficient or leasing models** for B2B users in Clusters 2 and 4, offering pay-per-use or EMIs to lower upfront cost barriers.

- **Subsidy-aligned pricing** in Cluster 3 to capture policy benefits and large-volume government contracts.

- **Penetration pricing strategy** in Cluster 0 to attract early users and build word-of-mouth in low-awareness regions.

3. Place (Distribution Strategy)

- **Direct-to-consumer** online platforms and flagship showrooms in Cluster 1 (urban tier-1 cities).

- **Local dealership & service partnerships** in semi-urban Cluster 0 and Cluster 2 to reach deep into the regional network.

- **Government tenders and institutional sales** channels in Cluster 3.

- Consider **mobile service units and battery swapping stations** in remote or high-usage B2B segments.

4. Promotion

- **Digital marketing & influencer tie-ups** for Cluster 1 to reach tech-savvy youth and urban professionals.

- **Local demonstrations, roadshows, and financial awareness camps** in Cluster 0 and Cluster 2.

- **CSR and public-private partnerships** in Cluster 3 for positive brand positioning with government and communities.

- **B2B targeted promotions**, fleet ROI calculators, and ecosystem incentives for Cluster 2 and 4.

Analysing Market Segments

1. **Vehicle Type Preferences Vary Geographically:**
    - Urban hubs prioritize **2-wheelers and 4-wheelers** for personal use.
    - Rural and tier-2/3 cities show rising demand in **3-wheelers and goods vehicles** for logistics and shared mobility.
2. **Policy Influence is Crucial:**
    - States with clear EV policies or incentives (Cluster 3) show steeper adoption curves.
    - Partnerships with state governments in such clusters could offer early mover advantages.
3. **Behavioral Differences are Clear:**
    - Some regions are **value-seeking**, preferring affordable vehicles (Cluster 0, 2).
    - Others are **technology-driven**, seeking performance and smart features (Cluster 1, 4).
4. **Infrastructure and Charging Access Varies Widely:**
    - Urban areas show readiness for EV infrastructure (home charging, fast charging).
    - Semi-urban and rural segments need innovative charging solutions (like battery swapping or mobile charging units).

Suitable Early Market Strategy

1. Focus on High-Potential Urban Clusters

Target Regions: Delhi, Bengaluru, Mumbai, Pune, Hyderabad
Reason: These cities show high 2W and 4W electric vehicle adoption, policy support, and better infrastructure (charging points, tech-savvy population).

Strategy:

- Launch premium electric 2-wheelers and compact 4-wheelers aimed at personal mobility.
- Offer app-enabled features (navigation, diagnostics) to attract tech-oriented consumers.
- Establish fast-charging networks or tie-ups with existing charging providers.

2. Tap the Commercial Mobility Segment (Cluster 2 & 4)

Target Regions: Uttar Pradesh, Bihar, Tamil Nadu, Gujarat
Reason: These clusters show a dominant share of electric 3-wheelers and goods vehicles, indicating strong B2B and shared transport demand.

Strategy:

- Introduce durable, affordable 3W EVs for last-mile delivery and passenger transport.
- Provide fleet leasing models and battery swapping solutions to reduce operating costs.
- Collaborate with local delivery aggregators and transport unions.

3. Collaborate in Policy-Driven States (Cluster 3)

Target Regions: Andhra Pradesh, Telangana
Reason: High growth in EV sales is driven by state-level incentives, subsidies, and pilot programs.

Strategy:

- Partner with state governments for EV fleet trials, school buses, or public utility vehicles.
- Leverage FAME II and state-specific EV incentives to reduce cost and boost adoption.
- Apply for government tenders and public transport contracts.

4. Pilot Programs in Emerging Markets (Cluster 0)

Target Regions: Northeast states, smaller towns
Reason: Currently low adoption but with future potential due to rising awareness and government focus on EV penetration in underserved areas.

Strategy:

- Start with pilot projects or micro-fleet launches to assess demand.
- Partner with local NGOs or panchayats for awareness campaigns and education.
- Deploy portable or solar-powered charging units for remote accessibility.

Conclusion

In this project, we conducted a comprehensive segmentation analysis of the Indian Electric Vehicle (EV) market using two key datasets—one detailing year-wise EV sales across various vehicle types, and the other capturing geographic and demographic EV distribution across Indian states. Our objective was to identify high-potential customer and vehicle segments and to formulate a suitable entry strategy for an EV startup in India.

Our analysis revealed that electric two-wheelers and three-wheelers currently dominate the Indian EV market due to their affordability, utility in daily commuting, and adaptability to the Indian road and traffic conditions. Four-wheelers and electric buses are gaining traction**,** especially in urban regions and through government-led transport initiatives. Using exploratory data analysis (EDA), we identified major contributing states such as Delhi, Maharashtra, Karnataka, Uttar Pradesh, and Gujarat—all of which show strong sales trends across multiple EV categories.

To understand underlying patterns, we applied Principal Component Analysis (PCA) and K-Means clustering, which helped classify states into five distinct clusters based on vehicle sales behavior and demographic trends. These clusters highlighted specific use-case segments:

- Cluster 1 represented urban centers with high adoption and demand for personal EVs.
- Cluster 2 and 4 included regions with strong commercial EV use, particularly in the form of electric three-wheelers and goods vehicles.
- Cluster 3 showed high EV adoption driven largely by state policy incentives and pilot projects.
- Cluster 0 represented emerging or low-adoption areas with future potential, especially in underserved or rural regions.

Based on these findings, we developed a phased go-to-market strategy. The startup should first enter metro markets by offering smart, app-connected 2W and compact 4W EVs for personal use. Next, it should target commercial hubs by deploying electric 3-wheelers and goods carriers under flexible pricing and leasing models. Partnerships with governments in policy-active states will be crucial for scaling into public EV fleets. Finally, pilot projects and awareness drives can help penetrate emerging rural markets, building long-term brand visibility and trust.

In conclusion, the Indian EV market presents a wide range of opportunities across personal, commercial, and public mobility sectors. By leveraging segmentation insights and tailoring the product, pricing, and distribution strategies accordingly, our startup can make a data-driven, scalable, and impactful entry into this rapidly growing space.