Market Segmentation Analysis of Electric Vehicles Market in India

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Project 2

Github: https://github.com/kapishash/ev_market_segmentation

OVERVIEW

Currently, over 90% of vehicles worldwide rely on oil for fuel, but there is a growing trend towards alternative energy sources for powering vehicles. This shift has brought electric vehicles (EVs) into the spotlight. Unlike traditional vehicles that use internal combustion engines, EVs operate on electric motors, making them a potential replacement for conventional automobiles in the near future.

The escalating issue of global air pollution underscores the need for sustainable development, and electric cars offer a viable solution. With the urgent requirement for smarter infrastructure and more supportive government policies, EVs are poised to play a crucial role in India's energy and mobility sectors. Presently, the market share of EVs, HEVs, and PHEVs in India is around 0.1%, with the majority of vehicles still dependent on fossil fuels. This reliance contributes to atmospheric pollution through the emission of greenhouse gases, exacerbating global warming.

India's transportation sector is expanding rapidly, and the gap between domestic crude oil production and consumption is widening. As a country that imports approximately 70% of its annual oil requirements, India faces an urgent need to explore sustainable and clean transportation alternatives. Electrified vehicles represent a promising, clean, and sustainable form of transportation, making them a key area of investigation for developing eco-friendly solutions.

The current state of the road transportation sector in India can be summarized as follows:

- The transportation sector in India accounts for approximately 28% of total energy consumption, and it is mostly dependent on oil.
- India has experienced a five-fold growth in per capita vehicle ownership, registering a total road vehicle stock of over 250 million in 2019, comprising two-wheelers (2W), three-wheelers (3W), and four-wheelers (4W)
- India's per capita energy consumption in 2021-22 stood at about 24.45 gigajoules (GJ), which is significantly lower than the world average of 75.6 GJ for the same year
- The transport sector in India is the third most GHG emitting sector, with a major contribution from road transport. Road transport accounts for nearly 80% of the transport demand and 94% of the total transport energy demand in India.
- The Indian EV market is evolving fast, with close to 0.32 million vehicles sold in 2021, up 168% year-over-year. Over the last three years, 0.52 million EVs were registered in India

Unlike many other countries, India has a high vehicle to people ratio. Despite this, the country's large population contributes to significant emissions. India ranks third globally in CO2

emissions, with a total of 1.726 billion metric tons. This underscores the urgent need to focus on electric vehicle (EV) technology, which has the potential to achieve zero emissions and support sustainable transportation.

Market Overview

The Indian Electric Vehicle (EV) market is categorized based on Vehicle Type and Power Source.

By Vehicle Type, the market is divided into:

- Passenger Cars
- Commercial Vehicles
- Two- and Three-wheelers

By Power Source Type, the market is classified into:

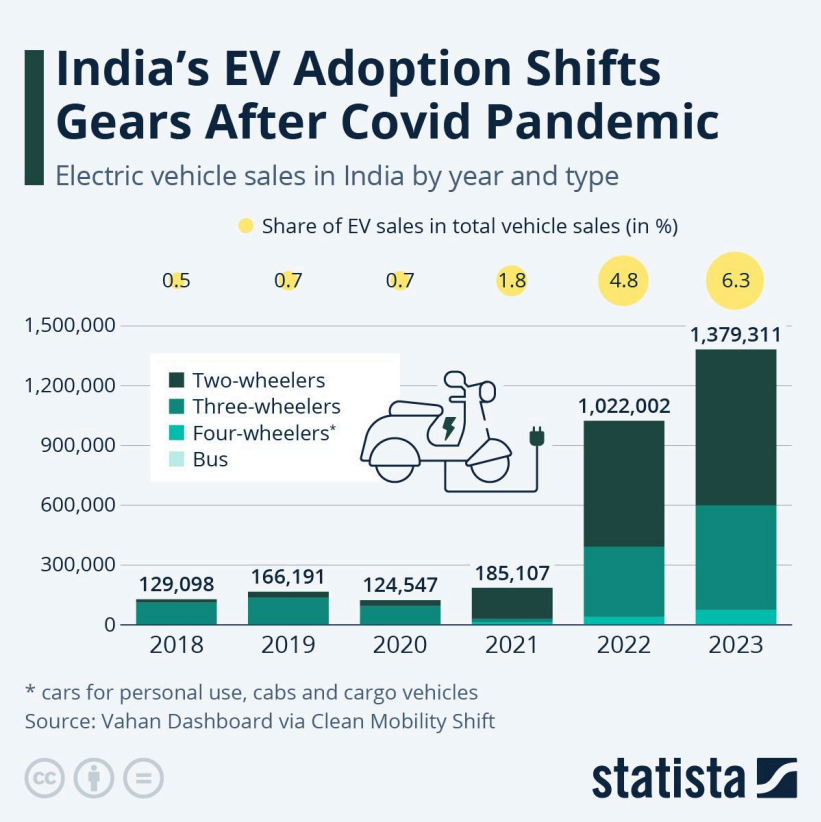
- Battery Electric Vehicles (BEVs)
- Plug-in Electric Vehicles (PHEVs)
- Hybrid Electric Vehicles (HEVs)

In 2020, the Indian Electric Vehicle (EV) market was valued at USD 5 billion. It is projected to grow to USD 47 billion by 2026, with a compound annual growth rate (CAGR) exceeding 44% during the period from 2021 to 2026.

The COVID-19 pandemic has significantly affected the Indian EV market, causing supply chain disruptions and halting manufacturing operations due to continuous lockdowns and travel restrictions. Despite these challenges, the EV market in India is still in its early stages and is poised for rapid growth in the coming years. This anticipated growth is driven by various government initiatives and supportive policies

The EV market in India has experienced a notable surge following the introduction of the FAME India scheme (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India). This initiative aims to accelerate the transition towards e-mobility, driven by increasing international policy commitments and environmental concerns. Additionally, India presents the world's largest untapped market, particularly in the electric two-wheeler segment. With 100%

foreign direct investment permitted in this sector, the market is poised for substantial growth during the forecast period.



In India, 1,675,800 electric vehicles (EVs) were sold between April 1, 2023 and March 31, 2024. This is a 42% increase from the previous year.

some highlights from the sales data:

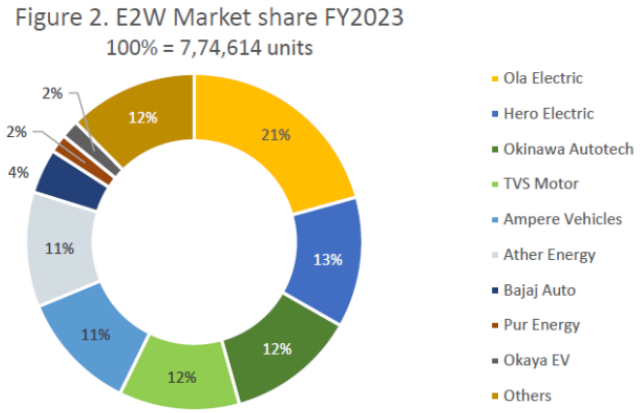
- Sales trend: Sales increased steadily from April 2023, peaking at 212,502 units in March 2024. There was a slight dip in June 2023 due to reduced subsidies, but sales rebounded in July 2023.
- State sales: Karnataka had the highest e-Bus sales in Q4 FY 23-24, with 419 units sold.
- Company sales: Tata Motors accounted for the highest sales in Q3 2023, with 12,491 units, followed by MG Motors with 3,205 units.
- Two-wheeler sales: Sales of electric two-wheelers jumped from 12,094 units to 55,057 units

GOVERNMENT INITIATIVES AND POLICIES SUPPORTING THE EV INDUSTRY

The Indian government has implemented several initiatives to support the growth of the EV market, such as the FAME scheme. One notable effort is the National Electric Mobility Mission Plan (NEMMP), aimed at enhancing the manufacturing capabilities of local automakers. This roadmap seeks to make electric vehicles economically viable and self-sustaining by 2020. The government has allocated significant investments, including over INR 13,000 crore for demand incentives, INR 1,800 crore for R&D, INR 5,000 crore for power infrastructure, and INR 1,200 crore for charging infrastructure. The plan aims to promote reliable, affordable, and efficient EVs that meet consumer performance and price expectations. It also involves collaboration between the government and industry to foster indigenous manufacturing capabilities, raise consumer awareness, advance technology, and develop the necessary infrastructure. These efforts aim to position India as a global leader in the electric two-wheeler and four-wheeler markets by 2026.

Market Challanges

While the push for electric vehicles (EVs) in India is gaining momentum, the actual sales of EVs have not kept up with the hype. Several factors contribute to the slow adoption of EVs, including limited options in the passenger car segment, concerns about vehicle driving range, affordability issues, and the lack of adequate charging infrastructure.



Market Segmentation

Two datasets have been used for market segmentation

1. Indian automoble buying behavour
2. Ev market data

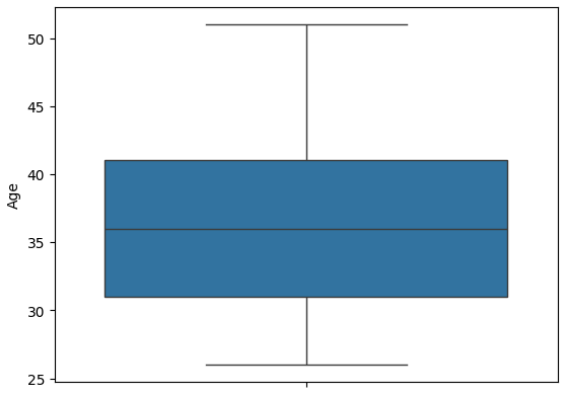
The dataset we have used is a survey of people who own particular brands of fuel-based vehicles and it contains some basic information such as their age, salary, loan status, marital status, number of dependents, education, occupation and the make of their car and its price.

Demographic Insights

Age

- Mean Age: The average age is approximately 36.3 years.
- Standard Deviation: The standard deviation is about 6.25 years, indicating a moderate spread around the mean.
- Range: The age ranges from 26 to 51 years.
- Quartiles:
    - 25th percentile (Q1): 31 years
    - 50th percentile (Median, Q2): 36 years
    - 75th percentile (Q3): 41 years

Insight: The dataset primarily consists of individuals in their mid-30s to early 40s, which is a key demographic for purchasing decisions, including electric vehicles (EVs).

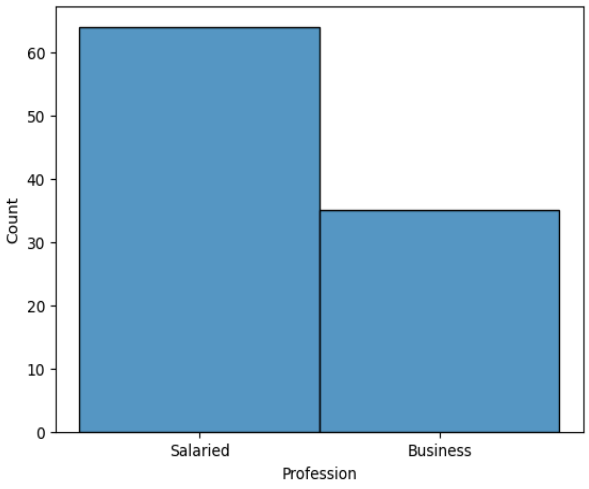


Profession Distribution

- Salaried: 64 individuals
- Business: 35 individuals

Insights

1. Majority are Salaried: The majority of the individuals in the dataset are salaried employees, making up approximately 64.6% of the total. This suggests that the market for electric vehicles (EVs) is largely driven by professionals with steady incomes.
2. Business Owners: Business owners make up about 35.4% of the total. This segment might have different purchasing behaviors and financial considerations compared to salaried individuals.

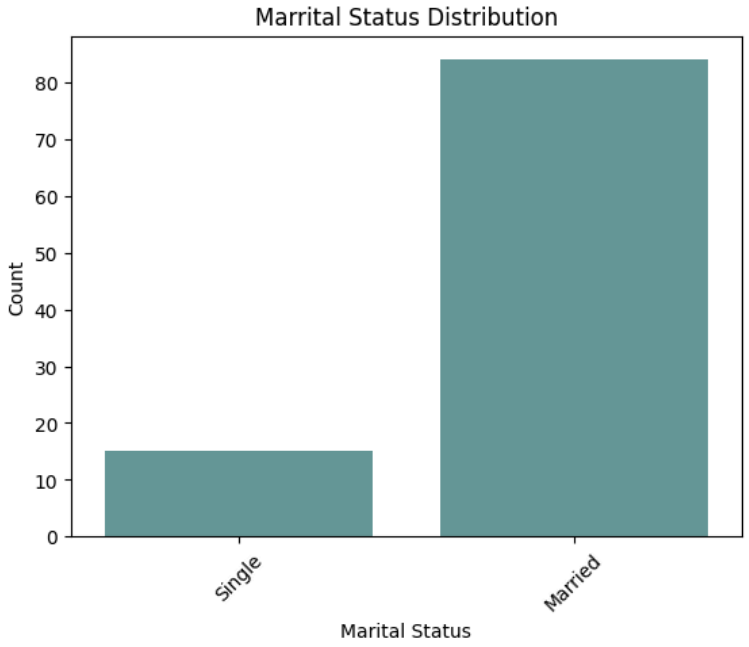


Marital Status Distribution

- Married: 84 individuals
- Single: 15 individuals

Insights

1. Majority are Married: The majority of the individuals in the dataset are married, making up approximately 84.8% of the total. This suggests that the market for electric vehicles (EVs) is largely driven by married individuals, who may have different priorities and considerations compared to single individuals.
2. Single Individuals: Single individuals make up about 15.2% of the total. This segment might have different purchasing behaviors and financial considerations compared to married individuals.



Financial Insights

Number of Dependents Distribution

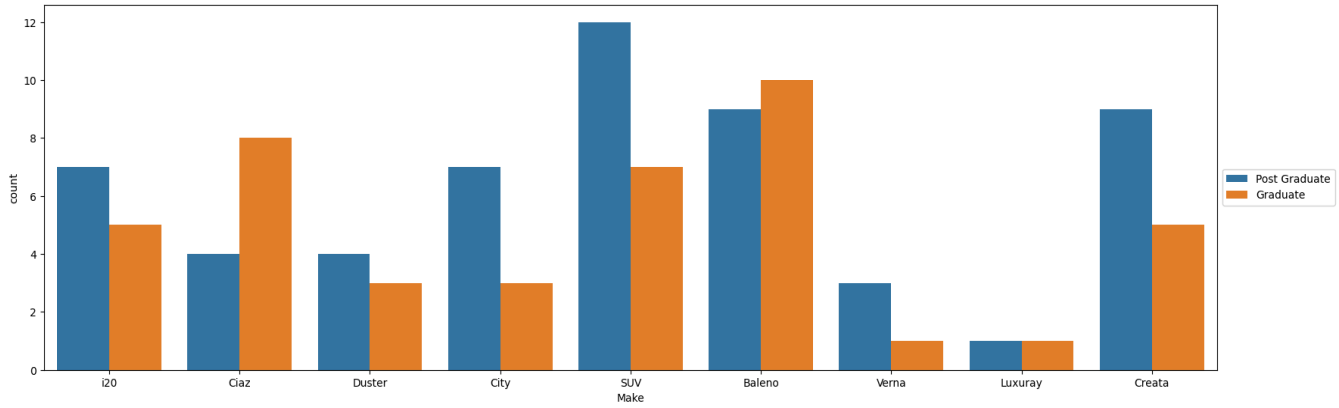
- 3 Dependents: 34 individuals
- 2 Dependents: 29 individuals
- 0 Dependents: 22 individuals
- 4 Dependents: 14 individuals

Insights

1. Majority with Dependents: The majority of individuals have dependents, with 34 having 3 dependents and 29 having 2 dependents. This suggests that family considerations are important in purchasing decisions.
2. No Dependents: A significant number of individuals (22) have no dependents, indicating a segment with potentially different purchasing behaviors and financial considerations.
3. High Number of Dependents: A smaller but notable group (14 individuals) have 4 dependents, suggesting a need for vehicles that can accommodate larger families.

Education

Vehicle purchase by education type.



Personal Loan

Personal Loan Distribution

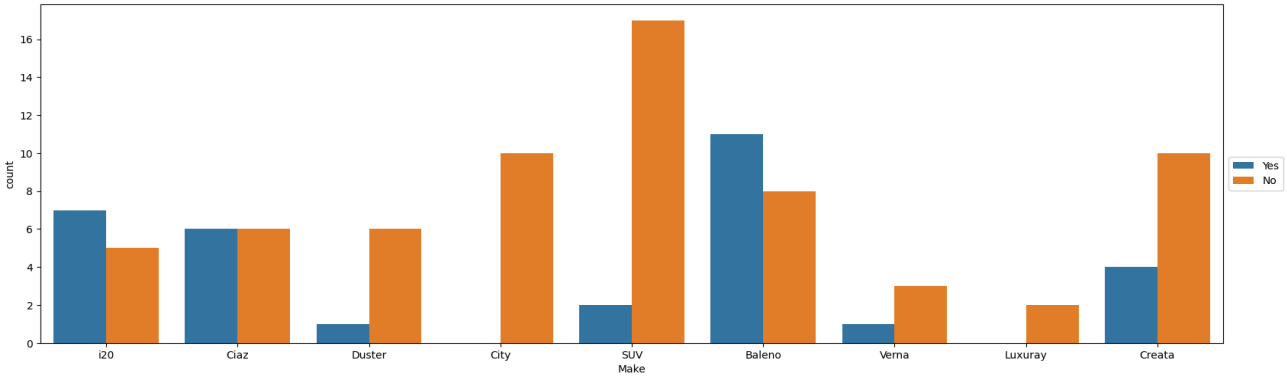
- No Personal Loan: 67 individuals
- Yes Personal Loan: 32 individuals

Insights

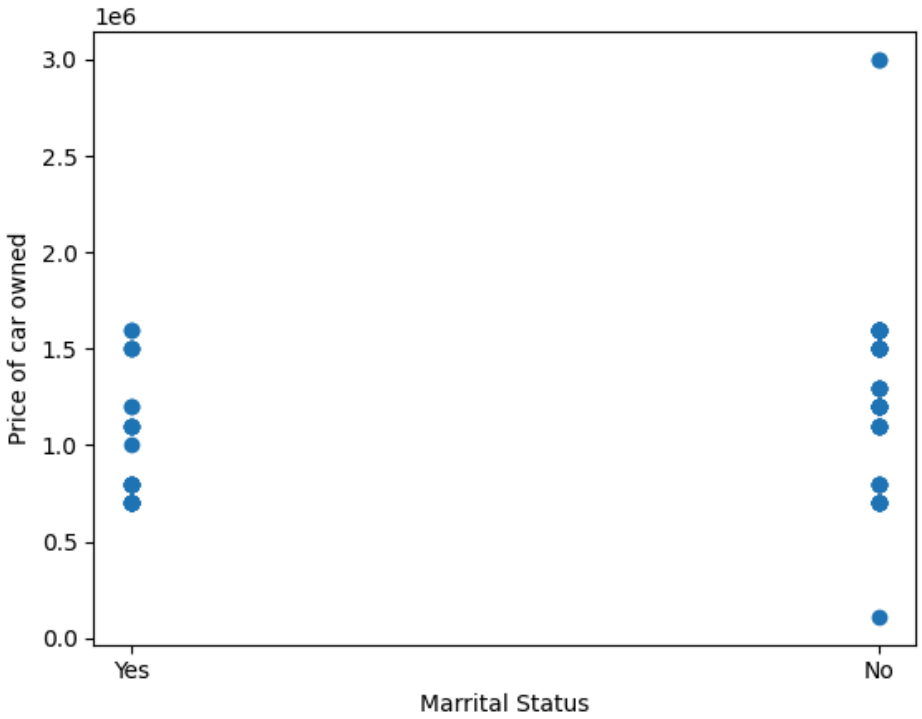
1. Majority Without Personal Loans: The majority of individuals (67 out of 99, or approximately 67.7%) do not have personal loans. This suggests that a significant portion of the market may

have fewer financial commitments, making them more open to considering electric vehicle (EV) purchases.

2. Individuals with Personal Loans: A notable minority (32 out of 99, or approximately 32.3%) have personal loans. This segment might have different financial considerations and purchasing behaviors due to their existing financial commitments.



Purchase of Vehicle Owned:



Distribution of Different demographic Variables:

Distplot of Age

- Description: This plot shows the distribution of ages in the dataset.
- Observations:
    - The age distribution appears to be roughly normal, with most individuals falling between 30 and 50 years old.
    - There are some outliers, with a few individuals being younger (around 20 years) or older (around 60 years).
    - The peak density is around the mid-30s to early 40s.

2. Distplot of Number of Dependents

- Description: This plot shows the distribution of the number of dependents.
- Observations:
    - The distribution is bimodal, with peaks at 0 and 3 dependents.
    - A significant number of individuals have either no dependents or three dependents.
    - There are fewer individuals with 1, 2, or 4 dependents.

3. Distplot of Salary

- Description: This plot shows the distribution of salaries (in units of 1e6, likely lakhs or hundreds of thousands).
- Observations:
    - The salary distribution is right-skewed, with most salaries clustered around the lower end (0 to 2e6).
    - There is a long tail indicating a few individuals with much higher salaries (up to 4e6).
    - The peak density is around 1e6.

4. Distplot of Wife Salary

- Description: This plot shows the distribution of wives' salaries (in units of 1e6).
- Observations:
    - Similar to the salary distribution, this is also right-skewed.
    - Most wives' salaries are clustered around the lower end (0 to 1e6).
    - There is a long tail indicating a few individuals with much higher salaries (up to 4e6).
    - The peak density is around 0.5e6.

5. Distplot of Total Salary

- Description: This plot shows the distribution of total household salaries (in units of 1e6).
- Observations:
    - The total salary distribution is also right-skewed.
    - Most total salaries are clustered around the lower to middle range (0 to 5e6).
    - There is a long tail indicating a few households with much higher total salaries (up to 7e6).
    - The peak density is around 2e6.

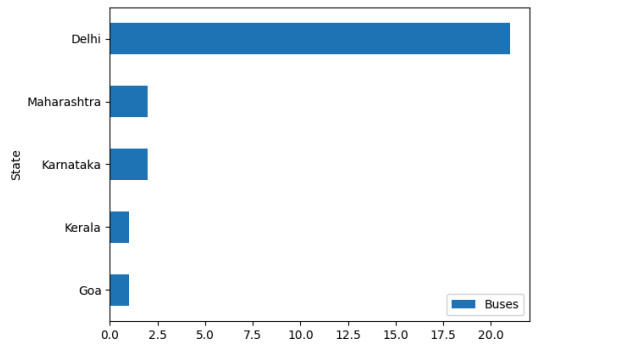
6. Distplot of Price

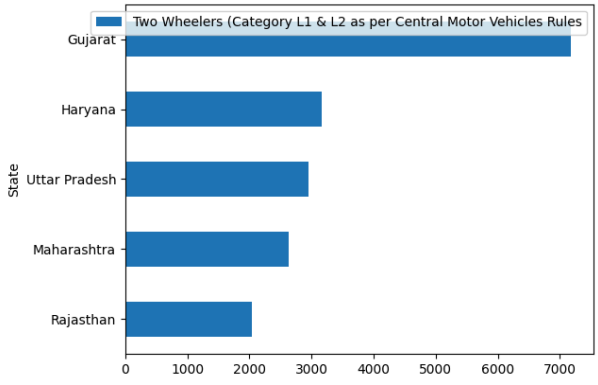
- Description: This plot shows the distribution of prices (in units of 1e6).
- Observations:
    - The price distribution is right-skewed, with most prices clustered around the lower end (0 to 1e6).
    - There is a long tail indicating a few items with much higher prices (up to 2e6).
    - The peak density is around 0.5e6.

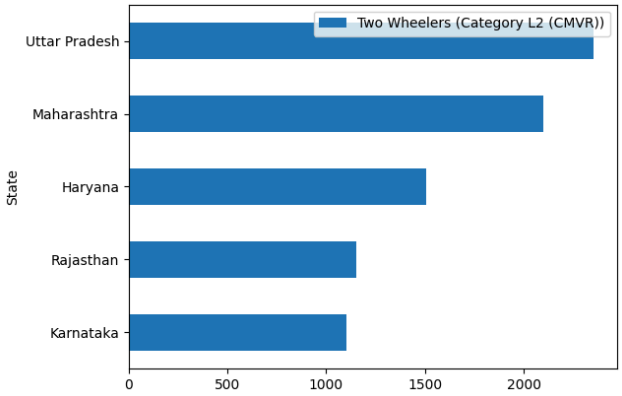
GEOGRAPHIC ANALYSIS:

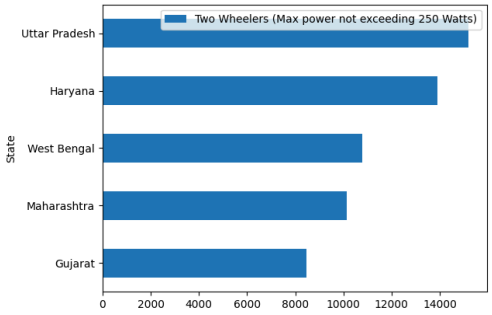
Geographic segmentation is a crucial component of a marketing strategy, allowing businesses to target products or services based on where their consumers live. This segmentation can be done by dividing the market into countries, states, regions, cities, colleges, or specific areas to better understand and cater to the audience. In this analysis, we have segmented the market by states and union territories in India.

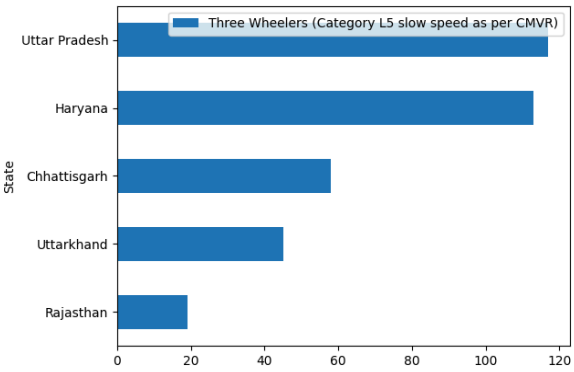
For our geographic analysis, we utilized a dataset of state-wise sales of different types of electric vehicles (EVs). This data helps us identify our target regions by understanding where EVs are most popular. States with higher numbers of electric vehicles are more likely to have consumers who are open to purchasing them. Below are bar charts showing the top 5 states in sales for each type of EV, providing insights into where to focus our marketing efforts.

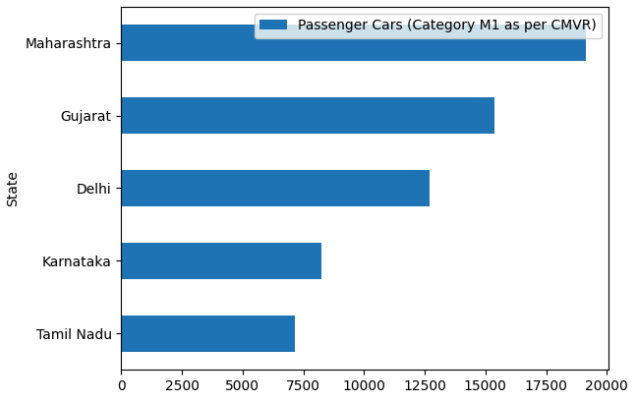












Depending on the type of Electric Vehicle the startup comes with, it can target that particular state. What is important to consider is that for most of these electric vehicles that market would be a fairly developed city in that state, because consumers should be willing to purchase the electric vehicle and factors like cost versus average consumer income and the resources to charge the EV (e.g. Charging Stations) and being able to maintain it are important.

Implementation:

Libraries Used:

- NumPy : Scientiic Computing Library
- Pandas : Data Analysis Library (mainly used to manage dataframes)
- Matplotlib : Data Visualization Library
- seaborn : Data Visualization Library
- scikit-learn : Machine Learning Library

Datasets Used ev stats, Behaviour Dataset, ev-market data

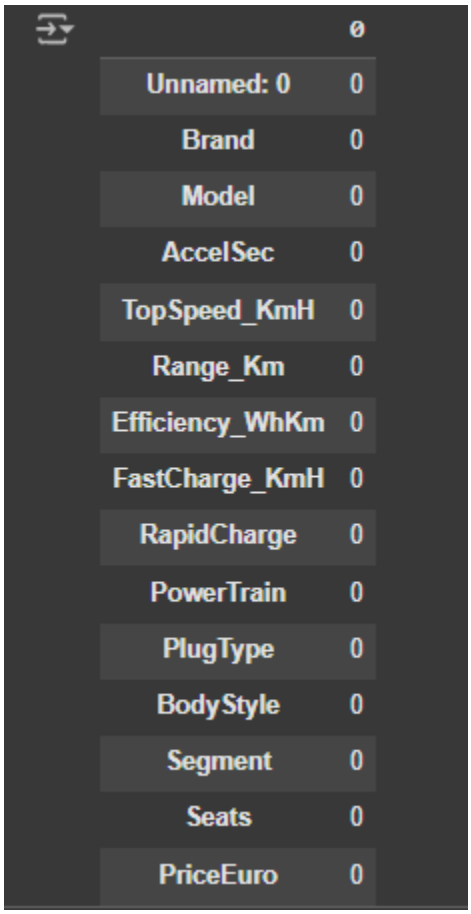
We have utilized the electric vehicle (EV) market dataset for our analysis. With this dataset, we aim to explore various attributes related to consumer buying behaviors.

	Unnamed: 0	Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats	PriceEuro
0	0	Tesla	Model 3 Long Range Dual Motor	4.6	233	450	161	940	Yes	AWD	Type 2 CCS	Sedan	D	5	55480
1	1	Volkswagen	ID.3 Pure	10.0	160	270	167	250	No	RWD	Type 2 CCS	Hatchback	C	5	30000
2	2	Polestar	2	4.7	210	400	181	620	Yes	AWD	Type 2 CCS	Liftback	D	5	56440
3	3	BMW	iX3	6.8	180	360	206	560	Yes	RWD	Type 2 CCS	SUV	D	5	68040
4	4	Honda	e	9.5	145	170	168	190	Yes	RWD	Type 2 CCS	Hatchback	B	4	32997

Following are the variables in the dataset

```
Index(['Unnamed: 0', 'Brand', 'Model', 'AccelSec', 'TopSpeed_KmH', 'Range_Km',
       'Efficiency_WhKm', 'FastCharge_KmH', 'RapidCharge', 'PowerTrain',
       'PlugType', 'BodyStyle', 'Segment', 'Seats', 'PriceEuro'],
      dtype='object')
```

It is important to check null entries in the dataset, if the dataset has null values it won't be good for the clustering algorithm. The dataset has no null values.



	0
Unnamed: 0	0
Brand	0
Model	0
AccelSec	0
TopSpeed_KmH	0
Range_Km	0
Efficiency_WhKm	0
FastCharge_KmH	0
RapidCharge	0
PowerTrain	0
PlugType	0
BodyStyle	0
Segment	0
Seats	0
PriceEuro	0

The complete dataset needed some preprocessing.

```
# PowerTrain feature
df2['PowerTrain'].replace(to_replace=['RWD','FWD','AWD'],value=[0, 1, 2],inplace=True)

# RapidCharge feature
df2['RapidCharge'].replace(to_replace=['No','Yes'],value=[0, 1],inplace=True)
```

Selected the required features and did some preprocessing as needed, applied standard scaler so that all the selected features are on the same scale.

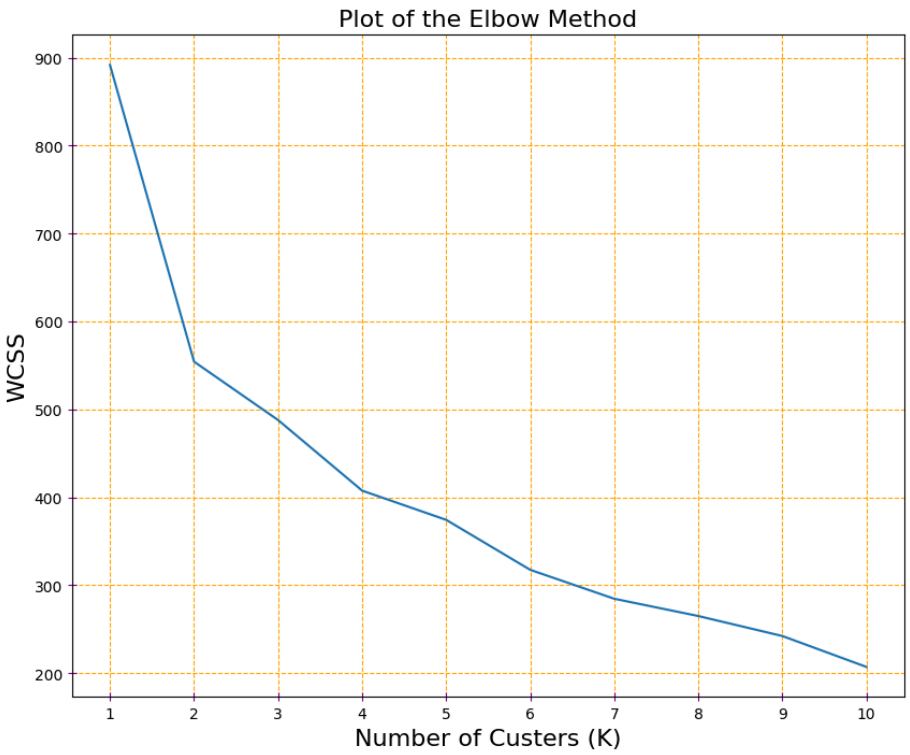
```
[46] X = df2[['AccelSec','TopSpeed_KmH','Efficiency_WhKm','FastCharge_KmH', 'Range_Km', 'RapidCharge', 'Seats', 'PriceEuro','PowerTrain']]

[47] scaler = StandardScaler()
     X_scaled = scaler.fit_transform(X)
```

Model Deployment:

Initially, we aim to determine the optimal number of clusters (K) using the Elbow Method. This involves calculating the Within-Cluster Sum of Squares (WCSS) for different values of K and identifying the point where the WCSS sharply decreases, forming an "elbow" shape on the graph. The value of K corresponding to this elbow point is considered the optimal number of clusters.

```
wcss = []

for i in range(1, 11):
  kmean = KMeans(n_clusters=i, init='k-means++', random_state=90)
  kmean.fit(X_pca)
  wcss.append(kmean.inertia_)

plt.figure(figsize=(10,8))
plt.title('Plot of the Elbow Method', size=16 )
plt.plot(range(1, 11), wcss)
plt.xticks(range(1, 11) )
plt.yticks()
plt.xlabel('Number of Custers (K)', size=16 , )
plt.ylabel('WCSS',  size=16 )
plt.grid()
plt.tick_params(axis='both', direction='inout', length=6, color='purple', grid_color='orange', grid_linestyle='--');
```

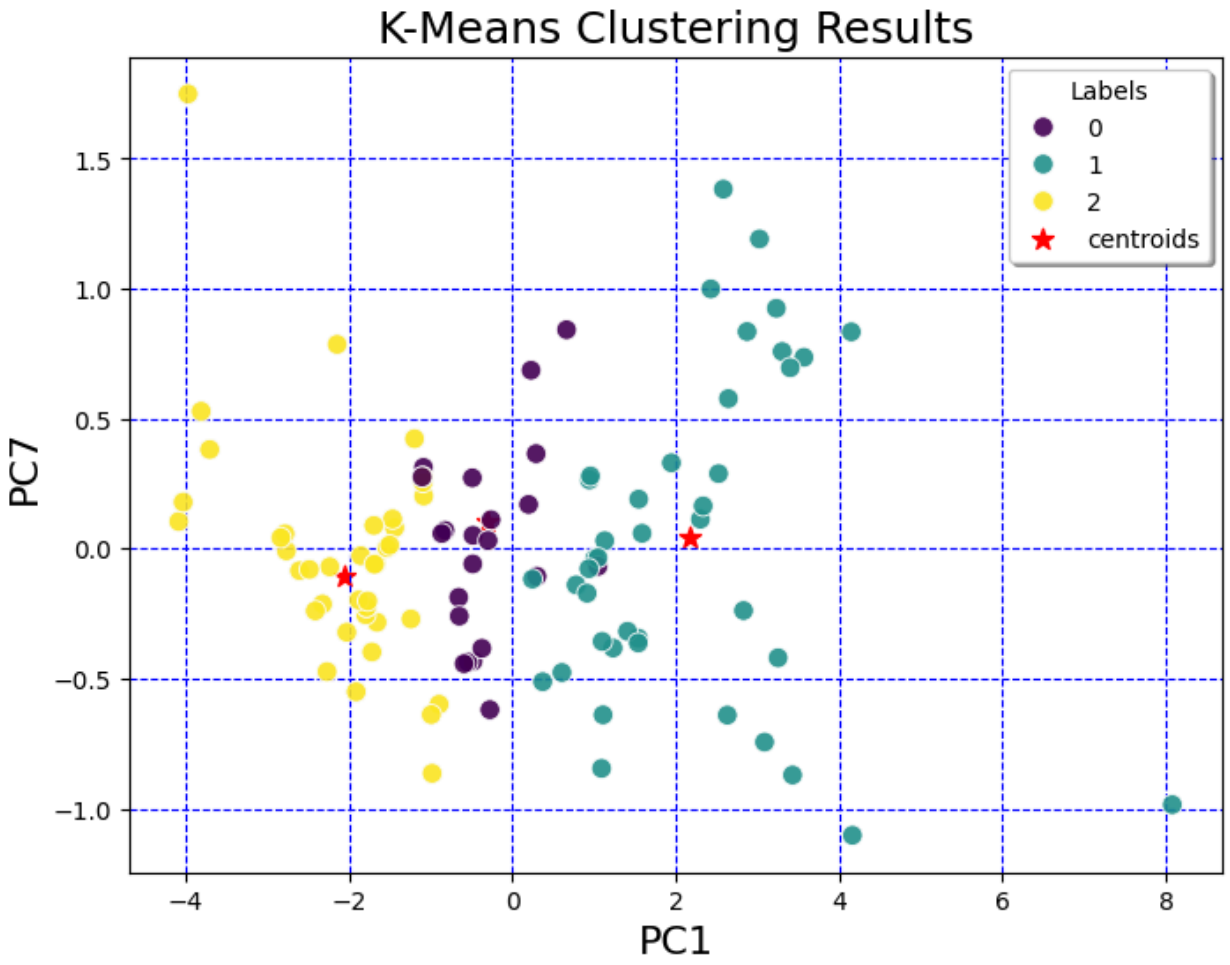
Upon examining the plot, we observe two potential elbow points, notably at K=3 and K=5, where the curve slightly bends. After identifying these possible optimal K values, we will further evaluate which K value yields the most appropriate clustering for our data.



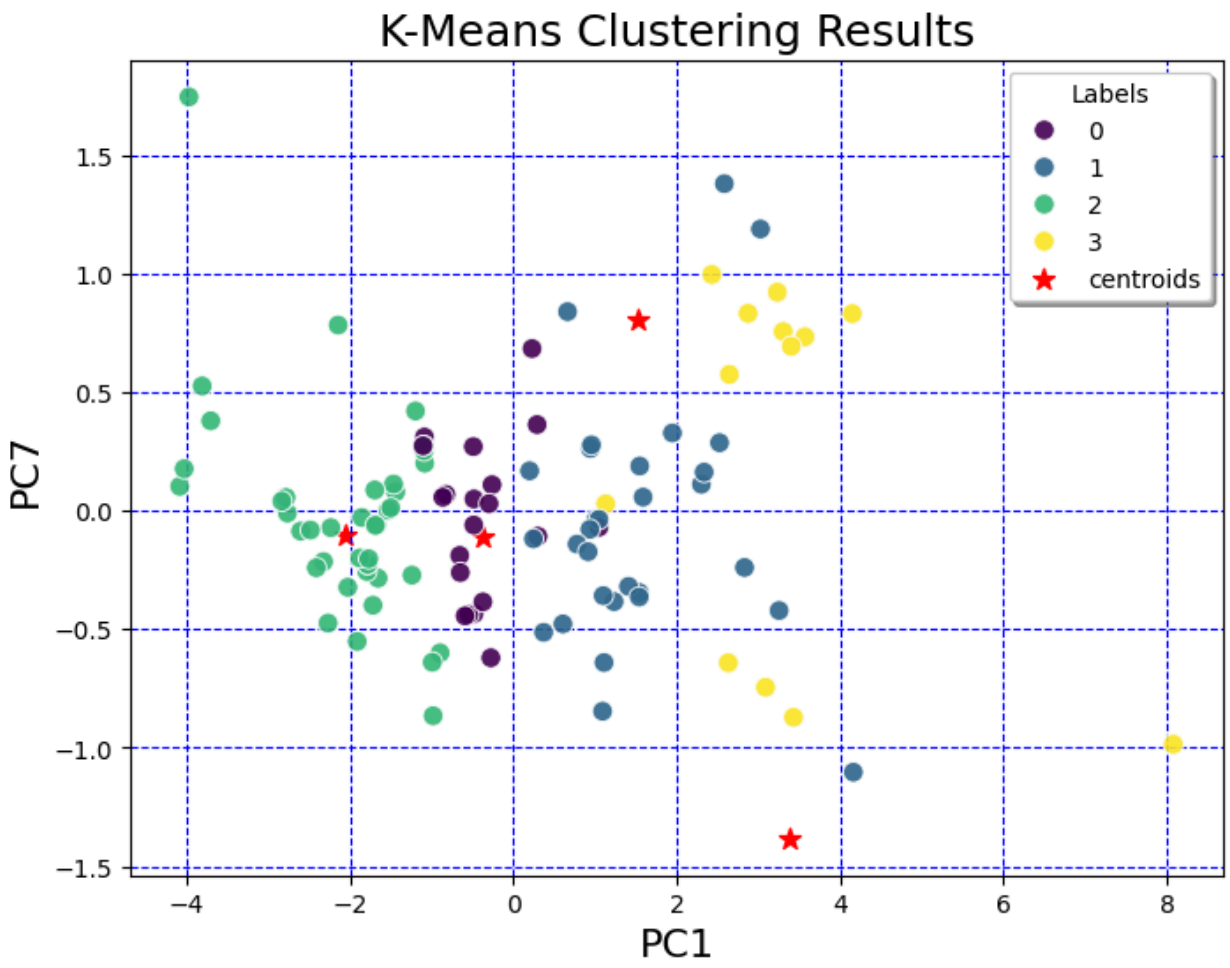
Therefore we will try to train K-Means Clustering by taking K = 3 and K = 5

```
[52] kmean = KMeans(n_clusters=4, init='k-means++', random_state=90)
     kmean.fit(X_pca)

     KMeans(n_clusters=4, random_state=90)

     print(kmean.labels_)

     [3 2 1 0 2 3 2 2 0 1 1 2 0 0 2 0 3 2 2 2 2 1 2 3 3 0 0 1 2 2 1 0 2 1 2 0 2
      0 2 1 3 2 1 2 2 0 2 3 3 2 1 3 2 0 1 2 2 2 2 3 2 1 0 1 0 3 2 1 2 1 2 1 3 1
      2 2 1 2 1 3 0 1 2 0 1 2 1 1 1 0 1 2 2 1 2 0 2 0 0 1 1 1 1]

[54] pd.Series(kmean.labels_).value_counts()

     count
2    40
1    30
0    20
3    13
```

Final result is as shown in the below diagram:



K = 3



K = 4

In this case, we are able to see the dataset is being clustered into very small groups of people that the model recognizes as a trend which is however not the case. We don't want to lose the homogeneity between our segments, therefore, going with K=4 will give the best results in the clustering analysis that is being done.

Target Segment:

The younger population is generally more inclined to adopt new technologies, including Electric Vehicles (EVs), due to their awareness of environmental benefits and desire for change. However, our report indicates that younger individuals tend to purchase less expensive vehicles, making the affordability of EVs a potential barrier. Therefore, it is advisable to target a segment

that is enthusiastic about new technologies and financially capable of affording EVs. This demographic is likely to be in the 30 to 40 age group.

Urban residents with access to infrastructure and education about technology are more likely to purchase EVs. Additionally, married individuals with dependents are more inclined to buy vehicles, making them a key target group.

The average salary of vehicle buyers is around 30 lakhs, with most automobile purchases falling in the 10-20 lakh range, and fewer purchases for two-wheelers. These financial considerations should also be taken into account.

Marketing Mix:

Setting prices for our products involves a blend of art and science. Crucially, it is essential to know and understand your production costs. From this foundation, you can make adjustments based on product characteristics, a specific pricing strategy, customer price sensitivity, customer values, and other relevant factors. The Marketing Mix aids in understanding what our product or service can offer to customers and assists in planning a successful product offering. It helps with the planning, development, and execution of effective marketing strategies, and determines whether your product or service meets the needs of your customers.

4 P's of Marketing Mix

Product:

The type of product an EV startup offers will vary, but our analysis indicates that for the Indian market, it is strategically best to start with two-wheelers. This is because two-wheelers dominate the automobile market share in India. Most consumers prefer two-wheelers due to their cost-effectiveness, and the current infrastructure supports their use.

Another potential product for EV startups to consider is public transport vehicles. Current government policies are supportive of transitioning public transport to electric-based engines, making this a viable market opportunity.

Price:

Affordability is a critical factor in the growth of Electric Vehicles. To appeal to consumers, the company's products must be cost-effective to both purchase and maintain. Ideally, the product's price should range between 10 to 20 lakhs, as this is the price range within which most consumers are likely to make a purchase.

Place:

Infrastructure is a crucial consideration when developing and launching any product. Major urban cities should be targeted, as they typically have the necessary infrastructure to support electric vehicles. Additionally, urban areas are more likely to have an educated population that is aware of the environmental benefits of EVs and, therefore, more willing to purchase them.

Our geographical analysis identifies the top states for different types of vehicles, highlighting regions that promise a strong market for EVs.

Promotion:

Promotion strategies should be tailored to the specific product. The most effective approach is to educate consumers about the benefits of EVs, HEVs, and PHEVs over traditional fuel-based vehicles. If the startup introduces an affordable product, this should be a key focus of the promotional efforts.

References:

https://www.statista.com/chart/31486/electric-vehicle-sales-in-india-by-year-and-type/

Datasets:

https://drive.google.com/file/d/1rDNyh0xGvJeHjna1YnE4-PSfcAIp6dWd/view?usp=sharing

https://drive.google.com/file/d/1FfuAqV3kgoKnyUY9PZ0mB-vkchj1mlsr/view?usp=sharing

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