Market Segmentation Analysis of the Electric Vehicle Market in India

Project Report

Submitted by

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1. Introduction

The global market for electric vehicles (EVs) has seen tremendous growth and evolution in recent years, driven by technological advancements, environmental concerns, and supportive government initiatives promoting sustainable transportation. At the same time, India has emerged as a significant player in the EV sector, with a rapidly increasing number of companies adopting this transformative technology. This article will compare the global EV market with the Indian market, focusing on key trends, challenges, and the leading Indian companies in the EV sector.

Globally, EV adoption has gained substantial momentum, with major automotive manufacturers investing heavily in electric mobility. Countries like China, the United States, and several European nations have experienced significant growth in EV sales, driven by favorable government policies, improved charging infrastructure, and a diverse range of electric models. This global market expansion has accelerated advancements in battery technology and spurred innovations in autonomous driving and vehicle connectivity.

In India, the EV market is still in its early stages but holds enormous growth potential. The Indian government has implemented various initiatives and ambitious policies to promote EV adoption, including tax incentives, subsidies, and the development of charging infrastructure across the country. Several Indian companies, from established automotive giants to emerging startups, have seized this opportunity and are actively manufacturing and promoting electric vehicles, contributing to the sector's growth and proliferation.

In the following sections, we will explore the global and Indian EV markets in greater detail, examining key players, market dynamics, and the future prospects for electric mobility in both contexts.

Key Words: Electric vehicles, Market segmentation, Cluster analysis, K-Means Clustering, PCA, Dendrogram, Attitude towards electric vehicles.

2.Problem Statement

The popularity of electric vehicles (EVs) is soaring globally as a sustainable alternative to conventional gasoline cars. In India, the demand for EVs has been steadily increasing due to concerns about air pollution, rising fuel prices, and government incentives. As an Electric Vehicle Startup, it is vital for us to carefully analyze the Indian EV market and formulate a viable strategy targeting the segments most likely to adopt EV usage.

Based on Market Analysis, the entire segmentation problem boils down to two main questions-

1. What type of EV the company will produce?

2. Who are the target customers?

Our objective is to perform a comprehensive analysis of the Indian EV market through segmentation analysis. We will consider various factors such as geographic, demographic, psychographic, and behavioural data to identify the most suitable locations for establishing an early market in line with the Innovation Adoption Life Cycle. Additionally, we will examine

available datasets to identify potential segments likely to adopt EVs and tailor our marketing mix to effectively target these segments.

In this report we have analysed the 2 Wheelers Electric Vehicles Market in India using segmentation analysis and tried to answer some of the crucial questions. Along with that, we have also performed Segmentation on customers based on their reviews.

3. Data Collection

The data used in our project encompassed three distinct datasets: EV bikes dataset, customers review, and state-wise EV growth. Both the customer review dataset and EV bikes dataset are collected from https://www.kaggle.com/ . The bikes dataset needed to be modified to add some missing values like products from Popular brands.

The link for the state-wise EV growth dataset is given below:

Link:https://github.com/Subhendu1998/Electric_Vehicle_Customer_Market_segmentation_Subhendu_Mandal

Each dataset was essential in providing insights and informing our analysis.

4.Packages/Tools used

• Numpy: To calculate various calculations related to arrays.

• Pandas: To read or load the datasets.

• Matplotlib: To create static, animated, and interactive visualizations.

• SKLearn: To model the K-Means algorithm and PCA. We also have used

LabelEncoder() to encode our values.

• Seaborn: It provides a high-level interface for creating informative and

attractive statistical graphics.

• Scipy: To solve the complex scientific and mathematical problems.

5. Customer Segmentation Analysis

At first some Exploratory Data Analysis is performed. An Exploratory Data Analysis or EDA is a thorough examination meant to uncover the underlying structure of a data set and is important for a company because it exposes trends, patterns, and relationships that are not readily apparent.

5.1. Exploratory Data Analysis

Dataset-

Features: The dataset used in this project contain 1000 rows and 15 features. The features are as follows: Age, City, Profession, Marital Status, Education, No. of Family members, Annual

Income, Preference for replacing all vehicles to Electronics vehicles?,If Yes/Maybe what type of EV would you prefer?, Do you think Electronic Vehicles are economical?, Which brand of

vehicle do you currently own ?, How much money could you spend on an Electronic vehicle?, Preference for wheels in EV, Do you think Electronic vehicles will replace fuel cars in India?

Data Visualization- By using various data visualization methods like pie-plot, distplot, countplot, histplot we visualize three important characteristics, namely age, profession and marital status, of the dataset

- The data presented in the following graph is collected from a survey conducted among various individuals, including businessmen, salaried persons, students, and working professionals who are the potential customers of EVs.

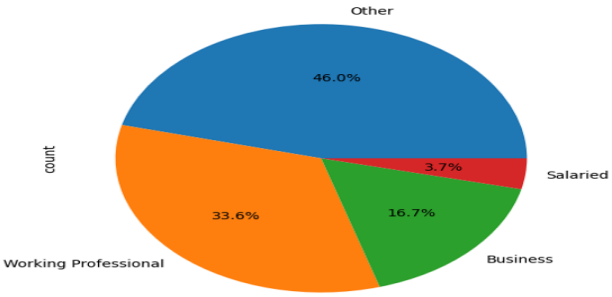

Figure 1: Professions of Customers

- In India, among all the electric vehicles (EVs), four-wheelers are the most demanded, followed by two-wheelers which also have significant demand.

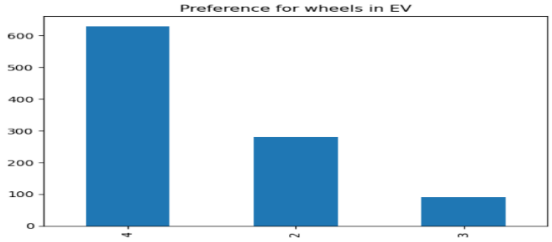

Figure 2: Demand in several EVs

- people having family member more than 2 recommend for 4 wheelers. Less number of people refer for 3 wheelers. Below we plot a counter plot of family Vs wheels.

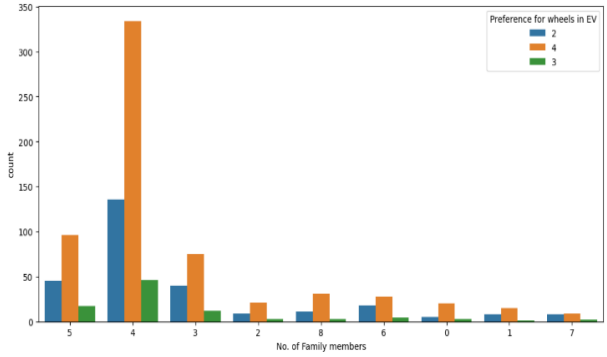

Figure 3: Family members Vs Preferable number of wheels

- SUV, Sedan are the most demanded brands, followed by Hatchback, Liftback and Cabrio.

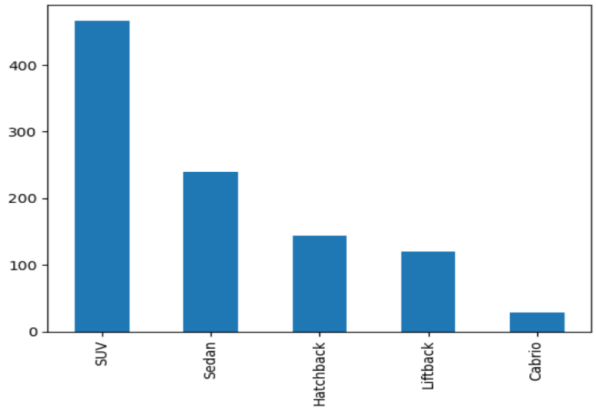

Figure 4: Preferable EV brands

- We plot a counter plot of Education of the people Vs their opinion on the question-"Do you think Electronic Vehicles are economical?"

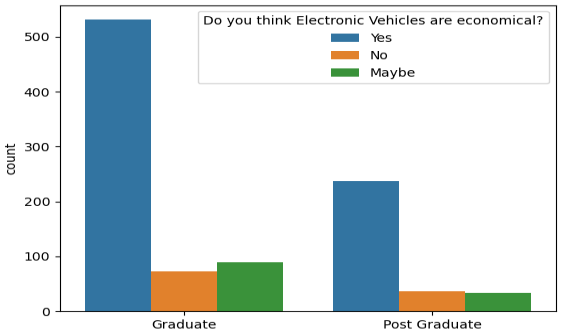

Figure 5: Education Vs Economical

- Tata, Hyundai are the most currently used car brands, followed by Honda, KIA, Maruti and others.

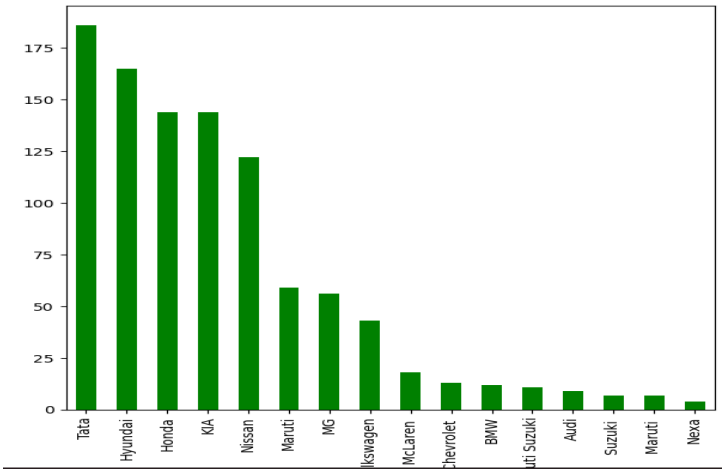

Figure 6: Currently owned brands of vehicles

5.2. Segmentation using KMeans Clustering Algorithm

5.2.1 Correlation of the Features

A correlation matrix is simply a table that displays the correlation. It is best used in variables that demonstrate a linear relationship between each other. The matrix depicts the correlation between all the possible pairs of values through the heatmap in the below figure.

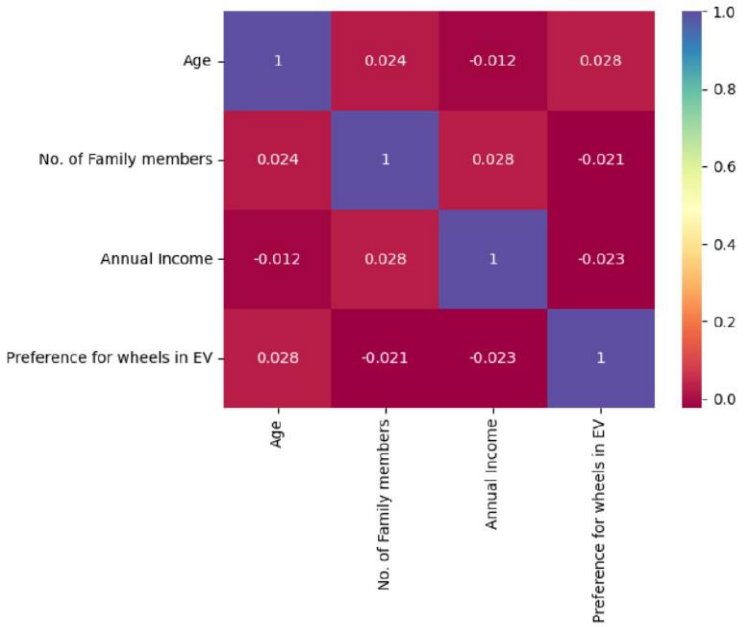

Figure 7: Correlation Between Several Features

5.2.2 Principal Component Analysis (PCA): The data are pre-processed using Standard Scalar class in ScikitLearn and I proceed for PCA to extract the independent components and less than the number of features for which most of the information is intact i.e. explained variance.

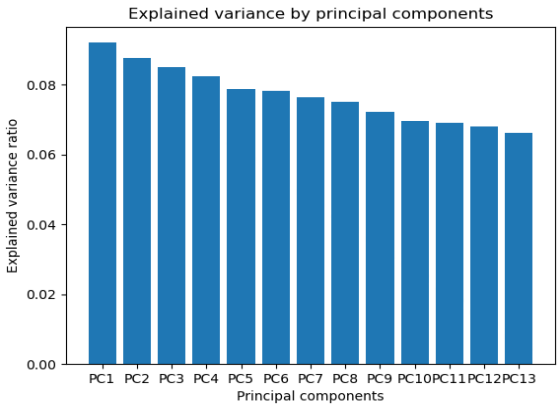

Figure 8: Explained variance of each PC

We take the first four principal components for our farther calculations.

5.2.3. Determining the Number of Clusters: The Elbow method is a popular method for determining the optimal number of clusters. The method is based on calculating the Within-Cluster-Sum of Squared Errors (WSS) for a different number of clusters (k) and selecting the k for which change in WSS first starts to diminish.

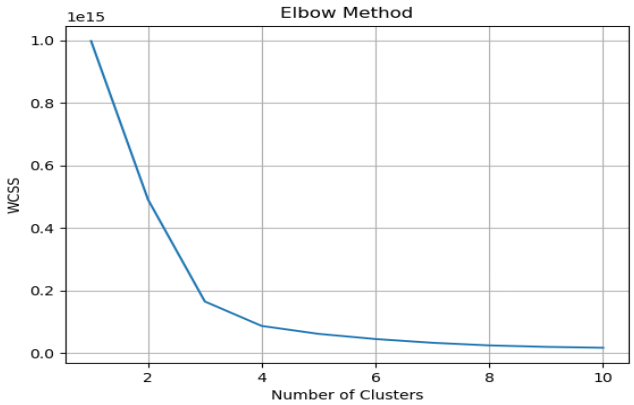

Figure 9: Elbow Curve

According to the Elbow curve I have chosen 4 clusters to preform K-Means. The clusters are shown in the plot (First vs Last principal components).

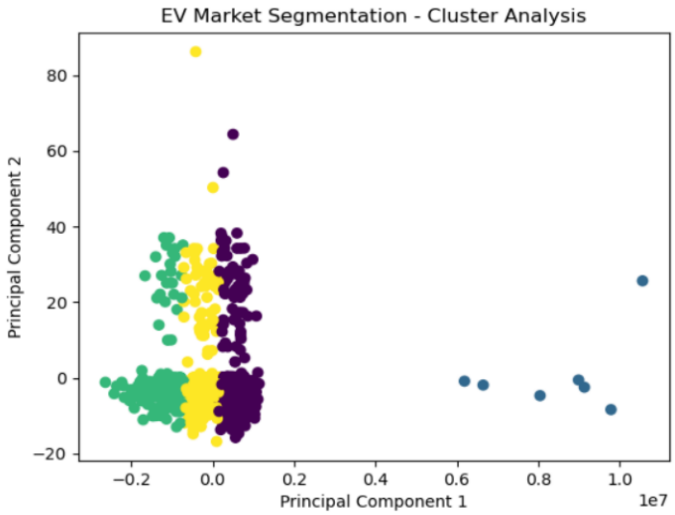

Figure 10: Cluster Analysis

5.2.4. Hierarchical Clustering: A similar hierarchical clustering is also performed which shows 2 different components, shown in the Dendrogram.

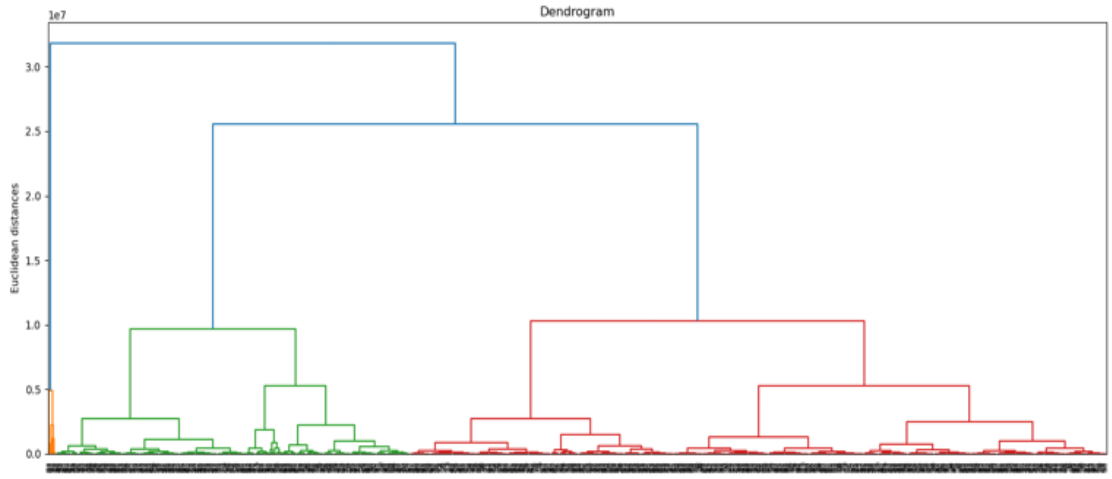

Figure 11: Dendrogram

5.3. Market Segmentation Analysis and Target Market for EVs:

Market segmentation identifies customer subgroups for targeted marketing. There are two main methods: a-priori and post-hoc. A-priori predefines segments by characteristics like age and income, then profiles them using behaviour and psychographics. Post-hoc identifies segments based on variable relationships. This study uses the a-priori approach to segment potential EV customers, incorporating psychographic and socioeconomic attributes. The target market for EVs can be categorized into Demographic, Geographic, Psychographic, and Behavioural segments.

5.3.1. Demographic Analysis

Demographic analysis was performed to identify patterns based on variables such as age group, education and income group, profession, education, and annual income. This analysis helped uncover trends specific to different demographic segments

```
[Age
 29    51
 28    46
 30    45
 25    41
 26    39
 Name: count, dtype: int64,
 Age
 29    43
 28    41
 27    36
 30    36
 31    35
 Name: count, dtype: int64,
 Age
 30    2
 26    1
 29    1
 56    1
 28    1
 Name: count, dtype: int64,
 Age
 31    26
 30    22
 29    21
 27    16
 28    14
 Name: count, dtype: int64]
```

(a) Age Clusters

```
[Education
 Graduate         311
 Post Graduate    141
 Name: count, dtype: int64,
 Education
 Graduate         257
 Post Graduate    103
 Name: count, dtype: int64,
 Education
 Graduate         5
 Post Graduate    2
 Name: count, dtype: int64,
 Education
 Graduate         120
 Post Graduate     61
 Name: count, dtype: int64]
```

(b) Education Clusters

```
[Profession
 Working Professional    143
 Business                 76
 Salaried                 16
 Name: count, dtype: int64,
 Profession
 Working Professional    128
 Business                 62
 Salaried                 13
 Name: count, dtype: int64,
 Profession
 Working Professional    1
 Business                1
 Name: count, dtype: int64,
 Profession
 Working Professional    64
 Business                28
 Salaried                 8
 Name: count, dtype: int64]
```

(c) Profession Clusters

Figure 12: Demographic Analysis

From the Demographic analysis, it is revealed that
• Age group of 28-31 needs to be targeted.
• The persons having profession as "Working Professionals" are more likely to buy EVs.
• Graduate people need to be targeted most.
• Cluster 1 has the highest average income, followed by cluster 0,3,2.

5.3.2. Geographic Analysis

Geographic analysis was conducted to explore regional variations in EV adoption and preferences. The "City" variable was used to analyze the concentration of EV users and potential market opportunities across different cities in India.

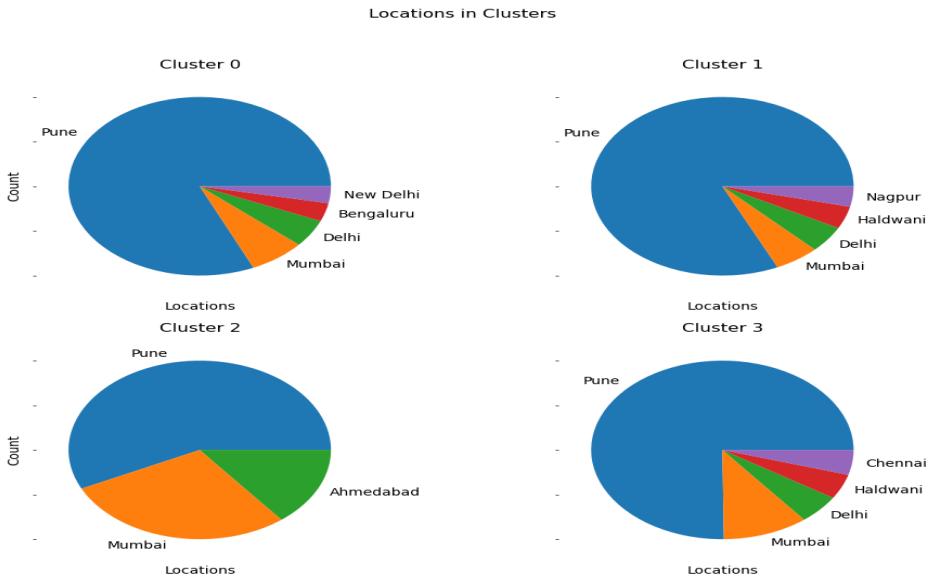

Figure 13: Geographic Clusters

From the Geographic analysis we have the following decisions:
• Pune and Mumbai are present in all the cluster and they are more suitable to target the EV Market.
• Delhi, Haldwani and Bengaluru should be the next city to target followed by Satara and Chennai.

5.3.3. Psychographic Analysis

This segmentation grouped based on beliefs, interests, preferences, aspirations, or benefits sought when purchasing a product. Suitable for lifestyle segmentation. The analysis was performed to identify patterns based on variables such as marital status, number of family members, type of preferred EV, current brand, EV brand preference and expected spending on EVs.

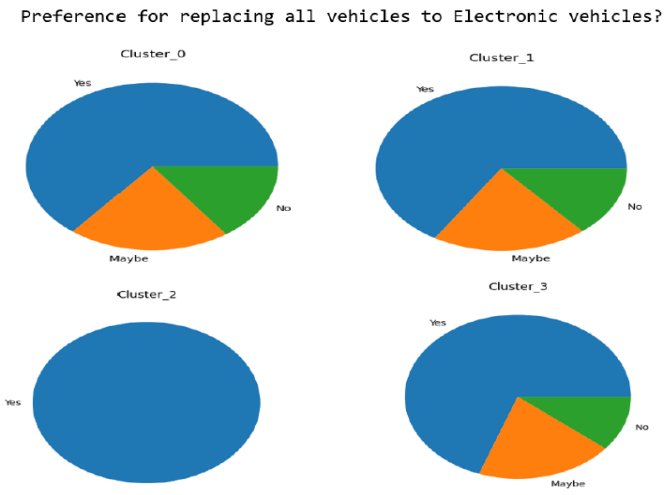

Figure 14: Preference for Replacing all Vehicles to Electric Vehicles

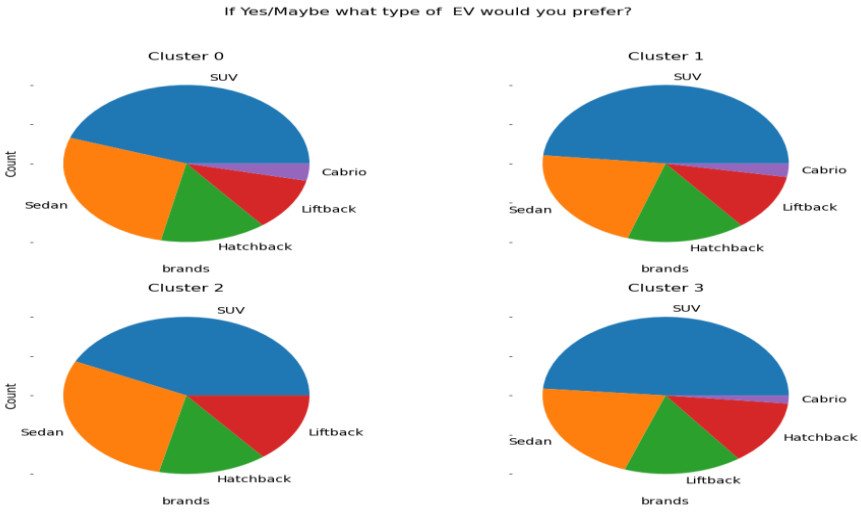

Figure 15: Customer Segments Based on Type of Four Wheelers

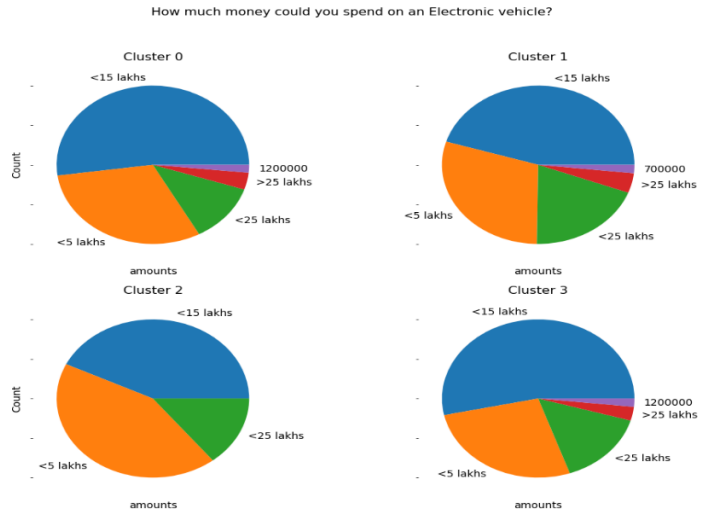

Figure 16: Customer Segments Based on the Expected Spending

5.3.4. Behavioural Analysis: A behavioural analysis was conducted to gain insights into consumers' preferences and attitudes towards EVs. Behavioural Segmentation searches directly for similarities in behaviour or reported behaviour. It has advantage as it uses the very behaviour of interest is used as the basis of segment extraction. From the Behavioural Analysis on customer outputs, we have the following decisions:

• To answer the question "Would you prefer replacing all your vehicles to Electronic vehicles?", 66.3% seems optimistic, 18.8% were neutral, and others said "No".

• In response to the question "If Yes/Maybe what type of EV would you prefer?", 46.7% choose SUV, 24% choose Sedan, 14.4% choose Hatchback followed by Liftback (12%) and Cabrio (2.9%).

• In response to the question "Do you think Electronic Vehicles are economical?", 76.8% said "Yes", 12.3% were neutral, and 10.9% said "No".

• In response to the question "Do you think Electronic vehicles will replace fuel cars in India?", 41.9 % said "in less than 10years", 35.2% said "in less than 20 years", 13.3% said "yes, possibly after 20 years", whereas others disagreed.

5.4. Price of Four Wheelers EVs in India

The price range of electric vehicles (EVs) in India can vary depending on the model, brand, and specifications. Generally, EV prices in India start from around 5 lakhs (approximately $6,700) for more affordable and compact models and can go up to 50 lakhs (approximately $67,000) or more for higher-end or luxury EVs. In our project, out of 1000 people 48.3 % of people are willing to spend less than 15 lakhs and above 12 lakhs. 28.8 % of people are willing to spend less than 15 lakhs. 14.8 % of people are willing to spend less than 25 lakhs and above 15 lakhs. 3.4 % of people are willing to spend more than 25 lakhs for EV.

6. VEHICLE SEGMENTATION

Here I perform a segmentation analysis on the possible segment to target depending on the product (2 wheelers) features during product development. Let's explore the data through Exploratory Data Analysis.

6.1. Exploratory Data Analysis:

Dataset-

	Model	Manufacturer	Vehicle Type	Battery Capacity (kWh)	Range per Charge (km)	Charging Time	Price	Power (HP or kW)	Top Speed (km/h)	Year of Manufacture
0	Ola Electric S1	Ola	Scooter	2.98	181	5.0	85099.0	4.5	116.0	2021.0
1	Ola Electric S1 Pro	Ola	Scooter	4.00	181	6.5	120149.0	11.0	116.0	2021.0
2	TVS iQube	TVS	Scooter	3.40	75	6.5	117630.0	4.4	78.0	2020.0
3	Aura 300 Plus	Ather Energy	Scooter	2.90	116	4.5	129000.0	6.0	80.0	2021.0
4	Pure EV Epluto 7G	Pure EV	Scooter	2.70	120	3.0	109000.0	5.0	80.0	2021.0

Data Visualization

- There are mainly two types of electric two wheelers -scooter and bike. The sales of 2-wheelers in the past 3 years are plotted below.

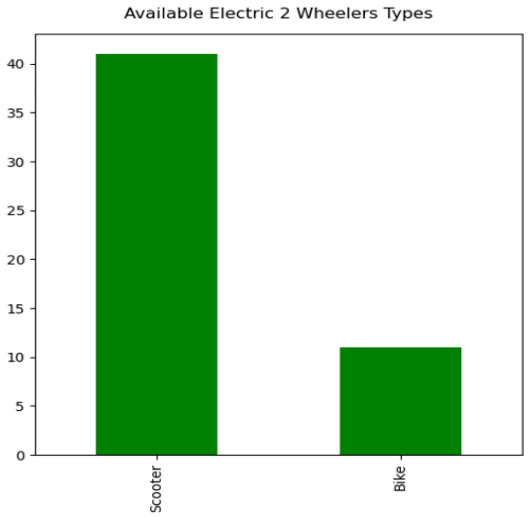

Figure 17: Types of 2-wheeelers

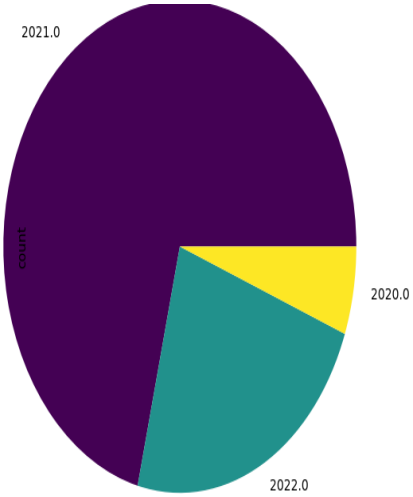

Figure 18: Sales in the past 3 years

- The most important features that the buyer might look for in an EV are Range, Battery Size and probably the Top Speed. These information help the buyer to choose a product. These features are plotted in bar plot-

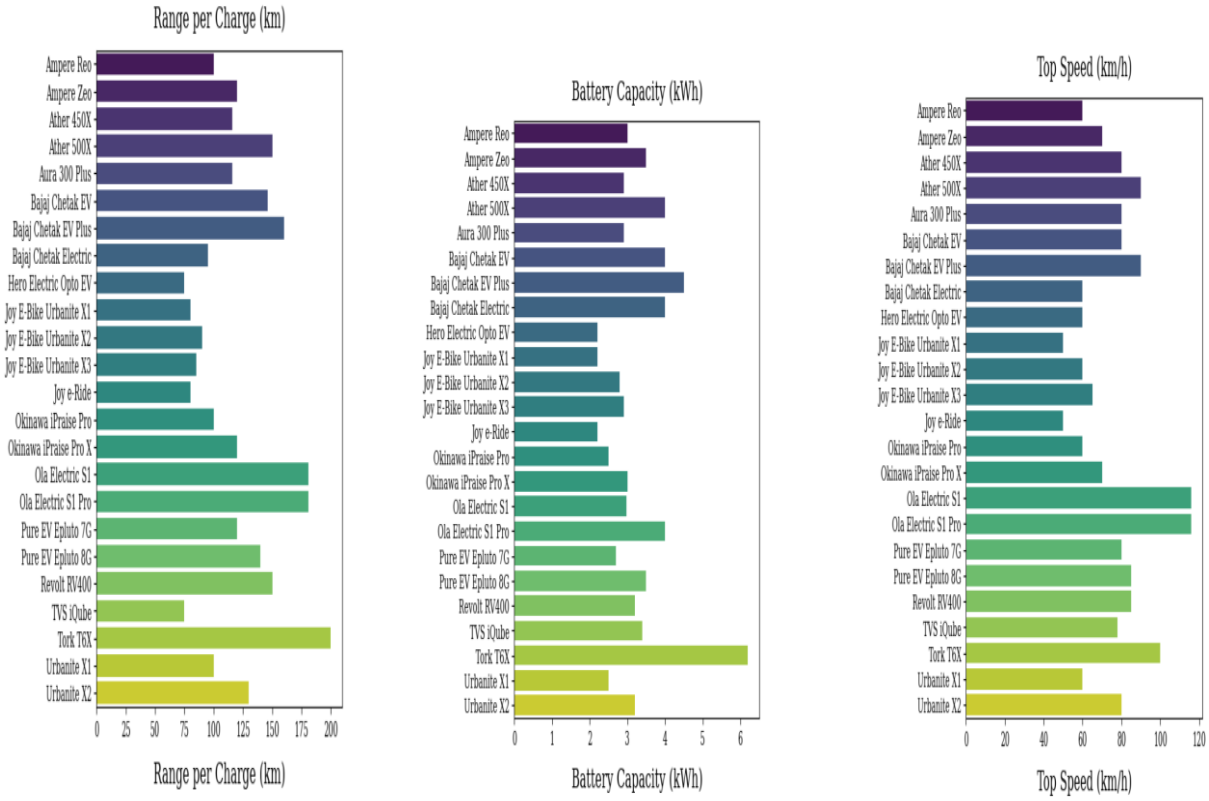

Figure 19: Range per Charge(km),Battery Capacity(kWh) and Top Speed(km/h)

- The buying decisions also depend on the price of the product. The price values from the dataset-

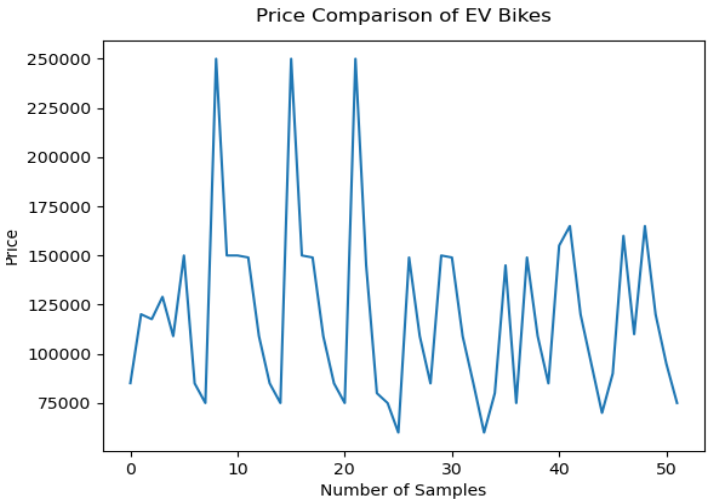

Figure 20: Price Compression of EV Bikes

6.2. Principal Components Analysis (PCA)

- I have performed the correlation analysis between the features of the dataset. The heatmap has plotted below:

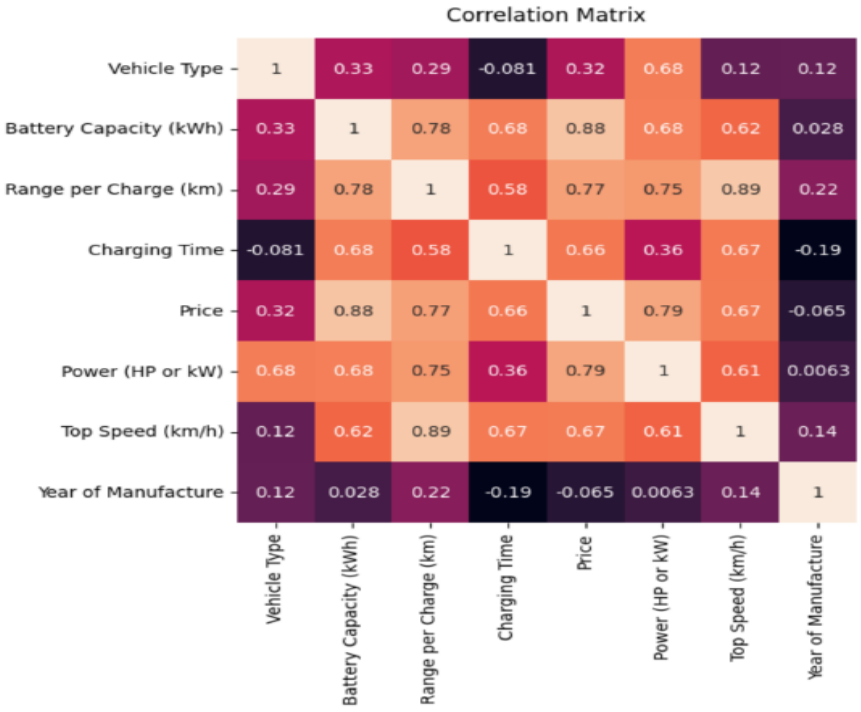

Figure 21: Heat Map

- Since there are some features which are highly correlated, we need to perform PCA. After scaling all the data using standard scaler, we perform PCA and take those principal components which explain more than 90% of the total variance.

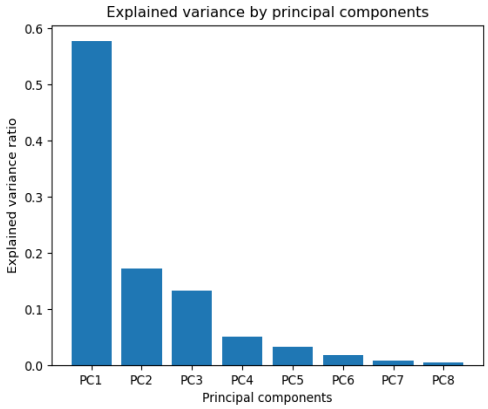

Figure 22: Explained Variance by PCs

Rotation matrix:

	PC1	PC2	PC3	PC4
Vehicle Type	0.2	-0.7	0.4	-0.0
Battery Capacity (kWh)	0.4	0.1	0.0	-0.6
Range per Charge (km)	0.4	-0.0	-0.2	0.3
Charging Time	0.3	0.5	-0.0	-0.2
Price	0.4	0.1	0.1	-0.3
Power (HP or kW)	0.4	-0.3	0.2	0.2
Top Speed (km/h)	0.4	0.1	-0.3	0.6
Year of Manufacture	0.0	-0.4	-0.8	-0.3

Figure 23: Weights of Features along PCs

6.3.K-Means Clustering

K-means clustering requires the number of clusters to be specified in advance since it cannot determine the optimal number on its own. To identify the best number of clusters, I ran K-means for various cluster counts and selected the optimal one. In this process, I used the "k-means++" initialization method. Unlike the standard K-means, which initializes clusters randomly, k-means++ initializes clusters in a more informed manner, leading to better convergence. The resulting elbow plot.

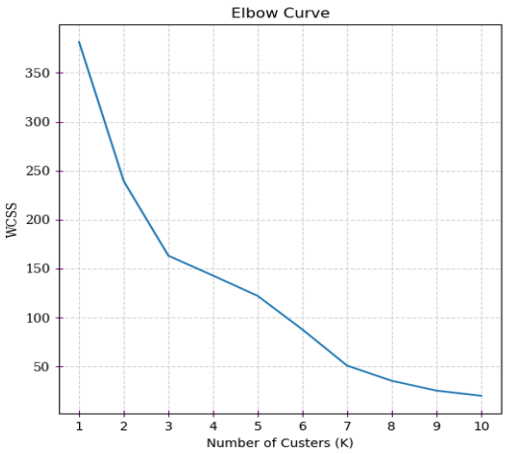

Figure 24: Elbow Curve

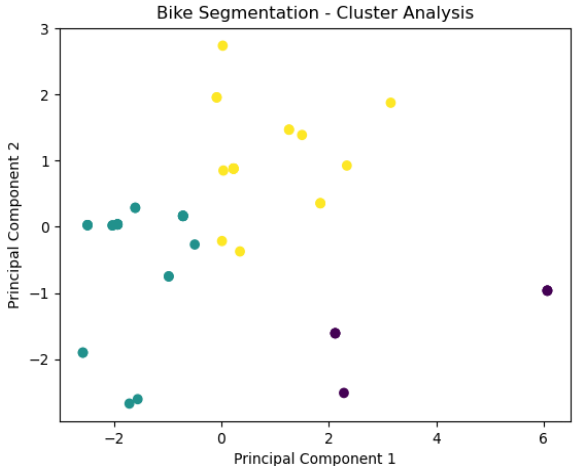

Figure 25: Clusters Analysis

6.4. Hierarchical Clustering: The Dendrogram showing the clusters performed using hierarchical clustering which also gives 3 clusters-

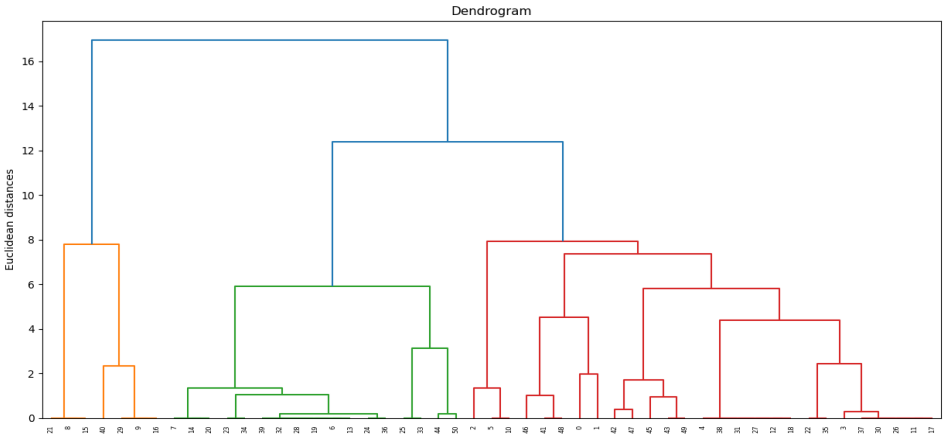

Figure 26: Dendrogram

6.5. Making Predictions

Now I try to answer the posed questions by selecting possible segments as targets. The target variables and chosen cluster can depend on the company policies and their goal. Possible target clusters are chosen here. The top features that a brand may focus on to select their segments are - *Price, Vehicle Type, Top Speed, Range Per Charge, Battery Capacity and Charging Time.* The segments are

Vehicle type: *1 means bike and 0 means scooter.*

```
[Vehicle Type
1   7
Name: count, dtype: int64,
Vehicle Type
0   22
1    4
Name: count, dtype: int64,
Vehicle Type
0   18
Name: count, dtype: int64]
```

```
[Price
250000.0    3
150000.0    3
155000.0    1
Name: count, dtype: int64,
Price
109000.0    6
85000.0     6
75000.0     6
80000.0     2
60000.0     2
Name: count, dtype: int64,
Price
149000.0    5
150000.0    2
145000.0    2
165000.0    2
85099.0     1
Name: count, dtype: int64]
```

```
[Range per Charge (km)
150    4
200    3
Name: count, dtype: int64,
Range per Charge (km)
100    10
120     9
75      3
80      2
90      1
Name: count, dtype: int64,
Range per Charge (km)
116    6
181    2
95     2
146    2
150    2
Name: count, dtype: int64]
```

```
[Battery Capacity (kWh)
3.2    4
6.2    3
Name: count, dtype: int64,
Battery Capacity (kWh)
2.5    8
2.7    6
2.2    5
3.0    4
2.8    1
Name: count, dtype: int64,
Battery Capacity (kWh)
4.00    7
2.90    6
2.98    1
3.40    1
3.50    1
Name: count, dtype: int64]
```

```
[Top Speed (km/h)
 85.0     4
 100.0    3
 Name: count, dtype: int64,
 Top Speed (km/h)
 60.0    14
 80.0     6
 70.0     3
 50.0     2
 65.0     1
 Name: count, dtype: int64,
 Top Speed (km/h)
 80.0     9
 90.0     3
 116.0    2
 60.0     2
 78.0     1
 Name: count, dtype: int64]
```

```
[Manufacturer
 Revolt Motors     4
 Tork Motors       3
 Name: count, dtype: int64,
 Manufacturer
 Okinawa Autotech        8
 Pure EV                 6
 Electric Vehicle Co.    5
 Hero Motocorp           3
 Ampere Vehicles         3
 Name: count, dtype: int64,
 Manufacturer
 Ather Energy    8
 Bajaj Auto      5
 Ola             2
 TVS             1
 Pure EV         1
 Name: count, dtype: int64]
```

```
[Charging Time
 4.0    4
 5.0    3
 Name: count, dtype: int64,
 Charging Time
 3.0    19
 2.5     4
 3.5     2
 4.0     1
 Name: count, dtype: int64,
 Charging Time
 4.5    6
 5.0    5
 6.5    2
 5.5    2
 3.5    1
 Name: count, dtype: int64]
```

The EV Manufacturer Company might choose the **1st Segment** having feature values-

• Manufacture EV Scooter

• Price Point of 85k-95k

• Top Speed having 50-70 km/h

• Range Having between 80-120 km,

• Battery Capacity of 2.2-3 kWh

• Charging Time of 2.5-2.5 Hrs

• Already Present Manufacturers in the Segment are Hero, Okinawa, Ampere, etc.

Another Possible Segment to target is **3rd Segment** with features as -

• Manufacture EV Scooter

• Price Point of 85k-149k

• Top Speed having 80-116 km/h

• Range Having between 95-181 km,

• Battery Capacity of 2.7-4 kWh

• Charging Time of 3-5.5 Hrs

•Already Present Manufacturers in the Segment are Ola, Aether, Bajaj , TVS, etc.

7.State Based Analysis of EV market in India

Here, we analyze data related to electric vehicles (EVs) in various states. The data includes information on different categories of EVs and their distribution across states in India. The objectives of this analysis are to:

• Examine the total number of EVs in each state.

• Investigate the distribution of EVs by category.

• Examine the total number of chargers in each state.

7.1 Data Description

The provided code uses the pandas library in Python to analyze the EV data. The data is represented as a list of lists, where each inner list contains information about a specific state. The columns in the data include the state name, various categories of EVs, and the total number of EVs in each state.

7.2 Total Electric Vehicles by State

To understand the overall distribution of EVs across different states, the code groups the data by state and calculates the total number of EVs in each state. The states are then sorted in

descending order based on the total number of EVs. Figure 27 shows a bar chart representing the total number of EVs by state.

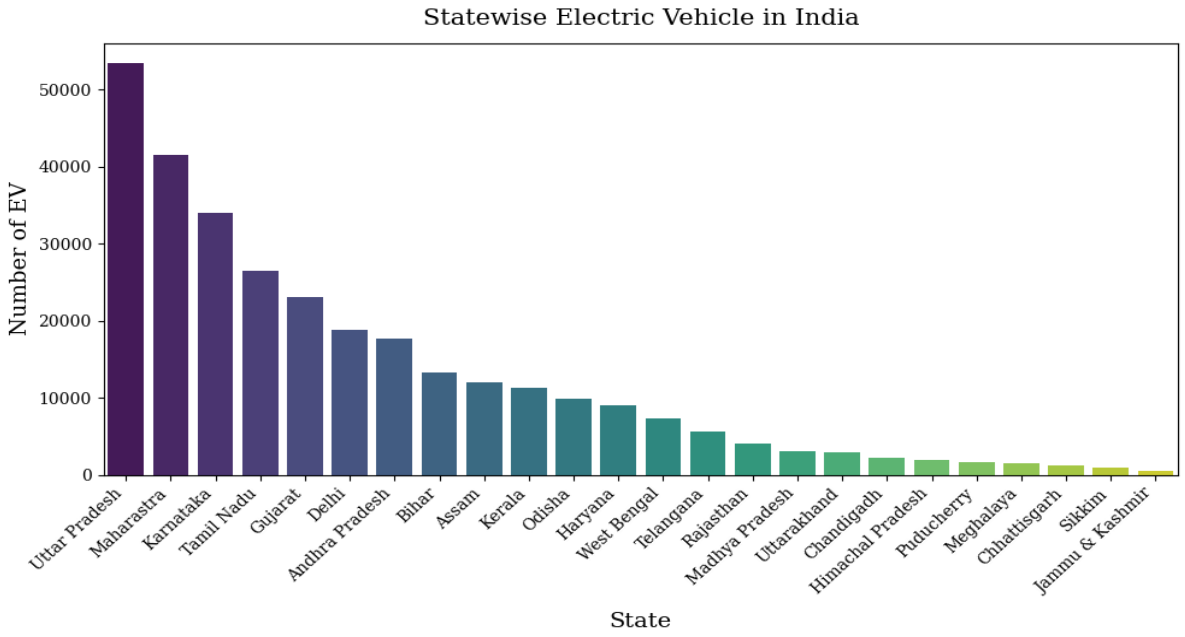

Figure 27: State wise Total Electric Vehicle in India

7.3 Breakdown of Vehicle Categories by State

To analyze the distribution of EVs by category, a stacked bar chart is created. This chart showcases the number of vehicles in each category for every state. Figure 28 illustrates the breakdown of vehicle categories by state.

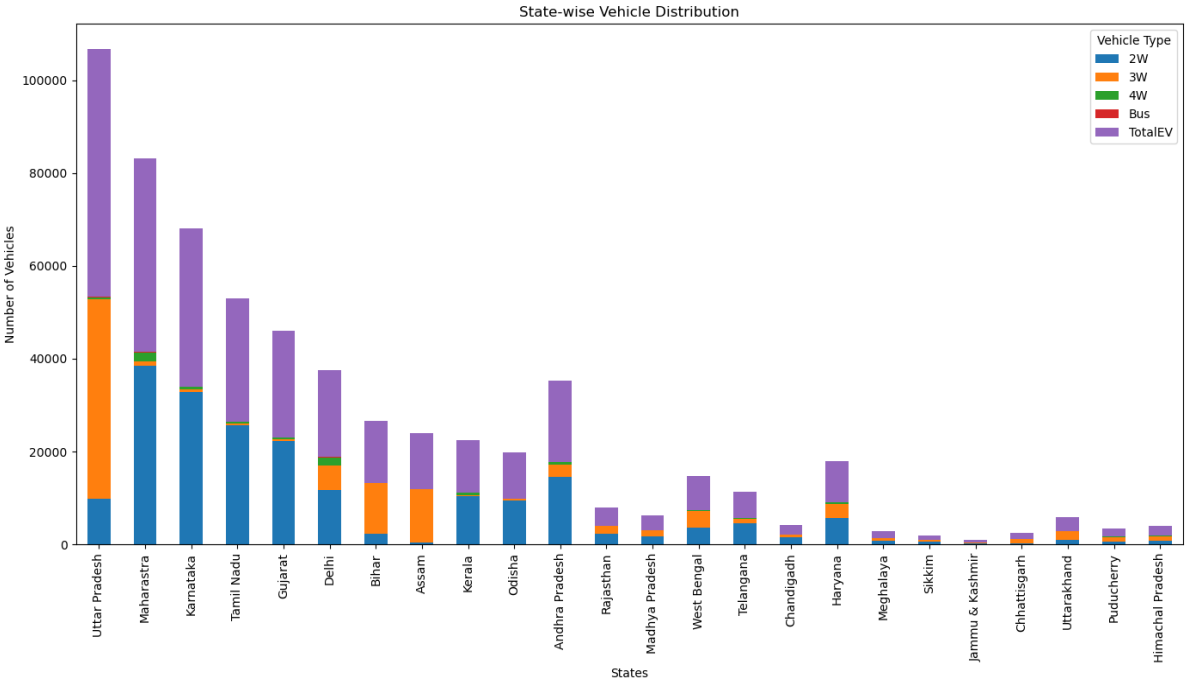

Figure 28: State wise distribution of EVs by category

7.4. Total Chargers by State

To understand the overall distribution of EV chargers across different states, the code groups the data by state and calculates the total number of EV chargers in each state. The states are then sorted in descending order based on the total number of chargers. Figure 29 shows a bar chart representing the total number of EV chargers by state.

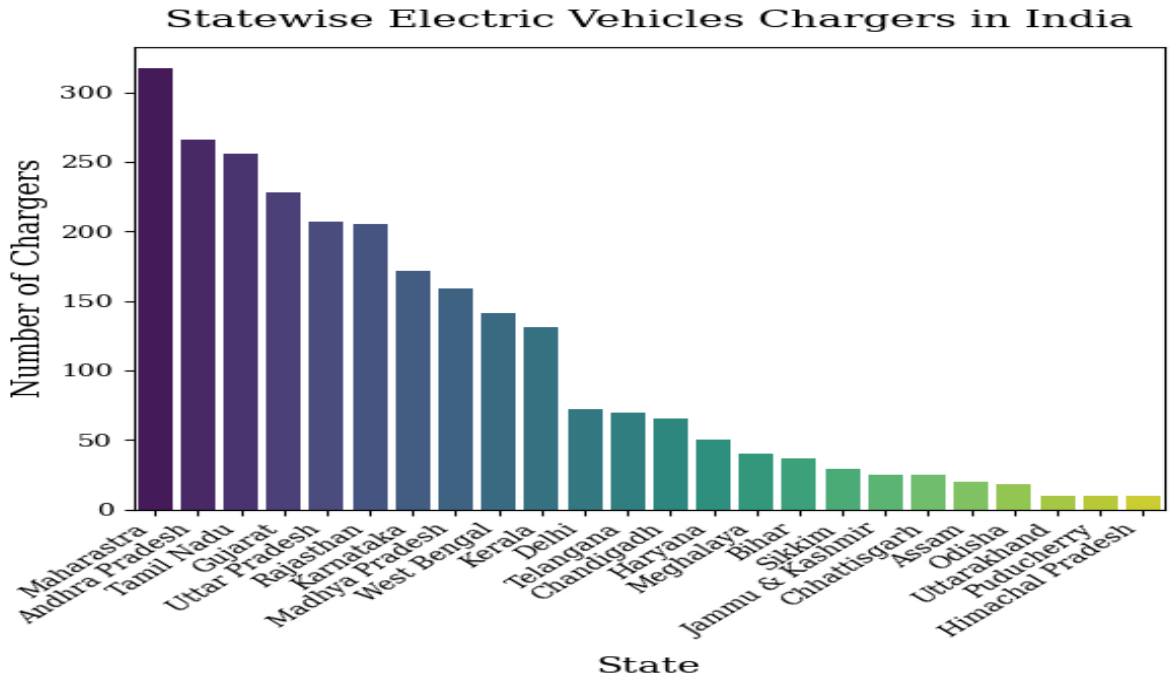

Figure 27: State wise Total EV Chargers in India

7.5. Results

Based on the analysis of the provided EV data, the following conclusions can be drawn:

- The state with the highest number of EVs is Uttar Pradesh, while the state with the lowest number of EVs is Jammu & Kashmir.
- Two-wheelers are the most prevalent category of EVs, followed by passenger cars.
- The state with the highest number of EV chargers is Maharashtra, while the state with the lowest number of EVs is Himachal Pradesh.

8.Conclusion:

The growing electric vehicle (EV) market is poised to replace traditional petrol and diesel cars in the future. Advancements in technology, environmental concerns, and government support are driving the shift toward electric mobility. EVs produce zero emissions, reducing carbon footprint and air pollution. Improved battery efficiency, extended ranges, and expanding charging infrastructure alleviate concerns about range anxiety. Decreasing production costs and operational savings make EVs increasingly affordable and competitive. Businesses, fleet operators, and governments recognize the benefits of EV adoption. Although a complete transition will require further investments and infrastructure development, the momentum

toward electric mobility is undeniable, leading us to a cleaner and more sustainable transportation future. The reasons for the growing EV market are:

- **Environmental Consciousness:** Many customers interested in EVs prioritize environmental sustainability. EVs produce zero tailpipe emissions, reducing air pollution and greenhouse gas emissions. This feature appeals to those seeking to minimize their carbon footprint and contribute to a cleaner, greener future.
- **Cost Savings:** EVs offer potential long-term cost savings compared to traditional internal combustion engine vehicles. Charging an EV is generally less expensive than fuelling a gas-powered vehicle, resulting in reduced operational costs. Additionally, EVs require less maintenance since they have fewer moving parts and do not require oil changes.
- **Government Incentives:** Various governments provide incentives to encourage the adoption of EVs, such as tax credits, rebates, and grants. These incentives can help offset the initial purchase cost and make EVs more financially attractive to prospective buyers.

9.References

[1] A. Razmjoo, A. Ghazanfari, M. Jahangiri, E. Franklin, M. Denai,M. Marzband, D. Astiaso Garcia, and A. Maheri, “A comprehensive study on the expansion of electric vehicles in europe,” Applied Sciences, vol. 12, p. 11656, 11 2022.

GitHub:https://github.com/Subhendu1998/Electric_Vehicle_Customer_Market_segmentation_Subhendu_Mandal