EV Market Segmentation

A Project Report For Internship In Feynn Lab

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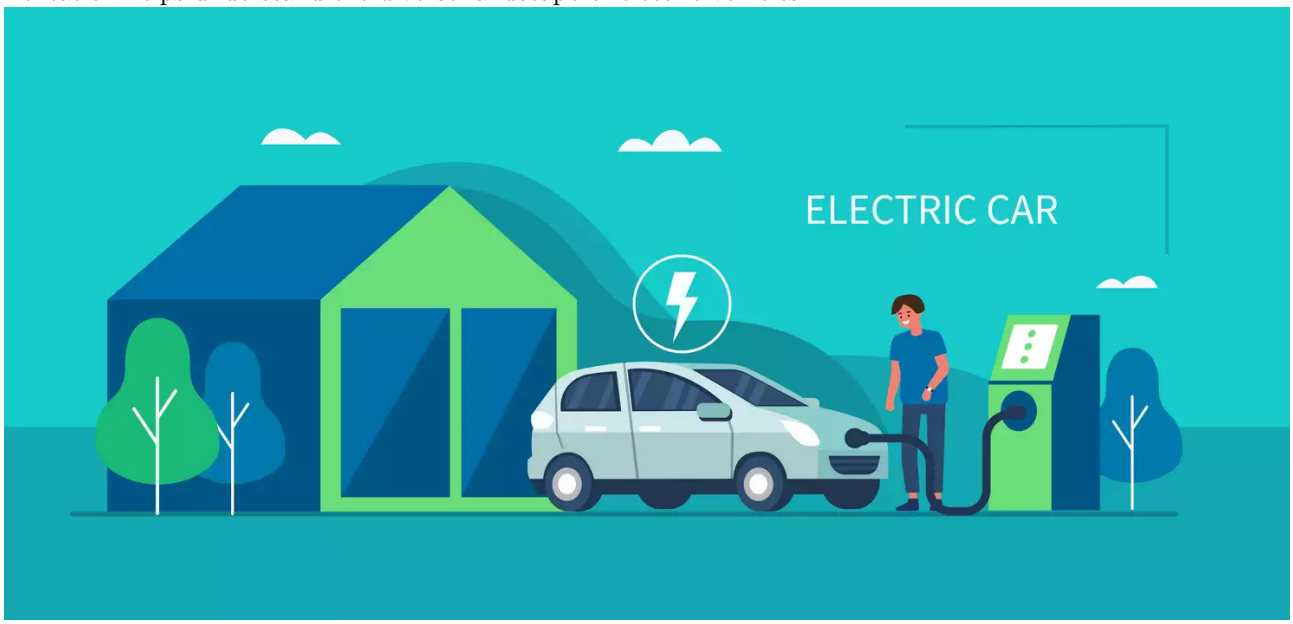
1 Introduction

The electric vehicle (EV) market is revolutionizing the automotive industry, driven by the global shift towards sustainable transportation. As concerns about climate change and environmental sustainability grow, the adoption of EVs has gained significant momentum. In this fast-evolving landscape, understanding the market segmentation of electric vehicles becomes crucial for businesses, investors, and policymakers alike.The EV market segmentation helps understand the diverse landscape of electric vehicles.



It categorizes EVs based on factors like vehicle type, range, price, and target audience. Segments include compact EVs for urban commuting, luxury EVs for affluent buyers, and long-range EVs for road trips. This segmentation assists manufacturers and consumers in making informed decisions, promoting the growth and development of the EV market.

2 Problem Statement

The popularity of electric vehicles (EVs) is surging worldwide as an eco-friendly alternative to traditional gasoline cars. In India, the demand for EVs has been steadily rising due to concerns about air pollution, escalating fuel prices, and government incentives. As an Electric Vehicle Startup, it is crucial for us to thoroughly examine the Indian EV market and develop a viable strategy that focuses on the segments most inclined to embrace EV usage.

3 Data Collection and Preprocessing

The data has been collected from Kaggle. The data collected is compact and is used for visualization purposes and for clustering. Our objective is to conduct an extensive analysis of the Indian EV market utilizing segmentation analysis. We will take into account various factors such as geographic, demographic, and behavioral data to pinpoint the most suitable location to establish an early market .

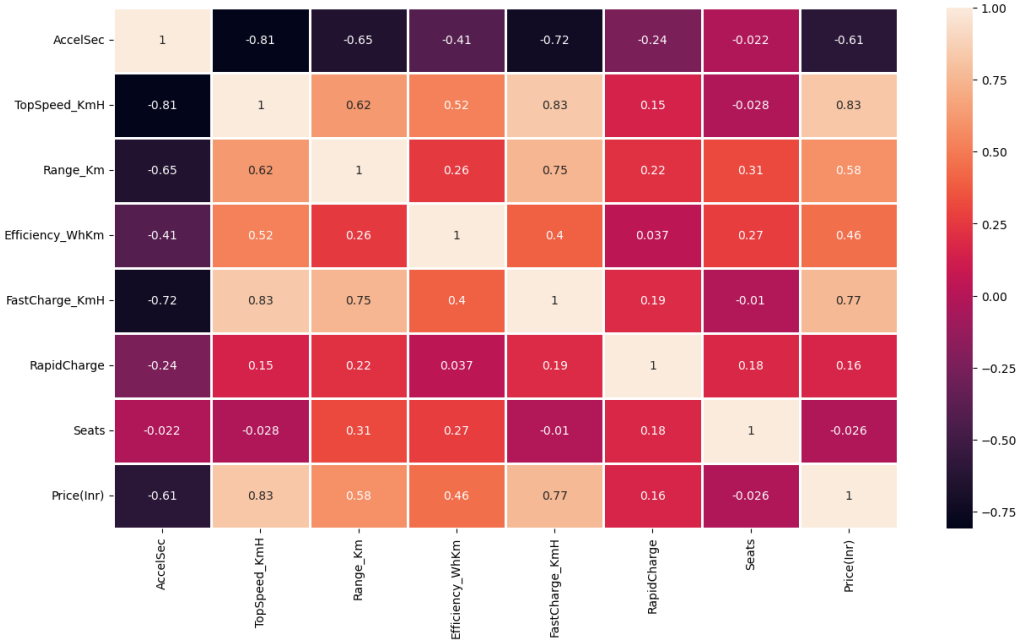
4 Packages/Tools used

- 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 KMeans 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 Segmentation using KMeans Clustering Algorithm

5.1 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. The correlation matrix between the features is attached in the Figure below:



5.2 KMeans Clustering

K Means algorithm is an iterative algorithm that tries to partition the dataset into pre-defined distinct non-overlapping subgroups (clusters) where each data point belongs to only one group. It tries to make the intra-cluster data points as similar as possible while also keeping the clusters as different (far) as possible. It assigns data points to a cluster such that the sum of the squared distance between the data points and the cluster's centroid (arithmetic mean of all the data points that belong to that cluster) is at the minimum. The less variation we have within clusters, the more homogeneous (similar) the data points are within the same cluster. The way k means algorithm works is as follows:

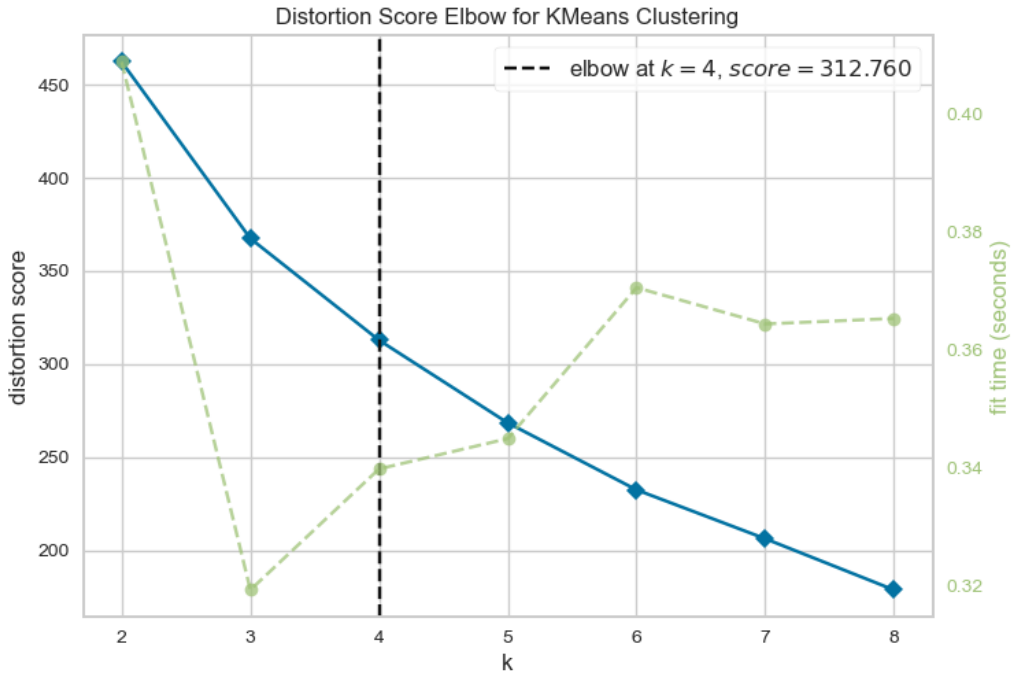
- Specify number of clusters K.
- Initialize centroids by first shuffling the dataset and then randomly selecting K data points for the centroids without replacement.
- Compute the sum of the squared distance between data points and all centroids. Assign each data point to the closest cluster (centroid).
- Compute the centroids for the clusters by taking the average of the all data points that belong to each cluster.
- Keep iterating until there is no change to the centroids. i.e assignment of data points to clusters isn't changing.

The approach k-means follows to solve the problem is expectation maximization The E-step is assigning the data points to the closest cluster. The M-step is computing the centroid of each cluster.

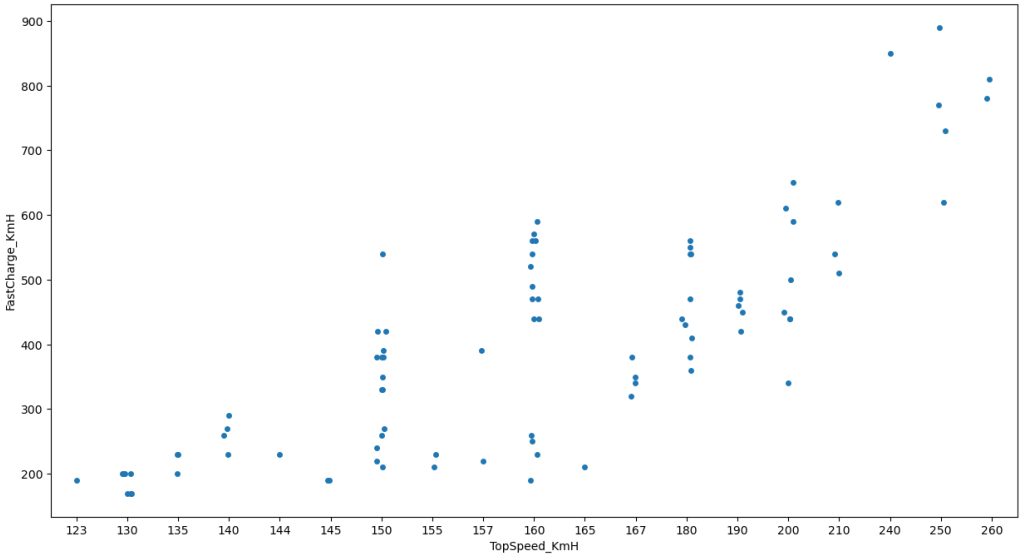
5.3 Determining the Number of Clusters

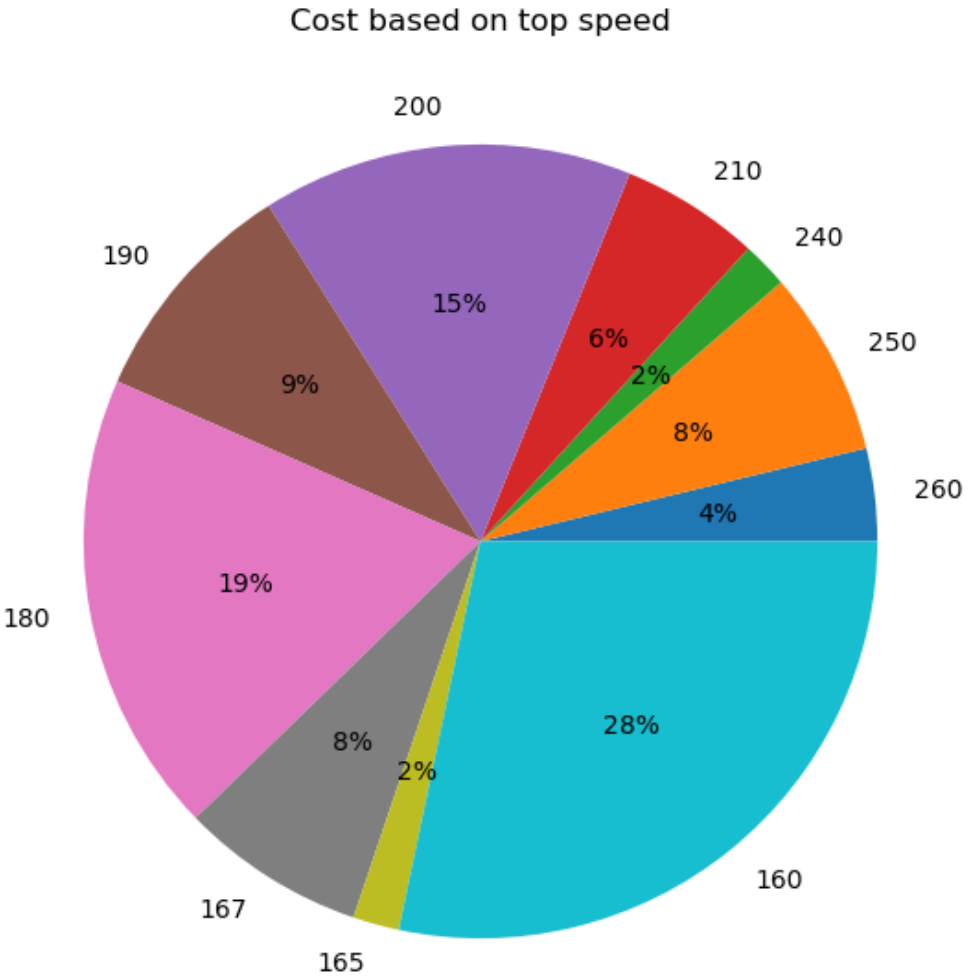
The Elbow method is a popular method for determining the optimal number of clusters. The method is based on calculating the Within-Cluster-Sum of Squared Errors (WSS) for a different number of clusters (k) and selecting the k for which change in WSS first starts to diminish. The idea behind the elbow method is that the explained variation changes rapidly for a small number of clusters and 6 then it slows down leading to an elbow formation in the curve. The elbow point is the number of clusters we can use for our clustering algorithm.

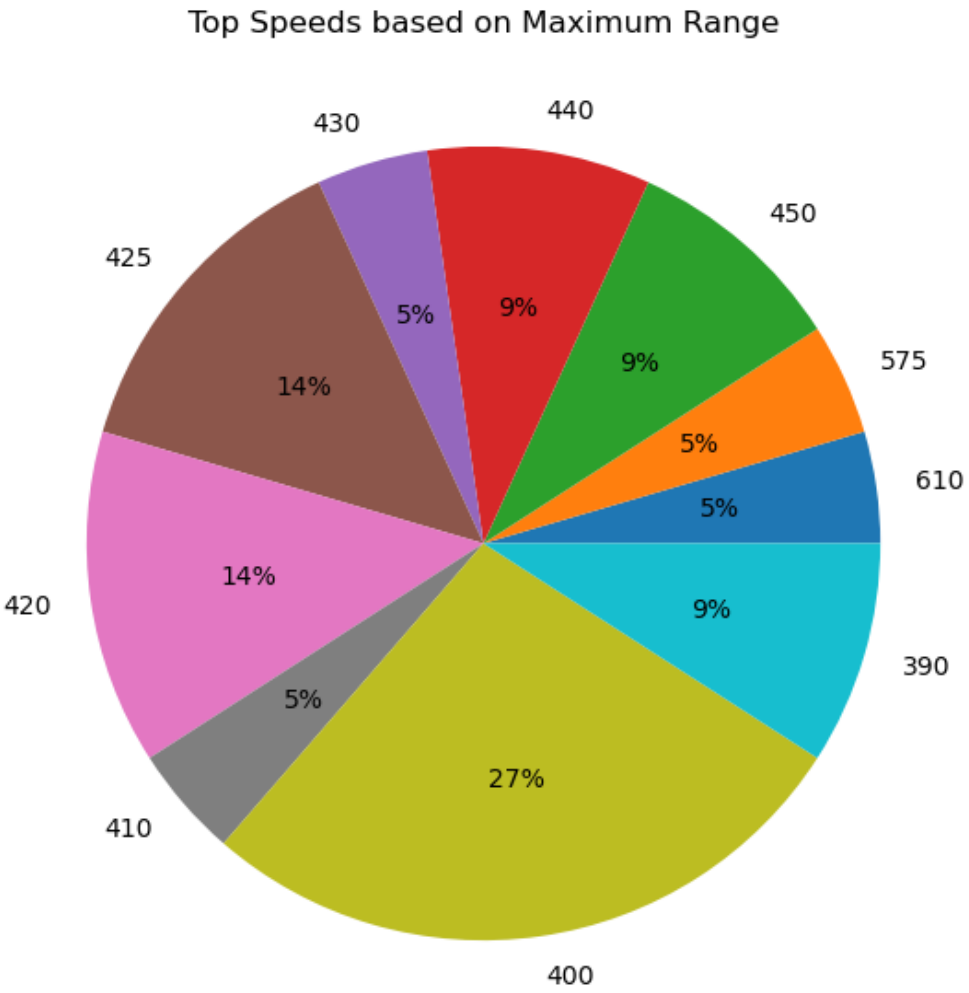
The Elbow method was used to identify the optimal number of clusters in the dataset. This technique involved running K-means clustering with a varying number of clusters and selecting the number that resulted in an elbow point in the plot of the sum of squared distances. The appropriate number of clusters was found to be n = 4 according to the Elbow method.



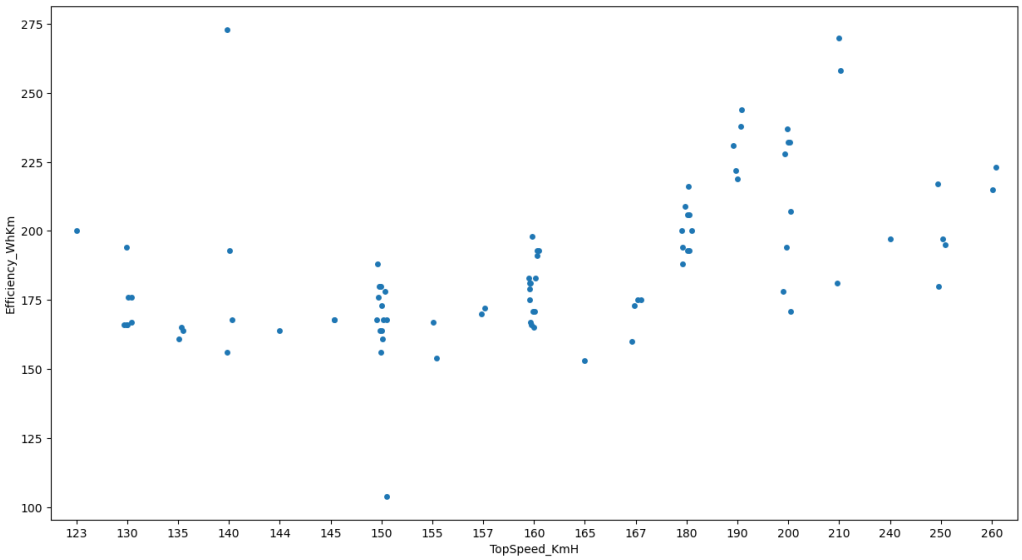
5.4 Relation Between Top speed and Fast Charge




Cost based on top speed
200
210
240
250
260
190
180
167
165
160
15%
6%
2%
8%
4%
9%
19%
8%
2%
28%



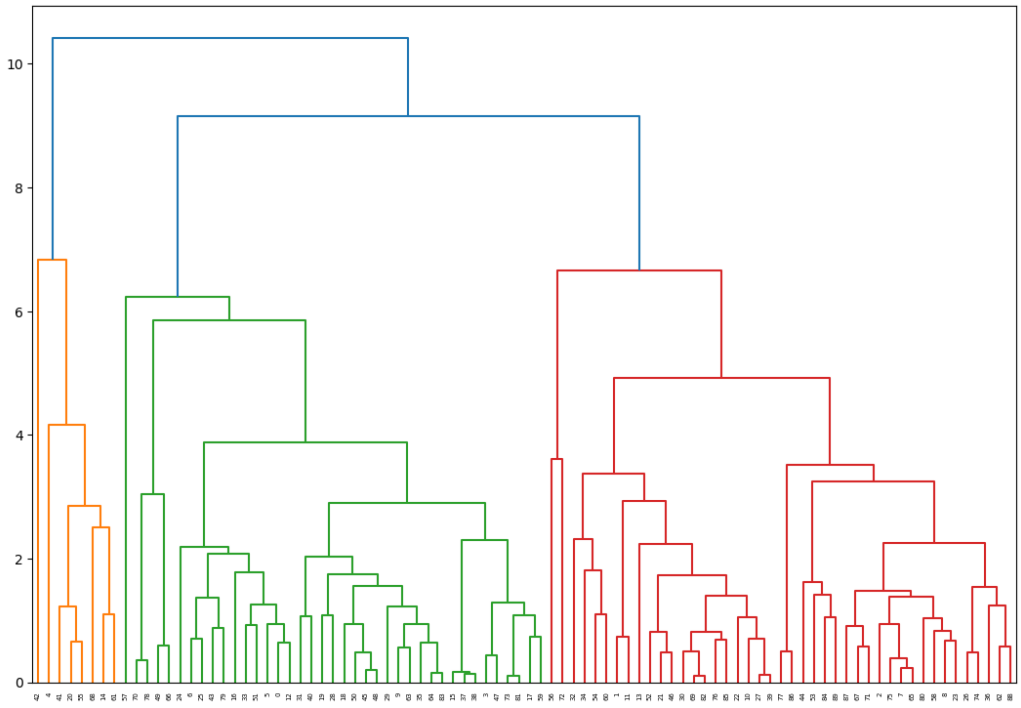
5.5 Relation Between Top speed and Efficiency



5.6 Dendrogram

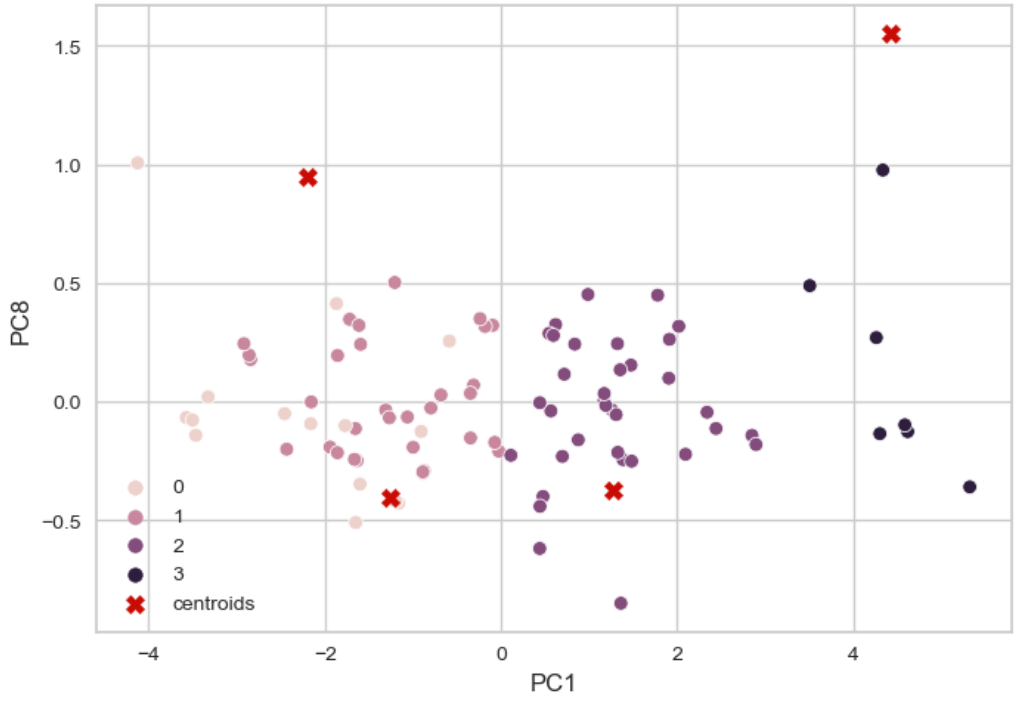
This technique is specific to the agglomerative hierarchical method of clustering. The agglomerative hierarchical method of clustering starts by considering each point as a separate cluster and starts joining points to clusters in a hierarchical fashion based on their distances. To get the optimal number of clusters for hierarchical clustering,

we make use of a dendrogram which is a tree-like chart that shows the sequences of merges or splits of clusters. If two clusters are merged, the dendrogram will join them in a graph and the height of the join will be the distance between those clusters. As shown in Figure, we can chose the optimal number of clusters based on hierarchical structure of the dendrogram.



5.7 . PCA implementation and visualization

Principal Component Analysis (PCA) was employed to visualize the clusters in a lower-dimensional space. This technique reduced the dimensionality of the data while retaining the most significant information. The clusters were then plotted using PCA for visualization purposes.



6 Geographic Segmentation

Analyzing charging stations data is crucial for understanding the infrastructure landscape for EVs in India. By visualizing the distribution of charging stations across different states, policymakers, electric utility com-

panies, and other stakeholders can identify regions with a higher demand for charging infrastructure and plan accordingly.

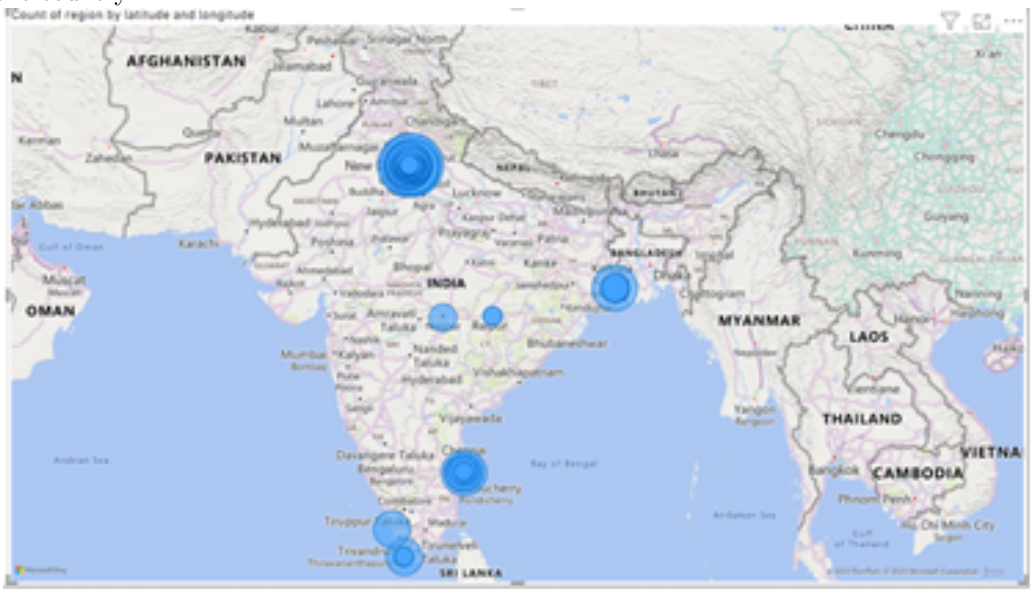
INDIAN EV MARKET INFRA IN MAJOR CITIES AND THERE DISTRIBUTERS

```
[87]: ev_station_state=pd.read_csv('CHARGING STATION STATEWISE.csv')


ev_city=ev_station_state.iloc[0:9,:].sort_values('Charging Stations',ascending=False)
ev_city
```

Out[87]:

	Category	City/Highway	Charging Stations
1	City	Delhi	94
3	City	Karnataka	65
6	City	Telangana	57
2	City	Rajasthan	49
0	City	Chandigarh	48
4	City	Jharkhand	30
5	City	Goa	30
7	City	Uttar Pradesh	16
8	City	Himachal Pradesh	9

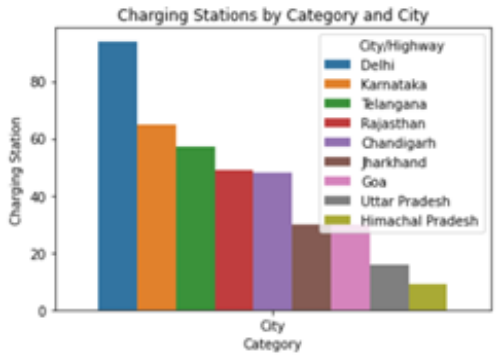
The spread of EV stations in India is gradually expanding, aiming to support the growing adoption of electric vehicles. Efforts from government initiatives, public-private partnerships, and corporate investments have led to an increase in charging infrastructure across major cities and highways. This expansion aims to enhance accessibility, convenience, and confidence in EV ownership, promoting a sustainable transportation ecosystem in the country.



6.1 Spread of Charging Stations in India

6.2 In Cities

```
]: sns.barplot(data=ev_city, x='Category', y='Charging Stations', hue='City/Highway')

   # Add labels and title
   plt.xlabel('Category')
   plt.ylabel('Charging Station')
   plt.title('Charging Stations by Category and City')

   # Show the plot
   plt.show()
```



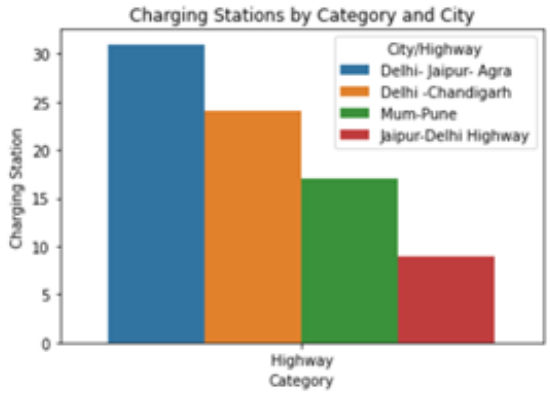
6.3 On Highways

```
n [89]: ev_highway=ev_station_state.iloc[10:14,:].sort_values('Charging Stations',ascending=False)
        ev_highway
```

ut[89]:

	Category	City/Highway	Charging Stations
12	Highway	Delhi- Jaipur- Agra	31
10	Highway	Delhi -Chandigarh	24
11	Highway	Mum-Pune	17
13	Highway	Jaipur-Delhi Highway	9

```
sns.barplot(data=ev_highway, x='Category', y='Charging Stations', hue='City/Highway')

# Add labels and title
plt.xlabel('Category')
plt.ylabel('Charging Station')
plt.title('Charging Stations by Category and City')

# Show the plot
plt.show()
```



6.4 Observation

The above plots tells us about the no. of EV charging stations in cities and on highways. From the above visualisation we can observe that the city Delhi has highest number of charging stations among cities present in the data set and Delhi-Jaipur-Agra highway has highest number of charging stations among highways present in the data set.

7 EV Market in USA

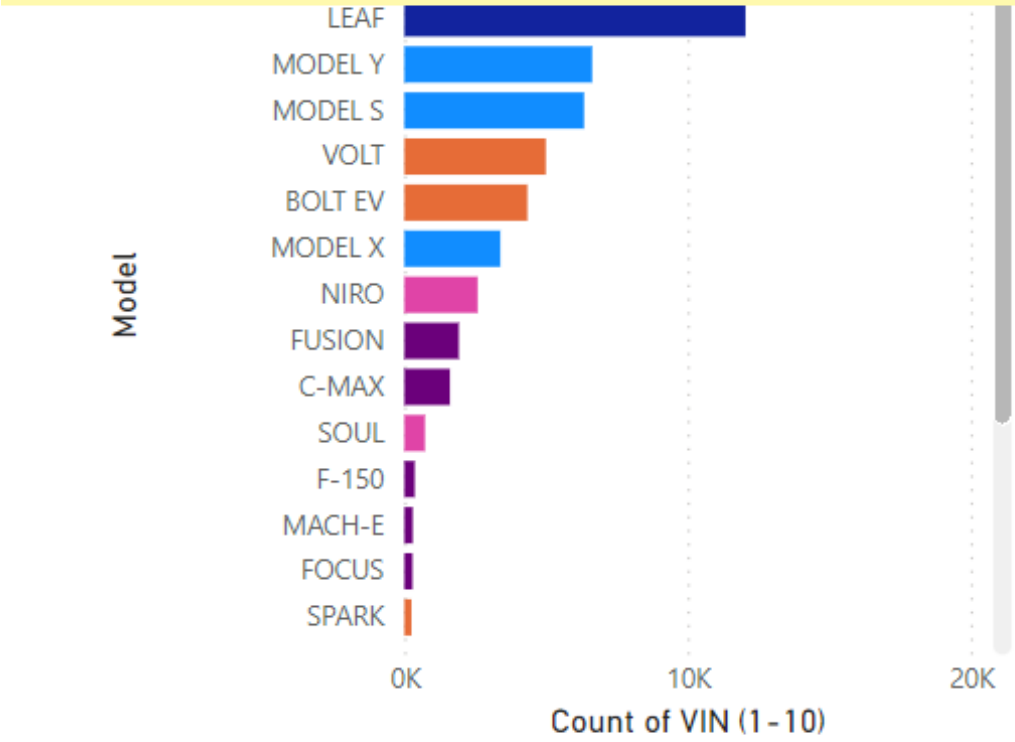
The EV market in the USA has witnessed significant growth, with a rising number of electric vehicles on the roads. Major brands such as Tesla, Chevrolet, Nissan, Ford, and BMW have played a significant role in shaping the market. The availability of charging infrastructure, federal and state incentives, and increased consumer awareness have contributed to the widespread adoption of EVs in the country.

```
# TOP 7 CAR COMPANIES IN USA


top_7_brand=washington_ev.groupby('Make')['State'].count().sort_values(ascending=False)
```

```
top_7_brand.nlargest(7)
```

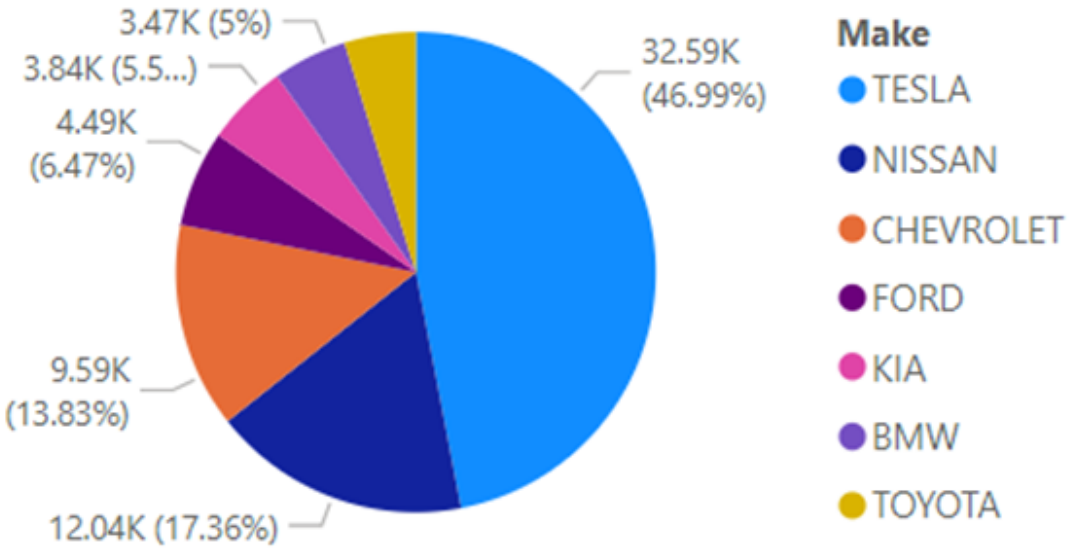
```
Make
TESLA        32594
NISSAN       12044
CHEVROLET     9590
FORD          4490
KIA           3843
BMW           3471
TOYOTA        3335
Name: State, dtype: int64
```

MARKET SHARE AND MOST SELLING CAR MODELS IN USA TOP 10 CARS SOLD IN USA



The EV market in the USA has reached a significant level of maturity, driven by advancements in technology, infrastructure development, and increasing consumer acceptance. The availability of a wide range of electric

vehicle models, including sedans, SUVs, and even pickup trucks, demonstrates the market's progress. Major automakers like Tesla, Chevrolet, Nissan, and Ford continue to expand their EV offerings, catering to diverse consumer needs. Additionally, the establishment of an extensive charging network, both at home and in public spaces, has alleviated range anxiety and boosted consumer confidence. Federal and state incentives, along with supportive policies, have further accelerated the growth of the EV market, making it a viable and sustainable transportation option for many Americans. With continuous advancements and investments, the future of the EV market in the USA appears promising, with even greater adoption anticipated in the coming years.




```
#TOP SELLING CARS AND THERE BRANDS IN USA


top_7_cars = washington_ev.groupby('Model')['Make'].count().nlargest(7)
```

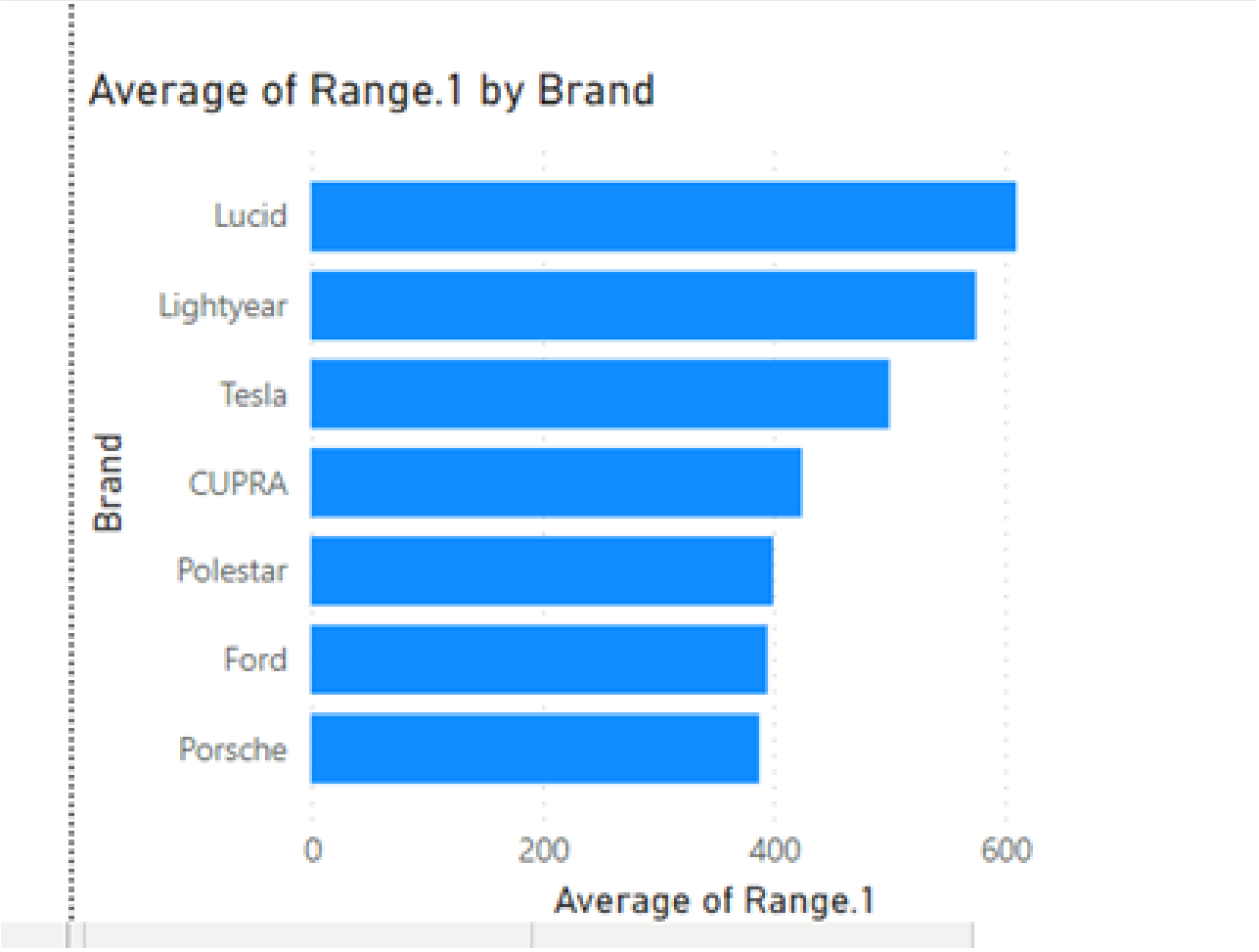
```
top_7_cars
```

```
Model
MODEL 3    16171
LEAF       12044
MODEL Y     6630
MODEL S     6344
VOLT        4994
BOLT EV     4345
MODEL X     3388
Name: Make, dtype: int64
```

```
top_brand_range=ev_general.groupby('Brand')['Range'].mean().astype(int).sort_values(ascending=False).nlargest(7)
```

```
top_brand_range
```

```
Brand
Lucid         610
Lightyear     575
Tesla         500
CUPRA         425
Polestar      400
Ford          395
Porsche       388
Name: Range, dtype: int32
```



8 EV Market in India

The EV market in India is experiencing significant growth and transformation as the country strives to reduce emissions and promote sustainable transportation. Several major companies are actively participating in this market, including Tata Motors, Mahindra & Mahindra, Hero Electric, and MG Motor India. Tata Motors, for instance, has introduced electric models like the Tata Nexon EV and Tata Tigor EV, while Mahindra & Mahindra offers the Mahindra eVerito and Mahindra eKUV100. Hero Electric specializes in electric two-wheelers, and MG Motor India has launched the MG ZS EV.

Certain states in India have emerged as leaders in promoting and adopting EVs. Maharashtra, particularly Mumbai and Pune, has witnessed significant EV adoption due to favorable policies, incentives, and charging infrastructure development. Other states like Delhi, Karnataka, and Tamil Nadu have also taken notable steps to encourage EVs through policy support, subsidies, and infrastructure initiatives.

To further accelerate the growth of the EV market, the Indian government has implemented initiatives like the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme. FAME provides financial incentives to both consumers and manufacturers, promoting the adoption of EVs across the country.

With increasing awareness, government support, and technological advancements, the EV market in India is poised for significant expansion, making electric mobility a crucial component of the country's transportation

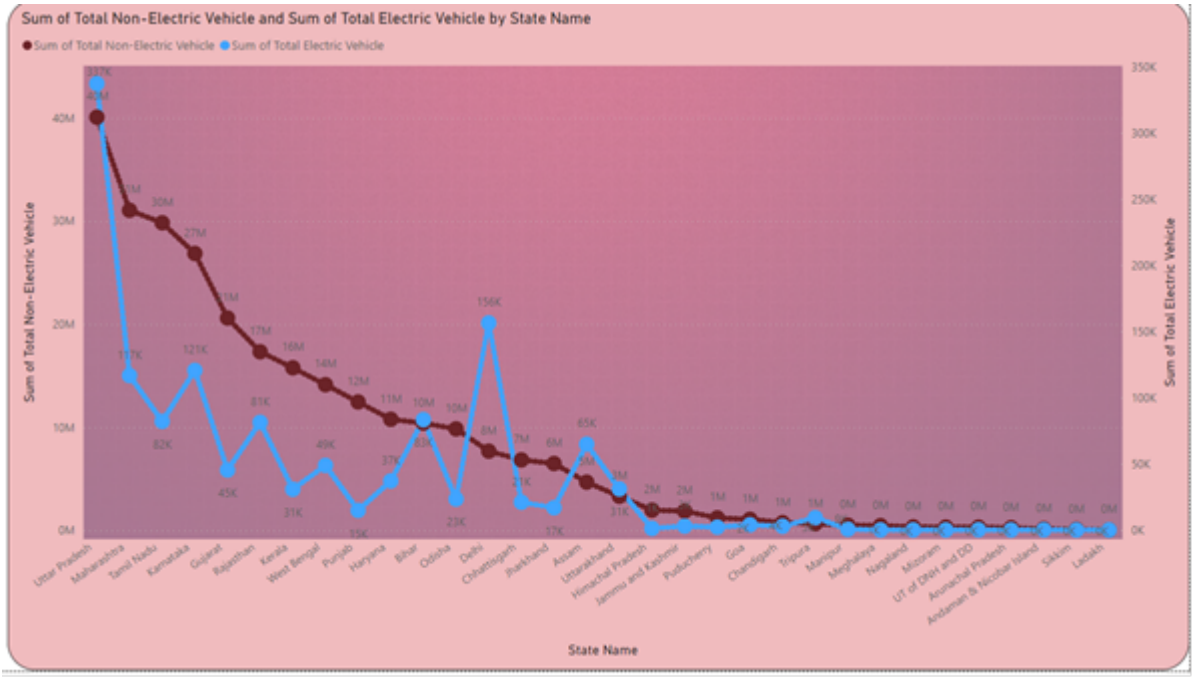
landscape.

```
state_ev_count= total_ev[['State','Total in state']]
```

```
state_ev_count.sort_values('Total in state',ascending=False)
```

	State	Total in state
30	Total	260863.0
14	Maharashtra	34013.0
6	Gujarat	31267.0
24	Uttar Pradesh	26209.0
7	Haryana	23589.0
4	Delhi	19381.0
21	Tamil Nadu	16746.0
20	Rajasthan	15763.0
26	West Bengal	14140.0
11	Karnataka	13386.0
12	Kerala	11202.0
0	Andhra Pradesh	9492.0
22	Telangana	9034.0
19	Punjab	6538.0
13	Madhya Pradesh	6461.0
3	Chhattisgarh	4234.0
25	Uttarkhand	4178.0
18	Odisha	3863.0
2	Bihar	3171.0

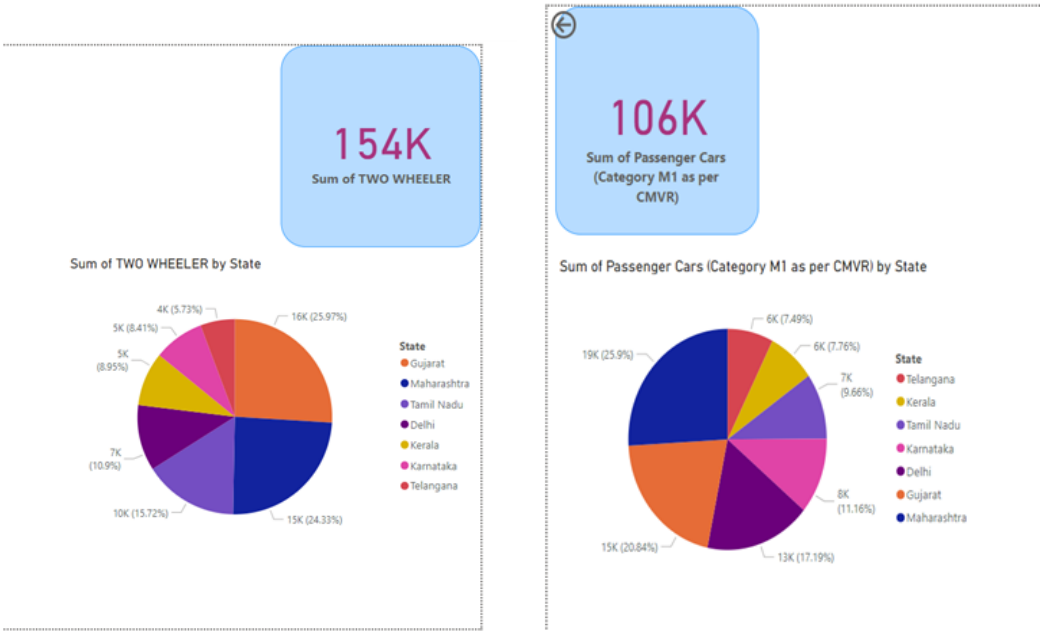
8.1 Chart for Total Count of EV vs Conventional Vehicle



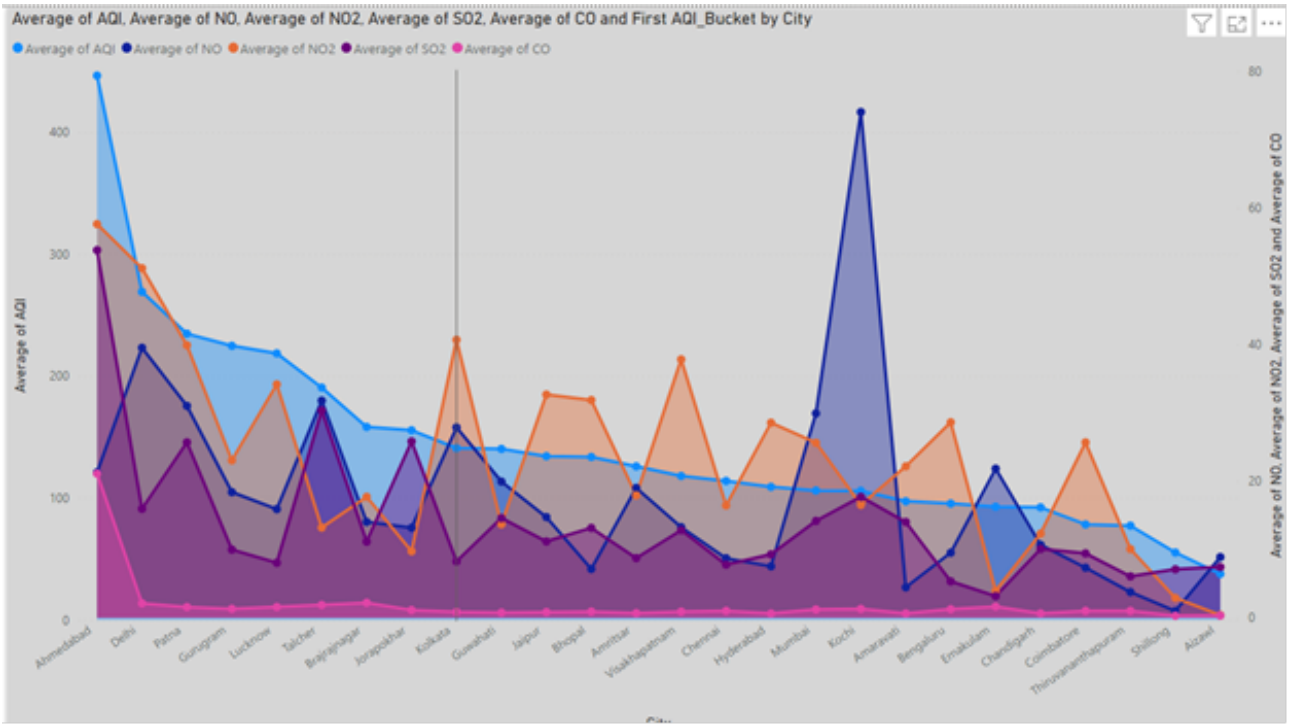
As of my knowledge cutoff in September 2021, I can provide a summary of passenger vehicle data in Indian states based on historical information. However, please note that the data might have changed since then. Here

is a general summary: Maharashtra: Maharashtra has a high number of passenger vehicles and is home to major automotive manufacturing hubs like Mumbai and Pune.

- Uttar Pradesh: Uttar Pradesh has a significant population and thus a considerable number of passenger vehicles.
- Tamil Nadu: Tamil Nadu is another state with a substantial presence in the automotive industry, housing manufacturing facilities for various automobile companies.
- Karnataka: Karnataka, specifically Bengaluru, has a significant number of passenger vehicles due to its status as a major IT hub.
- Gujarat: Gujarat has witnessed rapid industrialization and has attracted automotive manufacturing investments, resulting in a notable number of passenger vehicles.
- Delhi: Being the capital city, Delhi has a large number of passenger vehicles despite challenges related to pollution and traffic congestion.
- Rajasthan, Andhra Pradesh, Telangana, Kerala, and other states also have a considerable number of passenger vehicles .



8.2 Summary of Pollution in India



The increasing pollution in India can potentially contribute to the increase in the sale of electric vehicles (EVs) for several reasons:

1. Environmental Awareness: Rising pollution levels in cities have led to increased awareness about the detrimental effects of traditional gasoline and diesel vehicles on air quality. This awareness can drive individuals to consider cleaner alternatives like EVs.

2. Government Incentives: The Indian government has implemented various policies and incentives to promote the adoption of EVs. These include subsidies, tax benefits, and reduced registration fees, making EVs more financially attractive to potential buyers.

3. Improved Infrastructure: The need to combat pollution has led to the development of charging infrastructure in major cities. Increased availability of charging stations provides convenience and addresses concerns about range anxiety, making EVs a more viable option.

4. Stringent Emission Standards: The Indian government has set increasingly stringent emission standards for vehicles. To comply with these regulations, automakers are encouraged to introduce more electric and hybrid vehicles into the market.

5. Public Transport Transition: Government initiatives to electrify public transportation, such as buses and taxis, help create a visible shift towards EVs. This transition can inspire confidence in the technology and encourage private individuals to consider EVs for personal use.

6. Technological Advancements: As EV technology advances, concerns about limited range and charging times are being addressed. Improved battery technology and longer driving ranges make EVs more practical for everyday use. While the increasing pollution levels in India are a concerning issue, it has also acted as a catalyst for the growth of the EV market. The combination of environmental consciousness, government support, infrastructure development, and technological advancements is driving the shift towards electric mobility and contributing to the increased sale of EVs in India.

```
# MOST EXPENSIVE EV BIKE

most_expensive_bike=ev_bike[(ev_bike['price']==ev_bike['price'].max())]
```

```
most_expensive_bike[['model_name','price']]
```

	model_name	price
14	One Moto Electa	199000

```
#LEAST EXEPENSIVE

least_expensive_bike=ev_bike[(ev_bike['price']==ev_bike['price'].min())]
```

```
least_expensive_bike[['model_name','price']]
```

	model_name	price
44	Polarity Executive	38000

```
# AVERAGE EV COST


avg_ev_price =
```

```
avg_ev_price=ev_bike['price'].mean()


print('AVERAGE COST OF EV IN INDIA',avg_ev_price)
```

```
AVERAGE COST OF EV IN INDIA 80704.59649122808
```

```
# TOP 7 NITROGEN EMITTING CITIES

pol_1.groupby('City').mean().sort_values('NO',ascending=False).iloc[0:8]
```

City	PM2.5	PM10	NO	NO2	NOx	NH3	CO	SO2	O3	Benzene	Toluene	Xylene	AQI
Kochi	32.026487	67.156266	73.747842	16.207570	68.835785	8.356232	1.292734	17.649866	3.992697	NaN	0.002186	NaN	104.684593
Delhi	117.665396	233.114669	39.005350	50.763704	58.587961	42.128140	1.979092	15.927299	51.312347	3.546031	17.187459	1.443237	260.148048
Patna	121.156521	126.977728	31.332888	37.939637	44.569077	18.366670	1.552188	23.472227	38.807114	1.761845	11.254970	5.767587	237.929606
Talcher	63.910758	171.765254	30.864532	14.860062	31.548871	11.329284	1.837941	28.914755	16.771184	0.073813	0.000433	NaN	177.556503
Mumbai	35.491808	97.547894	30.023606	25.616875	54.376241	13.824966	0.564609	14.576615	32.591641	1.120393	0.012285	0.007699	105.945297
Kolkata	64.748260	116.229831	26.693920	40.515746	63.149616	18.414637	0.799987	8.267030	30.633001	10.894834	15.430997	2.562476	140.688918
Ernakulam	25.215284	48.312414	22.756429	3.966540	23.531341	20.120908	1.620186	3.175026	NaN	0.616919	1.296431	0.157817	92.753429
Ahmedabad	67.273271	111.493008	22.236505	59.470600	47.308052	NaN	21.999914	52.796652	39.067821	5.294880	27.464264	4.198443	453.542641

```
# TOP 7 NITOGEN DIOOXIDE EMITTING CITIES
pol_1.groupby('City').mean().sort_values('NO2',ascending=False).iloc[0:8]
```

City	PM2.5	PM10	NO	NO2	NOx	NH3	CO	SO2	O3	Benzene	Toluene	Xylene	A
Ahmedabad	67.273271	111.493008	22.236505	59.470600	47.308052	NaN	21.999914	52.796652	39.067821	5.294880	27.464264	4.198443	453.5426
Delhi	117.665396	233.114669	39.005350	50.763704	58.587961	42.128140	1.979092	15.927299	51.312347	3.546031	17.187459	1.443237	260.1480
Kolkata	64.748260	116.229831	26.693920	40.515746	63.149616	18.414637	0.799987	8.267030	30.633001	10.894834	15.430997	2.562476	140.6889
Patna	121.156521	126.977728	31.332888	37.939637	44.569077	18.366670	1.552188	23.472227	38.807114	1.761845	11.254970	5.767587	237.9296
Visakhapatnam	47.851225	106.749508	12.848235	37.361552	25.043768	10.989798	0.733738	12.750689	38.091288	3.842899	8.179757	2.725523	117.7298
Lucknow	110.013188	NaN	15.369607	33.399615	22.905554	29.563990	2.031276	8.569321	36.725474	2.584798	4.664041	NaN	218.2671
Jaipur	54.722702	124.089283	14.690761	32.622573	39.665021	26.620262	0.807314	11.122014	46.961860	1.588937	6.798902	NaN	134.0116
Bhopal	50.537683	120.233907	7.087250	31.602160	22.612549	19.105302	0.885071	13.115063	59.935130	NaN	NaN	NaN	133.4073

```
# TOP 7 CARBON MONOXIDE EMITTING CITIES
pol_1.groupby('City').mean().sort_values('CO',ascending=False).iloc[0:8]
```

City	PM2.5	PM10	NO	NO2	NOx	NH3	CO	SO2	O3	Benzene	Toluene	Xylene	AQI
Ahmedabad	67.273271	111.493008	22.236505	59.470600	47.308052	NaN	21.999914	52.796652	39.067821	5.294880	27.464264	4.198443	453.542641
Lucknow	110.013188	NaN	15.369607	33.399615	22.905554	29.563990	2.031276	8.569321	36.725474	2.584798	4.664041	NaN	218.267122
Delhi	117.665396	233.114669	39.005350	50.763704	58.587961	42.128140	1.979092	15.927299	51.312347	3.546031	17.187459	1.443237	260.148048
Talcher	63.910758	171.765254	30.864532	14.860062	31.548871	11.329284	1.837941	28.914755	16.771184	0.073813	0.000433	NaN	177.556503
Brajrajnagar	66.448648	125.422753	14.142573	16.821701	23.224338	35.687221	1.824064	10.036474	16.101145	4.677130	NaN	NaN	151.419829
Ernakulam	25.215284	48.312414	22.756429	3.966540	23.531341	20.120908	1.620186	3.175026	NaN	0.616919	1.296431	0.157817	92.753429
Patna	121.156521	126.977728	31.332888	37.939637	44.569077	18.366670	1.552188	23.472227	38.807114	1.761845	11.254970	5.767587	237.929606
Bengaluru	35.578011	82.527733	9.441072	28.057993	20.436661	21.599241	1.375805	5.477278	32.645345	2.345345	4.147976	NaN	94.407038

```
# TOP 7 SULPHUR DIOOXIDE  EMITTING CITIES

pol_1.groupby('City').mean().sort_values('SO2',ascending=False).iloc[0:8]
```

City	PM2.5	PM10	NO	NO2	NOx	NH3	CO	SO2	O3	Benzene	Toluene	Xylene	AQI
Ahmedabad	67.273271	111.493008	22.236505	59.470600	47.308052	NaN	21.999914	52.796652	39.067821	5.294880	27.464264	4.198443	453.542641
Jorapokhar	63.974117	149.724724	11.233604	9.346244	NaN	7.009084	0.708506	31.376817	32.654791	NaN	NaN	NaN	159.990075
Talcher	63.910758	171.765254	30.864532	14.860062	31.548871	11.329284	1.837941	28.914755	16.771184	0.073813	0.000433	NaN	177.556503
Patna	121.156521	126.977728	31.332888	37.939637	44.569077	18.366670	1.552188	23.472227	38.807114	1.761845	11.254970	5.767587	237.929606
Kochi	32.026487	67.156266	73.747842	16.207570	68.835785	8.356232	1.292734	17.649866	3.992697	NaN	0.002186	NaN	104.684593
Delhi	117.665396	233.114669	39.005350	50.763704	58.587961	42.128140	1.979092	15.927299	51.312347	3.546031	17.187459	1.443237	260.148048
Guwahati	61.777197	113.876706	20.131091	13.604104	44.475530	10.875834	0.737496	14.578609	24.999741	2.565226	NaN	NaN	140.246848
Mumbai	35.491808	97.547894	30.023606	25.616875	54.376241	13.824966	0.564609	14.576615	32.591641	1.120393	0.012285	0.007699	105.945297

9 Behavioral Segmentation

A behavioral analysis was conducted to gain insights into consumers' preferences and attitudes towards EVs. Behavioral Segmentation searches directly for similarities in behavior or reported behavior. It has advantage as it uses the very behavior of interest is used as the basis of segment extraction.

9.1 Data loading and preprocessing

The data contains various variables among which few important variables are:

1. Age,
2. Education,
3. Car_loan,
4. Total salary,
5. EV_price

```
# This data contains the details about consumers who purchased an EV
df8=pd.read_csv(r"C:\Users\bajaj\Desktop\internship\project2\datasets\behavioural_dataset (1).
```

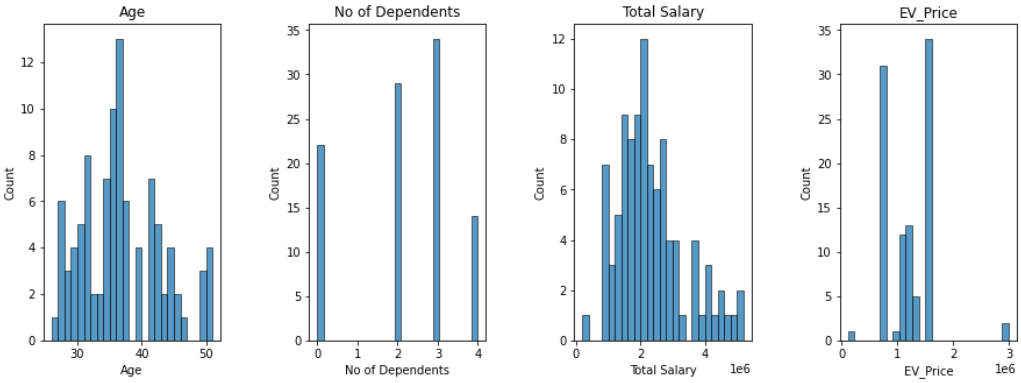
```
df8.rename(columns={'Personal loan':'Car_Loan'},inplace=True)
df8.rename(columns={'Price':'EV_Price'},inplace=True)
df8.head(10)
```

✓ 0.0s

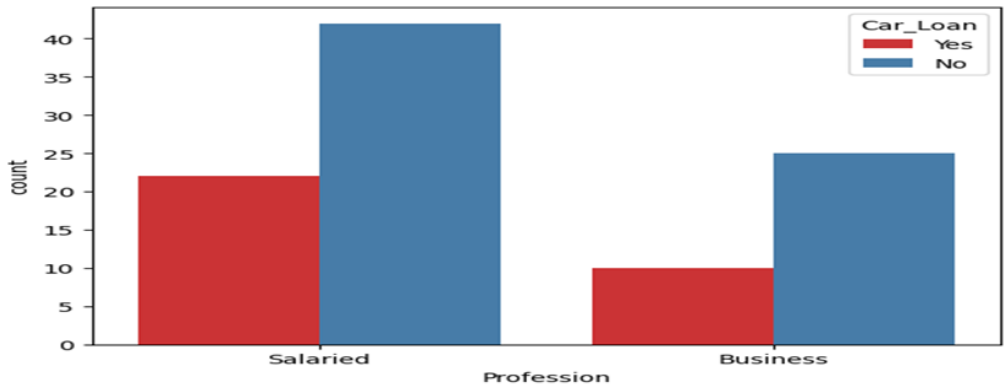
	Age	Profession	Marrital Status	Education	No of Dependents	Car_Loan	Total Salary	EV_Price
0	27	Salaried	Single	Post Graduate	0	Yes	800000	800000
1	35	Salaried	Married	Post Graduate	2	Yes	2000000	1000000
2	45	Business	Married	Graduate	4	Yes	1800000	1200000
3	41	Business	Married	Post Graduate	3	No	2200000	1200000
4	31	Salaried	Married	Post Graduate	2	Yes	2600000	1600000
5	28	Salaried	Married	Graduate	3	Yes	900000	700000
6	31	Salaried	Married	Graduate	4	No	1800000	1200000
7	33	Business	Married	Post Graduate	4	No	1400000	700000
8	34	Business	Married	Post Graduate	4	No	2000000	1100000
9	34	Salaried	Married	Graduate	3	Yes	1900000	800000

9.2 Data Visualisation

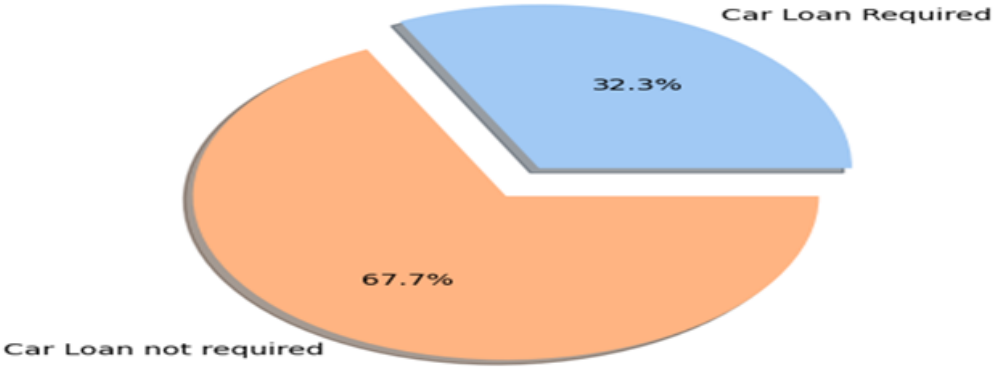
Frequency of each entry



Bar Chart



Pie chart



The 1st graph gives us insight about the count of no. of married and single people taking car loan The 2nd graph gives us insight about the percentage of total no. people taking car loan & percentage of people not taking car loan.

9.3 Model Training & Fitting

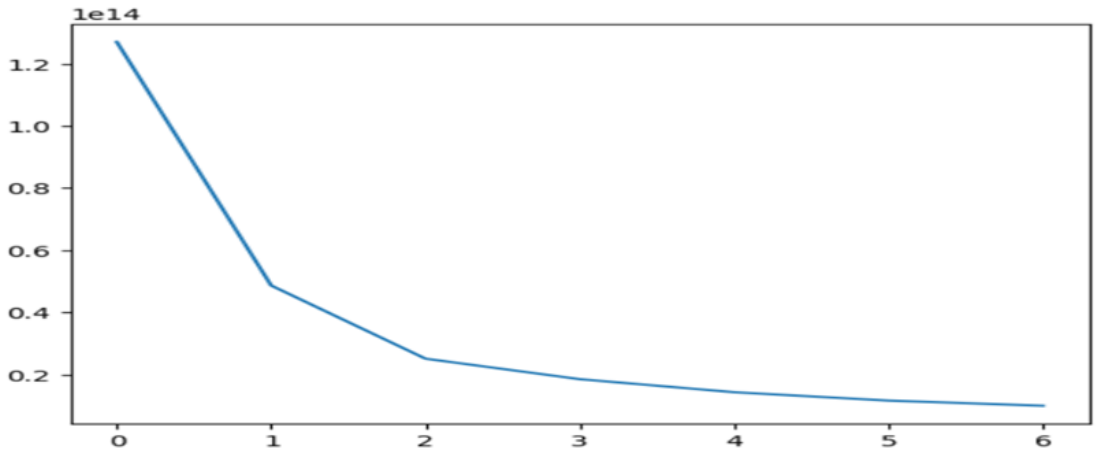
```
!pip install kmodes
from kmodes.kprototypes import KPrototypes
```

```
cluster_features = list(df8.columns)
cluster_data = df8[cluster_features].values
```

Here we have used the PCA technique to reduce the dimensionality of the data.We have used the elbow curve to find the optimal number of clusters.

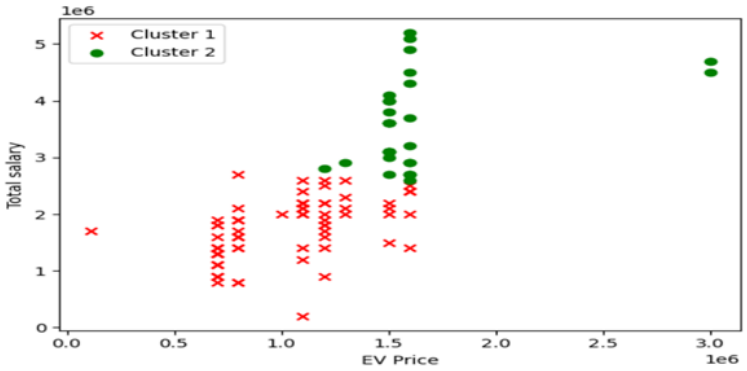
```
cost = []
for num_clusters in list(range(1,8)):
    kproto = KPrototypes(n_clusters=num_clusters, init='Cao')
    kproto.fit_predict(cluster_data, categorical=[1,2,3,5])
    cost.append(kproto.cost_)

plt.plot(cost)
```

```
[<matplotlib.lines.Line2D at 0x17c05c9bc70>]
```



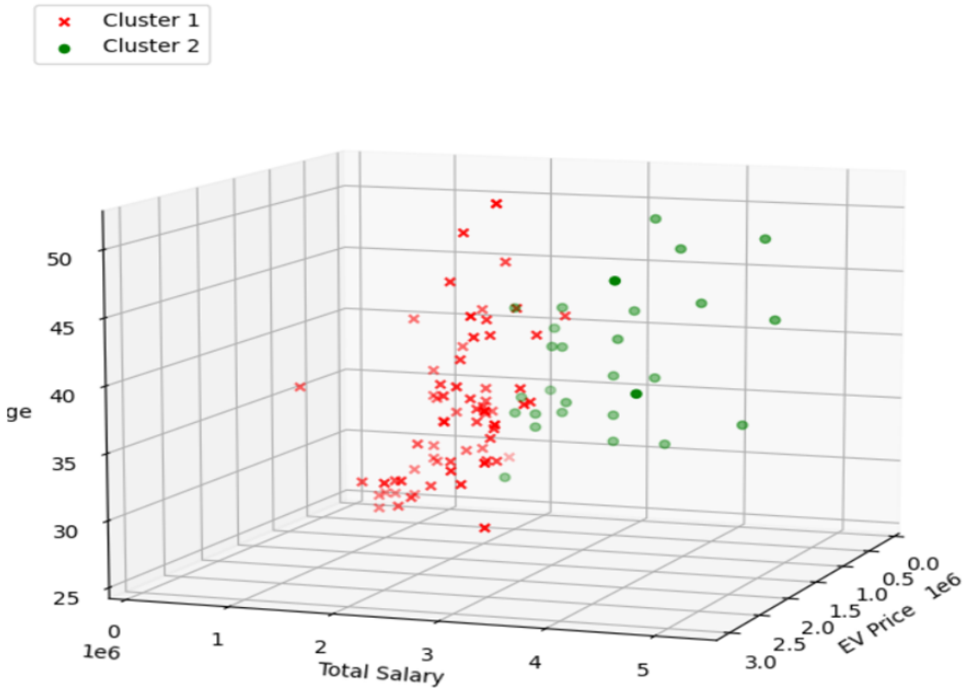
9.4 Analysing Clusters

```
Cluster_0 = df8[df8.Cluster==0]
Cluster_1 = df8[df8.Cluster==1]
plt.scatter(Cluster_0.EV_Price, Cluster_0['Total Salary'],color='red', marker = 'x', label = 'Cluster 1')
plt.scatter(Cluster_1.EV_Price, Cluster_1['Total Salary'],color='green', label = 'Cluster 2')
plt.legend(loc="upper left")

plt.xlabel('EV Price')
plt.ylabel('Total salary')
plt.show()
```




```
fig = plt.figure(figsize=(8,8))

ax = fig.add_subplot(111, projection='3d')

ax.scatter(Cluster_0.EV_Price, Cluster_0['Total Salary'], Cluster_0['Age'], color='red', marker = 'x', label = 'Cluster 1')
ax.scatter(Cluster_1.EV_Price, Cluster_1['Total Salary'],Cluster_1['Age'], color='green', label = 'Cluster 2')
plt.legend(loc = 'upper left')

ax.view_init(10, 20)

plt.xlabel("EV Price")
plt.ylabel("Total Salary")
ax.set_zlabel('Age')
plt.show()
```

9.5 3D Visualization



9.6 Observations & Insights

1. The optimal number of clusters for the given data comes out to be 2.
2. As the total salary increases the amount of money spent on the car increase.

3. The amount of money spent is also proportional to age as age increases, money spent also increase.

9.7 Target Segment

The above data visualisation and analysis completely tells about the trend that high salaried, old people prefers the Electric vehicles but keeping in mind the rising prices of petrol and diesel and increasing awareness about vehicle pollution in the younger people influence their decision to buy EVs.So the prefer market segment must be the mid tier which caters to both the need of young as well as old people.

10 Conclusion

The market segmentation analysis of the EV market in India provided valuable insights into consumer preferences and behaviors. The analysis revealed distinct clusters within the dataset, representing different consumer segments based on demographic, geographic, psycographic, and behavioral factors. This information can guide marketing strategies, product development, and target market selection to enhance EV adoption in India.

- The electric vehicle (EV) market segments in India are experiencing significant growth and potential. Several key factors contribute to the development and adoption of EVs in the country.
- The findings suggest the need for targeted campaigns to address specific segments' concerns and preferences. The analysis also highlighted the importance of factors such as affordability, perception of economic viability, and regional variations in driving EV adoption.
- Increasing Awareness: There is a growing awareness among Indian consumers regarding the environmental benefits of EVs, including reduced emissions and lower pollution levels. This awareness is driving the demand for EVs, especially among environmentally conscious individuals and organizations.
- Urban Commuting and Ride-Sharing: India's urban areas, particularly major cities, are witnessing a surge in demand for EVs for commuting and ride-sharing purposes. The lower operating costs and the ability to 15 navigate through congested traffic make EVs an attractive option for urban dwellers.

11 Limitations and Areas for Further Study

The interdependency of all the components in the marketing mix contributes to the overall business plan of a company and, when managed effectively, can lead to remarkable success. The marketing mix necessitates a comprehensive understanding of the market, extensive research, and consultation with various stakeholders, including customers, trade partners, and manufacturers.

- The Indian government has implemented several policies and initiatives to encourage the adoption of electric vehicles (EVs), such as offering financial incentives, subsidies, and tax benefits to EV manufacturers. Additionally, efforts have been made to develop a robust charging infrastructure throughout the country. To conduct a study in this area, relevant data collection would be necessary.
- In recent years, the cost of EVs, including batteries, has gradually decreased, making them more affordable for the Indian market. This reduction in costs, along with the availability of government incentives, has expanded the potential consumer base for EVs. A future study could be conducted to further explore this trend.
- Government agencies and public transport operators are progressively transitioning to electric buses, taxis, and rickshaws. This aspect could also be the subject of a research project.
- While the charging infrastructure for EVs in India is still developing, significant improvements have been made. Ongoing efforts are focused on establishing a greater number of charging stations, both public and private, in major cities and along highways, addressing the concerns of potential EV buyers regarding range anxiety. This could be a future scope of study as well. While the EV market in India is promising, advancements in battery technology, expansion of infrastructure, and raising public awareness, the EV market in India shows promise. With continued government support, technological advancements, and increasing consumer interest, the future of the EV market in India looks bright.

References

[1] C. Morton, J. Anable, and J. D. Nelson, "Consumer structure in the emerging market for electric vehicles: Identifying market segments using cluster analysis," *International Journal of Sustainable Transportation*, vol. 11, no. 6, pp. 443–459, 2017.

[2] F. L. Sara Dolnicar, Bettina Grün, "Market Segmentation Analysis," *Springer Singapore*, pp. XXI, 324, 2018.

12 GitHub Links for Codes

1. Swarup Bej - https://github.com/Bejswarup
2. Bhavin Bajaj - https://github.com/bhavinbajaj/15bhavin
3. Snehil Gupta - https://github.com/shehil943
4. Alwin K Antony -https://github.com/alwin-k-antony