MARKET SEGMENTATION OF ELECTRIC VEHICLE IN INDIA

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Abstract

Electric vehicles (EVs) are gaining popularity worldwide due to their environmental benefits and low operating costs. In India, the government has introduced various policies and incentives to promote the adoption of EVs, leading to a significant increase in their sales in recent years. However, the Indian market for EVs is diverse, and it is important for companies to understand the different segments to target their products and services effectively.
The problem statement is to identify the different segments of customers in the Indian market for EVs, based on their demographics, psychographics, and behavior. This requires analyzing the various factors that influence customers' decisions to buy an EV, such as price, range, charging infrastructure, and brand perception. The objective is to develop a comprehensive understanding of the Indian market for EVs and help companies tailor their marketing strategies to target the most profitable segments.

This study focuses on the market segmentation of electric vehicles (EVs) in India. With increasing environmental concerns and the government's push for electric mobility, the EV market in India has been growing rapidly. The aim of this study is to identify the various segments in the EV market in India and understand their characteristics, preferences, and behavior. The study uses a mix of qualitative and quantitative research methods, including surveys, interviews, and secondary data analysis, to identify the key segments in the Indian EV market. Based on the analysis, the study identifies four primary segments: early adopters, value seekers, eco-conscious consumers, and convenience-oriented buyers. Each segment is analyzed in terms of their demographics, psychographics, and behavior, and recommendations are made for marketing strategies that are tailored to each segment's unique needs and preferences. The study concludes that understanding the different segments in the Indian EV market is crucial for EV manufacturers and marketers to effectively target their customers and promote the adoption of EVs in India.

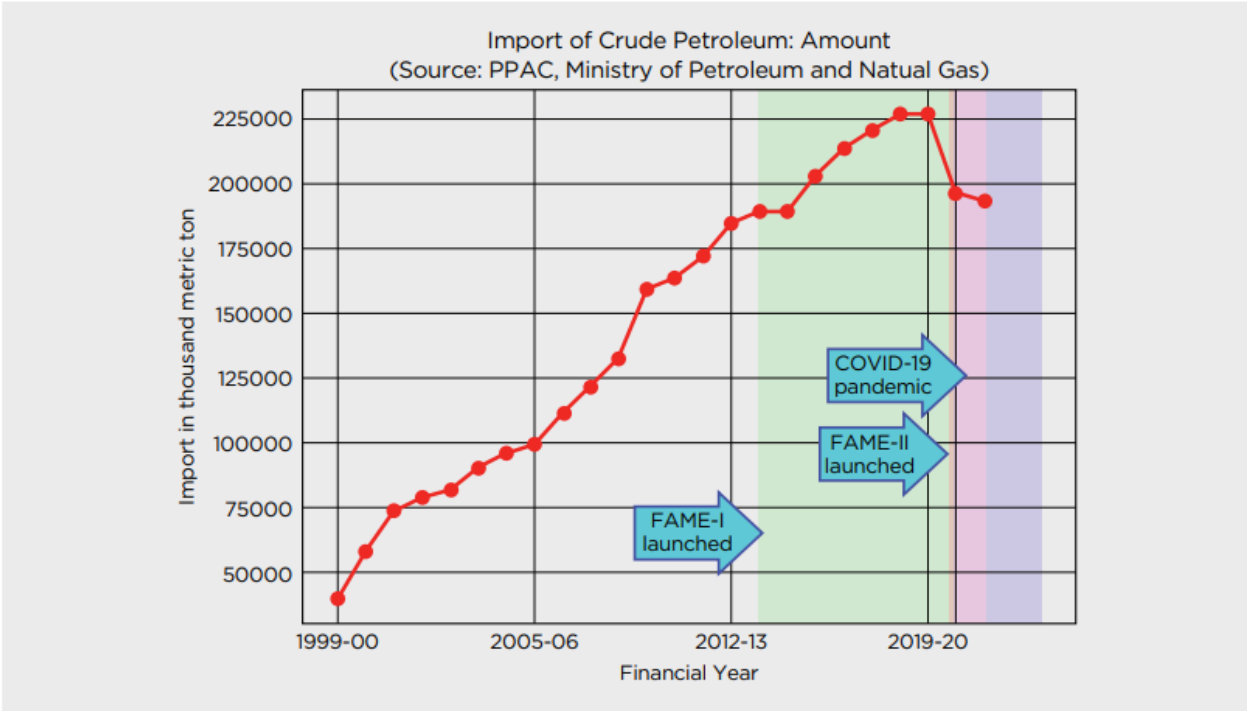
In this study we are going to analyze the data and solve the problem using *Fermi Estimation.*

Overview

The gap between domestic crude oil production and consumption is widening. India is a country which imports around 70% of oil required per year. Hence, there is an urgent need to investigate factors and challenges for the development of sustainable and clean alternatives for transportation systems. Electrified vehicles are one of the promising, clean and sustainable forms of transportation.

The recent scenario of the road transportation sector can be highlighted as:

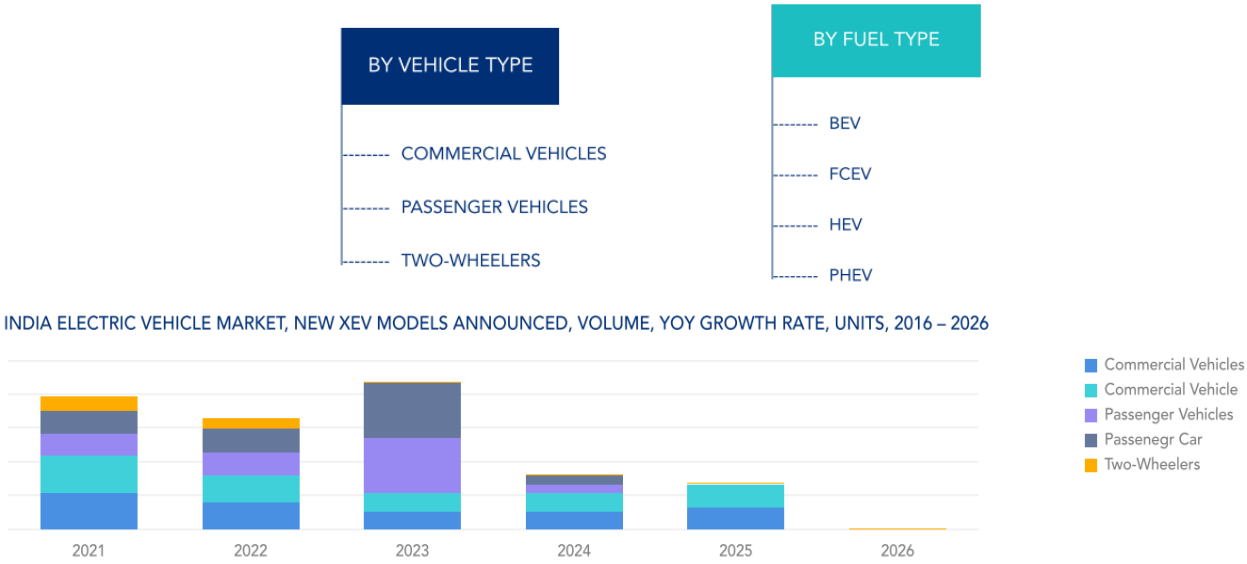
- Energy consumption : 524 million tons of oil equivalent
- Vehicle to people ratio : 1:56.3
- Per capita energy : 442 kg of oil equivalent



India has a high ratio of vehicles to people compared to many other countries, but this is coupled with a high population and consequently high emissions. In fact, India ranks third globally in terms of CO2 emissions, with 1.726 billion metric tons. To address this issue and promote sustainable transportation, there is an urgent need to focus on EV technology, which has the capability to produce zero emissions. Furthermore, due to urbanization and the decentralization of city areas, there has been a rapid increase in the number of personal vehicles on the roads in India.

In India, the Electric Vehicle Market can be categorized into three segments based on vehicle type, power source, and target customer:

1. Based on the type of vehicle and includes Passenger Cars, Commercial Vehicles, and Two- and Three-wheelers.
2. Based on the power source type and includes Battery Electric Vehicle, Plug-in Electric Vehicle, and Hybrid Electric Vehicle.
3. Based on target customer



Market Challenges

India's electric vehicle (EV) industry is experiencing a rapid surge in demand, but it seems that the market hype is not reflected in the sales figures. This can be attributed to various factors, such as limited options in the passenger car segment, driving range limitations, affordability issues, and lack of charging infrastructure.

The lack of affordability is a major hurdle in the growth of the EV market in India. In a price-sensitive country like India, the cost of the vehicle is the primary consideration for a majority of buyers. Unfortunately, EVs are currently out of reach for a significant portion of the population, who account for a substantial portion of vehicle sales in the country.

As the EV market in India is still in its early stages, the charging infrastructure is also in its nascent phase. In contrast, developed nations have well-established charging

stations that are easily accessible for EV owners. Developing a reliable charging infrastructure is vital for creating a conducive ecosystem for EV growth in India. Moreover, only a few models available in the market can provide a driving range of over 150 km/charge.

In summary, India's EV market is growing at a fast pace, but various obstacles such as affordability, limited driving range, and lack of charging infrastructure are preventing it from reaching its full potential. Addressing these challenges is crucial for creating a sustainable EV ecosystem in the country.

Competitive Landscape

The market for electric vehicles (EVs) in India is highly competitive and constantly evolving. Here are some of the key players and their market position:

- Tata Motors: Tata Motors is a leading player in the Indian automobile market and has been making significant investments in the EV segment. The company offers various models of EVs, including the Nexon EV and Tigor EV.
- Mahindra Electric: Mahindra Electric, a subsidiary of Mahindra & Mahindra, is a prominent player in the Indian EV market. The company offers the eKUV100 and the e-Verito models.
- MG Motor India: MG Motor India entered the Indian market with the launch of its MG ZS EV, which has received a positive response from customers. The company plans to expand its EV portfolio in India in the coming years.
- Hyundai Motor India: Hyundai is a well-established player in the Indian automobile market and has been making significant strides in the EV segment. The company offers the Kona Electric, which is one of the most popular EVs in India.
- Ather Energy: Ather Energy is an Indian start-up that has gained a lot of attention for its smart electric scooters. The company offers the Ather 450X and Ather 450 Plus models, which have been well-received by customers.
- Hero Electric: Hero Electric is a leading player in the electric scooter segment in India. The company offers a wide range of electric scooters, including the Optima, Flash, and Nyx models.

- Okinawa Autotech: Okinawa Autotech is another prominent player in the electric scooter segment in India. The company offers the PraisePro, Ridge+ and i-Praise models.

In addition to these players, various global automakers are also eyeing the Indian EV market, including Tesla, which plans to launch its electric cars in India soon. The market is expected to become more competitive in the coming years, with several new players expected to enter the space.

Situational Analysis

A situational analysis is an essential step in understanding the market segmentation of electric vehicles (EVs) in India. It involves examining the external and internal factors that influence the EV market in India.

External factors include political, economic, social, technological, environmental, and legal factors that impact the EV industry's growth in India. For instance, the government's ambitious plan to have only electric vehicles on Indian roads by 2030, coupled with incentives and subsidies for EVs, has resulted in a surge in the number of EVs on Indian roads. The increasing awareness of environmental issues, rising fuel prices, and the need for sustainable transport are also driving the growth of the EV market in India.

On the other hand, internal factors include the strengths, weaknesses, opportunities, and threats (SWOT analysis) of the EV industry in India. Strengths of the EV industry in India include the presence of various domestic and international EV manufacturers, a growing market for EVs, and a supportive regulatory environment. However, there are also weaknesses such as a lack of charging infrastructure and high initial costs of EVs, which act as a barrier to entry for potential customers.

Opportunities for the EV industry in India include the possibility of collaborations between domestic and international players to develop advanced technologies and lower costs, as well as the potential for Indian manufacturers to export EVs to other countries. However, threats to the EV industry in India include competition from established players in the automobile industry, potential delays in policy implementation, and fluctuating market demand.

Data Sources

We have considered multiple datasets from multiple resources for the analysis.
We have taken Kaggle datasets:
https://www.kaggle.com/datasets/geoffnel/evs-one-electric-vehicle-dataset?select=ElectricCarData_Clean.csv
https://www.kaggle.com/datasets/kkhandekar/electric-vehicles-india
https://www.kaggle.com/datasets/deadprstkrish/ev-cars-user-reviews-india?select=4-wheeler-EV-cardekho.csv
https://www.kaggle.com/datasets/deadprstkrish/ev-cars-user-reviews-india?select=2-wheeler-EV-bikewale.csv
https://www.kaggle.com/datasets/deadprstkrish/ev-cars-user-reviews-india?select=4-wheeler-EV-carwale.csv
https://www.kaggle.com/datasets/karivedha/indian-consumers-cars-purchasing-behaviour
https://www.kaggle.com/datasets/fathimaibrahimkunju/electric-vehicle-in-india-2022

Also from other sources:
https://lorien-live.mordorintelligence.com/MEs/90618/India_Electric_Vehicle_Market_1671628312425.xlsx
https://www.niti.gov.in/sites/default/files/2022-06/ForecastingPenetration-ofElectric2W_28-06.pdf
https://pib.gov.in/PressReleasePage.aspx?PRID=1842704
https://pqals.nic.in/annex/1711/AU2113.pdf

Some are extracted manually:
https://drive.google.com/file/d/1zIk3KNemuKRrWhdiu-515ldJqENPxRjf/view?usp=share_link
https://drive.google.com/file/d/1B72AhAzUXZMqKMM9eX_VXrXXRaFg56_E/view?usp=share_link

So the datasets are as follows:

1) Geographical data for subsidy distribution in states:

	state	capital	subsidy	road tax	petrol	diesel
0	Andhra Pradesh	Amaravati	0	1.0	111.65	99.41
1	Arunachal Pradesh	Itanagar	5000	0.0	95.89	84.81
2	Assam	Dispur	10000	1.0	96.34	84.24
3	Bihar	Patna	10000	1.0	109.17	95.82
4	Chhattisgarh	Raipur	5000	0.0	102.98	95.96
5	Goa	Panaji	8000	1.0	97.82	90.37
6	Gujarat	Gandhinagar	10000	0.5	96.49	92.23
7	Haryana	Chandigarh	0	0.0	97.24	90.08
8	Himachal Pradesh	Shimla	5000	0.0	95.74	81.99
9	Jharkhand	Ranchi	5000	0.0	100.09	94.88

2) This data consists the number of sales of EV2W, EV4W in different states of India:

	Sl. No	State	Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules	Two Wheelers (Category L2 (CMVR))	Two Wheelers (Max power not exceeding 250 Watts)	Three Wheelers (Category L5 slow speed as per CMVR)	Three Wheelers (Category L5 as per CMVR)	Passenger Cars (Category M1 as per CMVR)	Buses	Total in state
0	1	Meghalaya	0	0	0	0	0	6	0	6
1	2	Nagaland	0	20	3	0	0	1	0	24
2	3	Manipur	16	8	11	0	5	12	0	52
3	4	Tripura	28	9	36	0	0	8	0	81
4	5	Andaman & Nicobar islands	0	0	0	0	0	82	0	82
5	6	Himachal Pradesh	0	0	0	0	0	98	0	98
6	7	Jammu & Kashmir	2	76	152	0	0	208	0	438
7	8	Goa	0	0	0	0	0	513	1	514
8	9	Dadra and Nagar Haveli	4	0	9	0	0	803	0	816
9	10	Jharkhand	75	228	736	9	7	655	0	1710
10	11	Assam	463	138	1006	0	117	151	0	1875
11	12	Chandigarh	612	18	896	0	0	974	0	2500
12	13	Bihar	252	430	2148	6	64	271	0	3171
13	14	Odisha	377	824	2031	0	37	594	0	3863
14	15	Uttarkhand	423	168	3239	45	38	265	0	4178
15	16	Chhattisgarh	613	382	2078	58	106	997	0	4234
16	17	Madhya Pradesh	503	378	2904	8	106	2562	0	6461
17	18	Punjab	698	300	1968	0	5	3567	0	6538
18	19	Telangana	535	711	2256	2	0	5530	0	9034
19	20	Andhra Pradesh	431	692	4689	0	0	3680	0	9492

3) This data consists of different brands of electric cars in India, including the information of charger type, no. of seats, charging time, Top speed and many more, all about cars.

Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats
Tesla	Model 3 Long Range Dual Motor	4.6	233	450	161	940	Yes	AWD	Type 2 CCS	Sedan	D	5
Volkswagen	ID.3 Pure	10.0	160	270	167	250	Yes	RWD	Type 2 CCS	Hatchback	C	5
Polestar	2	4.7	210	400	181	620	Yes	AWD	Type 2 CCS	Liftback	D	5
BMW	iX3	6.8	180	360	206	560	Yes	RWD	Type 2 CCS	SUV	D	5
Honda	e	9.5	145	170	168	190	Yes	RWD	Type 2 CCS	Hatchback	B	4

4) This data consists the Indian consumer behavior regarding purchase of electric vehicles:

	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) This data contains the number of charging stations sanctioned in each states:

State	No. of EV chargers sanctioned
Maharashtra	317
Andhra Pradesh	266
Tamil Nadu	281
Gujarat	278
Uttar Pradesh	207

6) This dataset contains the Indian consumer reviews for different models of electric cars E4W on Cardekho website:

	review	Exterior	Comfort	Performance	Fuel Economy	Value for Money	Condition	driven	rating	model_name
0	Superb car like as fantastic as petroleum car....	5.0	4.0	5.0	5.0	5.0	New	Few hundred kilometers	5.0	hyundai kona
1	Anti national, worst service, worst customer c...	1.0	1.0	1.0	1.0	1.0	New	Haven't driven it	0.0	hyundai kona
2	Super happy with it. The car is too good	4.0	5.0	5.0	5.0	4.0	New	Few thousand kilometers	5.0	hyundai kona
3	Pretty good car, smooth as a glider fast car, ...	5.0	5.0	5.0	5.0	5.0	New	Few thousand kilometers	5.0	hyundai kona
4	Price difference between petrol and electronic...	4.0	4.0	5.0	3.0	2.0	Not Purchased	Haven't driven it	3.0	hyundai kona

7) This dataset contains the Indian consumer reviews for different model of bikes and scooter on Bikewale website:

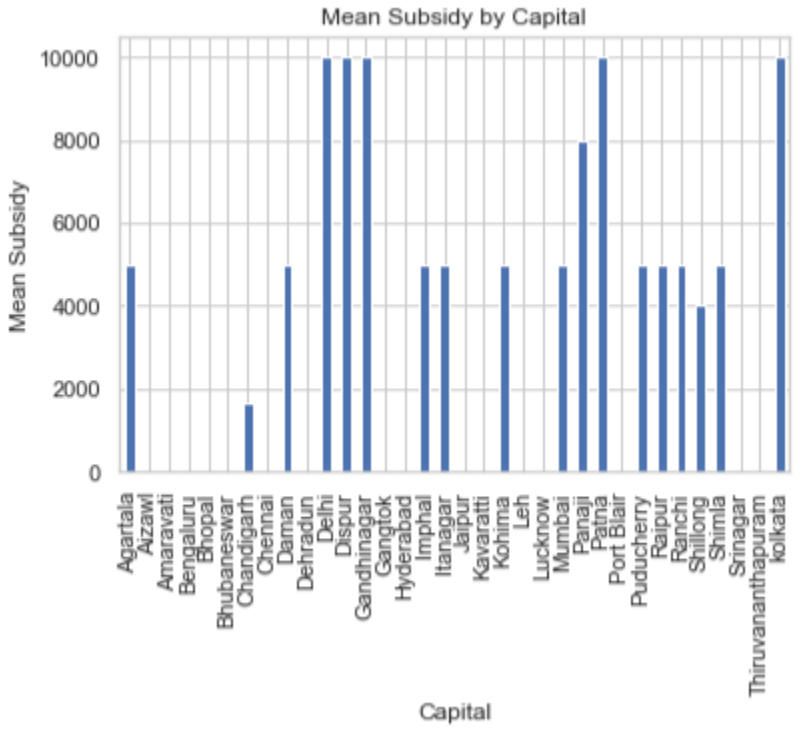
	review	Used it for	Owned for	Ridden for	rating	Visual Appeal	Reliability	Performance	Service Experience	Extra Features	Comfo
0	We all checked the bike's capacity to be 150 k...	Daily Commute	Never owned	NaN	1	3.0	4.0	NaN	NaN	NaN	4.0
1	Performance is very poor on this bike. The cha...	Everything	> 1 yr	< 5000 kms	1	3.0	1.0	NaN	1.0	NaN	3.0
2	I purchased this in April 2022 and the sales s...	Daily Commute	< 3 months	< 5000 kms	3	4.0	4.0	NaN	2.0	NaN	5.0
3	If any issues come in scooty parts not availab...	Daily Commute	6 months-1 yr	5000-10000 kms	1	1.0	1.0	NaN	1.0	NaN	1.0
4	Don't buy this vehicle unless you have a near	Daily Commute	6 months-1 yr	< 5000 kms	1	3.0	4.0	NaN	1.0	NaN	3.0

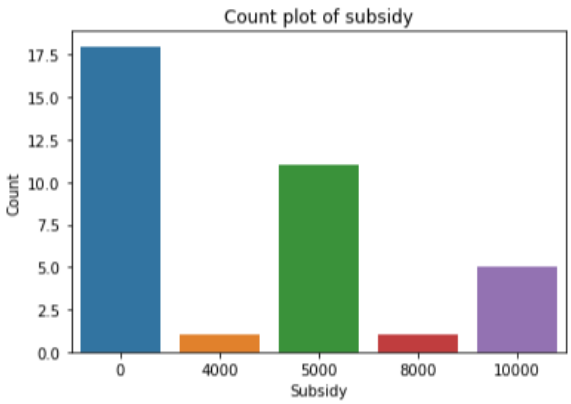
8) This dataset contains no. of operational EV charging stations in different states of India:

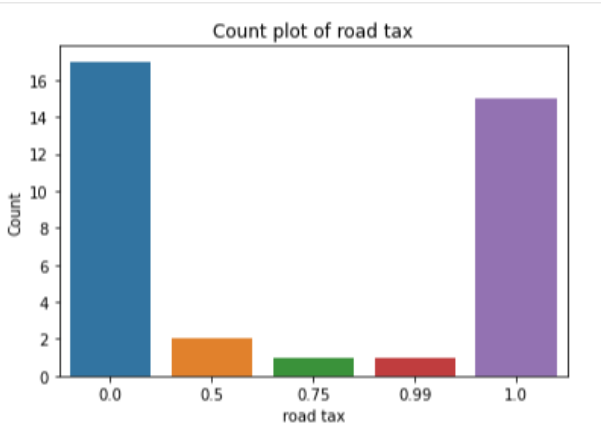
State Name	No. of Operational PCS
Andaman & Nicobar	3
Andhra Pradesh	222
Arunachal Pradesh	9
Assam	48
Bihar	83
Chandigarh	6
Chhattisgarh	46
Delhi	1845
Goa	44
Gujarat	195
Haryana	232
Himachal Pradesh	27

Market Segmentation analysis

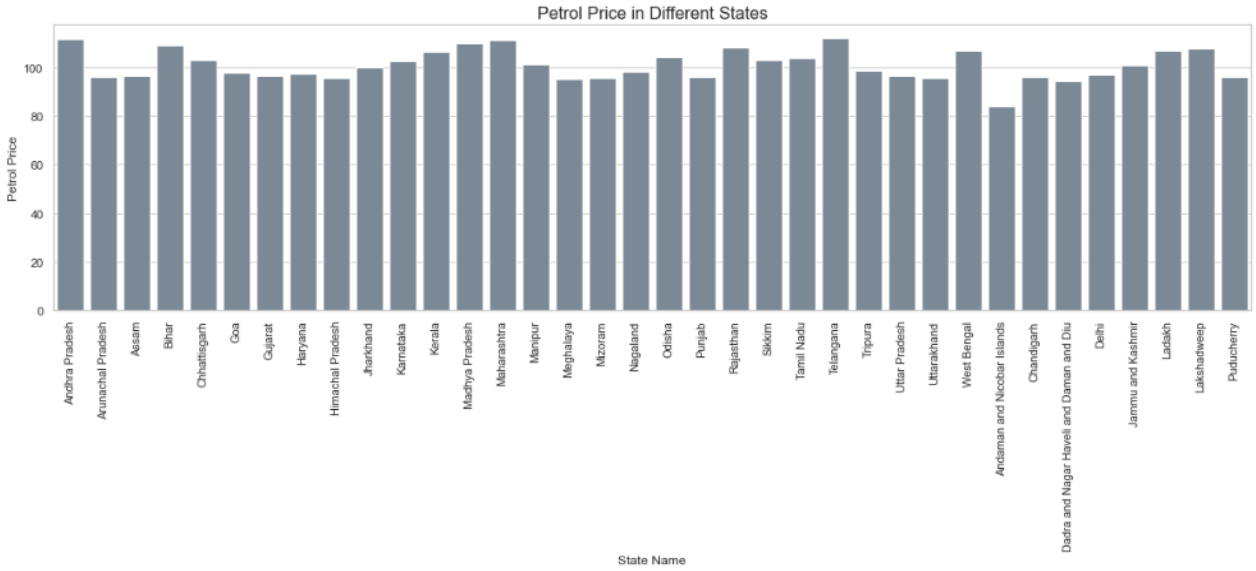
Geographical Analysis:

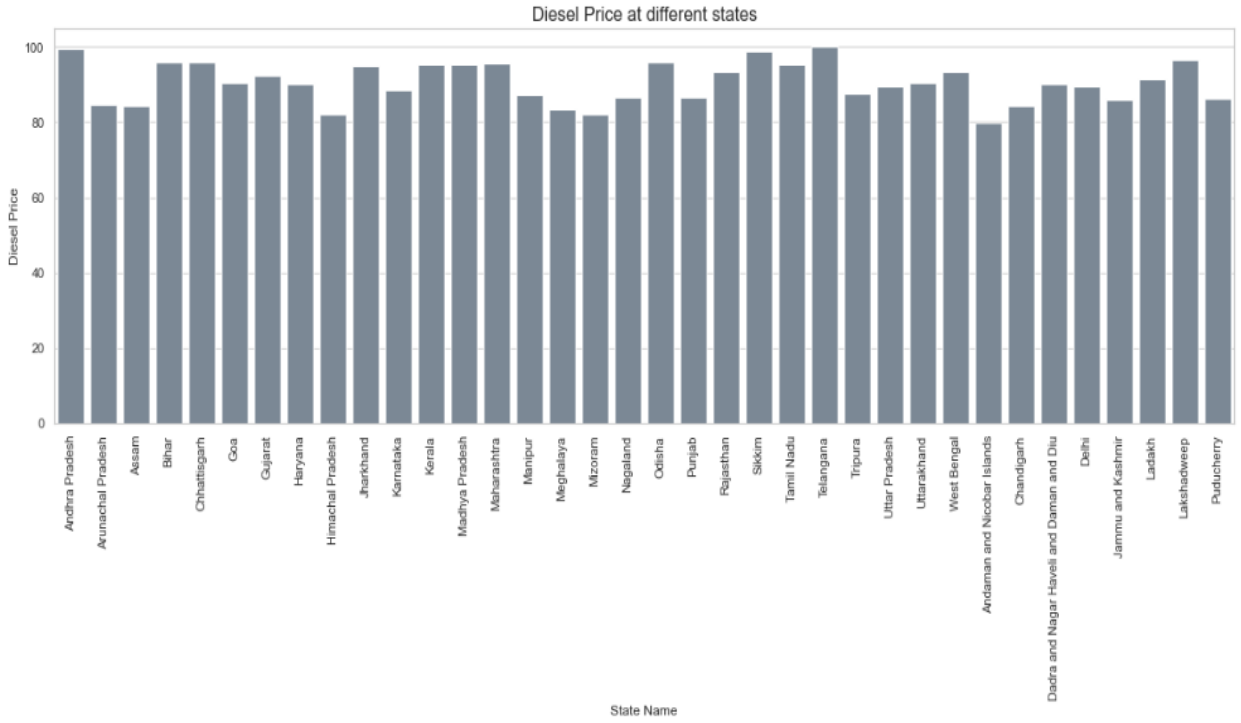




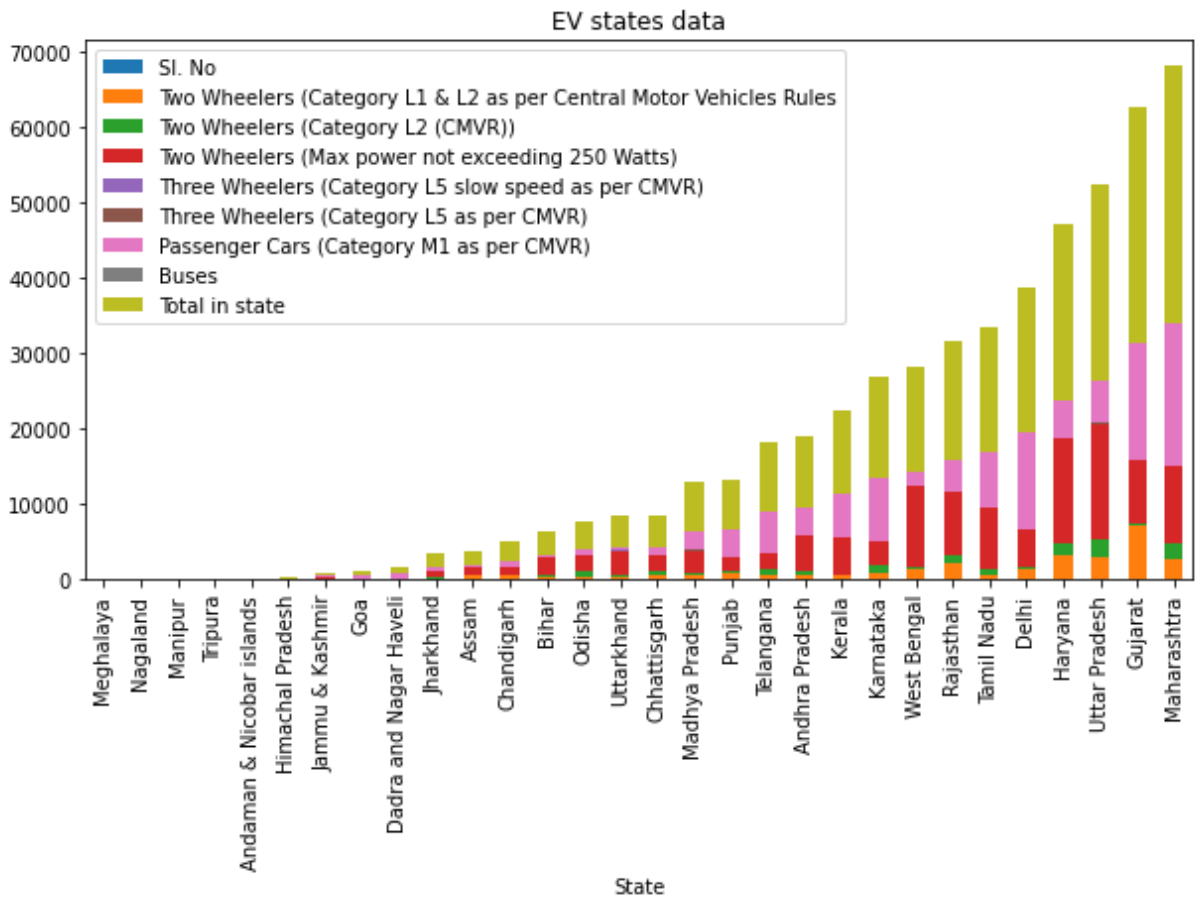


From the above data we analyze that subsidies are offered to customers as an incentive to purchase EVs. The amount of subsidy and its implementation vary from state to state. For instance, states like Delhi, Maharashtra, and Kolkata offer a higher subsidy for EVs compared to other states. The central government also provides subsidies through the FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles) scheme. These subsidies make EVs more affordable for consumers, thereby increasing their adoption.





Higher petrol/diesel prices make electric vehicles more cost-effective compared to petrol/diesel vehicles. EVs have lower running costs and maintenance costs than petrol/diesel vehicles, making them an attractive alternative for consumers. The higher the price of petrol, the more attractive electric vehicles become, as they provide long-term savings and can reduce a consumer's dependence on petrol/diesel.

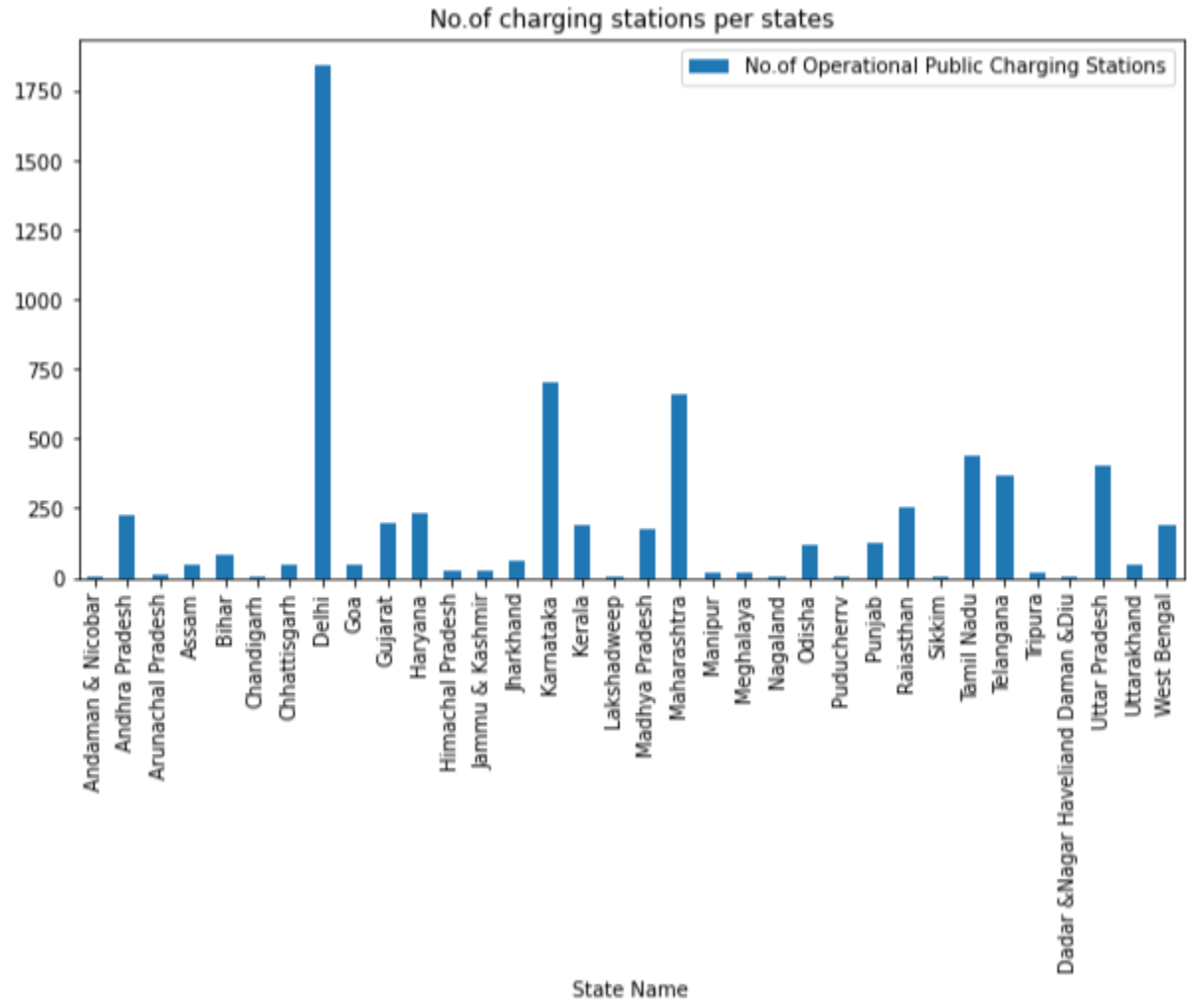


From the above data we can see that Maharashtra has the highest number of Electric vehicles sales.
But if we look at the top states in EV sales closely, some important insights we can make from the available data.

- Maharashtra leads the number in total EV sales but most sales are in the passenger cars segment.
- Gujarat has the highest percentage of two-wheeler(category L1 and L2) EV sales of the total sales in that state.
- Uttar Pradesh has the highest percentage of two-wheeler(which has max power not exceeding 250 watts) EV sales of the total sales in those states.
- Likewise, we can observe percentage sales in other segments.

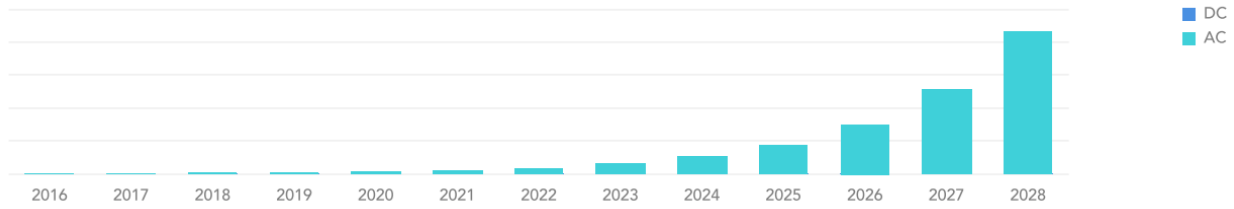
Charging Stations Analysis:

From the below data we can see that Delhi has the highest number of operational charging stations, and also we can see that the deployment of new charging stations will drastically increase in future.



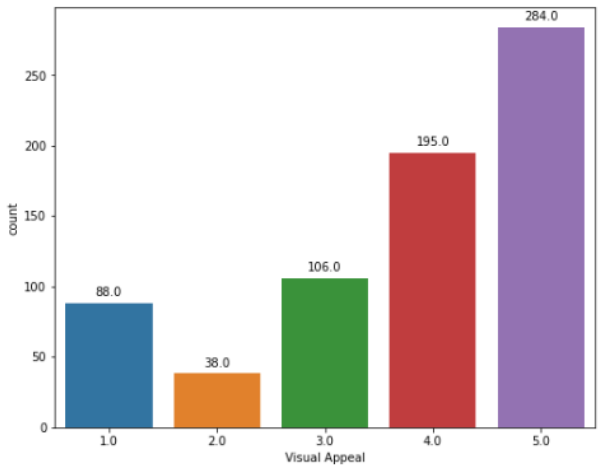
2.9 CHARGING STATIONS DEPLOYMENT

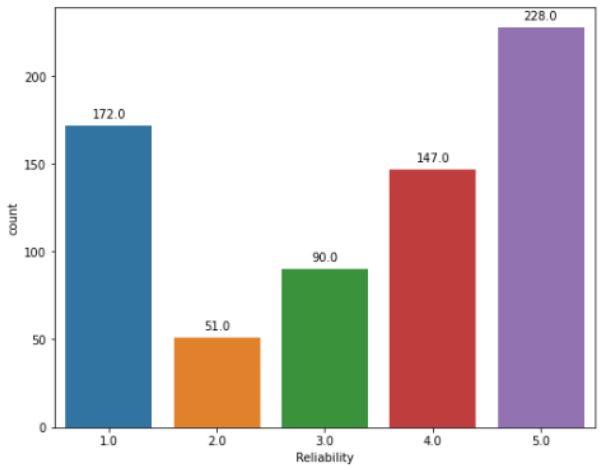
INDIA ELECTRIC VEHICLE MARKET, CHARGING STATIONS DEPLOYMENT, VOLUME, YOY GROWTH RATE, UNITS, 2016 – 2026

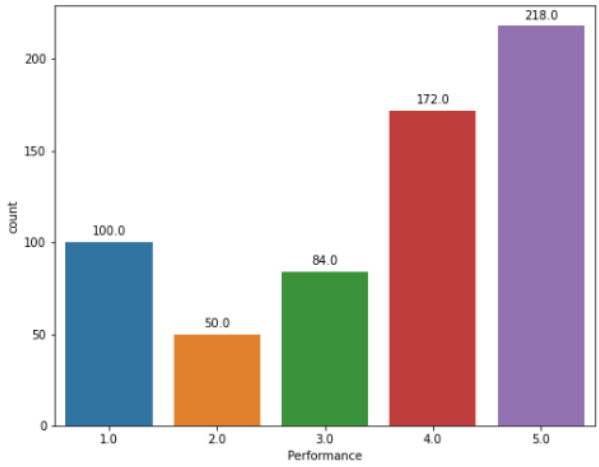


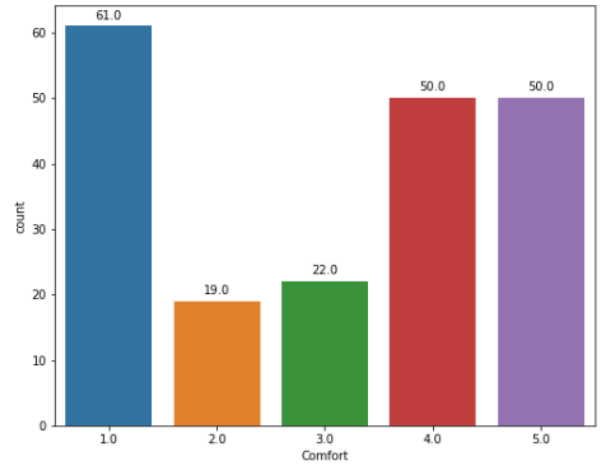
Psychographic Analysis

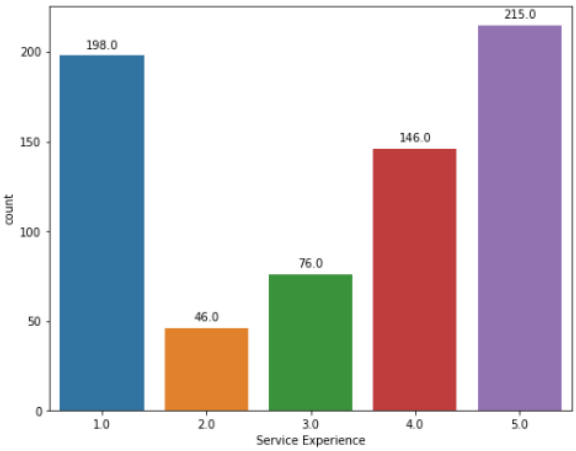
We have analyzed the psychographic aspect of market segmentation as:

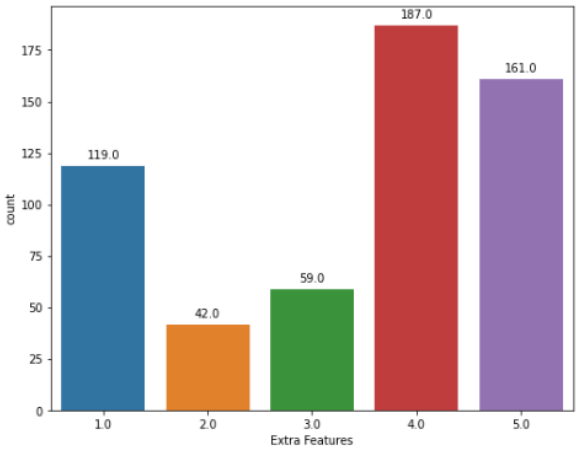


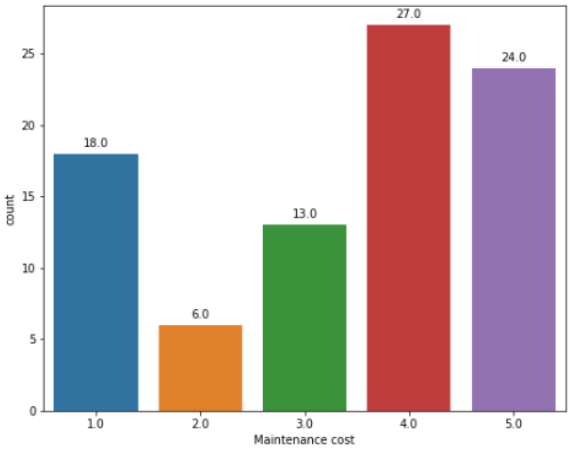


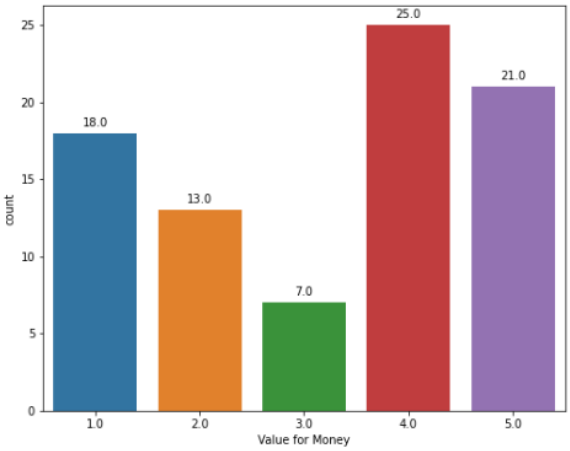






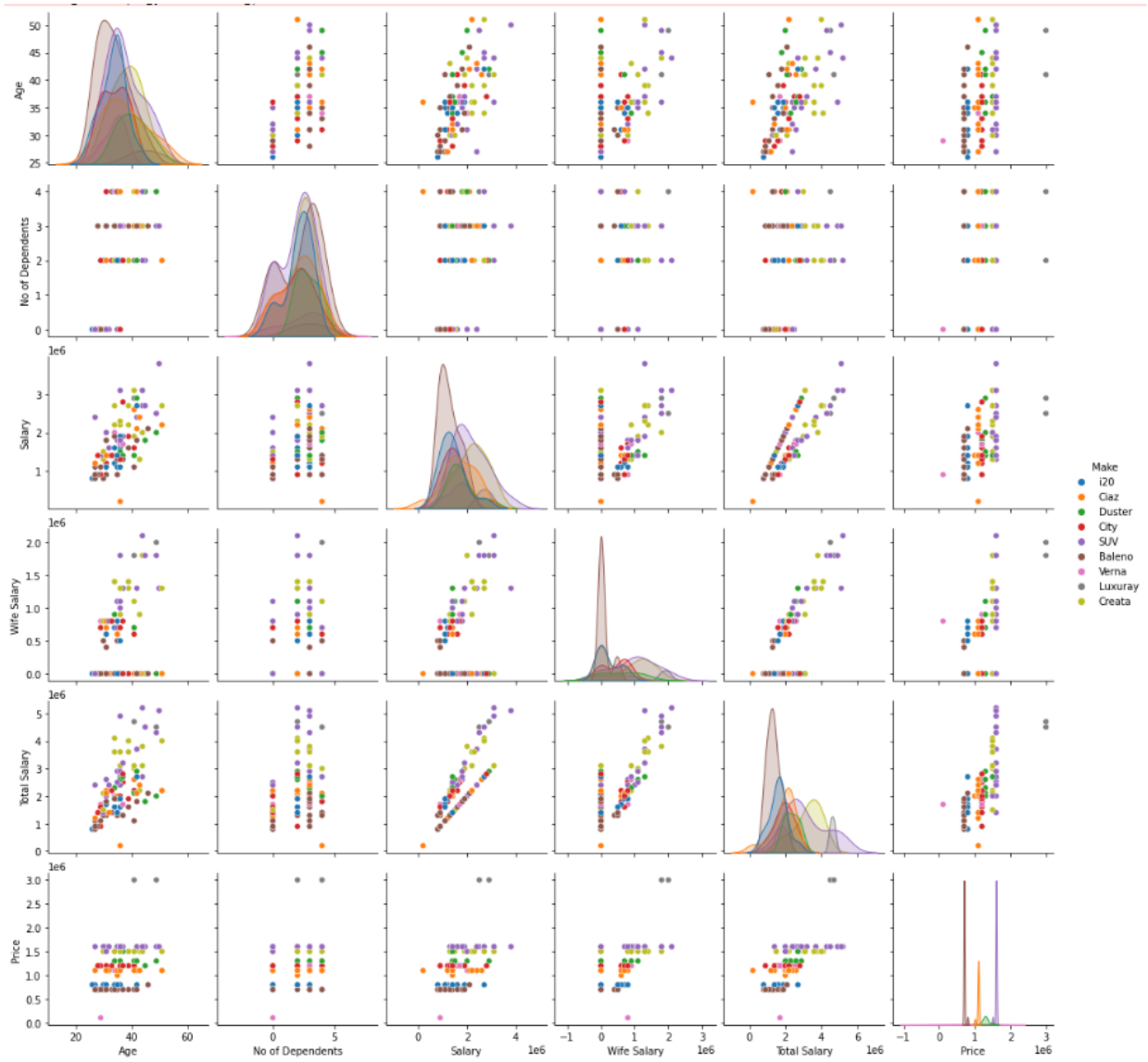




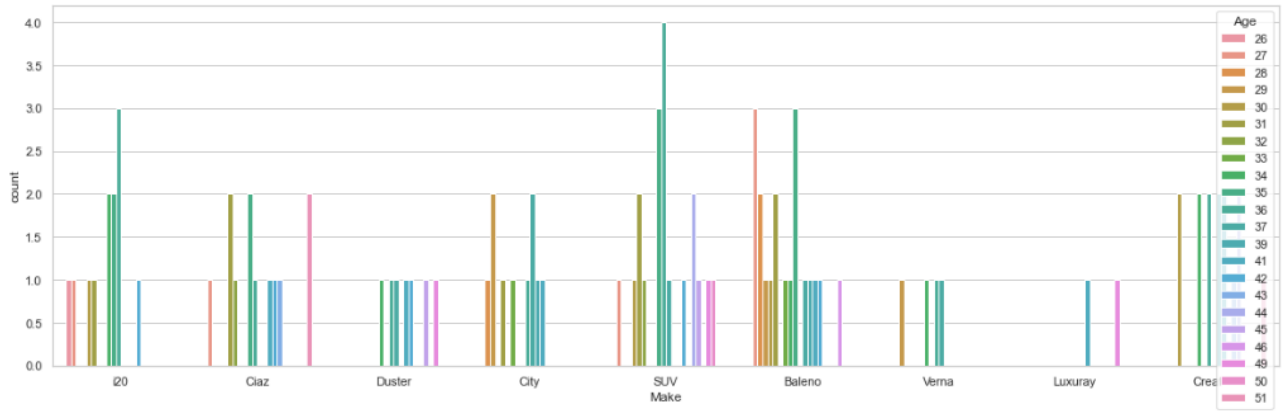


Demographic Analysis

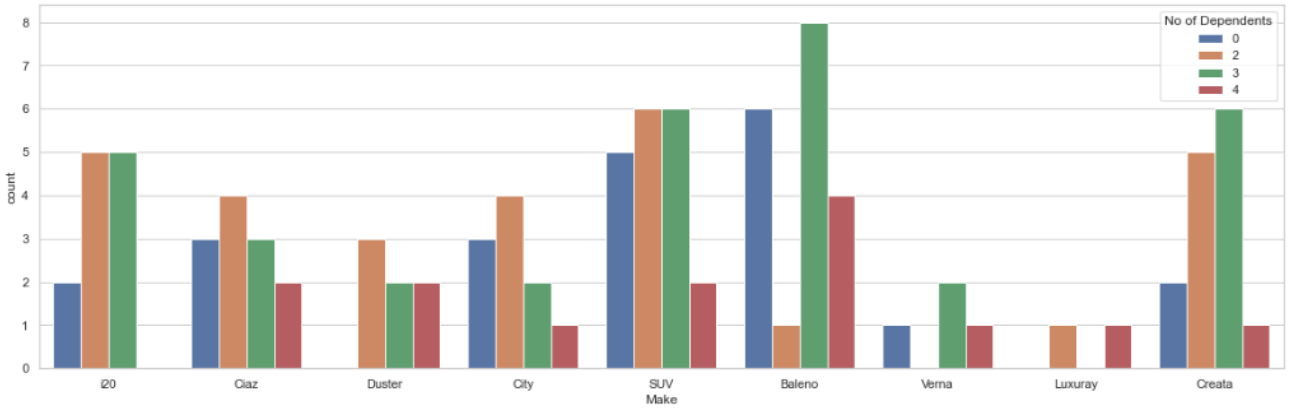
We can see the Demographic views of market segmentation as:



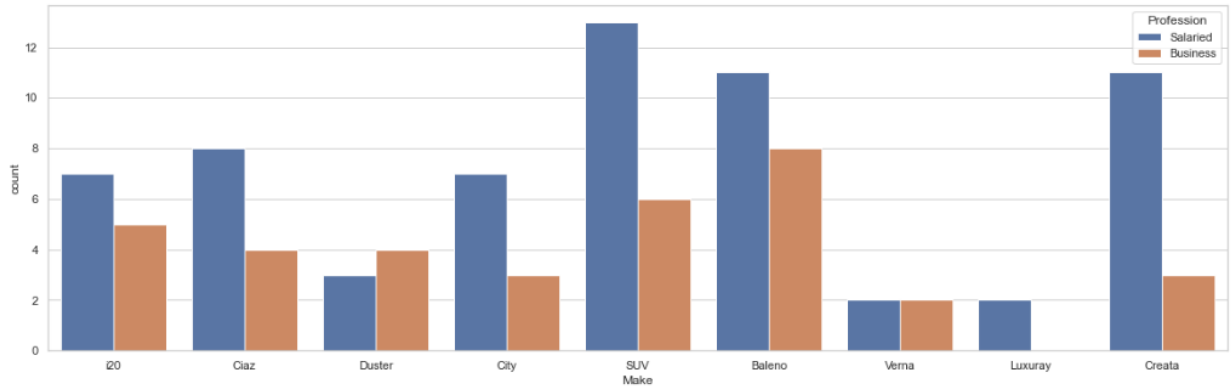
Relationship between consumers age and the vehicles they purchase:



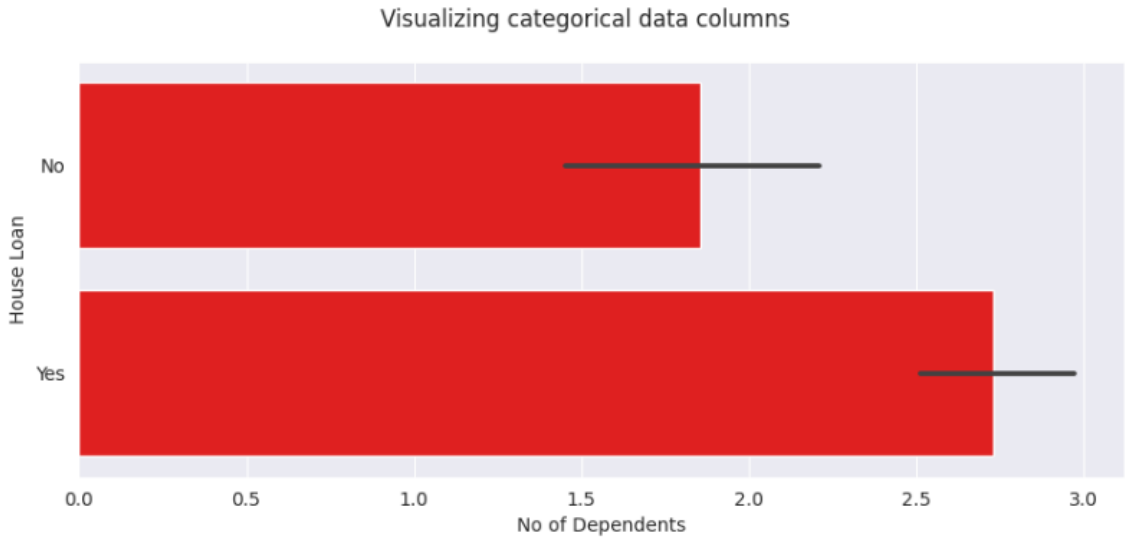
Relation between number of dependents on a consumer and the vehicles they purchase:



Relation between consumers profession and the vehicles they tend to purchase:



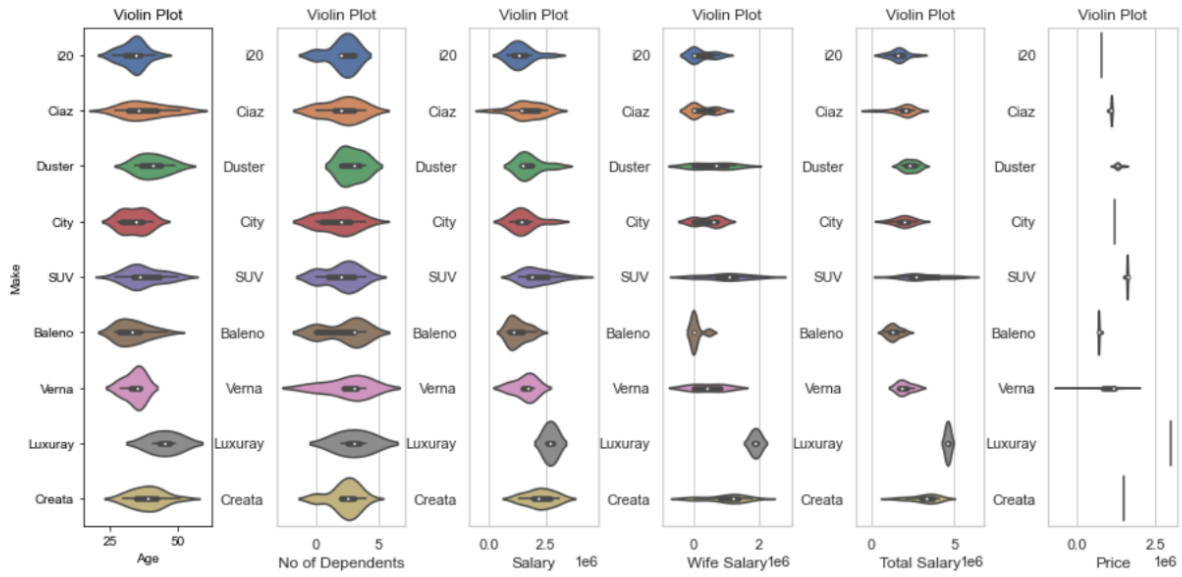
Relation between if a person has a house loan or not, and how it can be affect his/her family economically:



Conclusion:

From the above data and the violin plot, we finally concluded that:

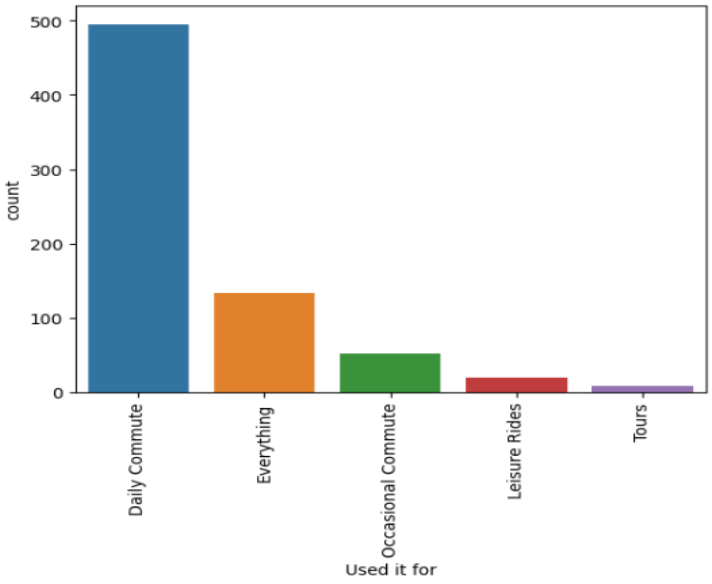
- Age: Younger consumers buy cheaper cars.
- Number of dependents: More dependents make consumers buy cars with more seats, so they prefer SUVs.
- Salary: If you fit the normal salary chart with the price chart, you'll notice that the average violin salary chart corresponds to the price of the car, which is a very direct relationship.

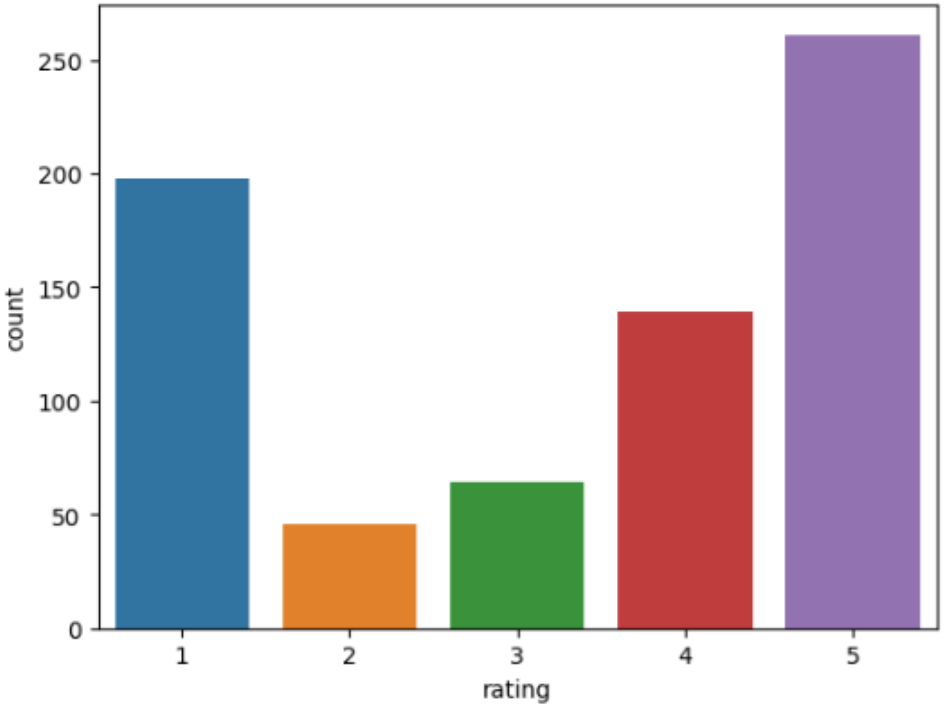


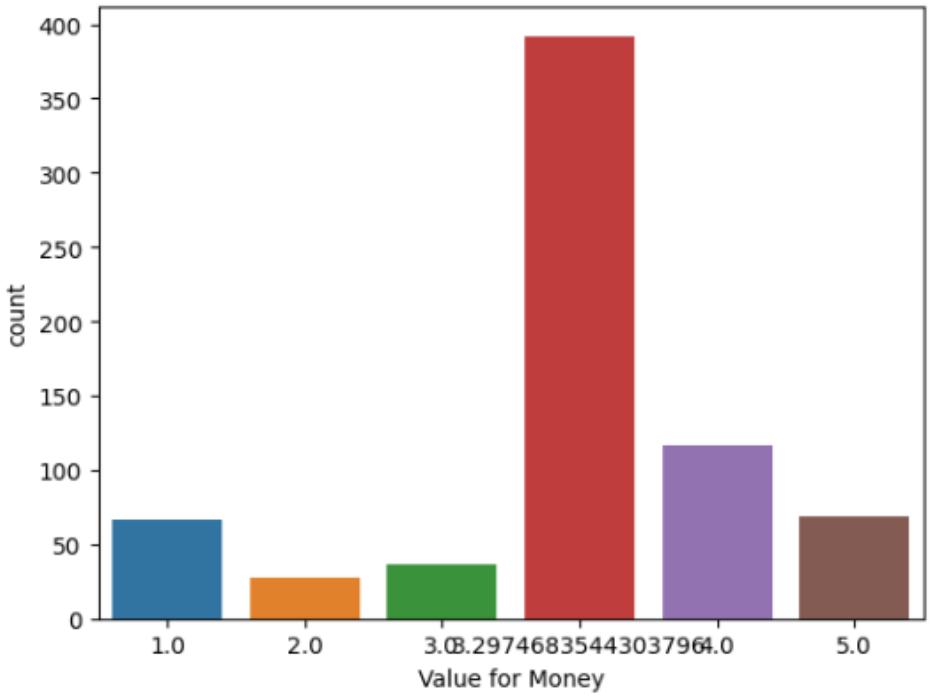
Behavioral Analysis

For Two wheelers Vehicles:

We can see the various behaviors of consumers through some plots, basically we have taken some review datasets from Kaggle, where reviews from some famous websites are given. We then visualize for different features:

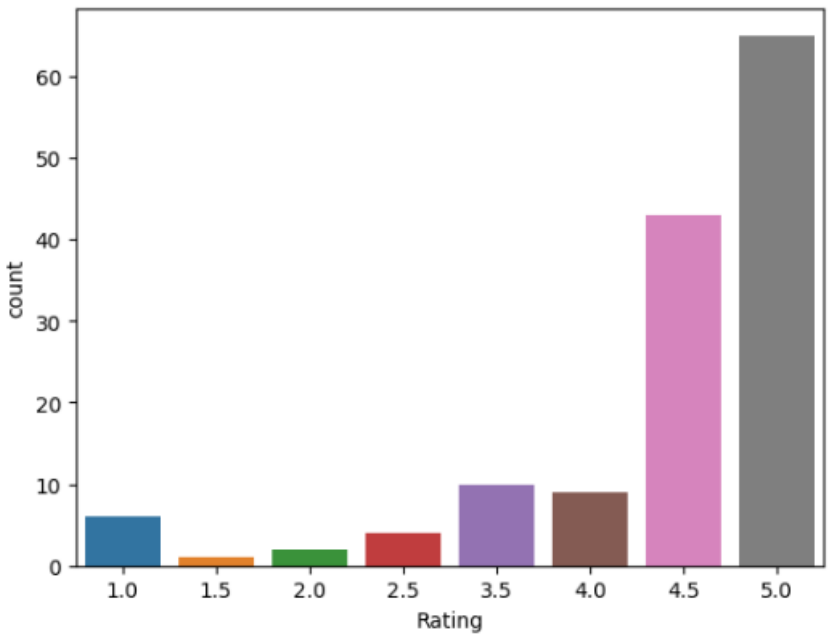

500
400
300
200
100
0
count
Daily Commute
Everything
Occasional Commute
Leisure Rides
Tours
Used it for

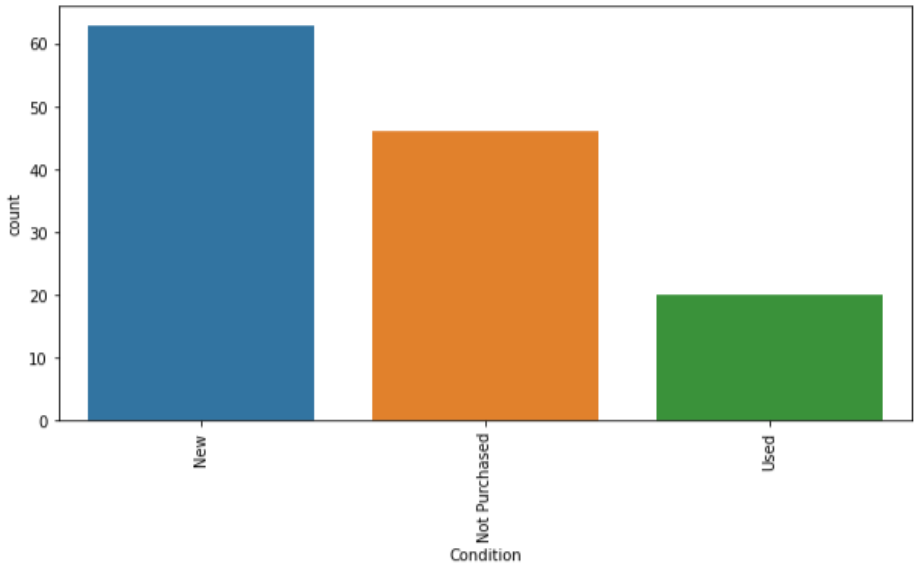

250
200
150
100
50
0
count
1
2
3
4
5
rating

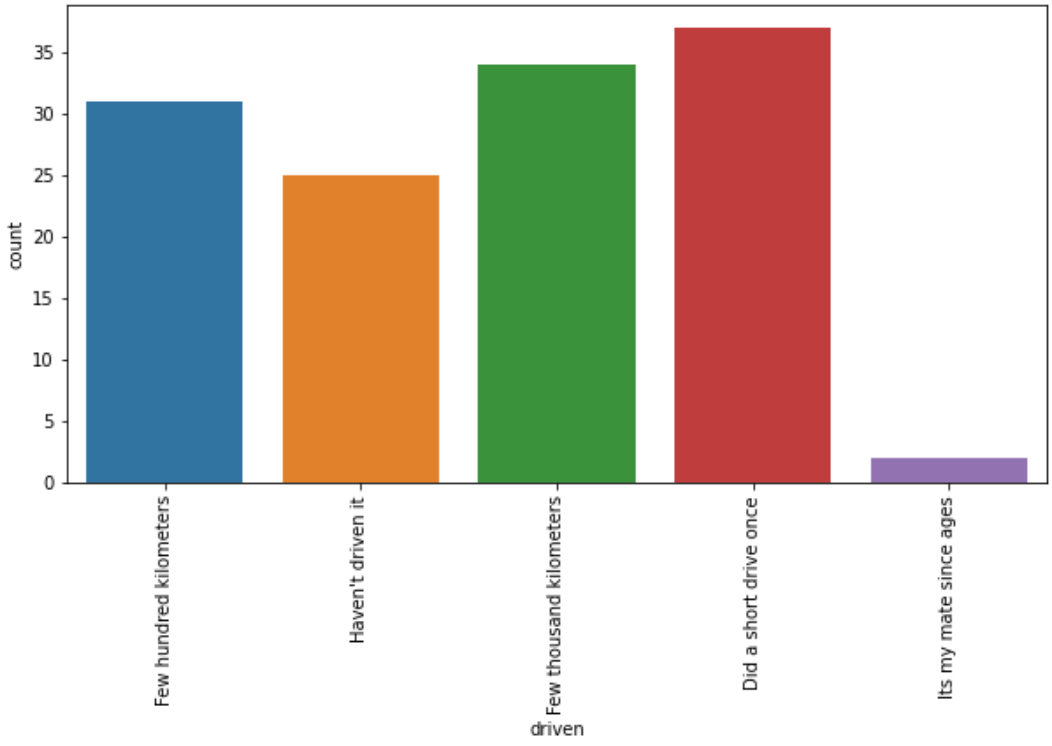


We can see that most users use E2Ws for daily commute only and most people are concerned about value for money as we can see a similar like normal distribution for this.

For 4 wheelers Vehicles:







There is currently limited availability of long-term reviews for electric four-wheelers (E4Ws) in India, as most owners have only recently purchased new EVs and have

only driven for short distances so far. Therefore, comprehensive long-term assessments of the performance and reliability of E4Ws are not yet widely available.

SEGMENT EXTRACTION

Here We are doing the clustering part for every types of segmentation, that is for every types of datasets:
So first is the geographical aspect:

Selecting relevant features

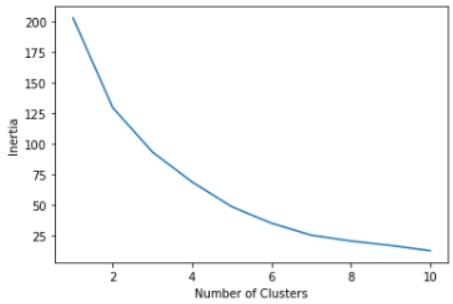
```
X = df[['Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules', 'Two Wheelers (Category L2 (CMVR))', 'Two Wheelers (Max power not exc
```

```
# normalize the data
X = (X - X.mean()) / X.std()
```

Determining the optimal number of clusters using elbow method

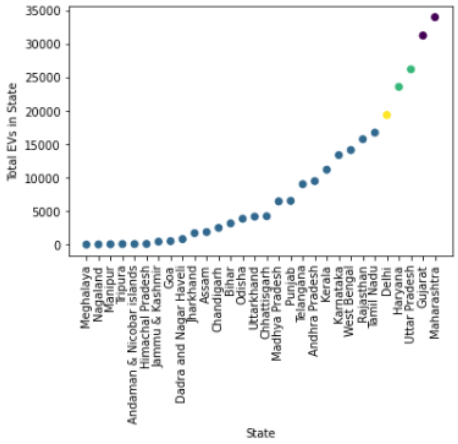
```
inertia = []
for k in range(1, 11):
    kmeans = KMeans(n_clusters=k, random_state=42).fit(X)
    inertia.append(kmeans.inertia_)
plt.plot(range(1, 11), inertia)
plt.xlabel('Number of Clusters')
plt.ylabel('Inertia')
plt.show()
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:881: UserWarning: KMeans is known to have a memory leak on Windows with MKL,
when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
```



visualize the clusters

```
plt.scatter(df['State'], df['Total in state'], c=df['Cluster'])
plt.xticks(rotation=90)
plt.xlabel('State')
plt.ylabel('Total EVs in State')
plt.show()
```



Regression Analysis

```
from sklearn.linear_model import LinearRegression
```

```

```

```
df1 = pd.read_excel('EV_states_data.xlsx')
```

```
df1.head()
```

	Sl. No	State	Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules	Two Wheelers (Category L2 (CMVR))	Two Wheelers (Max power not exceeding 250 Watts)	Three Wheelers (Category L5 slow speed as per CMVR)	Three Wheelers (Category L5 as per CMVR)	Passenger Cars (Category M1 as per CMVR)	Buses	Total in state
0	1	Meghalaya	0	0	0	0	0	6	0	6
1	2	Nagaland	0	20	3	0	0	1	0	24
2	3	Manipur	16	8	11	0	5	12	0	52
3	4	Tripura	28	9	36	0	0	8	0	81
4	5	Andaman & Nicobar Islands	0	0	0	0	0	82	0	82

drop the 'State' column

```
data = df1.drop('State', axis=1)
```

split data into X (input features) and y (target variable)

```
X = data.drop('Total in state', axis=1)
y = data['Total in state']
```

```
reg = LinearRegression().fit(X, y)
```

```
print('Coefficients:', reg.coef_)
print('Intercept:', reg.intercept_)
```

```
Coefficients: [3.97613302e-13 1.00000000e+00 1.00000000e+00 1.00000000e+00
 1.00000000e+00 1.00000000e+00 1.00000000e+00 1.00000000e+00]
Intercept: -7.275957614183426e-12
```

Using Decision Trees

```
from sklearn.tree import DecisionTreeRegressor
from sklearn.model_selection import train_test_split
```

```
df2 = pd.read_excel('EV_states_data.xlsx')
```

```
# Spliting the data into features and target variable
X = df2.drop(['State', 'Total in state'], axis=1)
y = df2['Total in state']
```

```
# Spliting the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

```
# Train the decision tree regressor
regressor = DecisionTreeRegressor(random_state=42)
regressor.fit(X_train, y_train)
```

```
DecisionTreeRegressor(random_state=42)
```

```
# Evaluating the model on the testing set
score = regressor.score(X_test, y_test)
print(f"R-squared score on testing set: {score:.2f}")
```

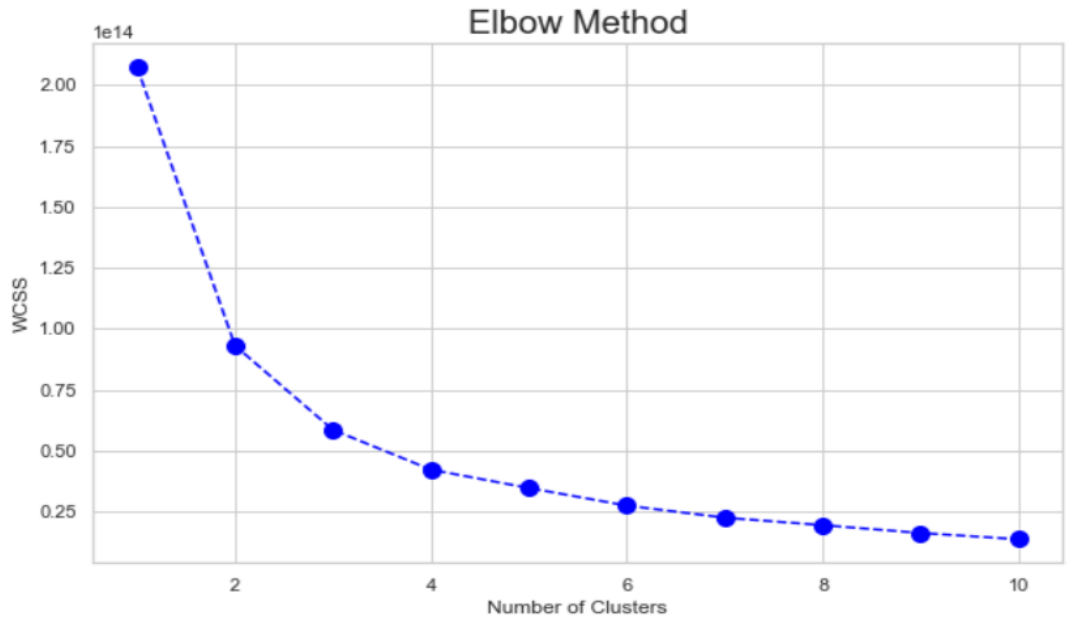
```
R-squared score on testing set: 0.97
```

Now for the Demographic Analysis:

Using K-means:

Elbow Method:

```
plt.figure(figsize=(10,6))
plt.plot(range(1,11),wcss,color='blue', linestyle='dashed', marker='o',
         markersize=10)
plt.title('Elbow Method', size=20)
plt.xlabel('Number of Clusters')
plt.ylabel('WCSS')
plt.show()
```



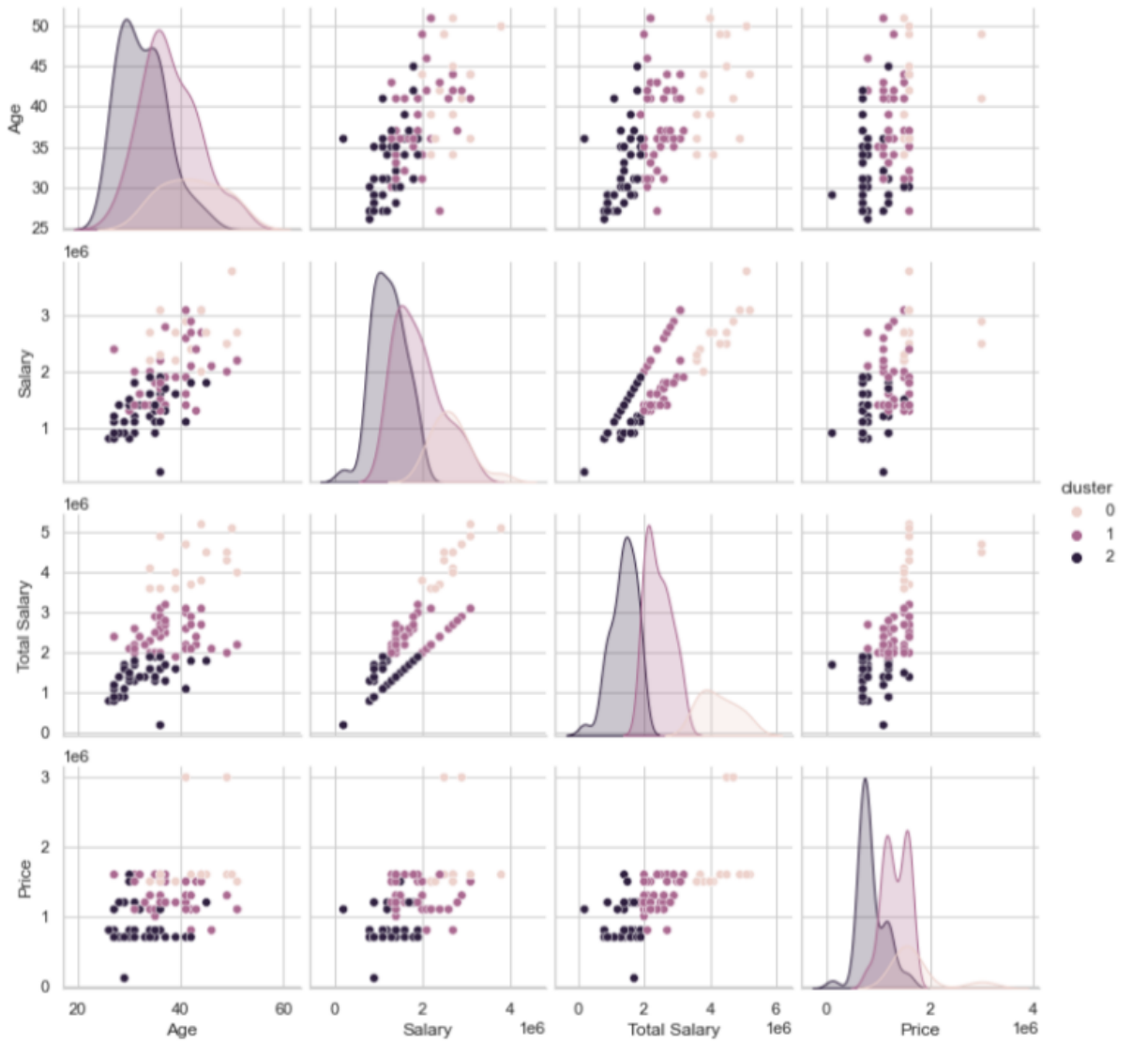
Finding the number of clusters:

```
# optimum number of clusters: 3
kmeans = KMeans(n_clusters = 3, init = "k-means++", random_state = 42)
y_kmeans = kmeans.fit_predict(obj_df)
y_kmeans
```

```
C:\Users\DELL\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1332: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
```

```
array([2, 1, 2, 1, 1, 2, 2, 2, 1, 2, 1, 2, 2, 2, 2, 0, 2, 2, 2, 2, 1, 2,
       1, 2, 1, 1, 2, 2, 1, 1, 2, 1, 1, 1, 1, 0, 2, 1, 2, 1, 2, 2, 1, 1,
       2, 0, 2, 1, 2, 1, 1, 0, 1, 0, 0, 1, 1, 2, 2, 2, 2, 2, 1, 2, 1, 2,
       0, 1, 0, 2, 1, 1, 2, 1, 1, 0, 2, 1, 1, 0, 1, 0, 1, 1, 1, 2, 2, 1,
       0, 2, 2, 0, 1, 2, 1, 0, 1, 0, 1])
```

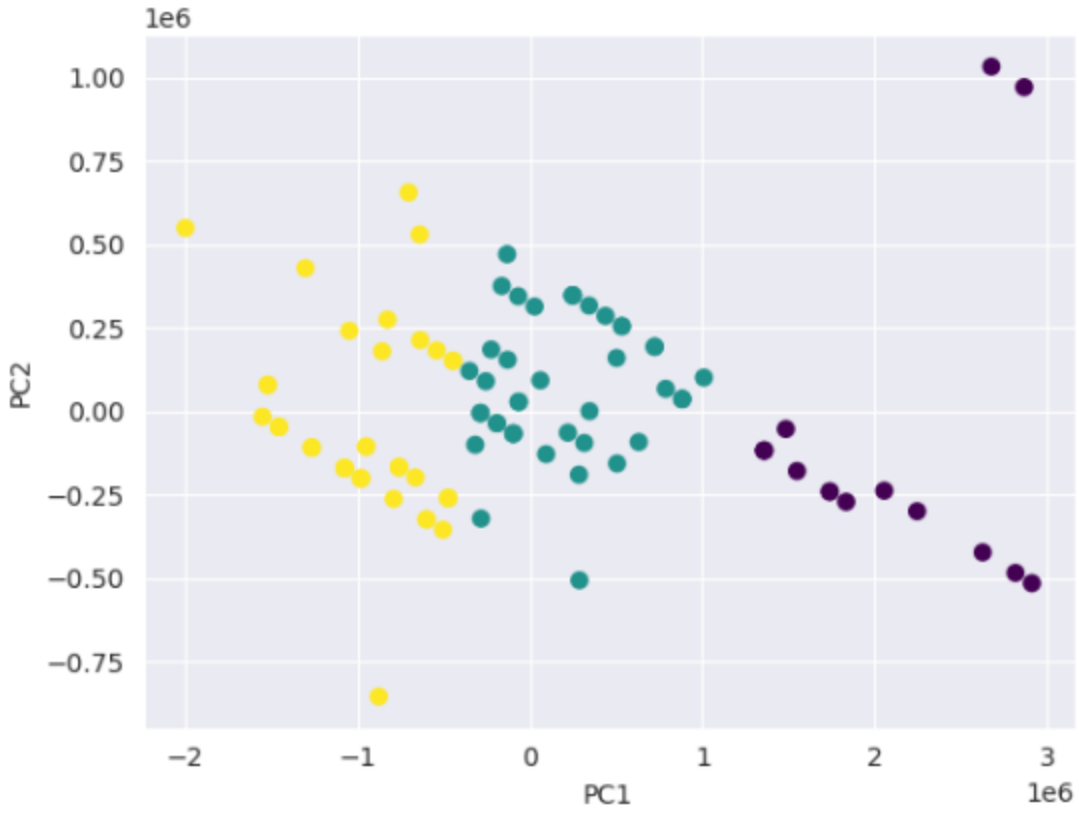
Plotting the pairplot:

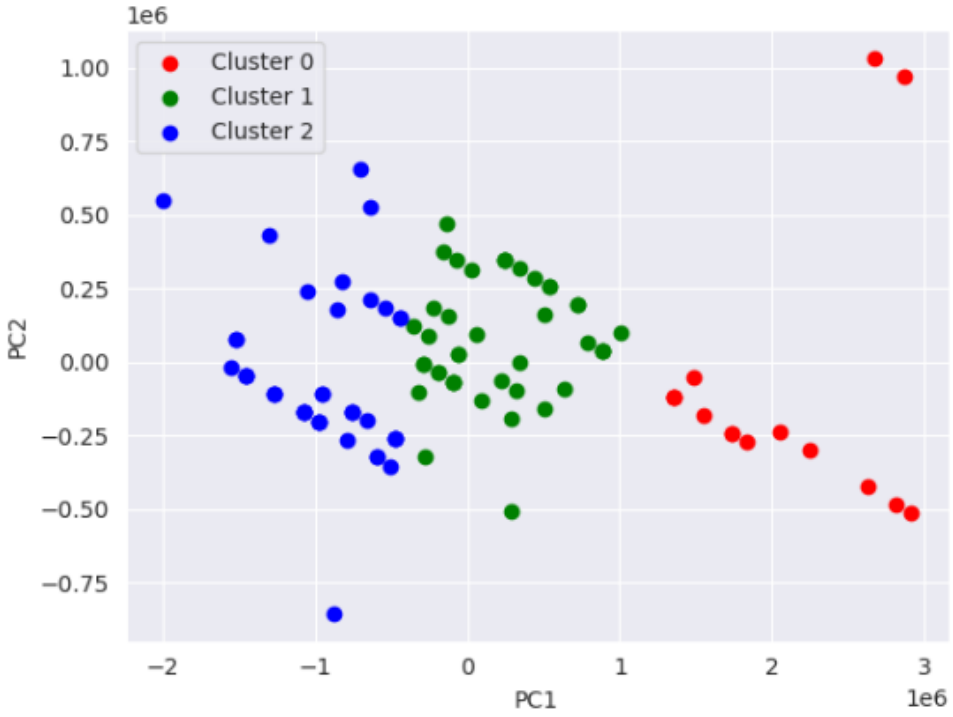


Applying K means to the automobile datasets

```
kmeans = KMeans(n_clusters=3, random_state=42).fit(X)
df_raw['Cluster'] = kmeans.labels_
print(df_raw['Cluster'].value_counts())
```

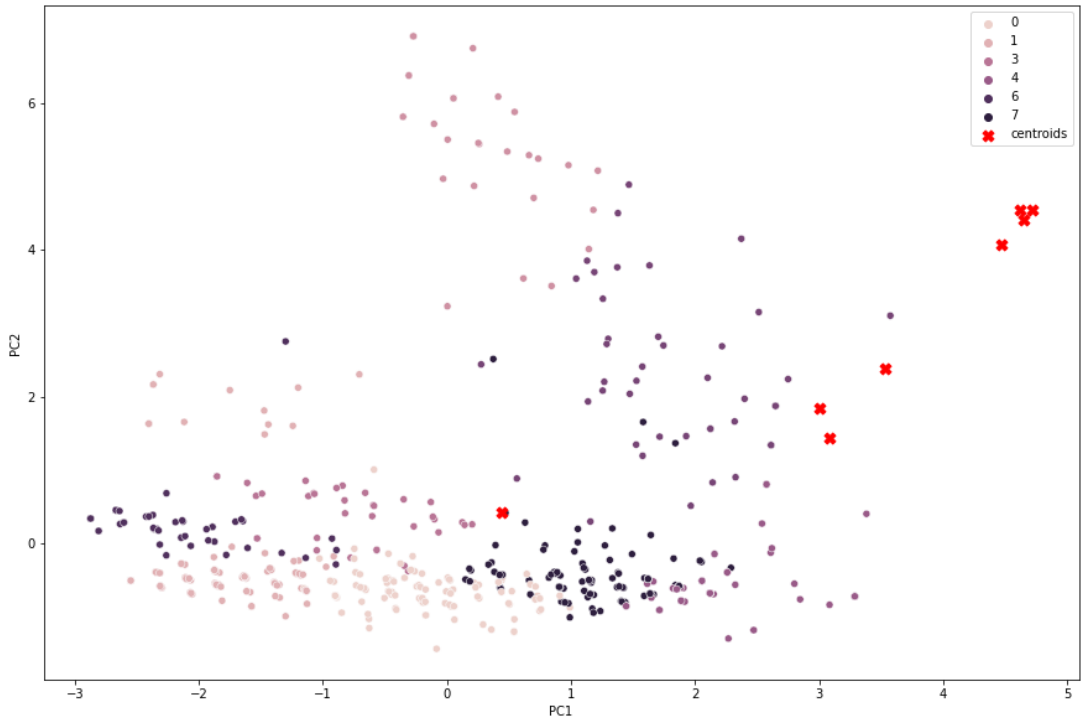
```
1    43
2    41
0    15
Name: Cluster, dtype: int64
```

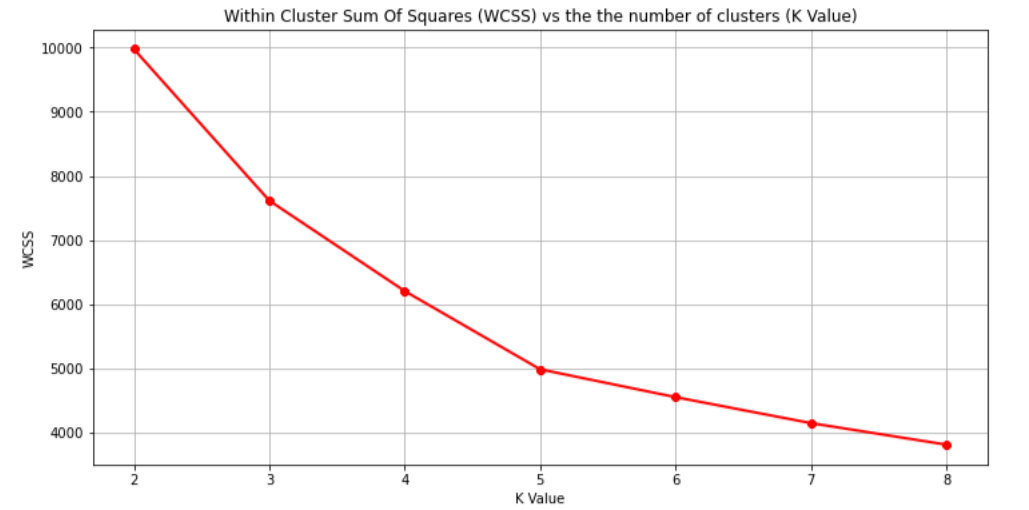

1e6
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
PC2
−2
−1
0
1
2
3
PC1
1e6


1e6
Cluster 0
Cluster 1
Cluster 2
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
PC2
−2
−1
0
1
2
3
PC1
1e6

Now we are doing PCA for the Behavioral analysis:

```
plt.figure(figsize=(15, 10))
kmeans = KMeans(8, random_state=0).fit(values)
scaled_data = StandardScaler().fit_transform(values)
pca = PCA(n_components=8)
pca_data = pca.fit_transform(scaled_data)

pf = pd.DataFrame(data=pca_data, columns=[f"PC{i+1}" for i in range(len(columns))])
sns.scatterplot(data=pf, x='PC1', y='PC2', hue=kmeans.labels_)
plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:, 1], marker='X', c="r", s=80, label='centroids')
plt.legend()
plt.show()
```





Using Mixtures of Regression Models

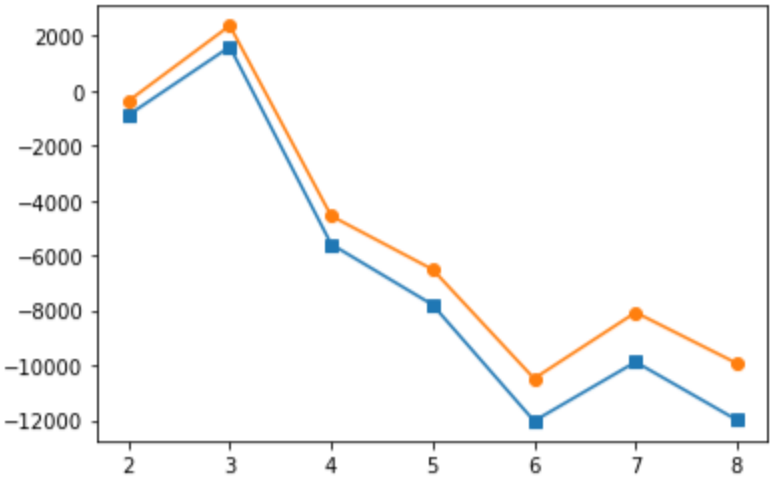
```
target = df['rating'].values
```

```
from sklearn.mixture import GaussianMixture
bic = []
aic = []

for k in range(2, 9):
    model = GaussianMixture(n_components=k, init_params='random')
    data = np.append(values, target.reshape(-1,1), axis=1)
    model.fit(data)
    print("For K : {} \t convergence after: {} iterations \n \n".format(k, model.n_iter_))

    bic.append(model.bic(data))
    aic.append(model.aic(data))
```

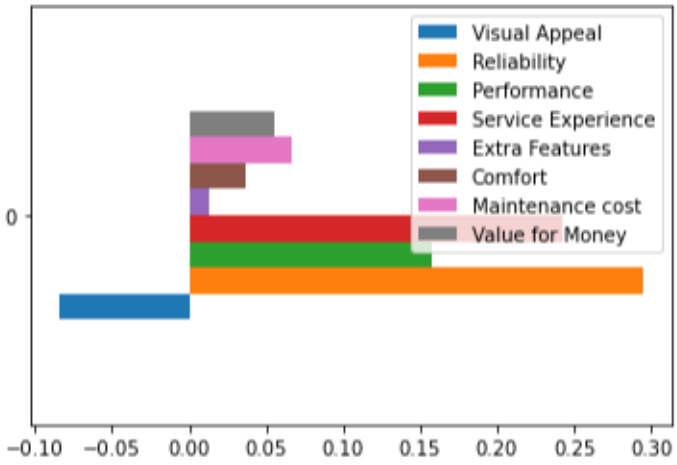
```
For K : 2       convergence after: 11 iterations


For K : 3       convergence after: 19 iterations


For K : 4       convergence after: 23 iterations


For K : 5       convergence after: 22 iterations


For K : 6       convergence after: 20 iterations


For K : 7       convergence after: 24 iterations


For K : 8       convergence after: 27 iterations
```

```
plt.plot(np.arange(2, 9), aic, marker = 's')
plt.plot(np.arange(2, 9), bic, marker = 'o')
```

```
[<matplotlib.lines.Line2D at 0x24ee3e9f190>]
```

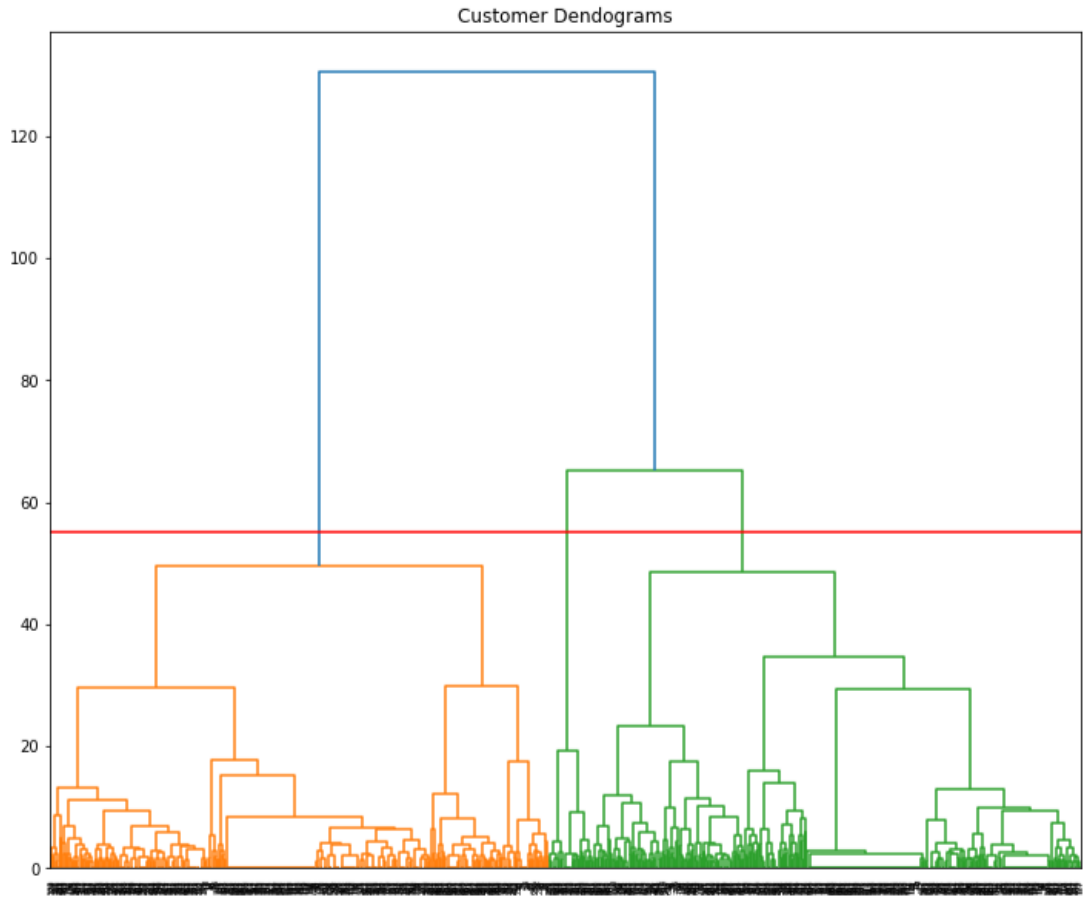



```
from sklearn.linear_model import LinearRegression
lr = LinearRegression()
lr.fit(values, target)

pd.DataFrame(lr.coef_.reshape(1,-1), columns=columns).plot(y=columns, kind='barh')
plt.show()
```



Profiling segments

```
import scipy.cluster.hierarchy as shc

plt.figure(figsize=(12, 10))
plt.title("Customer Dendograms")
dend = shc.dendrogram(shc.linkage(values, method='ward'))
plt.axhline(y = 55, color = 'r', linestyle = '-')
plt.show()
```

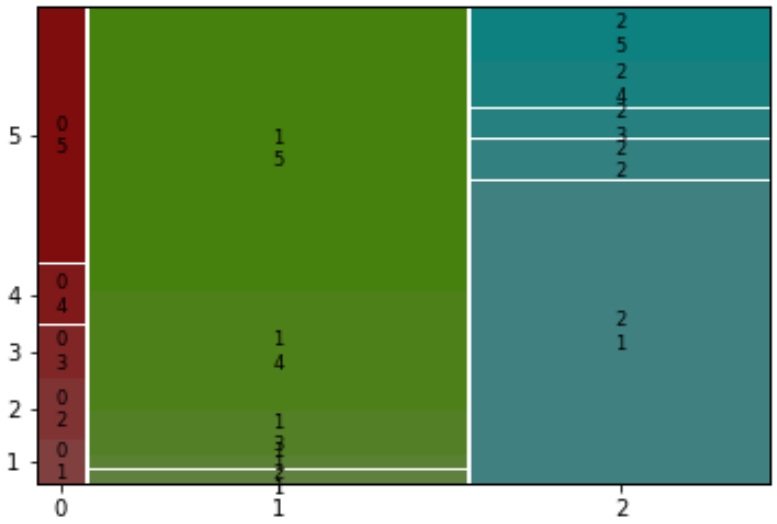


- Number of clusters given by dendograms is 3

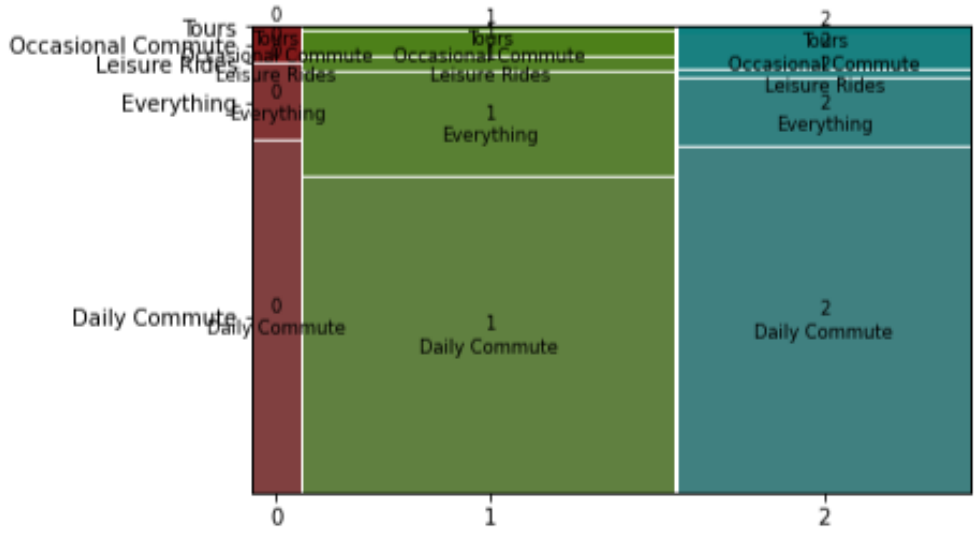
Step 7: Describing Segments

```
from statsmodels.graphics.mosaicplot import mosaic
kmeans = KMeans(3, random_state=0).fit(values)
crosstabLike = pd.crosstab(kmeans.labels_, target)
```

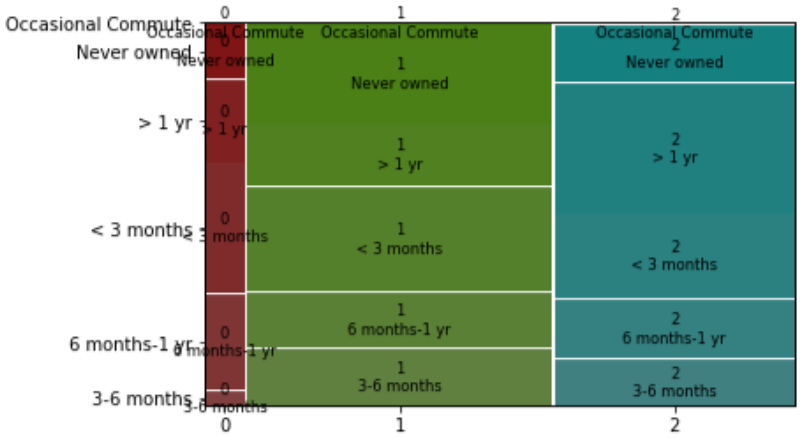
```
mosaic(crosstabLike.stack())
plt.show()
```



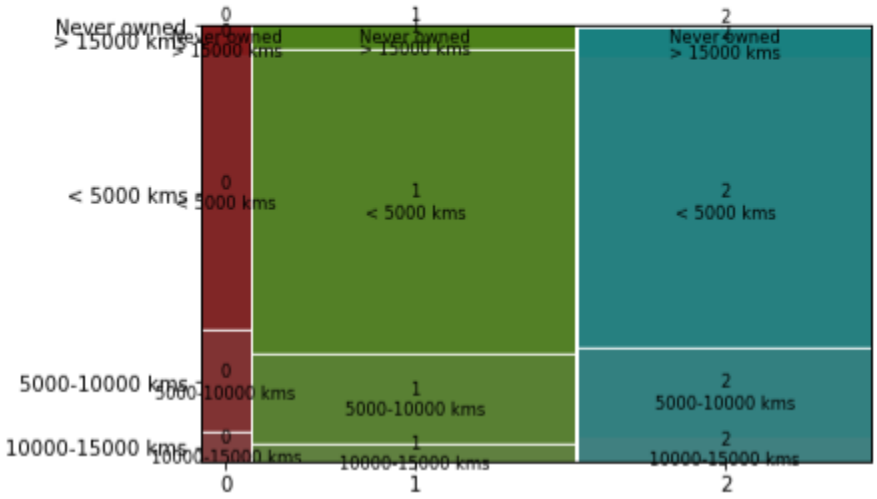
```
# Used it for
crosstabCondition = pd.crosstab(kmeans.labels_, df['Used it for'])
mosaic(crosstabCondition.stack())
plt.show()
```



```
: # Owned for
crosstabDriven = pd.crosstab(kmeans.labels_, df['Owned for'])
mosaic(crosstabDriven.stack())
plt.show()
```

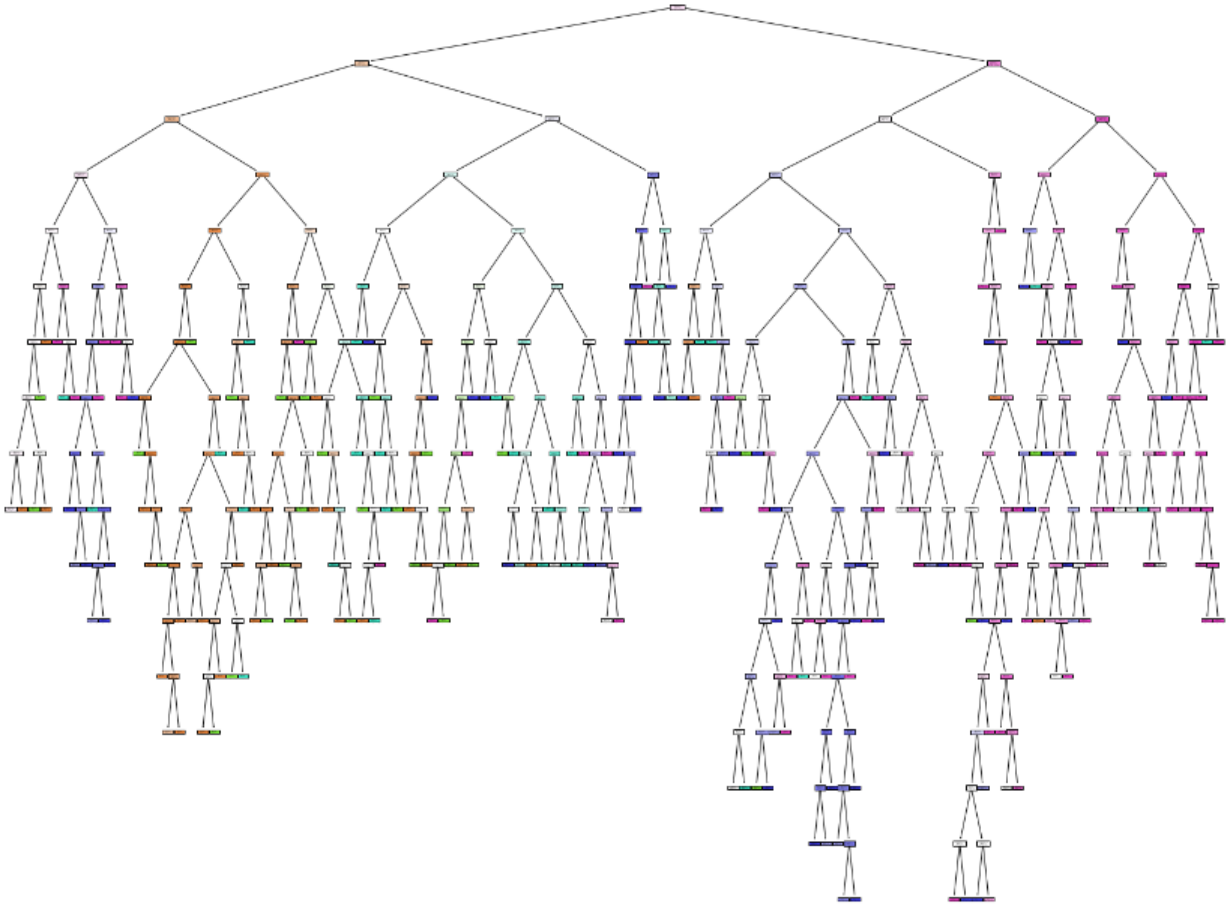



```
# Ridden for
crosstabDriven = pd.crosstab(kmeans.labels_, df['Ridden for'])
mosaic(crosstabDriven.stack())
plt.show()
```



Selecting the Target Segments

```
from sklearn.tree import DecisionTreeClassifier, plot_tree
dtree = DecisionTreeClassifier()
dtree.fit(values, target)

fig = plt.figure(figsize=(25,20))
_ = plot_tree(dtree,
                    feature_names=columns,
                    filled=True)
```



Marketing Mix

Marketing mix is a combination of product, price, promotion, and place (distribution) strategies used by companies to effectively target their desired market segments. Here's an example of a marketing mix for the Indian electric vehicle (EV) market based on the segmentation discussed earlier:

- **Product:** EV manufacturers need to offer a range of products that cater to different psychographic segments. For example, luxury EVs for high-income earners, practical and affordable EVs for value-seekers, and eco-friendly EVs for environmentalists.

- **Price:** EV manufacturers need to price their products based on the affordability and value preferences of different segments. This could involve offering financing options, incentives, and price discounts for different segments.

- **Promotion:** Promotional activities should be tailored to the interests and preferences of different segments. This could include social media campaigns, influencer marketing, and events targeting specific psychographic segments. For example, sponsoring environmental events for

environmentalists, tech fairs for tech-savvy consumers, and auto shows for early adopters.

- **Place:** The distribution strategy should be designed to reach the desired psychographic segments effectively. This could involve partnering with dealerships, establishing charging infrastructure in urban areas, and offering home charging solutions for convenience-oriented segments.

Overall, companies need to have a deep understanding of the needs, preferences, and motivations of different psychographic segments to develop an effective marketing mix for the Indian EV market. By tailoring their product, price, promotion, and distribution strategies to different segments, companies can effectively target their desired audience and increase adoption of EVs in India.

References:

As We have already taken the datasets above with some pure references, also here We are going to attached more references:

https://analysis.technavio.org/electric-car-market-size-research

https://www.alliedmarketresearch.com/electric-vehicle-market#:~:text=The%20global%20electric%20vehicle%20market%20is%20segmented%20on%20the%20basis,cell%20electric%20vehicle%20(FCEV)

https://www.sciencedirect.com/science/article/pii/S0969698922000625

https://www.psmarketresearch.com/market-analysis/india-electric-scooter-and-motorcycle-market

https://www.alliedmarketresearch.com/electric-vehicle-market#:~:text=The%20global%20electric%20vehicle%20market%20is%20segmented%20on%20the%20basis,cell%20electric%20vehicle%20(FCEV).

https://www.marketresearchfuture.com/reports/electric-vehicles-market-1793

Github Link:

https://github.com/khaderather/EV-Segmentation-Analysis

https://github.com/ashish-sadan/Feynn-Labs/tree/main/EVs%20Ass

https://github.com/ajayyy17/demo/blob/main/IndianAutomobileBuyingBehaviour.ipynb

https://github.com/Ashwani015/CV/blob/main/behavioral_analysis2wheelerand4wheeler.ipynb

https://github.com/Nandaraj-m/feynnlabs/tree/main/EV%20market%20segmentation

https://github.com/anandabhi2910/Electric-Vehicle-in-India_Market-Segmentation

Thank You