MARKET SEGMENTATION ANALYSIS OF ELECTRIC VEHICLE MARKET IN INDIA

OVERVIEW:

Electric vehicles are the key technology to decarbonise road transport, a sector that accounts for over 15% of global energy-related emissions. Recent years have seen exponential growth in the sale of electric vehicles together with improved range, wider model availability and increased performance. Passenger electric cars are surging in popularity – we estimate that 18% of new cars sold in 2023 will be electric.

If the growth experienced in the past two years is sustained, CO_2 emissions from cars can by 2030 be put on a pathway aligned with the Net Zero Emissions by 2050 (NZE) Scenario. However, electric vehicles are not yet a global phenomenon. Sales in developing and emerging economies have been slow due to the relatively high purchase price of an electric vehicle and a lack of charging infrastructure availability.

In addition, due to urbanization and decentralization of city areas, a rapid increase in personal vehicles has been observed.

EV (Electric Vehicle) /HEV (Hybrid Electric Vehicle) /PHEV (Plug-in Hybrid Electric Vehicle) can be more beneficial for Indian roads due to the following reasons:

1. Hybrid or electric powertrains operate at much higher efficiency at low Indian driving speeds than an Internal Combustion Engine.
2. A higher share of energy per Indian trip is lost in braking, which is almost recovered in a hybrid-electric vehicle (HEV) and EV (Regenerative braking).
3. HEVs and EVs use no fuel during idling and the share of idling time in traffic is much higher in India (than the U.S. & Europe).
4. The average range travelled in India is much smaller than in the U.S. & Europe, making EVs much more feasible and with no range problem with a single charge.
5. Vehicle use and vehicle distance – Urban driving cycle patterns have a frequent start and stop, high traffic benefits to provide high efficiency electric vehicles.

MARKET OVERVIEW:

The Indian Electric Vehicle Market is segmented by Vehicle Type and Power Source.
By Vehicle Type, the market is segmented into Passenger Cars, Commercial Vehicles, and Two- and Three-wheelers.

By Power Source Type, the market is segmented into Battery Electric Vehicle, Plug-in Electric Vehicle, and Hybrid Electric Vehicle.

The report mainly focuses on the Indian Electric Vehicle Market segmented by Vehicle Type. However, accessibility to Power Sources for Electric Vehicles affects the market and would be slightly discussed in the report.

The Indian Electric Vehicle Market was valued at USD 5 billion in 2020, and it is expected to reach USD 47 billion by 2026, registering a compound annual growth rate (CAGR) of above 44% during the forecast period (2021-2026).

The Indian Electric Vehicle Market has been impacted by the outbreak of the COVID-19 pandemic due to supply chain disruptions and halt of manufacturing units due to continuous lockdowns and travel restrictions across the country. However, the electric vehicle (EV) market is still in its nascent stage in India. It is expected to grow at a much faster rate during the forecast period due to various government initiatives and policies.

E-commerce companies (Amazon, for example) are launching initiatives to use e-Mobility for last-mile deliveries to reduce carbon footprint. India is experimenting with e-Mobility for public transport, and the country has deployed electric intercity buses across some major cities. In addition, state governments are also playing an active role in the deployment of policies encouraging the usage of EVs. For instance,
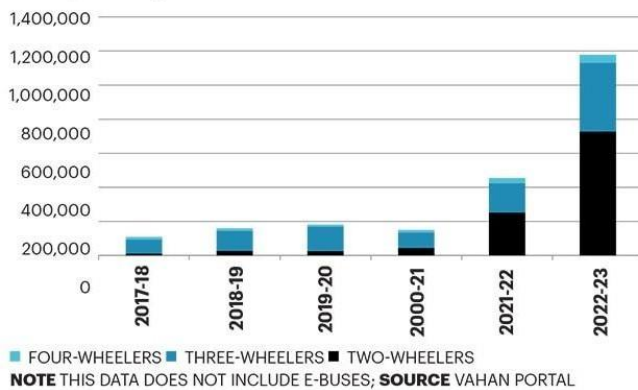Kerala aims to put one million EV units on the road by 2022 and 6,000 e-buses in public transport by 2025.

Telangana aims to have EV sales targets for 2025 to achieve 80% 2- and 3-wheelers (motorcycles, scooters, auto-rickshaws), 70% commercial cars (ride-hailing companies, such as Ola and Uber), 40% buses, 30% private cars, and 15% electrification of all vehicles.

The EV market in India has gained significant momentum after the implementation of the (Faster Adoption and Manufacturing of Hybrid & Electric Vehicles in India) FAME India scheme with
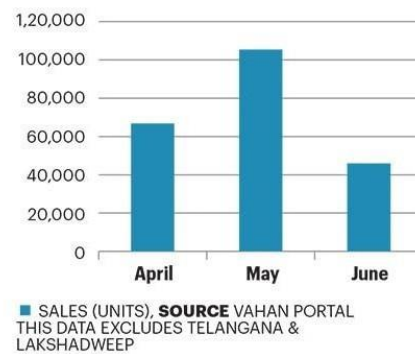
its aim of shifting toward e-mobility in the wake of growing international policy commitments and environmental challenges. Moreover, India offers the world's largest untapped market, especially in the electric two-wheeler segment. As 100% foreign direct investment is allowed in this sector, the automatic route market is expected to gain momentum during the forecast period.

STELLAR RISE

The sales of EVs jumped in financial year 2022-23, led by a sharp rise in two-wheelers...

...But electric two-wheeler numbers have plunged after the subsidy was cut beginning June 1

FOUR-WHEELERS ■ THREE-WHEELERS ■ TWO-WHEELERS
NOTE THIS DATA DOES NOT INCLUDE E-BUSES; **SOURCE** VAHAN PORTAL

■ SALES (UNITS), **SOURCE** VAHAN PORTAL
THIS DATA EXCLUDES TELANGANA & LAKSHADWEEP

GOVERNMENT INITIATIVES AND POLICIES SUPPORTING THE EV INDUSTRY

The government has set a target of 30% new sales of electric vehicles and two-wheelers by 2030. The government is working towards it by following the initiative and various government schemes.

National Electric Mobility Mission Plan (NEMMP)

- It is a road map/document for India's fuel security by promoting and faster adoption of electric vehicles in India with the initial allocation of Rs 75 crore. The ambition is to have around 6 million vehicles on the road by 2020.
- This plan is for affordable and environmentally friendly transportation in the country and to achieve automotive leadership in global manufacturing.

Faster Adoption and Manufacturing of (hybrid and) electric vehicles (FAME)

- The scheme was announced by the government in 2015 with the objective of market creation and developing a manufacturing ecosystem with sustainable development.
- It is formulated by the Department of Heavy Industry, having 4 key areas- technology creation, demand creation, pilot projects, and infrastructure related to charging.

Faster Adoption and Manufacturing of (hybrid and) electric vehicles (FAME) II

- Based on the result and experience of phase I of the scheme, phase II was launched with an allocation of Rs 10000 Crore over three years, recently approved by the cabinet.
- This scheme vision a holistic approach to the EV industry, including infrastructure for charging, manufacturing of batteries, market creation, public demand, and push for EVs in public transport.
- It also offers incentives to the manufacturer of electric vehicles and their components.
- It enables the creation of charging infrastructure in selected cities and major highways at an interval of 25 km.

ASSUMPTIONS

In India, there are 30 crore registered vehicles.

There are approximately 22 crore registered two-wheelers in India, with the remaining 8 crores being four-wheelers; trucks and other types of transport/construction vehicles are not included.

The average increase for two-wheelers is 75% year on year, while the average increase for four-wheelers is 25% year on year.

As of 2023, there are approximately 6.2 lakh electric vehicles in the country, with approximately 5.5 lakh being two-wheelers and 0.6 lakh being four-wheelers.

The total number of vehicles remains constant.

EVs are the only green substitute technology for gasoline/diesel vehicles.

CALCULATIONS
Let's see how long it will take for EVs to produce 80% of vehicles in each category.
For two-wheelers,
$18 = 0.054 \times (1 + 0.75)t$
$t = 10.38$ years
For four-wheelers,
$8 = 0.006 \times (1 + 0.25)t$
$t = 32$ years

CONCLUSION

So, by 2030 for two-wheelers and 2050 for four-wheelers, 80% of India's total vehicles will be electric.

From the above analysis of the Indian automobile industry, we can see that there is a lot of potential to grow, as the market has just started picking up the pace.

DATA PREPROCESSING AND ANALYSIS

Data was scraped from multiple websites using Selenium, such as kaggle, and user reviews were collected in which they shared their experiences with the available EV products on the market. We have considered multiple datasets for the analysis.

1. The first dataset consists of user reviews (EV - 4WHEELER).

	review	Exterior	Comfort	Performance	Fuel Economy	Value for Money	Condition	driven	rating
0	Need to improve body style.It's amazing and dr...	5.0	5.0	5.0	5.0	5.0	New	Few thousand kilometers	5.0
1	Tata EV has lot of flaws, worst part is servic...	3.0	2.0	1.0	2.0	1.0	New	Few thousand kilometers	0.0
2	Very nice car , environmental friendly i like ...	5.0	5.0	5.0	5.0	5.0	New	Few thousand kilometers	5.0
3	Company did not provide slow charging station ...	2.0	2.0	1.0	1.0	1.0	New	Haven't driven it	0.0
4	Servicing and maintenance overall good and goo...	5.0	5.0	5.0	5.0	5.0	Not Purchased	Few hundred kilometers	5.0

2. The second dataset consists of user reviews for **E-2W**.

	review	Used it for	Owned for	Ridden for	rating	Visual Appeal	Reliability	Performance	Service Experience	Extra Features	Comfort	Maintenance cost	Value for Money
0	Wanna buy this bike so i gave basic informatio...	Everything	Never owned	NaN	1	3.0	1.0	3.0	1.0	4.0	NaN	NaN	NaN
1	This is simply amazing and exceptionally well ...	Everything	> 1 yr	< 5000 kms	5	5.0	5.0	5.0	5.0	NaN	5.0	NaN	NaN
2	Battery life is good, I like this bike very mu...	Everything	< 3 months	< 5000 kms	5	4.0	4.0	5.0	3.0	NaN	4.0	NaN	NaN
3	I seen this bike on road. Very nice bike and g...	Everything	Never owned	NaN	5	5.0	5.0	5.0	5.0	NaN	5.0	NaN	NaN
4	I have a rv400 I have the bike for almost more...	Daily Commute	> 1 yr	5000-10000 kms	1	2.0	1.0	1.0	2.0	NaN	3.0	NaN	NaN

3. EVStats.csv : This data source has the information about each state in India and sales about the Electric vehicles line two wheelers and three wheelers. It gives total sales in each state.

	SI. 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

4. Indian automobile buying behaviour study 1.0.csv : This dataset Indian Consumers Automobiles (Cars) buying behaviour. By observing different brands and their sales pattern, we can predict customer demand and bring up new products that would reach customer satisfaction.

	Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats	PriceEuro
0	Tesla	Model 3 Long Range Dual Motor	4.6	233	450	161	940	Yes	AWD	Type 2 CCS	Sedan	D	5	55480
1	Volkswagen	ID.3 Pure	10.0	160	270	167	250	Yes	RWD	Type 2 CCS	Hatchback	C	5	30000
2	Polestar	2	4.7	210	400	181	620	Yes	AWD	Type 2 CCS	Liftback	D	5	56440
3	BMW	iX3	6.8	180	360	206	560	Yes	RWD	Type 2 CCS	SUV	D	5	68040
4	Honda	e	9.5	145	170	168	190	Yes	RWD	Type 2 CCS	Hatchback	B	4	32997

5. ElectricCarData_Clean.csv : This dataset has a detailed information on buying behaviour of Indians and factors that affects their probability of buying an electric vehicle.

	Age	Profession	Marrital Status	Education	No of Dependents	Personal loan	House Loan	Wife Working	Salary	Wife Salary	Total Salary	Make	Price
0	27	Salaried	Single	Post Graduate	0	Yes	No	No	800000	0	800000	i20	800000
1	35	Salaried	Married	Post Graduate	2	Yes	Yes	Yes	1400000	600000	2000000	Ciaz	1000000
2	45	Business	Married	Graduate	4	Yes	Yes	No	1800000	0	1800000	Duster	1200000
3	41	Business	Married	Post Graduate	3	No	No	Yes	1600000	600000	2200000	City	1200000
4	31	Salaried	Married	Post Graduate	2	Yes	No	Yes	1800000	800000	2600000	SUV	1600000

GEOGRAPHICAL ANALYSIS
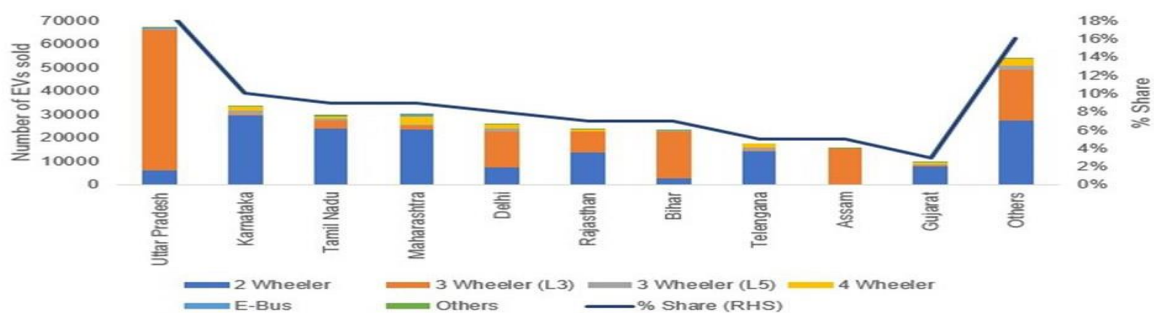
DEMOGRAPHIC ANALYSIS

By using the dataset Demographic analysis are as follows -
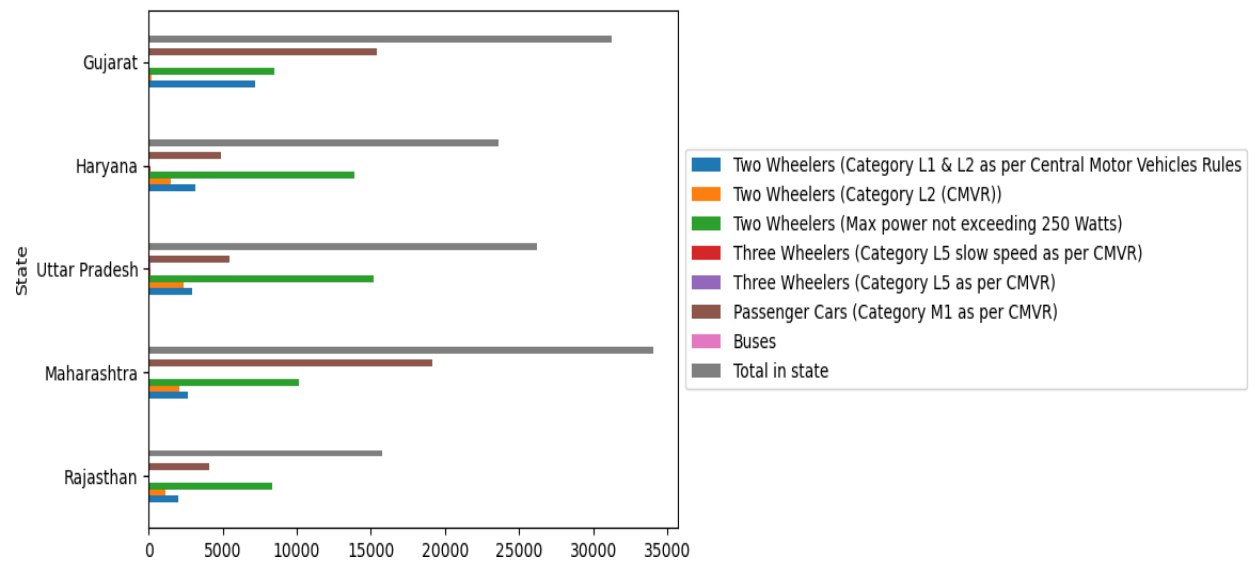
Visualizing the dataset to gain knowledge on customer preferences
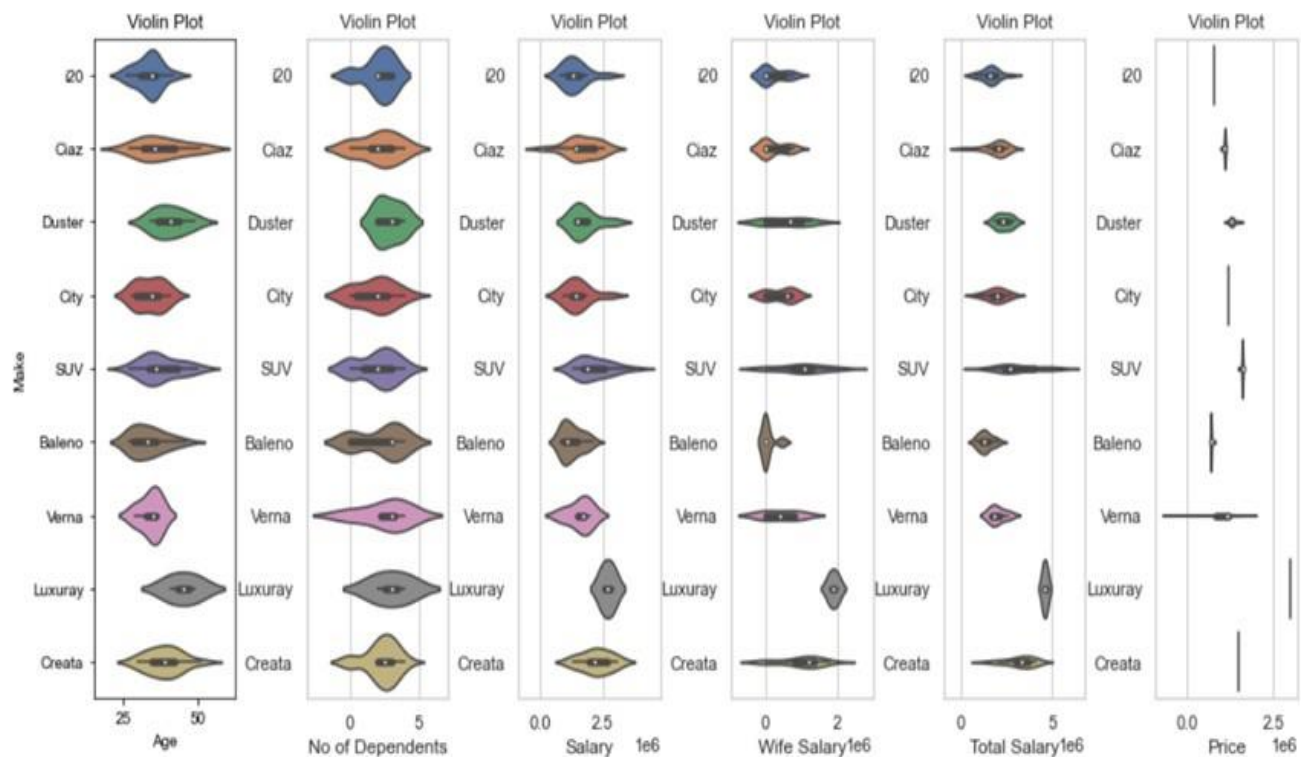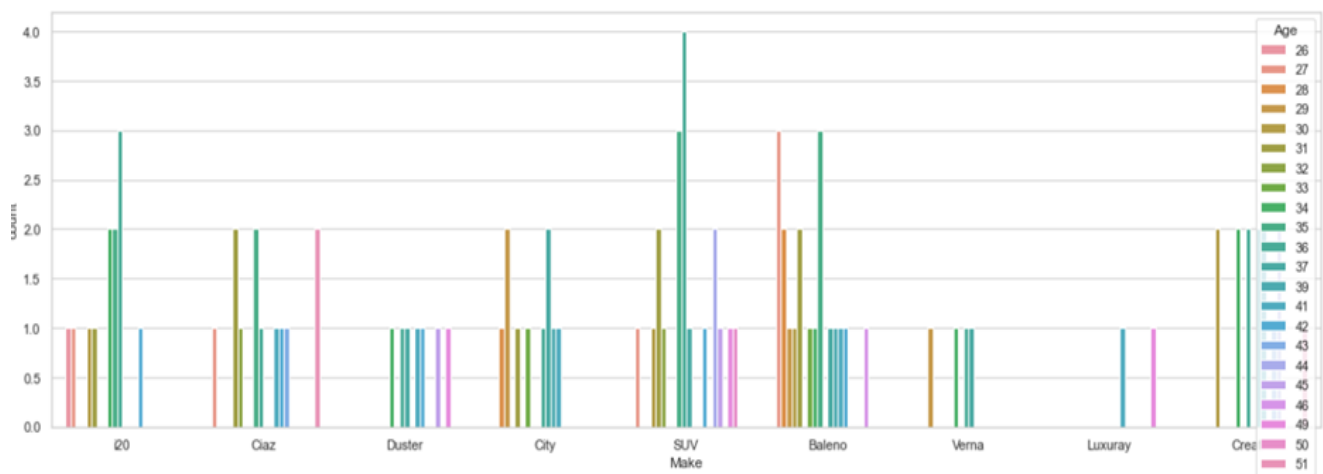
Observations:

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.

Plot for Relationship between consumers age and the vehicles they purchase

Observation: People in their 30s including early 40s and late 20s tend to buy electric vehicle comparatively than others.

Plot for Relation between consumers' marital status and the vehicles they purchase.
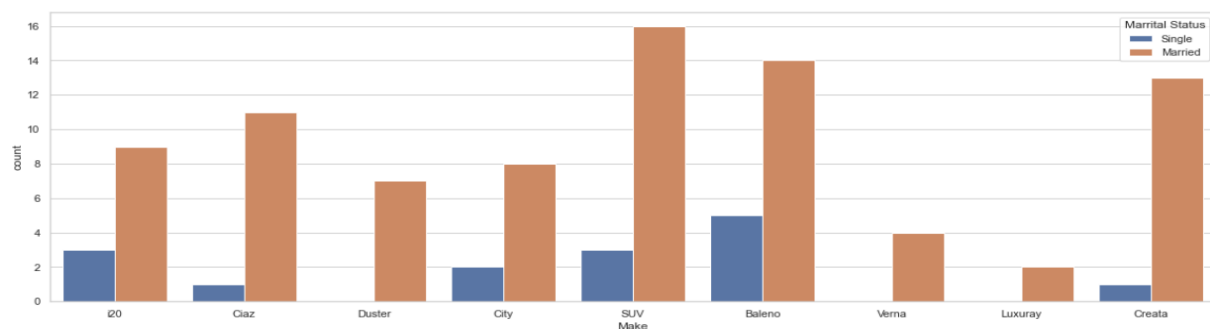
Observation: From the above plot it is clearly notable that married persons are more likely to purchase an electric vehicle when compared to a single person.

Plot for Relation between consumer's total salary and the vehicles they purchase.
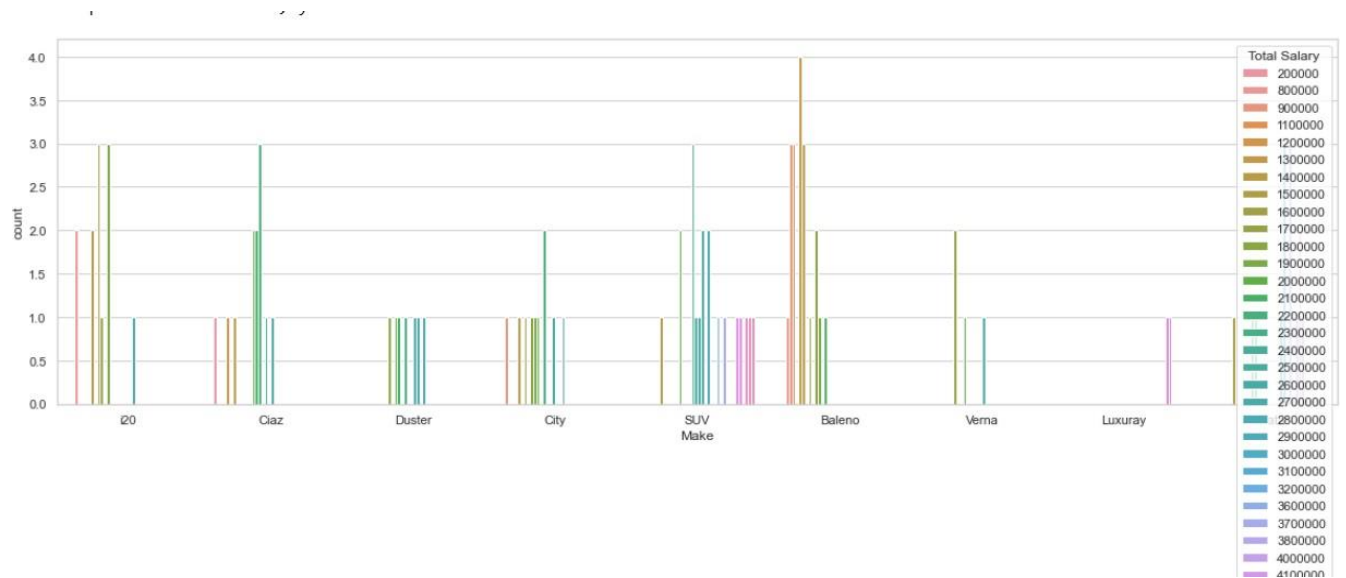
Observation: From the above plot we can analyse that salary is directly proportional to type of Electric vehicle a person tends to buy.

Plot for Relation between consumer's education and the vehicles they purchase
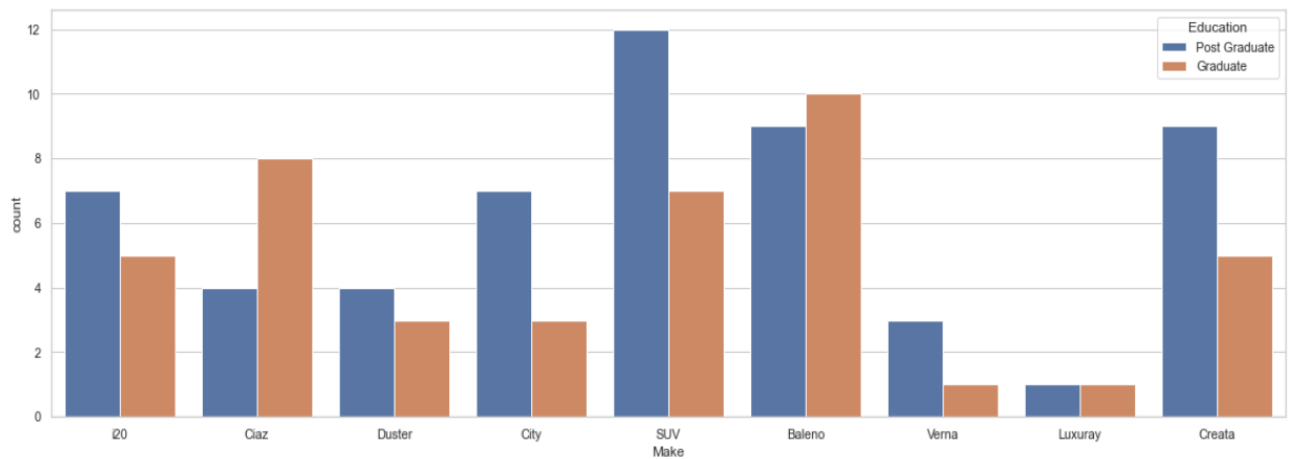
Observation: In this plot both graduate and undergraduate have equal probability of buying an e vehicle.
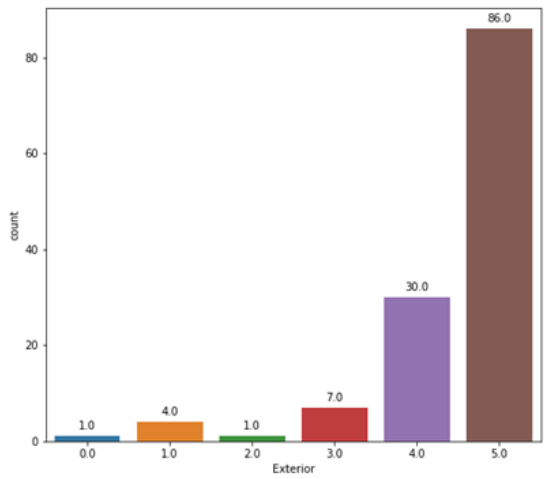
CORRELATION PLOT
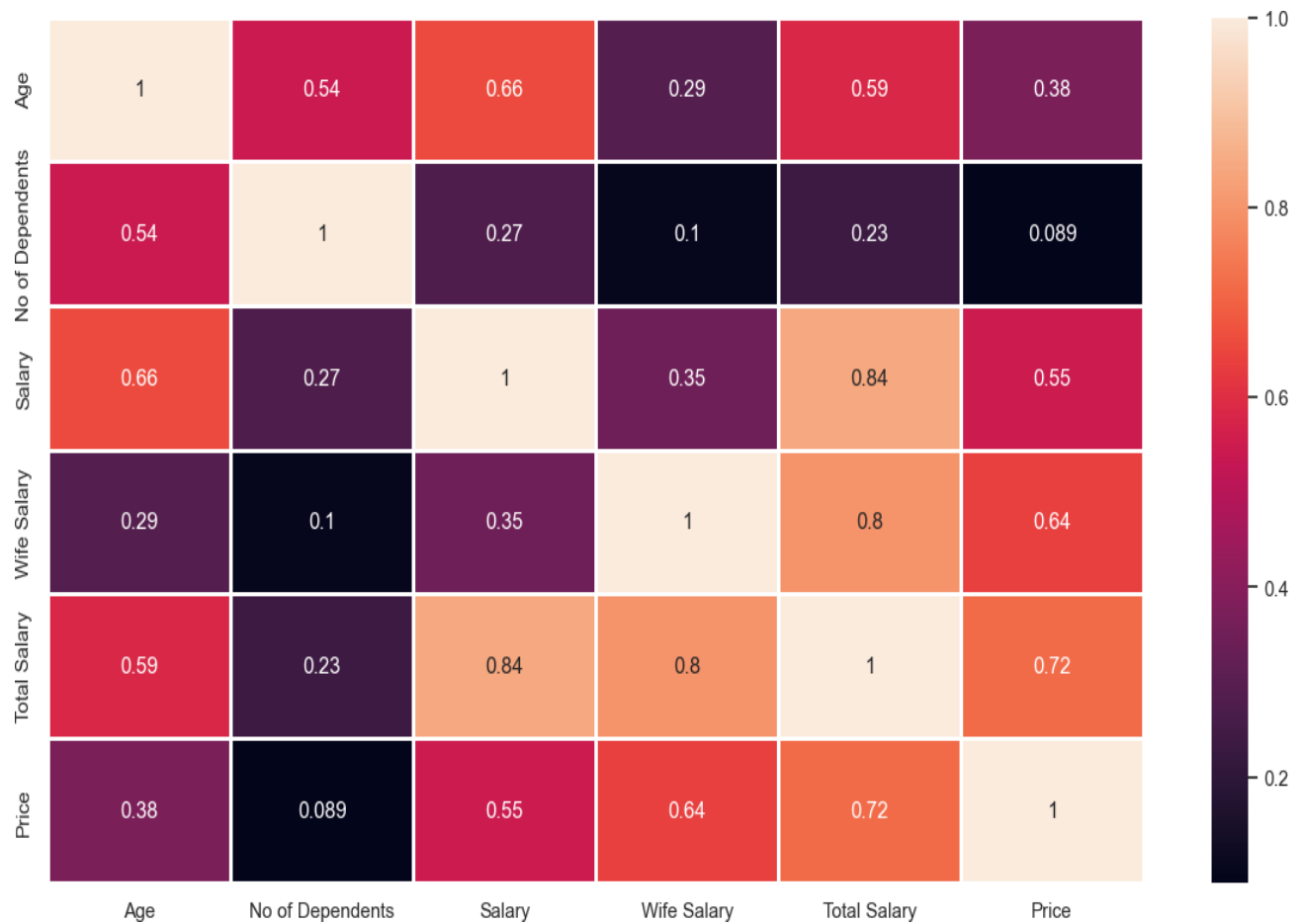
This correlation plot can clearly convey the attributes that affects the buying preference of any person

PSYCHOGRAPHIC ANALYSIS

Here we can analyse all the preferences and reviews of the customers on various aspects.
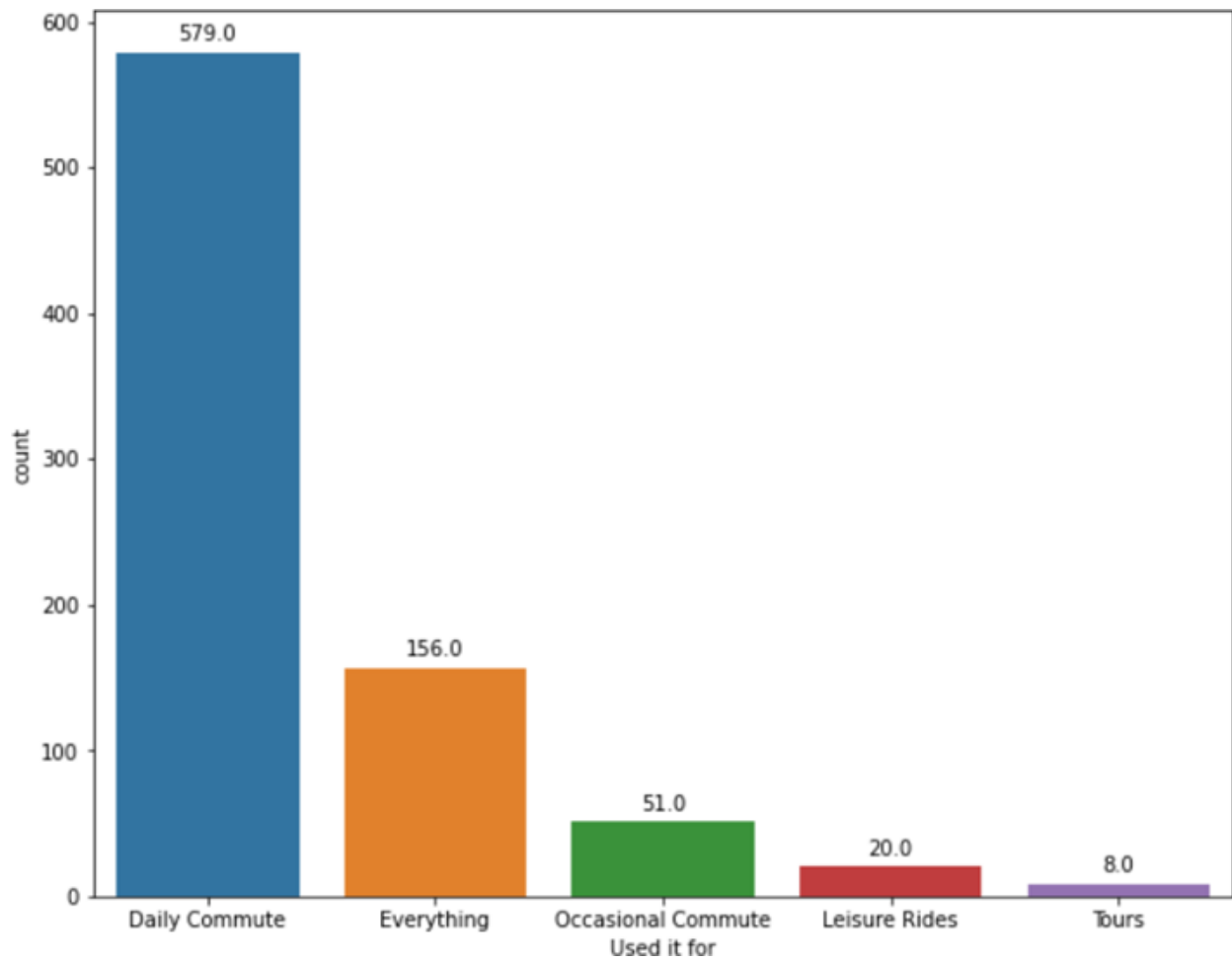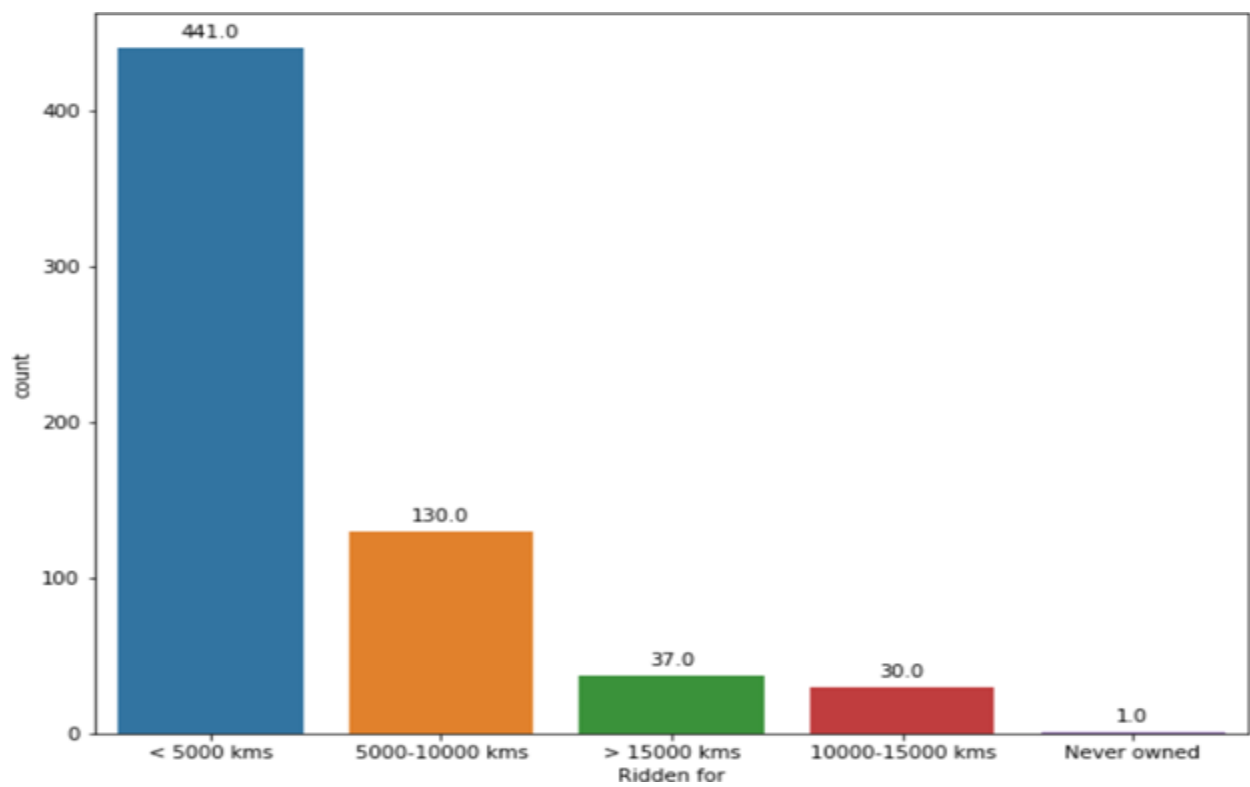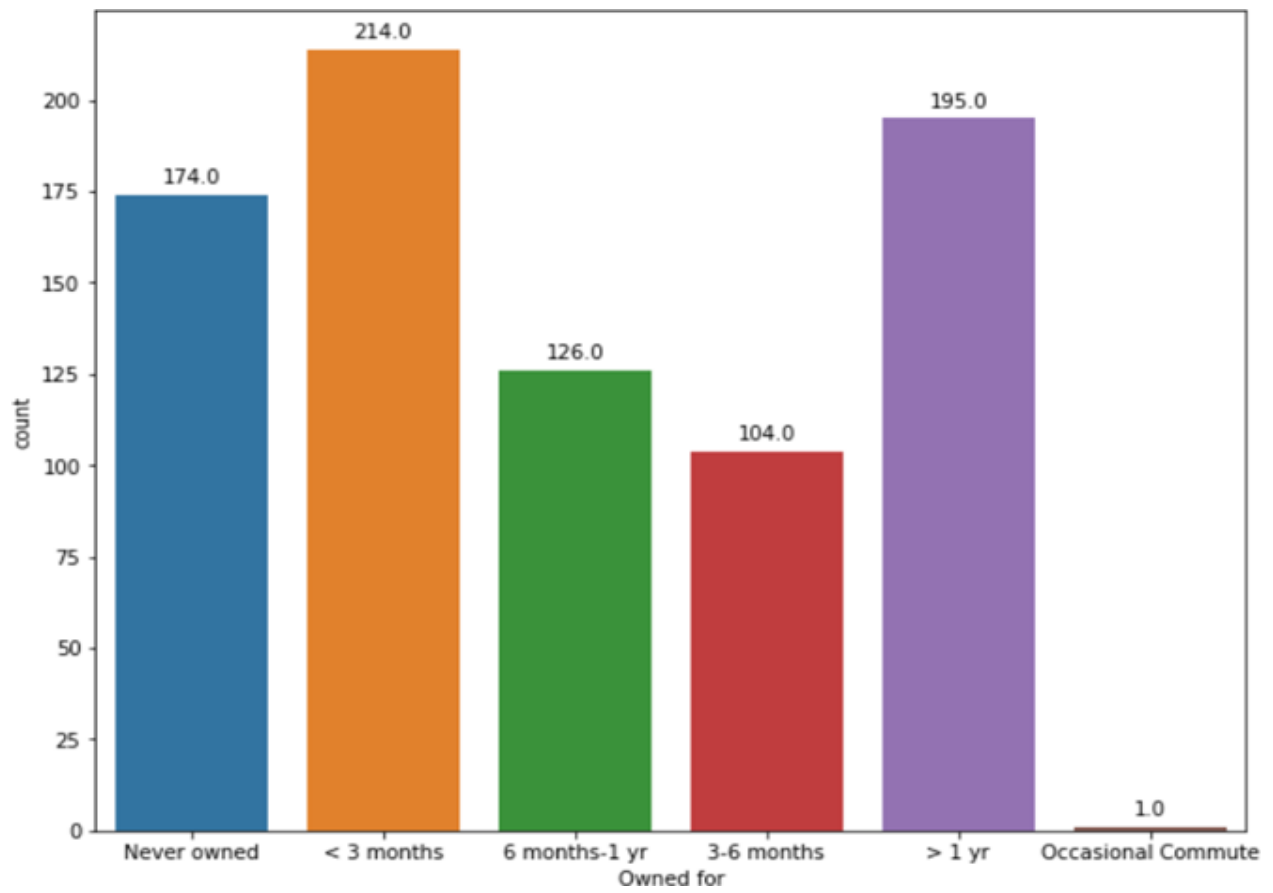For **E2Ws**:
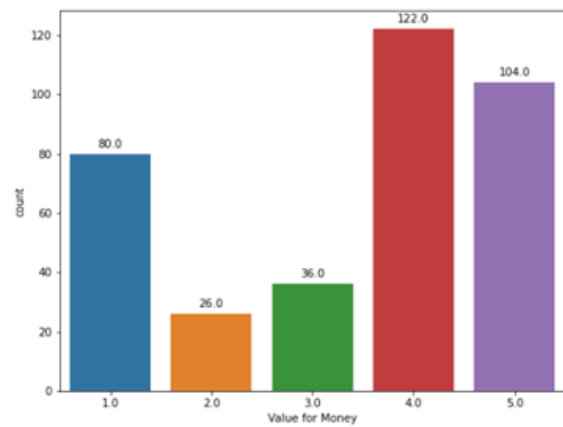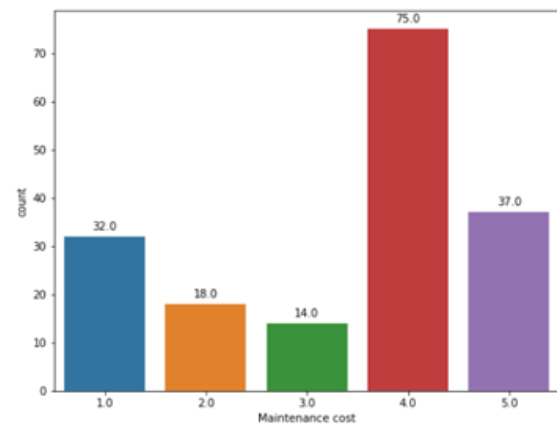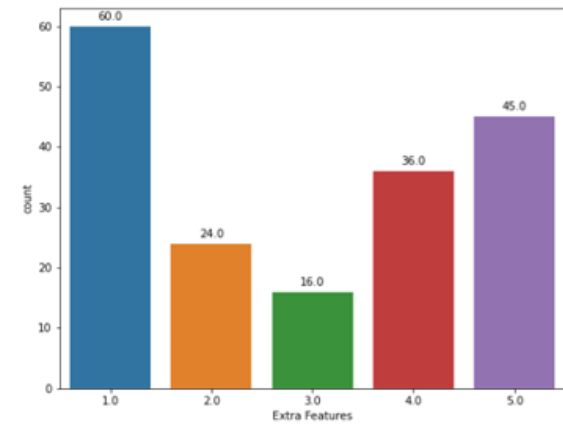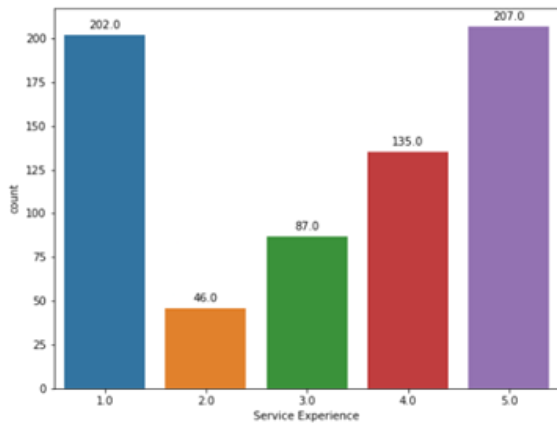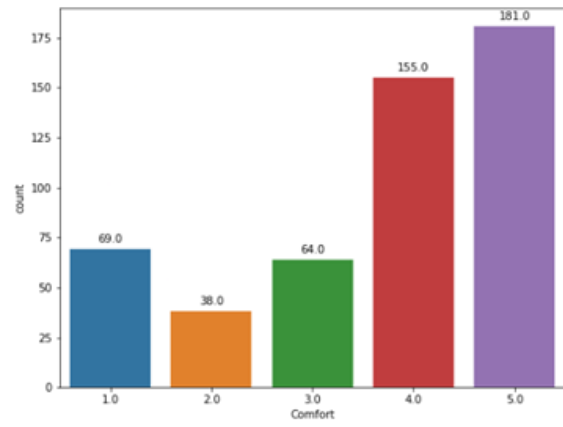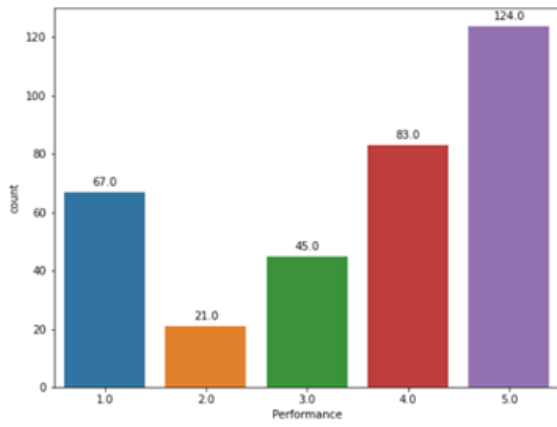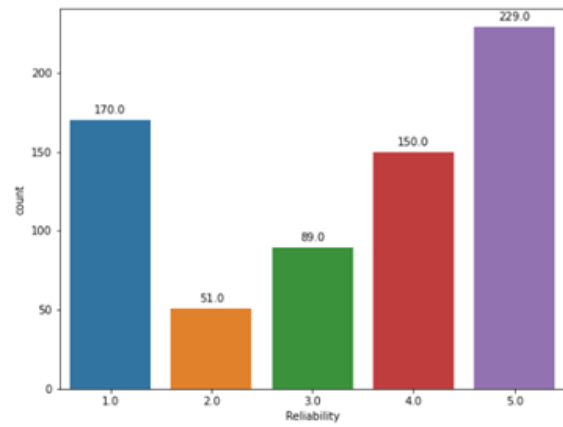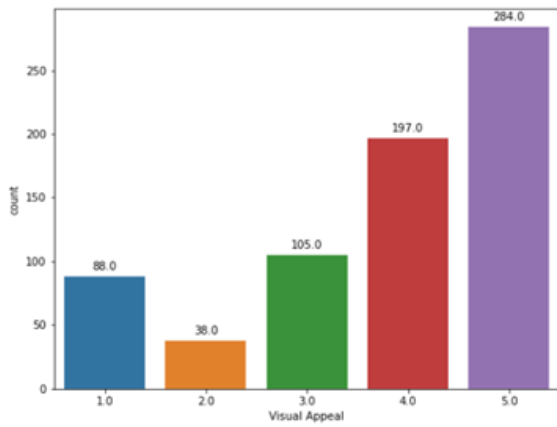
For **E4Ws**:
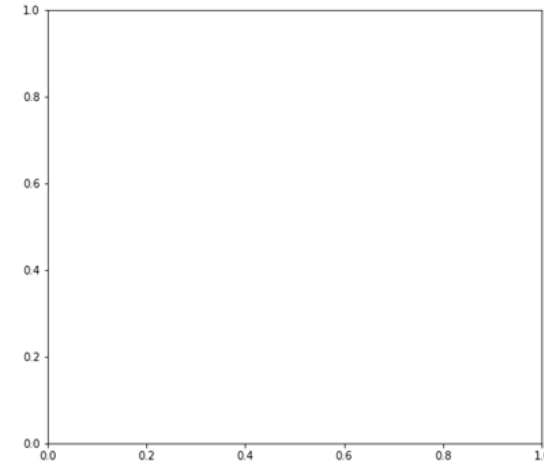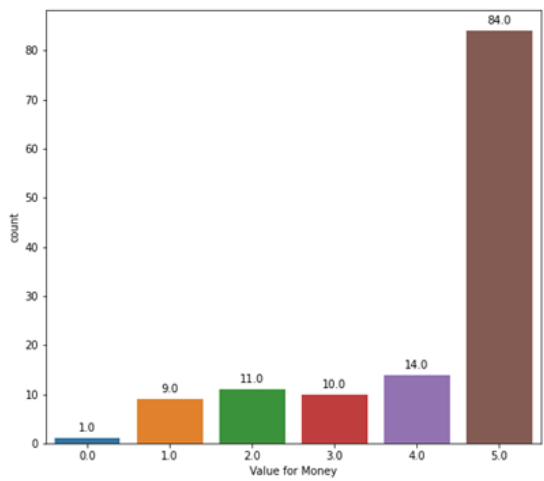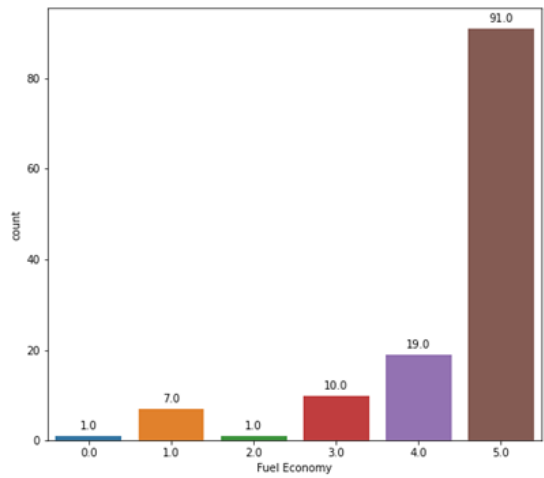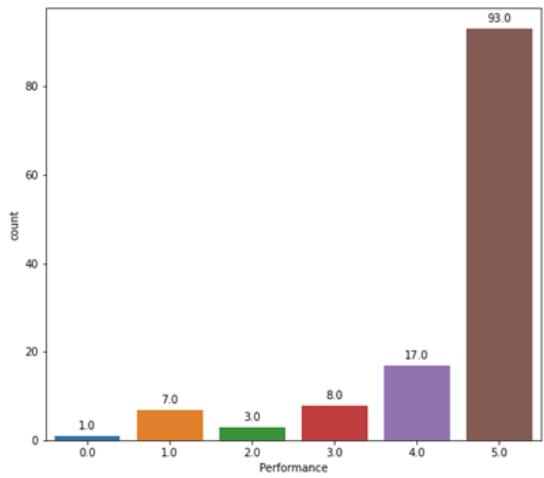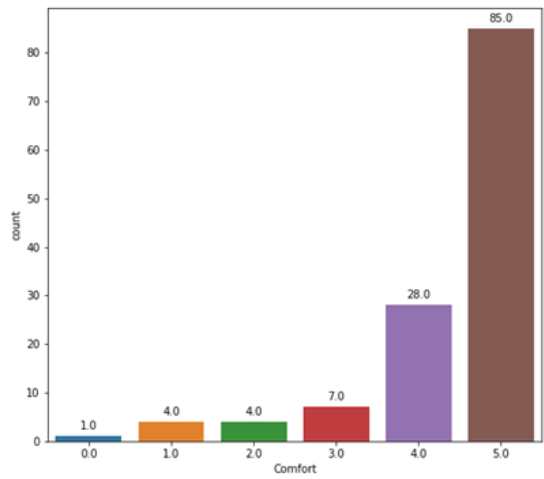
BEHAVIORAL ANALYSIS
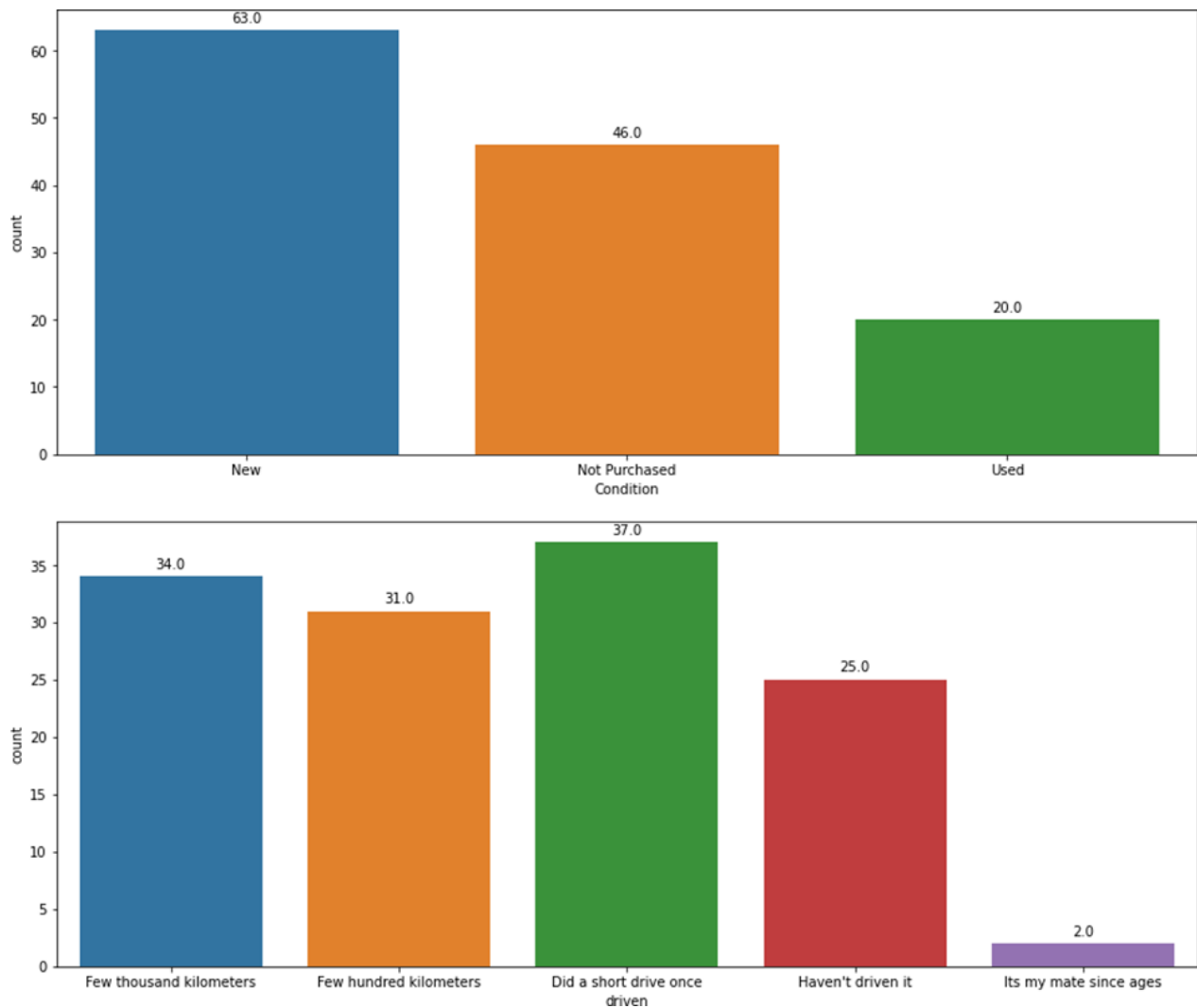
We can look into the behavioral aspect of users.
For **E2Ws**:

We can see that most users use E2Ws for daily commute only and many people who haven't owned an E2W also posted reviews, shows the interest of people towards EVs.
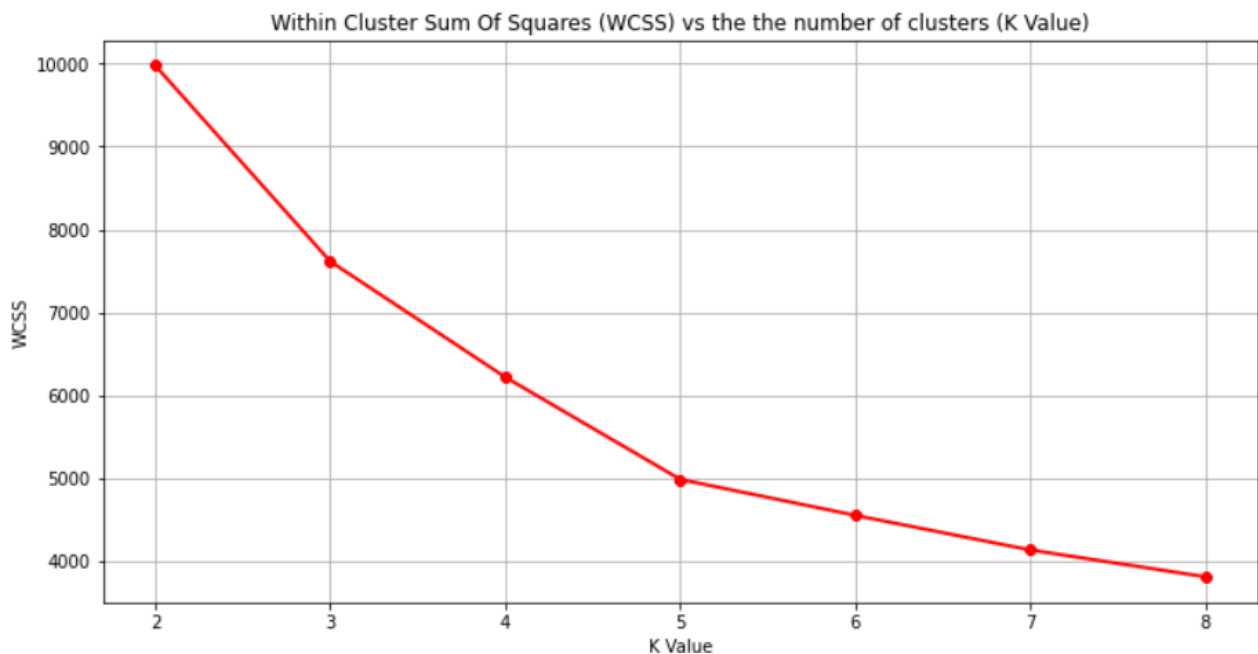
For **E4Ws**:

For E4W's, most people own a new EV and most of them have driven for short distances only, so no long-term review is available.

SEGMENTATION

USING K-MEANS

For **E2Ws**:
Using the Elbow method to find the optimum K value.

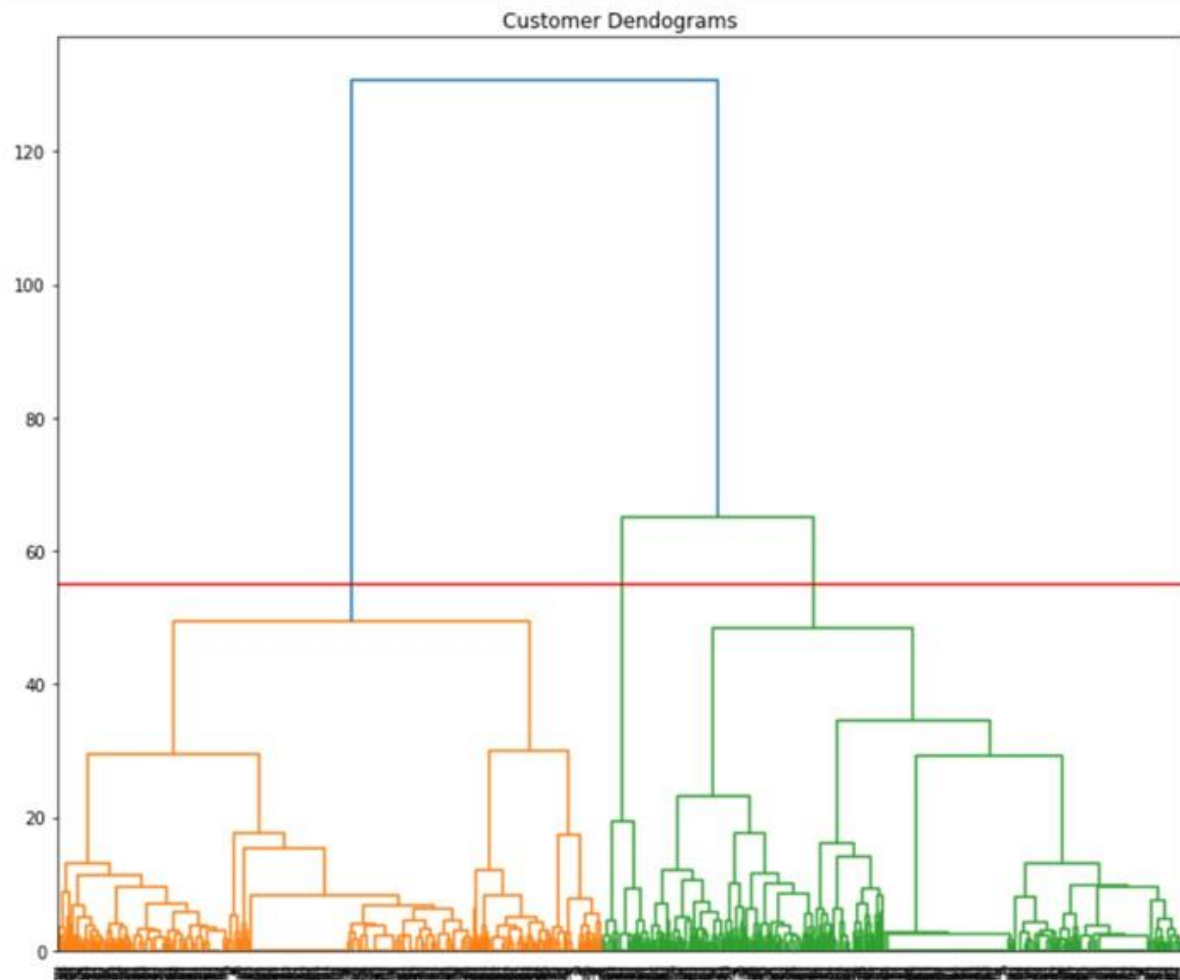Within Cluster Sum Of Squares (WCSS) vs the the number of clusters (K Value)

We clearly observe an elbow at k=3.
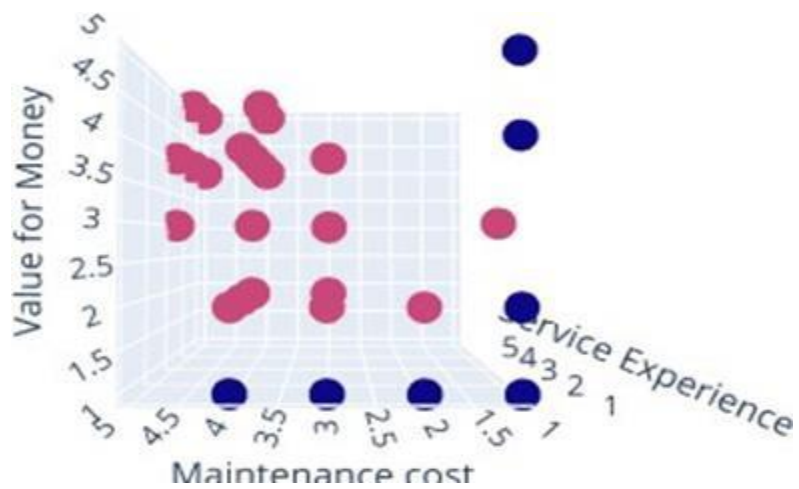
Using Silhouette Score

```
For n_clusters = 2 The average silhouette_score is : 0.4382798385117127
For n_clusters = 3 The average silhouette_score is : 0.47197983697315826
For n_clusters = 4 The average silhouette_score is : 0.44966426821874844
For n_clusters = 5 The average silhouette_score is : 0.4110356880565707
For n_clusters = 6 The average silhouette_score is : 0.3803659233066803
For n_clusters = 7 The average silhouette_score is : 0.38054950742527416
For n_clusters = 8 The average silhouette_score is : 0.3717438932186394
```

Silhouette Score also gives optimal clusters as 3.
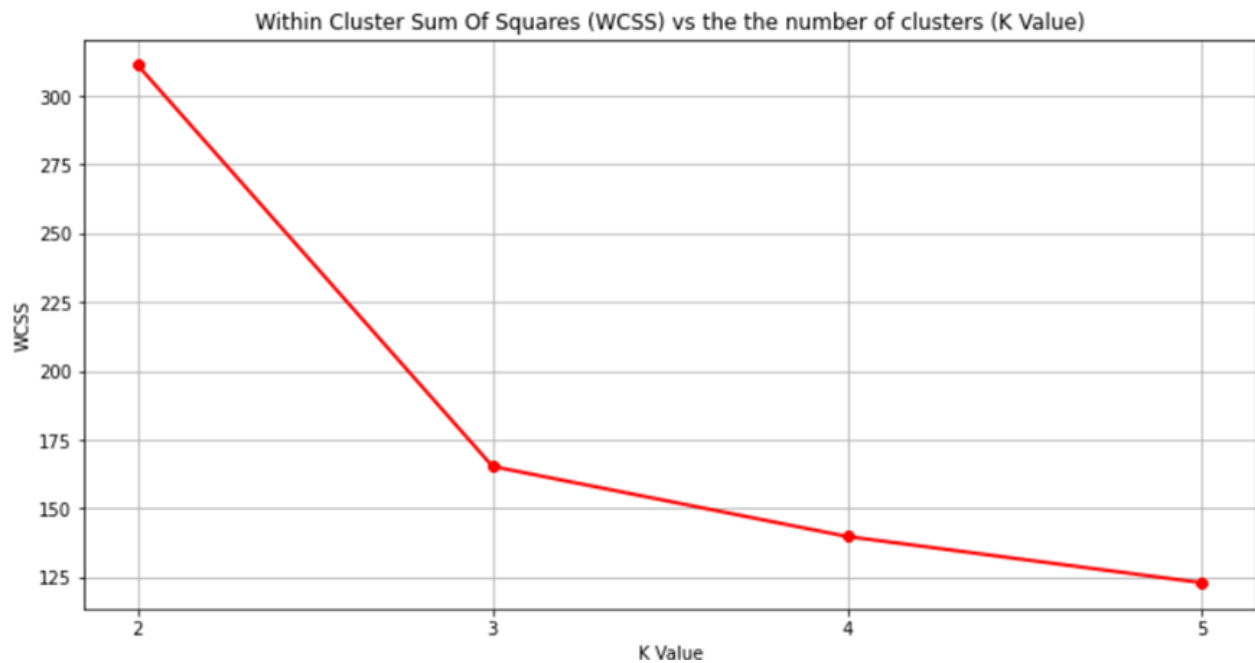
Using Dendrograms

This also gives optimal clusters as 3.

Cluster Plot for Service Experience, Maintenance cost and Value for Money.

For **E4Ws**:

Using the Elbow method to find the optimum K value.

We clearly observe an elbow at k=3.

Using Silhouette Score

```
For n_clusters = 2 The average silhouette_score is : 0.7219919432326541
For n_clusters = 3 The average silhouette_score is : 0.6315470424676867
For n_clusters = 4 The average silhouette_score is : 0.5479325325802188
For n_clusters = 5 The average silhouette_score is : 0.542824572239918
```
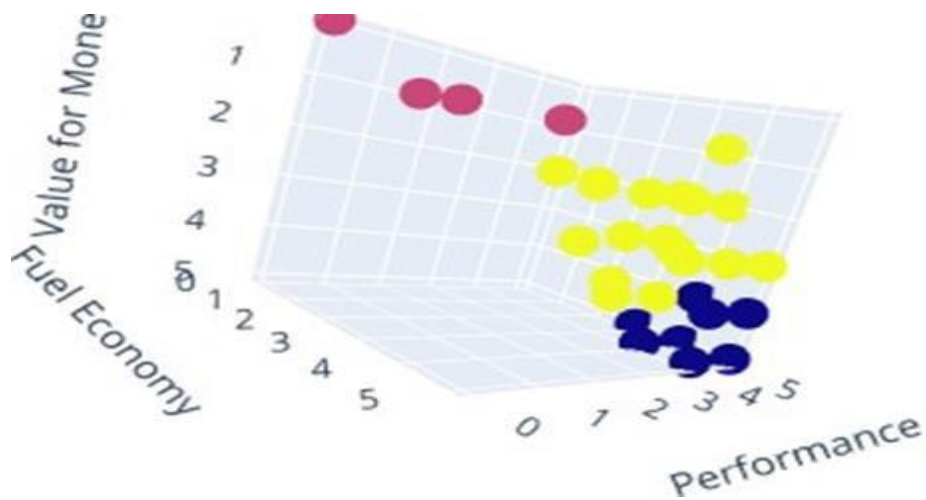
Silhouette Score also gives optimal clusters as 3.

Using Dendrograms

Customer Dendograms
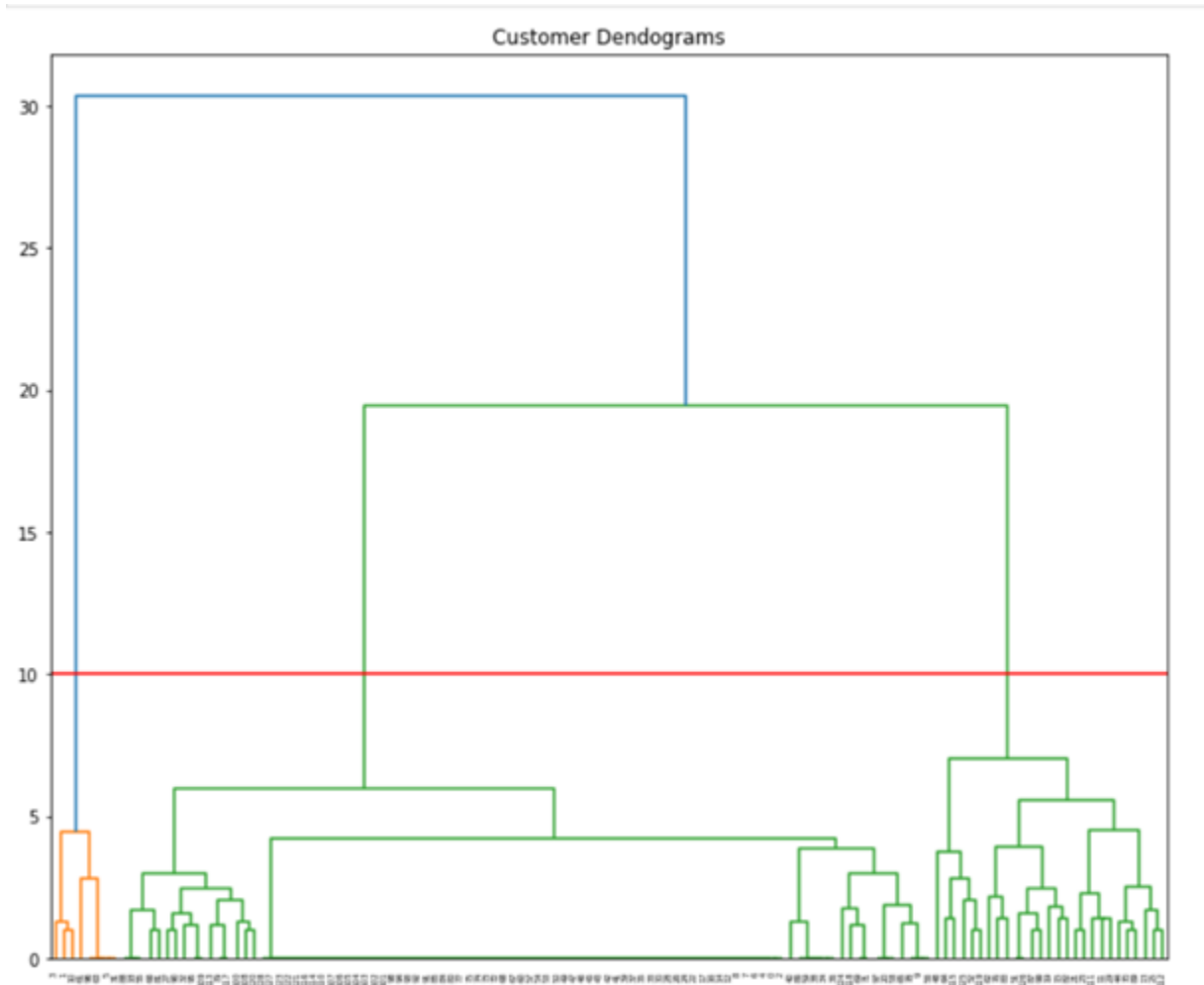
This also gives optimal clusters as 3.

Cluster Plot for Performance, Fuel Economy and Value for Money.

TARGET SEGMENT

For **E2Ws**:

So, from the analysis we can see that the company can target for E2W's vehicles in many parts of the country as many states have reported high E2W sales, but the most favourable location seems to be southern India as many states there like Karnataka, Tamil Nadu, Telangana, Kerala has high percentage sales of E2Ws of the total EV sales also they have high numbers of charging stations which makes convenient for the customer to adopt an EV. The company should also focus on many aspects of vehicle especially on reliability, comfort and service cost, as most people use the vehicle for daily commute and hence provide suitable customer experience. Age doesn't seem to matter as people from every age group are interested to adopt E2W's there is definitely anxiety in terms of range, service costs and safety of battery which have been already mentioned if the company can solve those issues, it would help in building customer trust, which would eventually help grow the business.

For **E4Ws**:

So, from the analysis we can see that the company can target for E4W's vehicles in many parts of the country as many states have reported high E4W sales, but the most favourable location again seems to be southern India as many states there like Karnataka, Tamil Nadu, Telangana, Kerala has high percentage sales of E4Ws of the total EV sales and they have high numbers of charging stations which makes convenient for the customer to adopt an EV. The company should also focus on many aspects of vehicle especially on Performance, Range and service cost, as people buy cars for long term. Age doesn't seem to matter as people from every age group are interested to adopt E4W's, there is definitely anxiety in terms of range, service costs and safety of battery which have been already mentioned if the company can solve those issues, it would help in building customer trust, which would eventually help grow the business.
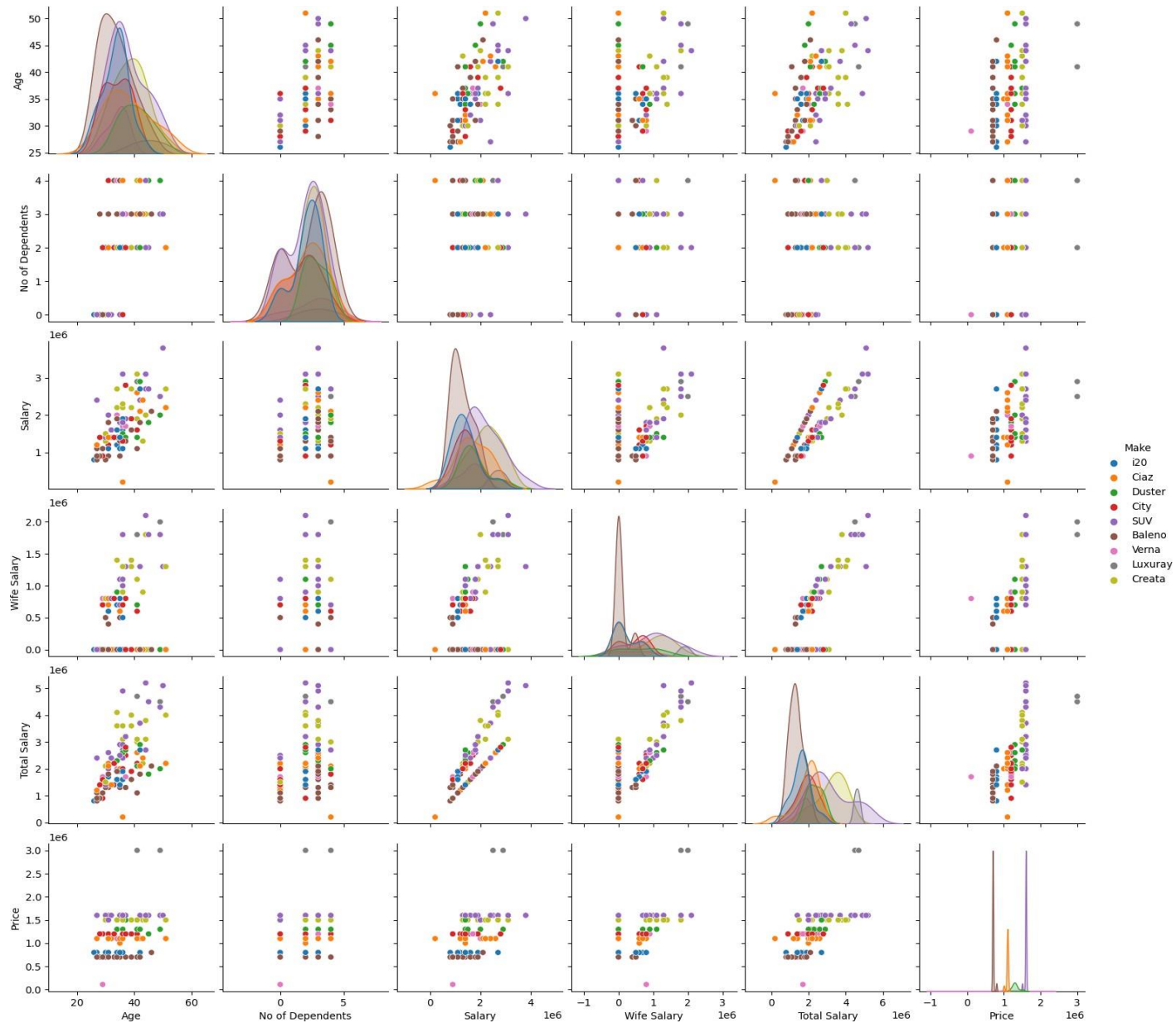
Above graph showing demographic analysis using various parameters.

To Improve Market segmentation project given additional time and additional data ML models I would like to try will be -

1.Sensitivity analysis

Sensitivity analysis was performed to determine which features significantly impacted the trained model. Thus, for each vehicle, the pre-trained model that was evaluated in previous

stages has once again predicted the number of vehicle sales with new input data, and its outputs have been assessed. All features, except the investigated feature, are valued at their average. For the investigated feature, the five values from the training data (the min value, the first quartile, the second quartile, the third quartile, and the max value) are taken into consideration. Five predictions were made based on these five values, and a range of changes in predicted sales was calculated. The change ranges for all features have been measured, and the four features with the most extensive range have been identified.

2.LSTM

Hochreiter and Schmidhuber introduced the LSTM network, a RNN capable of learning long-term dependencies and predicting sequential data with great accuracy. An LSTM is an extension of an RNN, capable of learning patterns from long sequences of source data by retaining a long-term memory. LSTMs improved the forgetfulness of RNNs. An RNN could retain a memory, but only for its immediate past. An LSTM, on the other hand, introduces loops to generate long-term gradients. While going through its loops, it can discover long-term patterns. LSTM is good at storing past information and performing well when faced with vanishing gradient issues.

Four features to create most optimal market segments will be -

1.Demographic segmentation

2.Geographic segmentation

3.Psychographic segmentation

4.Behavioral segmentation

All four points are mentioned above.Segmentation has been done keeping in mind all four points for better analysis and clarification.

Conclusion

This study addresses an important topic from a market segmentation perspective. Lower down the funnel, car dealers that operate in a highly competitive environment can strategize their sales events, marketing campaigns, and discounts to meet their business goals and target sales. This study used ML methods to develop a prediction model that estimated the sale of all cars in the

dataset, the share of EVs in each segment and identified the main factors affecting each EV's sales.