

## **PROJECT 2**

### **Market Segmentation Analysis of Electric Vehicle Market in India**



**Date of Submission: 27.06.2023**

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## 1.0 Overview

India is home to 1.4 billion people. India is also home to more than 210 million 2-wheelers and 70 million 4-wheelers. Almost all of which (99.5%) run on fossil fuel. This is a major cause of air pollution in urban areas.

- Typically, vehicular emission contributes 20-30% of Particulate Matter (PM) 2.5 at the breathing level of air quality in India. PM2.5 refers to particles that have a diameter less than 2.5 micrometers (more than 100 times thinner than a human hair) and remain suspended for longer. According to studies, vehicles annually contribute about 290 gigagrams (Gg) of PM2.5.
- At the same time, around 8% of total Greenhouse Gas (GHG) Emissions in India are from the transport sector, and in Delhi, it exceeds 30%.
- Carbon monoxide (CO) is a highly toxic, colorless, odorless gas that arises from the incomplete combustion of fossil fuels. This is highly detrimental to health as it affects the body's ability to absorb oxygen. Studies have found that in highly polluted cities like New Delhi, vehicular emissions are the primary source of CO, which most notably fell by nearly 86 per cent during the Covid-19 lockdown due to restrictions on vehicular movement.
- Nitrous oxide (NOx) arises from the high-temperature combustion of fossil fuels and further contributes to ozone depletion. Indian cities like New Delhi, Bangalore, Mumbai, and Kolkata have some of the highest sources of NOx in the country – linked exclusively to vehicular pollution. An excess amount of NOx gives rise to ground-level ozone. Although not directly emitted from transport, this deadly secondary gas is highly correlated with respiratory diseases and asthma upon creation.

From the above discussion we can realize that introduction of EV to the India market have become necessary. EV can help us get rid of all the problems related to Particulate Matter arising from vehicle in India as well as emissions harmful to nature.

The advantages of an EV are as follows:

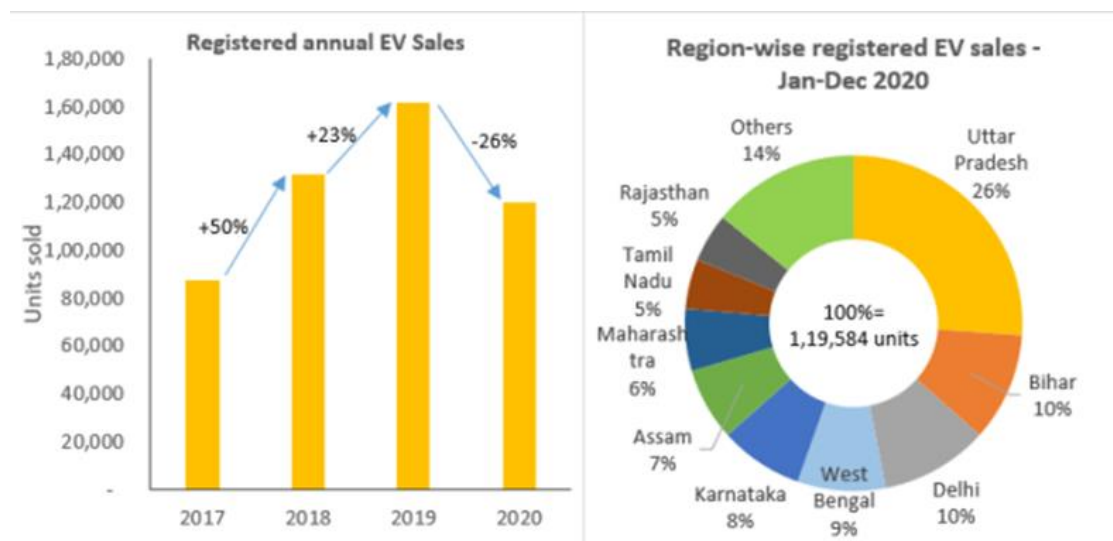
1. Cheaper to maintain: A battery powered electric vehicle has fewer moving parts than a conventionally fueled car. The servicing is easy, less frequent, and overall cheaper than a petrol/diesel vehicle.
2. Better for the environment: Harmful air pollution can be reduced from exhaust emissions by choosing to drive an EV. The reduced harmful exhaust emissions are good for human health too. The better air quality will lead to lesser health problems and costs.
3. Safe to drive: They undergo the same testing procedures test as other fuel-powered cars. An EV is safer to use, given their lower centre of gravity, which makes them more stable on the road in an accident

## 2.0 Market Overview

The Indian Electric Vehicle (EV) market has witnessed significant growth and development in recent years, driven by factors such as government initiatives, increasing environmental concerns, and the emergence of new players in the market.

One of the key segments driving the growth of the Indian EV market is two-wheelers. Electric scooters have gained significant popularity due to their affordability, low operating costs, and ease of maneuverability in congested urban areas. Several Indian and international companies have entered the two-wheeler EV space, offering a range of models at different price points. Companies like Hero Electric, Bajaj Auto, and Ather Energy have emerged as major players in this segment.

The electric four-wheeler segment is also gaining traction in India. Major automakers are introducing electric cars in the Indian market to cater to the growing demand. Tata Motors, Mahindra & Mahindra, and Hyundai are some of the prominent players in this space. The government's push for public transportation electrification has led to the adoption of electric buses in several cities. Ride-hailing companies like Ola and Uber are also focusing on adding electric cars to their fleets.



Charging infrastructure is a critical factor for the widespread adoption of EVs. The Indian government and private players are investing in expanding the charging network across the country. Public charging stations are being set up in major cities, highways, and parking facilities. Additionally, home charging solutions are becoming increasingly accessible to EV owners.

While the EV market in India is growing, there are still challenges to overcome. The high upfront cost of EVs remains a barrier for many consumers, although decreasing battery costs are expected to make EVs more affordable in the coming years. Limited charging infrastructure in certain areas and concerns over range anxiety are other factors that need to be addressed.

To promote domestic manufacturing and reduce dependence on imports, the Indian government has implemented policies to incentivize local production of EV components and batteries. This has encouraged investments from both domestic and international companies, leading to the establishment of manufacturing facilities and research and development centers in the country.

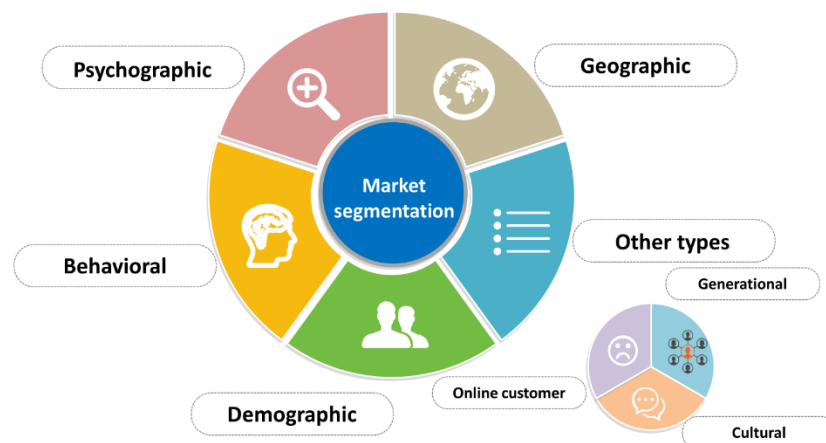
In conclusion, the Indian EV market is experiencing rapid growth, supported by government policies, environmental consciousness, and the entry of new players. With continued support from the government and increased investment, the Indian EV market has the potential to become one of the largest in the world, contributing to a cleaner and more sustainable transportation system.

### 3.0 Problem Statement

You are a team working under an Electric Vehicle Startup. The Startup is still deciding in which vehicle/customer space it will be developing its EVs. You must analyze the Electric Vehicle market in India using Segmentation analysis and come up with a feasible strategy to enter the market, targeting the segments most likely to use Electric vehicles.

Apart from geographic, demographic, psychographic, behavioral segments, teams can consider different category of segments for the Segmentation Tasks, based on the availability of data. Market Segmentation comes with a wide scope of possibility and segments created can change based on different datasets collected.

#### Bases for segmenting consumer markets



The team can work with multiple datasets to tackle the problem statement and even non-domain datasets can help you answer some of the demographic, psychographic, behavioral questions. Interns can collect datasets from government, or freely available sources after breaking down the problem statement using Fermi Technique and deciding which datasets will be most optimal to tackle the problem at hand.

#### 4.0 Government initiative and policies supporting the EV industry

The government of India is continuously showing its support to develop India as a global leader in the EV sector. Several schemes and incentives have been launched by the government to boost the demand for electric vehicles as well as motivate manufacturers to invest in the R&D of electric vehicles and related infrastructure.

To promote the adoption of EVs, the Department of Heavy Industry formulated a FAME India Scheme (Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles in India) in 2015.

The government has launched the following initiatives to promote EVs in India, they are as follows:

- They proposed the exemption of registration fees for battery operated/electric vehicles to promote eco-friendly vehicles in the country.
- Under the new GST system, GST on EVs is reduced from 12% to 5% against the 28% GST rate with up to 22% for conventional vehicles.
- The Ministry of Power has also allowed the sale of electricity as a 'service' for electric vehicles charging. It will attract investors into the charging infrastructure.
- Also, the government has granted an exemption to battery-operated transport vehicles and vehicles that run on methanol and ethanol fuels from the requirements of the permit.
- The Ministry of Road Transport and Highways has allowed 16-18 years to obtain driving licenses to drive e-scooters.

The Indian government has devised many Electric Car policies such as National Electric Mobility Mission Plan, FAME-I and II, National Mission for Transformation Mobility and Battery Manufacturing, The Phased Manufacturing Program, Advanced Chemistry Cell Production Linked Incentive Scheme to give the required boost to the sector. Below are some of the policies and subsidies for EVs

1. To boost electric mobility in India, the government has announced its plan to support 15.62 lakh electric vehicle through subsidies

To boost **electric** mobility in the country the Government of India **has announced its plan to support 15.62 lakh electric vehicle through subsidies**. ... In his speech, Gadkari also said that **the government** also **plans to support the** creation of charging infrastructure to address range anxiety among users of **electric vehicles**. 12-Feb-2021

2. The Union Minister for Road Transport and Highways (MoRTH), announced in Parliament that phase-II of the FAME India scheme is being implemented with total budgetary support of 10,000 crores. With this, the government has planned to support about 62,000 electric passenger buses and cars and 15 lakhs electric three- and two-wheelers in India. Mr. Nitin Gadkari said that if Elon Musk-led company in India talks about making its EV in the country, the India is ready to give incentives to reduce the cost of production of Tesla.

**India is ready to offer incentives to ensure Tesla Inc's cost of production would be less than in China if the carmaker commits to making its electric vehicles in the south Asian country**, transport minister **Nitin Gadkari** told Reuters. 03-Mar-2021

<https://www.indiatoday.in> › Auto › Latest Auto News

### 3. Indian Electric Car Policy 2020

Mumbai: **Electric two-wheeler penetration in India is expected to reach 25-35 per cent and that of e-three-wheelers at 65-75 per cent by 2030** even as OEMs and both central and state governments need to work collaboratively for an integrated policy and creating a conducive ecosystem for EV adoption in the country, a ...

So, these were some of the government initiatives and policies that have been taken to promote electric vehicle companies and their manufacturers to make many electric vehicles in India. As the Government of India is claiming to reach all-electric vehicle in India by 2050 and 40% of total fleets by 2030.

India has a lot to gain by converting its ICE vehicles to Electric vehicles at the earliest. Its oil-import bill would considerably reduce. ICE vehicles are a significant contributor to pollution in cities, and their replacement with EVs will improve air quality. There is a possibility that we can become leaders in small and public electric vehicles.

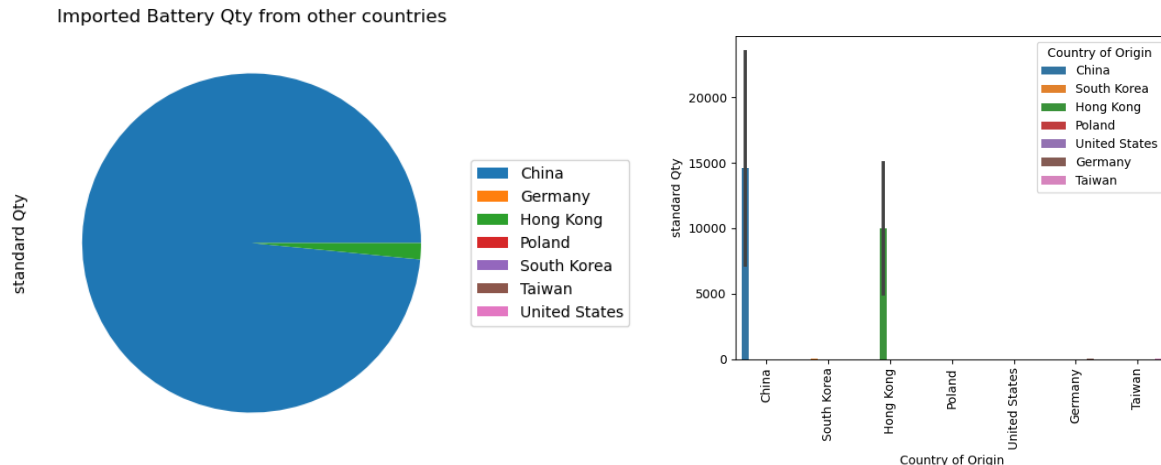
However, this would require innovations, a policy regime that encourages access to the latest technologies. and some effort by the Indian industry to achieve global competition by acquiring the necessary scale and cutting-edge technology for the EVs Industry.

## 5.0 Market Challenges

Companies and industries have to overcome some obstacle to capitalize on the market entirely. Here are some of the obstacles to adopt an EV in India, they are as follows:

1. Rang anxiety: EV customers are often worried about the vehicle's capability to reach the destination before the battery dies out and the absence of charging infrastructure. The charging infrastructure is considerably weak in rural or sparsely populated areas.
2. Consumer Protection: While the technology is still relatively new and is being accepted more day by day, the repair and maintenance network is still very minuscule compared to ICE vehicles. The lack of people skilled in EV maintenance is one of the major causes of this challenge.
3. High Initial Cost: Electric vehicles are initially very expensive compared to ICE cars.
4. Scarce Battery Technology: The number of OEMs manufacturing batteries from raw materials in India is very tiny. Coupled with the fact that the country lacks certain minerals (cobalt and lithium) to produce a battery, it negatively impacts the country's ambition to become an EV hub.

As mentioned above, one of the major problems for the Electric Vehicle (EV) industry in India is that there are not enough EV batteries being made in the country. India imports a lot of batteries from other countries to use in their electric vehicles.



The graph clearly indicates that India heavily relies on Chinese and Korean manufacturers for importing Lithium-ion batteries. This dependency on batteries significantly affects the cost of EV products for existing companies. To reduce the cost of the product, it is crucial to minimize the cost of batteries. Additionally, India faces a major market challenge in the form of inadequate charging stations for electric vehicles.



## 6.0 Data Sources

To investigate the EV market in India, data was gathered from multiple websites using web scraping techniques, such as BikeWale, CarWale, CarDekho and from various other sources such as government websites, Kaggle, GitHub etc. We have considered multiple datasets for the analysis. The links to the source of data is given below.

- <https://pib.gov.in/PressReleasePage.aspx?PRID=1842704>
- <https://morth.nic.in/national-highway-details>
- <https://pib.gov.in/PressReleasePage.aspx?PRID=1910392>
- <https://www.moneylife.in/article/12-percentage-of-indias-petrol-pumps-are-in-uttar-pradesh-alone-union-govt/66331.html>
- <https://pib.gov.in/PressReleasePage.aspx?PRID=1882098>
- <https://evreporter.com/q1-fy-2022-23-region-wise-ev-sale-trends-in-india/>
- <https://www.volza.com/p/ev-battery/import/import-in-india/hsn-code-85076000/>
- <https://www.kaggle.com/datasets/karivedha/indian-consumers-cars-purchasing-behaviour>
- <https://www.carwale.com/>
- <https://www.bikewale.com/>

The following are the datasets:

D1. This dataset has a detailed information of customer reviews for E4W

	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

D2. This dataset has a detailed information of customer reviews for E2W

	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

D3. This dataset contains comprehensive information about the market share of the leading electric vehicle manufacturers and their corresponding prices

	Product	Market type	Body	Production type	Market share(%)	Price(lakh)	Battery(kWh)	Range(km)
0	Tata Nexon Ev	Mass-market	SUV	Local	63.00	15.00	30.2	312
1	Tata Tigor Ev	Mass-market	sedan	Local	24.00	12.50	26.0	315
2	MG EZ5	Mass-market	SUV	CKD	11.50	23.38	50.3	419
3	Hyundai Kona	Mass-market	SUV	CKD	0.59	24.00	39.2	452
4	Mahindra E-Verito	Mass-market	sedan	Local	0.36	16.00	34.5	375

D4. This dataset has a detailed information on the buying behavior and other factors that affect the probability of buying and 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

D5. This dataset contains the information about the EV batteries imported from abroad

	produc Info	standard Qty	Country of Origin	Country of destination
0	BATERIA,INCELL,SP48-33-100S-SC, BATERIA DE LIT...	2	Mexico	Peru
1	House Battery EV BATTERY	110	Turkey	Sudan
2	24V 230 AH Lithium Eve Energy , 48V 100 AH LF...	2	Turkey	Turkey
3	BMZ BATTERY 168S01P EV 618V 94AH 58KWH (SER...	1	Poland	Turkey
4	BATTERY >> LITHIUM-ION BATTERY EV MODULE 4878-...	12	China	India

D6. This dataset contains information about the distribution of the Charging station in different states and National Highways.

State Name	Total EV	No. of Operational PCS	No of RO's where EV Charging Facility available	Number of highways through state	Number of Highway through state with PCS	Total PCS on the highways passing through state	No. of EV chargers sanctioned	Number of Operational Petrol pumps	Total Non-Electric Vehicle
Andaman & Nicobar	169	3	0	1	0	0	10	17	146945
Andhra Pradesh	30449	222	65	36	10	53	266	4168	0
Arunachal Pradesh	21	9	4	13	4	12	0	159	252965
Assam	82216	48	19	35	6	34	20	1243	4677053
Bihar	110325	83	26	47	4	7	37	3276	10407078

## 7.0 Data Preprocessing

### 7.1 Libraries

The libraries used for data analysis are as follows:

1. NumPy:  
NumPy stands for Numerical Python; it is an open-source library for Python programming. It is used for data manipulation and preprocessing tasks, such as handling missing values, reshaping data, and applying mathematical operations.
2. Pandas:  
Pandas is a widely used library for data manipulation and analysis. It provides data structures like DataFrames, which are efficient for handling structured data. High-performance merging and joining of data sets, data alignment and integrated handling of missing data are some of the fancy things.
3. Matplotlib:  
Matplotlib is a cross-platform, data visualization and graphical plotting library (histograms, scatter plots, bar plots, etc.) for Python and its numerical extension NumPy which helps us to understand trends, patterns, and to make correlations.
4. Seaborn:  
Seaborn is a library that uses Matplotlib underneath to plot graphs. It will be used to visualize random distributions.
5. Scikit-learn:  
Scikit-learn also known as sklearn, is an open-source data analysis library, and the gold standard for Machine Learning in the Python ecosystem. It provides classes and functions for feature extraction, feature scaling, dimensionality reduction, data normalization, and handling categorical variables.
6. SciPy:  
SciPy provides additional functionality for scientific and technical computing, including data preprocessing tasks such as signal processing, statistical functions, interpolation, and optimization.

### 7.2 Steps

Data preprocessing involves the following steps:

1. Initially the dataset was processed and cleaned to make it suitable for clustering.
2. The raw form of the data is shown below which is then processed and transformed into proper format for our usage. The steps can be summarized as follows:

State Name	2WN	2WT	2WIC	3WN	3WT	LMV	LPV	LGV	4WIC	MMV	MPV	MGV	HPV	HGV	OTH	Grand Total
Andaman & Nicobar Island	2	5.0	NaN	NaN	30.0	86	6.0	NaN	NaN	NaN	NaN	NaN	40.0	NaN	NaN	169
Andhra Pradesh	27629	NaN	2.0	374.0	108.0	1050	3.0	166.0	NaN	NaN	NaN	NaN	NaN	NaN	1117.0	30449
Arunachal Pradesh	14	NaN	NaN	NaN	NaN	6	1.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	21
Assam	2287	NaN	NaN	NaN	79661.0	233	5.0	15.0	NaN	NaN	NaN	NaN	15.0	NaN	NaN	82216
Bihar	13472	NaN	NaN	2.0	96560.0	231	8.0	21.0	1.0	NaN	NaN	1.0	27.0	2.0	NaN	110325

State Name	No. of Operational PCS
Andaman & Nicobar	3
Andhra Pradesh	222
Arunachal Pradesh	9
Assam	48
Bihar	83

State/UT	No of RO's where EV Charging Facility available
Andhra Pradesh	65
Arunachal Pradesh	4
Assam	19
Bihar	26
Chandigarh	4

NH	State
1	Jammu and Kashmir
301	Jammu and Kashmir
501	Jammu and Kashmir
701	Jammu and Kashmir
2	Assam

National Highway	No. of operational PCS
National Highway-10	1
National Highway-11	3
National Highway-128	1
National Highway-13	3
National Highway-130	1

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

States	Number of Operational Petrol pumps in the country as on 01.01.2022
Andhra Pradesh	4168
Arunachal Pradesh	159
Assam	1243
Bihar	3276
Chhatisgarh	1903

- Among all the datasets, states names are made consistent.
- The 'State Name' and 'Grand Total' column of the topmost data set in figure below is used among all the other variables for current study where 'Grand Total' denotes the total number EV in that state.
- An outer join is performed among all the datasets using 'State' like variable in the datasets except the rightmost dataset of second row and leftmost dataset of third row.
- New variables like 'No. of Highways through state', 'No. of Highways through state with PCS' and 'Total PCS on highways passing through state' is created using rightmost dataset of second row and leftmost dataset of third row and joined with the previously created dataset using 'State' like column.
- Null values are observed in some rows which are taken care of in accordance to the variable we are dealing with.

The final data which is used for the market segmentation is shown in 'Data Sources D6'. This dataset is generated to understand the one aspect of geographic segment for EV market which is distribution of the Charging Station in different states and National Highways.

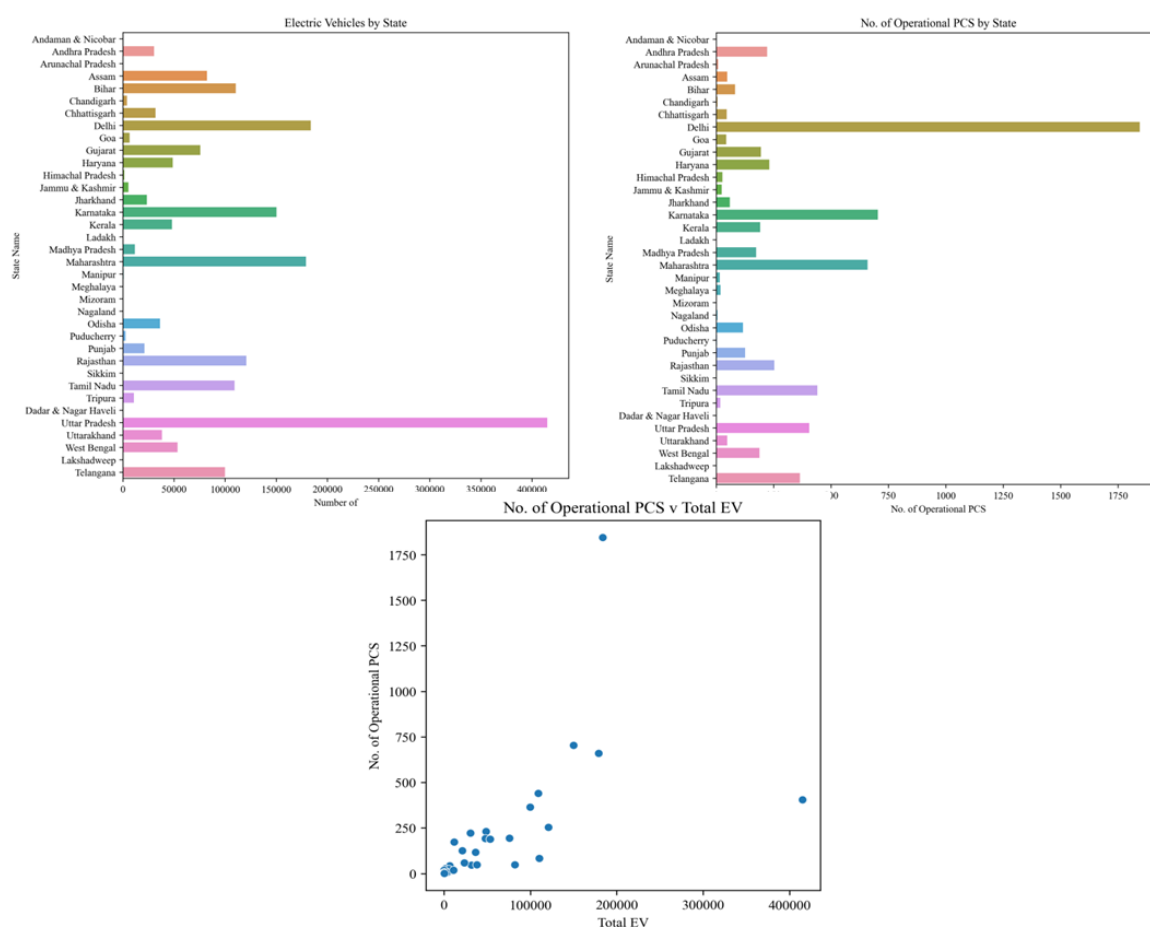
3. Converting necessary categorical columns in the dataset into numerical columns.
4. Relevant variables were encoded using LabelEncoder to ease the formation of clusters.
5. Applying normalization using MinMax Scaler or standardisation using Standard Scaler to necessary columns.

## 8.0 Exploratory Data Analysis

### 8.1 Geographical Analysis

#### State wise total EV analysis

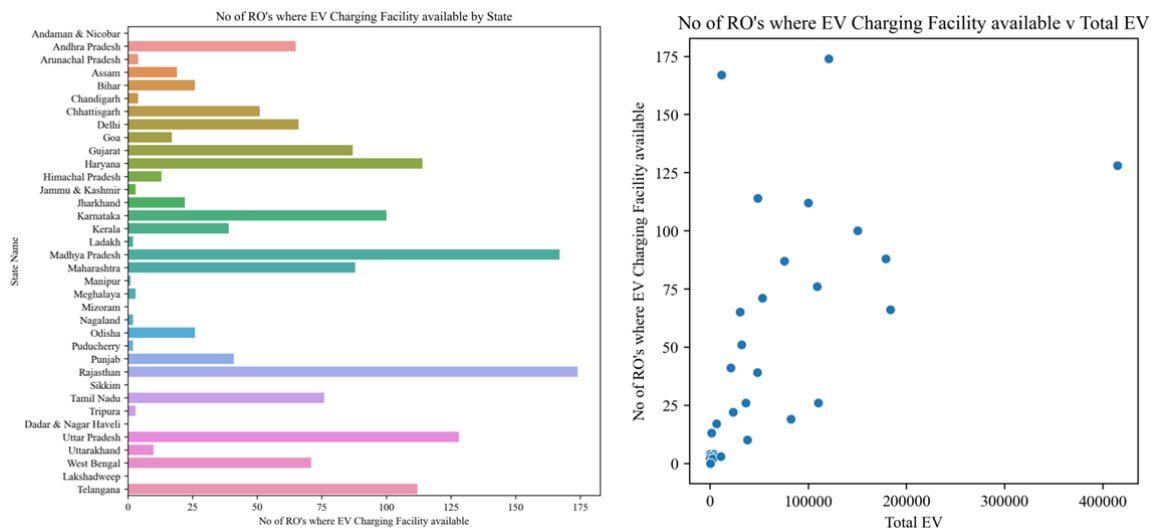
The following two graph depicts the overall number of Electric Vehicles in each state and the number of operational Public Charging Station (PCS) by state. A scatter plot is also shown for the same by taking the number of Electric Vehicles and the number of Public Charging Station.



**Observation:** The states with the highest number of electric vehicles are Uttar Pradesh, Delhi, Maharashtra, Karnataka, and Rajasthan. Whereas, Delhi is the only state with the highest number of public charging stations followed by Karnataka and Maharashtra.

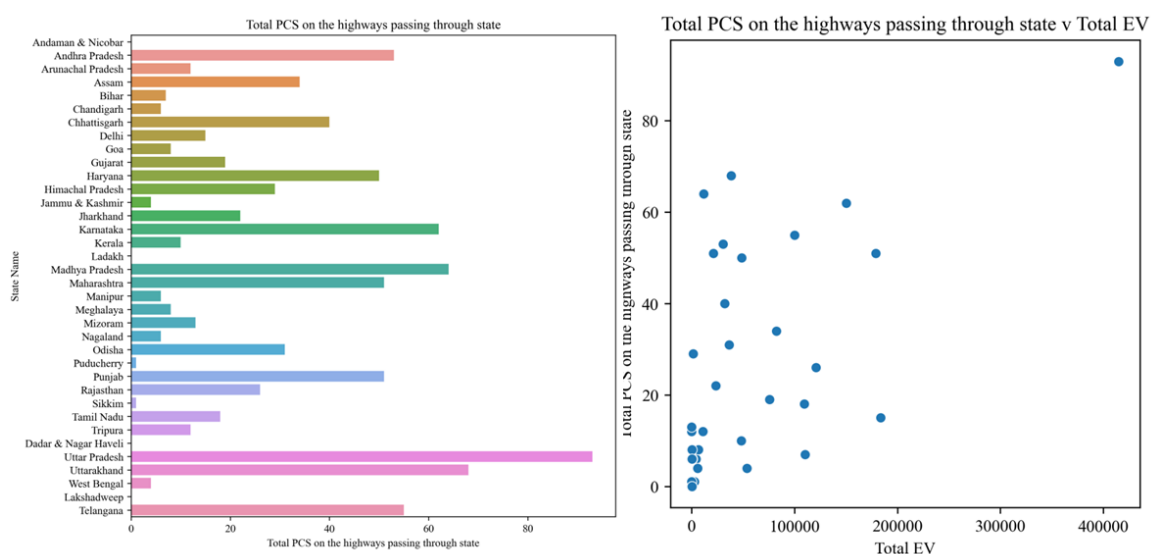
From the scatter plot, it can be deduced that there is a positive correlation between these two variables, which turn out to be 0.60 with p-value less than 0.05

Now, the number of RO's where the EV Charging Facility is available by state is shown below in a bar plot along with that a scatter plot for the same.



**Observation:** The plot suggests that there is a positive correlation between the number of RO's where EV Charging Facility available and the Total EV. The correlation value turns out to be 0.60 with p-value less than 0.05.

Now, for this study a special variable has been created which is called Total PCS (Public Charging Station) on highways passing through state. This variable is expected to capture that which states have better connectivity with other state via Public Charging Station. If one state does not have too many PCS on their highway then that state might not become lucrative for EV. The Total PCS (Public Charging Station) on highways passing through state is shown in a bar plot and a scatter plot with respect to Total EV is shown in the Figure 5.



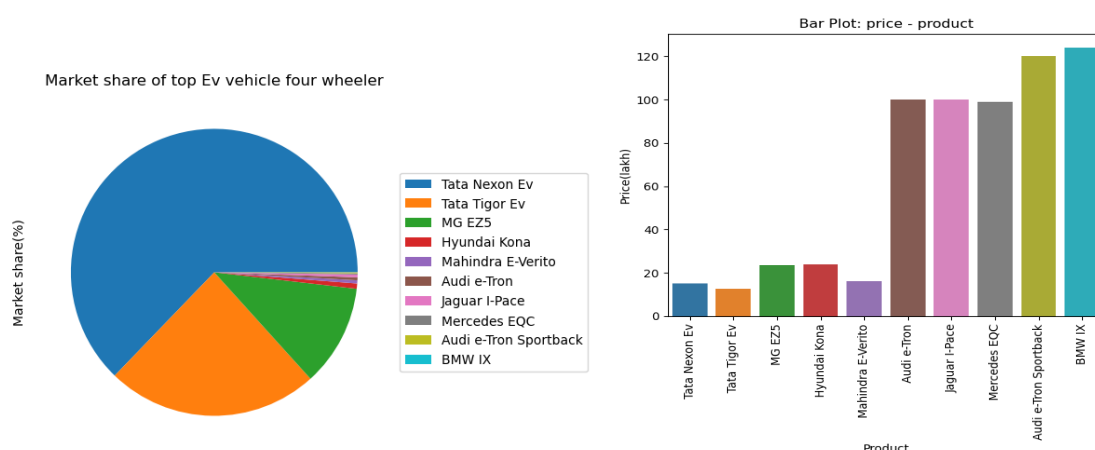
**Observation:** The scatter plot indicated a positive correlation among the Total PCS (Public Charging Station) on highways passing through state and the Total EV.

The calculated correlation value turns out to be 0.59 with p-value less than 0.05. We can say that variables like number of Public Charging station, No. of RO's where EV Charging Facility available, Total PCS on highways passing through state have positive relation with number of Total EV in State.

## 8.2 Demographic Analysis

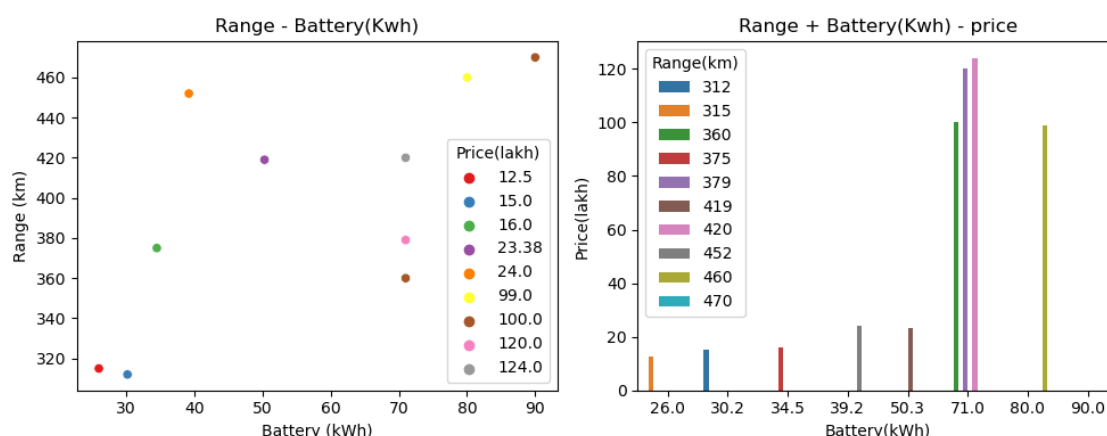
### Analysis of the market share of the leading EV models and strategy formulation

The graph below illustrates the market share of the top EV models for the fiscal year 2021-22



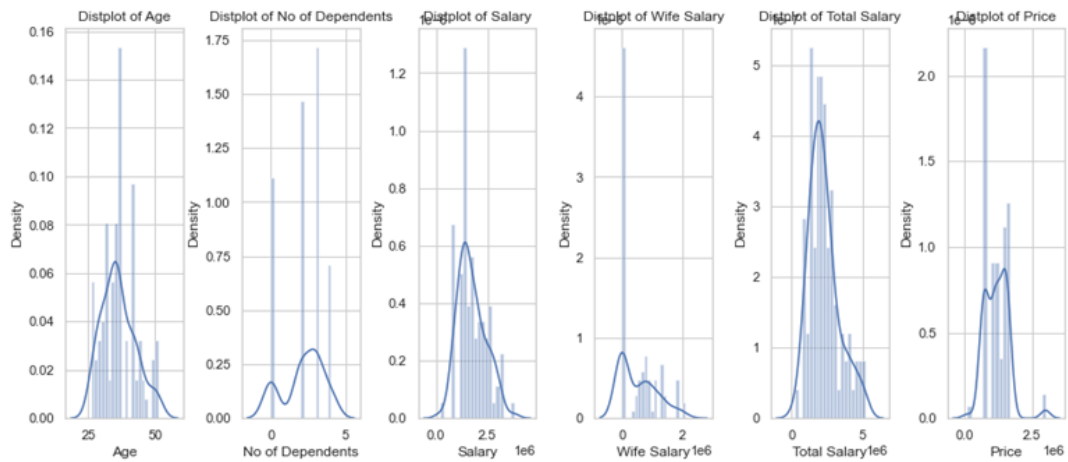
**Observation:** Based on the first graph, it can be observed that Tata Nexon EV and Tata Tigor EV have market shares exceeding 50%. On the second graph, it is evident that both vehicles are priced lower than other products in the market.

### Visualizing the product with respect to battery and range according their price.



**Observation:** Based on the analysis of the two graphs provided, it is evident that the successful EV products in the market are priced in the low to medium range, typically ranging from 12 to 20 lakh. Furthermore, these products have a battery capacity ranging from 30 to 45 kWh and offer a range of 360. We can consider incorporating these findings into our EV startup strategies.

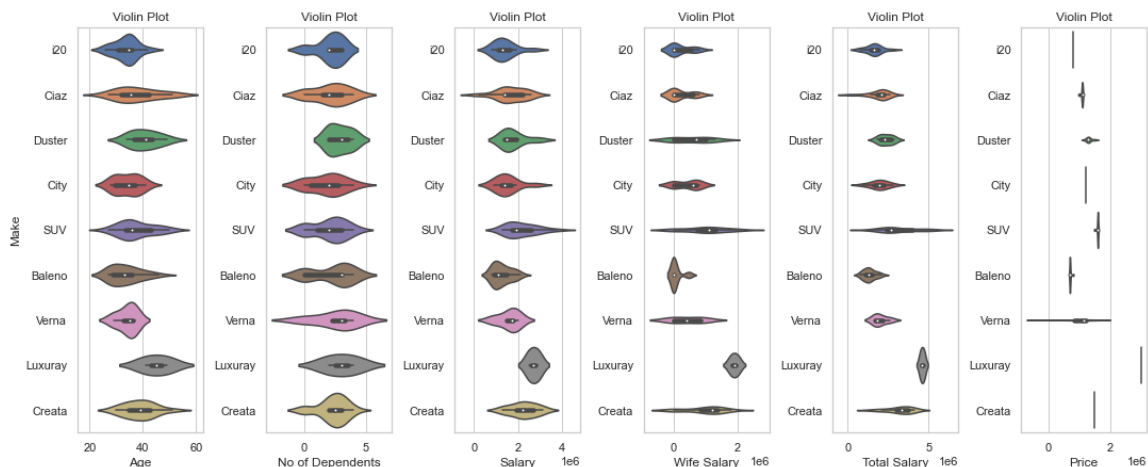
### Visualizing different variables that affect the buying behavior



**Observation:** Here are the following conclusions that can be made from above:

1. The age group between 25-50 has the highest density
2. Most of the people have a total salary of 25 lakhs
3. Wives of most of the people are unemployed
4. Most people spent around 10 to 20 lakhs for cars

### Effect of the given factors on decision making (purchase of a car)





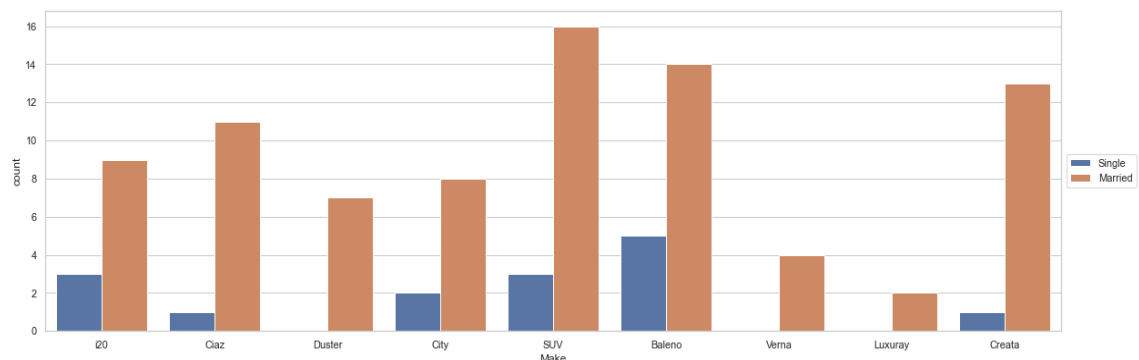
### Observation:

Age: Younger people have a smaller number of dependent's, less salary, and are single so they are not usually our target segment but they are most likely to buy electric vehicles. The price range for the younger target segment is below 10 lakhs.

Number of Dependent's: The more the number of dependent's, the bigger the need of cars for transportation, here SUVs are preferred for higher target segments.

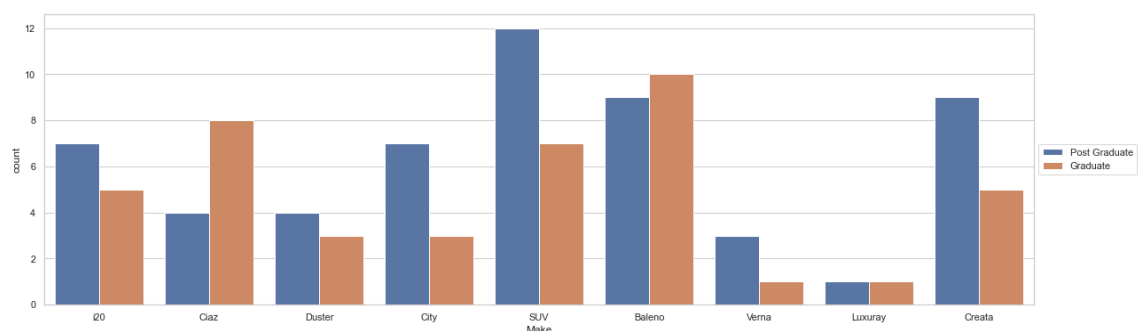
Salary: Different demographic has different people of different salaries. This is the main thing we should consider while segmenting the market based on a 4-wheeler and 2-wheeler automobiles as people with a higher salary are more likely to purchase a 4-wheeler.

### Relation between customers marital status and the vehicles they purchase



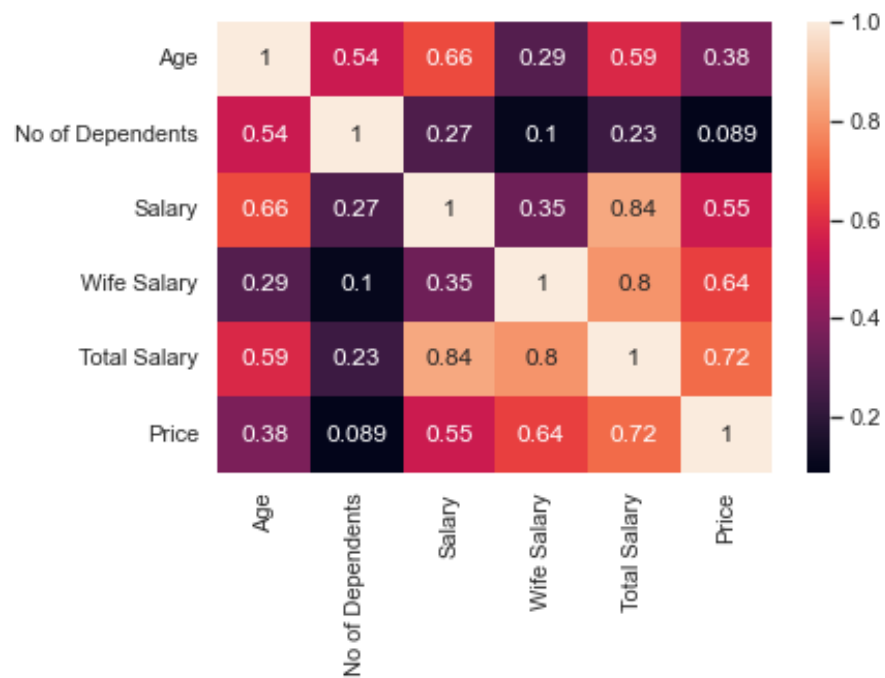
**Observation:** We observe that married people are more likely to purchase an EV

### Relation between customers education status and the vehicles they purchase



**Observation:** Both Post Graduates and Graduates have an equal probability of buying an electric vehicle.

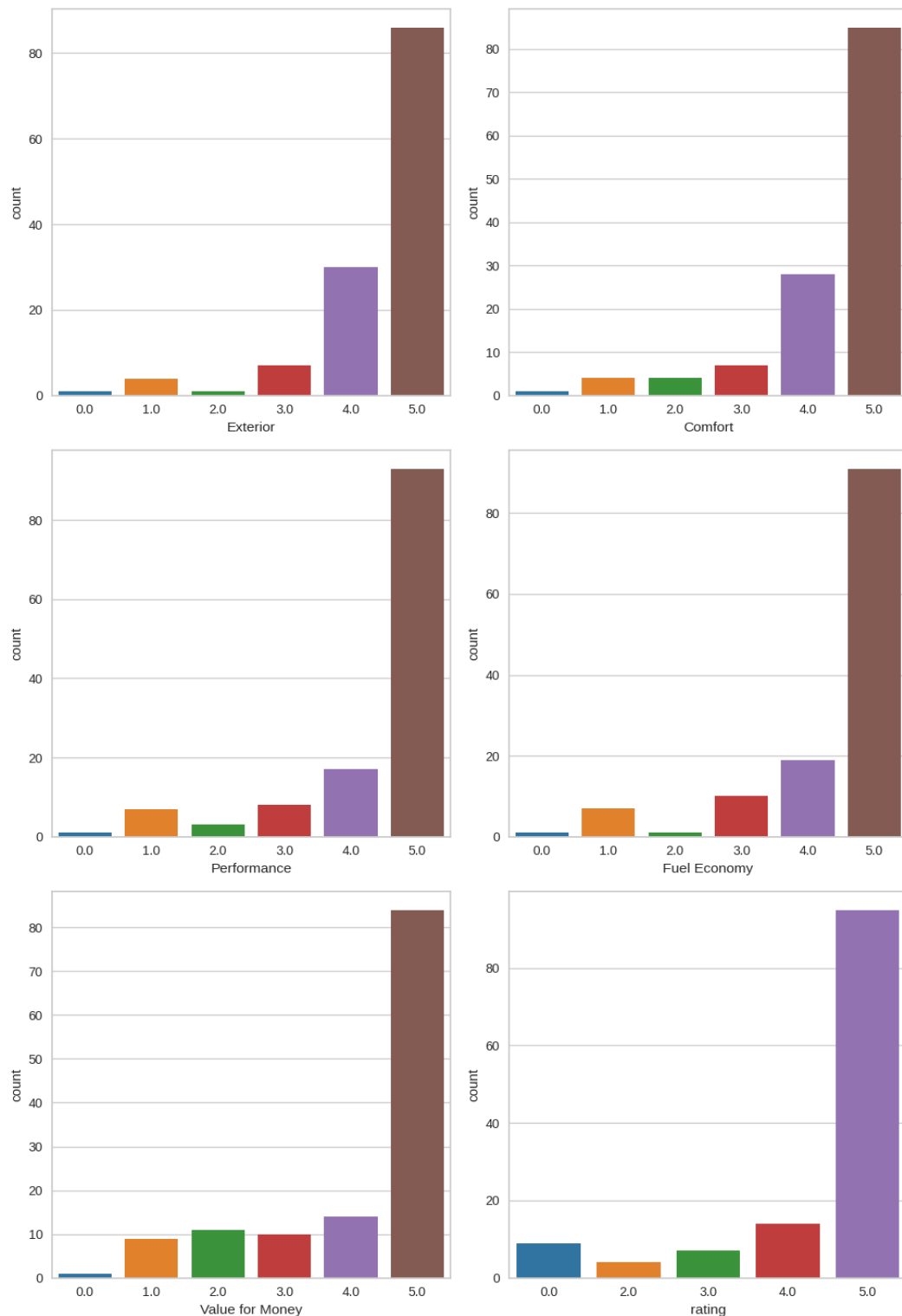
### Dependency of these variables on one another



**Observation:** This correlation plot shows how the variables are dependent on one another which is a major factor in clustering

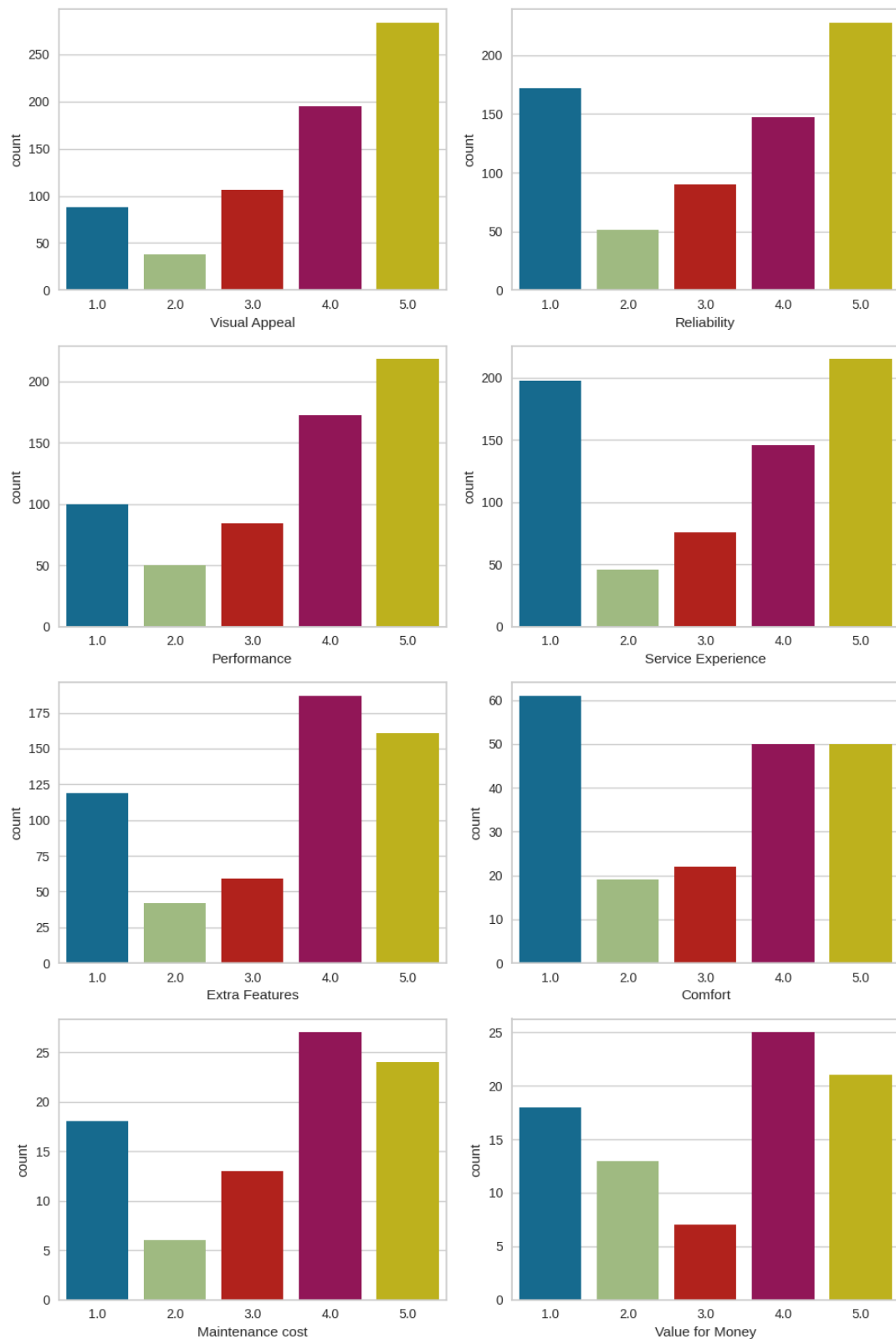
### 8.3 Psychographic Analysis

Analyzing all the preferences and reviews of users on various aspects for E4W



**Observation:** People seem to be very positive regarding the Exterior, Comfort, Performance, Fuel Economy and consider an EV as a Value for Money

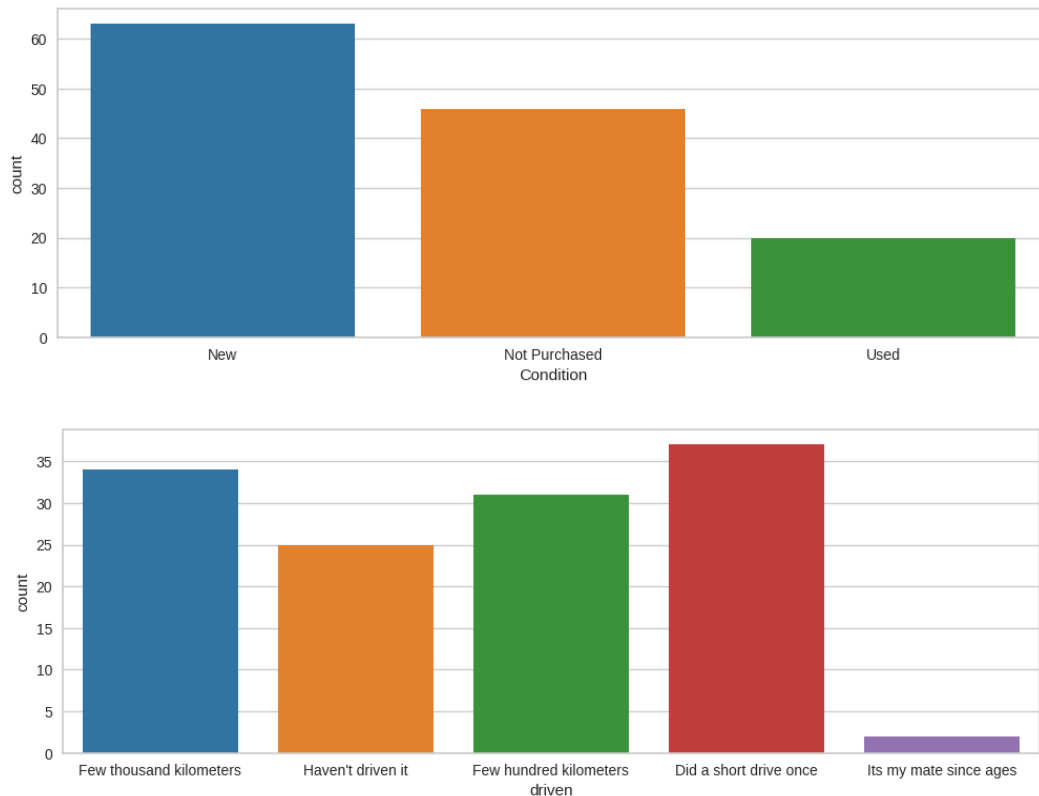
### Analyzing all the preferences and reviews of users on various aspects for E2W



**Observation:** People seem to be positive regarding the Visual Appeal, Performance and Extra Features, they have provided negative reviews regarding the Comfort and mixed reviews regarding the Reliability, Service Experience, Maintenance cost. Some of the users consider E2W as Value for Money, while some do not.

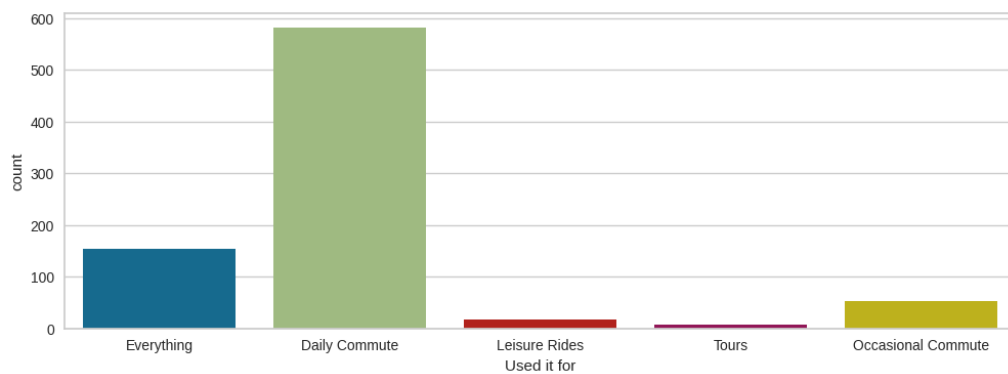
## 8.4 Behavioral Analysis

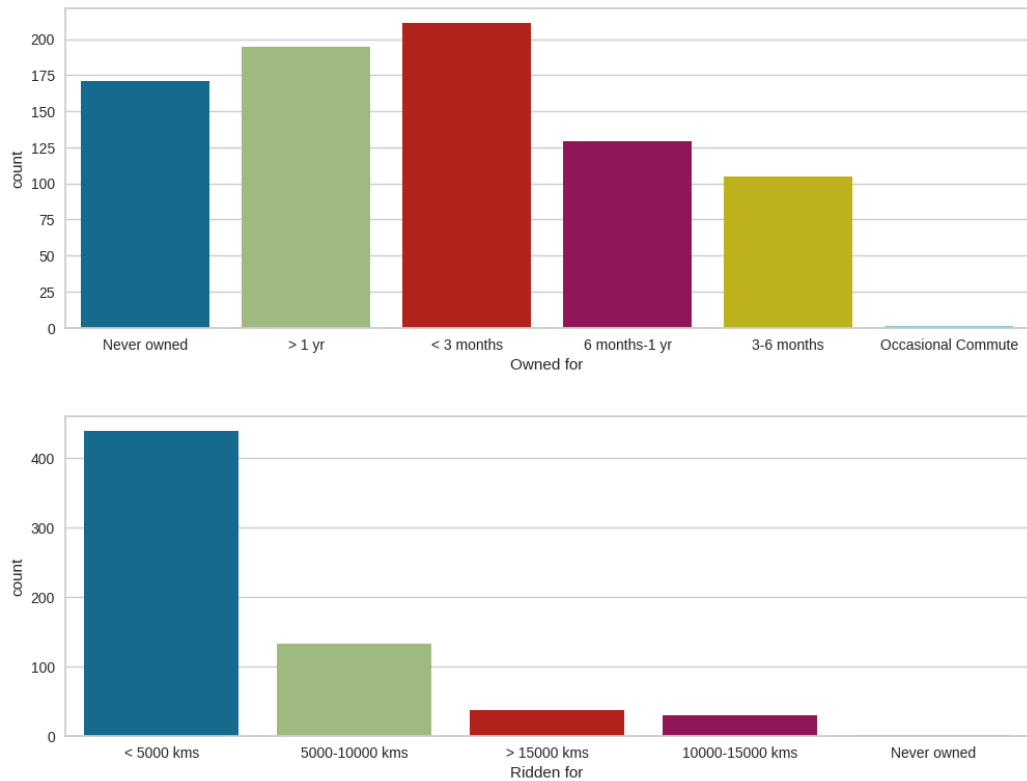
### Analyzing the behavioral aspect of users for E4W



**Observation:** From the first graph, it can be observed that most of the users have a new E4W. The second graph tells us that most of the users did a short drive once, while some of them drove few thousand kilometers.

### Analyzing the behavioral aspects of users for E2W

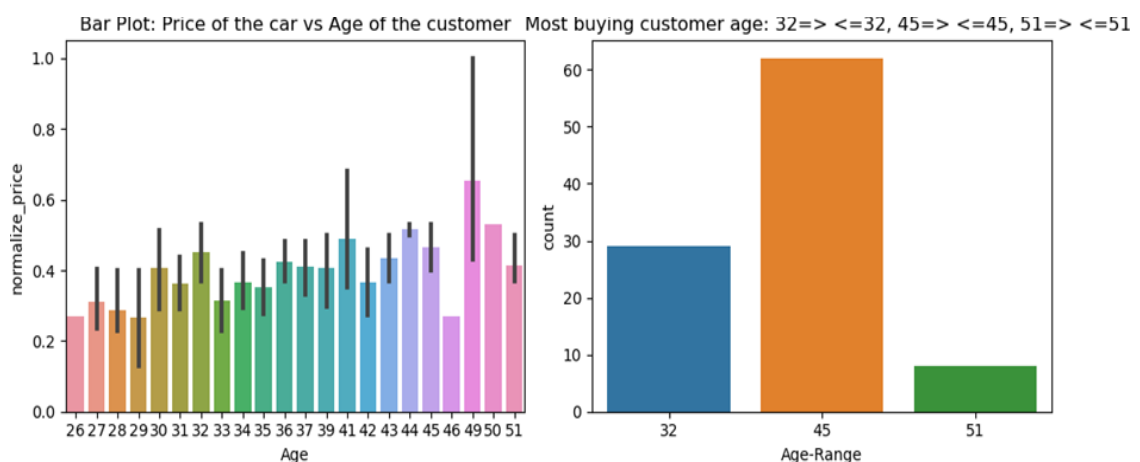




**Observation:** From the first graph, it is evident to say that most users use an E2W to commute daily. The second graph tells us that most of the users owned an EV for less than 3 months, greater than a year, while some of them did not even own an EV. Lastly, most of the users drove over somewhat less than 5000kms.

### Target Customers

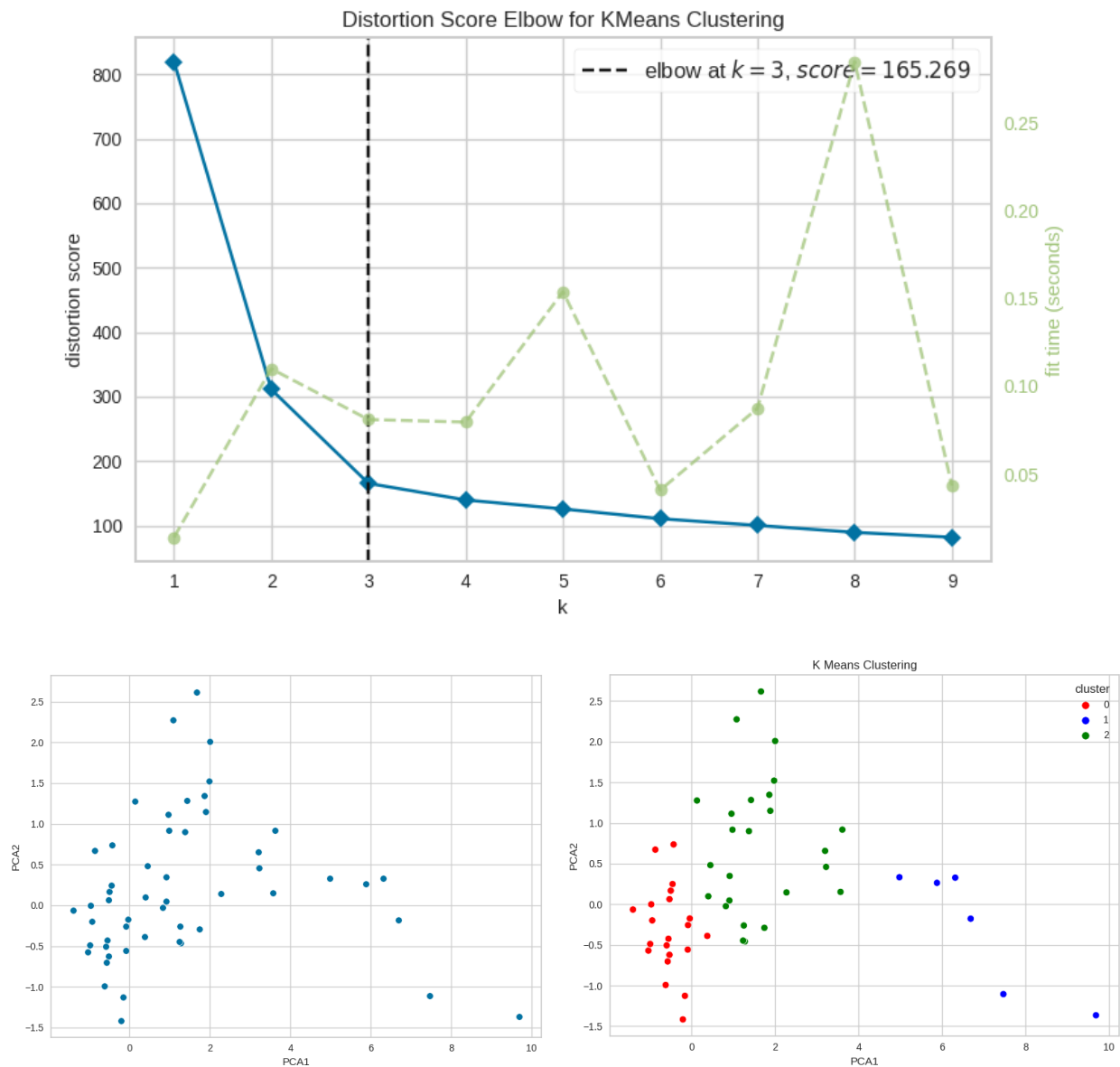
It contains the information about the buying customer, the below graph represents the relationship between the Price of the product and Age of the customer.



**Observation:** Individuals in their late 20s to early 40s show a higher inclination towards purchasing electric vehicles as compared to other age groups.

## 9.0 Segment Extraction & Analysis

### Using KElbowVisualizer for E4W dataset



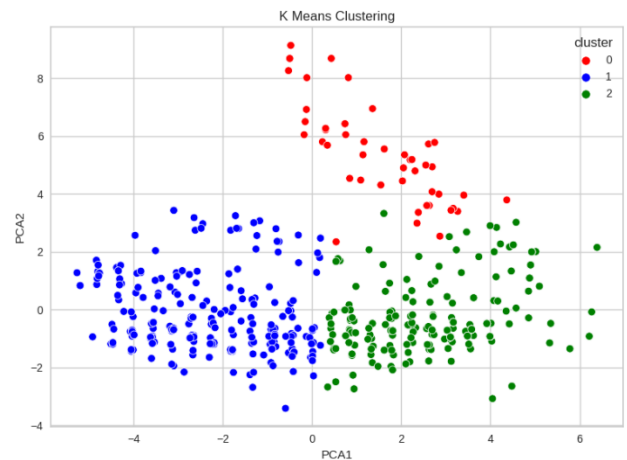
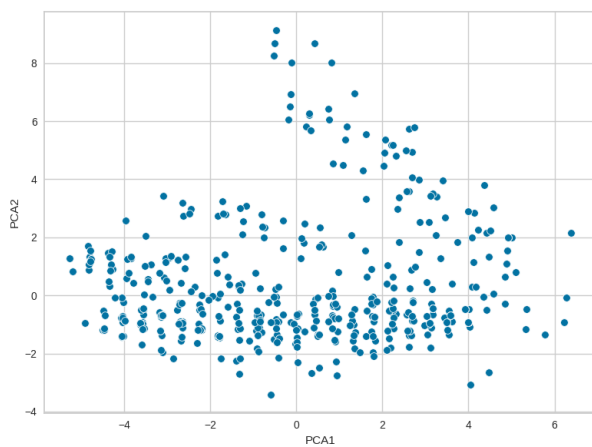
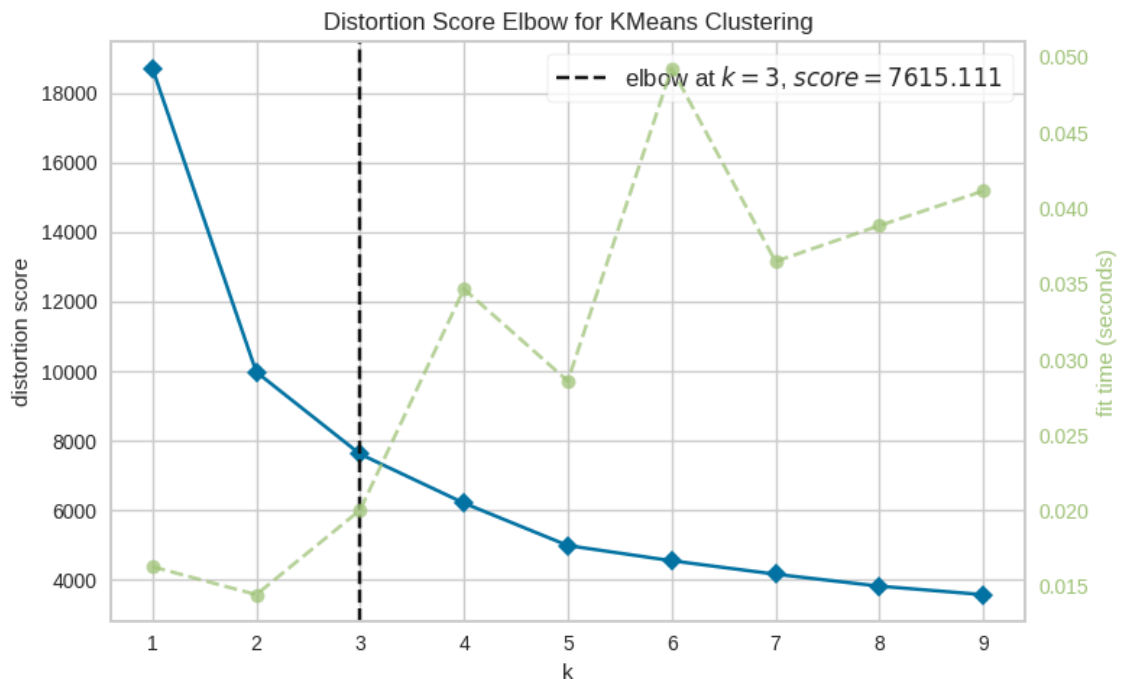
**Observation:** It appears that there is an elbow at  $k = 3$  clusters.

Cluster 0: This cluster contains users with excellent reviews for all the attributes and most of them have new EV's.

Cluster 1: This cluster contains users with negative reviews for all the attributes and most of them have new EV's.

Cluster 2: This cluster contains user who are satisfied with the Exterior and Comfort but have mixed reviews for all the other attributes and most them have not purchased an EV. In my opinion, this is the segment that a company can target easily and change their perception they have towards an EV.

### Using KElbowVisualizer for E2W dataset



**Observation:** It appears there is an elbow at  $k=3$  clusters.

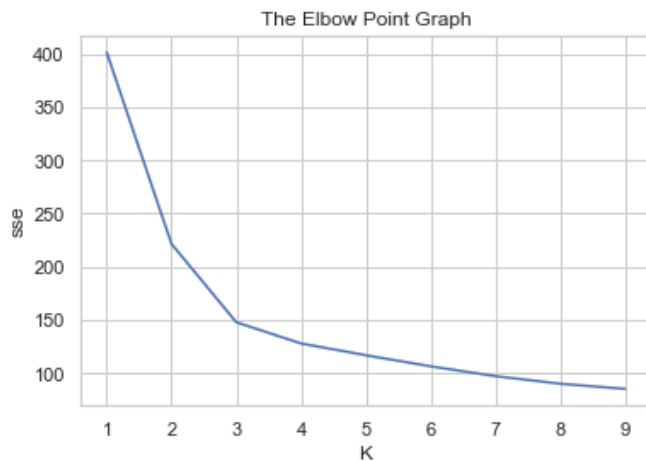
Cluster 0: This cluster contains users who are satisfied with the Visual Appeal, Reliability, Service Experience, Maintenance cost and consider an E2W Value for money, but they have negative reviews regarding the Comfort, Performance and Extra Features.

Cluster 1: This cluster contains users who are satisfied with the Visual Appeal, Reliability, Service Experience, Performance and Extra Features, but they have negative reviews regarding the Maintenance cost, Comfort and do not consider an E2W Value for Money.

Cluster 2: This cluster contains negative reviews for all the attributes

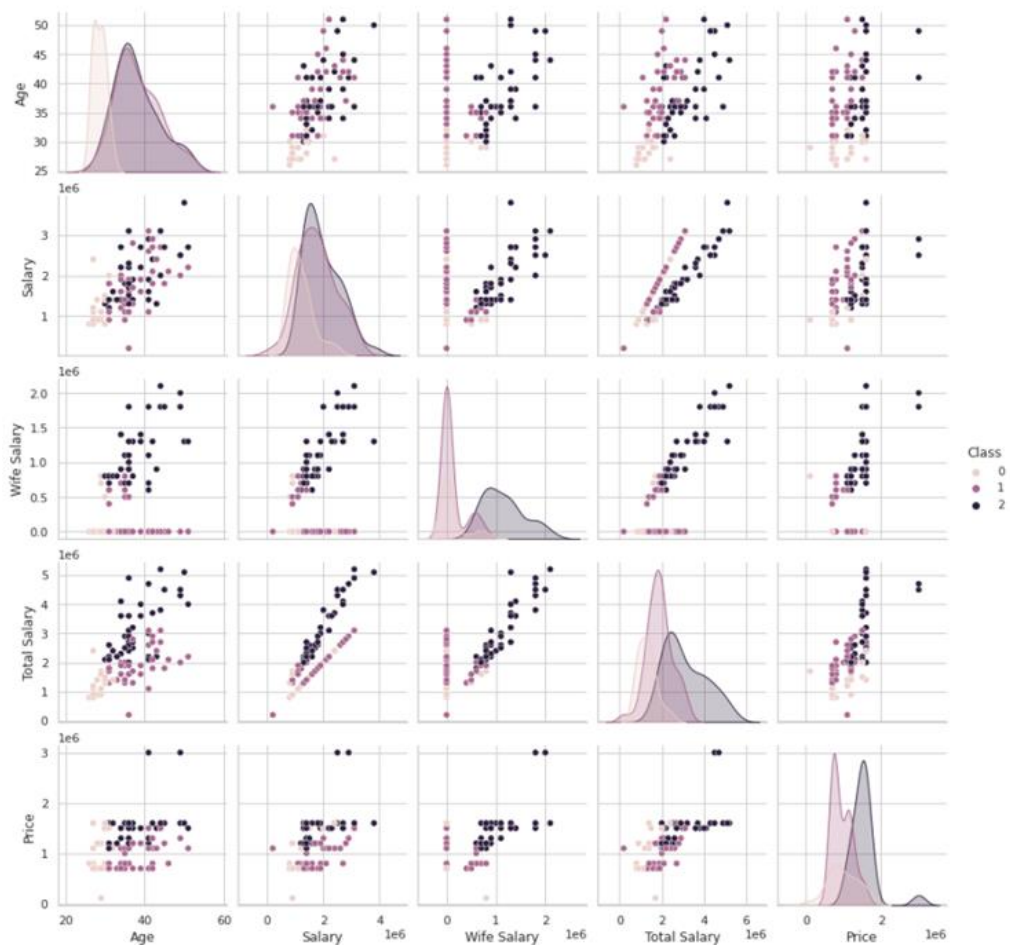


## Using Elbow Method for customer buying behavior dataset



We are trying to find the optimal K value using the Elbow Method wherein we will be finding the Within Cluster Sum of Square (WCSS) and try to find the point where it rapidly decreased which makes the graph look like an 'elbow' there. The K value corresponding to that point is the optimal K value. Hence, there are 3 clusters.

While looking into the clustered dataset, we were able to find 5 attributes that contributed most to the clustering (i.e., Age, Salary, Wife Salary, Total Salary, and Price). This can be seen in the pair-plot done below-



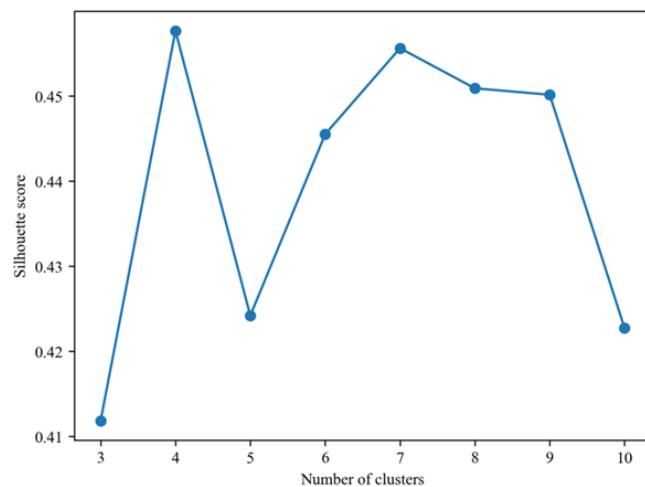
**Observation:** In this case, we can see the dataset is being clustered naturally. From here we are also able to see that the model is trying to cluster people based on their income wherein:

Cluster 0: They are the group of people who have Total Salary close to Salary (husband's salary) but their total salary is relatively less compared to other people.

Cluster 1: They are the group of people who have Total Salary close to Salary (husband's salary)

Cluster 2: They are the group of people who have Total Salary higher than Salary (husband's salary)

### Using Silhouette Score for Charging Stations dataset

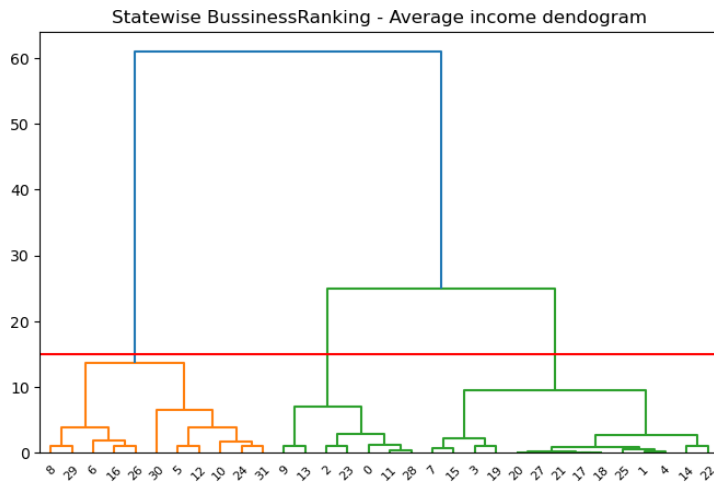


In the figure on the left side, we have plotted the inertia for each cluster. We can see that there is not a well-defined elbow present in the figure to determine the optimal number of clusters.

Therefore, a metric called Silhouette score is used to determine the optimal number of clusters. The optimal cluster number will be that number for which silhouette score is maximum. So, from the figure on the right side, we can clearly see that the score is highest for four clusters. Thus, we should segment our data in four clusters.

**Observation:** States in the first cluster has a smaller number of EV in the market and number of PCS and RO's with charging facility is also low. The number of sanctioned EV charging station for states in first cluster is low compared to states in second cluster. Thus, states like Andhra Pradesh, Gujrat, Haryana, Karnataka, Madhya Pradesh, Rajasthan, Tamil Nadu, Telangana which belong to the second cluster can be proven to be a good market for EV.

## Using Dendrogram Plot for Statewise Business Ranking



**Observation:** Through the clustering process, we have obtained three distinct clusters:

Cluster 0: They consist of cities with a business ranking below 14

Cluster 1: They consist of cities with a business ranking between 15 to 24

Cluster 2: They consist of cities with a business ranking above 24

## 10.0 Customizing the Marketing Mix

The marketing mix is a set of tools that marketers use to achieve sales results. Originally, there were 12 ingredients in the marketing mix, but the most used version includes the 4Ps: Product, Price, Promotion and Place.



To maximize the benefits of market segmentation, it is crucial to customize the marketing mix according to the target segment. This may involve designing new products, modifying existing ones, adjusting prices or discount structures, selecting appropriate distribution channels, and developing communication messages and promotion strategies that appeal to the target segment.

### **Product**

Organizations often struggle with aligning their product offerings with the specific needs of their target segments. They face challenges in modifying existing products or developing new ones to cater to the demand of different segments. Emphasizing EVs with extended range and improved performance to address range anxiety and meet the demands of India's diverse terrain, highlighting the localization of manufacturing and components to align with the governments 'Make in India' initiative etc. are some of the strategies.

### **Price:**

Determining the optimal pricing strategy is a common pain point for organizations when making marketing decisions. Setting the right price involves considering various factors such as market demand, competition, production costs, and perceived value by customers. Various government incentives, subsidies can be leveraged to reduce the upfront cost of EVs, various range of EV models can be introduced at different price points to make them more affordable for Indian consumers.

### **Place**

The distribution of a product to customers is a crucial decision within the place dimension of the marketing mix. Marketers must determine how the product should be distributed, considering factors such as whether it should be available for purchasing online, offline, or both. We should try to establish and expand a robust network of EV dealerships across major cities and regions, ensuring trained sales staff who can effectively communicate the benefits of EVs to potential customers.

### **Promotion**

When formulating a marketing mix, a pivotal element to consider is the strategic decision-making process for promotion. This process entails crafting and advertising message that resonates effectively with the intended target market and selecting the optimal communication channels to transmit this message. Various marketing campaigns can be launched that educate customers about the benefits of EVs, including environmental advantages, reduced operating costs, and technological advancements. Additionally, we can collaborate with government bodies, nonprofit organizations, and influencers to raise awareness about EVs and their positive impact on India's environment and energy security.

## 11.0 Most optimal Market Segment

Selecting the most optimal market segment for the electric vehicle market depends on various factors, including market conditions, consumer preferences, and government regulations.

The insights gathered from our analysis tell us that a company can target E2W and E4W vehicles in many parts of the country as many states have reported high sales, but the most favorable location seems to be states like Andhra Pradesh, Gujrat, Haryana, Karnataka, Madhya Pradesh, Rajasthan, Tamil Nadu, Telangana, also they have high numbers of charging stations which makes it convenient for the customer to adopt an EV. The company should also focus on many aspects of the vehicle, especially on Reliability, Comfort, Service Cost, Performance as most people use an E2W to commute daily while purchase an E4W for a longer term.

Age, Salary, and Price seem to matter as younger population tend to buy less expensive vehicles and hence electric vehicle not being affordable can be a downside. It is then suggested to target a segment which is still eager to try out new technologies but are financially stable to afford electric vehicles. People in their late 20s to early 40s show a higher inclination towards purchasing electric vehicles as compared to other age groups. The average salary of people who buy electric vehicles is around 30 lakhs and most of the purchases for automobiles lie in the range of 10 to 20 lakhs and lesser for E2W vehicles.

As the trend suggests, higher salaried, old people tend to buy cars in the range of 10 to 20 lakhs. However, the sharp rise in awareness in younger segments about climate change influences their decision to buy electric cars. So, the recommended segment is the mid-tier, with significant marketing about the pros of electric vehicles to the environment is required.

## 12.0 Implementation

The GitHub links are as follows:

1. Midhir Nambiar  
<https://github.com/Midhir12/Feynn-Labs/tree/main/Project2a>
2. Kushal Bosu  
<https://github.com/KushalBosu/EV-Market-Segmentation>
3. Pallab Pal  
<https://github.com/Pallabpal/Ev-market>
4. Pratham Singh  
<https://github.com/prathamsingh7/EV-Market-Segmentation>

## 13.0 References

[1] Indian Government initiatives to promote electric vehicles

<https://e-vehicleinfo.com/indian-government-initiatives-to-promote-electric-vehicles/>

[2] Gujarathi, Pritam Keshavdas & Shah, Varsha & Lokhande, Makarand. (2018). Electric Vehicles in India: Market Analysis with Consumer Perspective, Policies and Issues. Journal of Green Engineering. 8. 17-36. 10.13052/jge1904-4720.813.

<https://www.researchgate.net/publication/325801124>

[3] Indian Electric Vehicle Market

<https://www.mordorintelligence.com/industry-reports/india-electric-vehicle-market>