

Market Segmentation:

Analysing the respective market in India using Segmentation analysis for Electric Vehicle Start-up.

**By
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Overview:

An **electric vehicle (EV)** is a vehicle that uses one or more electric motors for propulsion. It can be powered by a collector system, with electricity from extravehicular sources, or it can be powered autonomously by a battery (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator).^[1] EVs include, but are not limited to, road and rail vehicles, surface and underwater vessels, electric aircraft and electric spacecraft.

EVs first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. Internal combustion engines were the dominant propulsion method for cars and trucks for about 100 years, but electric power remained commonplace in other vehicle types, such as trains and smaller vehicles of all types.

In the 21st century, EVs have seen a resurgence due to technological developments, and an increased focus on renewable energy and the potential reduction of transportation's impact on climate change and other environmental issues. Project Drawdown describes electric vehicles as one of the 100 best contemporary solutions for addressing climate change.

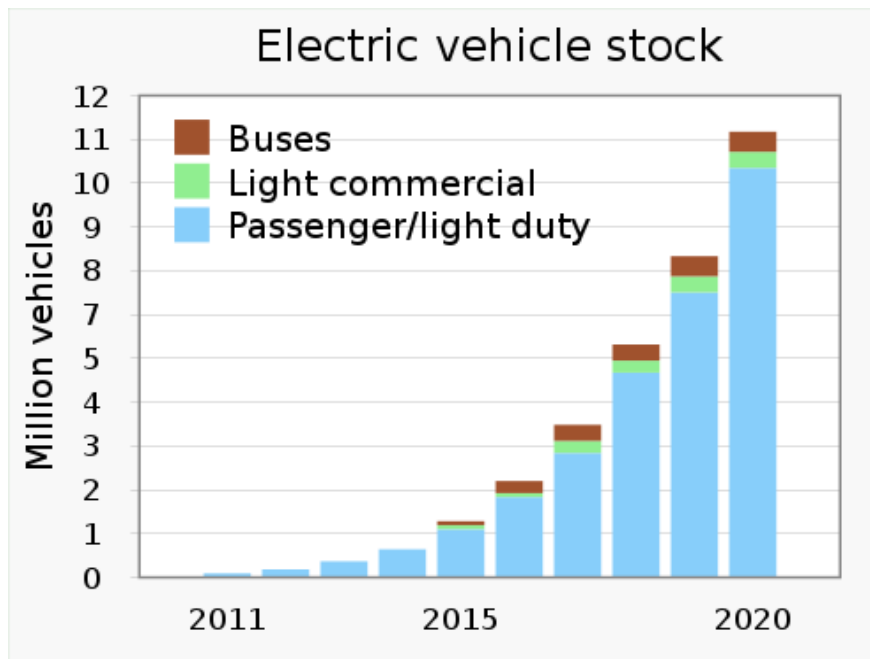
The electric vehicles industry is at a nascent stage in India. It is less than 1% of the total vehicle sales however has the potential to grow to more than 5% in a few years. At present there are more than 5 lac electric two-wheelers and few thousand electric cars on Indian roads. The industry volumes have been fluctuating, mostly depending on the incentives offered by the government. Many serious players (Hero Eco, Ather, Electrotherm, Avon, Lohia, Ampere, etc) are continuing with the mission and trying to enforce the positive change.

More than 90% of electric vehicles on Indian roads are low-speed electric scooters (less than 25km/hr) that do not require registration and licenses. Almost all electric scooters run on lead batteries to keep the prices low, however, battery failures and low life of batteries have become major limiting factors for sales besides government subsidies. Many manufacturers have taken initiatives to install the charging station with limited success. Players like Lohia and Electrotherm have developed Electric three-wheelers. Ampere and Hero have entered Electric Cycles segments. There are numbers of E-Rickshaw players mushrooming across the country and selling good numbers of E rickshaw for last-mile connectivity.

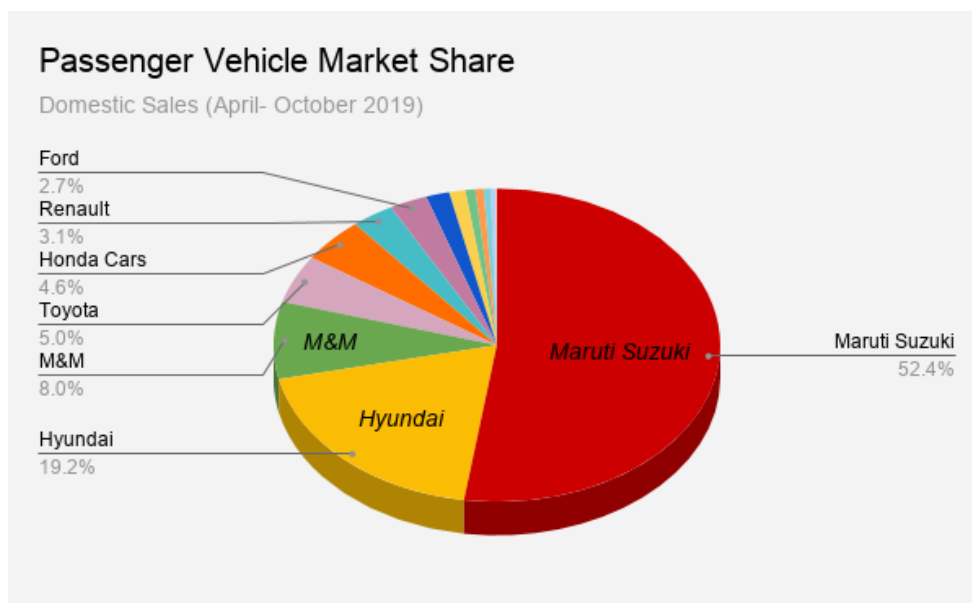
The industry is almost ready for take-off but for the incentives. It is expected that with FAME-2 the industry may witness a quantum leap in volumes and technology.

Market Overview:

As stated earlier in India the electric vehicle industry is in nascent stages, the majority of the automobile market is dominated by petrol/diesel engine automobiles. The global supply of electric vehicles is also rising rapidly with the increase risk of climate change. It is a very good opportunity for Indian EV manufacturers to enter the market. The rising EV's in the span of 10 years is shown as below:



The majority of the share is held by Maruti Suzuki, continued by the South-Korean automobile company Hyundai. The pie chart below represents the present market share of all the major automobile manufacturers in India.



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 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 inter-city 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.
- Bengaluru has recently bought 90 electric buses for in city transportation for BMTC and is looking to go all electric by 2023.

The EV market in India has gained significant momentum after the implementation of the 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.

An electric vehicle is one that operates on an electric motor instead of an internal combustion engine, which generates power by burning a mix of fuel and gases. Therefore, an electric vehicle is seen as a possible replacement for the current-generation automobile in the near future to address environmental challenges. The report covers the latest trends and technologies followed by the COVID-19 impact on the market.

Market Segmentation:

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.

India is the second most populated country in the world after China, and just like China, which has the largest electric bus fleet in the world. India is also pushing hard for the electrification of buses. Many state governments have already started procuring electric buses from Chinese and local electric bus manufacturers.

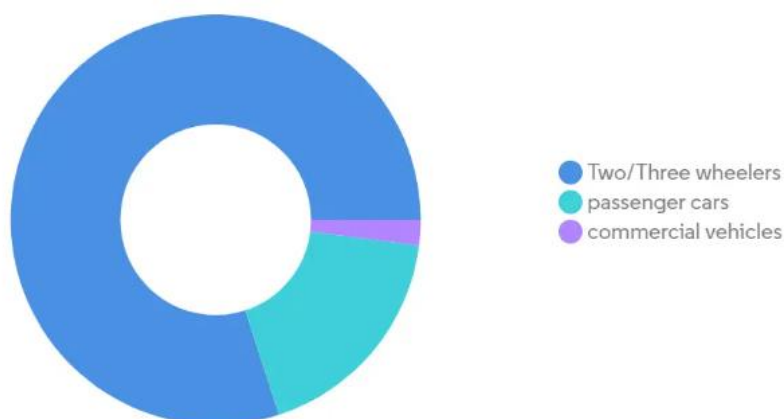
With the growing need for controlling GHG (Greenhouse gases) emissions emitted by vehicles, the government is encouraging the use of electric-powered vehicles across various states, boosting the demand for electric buses in India. The market is driven by factors such as the increase in domestic manufacturing, rapid urbanization, and a rise in environmental awareness. For instance,

- In February 2020, the Union Transport minister inaugurated India's first inter-city electric bus service. These buses were manufactured by Mitra Mobility Solution, with a range of 300 km on a full charge.

Many local bus manufacturers who are in collaboration with some Chinese manufacturers are trying to cater to the rising demand for electric buses in India. For instance,

- In 2019, Foton PMI was planning to invest around INR 500 crore in a joint venture with Beiqi Foton Motor Co. of China to manufacture electric buses in India. The company has already given five electric buses to one of the airlines for internal operations.

India Electric Vehicle (EV) Market - Revenue Share (%), By Vehicle Type, 2020



Electric Two-wheeler Vehicles Likely to have Optimistic Growth:

With transportation still being a challenge in India, a lot of people in these segments look forward to the two-wheeler industry in India. As a result of the surging pollution, the national government has launched stringent policies to curb vehicular emissions. In particular, the jump from Bharat Stage V (BSV) to BSVI emission standards is expected to benefit the Indian electric scooter and motorcycle market, by raising the prices of petrol-driven two-wheelers by 7–15%. From 1st April 2020 onward, automakers are only allowed to sell BSVI-compliant vehicles in the nation, driving the push toward electric variants.

For extracting the maximum revenue from the rapidly growing Indian electric scooter and motorcycle market, original equipment manufacturers (OEMs) are expanding their facilities. For instance,

- In January 2020, Ather Energy Pvt Ltd announced intentions to build a 400,000-sq-ft factory in Hosur, Tamil Nadu, which would have an annual output of 1 lakh units. Currently, the company operates one manufacturing plant in Bengaluru, which has a capacity of 25,000 units. The idea of the company behind an additional facility is meeting the rising demand for electric two-wheelers in India.
- In the same vein, Okinawa AutoTech Pvt Ltd invested USD 28.4 million (INR 200 crore) for its second manufacturing plant in May 2019. To be developed for electric two-wheeler vehicles in Rajasthan and planned to be commissioned in early 2020–21, the manufacturing plant will have an annual output of 10 lakh units.

Furthermore, the availability of a considerable number of electric two-wheeler models, their low cost, as well as their availability as a substitute for conventional fuel-based vehicles. These aforementioned factors are fuelling the demand in the Indian electric vehicle market.

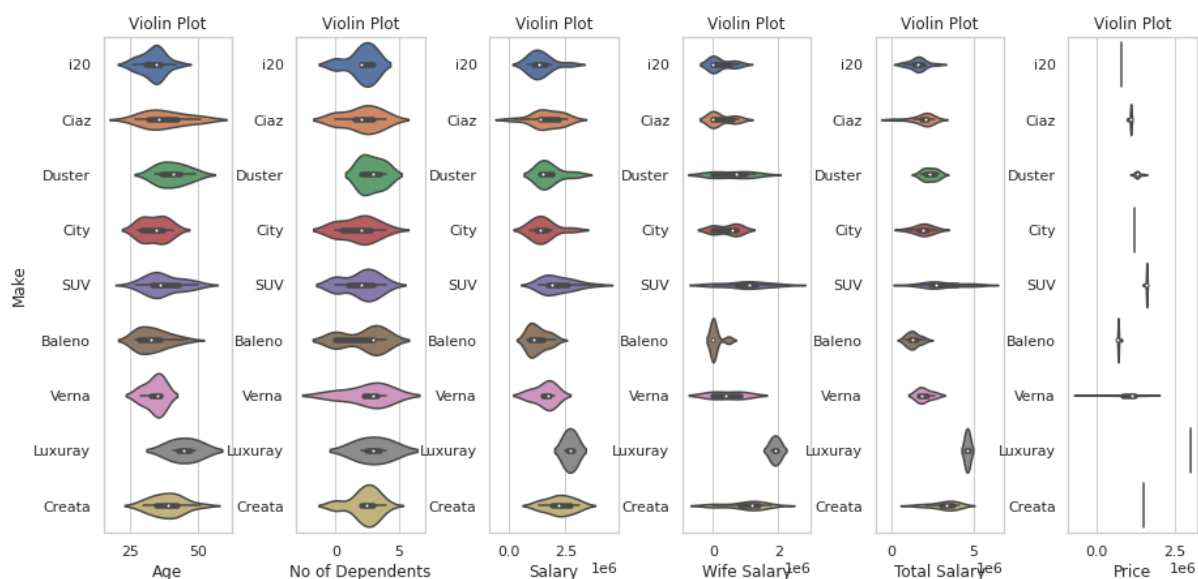
India Electric Two Wheeler Market - Revenue Share (%), By Manufacturers, 2020



Population Behavioural Study:

To enter a market an in-depth knowledge of the end user psychology, behaviour is required. This market research is imperative for setting prices, study spending habits, study the product they use the most, like 4-wheel diesel/petrol automobiles, what is their price range, the requirement of the automobile etc. The next series of visualizations are regarding this niche where we do a requirement analysis.

The below violin plot shows top existing cars and their dependency on various variables such as age, marital status, price, salary and number of dependents.



Let me explain the dependency of the variables:

Age:

Younger people have a smaller number of dependents, less salary, and are single so they are not usually our target segment but they are the most likely to buy electric vehicles as they are informed about climate change and its effects and want to help the planet.

The price range for younger target segment is below 10 Lakhs.

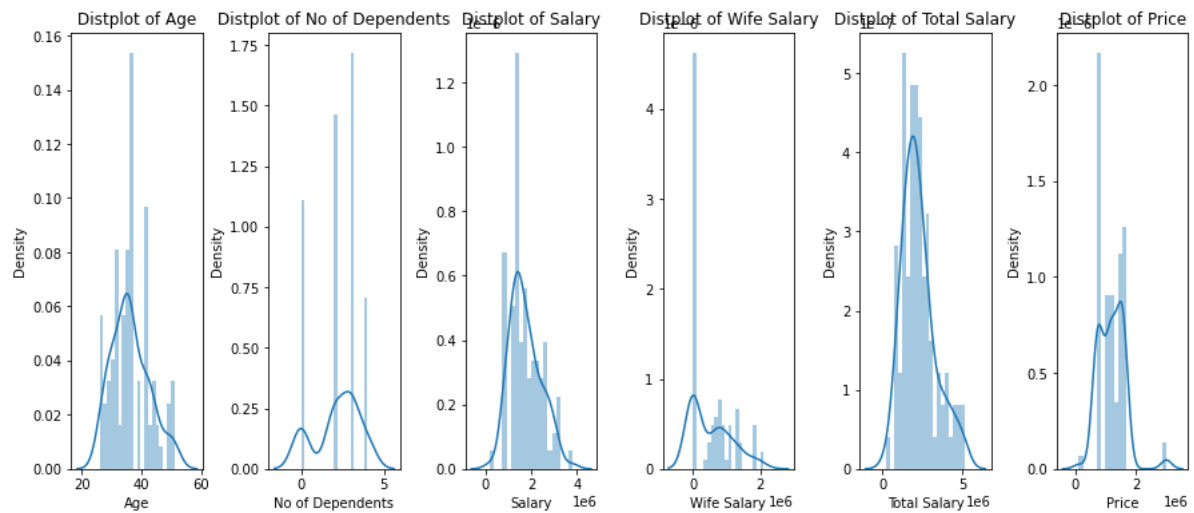
Number of Dependents:

The more the number of dependents, the bigger the need of cars for transportation, here SUVs are preferred for higher target segments.

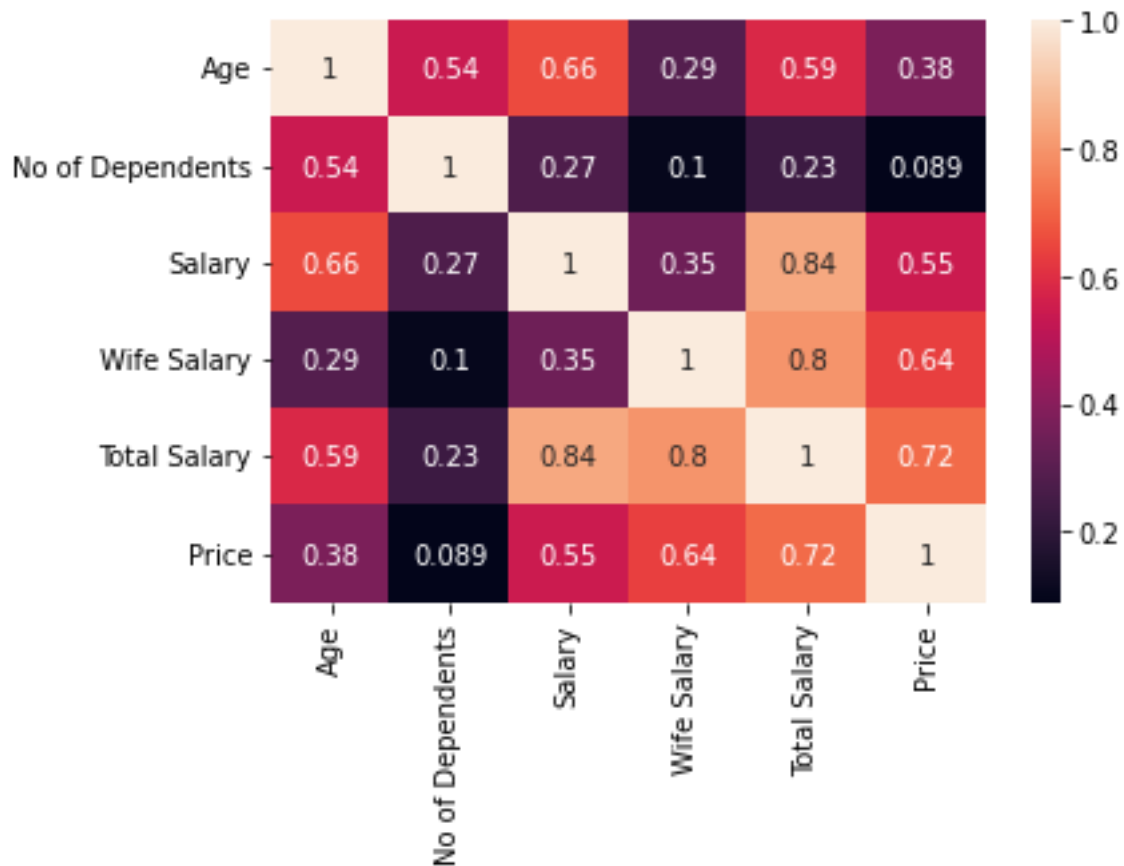
Salary:

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

To further see that what are the most important factors which affect the market of automobile, below is a heatmap and a continuous distribution-plot.



Here we can compare all variables with all the other variables.



K-Means Clustering:

Clustering:

Clustering is one of the most common exploratory data analysis techniques used to get an intuition about the structure of the data. It can be defined as the task of identifying subgroups in the data such that data points in the same subgroup (cluster) are very similar while data points in different clusters are very different. In other words, we try to find homogeneous subgroups within the data such that data points in each cluster are as similar as possible according to a similarity measure such as Euclidean-based distance or correlation-based distance. The decision of which similarity measure to use is application-specific.

Clustering analysis can be done on the basis of features where we try to find subgroups of samples based on features or on the basis of samples where we try to find subgroups of features based on samples.

K Means Algorithm:

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

The way k means algorithm works is as follows:

1. Specify number of clusters K .
2. Initialize centroids by first shuffling the dataset and then randomly selecting K data points for the centroids without replacement.
3. Keep iterating until there is no change to the centroids. i.e. assignment of data points to clusters isn't changing.

The approach k-means follows to solve the problem is **expectation maximization**

The E-step is assigning the data points to the closest cluster. The M-step is computing the centroid of each cluster. Below is a breakdown of how we can solve it mathematically.

The objective function is:

$$J = \sum_{i=1}^m \sum_{k=1}^K w_{ik} \|x^i - \mu_k\|^2 \quad (1)$$

And M-step is:

$$\begin{aligned} \frac{\partial J}{\partial \mu_k} &= 2 \sum_{i=1}^m w_{ik} (x^i - \mu_k) = 0 \\ \Rightarrow \mu_k &= \frac{\sum_{i=1}^m w_{ik} x^i}{\sum_{i=1}^m w_{ik}} \end{aligned} \quad (3)$$

Applications:

K means algorithm is very popular and used in a variety of applications such as market segmentation, document clustering, image segmentation and image compression, etc. The goal usually when we undergo a cluster analysis is either:

1. Get a meaningful intuition of the structure of the data we're dealing with.
2. Cluster-then-predict where different models will be built for different subgroups if we believe there is a wide variation in the behaviours of different subgroups.

Packages/ Tools used:

1. NumPy: To calculate various calculations related to arrays.
2. Pandas: To read or load the datasets.

We have considered a dataset which contains data regarding the spending habits of people regarding type of cars etc.

With respect to the above data the population can be segmented on the basis of age, marital status and salary, each of these segments should be targeted separately as they have different requirements.

```
data = pd.read_csv("/content/gdrive/My Drive/datasets/Indian automobile
buying behaviour study 1.0.csv", encoding= "ISO-8859-1")
data.head()
```

In [238]: data.head()

Out[238]:

	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

Data Pre-processing:

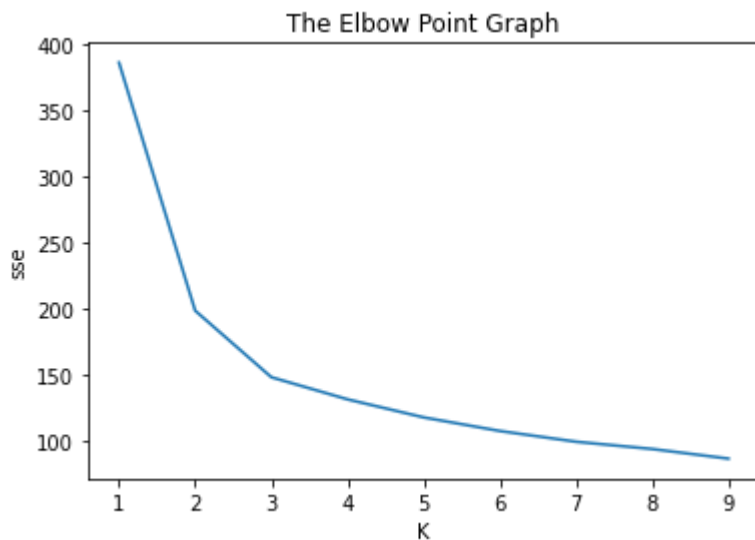
```
from sklearn.preprocessing import LabelEncoder

cols = ['Profession', 'Marrital Status', 'Education', 'Personal loan', 'House Loan', 'Wife Working']
#
# Encode labels of multiple columns at once
#
data[cols] = data[cols].apply(LabelEncoder().fit_transform)
#
# Print head
#
data_price = data.drop('Make', axis=1)
data_car = data.drop('Price', axis=1)
```

After the data is pre-processed, we can proceed with segmentation of population.

We calculate the number of clusters by using the elbow method.

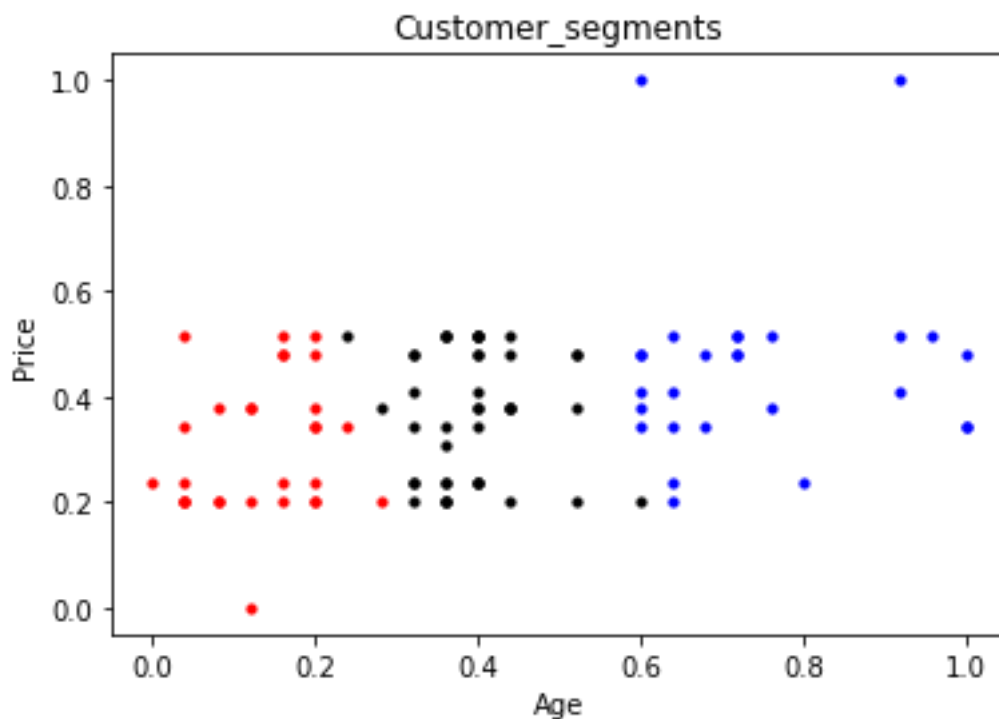
```
k_range = range(1,10)
#sum of squared error
sse = []
for k in k_range:
    km = KMeans(n_clusters=k)
    km.fit(d)
    sse.append(km.inertia_)
plt.title('The Elbow Point Graph')
plt.xlabel('K')
plt.ylabel('sse')
plt.plot(k_range, sse)
```



We get the number of clusters as 3.

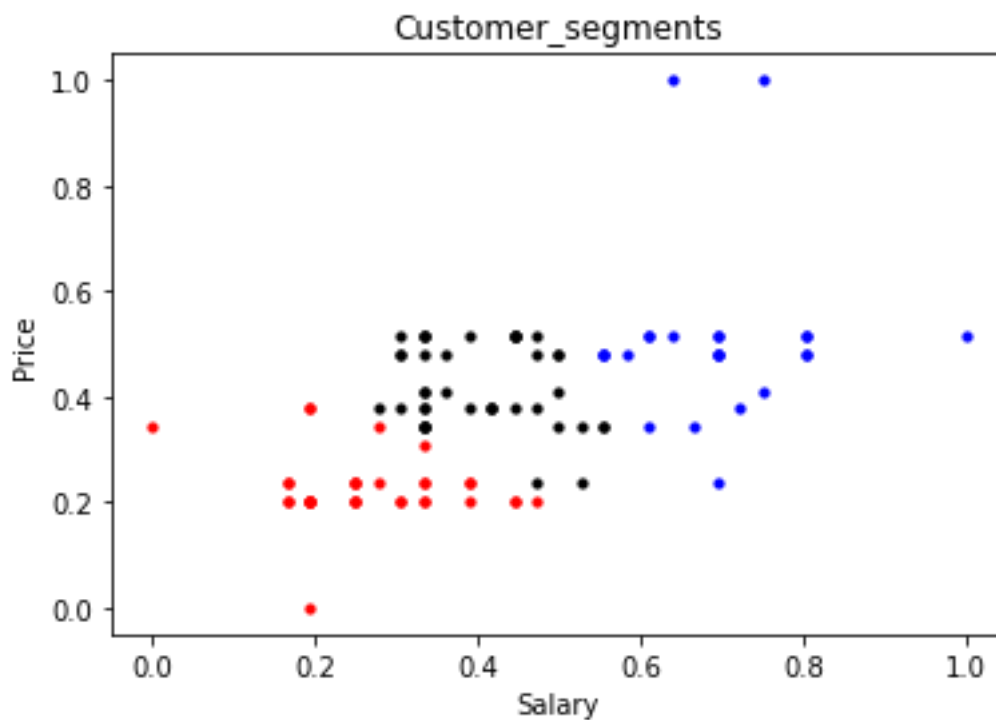
The clustering of age vs price is as follows. As we can see that as age increases the price of the car also increases. This can be justifying as older people tend to be in high paying jobs.

```
clus = d.loc[:, ["Age", "Price"]].values
kmeans = KMeans(n_clusters=3, init='k-means++')
Y = kmeans.fit_predict(clus)
plotseg(clus, Y, ["Age", "Price"])
```



Next, we compare salary and price, as we can guess the higher the salary the higher the price of the car is.

```
clus = d.loc[:, ["Salary", "Price"]].values
kmeans = KMeans(n_clusters=3, init='k-means++')
Y = kmeans.fit_predict(clus)
plotseg(clus, Y, ["Salary", "Price"])
```

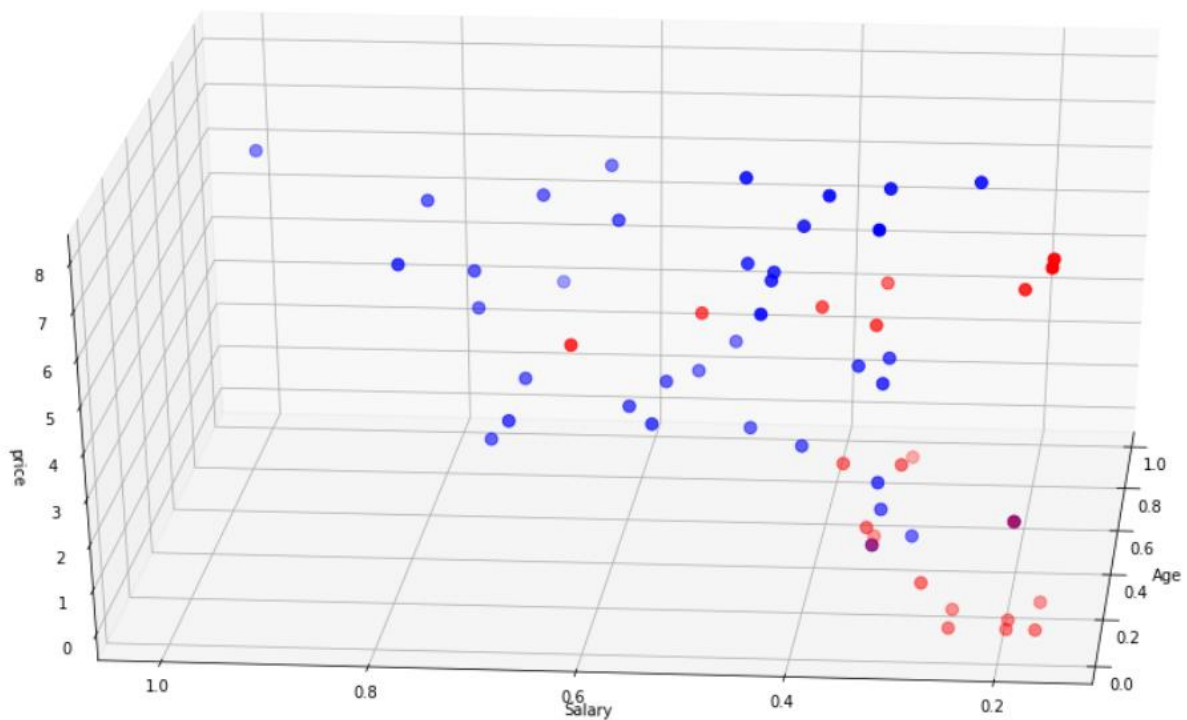


Observations:

- We found that 3 clusters groups can be formed from the data given (based on price of the vehicle) using the K-Means algorithm and Elbow Point Method
- While looking at the patterns, we find that as the Age increases the cost of the vehicle also rises.
- Also, amount spent on the car goes up with the number of dependents. The same is true for salary field too.
- The visualizations provided gives a clear idea about the patterns.

Next, we have 3D plots to see how variables influence each other when they are not taken out of the context.

The 3D plot is between age, salary and price.



Target Segment:

As the trend suggests, higher salaried, old people tend to buy cars in the range 10-20L. 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.

Marketing Mix:

Setting prices for our products is both an art and a science. Most importantly, you must know and understand your cost of production. From there you can adjust based on product characteristics, a specific pricing strategy, customer price sensitivity, customer values, and other factors. Price contributes to the perception of your product, that is, when consumers see a product price it sends signals to them about quality, match with the market outlet, expectations for assistance, etc. Keeping accurate and complete records accounting for all steps – production, packaging, storage, promotion, transportation/distribution, and sales – will assist you in setting a price and making adjustments as necessary.

4Ps of Marketing Mix:



The 4Ps helps companies to review and define key issues that affect the marketing of its products and services and are often now referred to as the 7Ps framework for the digital marketing mix.

Marketing as a whole relies on all seven Ps.

It is essential to consider them as a whole, and not in isolation. Customers must experience a coherent view of your company and your product, and that can only come from viewing the customer experience from end-to-end across all seven Ps.

Importance of Marketing Mix:

It helps understand what our product or service can offer to our customers and helps plan a successful product offering. Helps with planning, developing and executing effective marketing strategies. Help determine whether your product or service is suitable for your customers.

Product: Since the company is starting with the Electric vehicles, the battery quality, mileage per single charge, 0-60 speed/time all these affect the perception of the product as India is fairly new to this product.

Price: We can take reference from global market but that won't be applicable to India as its demographic is too diverse.

Place: It depends on the government schemes and the concession they provide to promote the production of the electric vehicles.

Promotion: Promotion can be based on the analysis. More offers and promotions can be given to the segments that are more valuable to the company.

References:

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- <https://electricvehicles.in/category/ev-startups/#>
- https://en.wikipedia.org/wiki/Electric_vehicle
- <https://www.smev.in/ev-industry>
- <https://www.statista.com/statistics/1234761/india-electric-vehicle-sales-by-type/>
- <https://www.mordorintelligence.com/industry-reports/india-electric-vehicle-market>

GitHub:

- https://github.com/cicykagnes/Market-Segmentation-Electronic-vehicles-India/blob/main/Feynnlabs_EVMarket_Segmentation.ipynb