MARKET SEGMENTATION ANALYSIS OF ELECTRIC VEHICLE(EV) MARKET

Submitted by

E R Shyama

GitHub link: https://github.com/shyamaer/Feynn-Labs/tree/main/EV%20Segmentation

Abstract

The popularity of electric vehicles (EVs) as a greener, more effective substitute for conventional gasoline-powered cars has grown significantly in recent years. EVs are now a feasible choice for many drivers worldwide because to improvements in battery technology, an expanding network of charging infrastructure, and rising consumer demand. These cars, which use electric motors to spin the wheels instead of petrol, are changing the way we think about driving since they are fuelled by energy that is stored in batteries. The potential market size for electric vehicles in India, as well as prospective market niches and ideal geographic areas for new emergent electric car start-ups, will be examined in this paper.

Fermi Estimation

A paradigm change is now taking place in the global automobile sector as it attempts to transition to alternative, less energy-intensive choices. India is also making investments in this transformation to electric vehicles. By 2030, the Indian automobile market is anticipated to rank third in terms of volume. Dependency on the traditional forms of fuel-intensive mobility will not be practical given the size of the domestic market. Federal authorities are creating a transportation alternative and they have set an ambitious goal of attaining 100% electrification by 2030. India has a lot to gain by switching to electric vehicles (EVs), including access to skilled labour in the manufacturing and technology industries and a relative abundance of renewable energy supplies. As of August 2022, there were 13, 92,265 electric vehicles (EVs) in total on Indian roads, according to the Ministry of Road Transport and Highways. There will probably be 45–50 million more EVs on the road by 2030.

The EV market in India has expanded significantly in recent years. Nevertheless, despite this development, the general public still does not seem to favour EV adoption. Several obstacles prevent EVs from becoming widely accepted in India.

1. The main obstacle is that electric vehicles are more expensive up front than traditional internal combustion engine (ICE) automobiles. The price of batteries, which account for a substantial portion of the cost of an EV, is still rather expensive. Due to this pricing difference, many consumers find EVs to be more expensive.
2. In comparison to conventional automobiles, there are presently few EV models available on the Indian market. Customers frequently like particular car models, such sedans or SUVs, which may not have many EV alternatives. Prospective EV consumers may be put off by the lack of diversity and the constrained selection of cars.
3. Particularly in smaller towns and rural regions, India's charging infrastructure is still far from ideal. Potential purchasers of EVs are concerned about the availability of charging stations and the time needed for recharging due to the lack of a well-established and accessible charging network. Driving range is a problem that is directly tied to charging time.

4. For EVs to perform better and be more accessible, more effective battery technology must be developed and manufactured. India, however, relies primarily on imports and has little indigenous battery production capacity. The key to overcome these difficulties is to create a strong ecosystem for battery manufacture and charging.
5. Gaining customer confidence in EVs requires addressing safety issues. It's important to handle battery technology risks including thermal runaways and fire accidents.

The following actions were done to accelerate the growth of the Indian EV market:

1. To increase EV demand and achieve the aspirational objective, several traditional automotive firms and oil corporations are making significant investments. 22,000 EV charging stations will be built, according to Indian Oil Corporation, during a three- to five-year period.
2. Incubator programmes, shared facilities for prototyping and small-scale manufacturing, financial support through the Credit Guarantee Scheme for Start-ups (CGSS), tax breaks, and consumer subsidies are just a few of the initiatives the Indian government has been putting in place to promote the growth of electric mobility.
3. Investment in EV startups surpassed previous records.
4. To promote local manufacturing of high-tech automotive goods and attract capital to the sector's value chain, the production linked incentive (PLI) programme for the automobile industry proposes financial incentives of up to 18%.

In the EV industry, India has already met one of the standards. The successful activation of 20 solar-powered EV chargers on the route between Delhi and Chandigarh makes it the first in the country to be e-vehicle friendly. In the financial year (FY) 2022, India's total number of charging stations increased by 285% year over year; aggressive government action is anticipated to hasten the expansion to 4 lakh stations by FY 2026.The future of the automobile industry is seen to lie with India's electric vehicles. EVs are expected to overtake gasoline-powered vehicles as the industry's mainstay in the next years due to the present climate change and concerns about it.

Data Sources

Kaggle (https://www.kaggle.com/)

Open Government Data (https://data.gov.in/)

Ministry of Road Transport & Highways (MoRTH) Government of India (https://vahan.parivahan.gov.in/)

Data Preprocessing (Steps and Libraries Used)

The libraries used for data preprocessing are:

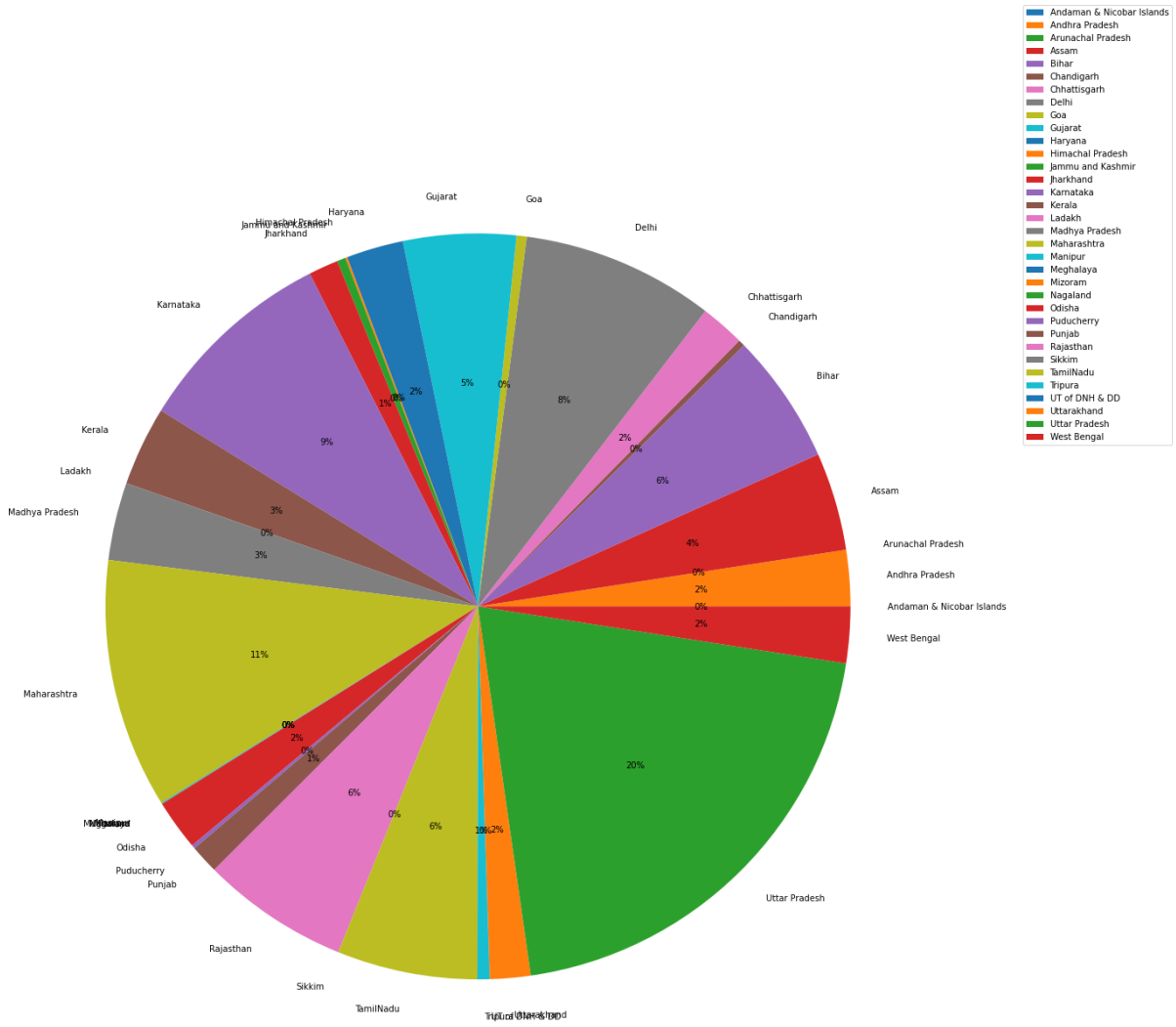
1. Numpy
2. Pandas
3. Seaborn
4. Matplotlib

The various datasets used are:

1. Data1 - Shows number of electric vehicles registered in each State and percentage of electric vehicles to total vehicles registered in each state.
2. Data2 – Contains various details of Electric Cars in India
3. Data3 – Details of various people who bought cars in India.
4. Data4 – Number of EVs registered according to vehicle category.
5. Data5 – Number of EV charging stations on highways and expressways.

The datasets can be understood using various visualization techniques.

The following pie chart shows the percentage of electric vehicles registered in different states of India.

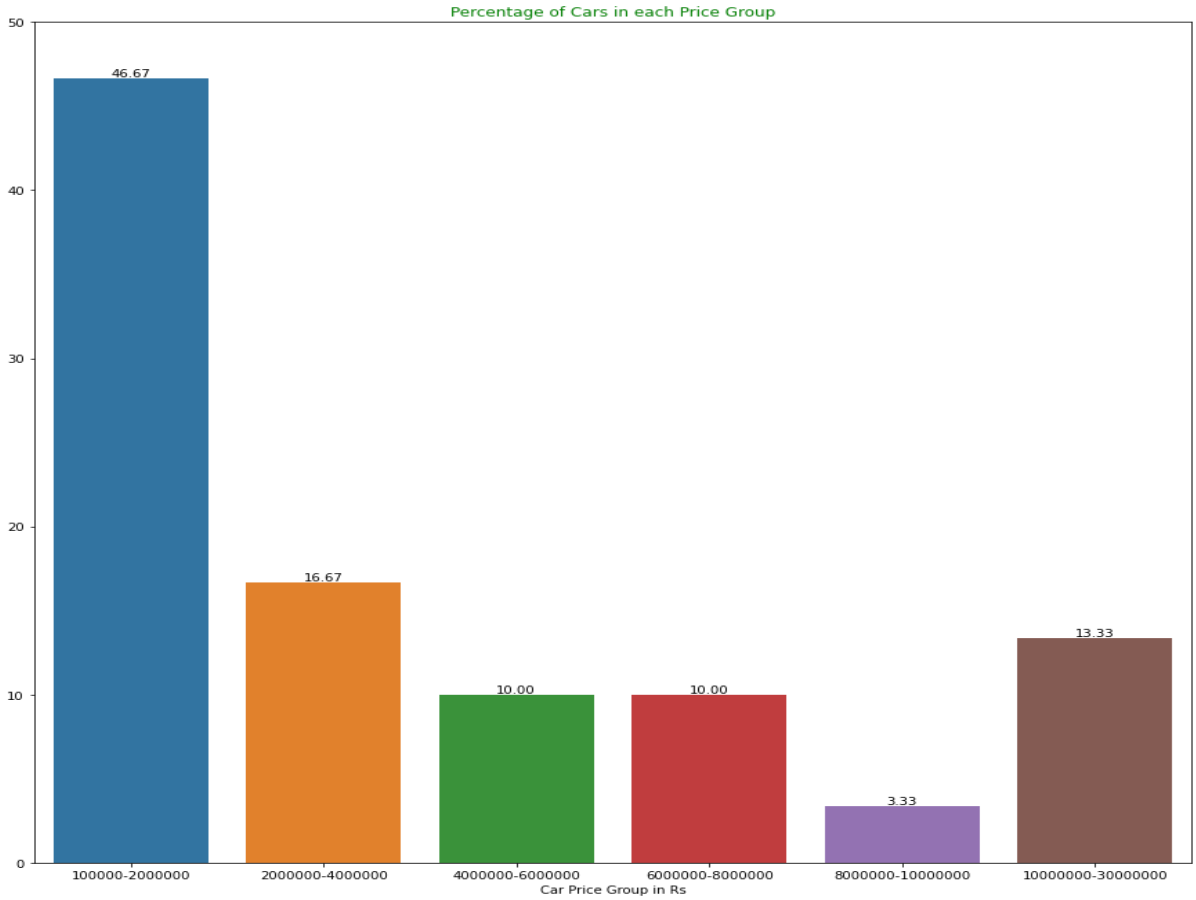


From the pie chart it is clear that UP, Maharashtra and Karnataka have the highest number of electric vehicles registered.

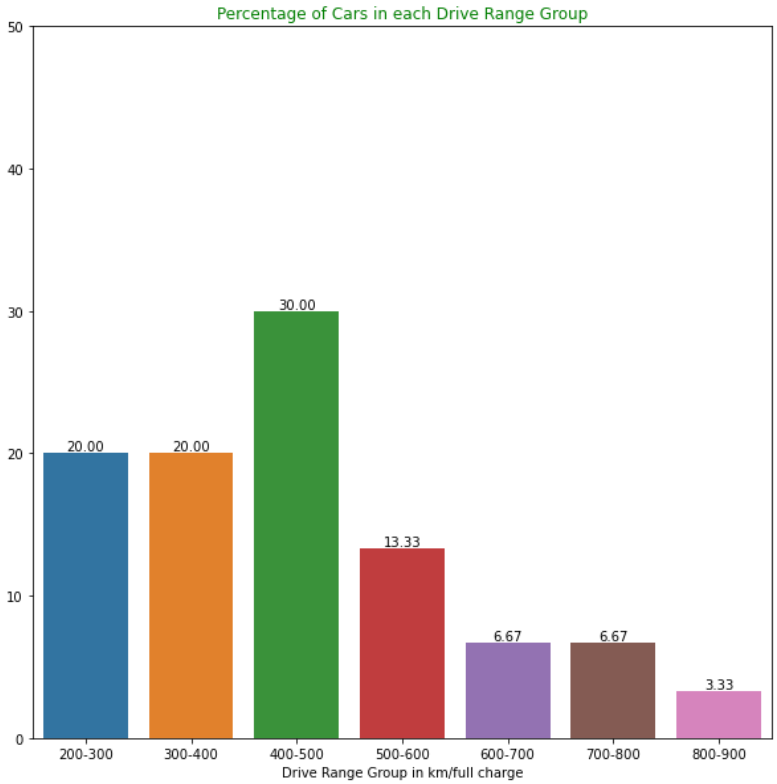
The following table shows the top 10 states with respect to electric vehicles registered:

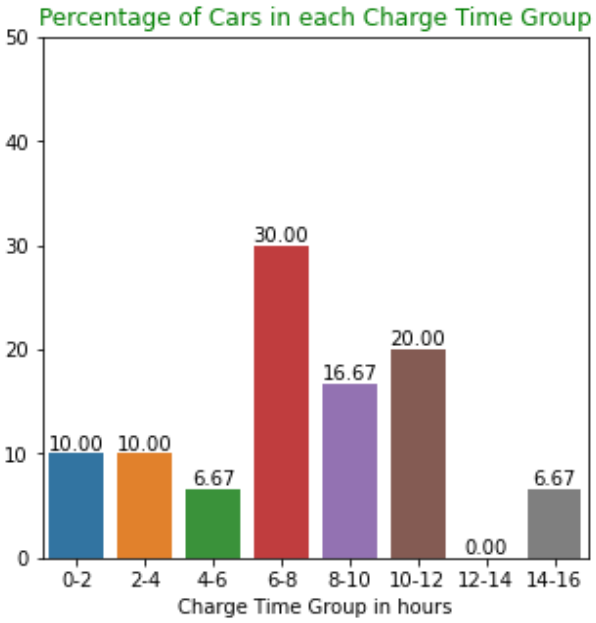
	Sl No	State/UT	Total Vehicles Registered	Total Electric Vehicles Registered	Percentage of Electric Vehicles
32	33	Uttar Pradesh	43943230	556629	1.27
18	19	Maharashtra	34371551	296885	0.86
14	15	Karnataka	29855843	239948	0.80
7	8	Delhi	8457200	229305	2.71
26	27	Rajasthan	18914170	175595	0.93
28	29	TamilNadu	31643747	167216	0.53
4	5	Bihar	11728184	155457	1.33
9	10	Gujarat	22799866	134273	0.59
3	4	Assam	5393542	116605	2.16
15	16	Kerala	16643512	94346	0.57

From the above table we can see that a greater number of electric vehicles are registered in UP, Maharashtra and Karnataka. From the column percentage of electric vehicles, it can be seen that electric vehicles form only a small percent of total number of vehicles registering in a state. These states would be best place to start a EV startup.

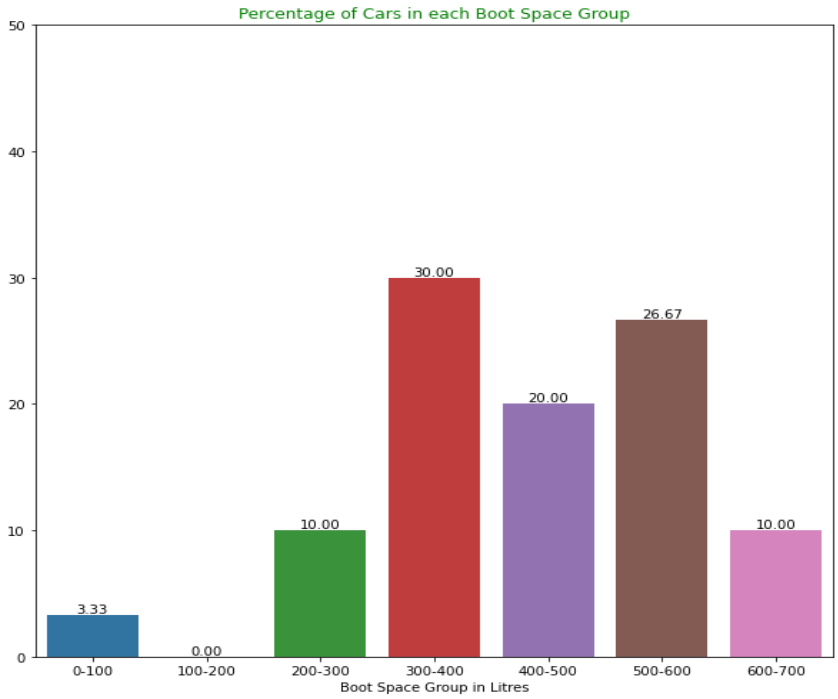


The above graph classifies various electric cars available in India into various price segments. It can be seen that people prefer buying cars in the lower price group. Larger number of electric vehicles are sold in the lower range of price.

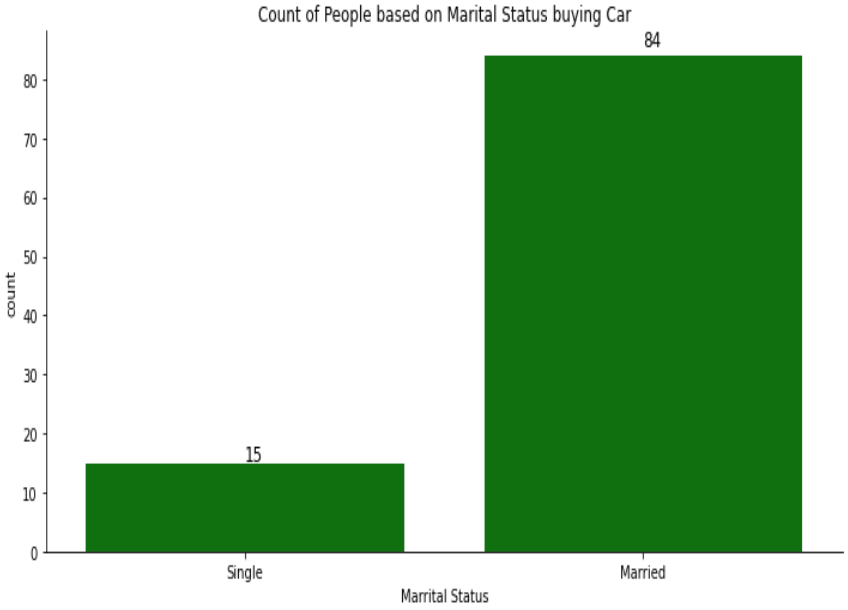




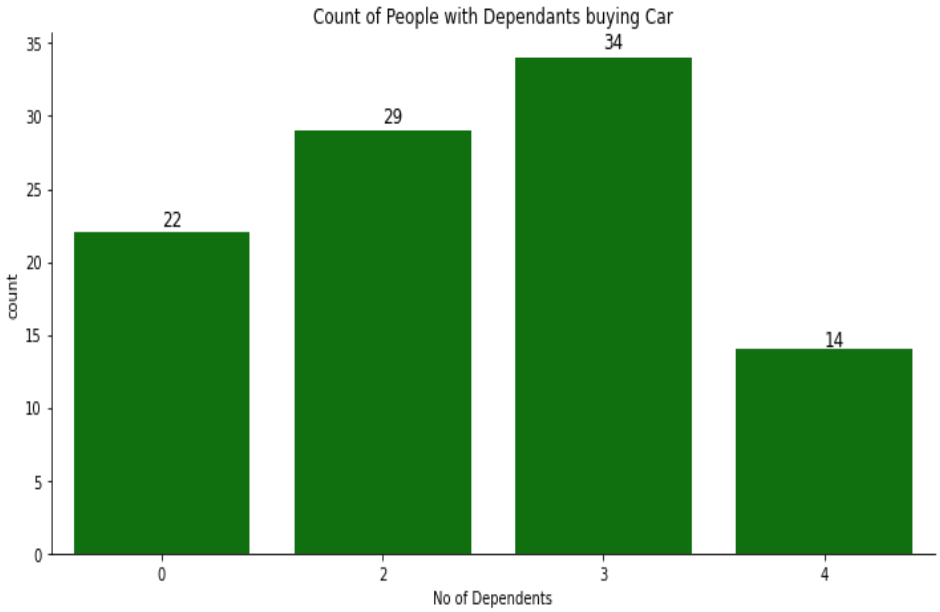
People mostly prefer electric vehicle with drive range of 400-500 km/full charge, ie distance that can be travelled in a single recharge with charging time of 6-8 hours. Boot space forms another major component for deciding which EV car to purchase. People mostly prefer a boot space in the range 300-400 litres.

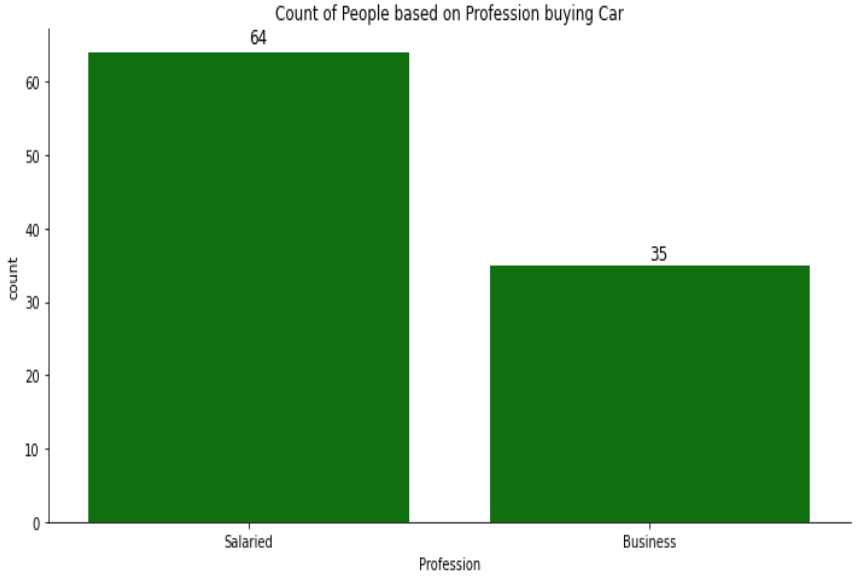


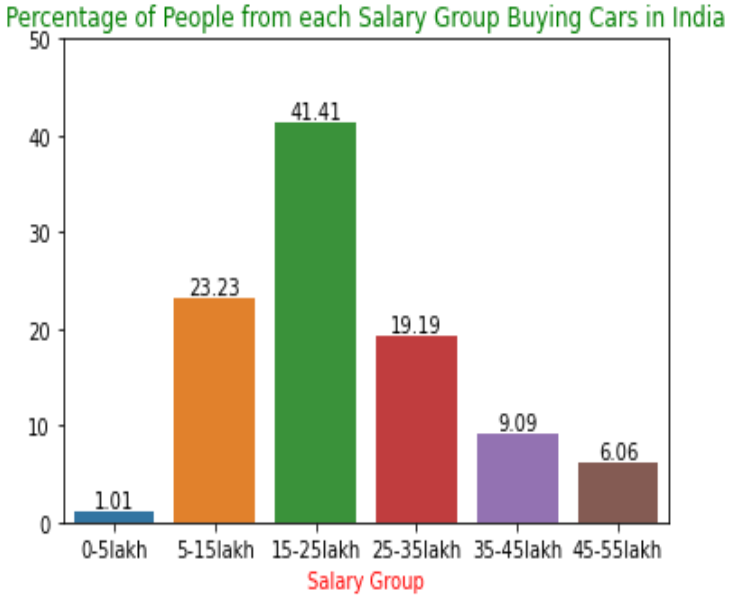
The following image shows the count of people buying car based on their marital status. It can be seen that married people prefer buying cars more than singles.



From the first image it is understood that people with dependants prefer buying cars. From the second image it can be seen that employed people prefer buying car to business people.

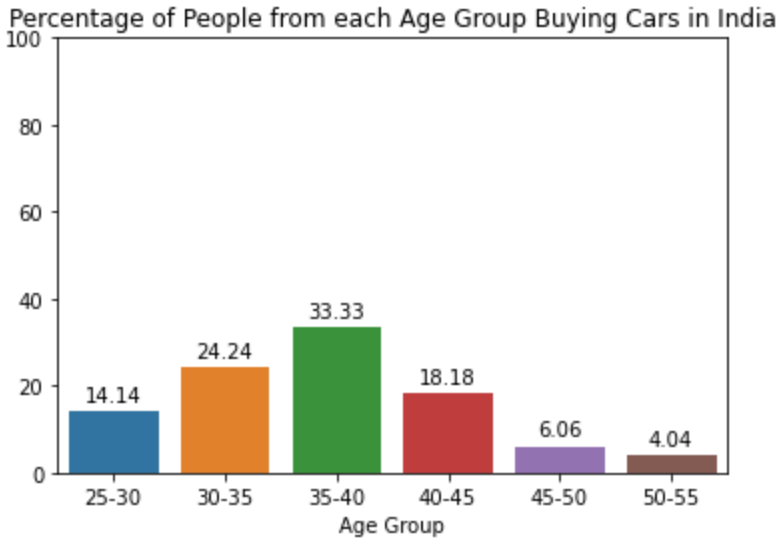

Count of People with Dependants buying Car
count
No of Dependents
0
2
3
4
22
29
34
14
0
5
10
15
20
25
30
35



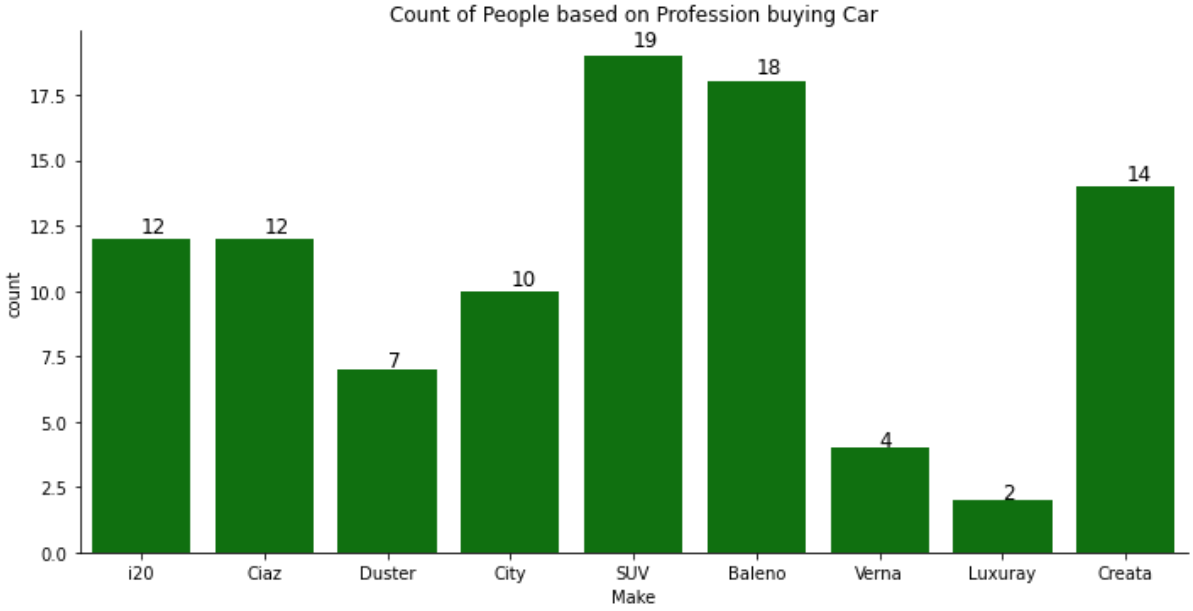


From the above graph it can be seen that people with salary in range 5 lakhs – 35 lakhs prefer buying car.

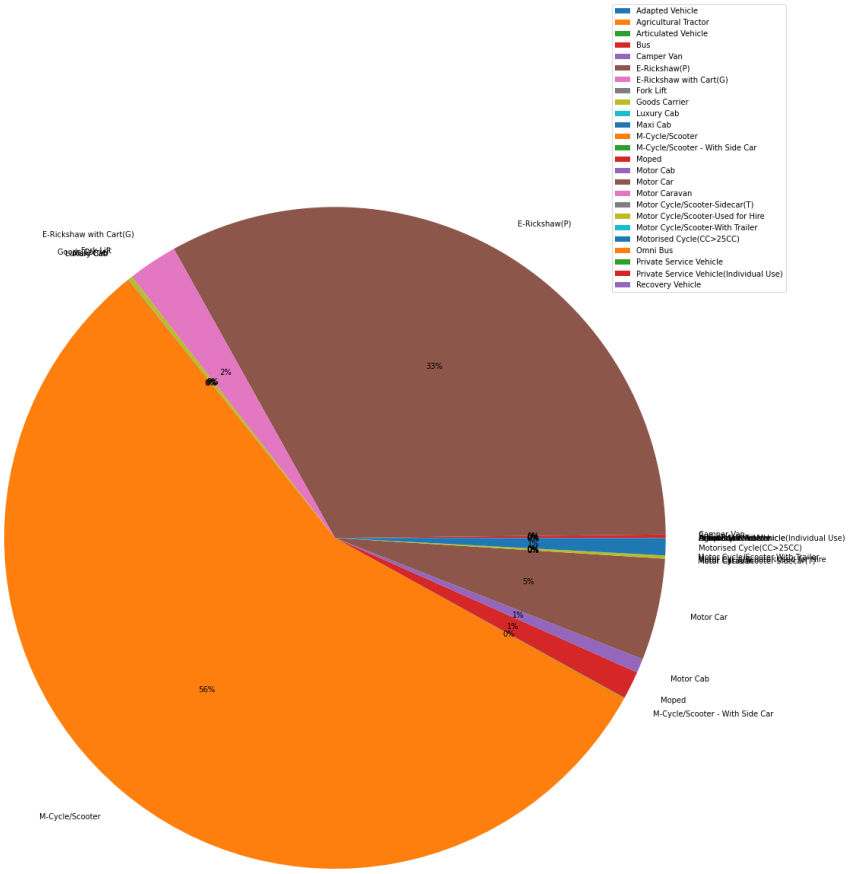
From the following graph it can be seen that people buying cars belong to the age group of 30-45 years.



The most preferred Make among people are SUVs. It can be seen from the following image:



The following pie chart shows the percentage distribution of various vehicle class in EV industry.



	Sl No	Vehicle Class	Total Registered on VAHAN
11	12	M-Cycle/Scooter	609864
5	6	E-Rickshaw(P)	357331
15	16	Motor Car	53894
6	7	E-Rickshaw with Cart(G)	26315
13	14	Moped	14757

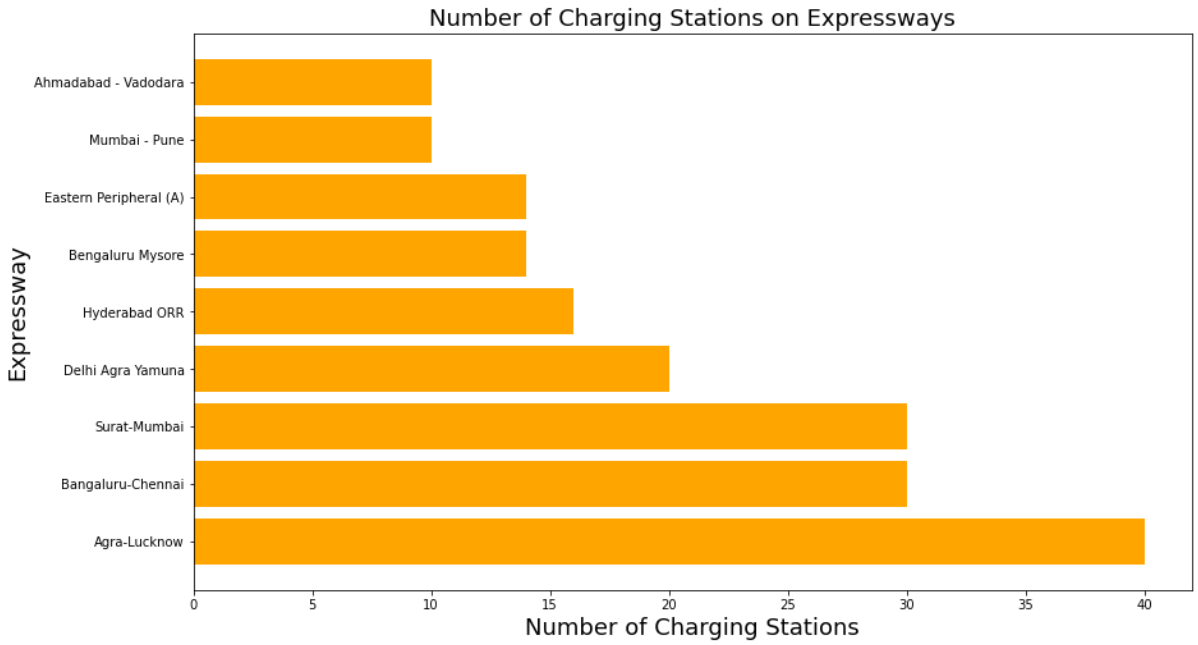
From the above table we can see that most number of electric vehicles registered belongs to cycle/scooter, rickshaw and car classes. This would be the best vehicle classes for a new EV company to launch new model EVs.

	Sl. No	Expressway Name	EV Charging Stations Sanctioned
0	1	Mumbai - Pune	10
1	2	Ahmadabad - Vadodara	10
2	3	Delhi Agra Yamuna	20
3	4	Bengaluru Mysore	14
4	5	Bangaluru-Chennai	30
5	6	Surat-Mumbai	30
6	7	Agra-Lucknow	40
7	8	Eastern Peripheral (A)	14
8	9	Hyderabad ORR	16

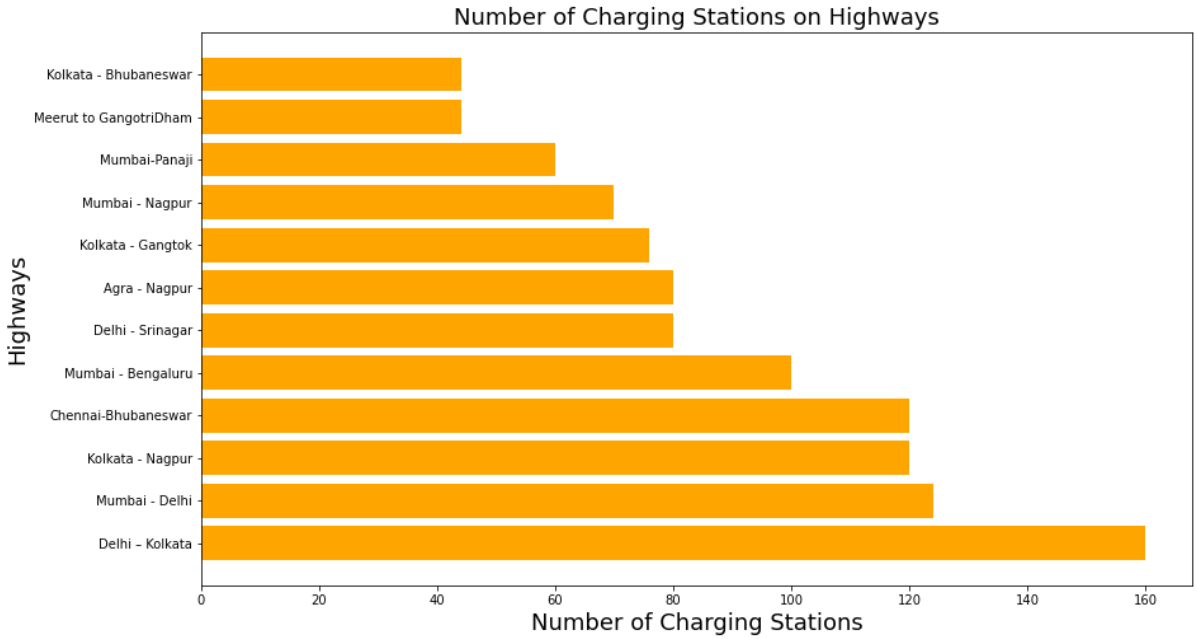
The above table shows the number of charging stations along different expressways. It can be seen that Agra-Lucknow, Bengaluru -Chennai Expressway and Surat-Mumbai Expressway has most number of EV charging stations.

	Sl. No	Highway Name	EV Charging Stations Sanctioned
9	1	Delhi - Srinagar	80
10	2	Delhi – Kolkata	160
11	3	Agra - Nagpur	80
12	4	Meerut to GangotriDham	44
13	5	Mumbai - Delhi	124
14	6	Mumbai-Panaji	60
15	7	Mumbai - Nagpur	70
16	8	Mumbai - Bengaluru	100
17	9	Kolkata - Bhubaneswar	44
18	10	Kolkata - Nagpur	120
19	11	Kolkata - Gangtok	76
20	12	Chennai-Bhubaneswar	120

The above table shows number of EV charging stations along different highways in India. Delhi-Kolkata, Mumbai-Delhi, Chennai-Bhubaneswar and Kolkata-Nagpur have largest number of charging stations.



The above bar plot shows the number of EV charging stations on different expressways.

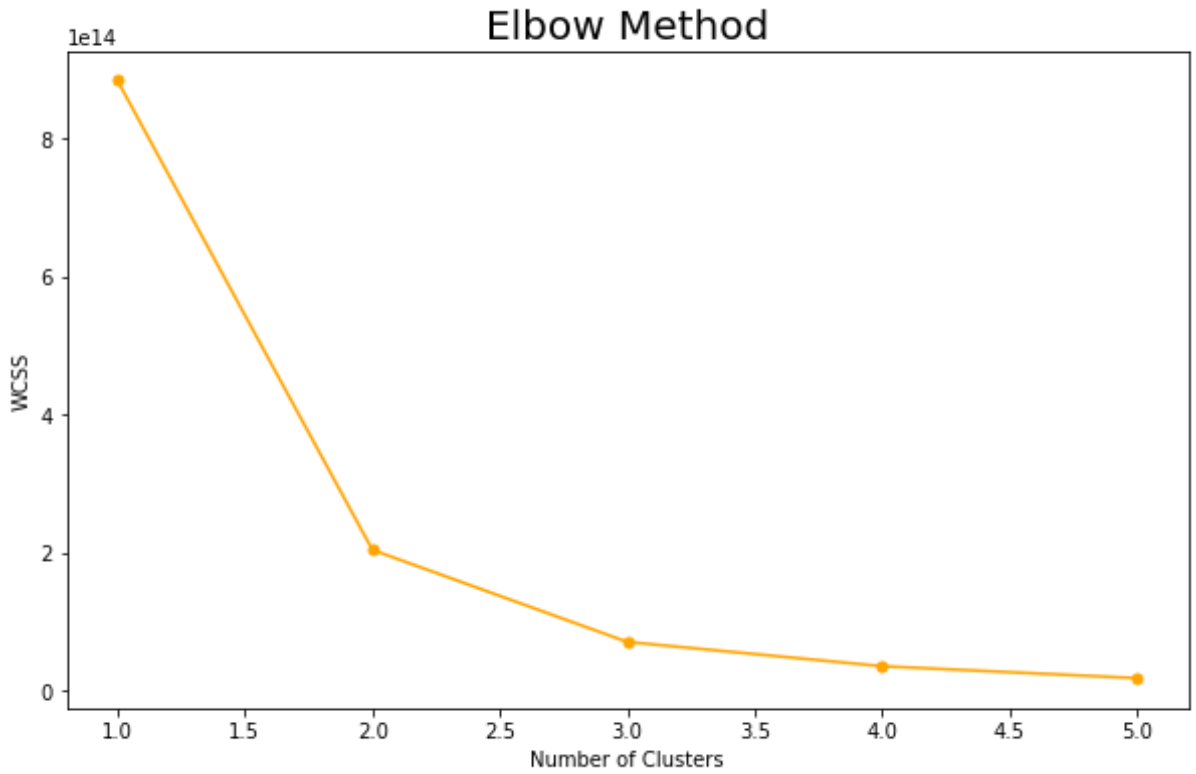


The above bar plot shows the number of EV charging stations on different highways.

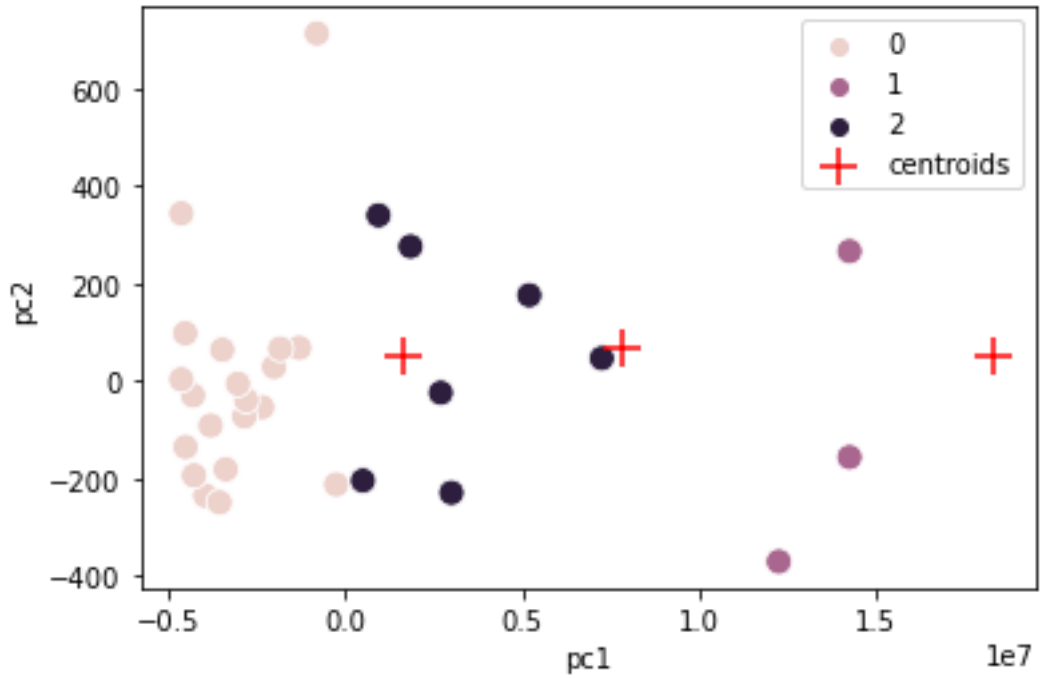
Segment Extraction

The K-Means technique has now been applied to extract the segments. KMeans is an unsupervised learning technique used to handle clustering issues in machine learning. It enables us to conveniently cluster the dataset into K number of groups. The elbow technique must be used to determine the number K if it is not already known. We may use this approach to locate portions of groups in an unlabelled dataset without any prior training. The algorithm's primary goal is to split the dataset into k segments with a minimum sum of distance between each one and the relevant data point. The right number of segments in the data must first be known in order to extract them. A technique known as elbow techniques can be used to determine the right number of segments. By fitting the model with a variety of k values, the elbow technique aids in the selection of the best value for k. The elbow is located using the K-means algorithm's cost function, commonly known as the epsilon or sum of squares of distances. It is anticipated that as K increases, the epsilon will decrease. The ideal value of k is thought to be one at which the value of epsilon drops very little.

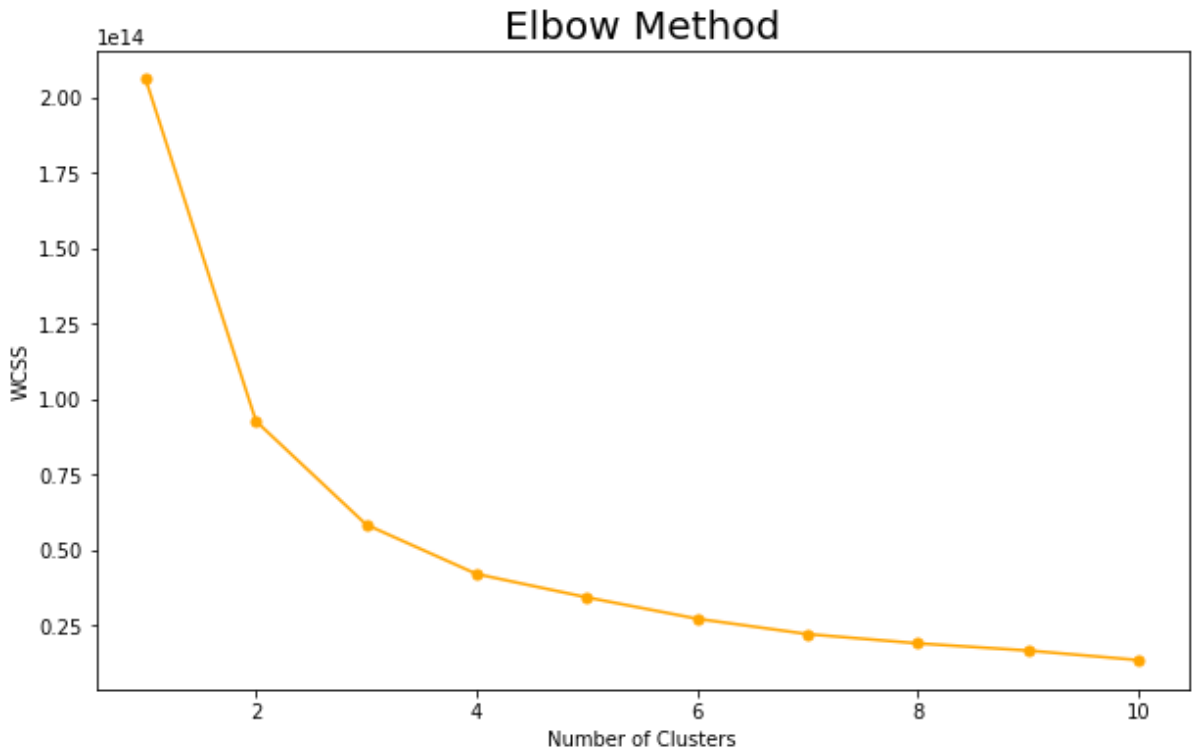
Elbow diagram used to cluster the cars from different manufactures is:



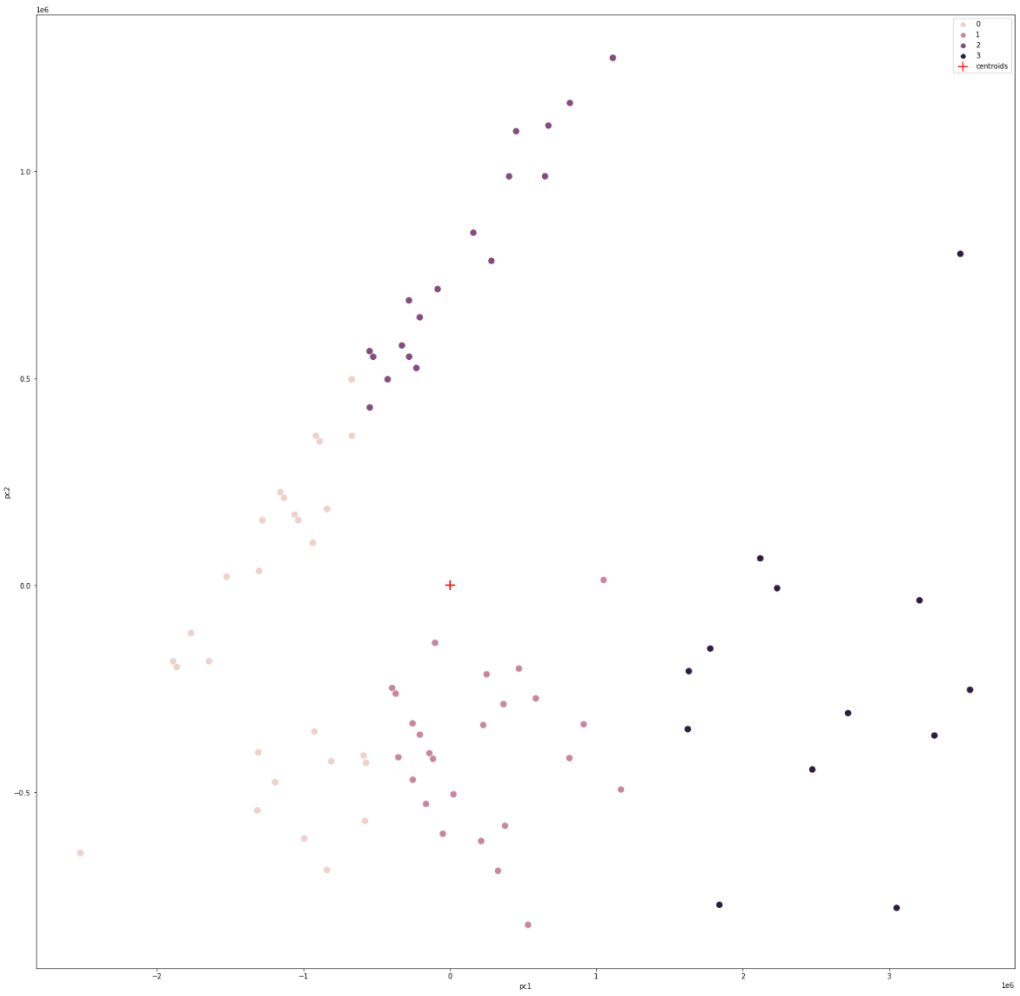
From the diagram it is clear that number of clusters is 3. The value of K for K-means will be taken as 3. Clusters after applying K-Means is as follows:



Elbow diagram used to cluster people buying cars is:



From the diagram it is clear that number of clusters is 4. The value of K for K-means will be taken as 4. Clusters after applying K-Means is as follows:



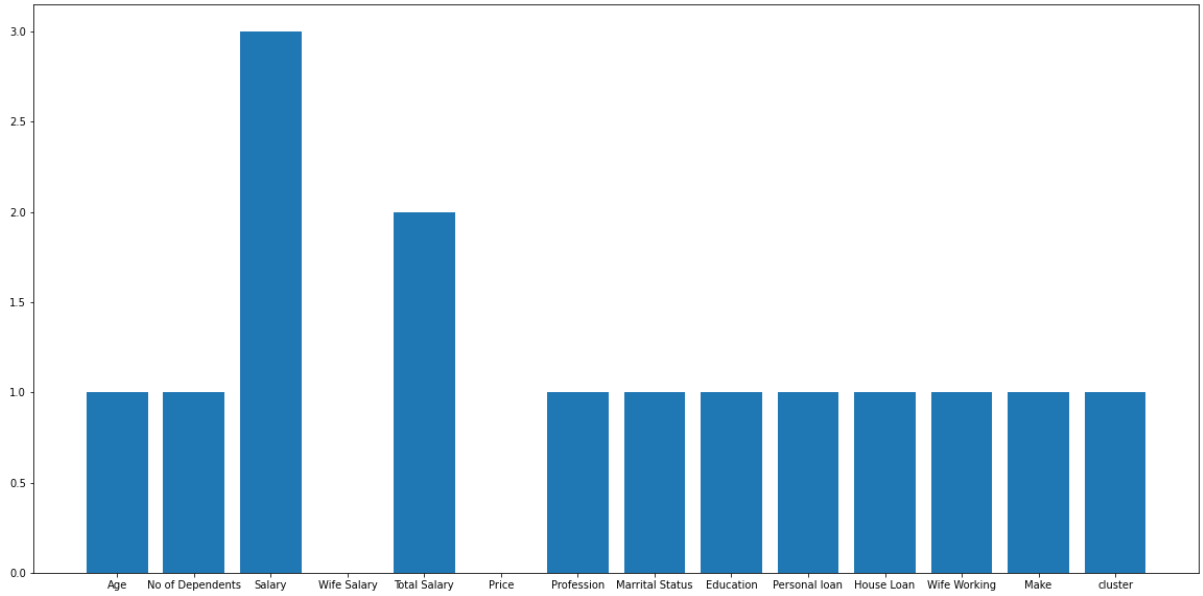
Profiling and describing potential segments

The next step is to profile the segments once we have extracted them from the dataset. The segments can be seen by plotting a segment profile plot. By initially performing agglomerative clustering on the segmentation variables, it can be shown as a bar graph.

The following is the code for the segment profile plot for customer buying behaviour.

```
from sklearn.cluster import AgglomerativeClustering
from scipy.cluster import hierarchy as shc
from sklearn.metrics import pairwise_distances
clust2 = AgglomerativeClustering(n_clusters = 4).fit_predict(pairwise_distances(X.transpose()))
plt.figure(figsize = (20,10))
plt.bar(X.columns,clust2)
plt.show()
```

This is segment separation for the Car Buying Behaviour Dataset. The bar plot will be:



From the bar plot the segmentation variables are:

Segment0 = Wife salary, Price

Segment1 = Age, No of dependants, Profession, Marritial Status, Education, Personal Loan, House Loan, Wife Working, Make

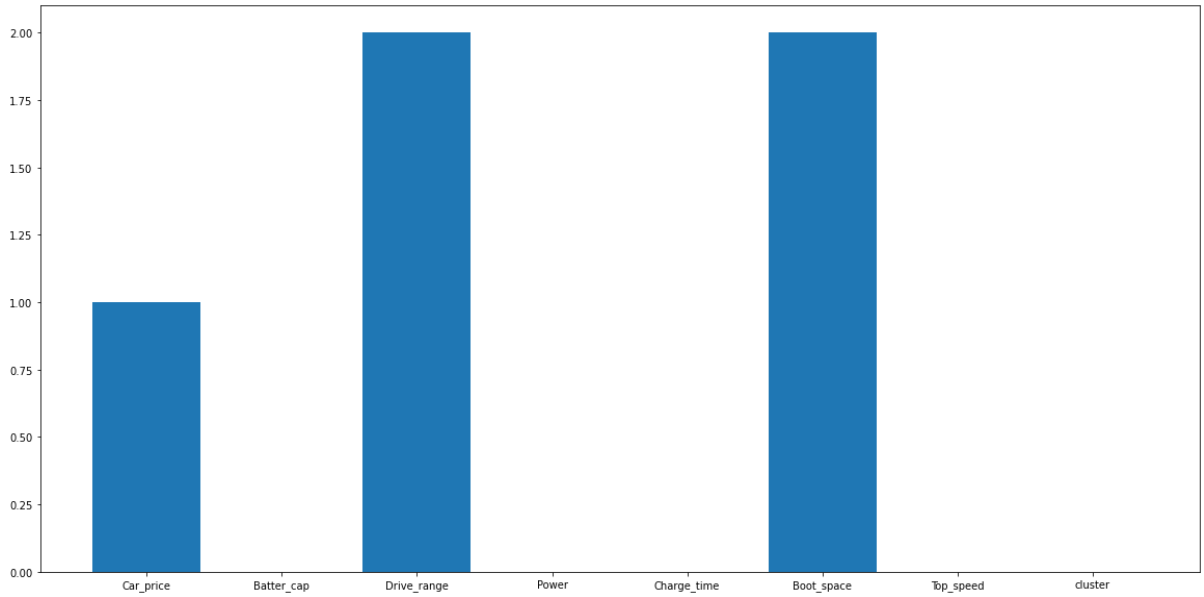
Segment 2 =Total Salary

Segment 3 = Salary

The following is the code for the segment profile plot for segmentation of cars.

```
from sklearn.cluster import AgglomerativeClustering
from scipy.cluster import hierarchy as shc
from sklearn.metrics import pairwise_distances
clust2 = AgglomerativeClustering(n_clusters = 3).fit_predict(pairwise_distances(X.transpose()))
plt.figure(figsize = (20,10))
plt.bar(X.columns,clust2)
plt.show()
```

The bar plot will be:



From this bar graph we have 3 segments:

Segment0 = Batter_Cap, Power, Charge_time, Top_speed

Segment1 = Car_price

Segment 2 =Drive Range, Boot Space

Selection of target segment

Marketing organisations often employ either a concentration strategy or a multisegmented strategy once an actionable segmentation technique has been established.

A corporation utilises a multi-segment strategy when it wants to concentrate its marketing efforts on two or more different market segments. For each category, the organisation creates a unique marketing mix. They then create marketing campaigns that are specific to each of these groups. This technique has the advantage of potentially increasing overall sales by utilising more marketing initiatives that target a wider audience. The drawback is the increased expenses, which result from the requirement for several marketing plans that may include price, distribution/delivery routes, pricing differential based on market segments, promotions, and communication plans.

From various plots from above shown the target segment can be based on the following condition:

- People prefer buying electric that take 6-12 hours to charge that give 200-500km range in one full charge.

- The preferred boot space is 300-400L when buying electric cars.
- People who are married prefer buying cars.
- People who are salaried are more likely to buy electric vehicles than businessman.
- People among the salary group 5lakh - 35 lakh and age group between 30-45 are more likely to buy electric vehicles.
- People mostly prefer buying SUVs in case of cars.

From all the above inferences the startup can build EVs in Scooters and Car categories (SUV). The EV should target people from the age group of 30-45 with a salary of 5lakh – 35lakh.