Market Segmentation

Segmentation analysis for Electric Vehicle Start-up in India's market

Team:

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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, air pollution, and other environmental issues. Project Drawdown describes electric vehicles as one of the 100 best contemporary solutions for addressing climate change.[2]

The **electric vehicle industry in India** is a growing industry. The central and state governments have launched schemes and incentives to promote electric mobility in the country and some regulations and standards are also in place. While the country stands to benefit in a large way by switching its transport from IC engines to electric motor-powered, there are challenges like lack of charging infrastructure, high initial cost and lack of electricity produced from renewable energy. Still, e-commerce companies, car manufacturers, app-based transportation network companies and mobility solution providers have entered the sector and are slowly building up electric car capacity and visibility.

India’s commitment to the EV30@30 initiative - to reach a 30 percent sales share for EVs by 2030 - presents a cumulative investment opportunity of as large as INR 19.7 lakh crore ($US266 billion). There has been a recent increase in public budgetary allocations and corporate investment in EVs in order to achieve this. Central and state governments have approved fiscal incentives for EVs, charging infrastructure, and manufacturing that are helping achieve parity in total cost of ownership with internal combustion engine (ICE) vehicles for several segments and use cases. Original equipment manufacturers (OEMs) and component manufacturers are investing in indigenous manufacturing and supply chains. EV startups are attracting significant venture funding due to their product and business model innovation, capturing as well as creating the market opportunity presented by EVs.

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 ERickshaw 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.

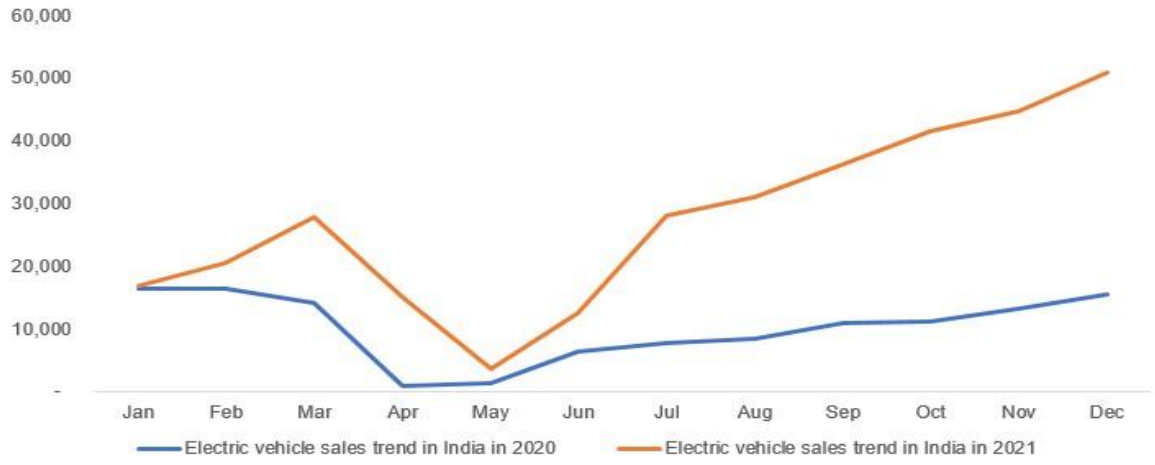
Benefits of electric vehicles:

- Electric vehicles are around 3–5 times more efficient than internal combustion vehicles in utilising energy. Even if electric vehicles run on electricity produced from fossil fuels, the overall efficiency of electric vehicles is still higher and the pollution is less, because large thermal power plants are much more efficient than IC engines, and it is easier to control emissions from power plants than vehicle engines.
- Electric vehicles save energy by regenerative braking. Around 30%–70% of the energy used for propulsion can be recovered, with higher percentages applicable to stop-and-go city driving.
- Air quality indices related to India indicate that the air in many cities of India is no longer healthy. Automobile related pollution has been one of the causes for this.
- Aspects related to global warming needs a shift to automobile solutions that reduce / do not produce greenhouse gas emissions. If electric vehicles run on electricity produced from non-polluting sources of energy like hydro, solar, wind, tidal and nuclear, they reduce emissions due to vehicles almost to zero.
- The need to reduce dependency on a fossil-fuel based economy. India's crude oil imports for 2014–15 was 112 billion dollars (approximately 7,00,000 crore rupees). For comparison, the allocation for the Mahatma Gandhi National Rural Employment Guarantee Scheme, in budget 2017–18, is 48,000 crore rupees.
- India can become a global provider for clean mobility solutions and processes that are affordable and scalable.
- Today we need revolution lane in electric vehicles to **maintain pollution free environment**. The problems like global warming and climate change are increasing day by day. We need to control the pollution and for that, electric vehicles can play a big roll.
- People living in some Indian cities are being affected by noise pollution. Some of the Indian cities have the worst noise pollution levels in the world. Electric vehicles are much quieter and may contribute to a reduction in noise pollution levels in the cities.
- Energy efficiency and emission reduction has improved in automobiles. Yet, the growth in total number of vehicles on road, and the resulting total pollution and total energy consumption removed all gains made by betterment in energy efficiency and emission reduction by automobiles. Energy efficiency measures and pollution control measures did not keep pace with the sales growth in vehicles. The total number of vehicles registered in India has been 5.4 million, 11 million, 33 million, 40 million and 210 million in the years 1981, 1986, 1996, 2000 and 2015. This indicates 39 times percentage growth in the total number of vehicles between 1981 and 2015. The total number of vehicles sold in India increased between 1,54,81,381 in 2010–11 and 2,04,69,385 in 2015–16 indicating a 30+ percentage growth in this five-year period.
- Through smart charging, electric vehicles can help to balance the balance-supply variations in the electricity grid, and provide a buffer against electricity supply failures.
- Electric vehicles have much fewer moving parts as compared to vehicles with IC engines. Thus, being simpler, they are cheaper and easier to maintain.

Market Overview:

The global electric vehicle (EV) market is developing at a rapid pace. According to EV volumes, overall electric vehicle reached a global share of 8.3% (including battery electric vehicles [BEVs] and Plug- in hybrid electric vehicles [PHEVs]) in 2021 from 4.2% in 2020 with 6.75 million vehicles on the road. This is an increase of 108% as of 2020. EVs are gaining attention across the globe as they help reduce emissions and depletion of natural resources. The Indian EV market is also evolving fast as close to 0.32 million vehicles were sold in 2021, up 168% YoY. Ongoing electric vehicle adoption in India is based on the Paris agreement to reduce carbon emissions, to improve the air quality in urban areas and reduce oil imports.

Electric Vehicle Sales Trend in India (2020-21)



EV Market in India

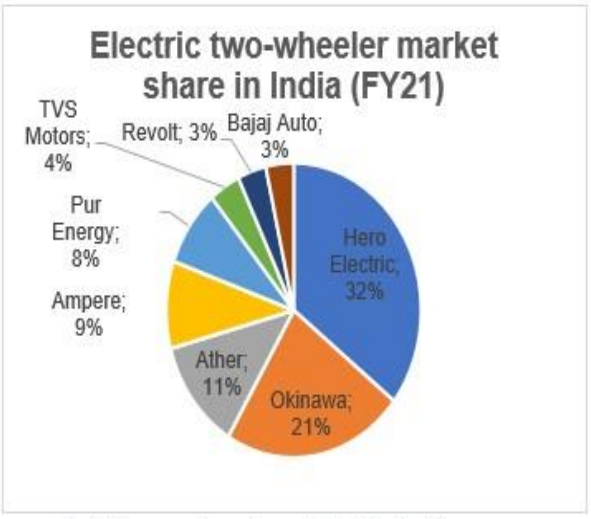
The Indian automobile industry is the fifth largest in the world and is expected to become the third largest by 2030. As per India Energy Storage Alliance (IESA), the Indian EV industry is expected to expand at a CAGR of 36%. As population rises and demand for vehicles grow, dependence on conventional energy resources is not a sustainable option as India imports close to 80% of its crude oil requirements. NITI Aayog aims to achieve EV sales penetration of 70% for all commercial cars, 30% for private cars, 40% for buses and 80% for two and three-wheelers by 2030. This is in line with the goal to achieve net zero carbon emission by 2070. Over the last three years, 0.52 million EVs were registered in India, according to the Ministry of Heavy Industries. EVs recorded robust growth in 2021, supported by the implementation of favourable policies and programmes by the government.

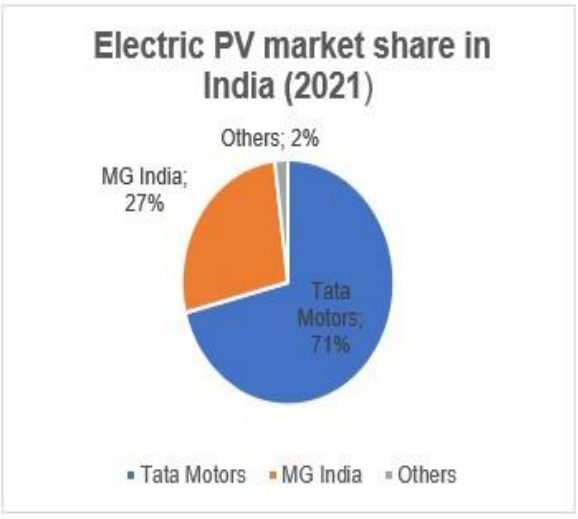
In India, Uttar Pradesh held the highest share in EV sales in 2021, with the number of units sold across all segments reaching 66,704, followed by Karnataka with 33,302 units and Tamil Nadu with 30,036 units. Uttar Pradesh dominated the three-wheeler segment, while Karnataka and Maharashtra led the two-wheeler segment and four-wheeler segment, respectively.

State -Wise-EV Sales Trend in 2021

Source: EV Reporter

Hero Electric, Okinawa and Ather Energy controls the electric two-wheeler market in India with a combined market share of 64%. Hero Electric has a market share of 36% followed by Okinawa with 21%. Ather Energy with an 11.1% market share is slowly gaining market share, as the company is currently expanding its distribution network across India. In the passenger vehicle segment, Tata Motors enjoys a commanding position in electric vehicle space with a market share of 71%, led by their two key models, Nexon and Tigor EV. MG Motors India enjoys the second position and offers the longest-range EV (MG EZS provides 439 KM range on a single charge). Other Indian manufacturers have announced their models and is expected to be launched in the future.





Business Opportunities

The EV push in India opens a plethora of business opportunities across three key segments – mobility, infrastructure and energy. These include opportunities in EV franchising, EV OEM market, battery infrastructure, solar vehicle charging and battery swapping technology among several others. According to NITI Aayog, the complete transition to EVs requires a total investment of US$ 267 billion (Rs.19.7 lakh crore) in EVs, battery infrastructure and charging infrastructure.

According to the Ministry of Skill Development and Entrepreneurship (MSDE), the EV industry could add 10 million direct jobs by 2030 which would create 50 million indirect jobs in the sector. Several automobile companies have plans to participate in the EV industry as listed in the table below:

Company	EV related plans
Kia	Kia plans to manufacture small SUV EVs in India for global markets in 2025.
Maruti Suzuki	Maruti Suzuki plans to launch its first EV model in India by 2025.
Tata Motors	Tata Motors bags an order worth US$ 678 million (Rs 5,000 crore) order from the government for electric buses; it plans to launch 10 more EVs in India.
Hyundai	Hyundai plans to launch IONIQ 5 EV in India by the second half of 2022.
Hopcharge	Hopcharge, a Gurgaon- based start-up has created the world's first on-demand doorstep fast charge service.
MG Motors	MG Motors India has partnered with Bharath petroleum for expanding the EV charging infrastructure.
Mahindra & Mahindra	Mahindra and Mahindra targets to launch 16 EV models across its SUV and LCV categories by 2027.

Market Segmentation:

Consumers frequently face the problem of selecting between conventional vehicles and hybrid electric vehicles. Although it has been anticipated that petroleum reserves will dry down in the years to come, owing to the present rate of consumption, consumers still see conventional vehicles as a better option.

The reason of this is higher flexibility and practicality that they offer with hybrid vehicles. This has led automobile manufacturers to develop vehicles that offer the benefits of both conventional and electric vehicles. This is the hybrid electric vehicles category. These vehicles come with an internal combustion engine and rechargeable batteries to drive the vehicle.

Apart from this, additional benefits associated with hybrid electric vehicles is the significant reason behind the tremendous growth of hybrid electric vehicles. The batteries of hybrid vehicles can be recharged through an internal combustion engine. Due to this, it has been witnessed that there is growth in the sales of hybrid vehicles which is much higher than pure and plug-in hybrid vehicles.

"In 2015, the government of India introduced a scheme – Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) – to promote clean fuel technology cars. This scheme was introduced under the National Electric Mobility Mission Plan (NEMMP) to mobilize a fleet of six million electric vehicles on Indian roads by 2020. For achieving their targets, the Indian government is planning to replace petrol and diesel variants being used by its agencies with electric vehicles.

This plan is to be executed by the government in the next three to four years. For making it possible, the Energy Efficiency Services Ltd (EESL), under the administration of the Ministry of Power and the government of India has taken an initiative by placing an order of 10,000 electric vehicles.

Table below shows a generalized view of market segmentation of electric vehicles in India:

By Technology	• Hybrid Electric Vehicle • Plug-In Hybrid Electric Vehicle • Battery Electric Vehicle
By Power Source	• Stored Electricity • On-Board Electric • Generator
By Vehicle Type	• Two Wheelers • Passenger Cars • Commercial Vehicles • Others (Golf Carts, etc.)
By Powertrain	• Series Hybrid • Parallel Hybrid • Combined Hybrid

Electric Vehicle Types:

The figure below shows various types of Electric Vehicle in different segments:

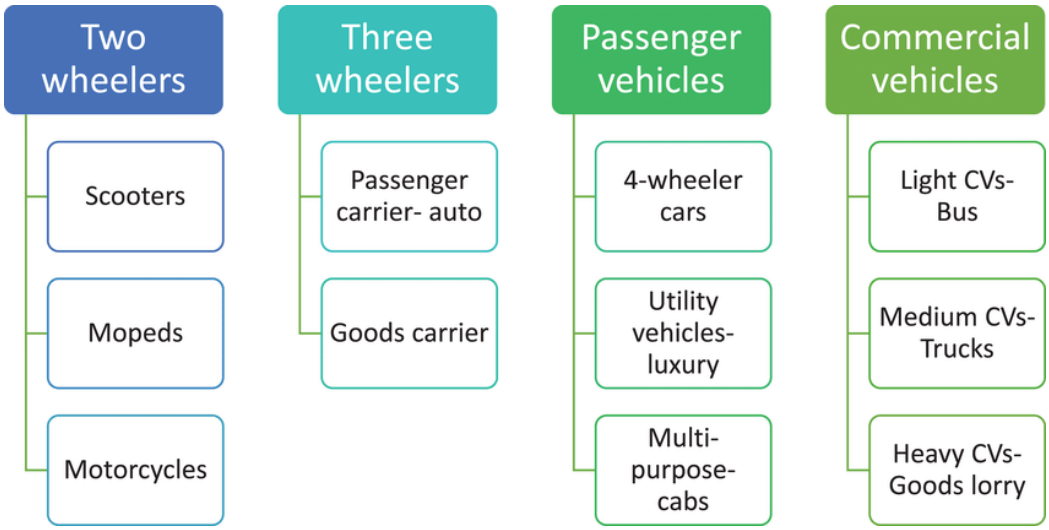


Figure: Types of Electric Vehicles in different segments

Geographical Segmentation:

To enter a market, one should be aware of the sales of the target product in different geographical areas. There should be a track on sales of target product of different segments in the geaographic segments available for the market.

The figure below shows the analysis of various segments of Electrical Vehicle sales in various geographical areas in India.

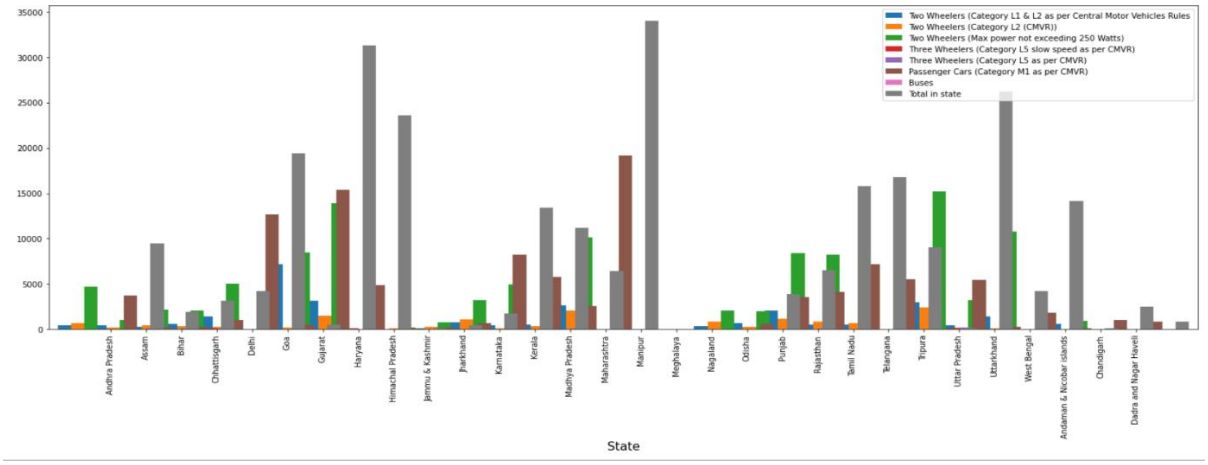


Figure: Sate-Wise sales of EV in India

Charging Stations location in India:

It is also very important to evaluate that a new introduce technology/product have available resources to execute in the market. Thus, it become necessary to evaluate number of charging stations/points for Electric Vehicles available in India to analyse any future needs, if any, for the charging stations.

As per the data available, below is the analysis of region-wise number of charging stations available in India:

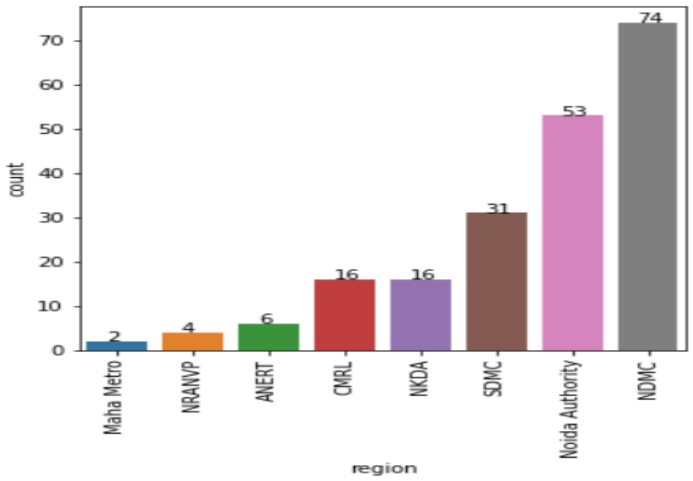


Figure: EV Charging Stations in India

Psychological Segmentation:

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.

Let's see the dependency of the variables:

Age:

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

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

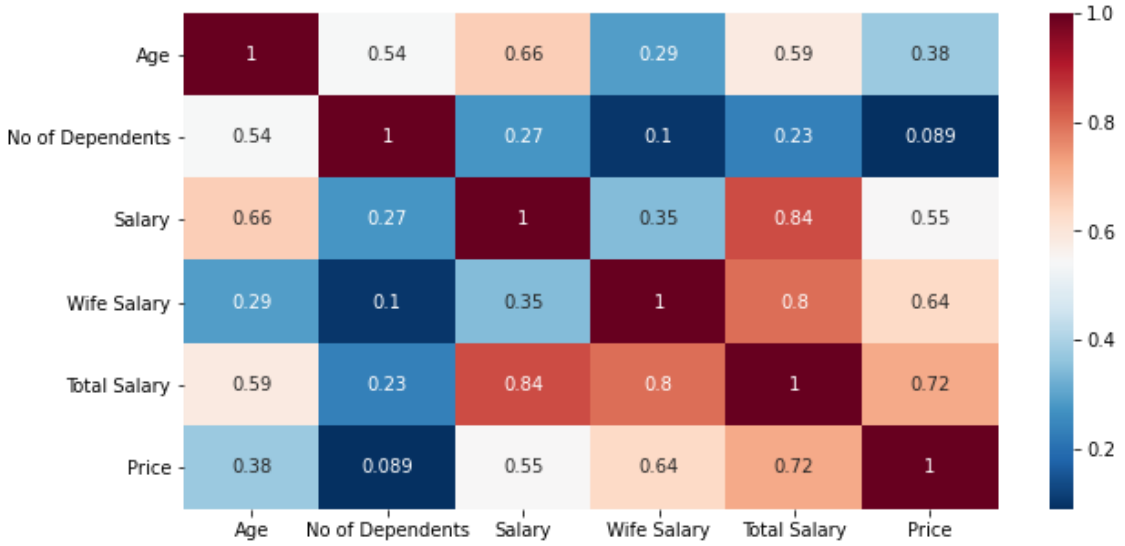
Total Salary:

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.

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.

Analysing the most important factors which affect the market of automobile, using a heatmap. We can compare all variables with all the other variables.



Extracting Segments:

K-Means 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.

Packages/ Tools used:

1. NumPy: To calculate various calculations related to arrays
2. Pandas: To read or load the datasets.
3. Matplotlib: To plot graph and charts
4. Seaborn: data visualization library based on matplotlib.

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.

Dataset:

1. Electric Vehicle Statistics dataset

```
[2]: # importing dataset EV-Stats-1
df_sales = pd.read_csv('EV Stats-1.csv',index_col=0)
df_sales.head()
```

[2]:

Sl. No	State	Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules	Two Wheelers (Category L2 (CMVR))	Two Wheelers (Max power not exceeding 250 Watts)	Three Wheelers (Category L5 slow speed as per CMVR)	Three Wheelers (Category L5 as per CMVR)	Passenger Cars (Category M1 as per CMVR)	Buses	Total in state
1	Andhra Pradesh	431	692	4689	0	0	3680	0	9492
2	Assam	463	138	1006	0	117	151	0	1875
3	Bihar	252	430	2148	6	64	271	0	3171
4	Chhattisgarh	613	382	2078	58	106	997	0	4234
5	Delhi	1395	251	5018	0	1	12695	21	19381

2. Electric Vehicle data

```
[17]: df_brand = pd.read_csv('ElectricCarData_Norm.csv')
      df_brand.head()
```

[17]:

	Brand	Model	Accel	TopSpeed	Range	Efficiency	FastCharge	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats	PriceEuro
0	Tesla	Model 3 Long Range Dual Motor	4.6 sec	233 km/h	450 km	161 Wh/km	940 km/h	Rapid charging possible	All Wheel Drive	Type 2 CCS	Sedan	D	5	55480
1	Volkswagen	ID.3 Pure	10.0 sec	160 km/h	270 km	167 Wh/km	250 km/h	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	Hatchback	C	5	30000
2	Polestar	2	4.7 sec	210 km/h	400 km	181 Wh/km	620 km/h	Rapid charging possible	All Wheel Drive	Type 2 CCS	Liftback	D	5	56440
3	BMW	iX3	6.8 sec	180 km/h	360 km	206 Wh/km	560 km/h	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	SUV	D	5	68040
4	Honda	e	9.5 sec	145 km/h	170 km	168 Wh/km	190 km/h	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	Hatchback	B	4	32997

3. Electric Vehicle Charging Station

```
[27]: # importing daset- EV charging station
      df_ch_stations = pd.read_csv('electric_vehicle_charging_station_list.csv')
      df_ch_stations.head()
```

[27]:

	no	region	address	aux addres	latitude	longitude	type	power	service
0	1	NDMC	Prithviraj Market, Rabindra Nagar, New Delhi- ...	Electric Vehicle Charger, Prithviraj Market, R...	28.600725	77.226252	DC-001	15 kW	Self Service
1	2	NDMC	Prithviraj Market, Rabindra Nagar, New Delhi- ...	Electric Vehicle Charger, Prithviraj Market, R...	28.600725	77.226252	DC-001	15 kW	Self Service
2	3	NDMC	Outside RWA Park, Jor Bagh Market, Jor Bagh Co...	Electric Vehicle Charger, Outside RWA Park, Jo...	28.588303	77.217697	DC-001	15 kW	Self Service
3	4	NDMC	Opposite Dory Pharmacy, Khanna Market, Aliganj...	Electric Vehicle Charger, Opposite Dory Pharma...	28.582654	77.220087	DC-001	15 kW	Self Service
4	5	NDMC	Opposite Goel Opticals, Khanna Market, Aliganj...	Electric Vehicle Charger, Opposite Goel Optica...	28.584485	77.220316	DC-001	15 kW	Self Service

4. Buying Behaviour Study

```
[32]: df_Buying_Behave = pd.read_csv('Indian automoble buying behavour study 1.0.csv')
      df_Buying_Behave.head()
```

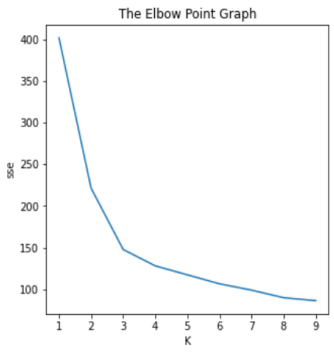
[32]:

	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

Calculating K using Elbow method

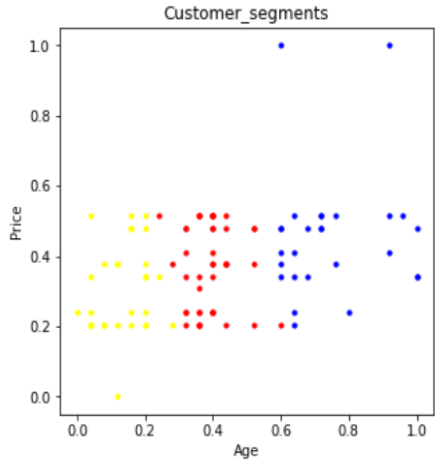
```
[75]: plt.title('The Elbow Point Graph')
      plt.xlabel('K')
      plt.ylabel('sse')
      plt.plot(k_range,sse)
```

```
[75]: [<matplotlib.lines.Line2D at 0x16a9ef05f10>]
```



From the above graph Elbow can be considered as 3

[79]:
```
clus = d.loc[:,["Age","Price"]].values
kmeans = KMeans(n_clusters=3, init='k-means++')
Y = kmeans.fit_predict(clus)
plotseg(clus, Y, ["Age","Price"])
```

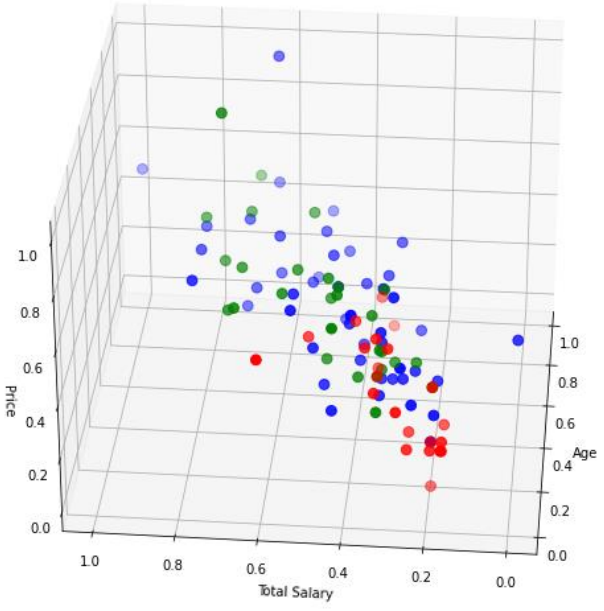


3rd dimensional visualization - Age, Total Salary, Price

[89]:
```
fig = plt.figure(figsize=(20,10))

ax = fig.add_subplot(111, projection='3d')
ax.scatter(d.Age[labels == 0], d["Salary"][labels == 0], d["Price"][labels == 0],  c='blue', s=60)
ax.scatter(d.Age[labels == 1], d["Salary"][labels == 1], d["Price"][labels == 1],  c='red', s=60)
ax.scatter(d.Age[labels == 2], d["Salary"][labels == 2], d["Price"][labels == 2],  c='green', s=60)
ax.view_init(30, 185)

plt.xlabel("Age")
plt.ylabel("Total Salary")
ax.set_zlabel('Price')
plt.show()
```



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 rise in Total Salary. The same is true for number of dependents too.

The visualizations provided gives a clear idea about the patterns.

References:

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- https://www.ibef.org/blogs/electric-vehicles-market-in-india
- https://www.persistencemarketresearch.com/market-research/india-electric-vehicles-market.asp
- https://www.researchgate.net/figure/Electric-vehicle-market-segment-in-India_fig1_352994590

GitHub:

- **https://github.com/RuhiNehri/EV-Segmentation-Analysis**