THE INDIAN ELECTRIC VEHICLE MARKET ANALYSIS

TEAM - PREMONVITHA

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Problem statement:

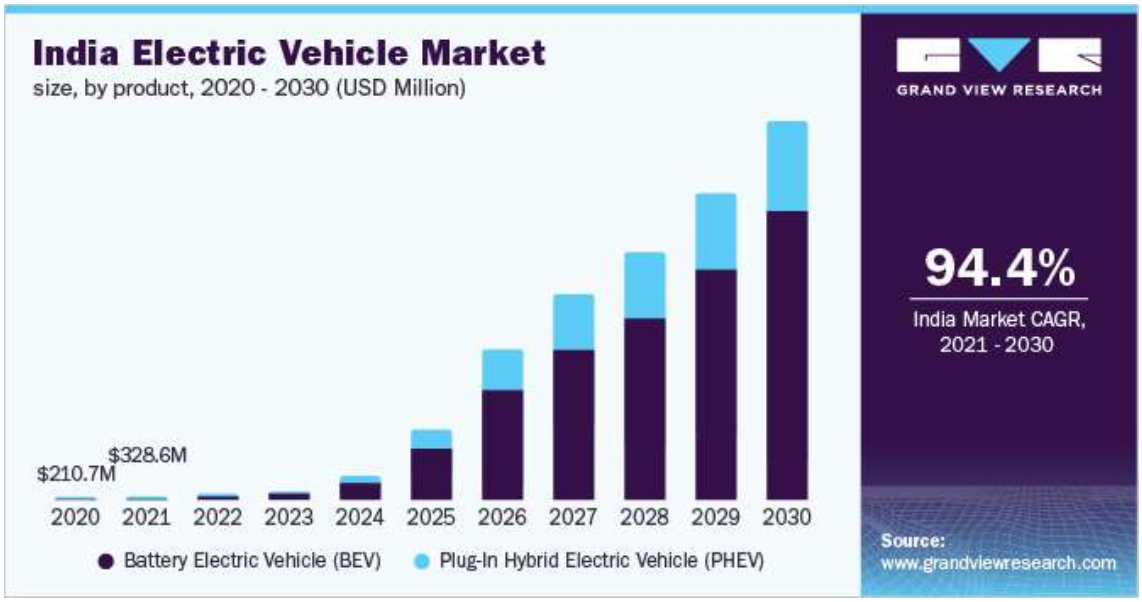
You are a team working for an electric vehicle startup. The startup is still deciding in which vehicle/customer space it will develop its EVs. You have to analyze the electric vehicle market in India using segmentation analysis and come up with a feasible strategy to enter the market, targeting the segments most likely to use electric vehicles.

Introduction:

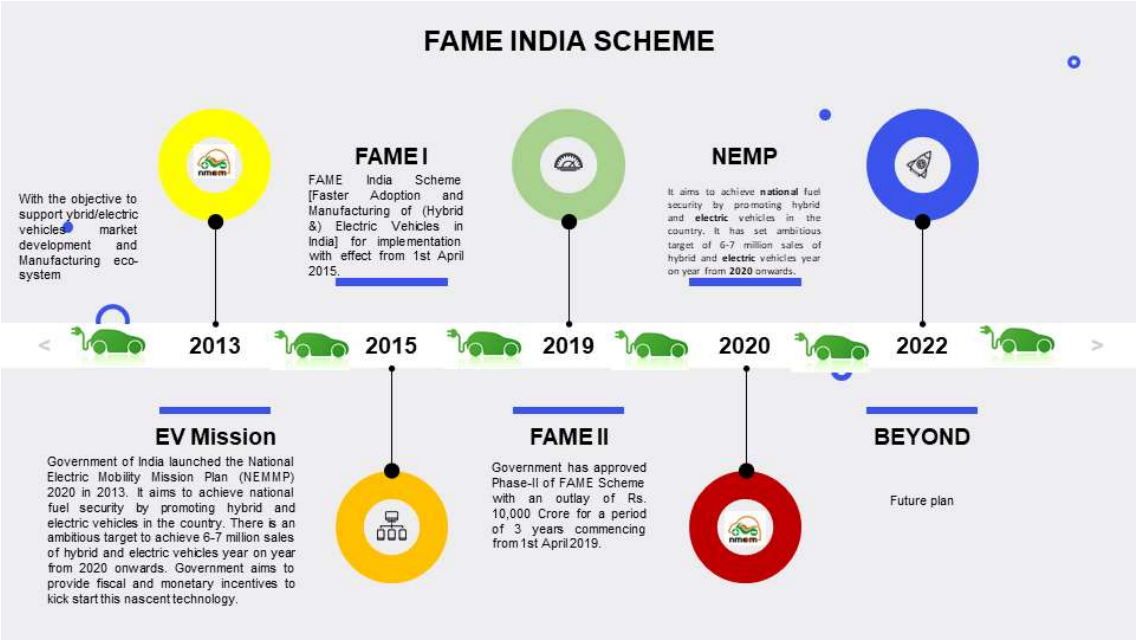
Electric vehicles are forms of transportation that operate solely on batteries.Due to their low noise and low environmental impact, electric vehicles are now very well-liked by users all over the world.

Electric vehicles are incredibly important in the modern world. Because of rising pollution levels and the effects of global warming, it is critical to transition to conventional energy sources.Mother Earth has suffered a great deal from our constant exploitation of her. Oil pollution is a significant source of exposure to hazardous gasses that are harmful to the environment's flora and fauna. Because fossil fuels like gasoline or diesel are not burned, electric cars have no emissions and are cleaner than conventional vehicles.

The Indian EV market, estimated at $1,435 billion in 2021, is predicted to grow at a CAGR of 47.09% between 2022 and 2027, reaching $15,398 billion. Rising fuel prices are a big motivator for vehicle owners and new buyers to look for cheaper options, and EVs fit the bill.According to experts, India will switch to all electric vehicles by 2030, necessitating the development of infrastructure for service centers and charging stations.



In India, the government has given EV companies a huge boost with the introduction of the FAME I and II schemes, the improvement of e-charging infrastructure, the reduction of Goods and Services Tax (GST) on EV purchases, and the provision of Rs 10,000 crore in subsidies. These schemes, in conjunction with production-linked incentive (PLI) schemes, scrappage policies, and the Make in India initiative, lay the groundwork for widespread EV manufacturing and adoption in the country. The Indian market, though, is cost conscious. Indian consumers constantly strive to get the best deal possible, which puts pressure on prices—a common occurrence in developing industries.



In India, the EV market is still very young. We have yet to witness the entire lifecycle of a single generation of EVs. Owning an EV necessitates a change in behavior regarding battery and vehicle maintenance. As a result, it is imperative that producers make it a top priority to inform customers about how to use and maintain their vehicles. All of these factors have an impact on one critical factory — safety. Only by educating the end-user on how safe EVs are for daily use will India's EV revolution be a success.

Standardization of technology, battery specifications, and other integral parts of an EV more suited to our country will help improve product quality and benefit the Indian EV industry. Right now, the Indian EV industry requires a 360-degree approach to ensure the safe and secure mass adoption of EVs.

This project's main goal is to analyze various datasets on electric vehicles and their market in order to provide meaningful insights that can be used to make informed decisions and aid in the creation of a solid strategic marketing plan.

Fermi Estimation:

Fermi estimation is a back-of-the-envelope calculation that is intended to teach dimensional analysis or the approximation of extremely difficult scientific calculations.
In business, it is often necessary to make quick estimates when neither time nor resources are available for making traditional assessments.
To use the fermi estimate to break down the problem statement, the right fermi questions must be asked.What is the size of the EV market(4 wheeler/2 wheeler) in India, according to the problem statement?

We will give a rough estimate for the aforementioned questions in this section, and after examining the data sources and conducting data analysis in accordance with the results, we will have appropriate solutions to compare with the rough estimate.

Calculating the size of India's EV market requires knowledge of the share of electric vehicles in the total vehicle population.
To do so, one must be aware of India's overall vehicle population.

- Let the estimate of India's population be 130 crores.
- Assume each household consists of 4 members. The total number of households in India would be 32.5 crores.
- Assuming 1 in every 10 households owns a vehicle(4 wheeler). So the 4 wheeler vehicle population of India would be approximately 4 crores.
- Assuming 3 in every 10 households owns a 2 wheeler vehicle. So the 2 wheeler vehicle population of India would be approximately 10 crores.

As per google current percentage of EV in India is at **0.15%**, So overall market size would be approx **2.1 lacs**. The **14 crore** vehicle population could be the future market size of EV in india.

Data Sources:

The data sources that were collected and used for the purpose of Electric Vehicle Market segmentation and analysis are:

1. **EV_Data.csv:** This dataset was to do the customer segmentation on the basis of various aspects like demographic, psychographic etc.source: https://www.kaggle.com/
2. **Active_EVs.csv:** This data was needed to get an perspective about overall vehicle vs EV distribution that are being actively used in different parts of India.
   source: https://www.kaggle.com/

3. **Charging_station_statewise.xlsx:** This data showcases the state wise charging stations allocated by the government for electric vehicles. source: https://data.gov.in/
4. **Charging_station_citywise.xlsx:** This data helped to analyze the city wise charging stations allocated by the government for electric vehicles. source: https://data.gov.in/
5. **Highwise_charging_station.csv:** This dataset provides a view of different EV charging ports available in various highways and expressways across India.

Data Preprocessing:

Data preprocessing, a component of data preparation, describes any type of processing performed on raw data to prepare it for another data processing procedure.This exploration stage also offers guidance on the most suitable algorithm for extracting meaningful market segments. At a more technical level, data exploration helps to:

- Identify the measurement levels of the variables.
- Investigate the univariate distributions of each of the variables.
- Assess dependency structures between variables.

EV_data.csv:

1. First import the necessary libraries required and load the dataset.

IMPORT LIBRARIES

In [1]:
```
#Import Libraries
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import sklearn
%matplotlib inline
import warnings
warnings.filterwarnings('ignore')
```

In [2]:
```
#Read File
df_Original = pd.read_csv('/kaggle/input/ev-data/EV_Data.csv')
pd.set_option('display.float_format', lambda x: '%.3f' % x)
df = df_Original.copy()
```

2. Next Check the information of data simultaneously looking for data type and null values in each variable.

In [7]:
```
#Data Preprocessing
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 15 columns):
 #   Column                                                    Non-Null Count  Dtype
---  ------                                                    --------------  -----
 0   Unnamed: 0                                                1000 non-null   int64
 1   Age                                                       1000 non-null   int64
 2   City                                                      1000 non-null   object
 3   Profession                                                1000 non-null   object
 4   Marital Status                                            1000 non-null   object
 5   Education                                                 1000 non-null   object
 6   No. of Family members                                     1000 non-null   int64
 7   Annual Income                                             1000 non-null   float64
 8   Would you prefer replacing all your vehicles to Electronic vehicles?  1000 non-null   object
 9   If Yes/Maybe what type of  EV would you prefer?           1000 non-null   object
 10  Do you think Electronic Vehicles are economical?          1000 non-null   object
 11  Which brand of vehicle do you currently own?              1000 non-null   object
 12  How much money could you spend on an Electronic vehicle?  1000 non-null   object
 13  Preference for wheels in EV                               1000 non-null   int64
 14  Do you think Electronic vehicles will replace fuel cars in India?  1000 non-null   object
dtypes: float64(1), int64(4), object(10)
memory usage: 117.3+ KB
```

In [8]:
```
df['Age'].unique()
```

Out[8]:
```
array([ 30,  27,  32,  55,  26,  28,  23,  25,  43,  59,  21,  29,  56,
        70,  50,  24,  61,  39,  31,  40,  18,  58,  22,  96,  64,  52,
        54,  42,  49,  57,  46,  36,  20,  19,  65,  17,  60,  44,  45,
        47,  82,  33,  37,  48,  69,  67,  86,  62,  66,  34,  63,  41,
        68,  16,  53,  15, 118,  38])
```

There are 1000 rows and 15 columns. As there are no null values after considering the data type we analyze for unique values in columns and with help of visualization perform univariate analysis on each variable. One column Unnamed is of no use so we dropped it. Data is ready for segment Analysis.

Active_EVs.csv,Charging_station_statewise.xlsx, Charging_station_citywise.xlsx, & Highwise_charging_station.csv:

1. Loaded the data sets, and there are no null values.

Analysis on Active Vehicles as on 08.12.2021 in India

n [58]:
```
Active_EVs = pd.read_csv('/kaggle/input/ev-data/Active_EVs.csv')
Active_EVs.head()
```

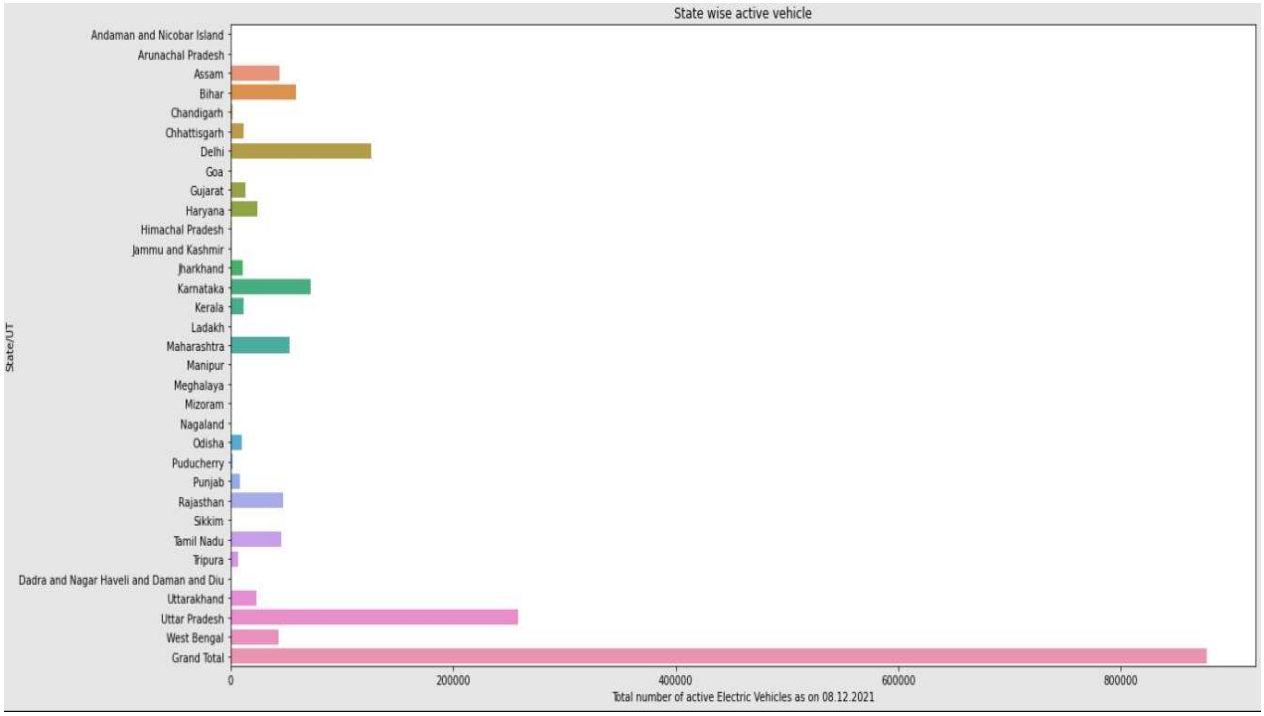
Out[58]:

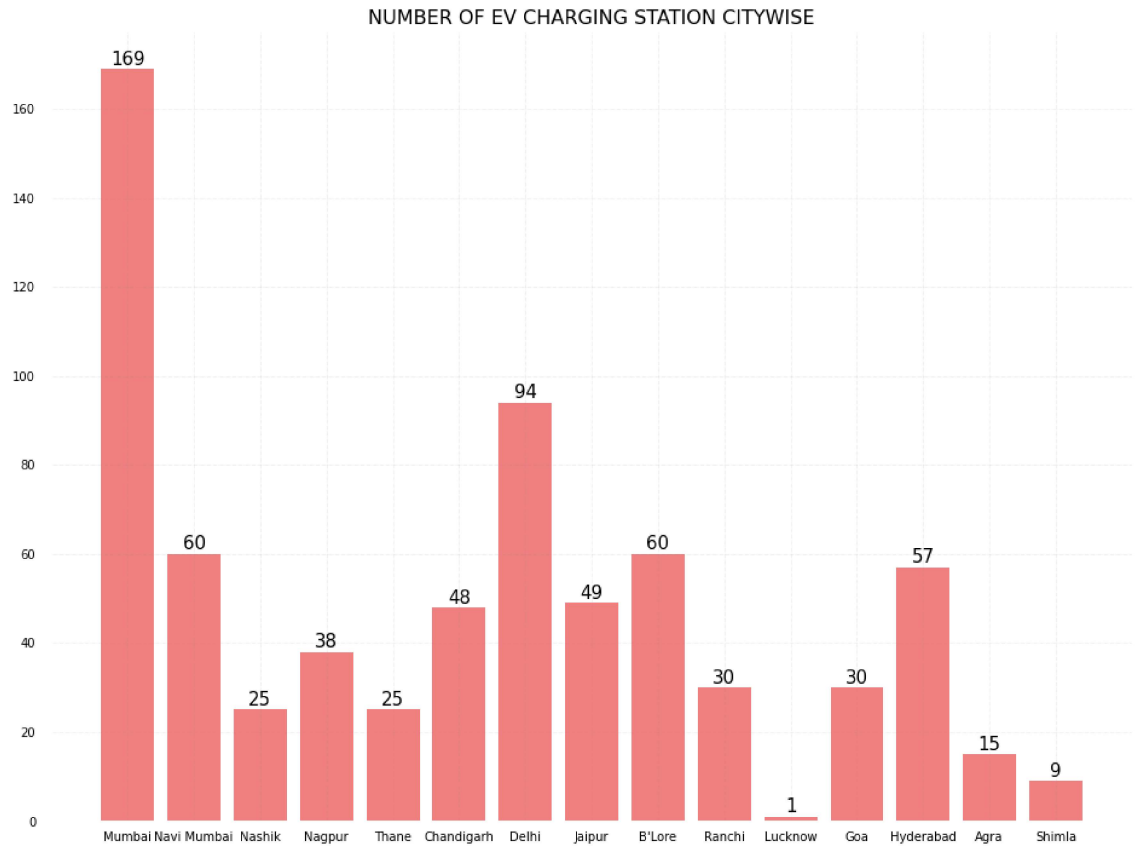
	Sl. No.	State/UT	Total Number of active Vehicle as on 08.12.2021	Total number of active Electric Vehicles as on 08.12.2021
0	1	Andaman and Nicobar Island	143529	157
1	2	Arunachal Pradesh	235189	20
2	3	Assam	4445227	43707
3	4	Bihar	9816784	58655
4	5	Chandigarh	720272	1791

n [59]:
```
Active_EVs.isnull().sum()
```

Out[59]:
```
Sl. No.                                                0
State/UT                                               0
Total Number of active Vehicle as on 08.12.2021        0
Total number of active Electric Vehicles as on 08.12.2021    0
dtype: int64
```

Further did some Visualization to get key Insights.


State wise active vehicle
Andaman and Nicobar Island
Arunachal Pradesh
Assam
Bihar
Chandigarh
Chhattisgarh
Delhi
Goa
Gujarat
Haryana
Himachal Pradesh
Jammu and Kashmir
Jharkhand
Karnataka
Kerala
Ladakh
Maharashtra
Manipur
Meghalaya
Mizoram
Nagaland
Odisha
Puducherry
Punjab
Rajasthan
Sikkim
Tamil Nadu
Tripura
Dadra and Nagar Haveli and Daman and Diu
Uttarakhand
Uttar Pradesh
West Bengal
Grand Total
State/UT
0
200000
400000
600000
800000
Total number of active Electric Vehicles as on 08.12.2021

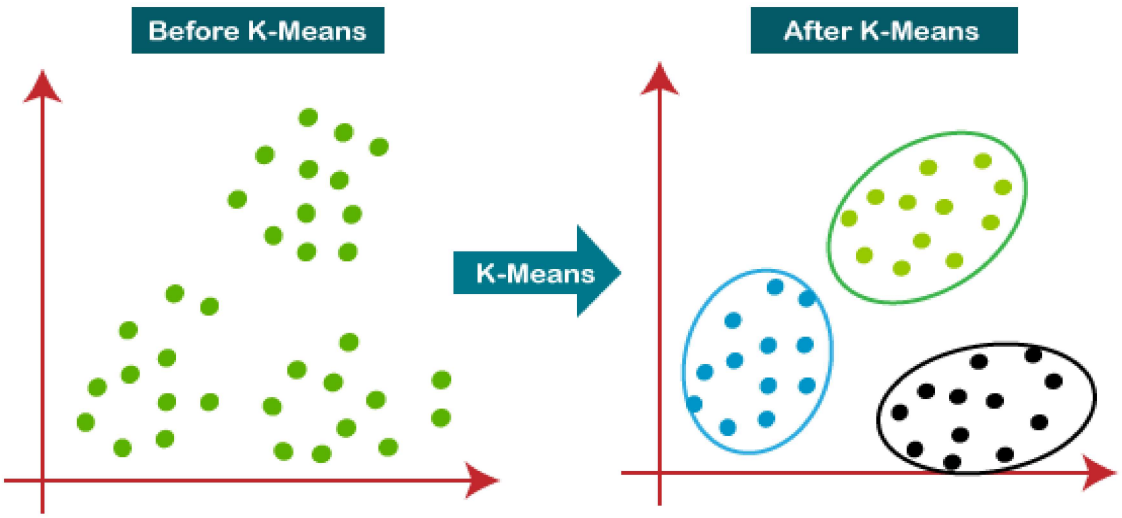

NUMBER OF EV CHARGING STATION CITYWISE
169
60
25
38
25
48
94
49
60
30
1
30
57
15
9
0
20
40
60
80
100
120
140
160
Mumbai
Navi Mumbai
Nashik
Nagpur
Thane
Chandigarh
Delhi
Jaipur
B'Lore
Ranchi
Lucknow
Goa
Hyderabad
Agra
Shimla

Segment Extraction (ML techniques used):

Segmentation in terms of marketing is a task of processing customer analytics and dividing them with respect to several features in such a way that a specific product/service can be presented to them in a way that appeals to their interests. Segment extraction basically means to extract these segments with respect to the insights we get from analysis of these features.

The machine learning techniques we used for segment extraction are:

1. K-Means Clustering: K-Means Clustering is an Unsupervised Learning algorithm that divides an unlabeled dataset into clusters. K denotes the number of predefined clusters that must be created during the process. It enables us to cluster the data into different groups and provides a convenient method for discovering the categories of groups in the unlabeled dataset without the need for training.
   It is a centroid-based algorithm, with each cluster having its own centroid. This algorithm's main goal is to minimize the sum of distances between data points and their corresponding clusters.
   - The k-means clustering algorithm is primarily responsible for two tasks: Iteratively determines the best value for K center points or centroids.
   - Each data point is allocated to the nearest k-center. A cluster is formed by data points that are close to a specific k-center.



Profiling and describing potential segments:

1. Age of Customer:

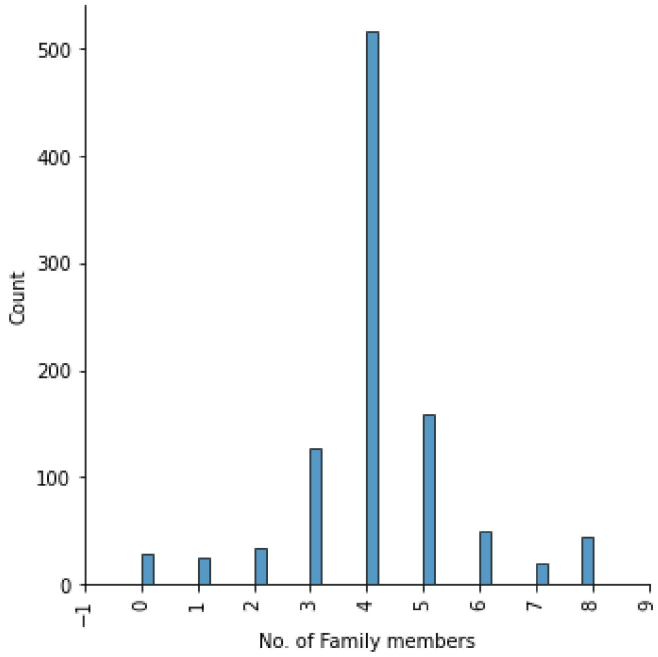
As per the univariate analysis done EV_data.csv one characteristic of the potential segment would be age. Most of the customers' ages are in the range of 20 yrs to 40 yrs.

2. Location of customer :

Location can play a vital role in companies growth and to build customer base. Further Analysis on city variable provides us with a potential city for the EV market as another characteristic of a potential market segment. The data suggest top priority to be Pune, Mumbai, & New delhi.

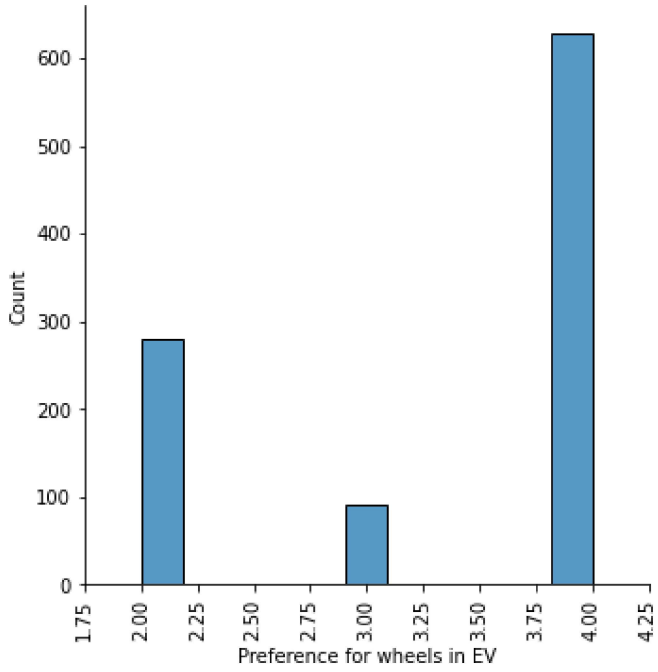
3. Family size of customer:

In modern India, every household needs a vehicle for transportation. Keeping this in mind Family size will help us determine the kind and size of vehicles.



4. Vehicle Wheel Type:

Regarding the number of wheels on a vehicle, wheel type also creates a variety of market segments that serve various customer bases. Making a potential market segment using this information may be beneficial.



5. Price Of EV:

Many market segments could be created based on the EV vehicle's selling price, and this gives us the chance to tailor the product to the needs and wants of affluent customers.

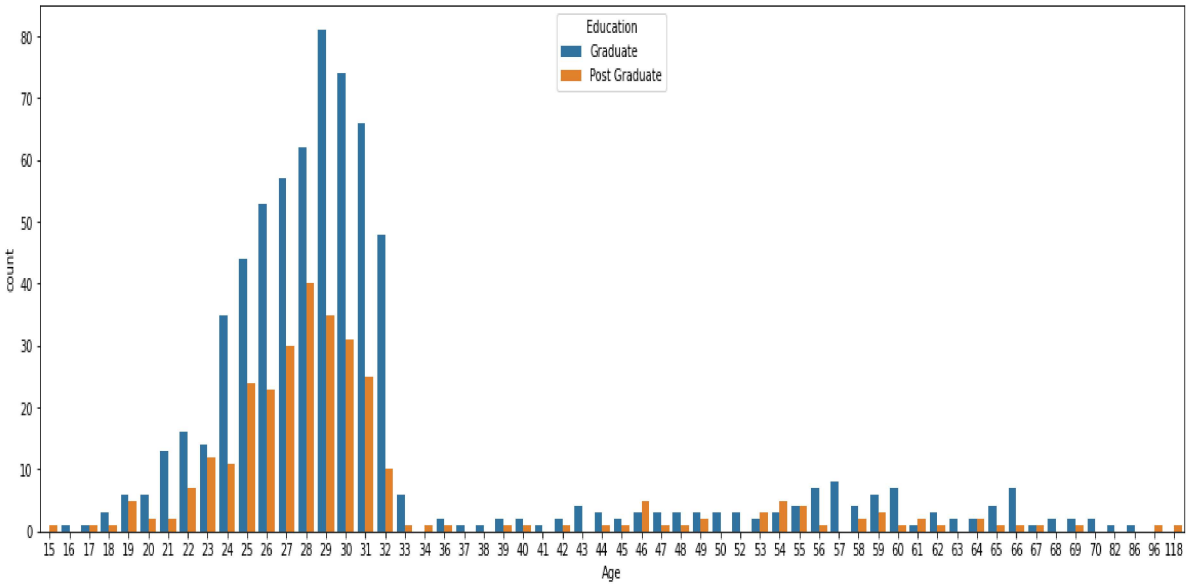
Selection of target segment:

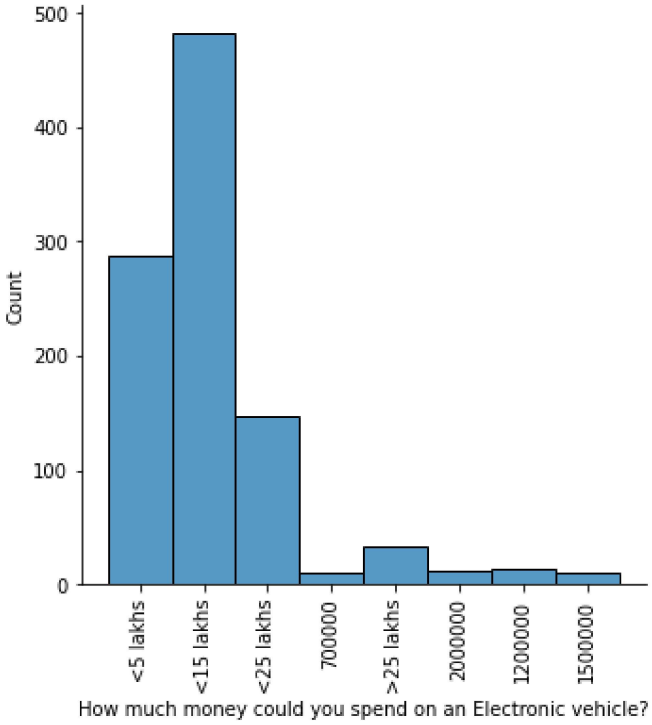
The process of selecting a target market (or markets) is known as S-T-P (Segmentation-Targeting-Positioning). Before developing a positioning strategy, an organization must first segment the market and determine the target (or targets) for the marketing plan.

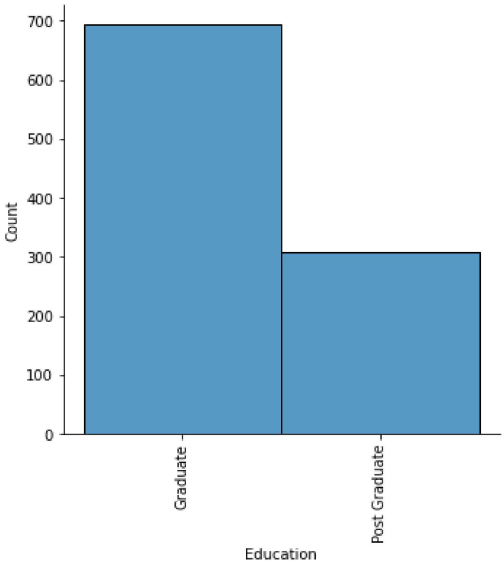
After the analysis of the electronic vehicles data in India that target segments that was inferred by us were:

- ## Targets w.r.t Demographic segmentation:

  It was inferred that most preferred targets for this market are the population who are between the age of 28-31 preferably graduates. With respect to income the people that earn from Rs. 20,64,995 to Rs. 28,12,149 per year must be focused on marketing strategy.

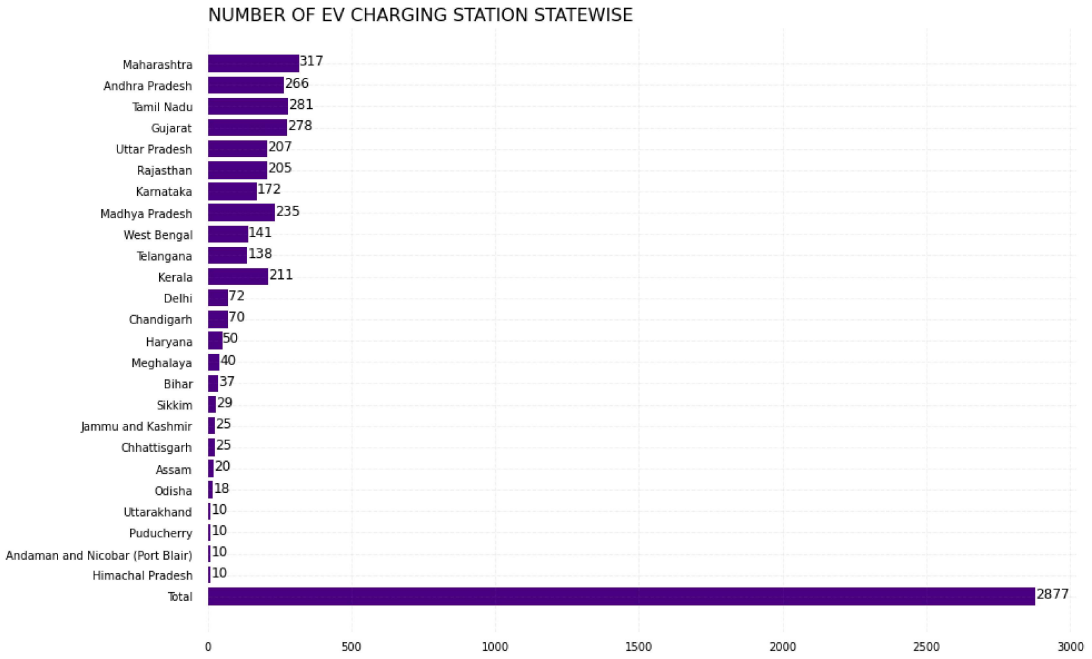


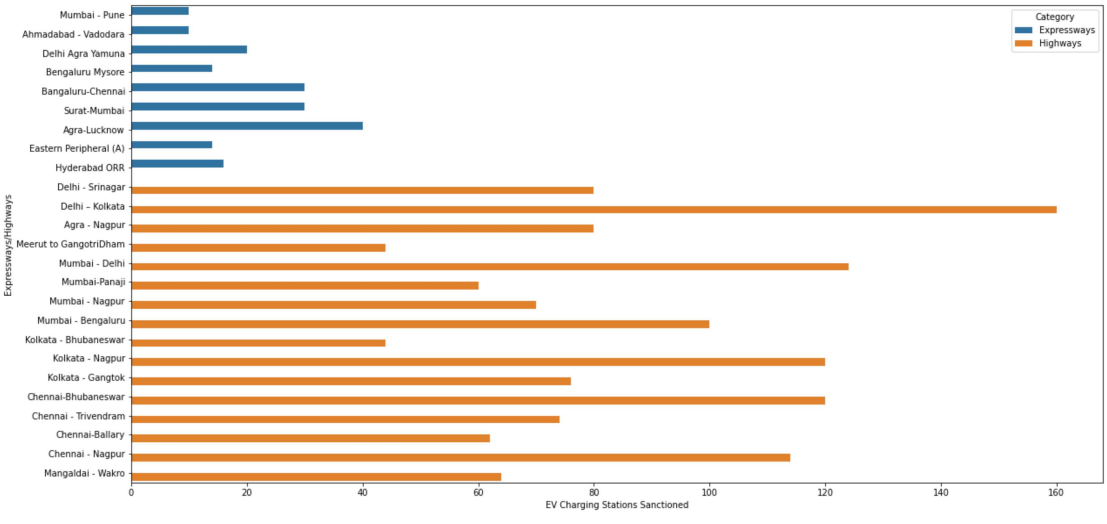

500
400
300
200
100
0
Count
<5 lakhs
<15 lakhs
<25 lakhs
700000
>25 lakhs
2000000
1200000
1500000
How much money could you spend on an Electronic vehicle?


700
600
500
400
300
200
100
0
Count
Graduate
Post Graduate
Education

- ## Targets w.r.t Geographic Segmentation:

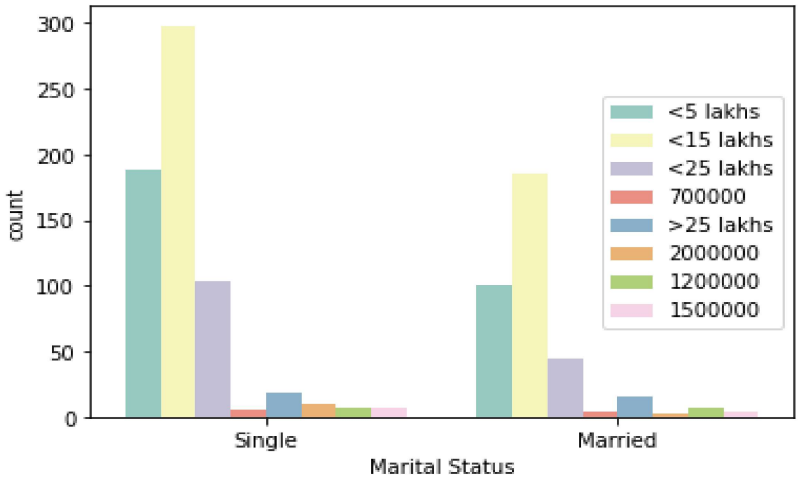
  The primary location that should be targeted are Pune, Mumbai, New Delhi and Bengaluru based on Segmentation Analysis and the infrastructures sanctioned by government such as availability of the EV charging stations in the different states and cities.

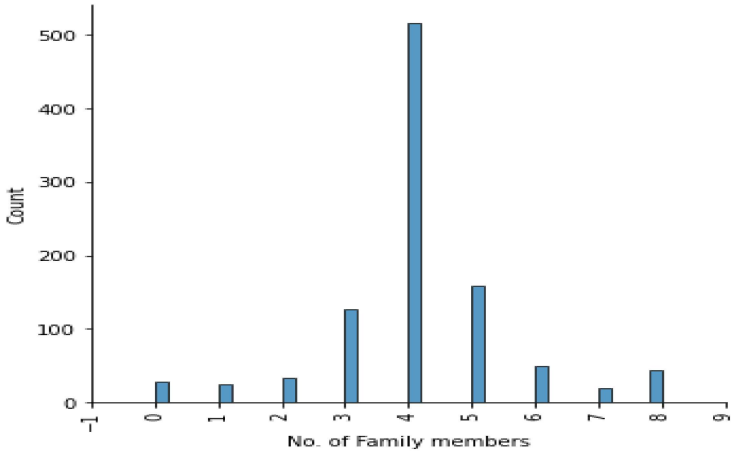




- ## Targets w.r.t Psychographic (lifestyle) Segmentation:

  According to the data analysis and segmentation it was found that the main objective of the marketing strategy should focus on the single (unmarried) citizens and following that the family with few members i.e around 3-5 members should me the target for the EV marketing strategy.





The market mix:

The tools or ingredients or the variables mixed together by the marketers to interact with a specific market are known as **Marketing Mix.** It is the essence of any marketing endeavor and is the main building block of the marketing efforts of an organization. The concept of marketing says that on the side there is the producer or marketer and on the other side there is the customer.

1. Product:

Product Mix means the important decisions related to a product like the design of the product, quality of the product, the quantity of the product, packaging of the product, etc. it depicts the tangible or intangible goods offered by organizations to customers to satisfy their needs and wants.

According to the research, customers have expressed a strong interest in buying SUVs, Sudan, and hatchbacks.
Additionally, consumers favor brands like TATA, Hyundai, Honda, and Kia because they embody the values of

- Tata: robust, safe, and affordable.
- Hyundai: Comfortable, original design.
- Honda: Performance and Durability.
- KIA: Efficiency and innovative features.

These are the characteristics that customers favor.

Two-wheelers are another popular product category that businesses should investigate because they have a sizable market in India and are more quickly switching from conventional to electric power.

2. Price:

Price is the value of a product or service passed on by the buyer to the seller. As a customer is very sensitive about the price of a product, it is a crucial element of the marketing mix.

According to the analysis, the majority of customers prefer EV vehicles that cost less than 15 lakh. To serve an early customer base, our recommendation would be to produce Sudan-type EVs for less than 15 lakhs. If a company wants to make an SUV, only 15.32% of customers are willing to pay more than 15 lakhs.

3. Place:

It is essential to make the product or service available to the customer at the right place and at the right time, then only the customer would be able to purchase the product or service. **Place Mix** is an important decision and is related to the physical distribution of the goods and services to the customers.

Based on a segmentation analysis and the infrastructure that the government has approved, Pune, Mumbai, New Delhi, and Bengaluru are the locations that should be taken into consideration.

4. Promotion:

The last element of the marketing mix is promotion, which includes activities undertaken by the marketer to communicate with the customers and distribution channels so they can enhance the sales of the firm.
Promotion Mix is an important decision and includes all decisions of an organization related to the promotion of a sale of goods and services. Some of the important decisions under promotion mix are selecting a media to advertise the product, selecting promotional techniques, public relations, etc.
Focusing on the single market for two-wheelers can be a successful marketing strategy, and for the time being, four-wheelers can serve nuclear families with better sales and business growth.

MOST OPTIMAL MARKET SEGMENTS:

It is essential to determine your company's potential for profit and revenue in a selected market. That is the goal of comprehensive market research. You will be better equipped to make decisions about your business based on accurate data about your market. The most crucial goal of all will be established with the assistance of good market research: your goals for sales. Your investors, lenders, business partners, key employees, and other stakeholders also have a stake in your potential for sales and market share.

Researching the market's overall size of the number of customers and potential customers, the total amount spent on annual sales, the number of competitors already present, and the market's long-term outlook is the first step in determining your desired market share.

In our research and analysis, we found that the majority of the target audience includes the young singles (unmarried) people of metropolitan cities like Mumbai, Delhi etc. Furthermore, it was found that **49.09%** of people only want to spend **<15 lakhs for EV**, **30.12%** of people only want to spend **<5 lakhs** and **15.32%** of people only want to spend **<25 lakhs**.

By this, we can infer most customers want to invest less than 15 lakhs for their EV. Considering **SUV, Sedan and Hatchback** as the **most preferred vehicle type**. Interestingly, Considering the money Customers can spend on EV and manufacturing cost for the company with respect to different EV types. Thus, Company should focus on making 'Sedan' in the price range less than 15 lakhs and If the company wants to make SUVs, only 15.32% of customers are willing to pay more than 15 lakhs. By applying this strategy on our marketing plan then the company can profit.

GITHUB links:

1.https://github.com/Aaryan-palit/EV_Market_Segmentation_Feynn_Labs
2.https://github.com/mohsin-syed-vazir/EV_market_segmentation_feyn_labs
3.https://github.com/AdarshKarthik/EV_Segmentation
4.https://github.com/Premonvitha-Sai/Feynn_EV_Segmentation.git

References:

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https://www.google.co.in/
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https://data.gov.in/