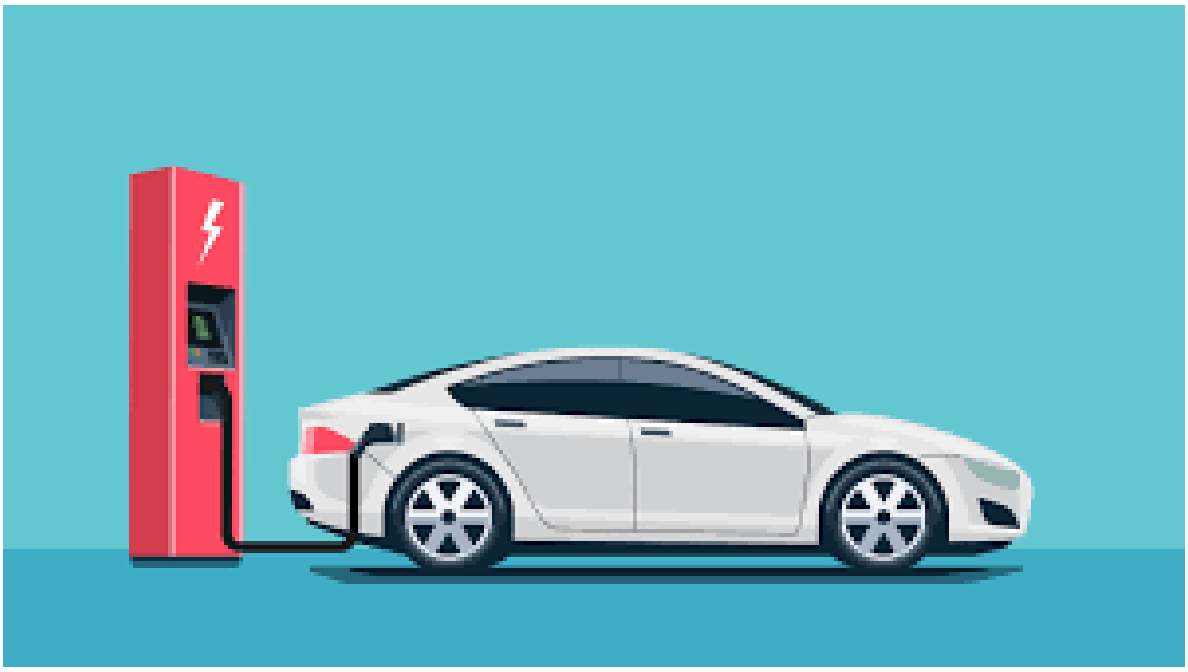
# ELETRIC VEHICLE MARKET SEGMENTATION




**Team Daidipya-**

**Moushreeta Debroy**

**Shraddha Deori**

**Kapil Dev Yadav**

**Daidipya Sisodiya**

# Fermi Estimation

**Problem Statement-**
You are a team working under an Electric Vehicle Startup. The Startup is still deciding in which vehicle/customer space it will be develop its EVs.

You have to analyse 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.

To better understand the market segmentation of the Electric Vehicle (EV) market in India, let's perform a Fermi estimation based on the given problem statement.

**1. Estimated Total Potential Customers:** Considering the population of India (approximately 1.3 billion), let's assume a certain percentage of individuals are potential customers for EVs based on factors such as affordability, awareness, and environmental consciousness. Assuming a conservative estimate of 10% of the population as potential customers, we can estimate around 130 million potential customers.

**2. Seating Capacity Preference:** Let's assume that customers in the EV market have varied seating capacity preferences. Based on general observations and market trends, we can estimate that around 40% of potential customers prefer 5-seater cars, while 30% prefer 4-seaters and the remaining 30% prefer 7-seaters. This estimation results in approximately 52 million potential customers for 5-seaters, 39 million for 4-seaters, and 39 million for 7-seaters.

**3. Price Range Distribution:** Assuming a range of EV prices in the market, let's estimate the distribution of potential customers across different price ranges. Based on market knowledge and analysis, we can estimate that approximately 25% of potential customers are interested in EVs priced below 5 lakhs, 40% in the range of 5-10 lakhs, and the remaining 35% in the range of 10-30 lakhs. This estimation results in approximately 32.5 million potential customers in the below 5 lakhs price range, 52 million in the 5-10 lakhs range, and 45.5 million in the 10-30 lakhs range.

**4. Horsepower Preference:** Assuming an equal distribution of customers across horsepower `with horsepower above 200.

These Fermi estimates provide a broad understanding of the market segmentation for the EV market in India. Further analysis and data validation are necessary to refine these estimations and gain more accurate insights into the specific market segments.

# ELECTRIC VEHICLE MARKET

The electric vehicle (EV) market is growing rapidly, driven by several factors, including increasing environmental consciousness, government incentives, and technological advancements. In 2022, global sales of electric cars reached a record 10 million, and sales are expected to continue to grow in the coming years.

The largest EV market is currently China, followed by the United States and Europe. China has been a major driver of the EV market, due to government policies that have supported the development of the industry. The United States and Europe are also seeing strong growth in EV sales, as consumers become more aware of the benefits of electric vehicles.

There are a few factors that are expected to continue to drive the growth of the EV market in the coming years. These include:

- **Increased environmental consciousness:** As consumers become more aware of the environmental impact of gasoline-powered vehicles, they are increasingly looking for alternative transportation options. Electric vehicles are zero-emission vehicles, which makes them a more sustainable choice.
- **Government incentives**: Many governments around the world are offering incentives to consumers who purchase electric vehicles. These incentives can take the form of tax breaks, rebates, or free parking.

- **Technological advancements:** Technological advancements in battery technology are making electric vehicles more affordable and practical. Batteries are becoming more energy-dense, which means that electric vehicles can travel longer distances on a single charge. The growth of the EV market is having a significant impact on the automotive industry. Traditional automakers are investing heavily in electric vehicle development, and new startups are entering the market. The EV market is still in its early stages, but it is poised for significant growth in the coming years. Here are some of the key trends in the EV market:
- **The rise of battery electric vehicles (BEVs)**: BEVs are the most common type of electric vehicle, and they are expected to continue to dominate the market in the coming years. BEVs are powered by batteries, and they do not have an internal combustion engine.
- **The growth of plug-in hybrid electric vehicles (PHEVs)**: PHEVs are a type of electric vehicle that has both an electric motor and an internal combustion engine. PHEVs can be driven on electricity for a limited distance, and then the internal combustion engine kicks in.
- **The development of hydrogen fuel cell vehicles (FCEVs)**: FCEVs are a type of electric vehicle that uses hydrogen fuel cells to generate electricity. FCEVs are still in the early stages of development, but they have the potential to offer longer range and faster refuelling than BEVs. The EV market is a rapidly growing and evolving market. The trends mentioned above are just a few of the factors that are shaping the future of the EV market. It will be interesting to see how the market develops in the coming years.

# Kapil Dev Yadav

Following analysis is based on **Geographical** segmentation variable representations of EV market in India across states and cities.

## Data

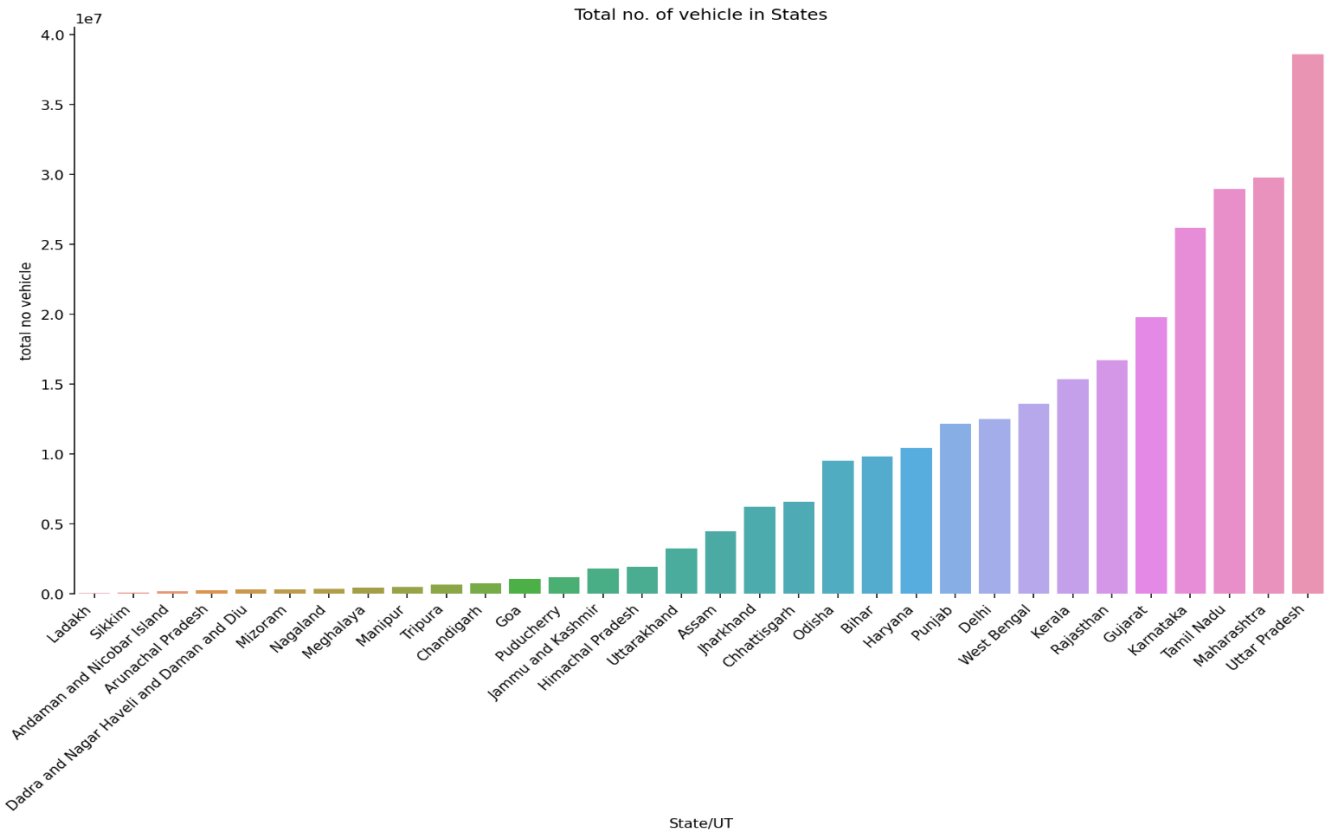
Data used in this study have been taken from government websites and from Kaggle.

1. https://dash.heavyindustries.gov.in/dhiev
2. https://data.gov.in/search?title=ELECTRIC%20VEHICLES

Data on total no. electric vehicles, no. charging stations, vehicle population have been used to generate visualizations giving an insight how Indian EV market is distributed across India.

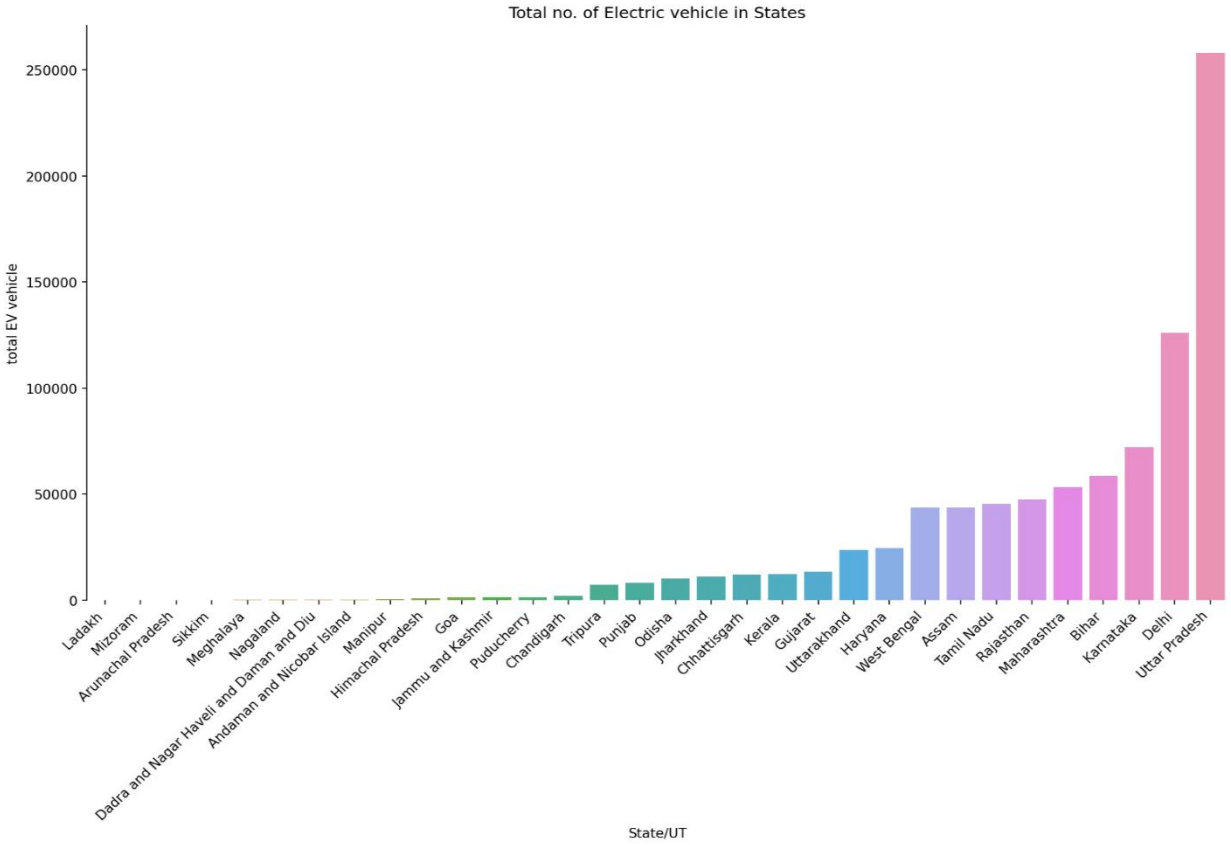
## EDA

To visualize the penetration of Electric vehicle in Indian Automobile sector comparison with other fuel type vehicle we first need to project total vehicle population.



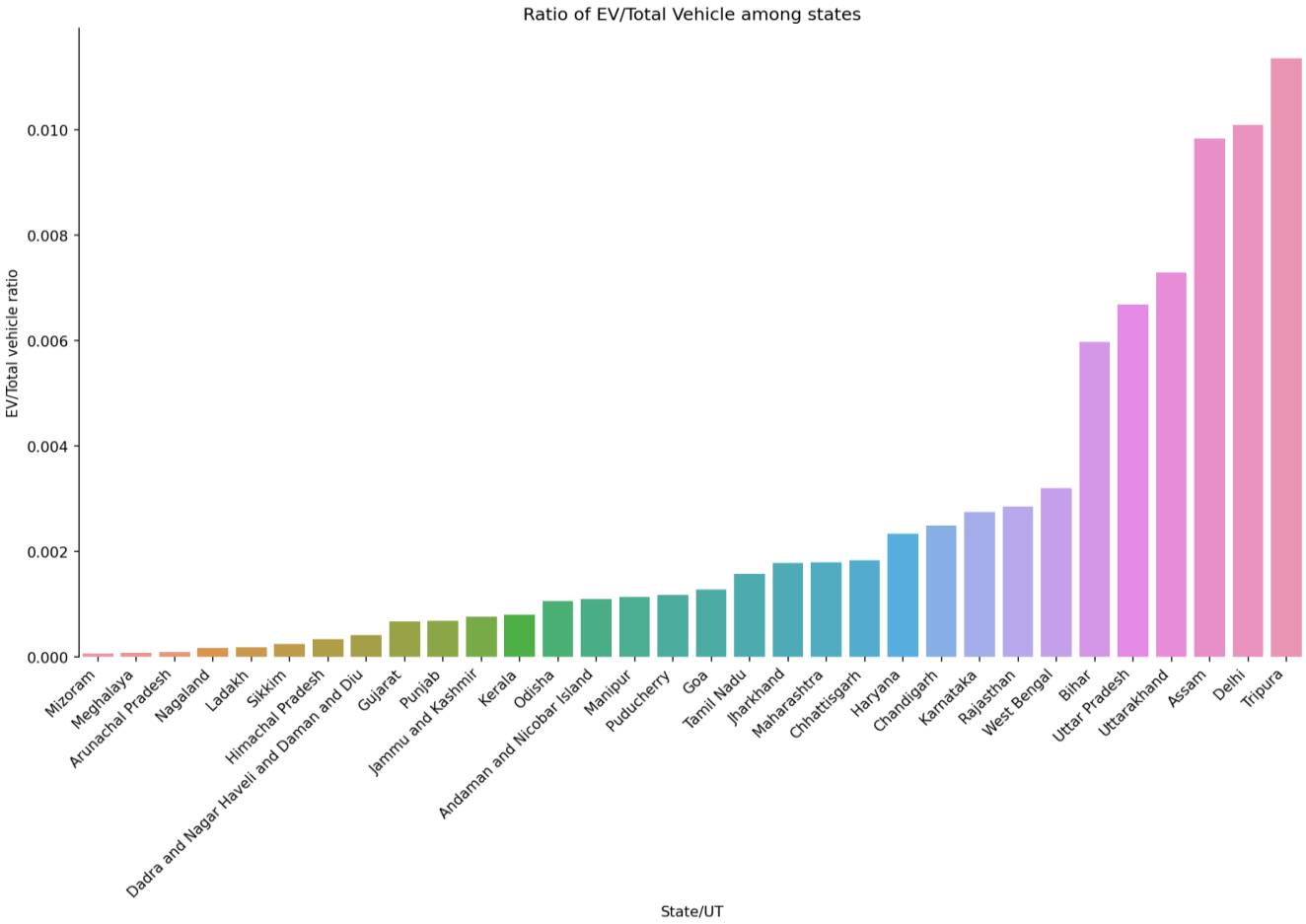

Here only we can easily infer from the above that the states like Uttar Pradesh, Maharashtra, Tamil Nadu, Karnataka and Gujrat are among the top 5 vehicle population that may be reason of human population, wealth ratio or spending behaviour that can describe this but that is a different aspect of segmentation.

**Projection of electric vehicle in India**



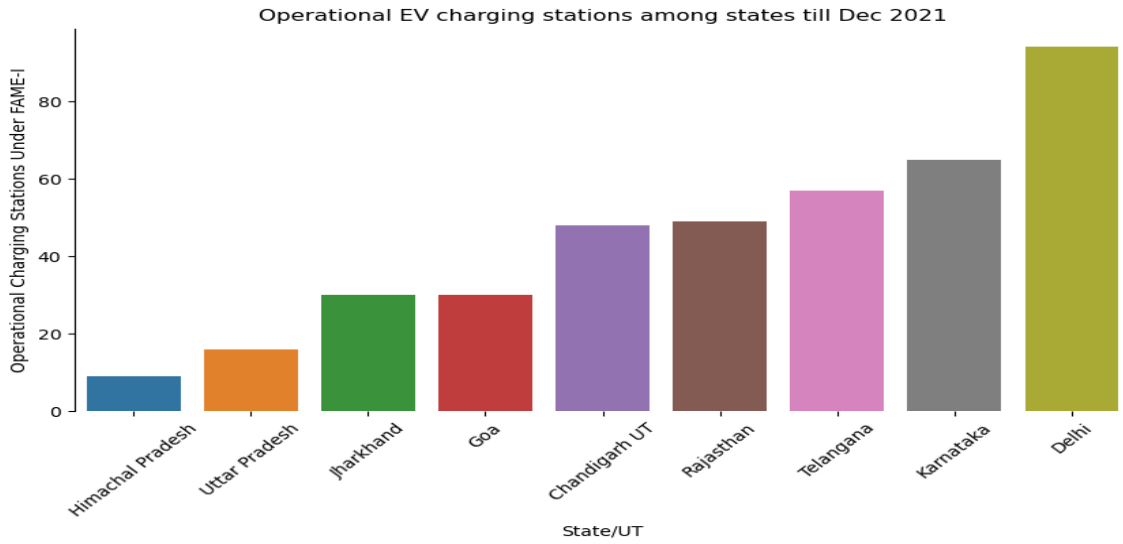
States Uttar Pradesh, Delhi, Karnataka, Bihar and Maharashtra are having top numbers of electric population.

Comparing the ratio of total vehicle with that of EV's in that state we can derive that people of Tripura, Delhi, Assam, Uttara Khand and Uttar Pradesh are having an edge in adopting Electric Vehicle as their choice. May be, it is the impact of literacy, awareness about pollution or the government schemes that leads to it. That's rest to further insights.



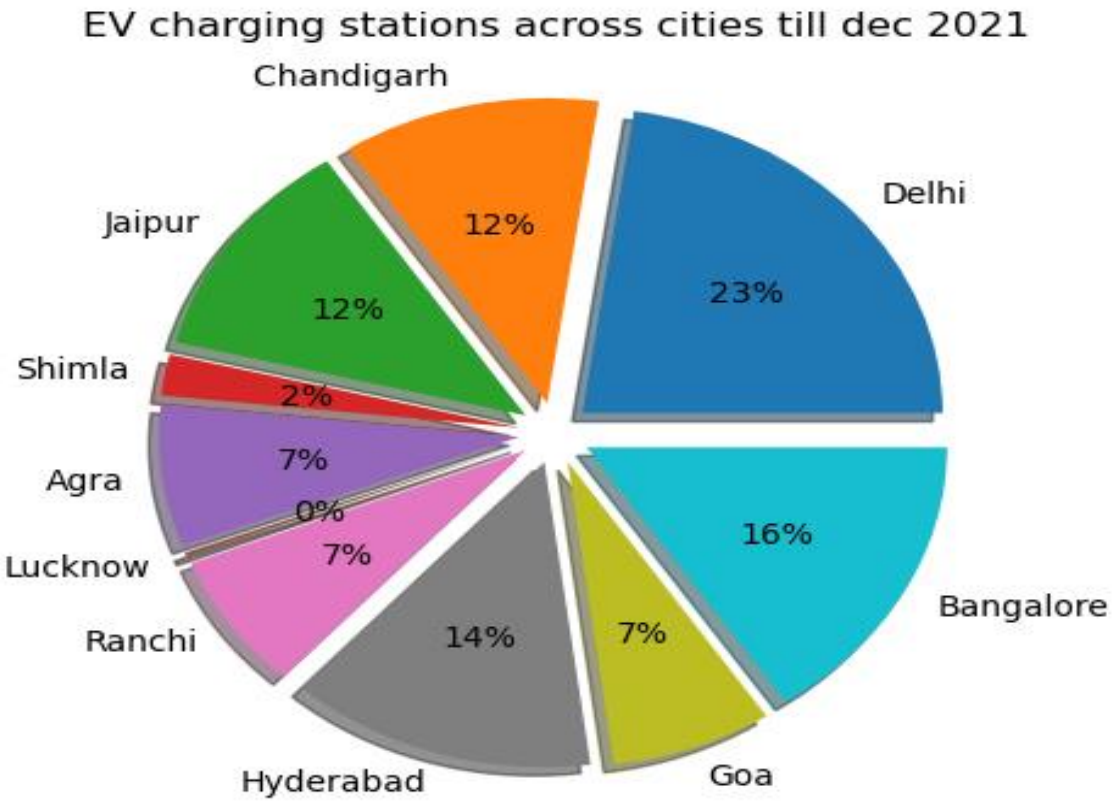

## EV charging stations across States/UT

EV charging station availability tells about ease of recharging electric vehicle and that can impact the consumers to adopt electric vehicles at pace.



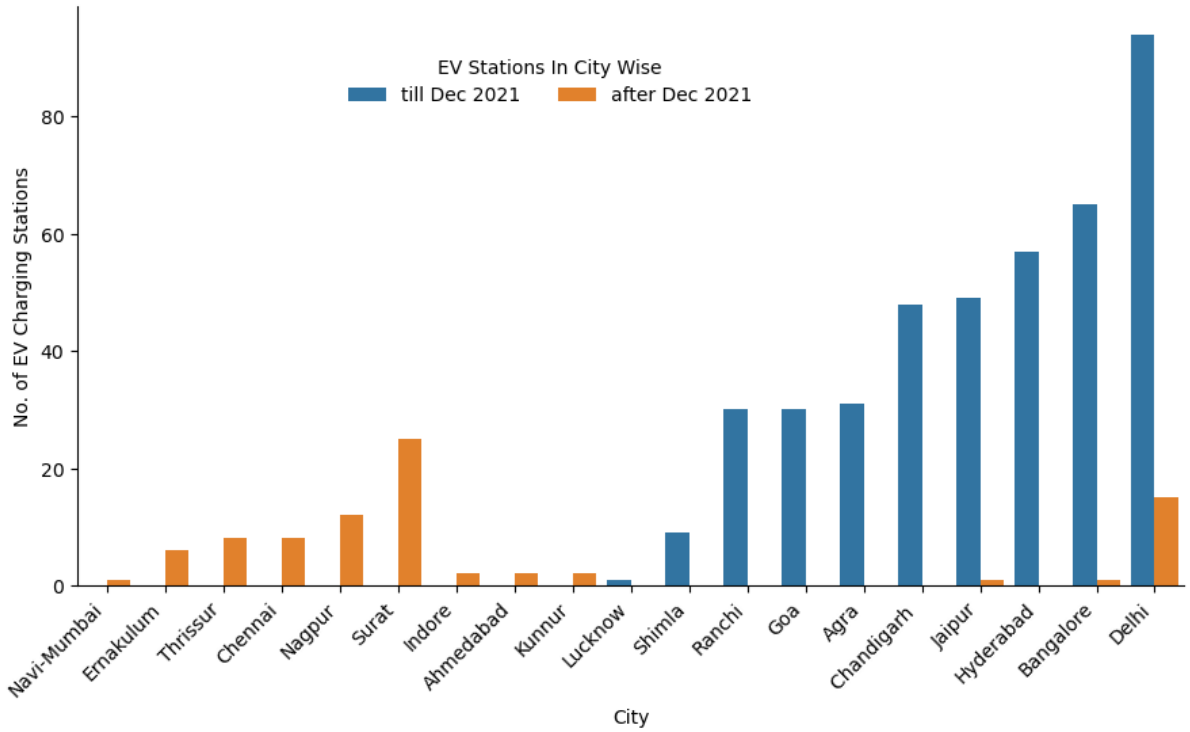
States like Delhi Karnataka Telangana Rajasthan and Chandigarh should be given more preference in policy decisions while roll out for EV's.

**Projections of EV stations in cities**




EV charging station are more in megacities so we should focus on megacities like Delhi, Bangalore, Hyderabad, and Chandigarh while deciding for policy related to EV cars.

**Sanctioned vs Deployed Charging stations**



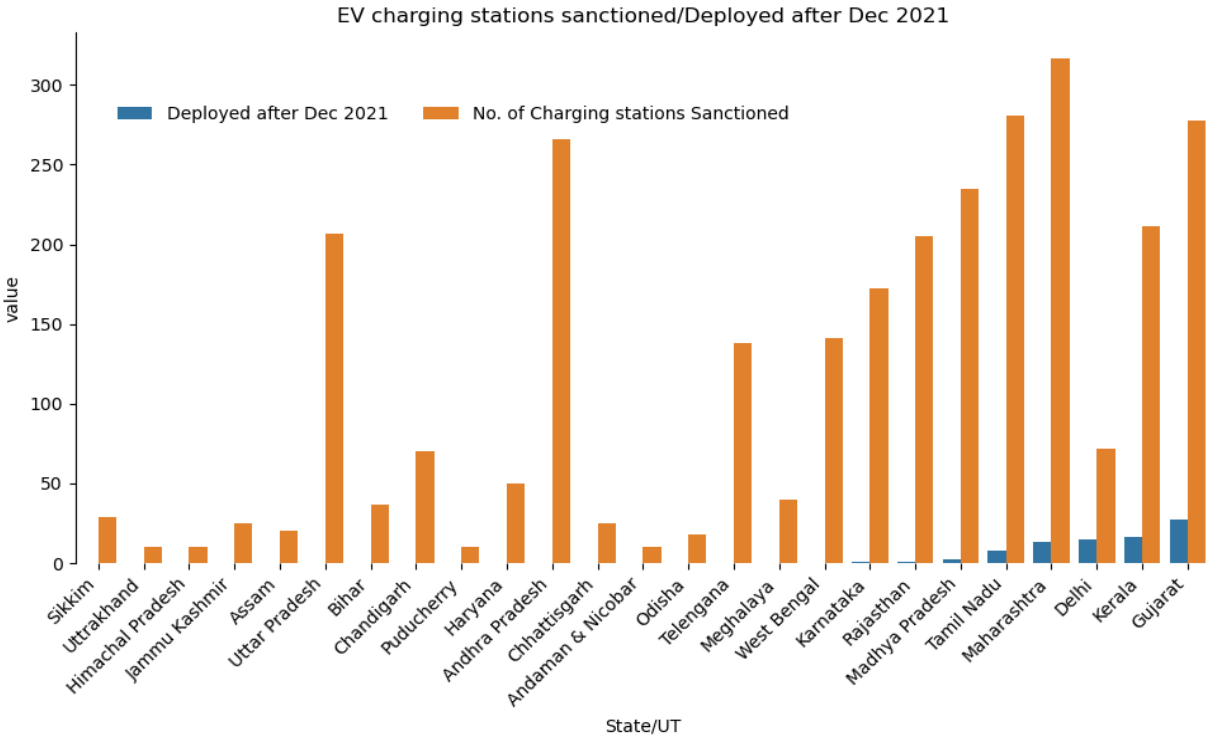

Blue bars show the EV stations deployed till Dec 2021 orange ones show the new deployed stations across new cities as well.

EV charging stations are deployed in new cities like Surat, Nagpur, Thrissur etc. as well new stations in previous cities but rate of deployment is low.

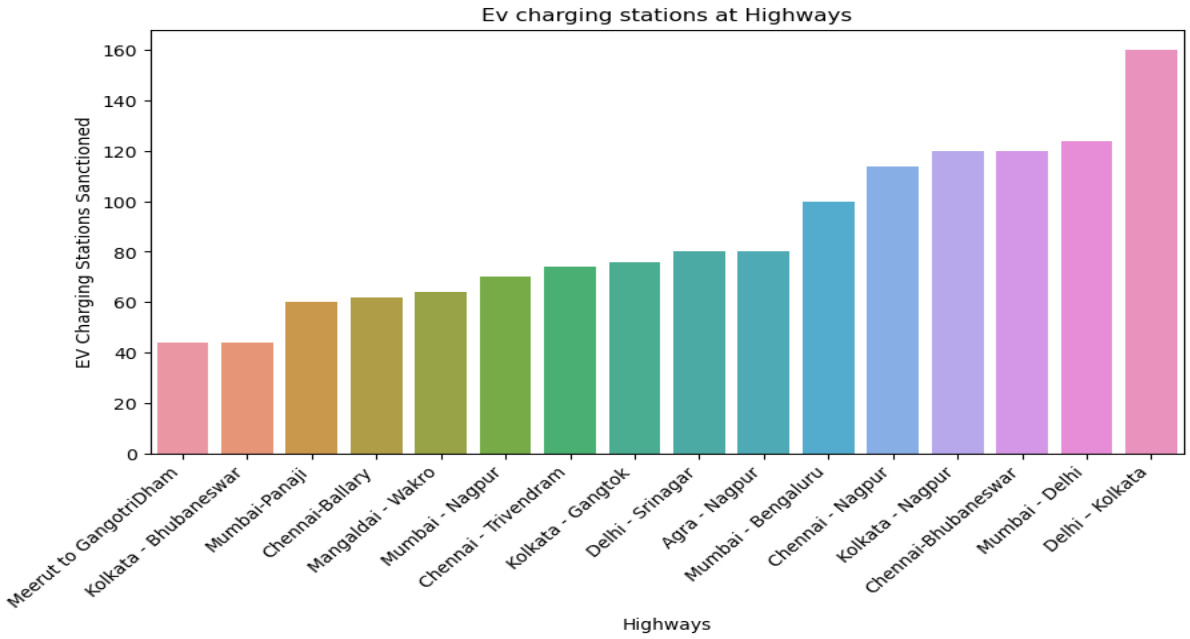
**New sanctioned stations at states**

The histogram below shows the number newly sanctioned EV charging stations across states like Maharashtra, Tamil Nadu, and Madhya Pradesh etc. have the largest number of deployed stations. These states have been lagging in EV charging stations but if the deployment happens then it would be invest in EV vehicles across these states.

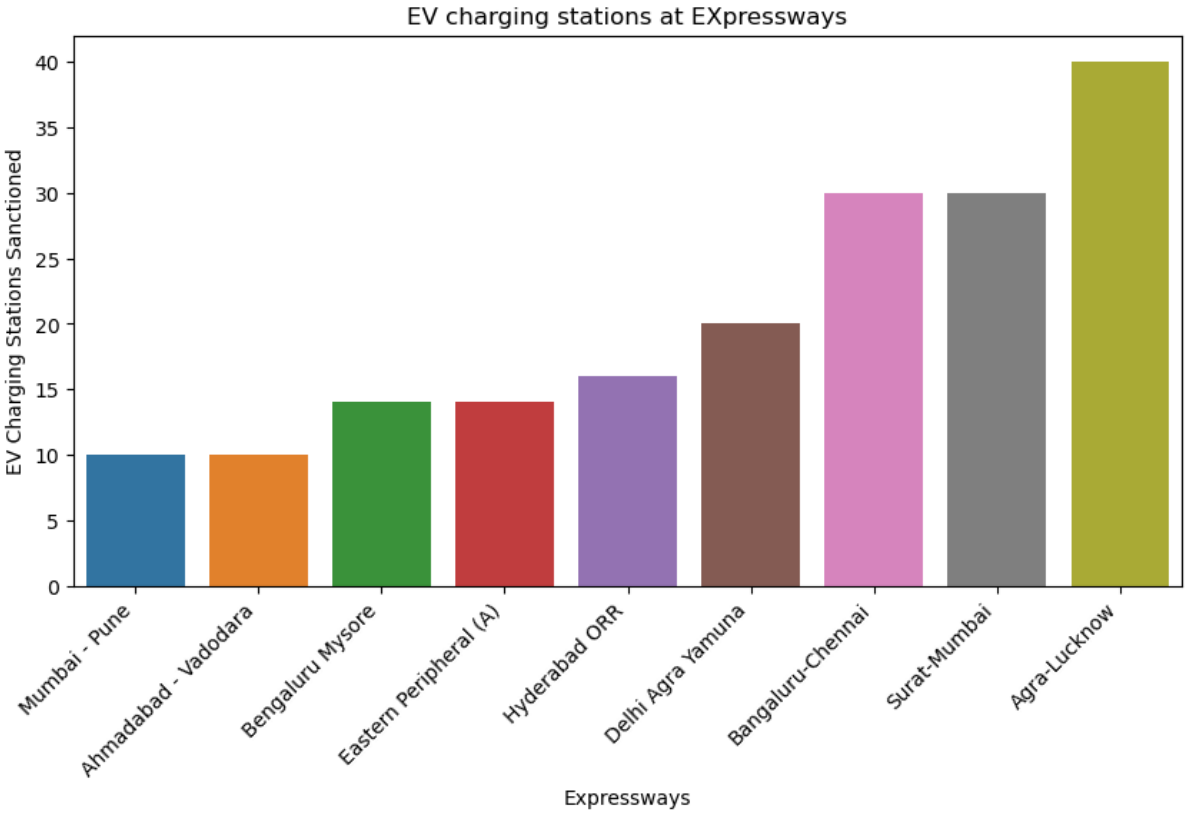
But the matter of concern could be rate of deployment after being sanctioned as very few new stations have been deployed in states.



**EV charging station on highways and expressway**




Delhi-Kolkata, Mumbai-Delhi, Chennai-Bhubaneshwar highways are the leading in EV stations



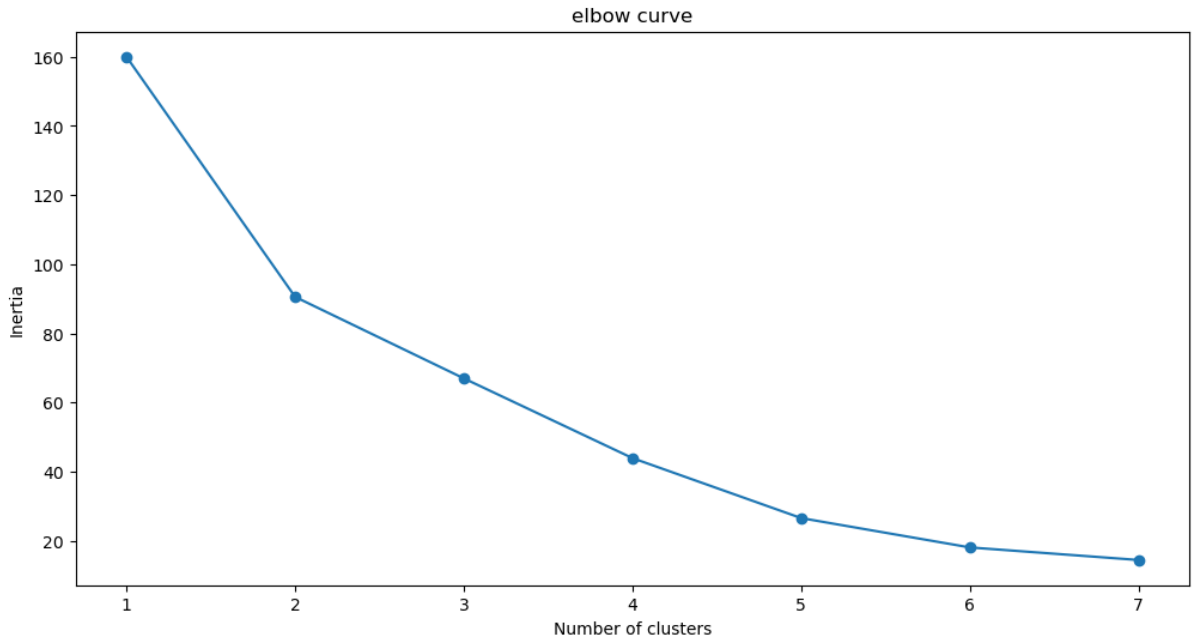

Agra-Lucknow, Surat-Mumbai, Bengaluru-Chennai are having high number of stations but the remaining expressways are also having average EV stations.

## K-means Clustering

So to determine the regions having same characteristics are to be grouped based on states . to get a better insights into the regional variance the following variable have been taken into account

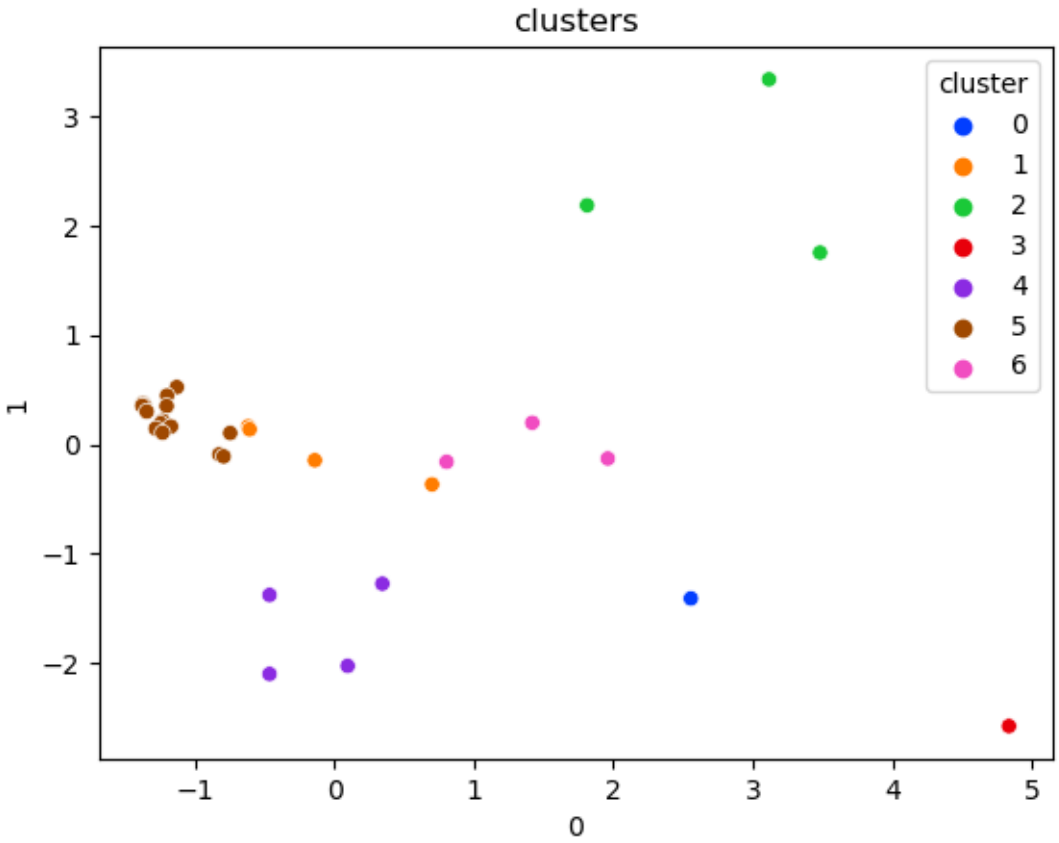
1. Total number of vehicles.
2. Charging station across states
3. Ratio of EV to the total vehicles

After doing the clustering to get optimal number of clusters plot of inertia vs cluster have been plotted to get elbow point.




From the above curve optimal number of clusters can be selected as 5.

**Plot of clusters**




Here we can see clusters 5, cluster 4, cluster 2, cluster 6 are well separated when we take geographical segmentation as segmentation variable.

**Clusters of Regional Groups**

After clustering grouping based on regional variable have been shown

| State_name | Cluster |
|---|---|
| ['Haryana' 'Jharkhand' 'Manipur' 'Odisha'] | 0 |
| ['Uttar Pradesh'] | 1 |
| ['Gujarat' 'Jammu and Kashmir' 'Mizoram'] | 2 |
| ['Tripura'] | 3 |
| ['Andaman & Nicobar' 'Arunachal Pradesh' 'Assam' 'Bihar' 'Chandigarh' 'Chhattishgarh' 'Delhi' 'Goa' 'Himachal Pradesh' 'Karnataka' 'Kerala' 'Ladakh' 'Maharashtra' 'Meghalaya' 'Nagaland' 'Puducherry'] | 4 |
| ['Tamilnadu' 'Daman and Diu and Dadra and Nagar Haveli' 'Uttarakhand' 'West Bengal'] | 5 |
| ['Punjab' 'Rajasthan' 'Sikkim'] | 6 |

## Conclusion

From this analysis we can easily conclude that based on Geographical segmentation variable we can divide whole states of India across 5 regions. Based on EDA we can select which group are beneficial as they tell us about regions with leading parameters such as no. of vehicles, no. charging stations, interest of energy sector companies etc.

# Moushreeta Debroy

## Problem statement:

Which profession and income group people should the company target for their business.

## Data source used:

https://www.kaggle.com/datasets/rkiattisak/car-ownership-predictionbeginnerintermediate

## Steps used:

1. Importing necessary libraries
2. Importing dataset

## Data preprocessing

Checking missing values ,NAN values Handling Missing ,Nan values

## Libraries :

Numpy , Pandas , Matplotlib ,Seaborn

## ML Technic used

Logistic Regression

## What conclusions you have drawn from your data

| | Occupation | Count |
|---|---|---|
| 0 | Electrician | 10 |
| 1 | Sales Manager | 8 |
| 2 | Real Estate Agent | 7 |
| 3 | Physical Therapist | 7 |

| | | |
|---|---|---|
| 4 | Nurse | 6 |
| 5 | Insurance Agent | 6 |
| 6 | Accountant | 6 |
| 7 | Architect | 6 |
| 8 | Financial Advisor | 5 |
| 9 | Marketing Manager | 5 |
| 10 | Veterinarian | 5 |
| 11 | Data Scientist | 5 |
| 12 | Financial Analyst | 5 |
| 13 | Mechanical Engineer | 4 |
| 14 | Sales Representative | 4 |
| 15 | Web Developer | 4 |
| 16 | Human Resources Manager | 4 |
| 17 | Engineer | 4 |
| 18 | Graphic Designer | 4 |
| 19 | Dental Hygienist | 4 |
| 20 | Project Manager | 4 |
| 21 | Software Engineer | 4 |
| 22 | Account Executive | 3 |
| 23 | Human Resources | 3 |
| 24 | Interior Designer | 3 |
| 25 | Physician Assistant | 3 |
| 26 | Pharmacist | 3 |
| 27 | IT Manager | 3 |
| 28 | Physician | 3 |
| 29 | Attorney | 3 |
| 30 | Web Designer | 2 |
| 31 | HR Generalist | 2 |
| 32 | Software Developer | 2 |
| 33 | Data Analyst | 2 |
| 34 | Marketing Coordinator | 2 |
| 35 | Account Manager | 2 |
| 36 | Physical Trainer | 2 |
| 37 | Business Analyst | 2 |
| 38 | Teacher | 2 |
| 39 | Office Manager | 2 |
| 40 | Psychologist | 2 |
| 41 | Doctor | 2 |
| 42 | Businessman | 2 |
| 43 | Chef | 2 |
| 44 | Lawyer | 2 |
| 45 | Executive Assistant | 2 |
| 46 | Electrical Engineer | 1 |
| 47 | Mechanical Technician | 1 |
| 48 | Registered Nurse | 1 |
| 49 | Dentist | 1 |
| 50 | Software Architect | 1 |

| | | |
|---|---|---|
| 51 | Graphic Artist | 1 |
| 52 | IT Consultant | 1 |
| 53 | Investment Banker | 1 |
| 54 | HR Manager | 1 |
| 55 | Social Media Manager | 1 |
| 56 | Event Planner | 1 |
| 57 | Public Relations | 1 |
| 58 | Mechanical Designer | 1 |
| 59 | Civil Engineer | 1 |
| 60 | Financial Planner | 1 |
| 61 | Computer Technician | 1 |
| 62 | Insurance Underwriter | 1 |
| 63 | Physical Education Teacher | 1 |
| 64 | Nurse Practitioner | 1 |
| 65 | Computer Programmer | 1 |
| 66 | Marketing Specialist | 1 |
| 67 | Optometrist | 1 |
| 68 | Business Owner | 1 |
| 69 | Entrepreneur | 1 |
| 70 | Police Officer | 1 |
| 71 | Flight Attendant | 1 |
| 72 | Financial Manager | 1 |
| 73 | Marketing Analyst | 1 |
| 74 | IT Support Specialist | 1 |
| 75 | Retail Manager | 1 |
| 76 | Marketing | 1 |
| 77 | Carpenter | 1 |
| 78 | HR Specialist | 1 |
| 79 | Construction Worker | 1 |
| 80 | Management Consultant | 1 |

## Conclusion:

As we can see Electrician has the highest number of cars, from the chart we can target people (initially) having 4-10 cars and whose avg salary range is between 0-3000**.**

## Github link:

**https://github.com/Moushreeta/feynn_lab_project_3**

# Shraddha Deori

## Psychographic Segmentation (based on preferred Electric Vehicle Type):

## Problem Statement:

When opening a new startup based on EV market, the analysis of the preferred types of vehicles by the end-users/ customers is of utmost importance. So, the problem statement that I am covering here is to analyze the psychographic segment of the data available. This will aid us in preparing new strategies to deploy in marketing and increasing revenue or sales.

## Data Sources:

https://github.com/AdarshKarthik/EV_Segmentation

## Data view:

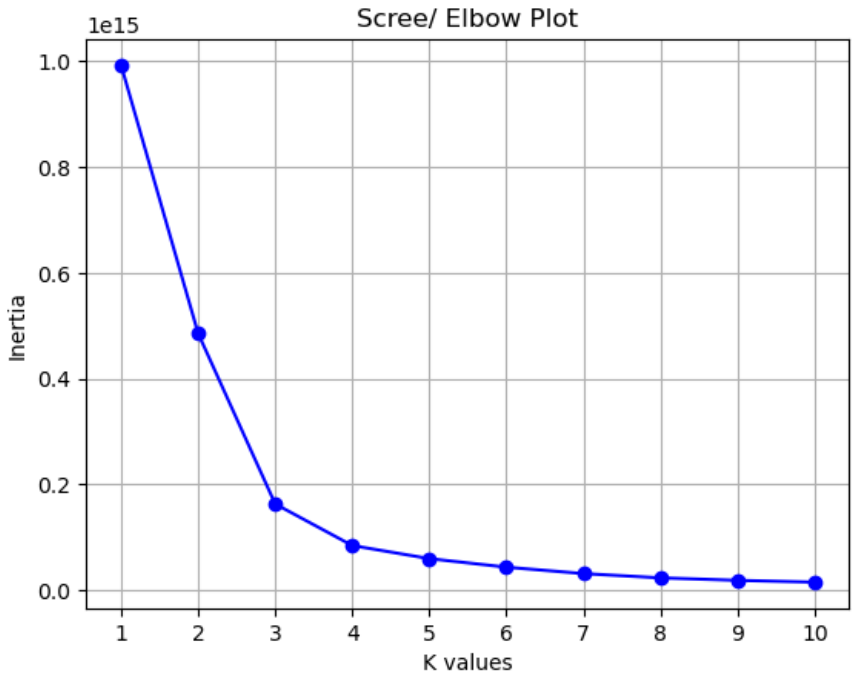
```
data = pd.read_csv('ev_data.csv')
data.head()
```

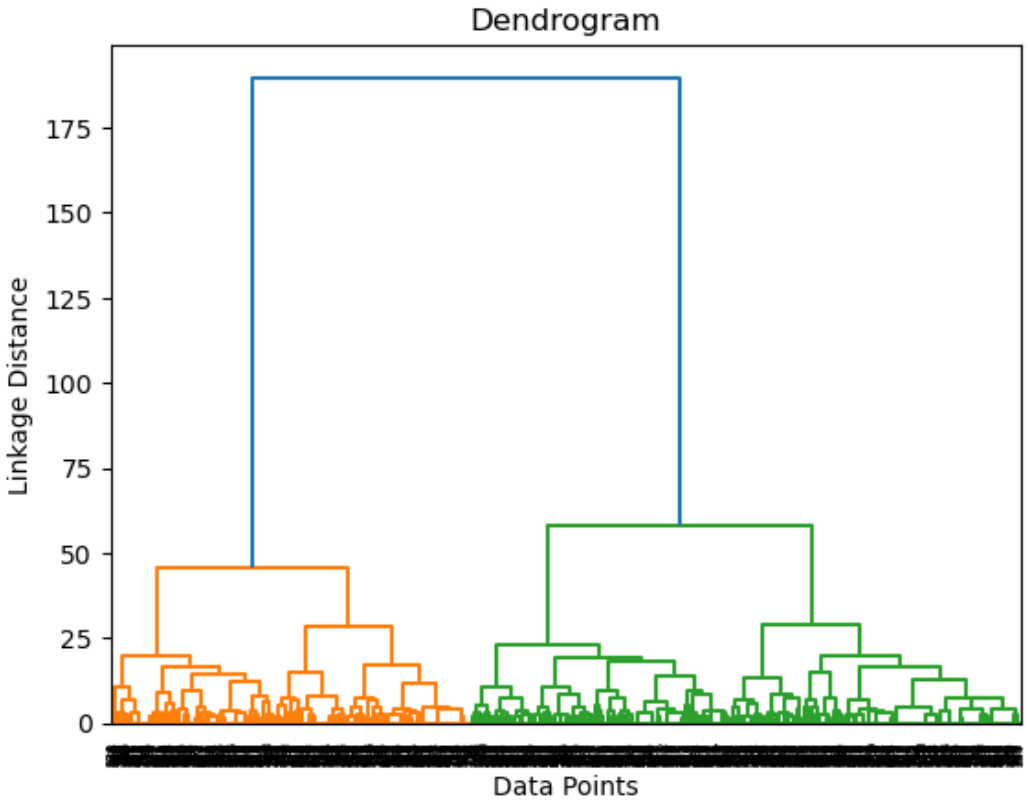
[2] Python

| | age | city | profession | marital_stat | education | family_count | annual_income | replace_with_ev | preferred_ev_type | think_ev_are_economical | preferred_ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 30 | New Delhi | Working Professional | Single | Post Graduate | 4 | 1.770466e+06 | Yes | SUV | Yes | |
| 1 | 27 | Ahmedabad | NaN | Single | Post Graduate | 4 | 7.600731e+05 | Yes | SUV | Yes | M |
| 2 | 28 | Pune | Working Professional | Single | Post Graduate | 4 | 2.779701e+06 | Maybe | Sedan | Yes | H |
| 3 | 26 | Pune | Salaried | Single | Post Graduate | 4 | 1.473698e+06 | Yes | Sedan | Yes | |
| 4 | 25 | Pune | Working Professional | Single | Post Graduate | 4 | 2.430643e+06 | Yes | Sedan | Yes | Hy |

## Steps used:

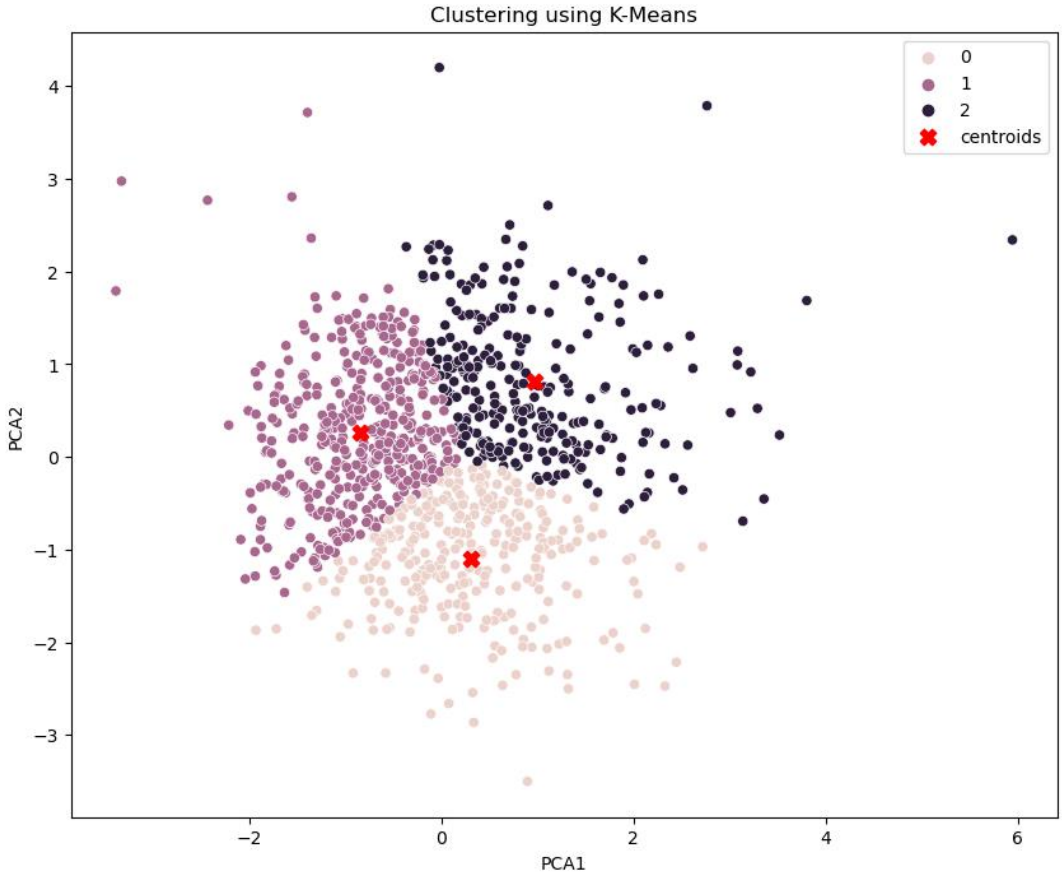
Finding optimum number of clusters:





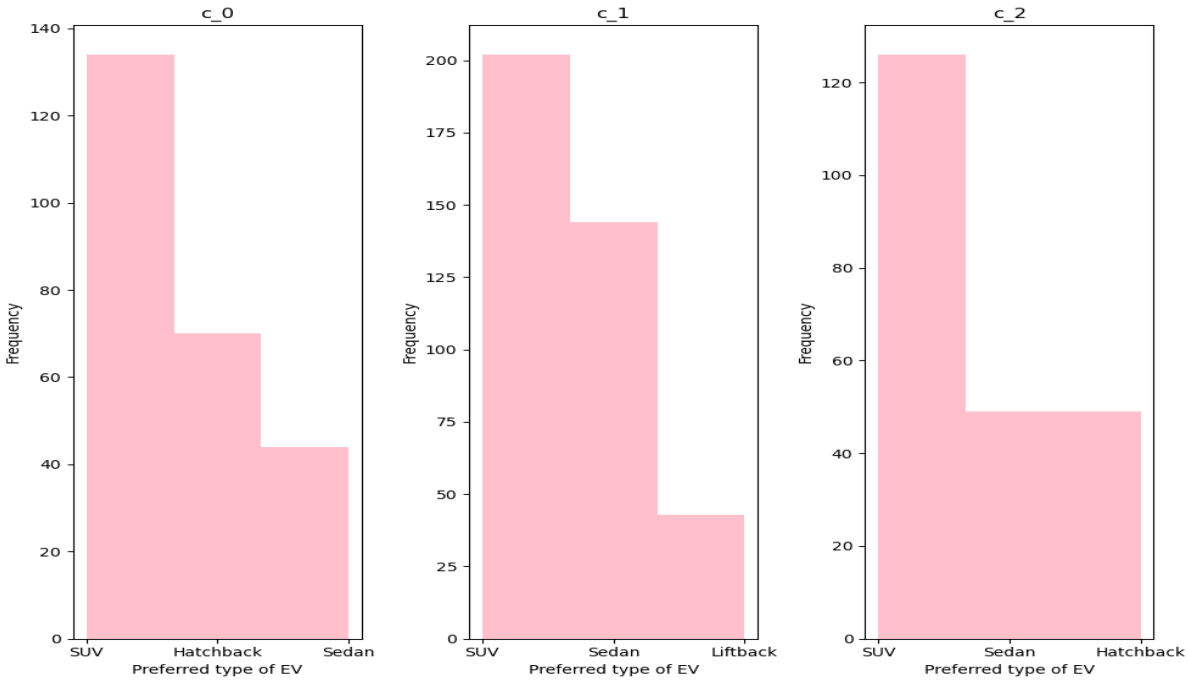

From the scree plot as well as dendogram, we get the optimum number of cluster size as 3.

So, we fit and predict the model using n_clusters = 3, and obtain the following plot:

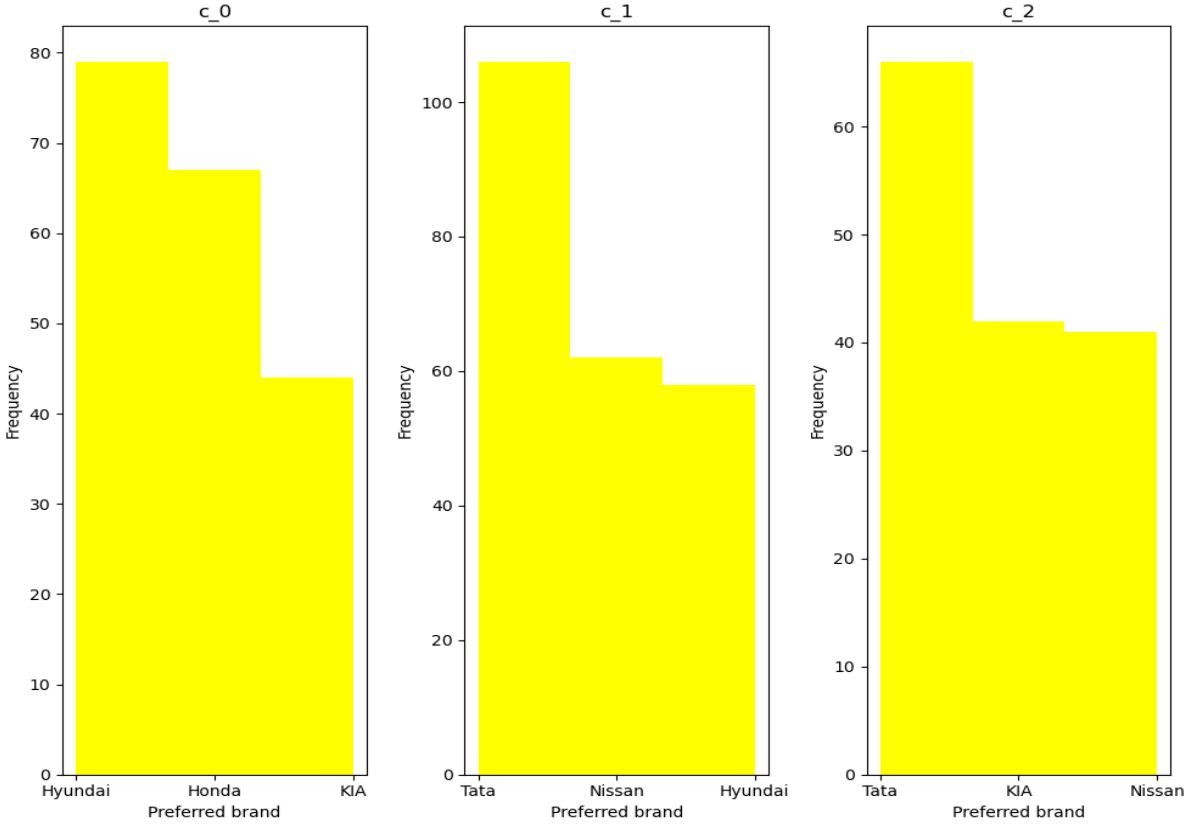



We find the below target segments by performing K-Means Clustering on the dataset:

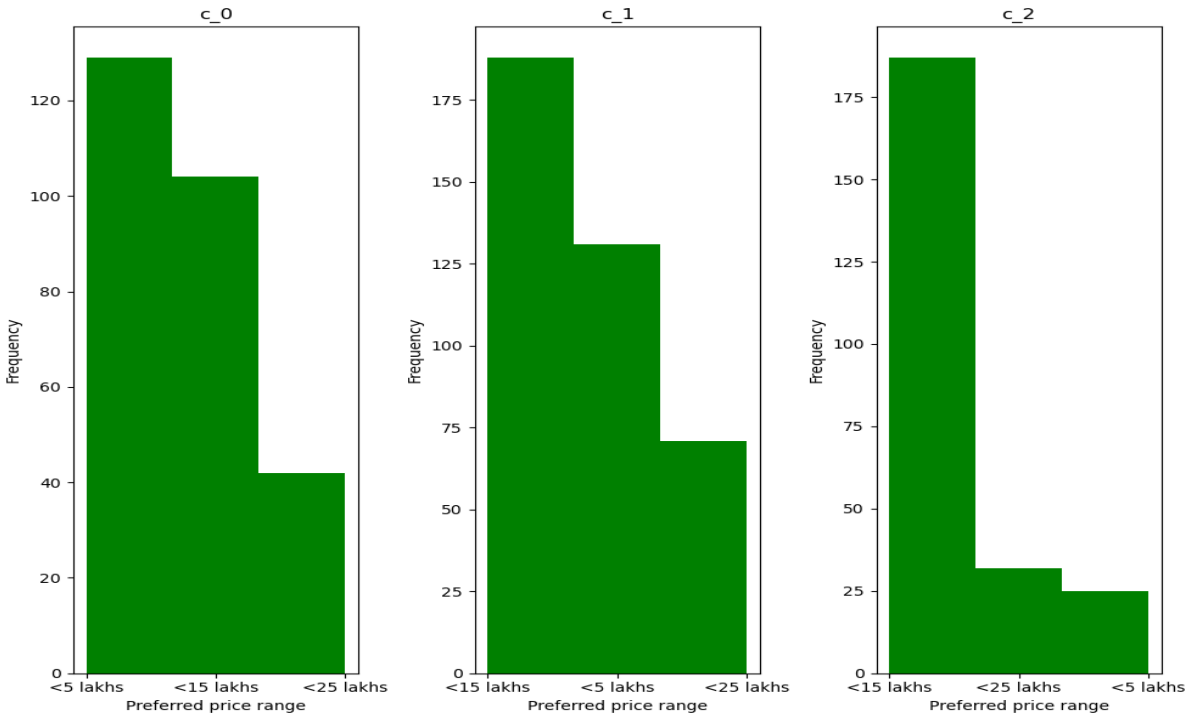
1. By Preferred EV Type:



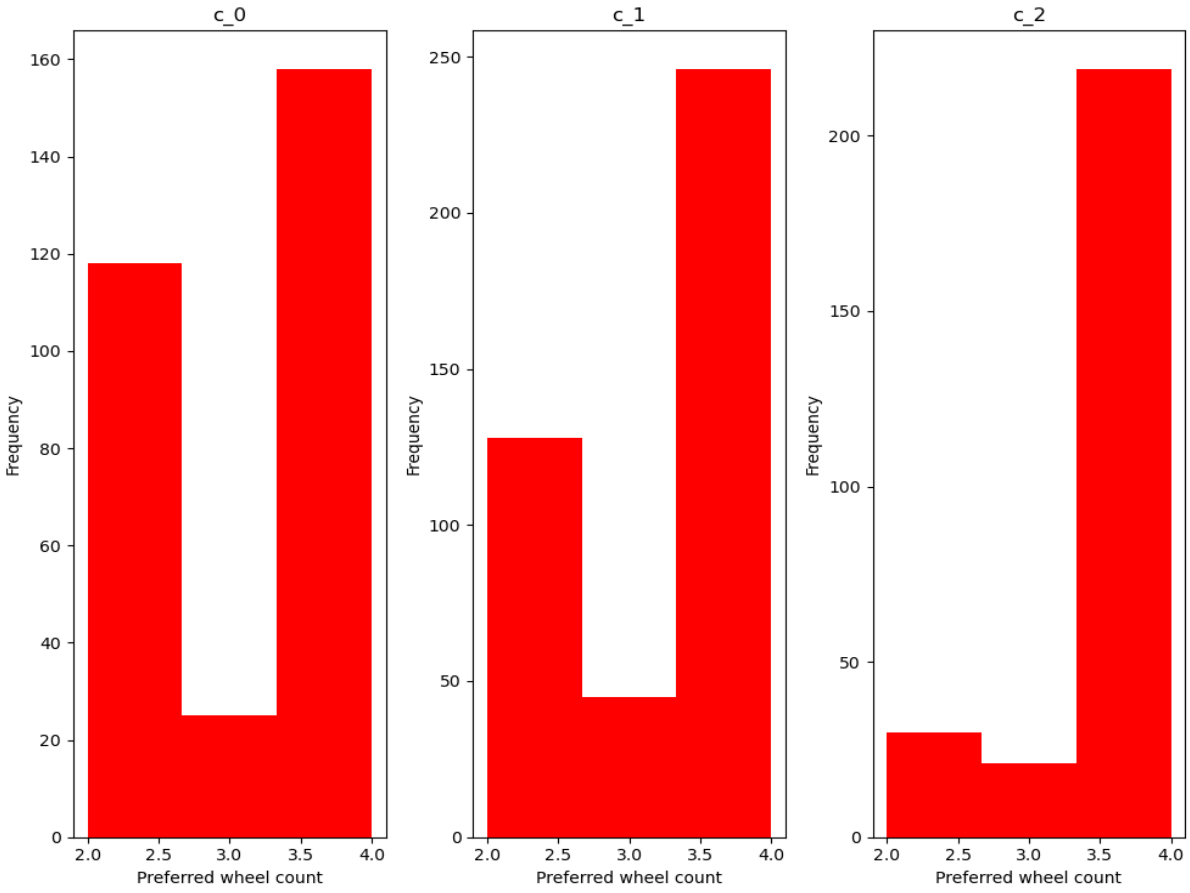

2. By Preferred Brand:




3. By Preferred Price Range:




4. By Preferred Wheel Count:




Evaluation Report:

In [160]:
```
from sklearn.metrics import r2_score, mean_squared_error
```

In [161]:
```
# Calculate R-squared (R2)
r2 = r2_score(y_test, y_pre)
print(f"R-squared (R2): {r2}")
```

```
R-squared (R2): 0.7254216654102634
```

In [162]:
```
# Calculate Mean Squared Error (MSE)
mse = mean_squared_error(y_test, y_pre)
print(f"Mean Squared Error (MSE): {mse}")
```

```
Mean Squared Error (MSE): 0.1552049763929334
```

In [163]:
```
accuracy = xgb.score(X_test, y_test)
accuracy
```

Out[163]:
```
0.7254216654102634
```

In [166]:
```
#Cross val score,cross val predict
from sklearn.model_selection import cross_val_score

print(cross_val_score(xgb,X_train,y_train))
```

```
[0.65035042 0.58500026 0.59536698 0.552511   0.6689613 ]
```

## Libraries:

```
import numpy as np

import pandas as pd

import matplotlib.pyplot as plt

%matplotlib inline

import seaborn as sns

from sklearn.preprocessing import LabelEncoder

from sklearn.preprocessing import StandardScaler

from sklearn.decomposition import PCA

from sklearn.cluster import KMeans

import scipy.cluster.hierarchy as shc

from sklearn.metrics import silhouette_score

from sklearn.model_selection import train_test_split

import xgboost as xg

from xgboost import XGBRegressor

from sklearn.metrics import r2_score, mean_squared_error

from sklearn.model_selection import cross_val_score
```

## ML Technique Used:

**K-Means Clustering:**

**XGBOOST:**

Regression problems have continuous or real results as their outcomes. Linear regression and decision trees are two extensively used regression algorithms. Regression involves a number of measures, including mean-squared error (MAE) and root-mean-square error (RMSE).

These individuals serve essential roles as major figures in the XGBoost models.

• RMSE: This abbreviation stands for root mean square error (MSE).

• MAE: In comparison to other metrics, it is employed less frequently even though it is an absolute sum of actual and expected differences.

A strong method for creating supervised regression models is XGBoost. By understanding this statement's (XGBoost's) objective function and base learners, one can infer its correctness.

XGBoost is one of the ensemble learning techniques, which entails training and integrating various independent models (sometimes referred to as base learners) to produce a single prediction. XGBoost anticipates so that when all the forecasts are added up, the bad predictions cancel out and the better ones add up to make the final good predictions, the base learners must be consistently awful at the rest.

## Conclusions:

- E4W (Electric 4 Wheeler) are the most popular with E3W (Electric 4 Wheeler) being the least popular in all the segments.
- Cars should be produced between marketing price of 5-15 lacs.
- Tata, Hyundai and Kia are the most preferred brand among all the segments.
- SUV and Sedan are the most popular vehicle type found in all the clusters. So, these are to be manufactured in maximum numbers.

# Daidipya sisodiya

## Problem statement

Finding which is best available Electric vehicle available in the market, so that company can chose which type od vehicle should they produce

## Data source

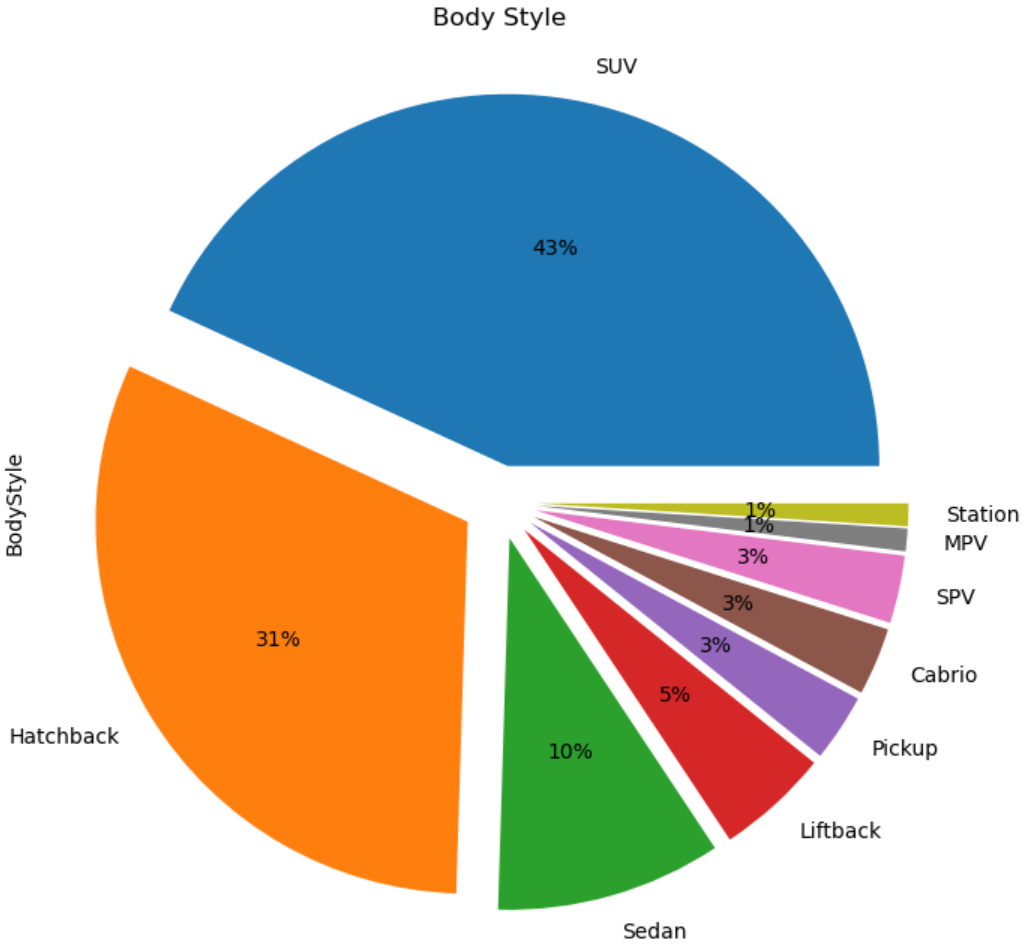
https://www.kaggle.com/datasets/divyanshugupta95/cars-dataset-with-battery-pack-capacity

## Libraries used

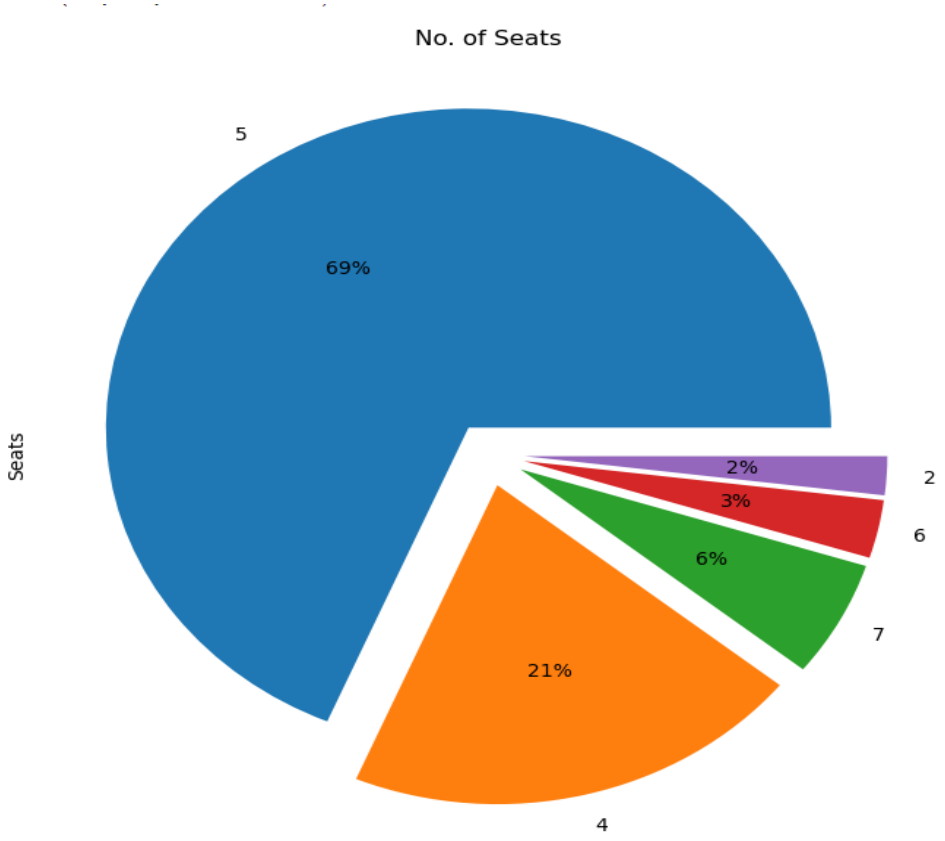
- NumPy
- Pandas
- Matplotlib
- Seaborn
- Scikit-learn

## Profiling and describing potential segments

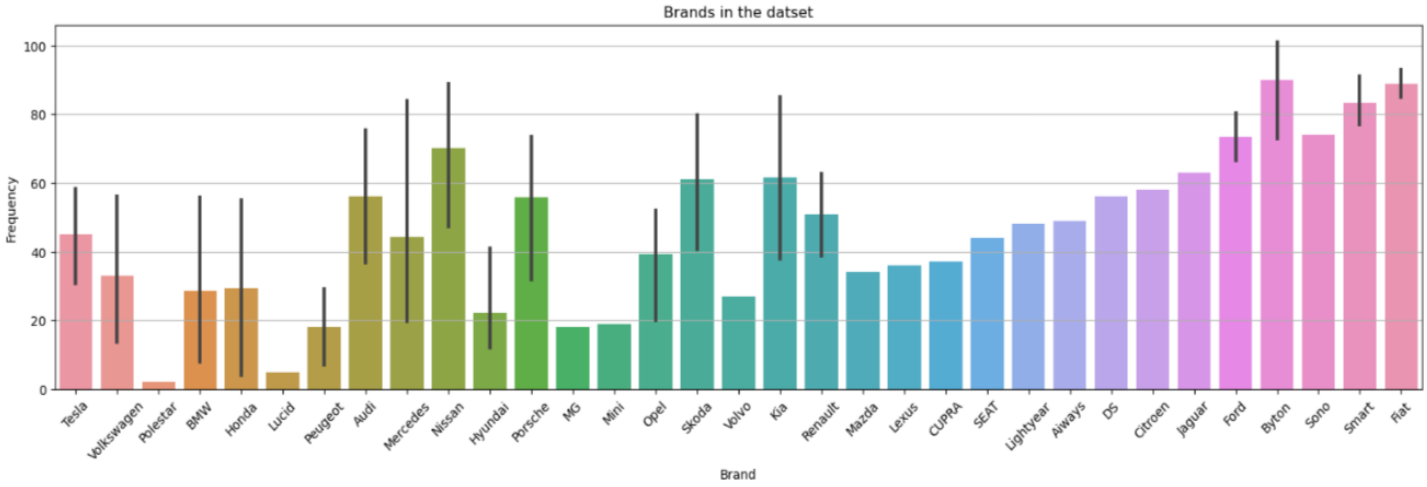
- **Most preferred body style is “SUV” & “Hatchback”**




- **5 seater are most preferable**




- **Most occurred car model in dataset**




## Conclusions

1. Range of vehicle is proportional to Battery Pack Capacity
2. Price of vehicle is proportional battery pack capacity
3. EV's which cost less have higher acceleration(0-100 Km/Hr) time in order to maximise range
4. High performance EV's have lower efficiency.
5. Most of the vehicles costing less than 50,000 Euros are Front Wheel Drive
6. Most of the vehicles costing over 50,000 Euros are either All wheel drive or Rear wheel drive and have better acceleration.

## GitHub link

https://github.com/Dadipya14/EV_Models

## ANALYSING THE MARKET TRENDS

There are several different variables by which segmentation is done:

1**. Geographic segmentation :**Geographic segmentation consists of creating different groups of customers based on geographic boundaries. The needs and interests of potential customers vary according to their geographic location, climate and region, and understanding this allows you to determine where to sell and advertise a brand, as well as where to expand a business.

● Charging station by State wise: State wise charging station will become a significant effect on consumer purchasing decisions. Those states with more charging stations may prefer to buy an EV and vice versa.

**2. Demographic segmentation**: Demographic segmentation consists of dividing the market through different variables such as age, gender, nationality, education level, family size, occupation, income, etc. This is one of the most widely used forms of market segmentation, since it is based on knowing how customers use your products and services and how much they are willing to pay for them.

● Income: Income levels have a significant effect on consumer purchasing decisions. Those with higher-income levels may prefer luxury vehicles. Conversely, individuals with lower income levels may prefer to get vehicles at the best deal and are likely to choose inexpensive products/services.

● Family size: Family size also determines consumers' purchase decisions. Those who have large family members may choose four wheelers and those who have less family members will choose two wheelers.

**3. Psychographic segmentation** :Psychographic segmentation consists of grouping the target audience based on their behavior, lifestyle, attitudes and interests. To understand the target audience, market research methods such as focus groups, surveys, interviews and case studies can be successful in compiling this type of conclusion.

● Lifestyle: A consumer whose profession is more time consuming than other average consumers , that consumer may select a vehicle who takes less time to charge a vehicle. This group of consumers only focus on the time required to charge an EV.

● Interests : Some consumers may have interest in particular manufacturing companies. Some consumers may like only vehicles made by the Tata company.

● Behaviour : Behaviour of consumers is the most important factor in the market segment. It shows what exactly consumers want from us?. Some consumers may want an EV who will cover far distance per a charging. Customizing the Market Mix The marketing mix refers to the set of actions, or tactics, that a company uses to promote its brand or product in the market. The 4Ps make up a typical marketing mix - Price, Product, Promotion and Place.

● Price: Refers to the value that is put for a product. It depends on costs of production, segment targeted, ability of the market to pay, supply - demand and a host of other direct and indirect factors. There can be several types of pricing strategies, each tied in with an overall business plan.

● Product: Refers to the item actually being sold. The product must deliver a minimum level of performance; otherwise even the best work on the other elements of the marketing mix won't do any good.

- Place: Refers to the point of sale. In every industry, catching the eye of the consumer and making it easy for her to buy it is the main aim of a good distribution or 'place' strategy. Retailers pay a premium for the right location. In fact, the mantra of a successful retail business is 'location, location, location'.

- Promotion: This refers to all the activities undertaken to make the product or service known to the user and trade. This can include advertising, word of mouth, press reports, incentives, commissions and awards to the trade. It can also include consumer schemes, direct marketing, contests and prizes. All the elements of the marketing mix influence each other. They make up the business plan for a company and handle it right, and can give it great success. The marketing mix needs a lot of understanding, market research and consultation with several people, from users to trade to manufacturing and several others.

# TARGET SEGMENTS

Target marketing involves breaking a market into segments and then concentrating your marketing efforts on one or a few key segments consisting of the customers whose needs and desires most closely match your product or service offerings. It can be the key to attracting new business, increasing sales, and making your business a success. It can be concluded from above figures that Range, Top Speed, Full charging time, Income and Types of Vehicles can be the most important segment categories for consumer purchasing decisions. These are the key factors who make markets different and similar at the same time. This segments have formed with distinct features which may indicate that their preferences for EVs are motivated by different factors.

# GITHUB LINKS

https://github.com/Dadipya14/EV_Models

**https://github.com/Moushreeta/feynn_lab_project_3**

**https://github.com/kapilYadav-001/Fyenn_labs/tree/p2/Electric_vehicle_market_segmentation**

**https://github.com/shraddha-deori/Feynn-Labs-Project-2**