EV Market Segmentation

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Problem Statement:

Task is to analyse the Electric Vehicles Market in India using Segmentation analysis and come up with a feasible strategy to enter the market, targeting the segments most likely to use their product in terms of Geographic, Demographic, Psychographic, and Behavioural.

In this report, I analyse the Electric Vehicles Market in India using segments such as region, price, charging facility, type of vehicles (e.g., 2 wheelers, 3 wheelers, 4 wheelers etc.), retail outlets, manufacturers, body type (e.g., Hatchback, Sedan, SUV, Autorickshaw etc.), safety, plug types and much more.

Fermi Estimation:

Estimate the total number of electric vehicles in India.

Breakdown of the Problem:

1. **Population:** India's population is approximately 1.3 billion as of my last knowledge update in January 2022.
2. **Vehicle Ownership:** Estimate the number of vehicles per 1,000 people in India. The vehicle ownership rate varies between urban and rural areas. As a rough estimate, consider an ownership rate of 20 vehicles per 1,000 people. This is a very approximate number and can vary significantly.
3. **EV Market Share:** Determine the market share of electric vehicles in India. As of my last update, the EV market share was relatively small, at around 1% of the total vehicle market.
4. **Estimated EVs:** Calculate the estimated number of electric vehicles by multiplying the population by the estimated number of vehicles per 1,000 people and then by the estimated EV market share.

Here's the formula:

Estimated EVs = Population * (Vehicles per 1,000 People) * (EV Market Share)

Using the figures provided:

Estimated EVs = 1,300,000,000 * (20 / 1,000) * 0.01 = 260,000 EVs

Data Collection:

I collected few datasets for our segmentation,

Link:

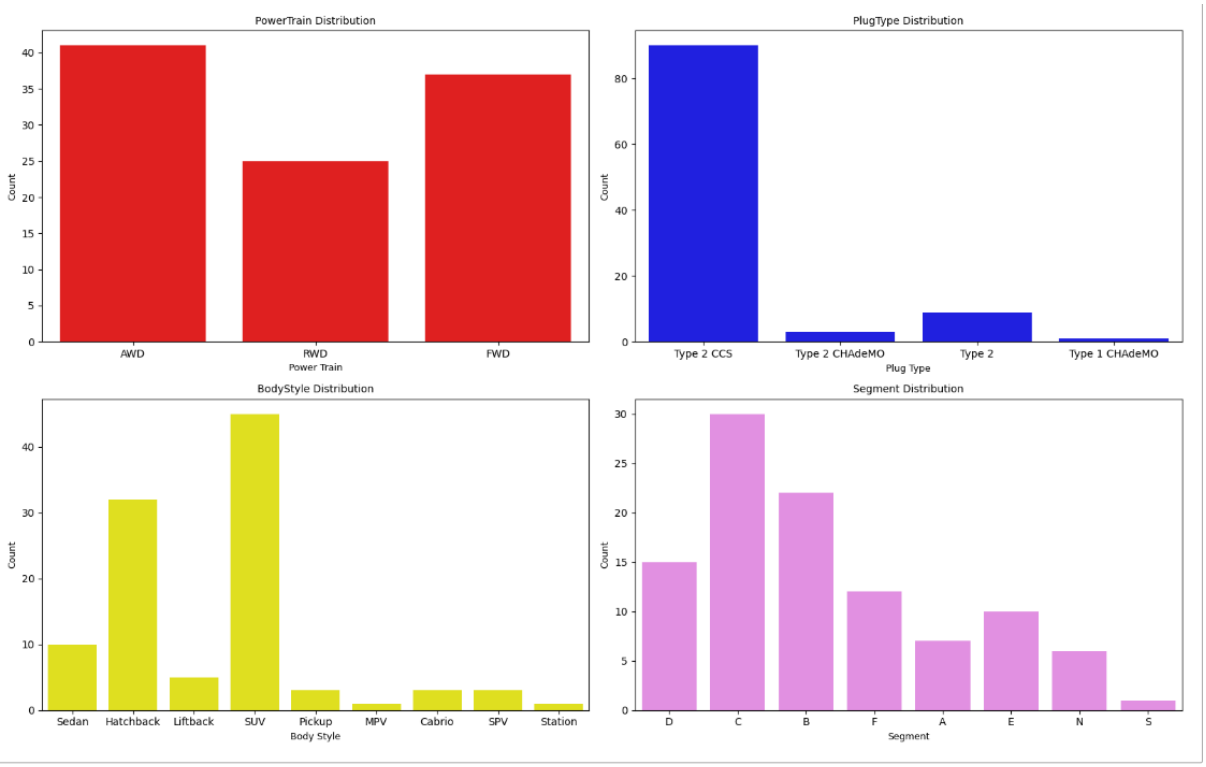
1. Dataset - 1
2. Dataset - 2
3. Dataset - 3

Data Pre-processing:

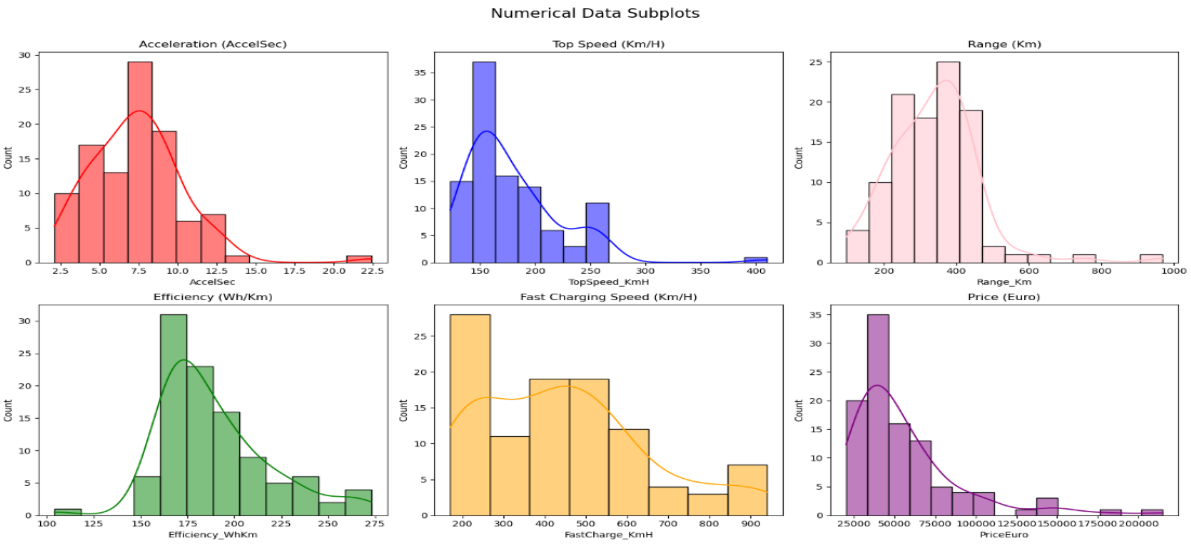
1. Dropped the columns before model building those columns are 'Brand', 'Model','PlugType', 'BodyStyle','Segment', 'PowerTrain', ‘Brand’, ‘Model’, ‘Segments’,
2. Label encoder used in the column ‘RapidCharge’.
3. Columns used for Model Building ‘AccelSec’, ’TopSpeed_KmH’,‘Range_Km’,’Efficiency_WhKm’,’FastCharge_KmH’, ’RapidCharge’,‘PriceEuro’.

Exploratory Data Analysis:

Exploratory Data Analysis (EDA) is a fundamental step in data analysis where the primary goal is to gain a deep understanding of a dataset. EDA involves data collection, cleaning, and visualization, enabling data analysts to uncover essential patterns, relationships, and outliers. By calculating summary statistics, creating various visualizations, and conducting univariate, bivariate, and multivariate analyses, EDA provides insights into the dataset's distribution and its variables' interactions. This process plays a pivotal role in identifying data quality issues, informing subsequent analyses and modelling decisions, and ultimately deriving meaningful conclusions from the data. EDA serves as the cornerstone for robust and insightful data-driven decision-making.

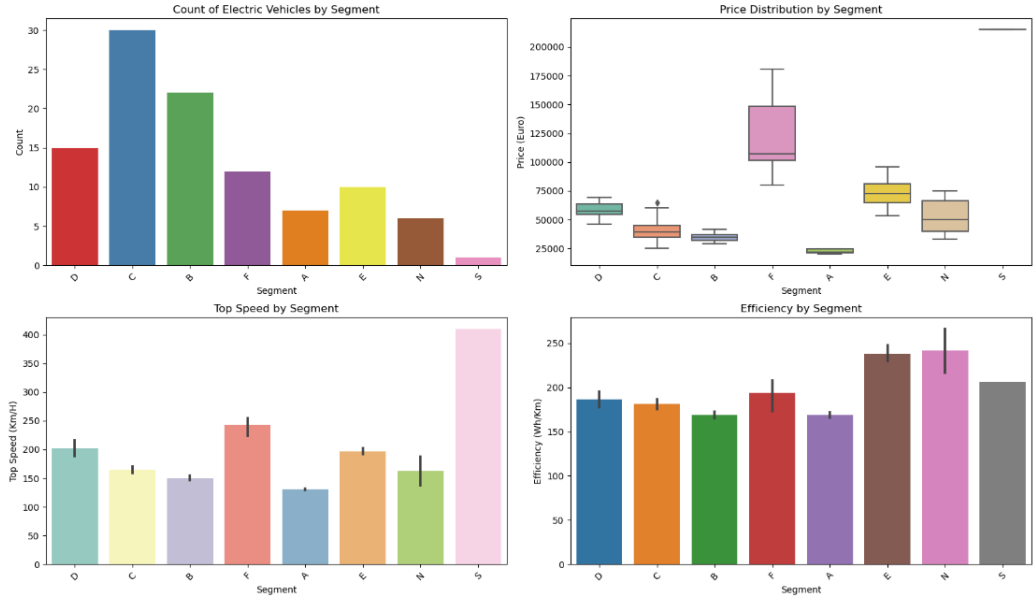


1. **PowerTrain Distribution:** It shows the prevalence of different powertrain types in electric vehicles (colored in red).
2. **PlugType Distribution:** This plot displays the distribution of plug types used for charging EVs (colored in blue).
3. **BodyStyle Distribution:** It illustrates the variety of body styles among electric vehicles (colored in yellow).
4. **Segment Distribution:** This plot provides insights into how EVs are distributed across different market segments (colored in violet).



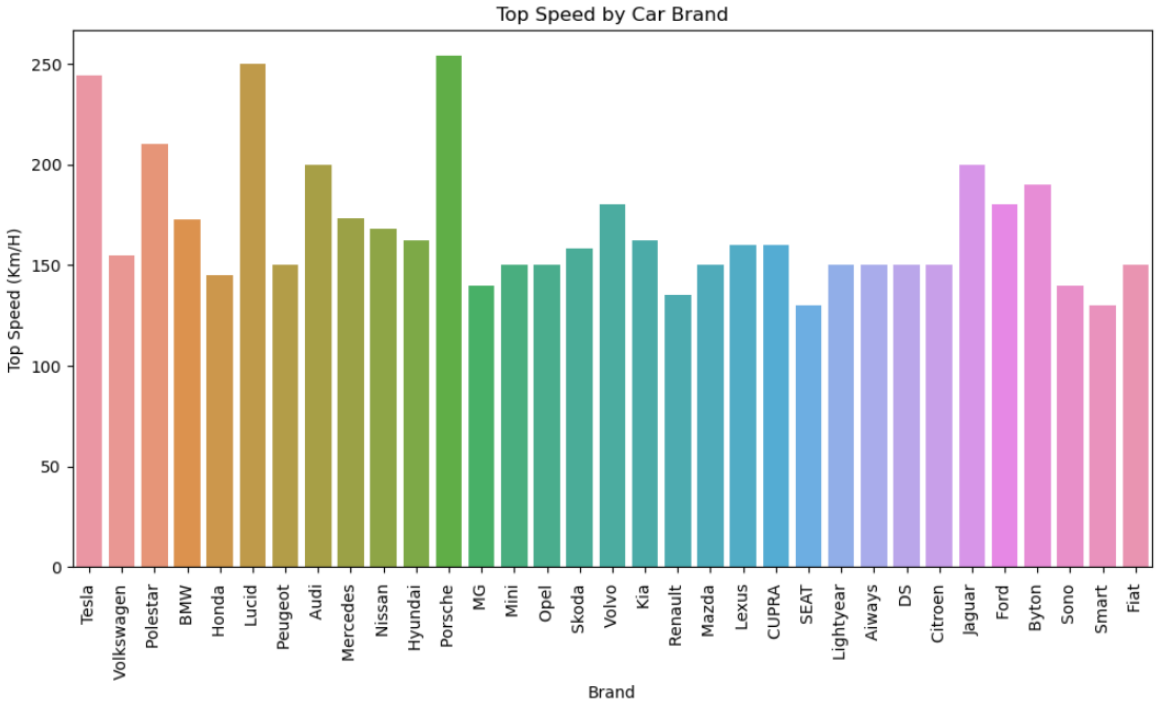
1. **Acceleration (AccelSec):** The first subplot displays the distribution of vehicle acceleration times in seconds, and it's shown in red.

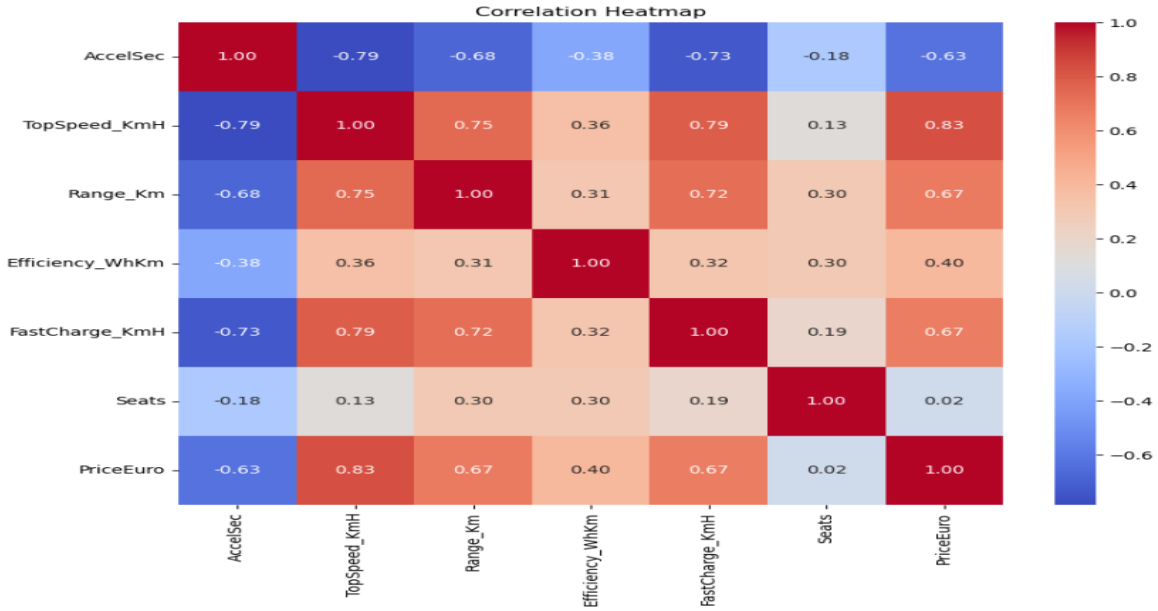
2. **Top Speed (Km/H):** The second subplot illustrates the distribution of the top speeds of vehicles in kilometers per hour, and it's colored in blue.
3. **Range (Km):** The third subplot represents the distribution of the range (distance an EV can travel on a single charge) in kilometers. It's displayed in pink.
4. **Efficiency (Wh/Km):** Subplot four shows the distribution of vehicle efficiency, measured in watt-hours per kilometer (Wh/Km), and it's in green.
5. **Fast Charging Speed (Km/H):** Subplot five displays the distribution of fast charging speeds in kilometers per hour, colored in orange.
6. **Price (Euro):** The final subplot presents the distribution of vehicle prices in euros, shown in purple.



1. **Count of Electric Vehicles by Segment (Top Left):** It shows the number of electric vehicles in each market segment, providing an overview of segment popularity.
2. **Price Distribution by Segment (Top Right):** The second subplot presents the distribution of vehicle prices in euros within different market segments, helping to understand price variations.
3. **Top Speed by Segment (Bottom Left):** In the third subplot, bar plots depict the top speed (in Km/H) of electric vehicles in different market segments, allowing for a comparison.
4. **Efficiency by Segment (Bottom Right):** The final subplot displays the efficiency of electric vehicles (measured in Wh/Km) for various market segments.

Electric Vehicles manufactured by companies:



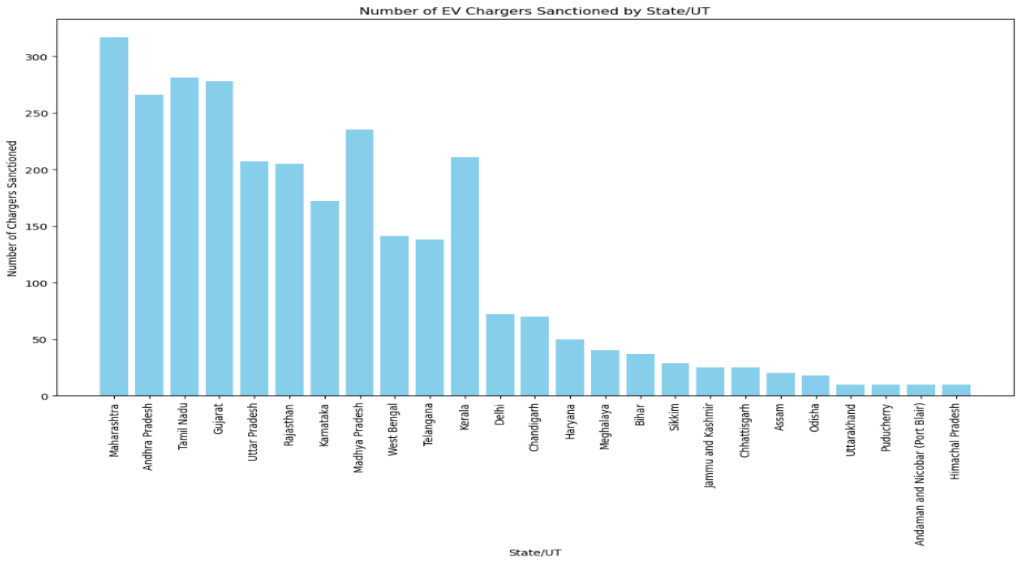


1. **Positive Correlations:**
    - Range_Km and PriceEuro: There is a positive correlation between the range of an electric vehicle and its price.

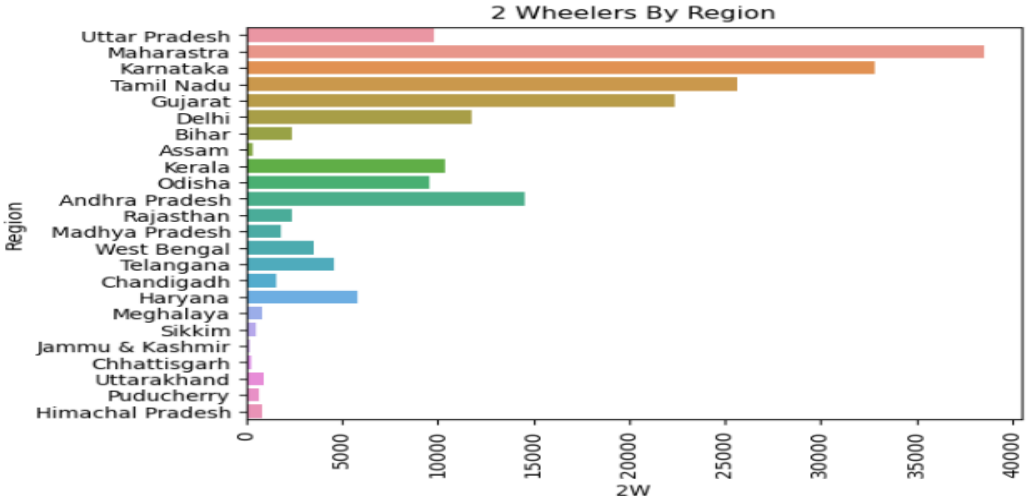
- TopSpeed_KmH and PriceEuro: Electric vehicles with higher top speeds tend to have higher prices.

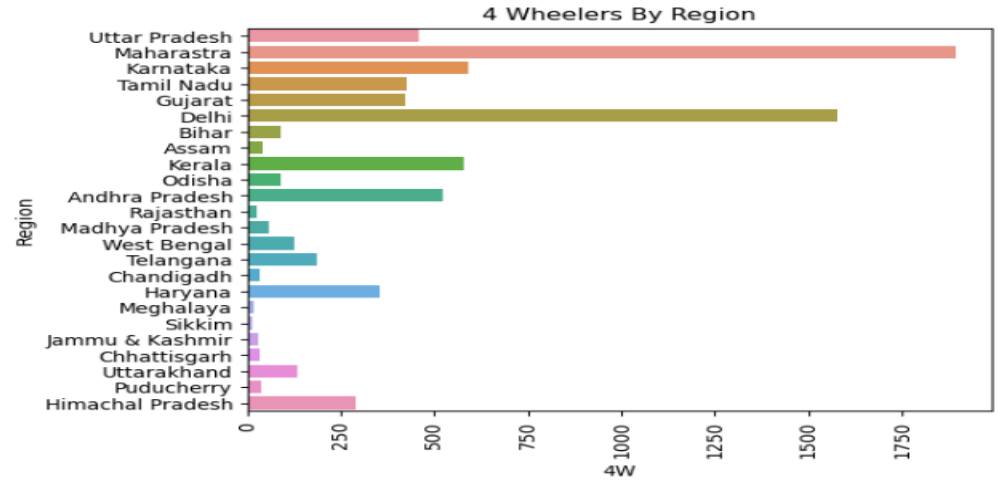
2. **Negative Correlations:**

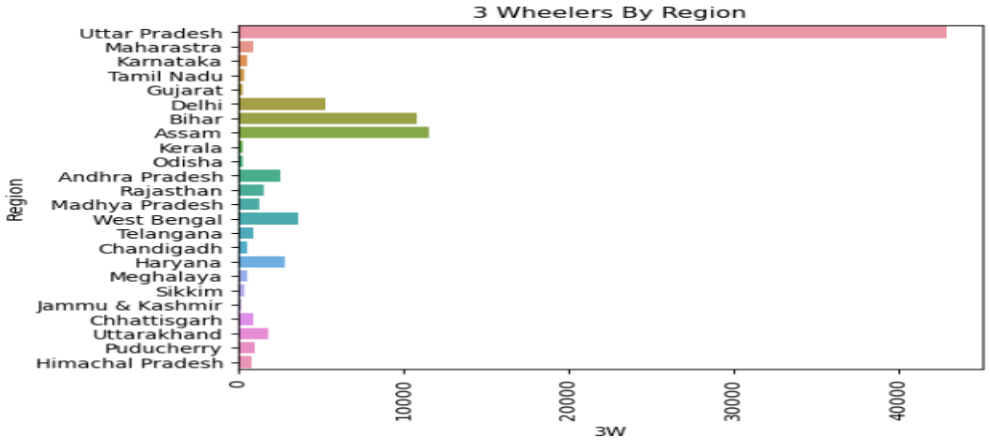
   - Efficiency_WhKm and Range_Km: Electric vehicles with higher efficiency (lower Wh/Km) tend to have longer ranges.



This bar chart provides an overview of the number of electric vehicle (EV) chargers that have been sanctioned in different Indian states and union territories. Each bar represents a state or union territory, and its height corresponds to the number of EV chargers that have been approved or authorized. The chart is color-coded in sky blue for easy visualization. It offers a quick visual comparison of the adoption and infrastructure development of EV charging points across various regions in India, with Maharashtra, Tamil Nadu, and Andhra Pradesh having some of the highest numbers of sanctioned chargers.







The chart provides a clear comparison of the 2,3,4-wheeler distribution across various regions, making it easy to identify which regions have a higher concentration of 2,3,4-wheelers. The rotation of the region names on the x-axis improves readability, and the title "2,3,4 Wheelers By Region" clarifies the purpose of the graph.

Segment Extraction:

K means clustering is one of the simplest and popular unsupervised machine learning algorithms. A cluster refers to a collection of data points aggregated together because of certain similarities. The algorithm tries to group similar items in the form of clusters. The number of groups is represented by You'll define a target number k, which refers to the number of centroids you need in the dataset. A centroid is the imaginary or reallocation representing the centre of the cluster. Every data point is allocated to each of the clusters through reducing the in-cluster sum of squares. In other words, the K-means algorithm identifies number of centroids, and then allocates every data point to the nearest cluster, while keeping the centroids as small as possible. The 'means' in the K-means refers to averaging of the data i.e., representing the centroid.

Below is the code snippet I have provided how kmeans is implemented.

```
# Selecting 3 clusters from the above scree plot which is the optimum number of clusters,
# as the curve is seemingly bent or showinf an elbow format at K = 3

model = KMeans(n_clusters = 3, init = 'k-means++', random_state = 123)
model.fit(ev_new)
```

```
KMeans(n_clusters=3, random_state=123)
```

```
model.labels_
```

```
array([2, 0, 2, 2, 0, 1, 0, 0, 0, 2, 2, 0, 0, 2, 0, 0, 1, 0, 0, 0, 0, 2,
       0, 1, 2, 0, 0, 2, 0, 0, 2, 0, 0, 2, 0, 0, 2, 0, 0, 0, 2, 0, 2, 0,
       0, 0, 0, 1, 1, 0, 2, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 2, 2, 2, 2, 1,
       0, 2, 0, 2, 0, 0, 1, 2, 0, 0, 2, 0, 2, 1, 0, 1, 0, 0, 2, 0, 0, 2,
       0, 0, 1, 0, 0, 2, 0, 0, 0, 2, 0, 1, 2, 2, 2])
```

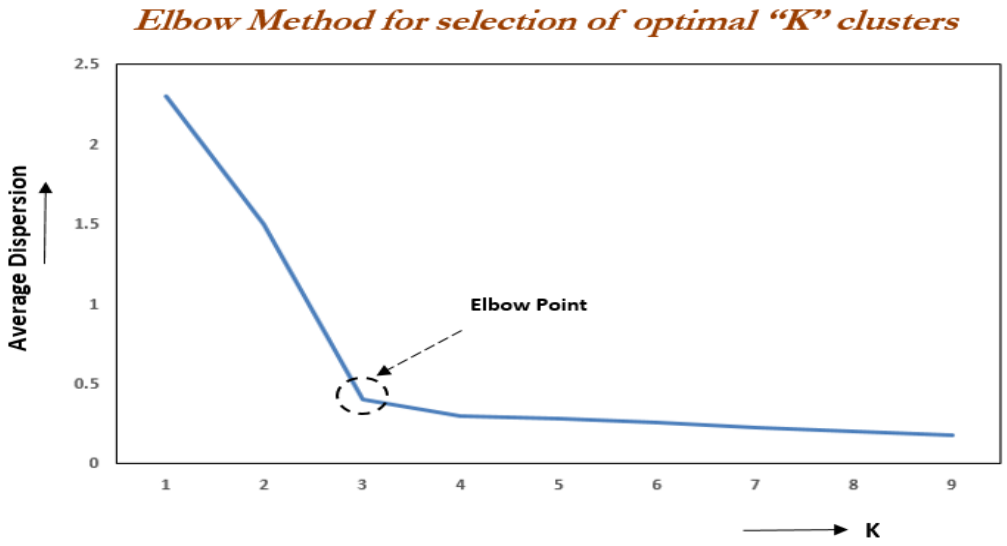
In [48]:
```
# In order to see the clusters we aggregate the records within the clusters and group them by the clusters to visualize the
# 3 nos of clear cluster formed
ev.iloc[:, 1:10].groupby(ev.clust).mean()
```

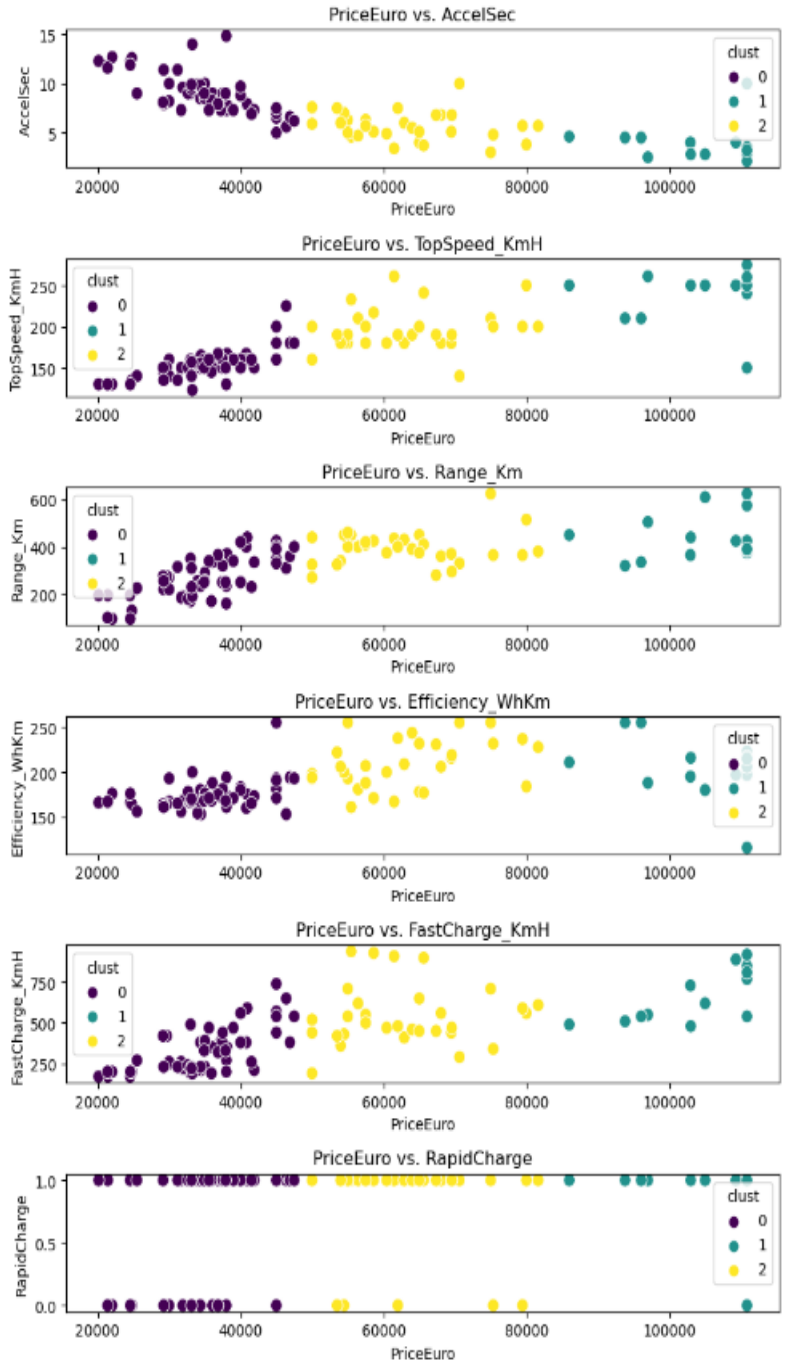
Out[48]:

clust	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PriceEuro
0	8.993966	153.344828	274.741379	174.025862	334.137931	0.655172	35120.706897
1	3.914286	240.428571	444.642857	205.107143	677.142857	0.928571	104157.250000
2	5.735484	195.548387	395.645161	208.983871	545.161290	0.838710	62917.451613

Elbow Method - Optimal Value:

It is one of the most popular methods to determine the optimal value of K. We use it to choose a K when we observe negligible change in the inertial values between different values of K.

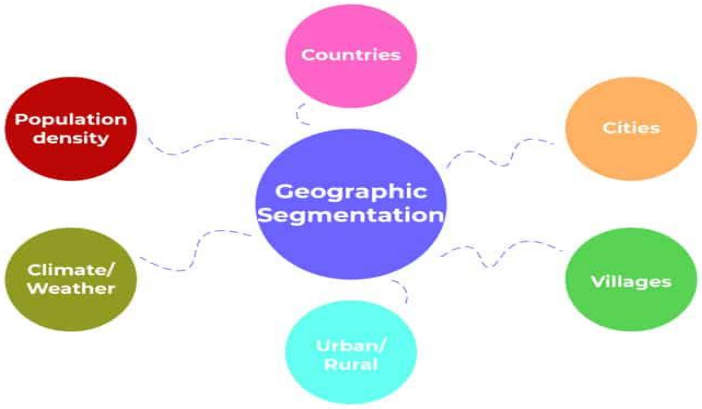




The scatterplots help to visualize how 'PriceEuro' correlates with the other features. It provides insights into whether there are patterns or relationships between the price of electric vehicles and these specific attributes. This analysis can be valuable for understanding how price relates to performance, range, and other characteristics, which is essential for market segmentation and decision-making in the electric vehicle market.

Profiling Potential Segments:

Geographic Segmentation: Geographic segmentation in the electric vehicle market involves dividing the market by geographical factors such as country, state, or urban versus rural areas. This allows EV manufacturers and marketers to cater to the unique needs and preferences of consumers in different locations, considering factors like charging infrastructure and local incentives for EV adoption.



Psychographic Segmentation: Psychographic segmentation categorizes consumers based on their psychological characteristics, lifestyles, values, and interests. It helps businesses understand and target specific customer segments with messages and products that resonate with their beliefs and lifestyles.

Behavioral segmentation: Behavioral segmentation categorizes consumers based on their purchasing behavior and how they interact with products or services. It helps businesses tailor marketing strategies and offers to specific customer segments, considering factors like loyalty, usage, and purchasing patterns.

Target Segments:

- Psychographic factors such as Comfort and Value for Money
- Behavioural factors such as good Acceleration and viable Price range
- Geographic factors such as States which are more market friendly.

In conclusion, the target segment should comprise of EVs having Acceleration of 7.5-10 sec,High in Comfort and Value for Money ratings, have a Price range of 20-30 Lakhs, and be focused mainly on States such as Maharashtra, Karnataka, Tamil Nadu and Rajasthan.

Customizing the market mix:

Customizing the marketing mix refers to tailoring the traditional marketing elements (the 4Ps - Product, Price, Place, and Promotion) to align with the specific needs and preferences of a target market segment. This customization may involve adapting the product features, setting appropriate pricing strategies, selecting the right distribution channels, and creating marketing campaigns that resonate with the identified segment. It allows businesses to address the unique requirements of a particular market segment, ultimately increasing the chances of success and customer satisfaction.

Most Optimal Market Segments:

In the context of the Electric Vehicle (EV) market in India, identifying the MOST OPTIMAL MARKET SEGMENTS involves identifying and prioritizing specific segments of consumers or businesses that offer the greatest potential for the widespread adoption and success of EVs. These segments typically exhibit the following characteristics in the Indian market:

1**. Urban Areas**: Metropolitan cities and urban centers with high population density and increased environmental concerns represent optimal segments due to the demand for eco-friendly transportation solutions.

2. **Government Initiatives**: Market segments influenced by government policies, incentives, and subsidies for EV adoption are considered highly favorable.

3. **Corporate Fleets**: Businesses with a focus on sustainability and cost-efficiency are optimal segments, as they may transition their fleets to electric vehicles.

4**. Tech-Savvy Consumers**: Segments comprising tech-savvy and environmentally conscious consumers who are willing to embrace EV technology are crucial for market growth.

5. **Infrastructure Development**: Areas where charging infrastructure is expanding, such as major highways and urban charging stations, are considered optimal segments.

6. **Price-Conscious Consumers:** Segments interested in affordable EV models and those who consider long-term cost savings are essential for market penetration.

7. **Environmental Advocates**: Consumers or organizations committed to reducing their carbon footprint and contributing to a cleaner environment represent valuable segments.

Identifying and targeting these MOST OPTIMAL MARKET SEGMENTS is vital for the growth and development of the EV market in India. It allows stakeholders in the EV industry to focus their efforts on areas with the greatest potential for adoption and success, ultimately contributing to a more sustainable and eco-friendly transportation landscape in the country**.**

Github link:

Code :https://github.com/SiddeshPardeshi/Feynn-Labs/blob/main/EV_market_kmeans.ipynb

Datasets:

https://github.com/SiddeshPardeshi/Feynn-Labs/blob/main/data.csv

https://github.com/SiddeshPardeshi/Feynn-Labs/blob/main/RS_Session_258_AU_1241_2.i%20(1).csv

https://github.com/SiddeshPardeshi/Feynn-Labs/blob/main/1_ev_charger_dataset.csv