MARKET SEGMENTATION ANALYSIS OF ELECTRIC VEHICLES MARKET IN INDIA

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1. Problem Statement

The problem statement revolves around the strategic decision-making process for an Electric Vehicle (EV) startup aiming to enter the Indian market. The startup seeks to identify the most promising segments within the electric vehicle market in India for developing its EVs. This involves conducting a comprehensive market segmentation analysis, considering various criteria such as geographic, demographic, psychographic, and behavioral factors. The goal is to understand the different customer segments and their preferences to devise a feasible strategy for market entry. Factors such as competition, regulatory landscape, infrastructure, consumer preferences, and technological trends must be evaluated to make informed decisions. By analyzing these aspects and estimating key parameters such as the total addressable market, segment sizes, and market entry costs, the startup can develop a strategic roadmap to effectively penetrate the Indian electric vehicle market.

2. Data Sources (Data Collection):

- Scraped electric car, bikes, scooter dataset using BeautifulSoup & Selenium using website https://www.zigwheels.com/
- Electric vehicle purchase Intention: https://data.mendeley.com/

3. Data Pre-processing (Steps and Libraries used)
### 3.1 Electric Vehicle Purchase Intention dataset

```
1  df = pd.read_excel("Electric Cars Purchase Intention.xlsx")
2  df.head()
```

This dataset contains 509 responses and columns are as follows:

- Commuted by e-car: 0 - No, 1 – Yes
- Educational Background: Science -1, Arts-2, Commerce-3, Engg/Tech-4, Others-5
- Student Gender: Male -1, Female-2
- Own a Car: 1- Yes, 2- No
- Own a e-bike: 1- Yes, 2-No
- Own a e-car: 1-Yes, 2-No
- Student Region: East-1, West-2, North-3, South-4
- Annual Family Income in INR: < 5 Lakhs-1, 5-10 Lakhs-2, >10 Lakhs-3
- Work Experience in Years: 0 year-1, <1 year-2, 1-5 years-3
- Student's Age: Age of students mainly between 20 to 29
- All other variables range between 1 to 5: 1-Strongly disagree and 5-Strongly Agree
    1. DRIVING CONVENIENCE (DC)
        - I think sufficient battery charging points are available on highways (DC1)
        - I think adequate service centres are available for e-cars (DC2)

- I think the range (the distance travelled in a single charge) of e-cars is adequate for me (DC3)
- I think charging speed of e-cars is adequate (DC4)

2. TECHNICAL ATTRIBUTES (TA)
- I think e-cars are sleek (TA1)
- I think e-cars are durable (TA2)
- I think e-cars are available in different size, colours and designs (TA3)
- I think e-cars are aesthetically appealing (TA4)
- I think e-cars are technologically superior (TA5)
- I think e-cars give comfortable ride (TA6)

3. GOVERNMENT POLICY (GP)
- I think that the government is providing incentives for the purchase of e-cars (GP1)
- I think that the government is providing subsidies to the manufacturers (GP2)
- I think the government is incentivizing research and development in electric vehicle technologies (GP3)
- I think the government is investing on the establishment of electric vehicle charging points (GP4)
- I think the government is planning to introduce electric vehicle policy (GP5)

4. ENVIRONMENTAL CONCERN (EC)
- I prefer to purchase ecologically safe products (EC1)
- Conventional vehicles are contributing to increasing level of air pollution in the country (EC2)
- I care about energy conservation (EC3)
- I think e-cars make less noise (EC4)

5. CHARGINING CONVENIENCE (CC)
- I think batteries can be charged at home (CC1)
- I think batteries can be charged at my college/ workplace (CC2)
- I think E-cars batteries can be charged at lower rates at off-peak hours (CC3)

6. ECONOMIC BENEFITS (EB)
- I think e-cars have better fuel efficiency (EB1)
- I think e-cars have lesser maintenance cost (EB2)
- I think e-cars have lesser mechanical complexity (EB3)

7. SYMBIOTIC ATTRIBUTES (SA)
- The society perceives that the persons with e-vehicles are more concerned for the environment (SA1)
- The society perceives that the persons with e-vehicles are more concerned for the societal health (SA2)

8. I think pickup of e-cars is adequate
9. I would recommend my friends and relatives to purchase an e-car
10. I intend to buy an e-car as my first car
11. I would like to be a part of promotional campaigns of e-cars

3.1.1 EDA (Visualizations)
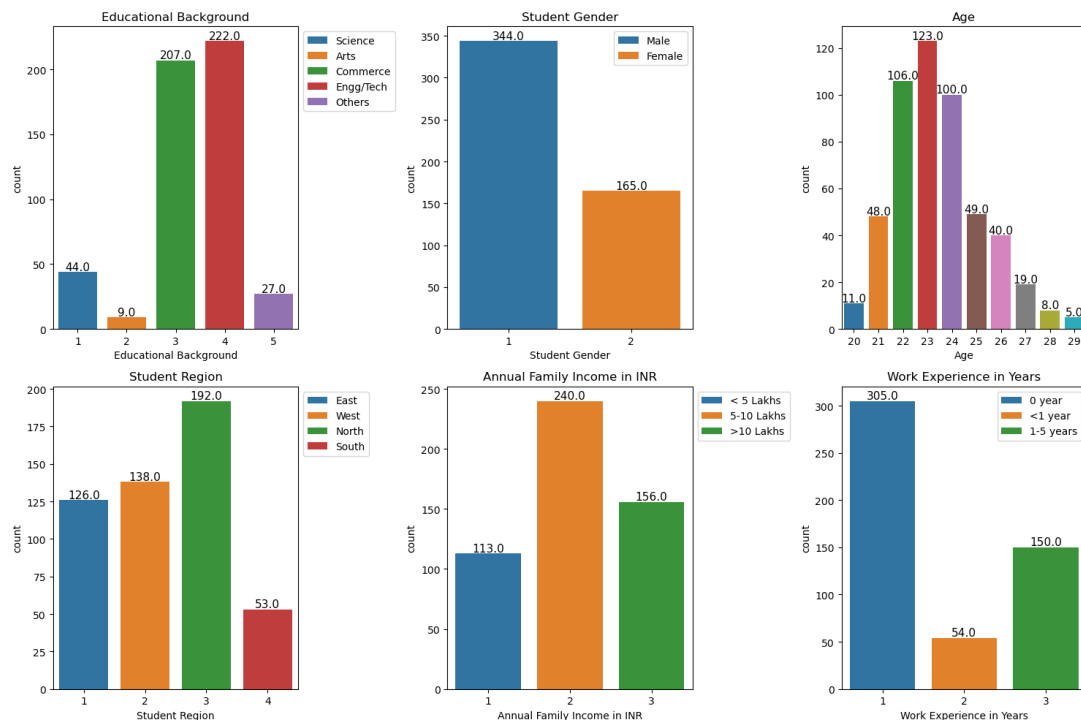
- Educational Background: This survey contains high number of responses from Engg/Tech followed by Commerce
- Student Gender: 67.5% of males & 32.5% of females have filled the form
- Age: Age distribution is right skewed, as we get low response from 28, 29 age group students, almost 64% of response are from 22-24 age group students
- Student Region: North region student has given high response followed by West, East, South.
- Annual Income: Almost 77% of student family income is more than 5 lakhs.
- Work Experience: Almost 40% of students have more than 0 years of experience
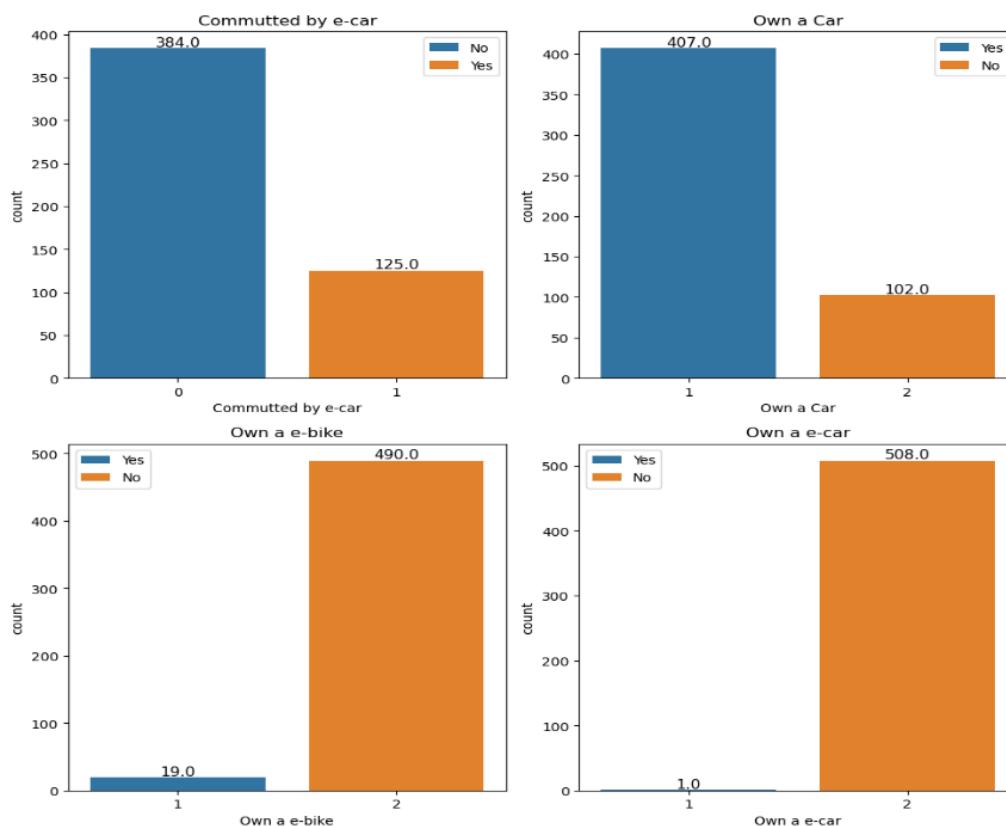
- Commuted by e-car: only 24.5% of students use e-cars
- Own a car and e-car: Almost 80% own a car and only 1 student has e car
- Own a e-bike: Only 3.7% of students owns a ebike.

DRIVING CONVENIENCE
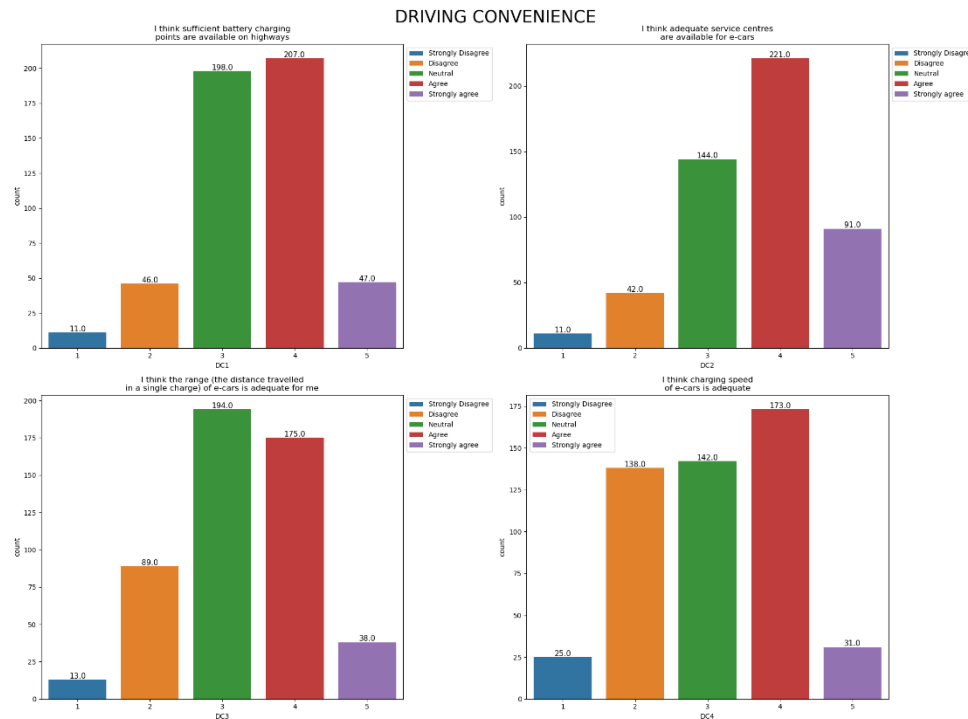
- I think sufficient battery charging points are available on highways: Almost 50 % of people have positive sentiment
- I think adequate service centres are available for e-cars: Almost 61% of people have positive sentiment
- I think the range (the distance travelled in a single charge) of e-cars is adequate for me: only 41 % of people are satisfied by range, & 38% of customers don't care about range i.e customer are less satisfied with range providing by companies today.
- I think charging speed of e-cars is adequate: only 40% are satisfied by charging speed of e-cars
- Here we can conclude that customer is less satisfied with charging speed, Range of e-cars
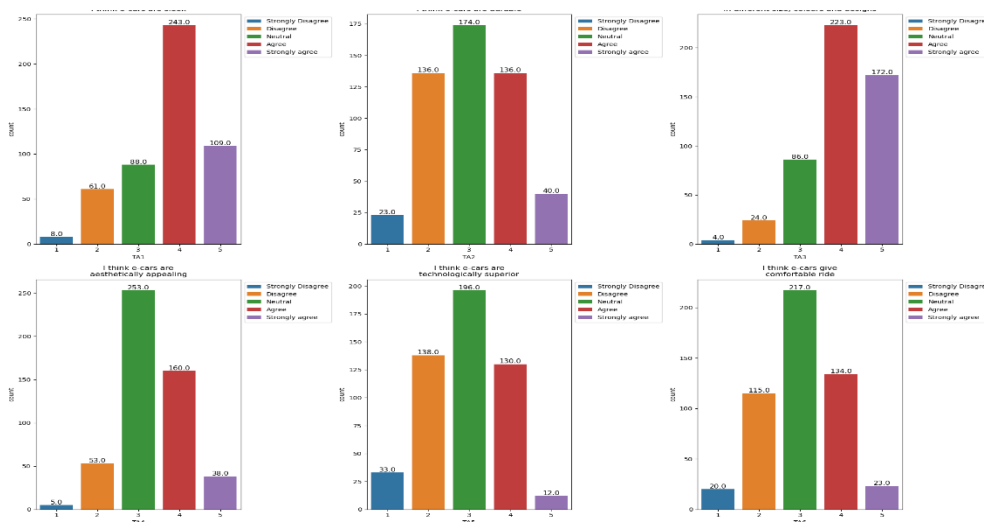
- I think e-cars are sleek: 69% customers are satisfied
- I think e-cars are durable: only 34% customers are satisfied, 34% are neutral
- I think e-cars are available in different size, colours and designs: almost 80% customers are satisfied
- I think e-cars are aesthetically appealing: 38% customers are satisfied, 50% are neutral
- I think e-cars are technologically superior: 27% customers are satisfied, 38% are neutral
- I think e-cars give comfortable ride (TA6): 30% customers are satisfied, 42% are neutra
- Here we can conclude that customer is not much satisfied with durability, comfortablity, and technologically superiority of e-cars.


GOVERNMENT POLICY
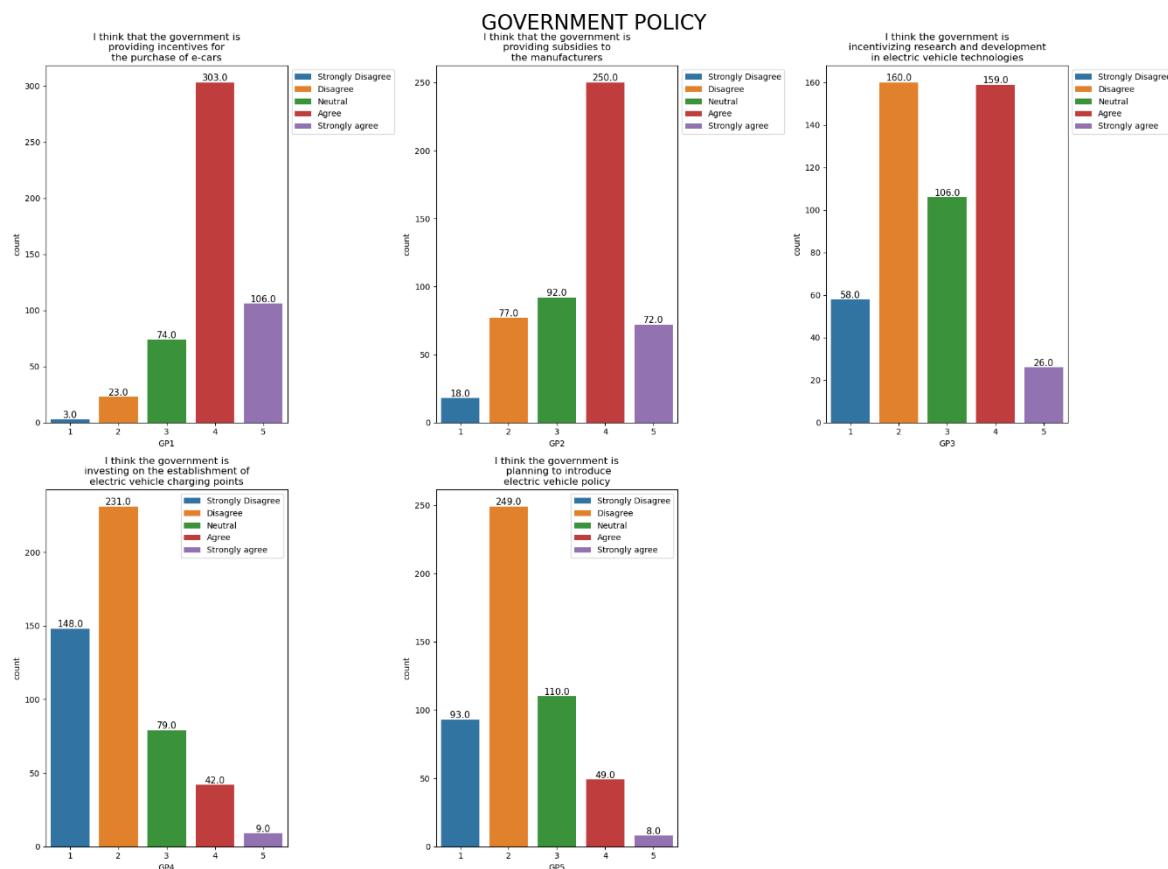
- I think that the government is providing incentives for the purchase of e-cars: 80% customers are satisfied
- I think that the government is providing subsidies to the manufacturers: 63% customer agrees
- I think the government is incentivizing research and development in electric vehicle technologies: only 36% agrees and almost 40 % doesn't agree
- I think the government is investing on the establishment of electric vehicle charging points: 74% customer disagrees
- I think the government is planning to introduce electric vehicle policy: 67% customer disagree.
- Here we can conclude that customers disagrees that government is planning for any ev policy and adding more charging points

ENVIRONMENTAL CONCERN
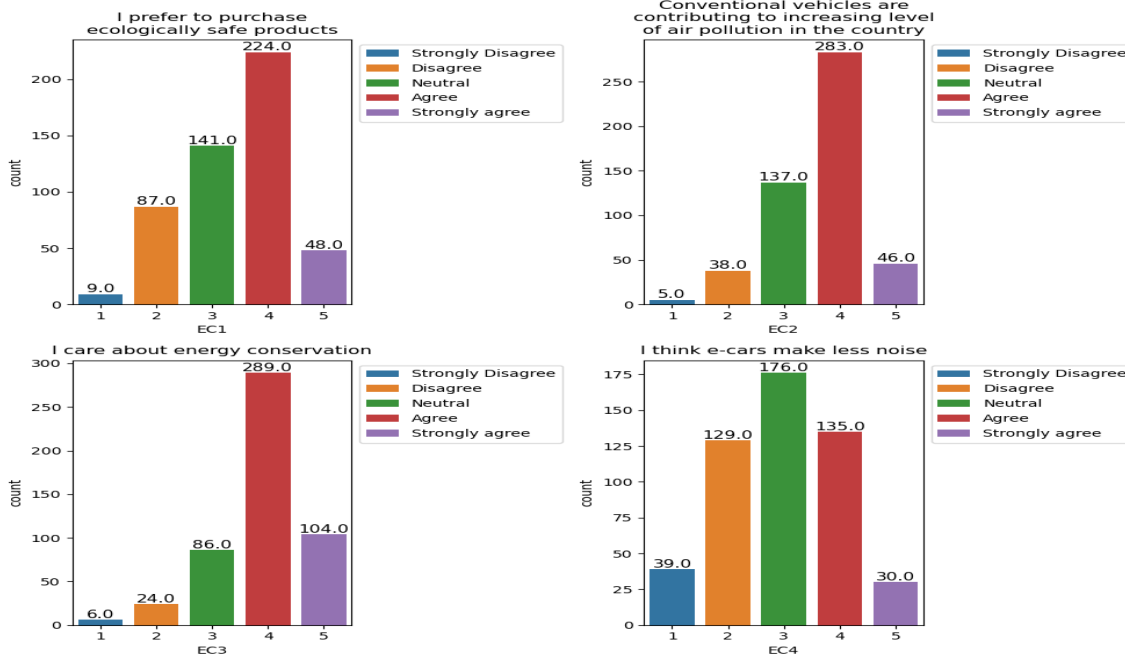
- I prefer to purchase ecologically safe products: 53% of customers prefer enviornment friendly products
- Conventional vehicles are contributing to increasing level of air pollution in the country: 64% customer agrees
- I care about energy conservation: 77% agrees
- I think e-cars make less noise: only 32 % agrees, and 34% are neutral
- Here we can conclude that customers do care about enviornment & conservation of energy and disagrees that e cars make less noise.

CHARGINING CONVENIENCE
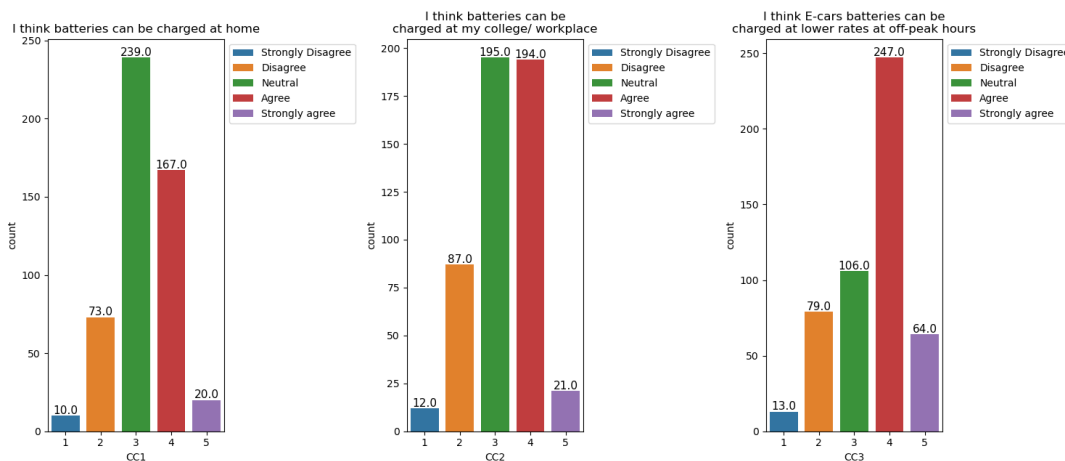
- I think batteries can be charged at home: 36% agrees, 46 % neutral
- I think batteries can be charged at my college/ workplace: 42% agrees, 38% neutral
- I think E-cars batteries can be charged at lower rates at off-peak hours: 61% agrees
- Here we can conclude that we 30-50% of customers agrees that batteries can be charged at home, college, workplace

ECONOMIC BENEFITS
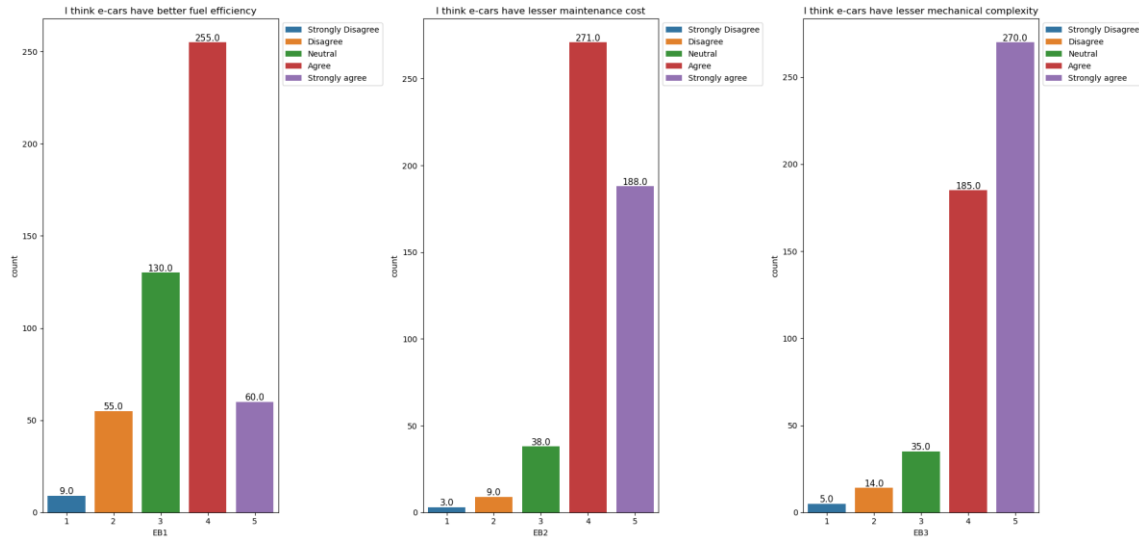
- I think e-cars have better fuel efficiency: 61% agrees
- I think e-cars have lesser maintenance cost: 90% agrees
- I think e-cars have lesser mechanical complexity: 89% agrees
- From here we can conclude that e-cars are fuel efficient, requires less maintainence cost, and less mechanical complexity

SYMBIOTIC ATTRIBUTES
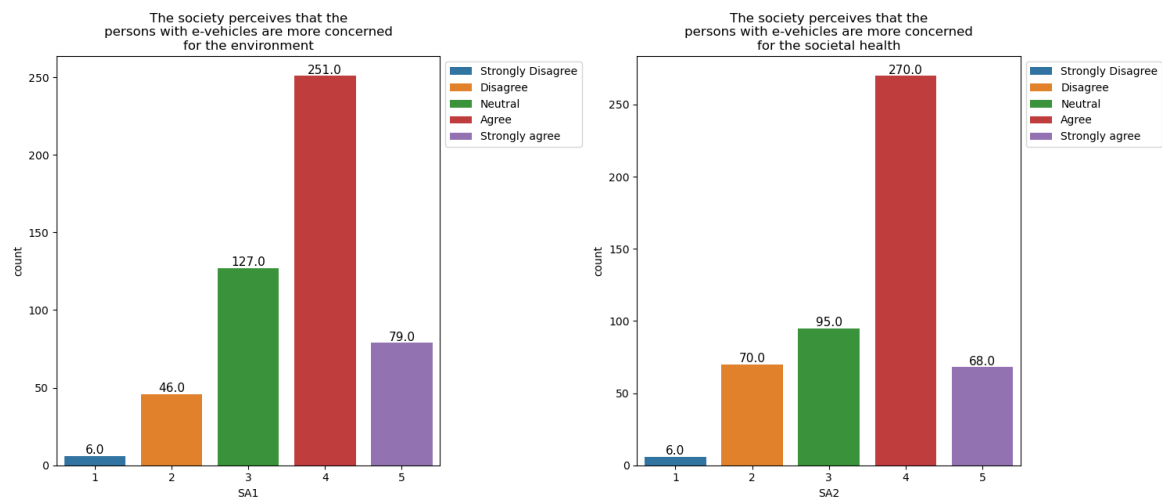
- The society perceives that the persons with e-vehicles are more concerned for the environment: only 29% agrees to it, 32% are neutral
- The society perceives that the persons with e-vehicles are more concerned for the societal health: 64% agrees to it, 23 % are neutral

3.1.2 Segment Extraction (K Means Clustering)

Distortion Score Elbow for KMeans Clustering
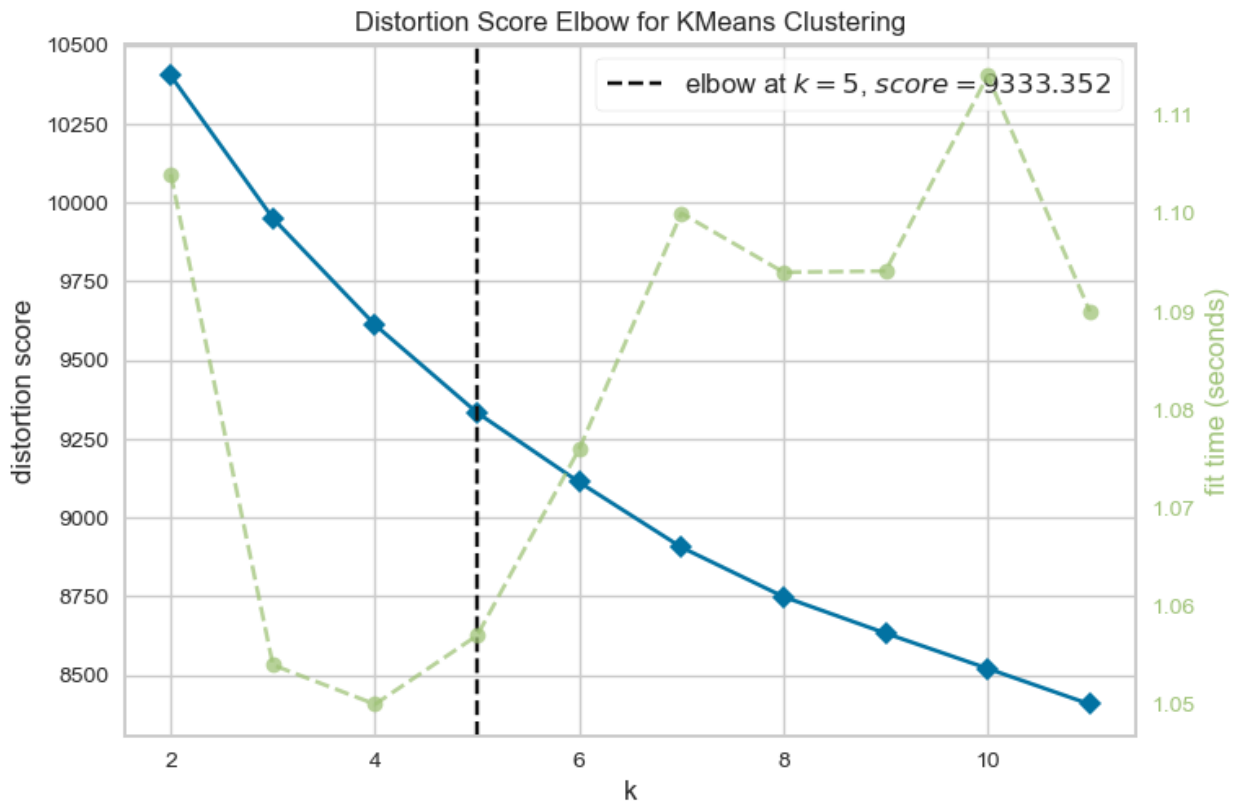
We utilized a set of 34 attributes encompassing various aspects such as Driving Convenience (DC1, DC2, DC3, DC4), Technical Attributes (TA1, TA2, TA3, TA4, TA5, TA6), Government Policy (GP1, GP2, GP3, GP4, GP5), Environmental Concern (EC1, EC2, EC3, EC4), Charging Convenience (CC1, CC2, CC3), Economic Benefits (EB1, EB2, EB3), and Symbiotic Attributes (SA1, SA2).

Using the K-means algorithm, we partitioned the data into 5 clusters. This segmentation was visualized utilizing the "KElbowVisualizer" from the Yellowbrick library.

3.1.3 Profiling and describing potential segments
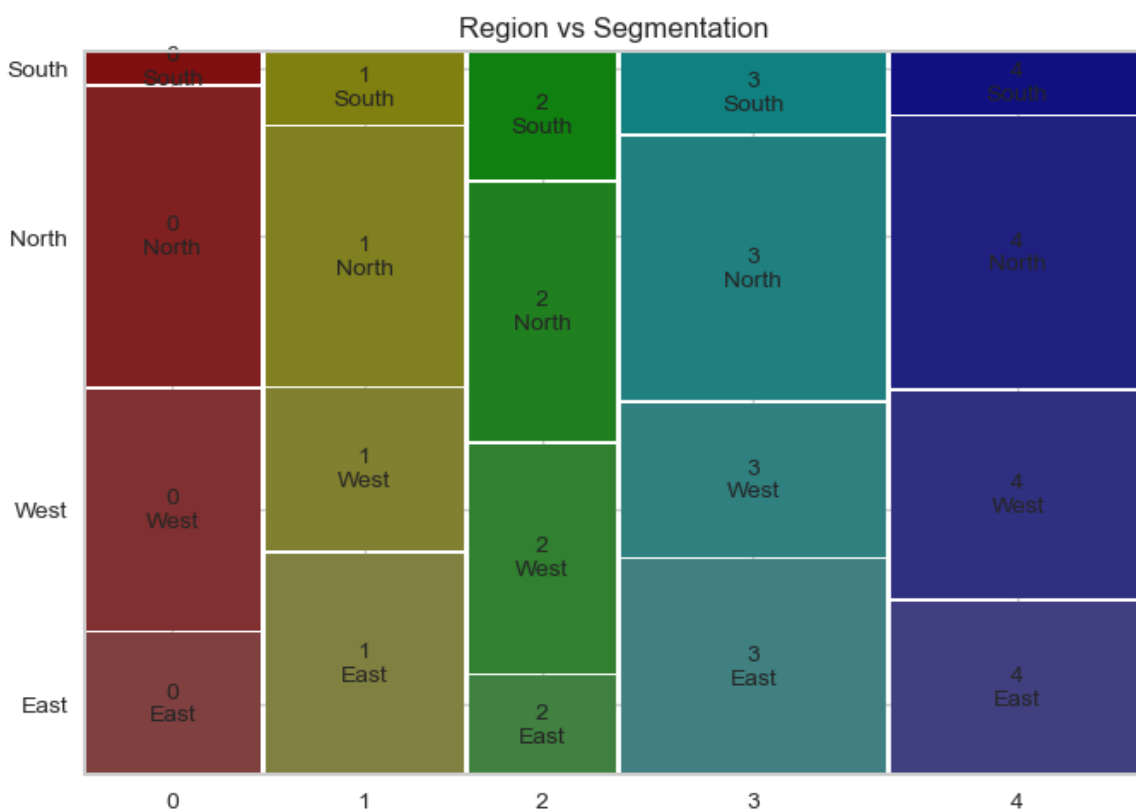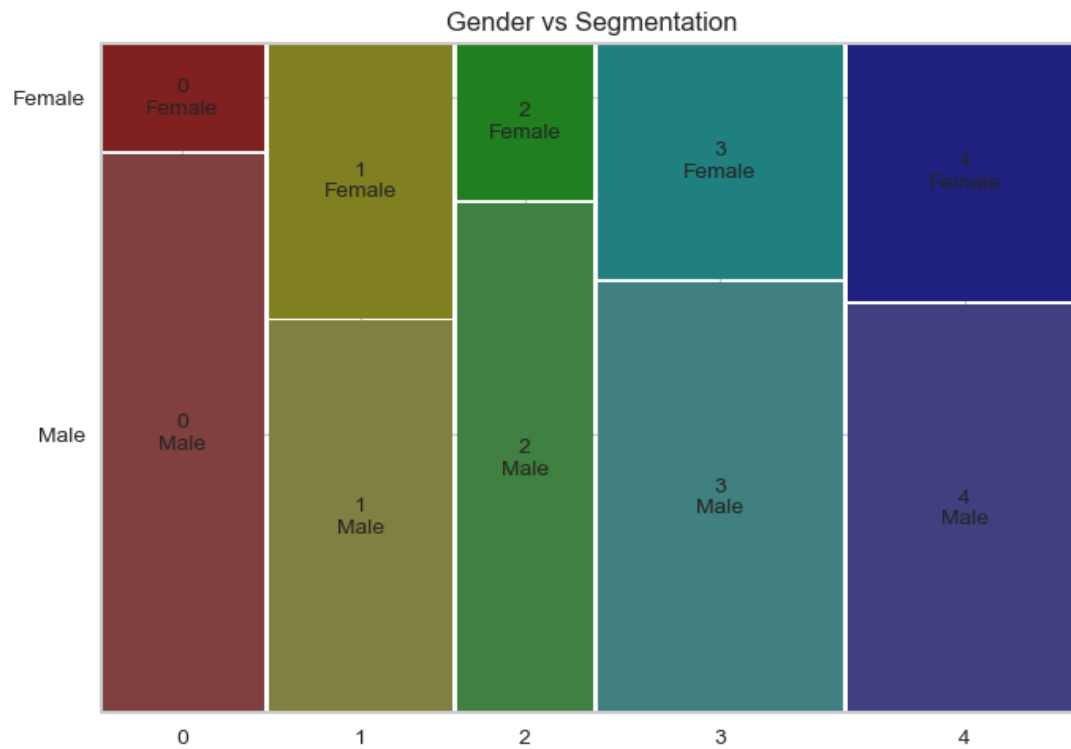

Age vs Segmentation
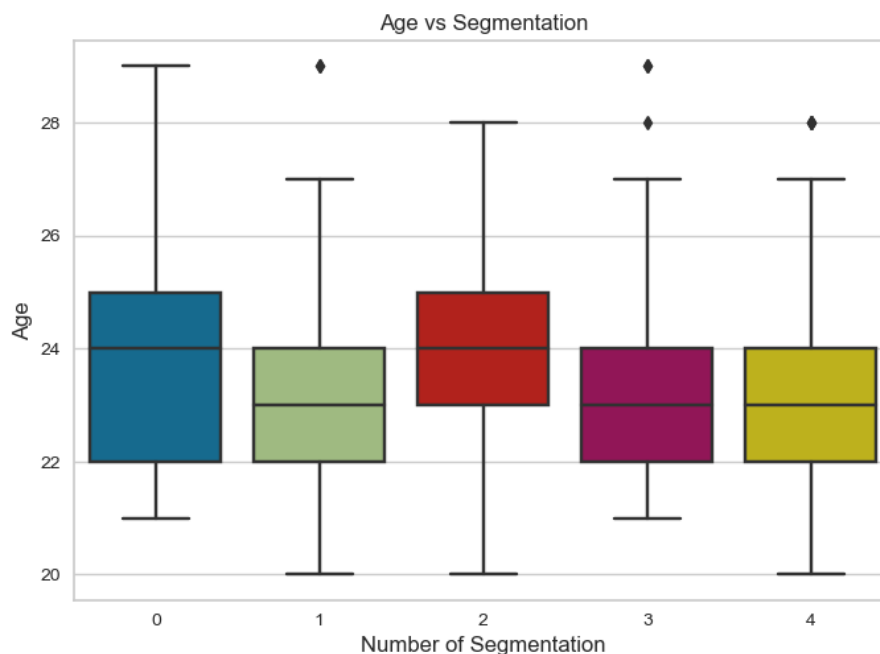
- The above boxplot concludes that:
- segment 1, Segment 3 & has segmented customer who are 23 years and
- Segment 0 & 2 has segmented customer who are 24 years
    1. Segment 0 ranges from [21,29]
    2. Segment 1 ranges from [20, 27]
    3. Segment 2 ranges from [20,28]
    4. Segment 3 ranges from [21, 27]
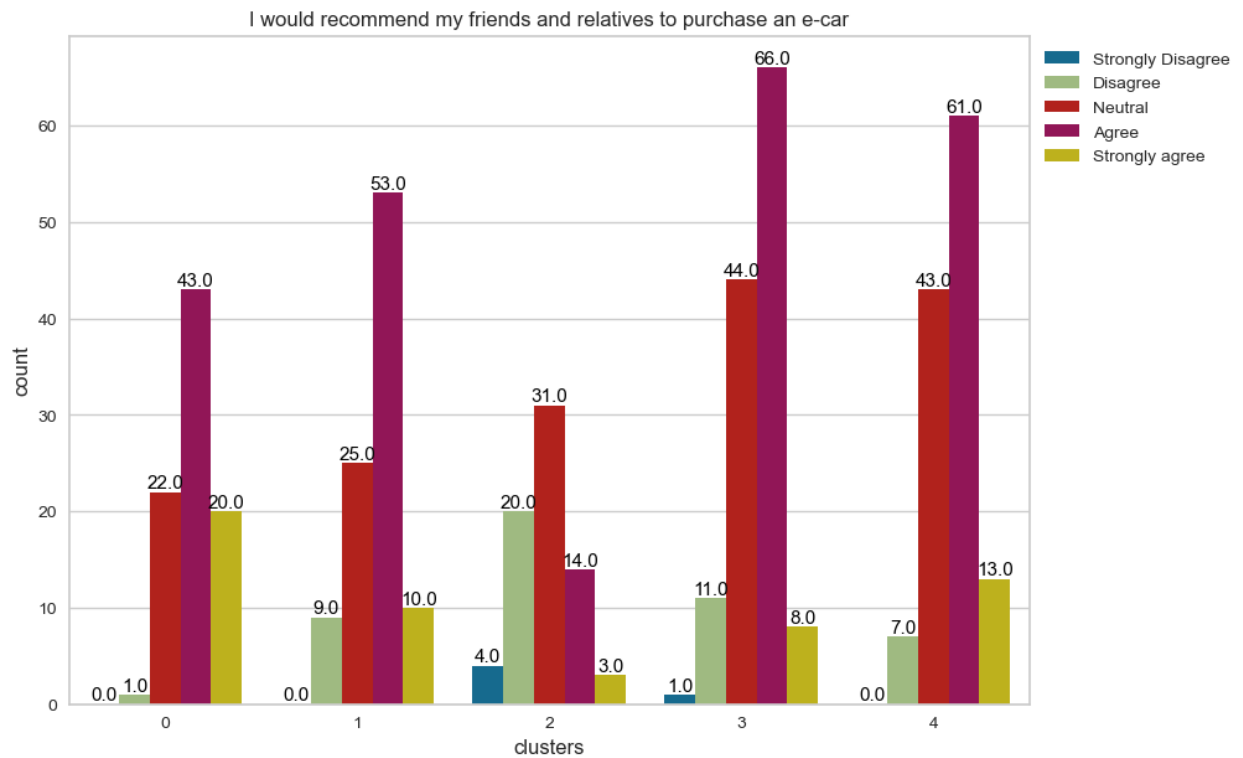   5. Segment 4 ranges from [20,27]
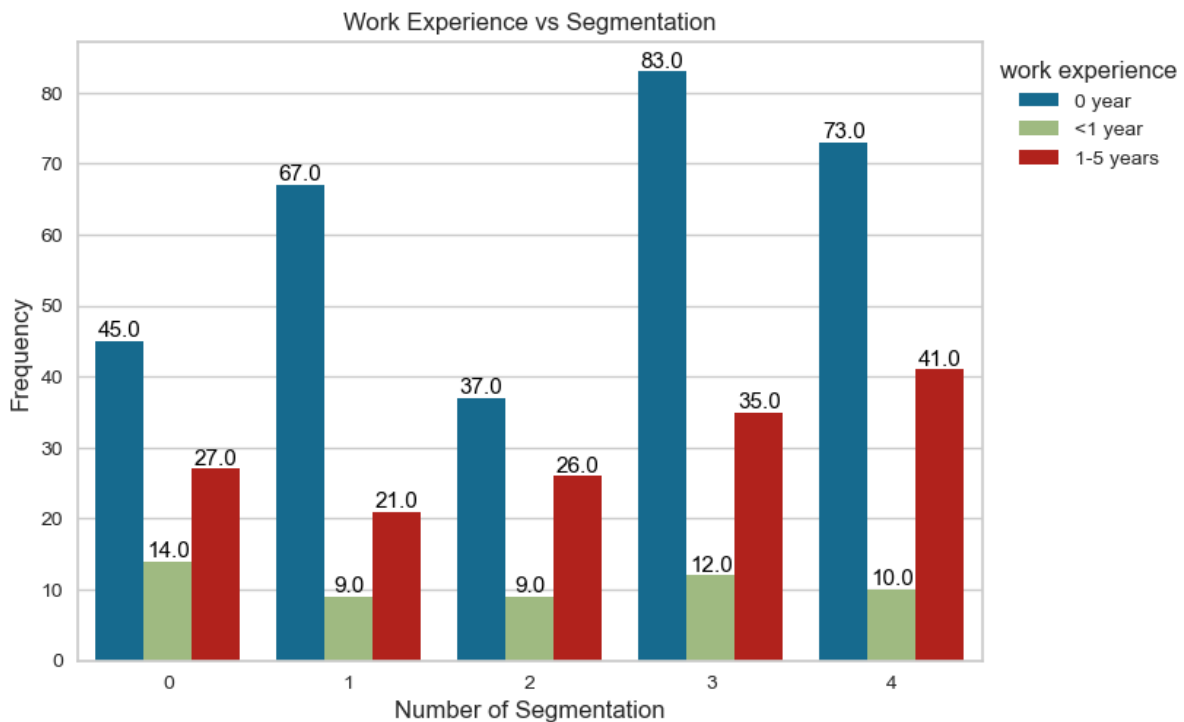
- Customer with 1-5 years of experience are clustered more into 4th segment
- Customer with 0 years of experience are clustered into 3rd segment heavily
- Customer with <1 years of experience is almost stable through each segment.
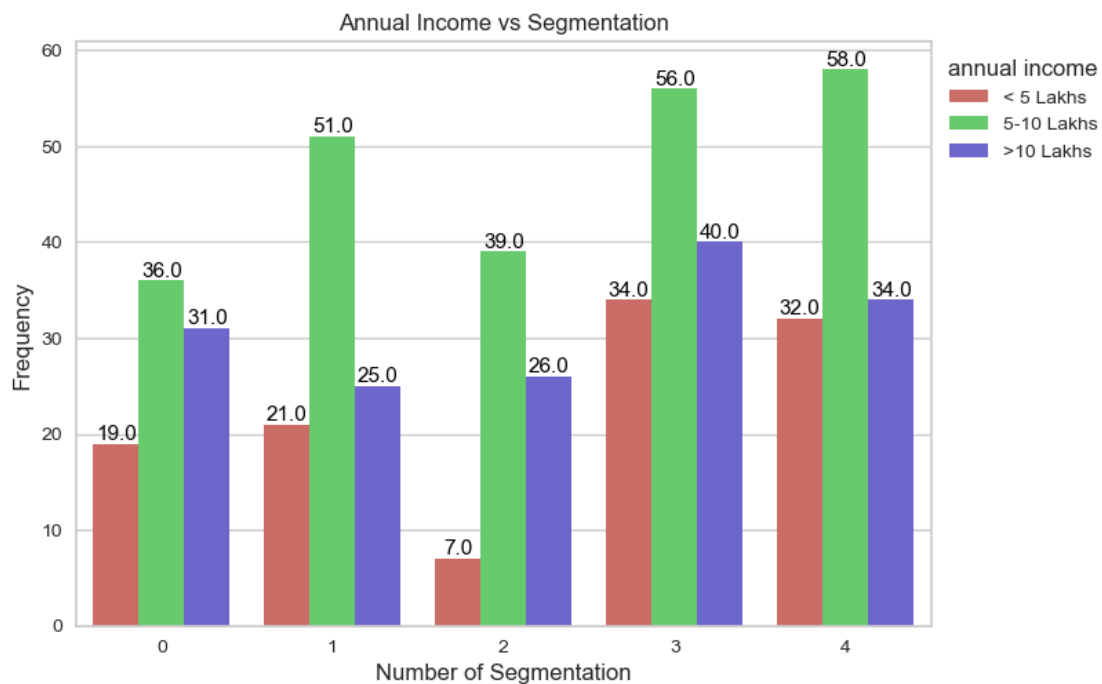
- Customer with 5-10L annual family income are segmented into segment 3 & 4.
- Customer with >10L annual income are segmented into segment 3.
- Customer with <5L annual income are segmented more into segment 3 & 4

Gender vs Segmentation

Region vs Segmentation

I would recommend my friends and relatives to purchase an e-car

- Segment 3 & 4 customers would recommend family/friend for EV
- Segment 2 customers would not recommend family/friend for EV compared to other segments

I intend to buy an e-car as my first car
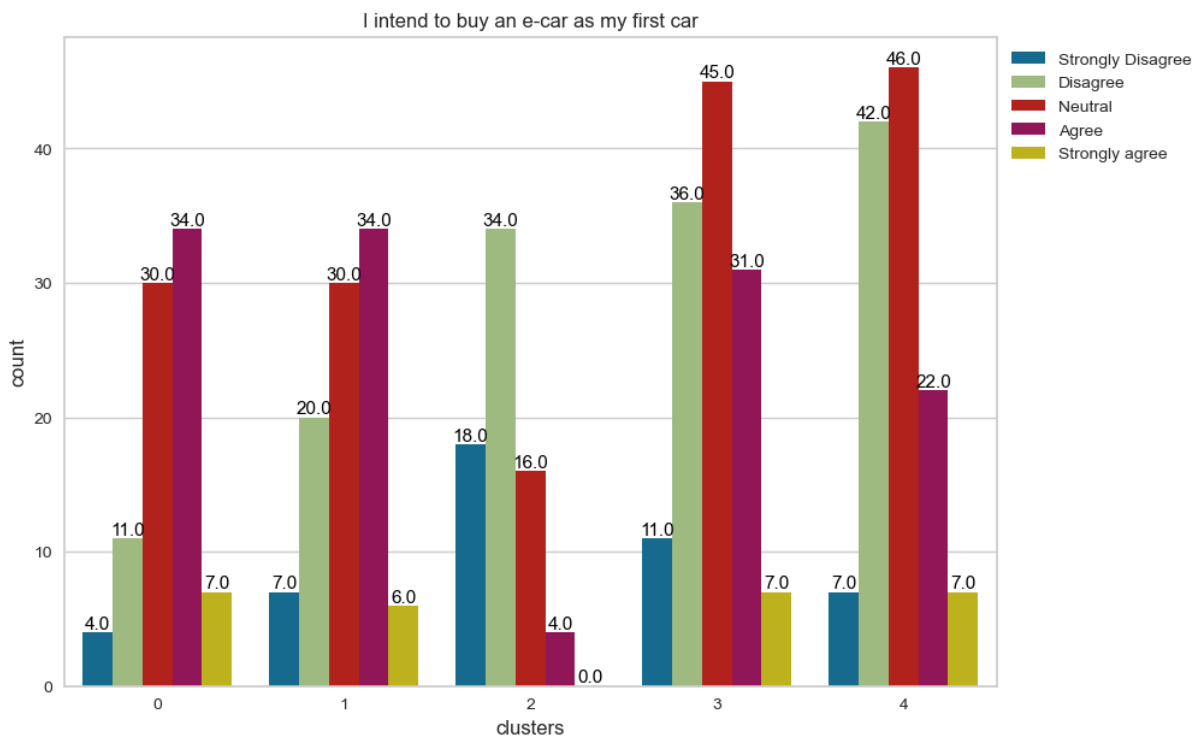
- Segment 3 & 4 customers are more neutral towards purchasing ev as there first car
- Segment 1 & 0 customers are more shifted towards purchasing ev as their first car

Cluster 3: 130 (25.54%) Cluster 4: 124 (24.36%)
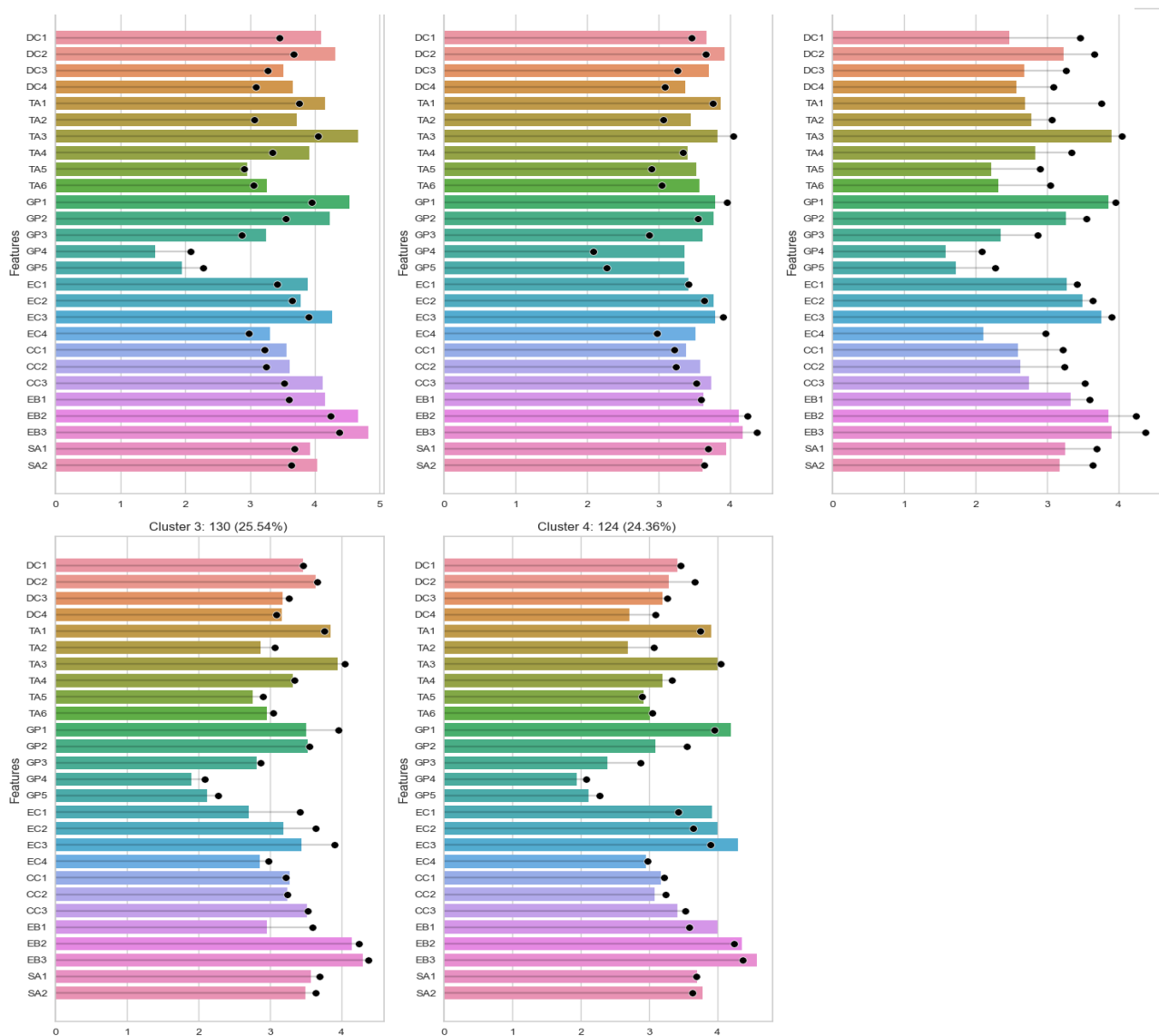
3.1.4 Selection of target segment

Based on the above graphs, we can infer that Segment 4 comprises a higher number of customers with 5-10L annual incomes. Additionally, the age range of students within this segment falls between 20 to 27 years. Moreover, there is a predominance of male customers compared to females. Furthermore, individuals from the South region are less represented in this segment. Interestingly, customers in Segment 4 are inclined to recommend purchasing EV cars to their relatives. Moreover, they exhibit a neutral stance towards purchasing their first vehicle as EV vehicles themselves.

Attributes that customers in Segment 4 are not satisfied with can provide valuable insights for entering the Indian EV market. By addressing these areas of dissatisfaction, companies can improve customer satisfaction and competitiveness in the market. Here are the attributes identified for Segment 4 along with potential strategies for addressing them:

- Sufficient battery charging points on highways (DC1): Invest in expanding the charging infrastructure network along highways to alleviate range anxiety for EV owners traveling long distances.
- Adequate service centers for e-cars (DC2): Increase the number of service centers and enhance service quality to ensure timely maintenance and repairs for EV owners.
- Range of e-cars is adequate (DC3): Focus on developing EV models with longer range capabilities to meet the diverse needs of customers, including those who require extended driving ranges.
- Charging speed of e-cars is adequate (DC4): Invest in fast-charging technology and infrastructure to reduce charging times and improve convenience for EV owners.
- E-cars are durable (TA2): Enhance the durability and reliability of EV components and systems to increase customer confidence in the longevity of EVs.
- E-cars are available in different sizes, colors, and designs (TA3): Expand the range of EV models available in the market to cater to diverse customer preferences and lifestyles.
- E-cars provide a comfortable ride (TA6): Focus on improving vehicle comfort features, such as seating, suspension, and cabin noise insulation, to enhance the overall ride experience for EV owners.
- Batteries can be charged at home (CC1): Encourage the adoption of home charging solutions by providing incentives, subsidies, and educational programs to promote residential EV charging infrastructure installation.
- Batteries can be charged at college/workplace (CC2): Collaborate with educational institutions and workplaces to install charging stations and offer incentives for EV charging during off-peak hours.
- E-cars batteries can be charged at lower rates during off-peak hours (CC3): Implement time-of-use pricing schemes and incentives to encourage EV owners to charge their vehicles during periods of lower electricity demand, reducing charging costs.

By addressing these key areas of dissatisfaction, companies can better meet the needs and preferences of customers in Segment 4 and improve their competitiveness in the Indian EV market. Additionally, continuous monitoring of customer feedback and market trends will be essential for adapting strategies and maintaining customer satisfaction over time.

3.2 Electric vehicle Specification dataset

```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
from yellowbrick.cluster import KElbowVisualizer
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```
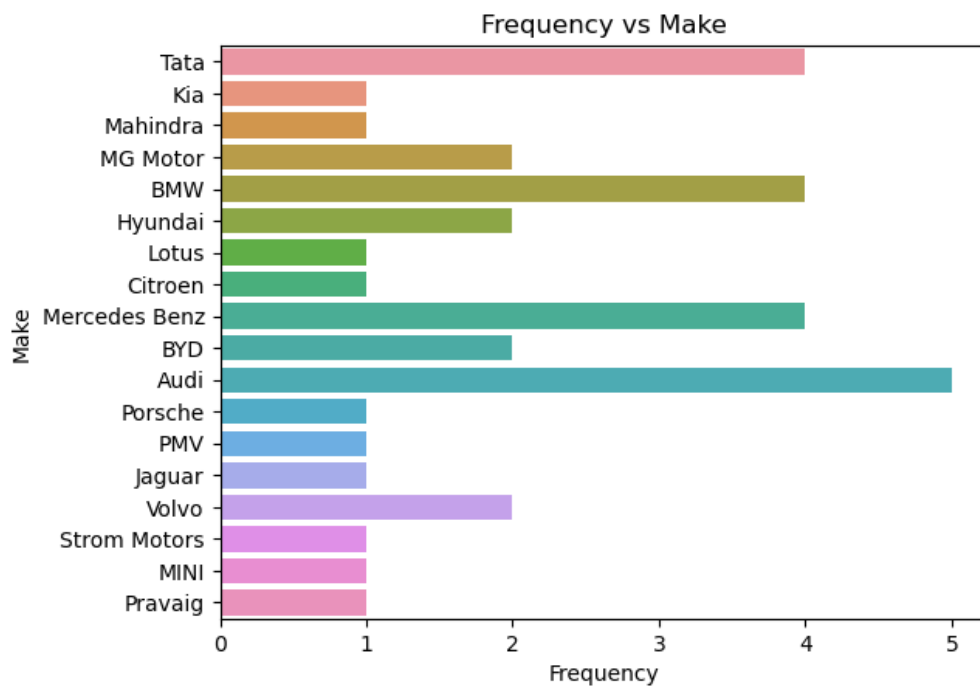
```python
df_cars = pd.read_csv('Electric_cars_vehicle_spec.csv')
df_cars.head()
```

This dataset contains 14 columns as:

- VehicleType
- Make
- BodyType
- Model
- StartingPrice(INR Lakhs)
- NoofSeats

- MaxTorque(Nm)
- MaxPower(BHP)
- Range(km/charge)
- BatteryCapacity(kwh)
- ChargingTime(Mins)
- GroundClearance(mm)
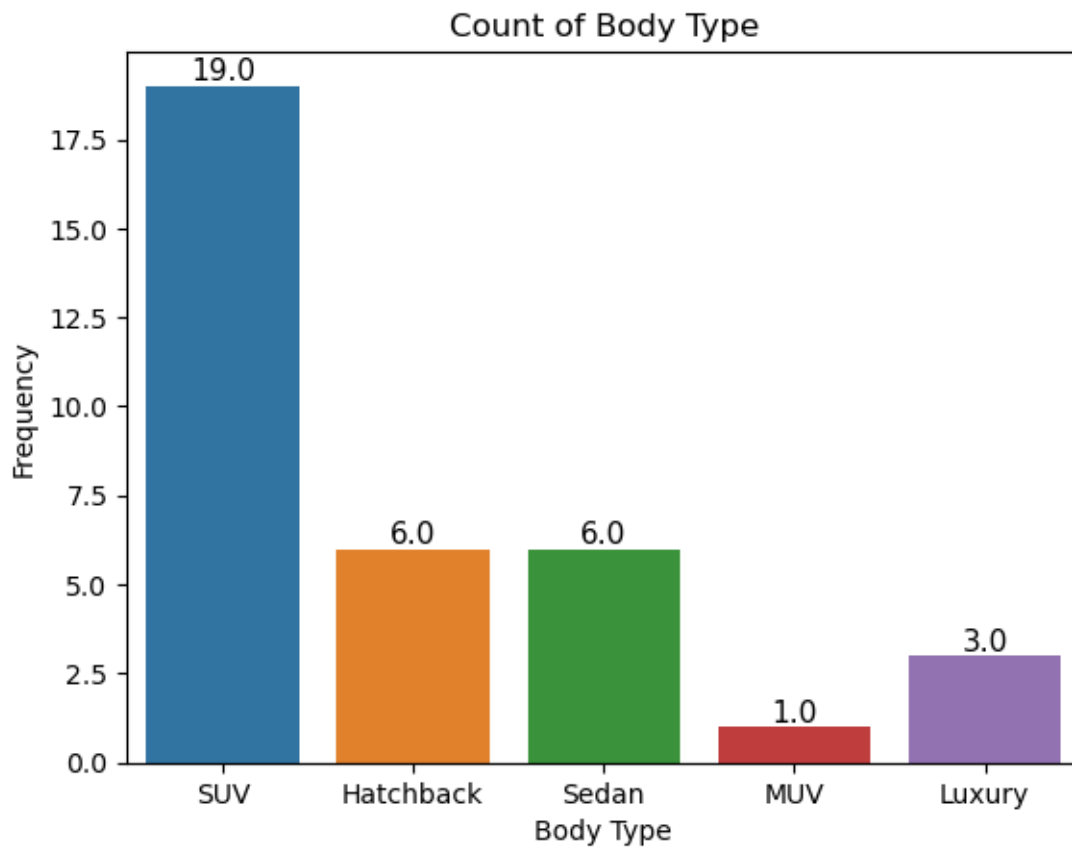- BootSpace(Liters)
- FastCharging

## 3.2.1 EDA (Visualisation)



Frequency vs Make

- Audi has make 5 cars which are running in India, followed by Tata, BMW, Mercedes Benz.



Price Distribution of e-cars
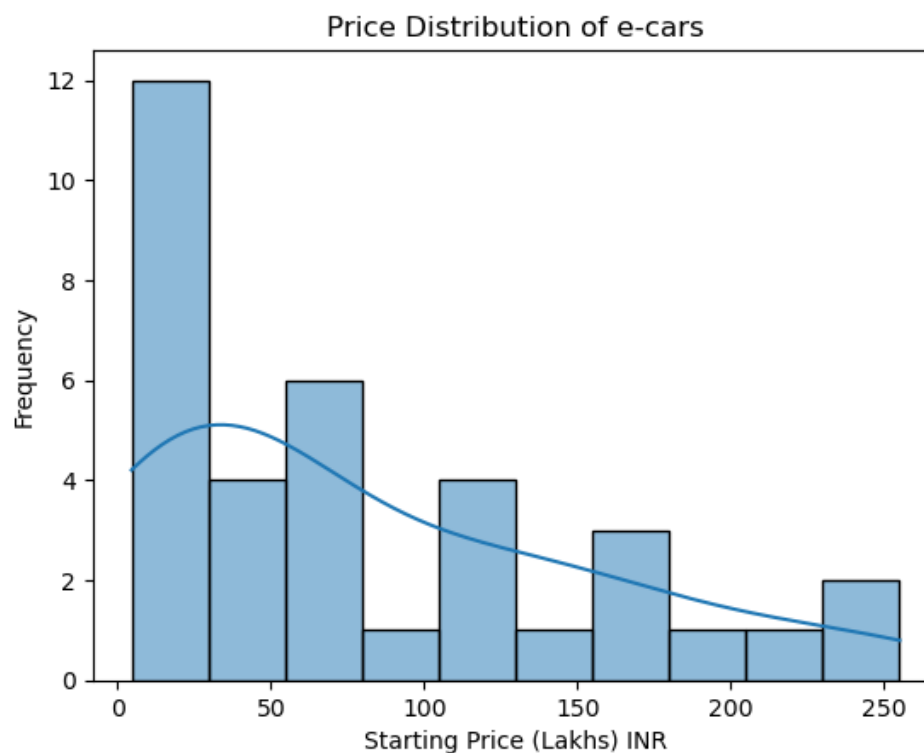
- Above histogram provides a skewed dataset showing the Starting price of e-cars. We can conclude that EV cars come with many different price segments.


Count of Body Type

- From the Body Type bar plot we can conclude that Ev- cars come with all Body Types which were used for conventional vehicles
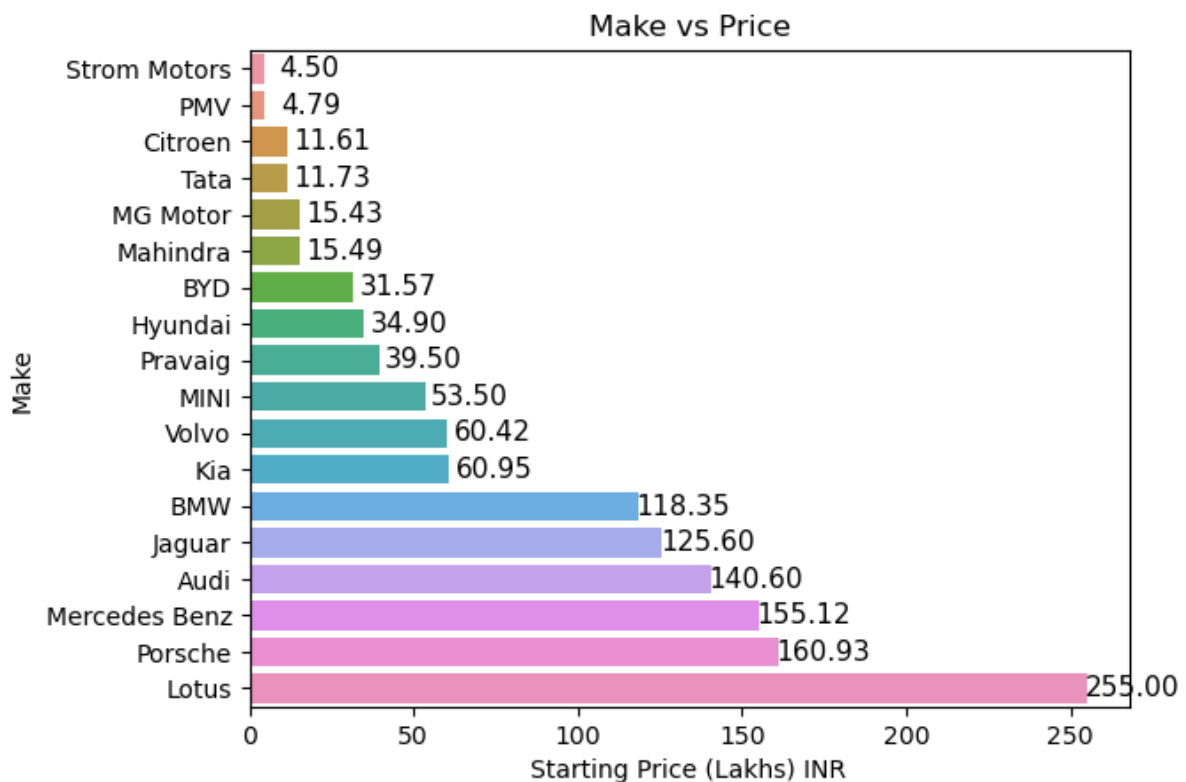

Make vs Price

- Make vs Price graph shows distribution of Price among the manufacturers. As per mean starting price of each manufacturer, we can conclude that Indian Middle class can afford Top four manufacturers Strom Motors, PMV, Citreon, Tata.



Make vs Range
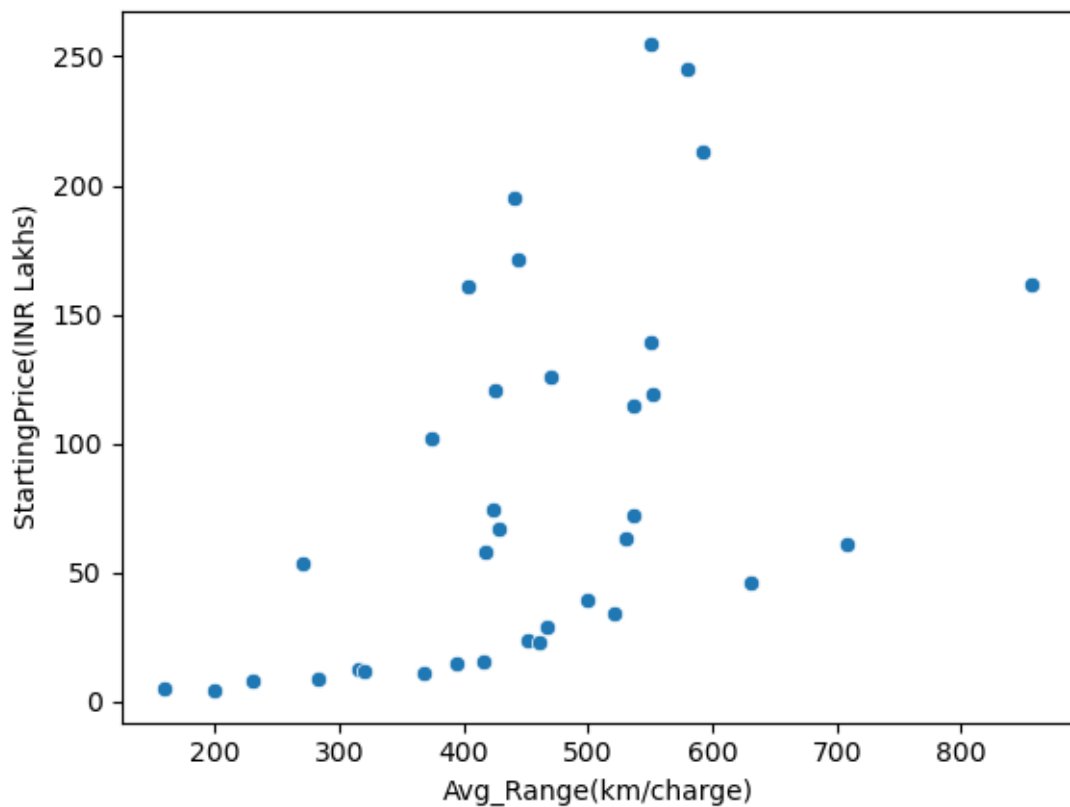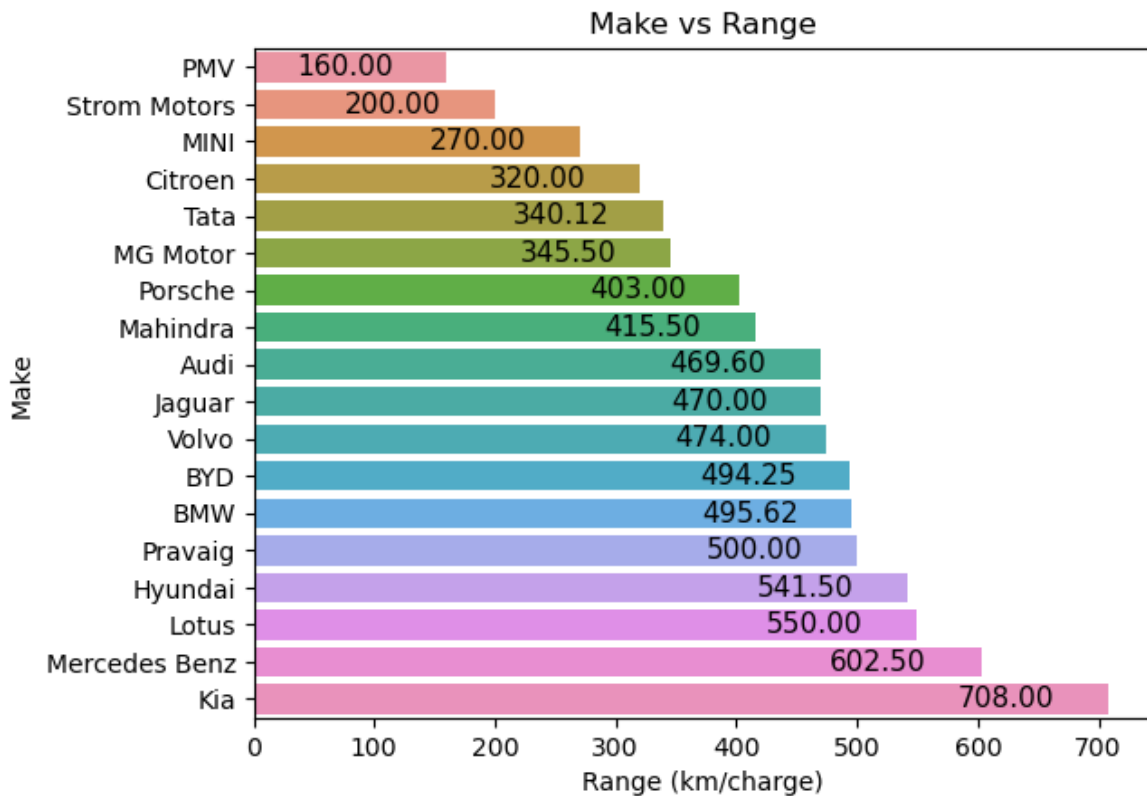


- This Visualisation concludes that as price of car goes up, Range also increases.

## 3.2.2 Segment Extraction (K Means Clustering)


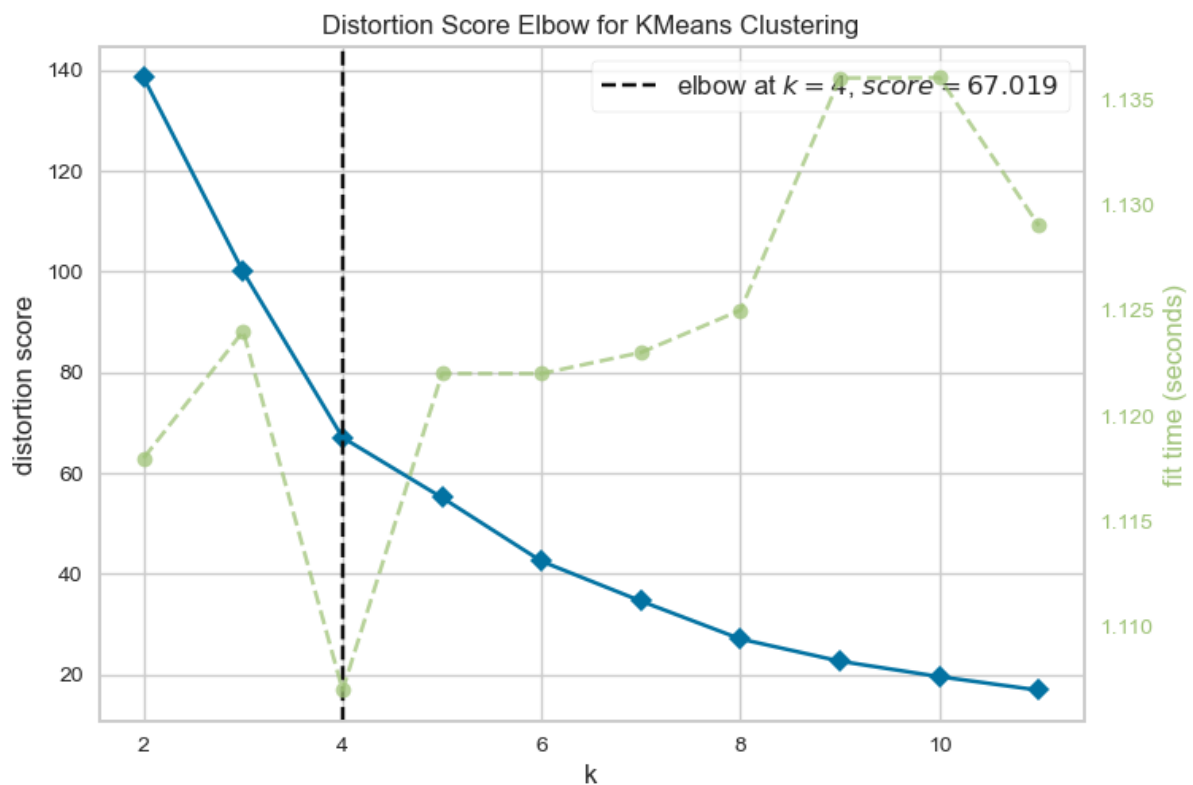
Distortion Score Elbow for KMeans Clustering
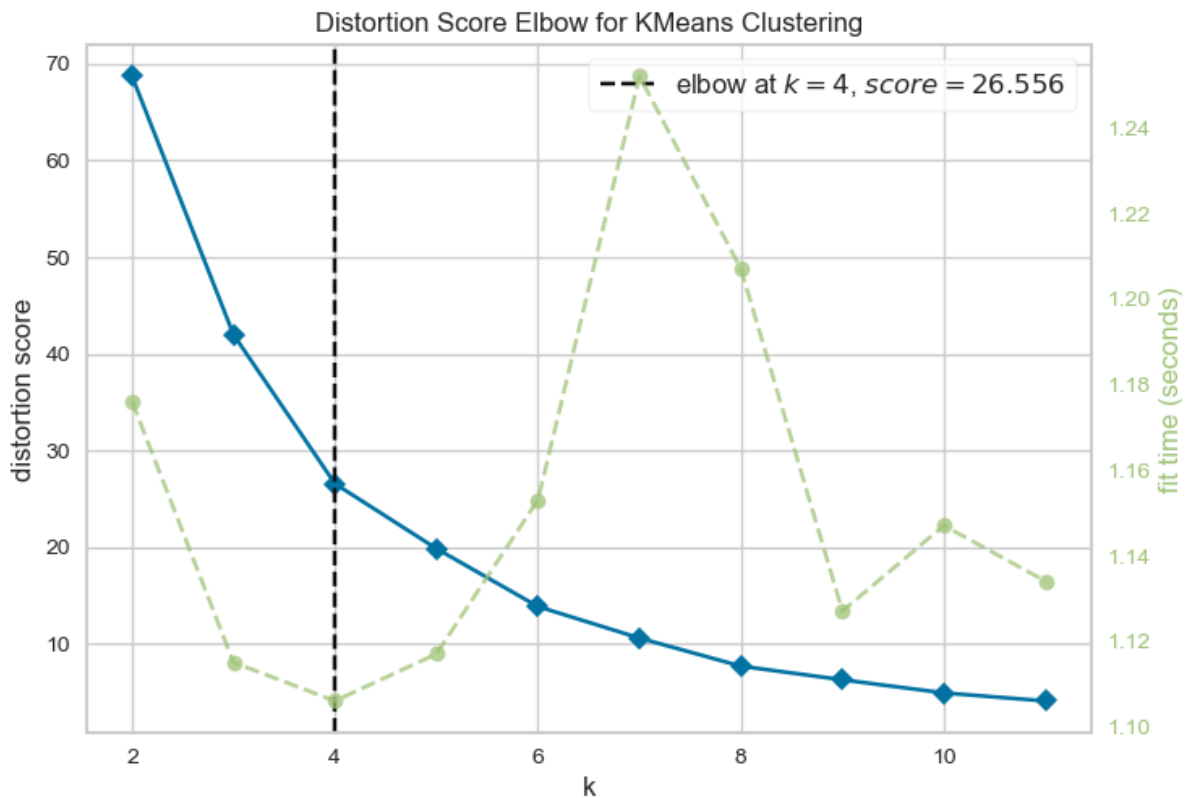
We utilized a set of 3 attributes encompassing various aspects such as StartingPrice, Range, Fast Charging. Using the K-means algorithm, we partitioned the data into 4 clusters. This segmentation was visualized utilizing the "KElbowVisualizer" from the Yellowbrick library.
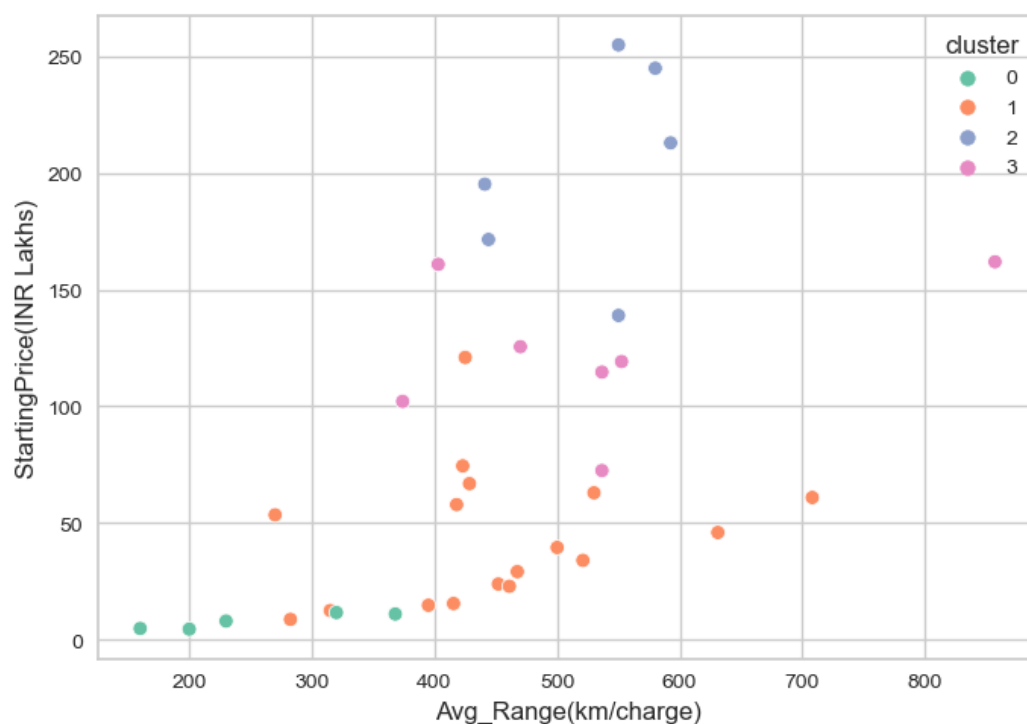
```
1 df_bikes = pd.read_csv("electric_two_wheeler_specs.csv")
2 df_bikes.head()
```

This datasets is of 2 wheelers EV and it contains features like

- VehicleType
- Make
- Model
- StartingPrice(INR Lakhs)
- Range(km/charge)
- BatteryCapacity(kwh)
- ChargingTime(Mins)
- Top Speed(km/Hr)
- KerbWeight(Kg)
- TyreType
- GroundClearance(mm)
- FastCharging



Distortion Score Elbow for KMeans Clustering

We utilized a set of 4 attributes encompassing various aspects such as StartingPrice, Range, Fast Charging, Top Speed. Using the K-means algorithm, we partitioned the data into 4 clusters. This segmentation was visualized utilizing the "KElbowVisualizer" from the Yellowbrick library.
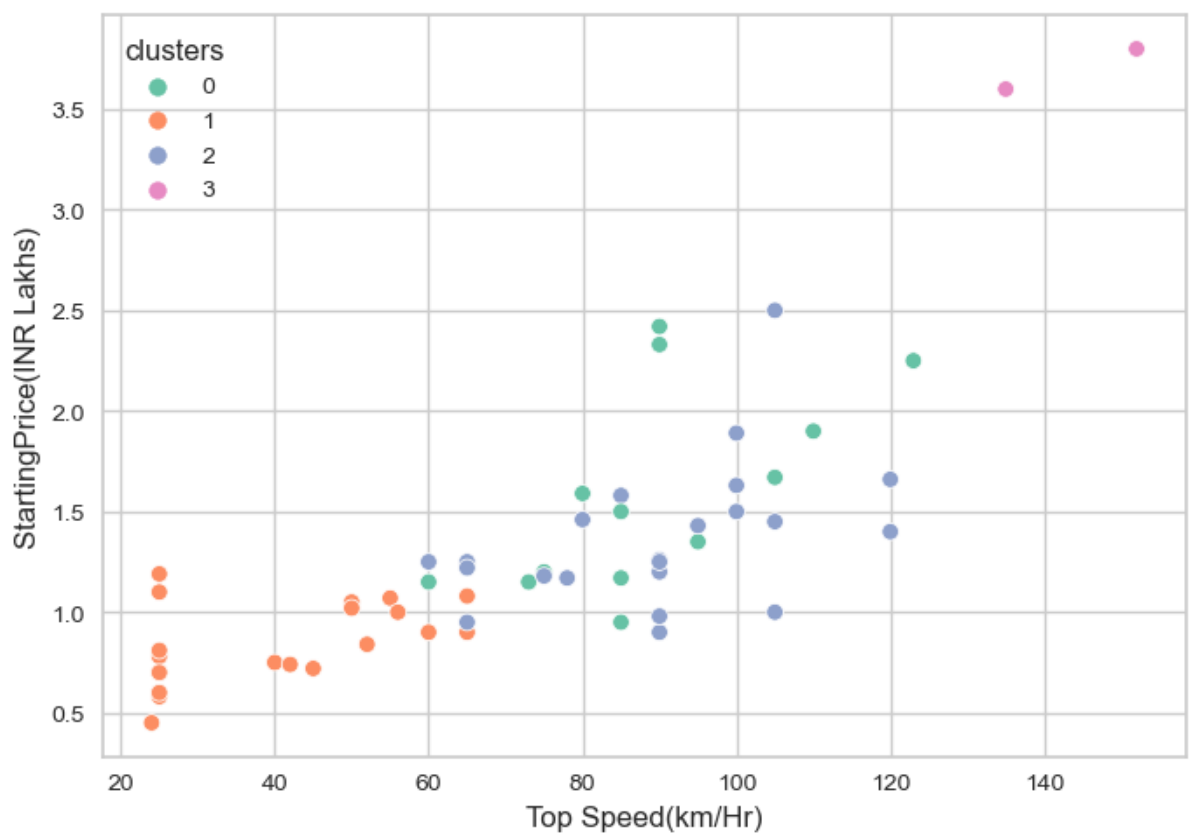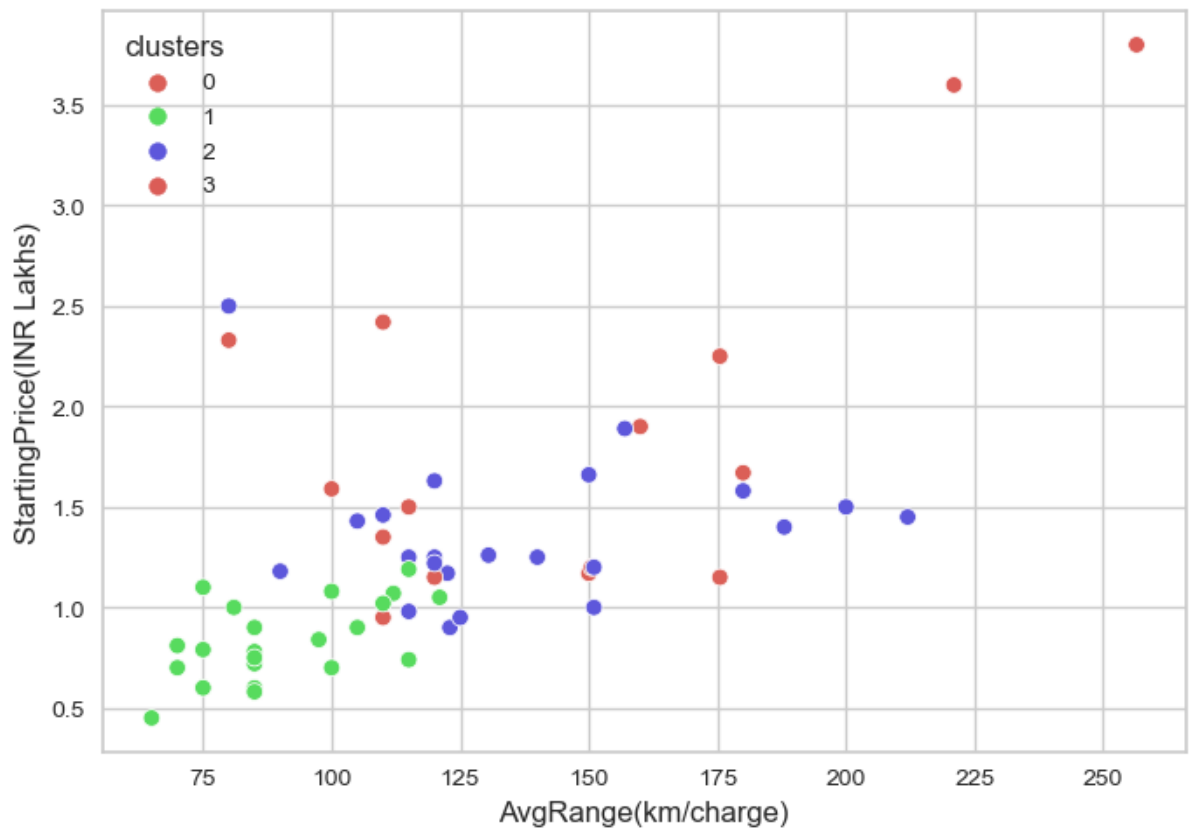
## 4. Most Optimal Market Segments

- **Segment Selection:** Segment 4, comprising 24.36% of consumers, represents a substantial portion of the target market, offering considerable market potential and opportunities for growth. With its balanced blend of specifications and price range, Segment 1's characteristics align well with the preferences of the target market, providing a harmonious balance between technical specifications and affordability.

- **Technical Specifications:**

  1. Price Range: The recommended price range for EV cars is ₹2L to ₹15L, and for EV two-wheelers, it is ₹50,000 to ₹3.6L. This range ensures affordability while offering a diverse range of options to accommodate various budget preferences within Segment 4.
  2. Riding Range: A recommended riding range of 250 to 500 km for EV cars and 50 to 250 km for EV two-wheelers addresses the commuting needs of consumers while providing flexibility for longer trips.
  3. Fast Charging: Vehicles should be equipped with fast charging options that allow charging on highways, workplaces, etc. This practical feature meets the daily usage needs of consumers, minimizing downtime.

## 5. Conclusions

In conclusion, after conducting a comprehensive analysis of India's electric vehicle market, Segment 4 emerged as the optimal target for our strategic focus. With a substantial consumer base of 24.36%, this segment presents a significant market opportunity ripe for exploration and growth. By customizing our electric two-wheeler and four-wheeler specifications to align with the preferences of Segment 4, we aim to seamlessly cater to the demands of this large customer base. This strategic decision is underpinned by a deep understanding of consumer behavior and technical specifications, ensuring that our products are finely attuned to meet market needs.

Furthermore, our approach emphasizes precision and relevance in both product development and marketing strategies. By leveraging these insights, we are well-positioned to make impactful market entry decisions and cultivate a strong presence within India's evolving electric vehicle landscape. Moving forward, this strategic foundation provides us with a robust framework for success, enabling our offerings to resonate effectively and drive sustainable growth in the dynamic Indian market.

## 6. GitHub Link:

https://github.com/sa-1-2/Feynn-Labs-EV-Market-Segmentation