# MARKET SEGMENTATION ANALYSIS OF ELECTRIC VEHICLE MARKET

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## Introduction

India, home to a population of 1.4 billion, also accommodates over 210 million two-wheelers and 70 million four-wheelers, the majority (99.5%) of which rely on fossil fuels. This widespread use of traditional vehicles significantly contributes to air pollution, with vehicular emissions responsible for 20-30% of Particulate Matter (PM) 2.5 levels at breathing altitudes. The transport sector in India contributes to approximately 8% of total Greenhouse Gas (GHG) emissions, exceeding 30% in Delhi. Furthermore, vehicular emissions, particularly carbon monoxide (CO) and nitrous oxide (NOx), pose severe health and environmental risks, with studies indicating a substantial decrease in CO levels during the Covid-19 lockdown due to restricted vehicular movement.

Given these environmental challenges, the introduction of Electric Vehicles (EVs) in the Indian market is imperative. EVs offer a solution to the problems associated with vehicular emissions, providing several advantages:

- **Cost-Effective Maintenance:** EVs, powered by batteries, entail fewer moving parts, resulting in less frequent and overall cheaper servicing compared to traditional petrol/diesel vehicles.
- **Environmental Friendliness:** Choosing EVs helps reduce harmful air pollution from exhaust emissions, contributing to better air quality, diminished health issues, and lower associated costs.
- **Safety:** EVs undergo rigorous testing procedures similar to fuel-powered cars. Their lower center of gravity enhances stability on the road, making them safer in accidents.

## Market overview

The Indian Electric Vehicle (EV) market has witnessed remarkable growth, spurred by government initiatives, rising environmental concerns, and the entry of new market players. Notably, the two-wheeler segment has emerged as a key driver, with electric scooters gaining popularity due to affordability, low operating costs, and maneuverability in urban areas. Major players in this segment include Hero Electric, Bajaj Auto, and Ather Energy.

The electric four-wheeler segment is also on the rise, with major automakers such as Tata Motors, Mahindra & Mahindra, and Hyundai introducing electric cars to meet growing demand. The government's emphasis on public transportation electrification has led to the incorporation of electric buses in various cities, while ride-hailing companies like Ola and Uber are integrating electric cars into their fleets.
To facilitate widespread EV adoption, the development of charging infrastructure is crucial. Both the Indian government and private entities are investing in expanding

the charging network, with public stations established in cities, highways, and parking facilities. Simultaneously, home charging solutions are becoming more accessible to EV owners.

Despite the growth, challenges persist, including the upfront cost of EVs. However, decreasing battery costs are expected to enhance affordability in the coming years. Addressing concerns such as limited charging infrastructure and range anxiety is essential for sustained growth.

In an effort to promote domestic manufacturing and reduce import dependence, the Indian government incentivizes local production of EV components and batteries. This has attracted investments from domestic and international companies, leading to the establishment of manufacturing facilities and research centers in the country.

In conclusion, the Indian EV market is rapidly expanding, fueled by government policies, environmental awareness, and the involvement of new players. With continued government support and increased investments, the Indian EV market holds the potential to become a global leader, contributing to a cleaner and more sustainable transportation system.

**Problem statement**

As a team operating within an Electric Vehicle Startup, the company is currently in the process of determining the specific vehicle/customer segment for its Electric Vehicles (EVs). The objective is to thoroughly analyze the Electric Vehicle market in India utilizing Segmentation analysis and formulate a viable market entry strategy. The focus is on targeting segments that are most inclined to embrace Electric Vehicles.

In addition to the conventional geographic, demographic, psychographic, and behavioral segments, the team has the flexibility to explore various category segments for the Segmentation analysis, dependent on the availability of relevant data. Market Segmentation offers a broad range of possibilities, and the identified segments may evolve based on the diverse datasets gathered.

To address the problem statement, the team has the option to engage with multiple datasets, including non-domain specific ones. Utilizing the Fermi Technique, teams can break down the problem statement and determine the most optimal datasets. These datasets can be collected from government sources or other freely available repositories, providing insights into demographic, psychographic, and behavioral aspects to inform the startup's strategic decision-making process.

## Data Sources

- https://www.moneylife.in/article/12-percentage-of-indias-petrol-pumps-are-inuttar-pradesh-alone-union-govt/66331.html
- https://pib.gov.in/PressReleasePage.aspx?PRID=1882098
- https://pib.gov.in/PressReleasePage.aspx?PRID=1910392
- https://evreporter.com/q1-fy-2022-23-region-wise-ev-sale-trends-in-india/
- https://www.kaggle.com/datasets/karivedha/indian-consumers-cars-purchasingbehaviour
- https://www.carwale.com/
- https://pib.gov.in/PressReleasePage.aspx?PRID=1842704
- https://www.bikewale.com/
- https://morth.nic.in/national-highway-details
- https://www.volza.com/p/ev-battery/import/import-in-india/hsn-code-85076000/

## Data Preprocessing

Libraries

The libraries employed for data analysis encompass a diverse set:

- **Matplotlib:** A cross-platform, Python library for data visualization and graphical plotting. It is used in conjunction with NumPy to comprehend trends, patterns, and correlations.

- **SciPy:** Extending capabilities in scientific and technical computing, SciPy adds functionality for tasks like signal processing, statistical functions, interpolation, and optimization.

- **Pandas:** A widely used library for data manipulation and analysis. It introduces efficient data structures like DataFrames, suitable for handling structured data. Notable features include high-performance merging, data alignment, and integrated handling of missing data.

- **NumPy:** An open-source Python library, NumPy (Numerical Python) is instrumental in data manipulation and preprocessing tasks. It excels in handling missing values, reshaping data, and applying mathematical operations.

- **Scikit-learn:** Also known as sklearn, this open-source library is the gold standard for machine learning in the Python ecosystem. It provides classes and functions for feature extraction, feature scaling, dimensionality reduction, data normalization, and handling categorical variables.

- **Seaborn**: Utilizing Matplotlib underneath, Seaborn is employed for graph plotting. It enhances the visualization of random distributions.

Steps

Data preprocessing encompasses the subsequent procedures:

- The dataset underwent initial processing and cleaning to render it appropriate for clustering.

- The raw representation of the data is presented below, subsequently undergoing processing and transformation into a suitable format for our purposes. The steps can be succinctly summarized as follows:

| | Sr. No. | State Name | 2WN | 2WT | 2WIC | 3WN | 3WT | LMV | LPV | LGV | 4WIC | MMV | MPV | MGV | HPV | HGV | OTH | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | Andaman & Nicobar Island | 2 | 5.0 | NaN | NaN | 30.0 | 86 | 6.0 | NaN | NaN | NaN | NaN | NaN | 40.0 | NaN | NaN | 169 |
| 1 | 2 | Andhra Pradesh | 27629 | NaN | 2.0 | 374.0 | 108.0 | 1050 | 3.0 | 166.0 | NaN | NaN | NaN | NaN | NaN | NaN | 1117.0 | 30449 |
| 2 | 3 | Arunachal Pradesh | 14 | NaN | NaN | NaN | NaN | 6 | 1.0 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 21 |
| 3 | 4 | Assam | 2287 | NaN | NaN | NaN | 79661.0 | 233 | 5.0 | 15.0 | NaN | NaN | NaN | NaN | 15.0 | NaN | NaN | 82216 |
| 4 | 5 | Bihar | 13472 | NaN | NaN | 2.0 | 96560.0 | 231 | 8.0 | 21.0 | 1.0 | NaN | NaN | 1.0 | 27.0 | 2.0 | NaN | 110325 |

| | S. No. | State Name | No. of Operational PCS |
|---|---|---|---|
| 0 | 1 | Andaman & Nicobar | 3 |
| 1 | 2 | Andhra Pradesh | 222 |
| 2 | 3 | Arunachal Pradesh | 9 |
| 3 | 4 | Assam | 48 |
| 4 | 5 | Bihar | 83 |

| | State/UT | No of RO's where EV Charging Facility available |
|---|---|---|
| 0 | Andhra Pradesh | 65 |
| 1 | Arunachal Pradesh | 4 |
| 2 | Assam | 19 |
| 3 | Bihar | 26 |
| 4 | Chandigarh | 4 |

| | NH | State |
|---|---|---|
| 0 | 1 | Jammu and Kashmir |
| 1 | 301 | Jammu and Kashmir |
| 2 | 501 | Jammu and Kashmir |
| 3 | 701 | Jammu and Kashmir |
| 4 | 2 | Assam |
| ... | ... | ... |
| 851 | 344P | Haryana |
| 852 | NE-1 | Gujarat |
| 853 | NE-2 | Uttar Pradesh |
| 854 | NE-3 | Haryana |
| 855 | 547E | Maharashtra |

856 rows × 2 columns

| | National Highway | No. of operational PCS |
|---|---|---|
| 0 | National Highway-10 | 1 |
| 1 | National Highway-11 | 3 |
| 2 | National Highway-128 | 1 |
| 3 | National Highway-13 | 3 |
| 4 | National Highway-130 | 1 |
| ... | ... | ... |
| 85 | National Highway-766 | 2 |
| 86 | National Highway-8 | 12 |
| 87 | National Highway-86 | 2 |
| 88 | National Highway-9 | 15 |
| 89 | National Highway-948A | 2 |

90 rows × 2 columns

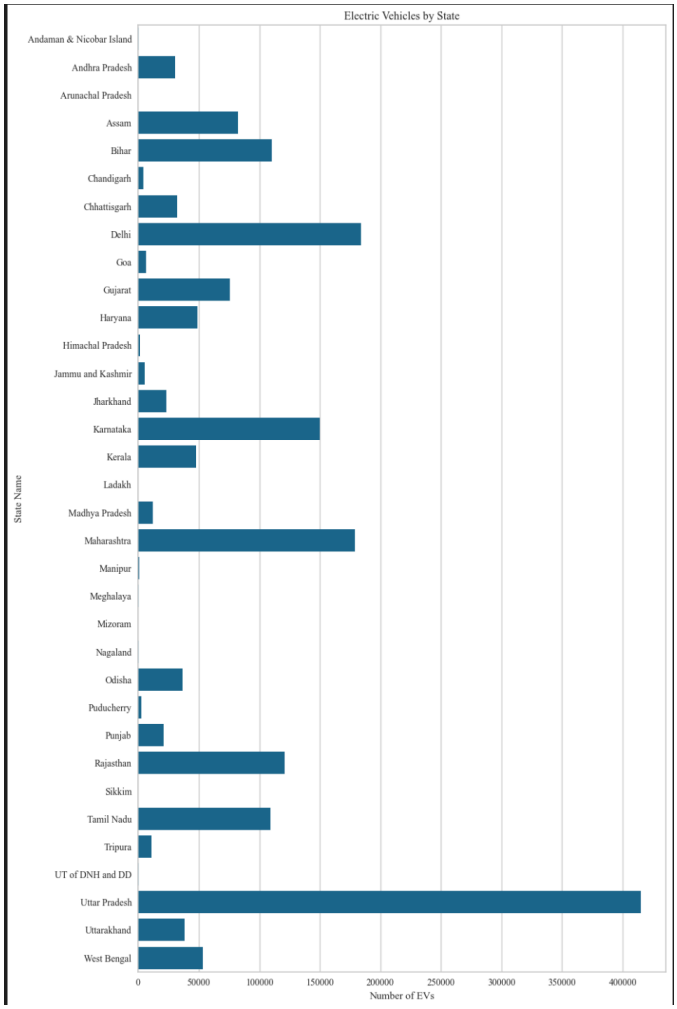
Within all the datasets, uniformity is established in the naming of states.

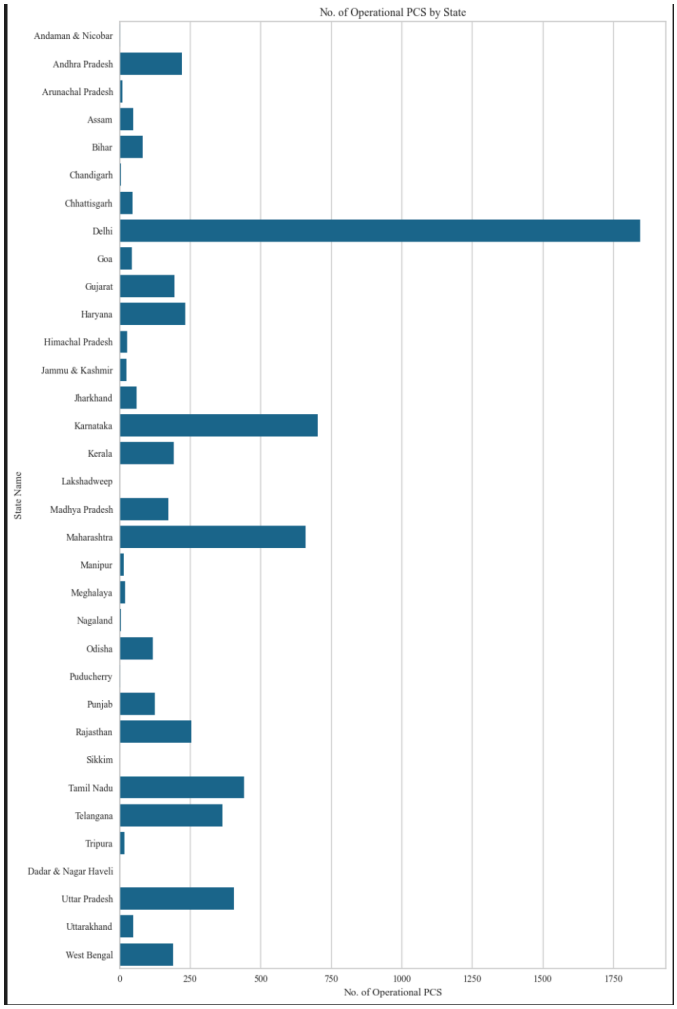
1. For the ongoing study, the 'State Name' and 'Grand Total' columns from the uppermost dataset in the figure below are utilized among all other variables. In this context, 'Grand Total' signifies the total number of Electric Vehicles (EV) in that state.
2. An outer join is executed across all datasets using a variable like 'State,' with exceptions for the rightmost dataset in the second row and the leftmost dataset in the third row.
3. New variables, such as 'No. of Highways through state,' 'No. of Highways through state with PCS,' and 'Total PCS on highways passing through state,' are generated using the rightmost dataset in the second row and the leftmost dataset in the third row. These are then integrated with the previously constructed dataset using a 'State'-like column.
4. Instances of null values in certain rows are addressed in accordance with the specific variable under consideration.

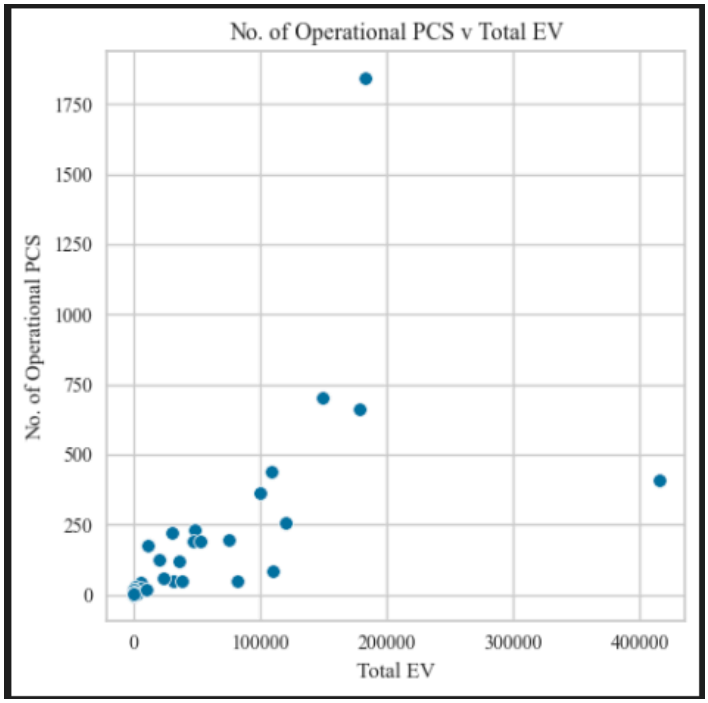
- Transforming essential categorical columns within the dataset into numerical counterparts.
- Employing LabelEncoder to encode pertinent variables, facilitating the clustering process.
- Normalizing with MinMax Scaler or standardizing using Standard Scaler is applied to selected columns as needed.

## Exploratory Data Analysis (EDA)

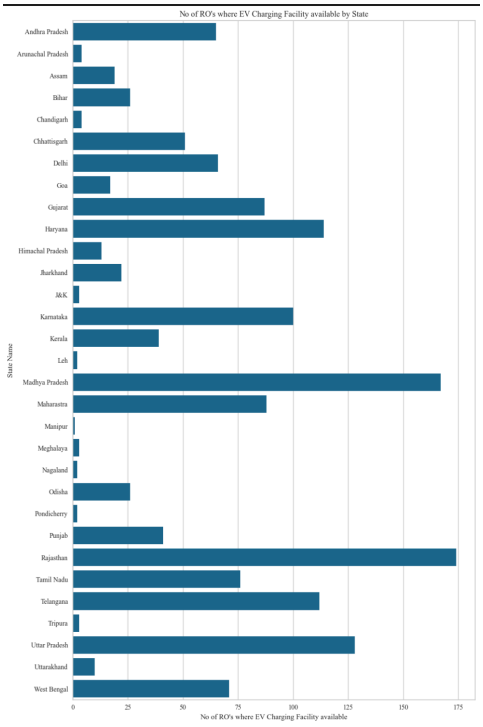
### Geographical Analysis

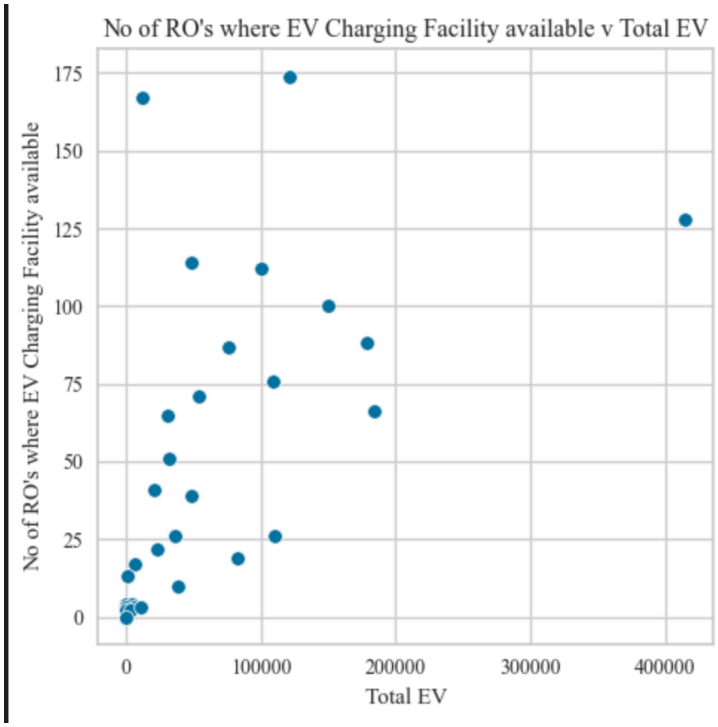


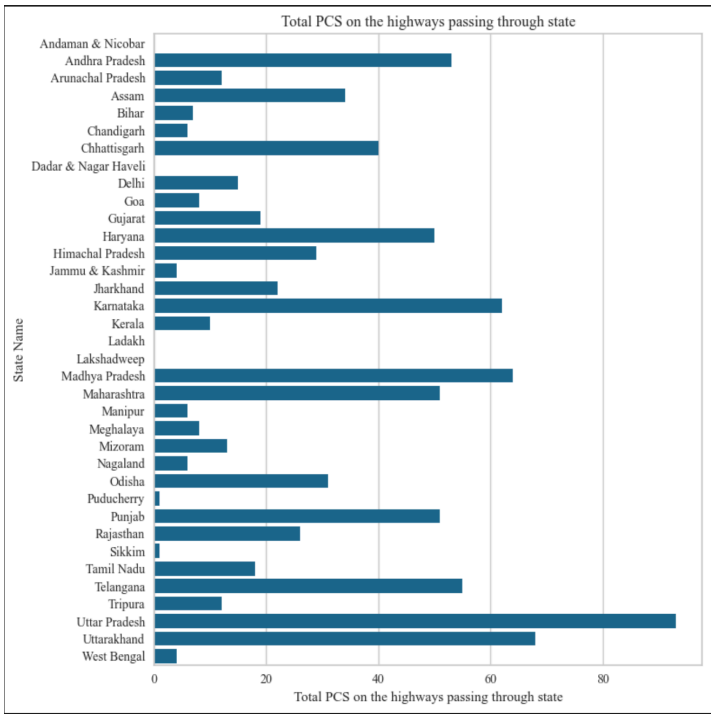
Observation: Uttar Pradesh, Delhi, Maharashtra, Karnataka, and Rajasthan stand out as the states with the highest count of electric vehicles. However, Delhi is the sole state leading in the number of public charging stations, followed by Karnataka and Maharashtra. Analysis of the scatter plot suggests a positive correlation between these two variables, with a correlation coefficient of 0.60 and a p-value below 0.05.
Now, the bar plot illustrates the count of Refueling Outlets (ROs) equipped with EV Charging Facilities by state, accompanied by a corresponding scatter plot.

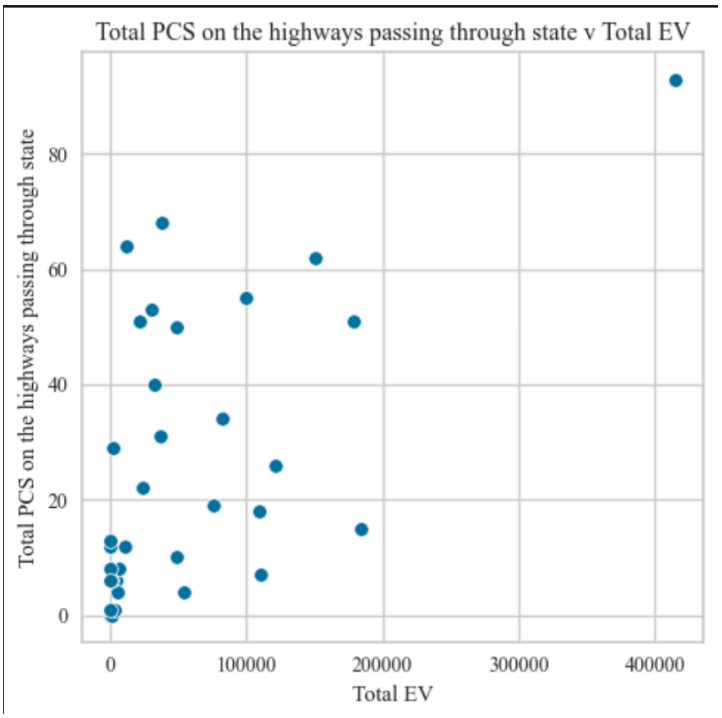



Observation: The plot indicates a positive correlation between the count of Refueling Outlets (ROs) equipped with EV Charging Facilities and the Total number of Electric Vehicles (EVs). The correlation coefficient is calculated to be 0.60, and the associated p-value is less than 0.05.

In the context of this study, a distinctive variable named Total PCS (Public Charging Station) on highways passing through the state has been introduced. This variable aims to assess the connectivity between states through Public Charging Stations. States with a higher count of PCS on their highways are expected to be more appealing for EV adoption. The bar plot illustrates the Total PCS on highways passing through the state, while the scatter plot demonstrates its relationship with the Total EV count.

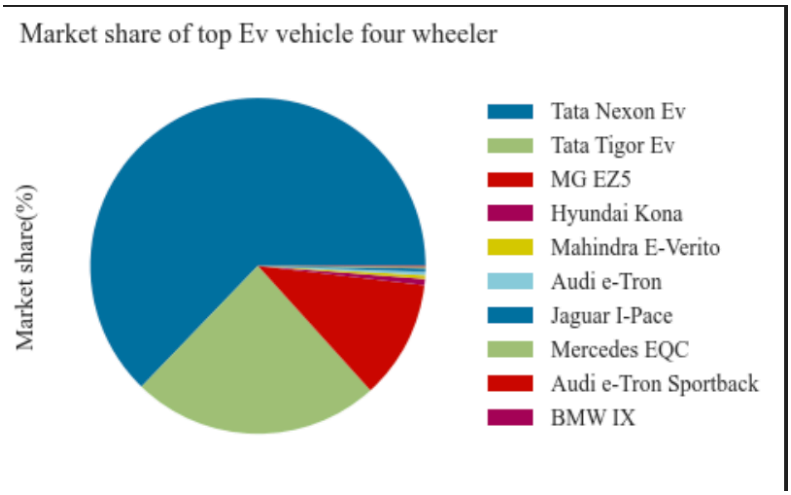


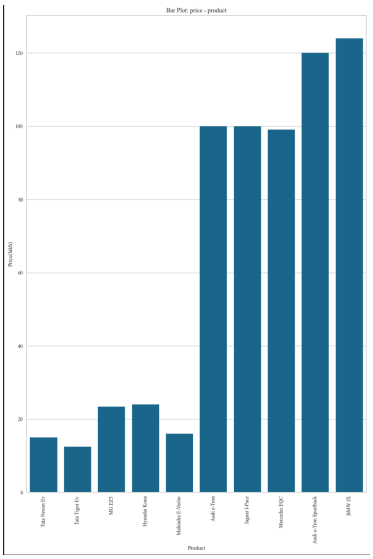




Observation: The scatter plot illustrates a positive correlation between the Total PCS (Public Charging Station) on highways passing through the state and the Total number of Electric Vehicles (EVs). The computed correlation coefficient is 0.59, with a p-value below 0.05. It can be inferred that variables such as the count of Public Charging Stations, the number of Refueling Outlets (ROs) with EV Charging Facilities, and the Total PCS on highways passing through the state exhibit a positive relationship with the total number of EVs in the state.

## Demographic Analysis

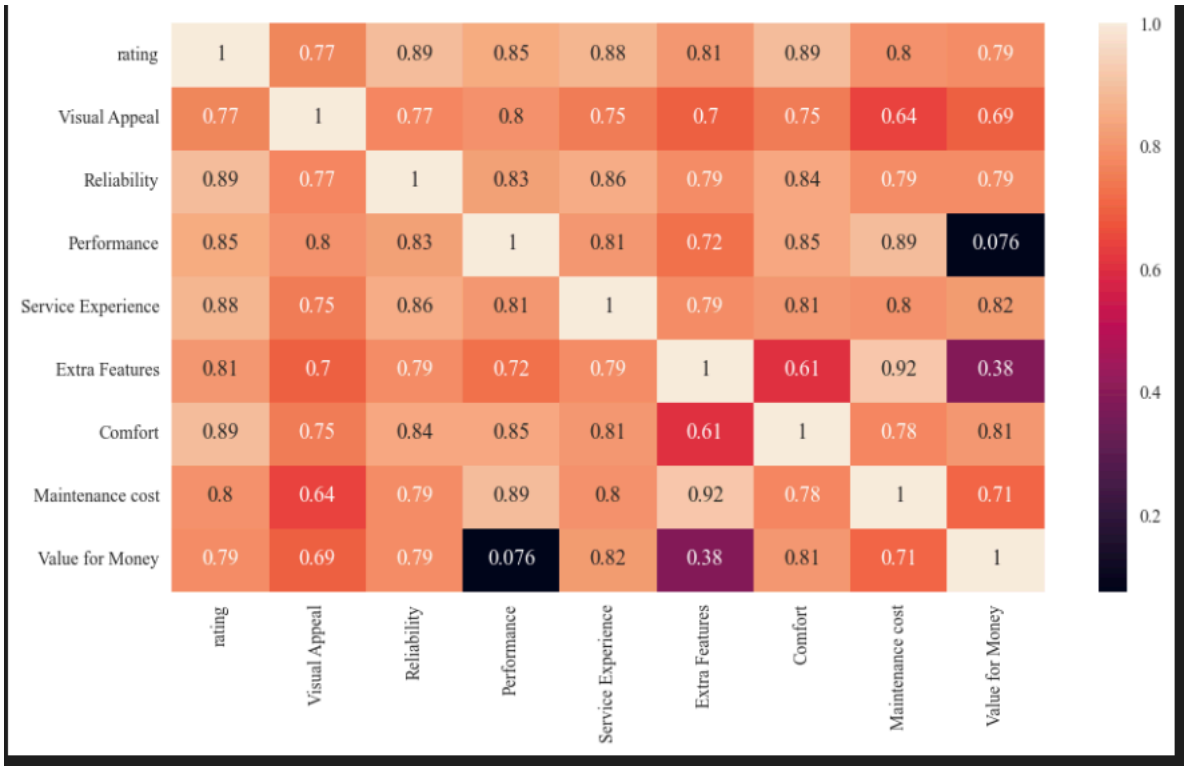
Analysis of the market share of the leading EV models and strategy formulation



Observation: Analyzing the initial graph reveals that Tata Nexon EV and Tata Tigor EV collectively hold more than a 50% market share. The second graph clearly illustrates that both vehicles are competitively priced compared to other products in the market.

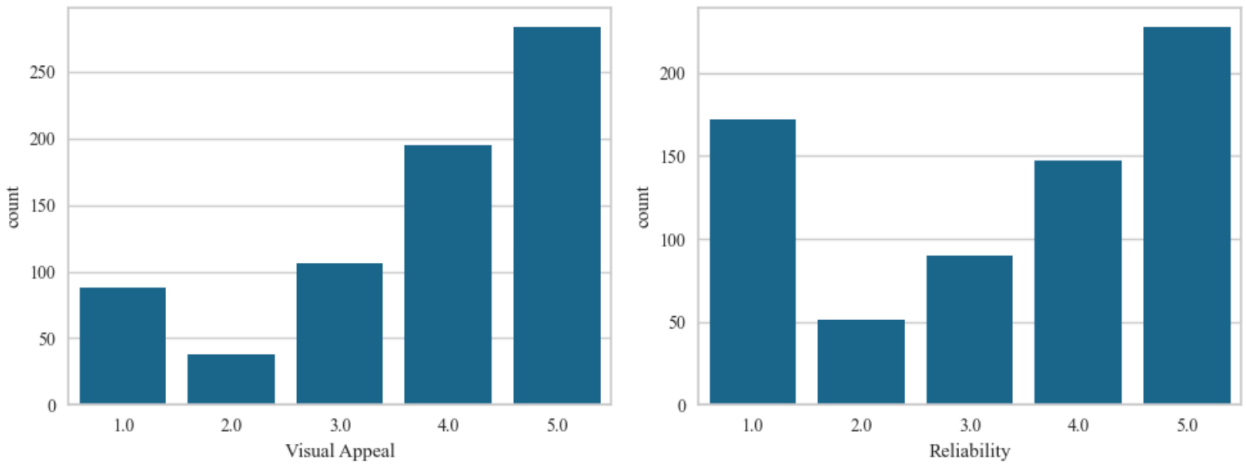
Dependency of these variables on one another

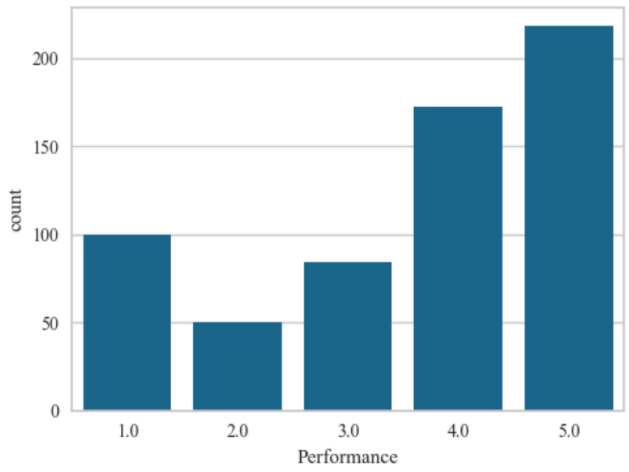


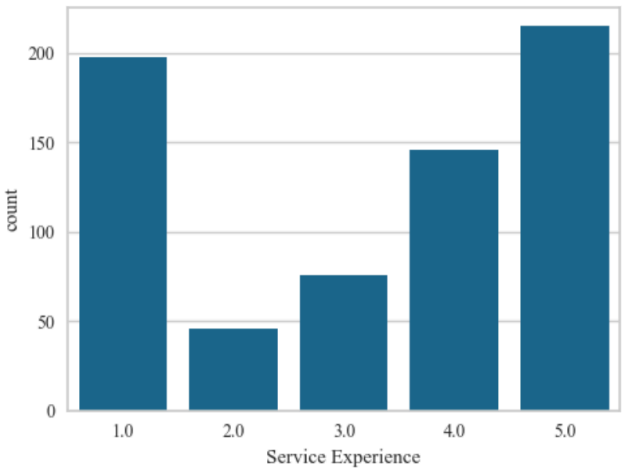

Observation: The correlation plot visually represents the interdependence of variables, a crucial factor in the clustering process.

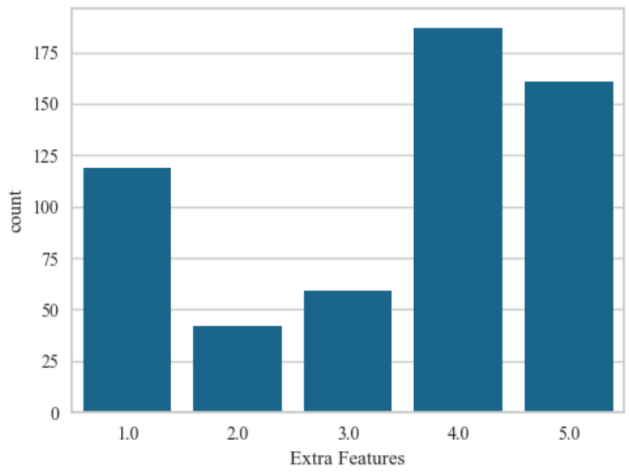
## Psychographic Analysis

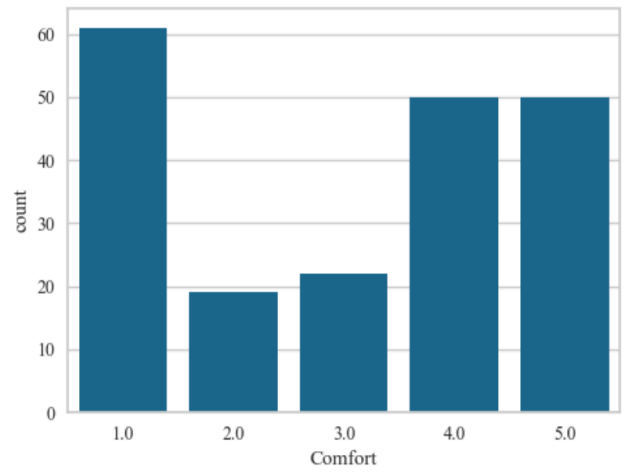
Analyzing all the preferences and reviews of users on various aspects for E2W

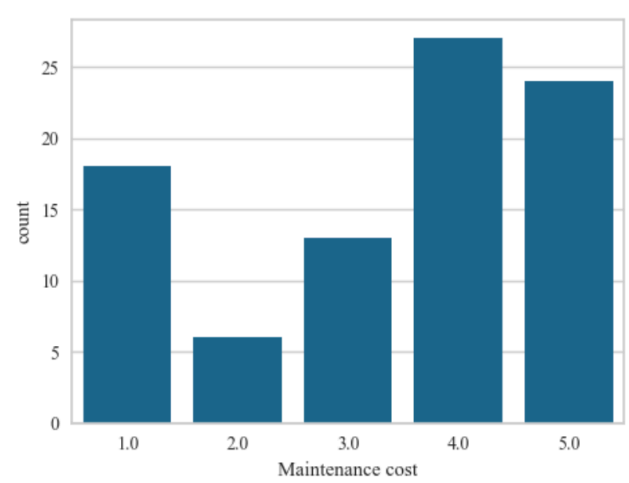


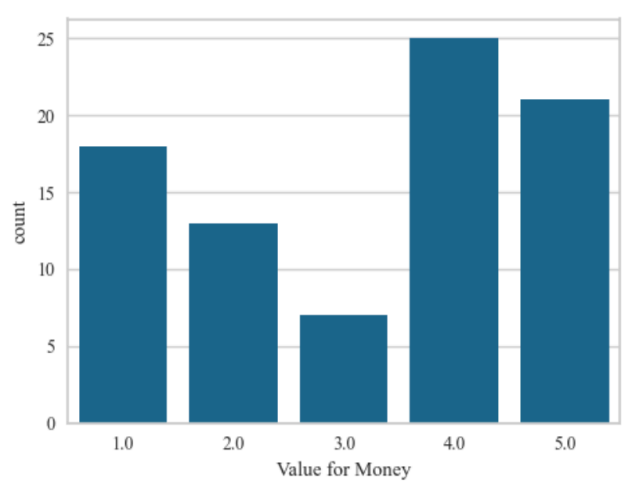

count
200
150
100
50
0
1.0
2.0
3.0
4.0
5.0
Performance


count
200
150
100
50
0
1.0
2.0
3.0
4.0
5.0
Service Experience


count
175
150
125
100
75
50
25
0
1.0
2.0
3.0
4.0
5.0
Extra Features

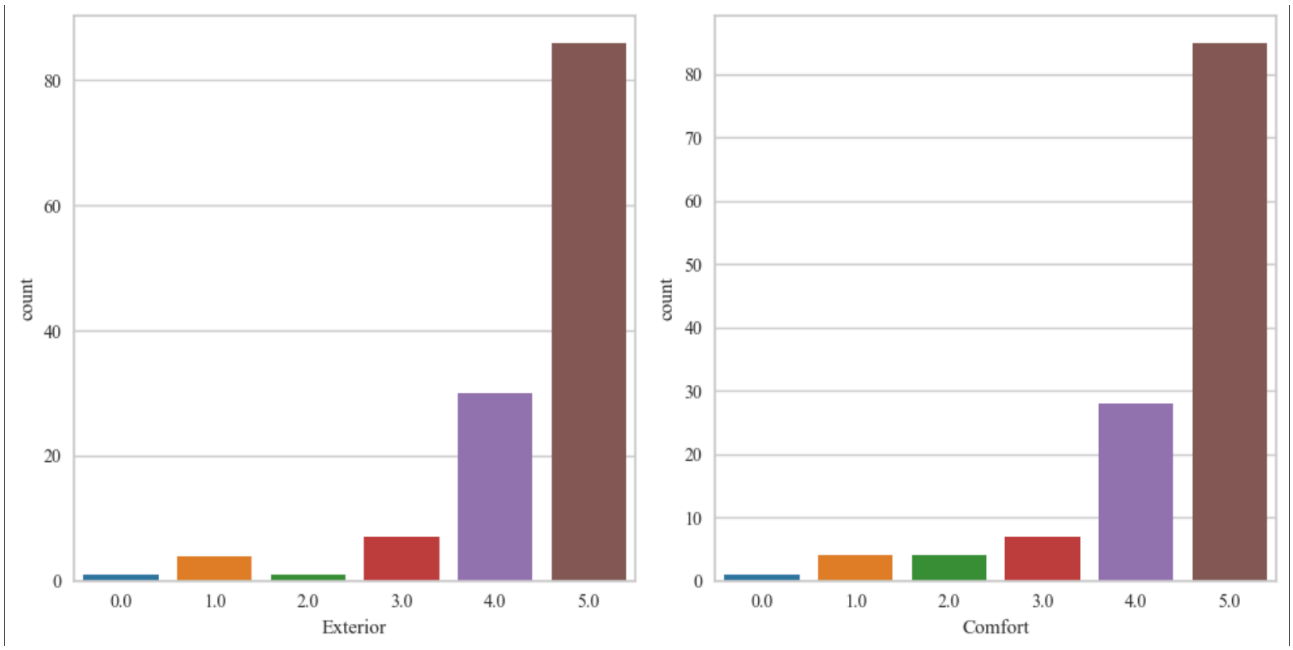

count
60
50
40
30
20
10
0
1.0
2.0
3.0
4.0
5.0
Comfort


count
25
20
15
10
5
0
1.0
2.0
3.0
4.0
5.0
Maintenance cost


count
25
20
15
10
5
0
1.0
2.0
3.0
4.0
5.0
Value for Money

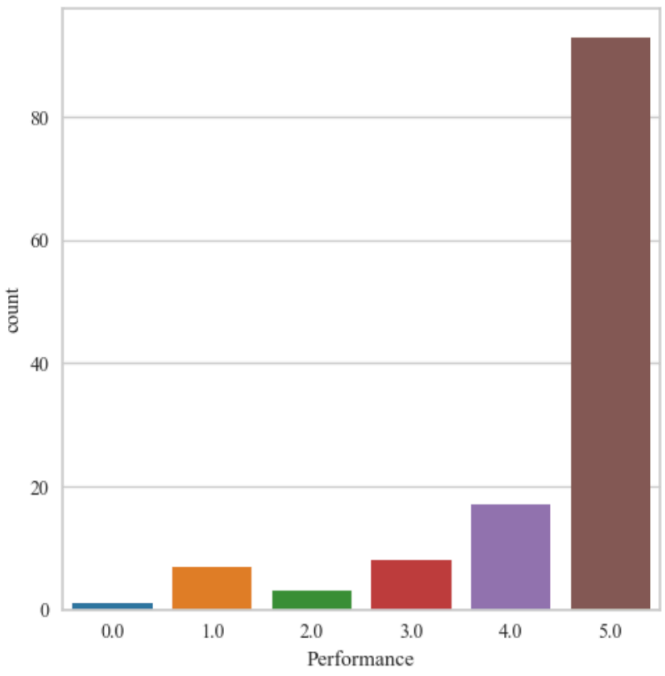
Observation: Users express positive sentiments regarding Visual Appeal, Performance, and Extra Features, while offering negative feedback on Comfort. Reviews are mixed for Reliability, Service Experience, and Maintenance cost. Opinions on whether Electric Two-Wheelers (E2W) are considered value for money vary among users.

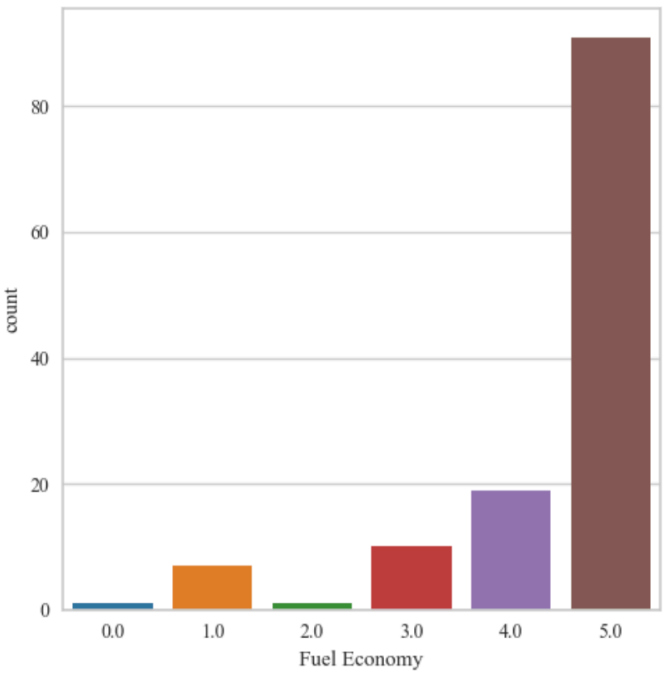
Analyzing all the preferences and reviews of users on various aspects for E4W

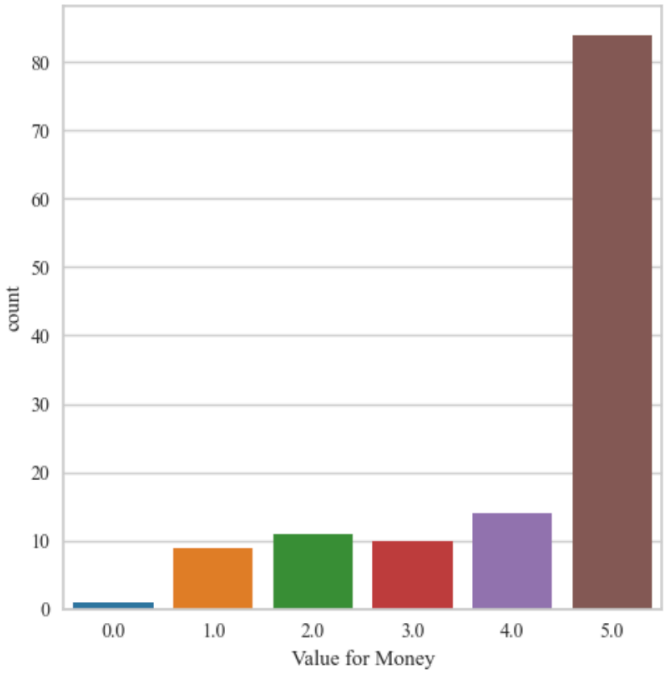


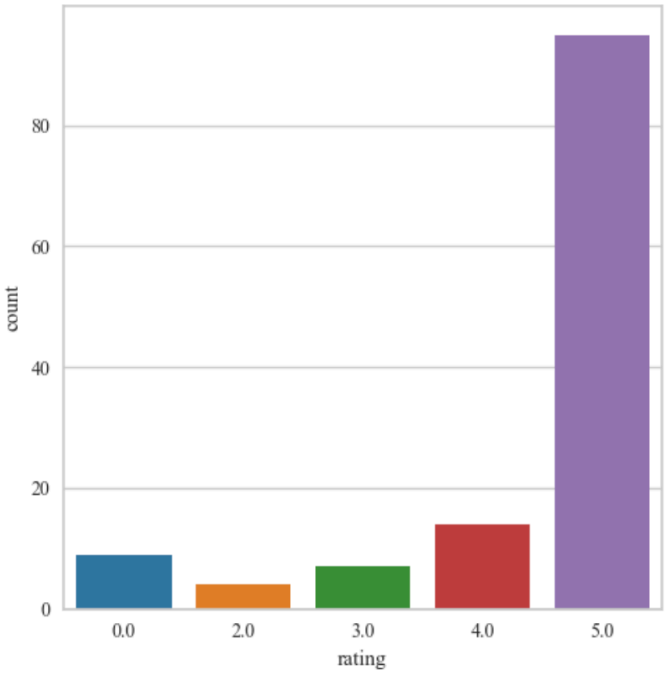






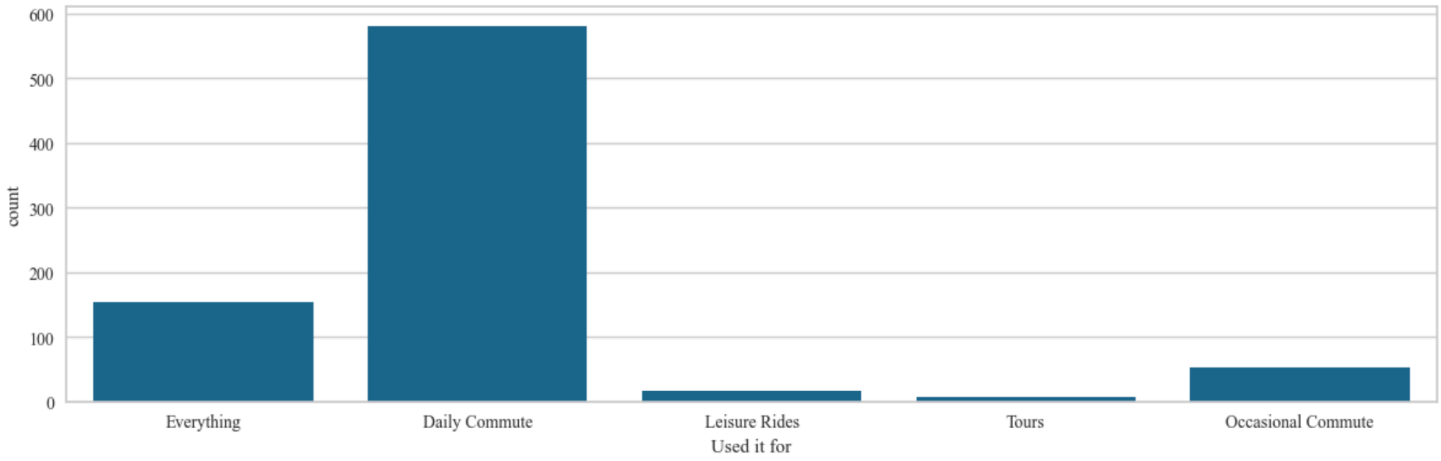


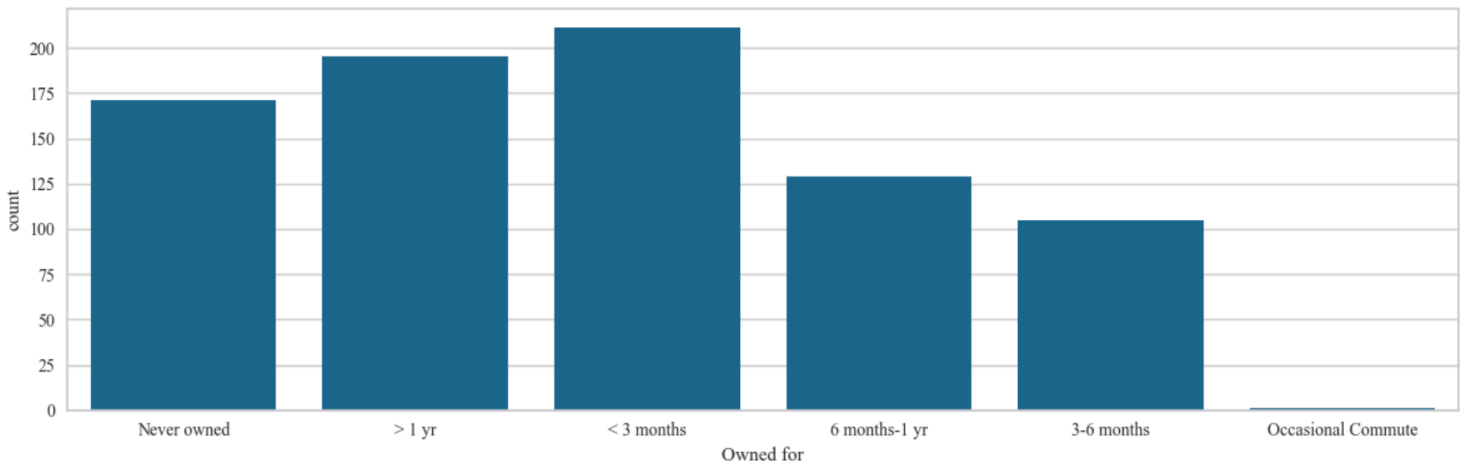



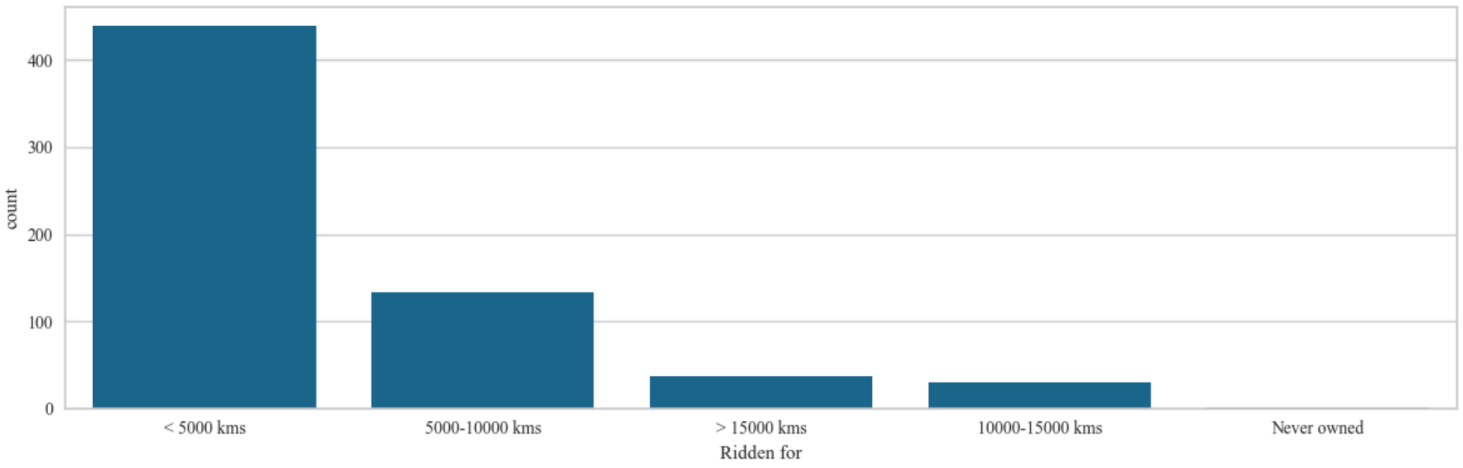

Observation: People seem to be very positive regarding the Exterior, Comfort, Performance, Fuel Economy and consider an EV as a Value for Money

## Behavioral Analysis

Analyzing the behavioral aspects of users for E2W

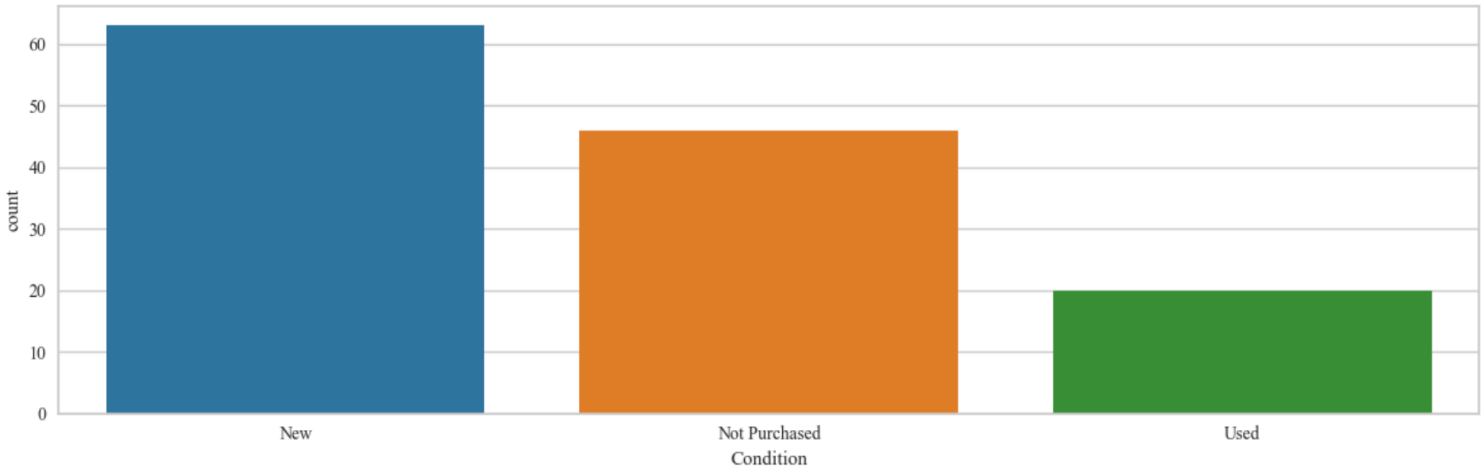


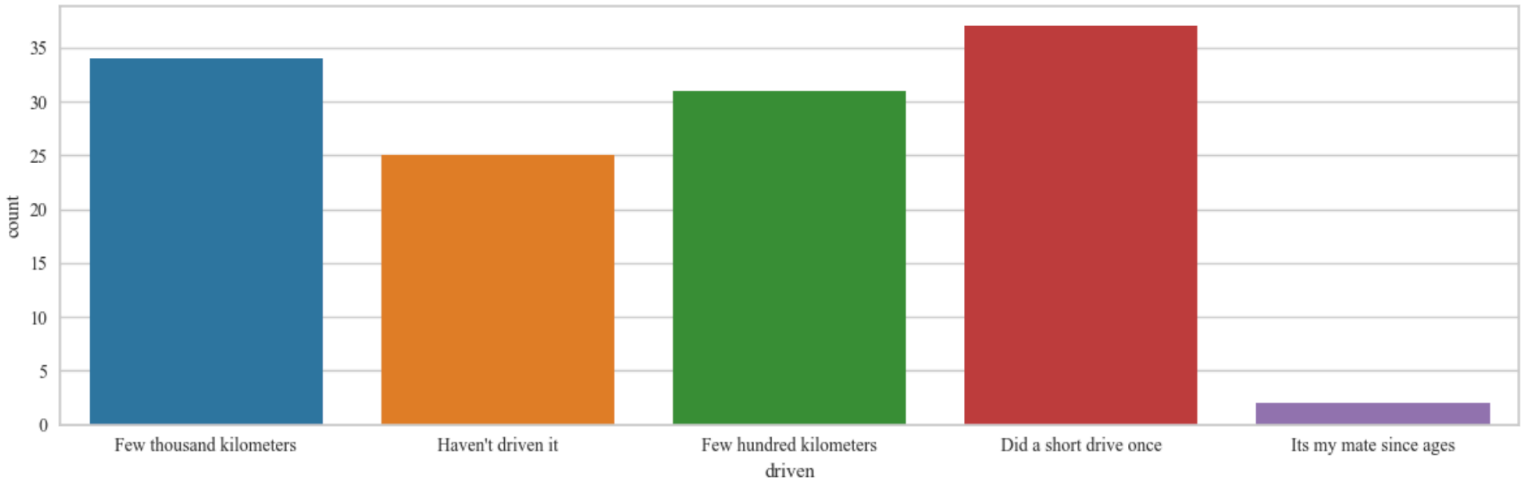



Observation: The initial graph clearly indicates that a significant portion of users employ an E2W for their daily commuting needs. In the second graph, it is apparent that a majority of users have owned an electric vehicle for less than three months or for over a year, while some users do not own an EV at all. Lastly, the majority of users have driven slightly under 5000 kilometers.

Analyzing the behavioral aspect of users for E4W

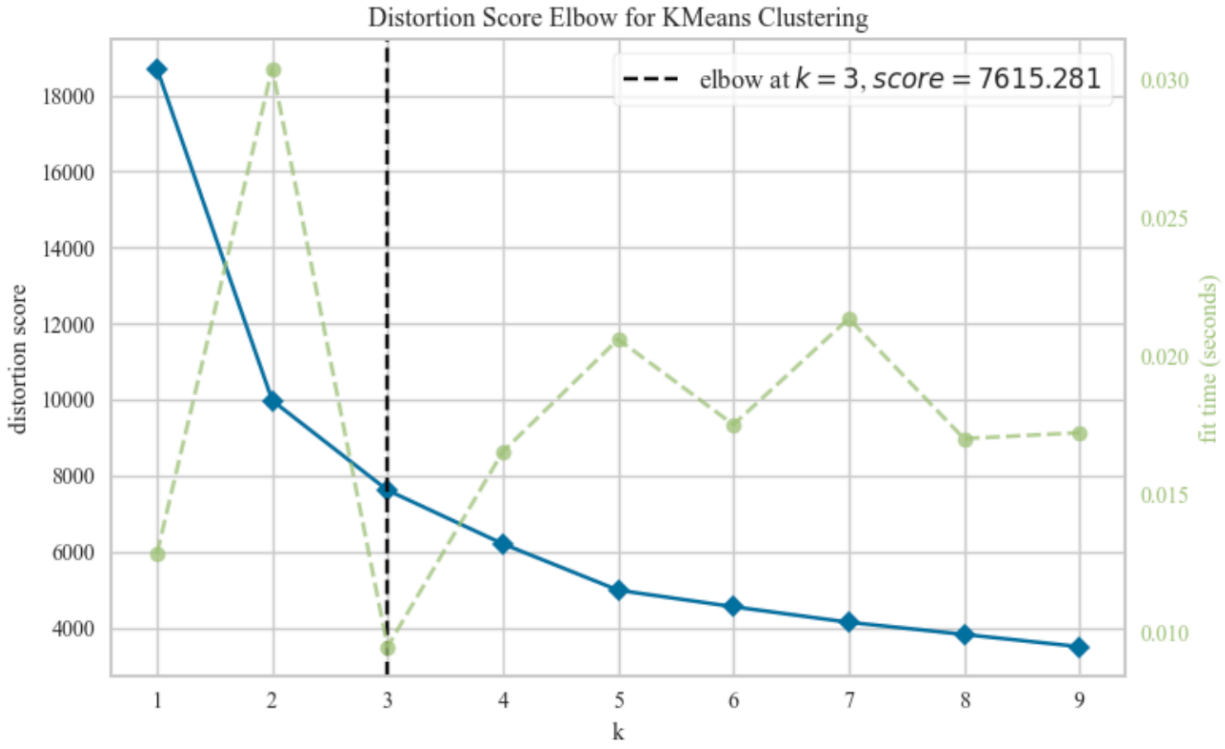


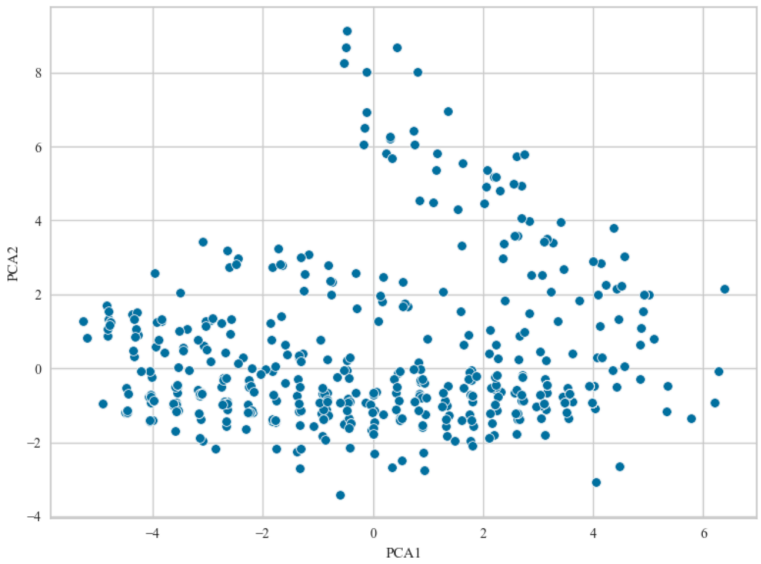



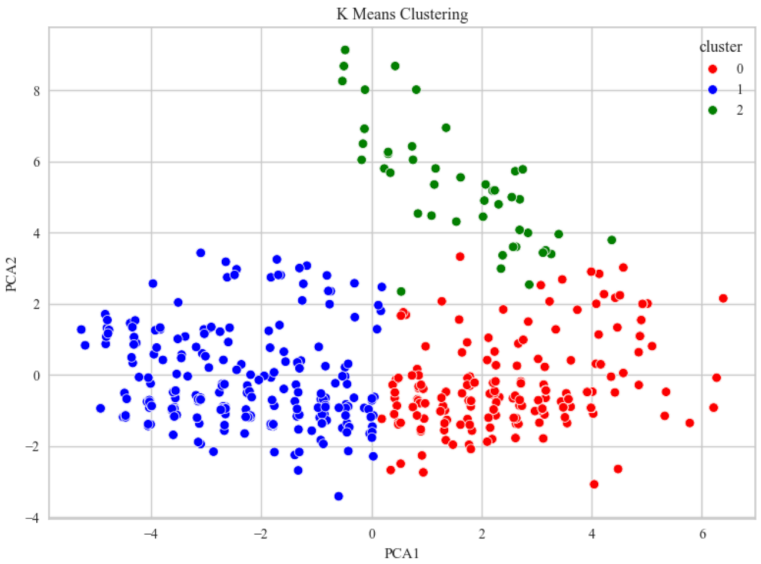

Observation: The initial graph reveals that the majority of users own a recently acquired E4W. In the second graph, it is evident that most users have undertaken a brief drive at least once, while a subset of users has covered a distance of a few thousand kilometers.

**Segment Extraction & Analysis**

Using KElbowVisualizer for E2W dataset



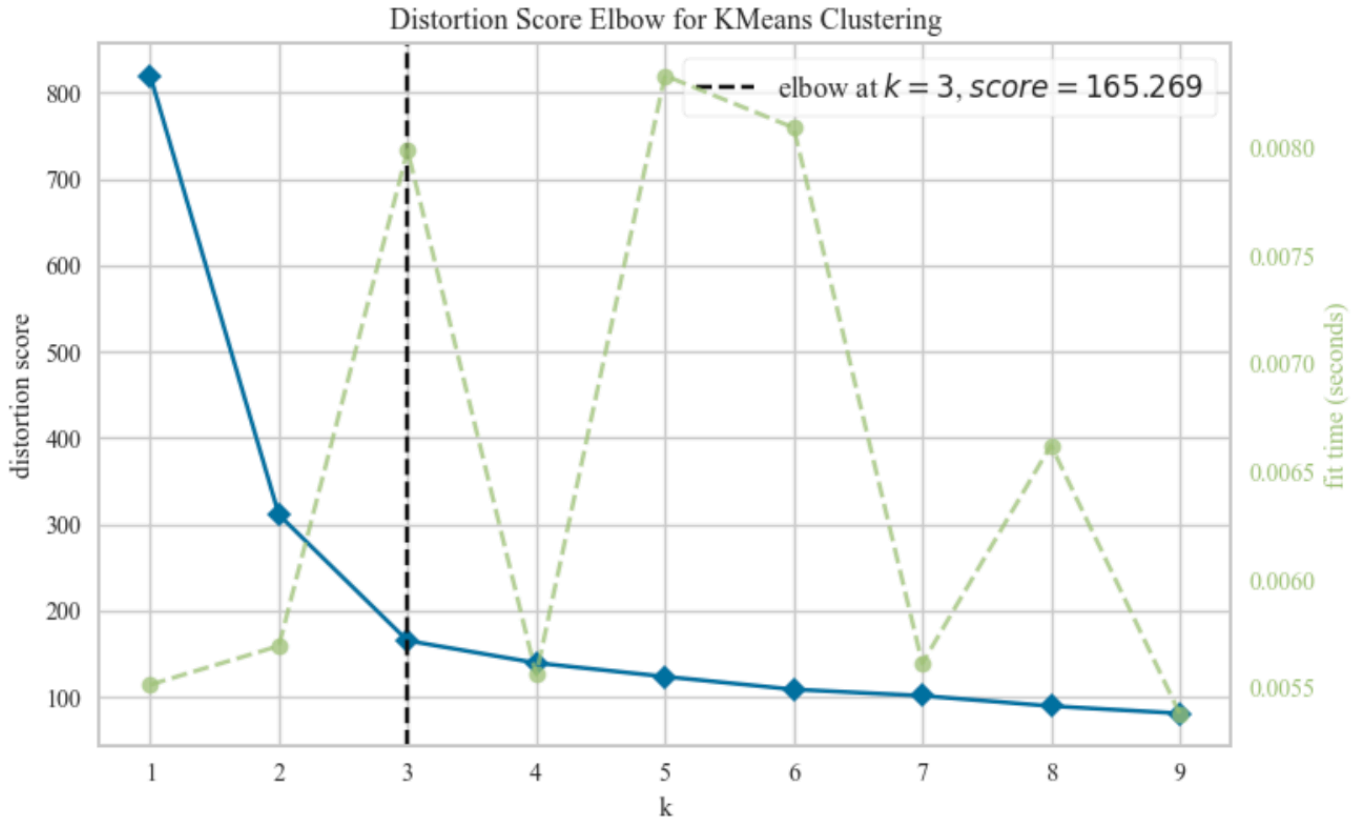

Observation: A distinct elbow is noticeable at k = 3 clusters.

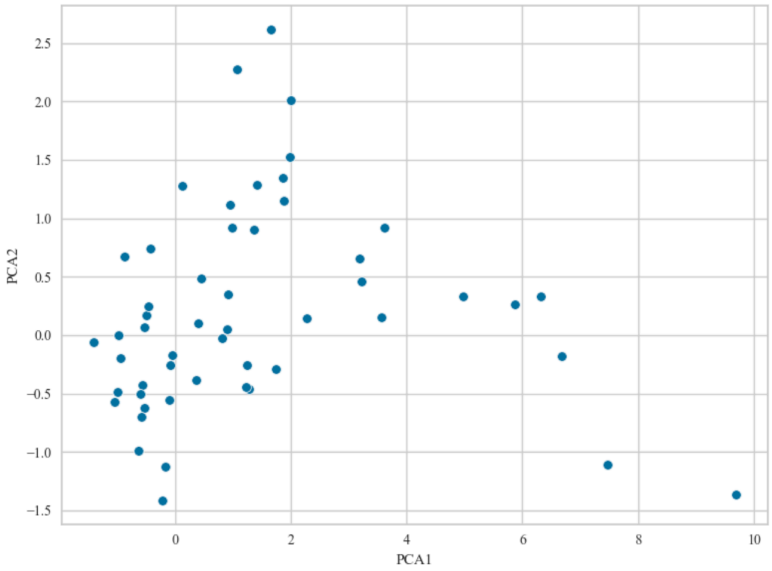
Cluster 0: Within this cluster are users expressing contentment with Visual Appeal, Reliability, Service Experience, Maintenance cost, and considering E2W value for money. However, they provide unfavorable reviews concerning Comfort, Performance, and Extra Features.

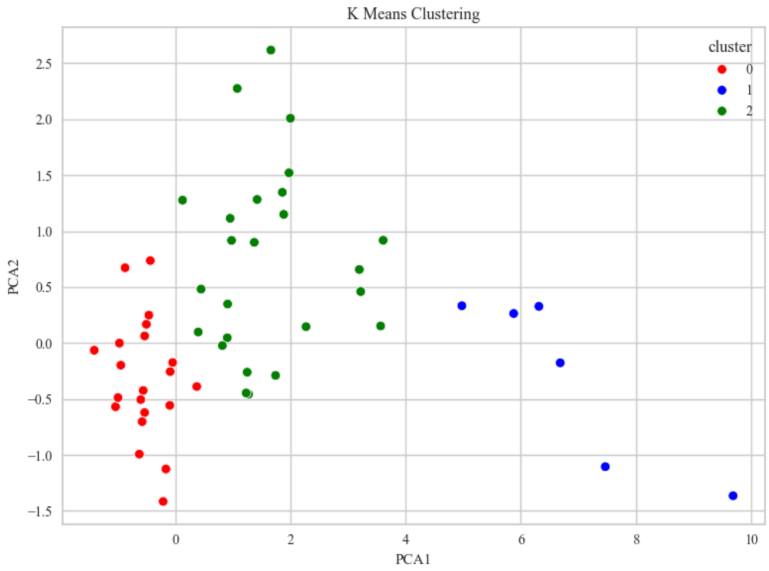
Cluster 1: This cluster comprises users satisfied with Visual Appeal, Reliability, Service Experience, Performance, and Extra Features. However, they express dissatisfaction with Maintenance cost and Comfort, and they do not regard E2W as value for money.

Cluster 2: Users in this cluster present negative reviews across all attributes.

Using KElbowVisualizer for E4W dataset



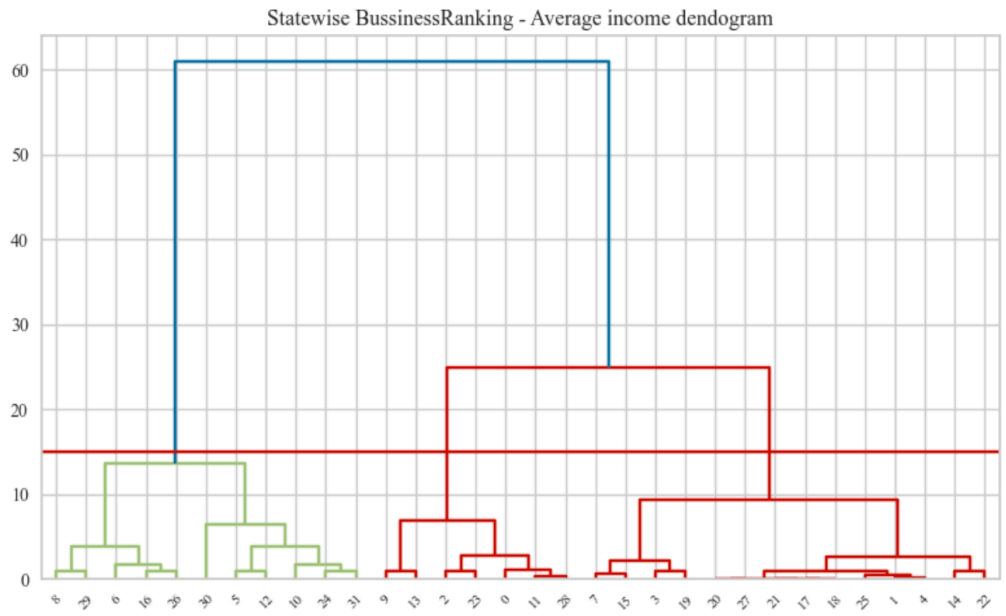
Observation: An elbow point is apparent at k = 3 clusters.

Cluster 0: Comprising users with favorable reviews across all attributes, the majority of whom own new EVs.

Cluster 1: Encompassing users with unfavorable reviews across all attributes, the majority of whom own new EVs.

Cluster 2: This cluster consists of users content with Exterior and Comfort but express mixed opinions on other attributes. Most of them have not yet purchased an EV. In my view, this segment presents an opportunity for a company to easily target and alter their perception towards EVs.

Using Dendogram Plot for Statewise Business Ranking




Observation: After applying the clustering process, three discernible clusters have been identified:

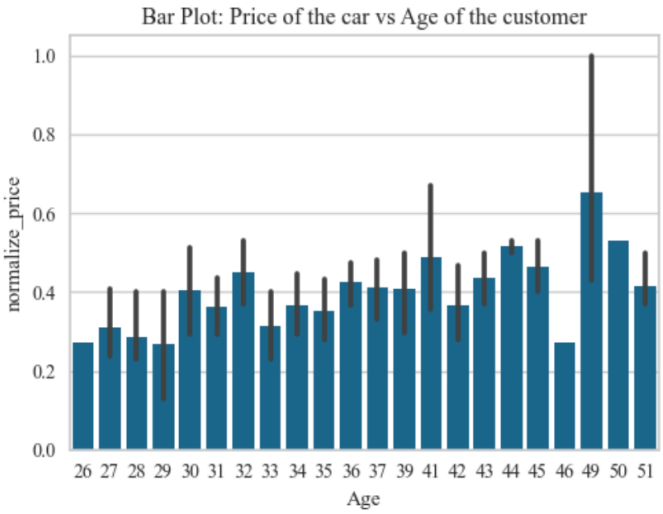
Cluster 0: Comprising cities with a business ranking below 14.

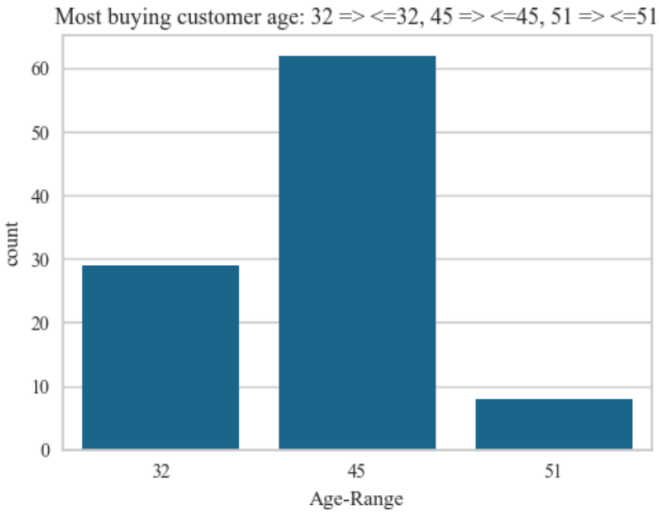
Cluster 1: Encompassing cities with a business ranking ranging from 15 to 24.

Cluster 2: Consisting of cities with a business ranking above 24.

## Target Customers

It contains information about the purchasing customer. The graph below illustrates the correlation between the product's price and the customer's age.




Observation: There is a stronger tendency among individuals in their late 20s to early 40s to opt for electric vehicles compared to other age groups.

## Customizing the Marketing mix

Customizing the marketing mix involves tailoring the different components of the marketing mix to meet the specific needs and preferences of a target market or customer segment. The marketing mix comprises four key elements, known as the "4Ps": product, price, place, and promotion. Customizing these elements enables businesses to formulate targeted and impactful marketing strategies.

Here's an overview of how customization can be applied to each element:

Product:

- **Features and benefits:** Adjust the product's features, functionalities, and benefits to align with the specific needs and preferences of the target market.
- **Packaging and branding:** Design packaging and branding elements to appeal to the target market's tastes, values, and preferences.

- **Product variants or customization:** Offer different variants or customization options to cater to diverse segments or individual preferences within the target market.

Price:

- **Pricing strategy:** Determine the most suitable pricing strategy based on the target market's willingness to pay, perceived value, and competitive landscape.
- **Discounts and promotions:** Customize discounts, promotions, or pricing bundles in line with the target market's purchasing behavior and preferences.
- **Payment options:** Offer flexible payment options or financing plans that accommodate the target market's financial situation and preferences.

Place:

- **Distribution channels:** Select distribution channels that are convenient and accessible to the target market, considering factors such as online platforms, retail locations, or direct sales.
- **Physical presence:** Establish a physical presence in locations that are relevant and easily reachable for the target market, such as specific regions or neighborhoods.
- **Inventory management:** Optimize inventory management to ensure the product's availability at the right time and in the right locations for the target market.

Promotion:

- **Advertising and messaging:** Develop advertising campaigns and messages that resonate with the target market's values, aspirations, and communication preferences.
- **Marketing channels:** Utilize effective marketing channels to reach and engage the target market, such as social media, influencer marketing, or traditional advertising mediums.
- **Sales promotions:** Create sales promotions, events, or partnerships that appeal to the target market's interests and drive engagement.

Customizing the marketing mix necessitates a profound understanding of the target market, including demographics, psychographics, behaviors, and preferences. Market research, customer surveys, and feedback serve as valuable tools to gather insights and inform the customization process. By tailoring the marketing mix, businesses can better address the unique needs and desires of their target market, leading to more effective marketing strategies and heightened customer satisfaction.

**Most optimal Market Segment**

Identifying the most optimal market segment for the electric vehicle market involves considering several factors, such as market conditions, consumer preferences, and government regulations.

Insights derived from our analysis indicate that targeting E2W and E4W vehicles can be viable in many parts of the country, given the reported high sales in several states. Particularly favorable locations include states such as Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Rajasthan, Tamil Nadu, and Telangana. These states not only exhibit high sales but also boast a significant number of charging stations, enhancing the convenience for customers to adopt electric vehicles. The company's focus should emphasize crucial aspects of the vehicle, especially Reliability, Comfort, Service Cost, and Performance, considering the prevalent use of E2Ws for daily commutes and E4Ws for longer-term purposes.

Factors such as Age, Salary, and Price play a crucial role, with younger populations tending to opt for less expensive vehicles. Electric vehicles may face challenges if perceived as unaffordable. Therefore, targeting a segment eager to embrace new technologies while being financially stable enough to afford electric vehicles is recommended. Individuals in their late 20s to early 40s exhibit a higher inclination toward purchasing electric vehicles compared to other age groups.

The average salary of electric vehicle buyers is approximately 30 lakhs, with most automobile purchases falling within the 10 to 20 lakhs range, and even less for E2W vehicles. The prevailing trend indicates that individuals with higher salaries and older age groups typically purchase cars in the 10 to 20 lakhs range. However, heightened awareness among younger segments about climate change influences their decision to opt for electric cars. Therefore, the recommended target segment is the mid-tier, requiring substantial marketing efforts to highlight the environmental benefits of electric vehicles.

Github link:

https://github.com/Kaviswar45/market-segmentation-EV

**Note:**
**Implementation file will be named “implementation.ipynb”**