Feynn Labs: Project 2

GitHub:https://github.com/Pacchu04/Feynn-Labs/tree/main/EV%20Market%20Segmentation

ELECTRIC VEHICLE MARKET SEGMENT ANALYSIS

"In order to have clean air in cities, you have to go electric."

- **Elon Musk**

Submitted By: Prashanth Devadiga

Problem Statement

The electric vehicle (EV) market is booming due to rising environmental concerns, government incentives, and technological advancements. However, increased competition necessitates differentiation for EV startups. Traditional demographic-based segmentation methods are inadequate for this diverse market. Hence, there's a rising demand for sophisticated segmentation strategies like machine learning.

Task is to analyze 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 Behavioral.

In this report we analyze 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

Fermi estimation specifically for electric vehicles in India in 2023:

1. **India's Population:** India's population is approximately 1.366 billion.

2. **Vehicle Ownership Rate:** The percentage of people who own vehicles in India is lower than in some developed countries, estimated at around 5%.

3. **Electric Vehicle Market Share in India:** India has been pushing for electric vehicle adoption, and government incentives are driving growth. Let's estimate that electric vehicles constitute about 10% of the market share in India by 2023.

4. **Average Distance Driven Annually:** Due to various factors like traffic congestion, road conditions, and shorter average commute distances, let's assume the average annual distance driven per vehicle is around 8,000 kilometers (approximately 5,000 miles).

5. **Efficiency Difference:** Similar to the global estimate, let's assume electric vehicles are about 3 times more efficient than conventional gasoline vehicles.

Now, let's calculate the total electricity consumed by electric vehicles in India in 2023:

Total Electricity Consumed = (India's Population)×(Vehicle Ownership Rate)×(Electric Vehicle Market Share)×(Average Distance Driven Annually)×(Efficiency Difference)

Total Electricity Consumed = $(1.366×10^9)×(0.05)×(0.10)×(8.0× 10^3$ km/year$) ×(3)$

Now, let's solve this equation:

Total Electricity Consumed $\approx 1.366 \times 10^9 \times 0.05 \times 0.10 \times 8.0 \times 10^3 \times 3$

$$\approx 1.0368 \times 10^{10} \times kWh/year$$

So, in 2023, electric vehicles in India might consume approximately 10.368 billion kWh of electricity annually. Again, this is a rough estimate, and actual figures may vary due to various factors like policy changes, technological advancements, and infrastructure development.

Data Collection

Data was extracted from the various websites mentioned below for EV market segmentation.

Link for data extraction:

- **https://www.kaggle.com/datasets/geoffnel/evs-one-electric-vehicle-dataset**

- **https://www.kaggle.com/datasets/saketpradhan/electric-vehicle-charging-stations-in-india**

- **https://www.kaggle.com/datasets/deadprstkrish/ev-cars-user-reviews-india**

- **https://data.gov.in/**

- **https://dataspace.mobi/dataset/electric-vehicle-charging-station-list**

- **https://www.statista.com/statistics/1264923/india-electric-passenger-vehicle-sales-by-manufacturers/**

This dataset comprises information on charging stations operational across India. It encompasses data on states, cities, and precise addresses of each charging station, along with latitude and longitude coordinates pinpointing their locations.

Additionally, the dataset provides insights into the types of charging stations available, offering a comprehensive overview of the infrastructure supporting electric vehicle adoption throughout the country.

Such detailed information is invaluable for stakeholders in the electric vehicle industry, aiding in strategic planning, infrastructure development, and market analysis to facilitate the transition towards sustainable mobility in India.

Data Pre-processing

Steps taken to pre-process the scraped raw data:

- Remove or correct any inconsistencies, errors, or missing values in the dataset. This ensures that the data is accurate and reliable for analysis.
- Normalization scales the values to a range between 0 and 1, while standardization scales the data to have a mean of 0 and a standard deviation of 1.
- Create new features or modify existing ones to better represent the underlying patterns in the data. This could involve combining features, creating indicator variables, or transforming variables to better fit the segmentation model.
- Label Encoding of dataset which is string format.
- Applying PCA to reduce dimensionality reduction in data analysis.

Exploratory Data Analysis

It's an approach to analyzing datasets to summarize their main characteristics, often with visual methods. EDA helps to understand the underlying structure, patterns, and relationships in the data before applying more complex statistical models.
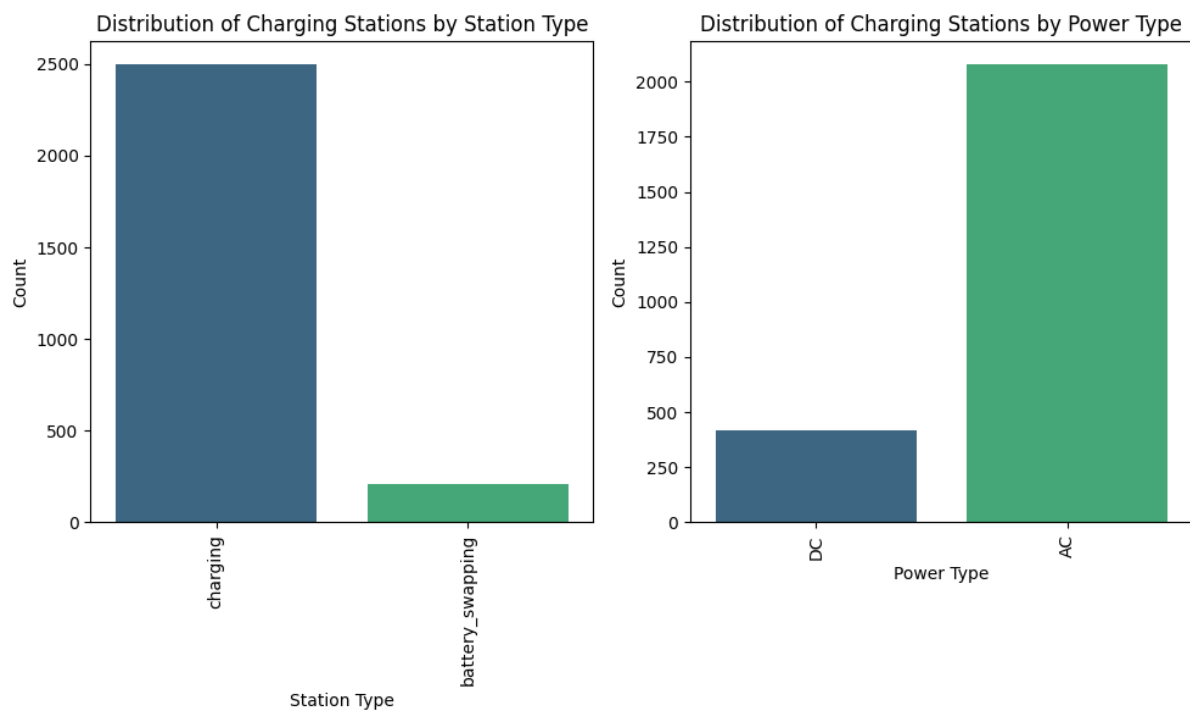

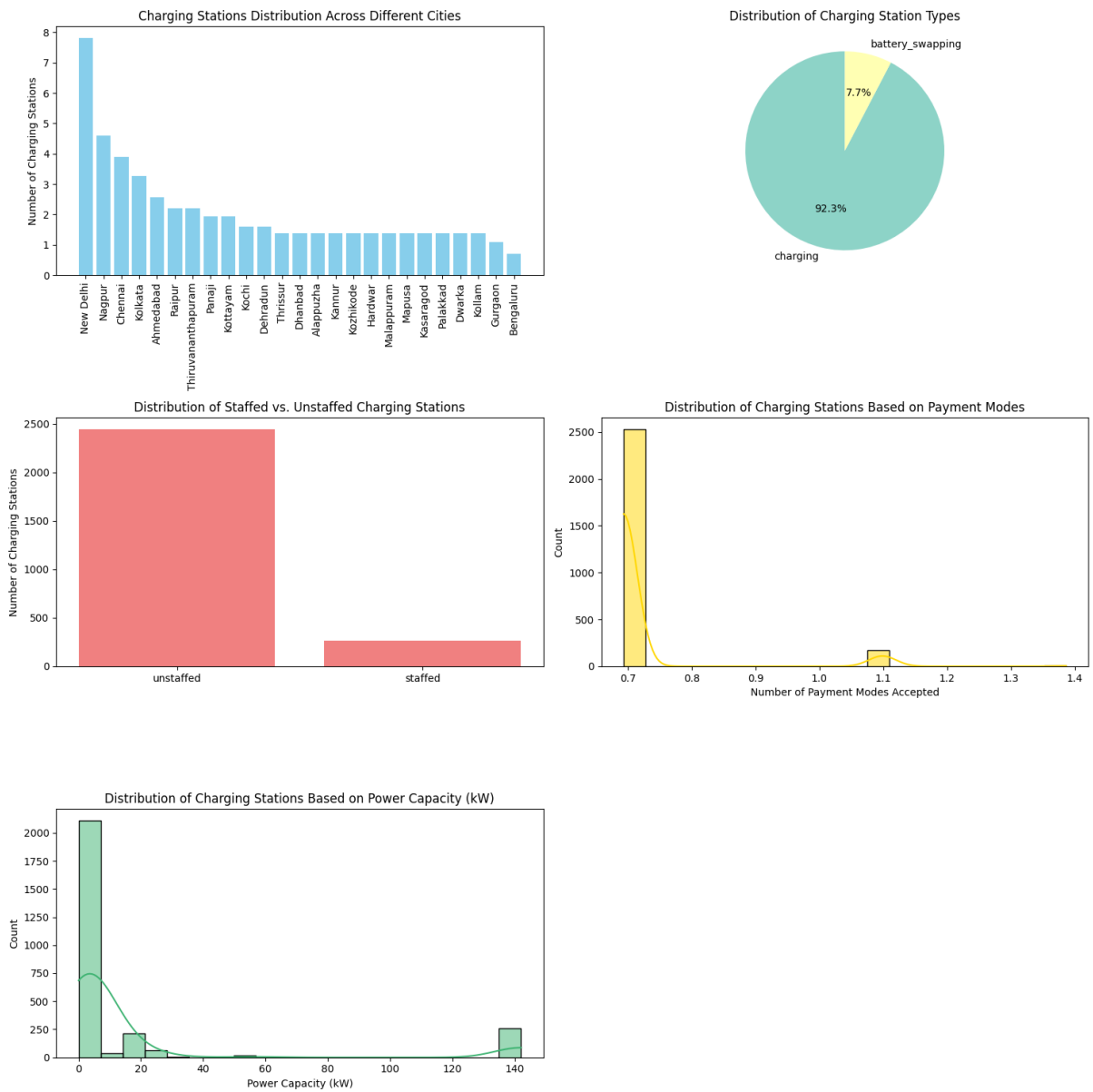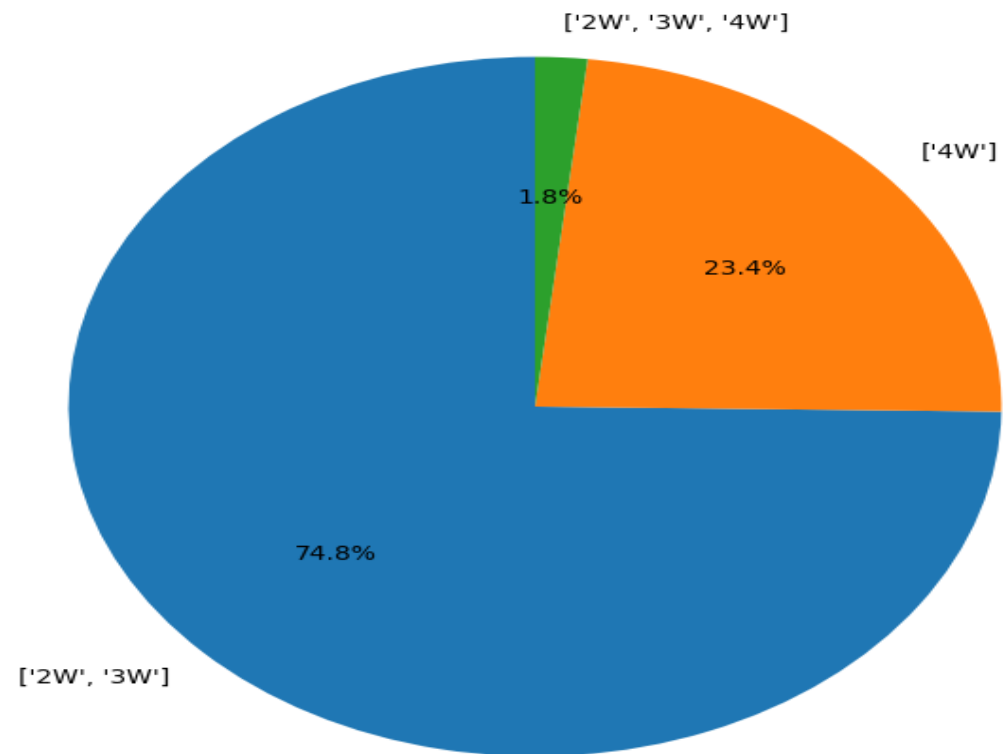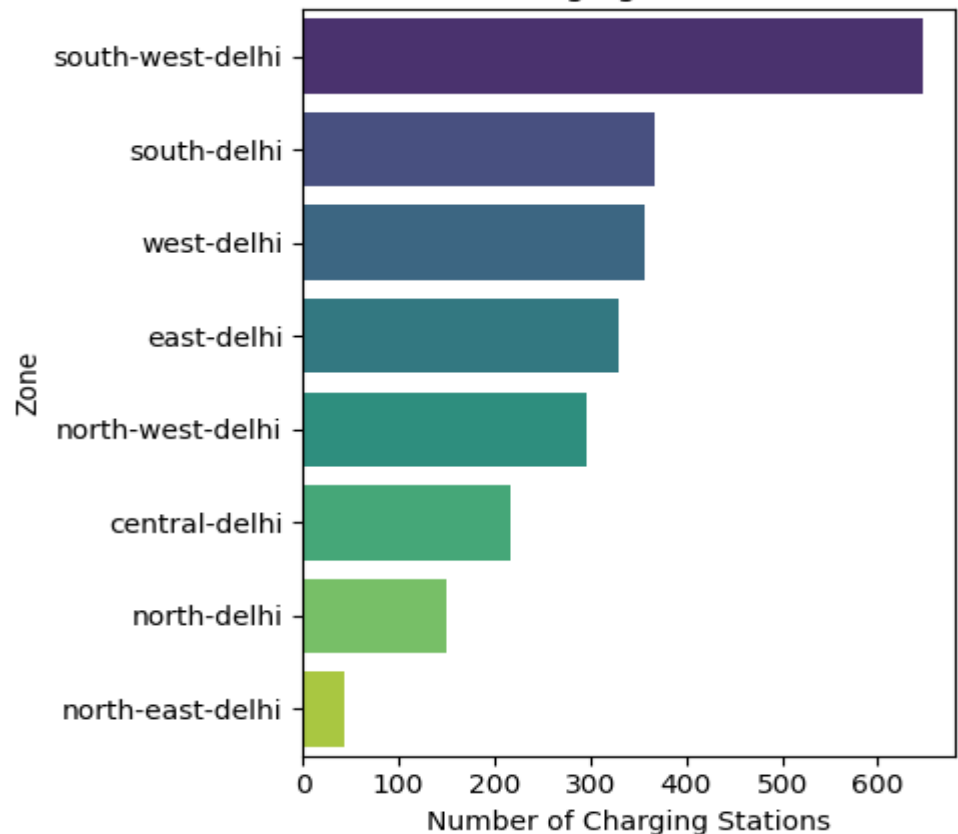**Fig-1: Distribution of Charging Stations by Station Type and Power Type**

Fig-2: Charing Station Distribution across Cities

Distribution of Charging Stations Based on Supported Vehicle Types

['2W', '3W', '4W']

['4W']

1.8%

23.4%

74.8%

['2W', '3W']

Distribution of Charging Stations Across Zones
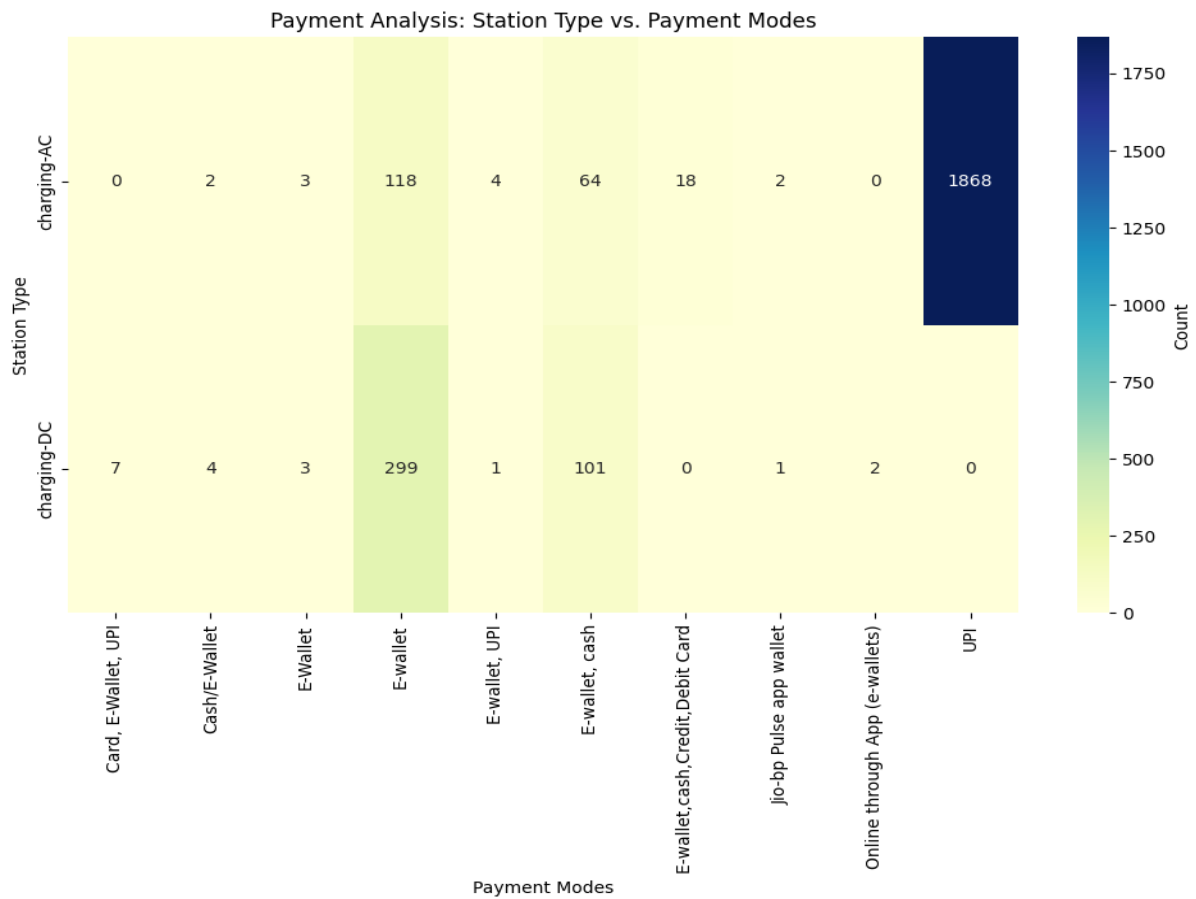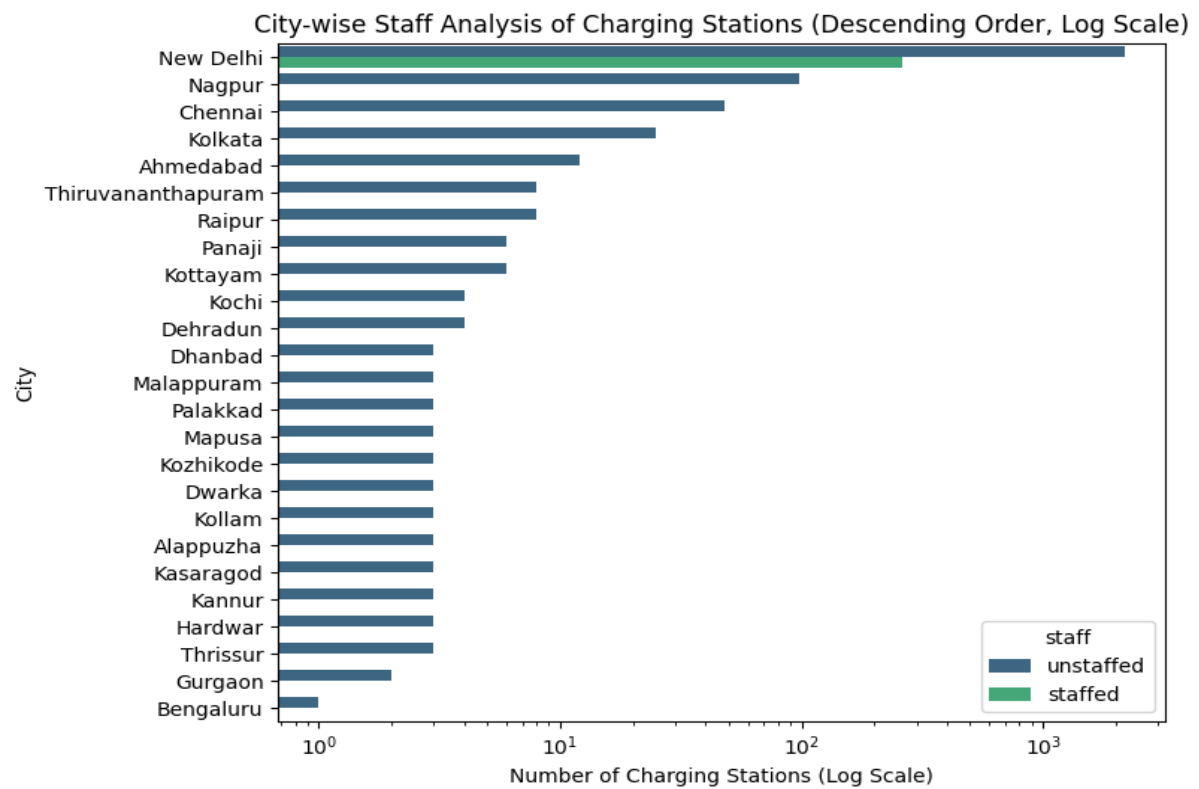

Number of Charging Stations

Zone

Fig-3: Payment Modes Analysis
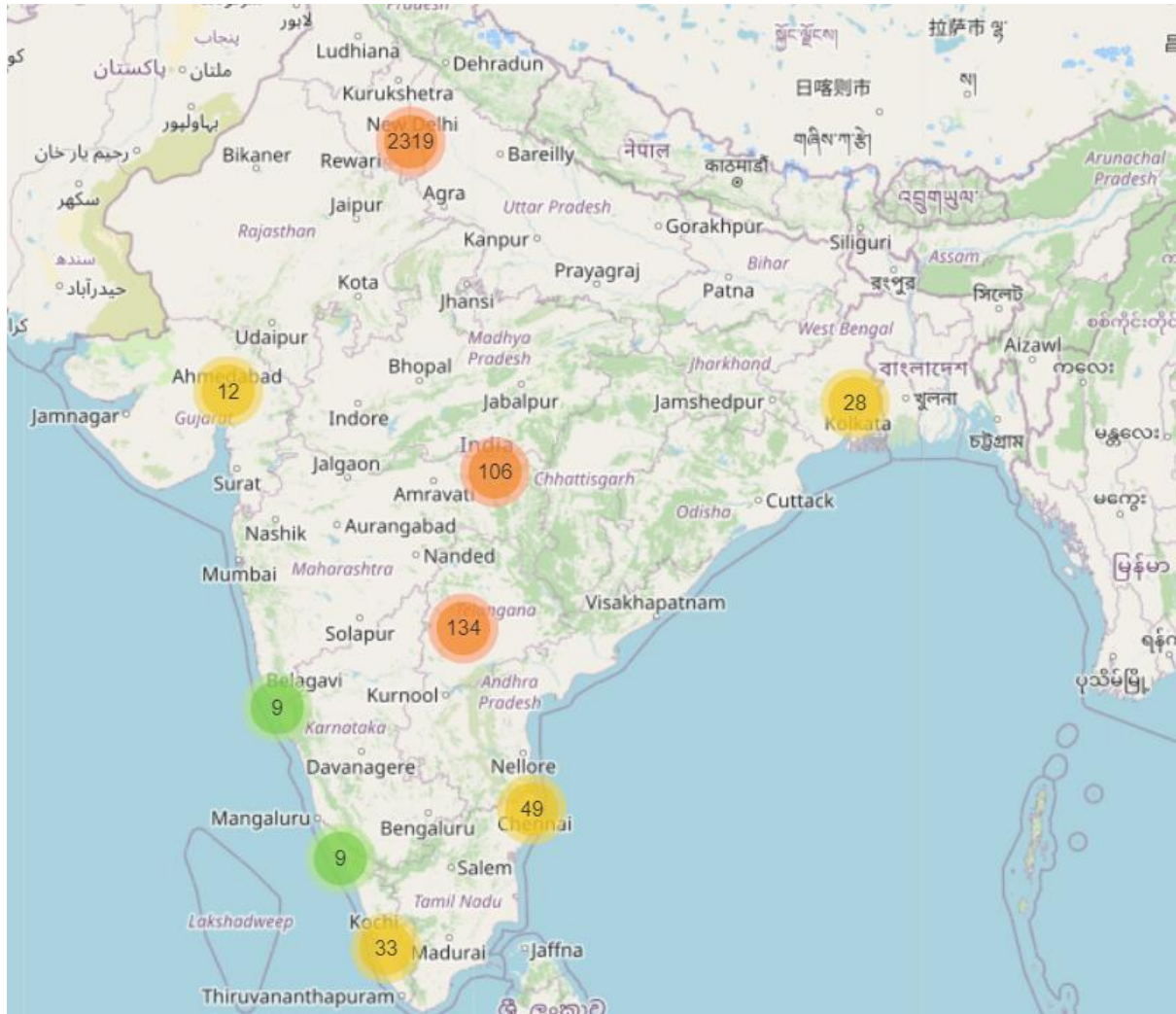
Fig-5: Geospatial Analysis With Folium

Fig-6: Fastest Acceleration

Top Speed achieved by a brand

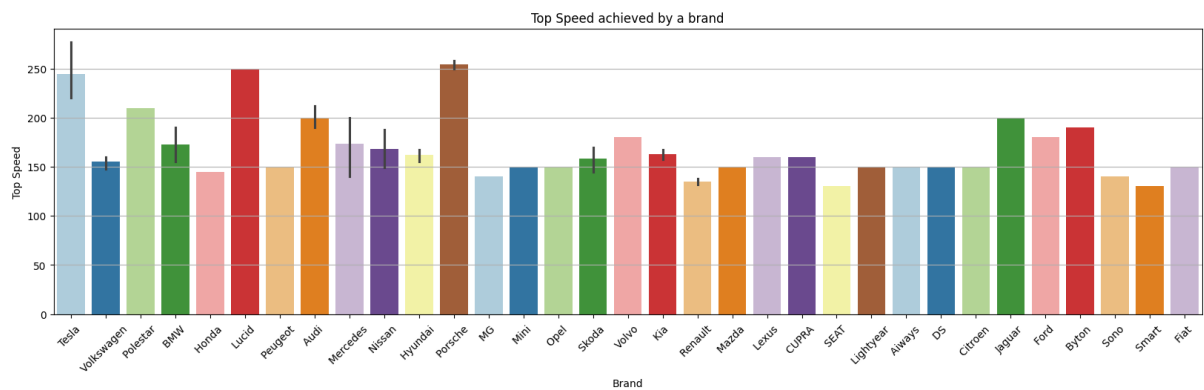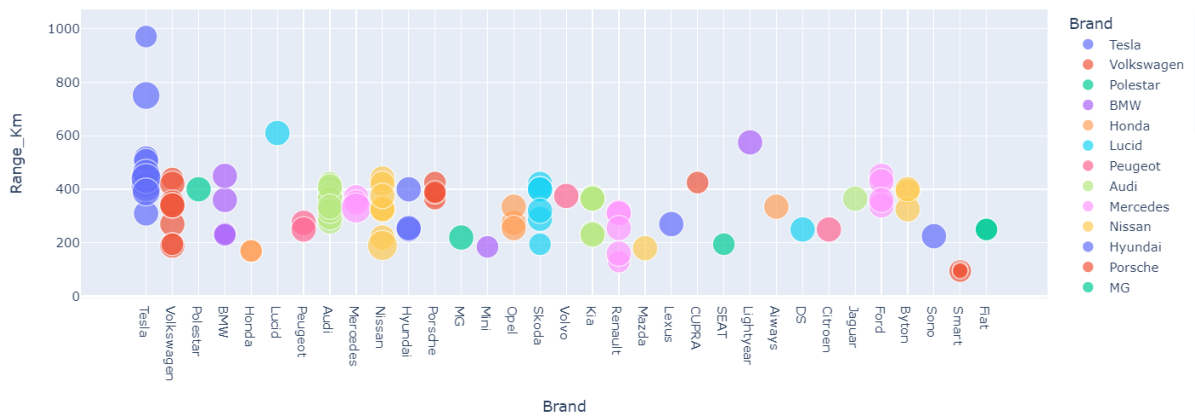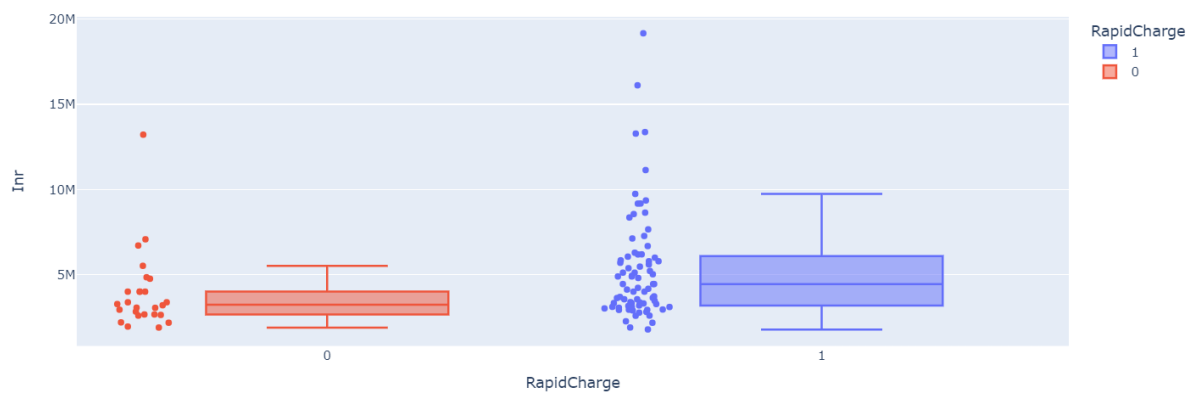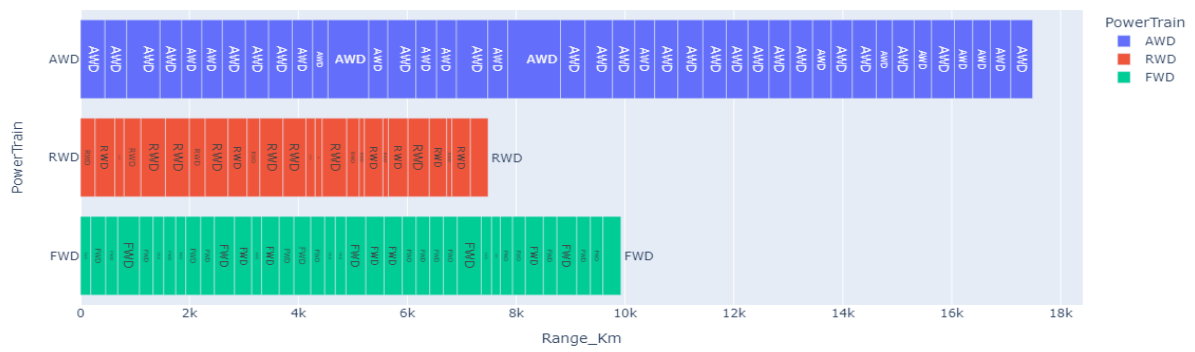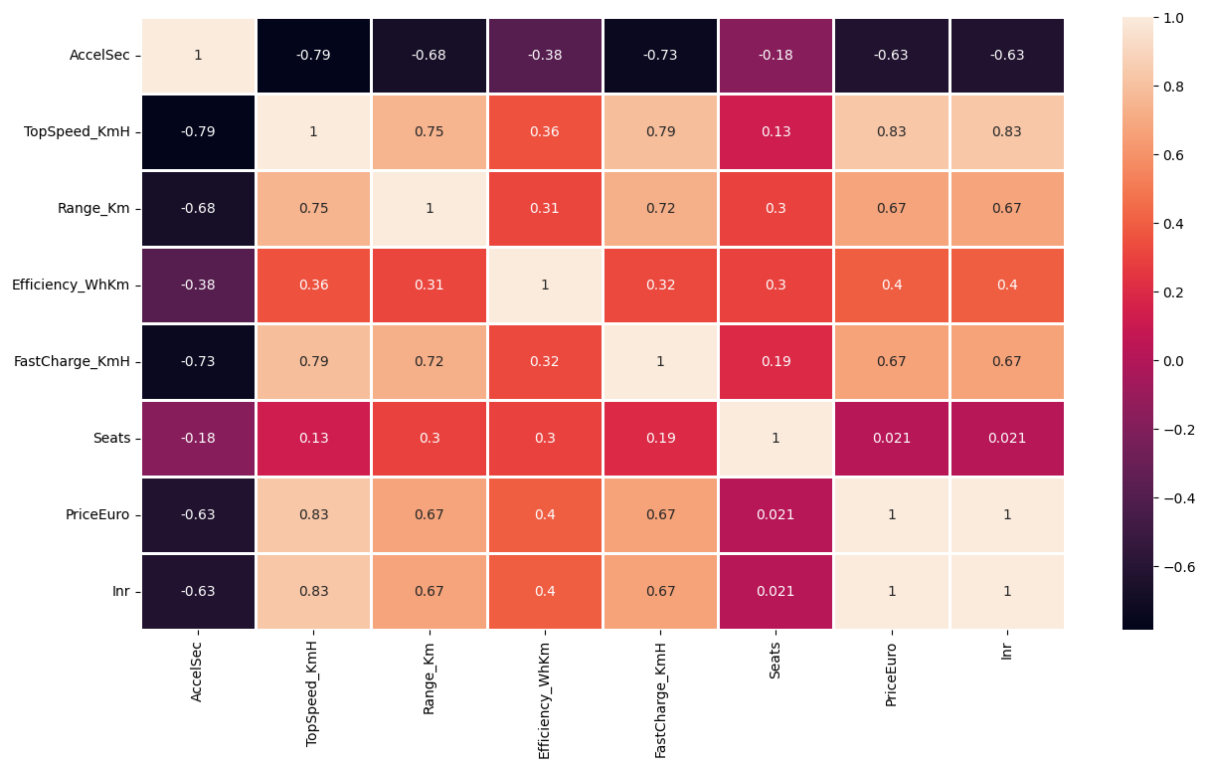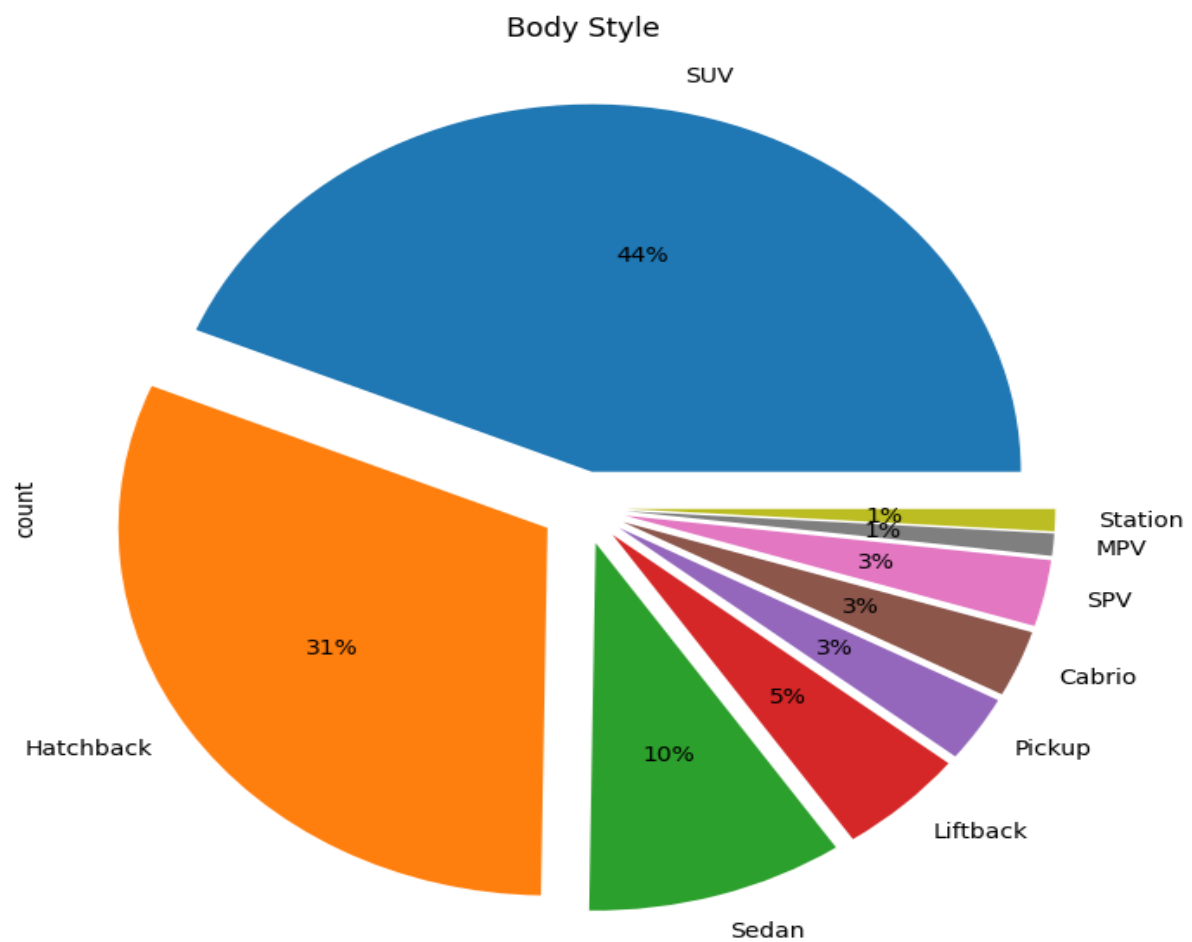**Fig-7: Correlation of Data**

Body Style

Average Positivity and Negativity by Region

Q-Q Plot for Positivity Scores in East Coast
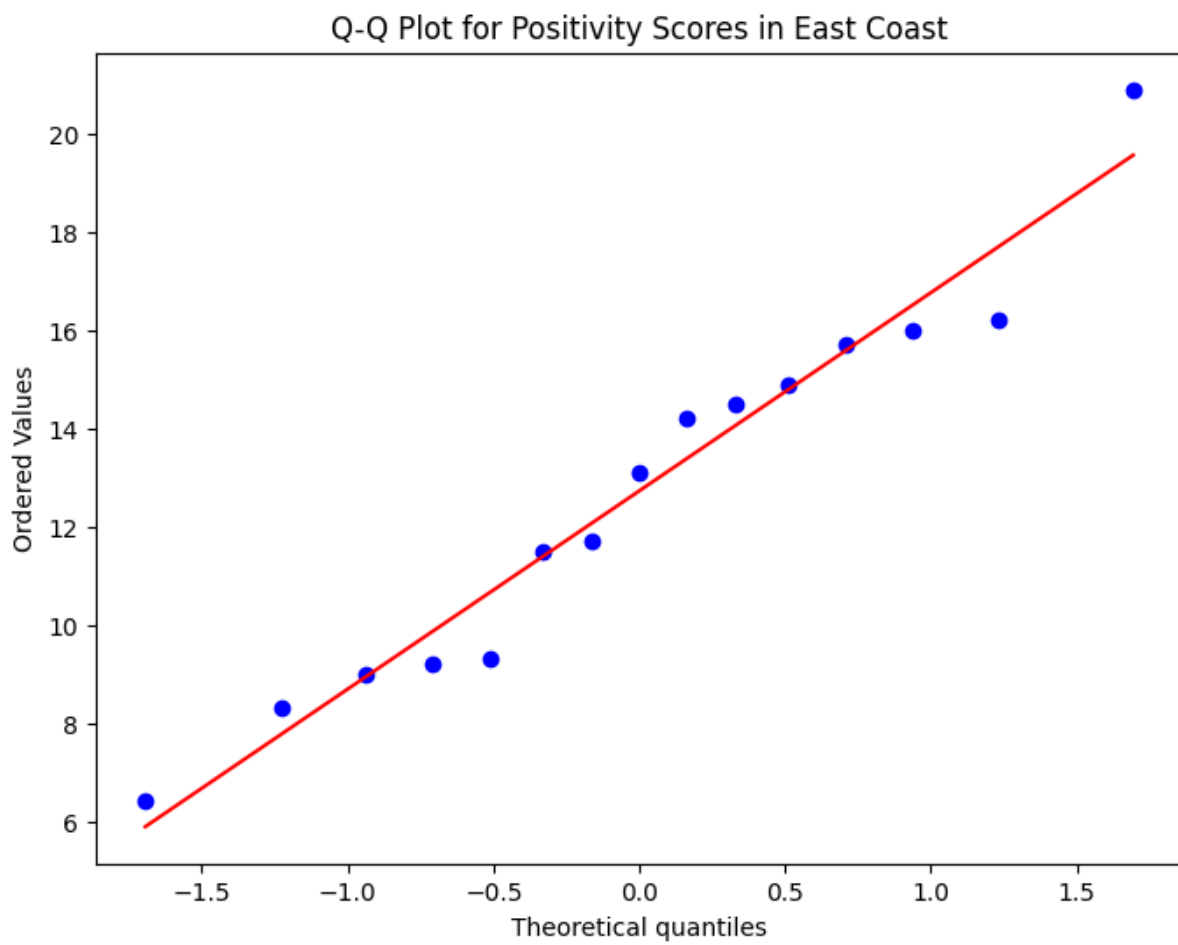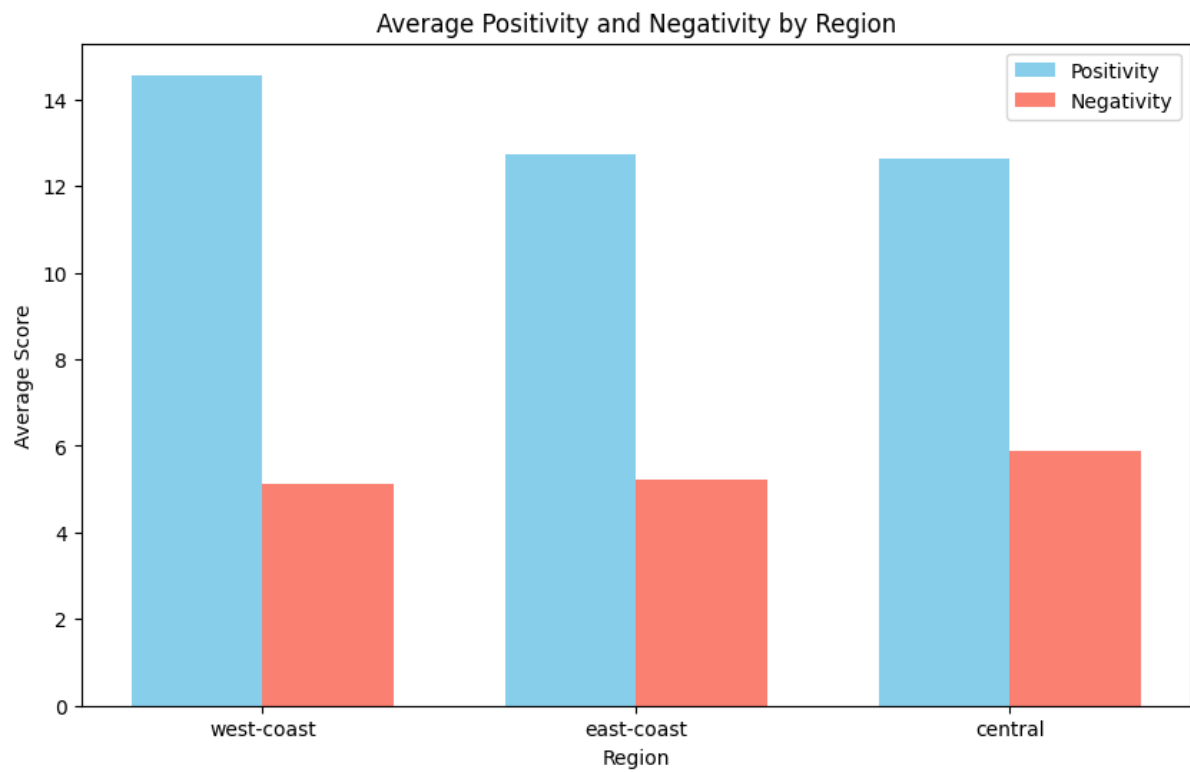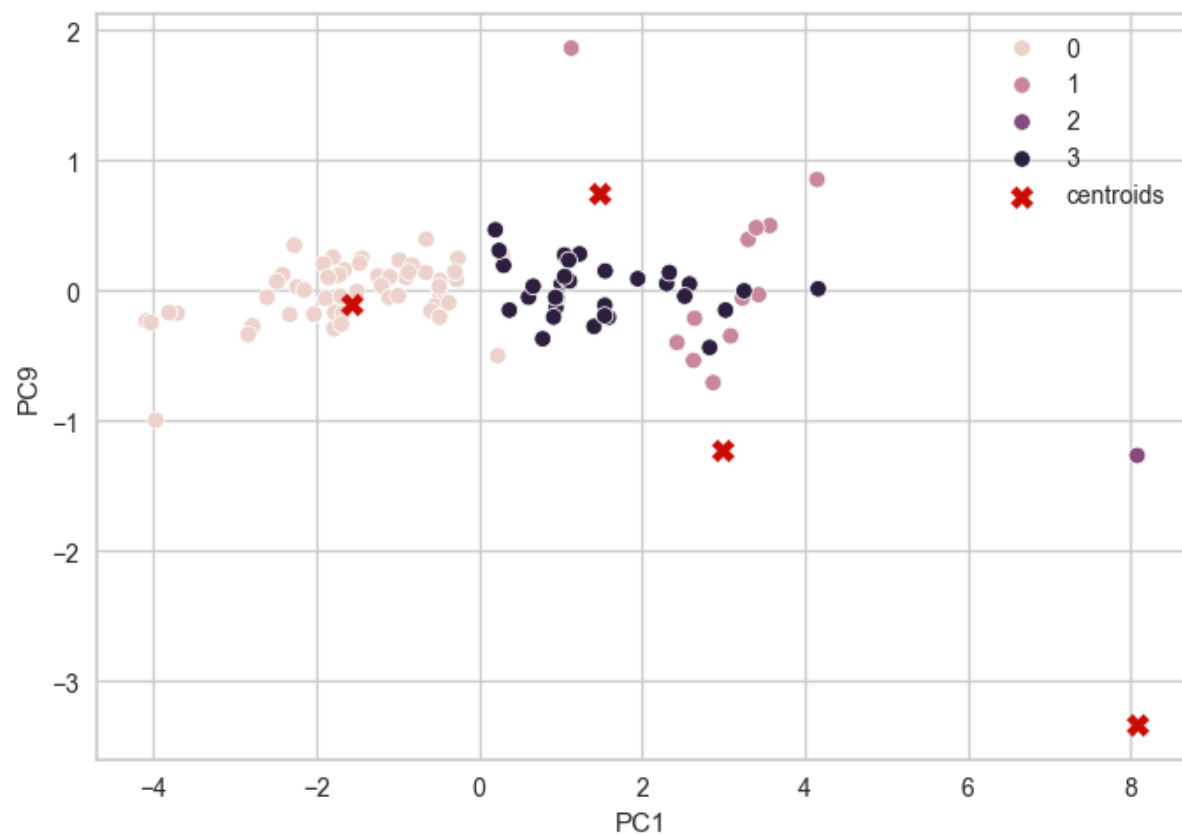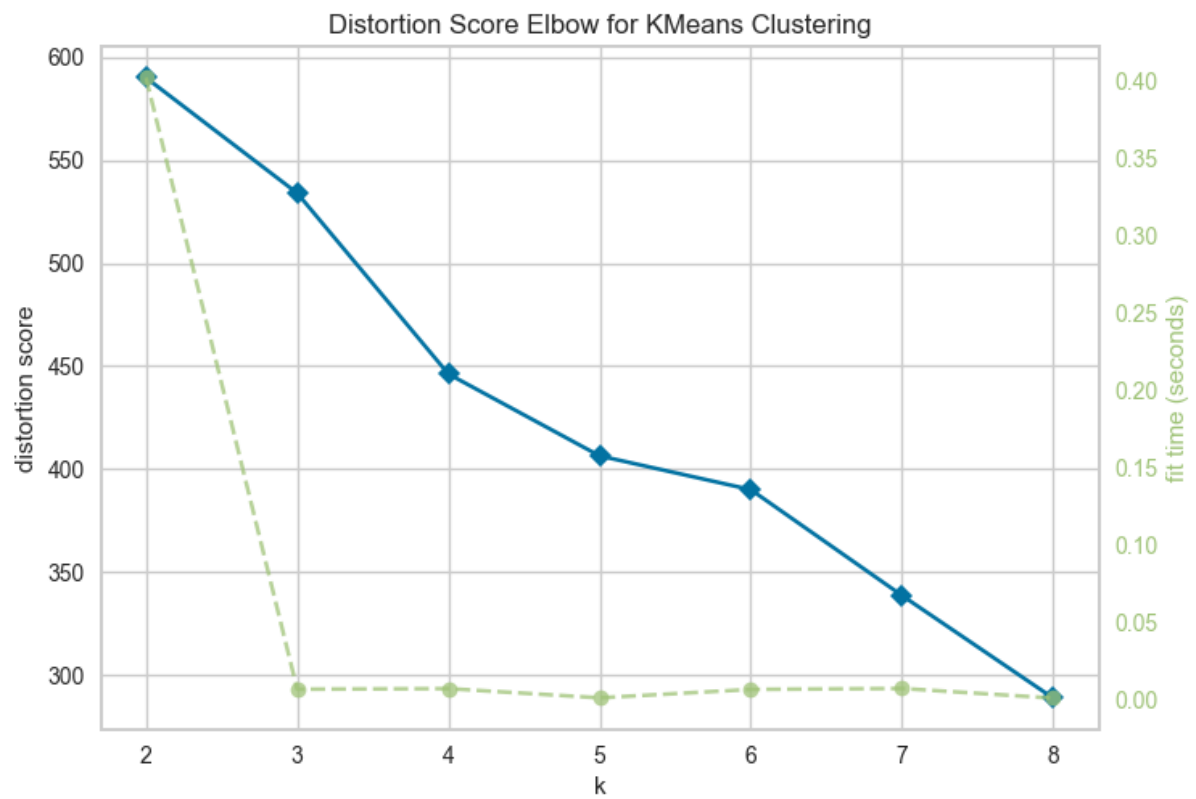
Fig-8: PCA Clustering

Segment Extraction

K-Means Clustering is one of the most popular Unsupervised Machine Learning Algorithms Used for Solving Classification Problems. K Means segregates the unlabeled data into various groups, called clusters, based on having similar features, common patterns.

Suppose we have N number of Unlabeled Multivariate Datasets of various features like wateravailability, price, city etc. from our dataset. The technique to segregate Datasets into various groups, on the basis of having similar features and characteristics, is called Clustering. The groups being Formed are known as Clusters.

Clustering is being used in Unsupervised Learning Algorithms in Machine Learning as it can segregate multivariate data into various groups, without any supervisor, on the basis of a common pattern hidden inside the datasets. In the Elbow method, we are actually varying the number of clusters (K) from 1 – 10. For each value of K, we are calculating WCSS (Within-Cluster Sum of Square). WCSS is the sum of squared distance between each point and the centroid in a cluster. When we plot the WCSS with the K value, the plot looks like an Elbow.

As the number of clusters increases, the WCSS value will start to decrease. WCSS value is largest when K = 1. When we analyze the graph, we can see that the graph will rapidly change at a point and thus creating an elbow shape. From this point, the graph starts to move almost parallel to the X-axis. The K value corresponding to this point is the optimal K value or an optimal number of clusters.

Calinski Harabasz Score Elbow for KMeans Clustering
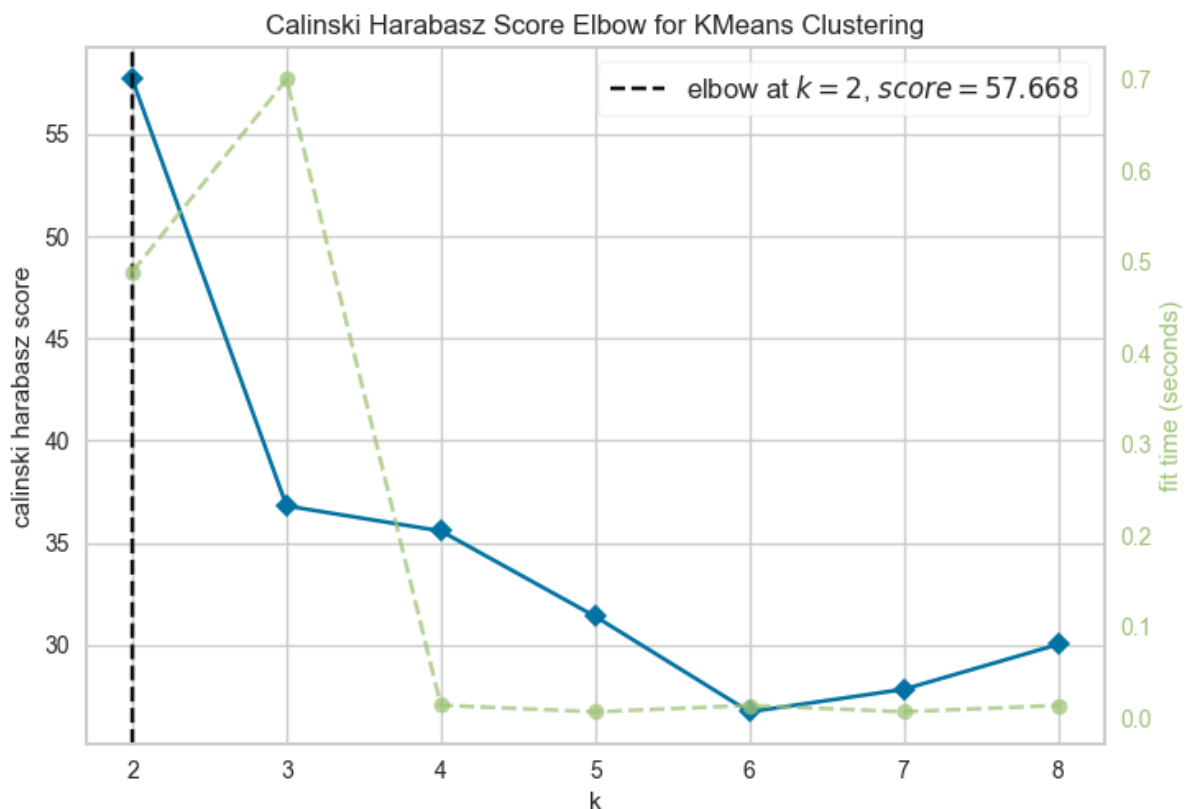
Profiling and Describing Potential Segments

1. Demographic Segmentation: Start by describing each segment in terms of demographic variables such as age, gender, income, education level, occupation, and family size. This provides a basic understanding of who the members of each segment are.
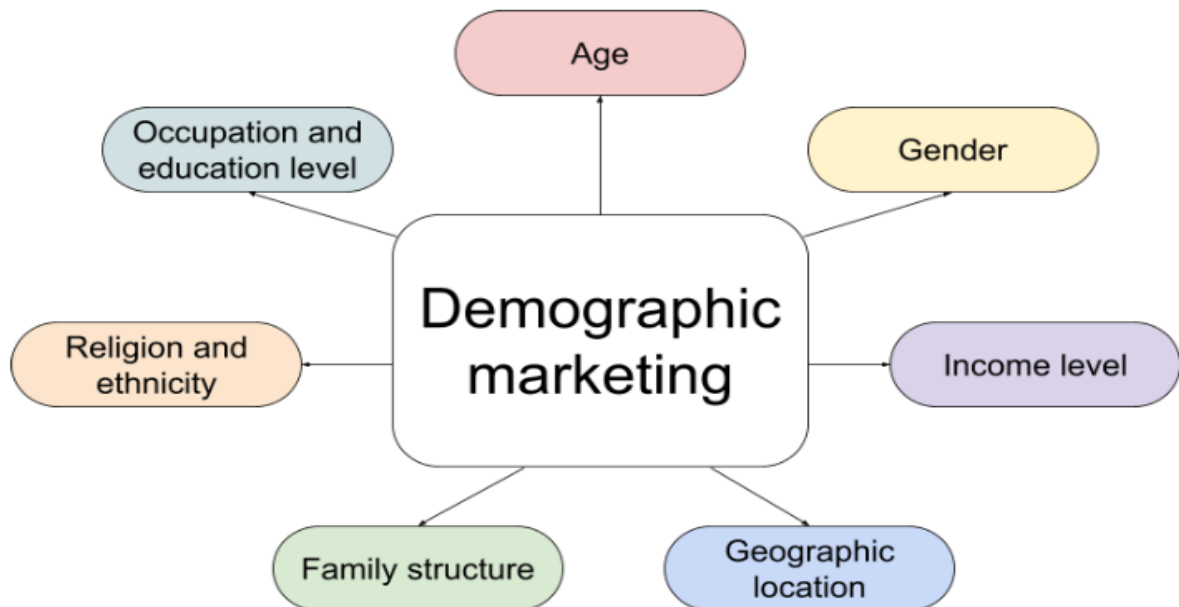
2. Geographic Segmentation:

- Urban vs. Rural: Segment consumers based on whether they reside in urban or rural areas, as infrastructure and charging availability may vary between these regions.
- Regional Preferences: Identify regional differences in EV adoption rates and preferences, which may be influenced by factors such as government incentives, climate, and infrastructure development.
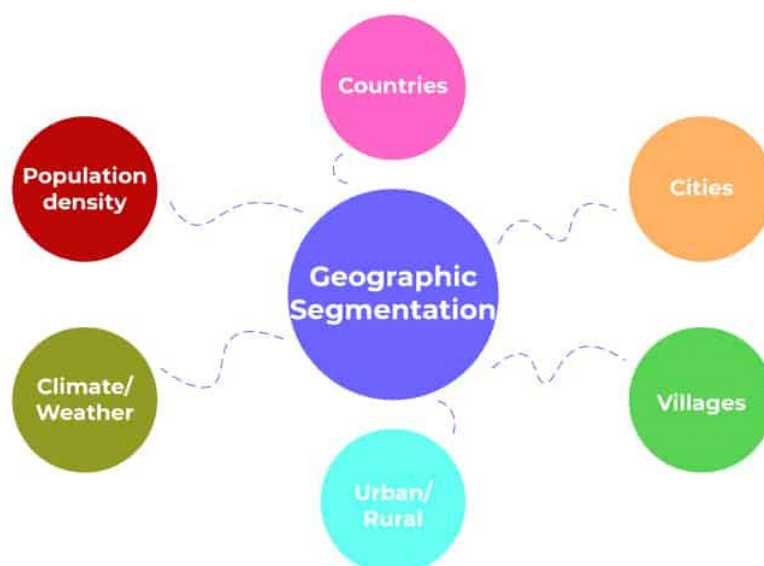
3. Psychographic Segmentation:

- Environmental Consciousness: Segment consumers based on their attitudes towards environmental sustainability and climate change, as many EV buyers prioritize reducing their carbon footprint.
- Early Adopters vs. Skeptics: Identify segments based on their willingness to embrace new technology, with early adopters being more open to EVs and skeptics requiring more persuasion.

Personality

Lifestyle

Psychographic Segmentation

Attitudes

Social Status

Activities, Interests, and Opinions
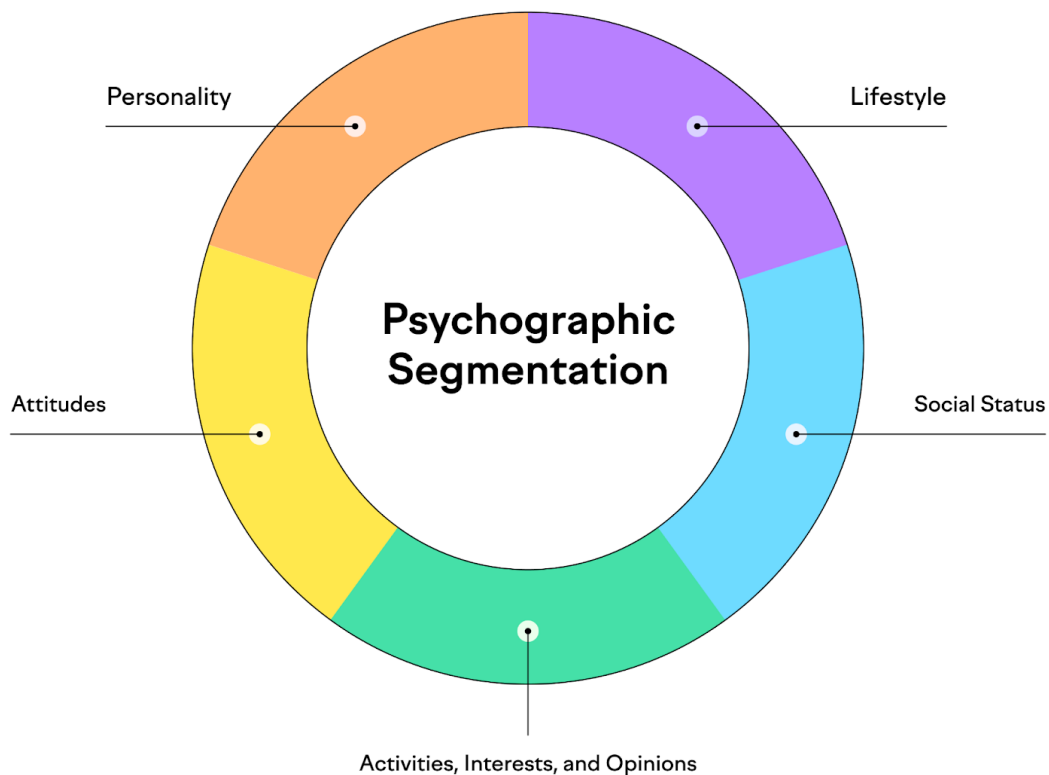
4. Behavioral Segmentation:

- Purchase Intent: Segment consumers based on their intention to purchase an EV in the near future, distinguishing between potential buyers and those who are not yet considering an EV.
- Usage Patterns: Consider the driving habits and usage patterns of potential EV owners, such as daily commute distance and frequency of long-distance travel.
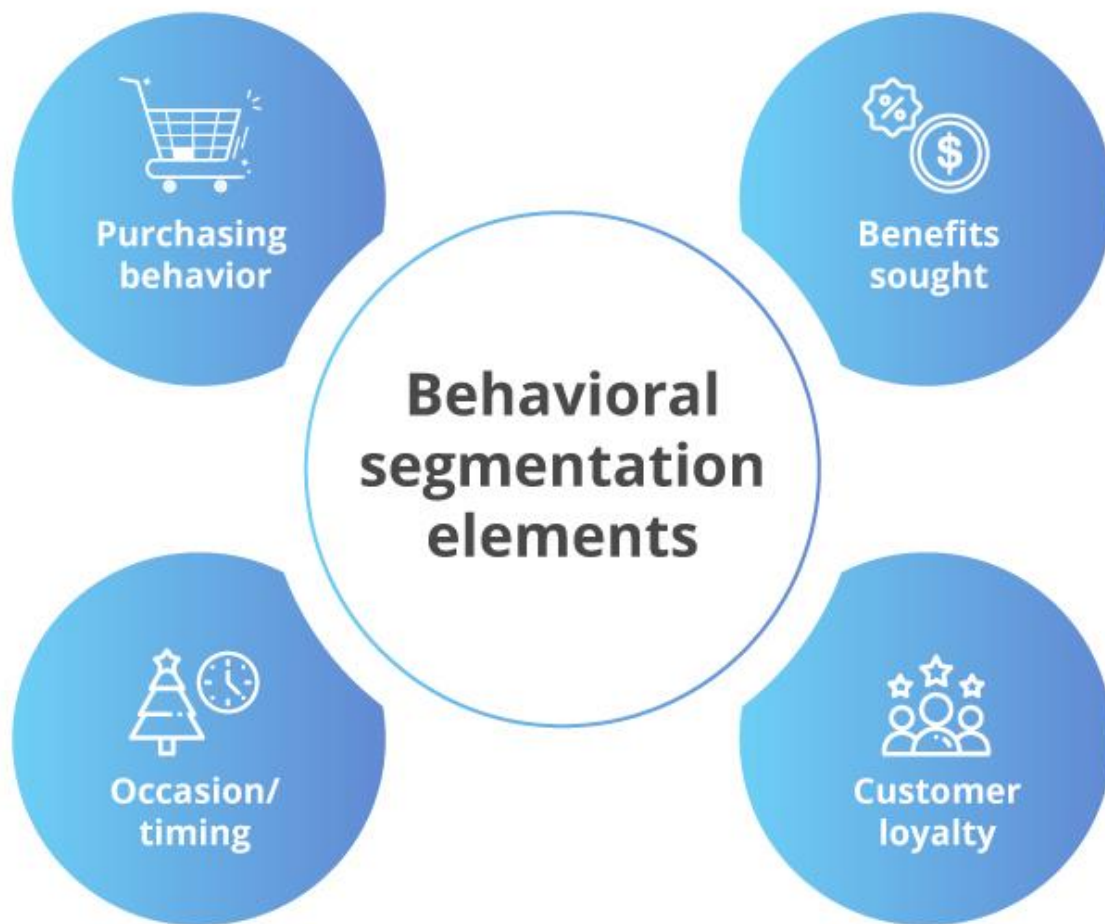
The major use of EVs in India is for daily commute.
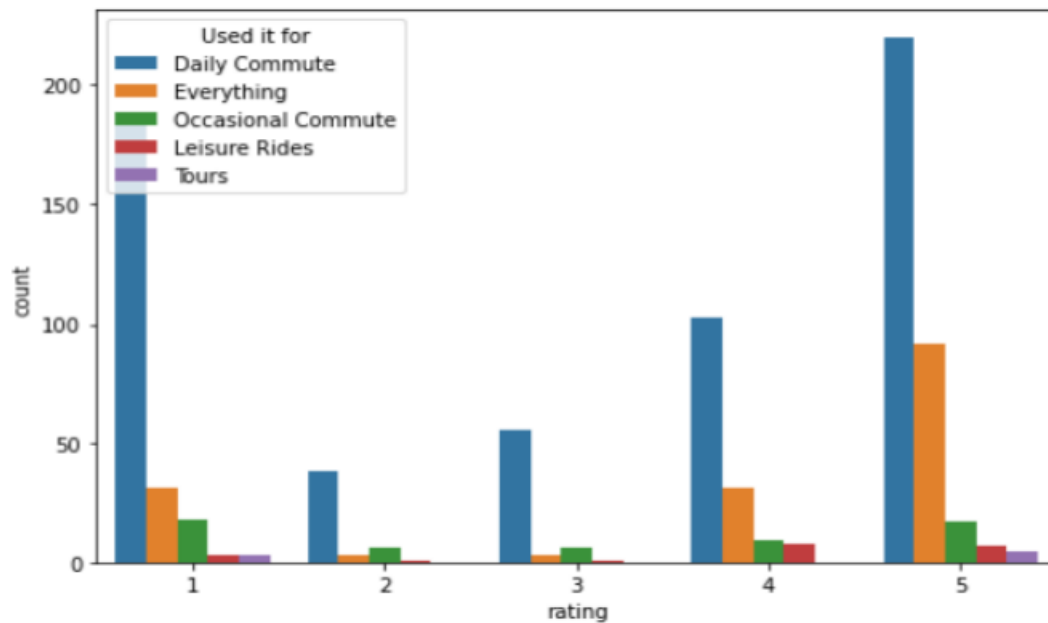
Psychographic Factors

Comfort, Visual Appeal and Value for Money are other key psychological aspects that attract customers.
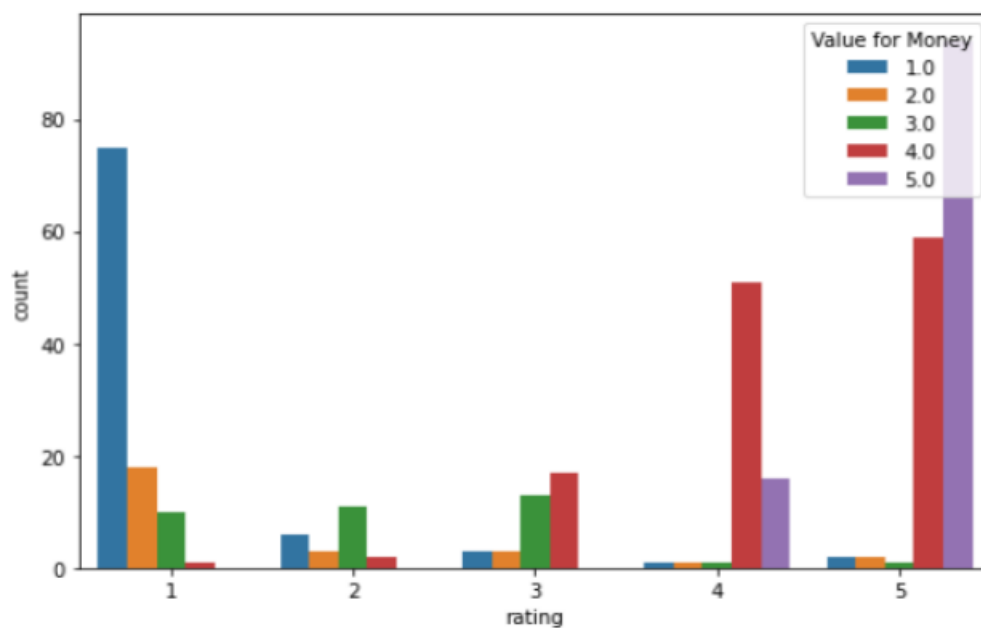
Major psychographic factors to consider – Value for Money and Comfort.

	Value for Money	Visual Appeal	Comfort	rating
Value for Money	1.000000	0.739205	0.775693	0.868278
Visual Appeal	0.739205	1.000000	0.785004	0.766609
Comfort	0.775693	0.785004	1.000000	0.830538
rating	0.868278	0.766609	0.830538	1.000000

Geographic Factors

The following graph shows the number of sales of EVs in different states.

State Wise Electric vehicle sales trend, 2021

	Uttar Pradesh	Karnataka	Tamil Nadu	Maharashtra	Delhi	Rajasthan	Bihar	Telengana	Assam	Gujarat	Others
2W	6286	29617	23940	23622	7565	13953	2788	14448	378	7887	27228
3W (L3)	59705	358	3398	1572	14954	8846	20011	63	15204	246	21979
3W (L5)	418	1782	865	368	1288	91	194	1516	45	507	1615
4W	79	1485	950	3743	1952	552	61	1812	7	857	2720
e-Bus	192	27	0	552	31	0	26	0	0	216	127
Others	24	33	883	3	19	12	1	0	1	65	23
% Share	20	10	9	9	8	7	7	5	5	3	16

Totals shown on bars: Uttar Pradesh 66704, Karnataka 33302, Tamil Nadu 30036, Maharashtra 29860, Delhi 25809, Rajasthan 23454, Bihar 23081, Telengana 17839, Assam 15635, Gujarat 9778, Others 53692.

States like Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu and Rajasthan are good geographic locations consider for an EV market.

Target Segments

Based on the analysis, the target segment can be narrowed down to EVs having:

- **Psychographic factors** such as Comfort and Value for Money.
- **Behavioral 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

The marketing mix helps enable the growth of the business in the automotive industry. A company's marketing mix or 4Ps (Product, Place, Promotion, and Price) specify the approaches and strategies that address the target market, based on the details of the marketing plan. The company's aim is to maximize sales and improve market presence. With astrong position in the market, However, strategic decision-makers must allow for flexibility in relevant strategies.

The automotive market has various opportunities for the growth, such as opportunities for products that integrate advanced computing technologies. However, the company faces threatsin its business environment. Managers can use the SWOT Analysis to determine appropriate adjustments in the marketing mix or 4Ps to deal with these threats and opportunities.

1. Product:

- Variety and Features: Offer a diverse range of EV models with different features and specifications to appeal to the varying needs and preferences of different segments. For example, offer compact EVs for urban commuters and larger SUVs for families.
- Customization Options: Provide customization options that allow consumers to personalize their EVs based on their preferences, such as color choices, interior options, and technology packages.
- Environmental Sustainability: Highlight the eco-friendly features of EVs, such as zero tailpipe emissions and reduced carbon footprint, to appeal to environmentally conscious segments.

2. Price:

- Affordability: Offer a range of pricing options to cater to different income levels within the market segments. Consider offering subsidies, tax incentives, or financing options to make EVs more affordable for price-sensitive segments.
- Total Cost of Ownership: Emphasize the long-term cost savings associated with EV ownership, including lower fuel and maintenance costs, to appeal to segments concerned with total cost of ownership rather than upfront price.

3. Promotion:

- Targeted Messaging: Tailor promotional messages and campaigns to resonate with the values, attitudes, and lifestyles of different market segments. For example, emphasize the performance and technology features of EVs to tech-savvy segments, while highlighting the environmental benefits to eco-conscious segments.
- Digital Marketing: Utilize digital marketing channels, such as social media, online forums, and targeted advertising, to reach and engage with specific segments more effectively.
- Partnerships and Collaborations: Form partnerships with influencers, environmental organizations, and local communities to raise awareness and credibility among target segments.
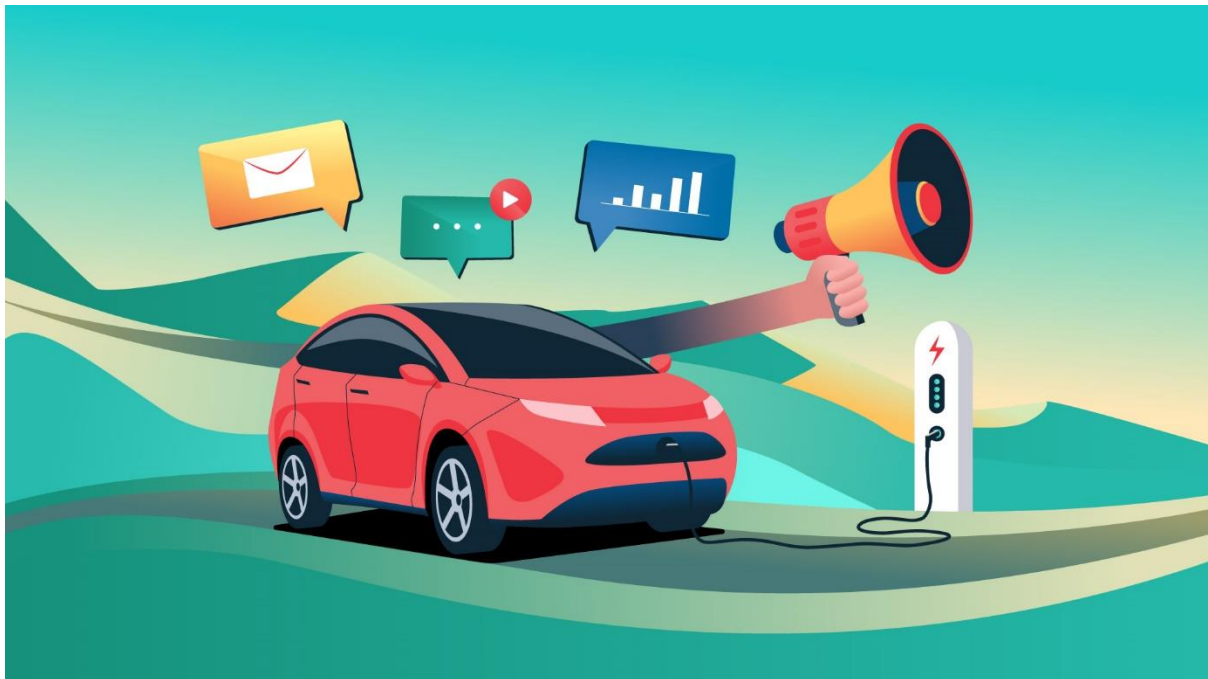
4. People (Extended "P" for services marketing):

- Customer Service: Provide exceptional customer service and support to address the unique needs and concerns of different segments throughout the purchase journey, from pre-sales inquiries to after-sales service.
- Education and Training: Offer educational resources and training programs to educate consumers about EV technology, charging infrastructure, and government incentives, particularly targeting segments with lower awareness or knowledge about EVs.

Potential Sales in Early Market

Purchasing a vehicle is one of those life accomplishments that top nearly everyone's bucket list. The majority of the customers have a family. For such folks there are a variety of reasons, including market and schooling. Whether you prefer a modernized urban loft or a sprawling suburban home with a white picket fence, most of us hope to find a vehicle that feels like it was made specifically for our family. Here is where our insights come in to assist such people to find a best vehicle at the best-fixed price according to the area and several other factors.

Some of the key points required to focus for the development of EV in India are:

1. Retrofitting conversion of Public Transport (Bus), Taxi and Three-Wheeler (Auto) to PHEV: This is one of the key requirements to move towards sustainable transportation. It will notonly balance emissions but also reduce the load on infrastructure requirement.

2. Government Incentives: Another key factor for XEV market to lift up will be identification of strategic incentives for electric vehicles. This will increase adoption rate and decrease main element barrier of the price of electric vehicles to customers. The incentive can be subsidy scheme for electric vehicles bridging gap price between the conventional and electric vehicle in similar performance range. e.g., if the cost of internal combustion engine car is INR 5 lakh and that of the electric vehicle is INR 6.5 lakh, the government can intend to offer discount or subsidy of the differential cost. In addition, benefit of Discount on VAT//Discount on Registration/Discount on Toll Plaza to motivate sell of EV can be planned.

3. Charging Infrastructure: Charging infrastructure development will occur with the development of XEV market. However, motivation can be provided by developing grid-connected charging station withthe moderate tariff, promotion to standalone renewable (solar/wind) charging station, add onfacility at petrol pump and bus stops for charging and state transport charging stations and permitting the development of private renewable charging stations.

4. Electrical Propulsion System (EPS): Currently no Indian manufacturer provide electrical propulsion system (EPS) manufactured in India, even REVA has a tie-up with Italy for EPS. Hence support and positive atmospherebuild-up in manufacturers in one of the critical tasks. Development of clear policies for supporting the growth of supply, manufacturing, and recycling of propulsion system. Power electronics converter and motor technology development are feasible as technology base is available in India, however currently used cost-effective Li-ion technology of battery development is challenging task as the majority of lithium stock are available in China and USA. In addition, battery replacement/swapping can be one of the promising and viable options in India.

5. Development of Skilled Manpower: Consideration of safety and advanced technology involved, development of certified skilled technician and professionals is one of the requirements.

6. Awareness: Awareness on benefits of XEV and promotions of the government can play a significant rolein development. It can be done with the help of extensive advertisement at airport/bus station/cinema halls/government offices/public places using banners/hoardings, use of print media-newspaper/magazines/periodicals, digital media/radio/e media-internet, TV shows, expert talks, providing micro-funding for projects/conferences in schools, colleges and

industry, supplying R & D grants to research scholar/institute/industry. The promotional highlights for the consumer can be:

- Good for the environment/Lowers Emission: Electric vehicles emit lower levels of a Page | 24 range of air pollutants, e.g. nitrogen oxides, particulate matter and greenhouse gases(e.g. carbon dioxide-CO_2) than vehicles using conventional petrol and diesel engines.
- Cheaper to run/Improve Fuel Economy: As electricity is cheaper than petrol or diesel,the running costs of EVs are less than conventional vehicles.
- Less Life Cycle Cost. d. Perfect for urban use: Reduced levels of pollution and noise make EVs ideal for innercity and urban use.
- Smooth acceleration and deceleration: EVs benefit from smooth gearless acceleration and deceleration, as a result of the characteristics of the electric motor.
- Quieter than conventional vehicles: EVs are also quieter than conventional vehicles. Battery operated cars operate in almost complete silence except noise from the tires.
- Proved Technology (a sharp rise in the market of XEV all over the world).

Most Optimal Market Segment

There are many EV manufacturing companies in the country like Hero Electric, Tata Motors, Ather Energy, Ashok Leyland, Hyundai Kona Electric, etc. Tesla has also arrived; the demand will get higher & higher since it is automotive so the investments and policies and all that would be bigger but it will take some time to perfectly settle in India. The following are the key insights of the project:

- The electric vehicle industry has not done that much good due to the devastating hit of the Covid outbreak but it will take a huge jump in upcoming years.
- The use of EVs will be game-changing in terms of environment, air, noise pollution-free, postelectric, and much more.
- The company should plan to establish local operations in India either by partnering with a local company or by setting up its own manufacturing/ development unit, potentially combined with imports of specific components.
- The company would expect to further grow in India, underpinned by a growing commercial fleet market for two-wheelers and three-wheelers especially for last km delivery/urban freight services. The company must see opportunities across the supply chain in the battery, EV component and charging infrastructure segments including the machinery and equipment needed for establishing manufacturing plants, training and provision of skilled workforce etc.
- The company should start their business from Metro Cities in India and then after considerable business expand to other cities of the same state of the Metro Cities. This will help the company to expand easily as they will be having a prior knowledge of business from Metro Cities and Network of Supply chain will be easy for the company as the time goes in business.

In the conclusion, electric vehicles are the future hence - "**Go Green Go Electric".**

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