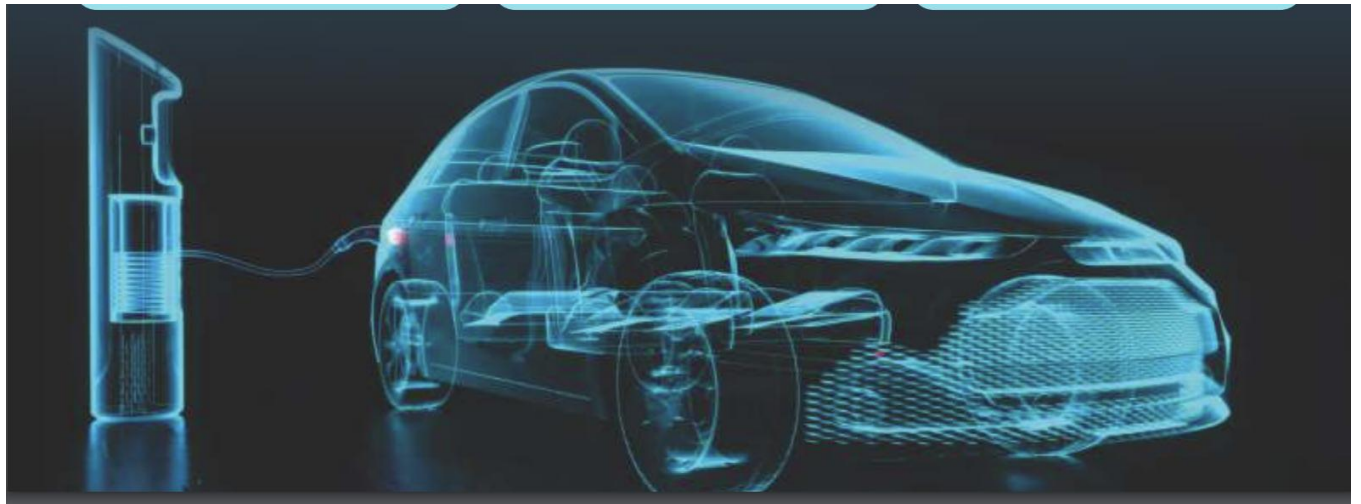




Feynn Labs

ARUN KUMAR RANA

Market Analysis Of Electric Vehicle Market



Overview :

India is home to 1.4 billion people. India is also home to more than 210 million 2-wheelers and 70 million 4-wheelers. Almost all of which (99.5%) run on fossil fuel. This is a major cause of air pollution in urban areas.

- Typically, vehicular emission contributes 20-30% of Particulate Matter (PM) 2.5 at the breathing level of air quality in India. PM2.5 refers to particles that have a diameter less than 2.5 micrometers (more than 100 times thinner than a human hair) and remain suspended for longer. According to studies, vehicles annually contribute about 290 gigagrams (Gg) of PM2.5.
- At the same time, around 8% of total Greenhouse Gas (GHG) Emissions in India are from the transport sector, and in Delhi, it exceeds 30%.
- Carbon monoxide (CO) is a highly toxic, colorless, odorless gas that arises from the incomplete combustion of fossil fuels. This is highly detrimental to health as it affects the body's ability to absorb oxygen. Studies have found that in highly polluted cities like New Delhi, vehicular emissions are the primary source of CO, which most notably fell by nearly 86 per cent during the Covid-19 lockdown due to restrictions on vehicular movement.
- Nitrous oxide (NOx) arises from the high-temperature combustion of fossil fuels and further contributes to ozone depletion. Indian cities like New Delhi, Bangalore, Mumbai, and Kolkata have some of the highest sources of NOx in the country – linked exclusively to vehicular pollution. An excess amount of NOx gives rise to ground-level ozone. Although not directly emitted from transport, this deadly secondary gas is highly correlated with respiratory diseases and asthma upon creation.

From the above discussion we can realize that introduction of EV to the India market have become necessary. EV can help us get rid of all the problems related to Particulate Matter arising from vehicle in India as well as emissions harmful to nature.

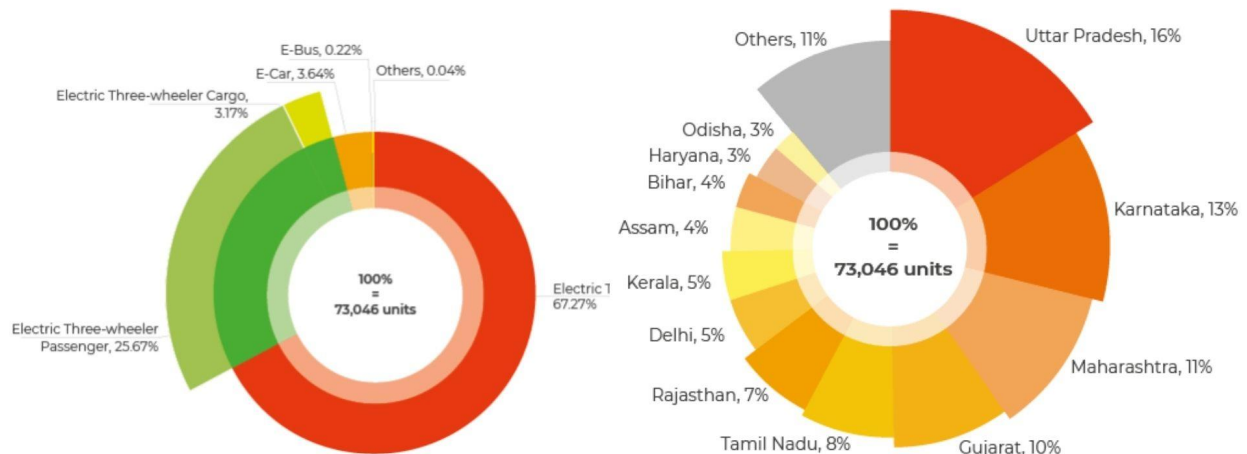
The advantages of an EV are as follows:

1. Cheaper to maintain: A battery powered electric vehicle has fewer moving parts than a conventionally fueled car. The servicing is easy, less frequent, and overall cheaper than a petrol/diesel vehicle.
2. Better for the environment: Harmful air pollution can be reduced from exhaust emissions by choosing to drive an EV. The reduced harmful exhaust emissions are good for human health too. The better air quality will lead to lesser health problems and costs.
3. Safe to drive: They undergo the same testing procedures test as other fuel-powered cars. An EV is safer to use, given their lower centre of gravity, which makes them more stable on the road in an accident

Market Overview

The electric four-wheeler segment is also gaining traction in India. Major automakers are introducing electric cars in the Indian market to cater to the growing demand. Tata Motors, Mahindra & Mahindra, and Hyundai are some of the prominent players in this space. The government's push for public transportation electrification has led to the adoption of electric buses in several cities. Ride-hailing companies like Ola and Uber are also focusing on adding electric cars to their fleets.

INDIA'S MONTHLY ELECTRIC VEHICLE SALES | APRIL 2022



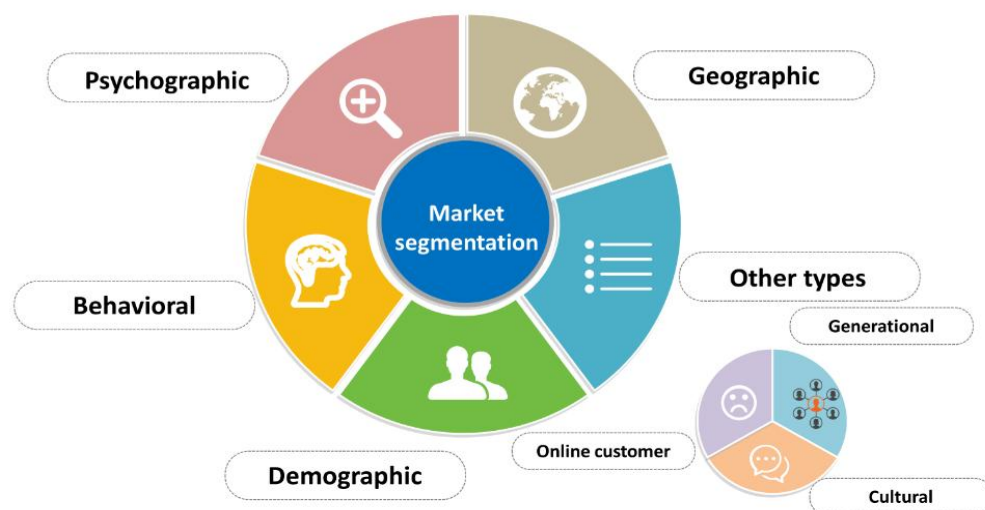
Problem Statement:

Need to analyse the Electric Vehicle market in India using Segmentation analysis and come up with a feasible strategy to enter the market, targeting the segments most likely to use Electric vehicles.

Apart from Geographic, Demographic, Psychographic, Behavioral segments, teams can consider different CATEGORY of Segments for the Segmentation Tasks, based on AVAILABILITY OF DATA. Market Segmentation comes with wide scope of possibility and Segments created can change based on different datasets collected.

Not every MARKET has Geographic, Demographic, Psychographic, Behavioral data available easily and there is going to be lot of research required in DATA Collection Tasks.

Bases for segmenting consumer markets

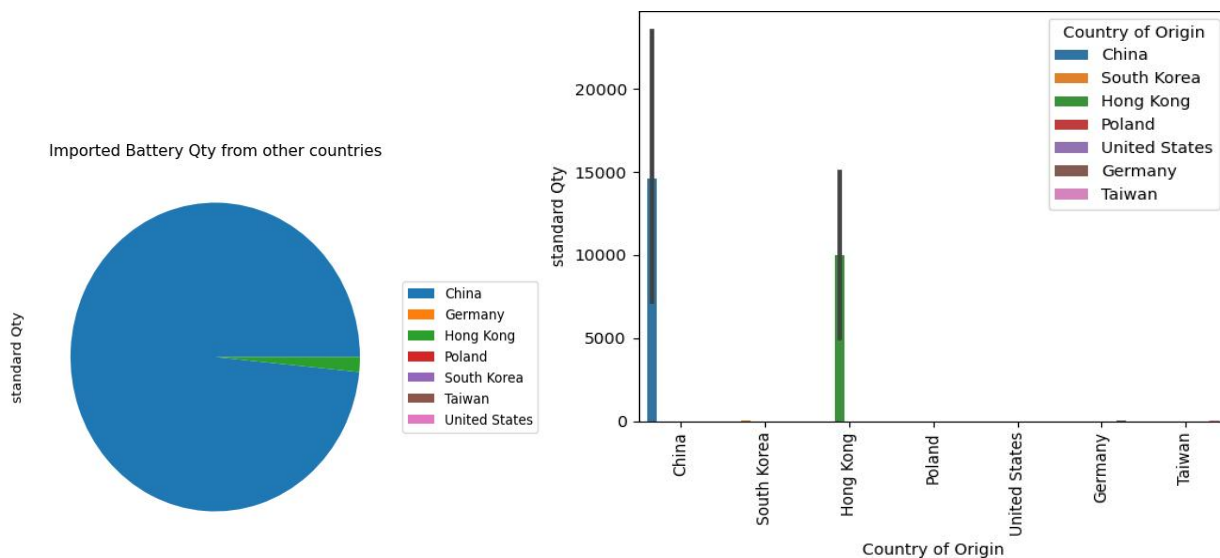


Market Challenges :

Companies and industries have to overcome some obstacle to capitalize on the market entirely. Here are some of the obstacles to adopt an EV in India, they are as follows:

1. Rang anxiety: EV customers are often worried about the vehicle's capability to reach the destination before the battery dies out and the absence of charging infrastructure. The charging infrastructure is considerably weak in rural or sparsely populated areas.
2. Consumer Protection: While the technology is still relatively new and is being accepted more day by day, the repair and maintenance network is still very minuscule compared to ICE vehicles. The lack of people skilled in EV maintenance is one of the major causes of this challenge.
3. High Initial Cost: Electric vehicles are initially very expensive compared to ICE cars.
4. Scarce Battery Technology: The number of OEMs manufacturing batteries from raw materials in India is very tiny. Coupled with the fact that the country lacks certain minerals (cobalt and lithium) to produce a battery, it negatively impacts the country's ambition to become an EV hub.

As mentioned above, one of the major problems for the Electric Vehicle (EV) industry in India is that there are not enough EV batteries being made in the country. India imports a lot of batteries from other countries to use in their electric vehicles.



Data Sources :

To investigate the EV market in India, data was gathered from multiple websites using web scraping techniques, such as BikeWale, CarWale, CarDekho and from various other sources such as government websites, Kaggle, GitHub etc. We have considered multiple datasets for the analysis. The links to the source of data is given below.

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

The following dataset is:-

	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	EngineSize	Cylinders	Horsepower	MPG_City	MPG_Highway	Weight	Wheelbase	Length
0	Acura	MDX	SUV	Asia	All	\$36,945	\$33,337	3.5	6.0	265.0	17.0	23.0	4451.0	106.0	189.0
1	Acura	RSX Type S 2dr	Sedan	Asia	Front	\$23,820	\$21,761	2.0	4.0	200.0	24.0	31.0	2778.0	101.0	172.0
2	Acura	TSX 4dr	Sedan	Asia	Front	\$26,990	\$24,647	2.4	4.0	200.0	22.0	29.0	3230.0	105.0	183.0
3	Acura	TL 4dr	Sedan	Asia	Front	\$33,195	\$30,299	3.2	6.0	270.0	20.0	28.0	3575.0	108.0	186.0
4	Acura	3.5 RL 4dr	Sedan	Asia	Front	\$43,755	\$39,014	3.5	6.0	225.0	18.0	24.0	3880.0	115.0	197.0

This dataset contains comprehensive information about the market share of the leading electric vehicle manufacturers and their corresponding prices :

	Product	Market type	Body	Production type	Market share(%)	Price(lakh)	Battery(kWh)	Range(km)
0	Tata Nexon Ev	Mass-market	SUV	Local	63.00	15.00	30.2	312
1	Tata Tigor Ev	Mass-market	sedan	Local	24.00	12.50	26.0	315
2	MG EZ5	Mass-market	SUV	CKD	11.50	23.38	50.3	419
3	Hyundai Kona	Mass-market	SUV	CKD	0.59	24.00	39.2	452
4	Mahindra E-Verito	Mass-market	sedan	Local	0.36	16.00	34.5	375

Libraries:

The libraries used for data analysis are as follows:

1. NumPy:

NumPy stands for Numerical Python; it is an open-source library for Python programming. It is used for data manipulation and preprocessing tasks, such as handling missing values, reshaping data, and applying mathematical operations.

2. Pandas:

Pandas is a widely used library for data manipulation and analysis. It provides data structures like DataFrames, which are efficient for handling structured data. High performance merging and joining of data sets, data alignment and integrated handling of missing data are some of the fancy things.

3. Matplotlib:

Matplotlib is a cross-platform, data visualization and graphical plotting library (histograms, scatter plots, bar plots, etc.) for Python and its numerical extension NumPy which helps us to understand trends, patterns, and to make correlations.

4. Seaborn:

Seaborn is a library that uses Matplotlib underneath to plot graphs. It will be used to visualize random distributions.

5. Scikit-learn:

Scikit-learn also known as sklearn, is an open-source data analysis library, and 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.

6. SciPy:

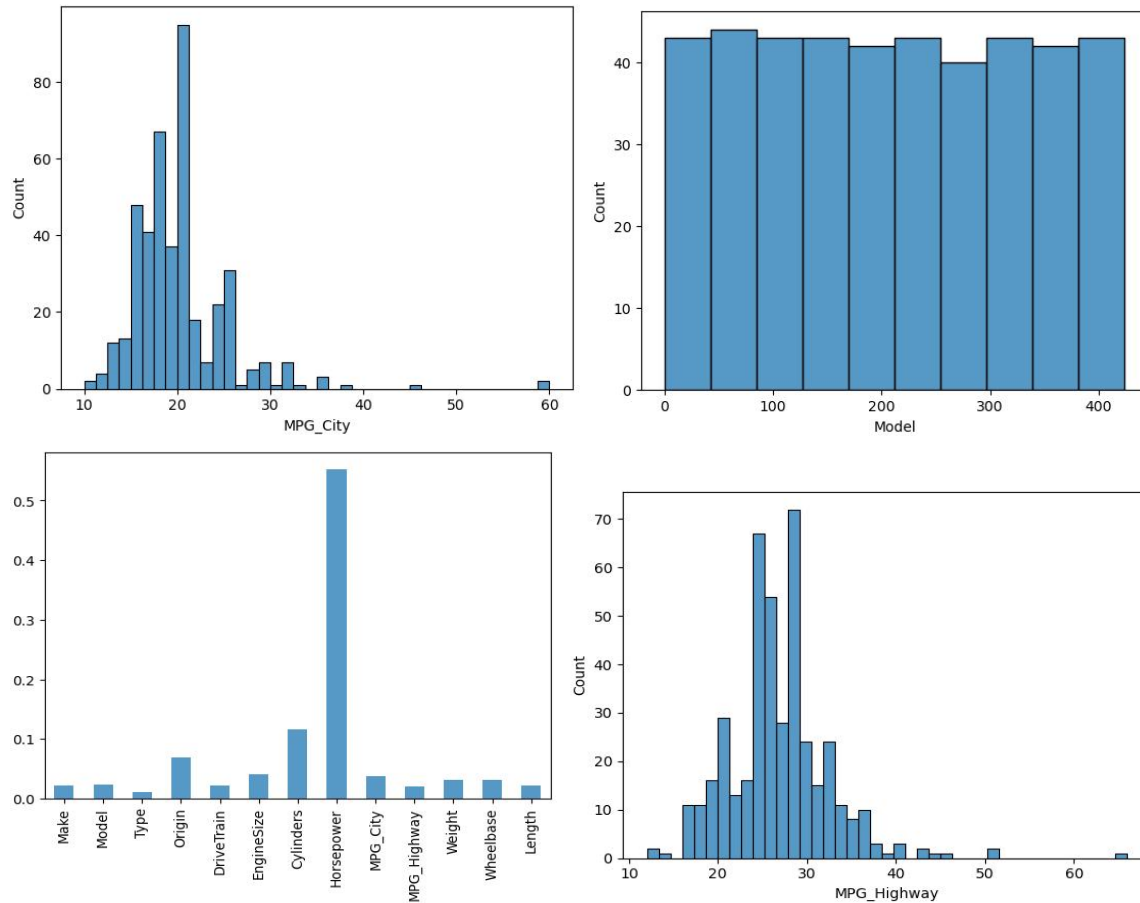
SciPy provides additional functionality for scientific and technical computing, including data preprocessing tasks such as signal processing, statistical functions, interpolation, and optimization.

Exploratory Data Analysis:

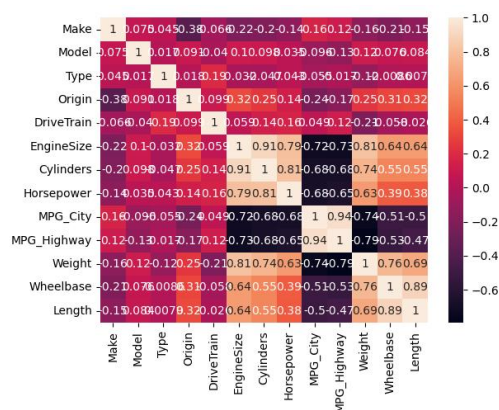
Geographical Analysis :

State wise total EV analysis

The following two graph depicts the overall number of Electric Vehicles in each state and the number of operational Public Charging Station (PCS) by state. A scatter plot is also shown for the same by taking the number of Electric Vehicles and the number of Public Charging Station.



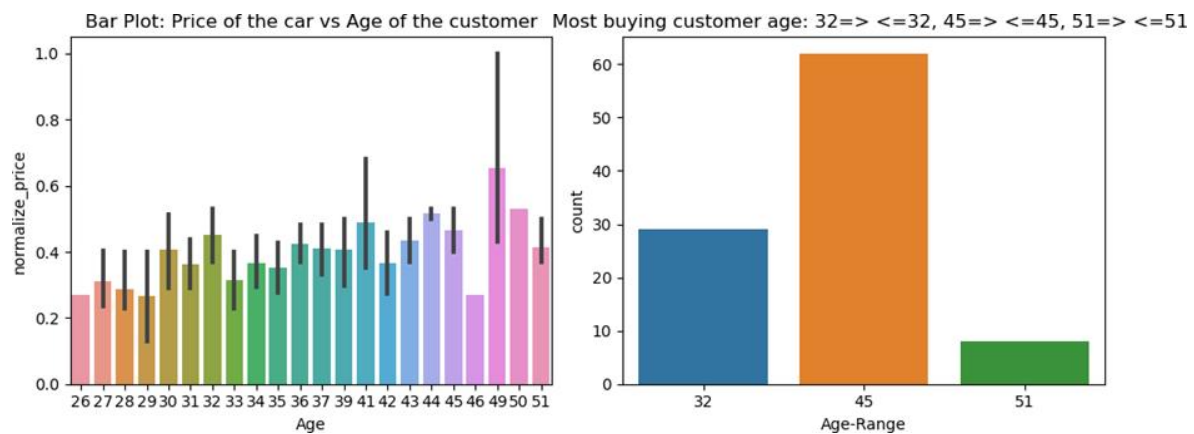
Dependency of these variables on one another



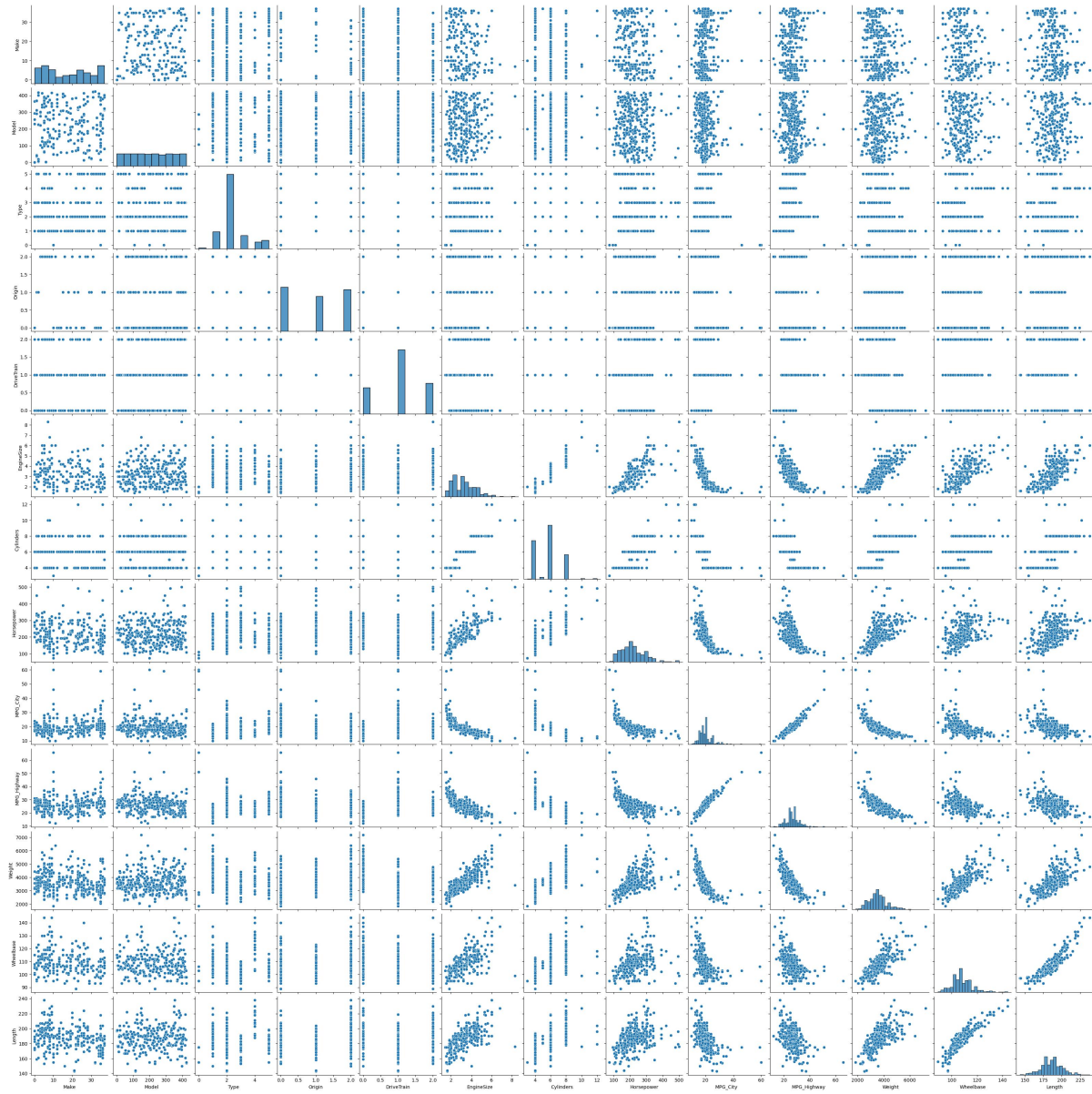
Observation: This correlation plot shows how the variables are dependent on one another which is a major factor in clustering

Target Customers :

It contains the information about the buying customer, the below graph represents the relationship between the Price of the product and Age of the customer.

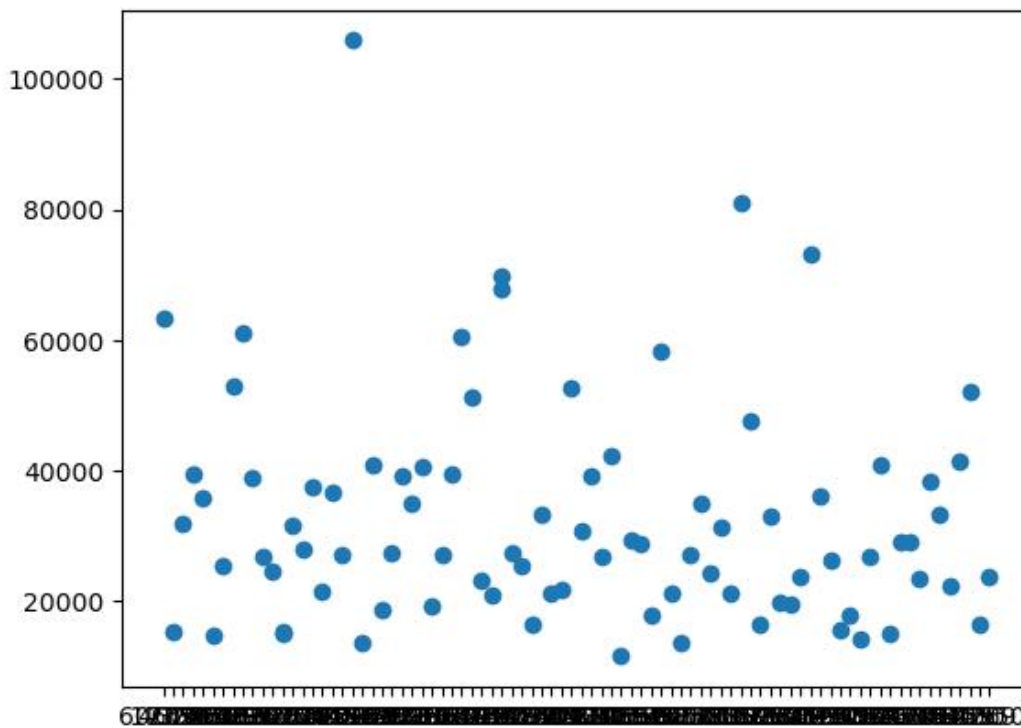


Segment Extraction & Analysis:



	model	best_score	best_params
0	Linear_Regression	0.742818	{'normalize': False}
1	Decision_Tree	0.741554	{'splitter': 'best', 'min_samples_leaf': 2, 'm...
2	Random_forest	0.833633	{'n_estimators': 140, 'min_samples_split': 2, ...

In the figure, we have plotted the inertia for each possible pairplot. We can see that there is not a well-defined elbow present in the figure to determine the optimal number of pairplot. Therefore, a metric called Silhouette score is used to determine the optimal number of pairplot. The optimal pairplot number will be that number for which silhouette score is maximum. So, from the figure on the below, we can clearly see that the score is highest for three model. Thus, we should segment our data in Random Forest



Customizing the Marketing Mix :

The marketing mix is a set of tools that marketers use to achieve sales results. Originally, there were 12 ingredients in the marketing mix, but the most used version includes the 4Ps: Product, Price, Promotion and Place.



To maximize the benefits of market segmentation, it is crucial to customize the marketing mix according to the target segment. This may involve designing new products, modifying existing ones, adjusting prices or discount structures, selecting appropriate distribution channels, and developing communication messages and promotion strategies that appeal to the target segment.

Product

Organizations often struggle with aligning their product offerings with the specific needs of their target segments. They face challenges in modifying existing products or developing new ones to cater to the demand of different segments. Emphasizing EVs with extended range and improved performance to address range anxiety and meet the demands of India's diverse terrain, highlighting the localization of manufacturing and components to align with the governments 'Make in India' initiative etc. are some of the strategies.

Price:

Determining the optimal pricing strategy is a common pain point for organizations when making marketing decisions. Setting the right price involves considering various factors such as market demand, competition, production costs, and perceived value by customers. Various government incentives, subsidies can be leveraged to reduce the upfront cost of

EVs, various range of EV models can be introduced at different price points to make them more affordable for Indian consumers.

Place

The distribution of a product to customers is a crucial decision within the place dimension of the marketing mix. Marketers must determine how the product should be distributed, considering factors such as whether it should be available for purchasing online, offline, or both. We should try to establish and expand a robust network of EV dealerships across major cities and regions, ensuring trained sales staff who can effectively communicate the benefits of EVs to potential customers.

Promotion

When formulating a marketing mix, a pivotal element to consider is the strategic decision making process for promotion. This process entails crafting and advertising message that resonates effectively with the intended target market and selecting the optimal communication channels to transmit this message. Various marketing campaigns can be launched that educate customers about the benefits of EVs, including environmental advantages, reduced operating costs, and technological advancements. Additionally, we can collaborate with government bodies, nonprofit organizations, and influencers to raise awareness about EVs and their positive impact on India's environment and energy security.

Most optimal Market Segment

Selecting the most optimal market segment for the electric vehicle market depends on various factors, including market conditions, consumer preferences, and government regulations.

The insights gathered from our analysis tell us that a company can target E2W and E4W vehicles in many parts of the country as many states have reported high sales, but the most favorable location seems to be states, also they have high numbers of charging stations which makes it convenient for the customer to adopt an EV. The company should also focus on many aspects of the vehicle, especially on Reliability, Comfort, Service Cost, Performance as most people use an model to commute daily while purchase an comfort model for a longer term.

Age, Salary, and Price seem to matter as younger population tend to buy less expensive vehicles and hence electric vehicle not being affordable can be a downside. It is then suggested to target a segment which is still eager to try out new technologies but are financially stable to afford electric vehicles. People in their late 20s to early 40s show a higher inclination towards purchasing electric vehicles as compared to other age groups. The average salary of people who buy electric vehicles is around 30 lakhs and most of the purchases for automobiles lie in the range of 10 to 20 lakhs and lesser for best model vehicles. As the trend suggests, higher salaried, old people tend to buy cars in the range of 10 to 20 lakhs. However, the sharp rise in awareness in younger segments about climate change influences their decision to buy electric cars. So, the recommended segment is the mid-tier, with significant marketing about the pros of electric vehicles to the environment is required.

Implementation :

The GitHub links are as follows:

ARUN KUMAR RANA

<https://github.com/arunkum54/ElectronicVehicleDetection>

13.0 References

[1] Indian Government initiatives to promote electric vehicles

<https://e-vehicleinfo.com/indian-government-initiatives-to-promote-electric-vehicles/>

[2] Indian Electric Vehicle Market

<https://www.mordorintelligence.com/industry-reports/india-electric-vehicle-market>

[3] Kaggle

<https://www.kaggle.com/>