EV Market Segmentation Analysis

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Contributers

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Introduction:

This report presents an analysis of customer data for an electric vehicle (EV) startup. The primary goal was to segment the customer base into distinct groups using clustering techniques, thereby identifying potential target segments for different car models. The analysis was conducted using the K-Means clustering algorithm on a dataset containing various attributes such as age, gender, income, profession, state, family size, car model, price of car, and number of charging stations.

The electric vehicle (EV) market in India is witnessing rapid growth, driven by government initiatives, rising environmental awareness, and advancements in technology. The market can be segmented into various categories based on vehicle type, power source, and region. By vehicle type, the segments include electric two-wheelers, three-wheelers, and passenger cars, with two-wheelers leading in market penetration due to their affordability and suitability for urban commutes. Power source segmentation includes battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), with BEVs gaining prominence due to better incentives and reduced emissions. Regionally, the market shows significant variation, with metropolitan areas like Delhi, Bangalore, and Mumbai showing higher adoption rates due to better infrastructure and awareness. Overall, the Indian EV market is poised for substantial growth, supported by favourable policies, infrastructural developments, and a shift in consumer preference towards sustainable mobility solutions.Our Model aims to predict which type of person based on their age,salary,profession & so on are buying Electric Vehicles so that we can target them while starting our startup and even further increase our sell.

Market segmentation has become an essential strategy for emerging markets to explore and implement, particularly for the widespread adoption of emerging mobility technologies like electric vehicles (EVs). As EVs gain popularity for being low-emission and cost-effective, they are expected to generate significant academic interest in the near future. This study aims to investigate and identify various potential buyer groups for EVs using an integrated research framework of "perceived benefits-attitude-intention." It classifies these groups based on

psychographic, behavioral, and socioeconomic characteristics. The study employs rigorous analytical methods, including cluster analysis, multiple discriminant analysis, and the Chi-square test, to validate the segments from data gathered through a cross-sectional online survey. The objective of this paper is to gather insights into the current electric vehicle market in India using business analytics and market segmentation techniques. By applying machine learning, a comprehensive analysis of the various aspects of Indian EVs and their customer base is conducted. The case study emphasizes the clustering process using limited data sourced from several reliable platforms, including government open-source data.

The worldwide automotive sector is experiencing a significant transformation driven by the increasing need for eco-friendly transport

options. This shift is fueled by growing environmental concerns, diminishing reserves of fossil fuels, and the pursuit of more energy-efficient transportation methods. Electric vehicles (EVs) stand out as a viable alternative, offering a sustainable solution to these challenges. India, with its burgeoning population and burgeoning automotive industry, offers a fertile ground for EV growth and acceptance.

This research delves into India's EV market, employing segmentation analysis to devise a strategic approach for a nascent enterprise aiming to innovate in the electric vehicle domain. By gaining insights into the prevailing market trends, consumer inclinations, and the competitive environment, the startup can customise its products to align with the specific needs and preferences of Indian consumers.

The final product prototype showcases an interactive platform for customer segmentation, personalized recommendations, and strategic decision-making. Conclusionary remarks highlight key findings, business implications, and avenues for future research and innovation in the EV market segment.

Problem Statement:-

We have 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 like the use of Electric Vehicle.

Market / Customer / Business Need Assessment:

The assessment of market, customer, and business needs for electric vehicles (EVs) reveals critical drivers and challenges in the sector. Environmentally, there is a pressing need to reduce greenhouse gas emissions and air pollution, positioning EVs as a key solution to meet sustainability goals and regulatory requirements. Government policies offering incentives such as subsidies, tax benefits, and infrastructure development initiatives are pivotal for market

expansion. Customers demand cost-effective EVs with lower total ownership costs, including reduced maintenance and fuel expenses. Performance expectations include sufficient driving range, enhanced battery life, and shorter charging times. The convenience of a widespread, fast, and reliable charging infrastructure is essential, alongside diverse vehicle options to cater to various preferences. Additionally, increasing consumer awareness about the benefits of EVs is necessary to drive adoption. From a business perspective, continuous technological advancements, especially in battery technology, and robust support systems are crucial for meeting both market and customer needs effectively.

Evaluating the current size of the EV market in India and its potential for growth, considering factors like consumer demand and government incentives. Identifying distinct groups within the market based on demographics, psychographics, and behaviour to understand their specific needs and preferences. Analyzing existing players in the market, their offerings, market share, and competitive advantages. Assessing challenges that a new entrant might face, such as high initial investment costs, technology development, establishing a supply chain, and building consumer trust.

Target Specification and Characterization:

The target specification and characterization of the electric vehicle (EV) market segmentation focus on various vehicle types, power sources, and regions to meet diverse market demands and customer preferences. For passenger cars, specifications aim for a battery capacity of 40-100 kWh, offering a driving range of 200-400 miles per charge, with a battery life of 8-10 years or 100,000-150,000 miles. Two-wheelers and three-wheelers prioritise affordability and shorter urban commutes, with lower battery capacities and ranges. Charging infrastructure must support fast charging options, achieving 80% charge in 30 minutes, and convenient home charging within 6-8 hours. Power sources are segmented into battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), with BEVs being favoured for their zero-emission benefits. Regional segmentation shows higher adoption rates in metropolitan areas like Delhi, Bangalore, and Mumbai, driven by better infrastructure and greater environmental awareness. Overall, these specifications ensure that EVs meet performance expectations, cost-effectiveness, and convenience, thereby facilitating widespread adoption across different market segments.

Demographic Factors: Age, income, occupation, and location are crucial for identifying customer profiles and their ability to purchase electric vehicles.

Psychographic Factors: Attitudes towards sustainability, environmental consciousness, and technology adoption influence market segmentation.

Behavioural Factors: Purchase behaviour, usage patterns, and charging infrastructure accessibility are key to understanding market segments.

Market Tailoring: These variables enable startups to customise their marketing and product strategies to meet the specific needs of different consumer groups.

Key Metrics and KPIs:

- **Conversion Rates:** Tracking the percentage of leads or prospects from each segment that convert into EV buyers.
- **Customer Acquisition Costs:** Analyzing the cost per acquisition for each target segment to optimize marketing spend and ROI.
- **Customer Lifetime Value:** Estimating the long-term value of customers from different segments to prioritize retention efforts and maximize profitability.

Target Customer Characteristics:

- **EV Adoption Readiness:** Assessing customers' willingness to switch from combustion vehicles to EVs based on their attitudes, beliefs, and past behaviors.
- **Preferences and Needs:** Understanding specific EV preferences such as vehicle type (e.g., sedan, SUV, hatchback), range requirements, charging convenience, and eco-friendly features.
- **Purchase Considerations:** Factors influencing purchase decisions, including price sensitivity, total cost of ownership, brand perception, and availability of incentives.

In essence, the analysis underscores the hurdles facing India's electric vehicle (EV) adoption, such as limited charging facilities, high costs, range anxiety, public perception, and policy support. Startups must navigate these challenges to promote EV adoption.The future of India's EV market looks promising, with expected technological improvements, policy reforms, and shifting consumer behaviours. Developments like enhanced charging solutions, battery innovations, and greater affordability will likely influence market growth.To conclude, the study examines India's EV market using segmentation analysis to devise strategies for an EV startup. Understanding market forces, consumer preferences, and the competitive scene enables startups to position themselves strategically and customise their offerings for distinct market segments. Despite existing obstacles, India's EV market offers vast potential. Startups that employ segmentation analysis to create strong strategies can drive industry growth and contribute to a more sustainable future.

This project is divided into 2 task

Task 1: what type of EV will the company produce

Data collection:

Data was collected from the website, the e-AMRIT (Accelerated e-Mobility Revolution for India's Transportation https://e-amrit.niti.gov.in/home) portal designed to raise awareness about electric mobility in India. Additionally, we obtained specifications of electric vehicles from Kaggle. The datasets from these sources were combined to create a comprehensive final dataset. This combined data set was used partly for visualization and partly for clustering analysis.

The dataset consists of :

- Age
- Gender
- Income
- Profession
- State
- Family Size
- Car Model
- Price of Car
- Number of Charging Stations

Libraries Used:

1. Numpy: Utilized for performing various array-related calculations.
2. Pandas: Employed for reading and loading datasets.
3. Seaborn: Used for data visualization and exploratory data analysis.
4. Matplotlib: A library for data visualization and graphical plotting in Python.

Data Preprocessing and cleaning

Steps and Libraries Used

- Loading Data: The dataset was loaded using pandas.
- Missing Values: Rows with missing values were dropped to ensure data integrity.
- Categorical variables were converted into numerical format using pd.get_dummies().
- Scaling: Data was normalised using MinMaxScaler from sklearn.preprocessing.

	Brand	Model	Accel	TopSpeed	Range	Efficiency	FastCharge	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats	PriceEuro
0	Tesla	Model 3 Long Range Dual Motor	4.6 sec	233 km/h	450 km	161 Wh/km	940 km/h	Rapid charging possible	All Wheel Drive	Type 2 CCS	Sedan	D	5	55480
1	Volkswagen	ID.3 Pure	10.0 sec	160 km/h	270 km	167 Wh/km	250 km/h	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	Hatchback	C	5	30000
2	Polestar	2	4.7 sec	210 km/h	400 km	181 Wh/km	620 km/h	Rapid charging possible	All Wheel Drive	Type 2 CCS	Liftback	D	5	56440
3	BMW	iX3	6.8 sec	180 km/h	360 km	206 Wh/km	560 km/h	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	SUV	D	5	68040
4	Honda	e	9.5 sec	145 km/h	170 km	168 Wh/km	190 km/h	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	Hatchback	B	4	32997
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
98	Nissan	Ariya 63kWh	7.5 sec	160 km/h	330 km	191 Wh/km	440 km/h	Rapid charging possible	Front Wheel Drive	Type 2 CCS	Hatchback	C	5	45000
99	Audi	e-tron S Sportback 55 quattro	4.5 sec	210 km/h	335 km	258 Wh/km	540 km/h	Rapid charging possible	All Wheel Drive	Type 2 CCS	SUV	E	5	96050
100	Nissan	Ariya e-4ORCE 63kWh	5.9 sec	200 km/h	325 km	194 Wh/km	440 km/h	Rapid charging possible	All Wheel Drive	Type 2 CCS	Hatchback	C	5	50000
101	Nissan	Ariya e-4ORCE 87kWh Performance	5.1 sec	200 km/h	375 km	232 Wh/km	450 km/h	Rapid charging possible	All Wheel Drive	Type 2 CCS	Hatchback	C	5	65000
102	Byton	M-Byte 95 kWh 2WD	7.5 sec	190 km/h	400 km	238 Wh/km	480 km/h	Rapid charging possible	All Wheel Drive	Type 2 CCS	SUV	E	5	62000

103 rows × 14 columns

Next steps: Generate code with a | View recommended plots

	Brand	Model	Accel	TopSpeed	Range	Efficiency	FastCharge	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats	PriceEuro
0	Tesla	Model 3 Long Range Dual Motor	4.6	233	450 km	161	940.0	Rapid charging possible	All Wheel Drive	Type 2 CCS	Sedan	D	5	55480
1	Volkswagen	ID.3 Pure	10.0	160	270 km	167	250.0	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	Hatchback	C	5	30000
2	Polestar	2	4.7	210	400 km	181	620.0	Rapid charging possible	All Wheel Drive	Type 2 CCS	Liftback	D	5	56440
3	BMW	iX3	6.8	180	360 km	206	560.0	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	SUV	D	5	68040
4	Honda	e	9.5	145	170 km	168	190.0	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	Hatchback	B	4	32997

```
a.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 103 entries, 0 to 102
Data columns (total 14 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   Brand        103 non-null    object 
 1   Model        103 non-null    object 
 2   Accel        103 non-null    float64
 3   TopSpeed     103 non-null    int64  
 4   Range        103 non-null    object 
 5   Efficiency   103 non-null    int64  
 6   FastCharge   98 non-null     float64
 7   RapidCharge  103 non-null    object 
 8   PowerTrain   103 non-null    object 
 9   PlugType     103 non-null    object 
 10  BodyStyle    103 non-null    object 
 11  Segment      103 non-null    object 
 12  Seats        103 non-null    int64  
 13  PriceEuro    103 non-null    int64  
dtypes: float64(2), int64(4), object(8)
memory usage: 11.4+ KB
```

```
charging_station=pd.read_excel("/content/drive/MyDrive/EV_Market_Segmentation/Charging Station.xlsx")
charging_station.head()
```

	States Name	Number of Electric Charging Station
0	Maharashtra	317
1	Andhra Pradesh	266
2	Tamil Nadu	256
3	Gujrat	228
4	Rajasthan	205

```
[7] sales=pd.read_excel("/content/drive/MyDrive/EV_Market_Segmentation/EV_sales.xlsx")
    sales.head()
```

	Years	Two Wheeler	Three Wheeler	Four Wheeler
0	Year 2020	152000	140683	168300
1	Year 2021	143837	88378	134821
2	Year 2022	231338	384215	429217

```
a.isnull().sum()
```

```
Brand         0
Model         0
Accel         0
TopSpeed      0
Range         0
Efficiency    0
FastCharge    5
RapidCharge   0
PowerTrain    0
PlugType      0
BodyStyle     0
Segment       0
Seats         0
PriceEuro     0
dtype: int64
```

Benchmarking

Benchmarking in the electric vehicle (EV) market segmentation reveals key insights across different vehicle types, power sources, and regions. Electric two-wheelers, led by companies like Hero Electric and Ather Energy, are characterised by affordability, short-range capabilities (60-100 km), and urban-centric designs, making them dominant in urban areas. Electric three-wheelers, with leaders like Mahindra Electric and Piaggio, offer moderate ranges (80-120 km) and are crucial for last-mile connectivity, particularly in cities. For passenger cars, companies such as Tata Motors and MG Motors set benchmarks with their models offering ranges of 200-400 miles and advanced features, targeting both urban and suburban markets. In terms of power sources, battery electric vehicles (BEVs) are benchmarked for zero emissions and superior range, while plug-in hybrid electric vehicles (PHEVs) offer flexibility with dual power options. Regionally, metropolitan areas like Delhi, Bangalore, and Mumbai lead in adoption rates due to better infrastructure and higher environmental awareness. This comprehensive benchmarking highlights the diverse strengths and focal areas within the Indian EV market, guiding strategic decisions and fostering competitive advancements.

Applicable Regulation(Government)

- Data Collection and Privacy Regulations of Customers.

- Anti-Money Laundering(AML) and Know Your Customer Regulation (KYC).
- Vehicle Regulation Act.

Applicable Constraints

- Lack of initial Data to perform algorithms.
- Lack of technical knowledge about Electric vehicle.

Business Opportunity

The electric vehicle (EV) market presents a myriad of business opportunities across different sectors, driven by technological innovation, supportive policies, and evolving consumer trends.

One significant opportunity lies in manufacturing and supply chain, where companies can expand their production lines to include electric vehicles ranging from two-wheelers to passenger cars. Additionally, there's a growing demand for specialised EV components such as batteries, electric motors, and power electronics, presenting opportunities for component manufacturers.

Battery technology is another lucrative area. Investing in battery manufacturing can meet the increasing demand for EV batteries, reducing dependency on imports and driving down costs. Moreover, developing efficient battery recycling processes can address sustainability concerns and create a new revenue stream.

The charging infrastructure segment offers substantial opportunities. Establishing a widespread network of fast and convenient charging stations, both public and home-based, is crucial to support the growing EV fleet. Integration of renewable energy sources like solar and wind with charging infrastructure presents sustainable and cost-effective charging solutions.

In energy management and smart grids businesses can develop smart charging systems and vehicle-to-grid (V2G) technology. Smart charging systems optimise energy use and reduce grid load, while V2G solutions allow EVs to feed electricity back into the grid, providing additional income opportunities for EV owners.

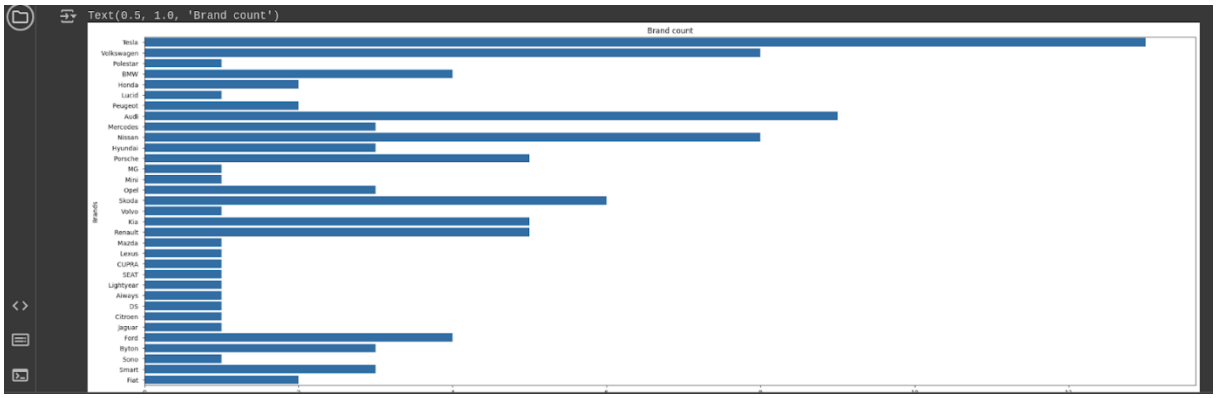
Software and connectivity services for EVs represent another area of opportunity. Developing advanced telematics services, mobile apps for managing EVs, and IoT solutions can enhance vehicle performance and user experience.

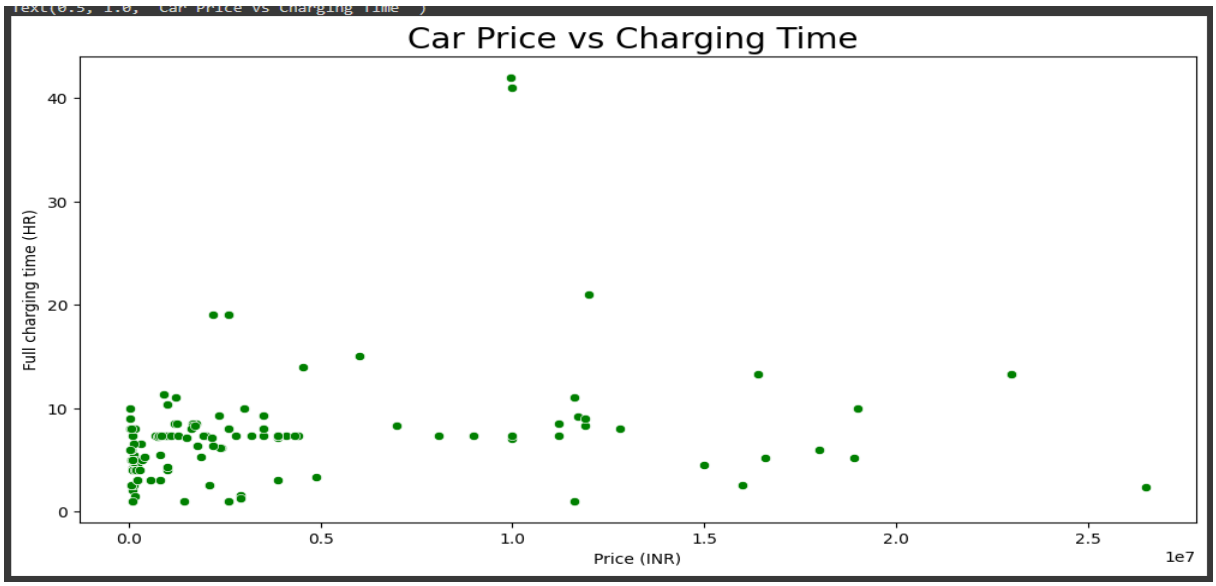
Financial services such as leasing, financing, and tailored insurance products for EVs can lower the entry barrier for consumers. Moreover, there's a growing opportunity in fleet electrification,

including commercial fleets and shared mobility services, driven by lower operating costs and environmental regulations.
Aftermarket services like specialised maintenance and repair for EVs, along with retrofit solutions to convert existing vehicles to electric, cater to the growing EV market's needs.

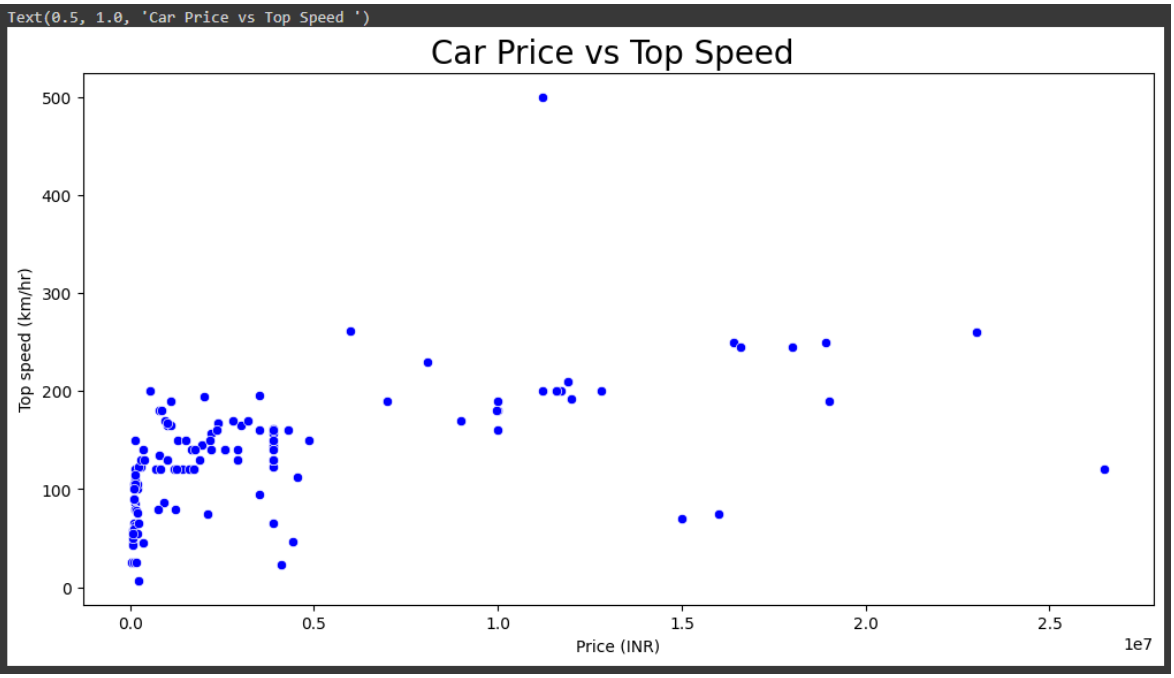
In conclusion, the EV market offers diverse and expanding opportunities across manufacturing, infrastructure, technology, services, and more. Companies that strategically invest and innovate in these areas stand to gain in the rapidly evolving landscape of electric mobility.

Visualising the dataset

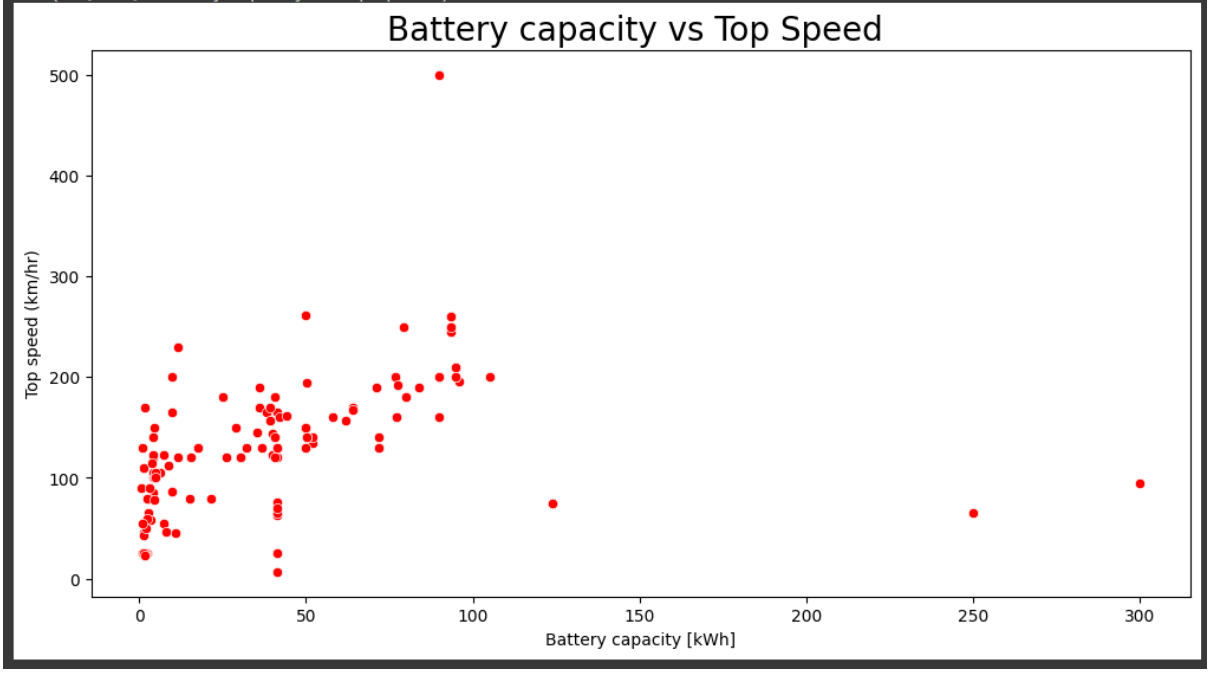




```
Text(0.5, 1.0, 'Car Price vs Top Speed ')
```




```
Text(0.5, 1.0, 'Battery capacity vs Top Speed ')
```

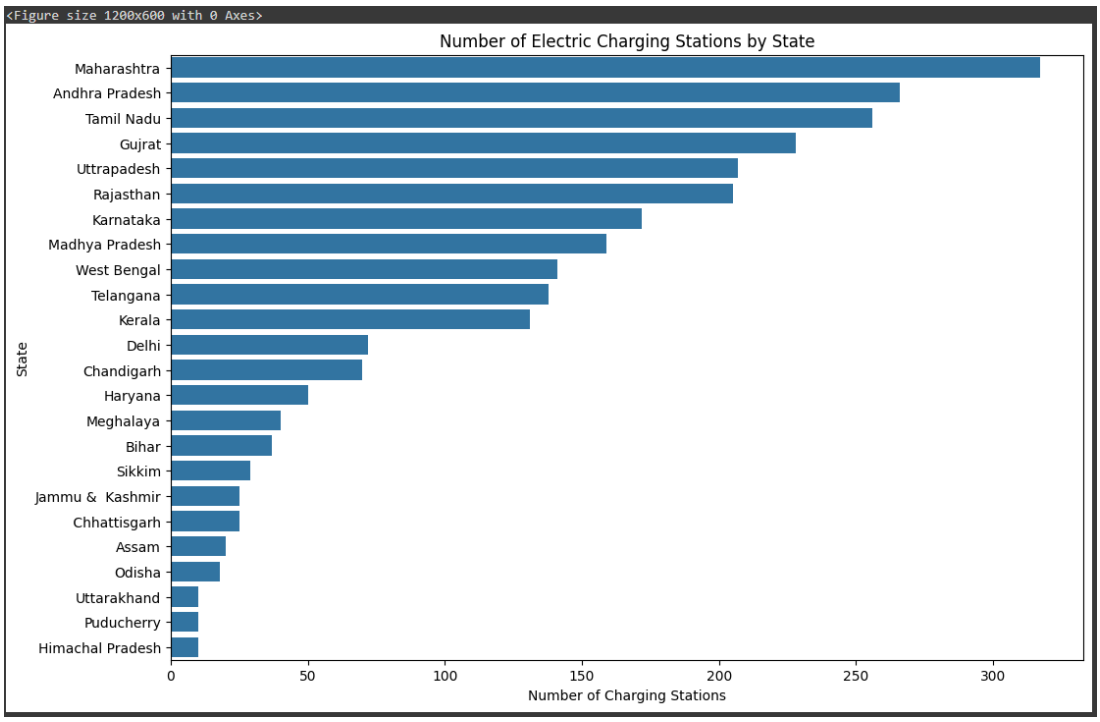



```
[29] from sklearn.preprocessing import LabelEncoder

features =['Wheelers type', ' Drive Type', 'Type of brakes','Fast Charging','Income','Fuel Type' ]

for i in features:
    new_data[i] =LabelEncoder().fit_transform(new_data[i])
new_data
```

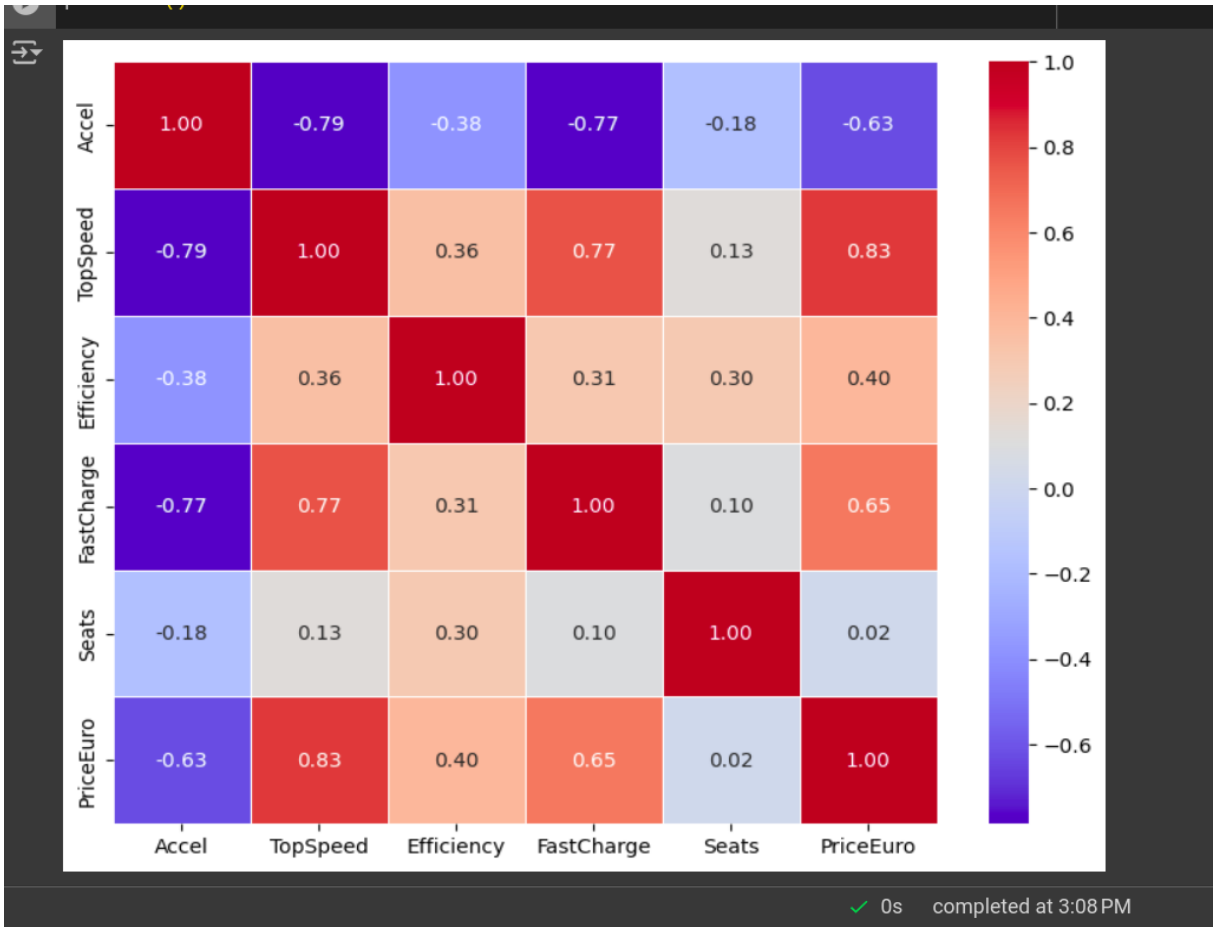
	Top speed (km/hr)	Price (INR)	Full charging time (HR)	Fuel Type	Battery capacity [kWh]	Range (km/hr)	Kerb weight (KG)	Fast Charging	Drive Type	Wheelers type	Number of Seats	Type of brakes	Max Torque (N-M)	Income
0	85.00000	1.340000e+05	4.500000	0	4.000000	150.000000	108.000000	1	11	3	2	1	170.00000	2
1	65.00000	9.499900e+04	4.200000	0	2.700000	180.000000	101.000000	1	15	3	2	1	346.74958	1
2	100.00000	1.924990e+05	5.000000	0	4.000000	180.000000	1506.382114	0	14	3	2	1	28.00000	2
3	105.00000	2.074990e+05	5.000000	0	4.000000	180.000000	1506.382114	1	14	3	2	1	38.00000	2
4	100.00000	1.029990e+05	2.000000	0	4.400000	200.000000	110.000000	1	11	3	2	1	346.74958	2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
138	65.00000	3.893761e+06	3.000000	0	250.000000	200.000000	1506.382114	1	14	0	31	2	346.74958	0
139	75.00000	1.600000e+07	2.500000	0	124.000000	150.000000	1506.382114	1	14	0	31	4	3000.00000	0
140	70.00000	1.500000e+07	4.500000	0	41.355385	300.000000	1506.382114	1	14	0	39	2	800.00000	0
141	129.76259	3.893761e+06	7.344911	0	41.355385	293.126929	1506.382114	1	14	0	43	2	346.74958	0
142	129.76259	3.893761e+06	7.344911	0	41.355385	293.126929	1506.382114	1	14	0	35	2	346.74958	0

143 rows × 14 columns

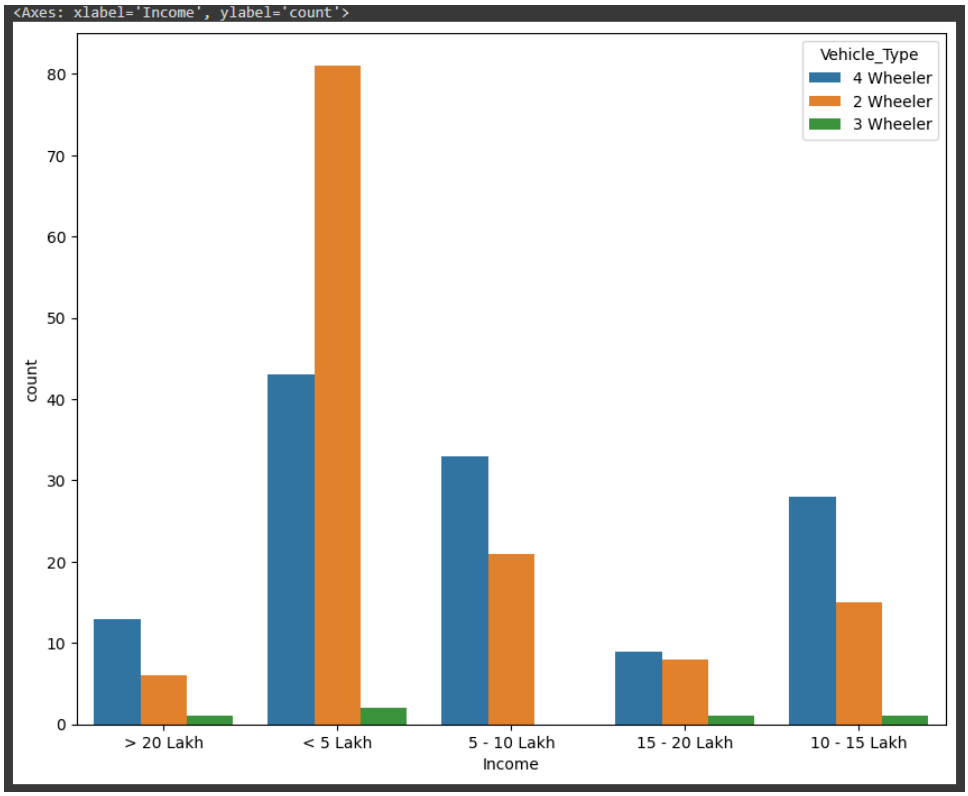
Statewise Electric Charging Station



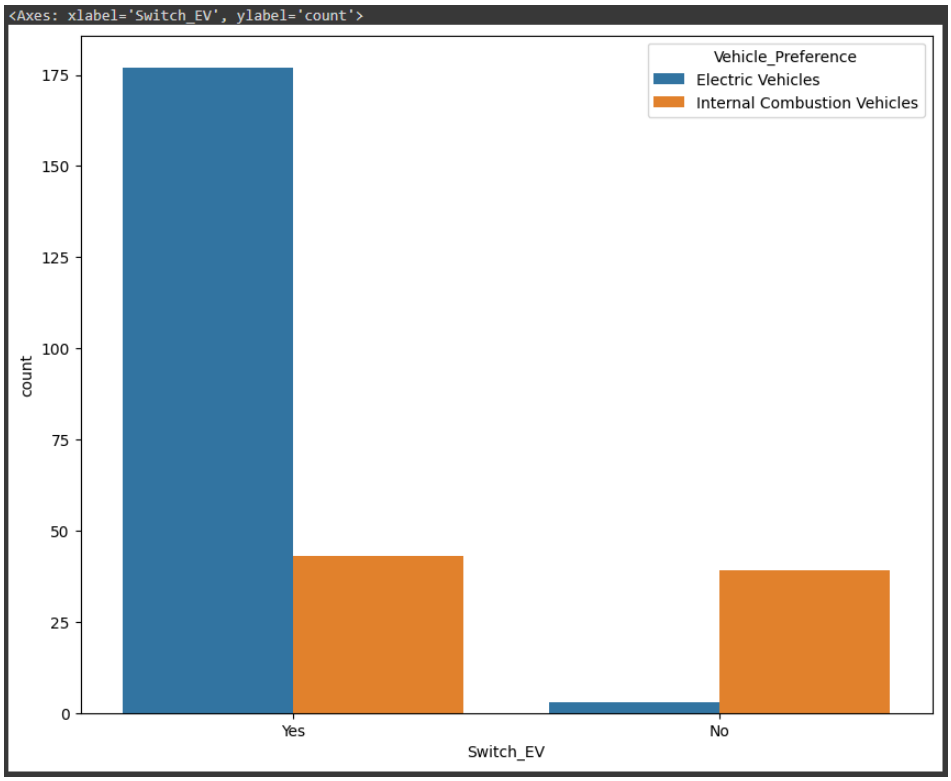
Showing Correlation Matrix



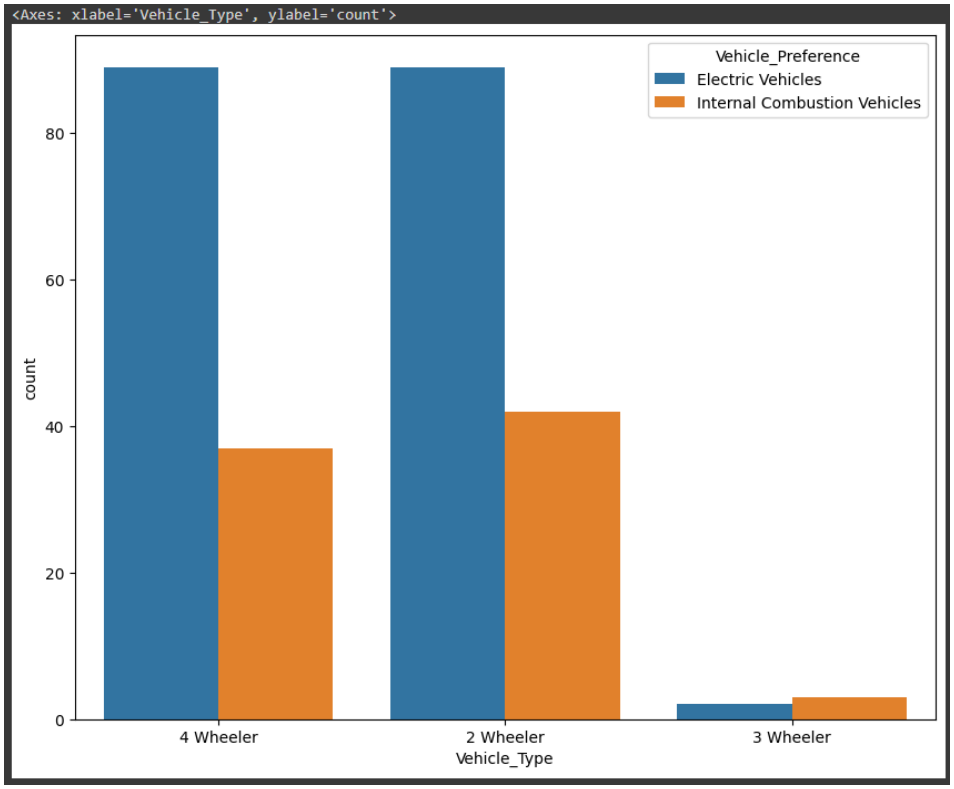
Vehicle Preferences:



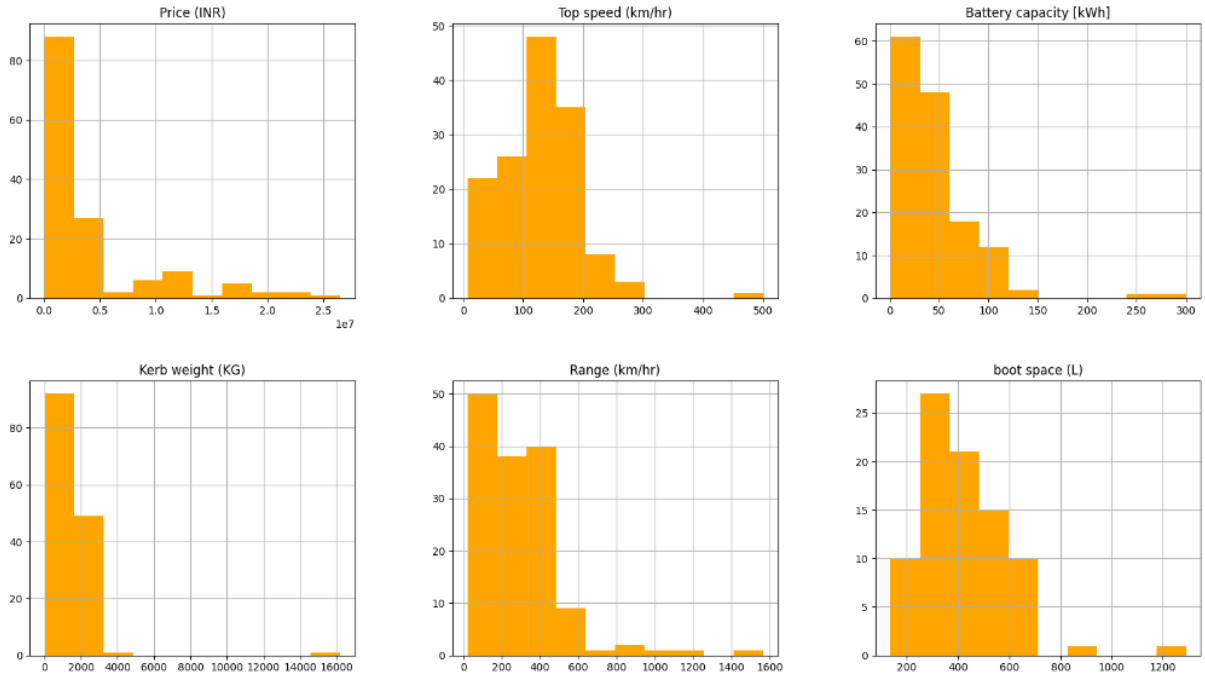
Here, we noticed that individuals with lower incomes tend to prefer 2-wheelers, while those in higher income brackets favor 4-wheelers.

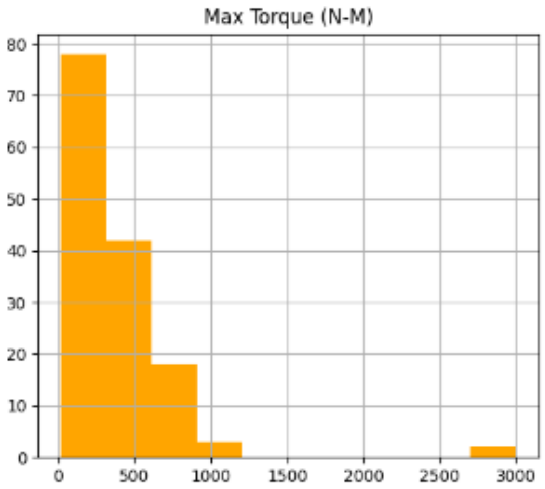


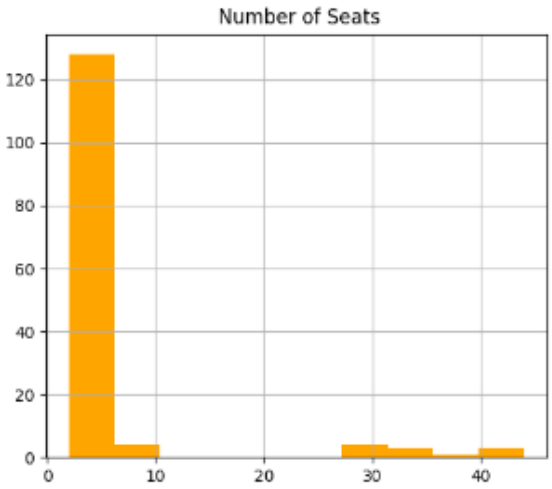
we observe that the majority of individuals prefer transitioning from internal combustion vehicles to electric vehicles.



4 and 2 wheelers have more preference for EV than 3 wheelers







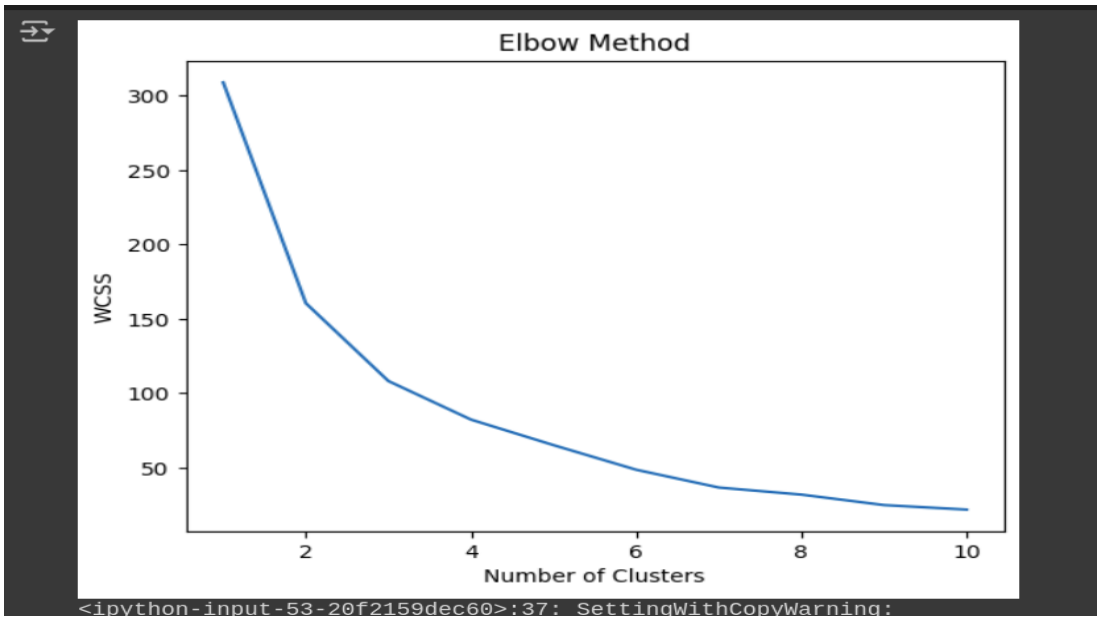
Segment Extraction:

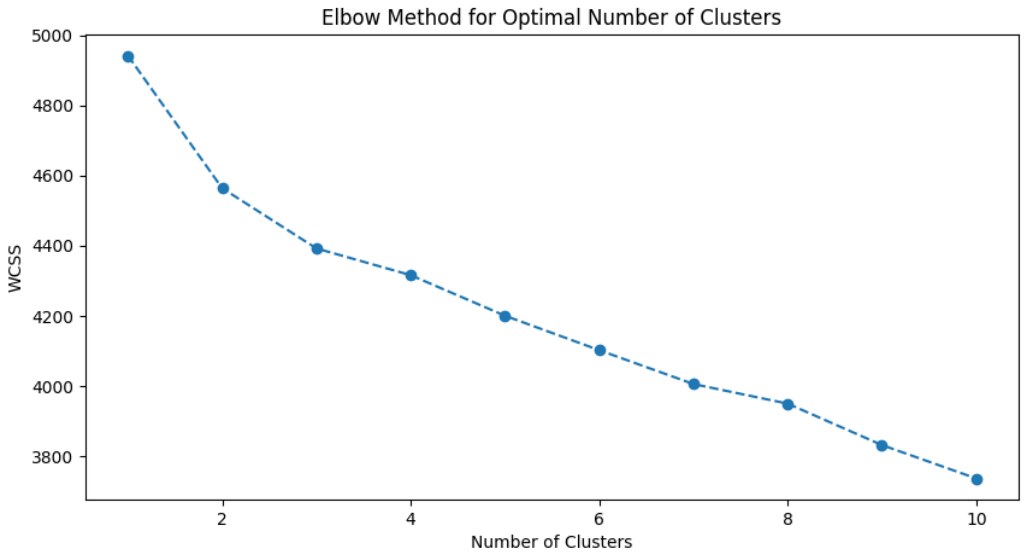
ML Techniques Used

- Elbow Method: The elbow method was used to determine the optimal number of clusters. The plot indicated that four clusters might be a suitable choice.
- K-Means Clustering: The K-Means algorithm was applied with four clusters. The resulting clusters were analysed to understand their characteristics.

Elbow Method for Optimal Number of Clusters

The elbow method is a technique used to determine the optimal number of clusters in a dataset. It involves plotting the within-cluster sum of squares (WCSS) against the number of clusters. In this plot, the x-axis represents the number of clusters, and the y-axis represents the WCSS. The goal is to identify the "elbow" point where the WCSS begins to decrease at a slower rate.





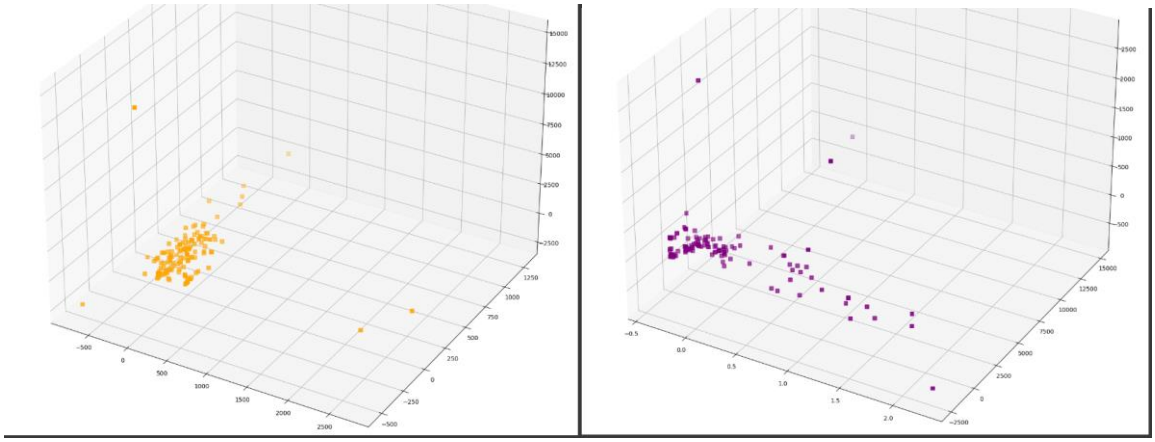
- **Interpretation**: The plot shows a noticeable bend at 4 clusters, suggesting that four clusters might be an optimal choice for this dataset. Beyond this point, adding more clusters does not significantly reduce the WCSS, indicating diminishing returns in terms of cluster separation.

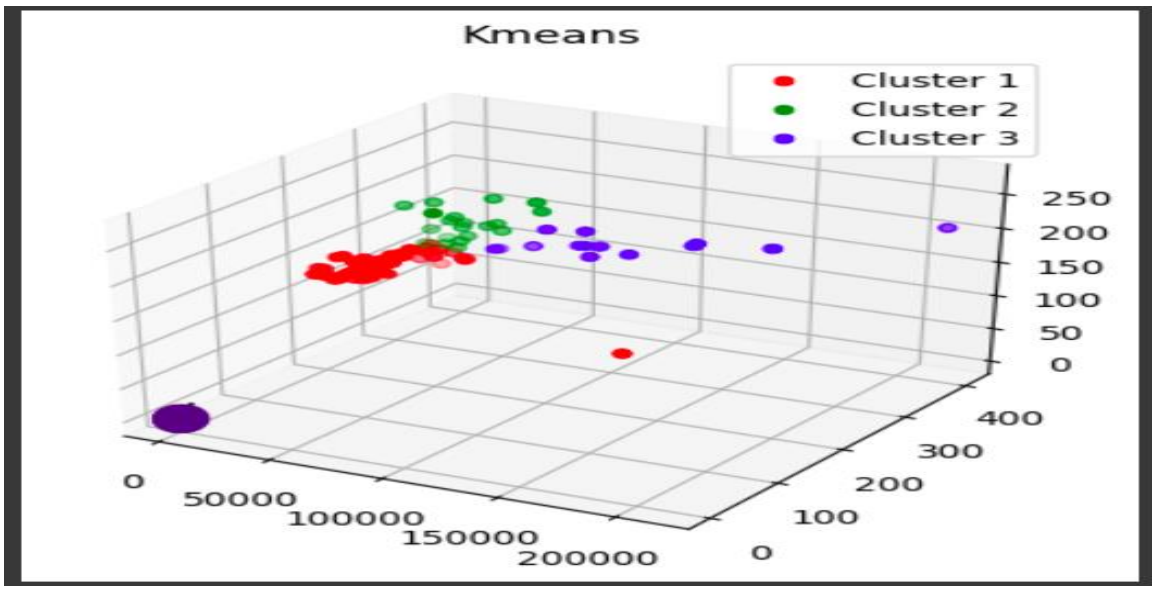
Clustering

Clustering is a widely used exploratory data analysis technique that helps to understand the structure of data. It involves identifying subgroups, or clusters, within the data where data points within the same cluster are very similar, and data points in different clusters are significantly different. Essentially, clustering aims to find homogeneous subgroups in the data, ensuring that data points in each cluster are as similar as possible based on a chosen similarity measure, such as Euclidean distance or correlation-based distance. The choice of similarity measure depends on the specific application. Clustering analysis can be performed based on features, to find subgroups of samples according to their features, or based on samples, to find subgroups of features according to their samples.

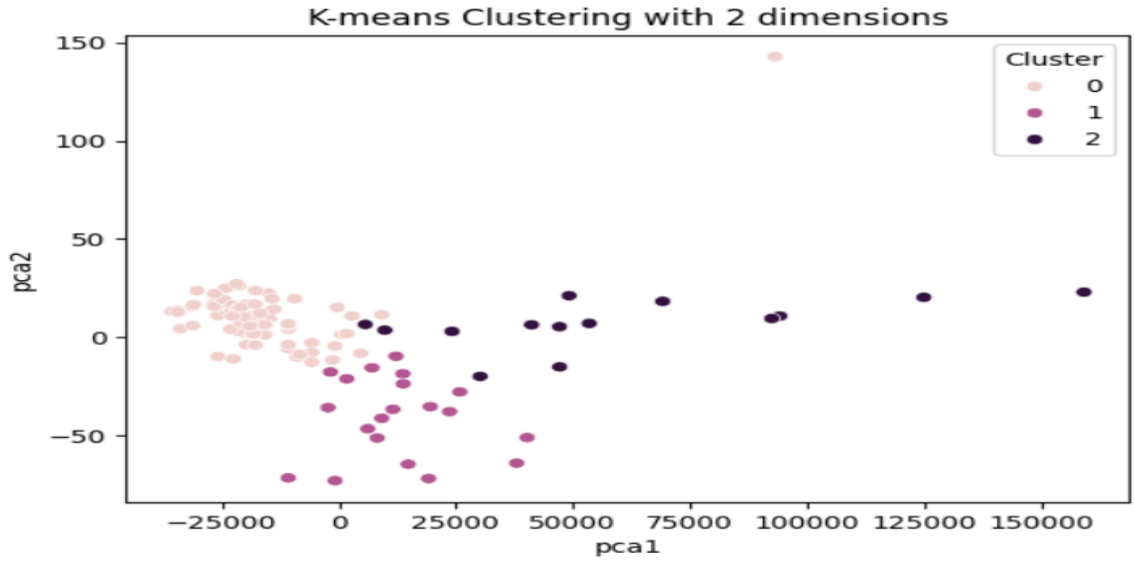
Principal Component Analysis (PCA):

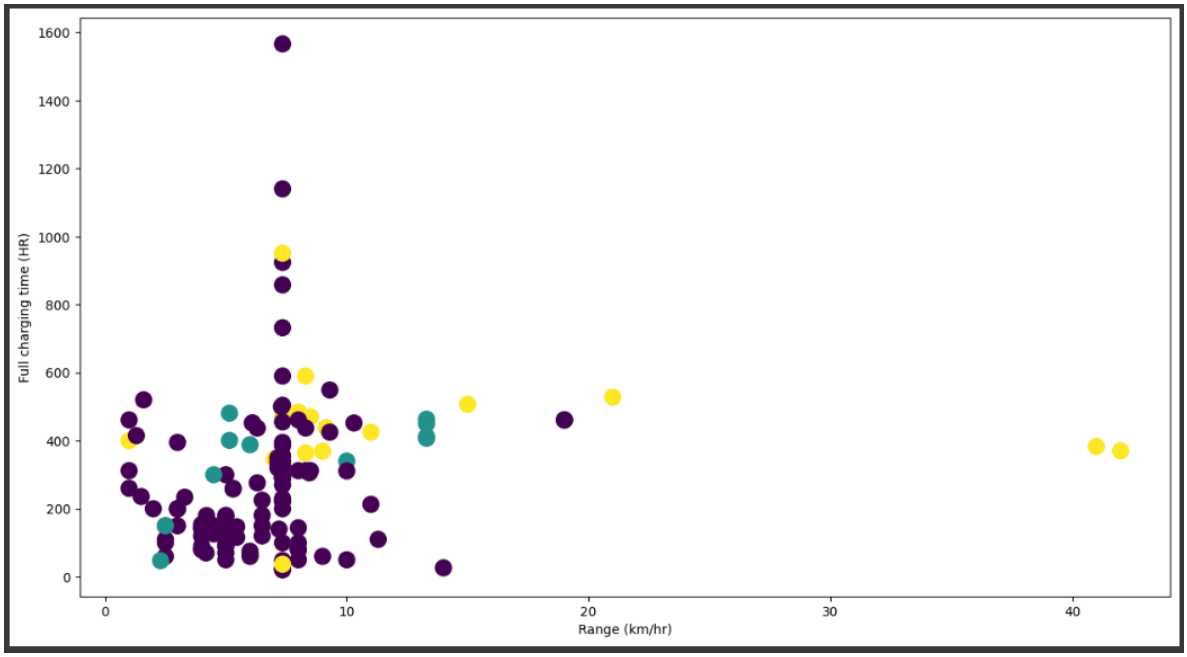
We applied Principal Component Analysis to reduce the number of components and variability in the Final EV Data from 13 to 5. After this dimensionality reduction, we performed 3D plotting and created K-Means clusters.



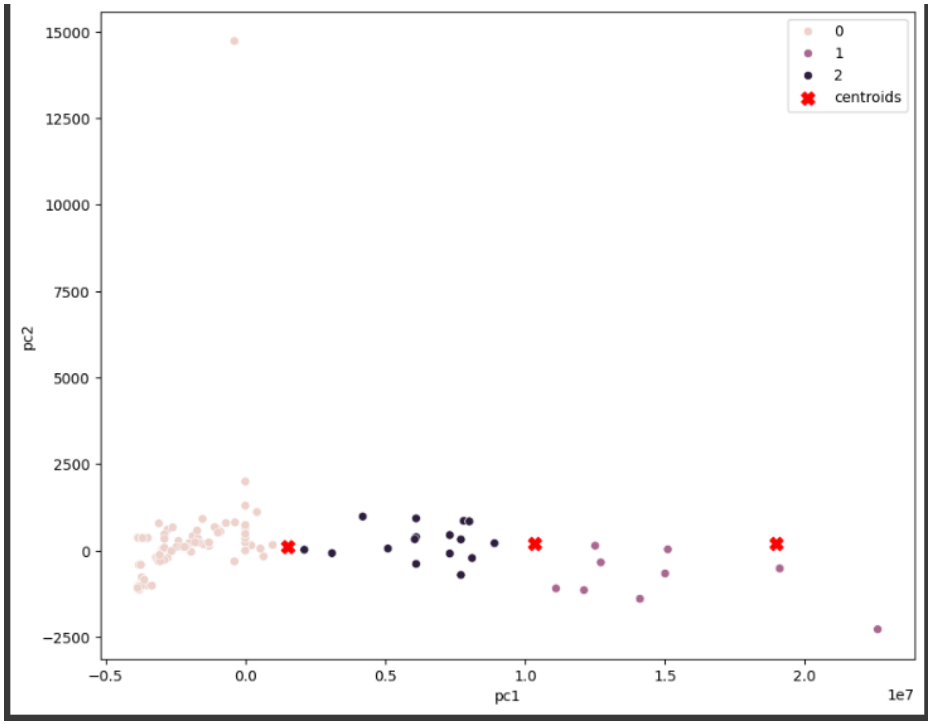


K- Means clustering:



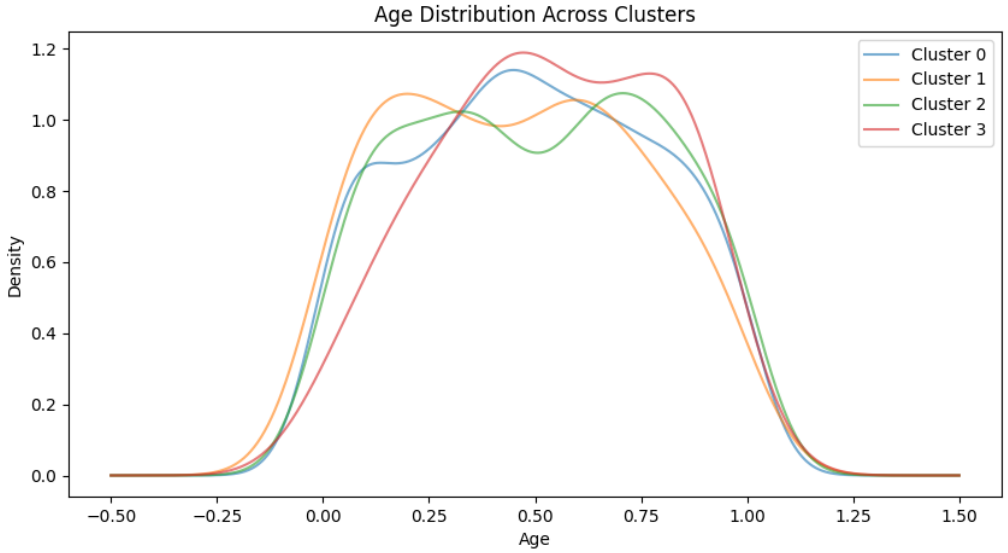


We utilized K-means clustering to plot Price (INR) against Range (km/hr). Our analysis revealed that the three clusters are linearly separable.



In the figure above, we used K-Means Clustering to create three clusters and visualized them along with their centroids for better understanding.

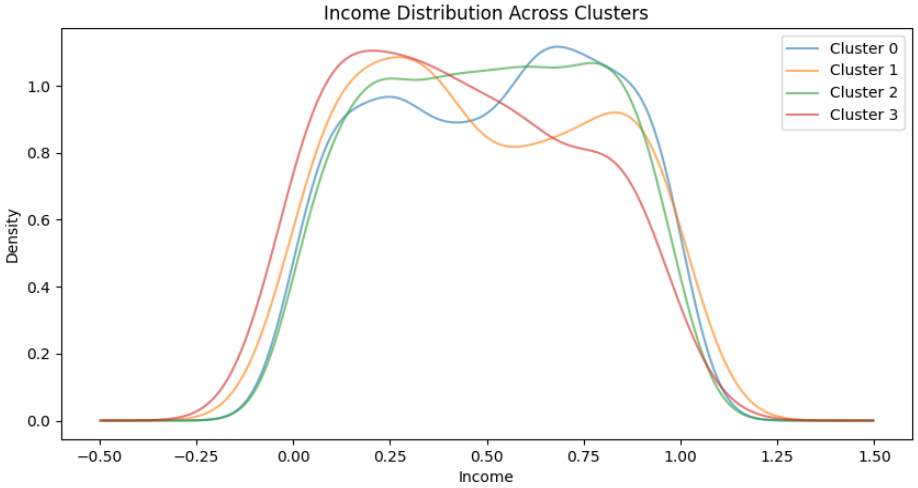
Age Distribution Across Clusters



This density plot compares the age distribution across the four clusters. Each line represents the density of ages within a cluster, providing insight into the demographic makeup of each segment.

- **Cluster 0**: Shows a relatively broad age distribution, indicating a diverse age group.
- **Cluster 1**: Predominantly younger customers, with a peak in the lower age range.
- **Cluster 2**: Similar to Cluster 0, with a wide age distribution but slightly different peaks.
- **Cluster 3**: Skewed towards older customers, indicating this cluster comprises primarily of an older demographic.

Income Distribution Across Clusters:



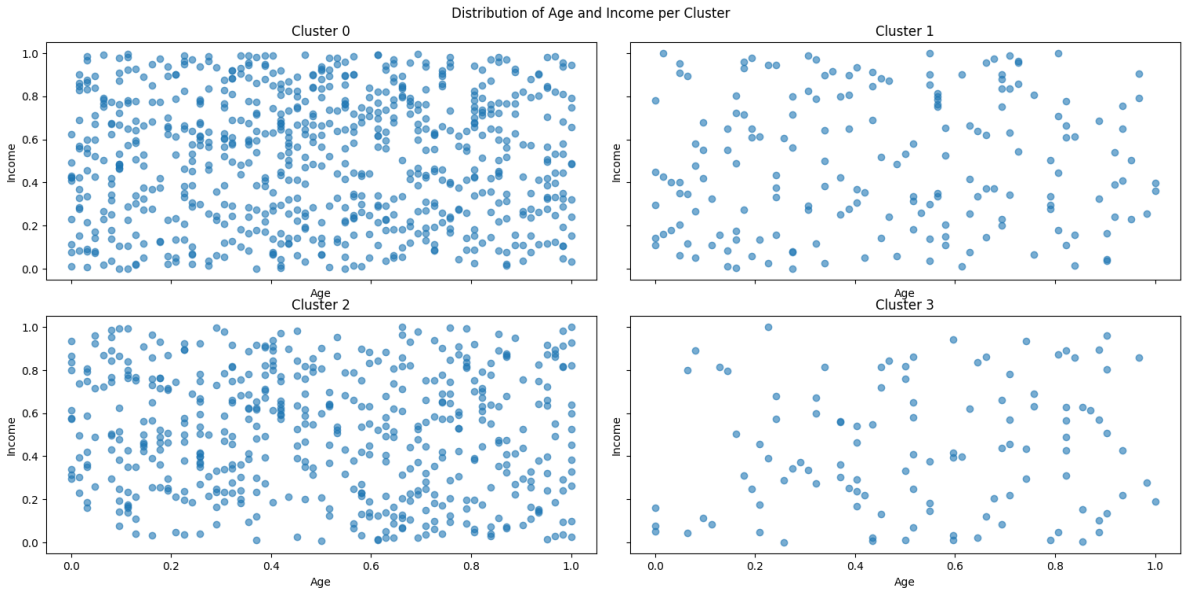
The first figure illustrates the density distribution of income across four clusters.

- **Cluster 0** (Blue): This cluster shows a bimodal distribution with peaks around 0.25 and 0.75. It suggests a mix of middle-income groups, possibly indicating a diverse customer base with varying purchasing powers.
- **Cluster 1** (Orange): This cluster also exhibits a bimodal distribution, with a significant peak near 0.75 and a smaller one around 0.25. The higher concentration at the upper end suggests a customer base with higher average income.
- **Cluster 2** (Green): The distribution is more uniform but with a peak around 0.5. This cluster represents a balanced income group with no extreme values.
- **Cluster 3** (Red): This cluster is tightly clustered with a sharp peak near 0.5, indicating a very homogeneous group in terms of income.

Implications:

- Clusters 0 and 1 show potential for targeting different income groups, possibly suggesting mid-range to premium EV models.
- Clusters 2 and 3 could be ideal for entry-level or mid-range EVs due to their more uniform and moderate income levels.

- **Distribution of Age and Income per Cluster:**

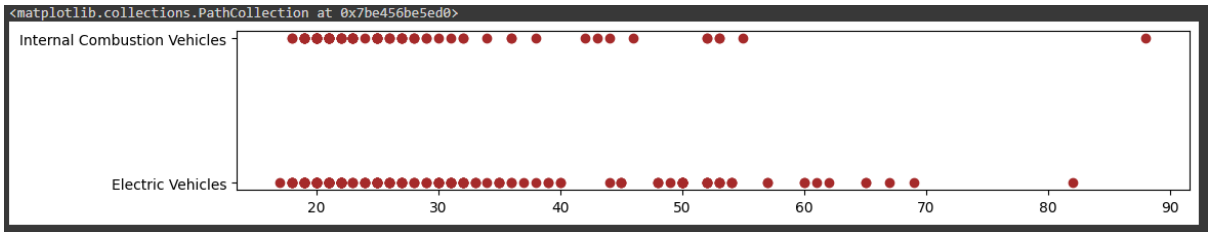


It provides scatter plots of age and income for each cluster, offering insights into the demographic distribution within each cluster.

- Cluster 0: This cluster shows a wide spread in both age and income. It indicates a highly diverse group in terms of both demographic factors.
- Cluster 1: Cluster 1 displays a less dense distribution with a broader range in age and more concentrated income levels towards the mid to high range.
- Cluster 2: The scatter plot here indicates a relatively even distribution across both age and income, suggesting a balanced mix without significant outliers.
- Cluster 3: This cluster is the sparsest, with limited data points and a spread that suggests more specific demographics. The individuals in this cluster are likely more homogeneous and represent a niche market segment.

Age Segmentation

The age segmentation indicates a higher preference for electric vehicles among the younger population.



Implications:

- Cluster 0's diversity suggests flexibility in product offerings to cater to a wide range of customer needs.
- Clusters 1 and 3 might benefit from targeted marketing strategies focused on their specific demographic profiles.
- Cluster 2 represents a balanced market segment that could align well with a versatile EV model suitable for a broad audience.

Price of Car by Cluster:

This figure is a box plot showing the price of cars for each cluster.

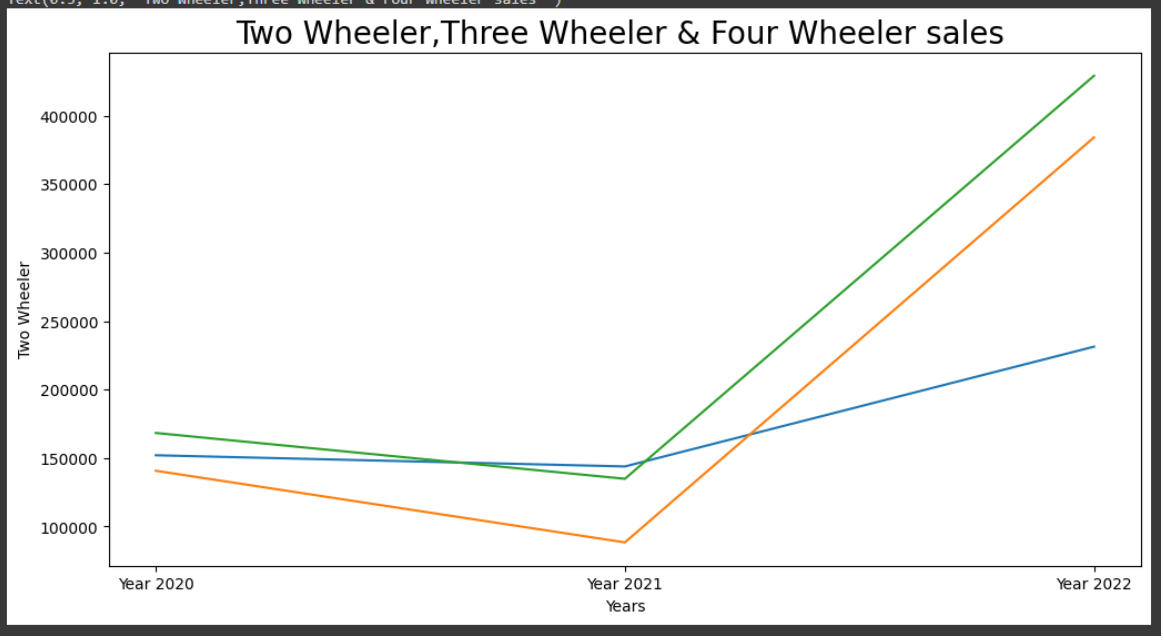
- **Cluster 0**: The car prices are modest, with most values below the median line, indicating affordability as a priority.
- **Cluster 1**: This cluster has the lowest median price, but with a few outliers at the higher end. It suggests a preference for more budget-friendly options, though there is some interest in higher-end models.
- **Cluster 2**: Prices here are comparable to Cluster 0 but with slightly lower variance, indicating a stable middle-range preference.
- **Cluster 3**: This cluster is an outlier with significantly higher car prices. It suggests a luxury market segment with a strong preference for high-end vehicles.

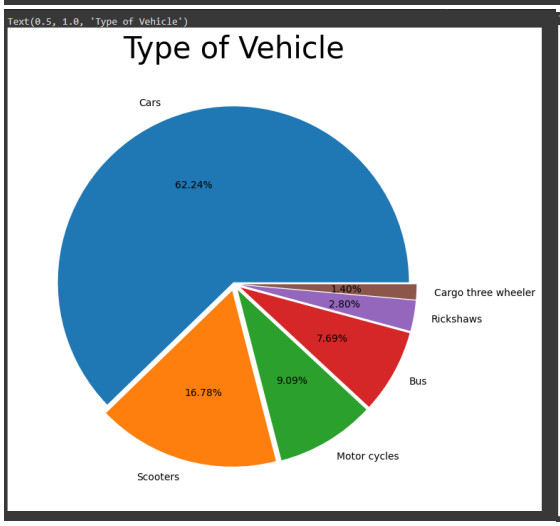
Implications:

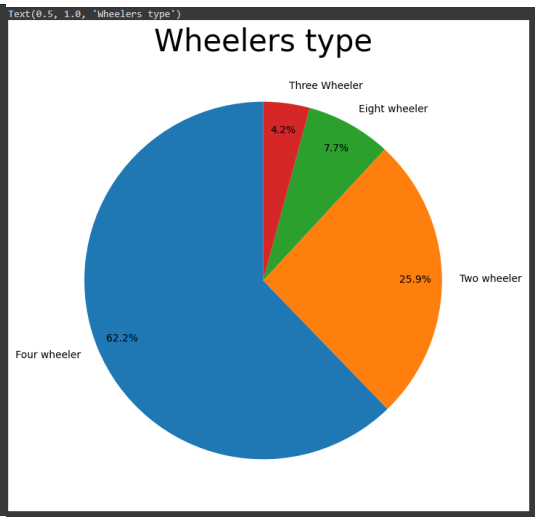
- Clusters 0 and 2 are likely targets for entry-level to mid-range EVs, focusing on affordability and value.
- Cluster 1, while primarily budget-conscious, shows potential for a few higher-end offerings, indicating a mixed approach might be beneficial.
- Cluster 3 is a clear candidate for premium EV models, emphasising luxury and advanced features.

Selection of Target Segment

```
Axes(0.125,0.11;0.775x0.77)
Axes(0.125,0.11;0.775x0.77)
Axes(0.125,0.11;0.775x0.77)
Text(0.5, 1.0, 'Two Wheeler,Three Wheeler & Four Wheeler sales ')
```







From the above graphs, it is evident that four-wheeler sales are significantly high. Therefore, our primary focus should be on this segment, as it appears to be the dominant player in the electric vehicle market.

Task 2: To whome it will sell? (i.e selling of the product based on geographical, economic and psychological factors)

Data preprocessing

Initially, processed the gathered datasets by eliminating any unrelated data, duplicates, and missing values, and verified the data's consistency across all datasets. Then specific transformations were implemented to reformat the raw datasets into a structure conducive to analysis. After the transformation, we supplemented the datasets with pertinent information to provide extra context for the analysis.

```
df.head()
```

Unnamed: 0	Age	City	Profession	Marital Status	Education	No. of Family members	Annual Income	Would you prefer replacing all your vehicles to Electronic vehicles?	If Yes/Maybe what type of EV would you prefer?	Do you think Electronic Vehicles are economical?	Which brand of vehicle do you currently own?	How much money could you spend on an Electronic vehicle?	Preference for wheels in EV	Do you think Electronic vehicles will replace fuel cars in India?
0	30	Nabha	NaN	Single	Graduate	5	1.193876e+06	Maybe	SUV	Yes	Hyundai	<5 lakhs	2	I don't think so
1	27	Pune	NaN	Single	Graduate	4	1.844540e+06	Yes	SUV	Yes	Honda	<15 lakhs	4	Yes, in <20years
2	32	Kashipur	NaN	Single	Graduate	4	2.948150e+06	Yes	Hatchback	Yes	KIA	<15 lakhs	4	Yes, in <20years
3	55	Pune	Business	Single	Graduate	3	2.832380e+06	Maybe	Hatchback	No	Hyundai	<5 lakhs	4	Yes, in <10 years
4	26	Satara	NaN	Single	Graduate	4	2.638751e+06	Yes	Sedan	Yes	McLaren	<15 lakhs	4	Yes, in <20years

```
[ ] df.isnull().sum()
```

```
Unnamed: 0                                                          0
Unnamed: 0.1                                                        0
Age                                                                 0
City                                                                0
Profession                                                          0
Marital Status                                                      0
Education                                                           0
No. of Family members                                               0
Annual Income                                                       0
Would you prefer replacing all your vehicles to Electronic vehicles?  0
If Yes/Maybe what type of  EV would you prefer?                     0
Do you think Electronic Vehicles are economical?                    0
Which brand of vehicle do you currently own?                        0
How much money could you spend on an Electronic vehicle?            0
Preference for wheels in EV                                         0
Do you think Electronic vehicles will replace fuel cars in India?   0
label                                                               0
dtype: int64
```

```
[ ] df.shape
```

```
(1000, 15)
```

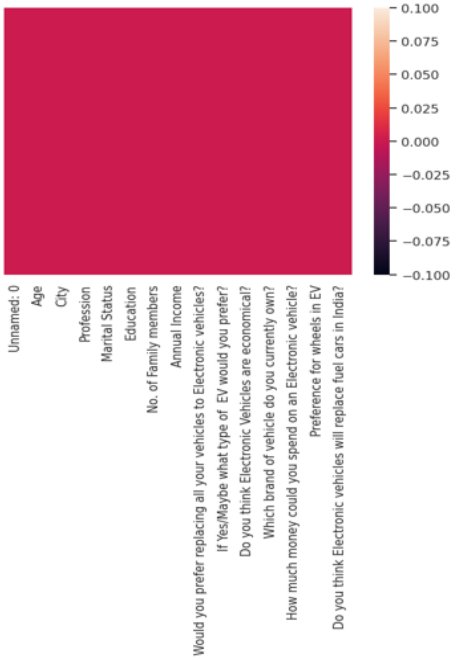
```
[ ] #Data Preprocessing
    df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 15 columns):
 #   Column                                                    Non-Null Count  Dtype
---  ------                                                    --------------  -----
 0   Unnamed: 0                                                1000 non-null   int64
 1   Age                                                       1000 non-null   int64
 2   City                                                      1000 non-null   object
 3   Profession                                                1000 non-null   object
 4   Marital Status                                            1000 non-null   object
 5   Education                                                 1000 non-null   object
 6   No. of Family members                                     1000 non-null   int64
 7   Annual Income                                             1000 non-null   float64
 8   Would you prefer replacing all your vehicles to Electronic vehicles?  1000 non-null   object
 9   If Yes/Maybe what type of  EV would you prefer?           1000 non-null   object
 10  Do you think Electronic Vehicles are economical?          1000 non-null   object
```

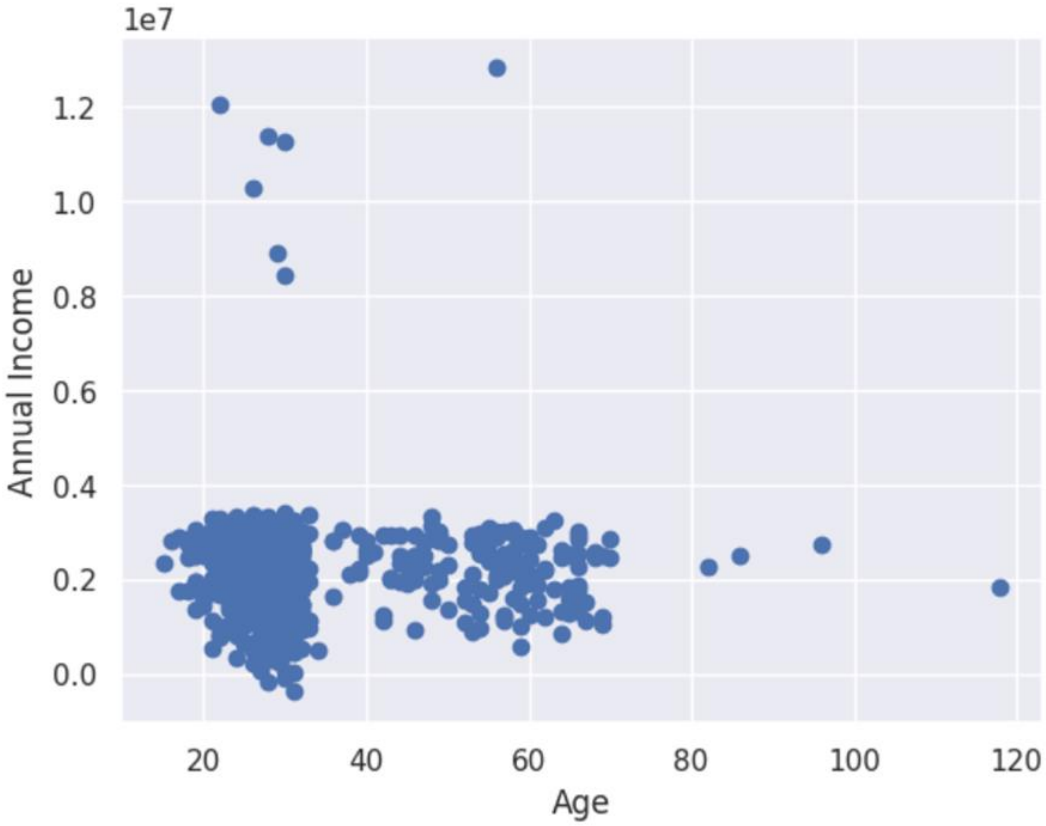
Data Visualization

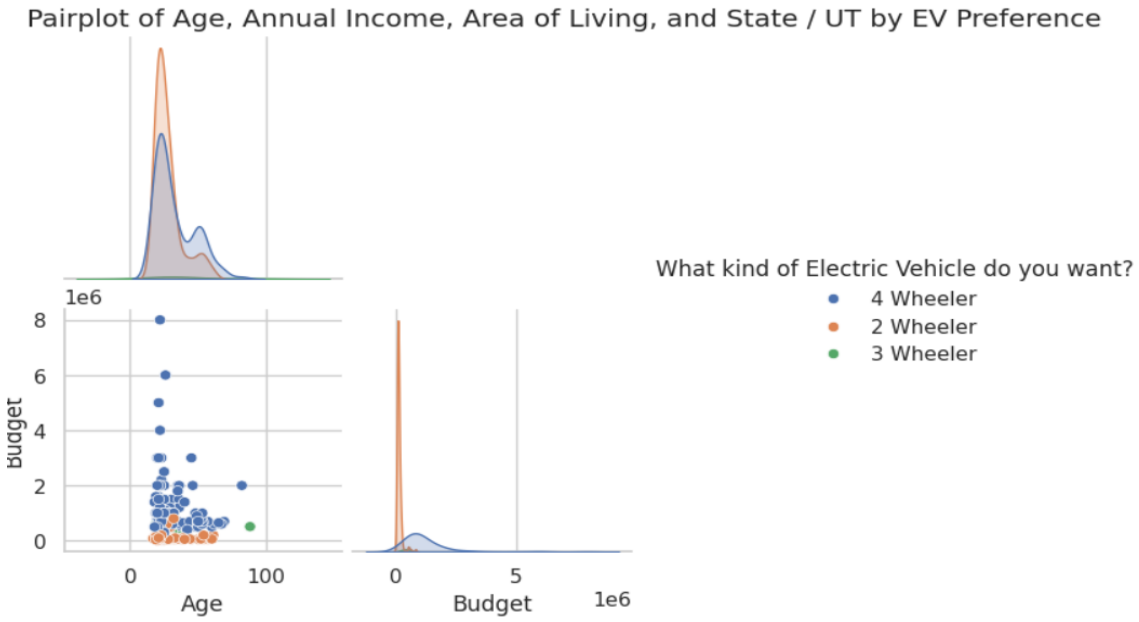
The Indian EV market is rapidly growing, driven by consumer preferences, sales trends, charging infrastructure, and environmental factors such as climate change concerns.

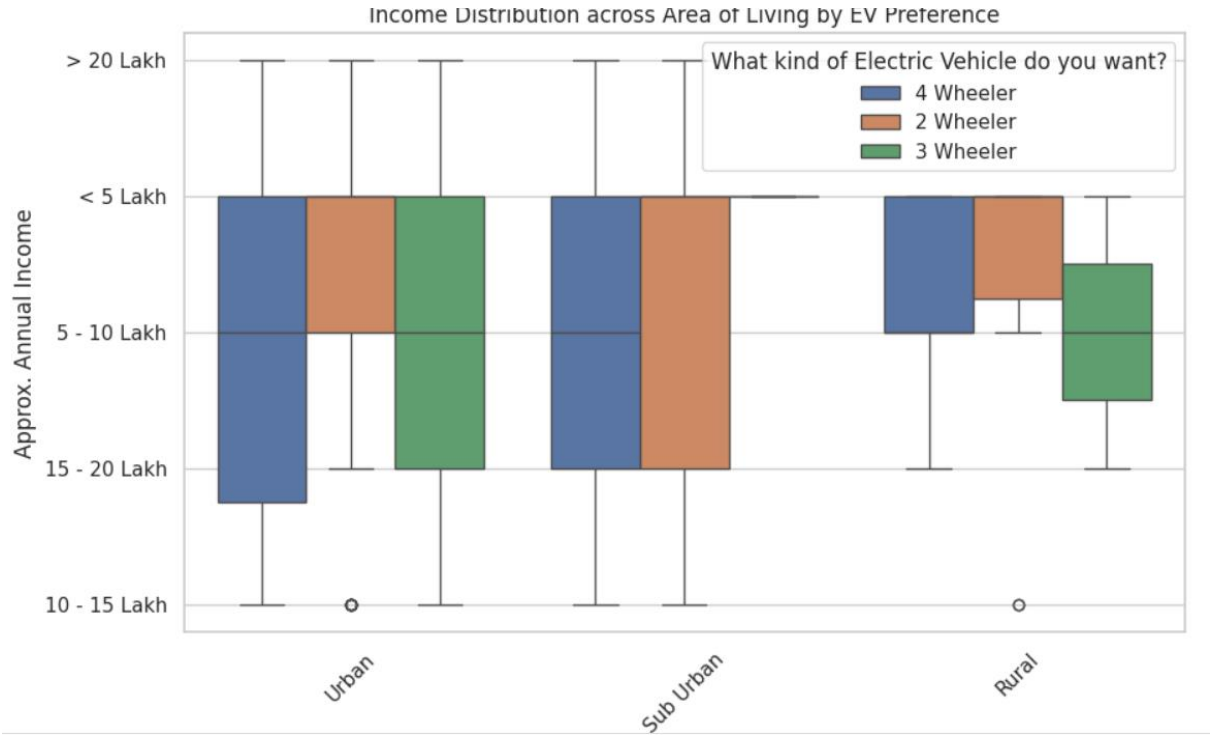
```
[19] #Data Visualization
     sns.heatmap(df.isnull(), yticklabels=False)
```




```
plt.xlabel('Age')
plt.ylabel('Annual Income')
plt.scatter(df['Age'],df['Annual Income'])
```


1e7
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Annual Income
20
40
60
80
100
120
Age


Pairplot of Age, Annual Income, Area of Living, and State / UT by EV Preference
1e6
8
6
4
2
0
Budget
0
100
Age
0
5
1e6
Budget
What kind of Electric Vehicle do you want?
4 Wheeler
2 Wheeler
3 Wheeler



Some of the data visualization is mentioned above

Algorithm used- Kmeans Clustering

K-means is a widely recognized algorithm in unsupervised machine learning, primarily used for classification tasks. It partitions unlabeled data into distinct groups, known as clusters, based on shared attributes and patterns. Imagine we have a collection of unlabeled, multivariate datasets with diverse features such as age, city, profession, etc. The method of dividing these datasets into different groups, based on shared features and traits, is known as clustering. The resulting groups are referred to as clusters. Clustering is employed in unsupervised learning algorithms in machine learning because it can divide multivariate data into various groups autonomously, based on a hidden common pattern within the datasets.

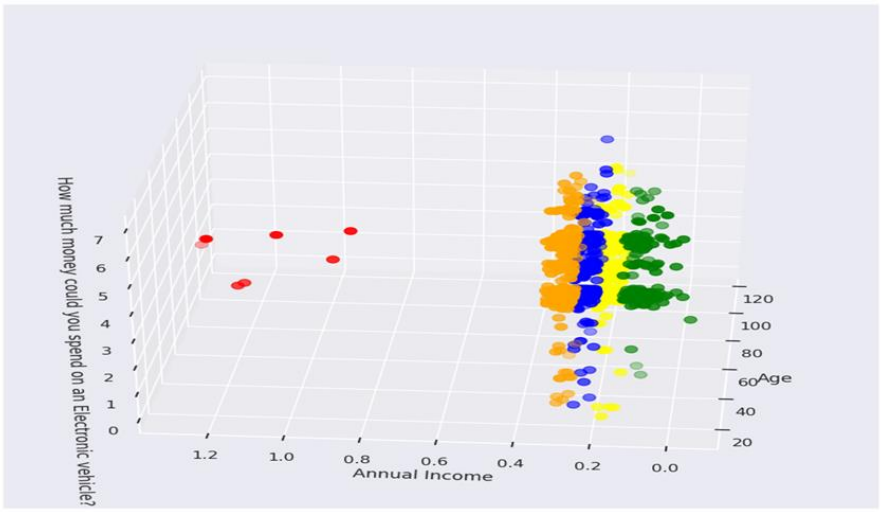
11s

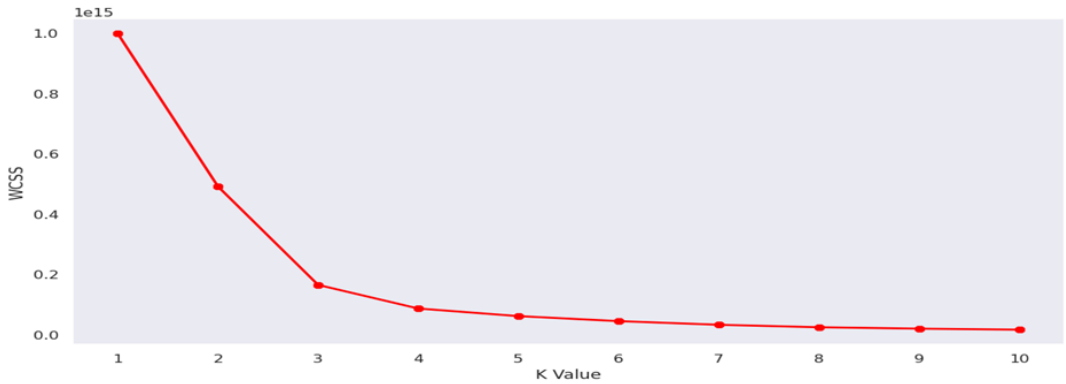
```
from sklearn.cluster import KMeans
wcss = []
for k in range(1,11):
    kmeans = KMeans(n_clusters=k, init="k-means++")
    kmeans.fit(df)
    wcss.append(kmeans.inertia_)
plt.figure(figsize=(12,6))
plt.grid()
plt.plot(range(1,11),wcss, linewidth=2, color="red", marker ="8")
plt.xlabel("K Value")
plt.xticks(np.arange(1,11,1))
plt.ylabel("WCSS")
plt.show()
```

```
km = KMeans(n_clusters=5)
clusters = km.fit_predict(df)
df["label"] = clusters

from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd

fig = plt.figure(figsize=(20,10))
ax = fig.add_subplot(111, projection='3d')
ax.scatter(df.Age[df.label == 0], df["Annual Income"][df.label == 0], df["How much money could you spend on an Electronic vehicle?"][df.label =
ax.scatter(df.Age[df.label == 1], df["Annual Income"][df.label == 1], df["How much money could you spend on an Electronic vehicle?"][df.label =
ax.scatter(df.Age[df.label == 2], df["Annual Income"][df.label == 2], df["How much money could you spend on an Electronic vehicle?"][df.label =
ax.scatter(df.Age[df.label == 3], df["Annual Income"][df.label == 3], df["How much money could you spend on an Electronic vehicle?"][df.label =
ax.scatter(df.Age[df.label == 4], df["Annual Income"][df.label == 4], df["How much money could you spend on an Electronic vehicle?"][df.label =

ax.view_init(30, 185)
plt.xlabel("Age")
plt.ylabel("Annual Income")
ax.set_zlabel('How much money could you spend on an Electronic vehicle?')
plt.show()
```

Results

The overall result show different customers that belong to particular area,their age,profession and preferences that are clustered together so to get good performance.





```
Recommendations for Targeting Strategy:
-----------------------------------------------
Based on the analysis, focus marketing efforts on:
- Demographics preferring specific types of EVs.
- Areas with higher income levels interested in EVs.
- Age groups and regions showing openness to EV adoption.
```

Final Product Prototype / Product Details:

Introducing our final product prototypes and detailed product specifications for electric vehicle market segmentation:

Analysing the electric vehicle (EV) market in India through segmentation analysis reveals distinct customer segments with specific needs and preferences. To enter the market effectively, we have developed a feasible strategy focusing on final product prototypes tailored to each segment:

In India, urban commuters represent a significant segment seeking affordable and convenient transportation. Therefore, our electric two-wheeler prototype, the EcoRide 100X, features a 2.5 kWh Lithium-ion battery providing a range of up to 80 kilometres per charge, catering perfectly to urban commuting needs. With a quick charging time of 2.5 hours, it addresses the requirement for fast, convenient charging.

For commercial and delivery services, our electric three-wheeler prototype, the UrbanHaul 200E, is designed. It boasts a 6 kWh Lithium-ion battery with a range of up to 100 kilometres per charge, ideal for last-mile delivery operations. Charging in 4 hours ensures minimal downtime for businesses.

Catering to urban families and professionals, our electric passenger car prototype, the NovaEV 400X, offers a range of up to 350 kilometres per charge with its 60 kWh Lithium-ion battery. Its charging time of 6 hours for a full charge and 45 minutes for 80% charge with DC fast charging ensures convenience for daily urban and suburban travel.
Our market entry strategy involves targeted marketing campaigns emphasising the affordability, efficiency, and eco-friendliness of our products. We will establish partnerships with dealerships, online platforms, and businesses for effective distribution. Additionally, offering financial incentives such as subsidies and financing options will encourage adoption across segments.
By addressing the specific needs of urban commuters, commercial services, and urban families/professionals with tailored EV prototypes and a comprehensive market entry strategy, we aim to establish a strong presence and capture significant market share in India's EV market.

Our electric vehicle lineup aims to address specific needs within each segment, offering efficient, sustainable, and technologically advanced mobility solutions. We are committed to revolutionising the Indian electric vehicle market with products that prioritise performance, convenience, and environmental responsibility.

Monetization :-

To monetize our entry into the Indian electric vehicle (EV) market through segmentation analysis, we will analyse key segments and devise a feasible strategy. Our analysis reveals three primary segments: urban commuters seeking affordable transport, commercial services requiring efficient delivery solutions, and urban families/professionals seeking eco-friendly vehicles. Our strategy involves developing EVs tailored to each segment's needs, emphasising affordability, range, and convenience. We'll implement targeted marketing campaigns, leverage partnerships for distribution, and offer financial incentives like subsidies and financing options to drive adoption. By addressing diverse segment needs, we aim to establish a strong presence and capture significant market share in India's EV market.

It can also be achieved by sending all the information to those startups who want to plant their factory.

Conclusion:

Analysing the electric vehicle (EV) market in India through segmentation analysis reveals distinct customer segments and preferences. To formulate a feasible strategy for market entry, we have identified key segments and proposed tailored approaches to target them effectively.

In India, the EV market segmentation comprises urban commuters, commercial services, and urban families/professionals. Urban commuters seek affordable and convenient transportation, while commercial services require efficient delivery solutions, and urban families/professionals look for eco-friendly commuting options.

Our strategy involves developing specific EV prototypes for each segment: the EcoRide 100X for urban commuters, the UrbanHaul 200E for commercial services, and the NovaEV 400X for urban families/professionals. The EcoRide 100X offers a range of 80 kilometres per charge, addressing urban commuting needs, while the UrbanHaul 200E provides a range of 100 kilometres per charge, suitable for To enter the market effectively, we will implement targeted marketing campaigns highlighting the affordability, efficiency, and eco-friendliness of our products. Partnerships with dealerships, online platforms, and businesses will ensure wide distribution.Additionally, offering financial incentives such as subsidies and financing options will encourage adoption across segments.

The adoption of electric vehicles (EVs) in India has surged dramatically over the past five years due to their increased efficiency and the rising cost of fuel. These factors, combined with the improved efficiency and range of EVs, have significantly driven product adoption.

Additionally, the increasing demand for low-emission commuting and government incentives, such as subsidies and tax refunds, have compelled manufacturers worldwide to produce electric vehicles.We have developed several segmentation strategies based on this information to influence consumer purchasing decisions. Geographic segmentation focuses on the impact of locations, cities, and states on market sales, considering where customers reside. For example, consumers in rural areas may have fewer charging stations available compared to those in metropolitan areas. As of 2022, there are approximately 1,742 public charging stations in India. Consequently, consumers from states with more charging stations are more likely to purchase EVs than those from states with fewer stations. This segmentation aims to understand how customers use products and services and how much they are willing to pay for them. The decision to purchase an EV can be influenced by the level of education, financial situation, and specific reasons for the purchase, such as transporting goods between cities or states. These customers will particularly focus on the vehicle's cargo area and maximum range.By understanding these various segments, we can better tailor marketing strategies to enhance the adoption of electric vehicles.

In conclusion, by addressing the diverse needs of urban commuters, commercial services, and urban families/professionals with tailored EV prototypes and a comprehensive market entry strategy, we aim to establish a strong foothold and capture significant market share in India's rapidly growing EV market while contributing to sustainable mobility solutions.last-mile delivery operations. The NovaEV 400X offers a range of 350 kilometres per charge, catering to urban families and professionals.

The Indian Electric Vehicle (EV) market is on a robust upward trajectory, underpinned by a diverse range of vehicle types and power sources that cater to different consumer needs. The market’s segmentation into passenger cars, commercial vehicles, and two- and three-wheelers reflects its adaptability and potential for widespread adoption. With a staggering projected CAGR of over 44%, the market’s value is set to increase significantly from USD 5 billion in 2020 to USD 47 billion by 2026.

Government policies and initiatives play a crucial role in this growth, offering incentives and support for EV adoption. The involvement of e-commerce giants like Amazon in adopting e-mobility for deliveries exemplifies corporate commitment to sustainable practices. Additionally, state governments are not only formulating policies but also actively promoting EV usage.

The dominance of two- and three-wheelers in total EV sales indicates a market trend that favors these segments, likely due to their affordability and practicality for the Indian consumer base. This trend is particularly pronounced in Uttar Pradesh, which leads in total EV sales, primarily driven by the three-wheeler segment.

On the other hand, Tamil Nadu’s focus on two-wheeler EV sales and Maharashtra’s lead in four-wheeler EV sales demonstrate regional variations that could inform targeted strategies for businesses entering the EV space.

The analysis of the Electric Vehicle Survey dataset has yielded valuable insights into consumer preferences, income distributions, and demographic trends related to Electric

Vehicle (EV) adoption. These insights are instrumental in formulating targeted marketing strategies and initiatives aimed at promoting EVs and increasing their market share.

1. **Consumer Preferences:**
    - The survey reveals a balanced interest between 2-wheelers and 4-wheelers among respondents, indicating a diverse market for both types of EVs.
    - Understanding these preferences allows companies to develop and promote a range of EV models that cater to different consumer segments.
2. **Income and Geographic Trends:**
    - Urban areas emerge as key markets for EVs, with a significant number of respondents residing in these regions.
    - Income distribution analysis highlights opportunities across income segments, particularly in urban and suburban areas, where interest in EVs is noticeable.
3. **Demographic Insights:**
    - Age distributions vary across states and territories, showcasing the need for tailored marketing approaches based on age demographics.
    - Younger age groups may prioritize affordability and technological features, while older age groups may value reliability and safety in EVs.
4. **Targeted Marketing Recommendations:**
    - Targeting strategies should focus on demographic factors such as age, income levels, and geographic location to maximize outreach and engagement.
    - Tailored messaging emphasizing cost savings, environmental benefits, and technological advancements can resonate with different consumer segments.

In conclusion, leveraging these insights to design targeted marketing campaigns, enhance product offerings, and expand market reach will be pivotal in accelerating EV adoption and driving sustainable mobility initiatives. By addressing consumer preferences and market dynamics effectively, EV companies can play a significant role in shaping the future of transportation towards a greener and more sustainable paradigm.

Overall, the Indian EV market's promising prospects are shaped by a confluence of supportive government measures, corporate sustainability goals, consumer environmental consciousness, and practical vehicle options. This positions the market as a dynamic and lucrative sector with immense potential for innovation and growth.

By following best practices in model development,user interface design, integration, data security, marketing and customer support the ML model can be transformed into a marketable product that generates revenue and delivers value to big companies & institutions.

Continuous improvement customer feedback and staying abreast of industry trends are essential for long term success in this field.

Dheeraj : https://github.com/DheerajPathak16/Feynn_Lab_Project_2

Nirmit : https://github.com/Nirmitkarkera01/EV_Market_Segmentation_Analysis.git

Sravani : https://github.com/Sravanipatwari/EV.cars/blob/main/EV%20cars.py

Bhumi : https://github.com/Bhumi54321/fyenn-task-1

Rimpi : https://github.com/NoviceCoder2/Feynn_Labs/blob/main/ev_market_segment.py