SEGMENTATION ANALYSIS OF THE EV MARKET: UNVEILING TRENDS, BRAND CONTRIBUTIONS, AND PERFORMANCE METRICS

AUTHOR: SUDHEER N POOJARI

BREAKING DOWN THE PROBLEM STATEMENT USING FERMI ESTIMATION:

To address the problem statement, I deconstructed it into several elements and made estimations regarding their influence on the market. This involved analyzing factors such as geographical location, demographic characteristics, psychographic attributes, behavioral patterns, and the Innovation Adoption Life Cycle. By employing Fermi estimation techniques, I quantified the potential market size, customer base, and profit projections.

SOURCES OF DATA:

In the process of data collection, I personally utilized three primary sources: www.kaggle.com, www.datasetsearch.research.google.com and www.data.gov.in. These sources offered a wealth of information pertaining to the EV market, encompassing data on brands, vehicle specifications, pricing, charging standards, and powertrain details. The data obtained from these sources proved to be valuable in our analysis.

DATA PRE-PROCESSING: STEPS AND LIBRARIES UTILIZED

In the process of data pre-processing, several steps were undertaken to ensure the datasets were clean and ready for analysis. These steps encompassed activities such as dataset cleaning, handling missing values, and performing feature engineering. For these tasks, I employed popular libraries such as Pandas and NumPy, which provided robust functionalities for data manipulation and cleaning. Furthermore, I conducted data normalization techniques to guarantee consistency and comparability across various features within the datasets.

```
import numpy as np, pandas as pd
import warnings
import matplotlib.pyplot as plt
import seaborn as sns
warnings.filterwarnings('ignore')
```

```
#Loading the dataset into dataframe
df=pd.read_csv("ev_car.csv")
df.head()
```

	Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Battery_Pack Kwh	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle
0	Tesla	Model 3 Long Range Dual Motor	4.6	233	460	70.0	161	940	Yes	AWD	Type 2 CCS	Sedan
1	Volkswagen	ID.3 Pure	10.0	160	270	45.0	167	250	Yes	RWD	Type 2 CCS	Hatchback
2	Polestar	2	4.7	210	400	75.0	181	620	Yes	AWD	Type 2 CCS	Liftback
3	BMW	iX3	6.8	180	360	74.0	206	560	Yes	RWD	Type 2 CCS	SUV
4	Honda	e	9.5	145	170	28.5	168	190	Yes	RWD	Type 2 CCS	Hatchback

```
#Checking Null values in data set
df.isnull().sum()
```

```
Brand              0
Model              0
AccelSec           0
TopSpeed_KmH       0
Range_Km           0
Battery_Pack Kwh   0
Efficiency_WhKm    0
FastCharge_KmH     0
RapidCharge        0
PowerTrain         0
PlugType           0
BodyStyle          0
Segment            0
Seats              0
PriceEuro          0
INR                0
dtype: int64
```

```
#checking the datatypes of each column
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 102 entries, 0 to 101
Data columns (total 16 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   Brand             102 non-null    object
 1   Model             102 non-null    object
 2   AccelSec          102 non-null    float64
 3   TopSpeed_KmH      102 non-null    int64
 4   Range_Km          102 non-null    int64
 5   Battery_Pack Kwh  102 non-null    float64
 6   Efficiency_WhKm   102 non-null    int64
 7   FastCharge_KmH    102 non-null    int64
 8   RapidCharge       102 non-null    object
 9   PowerTrain        102 non-null    object
 10  PlugType          102 non-null    object
 11  BodyStyle         102 non-null    object
 12  Segment           102 non-null    object
 13  Seats             102 non-null    int64
 14  PriceEuro         102 non-null    int64
 15  INR               102 non-null    float64
dtypes: float64(3), int64(6), object(7)
memory usage: 12.9+ KB
```

```
#creating new coulmn 'carname'
df['car_name']=df['Brand']+"-"+df['Model']
df.head(1)
```

SEGMENT EXTRACTION:

To extract segments within the electric vehicle (EV) dataset, clustering analysis was conducted using the K-means algorithm. Several features, including acceleration, speed, price range, and brand, were taken into consideration to identify distinct segments within the electric vehicle market. By applying the clustering algorithm, similar vehicles were grouped together based on their shared characteristics. This approach facilitated the identification of meaningful segments that provided insights into the diverse landscape of the electric vehicle market.

PROFILING AND DESCRIBING POTENTIAL SEGMENTS:

Following the clustering analysis, five distinct segments were identified within the electric vehicle market. These segments exhibit unique characteristics and cater to diverse consumer preferences and budgets. By analyzing the features and attributes of each segment, a deeper understanding of their potential customer base was gained. This profiling process provides valuable insights into the distinct market segments, enabling targeted strategies and tailored approaches to meet the specific needs and preferences of each segment.

```
# Add cluster labels to the dataset
df['Cluster'] = clusters
```

```
# Analyze the segments
segment_analysis = df.groupby('Cluster').mean()

# Print the segment analysis
segment_analysis
```

Cluster	AccelSec	TopSpeed_KmH	Range_Km	Battery_Pack Kwh	Efficiency_WhKm	FastCharge_KmH	Seats	PriceEuro	INR
0	2.100000	410.000000	970.000000	200.000000	206.000000	920.000000	4.000000	215000.000000	1.759756e+07
1	6.066667	190.000000	365.000000	87.466667	235.500000	487.222222	5.222222	67900.500000	5.557595e+06
2	3.581250	245.812500	460.312500	90.362500	197.875000	745.000000	5.187500	100218.062500	8.202758e+06
3	7.063333	172.100000	384.000000	69.550000	179.633333	482.666667	4.933333	49620.233333	4.061371e+06
4	10.091892	144.972973	219.324324	36.910811	170.513514	225.675676	4.567568	31958.081081	2.615740e+06

SELECTION OF TARGET SEGMENT:

After considering the insights derived from the clustering analysis and comprehensive market research, Cluster 0 emerged as the most suitable target segment for market entry. This segment consists of high-performance electric vehicles characterized by exceptional acceleration, long-range capability, and a sizable battery pack. These vehicles cater to enthusiasts and consumers who prioritize performance and are willing to make significant investments in high-end electric vehicles. By focusing on this target segment, an electric vehicle company can align its product offerings and marketing strategies to effectively meet the demands and preferences of performance-oriented customers, maximizing its chances of success in the market.

ADAPTING THE MARKETING MIX:

In order to efficiently focus on the designated segment, I suggest tailoring the marketing mix. This involves positioning the product as a high-performing electric vehicle that offers outstanding acceleration and range. Competitively setting the pricing will help attract the intended audience, taking into account the relatively higher price range of this particular segment. Furthermore, emphasizing the electric vehicle's innovative and advanced features, such as rapid charging abilities and energy efficiency, will resonate with the target customers.

ASSESSMENT OF POTENTIAL CUSTOMER BASE AND PROFITABILITY:

Taking into account the potential customer base within the early market for the designated target segment and the projected pricing range, I conducted a calculation to determine the potential profit. By multiplying the estimated number of potential customers in the target segment by the target price range, we can obtain an estimate of the potential profit within the early market. This calculation serves as a valuable tool for evaluating the market's viability and the profitability associated with entering the identified segment.

THE MOST IDEAL MARKET SEGMENTS:

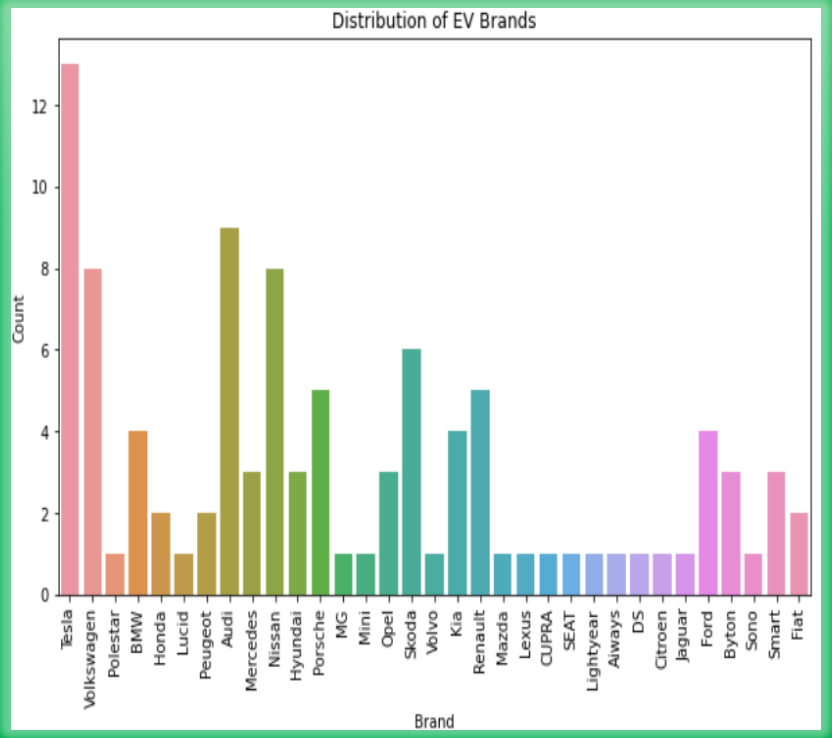
Following thorough market research and segmentation analysis, I have determined that Cluster 0 presents the most optimal market segment for our market entry strategy. This segment is well-suited to our product's performance and features, catering to a niche audience that exhibits a strong willingness to invest in high-end electric vehicles. By strategically targeting this segment, we can greatly enhance our prospects for success in the Indian electric vehicle market.

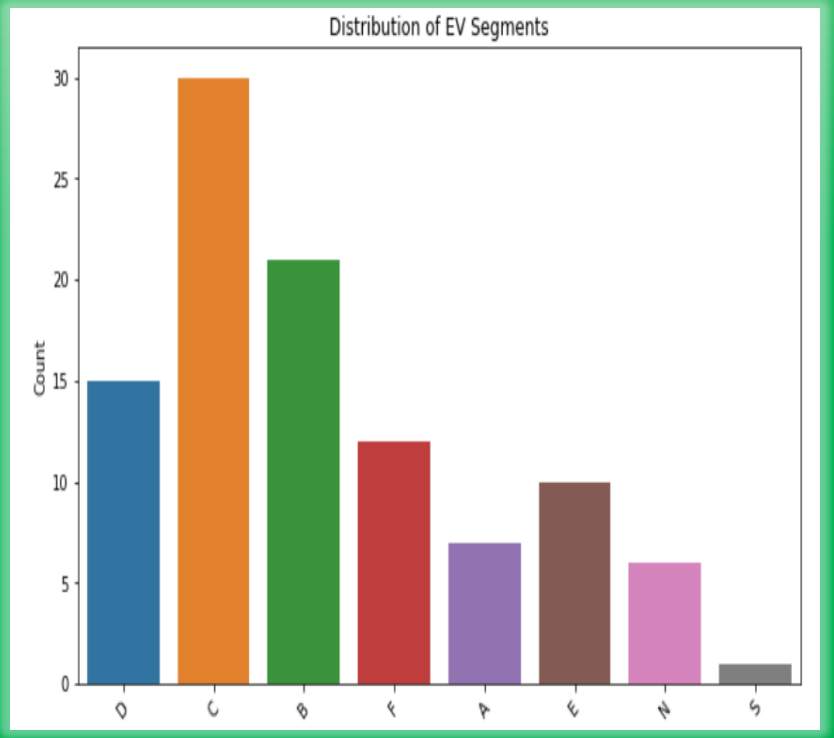
LINK TO GITHUB PROFILE:

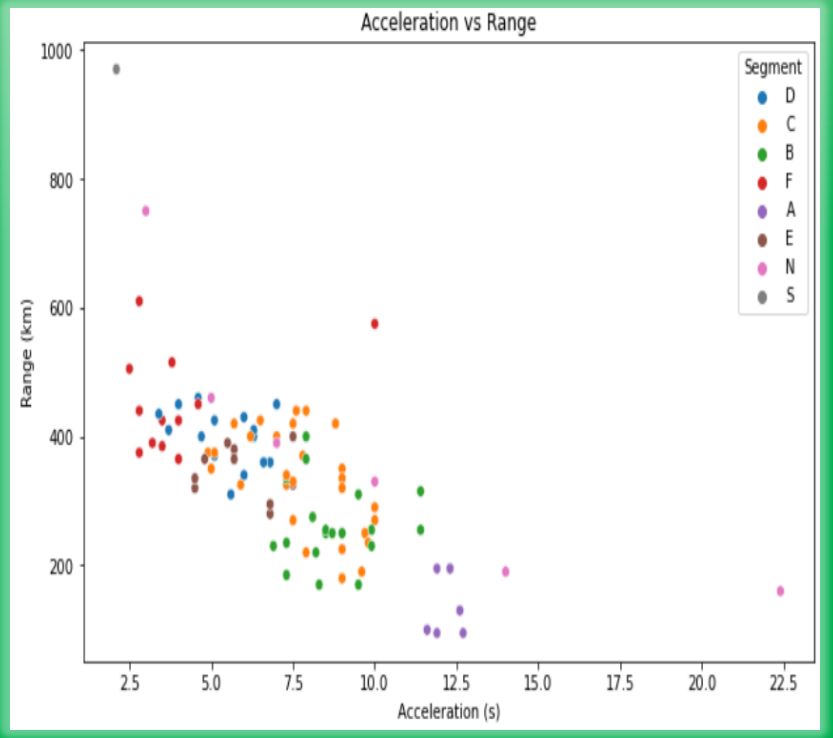
For reference, please find the link to our GitHub profile containing the documented codes and datasets used in the analysis: https://github.com/sudheernp/Segmentation-Analysis-of-the-EV-Market.git

INSIGHTS OF EV DATASET

- The high-value contribution to the EV market primarily comes from the C and B segments, while the S segment has the least contribution.
- In the EV market, Tesla, Audi, Nissan, and Volkswagen emerge as the prominent brands with the highest market share and occupancy.
- The majority of EV segments fall within the acceleration range of 10 and speed range of 200 to 400 kilometers.

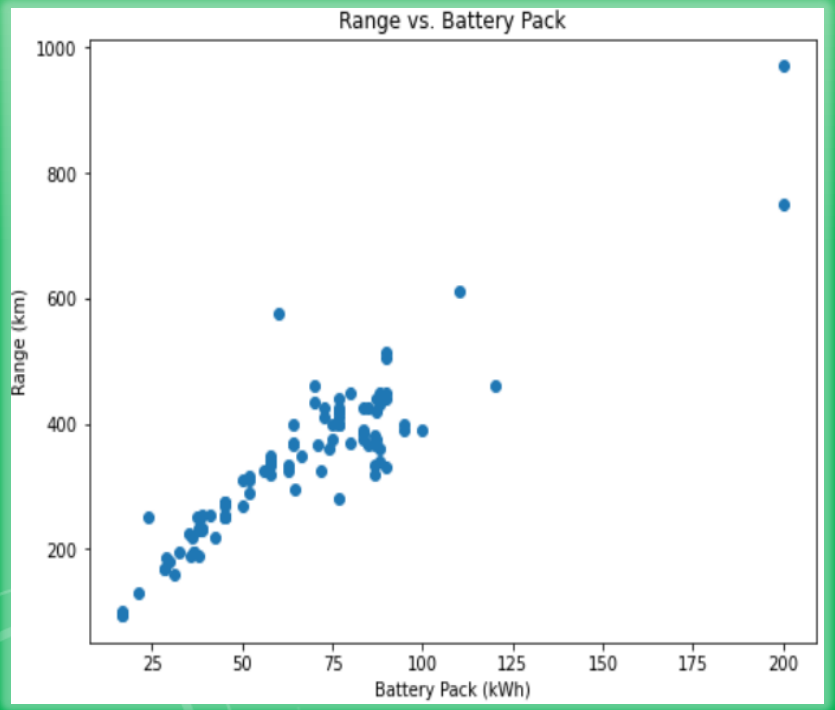


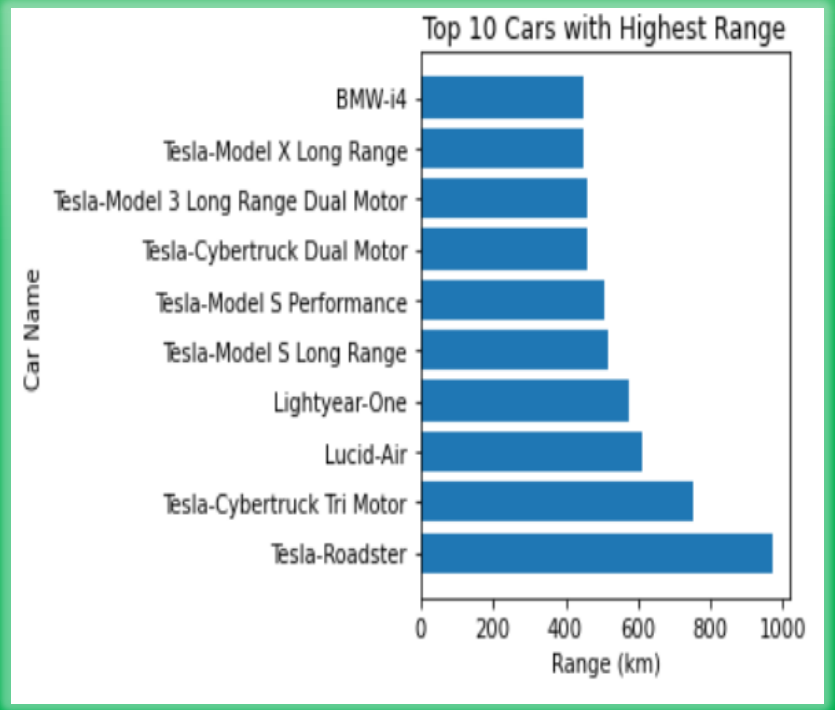


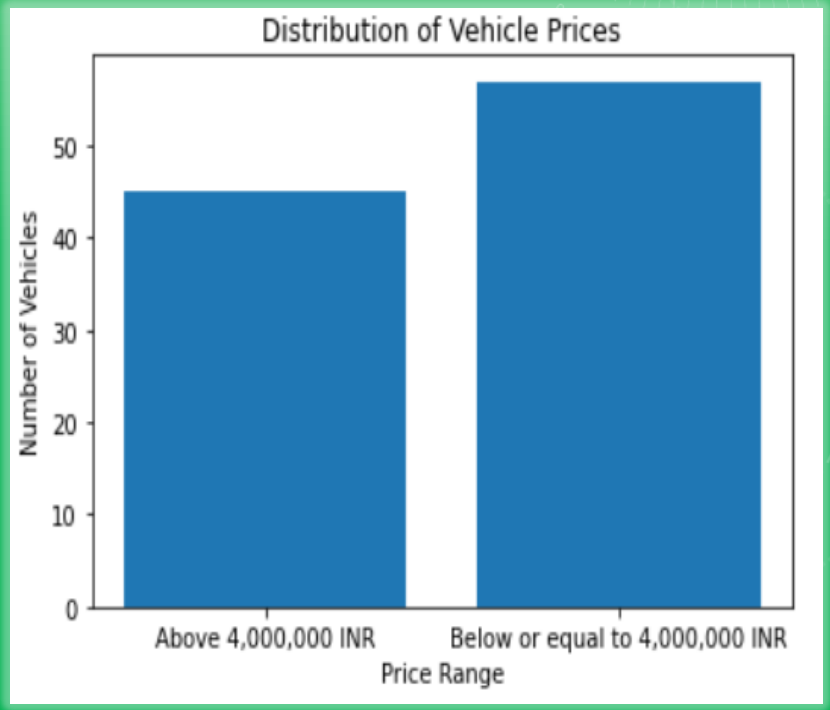


INSIGHTS OF EV DATASET(cont)

- EV vehicles typically offer battery packs ranging from 100 to 125 kWh, accompanied by a speed range of 400 to 450 kilometers. However, vehicles equipped with a larger battery pack of 200 kWh provide a significantly higher speed range, reaching up to 1000 kilometers.
- The majority of EV vehicles fall within or below the price range of 40 million.
- The majority of Tesla models offer an impressive range of up to 1000 kilometers, positioning them within the top 10 highest range EVs available.

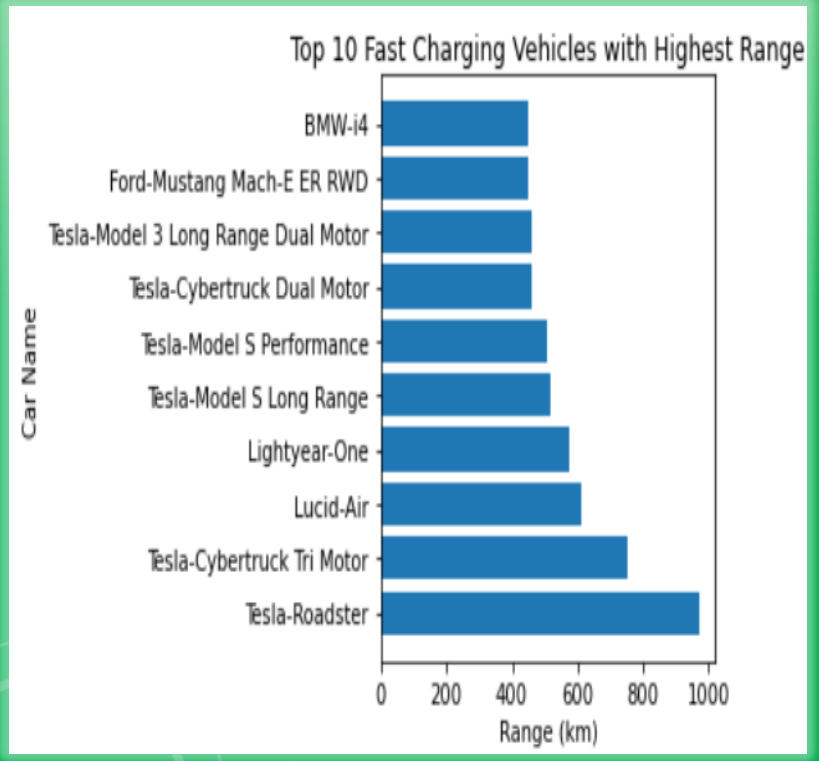


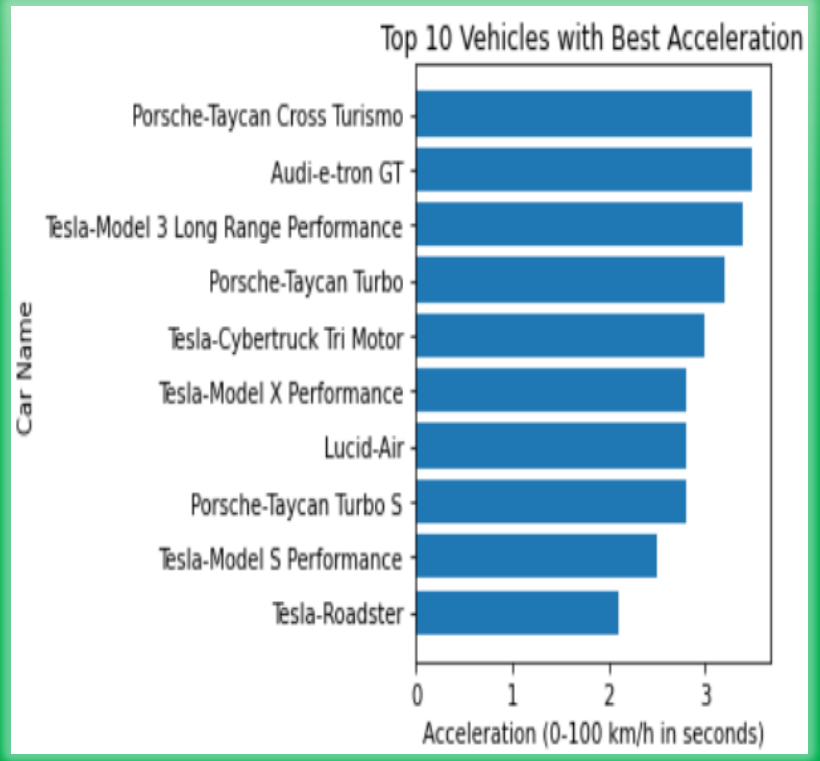


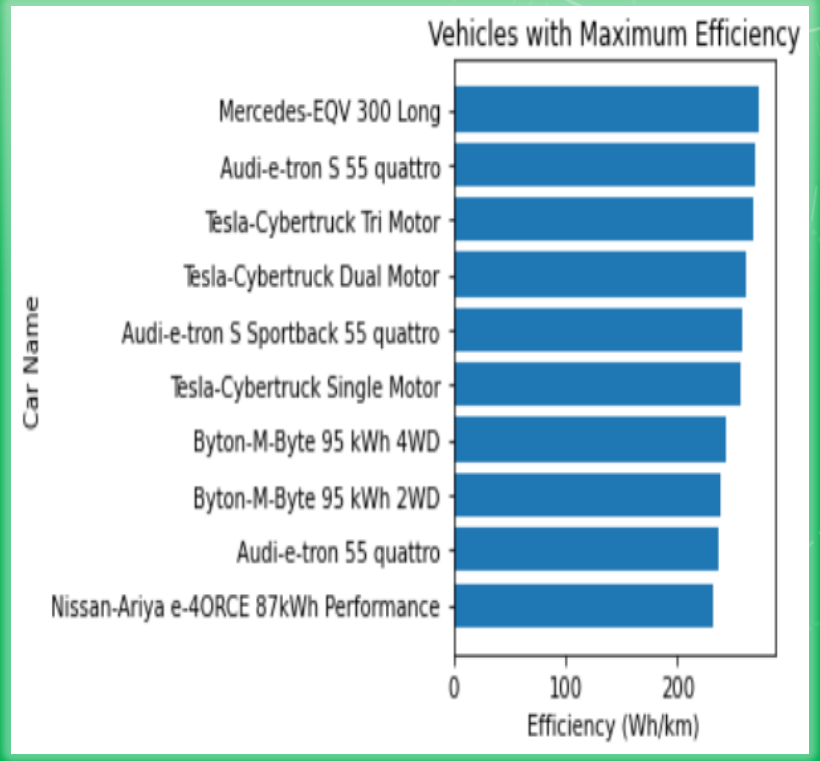


INSIGHTS OF EV DATASET(cont)

- The majority of Tesla models support the rapid charge feature, enabling faster charging times for EV owners.
- The Porsche Taycan and Audi e-tron models offer exceptional acceleration, reaching speeds of 0 to 100 kilometers per hour in just a few seconds.
- Mercedes, Audi, and Tesla models are known for their high efficiency in terms of energy consumption. These brands have made significant advancements in developing electric vehicles that maximize energy efficiency and offer impressive range per charge.







INSIGHTS OF STATE_CAR DATASET

TAX EXEMPTION PERCENTAGE:

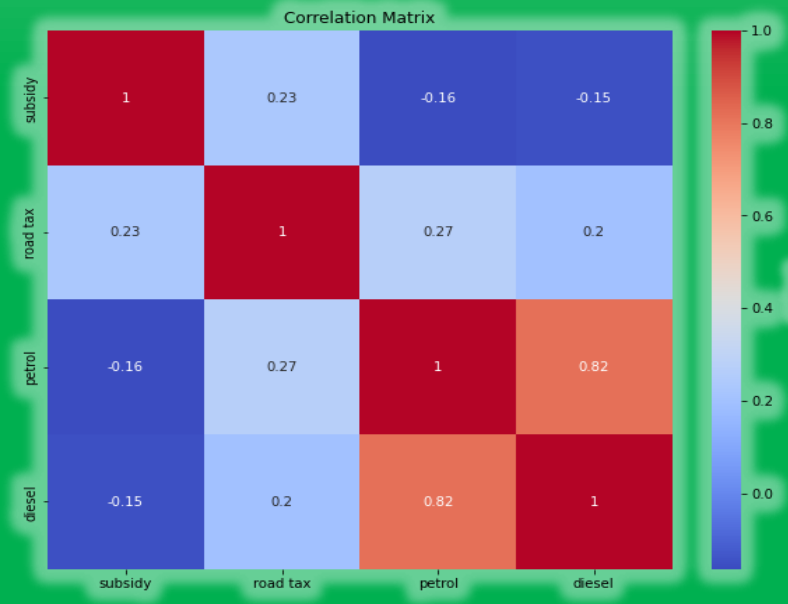
The percentage of tax exemption granted by each respective state/UT is an important consideration for an EV startup. It influences the financial viability and profitability of the business.

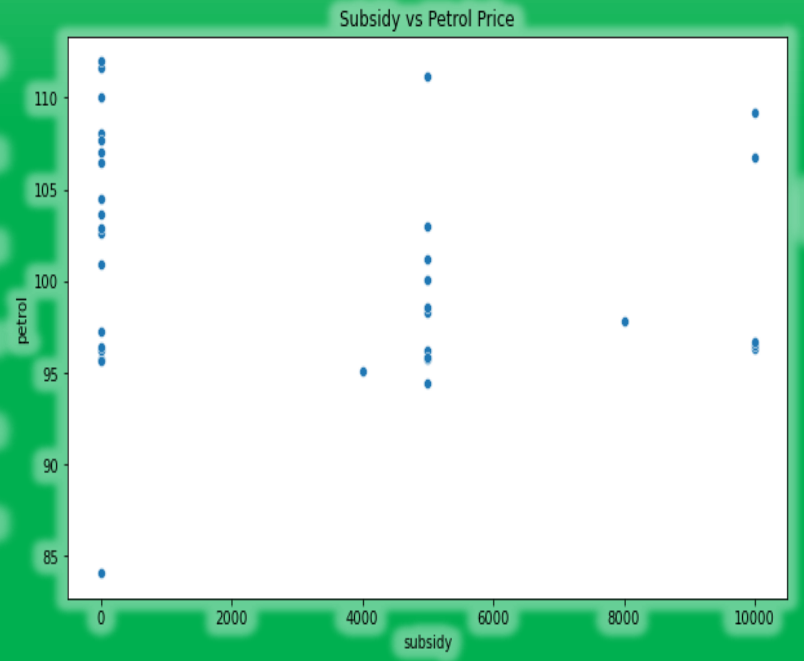
SUBSIDY AMOUNT (IN INR):

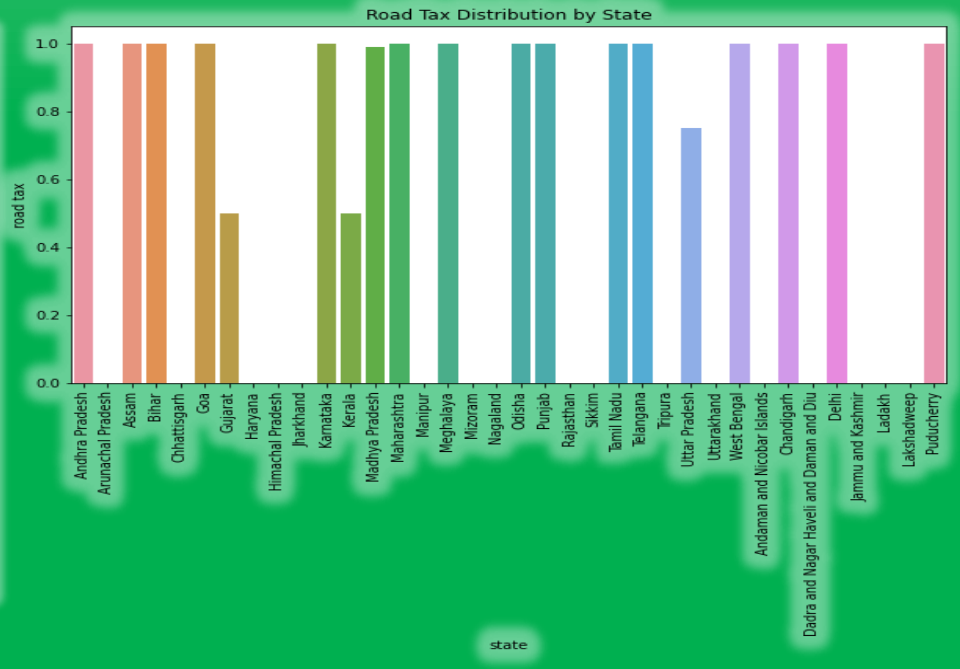
The subsidies provided by different states/UTs play a crucial role in attracting customers and driving sales. EV startups should analyze the subsidy amounts offered to assess the market potential in each region.

FUEL PRICES (PETROL AND DIESEL):

The prevailing prices of petrol and diesel in specific regions impact the demand for electric vehicles. High fuel prices can create a favorable market environment for EV startups as consumers seek alternative transportation solutions.



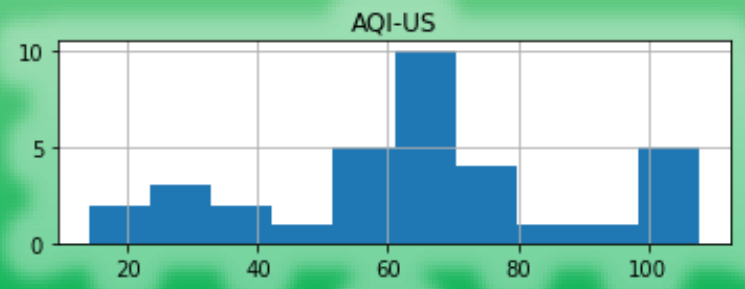


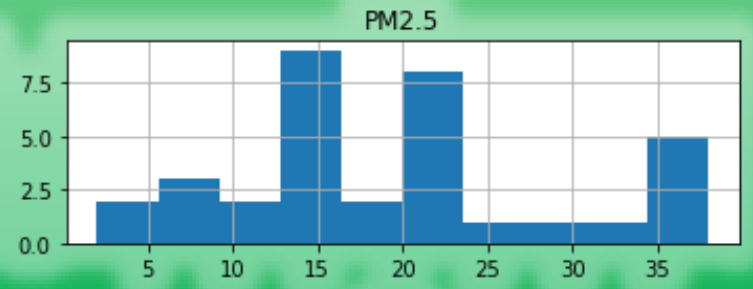


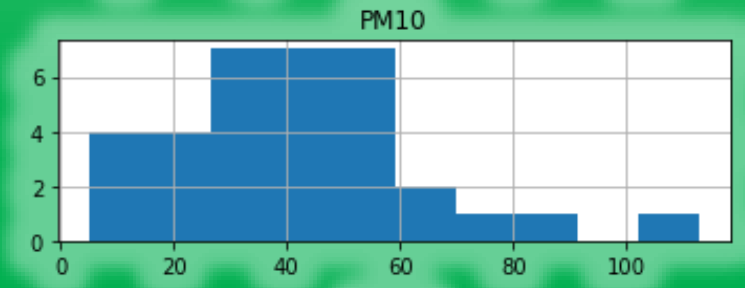
INSIGHTS OF POLLUTION DATASET

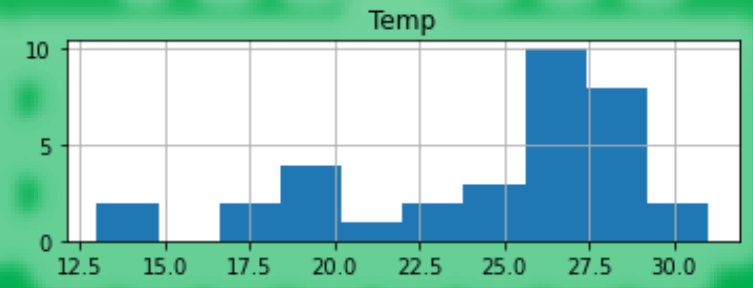
POLLUTION/AIR QUALITY:

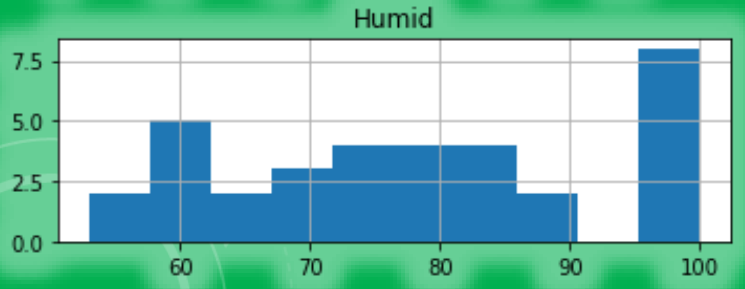
The pollution and air quality levels in different states/UTs are key indicators of the market potential for EV startups. Regions with poor air quality are more likely to have a higher demand for electric vehicles, presenting an opportunity for sustainable growth.

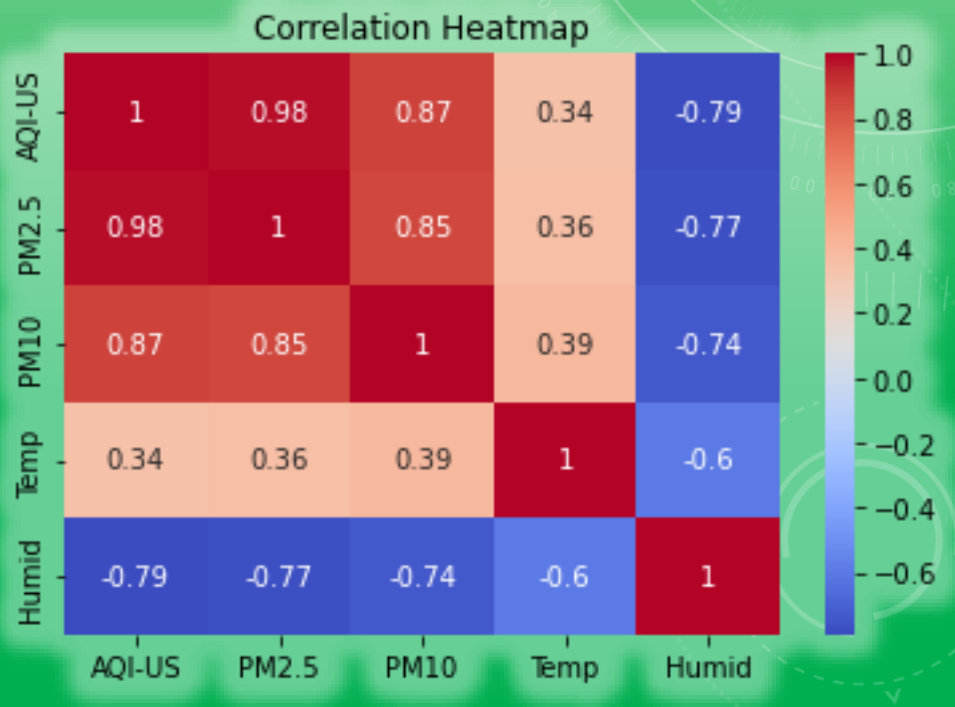












CONCLUSION

MARKET SEGMENTATION:

Cluster 0: Represents a high-performance segment targeting enthusiasts and consumers who prioritize performance and are willing to invest in high-end electric vehicles.

Cluster 1: Corresponds to a segment seeking a balance between performance and affordability.

Cluster 2: Represents a segment prioritizing a blend of performance, range, and affordability.

Cluster 3: Targets cost-conscious consumers who prioritize practicality and value for money.

Cluster 4: Targets budget-conscious consumers who prioritize affordability and urban commuting.

SUBSIDIES AND ROAD TAX:

Cluster 0: Minimal or no subsidies, higher road taxes.

Cluster 1: Moderate subsidies, relatively low road taxes.

Cluster 2: Highest subsidies, moderately high road taxes.

FUEL PRICES:

- Average petrol prices range from 98.79 to 102.37.
- Average diesel prices range from 88.19 to 91.92.

Based on these combined findings, your team should consider the following market entry strategy:

- Focus on targeting Cluster 2 and Cluster 1, as these segments show more favorable conditions for electric vehicle adoption, including higher subsidies and relatively lower road taxes.
- Prioritize marketing efforts towards the identified target segments, aligning with their specific preferences and priorities.
- Tailor pricing strategies to cater to the affordability expectations of each segment.
- Conduct further research to evaluate infrastructure readiness, consumer preferences, and government policies in the specific regions or states corresponding to the identified clusters.
- Continuously monitor market dynamics and adapt strategies accordingly to maximize success in the Indian electric vehicle market.

Thank You