FEYNN LABS

PROJECT 2

TASK REPORT ON

Market Segmentation Analysis of Electric Vehicle Market

27/06/2023

SUBMITTED BY: -

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PROBLEM STATEMENT: -

Our Task is 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.

In this report we will be analyzing EV market and find out ,what kind of potential buyers are interested in buying the Electric Vehicles, What are their demands, requirements, need they want in their Electric Vehicles and Which vehicle is able to provide all these demands, Infrastructure and resources that are required to support mass adoption of electronic vehicles , the demand of EVs across country of several manufacturing companies for the year 2011-2013, depending upon the demands we will also find out the types of EV that a company should produce to make it market fit and will also work upon the performance and efficiency of EVs. We also explored and identified distinct sets of potential buyer segments for EVs based on psychographic, behavioural, and socio-economic characterization

DATA COLLECTION:-

Data has been collected from Kaggle and some datasets has been made using beautiful soup (web Scrapping) as per the requirement. We have considered multiple datasets for the analysis. The links to the source of data is given below.

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

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

3).https://www.kaggle.com/datasets

4). https://data.gov.in/

5). https://www.data.gov/

6).https://drive.google.com/drive/folders/1SIWJBfOIK44TcV6su87spjvQgoVsWS6k?usp=sharing

In [6]:
```
# fetching dataset - 1
df1 = pd.read_csv('Ev_charger.csv')
df1.head()
```

Out[6]:

	Region	2W	3W	4W	Bus	Chargers
0	Uttar Pradesh	9852	42881	458	197	207
1	Maharastra	38558	893	1895	186	317
2	Karnataka	32844	568	589	57	172
3	Tamil Nadu	25642	396	426	0	256
4	Gujarat	22359	254	423	22	228

In [2]:
```
df = pd.read_csv('ElectricCarData_Clean.csv')

df.head()
```

Out[2]:

	Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle	Segmen
0	Tesla	Model 3 Long Range Dual Motor	4.6000	233	450	161	940	Yes	AWD	Type 2 CCS	Sedan	D
1	Volkswagen	ID.3 Pure	10.0000	160	270	167	250	Yes	RWD	Type 2 CCS	Hatchback	C
2	Polestar	2	4.7000	210	400	181	620	Yes	AWD	Type 2 CCS	Liftback	D
3	BMW	iX3	6.8000	180	360	206	560	Yes	RWD	Type 2 CCS	SUV	D
4	Honda	e	9.5000	145	170	168	190	Yes	RWD	Type 2 CCS	Hatchback	B

In [44]:
```
df.drop(['VIN (1-10)','Postal Code','Base MSRP','Legislative District','DOL Vehicle ID','Electric Utility','2020 Census Tract
```

In [45]:
```
df.head()
```

Out[45]:

	County	City	State	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electric Range	Vehicle Location
0	Yakima	Yakima	WA	2018	TESLA	MODEL X	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	238	POINT (-120.56916 46.58514)
1	Kitsap	Poulsbo	WA	2021	HONDA	CLARITY	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	47	POINT (-122.64681 47.73689)
2	King	Seattle	WA	2019	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	220	POINT (-122.40092 47.65908)
3	King	Seattle	WA	2013	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	75	POINT (-122.3684 47.64586)
4	Thurston	Lacey	WA	2017	TESLA	MODEL S	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	210	POINT (-122.75379 47.06316)

In [84]:

```
# Basic data exploration
print(df.head())
```

```
       Brand                           Model  AccelSec  TopSpeed_KmH  \
0      Tesla  Model 3 Long Range Dual Motor       4.6           233
1  Volkswagen                  ID.3 Pure       10.0           160
2    Polestar                           2       4.7           210
3         BMW                        iX3       6.8           180
4      Honda                          e       9.5           145

   Range_Km  Efficiency_WhKm  FastCharge_KmH RapidCharge PowerTrain  \
0       450              161             940         Yes        AWD
1       270              167             250          No        RWD
2       400              181             620         Yes        AWD
3       360              206             560         Yes        RWD
4       170              168             190         Yes        RWD

     PlugType  BodyStyle Segment  Seats  PriceEuro
0  Type 2 CCS      Sedan       D      5      55480
1  Type 2 CCS  Hatchback       C      5      30000
2  Type 2 CCS   Liftback       D      5      56440
3  Type 2 CCS        SUV       D      5      68040
4  Type 2 CCS  Hatchback       B      4      32997
```

In [11]:

```
# fetching dataset - 2
df2 = pd.read_csv('ev_charging_station_dataset.csv')
df2.head()
```

Out[11]:

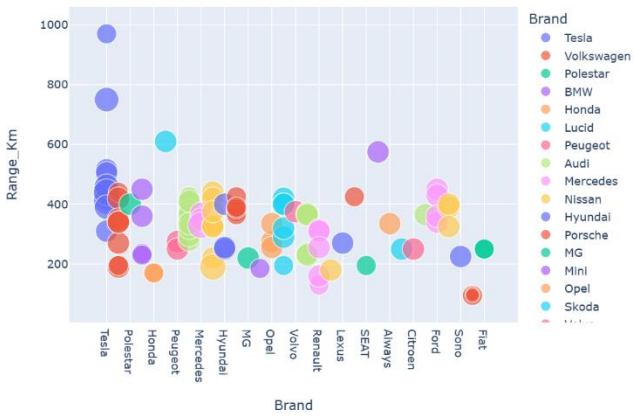
	State/UT No. of Retail Outlets (Ros) where EV Charging facility is available as on 1.1.2022	Unnamed: 1
0	State/UT	EV Charging Facility
1	Andhra Pradesh	65
2	Arunachal Pradesh	4
3	Assam	19
4	Bihar	26

DATA PREPROCESSING AND ANALYSIS:-

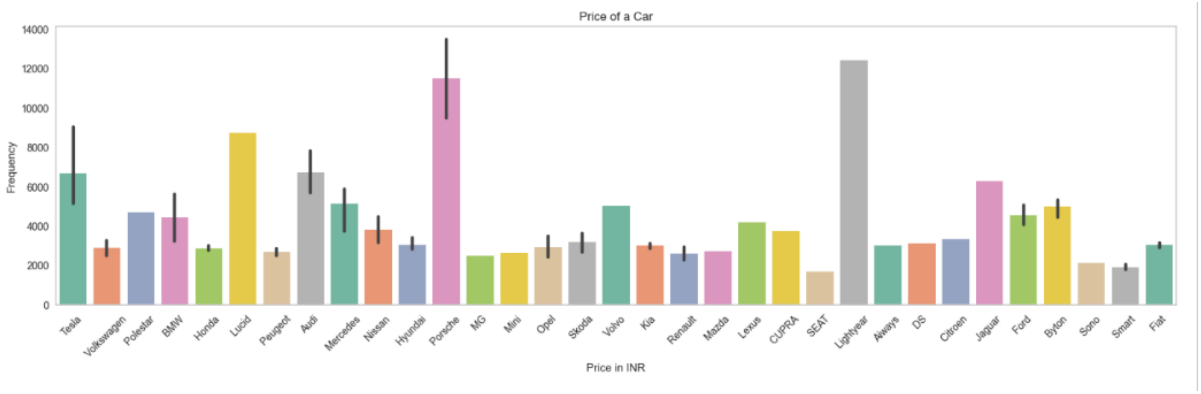
Data pre-processing is an important step for the creation of a machine learning model. Initially, data may not be clean or in the required format for the model which can cause misleading outcomes. In pre-processing of data, we transform data into our required format. It is used to deal with noises, duplicates, and missing values of the dataset. Data pre-processing has the activities like importing datasets, splitting datasets, attribute scaling, etc. Preprocessing of data is required for improving the accuracy of the model.

Exploratory Data Analysis

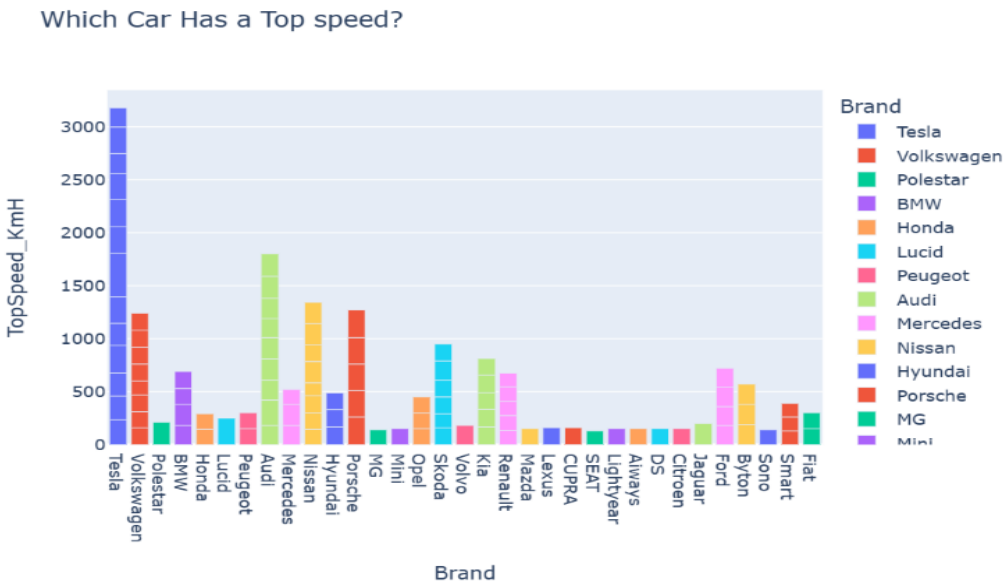
Exploratory Data Analysis (EDA) is a crucial step in the data analysis process. It involves examining and summarizing the main characteristics, patterns, and relationships present in a dataset. The primary goal of EDA is to gain insights and understanding of the data, identify any underlying patterns or trends, and potentially formulate hypotheses for further analysis.



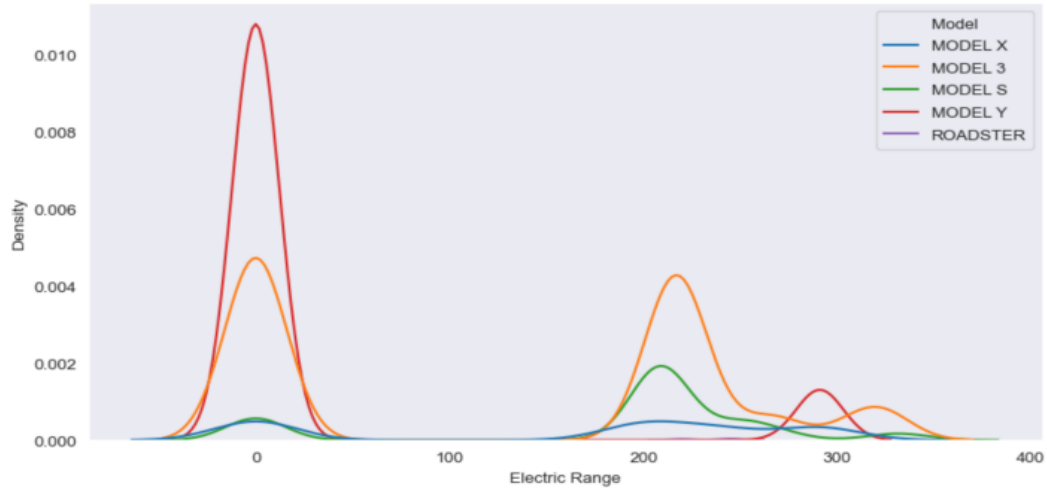
Analysis of Range of Different Evs



Price of Different Electric Vehicles INR



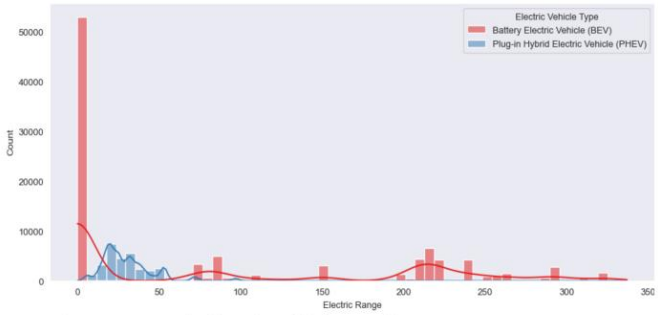
Out of 10 most sold vehicles 4 are from tesla



Electric range difference between PHEV and BEV?

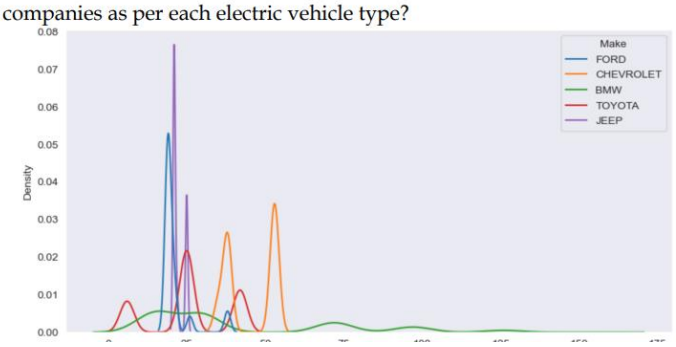
a. the data shows that BEVs will give more range but there are some vehicles which give almos t 0 range on PHEV

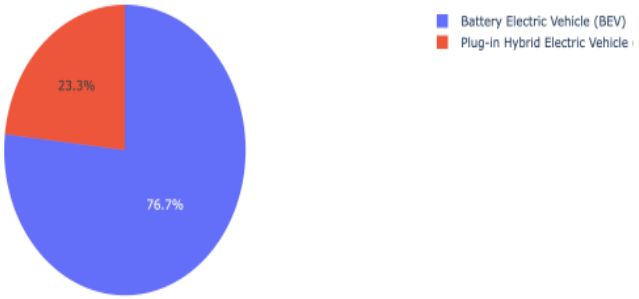
b.



c.

top 5 companies as per each electric vehicle type?





PERCENTAGE OF BEV Vs PHEV

As per the above analysis the most sold top 10 models per each company are-

a. Top selling models for TESLA are rank 1 MODEL 3 & rank 2 MODEL Y

b. Top selling models for NISSAN are rank 1 LEAF & rank 2 ARIYA

c. Top selling models for CHEVROLET are rank 1 BOLT EV & rank 2 VOLT

d. Top selling models for FORD are rank 1 MUSTANG MACH-E & rank 2 FUSION

e. Top selling models for BMW are rank 1 I3 & rank 2 X5

f. Top selling models for KIA are rank 1 NIRO & rank 2 EV6

g. Top selling models for TOYOTA are rank 1 PRIUS PRIME & rank 2 RAV4 PRIME

h. Top selling models for VOLKSWAGEN are rank 1 ID.4 & rank 2 E-GOLF

i. Top selling models for VOLVO are rank 1 XC90 & rank 2 XC60

j. Top selling models for AUDI are rank 1 E-TRON & rank 2 A3

The percentage of top 10 companies vehicles are BEV and PHEV-

a. Tesla : BEV 100%

b. Nissan : BEV 100%

c. Chevrolet : BEV 56.7% and PHEV 43.3%

d. Ford : BEV 45.8% and PHEV 54.2%

e. BMW: BEV 31% and PHEV 69%

f. Toyota: BEV 2.12% and PHEV 97.9%

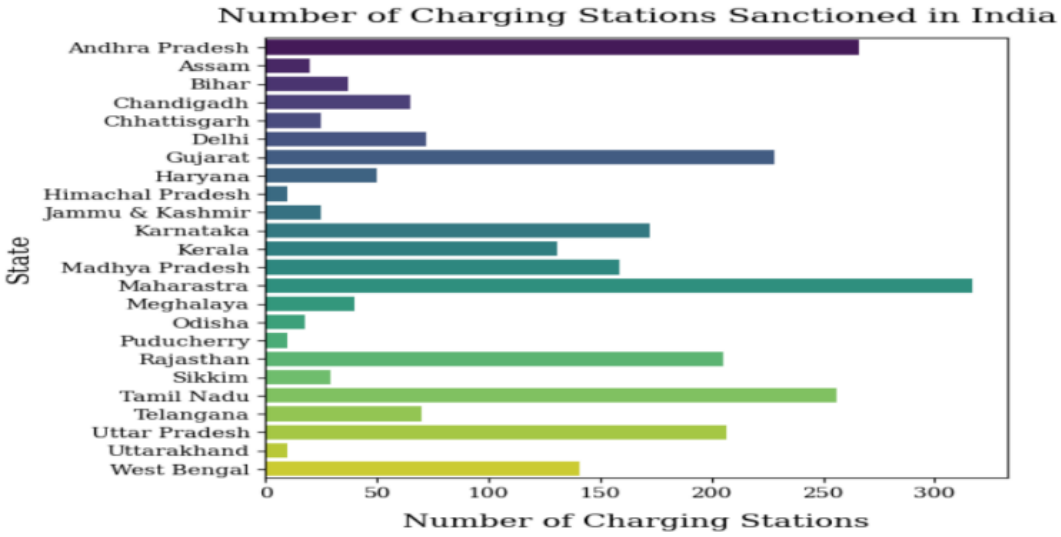
g. Volkswagen: BEV 100%

h. Volvo: BEV 25.6% and PHEV 74.4%

i. Audi: BEV 51% and PHEV 49%

j. Jeep: PHEV 100%

Number of Charging Stations Sanctioned by India



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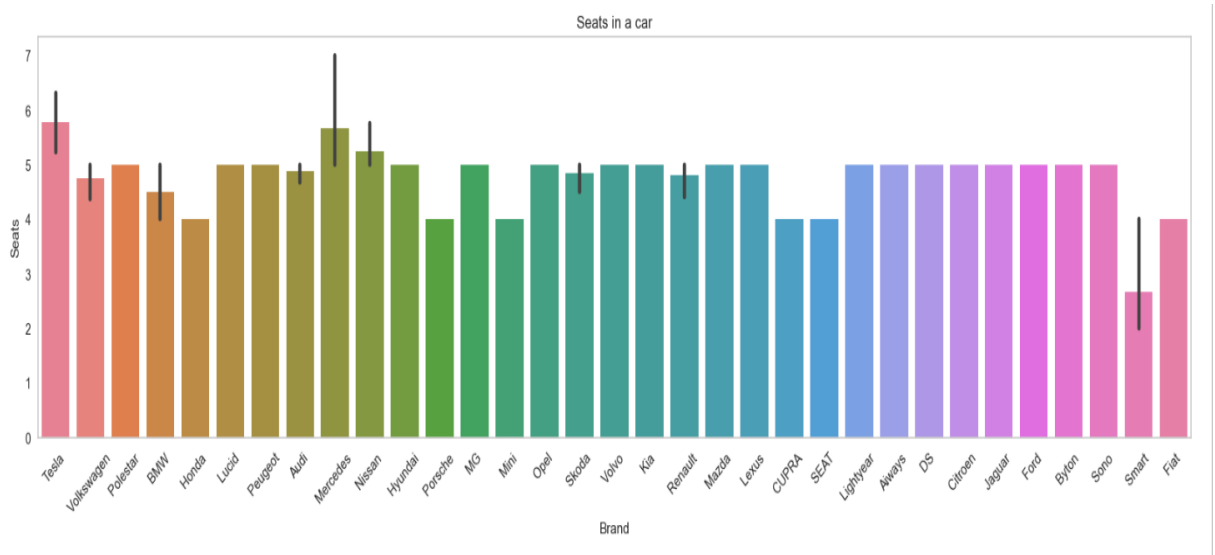
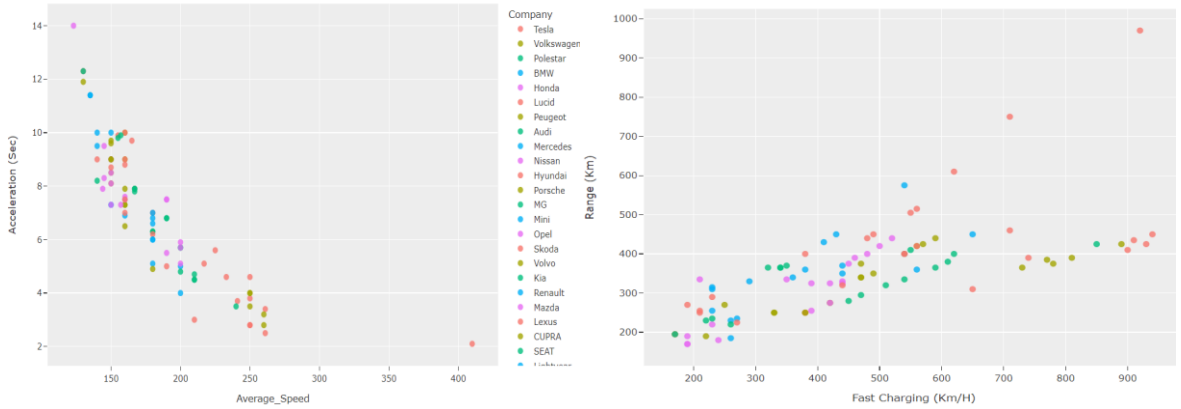
Ev Chargers





The above dataset for different kinds of vehicles is analysed based on prices, average speed, charging speed and efficiency to conclude which kind of vehicle is performing best in the market.

LIBRARIES AND FRAMEWORKS USED :-

- **SKLearn:** Simple and efficient tools for predictive data analysis
- **Seaborn:** Seaborn is a Python data visualization library based on matplotlib. It provides a high-level interface for drawing attractive and informative statistical graphics.
- **Plotly:** The plotly Python library is an interactive, open-source plotting library that supports over 40 unique chart types covering a wide range of statistical, financial, geographic, scientific, and 3-dimensional use-cases.
- **KElbowVisualizer:** The KElbowVisualizer implements the “elbow” method to help data scientists select the optimal number of clusters by fitting the model with a range of values for . If the line chart resembles an arm, then the “elbow” (the point of

inflection on the curve) is a good indication that the underlying model fits best at that point. In the visualizer “elbow” will be annotated with a dashed line.

- **Matplotlib :** Matplotlib is a comprehensive library for creating static, animated, and interactive visualizations in Python.
- **Numpy:** Caffe-based Single Shot-Multibox Detector (SSD) model used to detect faces
- **Pandas:** pandas is a fast, powerful, flexible and easy to use open source data analysis and manipulation tool, built on top of the Python programming language.

SEGMENT EXTRACTION:-

Clustering

Clustering is a technique used in exploratory data analysis and unsupervised machine learning to group similar objects or data points together based on their characteristics or attributes. The goal of clustering is to identify inherent structures or patterns in the data without any predefined labels or target variables.

K-Means Clustering

K-means clustering is one of the most widely used algorithms for partitioning data into distinct clusters. It is an iterative algorithm that aims to minimize the sum of squared distances between data points and their assigned cluster centroids.

The K-Means Algorithm works with the following way:

1.Choose the number of clusters (K) you want to identify in your data.

2.Initialize K cluster centroids randomly or using a specific initialization technique.

3.Assign each data point to the nearest centroid based on the Euclidean distance (or other distance metrics) between the point and the centroid.

4.Recalculate the centroids of each cluster by taking the mean of all data points assigned to that cluster.

5.Repeat steps 3 and 4 until convergence or a stopping criterion is met. Convergence is typically achieved when the cluster assignments and centroid positions no longer change significantly.

6.The final outcome of the K-means algorithm is a set of K cluster centroids and the assignment of each data point to one of the clusters.

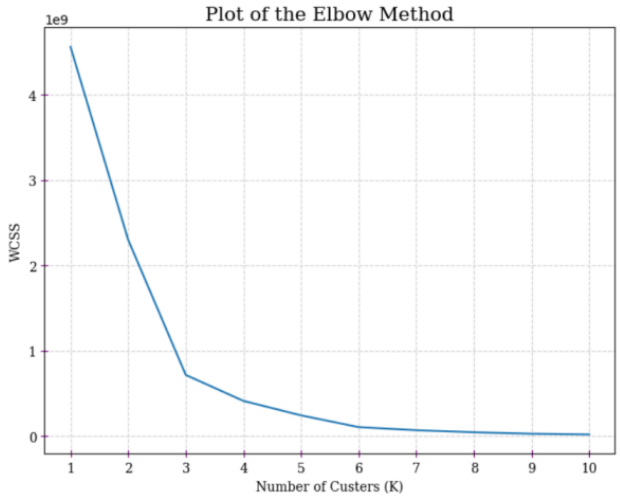
It's important to note that K-means clustering is sensitive to the initial centroid positions, which can result in different solutions. To mitigate this, it is common practice to run the algorithm multiple times with different initializations and choose the clustering solution with the lowest sum of squared distances.

K-means clustering is widely used in various applications, including customer segmentation, image compression, document clustering, and anomaly detection.

Principal Component Analysis

Principal Component Analysis (PCA) is a widely used dimensionality reduction technique that aims to transform a high-dimensional dataset into a lower-dimensional representation while preserving the most important information. PCA achieves this by identifying the directions, called principal components, along which the data exhibits the most significant variation.

Elbow Method

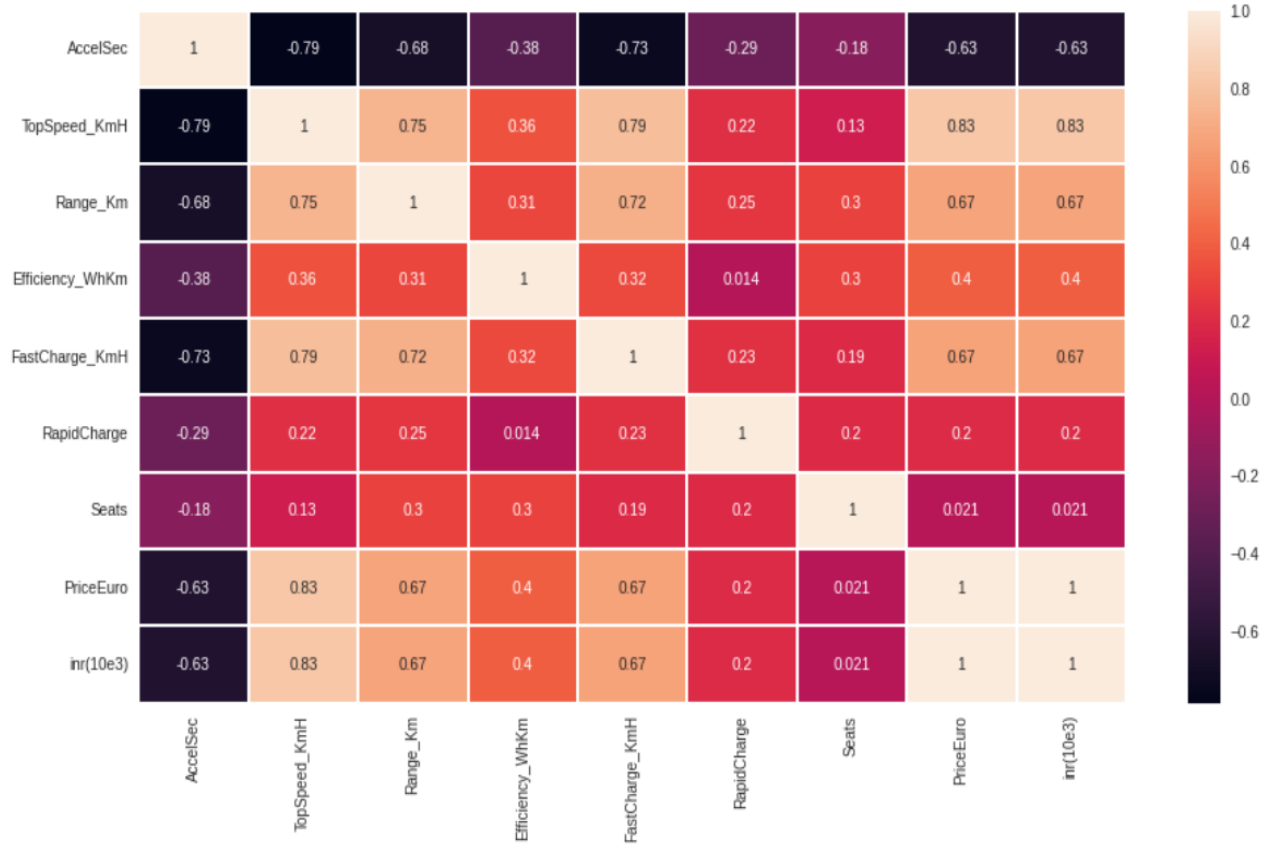


The Elbow Method is a technique used to determine the optimal number of clusters (K) in a dataset when performing clustering analysis, particularly with algorithms like K-means. The method is based on evaluating the sum of squared distances between data points and their assigned cluster centroids for different values of K

We also used machine learning techniques, particular the Regression Tree and Random Forest Regressor models, in order to better comprehend the performance of EVs. These models were trained on a dataset of EV specs and performance characteristics, and they were used to forecast EV performance based on speed, acceleration, and range. The

Regression Tree model visualised the decision-making process clearly, showing how different combinations of speed, acceleration, and range could end in varying degrees of efficiency. The Random Forest Regressor, a more complex model involving many decision trees, projected EV performance more accurately.

HEATMAP SHOWING THE CORRELATION OF THE DATA



Regression

Putting independent variables as x and dependent variable as y

```
df['PowerTrain'].replace(to_replace=['RWD','AWD','FWD'],value=[0, 2,1],inplace=True)
x=df[['AccelSec','Range_Km','TopSpeed_KmH','Efficiency_WhKm', 'RapidCharge','PowerTrain']]
y=df['PriceEuro']
```

Finding out the linear regression using OLS method

```
x= sm.add_constant(x)
results = sm.OLS(y,x)
```

Used Regression in determining the customer/potential Buyer segment

SELECTION OF TARGET SEGMENT: -

The selection of a target segment for electric vehicles (EVs) involves considering various factors such as market demand, competition, infrastructure, and consumer preferences. Here are some key considerations for selecting a target segment in the EV market:

1. Market analysis: Conduct a thorough analysis of the current EV market, including growth projections, market size, and trends. Identify segments with high growth potential and where EV adoption is likely to be significant.
2. Consumer preferences: Understand the preferences and needs of different consumer segments. Consider factors such as range requirements, charging infrastructure availability, price sensitivity, and lifestyle preferences. Some segments, such as urban commuters or eco-conscious consumers, may be more inclined to adopt EVs.
3. Competition analysis: Assess the competitive landscape within each segment. Evaluate the presence of established players and identify any gaps or underserved niches. Targeting segments with less competition or unique needs can provide a competitive advantage.
4. Infrastructure readiness: Evaluate the availability and accessibility of charging infrastructure. Segments with well-developed charging networks or where charging infrastructure investments are being made can be attractive targets. Urban areas, where shorter commutes and charging facilities are more readily available, are often considered favorable segments.
5. Government policies and incentives: Consider government policies and incentives supporting EV adoption. Incentives such as tax credits, rebates, or grants can significantly influence consumer behavior and make certain segments more appealing.
6. Total Cost of Ownership (TCO): Compare the TCO of EVs with traditional internal combustion engine vehicles in different segments. Assess factors like fuel savings, maintenance costs, and potential tax benefits. Target segments where EVs offer competitive or cost advantages over conventional vehicles.
7. Technological advancements: Take into account the advancements in battery technology and charging infrastructure. Segments that can benefit the most from these advancements, such as long-range vehicles or those requiring fast-charging capabilities, can be attractive targets.
8. Brand positioning: Consider the brand's strengths, image, and expertise. Target segments that align with the brand's values and capabilities. For example, luxury or performance-focused EVs may target higher-end segments, while affordable and practical EVs may target mass-market segments.

9. Scalability and production capacity: Evaluate the production capacity and scalability of the chosen segment. Ensure that the target segment can support sufficient sales volume to make the venture economically viable.
10. Long-term viability: Consider the long-term viability and sustainability of the target segment. Anticipate future market trends, policy changes, and technological advancements that may impact the segment's growth potential.

Ultimately, the selection of a target segment for EVs involves a careful evaluation of market dynamics, consumer needs, competition, and infrastructure considerations. It requires a holistic approach to identify segments that offer the best opportunities for success and align with the company's goals and capabilities.

CUSTOMIZING THE MARKET MIX: -

Customizing the marketing mix for electric vehicles (EVs) involves tailoring the product, price, promotion, and place (distribution) strategies to meet the unique needs and characteristics of the EV market. Here's how each element of the marketing mix can be customized for EVs:

Product:

- Range and Performance: Emphasize the range capabilities and performance features of the EVs. Highlight the technology and advancements that enable longer ranges and faster acceleration.
- Charging Infrastructure: Showcase compatibility with different charging standards, availability of fast-charging options, and integration with home charging solutions.
- Environmental Benefits: Highlight the environmental advantages of EVs, such as zero tailpipe emissions and reduced carbon footprint.
- Technology and Connectivity: Emphasize smart features, connectivity, and software updates that enhance the EV experience, such as remote monitoring and control, over-the-air updates, and integration with mobile apps.

Price:

- Incentives and Rebates: Communicate the financial benefits of purchasing an EV, such as government incentives, tax credits, and lower operating costs.
- Total Cost of Ownership: Educate consumers about the long-term cost advantages of EVs, including lower fuel and maintenance costs.

- Financing Options: Offer attractive financing options, such as low-interest rates or leasing programs, to make EVs more accessible to a broader range of consumers.

Promotion:

- Education and Awareness: Conduct marketing campaigns that focus on educating consumers about the benefits of EVs, dispelling myths, and addressing common concerns (e.g., range anxiety).
- Environmental Messaging: Highlight the positive environmental impact of driving an EV and position it as a responsible choice for eco-conscious consumers.
- Test Drives and Experiences: Provide opportunities for consumers to test drive EVs and experience the benefits firsthand. Organize events or partnerships that allow potential buyers to engage with the EV community and share experiences.

Place (Distribution):

- Charging Infrastructure: Collaborate with charging network providers to ensure a widespread and reliable charging infrastructure. Highlight the accessibility of charging stations in marketing efforts.
- Dealerships and Showrooms: Train sales staff on EV technology and benefits to provide accurate information and address customer concerns. Create dedicated spaces within dealerships to showcase EVs and provide a seamless purchasing experience.
- Online Presence: Develop a robust online presence, including an informative website, social media platforms, and online sales channels, to reach a broader audience and facilitate online purchases.

Additionally, integrating sustainability into all aspects of the marketing mix can strengthen the brand's positioning and resonate with environmentally conscious consumers. Communicate the brand's commitment to sustainability through eco-friendly packaging, partnerships with renewable energy providers, and transparent reporting on the carbon footprint of the manufacturing process.

It's crucial to continuously monitor the EV market, consumer preferences, and technological advancements to adapt the marketing mix strategies accordingly. EVs are an evolving industry, and staying agile and responsive to market dynamics will be key to success.

MOST OPTIMAL MARKET SEGMENT

Determining the most optimal market segment for electric vehicles (EVs) depends on various factors, including market conditions, consumer preferences, infrastructure development,

and business goals. While there is not a one-size-fits-all answer, the following segments have shown significant potential for EV adoption:

According to our analysis

top20 most sold cars and top20 most range giving vehicles and check if there is any correlation.

a. 6 out of top 10 most selling ones are in the top_10 electric range vehicles so range can be a reason of their sales

b. Model Names: MODEL 3, MODEL X, MODEL Y, NIRO, MODEL S, BOLT EV

Number of models of top 10 companies for each year for last 10.

a. earlier NISSAN and CHEVY used to have hold of the market then TESLA took over it

If we look at Tesla how they managed to sell highest vehicles in 2018 to 2023.

a. Tesla makes most EV.

b. Most of the Tesla vehicles are from 'WA' state

c. most models are from 2022 which are sold by tesla

d. Model S provide range up to 400 followed by Model 3 and Model Y

From average price analysis it can be concluded that 20.129k Euro is the most sustainable price required to manufacture SEAT Mii Electric(assumed to be any kind of vehicle like bike,car,mini scooter etc).While companies like skoda,opel,Volswagen producing vehicle under 50k Euro.

- Tesla produces the best automobile in terms of acceleration
- Tesla and Porcha have minimum charging time.
- It can be concluded that from a quality point of view Tesla won over others and is slightly more expensive than other vehicles.(Here Tesla refers to a Company in a hypothetical dataset that is producing one kind of vehicle only, say bikes, hence our company should start with manufacturing bikes).

According to the trend and dataset it suggests, people tend to buy cars in the range of 10 to 15 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 middle-level, with significant marketing about the pros of electric vehicles to the environment is required.

Our research also sheds light on the performance and efficiency of electric cars. We can make better educated judgements about the design and use of EVs if we understand the link between speed, acceleration, range, and economy. Furthermore, our prediction models provide a valuable tool for estimating EV performance, which can aid in the direction of future research and development in this quickly growing sector.

CODE IMPEMENTATION: -

1).Shubham Gupta- https://github.com/Shubhamgupta12345/ELectric-Vehicle

2).Jagjeet Singh- https://github.com/singhjagjeet101/EDA-Electric-Vehicle-Population-data

3).Gunjana Dhakad- https://github.com/Gunjanadhakad/EVs

4).Palla Pavan Kalyan-https://github.com/pkalyan607

5).Nimatullah-
https://github.com/naimat04/feynn_lab/tree/main/Project%202.1%3A%20Market%20Segmentation%20of%20Electric%20Vehicles