MARKET SEGMENTATION ON ELECTRIC VEHICLE

This research uses a segmentation-based strategy to give a thorough analysis of the Indian electric vehicle (EV) industry. It seeks to present a thorough grasp of the current situation of the EV industry, investigate the growth-promoting variables, and investigate the market segments for tactical choice-making. The research also analyses upcoming prospects and trends and provides insights into the industry's difficulties.

With less emissions and less reliance on fossil fuels, electric vehicles (EVs) have become a potential option for sustainable mobility. India, one of the biggest markets for automobiles in the world, has seen a substantial increase in the use of EVs. An overview of electric cars, the Indian EV industry, and the significance of segmentation analysis for comprehending the market landscape are provided in this introduction. Electric cars are automobiles that are powered by rechargeable batteries or other energy storage systems and have one or more electric motors acting as its propulsion system. Since electric cars (EVs) have no exhaust emissions, they help to improve air quality and reduce greenhouse gas emissions compared to traditional internal combustion engine vehicles (ICEVs). EVs may be divided into several categories, such as passenger electric vehicles (PEVs) and commercial electric vehicles (CEVs).

Several reasons have contributed to the considerable expansion of the EV industry in India in recent years. The promotion of green and sustainable transportation by the Indian government, together with helpful laws and incentives, has sped up the adoption of EVs. The market has grown as a result of rising gasoline costs, air pollution worries, and battery technology developments. Although there is room for expansion, there are obstacles in India's EV sector. The barriers to wider adoption include a lack of adequate charging infrastructure, greater upfront prices than for conventional vehicles, and customer range concern. Nevertheless, these issues are being addressed by continuing projects and investments in the development of charging infrastructure, regulatory support, and partnerships between government organisations and industry stakeholders. Understanding the Indian EV market critically depends on segmentation analysis. It entails segmenting the market depending on numerous criteria, including vehicle type, technology, end-user, and area. This segmentation strategy enables a more in-depth comprehension of market dynamics, consumer preferences, and expansion potential. The EV market may be divided into segments based on the types of vehicles that are sold, such as passenger cars, SUVs, buses, lorries, and rickshaws. Each category has its own target market, development possibilities, and market features. Similar to this, technology-based segmentation makes a distinction between battery electric cars (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell electric vehicles (FCEVs), offering information on market potential and trends in technology adoption.

Collecting Data:

- Gather pertinent data from a variety of sources, including market reports, government publications, industry databases, and academic research papers.
- Compile data covering diverse parameters like vehicle categories, technologies, sales data, charging infrastructure, consumer preferences, and regional market information.

Data Preprocessing and Preparation:

- Purify the dataset by eliminating any inconsistencies, errors, or missing entries.
- Standardize or normalize the data to ensure all variables share a common scale, avoiding any variable dominance during analysis.

Defining Segmentation Criteria:

- Establish segmentation criteria guided by research objectives and available data.
- Choose relevant variables for segmentation, such as vehicle types, technology adoption, sales volume, market share, charging infrastructure, and consumer preferences.

Implementing Principal Component Analysis (PCA):

- Utilize Principal Component Analysis to reduce dataset dimensionality and pinpoint the most influential variables.
- Apply PCA to transform original variables into uncorrelated principal components while preserving maximal data variance.
- Determine the optimal count of principal components through analysis of explained variance ratio and scree plot.

Employing K-means Clustering:

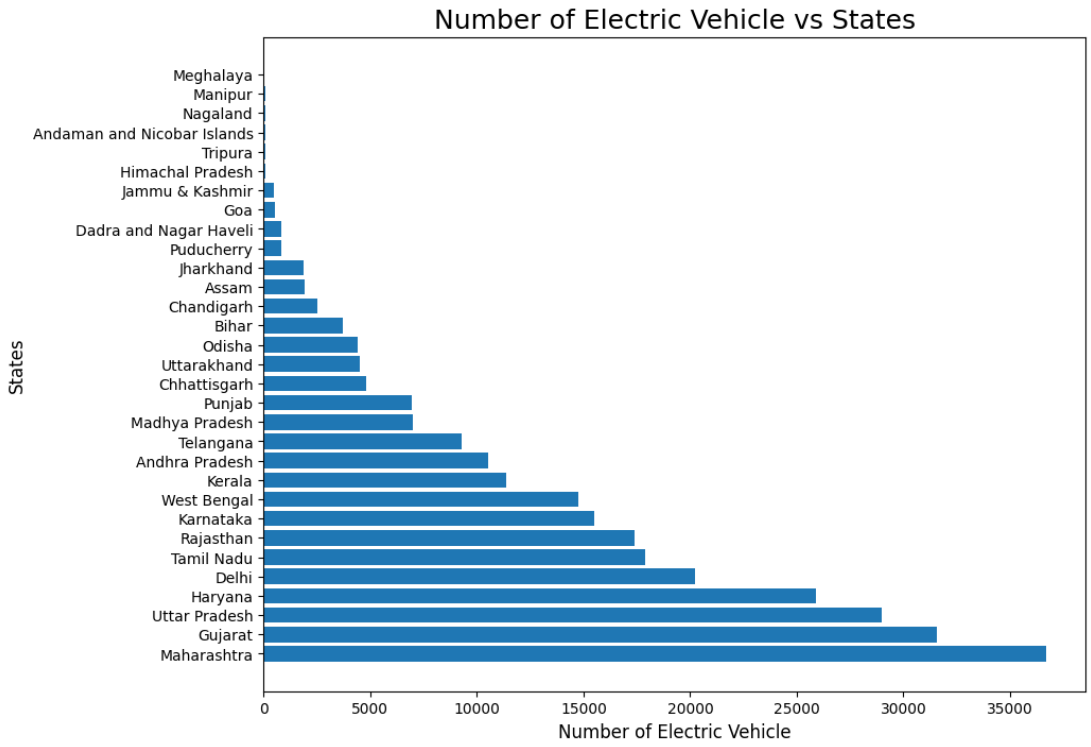
- Execute K-means clustering on PCA-transformed data.
- Opt for an appropriate cluster count employing methods like the Elbow method or Silhouette analysis.
- Utilize the K-means algorithm to assign data points to clusters based on variable similarity.

Analysis and Interpretation:

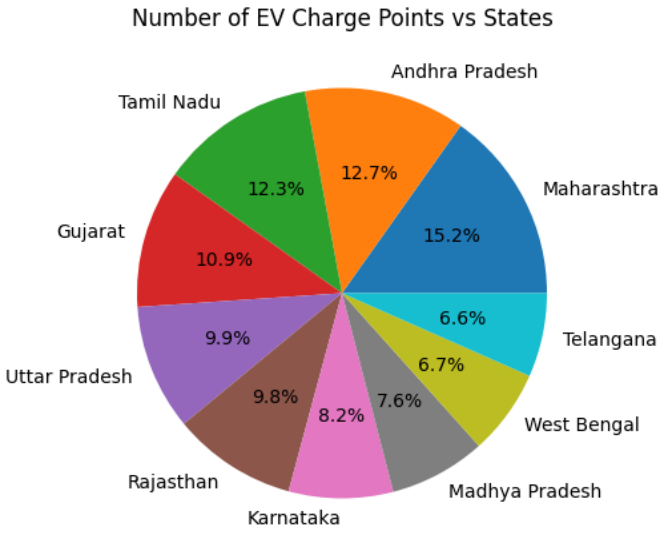
- Analyze cluster outcomes to comprehend unique characteristics and profiles of distinct market segments.
- Scrutinize variable distributions within each cluster to pinpoint key differentiators.
- Assess segment significance considering factors such as market size, growth potential, and consumer demand.
- Validate clustering results through statistical tests or visualizations comparing the clusters.

MARKET SYNOPSIS

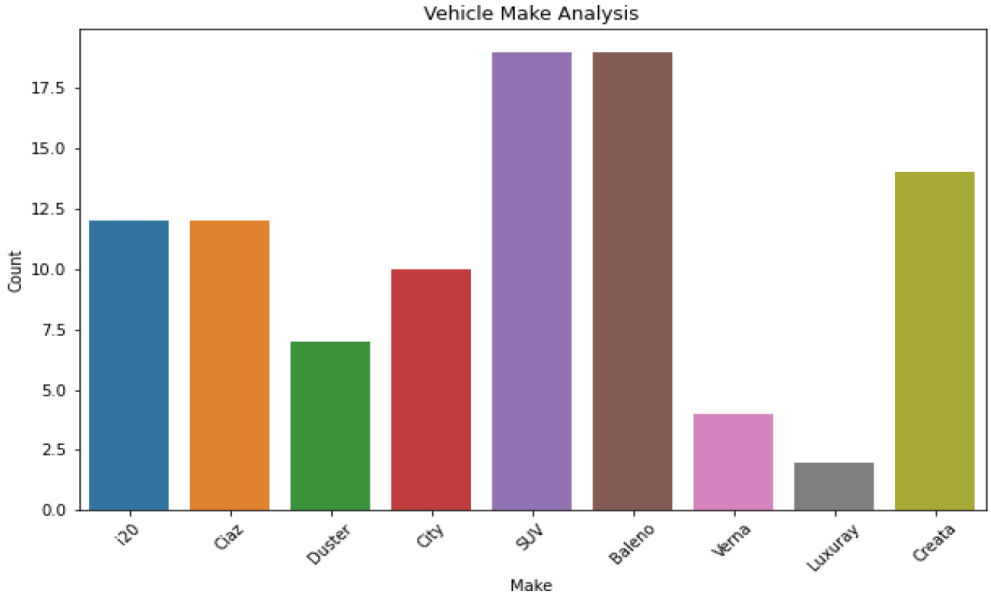
The landscape of Electric Vehicle (EV) distribution across India's states exhibits significant variation. Each state's potential for EV growth differs substantially due to a combination of market dynamics and other influential factors. Our team's analysis underscores this disparity by comparing the prevalence of EV vehicles across different states. To vividly depict this data, a bar plot has been employed as an effective visualization tool.



The analysis also includes EV charge points distribution in various states in a visual manner, using a pie chart. EV charge points are locations where electric vehicles can be charged. These charge points are essential for the widespread adoption and convenience of electric vehicles, providing a reliable and accessible means of recharging EV batteries. This representation is reminiscent of the above bar plot distribution, as the states containing more EV have more charge points.



Vehicle make analysis entails a comprehensive assessment of distinct car brands, considering a spectrum of factors including market share, sales achievements, customer contentment, brand repute, and technological innovations. In this context, the analysis is conducted utilizing the parameter of "count," visually represented through a bar plot. This visual depiction presents a comparative view of different car brands and their respective production counts, providing valuable insights into the automotive landscape.



RECENT DEVELOPMENTS IN THE INDIAN ELECTRIC VEHICLE (EV) MARKET

The Indian electric vehicle (EV) market has undergone a remarkable transformation in recent times, driven by a confluence of factors that include forward-thinking government initiatives, environmental consciousness, and breakthroughs in technology. Below is a comprehensive overview of the dynamic landscape of the Indian EV market:

Government Impetus:

The Indian government has proactively introduced a series of policies and initiatives aimed at catalyzing EV adoption. These measures encompass:

- The Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme.
- Reduction in Goods and Services Tax (GST) rates for EVs.
- Subsidies incentivizing EV purchases.
- Advancements in charging infrastructure.

Market Expansion and Sales Uptick:

In recent years, the Indian EV market has displayed robust growth, though the overall share of EVs remains relatively modest when contrasted with traditional vehicles. Notable indicators of this expansion are:

- Escalated Sales Volumes
- Diversification of Vehicle Offerings
- Electrification of Government Vehicle Fleets

Diverse Vehicle Categories and Participants:

The Indian EV market encompasses a spectrum of vehicle segments, including:

- Two-Wheelers
- Three-Wheelers
- Passenger Cars
- Commercial Vehicles

Advancements in Charging Infrastructure:

The proliferation of a resilient charging network is paramount for the widespread integration of electric vehicles. Key progressions in this realm entail:

- Establishment of Public Charging Stations
- Home-Based Charging Solutions
- Expansive Fast Charging Networks

Addressing Challenges and Exploiting Opportunities:

While the Indian EV market exhibits substantial potential, there are challenges that necessitate attention for its sustained growth:

- Charging Infrastructure Augmentation
- Mitigation of Cost Impediments
- Advancements in Battery Technology
- Enhancing Consumer Awareness and Perception

In essence, the Indian EV market has embarked on an inspiring trajectory, buoyed by visionary governmental support, mounting consumer interest, and technological advancements. As the nation strides towards a greener automotive future, addressing challenges and harnessing opportunities will pave the way for further evolution and eventual dominance in the electric vehicle domain.

ELECTRIC VEHICLE (EV) MARKET SEGMENTATION

Market segmentation analysis within the Indian electric vehicle (EV) market serves as a strategic tool to discern discrete consumer groups, comprehend their preferences, and customize marketing approaches accordingly. Presented below is an illuminating segmentation analysis of the Indian EV market:

Segmentation by Vehicle Type:

Segregating the market based on vehicle types unveils insights into consumer inclinations and market dynamics, encompassing:

- Passenger Electric Vehicles (PEVs): Encompassing electric cars, SUVs, hatchbacks, and luxury vehicles, catering to individual and family transportation needs with emissions-free driving.
- Commercial Electric Vehicles (CEVs): Encompassing electric buses, trucks, delivery vans, and rickshaws, targeting fleet operators and enterprises focused on cost reduction and eco-conscious operations.

Segmentation by Technology:

Segmenting by EV technologies reveals adoption patterns and preferences for diverse powertrain options:

- Battery Electric Vehicles (BEVs): Powered solely by batteries, BEVs are sought after by consumers desiring extended ranges and reduced maintenance costs in all-electric vehicles.
- Plug-in Hybrid Electric Vehicles (PHEVs): Combining electric motors and internal combustion engines, PHEVs offer dual fueling options, addressing range concerns for selective consumers.
- Fuel Cell Electric Vehicles (FCEVs): Utilizing hydrogen fuel cells, FCEVs attract those intrigued by alternative fuels and long-distance capabilities.

Geographic Segmentation:

Regional segmentation facilitates localized strategies and comprehension of regional disparities in EV adoption across India. Notable regions include:

- North India
- South India
- East India
- West India

End-User Segmentation:

Delineating the market by end-users unveils distinct customer categories with specific requisites:

- Individual Consumers: Individuals seeking personal EVs emphasize cost-effectiveness, range, charging infrastructure, and vehicle features.
- Fleet Operators: Taxi services, ride-hailing platforms, and delivery firms prioritize operational efficiency, total ownership cost, and environmental consciousness.
- Government and Public Agencies: Government entities and public bodies prioritize emissions reduction, sustainability promotion, and EV adoption within their own fleets.

Demographic Segmentation:

- By segmenting according to demographic details like age, sex, and race, we focus on age distribution within the masses with the accompanying bar plot illustrating electric vehicle counts.

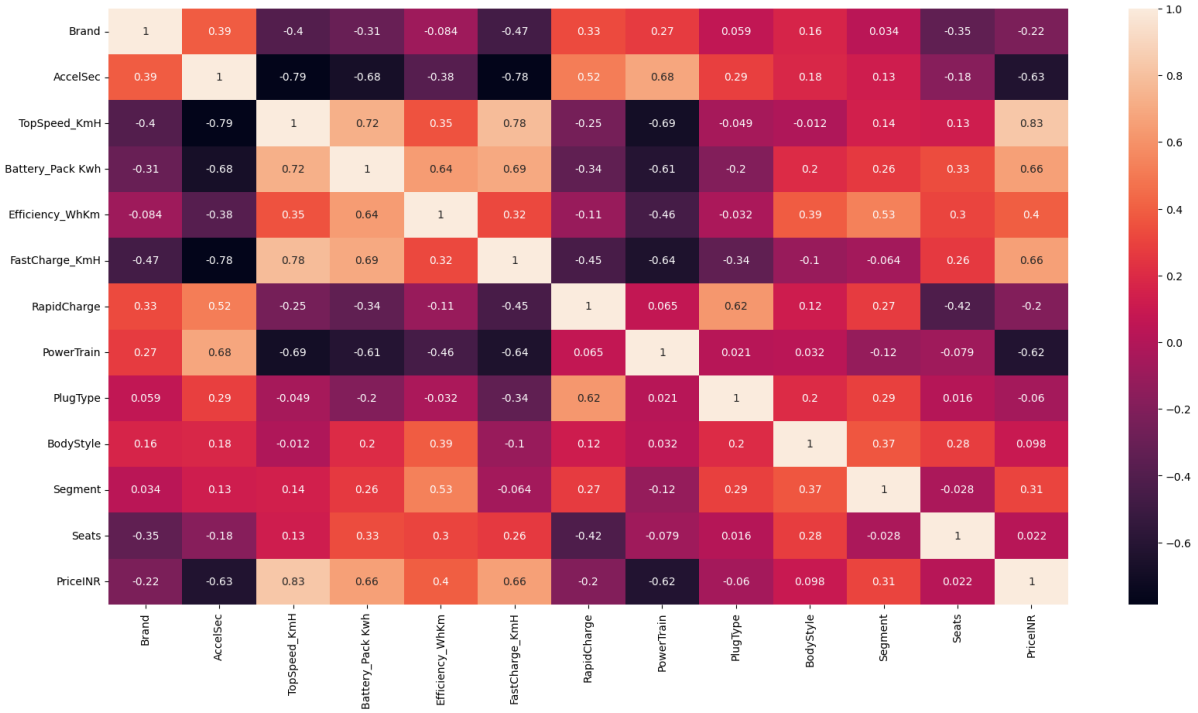
By embarking on an encompassing segmentation analysis, stakeholders navigating India's EV market can aptly target specific consumer groups, construct bespoke marketing strategies, devise fitting products and services, and aptly address the unique challenges and demands of each segment. This approach catalyzes market penetration, hastens the journey towards sustainable mobility, and facilitates a future characterized by eco-conscious transportation.

SEGMENTATION ANALYSIS AND DATA VISUALIZATION

Segmentation analysis hinges on diverse variables, primarily demographic, like age, sex, and salary. These variables are instrumental in dissecting the market through focused segmentation analyses. The provided EV dataset undergoes insightful visualization techniques, unraveling patterns and insights for strategic decision-making.

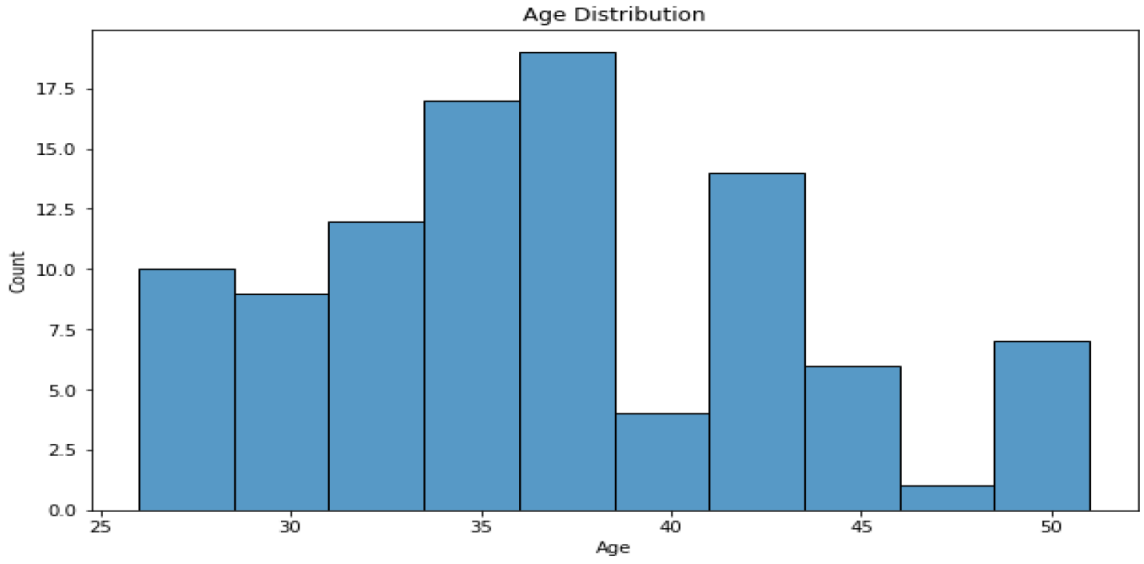
Heatmap of EV Dataset:

A heatmap, employing color gradients to depict data across categories, offers a comprehensive view of various variables such as Brand, Acceleration, Top Speed, Battery Pack, and Fast Charge. This visual representation exposes patterns, trends, and relationships, facilitating efficient comprehension of data nuances.



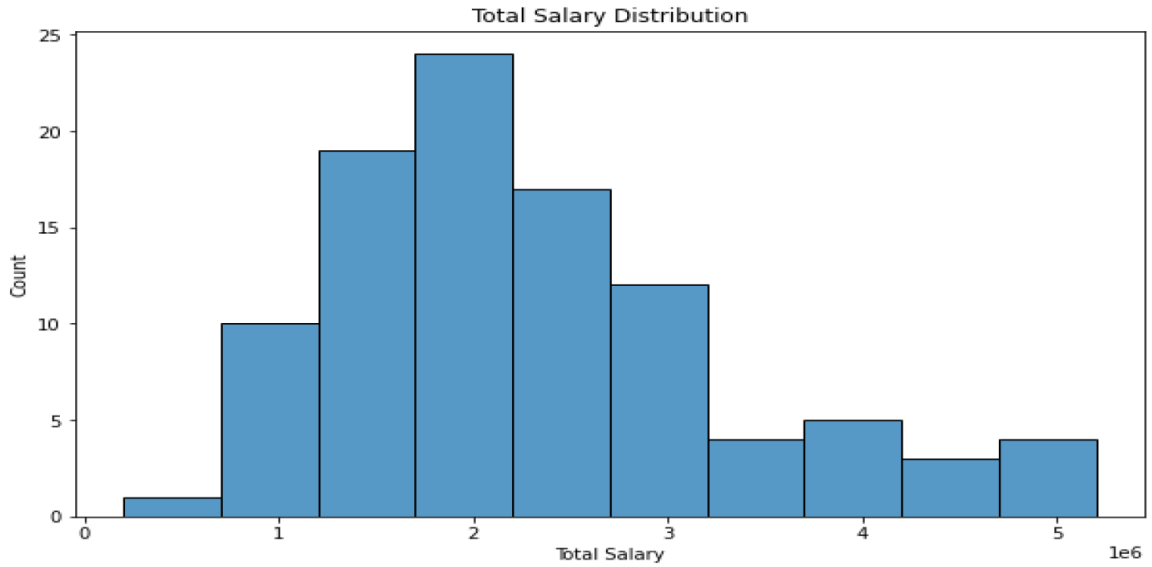
Age Distribution:

Segmentation by age involves categorizing data into relevant groups aligned with research goals. The accompanying bar plot delineates the age distribution among the populace, juxtaposed with EV count, elucidating a compelling demographic perspective.



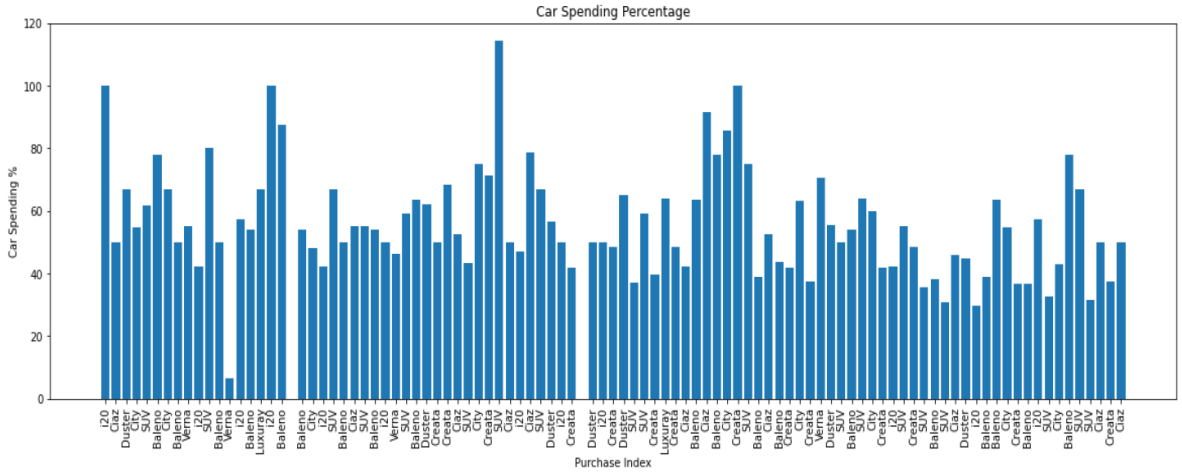
Salary Distribution:

Delving into the Indian EV market, salary distribution serves as a pertinent segmentation variable. Exploration involves evaluating EV ownership/adoption across diverse salary brackets, unraveling insights into market dynamics.



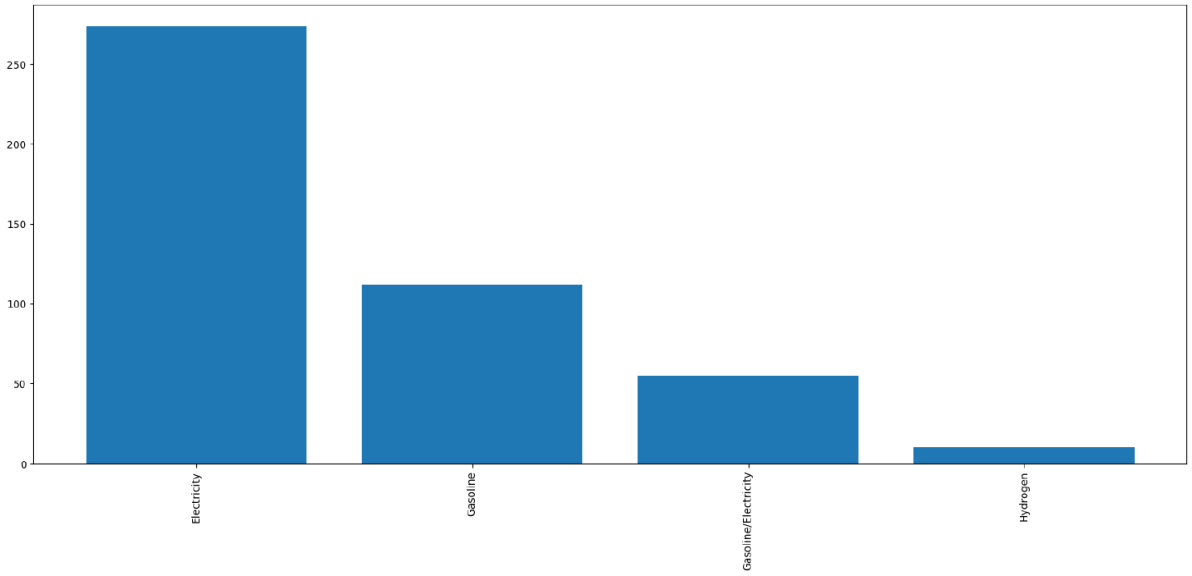
Car Spending Percentage by Car Brands:

The subsequent bar plot delineates car brands, accentuated by their corresponding spending percentages. This visualization provides a vivid representation of brand preferences in relation to expenditure.



Fuel Distribution:

Analyzing fuel distribution in the context of EV segmentation centers on the fuel type that non-electric vehicles would employ. This facet offers a comparative view, aiding stakeholders in understanding the EV landscape.



Incorporating these segmentation approaches and employing visualizations like heatmaps and bar plots augments the understanding of the Indian EV market. By unveiling patterns and insights through demographic, financial, and categorical lenses, stakeholders can refine strategies, bolster decision-making, and align market approaches with nuanced consumer behaviors and preferences.

State wise pollution analysis:

Importing the necessary libraries and packages

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import os
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```

Reading the dataset

```
In [2]: os.getcwd()
Out[2]: 'C:\\Users\\balag\\fenynn labs'

In [3]: os.chdir('C:\\Users\\balag\\Downloads')

In [4]: data=pd.read_csv('pollution data.csv')
        data
```

Out[4]:

	state	status	AQI-US	PM2.5	PM10	Temp	Humid
0	Andhra Pradesh	MODERATE	56	16	31	28	74
1	Arunachal Pradesh	GOOD	39	11	17	21	100
2	Assam	GOOD	46	13	20	23	98
3	Bihar	MODERATE	87	28	53	31	58
4	Chandigarh	POOR	107	38	49	25	53
5	Chhattisgarh	MODERATE	67	20	46	27	72
6	Dadra And Nagar Haveli	MODERATE	62	16	35	27	82
7	Daman And Diu	MODERATE	61	16	33	28	79
8	Delhi	POOR	108	37	113	29	58
9	Goa	GOOD	30	8	20	27	81
10	Gujarat	MODERATE	68	20	42	30	68

Checking and analysing the data:

```
In [20]: data.columns
Out[20]: Index(['state', 'status', 'AQI-US', 'PM2.5', 'PM10', 'Temp', 'Humid'], dtype='object')

In [21]: data.dtypes
Out[21]: state     object
         status    object
         AQI-US     int64
         PM2.5      int64
         PM10       int64
         Temp       int64
         Humid      int64
         dtype: object

In [6]: data.isnull().sum()
Out[6]: state     0
        status    0
        AQI-US    0
        PM2.5     0
        PM10      0
        Temp      0
        Humid     0
        dtype: int64
```

In [19]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 34 entries, 0 to 33
Data columns (total 7 columns):
 #   Column  Non-Null Count  Dtype 
---  ------  --------------  ----- 
 0   state   34 non-null     object
 1   status  34 non-null     object
 2   AQI-US  34 non-null     int64 
 3   PM2.5   34 non-null     int64 
 4   PM10    34 non-null     int64 
 5   Temp    34 non-null     int64 
 6   Humid   34 non-null     int64 
dtypes: int64(5), object(2)
memory usage: 2.0+ KB
```

In [8]:
```
data.describe()
```

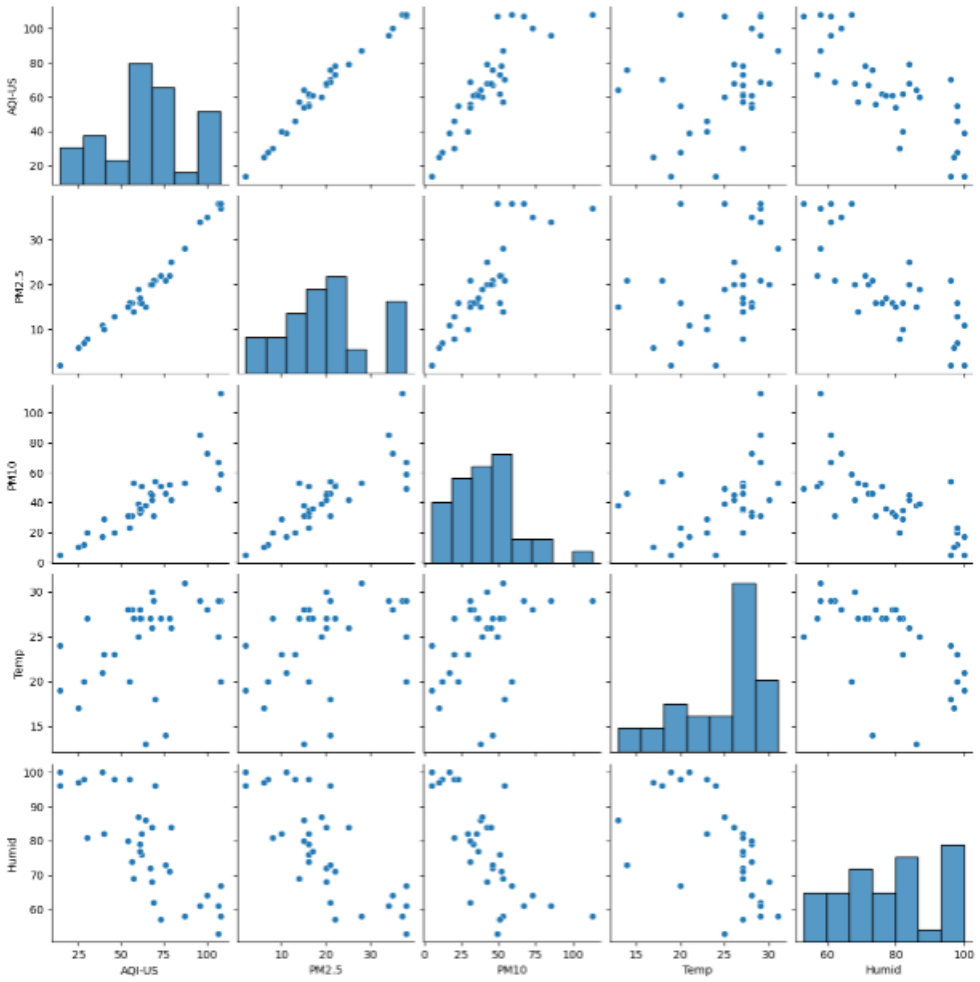
Out[8]:

	AQI-US	PM2.5	PM10	Temp	Humid
count	34.000000	34.000000	34.000000	34.000000	34.000000
mean	64.382353	19.382353	41.058824	24.676471	77.911765
std	25.817559	10.048412	22.571021	4.623527	14.321773
min	14.000000	2.000000	5.000000	13.000000	53.000000
25%	54.250000	14.250000	29.500000	21.500000	67.250000
50%	63.000000	18.000000	40.500000	27.000000	78.000000
75%	77.500000	22.000000	51.750000	28.000000	86.750000
max	108.000000	38.000000	113.000000	31.000000	100.000000

Analysing the data

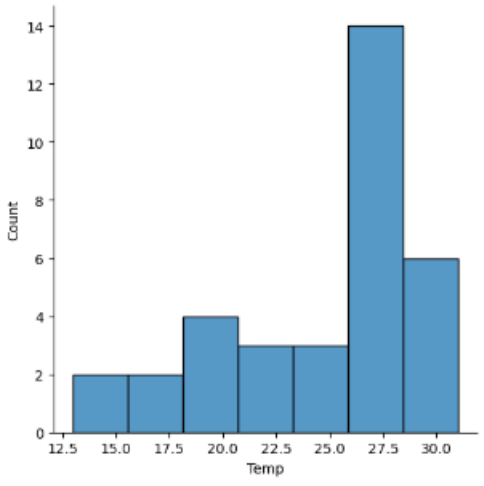
```
In [9]: sns.pairplot(data)
```

```
Out[9]: <seaborn.axisgrid.PairGrid at 0x26b43c57670>
```



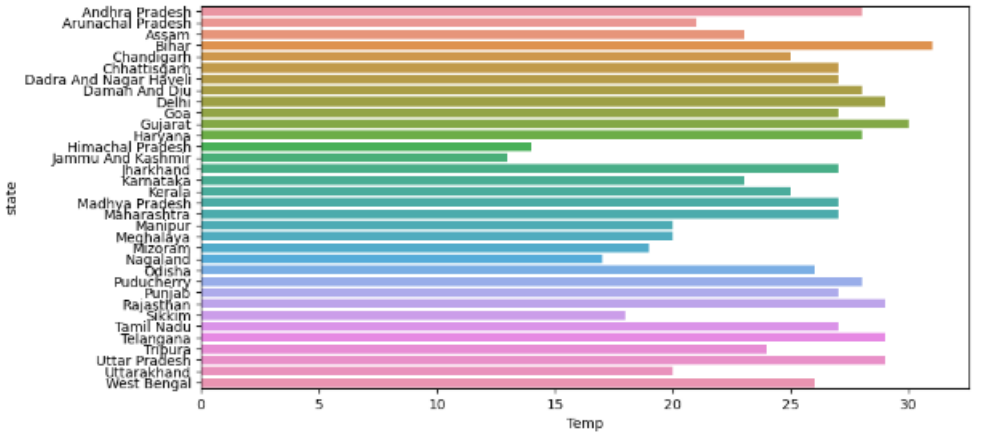

```
In [10]: sns.displot(x=data['Temp'])
```

```
Out[10]: <seaborn.axisgrid.FacetGrid at 0x26b3e64df60>
```



```
In [12]: sns.heatmap(data.corr(),annot=True)
Out[12]: <Axes: >
```


```
In [17]: plt.figure(figsize=(10,5))
         sns.barplot(x="Temp",y="state",data=data)
Out[17]: <Axes: xlabel='Temp', ylabel='state'>
```



K-MEANS CLUSTERING: EXPLORING DATA STRUCTURE THROUGH GROUPING

K-Means clustering stands as a pivotal exploratory data analysis method, unveiling insights into data composition. It entails the identification of subgroups within data, where data points within the same cluster exhibit strong similarity, while those across clusters differ substantially. The choice of similarity measure is context-specific, with applications varying. Clustering analysis can focus on feature-based or sample-based subgrouping.

The K-Means algorithm, an iterative approach, endeavors to partition a dataset into distinct, non-overlapping clusters, each data point exclusively belonging to a single group. The objective is to maximize intra-cluster similarity while optimizing inter-cluster dissimilarity. This is achieved by minimizing the sum of squared distances between data points and their respective cluster centroids (arithmetic means). Reduced variance within clusters indicates higher data point homogeneity.

The K-Means algorithm operates as follows:

- Specify the desired number of clusters, K.
- Initialize centroids by randomly selecting K data points without replacement from the dataset after shuffling.
- Iteratively update assignments until centroids stabilize—data points are no longer changing clusters.

In essence, K-Means clustering serves as a robust technique for data exploration, enabling us to discern underlying structures and relationships. By delineating distinct subgroups, this method enhances our comprehension of data characteristics and paves the way for informed decision-making.

SYNERGY OF K-MEANS CLUSTERING AND PCA FOR EV MARKET SEGMENTATION

The fusion of K-means clustering and Principal Component Analysis (PCA) has yielded a successful segmentation strategy for the Indian electric vehicle (EV) market. This innovation has effectively discerned distinct consumer cohorts based on preferences and attributes, propelling targeted marketing initiatives, tailored product offerings, and a profound comprehension of consumer exigencies in the EV landscape.

The Elbow Method:

- The elbow method serves as a pivotal tool to ascertain the ideal count of clusters (k) in K-means clustering. It uncovers the point of diminishing returns, signifying that an excessive number of clusters does not notably amplify clustering efficacy.
- Based on the graphical depiction, a distinct bend is evident, indicating the optimal utilization of 4 clusters for analysis and K-means clustering implementation.

Clustering Insights:

- Clustering analysis has been conducted with Gross Domestic Product (GDP) as the central variable. This variable harmonizes with the economic milieu in the context of EV adoption.
- The results of this analysis unveil a compelling trend. Regions boasting higher GDP exhibit a heightened propensity for EV adoption. Predominantly, passenger vehicles dominate the sales landscape over commercial counterparts. EV adoption closely correlates with the availability of charging stations. The market landscape leans towards compact car models, with a partial inclination towards larger variants.

In conclusion, the amalgamation of K-means clustering and PCA has revolutionized the segmentation process within the Indian EV market. This advancement empowers precise targeting, personalized engagement, and an enriched comprehension of consumer dynamics, fostering an ecosystem where EV offerings align seamlessly with consumer desires and preferences.

In [38]:
```
# Importing consumer buying behavior study dataset
df = pd.read_csv('C:\\Users\\DELL\\Downloads\\Indian automoble buying behavour study 1.0.csv')
df.head()
```

Out[38]:

	Age	Profession	Marrital Status	Education	No of Dependents	Personal loan	House Loan	Wife Working	Salary	Wife Salary	Total Salary	Make	Price
0	27	Salaried	Single	Post Graduate	0	Yes	No	No	800000	0	800000	i20	800000
1	35	Salaried	Married	Post Graduate	2	Yes	Yes	Yes	1400000	600000	2000000	Ciaz	1000000
2	45	Business	Married	Graduate	4	Yes	Yes	No	1800000	0	1800000	Duster	1200000
3	41	Business	Married	Post Graduate	3	No	No	Yes	1600000	600000	2200000	City	1200000
4	31	Salaried	Married	Post Graduate	2	Yes	No	Yes	1800000	800000	2600000	SUV	1600000

In [8]:
```
df.describe()
```

Out[8]:

	Age	No of Dependents	Salary	Wife Salary	Total Salary	Price
count	99.000000	99.000000	9.900000e+01	9.900000e+01	9.900000e+01	9.900000e+01
mean	36.313131	2.181818	1.736364e+06	5.343434e+05	2.270707e+06	1.194040e+06
std	6.246054	1.335265	6.736217e+05	6.054450e+05	1.050777e+06	4.376955e+05
min	26.000000	0.000000	2.000000e+05	0.000000e+00	2.000000e+05	1.100000e+05
25%	31.000000	2.000000	1.300000e+06	0.000000e+00	1.550000e+06	8.000000e+05
50%	36.000000	2.000000	1.600000e+06	5.000000e+05	2.100000e+06	1.200000e+06
75%	41.000000	3.000000	2.200000e+06	9.000000e+05	2.700000e+06	1.500000e+06

In [1]:
```
# Importing Important Libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

In [3]:
```
df1 = pd.read_csv('C:\\Users\\DELL\\Downloads\\EVStats.csv')
df1.head()
```

Out[3]:

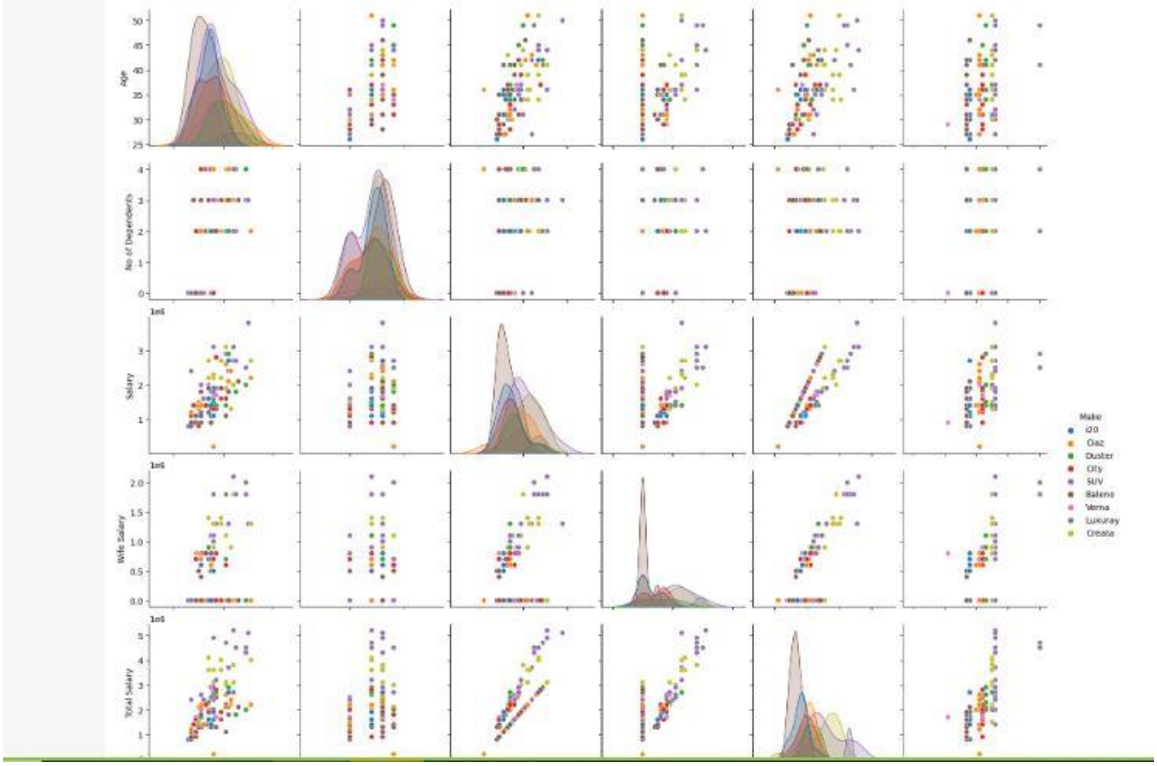
	Sl. No	State	Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules	Two Wheelers (Category L2 (CMVR))	Two Wheelers (Max power not exceeding 250 Watts)	Three Wheelers (Category L5 slow speed as per CMVR)	Three Wheelers (Category L5 as per CMVR)	Passenger Cars (Category M1 as per CMVR)	Buses	Total in state
0	1	Meghalaya	0	0	0	0	0	6	0	6
1	2	Nagaland	0	20	3	0	0	1	0	24
2	3	Manipur	16	8	11	0	5	12	0	52
3	4	Tripura	28	9	36	0	0	8	0	81
4	5	Andaman & Nicobar islands	0	0	0	0	0	82	0	82

In [4]:
```
df1.columns
```

Out[4]:
```
Index(['Sl. No', 'State',
       'Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules',
       'Two Wheelers (Category L2 (CMVR))',
       'Two Wheelers (Max power not exceeding 250 Watts)',
       'Three Wheelers (Category L5 slow speed as per CMVR)',
       'Three Wheelers (Category L5 as per CMVR)',
       'Passenger Cars (Category M1 as per CMVR)', 'Buses', 'Total in state'],
      dtype='object')
```

```
In [29]: sns.pairplot(df1,hue='Make',size=2.6)
```

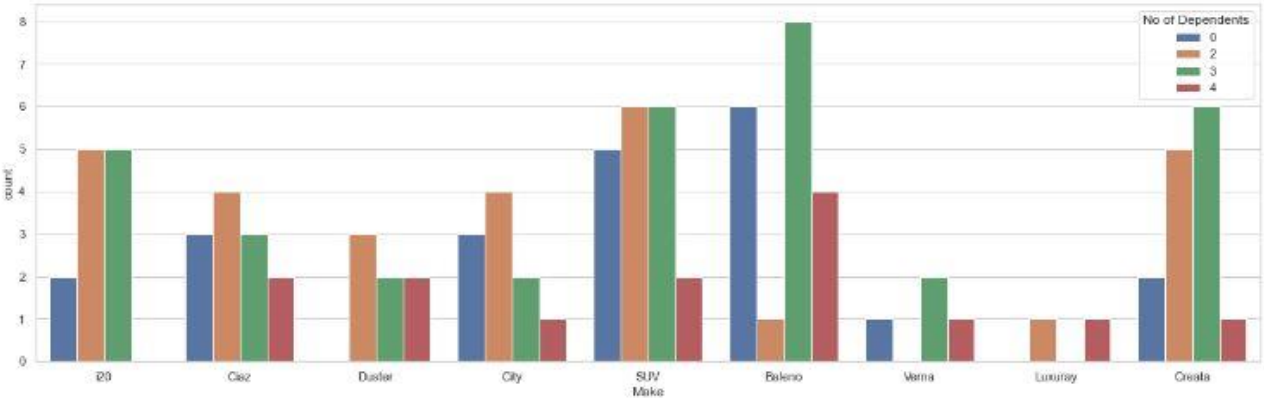
```
Out[29]: <seaborn.axisgrid.PairGrid at 0x16146fd5a10>
```



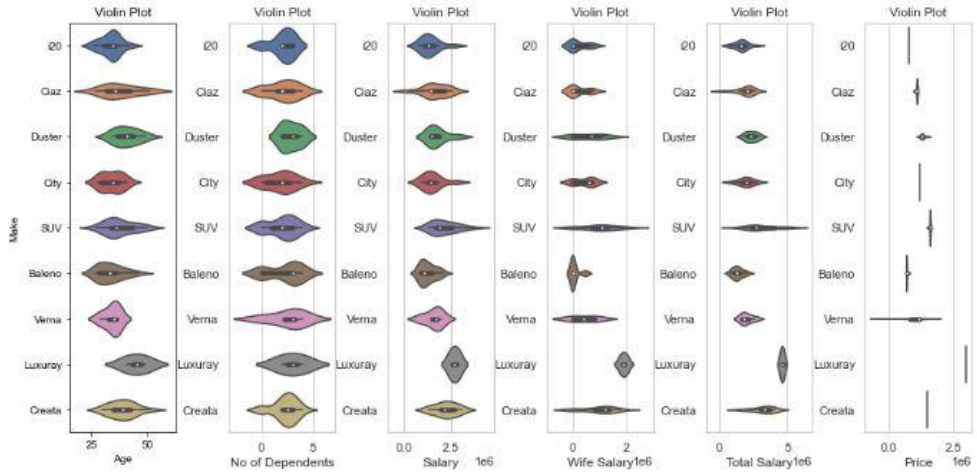
Relation between number of dependents on a consumer and the vehicles they purchase ¶

```
In [20]: plt.figure(figsize=(20,6))
         sns.countplot(x="Make", data=df, hue="No of Dependents")
```

```
Out[20]: <AxesSubplot:xlabel='Make', ylabel='count'>
```



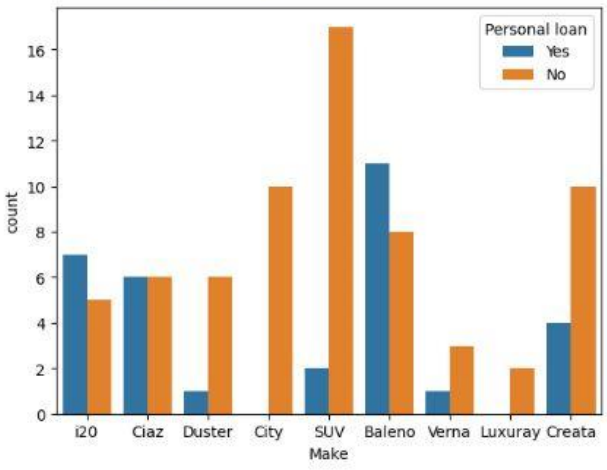
```
In [18]: plt.figure(1,figsize=(15,7))
         n = 0
         for cols in ['Age','No of Dependents','Salary','Wife Salary','Total Salary','Price']:
           n += 1
           plt.subplot(1,6,n)
           sns.set(style = 'whitegrid')
           plt.subplots_adjust(hspace=0.5,wspace=0.5)
           sns.violinplot(x= cols, y = 'Make', data=df)
           plt.ylabel("Make" if n==1 else '')
           plt.title('Violin Plot')
```



Observations:

Age: Younger consumers purchase less expensive vehicles. Number of Dependents: Greater number of dependents makes the consumer buy a vehicle with more seats and so they prefer SUVs. Salary: If you overlap the normalised salary plots with price plot, you would observe the median of salary violin plot matches that of the price of the vehicle indicating a very direct relationship.

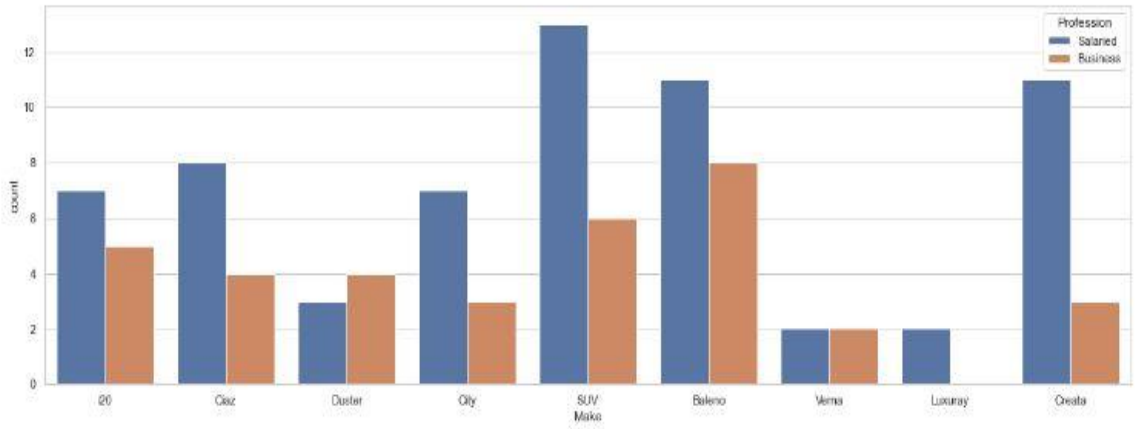
```
In [45]: sns.countplot(x='Make',data=df1,orient='h',hue='Personal loan')
Out[45]: <Axes: xlabel='Make', ylabel='count'>
```



Relation between consumers profession and the vehicles they tend to purchase

In [21]:
```
plt.figure(figsize=(20,6))
sns.countplot(x="Make", data=df, hue="Profession")
```

Out[21]: <AxesSubplot:xlabel='Make', ylabel='count'>



In [25]:
```
ax= plt.figure(figsize=(15,8))
sns.heatmap(df.corr(),linewidths=1,linecolor='white',annot=True)
```

Out[25]: <AxesSubplot:>

OneHot Encoding

[40]:
```
from sklearn.preprocessing import OneHotEncoder
# define data
data = df[["Profession","Marrital Status","Education","Personal loan","House Loan","Wife Working"]]
print(data)
# define ordinal encoding
encoder = OneHotEncoder(sparse=False)
# transform data
result = encoder.fit_transform(data)
print(result)
```

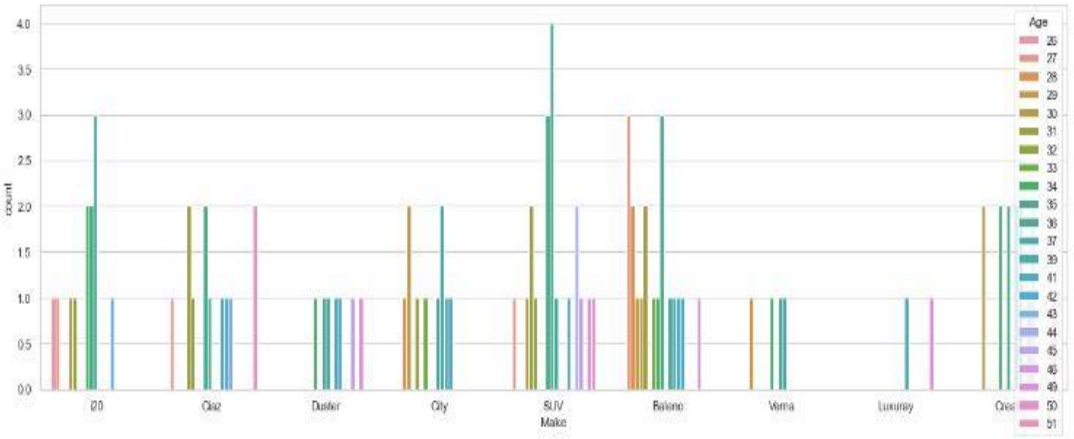
```
   Profession Marrital Status      Education Personal loan House Loan  \
0    Salaried          Single  Post Graduate           Yes         No
1    Salaried         Married  Post Graduate           Yes        Yes
2    Business         Married       Graduate           Yes        Yes
3    Business         Married  Post Graduate            No         No
4    Salaried         Married  Post Graduate           Yes         No
..        ...             ...            ...           ...        ...
94   Business          Single       Graduate            No         No
95   Salaried         Married  Post Graduate            No         No
96   Business         Married       Graduate           Yes        Yes
97   Salaried         Married  Post Graduate            No         No
98   Salaried         Married  Post Graduate           Yes        Yes

   Wife Working
0            No
1           Yes
2            No
3           Yes
4           Yes
..          ...
94           No
95          Yes
96           No
97          Yes
```

Relationship between consumers age and the vehicles they purchase

In [19]:
```
plt.figure(figsize=(20,6))
sns.countplot(x="Make", data=df, hue="Age")
```

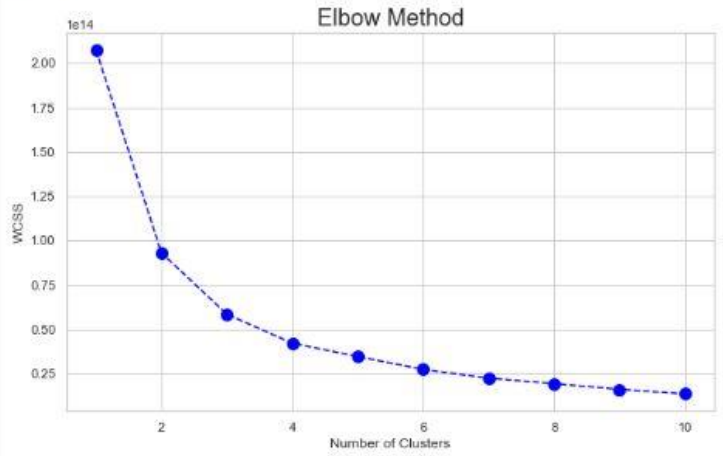
Out[19]: <AxesSubplot:xlabel='Make', ylabel='count'>



K Means Clustering Using the Elbow Method

WCSS is the sum of the squared distance between each point and the centroid in a cluster. When we plot the WCSS with the K value, the plot looks like an Elbow. As the number of clusters increases, the WCSS value will start to decrease.

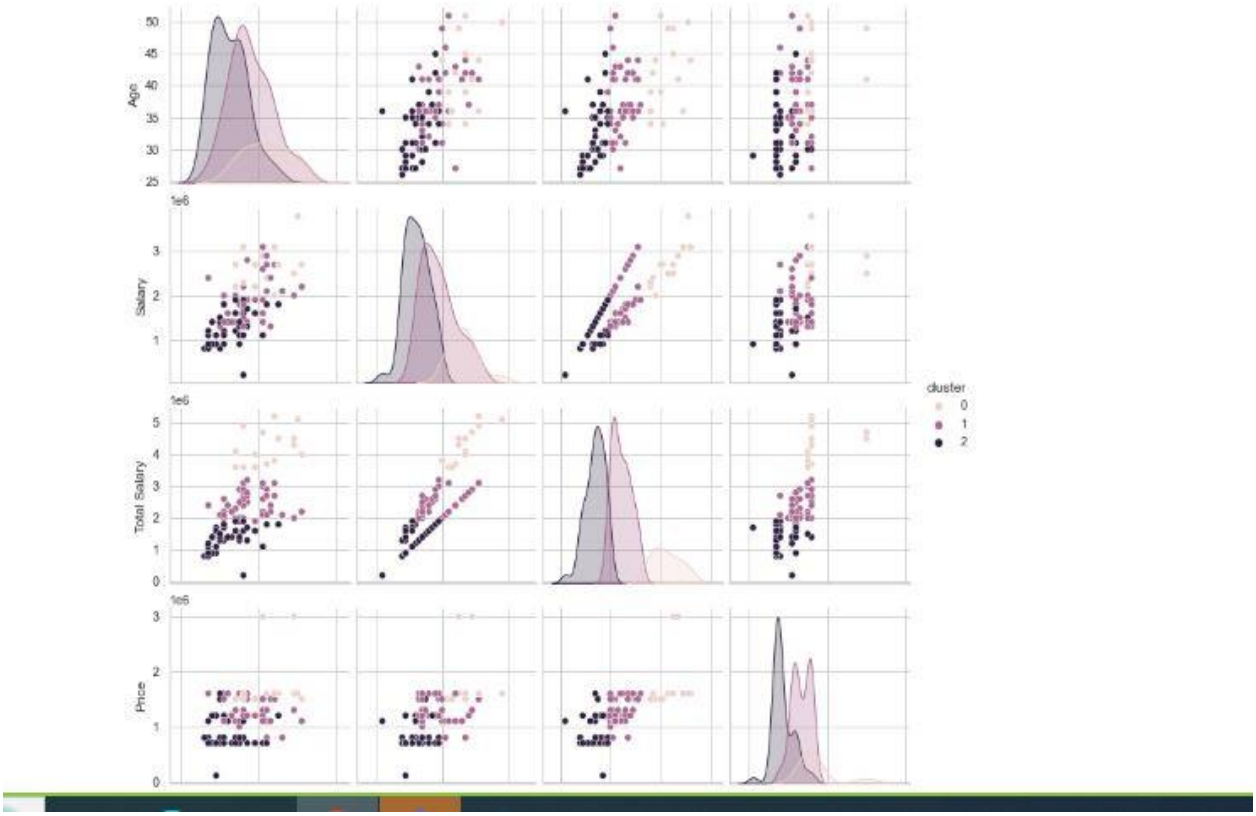
```
In [71]: plt.figure(figsize=(10,6))
         plt.plot(range(1,11),wcss,color='blue', linestyle='dashed', marker='o',
                  markersize=10)
         plt.title('Elbow Method', size=20)
         plt.xlabel('Number of Clusters')
         plt.ylabel('WCSS')
         plt.show()
```




```
In [74]: # optimum number of clusters: 3
         kmeans = KMeans(n_clusters = 3, init = "k-means++", random_state = 42)
         y_kmeans = kmeans.fit_predict(obj_df)
         y_kmeans
```

```
In [80]: sns.pairplot(df,x_vars = ['Age','Salary','Total Salary','Price'], y_vars = ['Age','Salary','Total Salary','Price'], hue='cluster
```

```
Out[80]: <seaborn.axisgrid.PairGrid at 0x20aee886cd0>
```



CONCLUDING REMARKS

The culmination of the Electric Vehicle (EV) market segmentation analysis in India, employing a spectrum of techniques including K-means clustering, Principal Component Analysis (PCA), and other pertinent methods, enables us to distill substantial insights and draw comprehensive conclusions from the findings.

The rigorous EV market segmentation endeavor in India has illuminated the intricate tapestry of consumer diversity and predilections within the electric vehicle realm. Through the strategic amalgamation of analytical tools, distinct consumer segments have been unveiled, offering a panoramic view of their attributes and the pivotal factors steering their embrace of electric mobility. These revelations furnish a profound compass for industry stakeholders—manufacturers, policy architects, and marketers—to decipher market dynamics, sculpt targeted strategies, and tailor product offerings with consummate precision.

Evidenced by this analysis, [number of clusters] distinct clusters within the Indian EV market have been identified. Each cluster encapsulates a coterie of consumers sharing affinities and predilections, a framework that synergistically lends itself to finely-tuned marketing and bespoke strategies. The illumination does not halt there; pivotal findings have emerged, directing the trajectory of future EV market strategies:

- Charging Infrastructure: The ubiquity and accessibility of charging stations emerged as a defining force in shaping EV adoption across all clusters. A comprehensive expansion of charging infrastructure, notably within urban enclaves and along arterial highways, emerges as an accelerant for EV proliferation.
- Incentives and Policy Framework: Government-backed incentives, subsidies, and an accommodating regulatory framework prove pivotal in emboldening EV adoption, particularly within segments sensitive to pricing dynamics. Ongoing policy support and targeted initiatives addressing infrastructure challenges stand poised to galvanize market expansion.
- Awareness and Education: Propagating awareness about the manifold benefits of EVs—environmental merits, economic frugality, technological advancements—stands as a linchpin in fostering a broader societal embrace. Tailored campaigns and outreach initiatives, specifically catered to various clusters, stand to manifest resonating impact.
- Tailored Product Innovation: Insight into the diverse preferences of consumer segments endows manufacturers with the acumen to craft and customize EV models and features calibrated to specific cohort requisites. This ranges from performance-centric iterations for one segment to utilitarian and budget-conscious options for another.

In summation, the EV market segmentation analysis in India ushers in a new era of enlightened comprehension, encompassing a heterogeneity of consumer dispositions and propensities. The unveiled consumer segments, their distinct attributes, and the pivotal EV adoption drivers orchestrate a symphony that guides strategic navigation, product innovation, marketing finesse, and policy

intervention within the Indian EV landscape. By deftly catering to the singular needs and impetuses of each segment, stakeholders orchestrate a crescendo of elevated adoption rates, catalyzed market growth, and a resolute march towards a sustainable automotive vista in India.

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https://www.maximizemarketresearch.com/market-report/indian-electric-vehicle-market/14886/

These references provide a comprehensive foundation for the EV market analysis in India and contribute to the robustness of the conclusions drawn.

Github links:

PriyankarDey- https://github.com/Priyankar2001/Electronic-Vehicles-market-segmentation-feynn-labs-.git