ELECTRIC VEHICLES MARKET ANALYSIS

By
Shinde Aditya

Problem Statement

I have to work under an Electric Vehicle Start-up. The Start-up is still deciding in which vehicle/customer space it will be develop its EVs.
I 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 most likely to use Electric vehicles.

What is Electric Vehicle?

An electric vehicle (EV) refers to a mode of transportation powered partially or entirely by electricity. The operational costs of EVs are notably low due to their simpler maintenance requirements, attributed to fewer moving parts. Additionally, they contribute to environmental well-being by minimizing reliance on fossil fuels such as petrol or diesel.

Although earlier EVs utilized lead acid or nickel-metal hydride batteries, contemporary battery electric vehicles predominantly employ lithium-ion batteries. These batteries have become the industry standard due to their extended lifespan and exceptional energy retention, featuring a mere 5% self-discharge rate per month. Despite these advancements, challenges persist, such as the risk of thermal runaway. This issue has led to incidents like fires or explosions in certain EV models, including the Tesla Model S. Nevertheless, ongoing efforts focus on enhancing the safety aspects of lithium-ion batteries.

Working principle

Electric vehicles operate based on a fundamental scientific principle: the conversion of energy. In this case, electrical energy undergoes transformation into mechanical energy. The essential component responsible for this conversion is an electric motor within the vehicle's electrical system. These motors come in various types, each playing a crucial role in facilitating the efficient and smooth transfer of energy from electricity to mechanical motion.

Market study

The question of whether electric vehicles will replace conventional vehicles yields an affirmative answer—yes. This shift is propelled by the abundant advantages of electric vehicles and the rapidly expanding market. The growth in

the electric vehicle sector is occurring at a threefold pace, and presently, electric vehicles account for 30% of the market supply. This trend suggests a trajectory where electric vehicles are poised to replace traditional vehicles in the foreseeable future.

People would prefer electric vehicles over normal vehicle in future because of the following reasons:

- **Lower running costs**

  The running cost of an electric vehicle is much lower than an equivalent petrol or diesel vehicle. Electric vehicles use electricity to charge their batteries instead of using fossil fuels like petrol or diesel. Electric vehicles are more efficient, and that combined with the electricity cost means that charging an electric vehicle is cheaper than filling petrol or diesel for your travel requirements. Using renewable energy sources can make the use of electric vehicles more eco-friendly. The electricity cost can be reduced further if charging is done with the help of renewable energy sources installed at home, such as solar panels.

- **Low maintenance cost**

  Electric vehicles have very low maintenance costs because they don't have as many moving parts as an internal combustion vehicle. The servicing requirements for electric vehicles are lesser than the conventional petrol or diesel vehicles. Therefore, the yearly cost of running an electric vehicle is significantly low.

- **Zero Tailpipe Emissions**

  Driving an electric vehicle can help you reduce your carbon footprint because there will be zero tailpipe emissions. You can reduce the environmental impact of charging your vehicle further by choosing renewable energy options for homeelectricity.

- **Tax and financial benefits**

  Registration fees and road tax on purchasing electric vehicles are lesser than petrol or diesel vehicles. There are multiple policies and incentives offered by thegovernment depending on which state you are in.

- **Creates very little noise**

  The electric vehicles run at almost no noise hence decreasing the sound pollutionand environmentally friendly.

- **No exhaust, spark plugs**

  No exhaust, hence no air, sound pollution; as it runs on electrical energy, there isno need of any spark plug.

Data Collection

1. Kaggle
2. FirstPost
3. JmkResearch

Segmentation Criteria

The concept of segmentation criteria pertains to the kind or nature of information utilized in market segmentation, distinct from the segmentation variable, which refers to empirical data variables used to split a sample into market segments. In the process of segmentation, the focus is on identifying specific characteristics within a data sample, clustering individuals with similar traits, and analyzing shared interests to optimize organizational profits.

Geographic Segmentation

In Geographic Segmentation the key criteria to form market segments is the geographic location or the residence of the customer. There are some specific advantages of doing geographic segmentation, they are, we can segment down all the customers in that particular area, do promotions which are meaningful in that area and even run adds in news-papers, television, etc. in that local area. The only key disadvantage is that it not always the case that all the people residing in the same location will have same opinions and preferences in the products.

Socio-Demographic Segmentation

Socio-Demographic Segmentation criteria includes parameters like age, gender, education, income, etc. For ex, while buying cosmetics criteria associated is gender, while buying branded and luxury items criteria associated is income, while planning on vacation destination criteria associated is age (i.e., if people go in couple the vacation destination will be different if people going with children, then the vacation destination is different). The socio-demographic segmentation at times with better data can give us the better market segments and gives us the clear clarity on the who the customer is, this is achievable provided better data that provides sufficient insights about who the customer is and the market segments. But in many cases, socio-demographic segmentation would not be the best fit for product preferences.

Psychographic Segmentation

This type involves segmenting the market based on psychological and lifestyle attributes of individuals, considering factors like values, interests, attitudes, and behaviors.

Behavioural Segmentation

In Behavioural segmentation we can directly find similarities in behaviours of customers. There can be many useful implementations possible for doing market segments. Behavioural segmentation criteria depend on the way visitors interact with the website. Some data depends on their immediate online behaviour and giving positive feedback while other data depends on their past offline behaviour or negative feedback.

Pre-Processing Data before performing Segmentation

1. **Categorical Variables**
   Two pre-processing procedures are often used for categorical variables. One is merging levels of categorical variables before further analysis, the other one is converting categorical variables to numeric ones, if it makes sense to do so. Merging levels of categorical variables is useful if the original categories are too differentiated (too many).

2. **Numerical Variables**
   In distance-based methods of segment extraction, the range of values of a segmentation variable determines its relative influence. If one of the segmentation variables is binary (with values 0 or 1 indicating whether or not a customer views on the product of fast food), and a second variable indicates the expenditure in dollars per person per day (with values ranging from zero to $1000), a one-dollar difference in spend per person per day is weighted equally as the difference in liking to dine out or not.

3. **Univariate Variables**
   We take one feature and based on that we will try to classify what the output is going to be. In McDonald's dataset, we took age as feature and classified based how much they are liked. From our data all the persons who gave positive feedback '4' and above their age is around '20' and the data are fit (overlapped) one guy from age.

4. **Bivariate Variables**
   Bivariate analysis is slightly more analytical than Univariate analysis. When

the data set contains two variables and researchers aim to undertake comparisons between the two data set then Bivariate analysis is the right type of analysis technique.

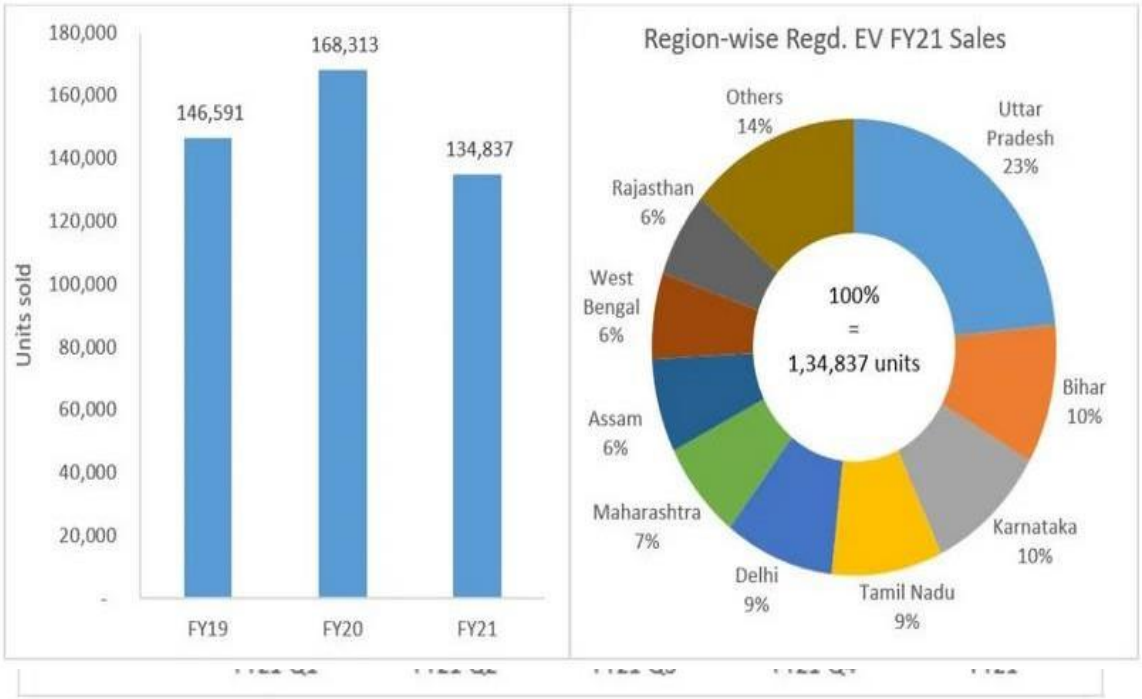
5. **Multivariate Variables**

Multivariate analysis is a more complex form of statistical analysis technique and used when there are more than two variables in the data set. Here we can apply PCA to reduce the dimensions.

Electric Vehicles Sales trends

Fig. 1: FY2021 Quarterly Sales Trend – Registered EVs

Fig. 2: FY Sales Trend – Registered EVs



Budget wise EV cars analysis

Analysing the data

In [58]:
```
mid_range_cars= df1.loc[df1['PriceRange'] <=3000000]
high_range_cars= df1.loc[df1['PriceRange'] >3000000]
s1 = ['Less than INR 3000000']
s2 = ['More than INR 3000000']
```

In [68]:
```
mid_range_cars
```

Out[68]:

	Car	Style	Range	Transmission	VehicleType	PriceRange	Capacity	BootSpace	BaseModel	TopModel	Unnamed: 10
0	Tata Nexon EV	Compact SUV	312 Km/Full Charge	Automatic	Electric	939950.0	5 Seater	350 L	XM	Dark XZ Plus LUX	NaN
1	Tata Tigor EV	Subcompact Sedan	306 Km/Full Charge	Automatic	Electric	1306500.0	5 Seater	316 L	XE	XZ Plus Dual Tone	NaN
2	Tata Nexon EV Max	Compact SUV	437 Km/Full Charge	Automatic	Electric	1306500.0	5 Seater	350 L	XZ Plus 3.3 kW	XZ Plus Lux 7.2 kW	NaN
3	MG ZS EV	Compact SUV	419 Km/Full Charge	Automatic	Electric	2393500.0	5 Seater	448 L	Excite	Exclusive	NaN
4	Hyundai Kona Electric	Compact SUV	452 Km/Full Charge	Automatic	Electric	2388500.0	5 Seater	na	Premium Dual Tone	HSE	NaN
7	BYD E6	Subcompact MPV	415 Km/Full Charge	Automatic	Electric	2915000.0	5 Seater	580 L	STD	na	NaN

In [69]:
```
high_range_cars
```

Out[69]:

	Car	Style	Range	Transmission	VehicleType	PriceRange	Capacity	BootSpace	BaseModel	TopModel	Unnamed: 10
5	Jaguar I-Pace	Premium Midsize Sedan	470 Km/Full Charge	Automatic	Electric	10900000.0	5 Seater	656 L	S	Sportback 55	NaN
6	Audi E-Tron GT	Premium Coupe	388 Km/Full Charge	Automatic	Electric	18000000.0	5 Seater	405 L	Quattro	na	NaN
8	Mercedes-Benz EQC	Compact SUV	471 Km/Full Charge	Automatic	Electric	10000000.0	5 Seater	na	na	na	NaN
9	BMW iX	Premium Fullsize SUV	425 Km/Full Charge	Automatic	Electric	11600000.0	5 Seater	na	na	na	NaN
10	Porsche Taycan	Premium Sports Sedan	na	Automatic	Electric	15000000.0	4 Seater	na	na	na	NaN

Creating segments of high range and low-mid range cars

mid-range vehicles with max range

In [59]:
```
pd.set_option('display.max_columns', None)
max_range = mid_range_cars.sort_values(by= 'Range')
print(max_range[['Car', 'Style', 'Range', 'PriceRange', 'BootSpace']])
```

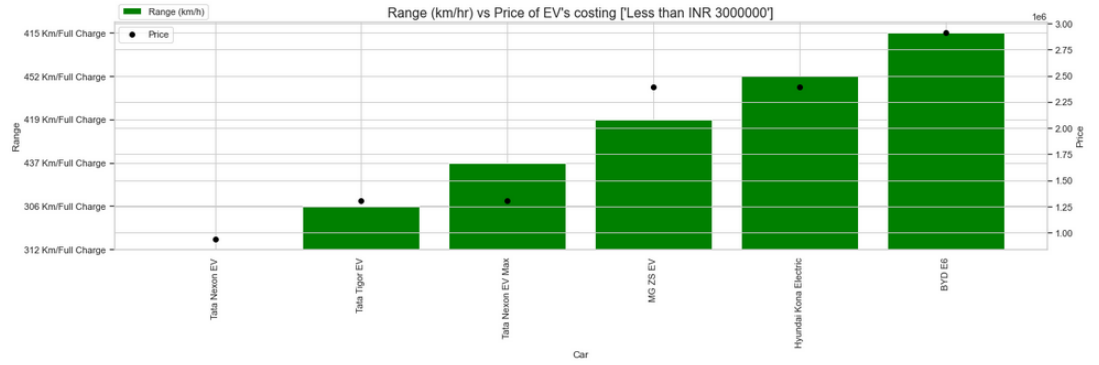
```
                  Car             Style              Range  PriceRange  \
1         Tata Tigor EV  Subcompact Sedan  306 Km/Full Charge   1306500.0
0         Tata Nexon EV       Compact SUV  312 Km/Full Charge    939950.0
7                BYD E6    Subcompact MPV  415 Km/Full Charge   2915000.0
3             MG ZS EV       Compact SUV  419 Km/Full Charge   2393500.0
2     Tata Nexon EV Max       Compact SUV  437 Km/Full Charge   1306500.0
4  Hyundai Kona Electric      Compact SUV  452 Km/Full Charge   2388500.0

  BootSpace
1     316 L
0     350 L
7     580 L
3     448 L
2     350 L
4        na
```

Mid-range vehicles(mid-range price) with max range(Km/Full)

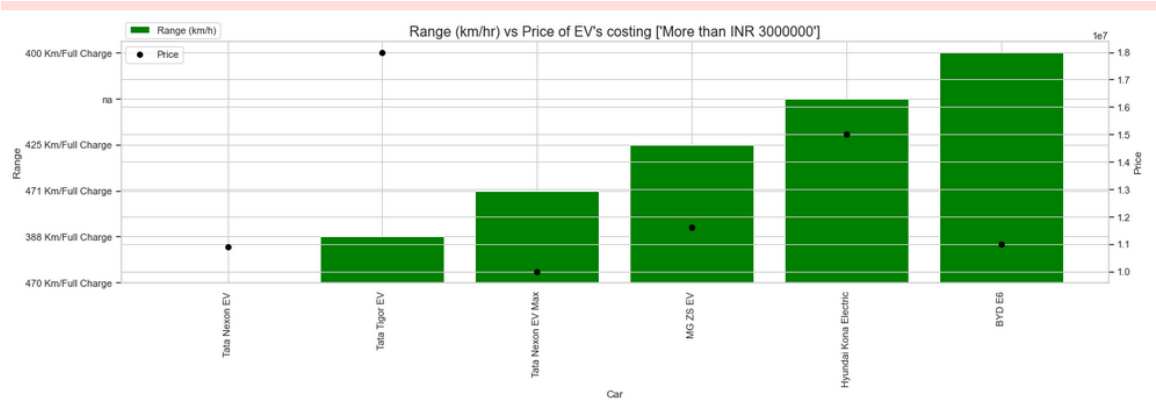
Visualizing Price - Range

In [67]:
```
def pricerange(dataframe, text):
    plt.figure(figsize=(20,5))
    a_1 = plt.subplot()
    a_1.bar(dataframe['Car'], dataframe['Range'], label='Range (km/h)', color='green')
    plt.legend(loc = 'upper left', bbox_to_anchor = (0,1.1))
    a_2 = a_1.twinx()
    a_2.scatter(dataframe['Car'], dataframe['PriceRange'], label = 'Price', color='black')
    plt.title('''Range (km/hr) vs Price of EV's costing {}'''.format(text), fontsize = 16)
    a_1.set_xlabel('Car')
    a_1.set_ylabel('Range')
    a_2.set_ylabel('Price')
    plt.legend(loc= 'upper left', bbox_to_anchor = (0,1))
    a_1.set_xticklabels(mid_range_cars['Car'], rotation = 'vertical')
    plt.show()

pricerange(mid_range_cars,s1)
pricerange(high_range_cars,s2)
```

```
C:\Users\SWAYAM\AppData\Local\Temp/ipykernel_6668/4044561395.py:13: UserWarning: FixedFormatter should only be used togeth
er with FixedLocator
  a_1.set_xticklabels(mid_range_cars['Car'], rotation = 'vertical')
```



Barplot of Range vs Price of Mid-range cars



Barplot of Range vs Price of High-range cars

Factors Affecting an EV start up in India

For an EV start up there are some other factors which may affect its business. To analyse these factors we have divided our segments state wise. Some of the factors considered in our report are:

1. Percentage of Tax Exemption given by the respective State/UT
2. Subsidy Amount(in INR) given by the respective State/UT
3. Fuel(Petrol and diesel) prices in the respective State/UT
4. Pollution/Air Quality of the respective State/UT

An EV company can put up their showroom in the region where the state is

giving maximum Tax Exemption and Subsidy as this would be helpful in business point of view. It can also put up their showroom where the fuel prices are high as people in those states/UT's would be looking for another alternative than paying huge prices for the fuel. In environment point of view an EV company start their business in the region whose air quality is not good or poor, people over there would be also willing to decrease the pollution rate by switching their means of transport from fuel to electric, This would be helpful for both company and the environment.

Based on these factors and their dependencies some datasets are prepared manually to analyse which region would be helpful for an EV start up in India. The information present there is not 100% accurate, but maximum care has been taken for the information to be error free.

State wise tax relaxation, subsidy and fuel prices analysis

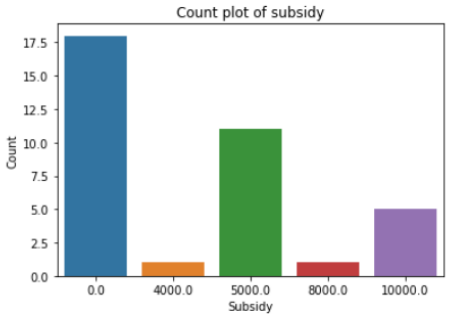
Analysing the data

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

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 36 entries, 0 to 35
Data columns (total 6 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   state     36 non-null     object
 1   capital   36 non-null     object
 2   subsidy   36 non-null     float64
 3   road tax  36 non-null     float64
 4   petrol    36 non-null     float64
 5   diesel    36 non-null     float64
dtypes: float64(4), object(2)
memory usage: 1.8+ KB

In [3]: data.isnull().sum()

Out[3]: state       0
capital     0
subsidy     0
road tax    0
petrol      0
diesel      0
dtype: int64
```

Information about the data and checking for any null values in it

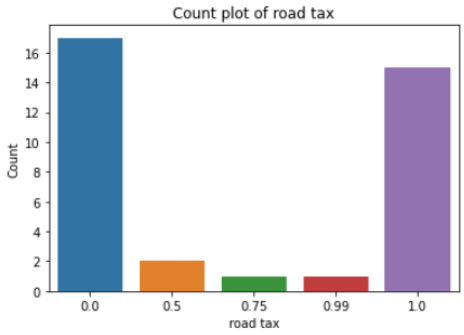
Visualization

In [5]:
```
sns.countplot(x=data["subsidy"])
plt.title('Count plot of subsidy')
plt.xlabel('Subsidy')
plt.ylabel('Count')
plt.show()
```



Count plot of subsidy

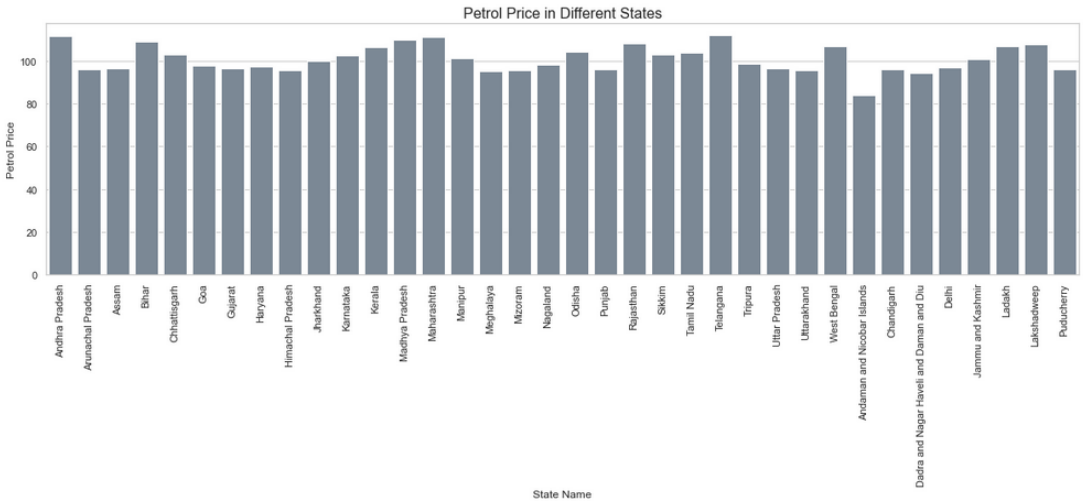
In [6]:
```
sns.countplot(x=data["road tax"])
plt.title('Count plot of road tax')
plt.xlabel('road tax')
plt.ylabel('Count')
plt.show()
```



count plot of road tax

In [14]:
```
plt.figure(figsize=(20, 5))
sns.set_theme(style="whitegrid")
sns.barplot('state', 'petrol', data=data, color = 'lightslategrey')
plt.title('Petrol Price in Different States' , fontsize = 16)
plt.ylabel('Petrol Price')
plt.xlabel('State Name')
plt.xticks(rotation=90)
plt.show()
```

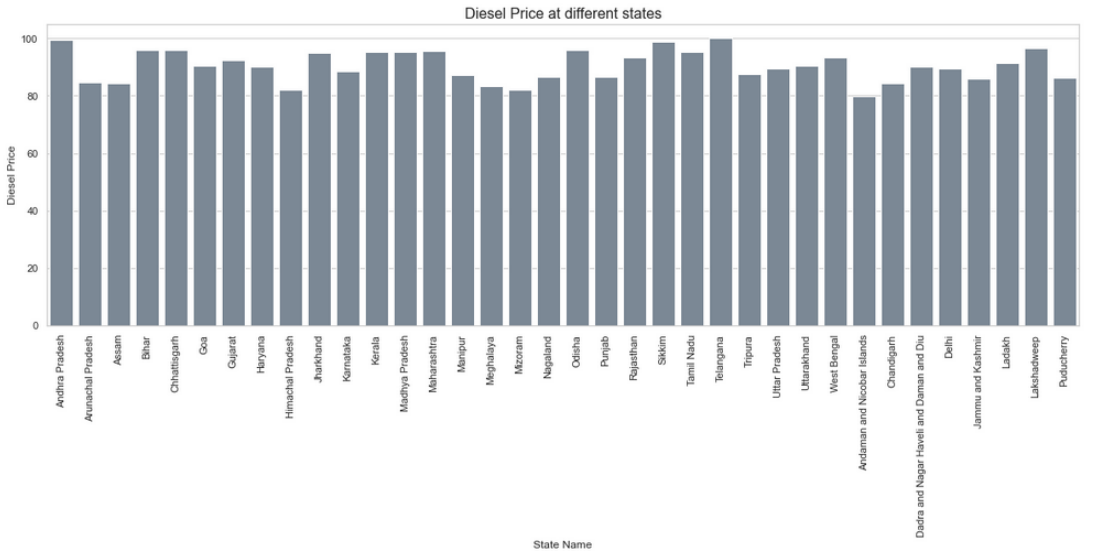
```
F:\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variables as keyword args: x,
y. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit k
eyword will result in an error or misinterpretation.
  warnings.warn(
```



Bar plot of petrol prices in different states

In [16]:
```
plt.figure(figsize=(20, 6))
sns.set_theme(style="whitegrid")
sns.barplot('state', 'diesel', data=data, color = 'lightslategrey')
plt.title('Diesel Price at different states' , fontsize = 16)
plt.ylabel('Diesel Price')
plt.xlabel('State Name')
plt.xticks(rotation=90)
plt.show()
```

```
F:\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variables as keyword args: x,
y. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit k
eyword will result in an error or misinterpretation.
  warnings.warn(
```

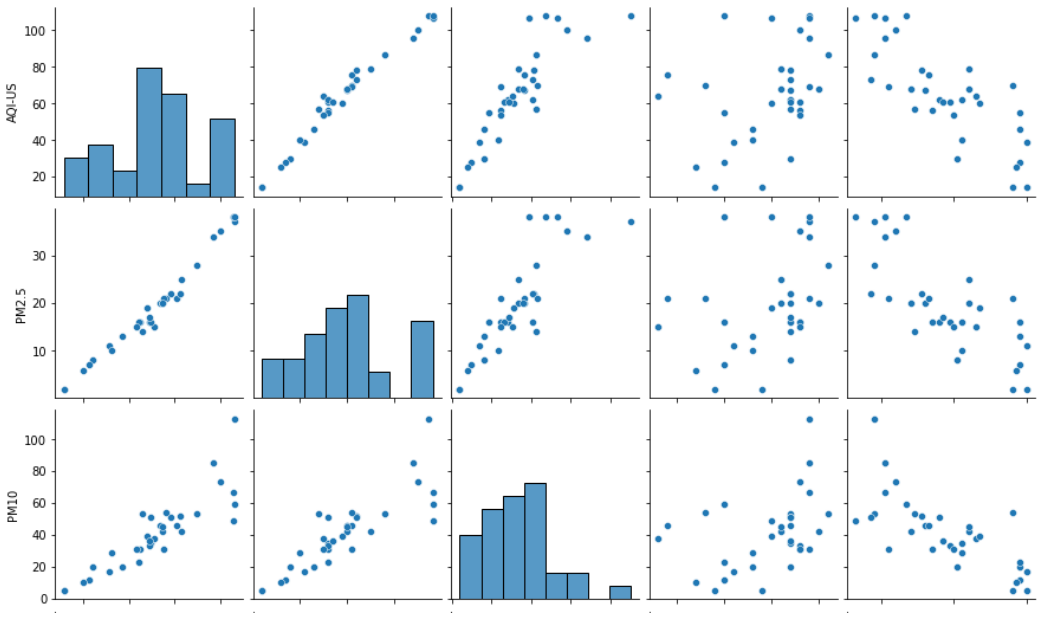


Bar plot of Diesel prices in different states

State wise Pollution data analysis

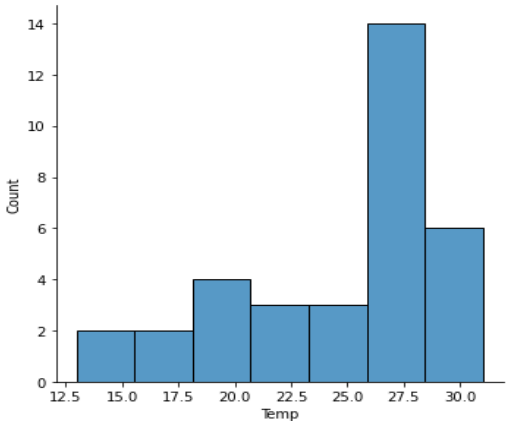
Analysing the data

```
In [6]: sns.pairplot(data)
Out[6]: <seaborn.axisgrid.PairGrid at 0x2bdb112efa0>
```



Pairplot of the data present in the dataset

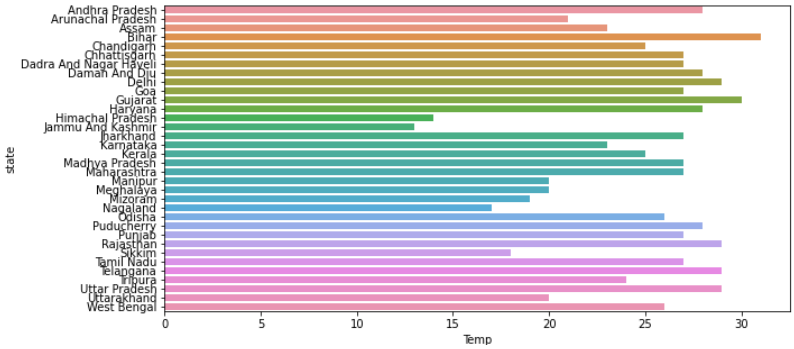
```
In [8]: sns.displot(x=data["Temp"])
Out[8]: <seaborn.axisgrid.FacetGrid at 0x2bdad3e0250>
```



Displot of State wise Temperature data

In [19]:
```
plt.figure(figsize=(10,5))
sns.barplot("Temp","state",data=data)
```

Out[19]: <AxesSubplot:xlabel='Temp', ylabel='state'>

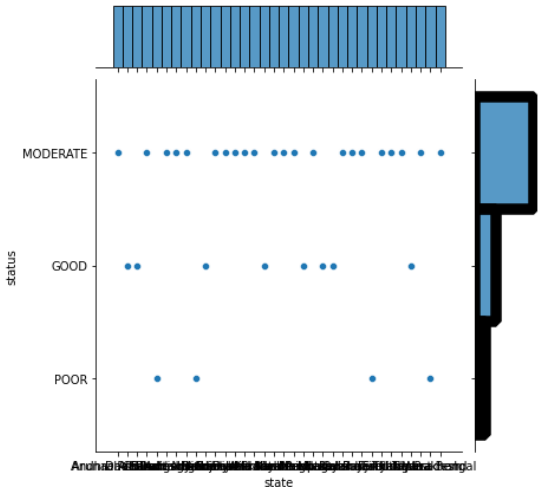


Barplot of State wise Temperature data

temp

In [32]:
```
plt.figure(figsize=(8,16));
sns.jointplot(x='state', y='status', data=data, kind='scatter',space=0.2,palette="coolwarm");
```

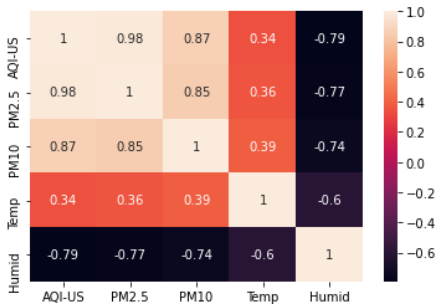
<Figure size 576x1152 with 0 Axes>



Jointplot of State wise air quality

In [52]:
```
sns.heatmap(data.corr(),annot=True)
```

Out[52]: <AxesSubplot:>



Heatmap of the data present in the dataset

Conclusion

The insights and visualizations presented in this analysis offer valuable guidance for any company contemplating the establishment of an electric vehicle (EV) startup in India. Notably, the concentration within the EV market is observed to be higher in the segment of four-wheeler EVs. The detailed visualization of customer demographics provides a comprehensive understanding of prevailing trends, enabling companies to align their strategies with the identified patterns and make informed decisions accordingly. This report serves as a beneficial resource for prospective EV startups, offering a strategic perspective on market dynamics and consumer preferences within the Indian market.

GitHub link:- https://github.com/shindeaditya/Feynn_lab_internship.git