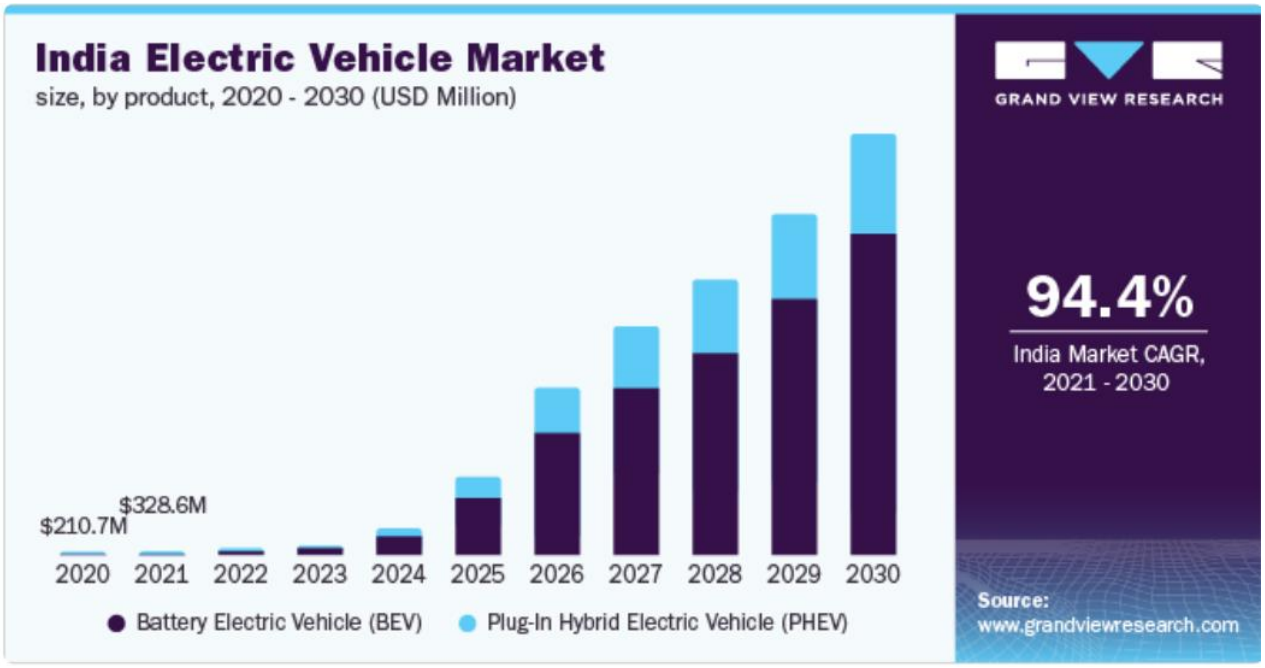
SHREYA PRASAD

ELECTRIC VEHICLES MARKET-(INDIAN DATA SET):



SHREYA PRASAD-(SOLO)

SHREYA PRASAD

INDEX

Problem Statement:

This exciting new EV startup is poised to disrupt the Indian transportation landscape! But first, we need to chart the most strategic course. To ensure our success, we'll leverage market segmentation analysis to identify the ideal customer segments most receptive to electric vehicles. By understanding their needs and preferences, we can develop a targeted entry strategy that positions our startup for

rapid growth. Let's dive into the Indian EV market and discover the key to unlocking its vast potential

What is Electric Vehicle?

An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. Electricity can be stored on board in batteries, or it can be delivered through a collector system by overhead wires or a conductive ground surface. Electric vehicles are becoming increasingly popular because they offer a number of advantages over traditional gasoline-powered vehicles, including:

- Reduced emissions: EVs produce zero tailpipe emissions, which helps to improve air quality and reduce greenhouse gas emissions.
- Lower operating costs: EVs are typically cheaper to operate than gasoline-powered vehicles, because electricity is generally less expensive than gasoline.
- Quieter operation: EVs are much quieter than gasoline-powered vehicles, which can make them more pleasant to drive and live around.
- Improved performance: Electric motors can provide instant torque, which can make EVs feel more responsive and acceleration than gasoline-powered vehicles.

Working principle

Electric vehicles (EVs) translate the science of energy conversion into motion. A high-voltage battery stores electrical energy, managed by a Battery Management System (BMS) for safety and efficiency. An inverter converts the battery's DC power to AC, which then energizes the electric motor, the heart of the EV. This motor transforms electrical energy into rotational force (torque) that propels the vehicle through the drivetrain. With various electric motor types available, like AC induction for simplicity or DC permanent magnet for performance, EVs offer a clean and quiet driving experience.

Market study

Will Electric Vehicles Take Over? Here's a Shocking Truth (and Why They Might)

Electric vehicles (EVs) are making serious waves, and the question on everyone's mind is: **will they replace traditional gasoline and diesel cars?** Buckle up, because the answer might surprise you:

- **EVs Are on a Tear:** The market for EVs is growing at a whopping 3x the speed of traditional vehicles! Currently, an estimated 30% of new vehicle sales are already electric.
- **Cost Savings Galore:** Owning an EV is significantly cheaper than a gas-guzzler. Electricity is generally less expensive than fossil fuels, and EVs require less maintenance due to fewer moving parts. Imagine the savings on fuel and service stations! Plus, charging with renewable energy sources like solar panels makes them even more eco-friendly and budget-friendly.
- **Going Green:** EVs produce zero tailpipe emissions, drastically reducing your carbon footprint and cleaning up the air we breathe. You can further minimize your environmental impact by using renewable energy sources to charge your vehicle.
- **Government Perks:** Many governments are offering tax breaks and financial incentives to promote EV adoption. Check with your local authorities to see what benefits you might be eligible for!
- **Quieter Than a Whisper:** EVs operate silently, significantly reducing noise pollution in urban areas. Imagine peaceful city commutes without the constant roar of engines!
- **Simpler Mechanics:** Say goodbye to spark plugs and exhaust fumes! EVs have fewer moving parts, making them generally easier and less expensive to maintain.
- **Performance Powerhouse:** Gone are the days of EVs being seen as slow and sluggish. Modern EVs are packing serious performance punches, with some boasting impressive acceleration and handling that rival high-performance gasoline cars.

- **Tech-Savvy Transportation:** EVs are becoming increasingly integrated with cutting-edge technology. Imagine features like self-driving capabilities, seamless smartphone integration, and advanced driver-assistance systems, all rolled into one eco-friendly package.

- **Constant Innovation:** Battery technology is constantly evolving, promising longer ranges and faster charging times. This will address a major concern for potential EV buyers: range anxiety.

- **A Shift in Infrastructure:** As EV adoption grows, the infrastructure will adapt. Expect to see a surge in charging stations, including convenient options like workplace and public charging networks.

So, will EVs completely replace traditional vehicles? The future is uncertain, but with their growing popularity, environmental benefits, and cost advantages, it's certainly a strong possibility.

Data Collection :

1. Cardekho
2. BikeWala
3. Kaggle
4. Jmkresearch

Segmentation Criteria

segmentation criteria refers to the **categories of information** used to group potential customers into distinct segments. These segments share similar characteristics and needs, allowing businesses to target them more effectively.

Segmentation Criteria for the Indian Electric Vehicle Market

To develop a successful entry strategy, your EV startup should consider segmenting the Indian EV market based on various criteria:

1. Geographic Segmentation:

- **Urban vs. Rural:** Urban areas with established charging infrastructure and higher environmental consciousness might be more receptive to EVs compared to rural areas.

- **Climate:** Consider the impact of climate on battery performance. Colder regions might require EVs with better battery management systems.

- **Government Incentives:** Certain states offer higher subsidies for EV purchases. Target areas with these incentives to leverage their appeal.

2. Socio-Demographic Segmentation:

- **Age:** Younger generations (Millennials, Gen Z) are generally more environmentally conscious and open to new technologies.

- **Income:** Higher income groups might be more willing to pay a premium for EVs. However, don't neglect budget-conscious segments with innovative financing options.
- **Family Size:** Families needing larger vehicles might require spacious electric SUVs or MPVs.

3. Psychographic Segmentation:

- **Environmental Concerns:** Target eco-conscious individuals who prioritize reducing their carbon footprint.
- **Technological Affinity:** Early adopters and tech-savvy consumers might be interested in cutting-edge EV features like self-driving capabilities.
- **Lifestyle:** Urban professionals with shorter commutes might be ideal for smaller, fuel-efficient electric cars.

4. Behavioral Segmentation:

- **Driving Habits:** Commuters with predictable driving patterns might be well-suited for EVs with sufficient range.
- **Charging Behavior:** Consider if potential customers have access to home charging or rely on public charging infrastructure.
- **Brand Loyalty:** Analyze existing car ownership trends and target segments with a history of adopting new technologies within the automotive industry.

By combining these segmentation criteria, your startup can create a detailed profile of your ideal EV customer in the Indian market. This will allow you to:

- **Develop targeted marketing campaigns:** Tailor your message to resonate with specific segments.
- **Design the right product:** Focus on features and functionalities that meet the needs and preferences of your target audience.
- **Choose optimal pricing strategies:** Offer competitive pricing models like battery leasing or subscription plans to cater to budget-conscious segments.
- **Plan your distribution network:** Prioritize establishing a presence in areas with high concentrations of your target customer base and ensure convenient charging options.

Pre-Processing Data before performing Segmentation

1. Data Collection:

- Gather data: Utilize various sources like:
    - Online platforms (CarDekho, BikeWala)
    - Public datasets (Kaggle)
    - Market research reports (JMK Research)
    - Government reports on EV adoption
    - Surveys or focus groups conducted by your team
- Data format: Ensure data consistency. Convert different data formats (e.g., .csv, .xlsx) into a unified format for easier analysis.

2. Data Cleaning:

- Missing values: Identify and address missing data points. You can choose to remove rows with significant missing values, impute missing values based on averages or medians within the segment, or use more sophisticated techniques like k-Nearest Neighbors (kNN).
- Outliers: Detect and handle outliers (extreme values) that might skew your analysis. You can remove outliers if justified, but consider winsorizing (replacing extreme values with values at specific percentiles) to preserve valuable data.
- Data inconsistencies: Correct any errors or inconsistencies in the data, such as typos or formatting issues.

3. Data Transformation:

- Categorical variables: For variables like location or car type, convert them into dummy variables if needed for segmentation analysis.
- Feature scaling: If variables have different scales (e.g., income vs. age), consider scaling them to a common range (e.g., min-max scaling) to ensure all features contribute equally to the segmentation process.

4. Feature Engineering:

- Create new features by combining existing ones to gain deeper insights. For example, a "daily commute distance" feature could be derived from residence location and workplace location.

5. Data Integration (Optional):

- If using data from multiple sources, ensure data points have a unique identifier to merge them seamlessly**.**

1. Categorical Variables:

- **Merging Levels:**
  - Analyze the distribution of your categorical variables. If some categories have very few data points, consider merging them with similar categories to create more statistically significant groups.
  - Example: You might have income categories like "Below ₹1 Lakh," "₹1-3 Lakh," "₹3-5 Lakh," etc. If the "Below ₹1 Lakh" category has very few entries, you could merge it with the "₹1-3 Lakh" category.
- **Label Encoding:**
  - You can convert categorical variables into numerical values for segmentation algorithms. However, this is only appropriate if the categories have a natural ordering or hierarchy.
  - Example: You could convert "Age Group" (Young Adult, Middle-aged, Senior) into numerical values (1, 2, 3) as long as the order reflects increasing age.
  - **Avoid One-Hot Encoding:** This method creates a separate binary variable for each category, which can increase dimensionality and potentially distort distance-based segmentation algorithms.

2. Numerical Variables:

- **Scaling:**
  - If your numerical variables have vastly different ranges (e.g., income vs. age), consider scaling them to a common range (e.g., 0-1 or standard deviation) to prevent variables with larger scales from dominating the analysis. Popular methods include Min-Max Scaling and Standardization.
- **Outlier Detection:**
  - Identify and address outliers in your numerical data. Extreme values can skew the results of segmentation algorithms. You can choose to remove outliers, winsorize them (cap their values), or transform them (e.g., using log transformation).

3. Univariate Analysis:

- **Missing Value Imputation:**
  - Check for missing values in your data. Depending on the extent and distribution of missingness, you might choose to impute missing values (fill them with estimated values) or remove data points with missing values.

- **Exploratory Data Analysis (EDA):**
    - Use techniques like histograms, boxplots, and descriptive statistics to understand the distribution of each variable. This can help identify potential issues like skewness or outliers.

4. Bivariate Analysis:

- **Cross-tabulation:**
    - Analyze the relationship between two categorical variables using cross-tabulation tables. This can identify potential segment formation based on combined characteristics.
- **Correlation Analysis:**
    - Calculate the correlation coefficients between numerical variables to understand how they influence each other. This can guide the decision on whether to combine variables or use them independently for segmentation.

5. Multivariate Analysis (if applicable):

- **Dimensionality Reduction:**
    - If your data has a high number of variables, consider using techniques like Principal Component Analysis (PCA) to reduce dimensionality while preserving the most important information. This can improve the efficiency and interpretability of segmentation models.

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

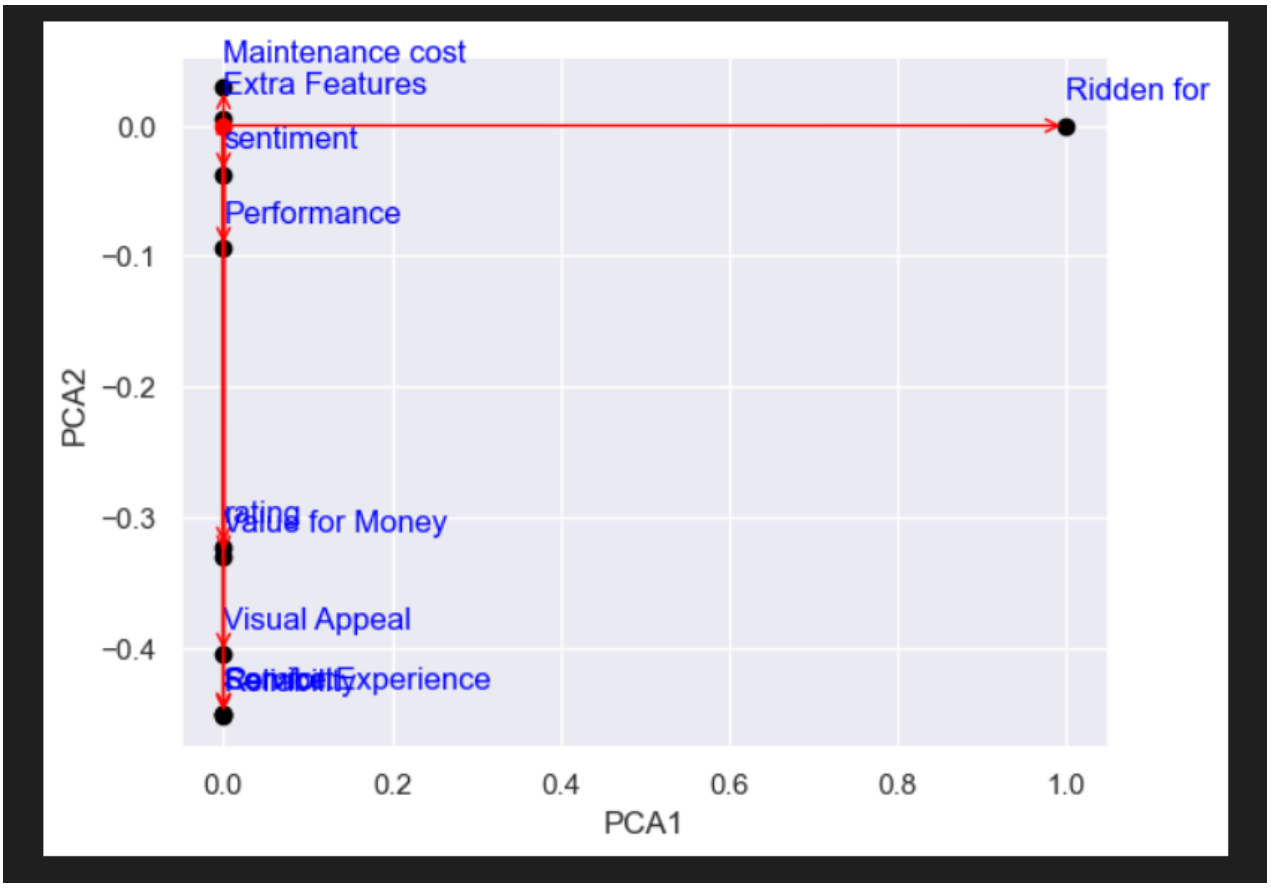
An EV company can put up their showroom in the region where the state is giving maximum Tax Exemption and Subsidy as this would be helpful in business point of view. It can also put up their showroom where the fuel prices are high as people in those states/UT's would be looking for another alternative 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.

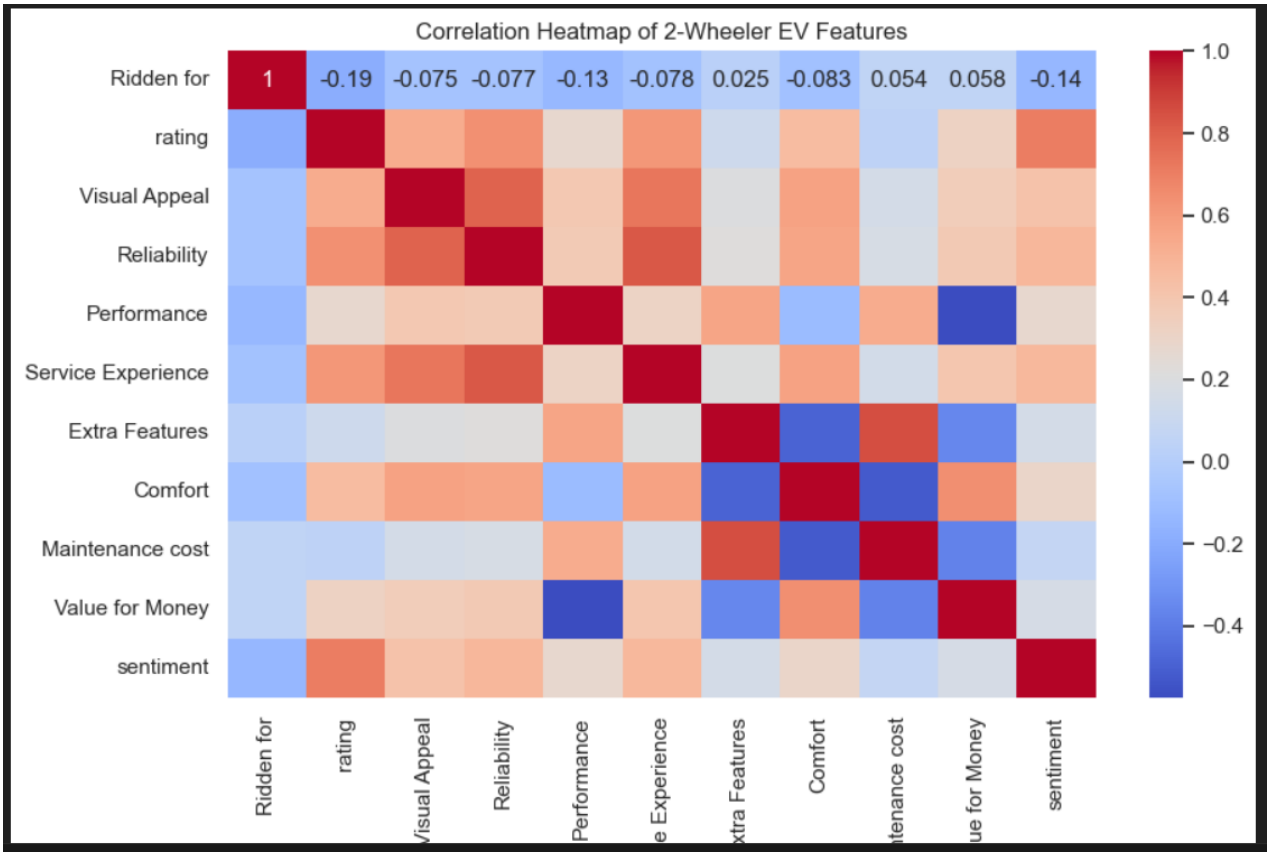
Based on these factors and their dependencies some datasets are prepared manually to analyse which region would be helpful for an EV start up in India. The information present there is not 100% accurate, but maximum care has been taken for the information to be error free.

CODE IMPLEMENTATION AND ANALYSIS:

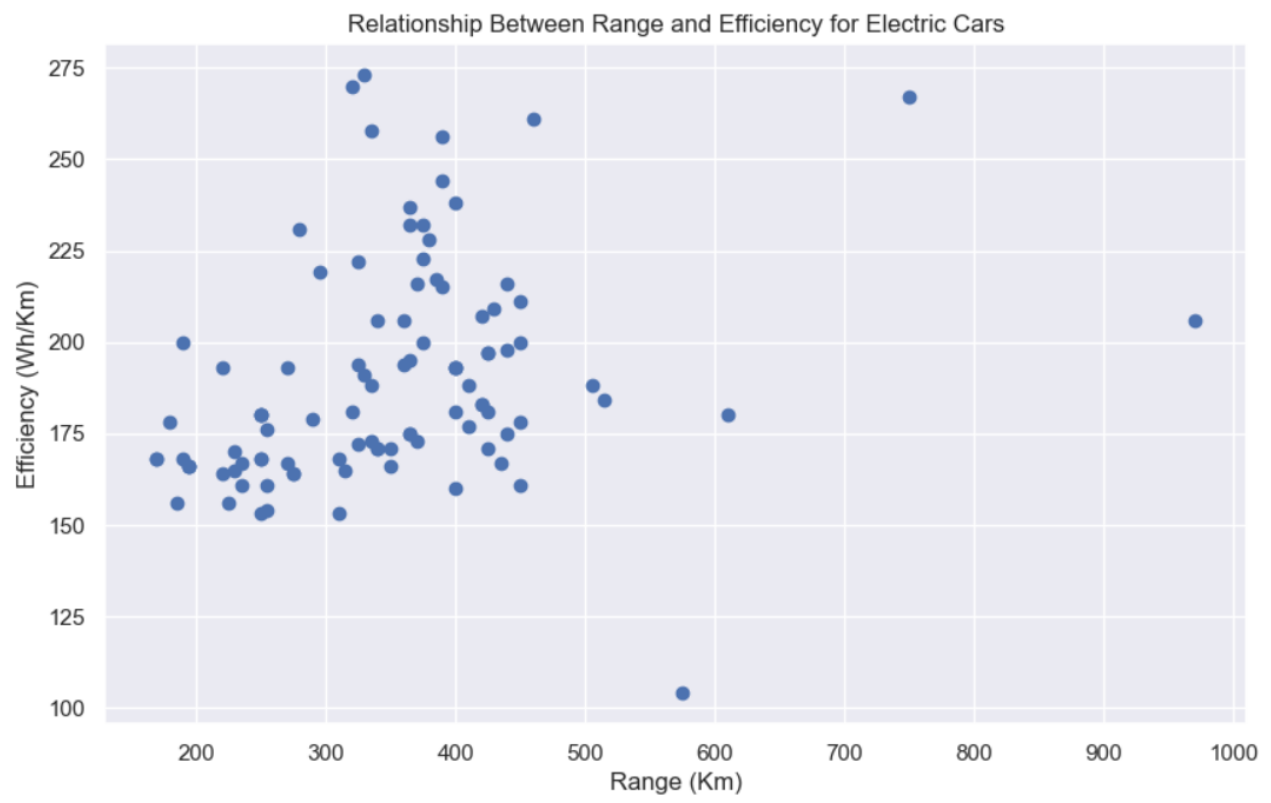
1-EV ANALYSIS

PCA (2 WHEELERS):

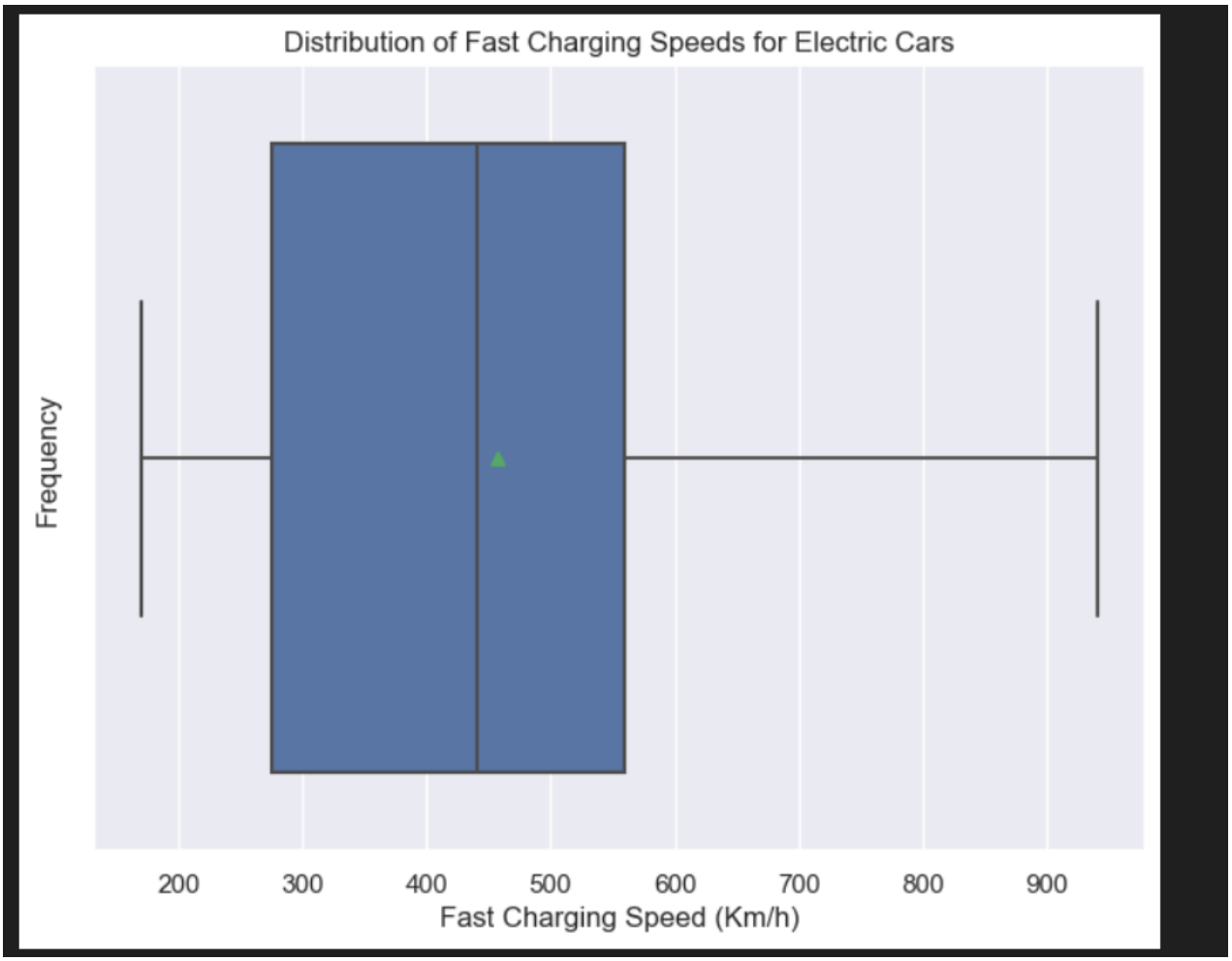


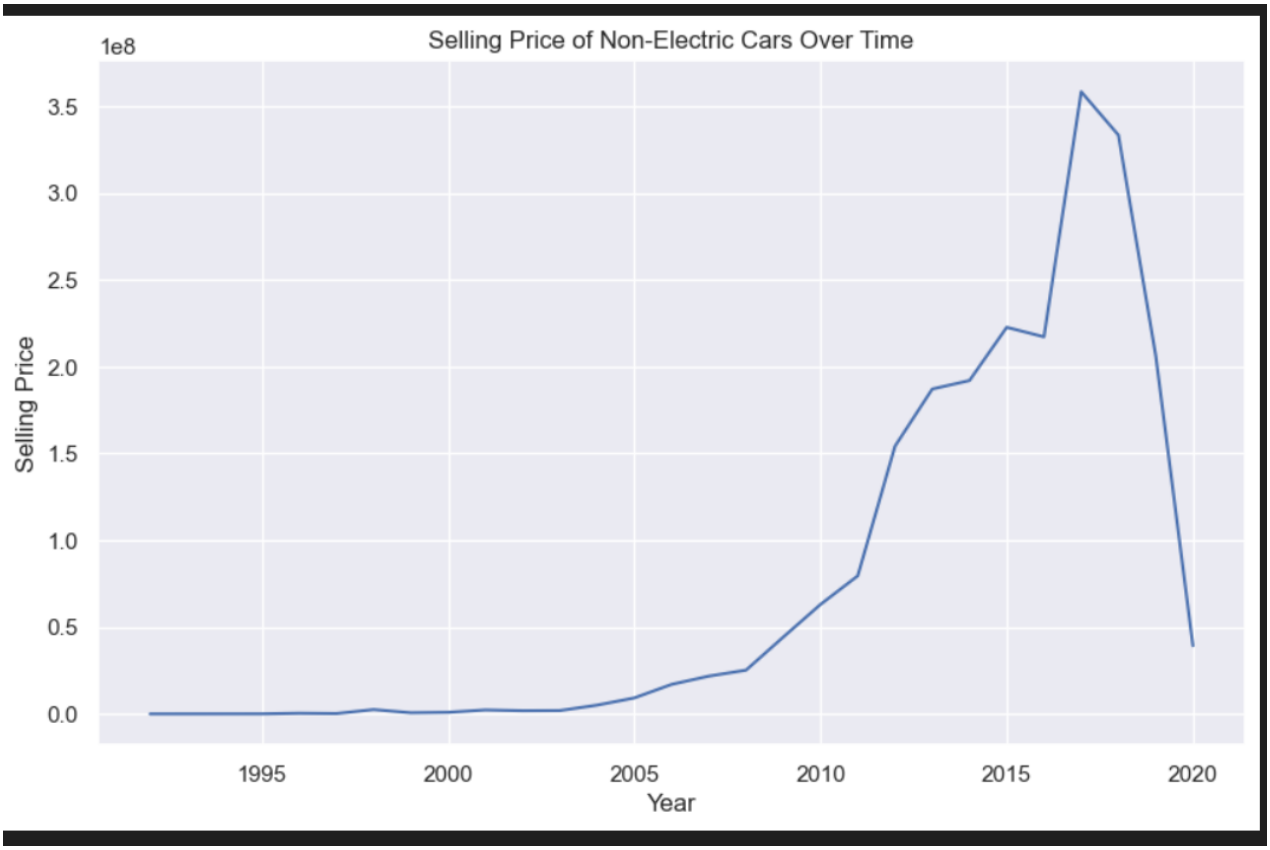


ELECTRIC CARS



Box Plot of Fast Charging Speed for Electric Cars:





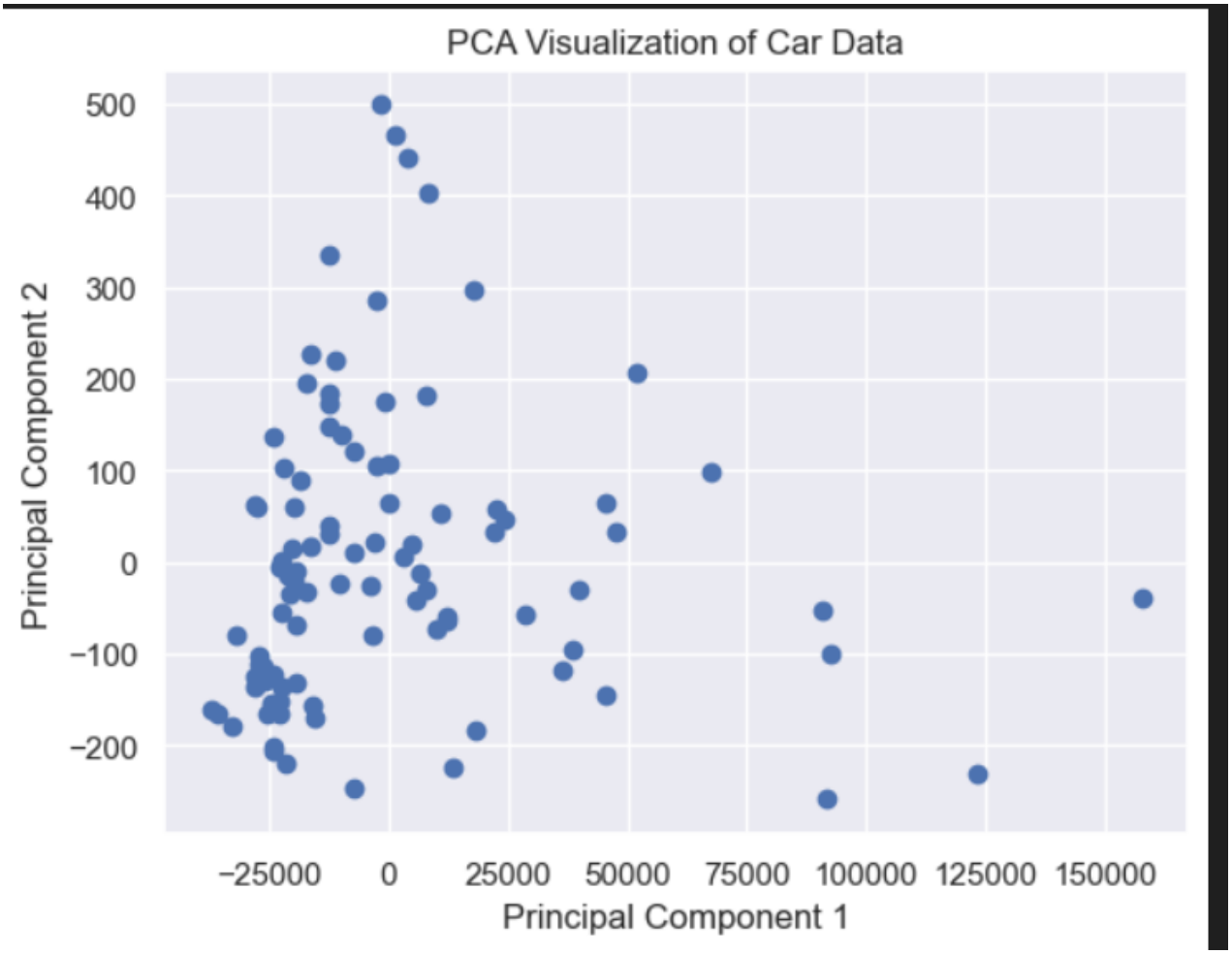
Car Price prediction model:

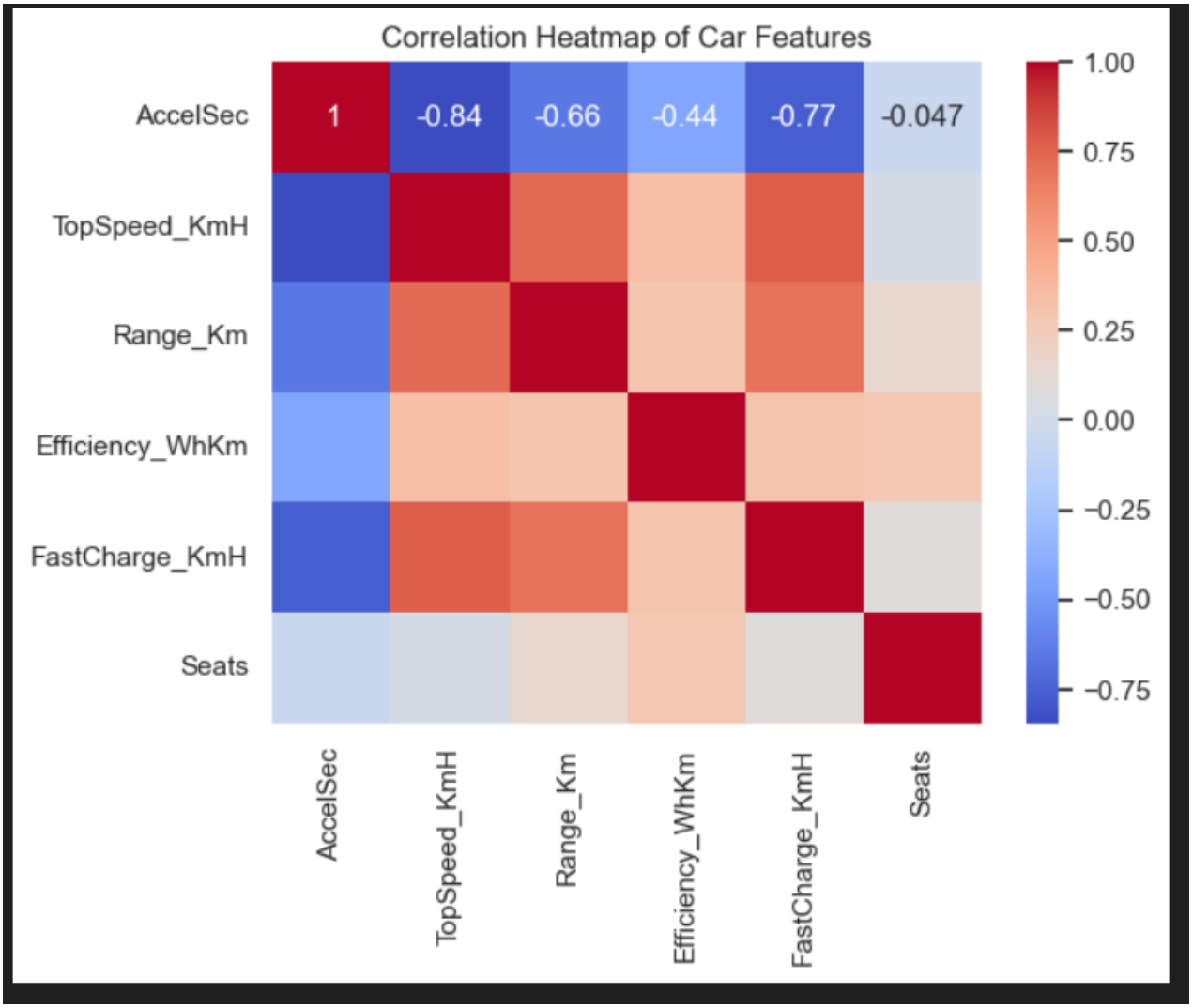
Car Price prediction model

```
import pickle

# Define absolute paths to your pickle files
car_model_path = "C:\\Users\\sp125\\OneDrive\\Desktop\\EV2__SHREYA_FINAL\\car_model.pkl"
scaler_x_path = "C:\\Users\\sp125\\OneDrive\\Desktop\\EV2__SHREYA_FINAL\\scaler_x.pkl"
scaler_y_path = "C:\\Users\\sp125\\OneDrive\\Desktop\\EV2__SHREYA_FINAL\\scaler_y.pkl"

# Load the model and scalers
try:
    with open(car_model_path, 'rb') as f:
        car_model = pickle.load(f)

    with open(scaler_x_path, 'rb') as f:
        scaler_x = pickle.load(f)

    with open(scaler_y_path, 'rb') as f:
        scaler_y = pickle.load(f)

    # Rest of your code using car_model, scaler_x, and scaler_y
except FileNotFoundError as e:
    print(f"Error: Files not found. Please check the paths. ({e})")

def car_price(AccelSec, TopSpeed_KmH, Range_Km,
              Efficiency_WhKm, FastCharge_KmH, Seats):
    """This function gets AccelSec, TopSpeed_KmH, Range_Km, Efficiency_WhKm,
    FastCharge_KmH and Seats of car. It returns price of car in rupees"""
    x = scaler_x.transform([[AccelSec, TopSpeed_KmH, Range_Km,
                             Efficiency_WhKm, FastCharge_KmH, Seats]])
    y = car_model.predict(x)
    y = scaler_y.inverse_transform(y.reshape(1, -1))
    return y[0][0] * 88.8  # Assuming 88.8 represents a conversion factor

# Example usage (assuming you have data for the car)
car_data = [5, 200, 300, 150, 80, 5]  # Replace with your actual data
predicted_price = car_price(*car_data)
print("Predicted Price:", predicted_price)
```

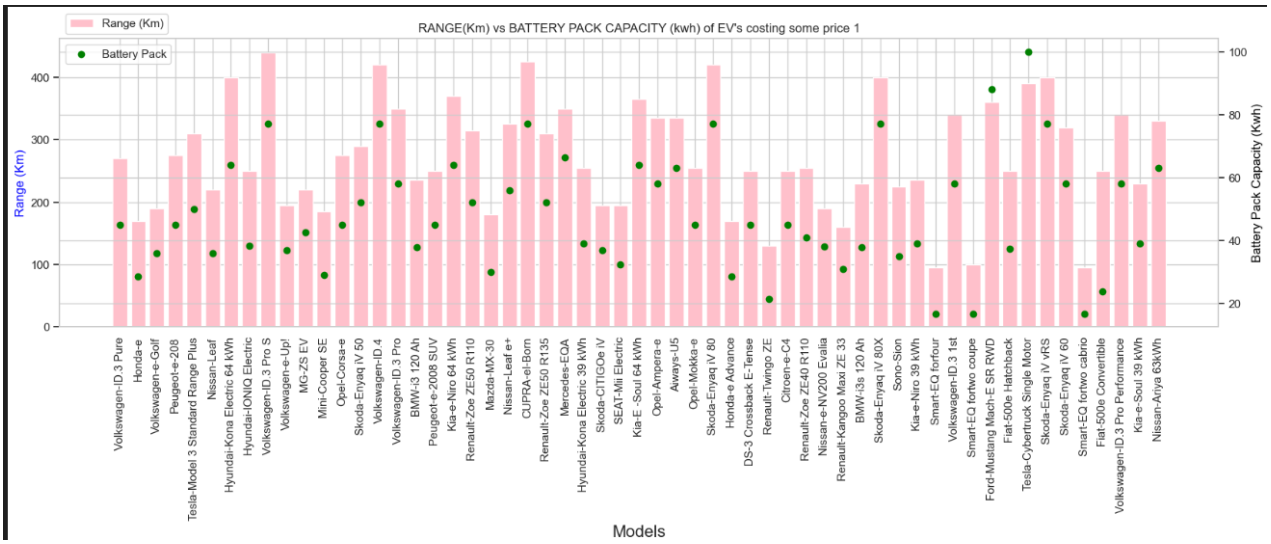
✓ 0.0s

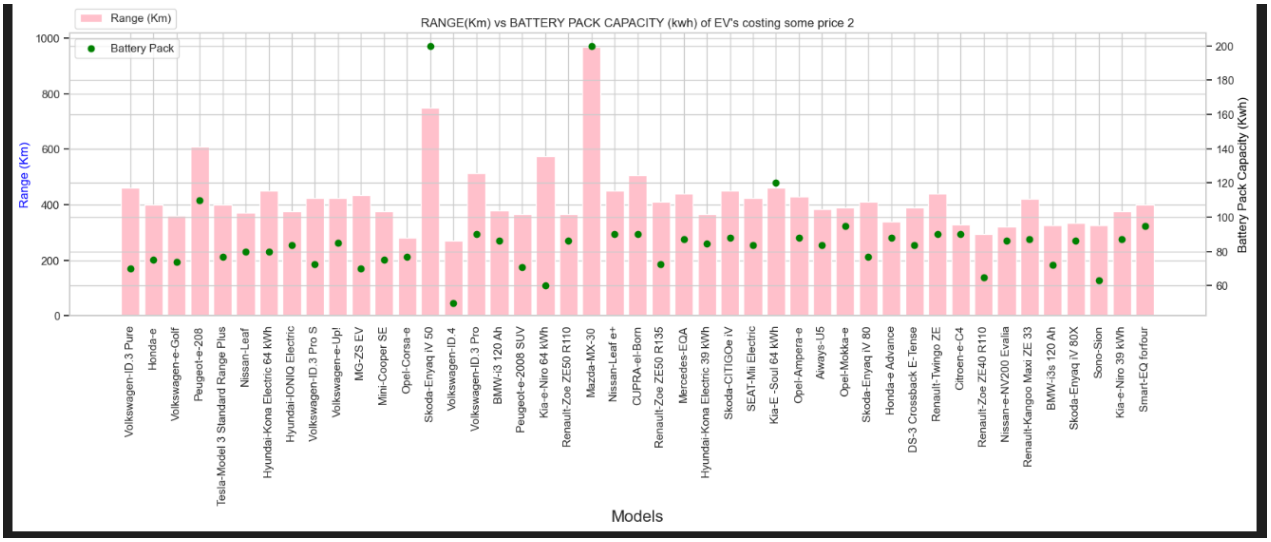
```
Predicted Price: 4969407.289995525
```

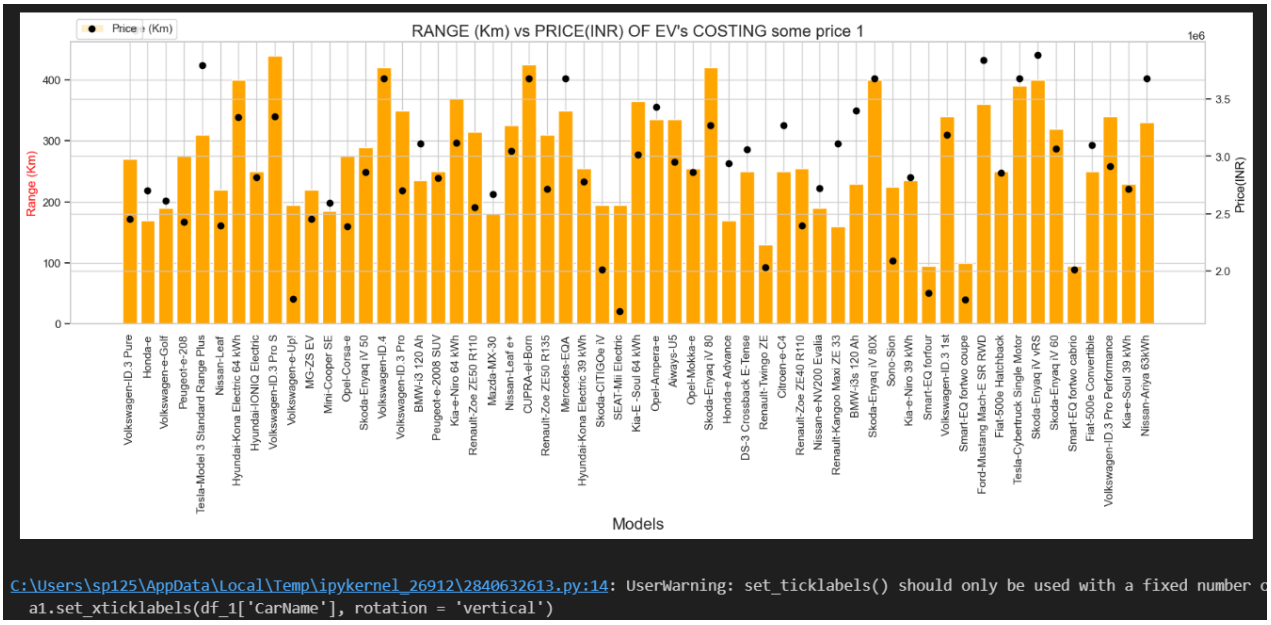

PCA Visualization of Car Data
Principal Component 2
500
400
300
200
100
0
−100
−200
−25000
0
25000
50000
75000
100000
125000
150000
Principal Component 1


Correlation Heatmap of Car Features
AccelSec
TopSpeed_KmH
Range_Km
Efficiency_WhKm
FastCharge_KmH
Seats
1
-0.84
-0.66
-0.44
-0.77
-0.047
AccelSec
TopSpeed_KmH
Range_Km
Efficiency_WhKm
FastCharge_KmH
Seats
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75

2-EV CAR ANALYSIS





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C:\Users\sp125\AppData\Local\Temp\ipykernel_26912\2840632613.py:14: UserWarning: set_ticklabels() should only be used with a fixed number o
  a1.set_xticklabels(df_1['CarName'], rotation = 'vertical')
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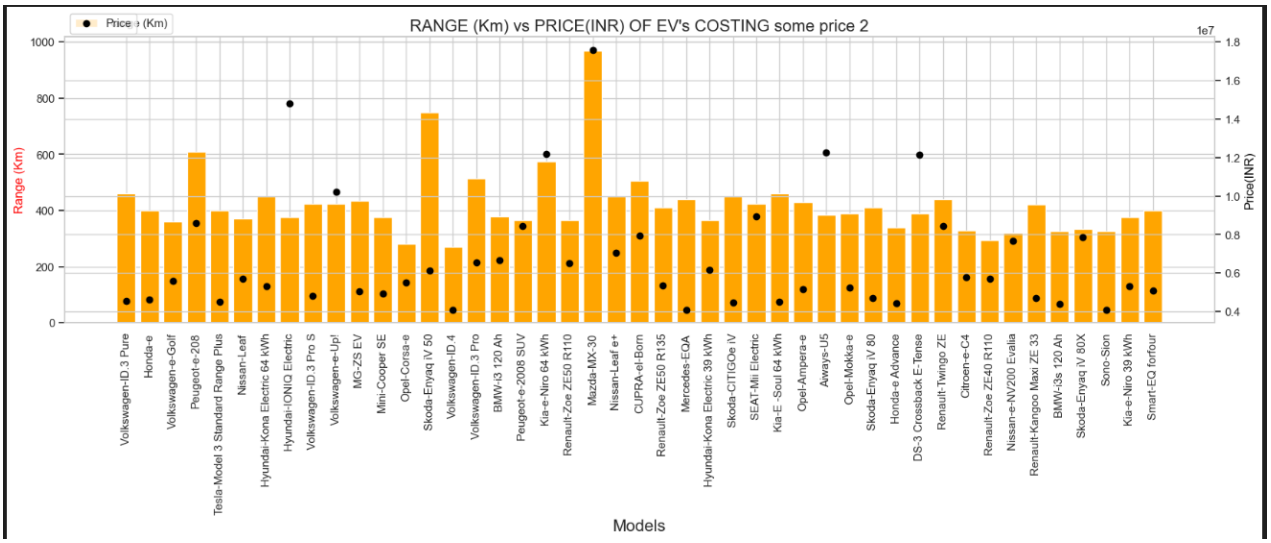
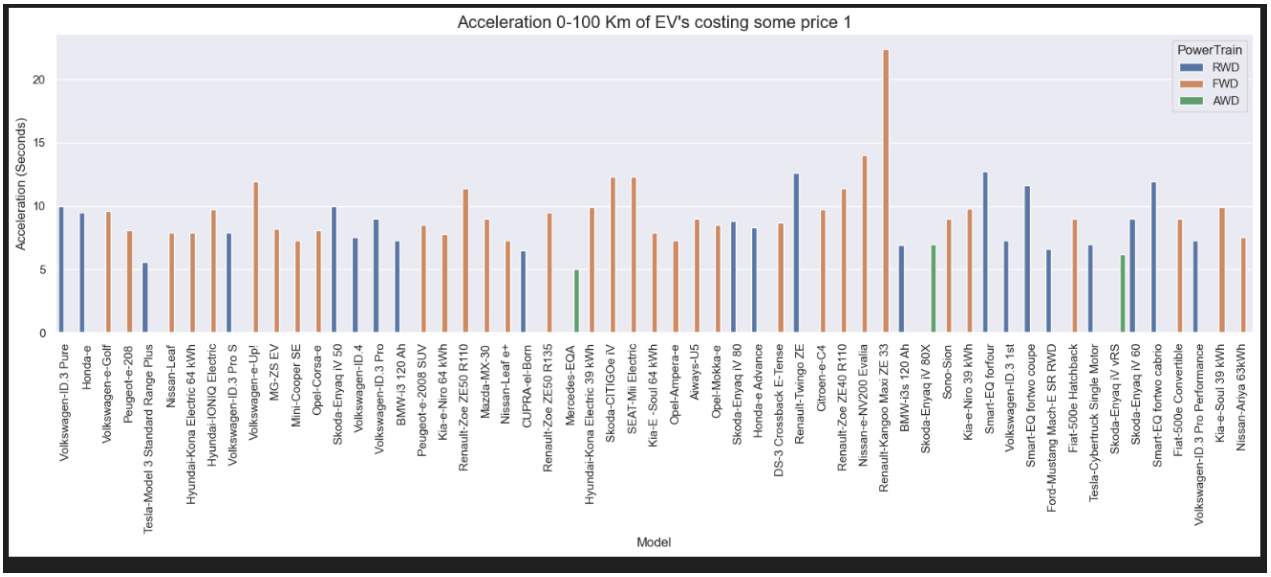
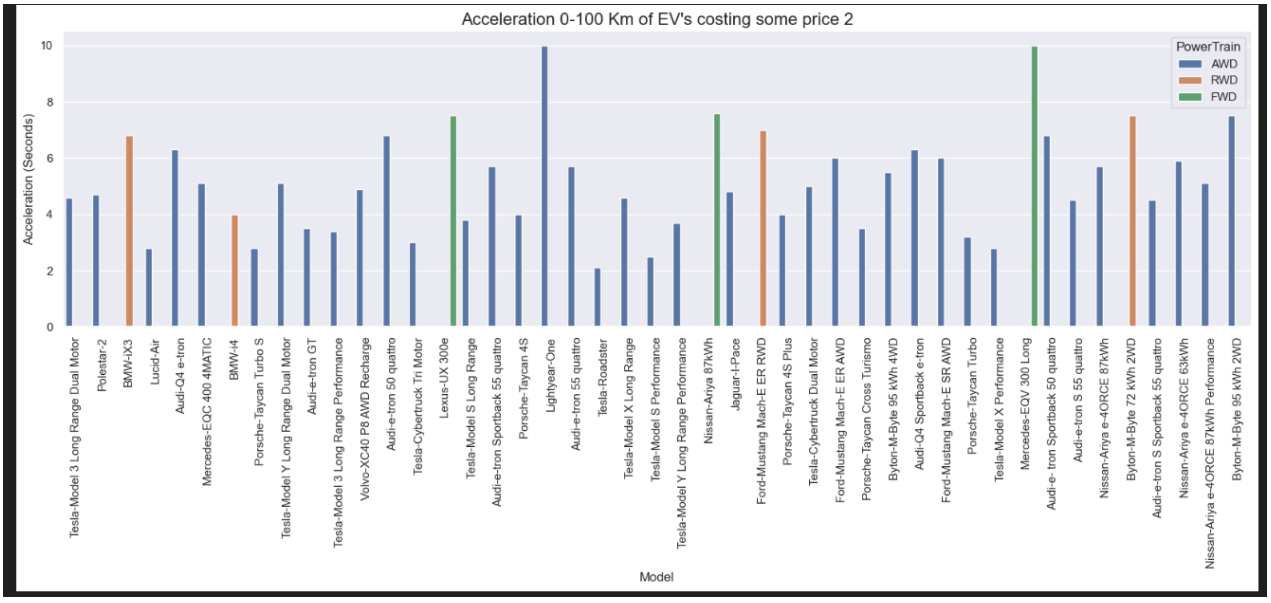
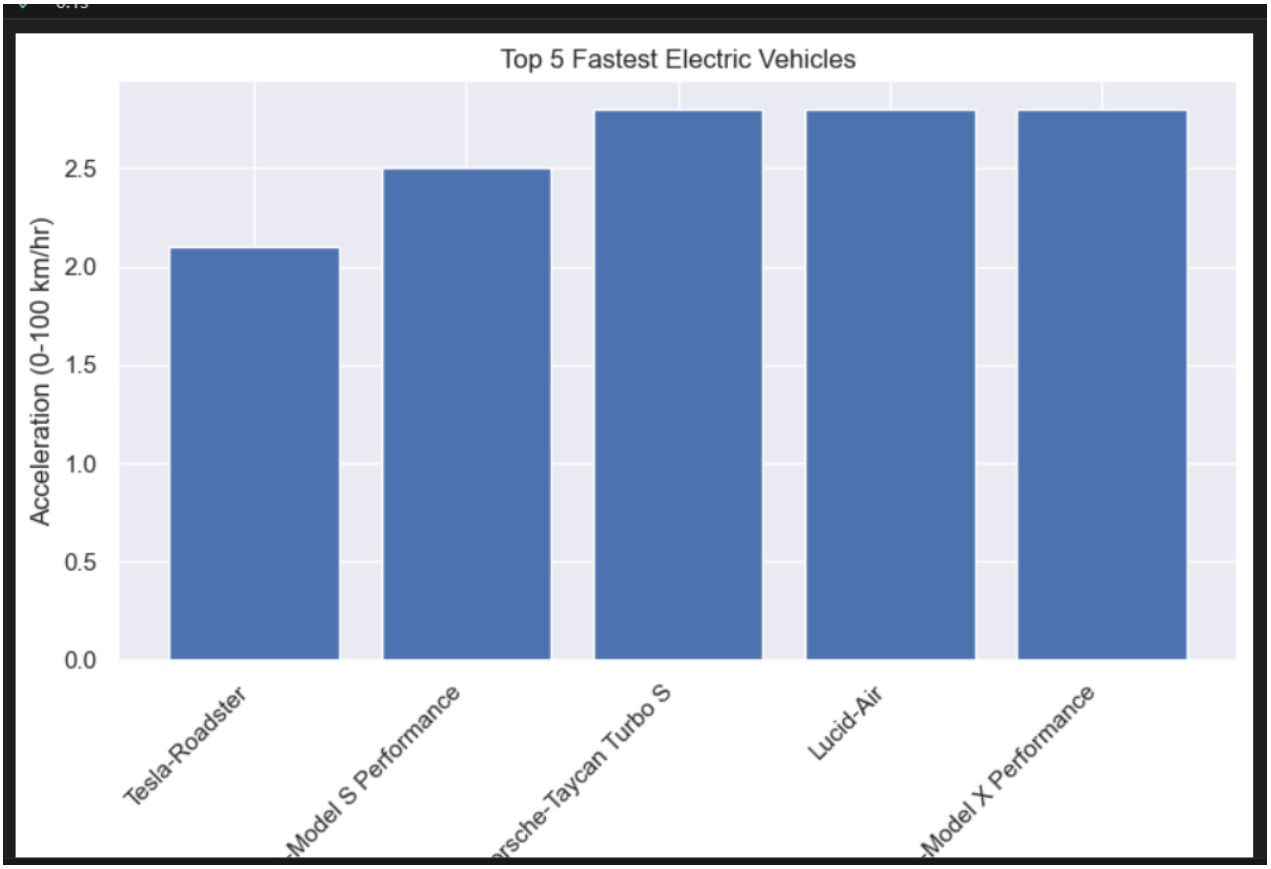
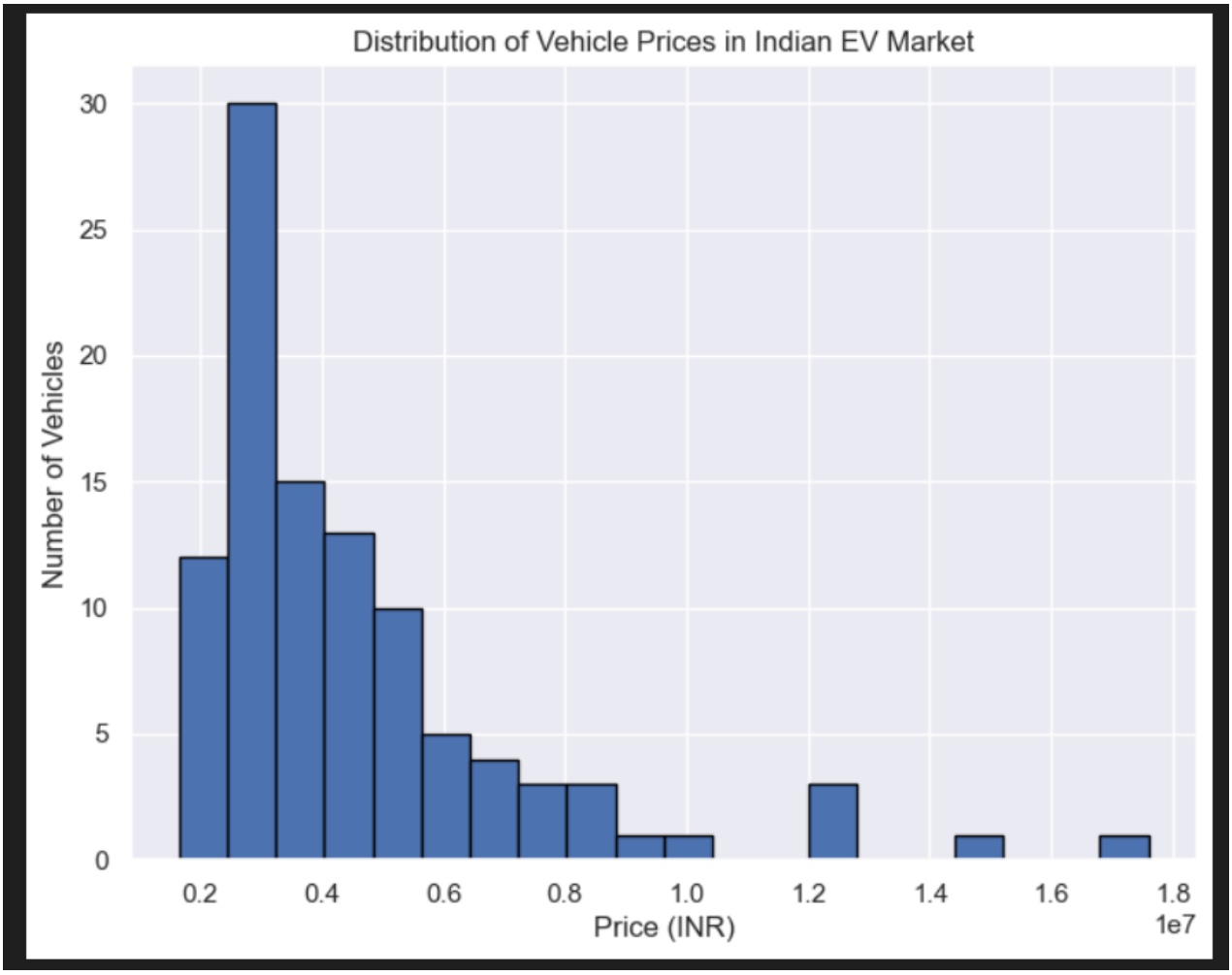
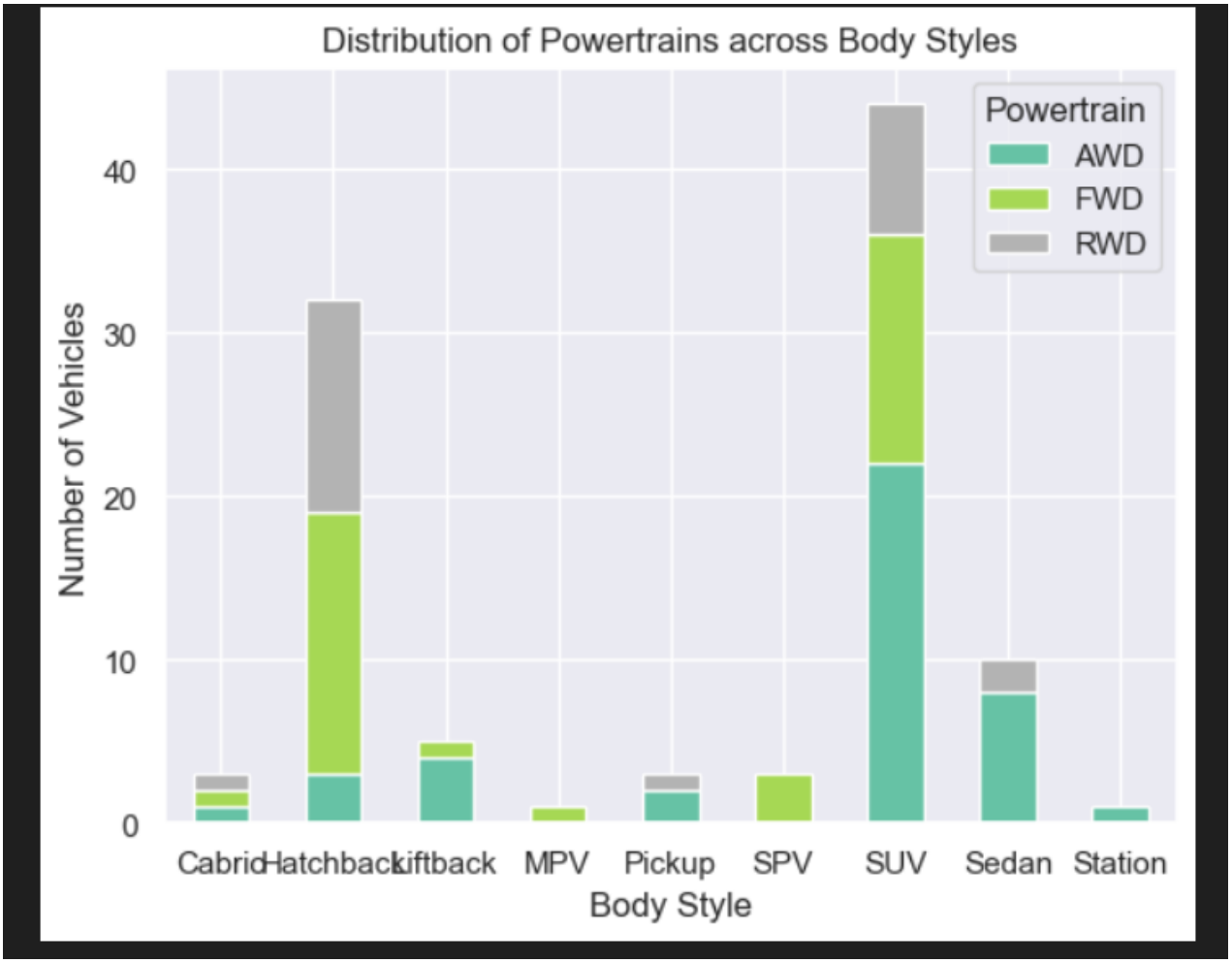




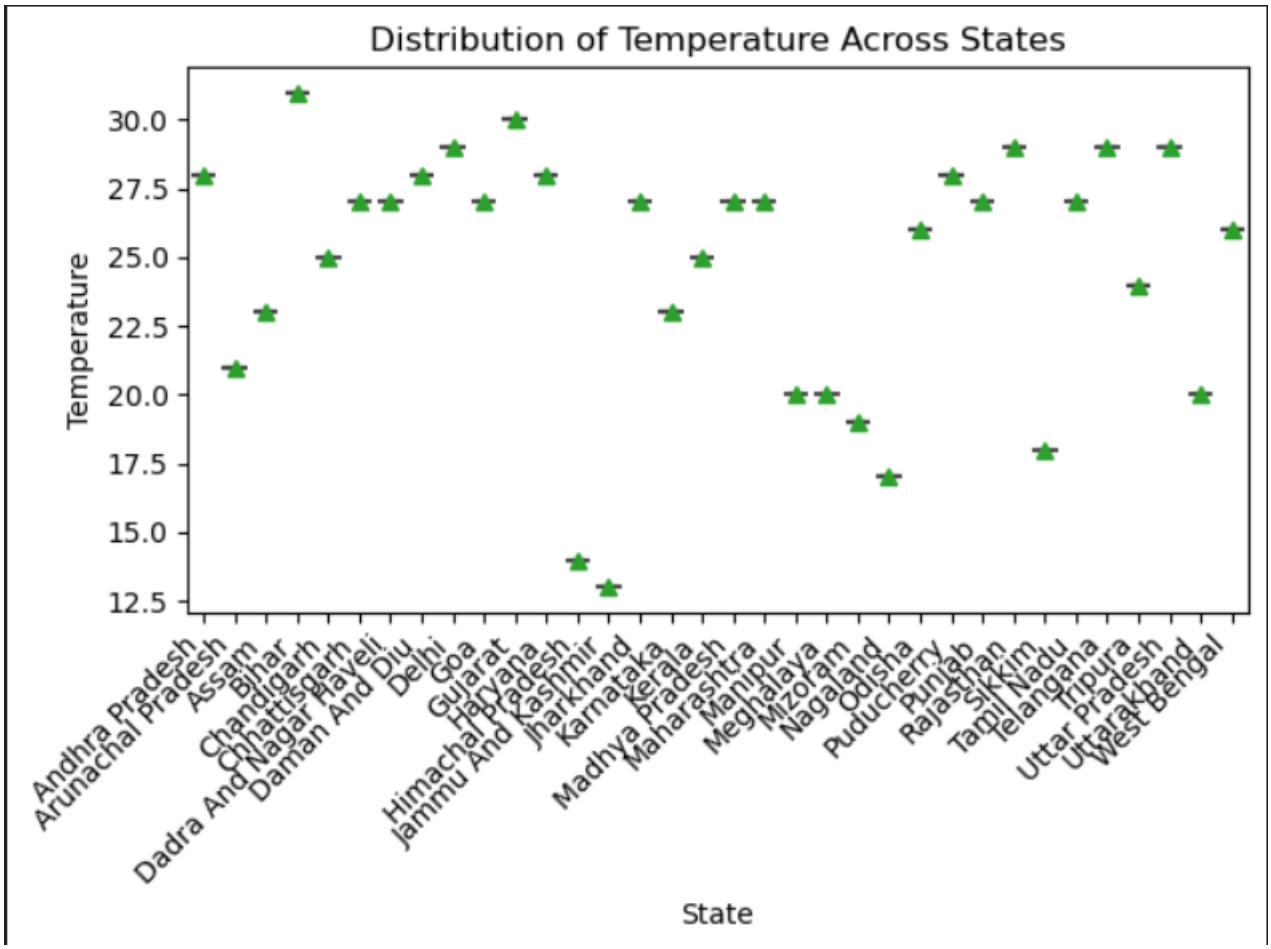

Acceleration 0-100 Km of EV's costing some price 2
PowerTrain
AWD
RWD
FWD
Acceleration (Seconds)
0
2
4
6
8
10
Tesla-Model 3 Long Range Dual Motor
Polestar-2
BMW-iX3
Lucid-Air
Audi-Q4 e-tron
Mercedes-EQC 400 4MATIC
BMW-i4
Porsche-Taycan Turbo S
Tesla-Model Y Long Range Dual Motor
Audi-e-tron GT
Tesla-Model 3 Long Range Performance
Volvo-XC40 P8 AWD Recharge
Audi-e-tron 50 quattro
Tesla-Cybertruck Tri Motor
Lexus-UX 300e
Tesla-Model S Long Range
Audi-e-tron Sportback 55 quattro
Porsche-Taycan 4S
Lightyear-One
Audi-e-tron 55 quattro
Tesla-Roadster
Tesla-Model X Long Range
Tesla-Model S Performance
Tesla-Model Y Long Range Performance
Nissan-Ariya 87kWh
Jaguar-I-Pace
Ford-Mustang Mach-E ER RWD
Porsche-Taycan 4S Plus
Tesla-Cybertruck Dual Motor
Ford-Mustang Mach-E ER AWD
Porsche-Taycan Cross Turismo
Byton-M-Byte 95 kWh 4WD
Audi-Q4 Sportback e-tron
Ford-Mustang Mach-E SR AWD
Porsche-Taycan Turbo
Tesla-Model X Performance
Mercedes-EQV 300 Long
Audi-e- tron Sportback 50 quattro
Audi-e-tron S 55 quattro
Nissan-Ariya e-4ORCE 87kWh
Byton-M-Byte 72 kWh 2WD
Audi-e-tron S Sportback 55 quattro
Nissan-Ariya e-4ORCE 63kWh
Nissan-Ariya e-4ORCE 87kWh Performance
Byton-M-Byte 95 kWh 2WD
Model

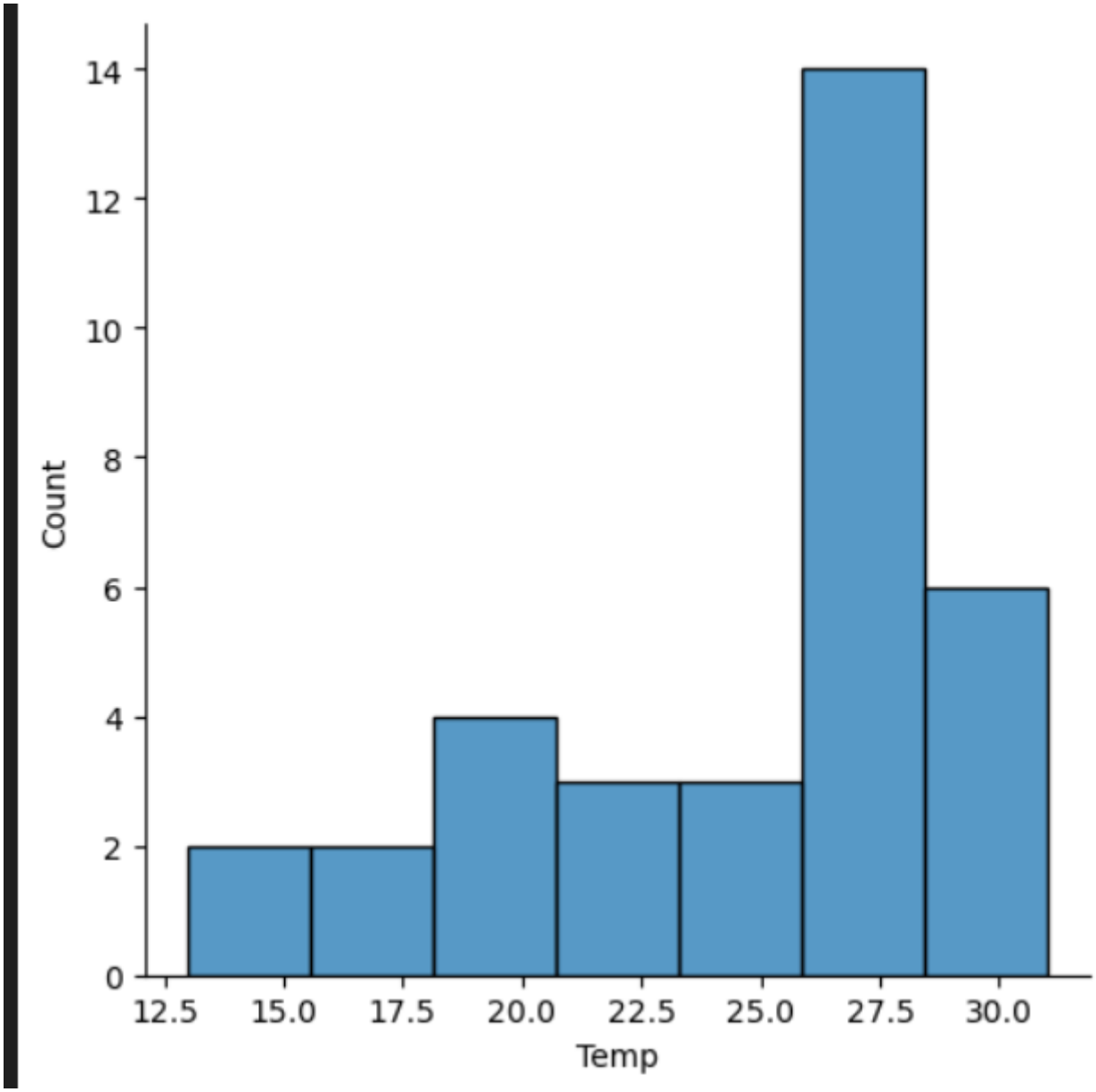

Top 5 Fastest Electric Vehicles
Acceleration (0-100 km/hr)
0.0
0.5
1.0
1.5
2.0
2.5
Tesla-Roadster
Model S Performance
rsche-Taycan Turbo S
Lucid-Air
Model X Performance


Distribution of Vehicle Prices in Indian EV Market
Number of Vehicles
0
5
10
15
20
25
30
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
Price (INR)
1e7

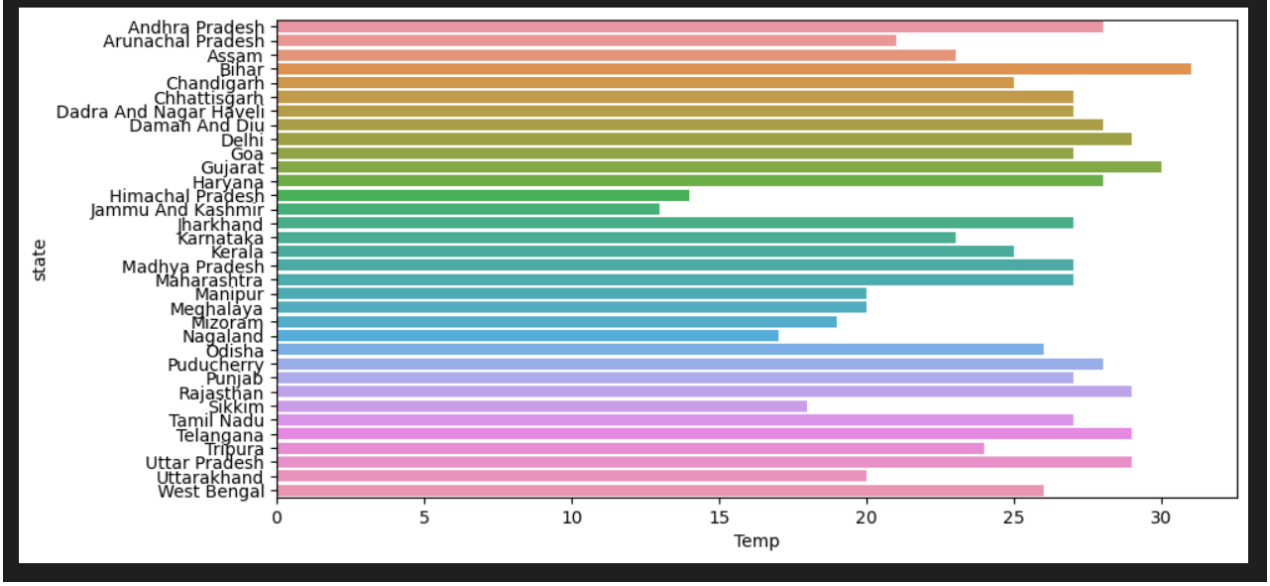

Distribution of Powertrains across Body Styles
Powertrain
AWD
FWD
RWD
Number of Vehicles
0
10
20
30
40
Cabrio
Hatchback
Liftback
MPV
Pickup
SPV
SUV
Sedan
Station
Body Style

3-POLLUTION-


Distribution of Temperature Across States
Temperature
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
Andhra Pradesh
Arunachal Pradesh
Assam
Bihar
Chandigarh
Chhattisgarh
Dadra And Nagar Haveli
Daman And Diu
Delhi
Goa
Gujarat
Haryana
Himachal Pradesh
Jammu And Kashmir
Jharkhand
Karnataka
Kerala
Madhya Pradesh
Maharashtra
Manipur
Meghalaya
Mizoram
Nagaland
Odisha
Puducherry
Punjab
Rajasthan
Sikkim
Tamil Nadu
Telangana
Tripura
Uttar Pradesh
Uttarakhand
West Bengal
State


14
12
10
8
6
4
2
0
Count
12.5
15.0
17.5
20.0
22.5
25.0
27.5
30.0
Temp

```
<Axes: xlabel='Temp', ylabel='state'>
```




```
plt.figure(figsize=(8,16));
sns.jointplot(x='state', y='status', data=data, kind='scatter',space=0.2,palette="coolwarm");
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✓ 0.5s

```
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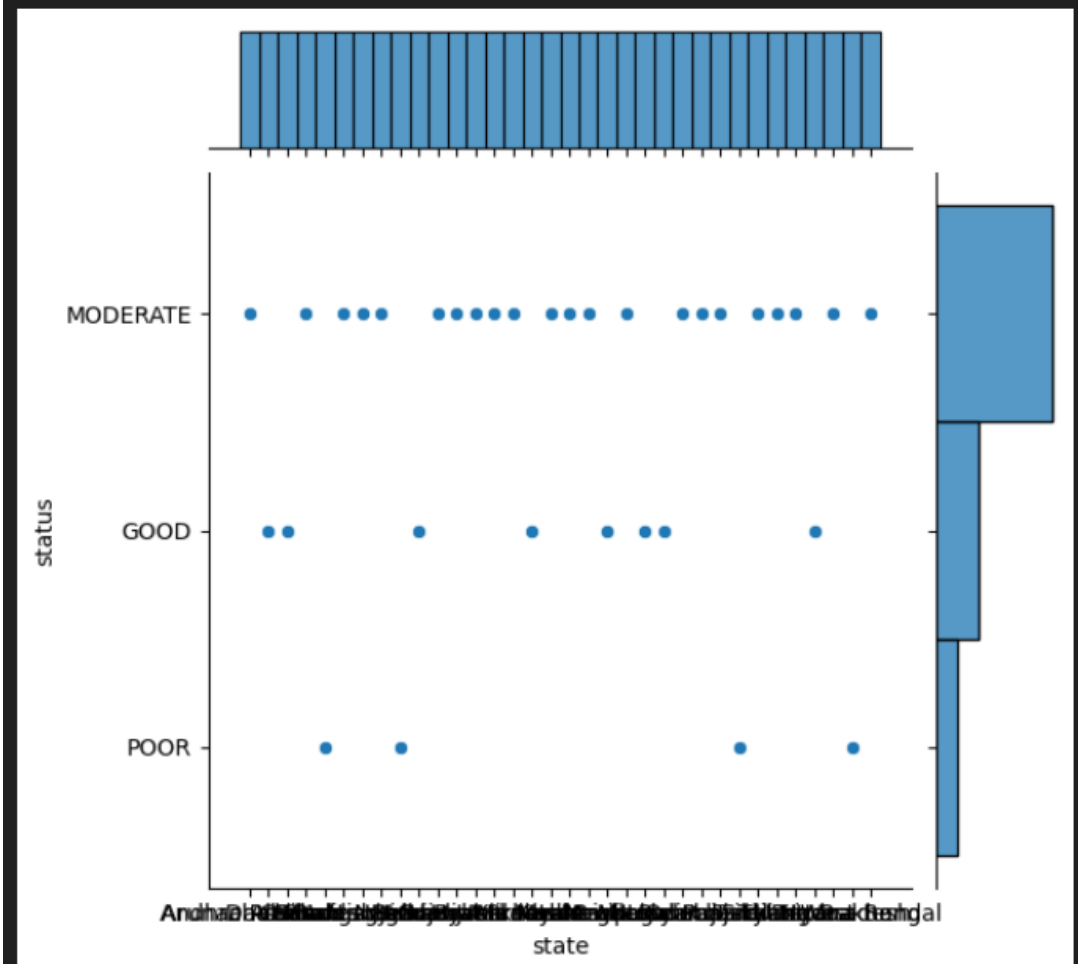
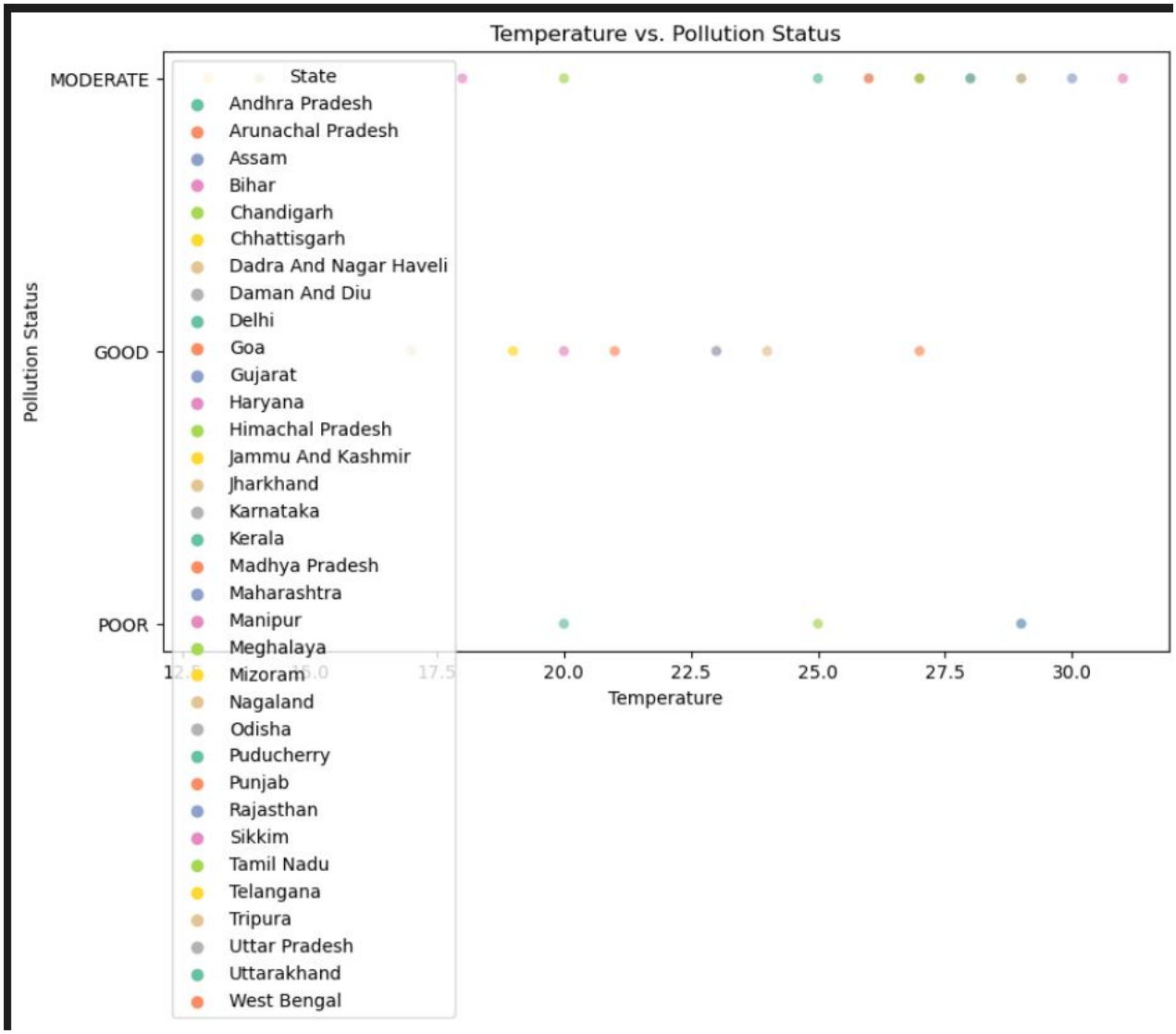
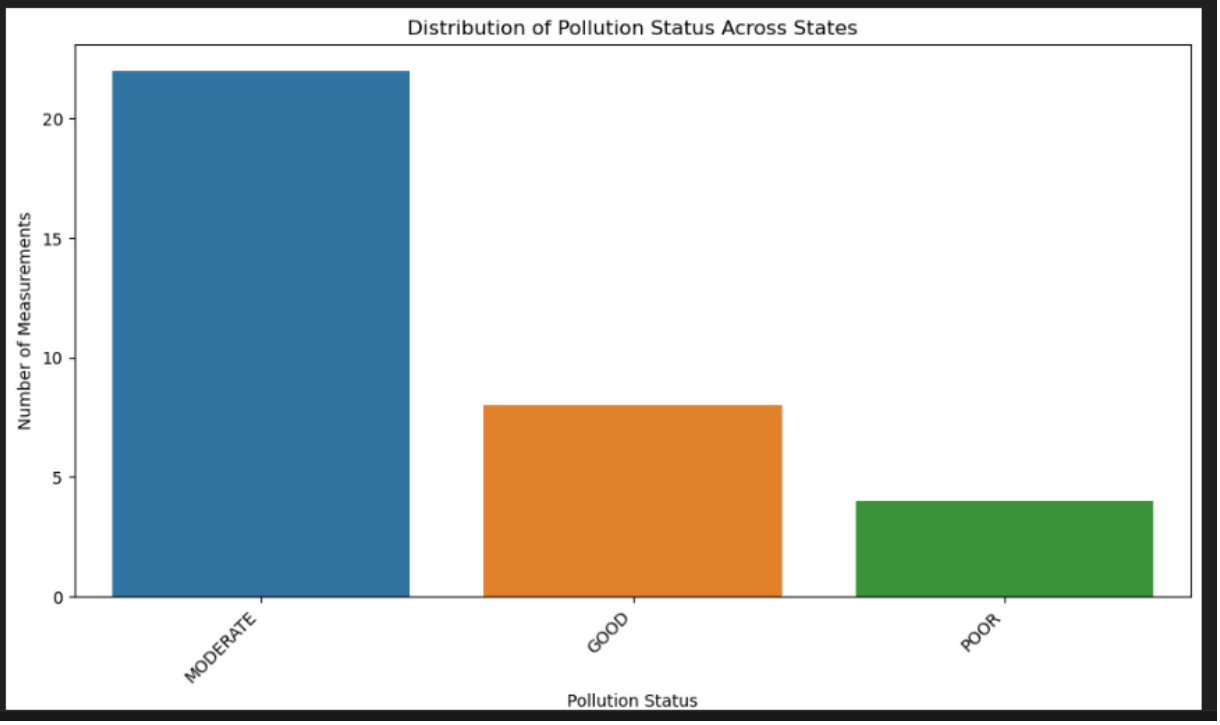



Temperature vs. Pollution Status
Pollution Status
MODERATE
GOOD
POOR
Temperature
20.0
22.5
25.0
27.5
30.0
State
Andhra Pradesh
Arunachal Pradesh
Assam
Bihar
Chandigarh
Chhattisgarh
Dadra And Nagar Haveli
Daman And Diu
Delhi
Goa
Gujarat
Haryana
Himachal Pradesh
Jammu And Kashmir
Jharkhand
Karnataka
Kerala
Madhya Pradesh
Maharashtra
Manipur
Meghalaya
Mizoram
Nagaland
Odisha
Puducherry
Punjab
Rajasthan
Sikkim
Tamil Nadu
Telangana
Tripura
Uttar Pradesh
Uttarakhand
West Bengal

Statewise Pollution Status Distribution (Stacked Bar Chart):

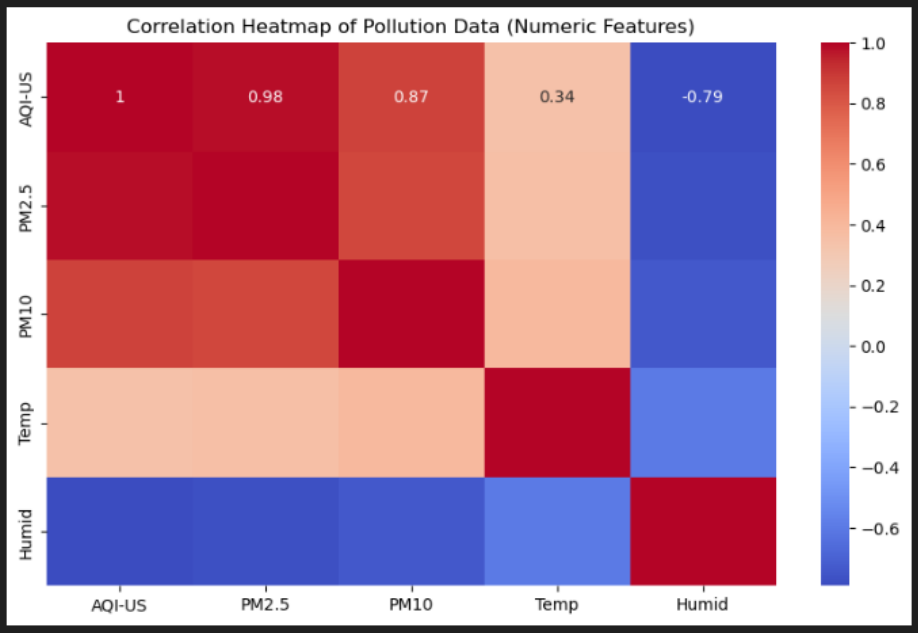
```
pollution_status_counts = data["status"].value_counts().sort_values(ascending=False)
plt.figure(figsize=(10, 6))
sns.barplot(x=pollution_status_counts.index, y=pollution_status_counts.values)
plt.xlabel("Pollution Status")
plt.ylabel("Number of Measurements")
plt.title("Distribution of Pollution Status Across States")
plt.xticks(rotation=45, ha='right')  # Rotate x-axis labels for readability
plt.tight_layout()
plt.show()
```

[10] ✓ 0.4s



```python
if data.select_dtypes(include=[np.number]).shape[1] > 1:  # Check for multiple numeric columns
    correlation_matrix = data.select_dtypes(include=[np.number]).corr()
    plt.figure(figsize=(10, 6))
    sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm')  # Adjust colormap as desired
    plt.title('Correlation Heatmap of Pollution Data (Numeric Features)')
    plt.show()
```

✓ 0.4s

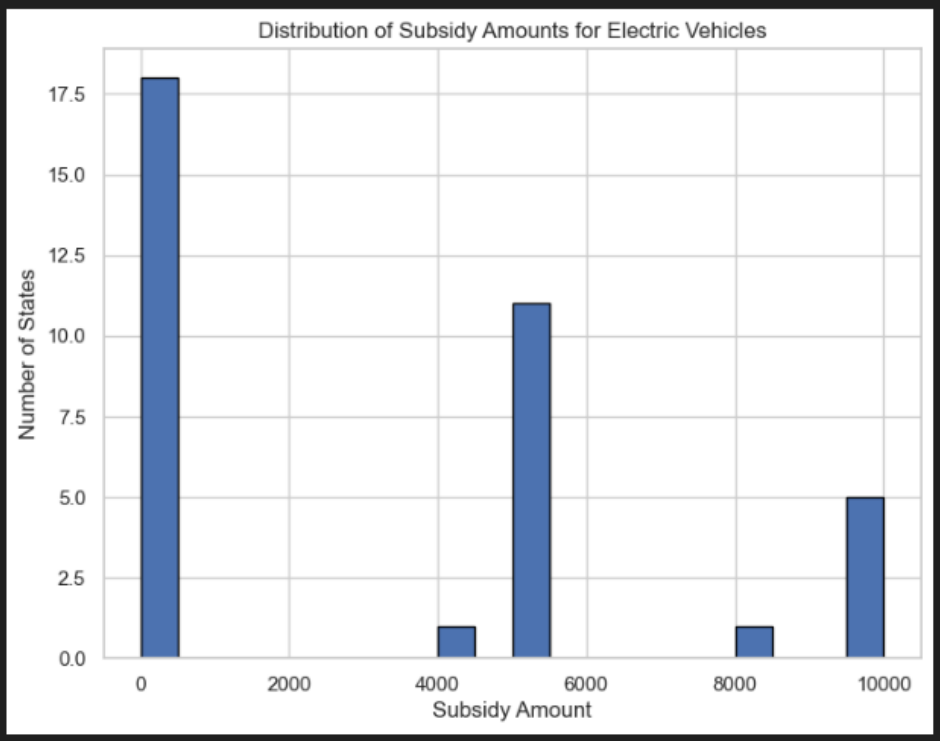


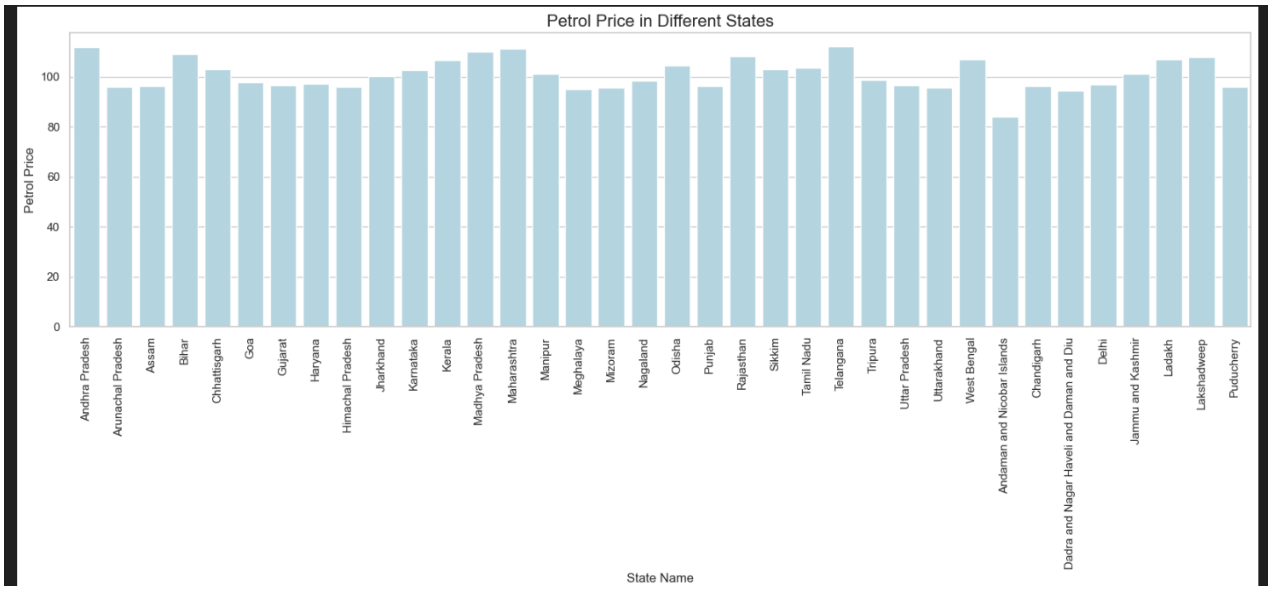
4-STATEWISE PRICE VARAIATIONS:

Distribution of Subsidy Amounts (Histogram):

```
plt.figure(figsize=(8, 6))
plt.hist(data["subsidy"], bins=20, edgecolor='black')  # Adjust bin count as needed
plt.xlabel('Subsidy Amount')
plt.ylabel('Number of States')
plt.title('Distribution of Subsidy Amounts for Electric Vehicles')
plt.show()
```

✓ 0.2s

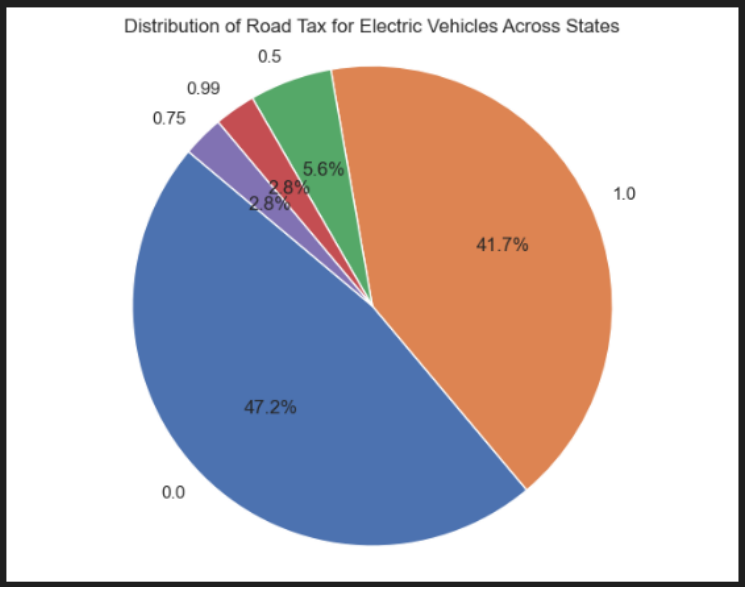




State-wise Road Tax Distribution (Pie Chart):

```
road_tax_counts = data["road tax"].value_counts()
plt.figure(figsize=(8, 6))
plt.pie(road_tax_counts, labels=road_tax_counts.index, autopct='%1.1f%%', startangle=140)  # Customize labels and starting angle
plt.title('Distribution of Road Tax for Electric Vehicles Across States')
plt.axis('equal')  # Equal aspect ratio for a circular pie chart
plt.show()
```

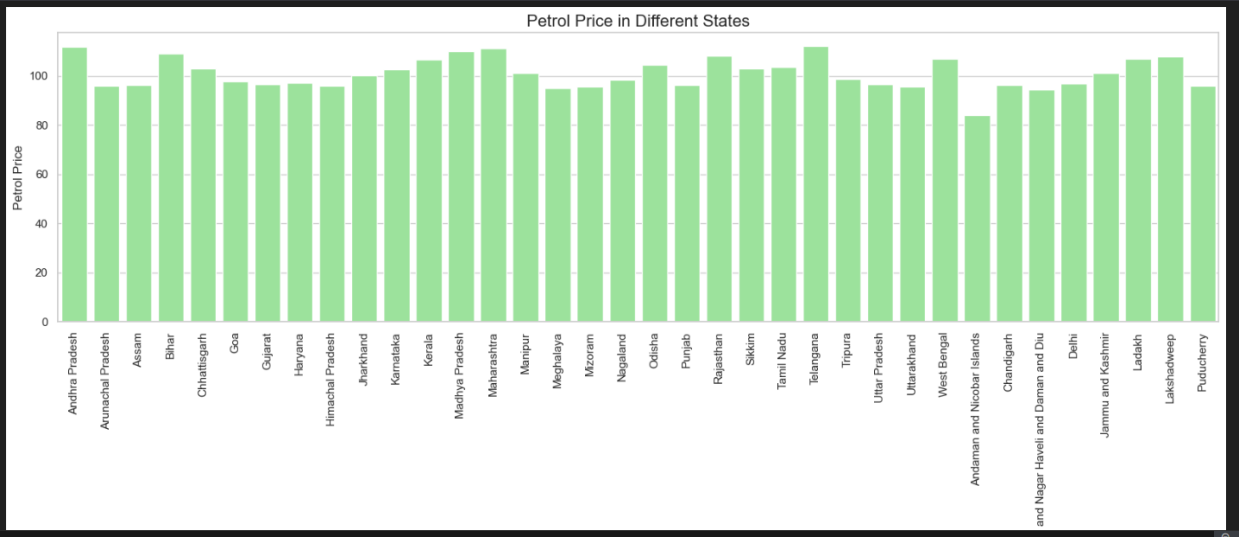
0.1s

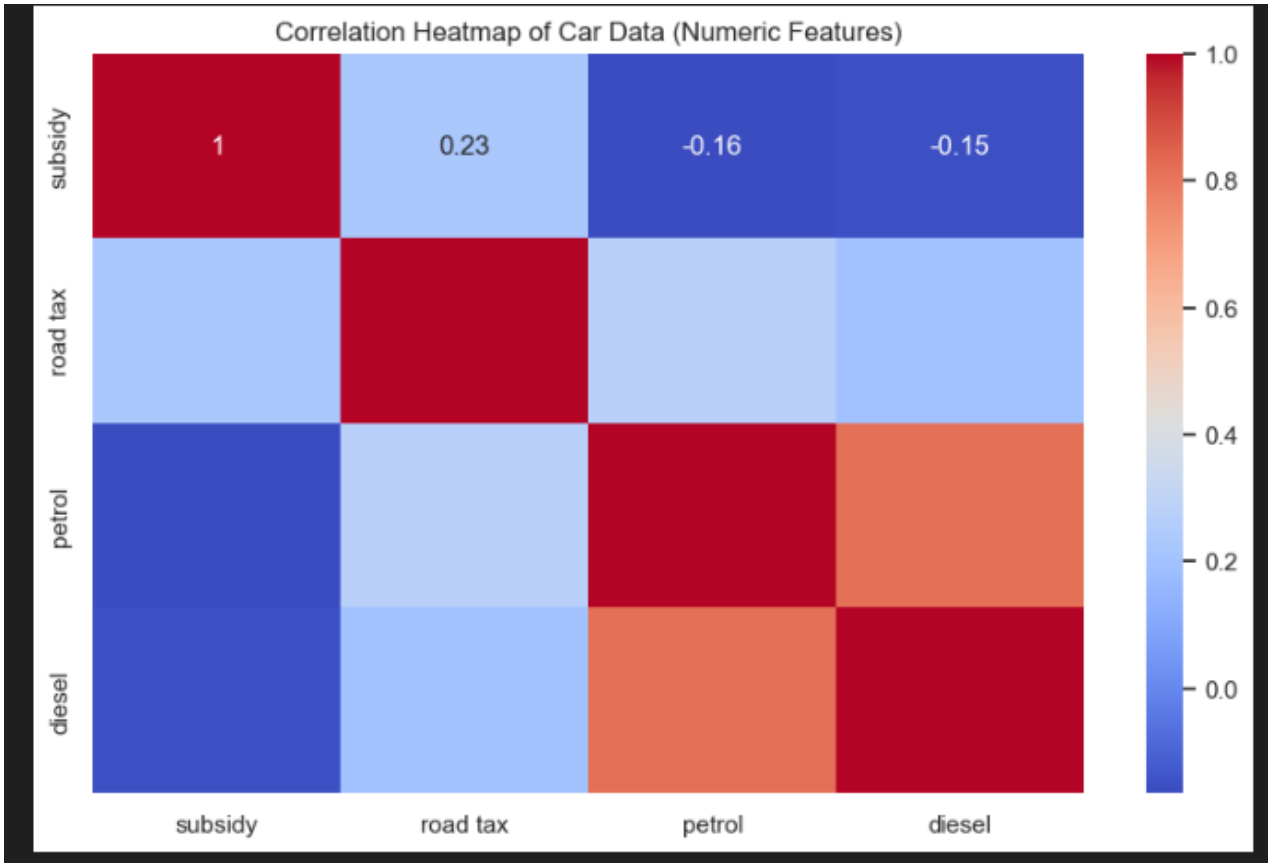


Petrol Price Comparison Across States

```
# Assuming data has a "state" and "petrol" column
plt.figure(figsize=(20, 5))
sns.set_theme(style="whitegrid")
sns.barplot(x="state", y="petrol", data=data, color="lightgreen")  # Adjust color as desired
plt.title("Petrol Price in Different States", fontsize=16)
plt.ylabel("Petrol Price")
plt.xlabel("State Name")
plt.xticks(rotation=90)
plt.show()
```

0.3s




Correlation Heatmap of Car Data (Numeric Features)
subsidy
road tax
petrol
diesel
1
0.23
-0.16
-0.15
subsidy
road tax
petrol
diesel
1.0
0.8
0.6
0.4
0.2
0.0

Conclusion

Feasibility of an EV Startup in India: Analyzing the 2-Wheeler and 4-Wheeler Market

The Indian Electric Vehicle (EV) market presents a compelling opportunity for startups, particularly in the 2-wheeler and 4-wheeler segments. Here's an analysis exploring the feasibility of starting an EV company in India based on these market sectors:

Market Growth:

The Indian EV market is experiencing significant growth, driven by factors like:
Government incentives promoting EV adoption
Rising fuel prices
Increasing environmental awareness
Technological advancements making EVs more affordable and efficient

2-Wheeler Segment:

This segment holds a dominant position in the Indian automobile market.
Growing demand for affordable and environmentally friendly alternatives to traditional scooters and motorcycles presents a significant opportunity for EV startups.
The focus should be on developing cost-effective, low-maintenance, and feature-rich electric scooters and motorcycles catering to the daily needs of commuters.

4-Wheeler Segment:

While the 4-wheeler EV market is still nascent compared to 2-wheelers, it's rapidly gaining traction.
Factors like increasing awareness, growing charging infrastructure, and a wider range of EV models are fueling this growth.
The opportunity lies in offering innovative and competitive electric car options for both personal and commercial use.
Feasibility for a Startup:

Based on the market trends, there's definite potential for EV startups in India. However, success depends on several crucial factors:

Understanding Consumer Needs:

Conduct thorough research to identify unmet needs and preferences of Indian EV consumers in both 2-wheeler and 4-wheeler segments.

Product Differentiation: Develop unique selling propositions (USPs) for your EVs to stand out from established players. This could involve features like innovative design, superior range, advanced technology, or exceptional affordability.

Conclusion:
The Indian EV market presents a promising landscape for startups with a well-defined strategy and a commitment to innovation. By focusing on specific needs within the 2-wheeler and 4-wheeler segments, and addressing existing challenges, startups have the potential to contribute significantly to India's growing EV ecosystem.

Github: https://github.com/Shreyaprasad21/ShreyaFeynnLabs-Task2-EV-Market