Electrical Vehicle Market Segmentation analysis

Abstract: Analysing Electric Vehicle (EV) segments through heatmaps

In this analysis of the electric vehicle (EV) segment, we explore the correlations among key vehicle attributes such as battery capacity, power, driving range, charging time, and price. The analysis reveals several consistent patterns across two different correlation heatmaps. Notably, battery capacity, power, and driving range are all strongly positively correlated with the price of EVs, indicating that higher performance and extended range come at a higher cost. Battery capacity is also strongly associated with both power and driving range, highlighting its critical role in enhancing vehicle performance. However, the correlation between charging time and other factors, including price, is weaker and more variable, suggesting that while charging time is important, it may not be as directly tied to vehicle cost or performance as the other attributes. These insights can guide both consumers and manufacturers in understanding the trade-offs and relationships among key attributes in the EV market.

Data Set 1:

DATA FIELDS:

1. **Brand Name**: The name of the car manufacturer and model.
2. **Battery Capacity (kWh)**: The capacity of the electric vehicle's battery, measured in kilowatt-hours (kWh). A higher capacity generally means a longer range.
3. **Acceleration (sec)**: The time it takes for the vehicle to accelerate from 0 to 100 km/h, measured in seconds. Lower values indicate faster acceleration.
4. **Top Speed (km/h)**: The maximum speed the vehicle can reach, measured in kilometers per hour (km/h).
5. **Range (km)**: The maximum distance the vehicle can travel on a single charge, measured in kilometers (km).
6. **Max Power (kW)**: The maximum power output of the vehicle's motor, measured in kilowatts (kW). Higher values typically indicate better performance.

7. **Max Torque (Nm)**: The maximum torque produced by the vehicle's motor, measured in newton-meters (Nm). Torque affects acceleration and overall performance.
8. **Transmission**: The type of transmission the vehicle uses (e.g., Automatic, Manual). In this dataset, all vehicles have Automatic transmissions.
9. **No. of Seats**: The number of seats available in the vehicle.
10. **Charging Time (h)**: The time required to fully charge the vehicle's battery, measured in hours.
11. **No. of Airbags**: The number of airbags equipped in the vehicle for safety.
12. **Drive Type**: The type of drive system (e.g., AWD for All-Wheel Drive, FWD for Front-Wheel Drive, RWD for Rear-Wheel Drive). It indicates which wheels are powered by the motor.
13. **Price (Lh)**: The price of the vehicle in lakhs (L) of Indian Rupees (₹).

4o mini

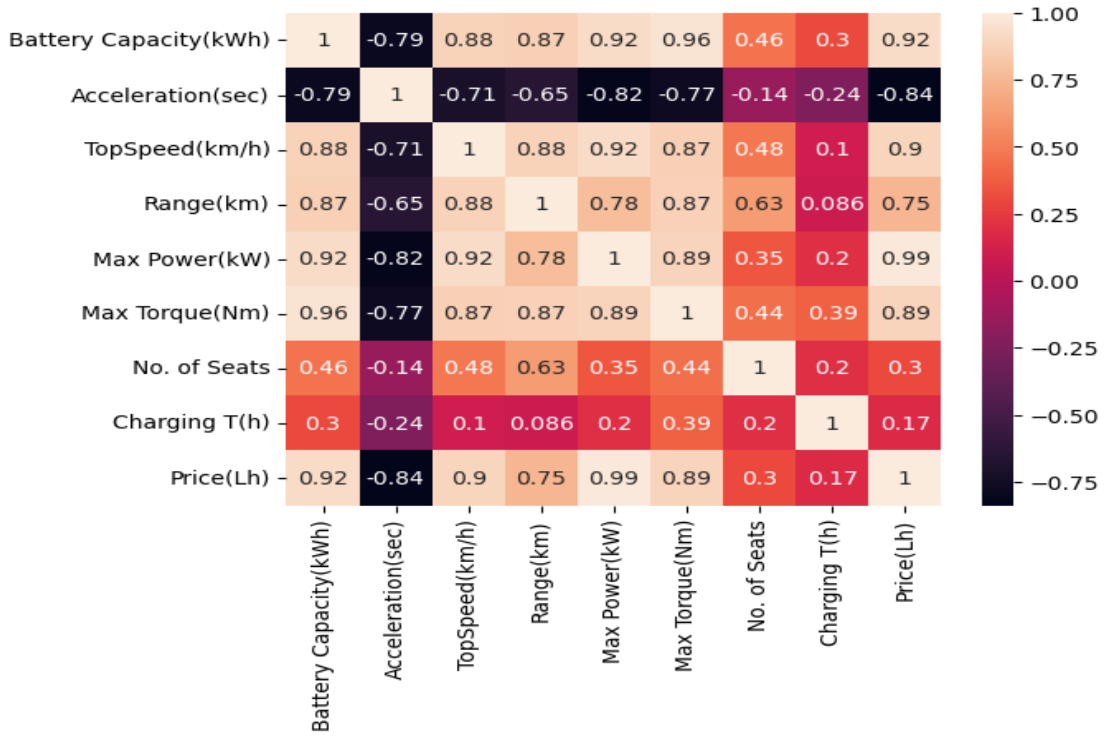
PROCESS:

#check for null values

#check for any hidden special characters

#now data visualization

#Based on the analysis of the plots, it's evident that the Jaguar I-Pace offers an excellent balance between price and features. This brand stands out for providing a competitive price point while maintaining strong performance across other key features, making it a compelling choice in the market .



#From the heatmap analysis, we observe that acceleration tends to decrease as other characteristics improve, indicating an inverse relationship. Additionally, top speed and max power exhibit a strong positive correlation, suggesting that both features capture similar information. To reduce redundancy, we can consider excluding one of these correlated features from the analysis. Similarly, the strong correlation between max power and price implies that changes in max power are closely linked with price variations, making it another candidate for feature reduction

DATA SET 2:

DATA:

Dataset 1: Electric Vehicle Specifications

1. **Brand**: The manufacturer or brand name of the electric vehicle.
2. **Model**: The specific model of the electric vehicle.
3. **Battery Capacity (kWh)**: The capacity of the vehicle's battery measured in kilowatt-hours, indicating how much energy the battery can store.
4. **Acceleration (sec)**: The time it takes for the vehicle to accelerate from 0 to 100 km/h (or another specified speed) measured in seconds.
5. **Top Speed (km/h)**: The maximum speed the vehicle can reach, measured in kilometers per hour.

6. **Range (km)**: The maximum distance the vehicle can travel on a single charge, measured in kilometers.
7. **Max Power (kW)**: The maximum power output of the vehicle's electric motor, measured in kilowatts.
8. **Max Torque (Nm)**: The maximum torque output of the vehicle's motor, measured in newton-meters.
9. **Transmission**: The type of transmission system used in the vehicle (e.g., automatic).
10. **No. of Seats**: The number of seats available in the vehicle.
11. **Charging T (h)**: The time required to fully charge the vehicle's battery, measured in hours.
12. **No. of Airbags**: The number of airbags installed in the vehicle for safety.
13. **Drive Type**: The type of drive system (e.g., AWD - All-Wheel Drive, FWD - Front-Wheel Drive).
14. **Price (Lh)**: The price of the vehicle in lakhs (Lh) or another currency.

Dataset 2: Personal Finance

1. **Age**: The age of the individual.
2. **Profession**: The current occupation or job of the individual.
3. **Marital Status**: The marital status of the individual (e.g., Single, Married).
4. **Education**: The highest level of education attained by the individual.
5. **No of Dependents**: The number of dependents financially supported by the individual.
6. **Personal Loan**: Whether the individual has a personal loan (Yes/No).
7. **House Loan**: Whether the individual has a house loan (Yes/No).
8. **Wife Working**: Whether the individual's spouse is employed (Yes/No).
9. **Salary**: The individual's annual salary.
10. **Wife Salary**: The annual salary of the individual's spouse.
11. **Total Salary**: The combined annual salary of the individual and their spouse.

12. **Make**: The make or model of the vehicle being purchased.
13. **Price**: The price of the vehicle in the local currency.

Dataset 3: Vehicle Registration by State

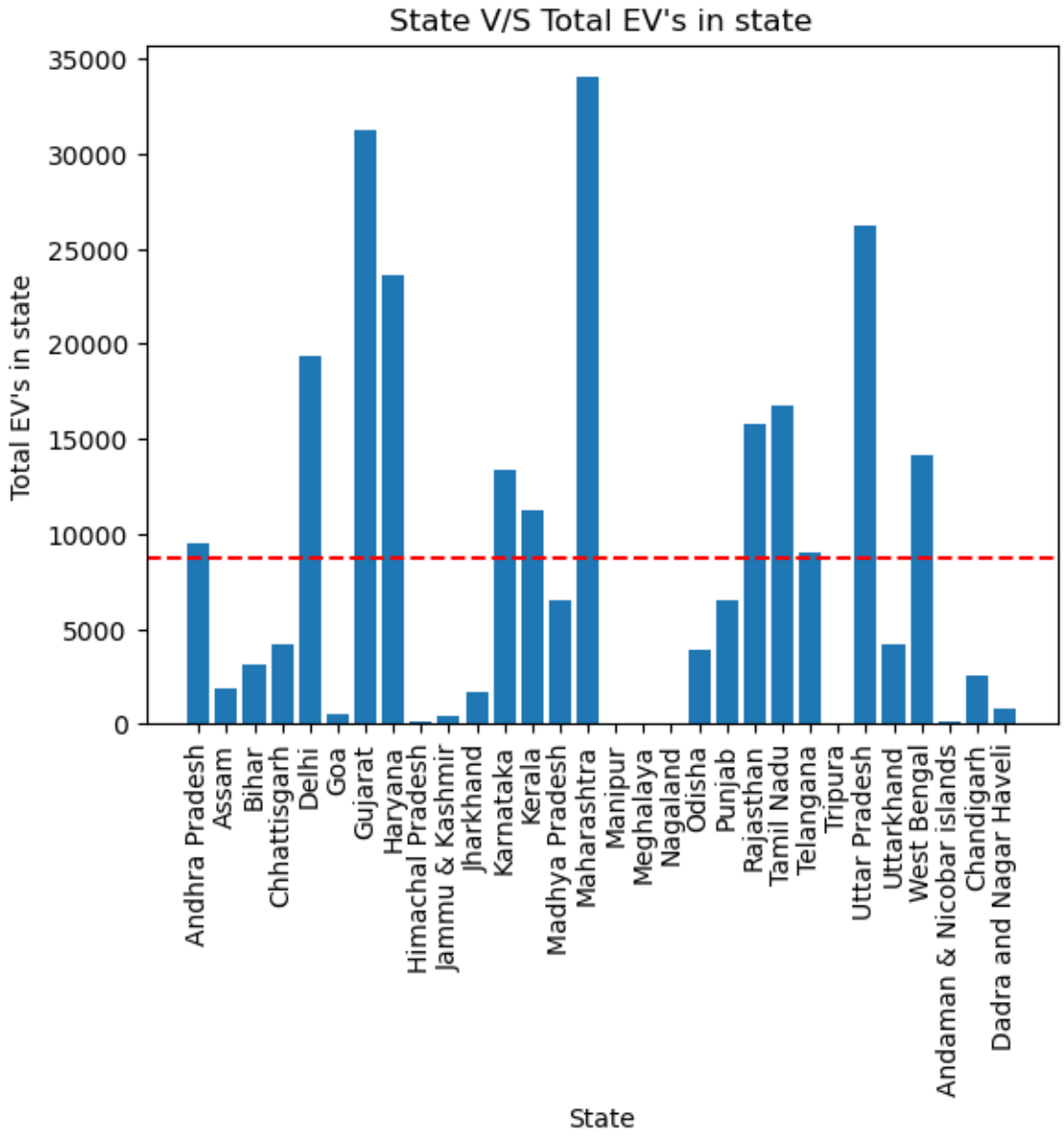
1. **Sl. No**: Serial number or identifier for each state.
2. **State**: The name of the state in the country.
3. **Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules)**: The number of two-wheelers in categories L1 and L2 registered in the state.
4. **Two Wheelers (Category L2 (CMVR))**: The number of two-wheelers in category L2 registered in the state.
5. **Two Wheelers (Max power not exceeding 250 Watts)**: The number of two-wheelers with a maximum power output not exceeding 250 watts.
6. **Three Wheelers (Category L5 slow speed as per CMVR)**: The number of three-wheelers in the slow-speed category L5 registered in the state.
7. **Three Wheelers (Category L5 as per CMVR)**: The number of three-wheelers in category L5 (not slow-speed) registered in the state.
8. **Passenger Cars (Category M1 as per CMVR)**: The number of passenger cars in category M1 registered in the state.
9. **Buses**: The number of buses registered in the state.
10. **Total in State**: The total number of vehicles (all categories) registered in the state.

PROCESS:

#Read the data

Plotting state v/S Total EVVehicles in state

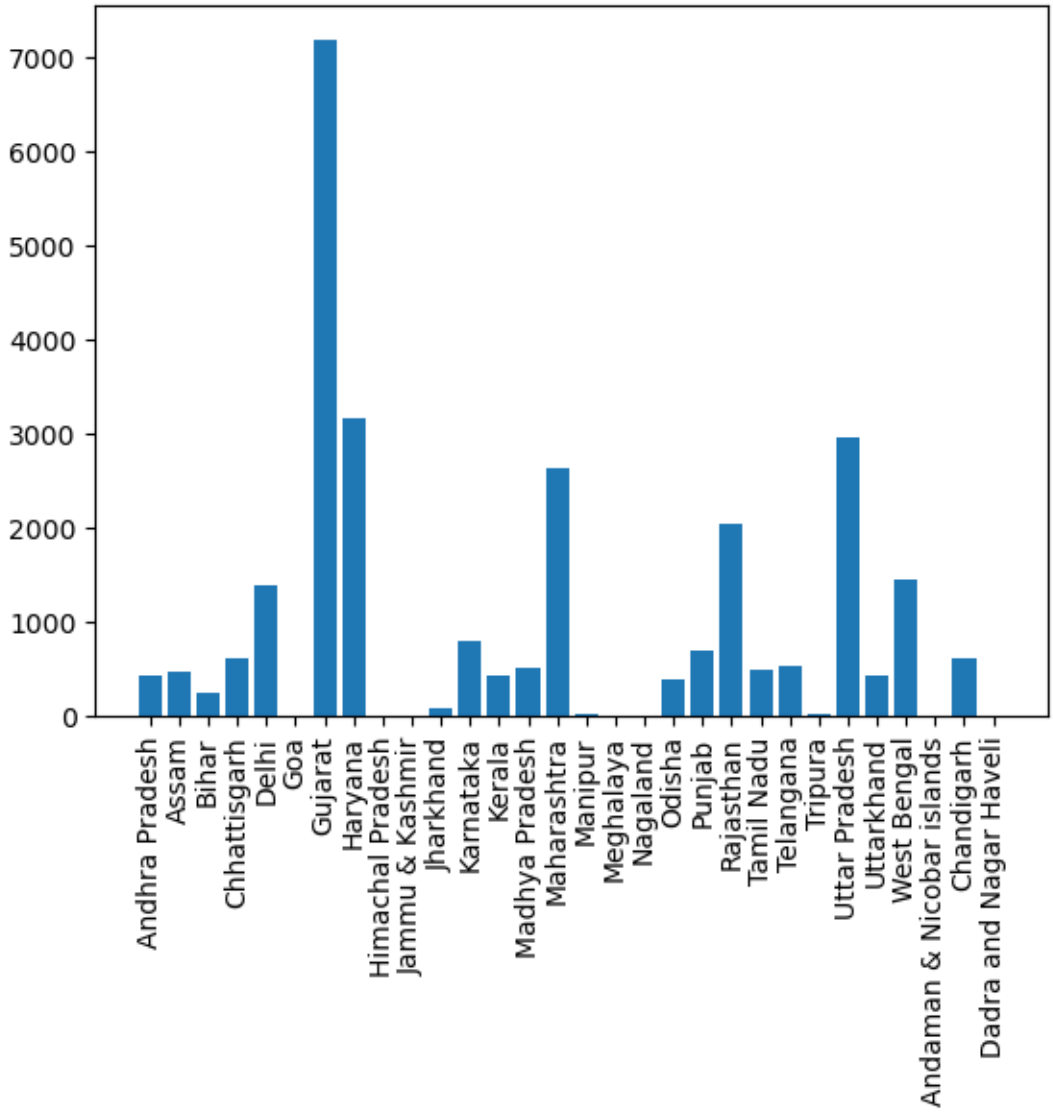
Mean of total Sales from each state



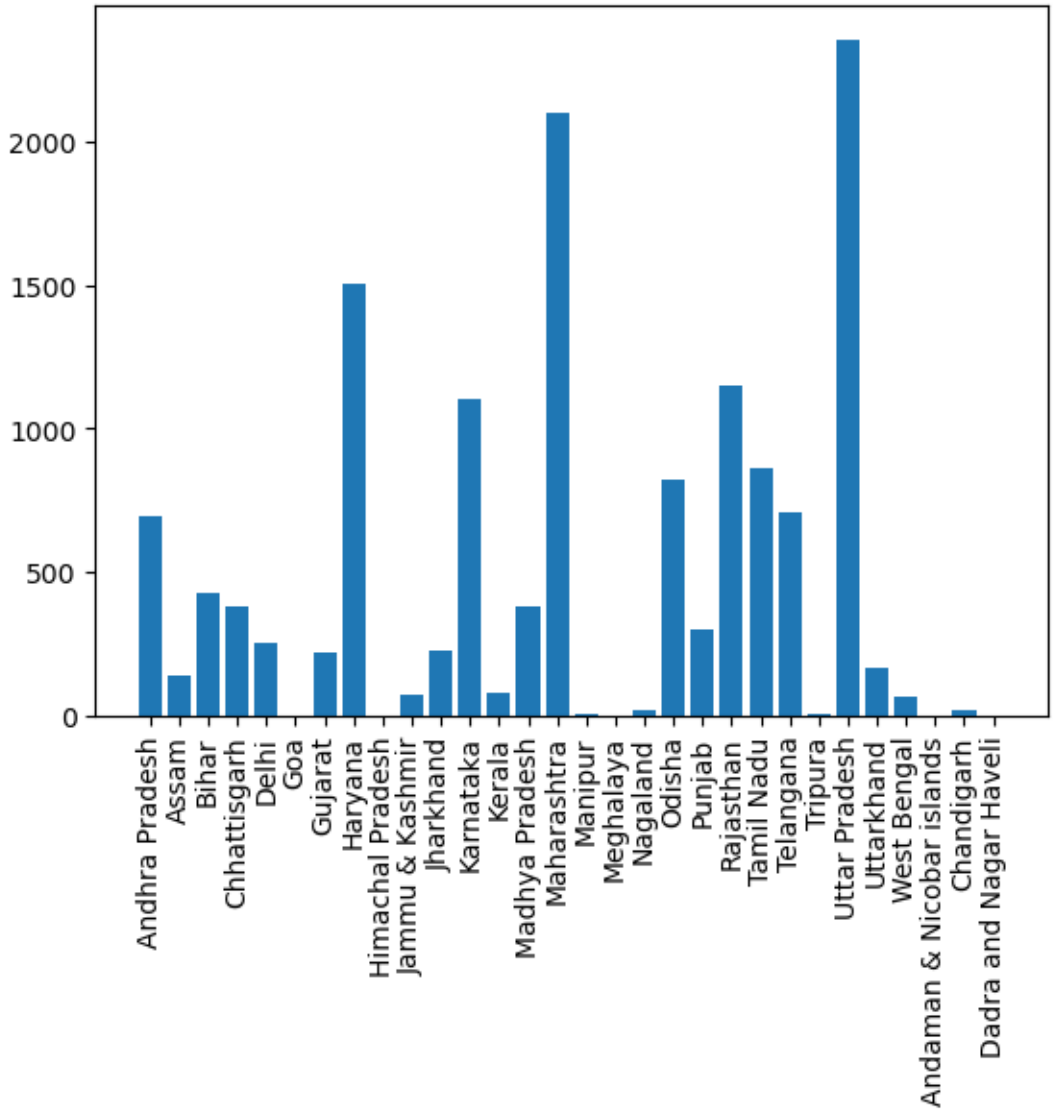
Horizonal red-dotted line represents the mean....so the state having the sales above mean have higher chance of increased sales in the upcoming year as well

#State V/S every ev vehicle category

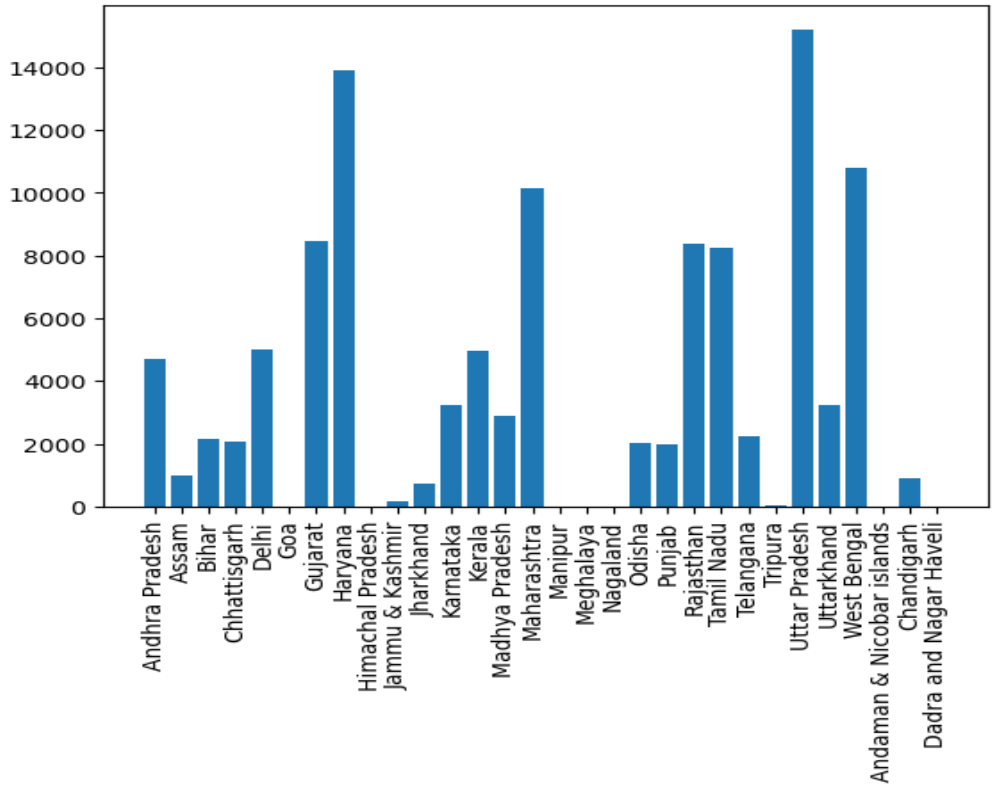
1. Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules



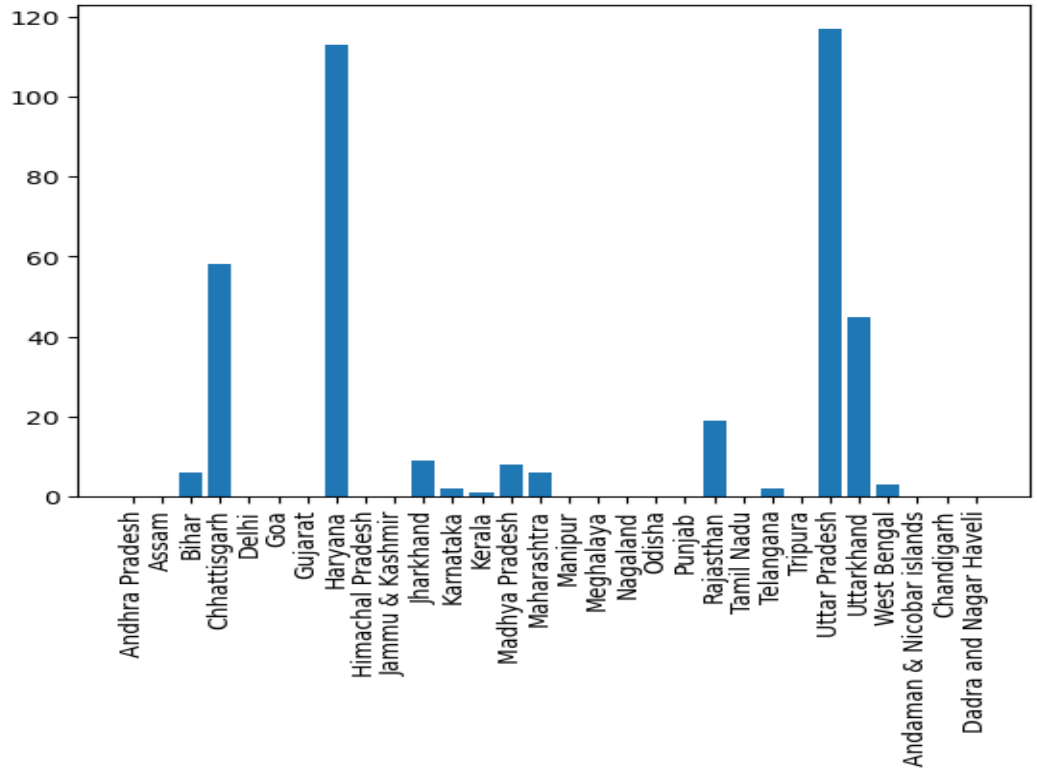
Two Wheelers (Category L2 (CMVR)) Two Wheelers (Category L2 (CMVR))


2000
1500
1000
500
0
Andhra Pradesh
Assam
Bihar
Chhattisgarh
Delhi
Goa
Gujarat
Haryana
Himachal Pradesh
Jammu & Kashmir
Jharkhand
Karnataka
Kerala
Madhya Pradesh
Maharashtra
Manipur
Meghalaya
Nagaland
Odisha
Punjab
Rajasthan
Tamil Nadu
Telangana
Tripura
Uttar Pradesh
Uttarkhand
West Bengal
Andaman & Nicobar islands
Chandigarh
Dadra and Nagar Haveli

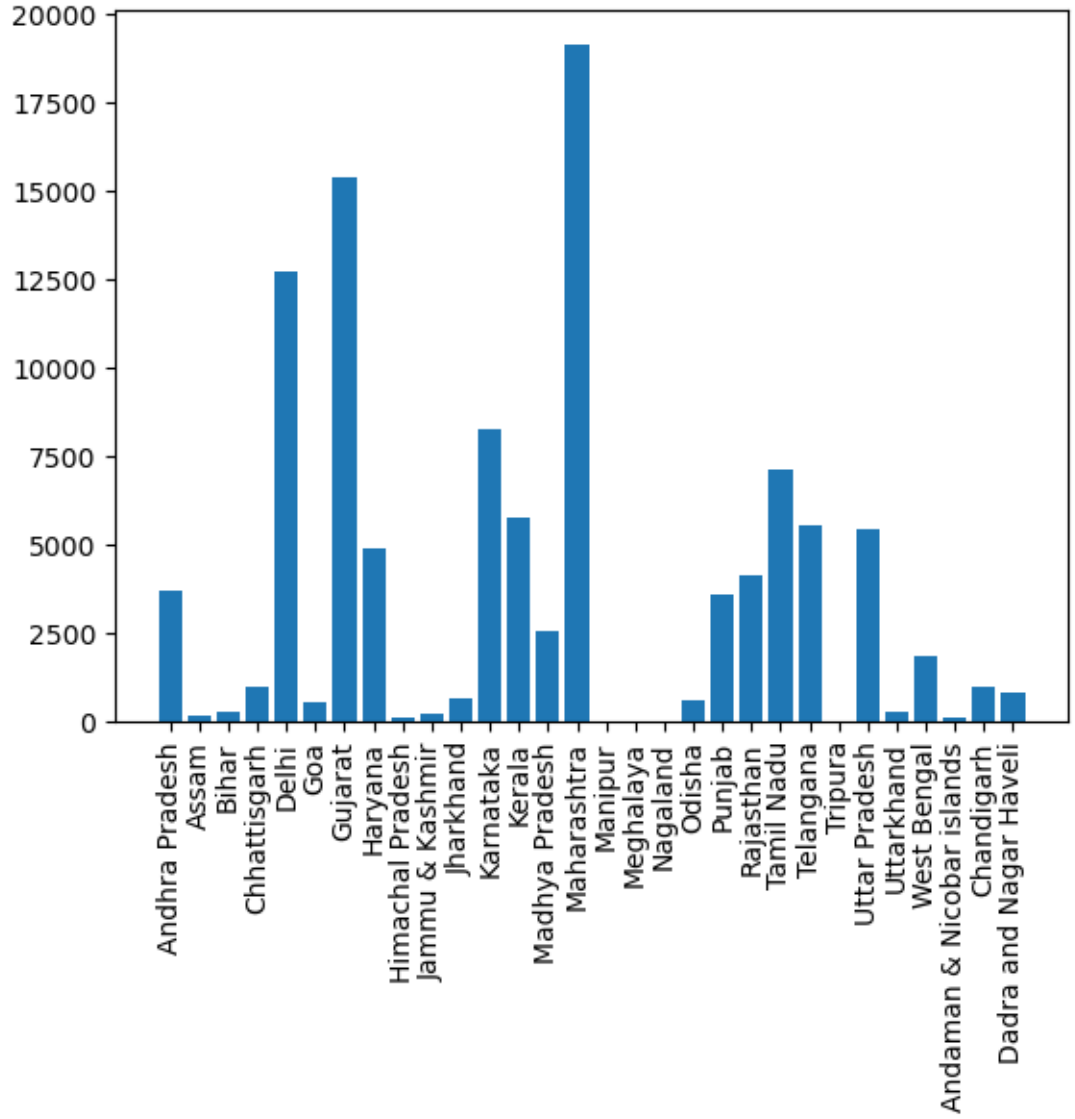
Two Wheelers (Max power not exceeding 250 Watts)



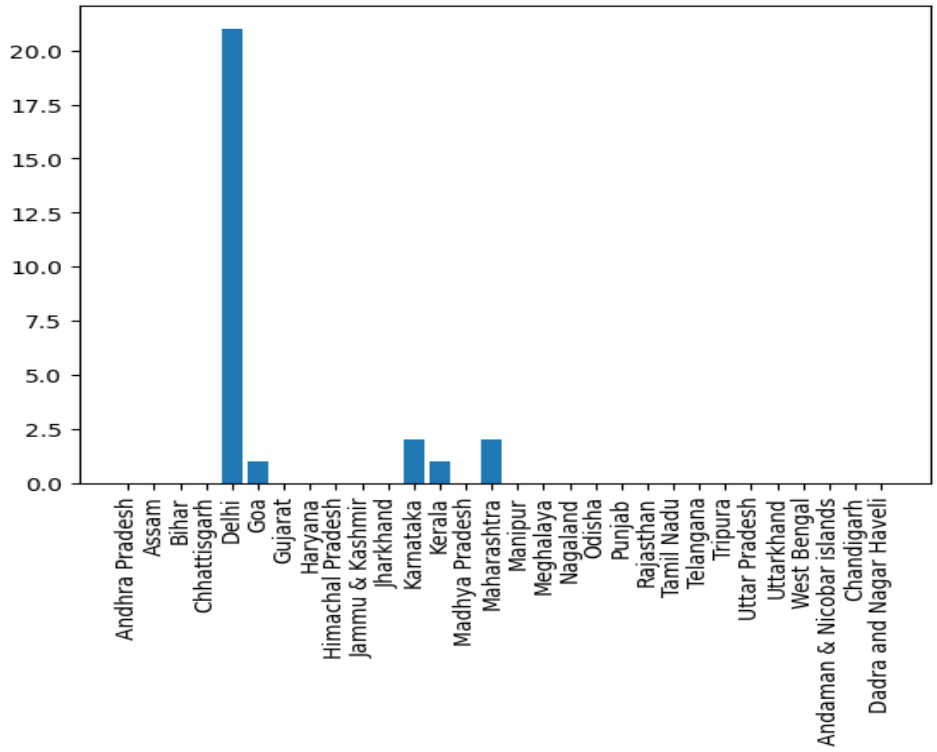
Three Wheelers (Category L5 slow speed as per CMVR)



Passenger Cars (Category M1 as per CMVR)

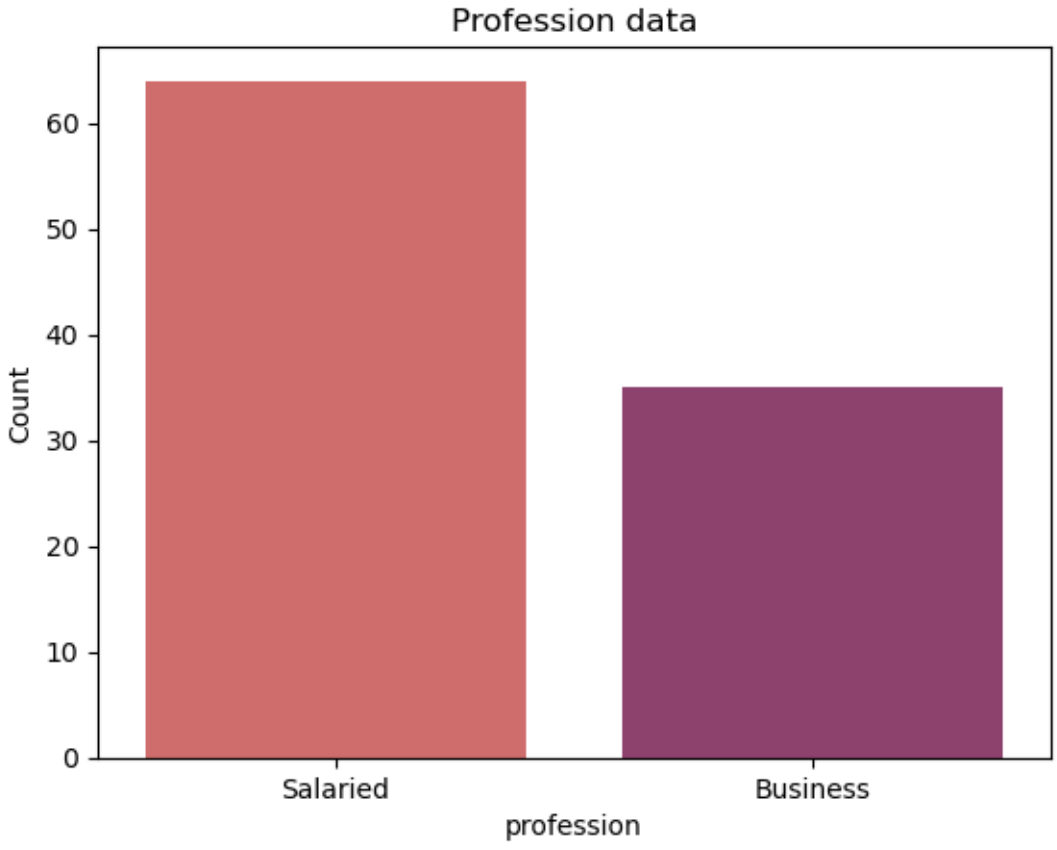


Buses

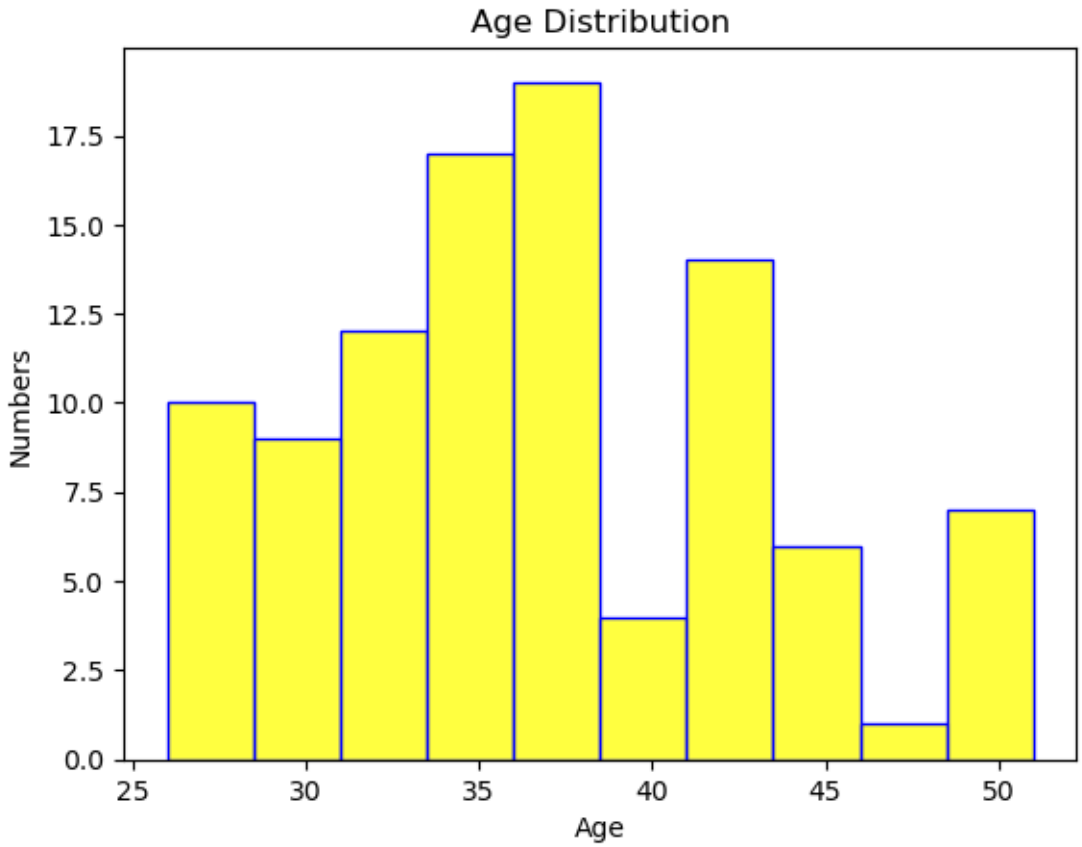


Checking Null values

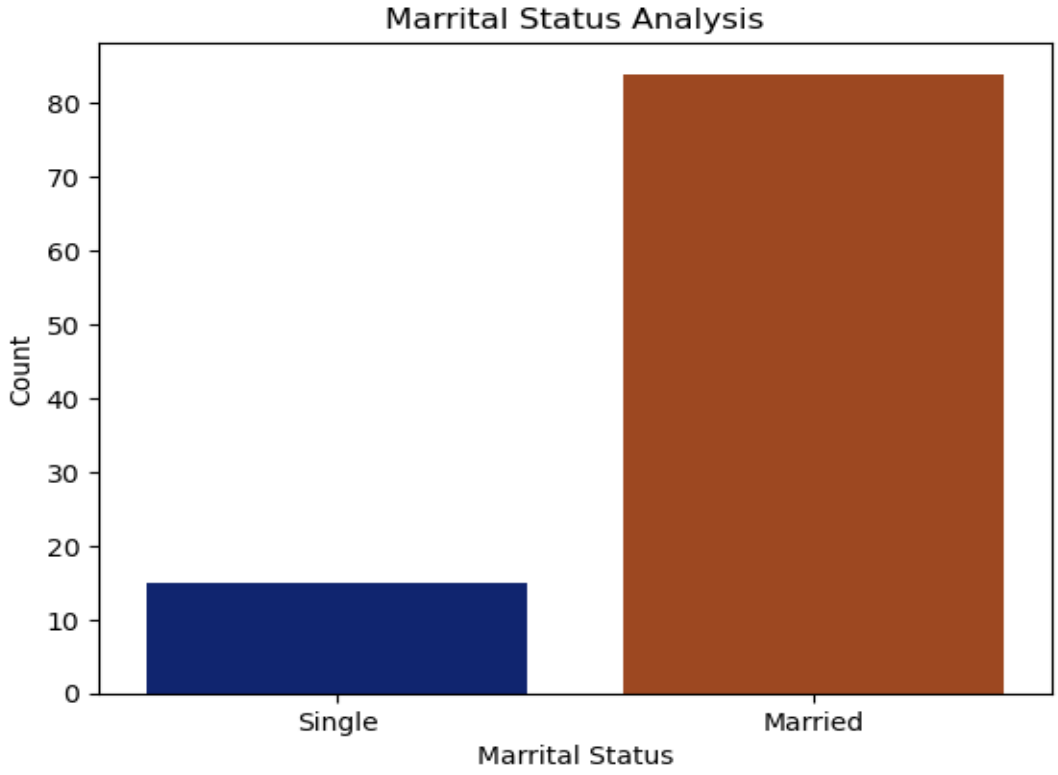
#Some Visualizations regarding the data



Histogram of Ages

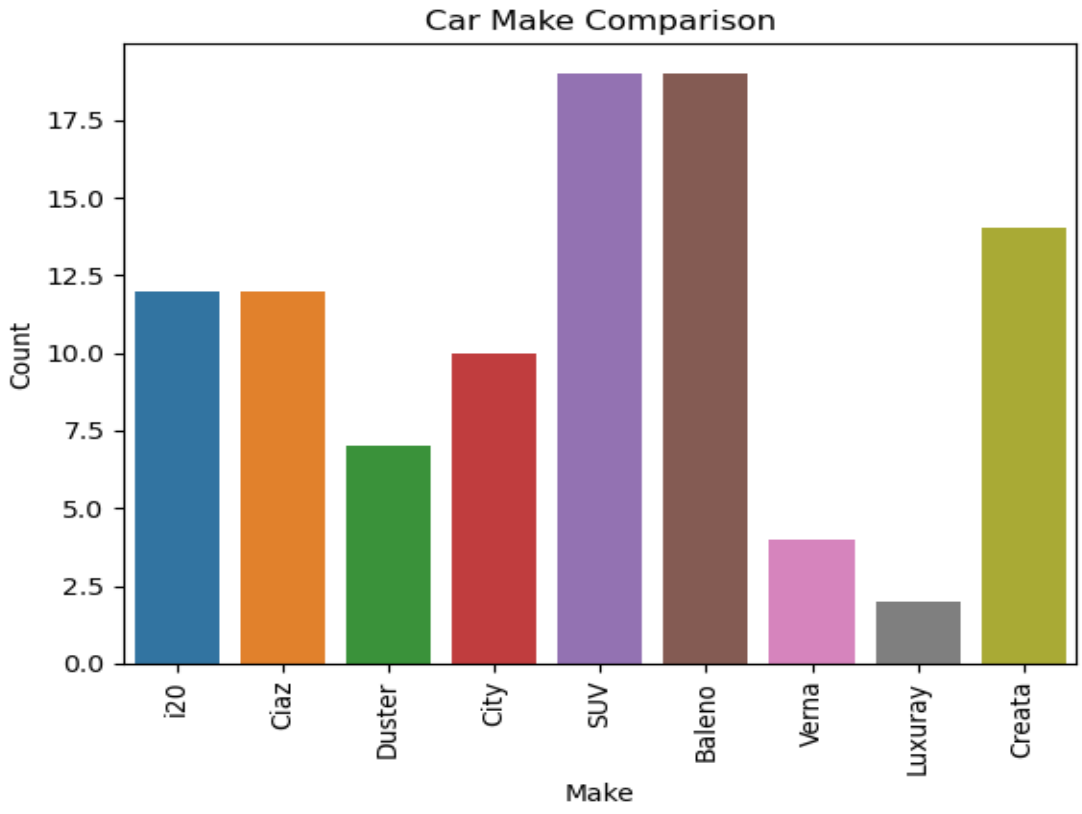


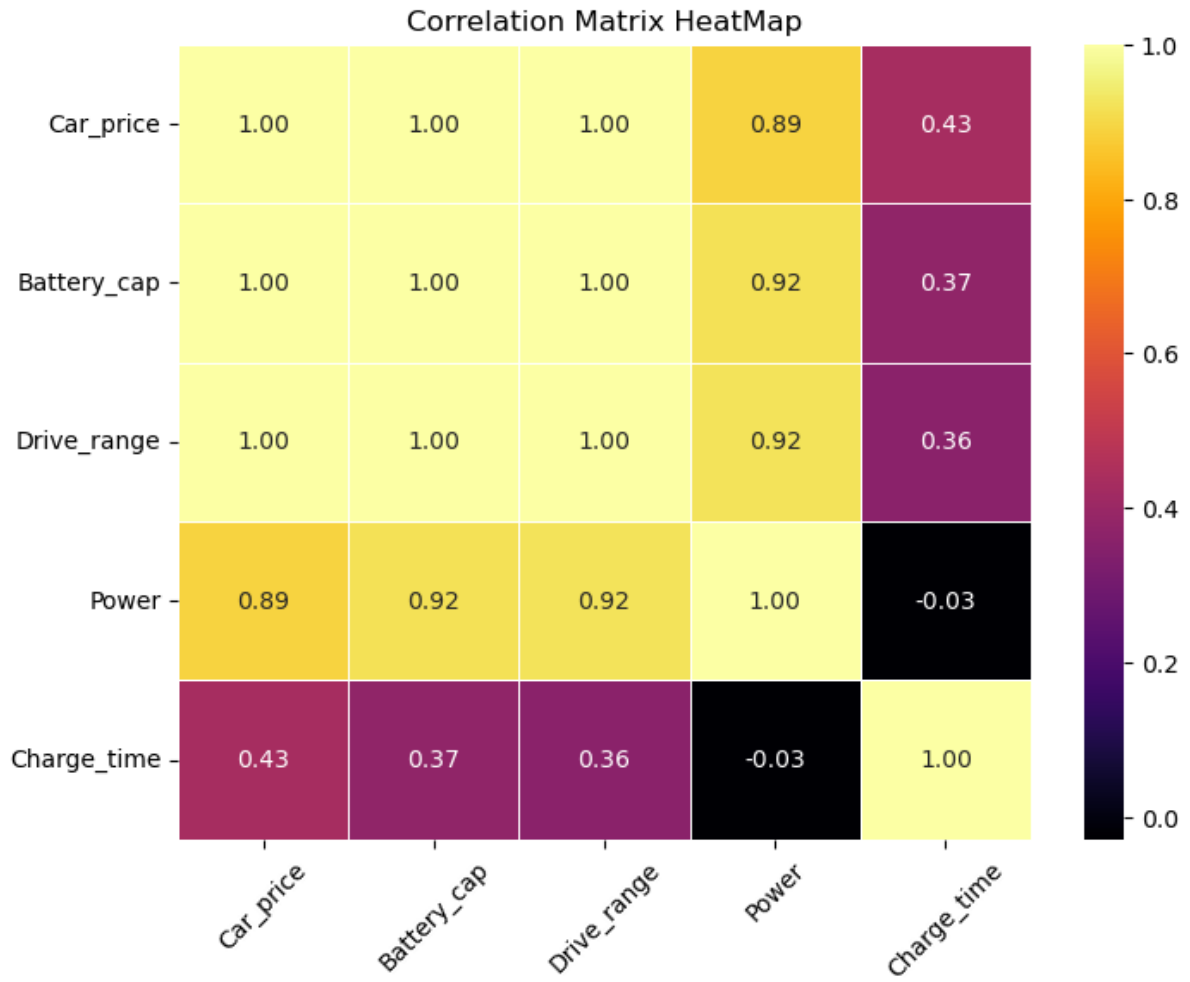
Marital Status



Salary Analysis

#Car Make Comparison





#conclusion

The first heatmap reveals several key insights about the relationships between different factors in the electric vehicle (EV) segment. There is a perfect positive correlation between car price and both battery capacity and drive range, indicating that vehicles with larger batteries and longer ranges are typically more expensive. Additionally, power shows a strong positive correlation with both battery capacity and drive range, suggesting that more powerful vehicles tend to have better battery capacity and range. However, charge time has a weaker correlation with the other factors, particularly showing only a moderate correlation with car price and battery capacity, indicating that while important, charge time does not heavily influence the cost or performance attributes of EVs

COMMON COCLUSIONS FROM BOTH:

Battery Capacity and Price:

Both heatmaps show a strong positive correlation between Battery Capacity and Price (1.00 in the first, 0.92 in the second). This indicates that higher battery capacities generally correspond to higher prices for EVs.

Power and Price:

A strong positive correlation between Power and Price is observed in both heatmaps (0.89 in the first, 0.99 in the second). This suggests that vehicles with higher power output are generally more expensive.

Range and Price:

There is a perfect positive correlation between Drive Range (or Range) and Price (1.00 in the first heatmap, 0.9 in the second), indicating that vehicles with a longer driving range tend to be more expensive.

FINAL TO IMPROVE INDIAN EV MARKET:

Based on the insights from the heatmaps, the following suggestions could help improve the Indian EV market:

Focus on Battery Technology: Given the strong correlation between battery capacity and key factors like price, range, and power, enhancing battery technology should be a priority. Investments in research and development to create more efficient, higher-capacity batteries could lead to EVs with better range and performance, making them more appealing to consumers.

Reduce Costs through Local Manufacturing: The high correlation between battery capacity, range, and price suggests that these factors are critical in determining the overall cost of an EV. Promoting local manufacturing of batteries and other EV components could reduce costs, making EVs more affordable for the Indian market. This could include government incentives for companies to produce batteries domestically.

Improve Charging Infrastructure: Although charging time has a weaker correlation with price and performance, it remains a significant factor for consumers. Expanding the charging infrastructure across the country, especially with fast-charging options, can alleviate concerns about long charging times and encourage more people to adopt EVs.

Incentivize High-Performance EVs: The strong relationship between power, battery capacity, and price indicates that high-performance EVs tend to be more expensive. Offering subsidies or tax incentives for high-performance, long-range EVs could make them more accessible to a broader audience, thus driving adoption.