Market Segmentation Analysis

of

Electric Vehicle Market in India

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Problem Statement:

Our Task is to analyze the Electric Vehicles Market in India using segmentation analysis and determine a feasible strategy for a newcomer to enter the market, targeting the most viable segments in terms of Geographic, Demographic, etc.

Here we are going to analyze the Electric Vehicles Market in India using different segments like states, charging stations, type, manufacturer, and other buyer details that are at our disposal.

Fermi Estimation:

First we would like to estimate the number of people that will own an EV by the end of 2025 in India using Fermi Estimation. Estimating the number of people who will own an Electric Vehicle (EV) in India by the end of 2025 involves several assumptions and simplifications. Let's break it down step by step:

1. Population of India: The population of India is approximately 1.432 billion(1.432×10^9).

2. Economic Growth: India's economy has been growing, and a growing economy often correlates with an increase in disposable income, which could lead to more people purchasing EVs. Assuming a conservative annual economic growth rate of 5%, we can estimate the increase in the number of potential EV buyers.

3. EV Market Growth: The growth of the EV market depends on government policies, infrastructure development, and consumer adoption. India has set ambitious targets for electric mobility. Assuming a significant boost in the EV market, let's estimate that the market will grow at a rapid annual rate, say 30%.

4. EV Market Share: Not everyone will switch to EVs, and the market share of EVs in the automobile market is crucial. Assuming a small but growing market share, say 5% of all new vehicle sales.

5. Average Household Size: The number of people who own a car is often shared within a household. Let's assume an average household size of 4 people.

Now, we can use these assumptions to estimate the number of people who will own an EV in India by the end of 2025:

- Estimated population of India by the end of 2025: 1.432 billion * (1 + 0.05) ^ 4 (four years of 5% growth) ≈ 1.66 billion people.

- Estimated number of potential EV buyers (conservative estimate): 1.66 billion - 1.432 billion ≈ 228 million people.

- Estimated number of EVs sold in 2025: 228 million * 0.3 (30% annual growth) ≈ 68.4 million EVs sold in 2025.

- Estimated number of people who will own an EV by the end of 2025: 68.4 million * 0.05 (5% market share) ≈ 3.42 million people.

Keep in mind that this is a rough estimation, and actual numbers can vary significantly based on various factors such as government policies, infrastructure development, consumer preferences, and economic conditions. It's essential to consult more recent data and expert analyses for a more accurate prediction.

About the Data used:

Columns explanations:
1. 'Brand' tell the manufacturers of electric vehicles.
2. 'model' tells the various electric vehicles.
3. 'AccelSec', 'Top Speed', 'PowerTrain' tell the specification about the vehicles.
4. 'Range_km', 'Fast_Charge', 'Plug_type' and ' Bodystyle' tell us about the range of vehicle per full charge,fast charging is provided or not, type of charging plug and body style of vehicle respectively.
5. 'Seats' and 'Price' tells about the number of seats available on a vehicle and their price.
6. 'Region' and 'State/UT' tell about the states of India.
7. 'EV Charging Facility' and 'Chargers' tell about the facility of charging in the respective states.
8. '2V', '3V', '4V', 'Bus' tells about the type of vehicles in the market.
9. 'Age' tells the age of the buyer.
10. 'Profession' tells the profession of the buyer.
11. 'Marital Status' tells us if the buyer is married or single.
12. 'Education' tells us about the level of education of the buyer.
13. 'No of Dependents' tells us about the number of people who depend upon the buyer as a source of income.
14. 'Personal Loan' tells us if the buyer has a personal loan.
15. 'House Loan' tells us if the buyer has a pending House Loan or not.
16. 'Wife Working' tells us if the buyer has a wife that has a paying job or not.
17. 'Total Salary' tells about the total salary earned by the buyer's family.
18. 'Price' tells us the cost of the vehicle the buyer had to pay.

Exploratory Data Analysis of the Datasets:

The graph below shows the total number of Electric Vehicles in the various states of India. From the below graph we can clearly see that Uttar Pradesh has the most number of EVs hence it also has the highest demand for EVs, followed closely by Karnataka, Maharashtra, and Delhi with states like Tamil Nadu and Bihar not far behind.
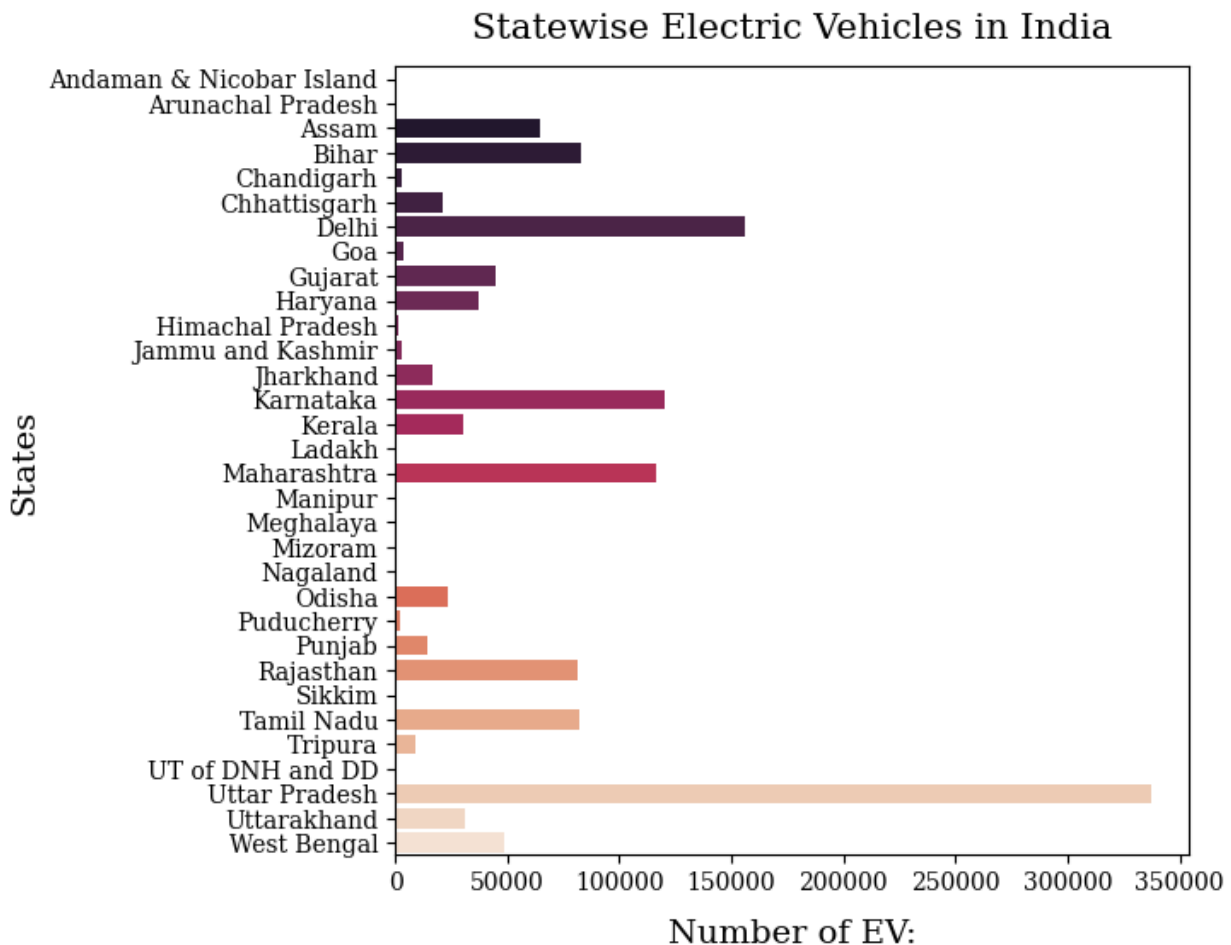

The below graph shows the number of Two wheeled EVs in the various states of India. It is clearly visible that Maharashtra and Karnataka have a large number of Two wheeler EVs, so it is clearly a viable idea for a new company to target these states if they intend to deal in two wheelers. Also targeting states like Bihar that have a high number of EVs but a low number of Two wheeler EVs can be an ideal target for a new company to reach out to by making designs that are suitable for that segment of people.
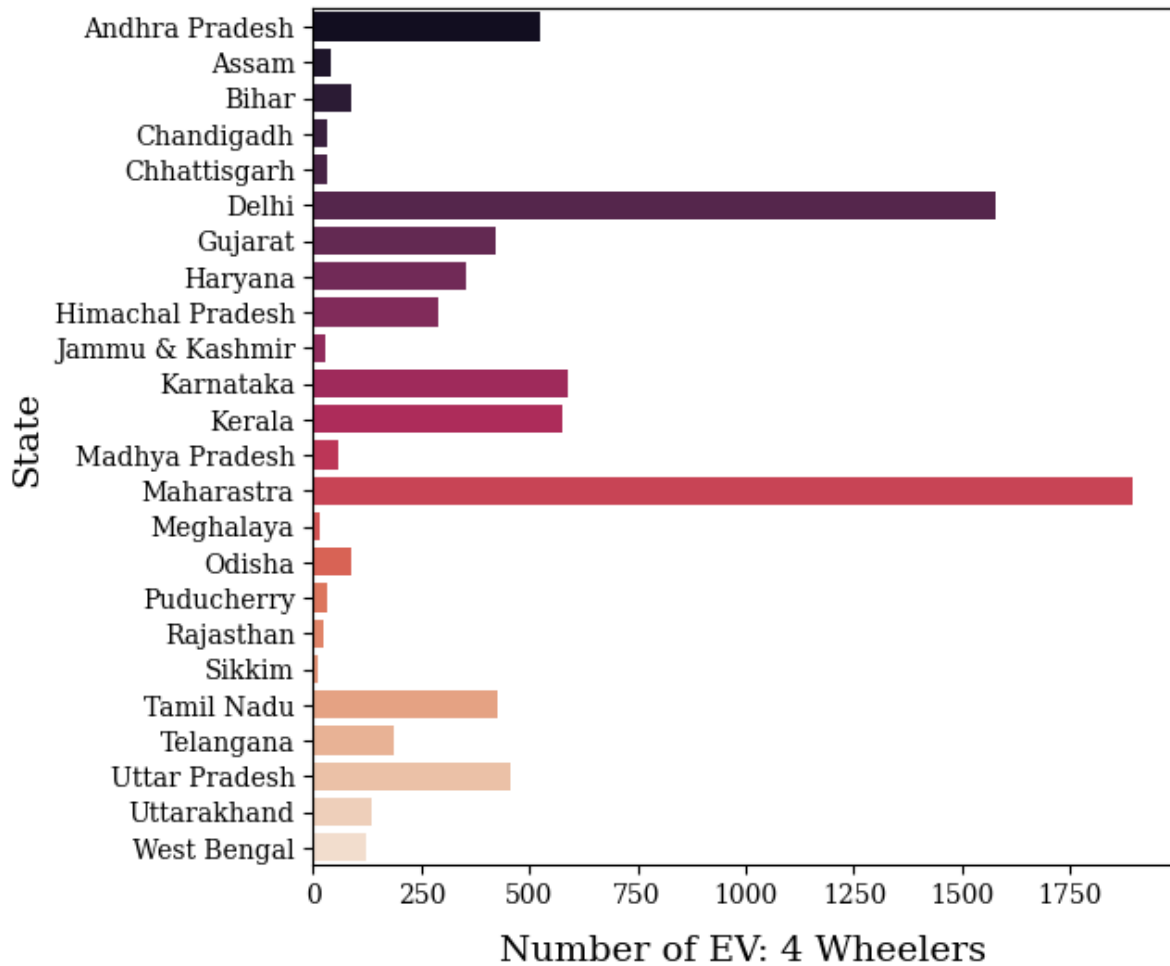
Statewise Electric Vehicles (2 Wheelers) in India
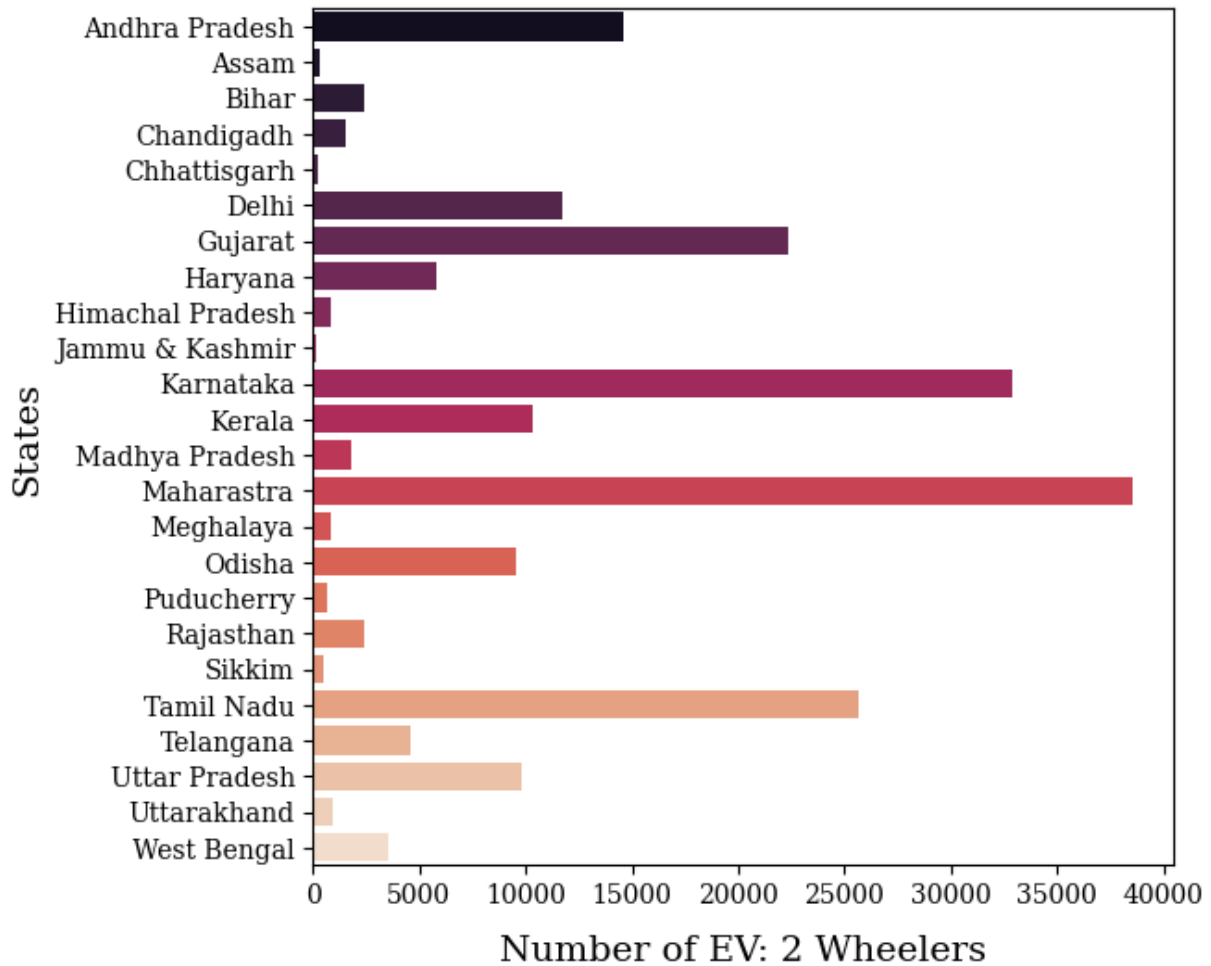
Developing states like Uttar Pradesh, Bihar, Assam are visible to have a high number of 3 wheeled EVs. It is also visible that most of the states have a poor count of 3 wheeler EVs .
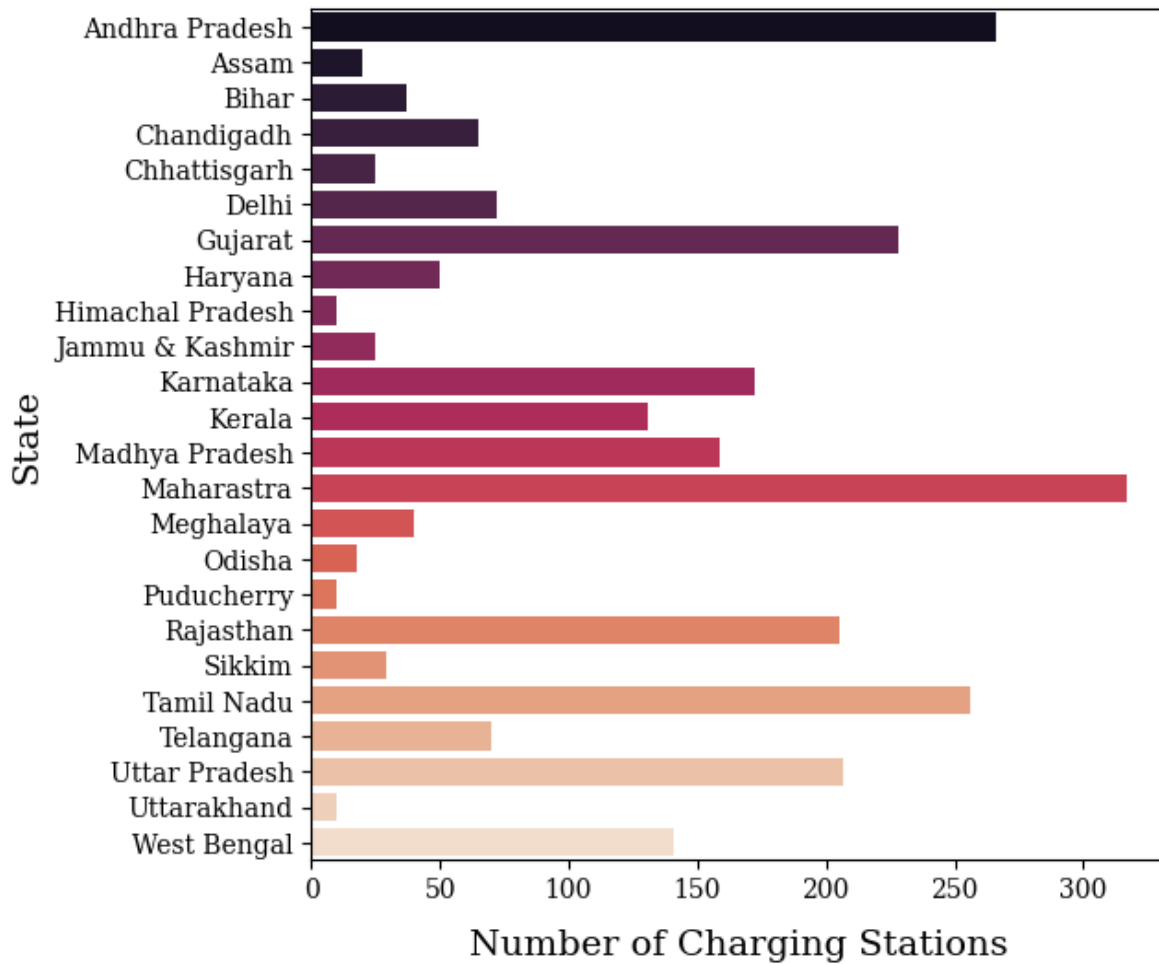
Statewise Electric Vehicles (3 Wheelers) in India
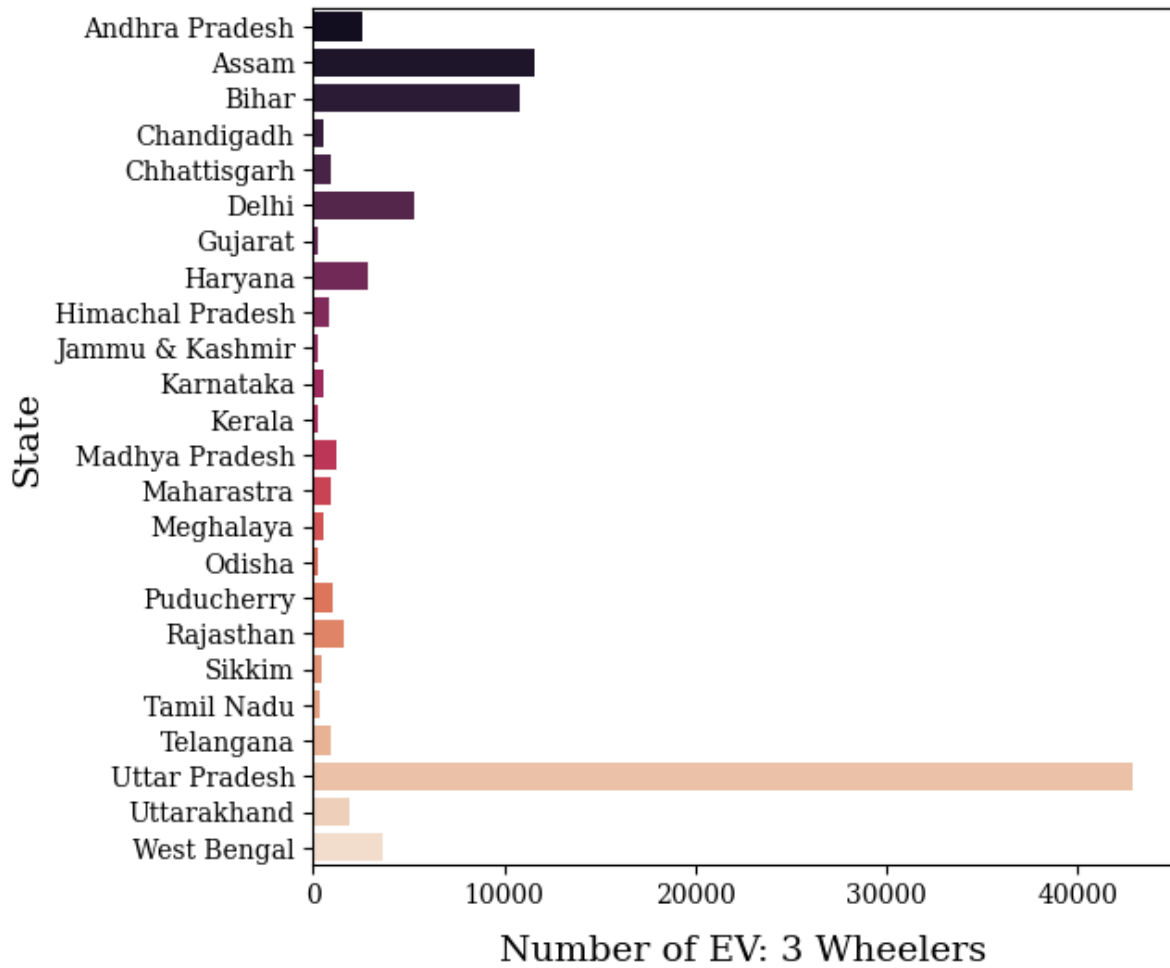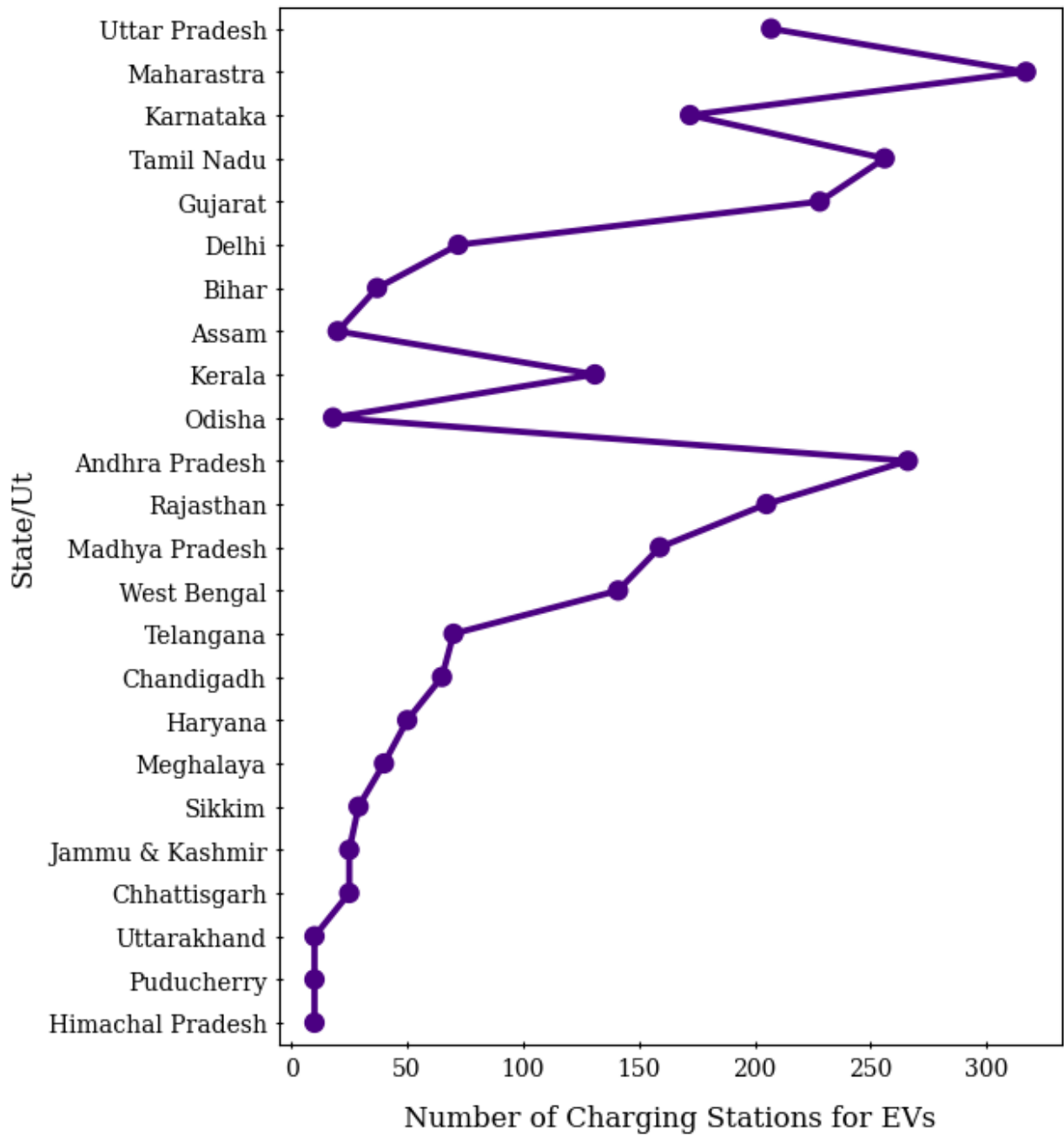
Statewise Electric Vehicles (4 Wheelers) in India

The graph below shows the number of charging stations in each state of India. A viable target for charging infrastructure companies would be states that have less number of charging stations.
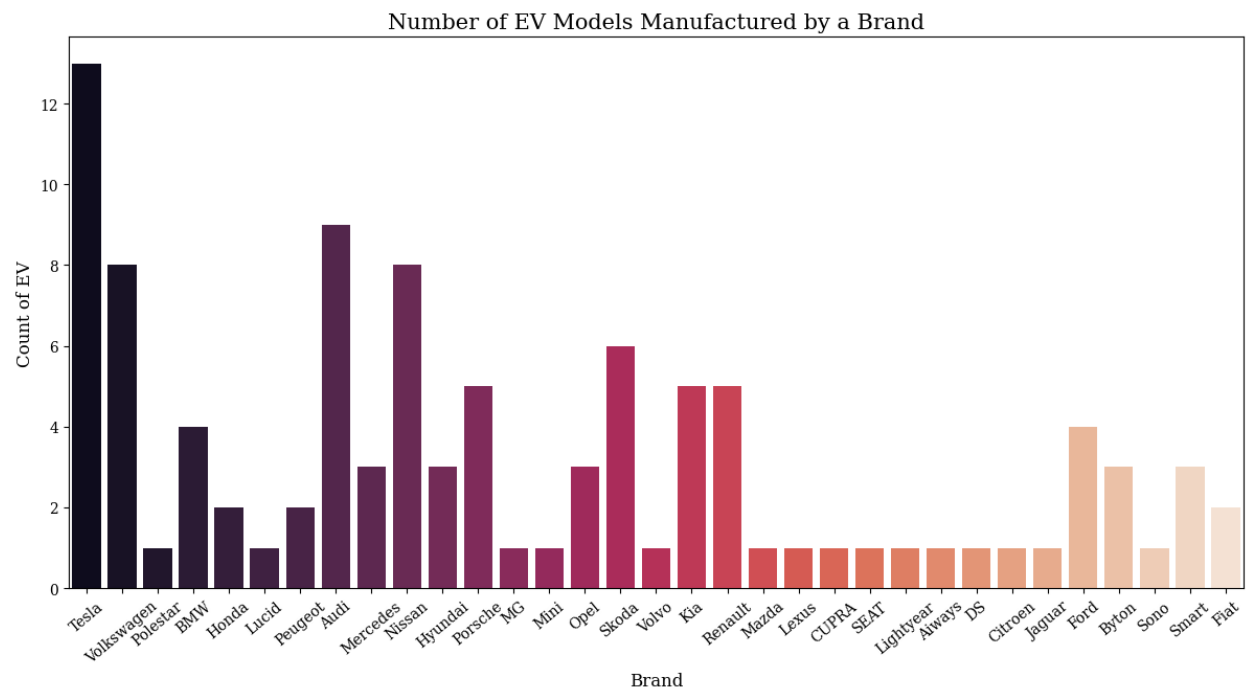
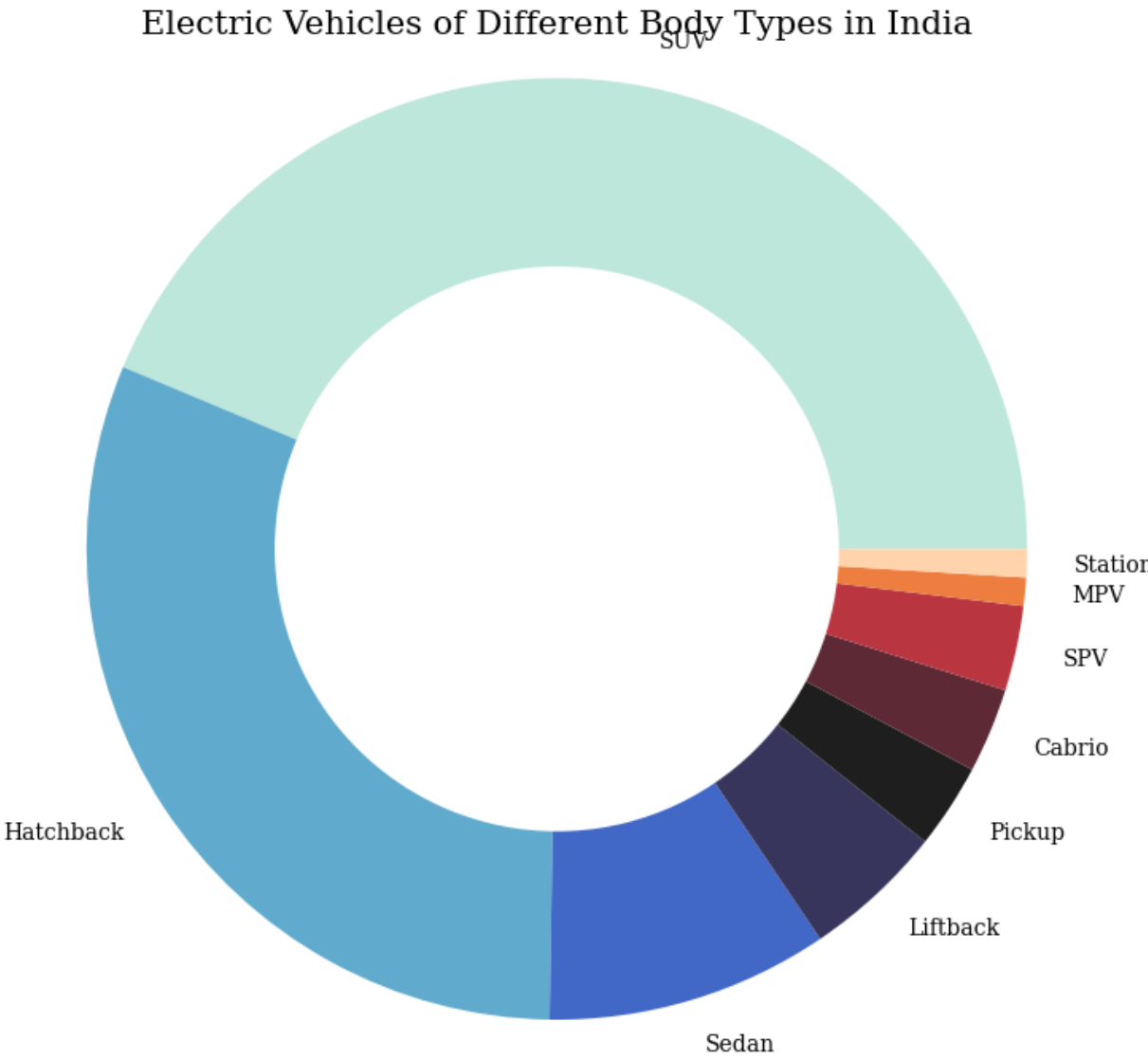Number of Charging Stations Sanctioned in India

State Wise EV charging stations

The below graph shows the number of models of EVs each company has in the market.

Number of EV Models Manufactured by a Brand

The below pie chart shows the demand of different types of EVs that the customers buy.

Electric Vehicles of Different Body Types in India

The graph below shows the number of seats in the EV that the customers buy.
It is quite evident that five seater vehicles are the most sought after vehicles.
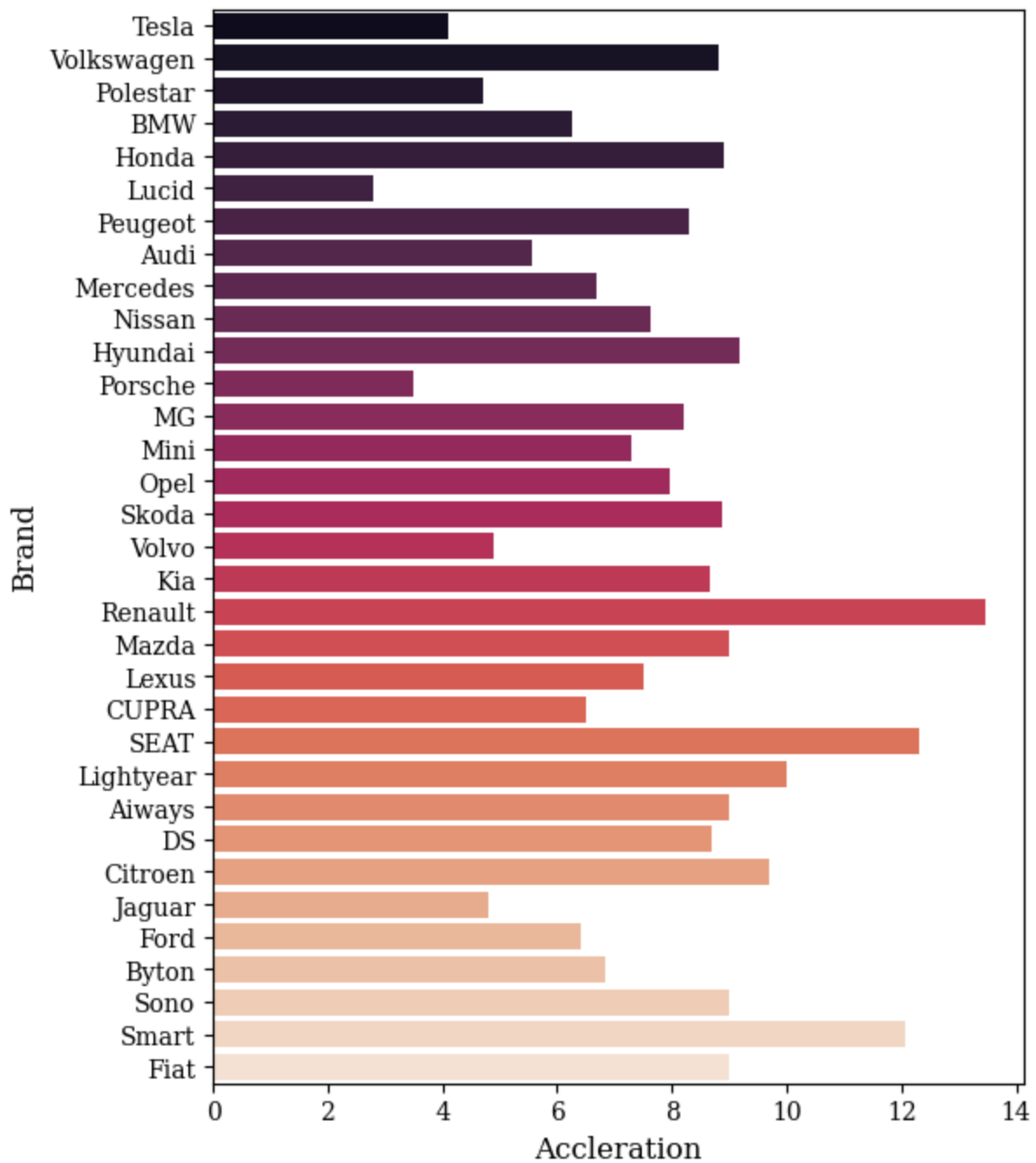
Available Electric Vehicles of Different Number of Seats in India
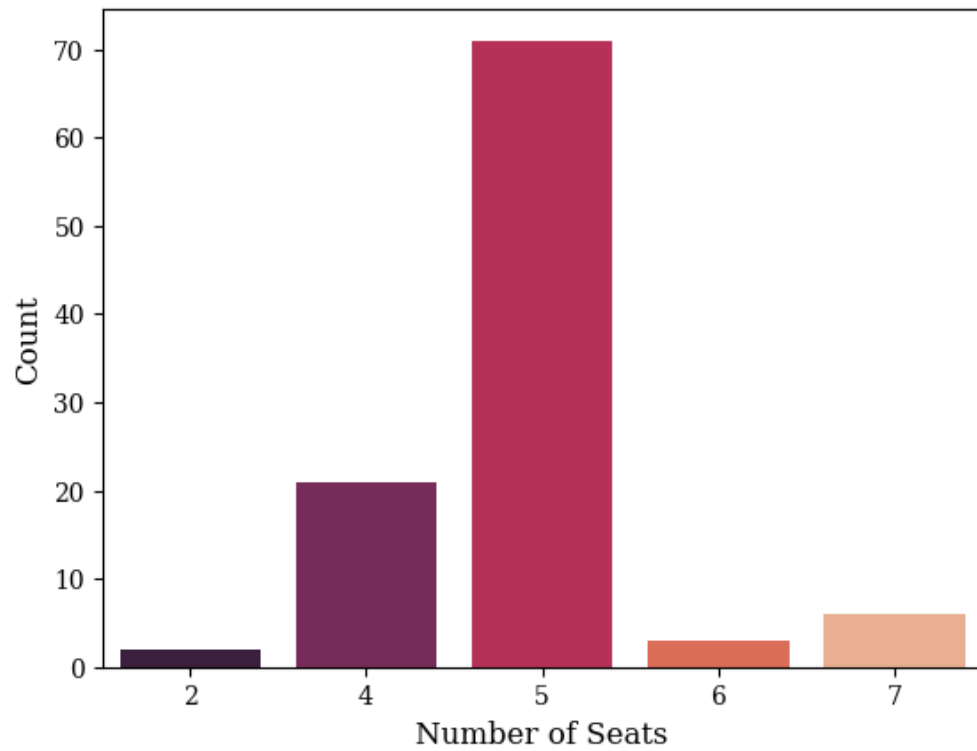
The graph below shows the prices chart of the EVs that are bought by the people.
The most expensive EV costs 215000 Euros.
The least expensive EV costs 20129 Euros.
The mean expenditure on EVs is 55811 Euros.

Price Comparison
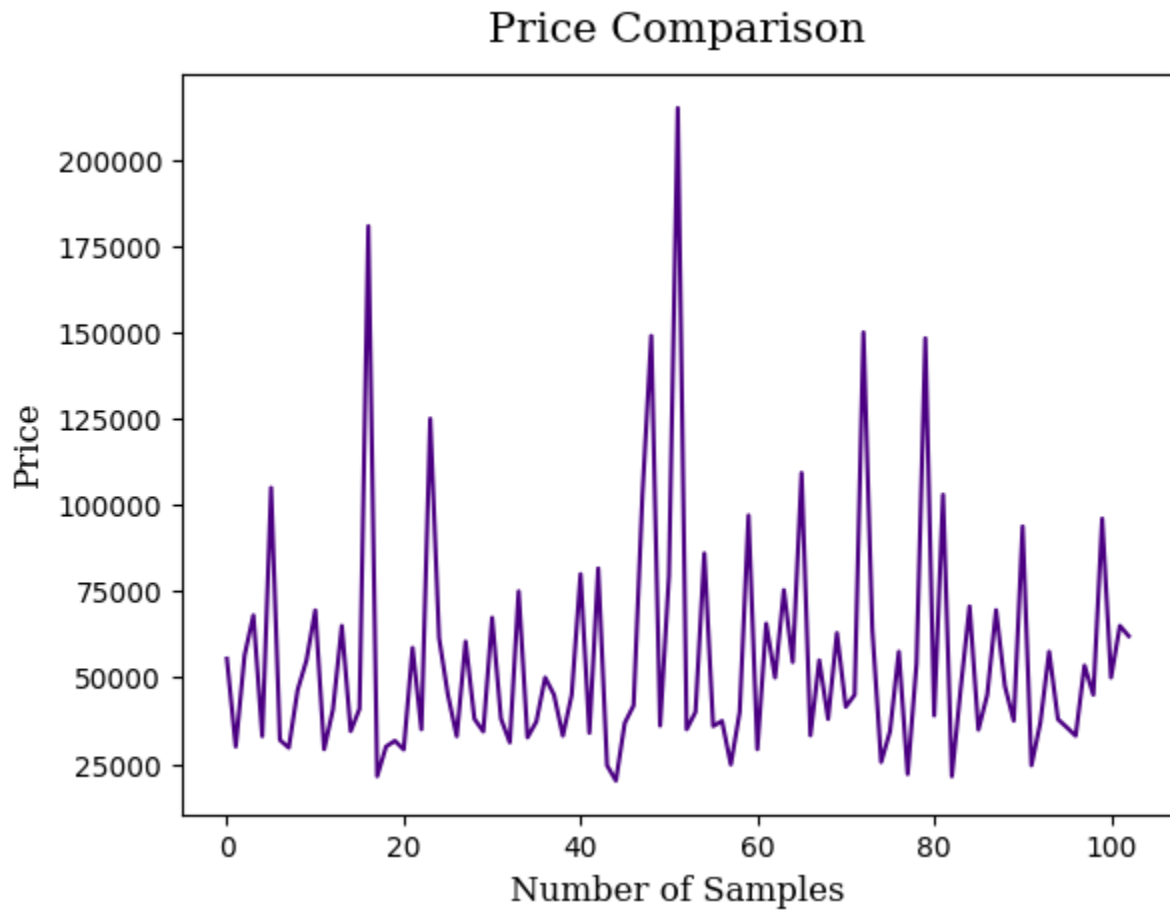
Accleration of EVs in India

Brands like Lucid, Tesla and Porsche have a higher top speed among other EV manufactures.


Brand-wise Speed Comparison of EVs in India
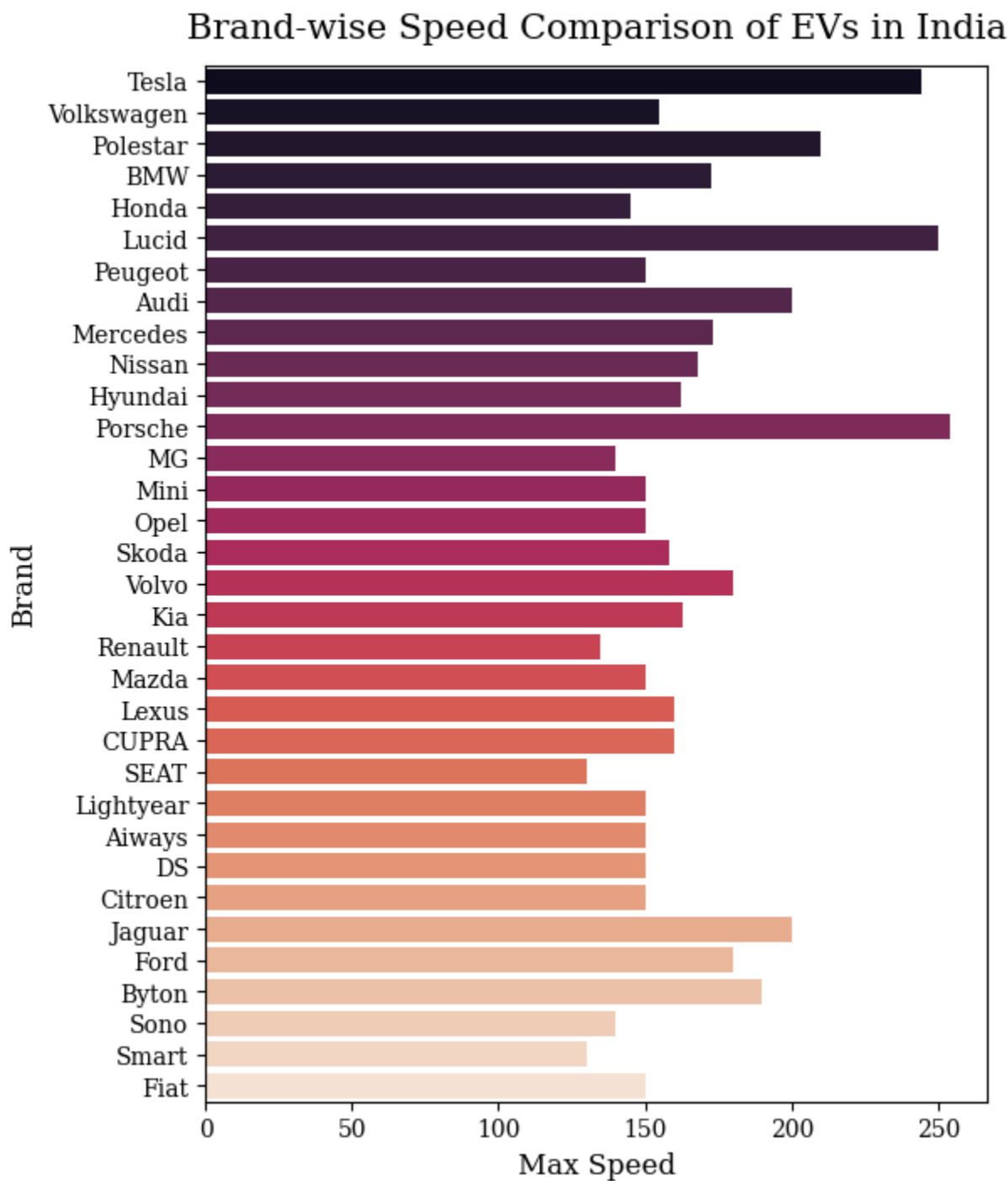
From the below Correlation Matrix many things can be deduced:

   1: Cars with higher acceleration tend to be more expensive.
   2: Cars with a higher top speed tend to be more expensive.
   3: Range of the car depends upon the top speed and fast charging.
   4: Efficiency of the car depends upon the price.
   5: Fast Charging of the car depends upon the range of the car.
   6: Number of Seats depends upon the Range and Efficiency of the car.
   7: Price of the car depends on multiple factors like Top Speed, Range, Fast charge etc.

Correlation Matrix

	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	Seats	PriceEuro
AccelSec	1.00	-0.79	-0.68	-0.38	-0.73	-0.18	-0.63
TopSpeed_KmH	-0.79	1.00	0.75	0.36	0.79	0.13	0.83
Range_Km	-0.68	0.75	1.00	0.31	0.72	0.30	0.67
Efficiency_WhKm	-0.38	0.36	0.31	1.00	0.32	0.30	0.40
FastCharge_KmH	-0.73	0.79	0.72	0.32	1.00	0.19	0.67
Seats	-0.18	0.13	0.30	0.30	0.19	1.00	0.02
PriceEuro	-0.63	0.83	0.67	0.40	0.67	0.02	1.00

From the below graph it is visible that Lucid and Lightyear have a better range than other manufacturers.
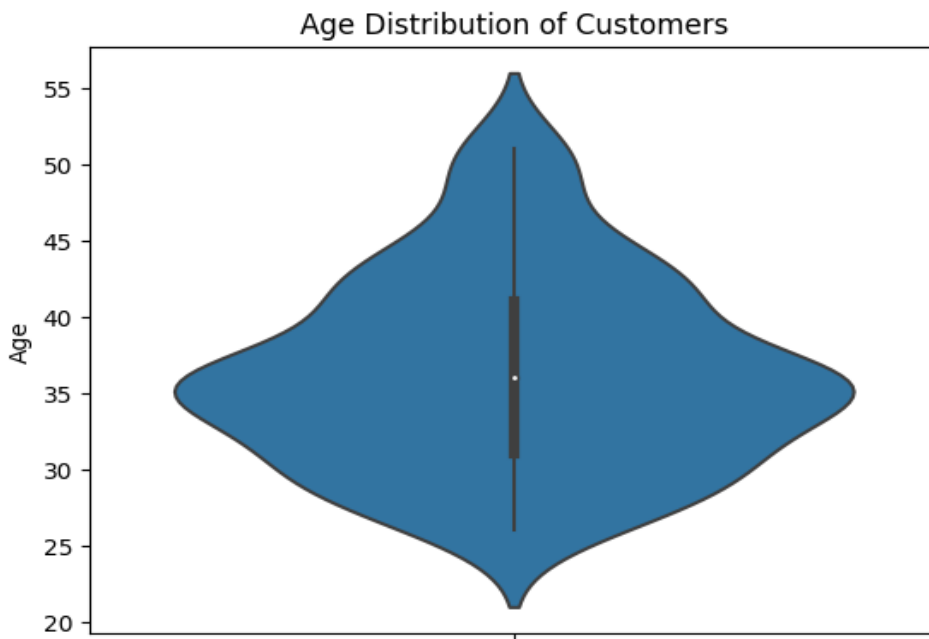

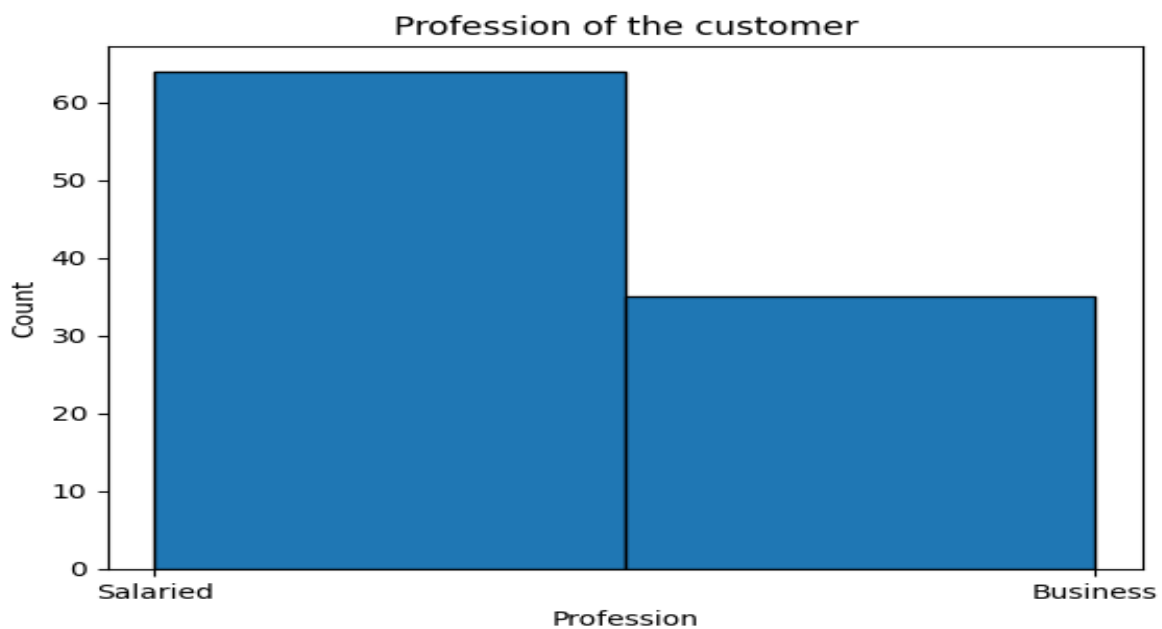Brand-wise Analysis of the Range Parameter
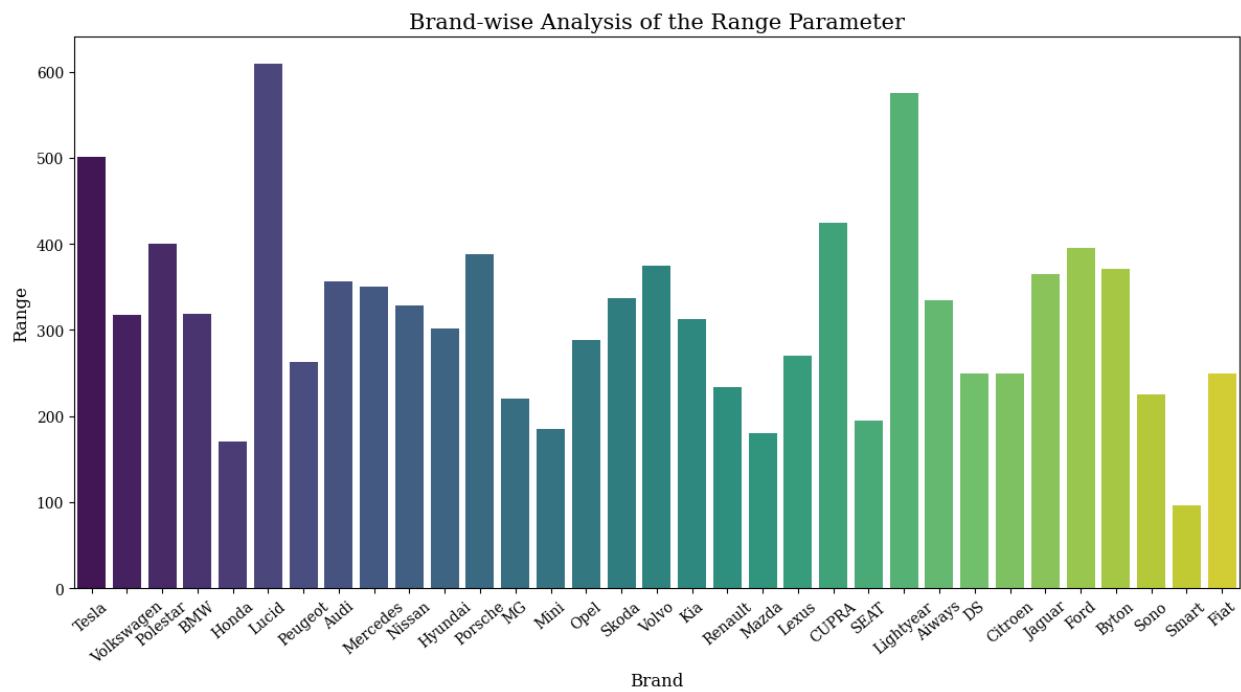
Plot of the Elbow Method
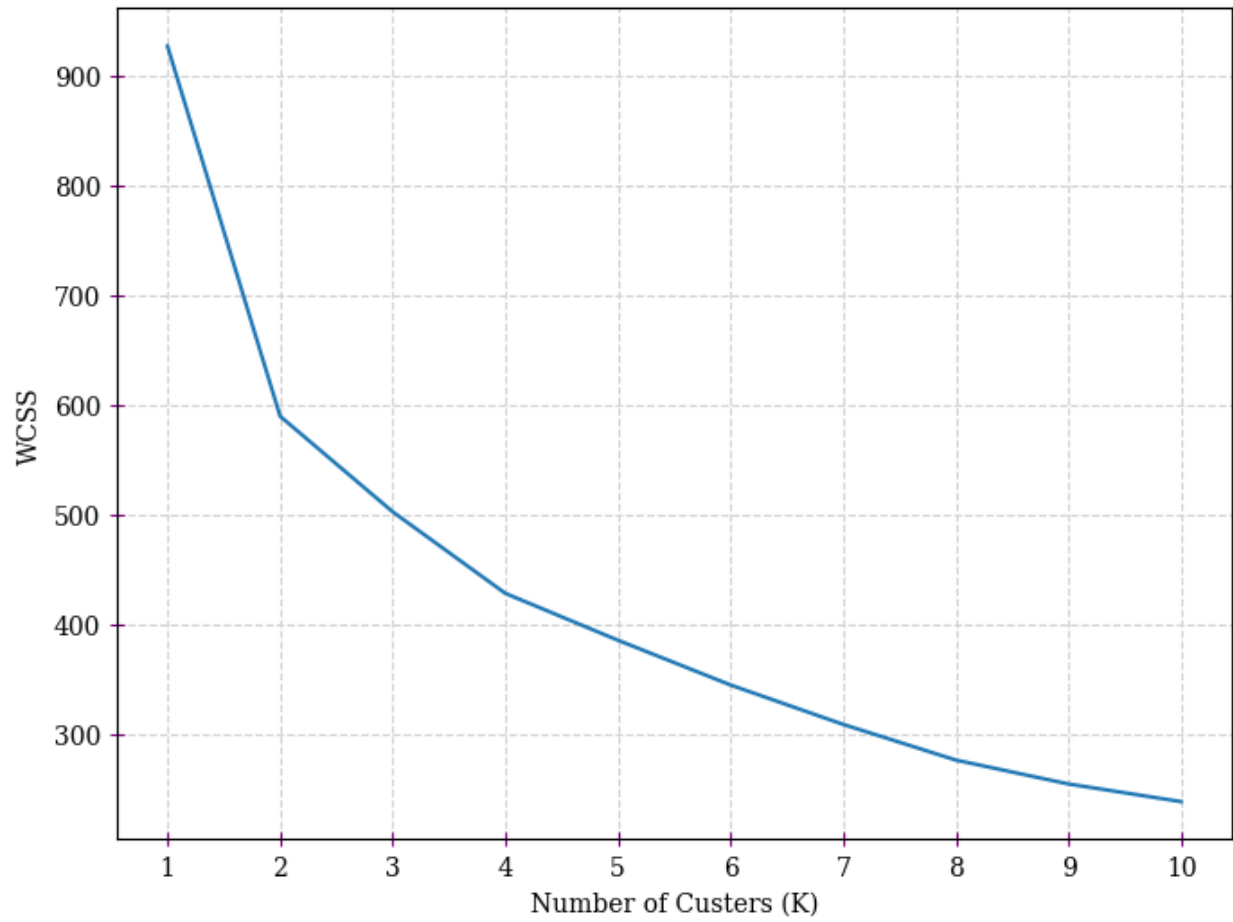
K-Means Clustering Results
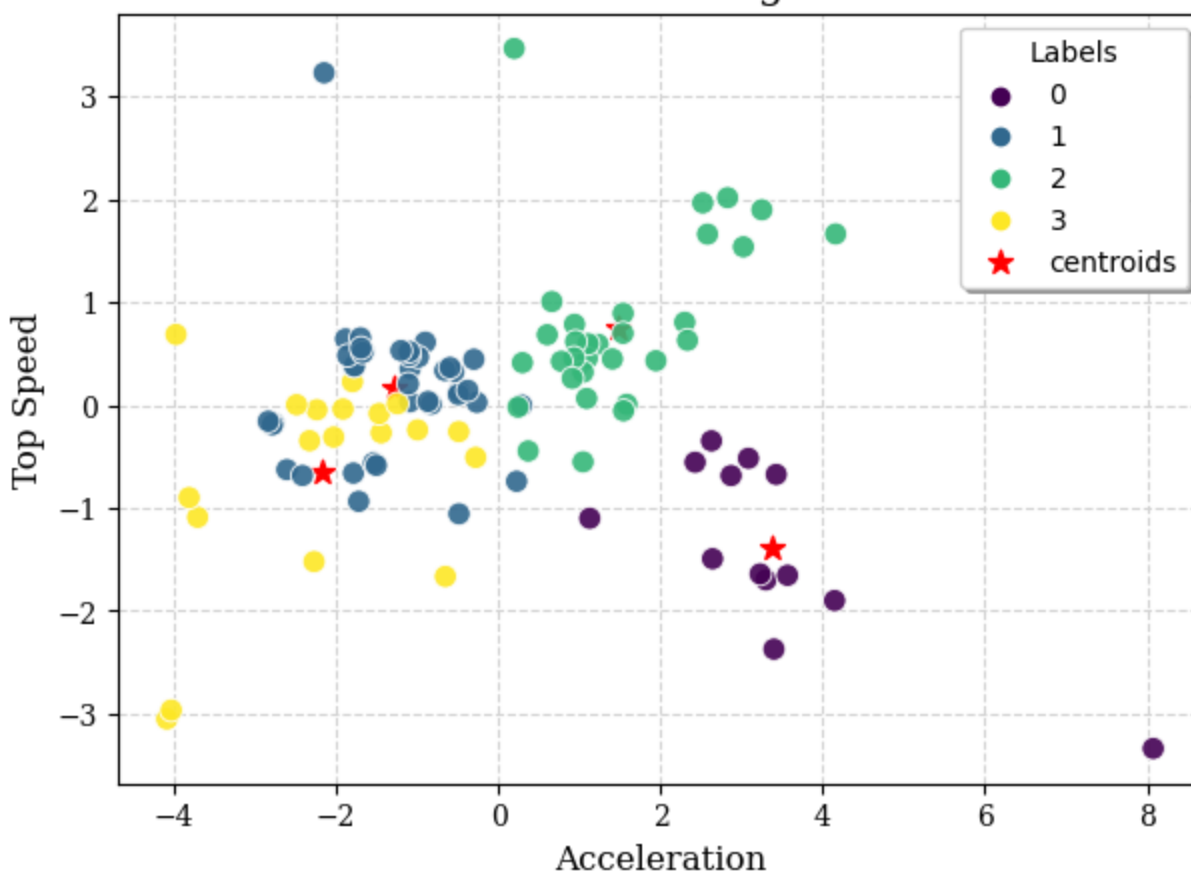
The Age Distribution Violin graph shows that people around the age of 30-40 are most likely to buy a car.

Age Distribution of Customers

The below graph depicts the count of salaried and business professionals that are buying a car.

Profession of the customer

The below graph shows the Marital status of the customers, and it is clearly visible that married people are more likely to buy a new car.

MArrital Status of Customers
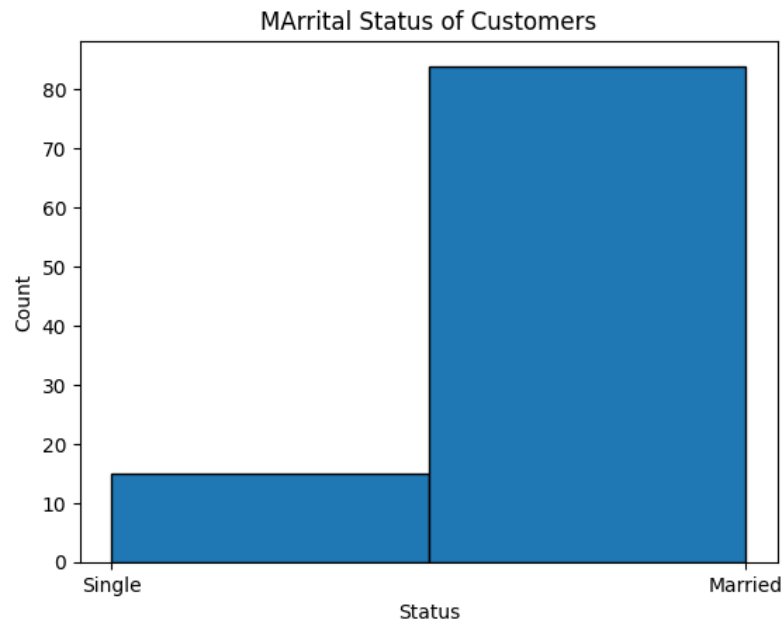
The graph below shows the count of customers that have a personal loan. It is quite evident from the data and graph that most people take personal loans to buy cars.

Count of Customers that have Personal Loan
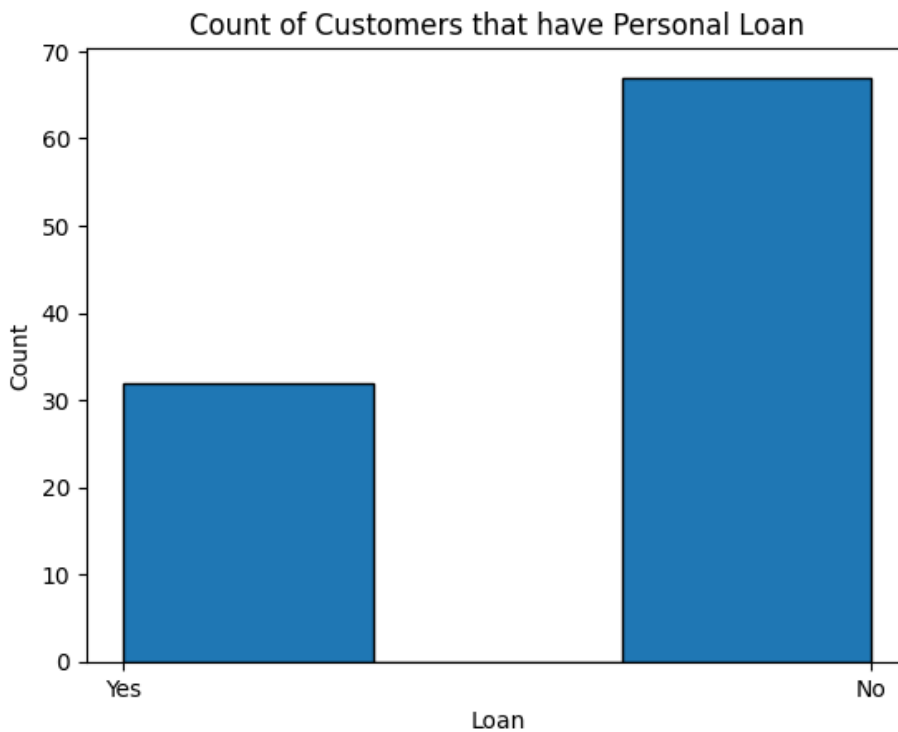
The graph below shows the number of people that have a house loan and have bought a car. It clearly shows that the number of people that have a house loan tend not to buy new cars.

Count of Customers that have House Loan
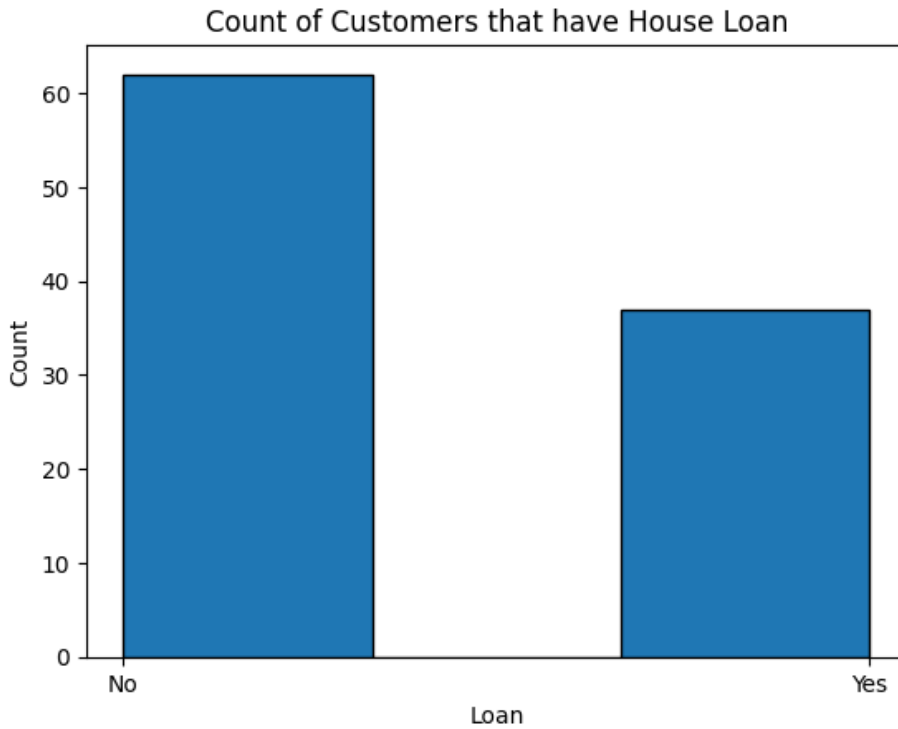
The below graph shows the salary of the customers that have bought a new car.
From our analysis we also found that the mean salary was INR 1194040.
The max salary was INR 3000000.
The min salary was INR 110000.

Salary Comparison
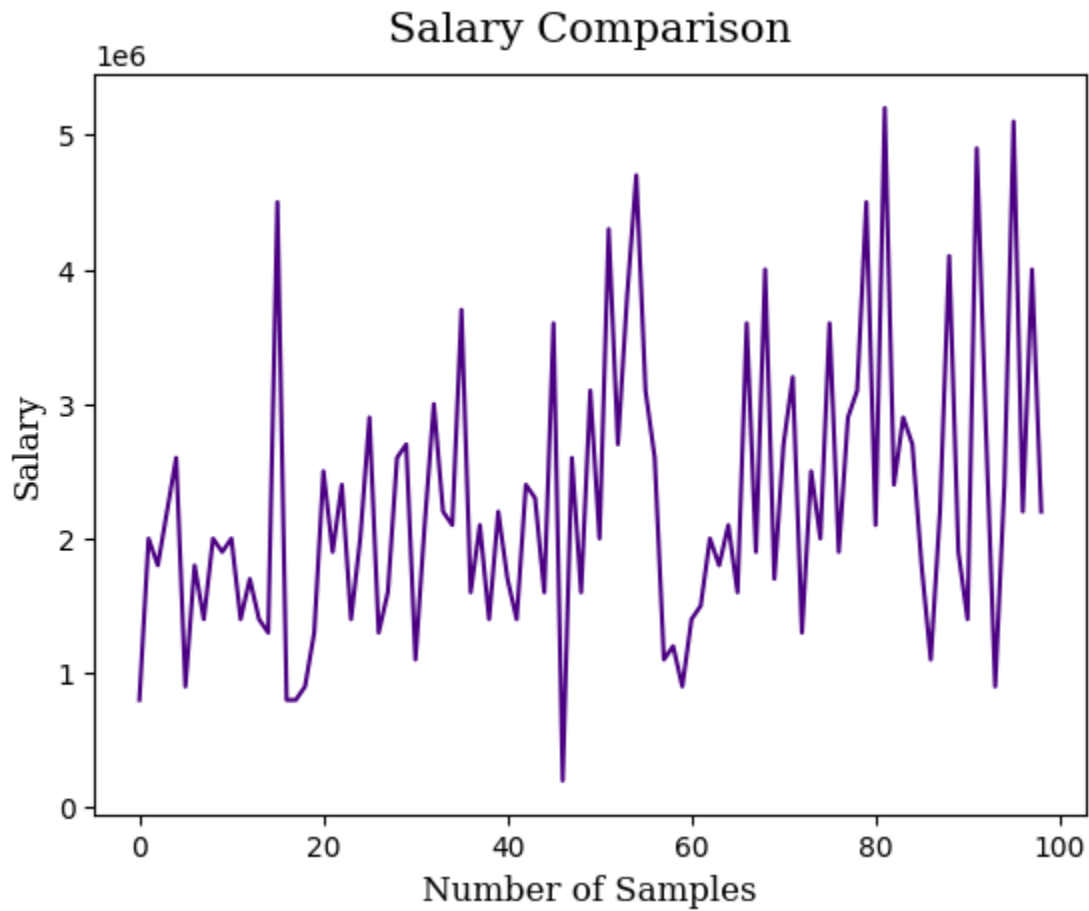
From the below Correlation Matrix we are able to get the following deductions:
1: The older the age, the more is the salary of the person.
2: The number of dependents is highly dependent on the age of the person.
3: The more the total salary of a family , the more expensive the car they buy.

Correlation Matrix

	Age	No of Dependents	Salary	Wife Salary	Total Salary	Price
Age	1.00	0.54	0.66	0.29	0.59	0.38
No of Dependents	0.54	1.00	0.27	0.10	0.23	0.09
Salary	0.66	0.27	1.00	0.35	0.84	0.55
Wife Salary	0.29	0.10	0.35	1.00	0.80	0.64
Total Salary	0.59	0.23	0.84	0.80	1.00	0.72
Price	0.38	0.09	0.55	0.64	0.72	1.00

Target Segments:

Based on the analysis , the target segment can be narrowed down to EVs having,
Factors like comfort, value for money, good acceleration, viable price range, as well as States which are more market friendly towards newcomers to the EV market.

From our analysis we can conclude that the target segment should consist of EV's having Acceleration of 7.5-10 sec, high in comfort and value for money, have a price range of 20-30 Lakhs, and target states like Maharashtra, Karnataka, Tamil Nadu, and Rajasthan.

Question Formulation:

1. Explain how and which ML model (algorithm) helped you in 2nd Project?

In our 2nd Project related to the EV market segmentation, we used various machine learning models to help analyze and segment the market. Some of the key algorithms we employed include K-Means Clustering,and Principal Component Analysis (PCA). These models helped us cluster similar customer segments based on various features, identify the key drivers behind market segments, and predict customer preferences for different EV models.

2. Elaborate on the final conclusion & insights gained from the research/analysis work.

The final conclusion and insights gained from the research and analysis of the EV market segmentation project are as follows:
  - We identified distinct customer segments based on factors like demographic data, location,and preferences.
  - The most significant insights included the preference for specific EV features (e.g., range, charging infrastructure) within different market segments.
  - Insights on the geographic distribution of potential EV buyers and the most suitable regions for marketing efforts.
  - The identification of market segments allowed for targeted marketing campaigns, product development, and pricing strategies.

3.How will you improve upon the Market Segmentation Project given additional time & some budget to purchase data?

 With additional time and budget for data collection, we would aim to improve the Market Segmentation Project by focusing on:
  - Gathering more granular data on customer behaviors and preferences, potentially through surveys or social media analysis.

- Exploring external data sources, such as real-time traffic data, to understand the impact of traffic conditions on EV adoption.
- Evaluating additional ML models like Support Vector Machines (SVM) and Neural Networks to enhance segmentation accuracy.

4. What is the estimated Market Size for your Market Domain in Numbers?

 The estimated Market Size for the non-segmented EV market domain is essential for understanding the total potential. The size can be calculated based on factors like the number of registered EVs, potential EV buyers, and the market's annual growth rate. These numbers would vary by region and country.

5. Name top 4 Variables/features which can be used to create most optimal Market Segments for your Market Domain

 The top 4 variables or features to create the most optimal market segments for the EV market include:
  - Geographic location: Understanding where potential customers are located and the impact of local factors like climate and charging infrastructure.
  - Demographic data: Analyzing age, income, family size, and other demographic factors to tailor marketing strategies.
  - Driving habits and distance: Identifying customers' daily driving routines and the importance of range and charging infrastructure.
  - Environmental consciousness: Considering the level of importance placed on eco-friendliness and sustainability in vehicle choices.

These variables will help in creating more focused and effective market segments within the broader EV market.

Github Repo Link:https://github.com/HereticInquisitor/EV-segmentation