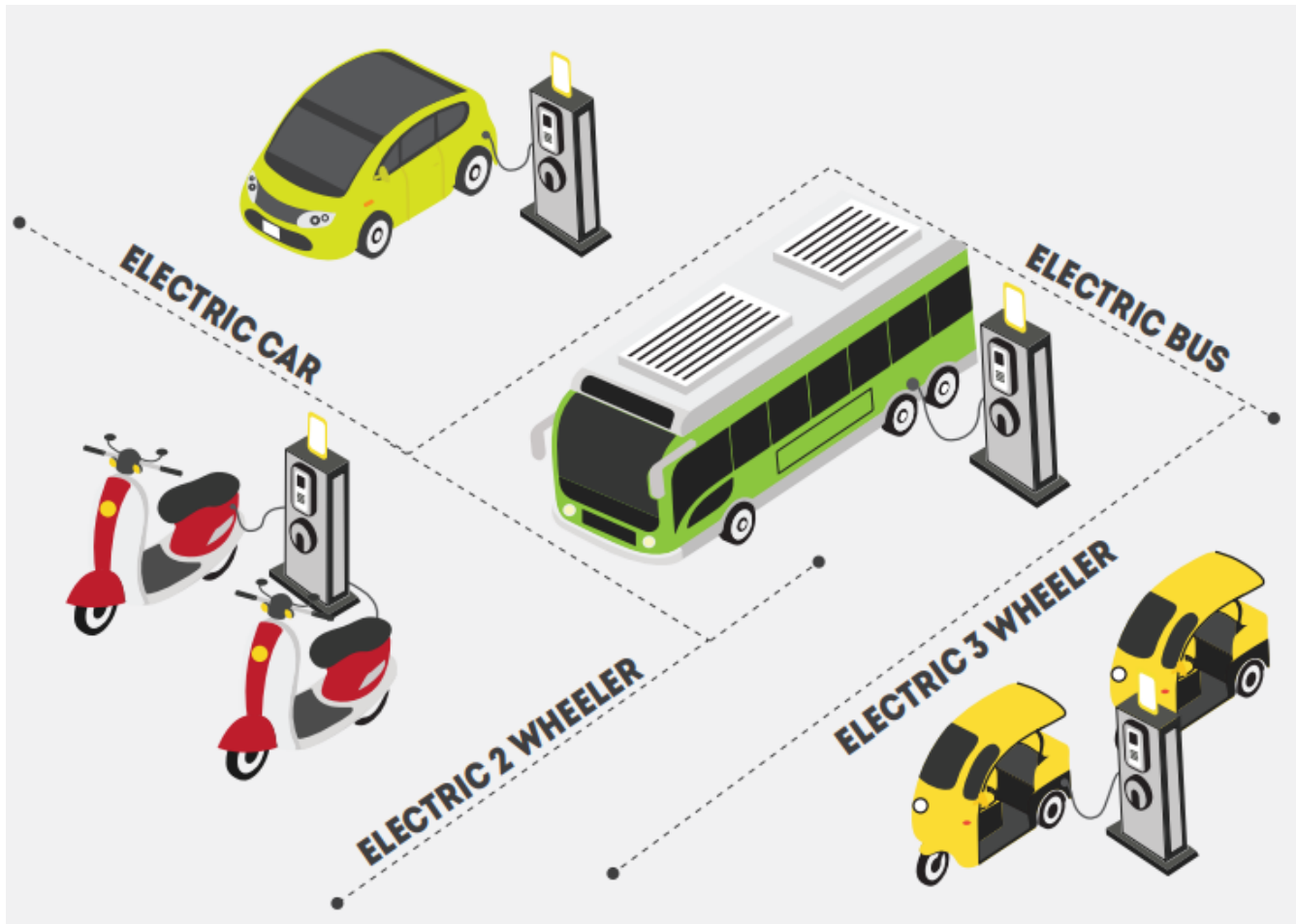


# EV MARKET

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FEYNN LABS PROJECT 2

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**Problem Statement:** You are a team working under an Electric Vehicle Startup. The Startup is still deciding in which vehicle/customer space it will be developing its EVs. You have to analyze 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.

### **Breakdown Of The Problem:**

A good segment for the development of electric vehicles can be found by analyzing the following points:

- For the ideal vehicle category(2,3 or 4-wheeler) and type(bike, car, rickshaw, etc) we can analyze the sales trend for these different segments along with the price and features of different e-vehicles currently available in the market.
- For the ideal demographic and region, we can analyze the sales data in different states and changing infrastructure available there.

### **Data Sources**

#### 1. Vahan Dashboard

(<https://vahan.parivahan.gov.in/vahan4dashboard/vahan/view/reportview.xhtml>)

- EV sales for different vehicle categories for the years 2019,2020,2021,2022.
- EV sales for different vehicle classes for the year 2019,2020,2021,2022.
- EV sales by different companies in different segments.
- EV sales in different states.

#### 2. E-amrit (<https://e-amrit.niti.gov.in/choose-my-electric-vehicle>)

- Major electric vehicles available in India in a different categories.

#### 3. data.gov.in

- <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1778958>  
Electric charging stations available and sanctioned in different states.
- [Category-wise Total Number of Electric Cars and Other Vehicles \(Transport and Non-transport vehicles \) in India, as per VAHAN 4.0 \(in reply to Unstarred Question on 09 August, 2021\) |Open Government Data \(OGD\) Platform India](#)  
Total no. of Electric vehicles sold till date.

#### 4. Kaggle

([https://www.kaggle.com/geoffnel/evs-one-electric-vehicle-dataset?select=ElectricCarData\\_Clean.csv](https://www.kaggle.com/geoffnel/evs-one-electric-vehicle-dataset?select=ElectricCarData_Clean.csv))

- Different electric cars model available around the world.

## Data Pre-processing (Steps and Libraries used)

From the data sources mentioned above the data was collected and stored in a .csv format.

Then we have done data preprocessing by following the below-mentioned steps: -

- 1. Data Quality Assessment:** -Data quality assessment is the process of scientifically and statistically evaluating data to determine whether it meets the quality requirements for projects or business processes and is of the appropriate type and quantity to support its intended use.
- 2. Data Cleaning:** -Data cleaning is the process of repairing or removing incorrect, corrupted, incorrectly formatted, duplicate, or incomplete data from a dataset. When combining multiple data sources, there are numerous opportunities for data to be duplicated or mislabeled.
- 3. Data Transformation:** -The process of converting raw data into a format or structure that is more suitable for model building and data discovery in general is known as data transformation. It is a critical step in feature engineering that aids in the discovery of insights. This article will go over numeric data transformation techniques such as log transformation, clipping methods, and data scaling.
- 4. Data Reduction:** -While reducing data, data reduction techniques ensure data integrity. Data reduction is a process that reduces the volume of original data and represents it in a much smaller volume. Data reduction techniques are used to obtain a reduced representation of the dataset that is much smaller in volume while maintaining the integrity of the original data. By reducing the data, the efficiency of the data mining process is improved, resulting in the same analytical results.

After performing Data preprocessing python libraries are used for visualizing the data. The libraries used are “numpy, pandas, matplotlib and seaborn”.

**Numpy:** - NumPy is a general-purpose array-processing package. It provides a high-performance multidimensional array object, and tools for working with these arrays. It is the fundamental package for scientific computing with Python. It is open-source software.

**Pandas:** - Pandas is an open-source library designed primarily for working with relational or labelled data in an easy and intuitive manner. It offers a number of data structures and operations for manipulating numerical data and time series. This library is based on the NumPy library.

**Matplotlib:** - Matplotlib is a Python library that can be used to generate 2D graphs and plots from Python scripts. It has a module called pyplot that simplifies plotting by allowing you to control line styles, font properties, axes formatting, and so on. It supports a wide range of graphs and plots, including histograms, bar charts, power spectra, error charts, and so on. It is used in conjunction with NumPy to provide an environment that is a viable open source alternative to MatLab.

**Seaborn:** - Seaborn is a fantastic Python visualisation library for statistical graphics plotting. It includes attractive default styles and colour palettes to make statistical plots more appealing. It is built on top of the matplotlib library and is tightly integrated with pandas data structures. Seaborn's goal is to make visualisation the primary means of exploring and comprehending data. It provides dataset-oriented APIs, allowing us to switch between different visual representations for the same variables in order to gain a better understanding of the dataset.

### **Segment Extraction (ML techniques used):**

**K Means Clustering Algorithm** is one of the most popular clustering algorithms and usually, the first thing practitioners apply when solving clustering tasks to get an idea of the structure of the dataset. The goal of K means to group data points into distinct non-overlapping subgroups. One of the major applications of K means clustering is the segmentation of customers to get a better understanding of them which in turn could be used to increase the revenue of the company.

Algorithm:

1. Specify the number of clusters  $K$ .
2. Initialize centroids by first shuffling the dataset and then randomly selecting  $K$  data points for the centroids without replacement.
3. Keep iterating until there is no change to the centroids. i.e., the assignment of data points to clusters is not changing.

Next plot Within Cluster Sum Of Squares (WCSS) against the number of clusters (K Value) to figure out the optimal number of clusters value. WCSS measures the sum of distances of observations from their cluster centroids which is given by the below formula.

$$WCSS = \sum_{i \in n} (X_i - Y_i)^2$$

where  $Y_i$  is centroid for observation  $X_i$ . The main goal is to maximize the number of clusters and in limiting case, each data point becomes its own cluster centroid

## The Elbow Method

The elbow method runs k-means clustering on the dataset for a range of values for k (say from 1-10) and then for each value of k computes an average score for all clusters. By default, the distortion score is computed, the sum of square distances from each point to its assigned center.

Calculate the Within Cluster Sum of Squared Errors (WSS) for different values of k, and choose the k for which WSS first starts to diminish. In the plot of WSS-versus k, this is visible as an elbow.

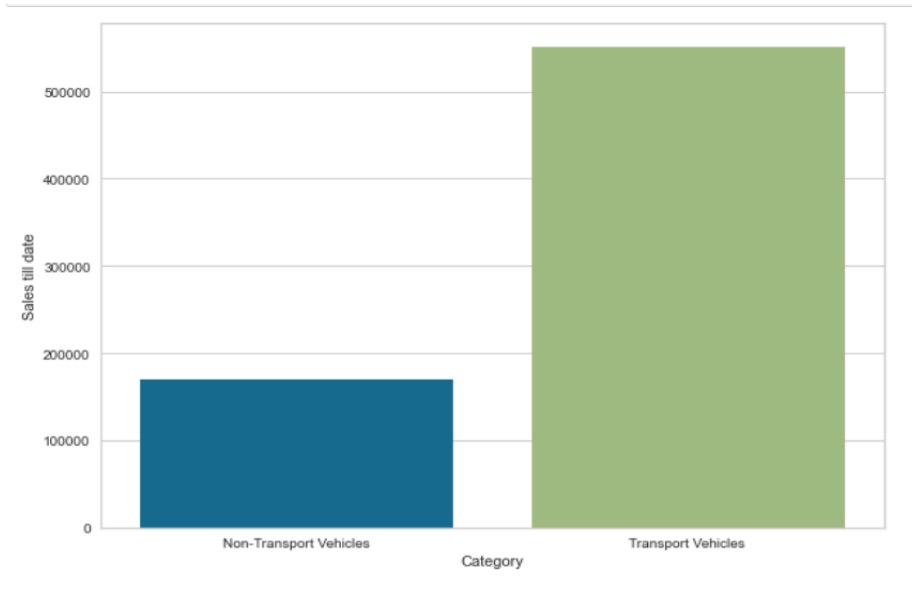
The steps can be summarized in the below steps:

1. Compute K-Means clustering for different values of K by varying K from 1 to 10 clusters.
2. For each K, calculate the total within-cluster sum of square (WCSS).
3. Plot the curve of WCSS vs the number of clusters K.
4. The location of a bend (knee) in the plot is generally considered as an indicator of the appropriate number of clusters.

## Segmentation Analysis

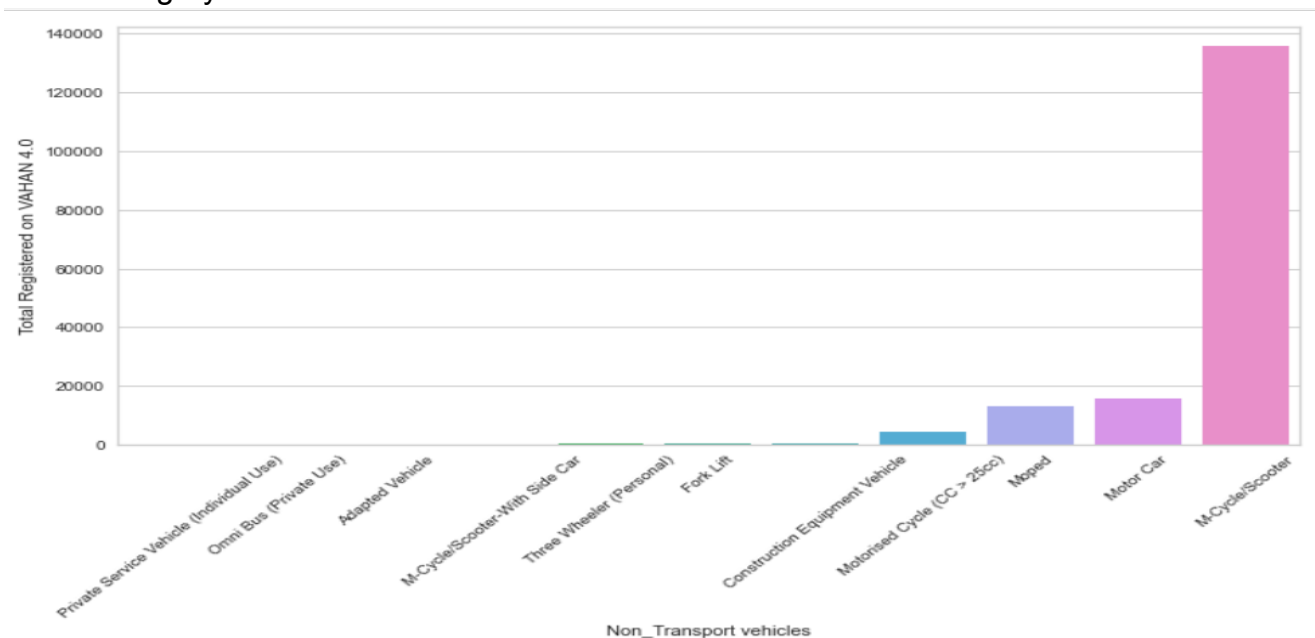
### (A) ANALYSIS OF EV SALES FOR DIFFERENT TYPES AND CATEGORIES OF VEHICLES.

The sales of EVs are on a constant rise, with the sales of transport vehicles being significantly higher as compared to vehicles used for personal use.

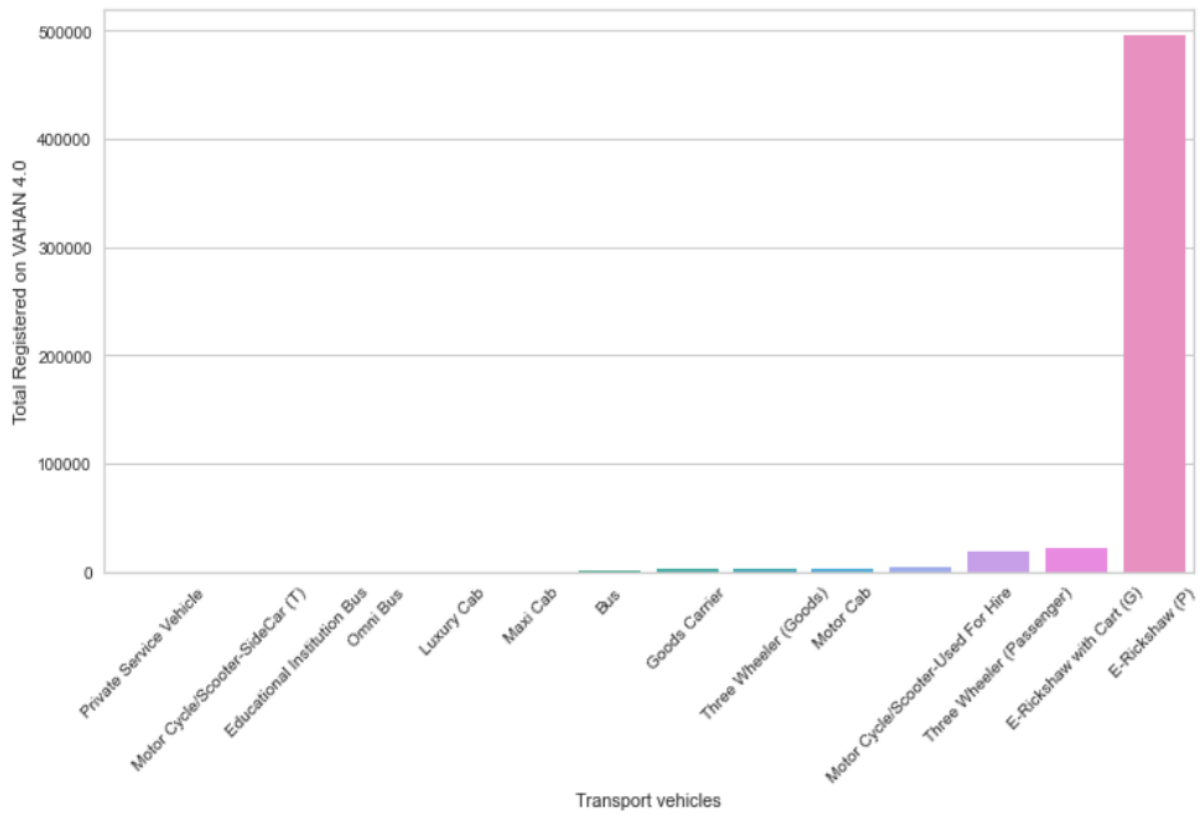


The analyses of different vehicles types sales under the non-transport and transport category shows that:

- Motorcycles/scooters and cars make up almost all the sales in the non-transport category.

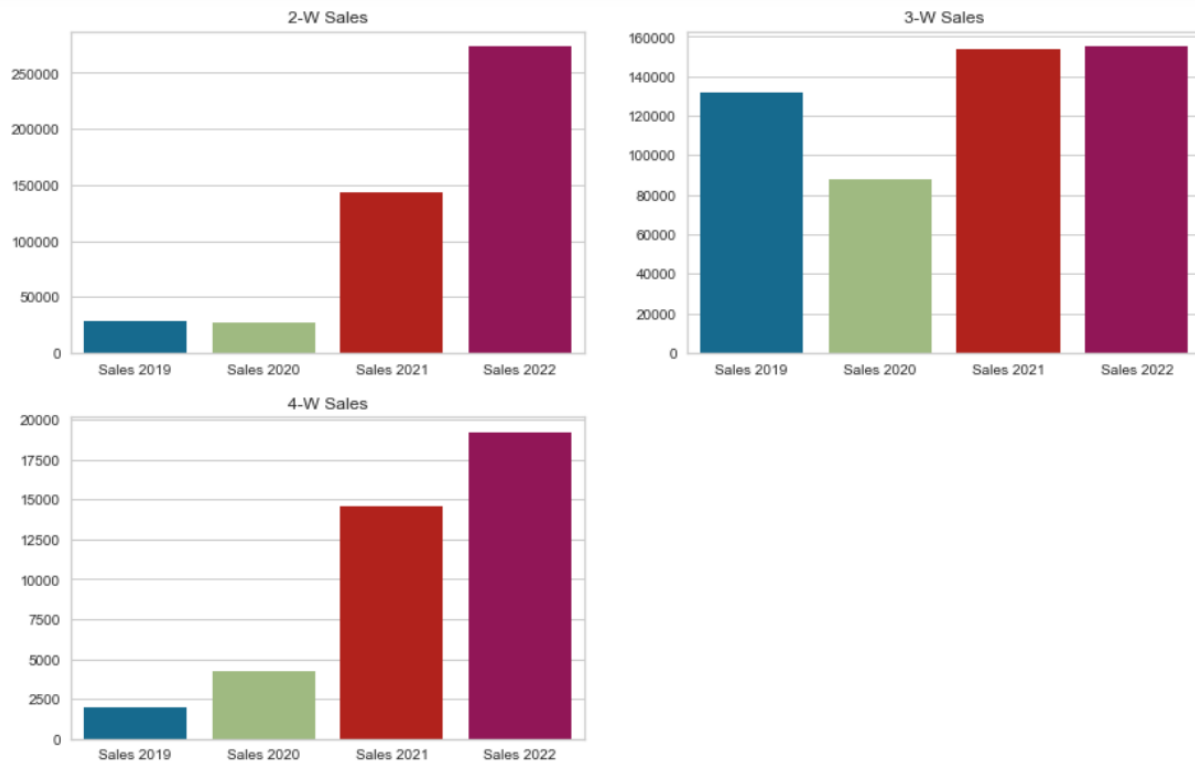


- E-Rickshaw makes up for almost all the sales in the transport category.

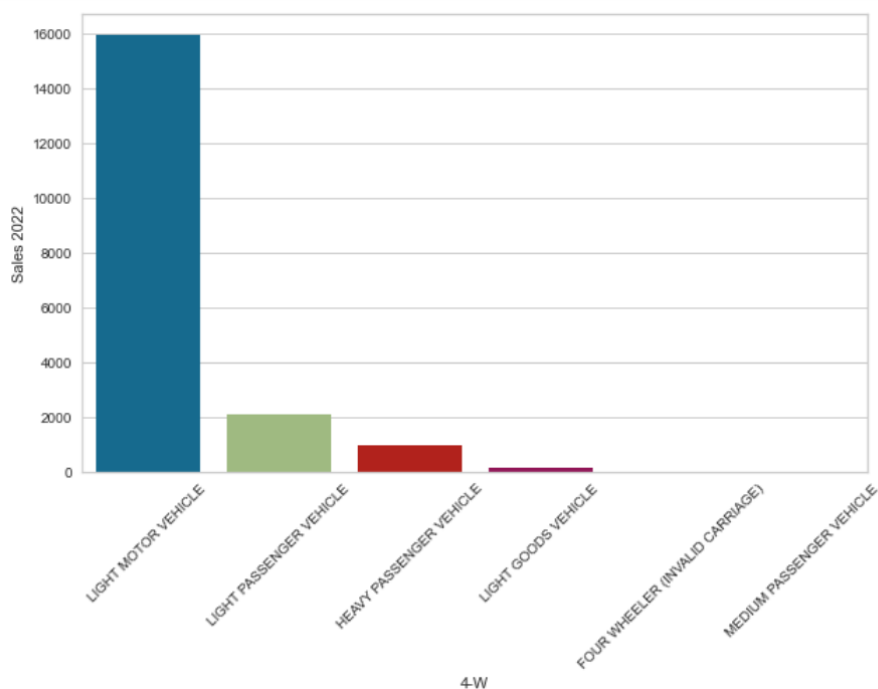




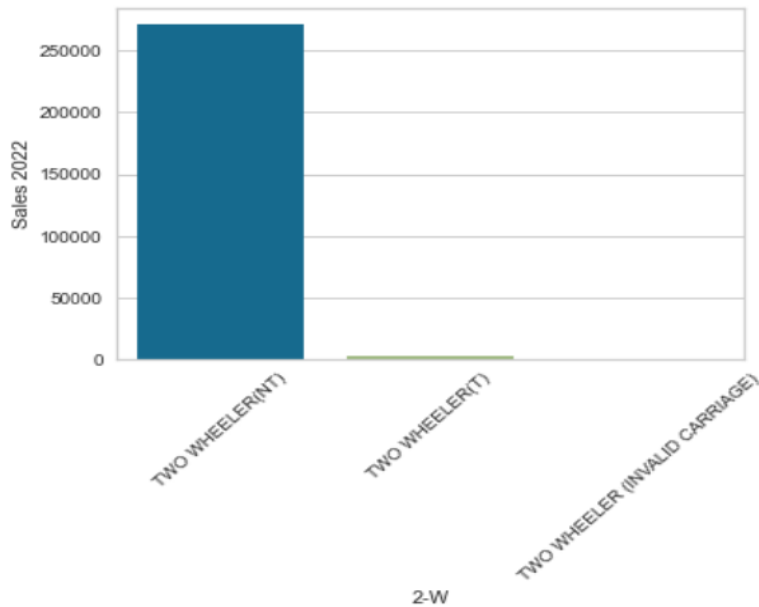
Then we analyzed the sales trend for 2-W,3-W, and 4-w electric vehicles from the year 2019-2022



It can be seen that the 3-W category has the highest sales among all the categories but there is stagnation in this category. The 2-W and 4-w are emerging categories with a constant increase in sales.

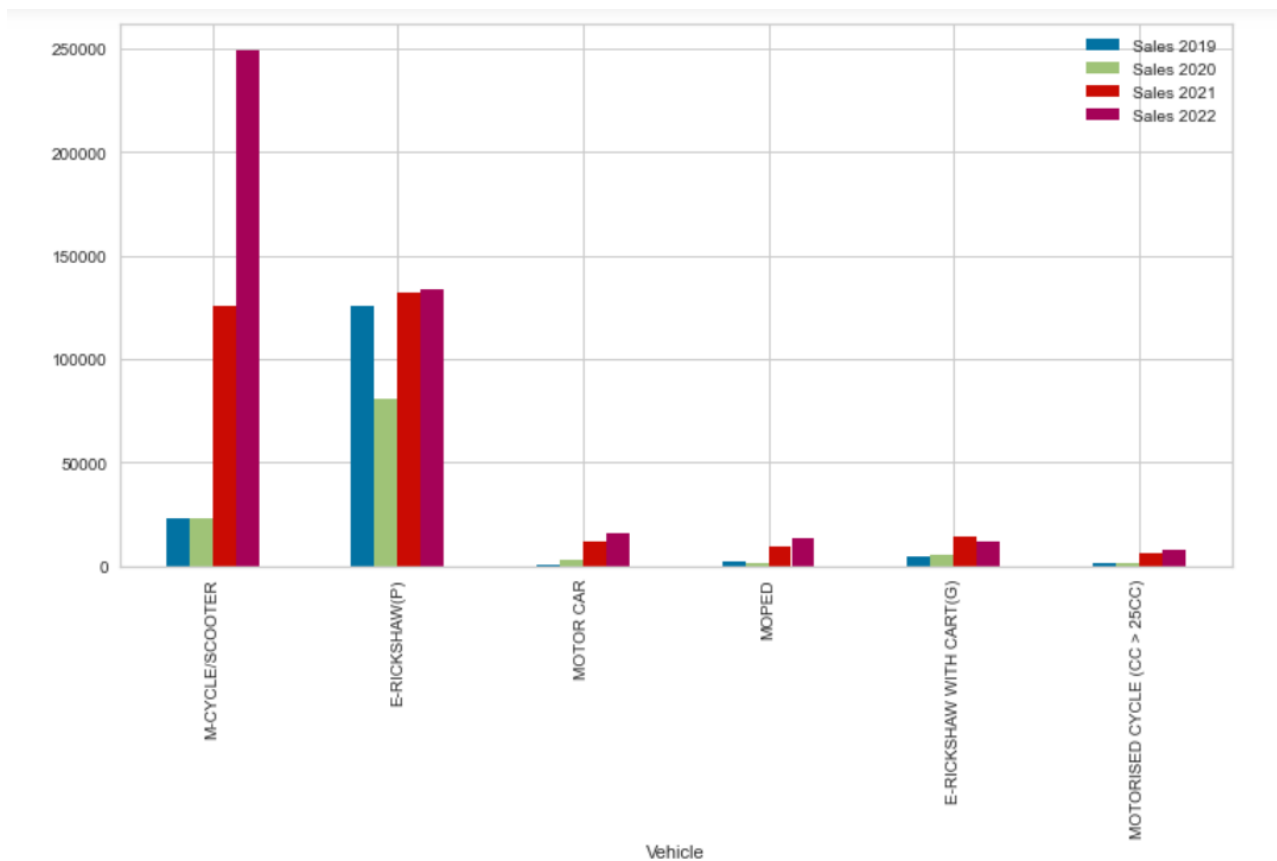


In the 4-Wheeler segment, light motor and passenger vehicles(personal cars) dominate. After that Heavy passenger vehicles(e-buses) make up most of the remaining sales.



In the 2-Wheeler segment, personal vehicles(non-transport) dominate.

A further analysis of EV for different vehicles under 2,3 and 4-wheeler vehicle categories also confirms that 3-W sales which are mostly dominated by E-Rickshaw are stagnant, whereas the sales of M-cycle/Scooters and motor car which dominates the 2-W and 4-W segment is on a constant rise.

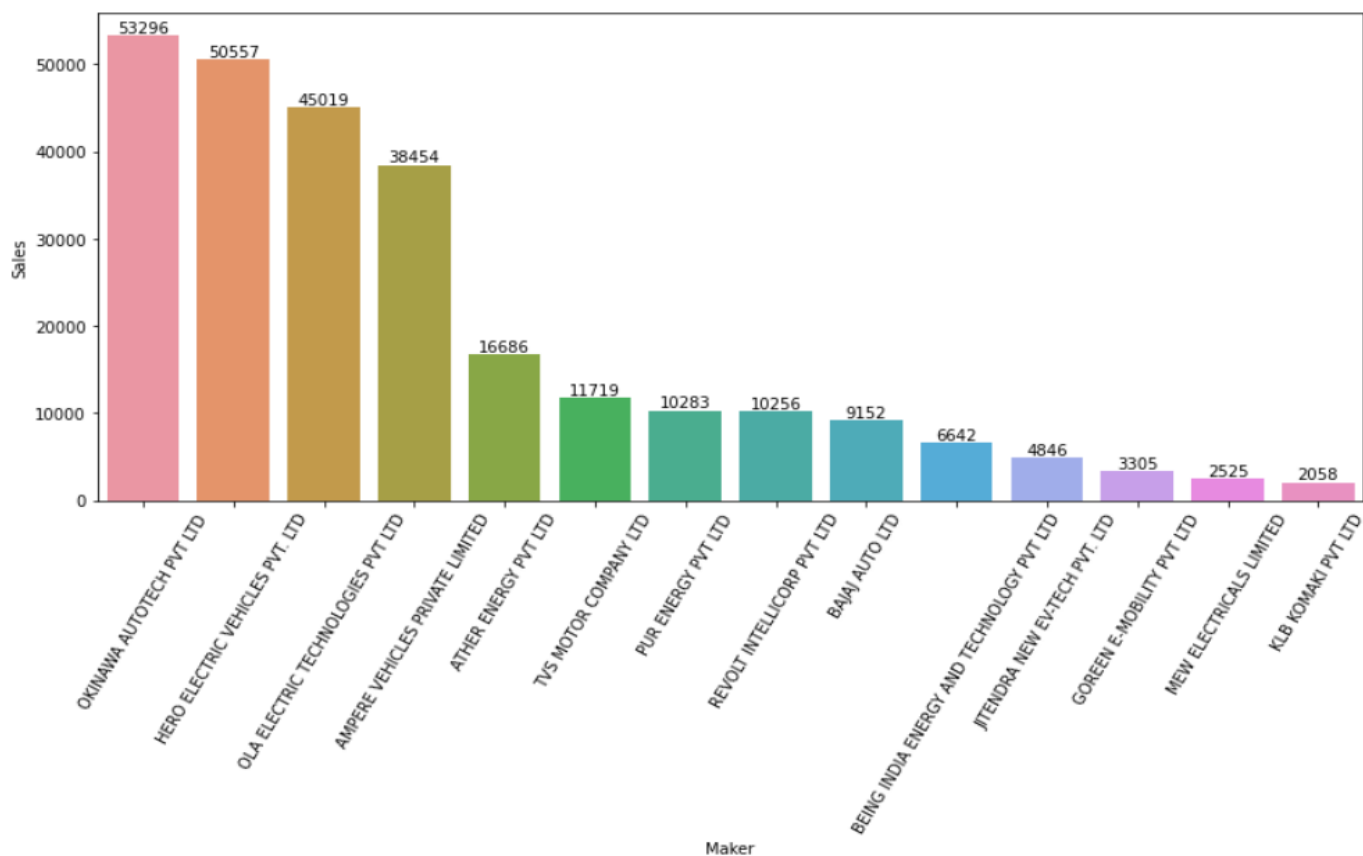


Therefore, we can conclude that Motorbikes/Scooter(2-W) and Motor cars(4-W) have great potential, E-rickshaw(3-W) segment has high sales but stagnation, maybe due to the fact that early development in the EVs came in this segment and now it has constant sales and very high competition.

## (B) ANALYSIS OF EV SALES OF DIFFERENT COMPANIES

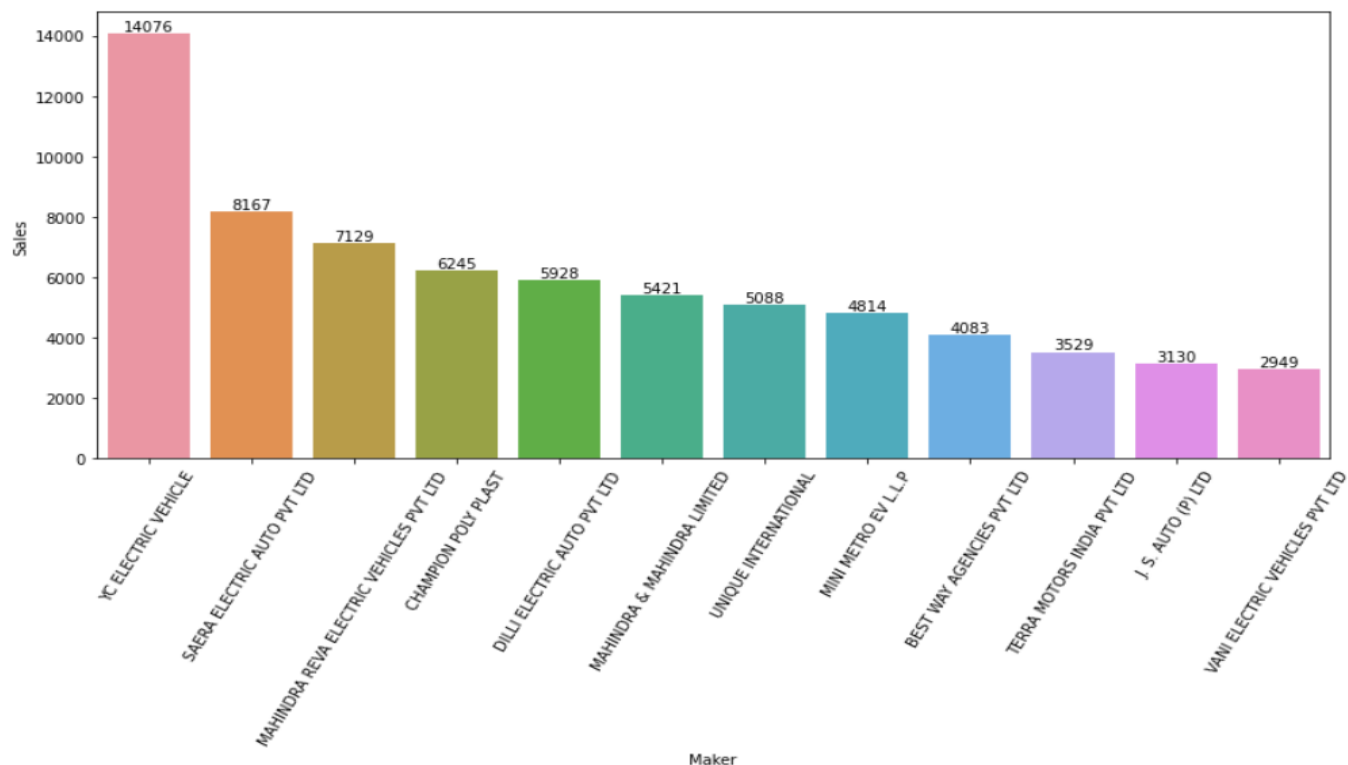
This analysis would give us an idea of the competition we will face in the potential segments and whether it will be feasible.

- Sales of 2-Wheeler electric vehicles of different manufacturers.



In this segment there are some big players dominating the market, Okinawa , Hero , Ola and Ampere being the top players.

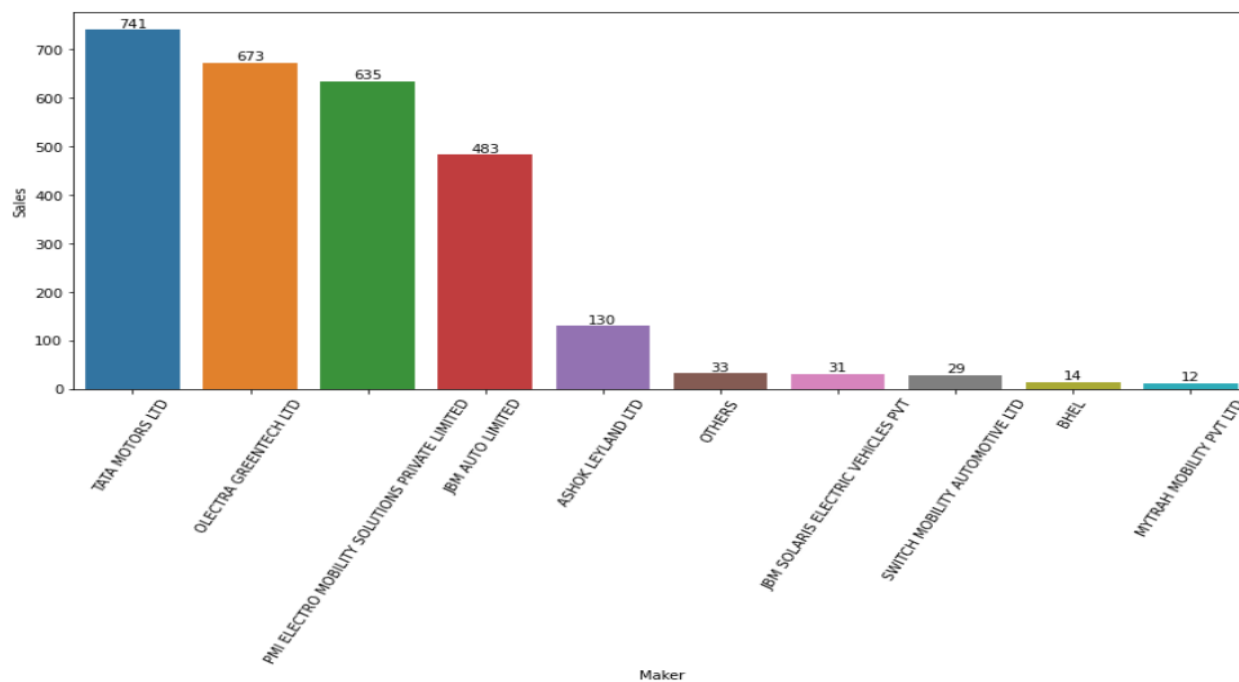
- Sales of 3-heeler electric vehicles of different manufacturers.



In the 3-wheeler segment, YC electric dominates with some competition from Saera, Mahindra, and some other players.

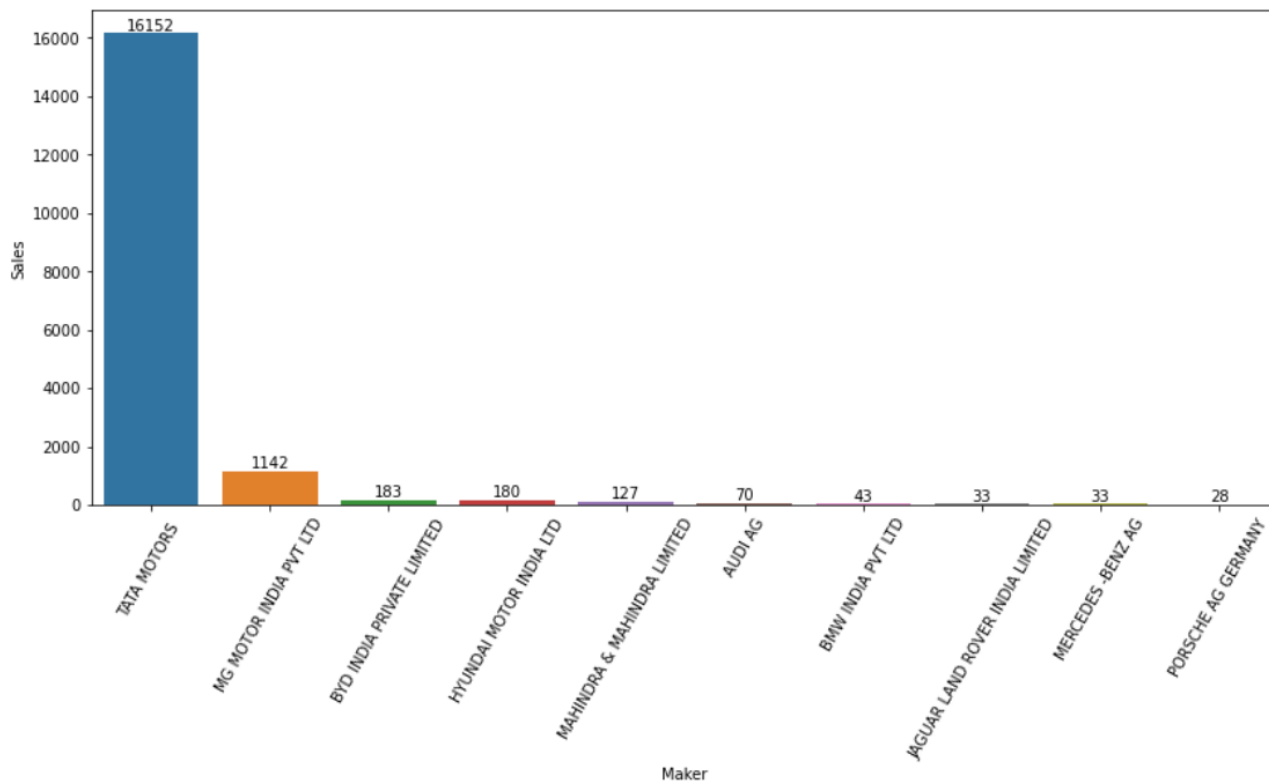
For the 4-W segment, we saw that e-cars and e-buses make up almost all the sales in these categories. Analyzing their respective sales we can conclude the following:-

- Sales of 4-Wheeler(Buses) electric vehicles of different manufacturers.



E-Buses also have some significant players, tata motors being at the top. A lot of states and center governments' push for electric buses can be attributed to the growth of this segment. Although this is a growing segment , it is resource-heavy and a majority of sales is to government organizations.

- Sales of 4-Wheeler(Cars) electric vehicles of different manufacturers.

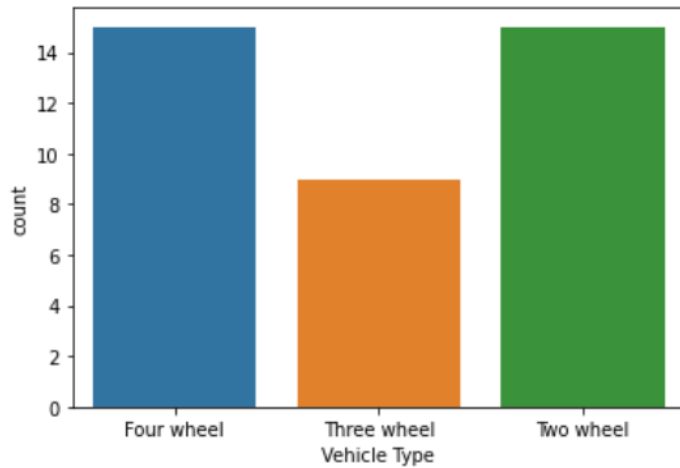


- Tata motors completely dominates the e-cars segment in India, other players are trying but it is clear that they are far behind.

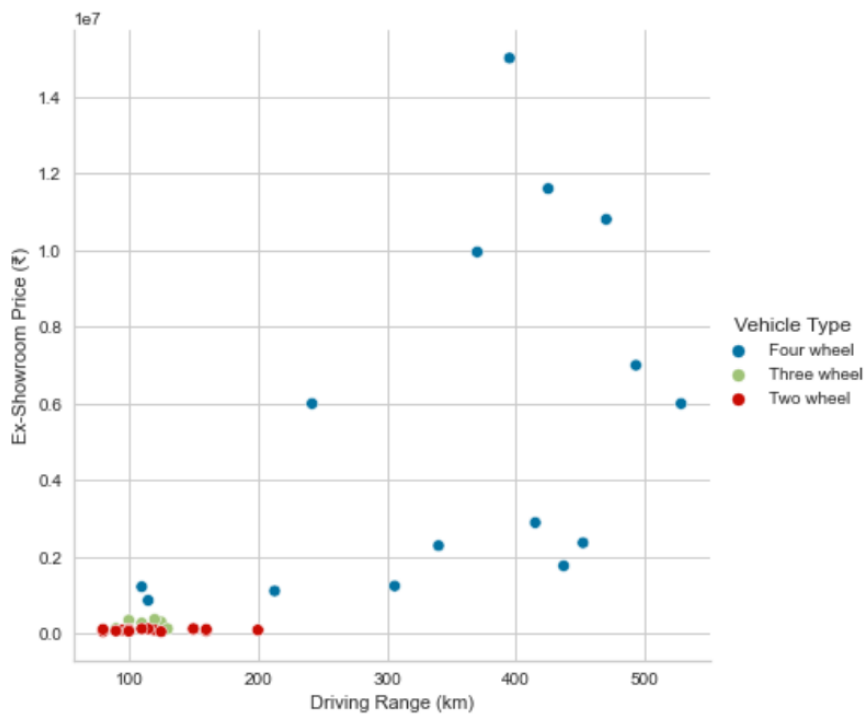
**Conclusion:** From the analysis of EV sales by different categories and manufacturers, we can conclude that the 3-W market is stagnant as compared to 2 and 4 wheeler and has a lot of competition from existing players, the 2-W market has a lot of big existing players and since the capital requirement is comparatively low, it is cluttered with a lot of companies trying to make big. The 4-W( car) segment is on a constant rise. Although this segment has lower sales as compared to the 2 and 3-wheeler segment, the 4-Wheeler(cars) segment on its own is significant and is on a constant rise. Also, a lot of government policies encourage the migration of people from conventional cars to Electric. This segment will be quite big in the coming decades and international players have a big entry barrier in the form of import duty. Further, currently, it only has one key player TATA Motors, with the right product this segment can be easily disrupted.

### (C) ANALYSIS OF SOME ELECTRIC VEHICLES AVAILABLE IN INDIA.

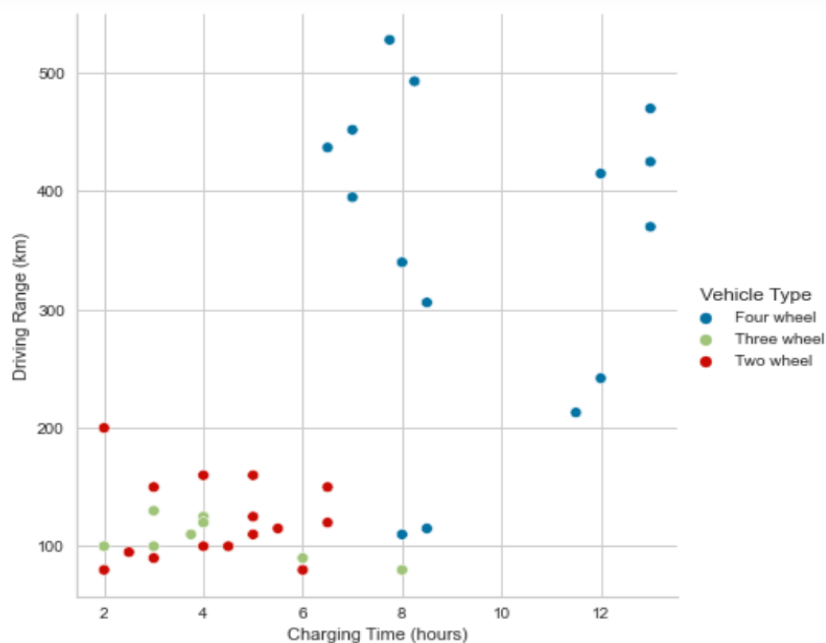
The dataset we are analyzing has data for all the e-cars available in the country along with some significant 3 and 2-wheeler vehicles that are available.



As we can see, the market for e-cars is still new in India, with just 15 models available.



The average driving range of e-cars available in the market is around 350 km and the price fluctuates from 8 lakhs to 1.5 crores.



The average charging time for 4 wheeler is around 9.6 hours.

Tata motors clearly dominate the e-car segment in India and their Nexon EV is the best-selling e-car in the country.

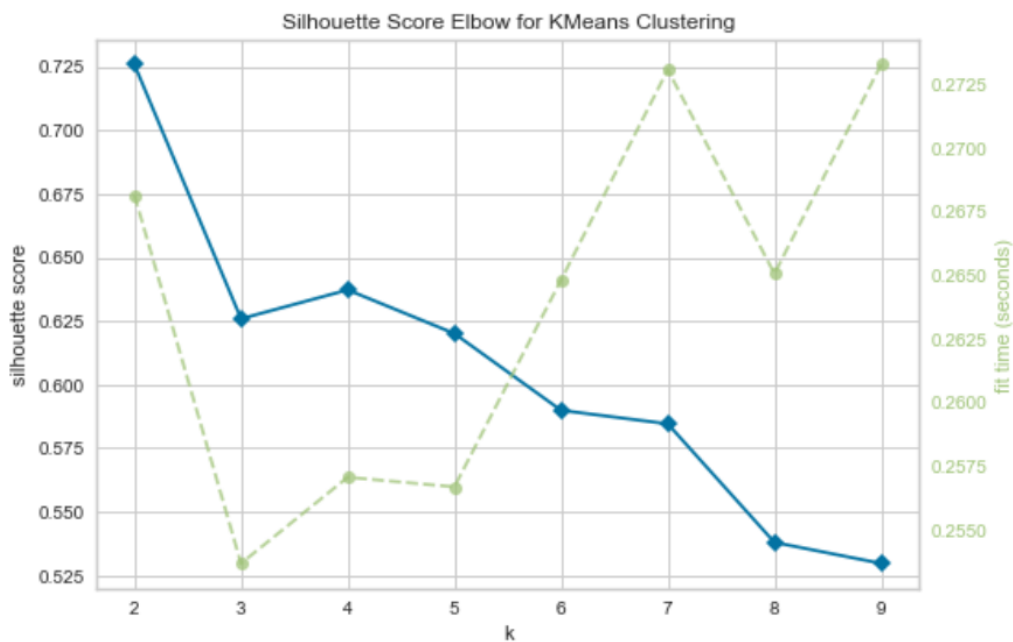
Vehicle Type	Make	Model	Ex-Showroom Price (₹)	Battery Size (kWh)	Battery Type	Charger Rating (kW)	Driving Range (km)	Charging Time (hours)	Top Speed (km/hr)	No. of seats	Type
Four wheel	Tata	Nexon EV Max	1775000	40.5	Lithium Polymer	30.0	437	6.5	140.0	5.0	SUV
Four wheel	Tata	Tata Tigor	1250000	26.0	Lithium ion	25.0	306	8.5	120.0	5.0	Sedan
Four wheel	Tata	Tata Xpres-T	1120000	21.5	Lithium ion	22.0	213	11.5	80.0	5.0	Sedan

Nexon comes with a range of 437 Km at a price ranging from 15 to 18 lakhs for different models. Although the price is a bit on the higher side, the sales prove that this segment has great potential.

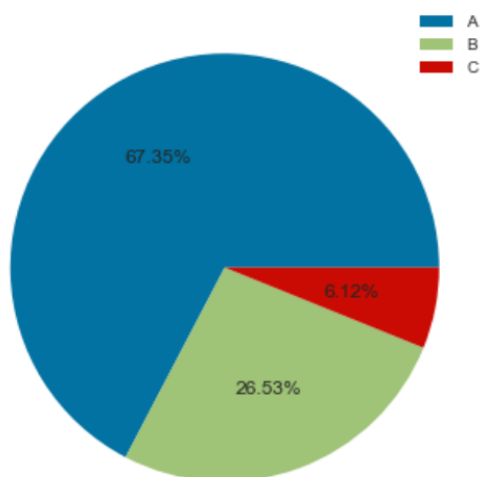
#### (D): ANALYZING E-CARS around the world:

Since the e-cars market in India is still a new one with only a few options, we analyze the global e-cars market to get an idea of different features currently offered at different prices.

For this, we do cluster analysis on the e-cars data to get different segments according to price and different features like range, efficiency, and top speed.



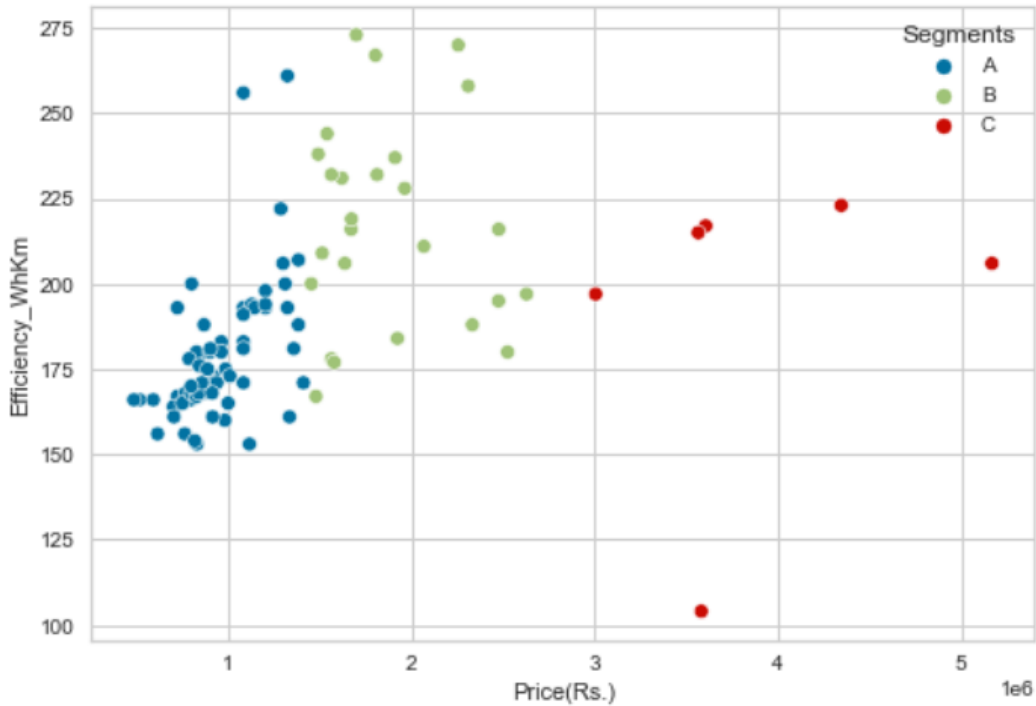
Using the elbow method and dendrogram analysis we find out that 3 seems to be a good fit for the number of segments.



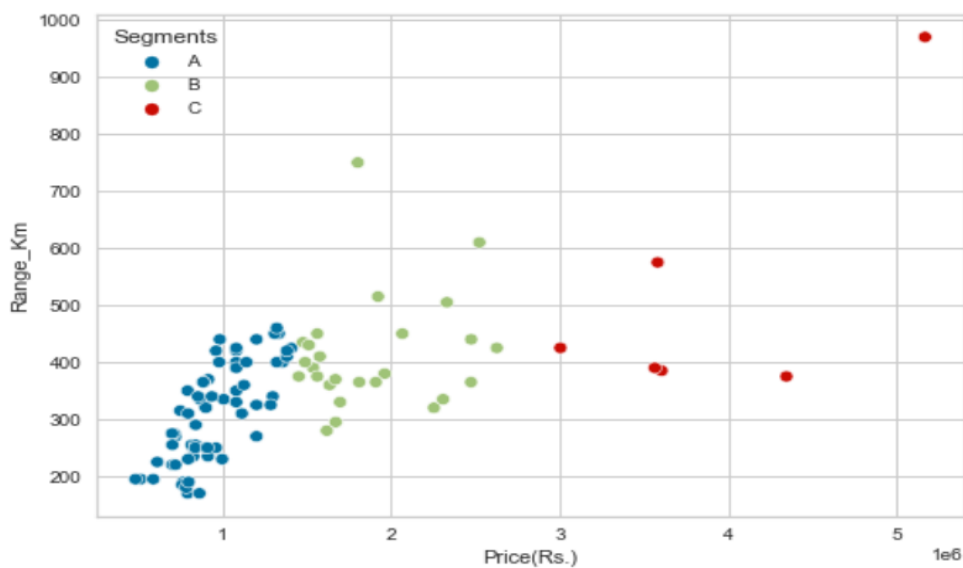
Then using the K-means algorithm we formed 3 segments of different e-cars models. Segment A has 67 percent of the cars, and B and C has around 26 and 6 percent respectively.



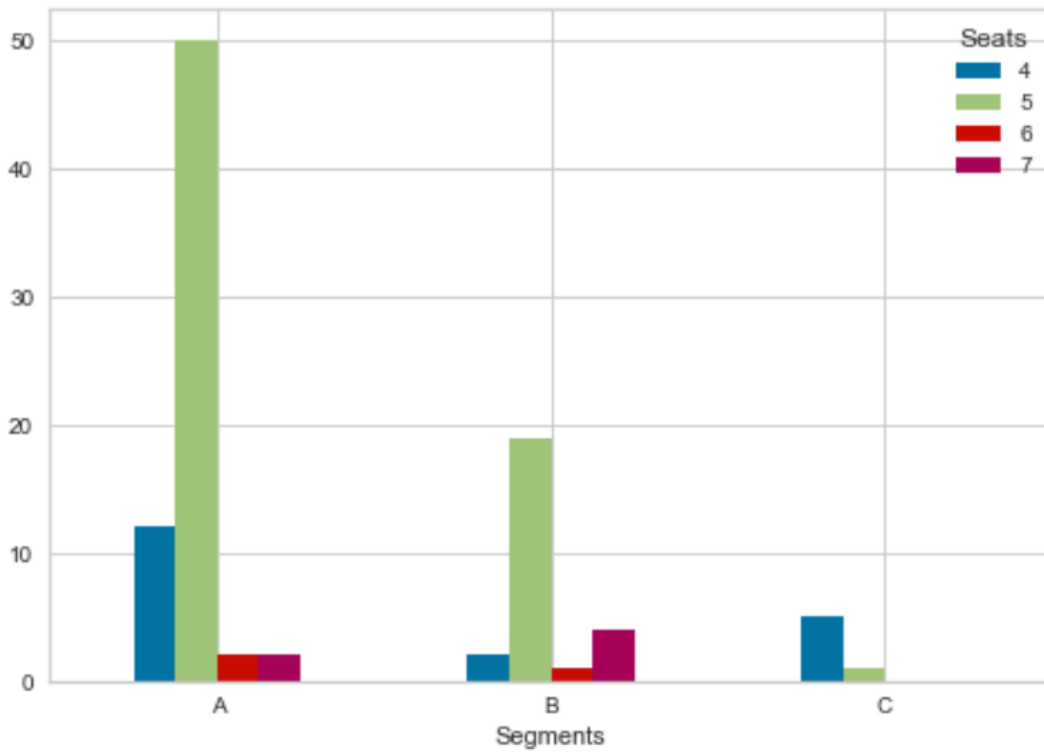
Segment description :



Segment A has the lowest efficiency as well as price. Segment C has the highest prices but the efficiency doesn't improve significantly as the price increases. Segment B has the best efficiency and reasonable price.

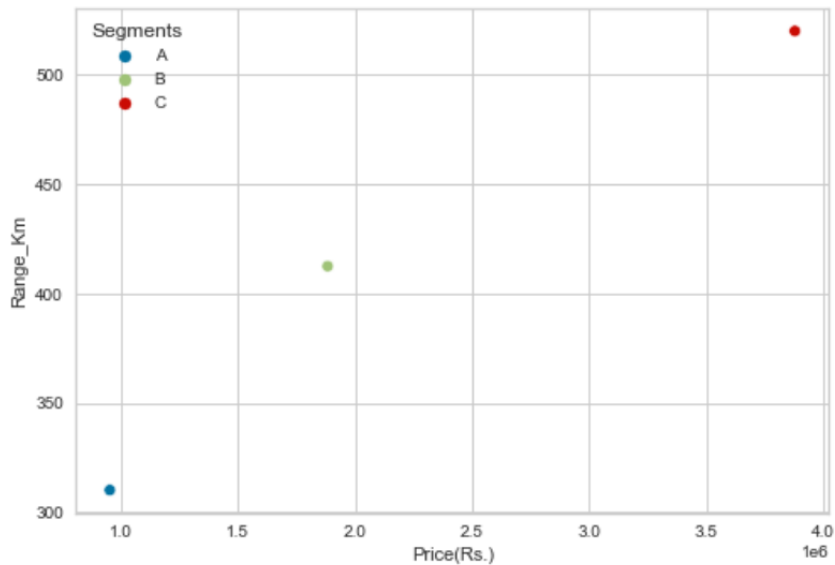


The range of many cars in segment A is on the lower side. In segments B and C, we observe that after a certain price the range becomes almost constant for all three segments. No significant improvement is seen even after increasing the price.

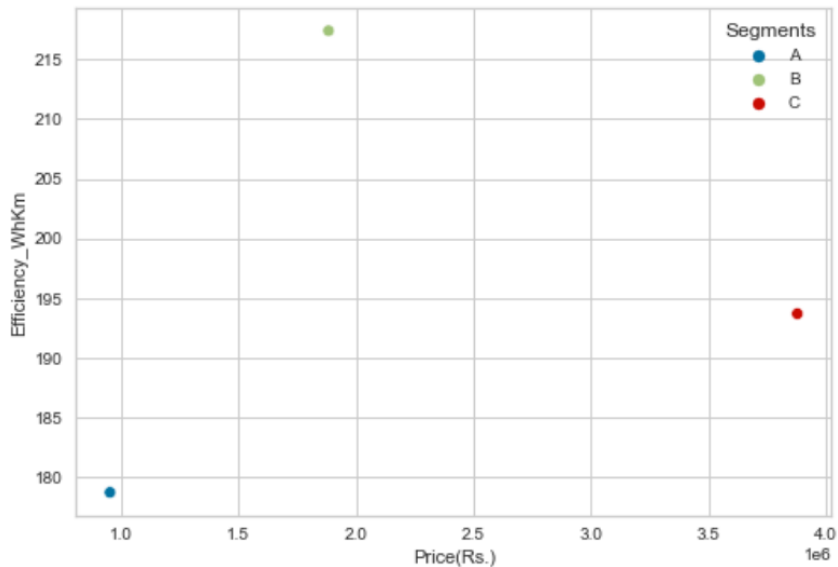


All three segments have a majority of cars with 5 seats and some with 4 seats.

## Segment Evaluation Plot



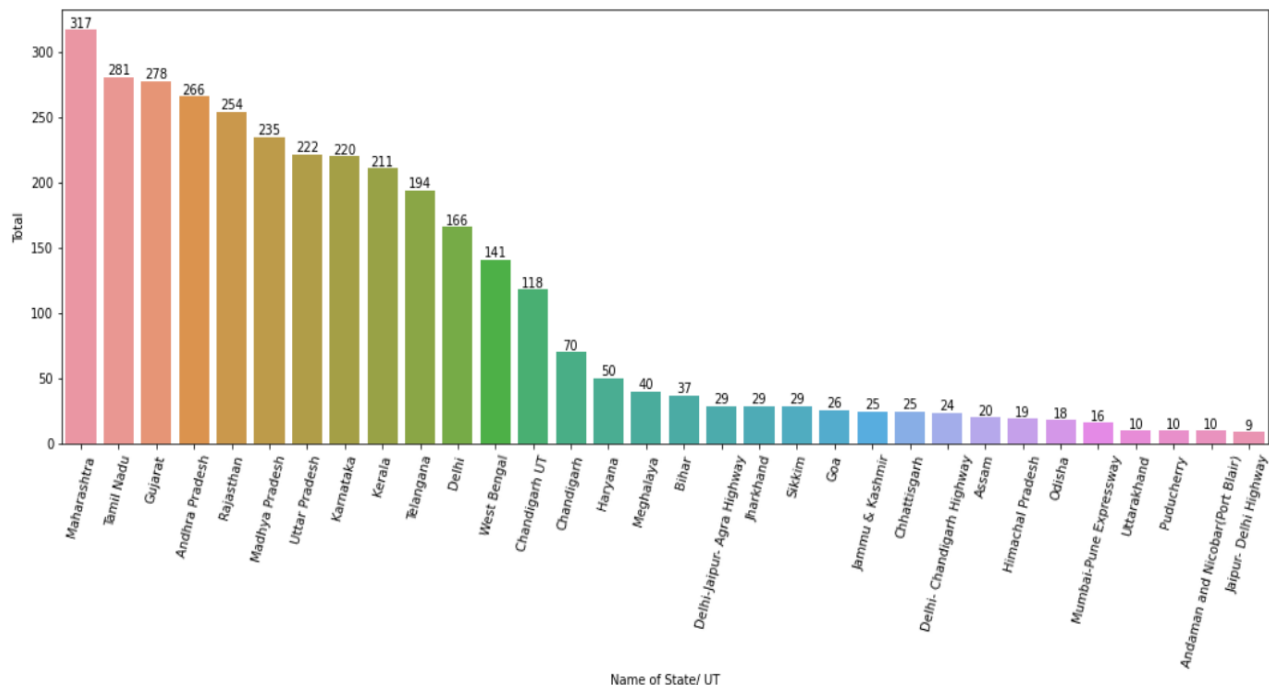
Segment B lies in the attractive segment of the segment evaluation plot, the sales of TATA Motors prove that this price range (around 15-18 lakhs) has a lot of potential. Further after this point, the features in a car don't improve, and there is a stagnation. (the increase in range in segment C is due to the outlier which can be seen in the price vs range scatterplot)



Therefore the most optimal market segment is 5-seater e-cars with a price range of around 15-20 lakhs and a range of around 400 km.

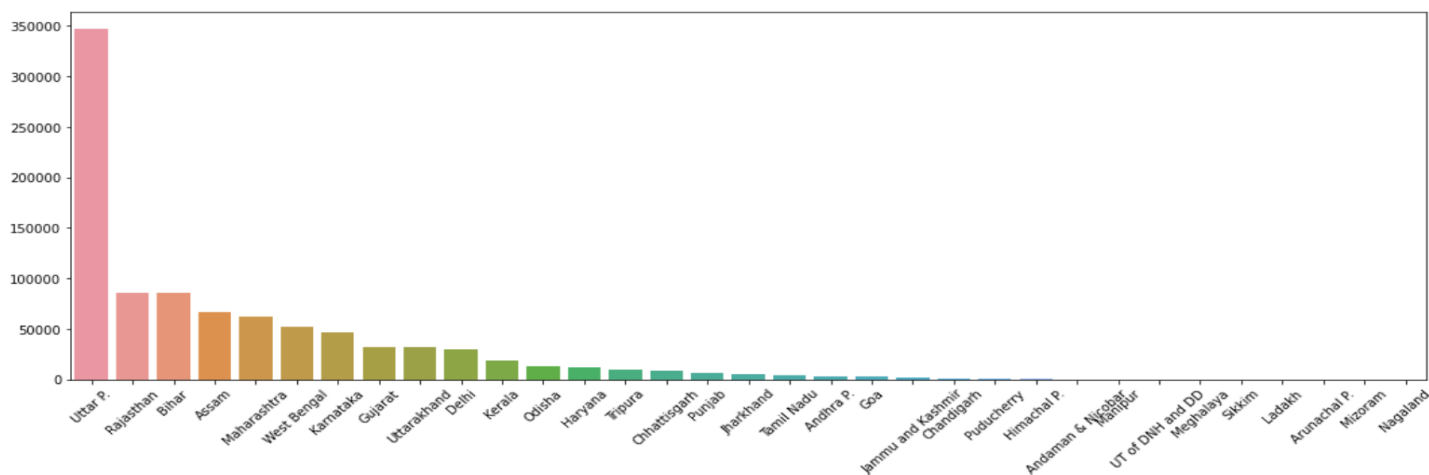
## (E): Demographic Segmentation:

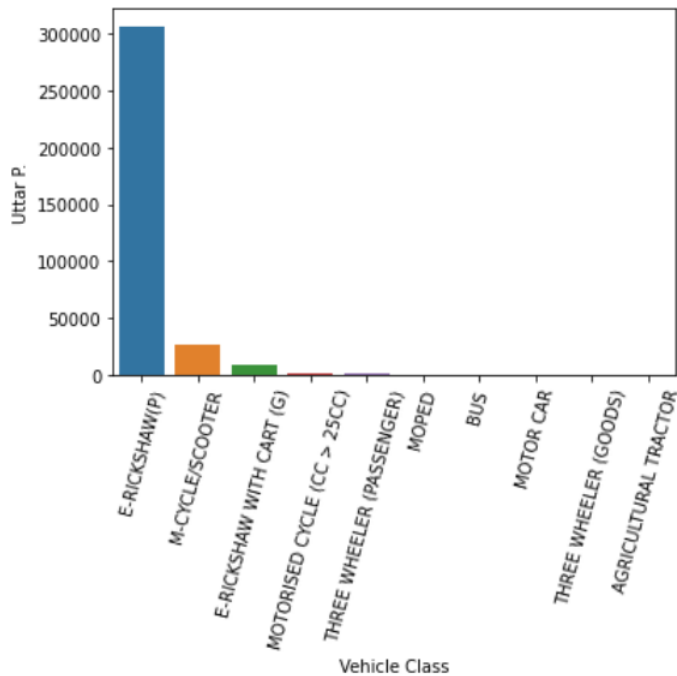
The total number of charging stations projected in the states with the help of data of current charging stations as well as stations sanctioned to states under the FAME-2 scheme.



The state of Maharashtra, Tamil Nadu , Gujrat, Andra Pradesh, Rajasthan, Madhya Pradesh, Uttar Pradesh, and Karnataka has a good infrastructure, which would encourage the sales of EVs in these regions.

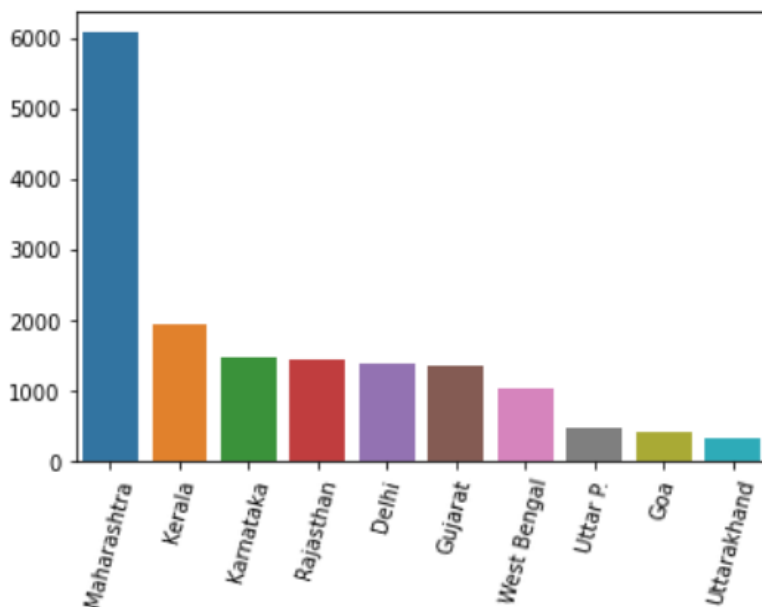
The sales data of EVs in different states shows that UP has the highest sales





But the majority of sales in UP is from the sales of E-Rickshaw.

- Sales of e-cars in different states



The sales of e-cars show that Maharashtra has the highest number of sales followed by Kerala, Karnataka, Rajasthan, and Delhi. These regions also have great charging infrastructure in development. Therefore they are an attractive demographic to target.

## **Customizing the Marketing Mix:**

To best ensure maximizing the benefits of a market segmentation strategy, it is important to customize the marketing mix to the target segment. The 4Ps make up a typical marketing mix - Price, Product, Promotion, and Price

- **Product:-** Our ideal product is a 5-seater electric car with a range of around 400 kms.
- **Price:-** The price of the car should be around 16-20 lakhs depending on the model(base or top).
- **Place:-** The state of Maharastra, Kerala, Karnataka, and Rajasthan are ideal regions with strong sales records and good charging infrastructure. We should develop a strong chain of distributors along with charging infrastructure with special benefits to our customers and service centers.
- **Promotion:-:** Our potential customers are an urban population with an above-average income. The best-suited promotion Channels for this customer base would be social media platforms especially youtube channel reviews as it is an emerging technology people would like to see product demonstrations and reviews. Also, we can use local city radios and offer free rides for trial.

## **Potential Customer base:**

Going by the e-cars sales data, around 18000 e-cars are sold in 2022 till date with around 16000 sales from tata motors which also is in the same segment as we are targeting. Assuming constant growth this year and factoring in festive seasons which sees the highest sales of vehicles in India ,we can safely project a sales of around 35-40 thousand in this segment for 2022. The e-cars segment is projected to grow at a rate of 20% cagr, so we are looking at a potential customer base of around 1.8-2 lakhs customers by 2030.

## **Link to GitHub repo:**

<https://github.com/Anni0223/EV-market-segmentation>