Market Segmentation Analysis of Electric Vehicles Market in India

BY

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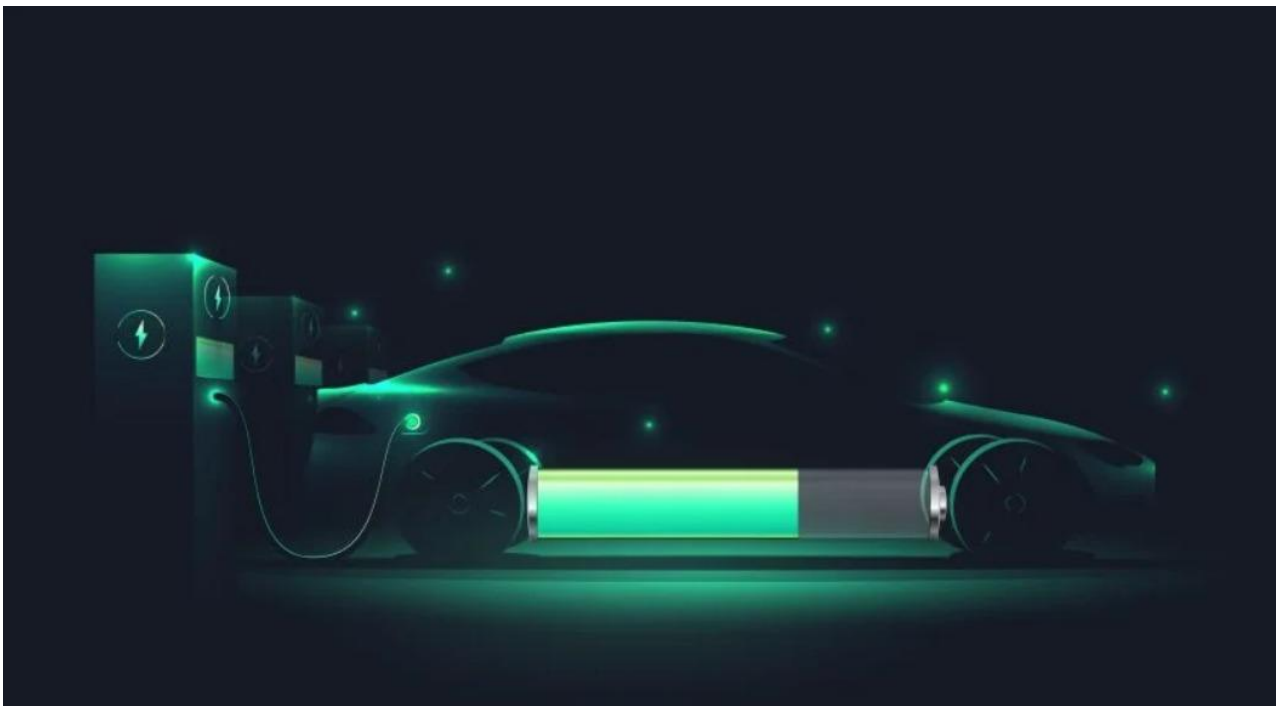

Problem Statement

Task is to analyze the Electric Vehicles Market in India using Segmentation analysis and come up with a feasible strategy to enter the market, targeting the segments most likely to use their product in terms of Geographic, Demographic, Psychographic, and Behavioral.
This report contains the Electric Vehicles Market in India using segments such as region, price, charging facility, type of vehicles (e.g., 2 wheelers, 3 wheelers, 4 wheelers etc.), retail outlets, manufacturers, body type (e.g., Hatchback, Sedan, SUV, Autorickshaw etc.), safety, plug types and much more.

Fermi Estimation

Given the rapid advancements and increasing adoption of electric vehicles (EVs), let's project the market penetration by the end of 2024 in India.

Wild Guess:
By the end of 2023, we anticipate that around 15-20% of people will have electric vehicles in India.

Educated Guess:
Considering the evolving landscape and potential shifts in demographics and technology adoption rates, let's revise our estimates for the end of 2024.

Assumptions:

- Total Indian population: Projected to be 1.55 billion by 2024.
- Working-age population (18-60 years): 60% of total population.
- Employment rate in 2024: Projected to increase to 50% due to economic growth and government initiatives.
- Middle-class individuals who can afford EVs: Projected to increase to 50 million due to improving affordability and incentives.
- Willingness to buy EVs among middle-class: Expected to increase to 15 million due to growing awareness and infrastructure development.

Calculation:

1. Population estimates:

   Assuming an average annual increase similar to recent trends, the estimated population in 2024 would be approximately 1.55 billion.
2. Available labor force (A(x)) assumed constant: 471,688,990.
3. Ratio of Indians aged 18-60 to total population (r): 0.6.
4. Employment rate in 2024 (E(2024)):

   Projected employment rate: (471,688,990 / (1,550,000,000 * 0.6)) * 0.75

   E(2024) ≈ 50%.

Conclusion:

By the end of 2024, with a projected employment rate of 50%, out of approximately 465 million people in the workforce, around 232.5 million would be employed. Assuming 10% of them can afford EVs, this would amount to approximately 23.25 million potential EV buyers. Considering the increasing awareness, affordability, and infrastructure development, we estimate that around 15-20% of them, i.e., roughly 3.5-4.5 million people, could have electric vehicles by the end of 2024.

Data Collection

Data was extracted from the various websites mentioned below for EV market segmentation.

Link for data extraction:

- Press Information Bureau (pib.gov.in)
- The Electric Vehicle Ecosystem in India: A Look at the Progress So Far (india-briefing.com)

Columns explanations:

1. ‘Brand’ and tells the manufacturers of electric vehicles.
2. ‘model’ tells the various of electric vehicles.
3. ‘AccelSec’, ‘Top Speed’, ’Power Train’ tellsspecification about the vehicles.

4. ‘Range_km’, ‘Fast_Charge’, ‘Plug_type’ and ‘Bodystyle’ tells us about rangeof 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 vehicle and theirprice.
6. ‘Region’ and ‘State/UT’ tells about the states of India.
7. ‘EV Charging Facility’ and ‘Chargers’ tells about the facility of charging in the respectivestates.
8. ‘2V’, ‘3V’, ‘4V’, ‘Bus’ tells about the type of vehicles in the market.

Data Preprocessing

Steps taken to preprocess the scraped raw data:

1. Ordinal encoded 'PowerTrain'
2. Label encoded 'RapidCharge’
3. Used Label Encoder and Standard Scaler package for preprocessing of the dataset.

Required libraries

In order to perform EDA and clustering on the collected data, the following Python libraries are used:

1. Pandas: for data handling/manipulation
2. Matplotlib and Seaborn: for data visualization
3. Scikit-learn: for the k-means clustering algorithm and some other algorithms

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Importing libraries

In [2]:
```
# importing the dependencies
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA
from sklearn.cluster import KMeans
```

Fetching Datasets

In [3]:
```
# fetching dataset - 1
df1 = pd.read_csv('1_ev_charger_dataset.csv')
df1.head()
```

Out[3]:

	Region	2W	3W	4W	Bus	Chargers
0	Uttar Pradesh	9852	42881	458	197	207
1	Maharastra	38558	893	1895	186	317
2	Karnataka	32844	568	589	57	172
3	Tamil Nadu	25642	396	426	0	256
4	Gujarat	22359	254	423	22	228

In [4]:
```
# fetching dataset - 2
df2 = pd.read_excel('2_ev_charging_station_dataset.xlsx', sheet_name='Table 4', header=1)
df2.head()
```

Out[4]:

	State/UT	EV Charging Facility
0	Andhra Pradesh	65
1	Arunachal Pradesh	4
2	Assam	19
3	Bihar	26
4	Chandigarh	4

In [5]:
```
# fetching dataset - 3
df3 = pd.read_excel('3_ev_market_india_dataset.xlsx')
df3.head()
```

Out[5]:

	Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	S
0	Tesla	Model 3 Long Range Dual Motor	4.6	233	450	161	940	Yes	AWD	Type 2 CCS	Sedan	D	
1	Volkswagen	ID.3 Pure	10.0	160	270	167	250	No	RWD	Type 2 CCS	Hatchback	C	
2	Polestar	2	4.7	210	400	181	620	Yes	AWD	Type 2 CCS	Liftback	D	
3	BMW	iX3	6.8	180	360	206	560	Yes	RWD	Type 2 CCS	SUV	D	
4	Honda	e	9.5	145	170	168	190	Yes	RWD	Type 2 CCS	Hatchback	B	

Exploratory Data Analysis

An Exploratory Data Analysis or EDA is a thorough examination meant to uncover the underlying structure of a data set and is important for a company because it exposes trends, patterns, and relationships that are not readily apparent.

Analyzed our dataset using univariate (analyze data over a single variable/column from a dataset), bivariate (analyze data by taking two variables/columns into consideration from a dataset) and multivariate (analyze data by taking more than two variables/columns into consideration from a dataset) analysis.

Analysing the datasets

In [6]:
```
# checking the shape (# of rows and columns) of the datasets
print('DF1 Shape: ', df1.shape)
print('DF2 Shape: ', df2.shape)
print('DF3 Shape: ', df3.shape)
```

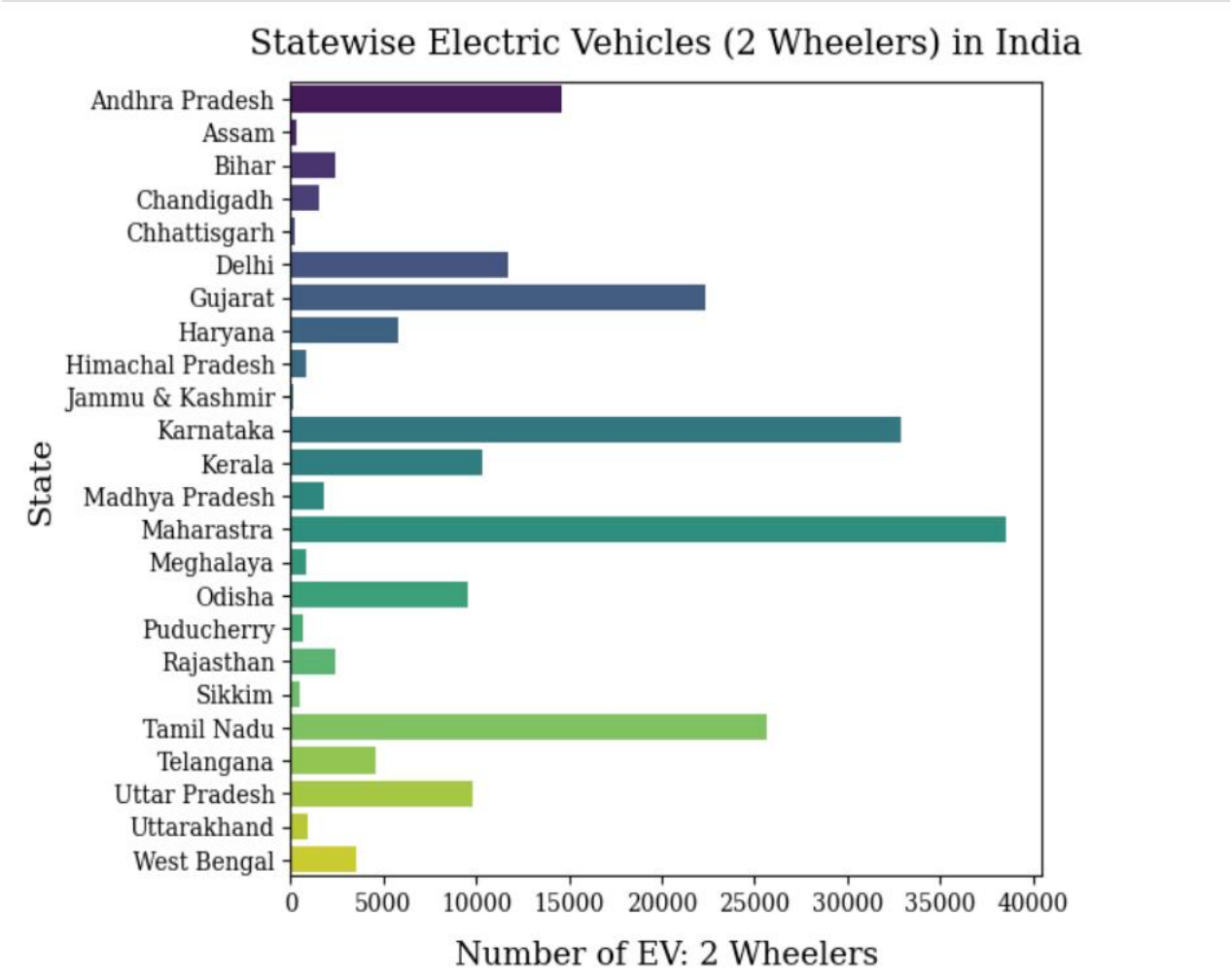
```
DF1 Shape:  (24, 6)
DF2 Shape:  (31, 2)
DF3 Shape:  (103, 14)
```

In [7]:
```
# checking the info (columns, datatypes, nulls) of the datasets
print(' <<< DATASET 1 ------------------------------------------------------------')
print(df1.info())
print(' <<< DATASET 2 ------------------------------------------------------------')
print(df2.info())
print(' <<< DATASET 3 ------------------------------------------------------------')
print(df3.info())
```

```
 <<< DATASET 1 ------------------------------------------------------------
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 24 entries, 0 to 23
Data columns (total 6 columns):
 #   Column    Non-Null Count  Dtype 
---  ------    --------------  ----- 
 0   Region    24 non-null     object
 1   2W        24 non-null     int64 
 2   3W        24 non-null     int64 
 3   4W        24 non-null     int64 
 4   Bus       24 non-null     int64 
 5   Chargers  24 non-null     int64 
dtypes: int64(5), object(1)
memory usage: 1.2+ KB
None
 <<< DATASET 2 ------------------------------------------------------------
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 31 entries, 0 to 30
Data columns (total 2 columns):
 #   Column                Non-Null Count  Dtype 
---  ------                --------------  ----- 
 0   State/UT              31 non-null     object
 1   EV Charging Facility  31 non-null     int64 
dtypes: int64(1), object(1)
memory usage: 624.0+ bytes
None
 <<< DATASET 3 ------------------------------------------------------------
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 103 entries, 0 to 102
Data columns (total 14 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   Brand            103 non-null    object 
 1   Model            103 non-null    object 
 2   AccelSec         103 non-null    float64
 3   TopSpeed_KmH     103 non-null    int64  
 4   Range_Km         103 non-null    int64  
 5   Efficiency_WhKm  103 non-null    int64  
 6   FastCharge_KmH   103 non-null    int64  
 7   RapidCharge      103 non-null    object 
 8   PowerTrain       103 non-null    object 
 9   PlugType         103 non-null    object 
 10  BodyStyle        103 non-null    object 
 11  Segment          103 non-null    object 
 12  Seats            103 non-null    int64  
 13  PriceEuro        103 non-null    int64  
dtypes: float64(1), int64(6), object(7)
memory usage: 11.4+ KB
None
```

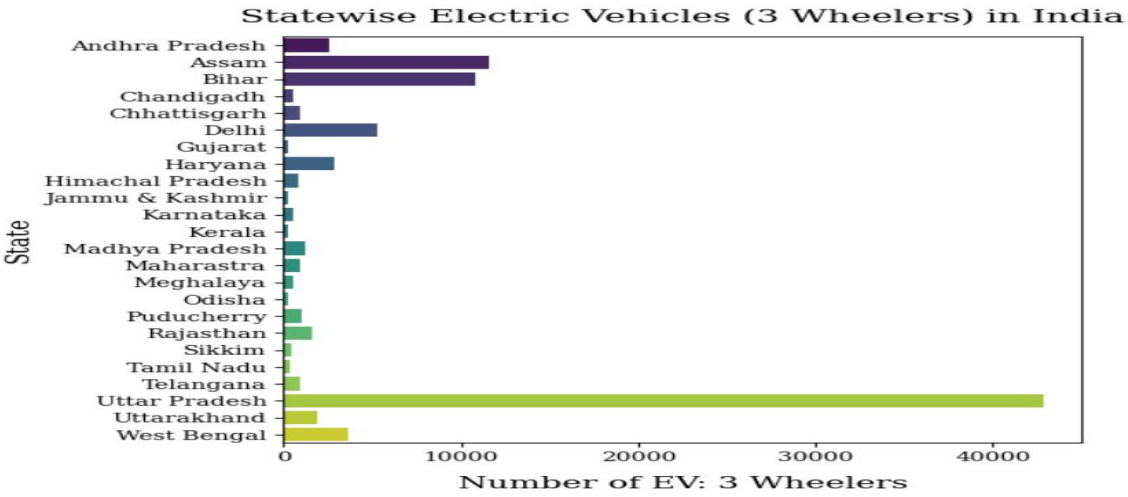
Analysis of 2-wheeler EVs

Observation: Maharashtra, Gujarat, Tamilnadu, Karnataka and Andhra Pradesh are among the top states with the majority of EV 2-wheelers while Assam, Himachal Pradesh, Sikkim, J&K with the least.



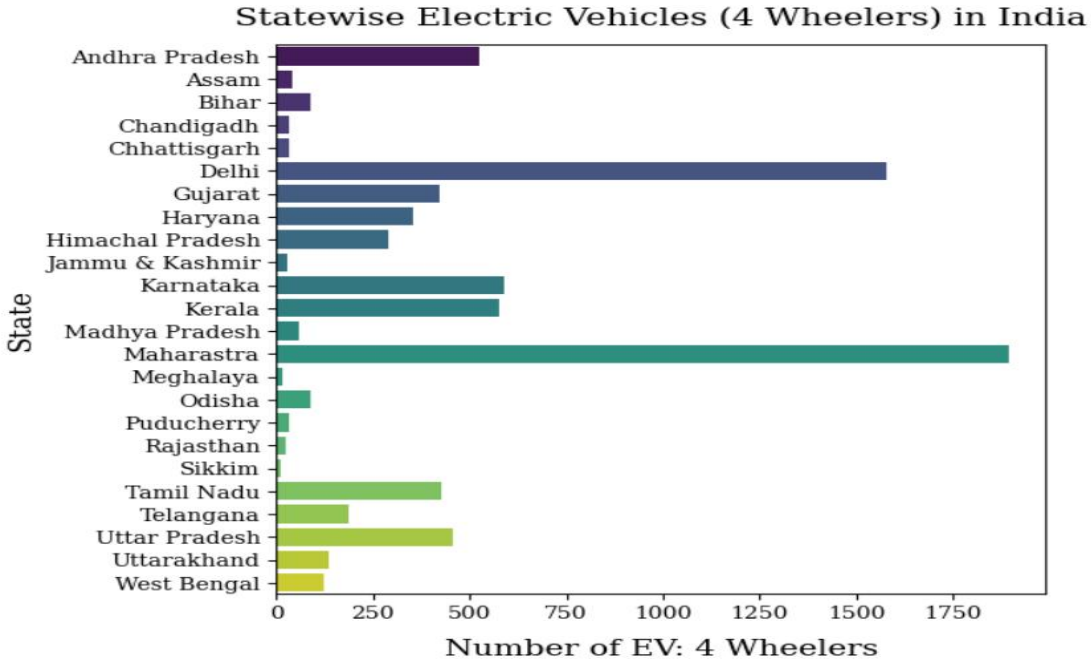
Analysis of 3-wheeler EVs

Observation: Uttar Pradesh, Assam and Bihar are among the top states with the majority of EV 3-wheelers while the remaining states don't seem to depend on the same.



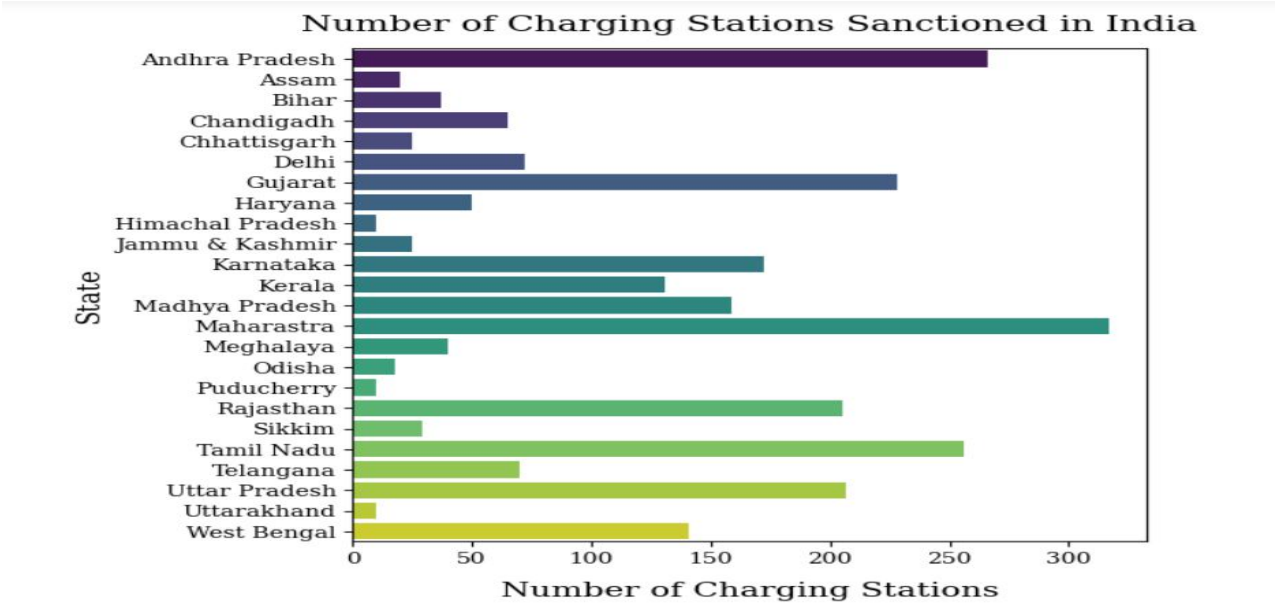
Analysis 4-wheeler EVs

Observation: Maharashtra, Delhi, Karnataka, Kerala and Andhra Pradhesh are among the top states with the majority of EV 4-wheelers while the remaining states have less number of EV 4-wheelers.



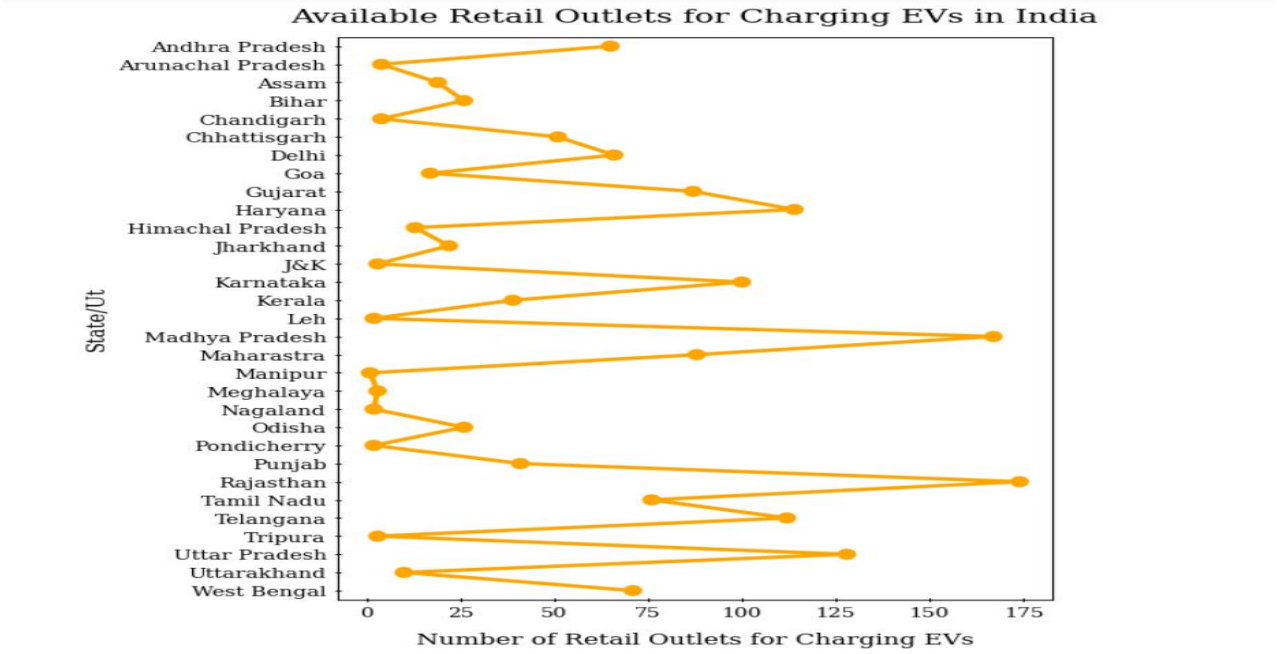
Analysis of charging stations sanctioned

Observation: Maharashtra, Gujarat, Karnataka, Kerala, Uttar Pradesh, Rajasthan, and Andhra Pradhesh are among the top states with the majority of EV charging stations sanctioned while the remaining states have less number of the same.



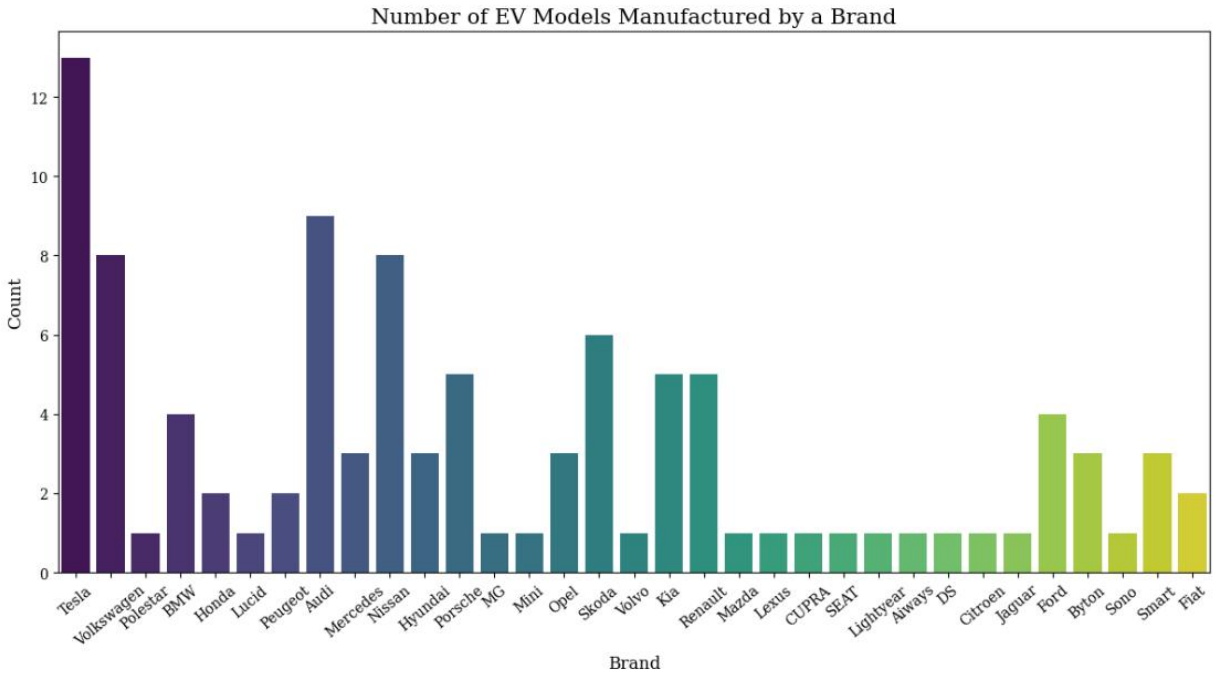
Analysis of retail outlets for EV charging

Observation: Rajasthan, Madhya Pradesh, Maharashtra, Karnataka, Uttar Pradesh are among the top states with the majority of retail outlets for EV charging while the remaining states have less number of the same



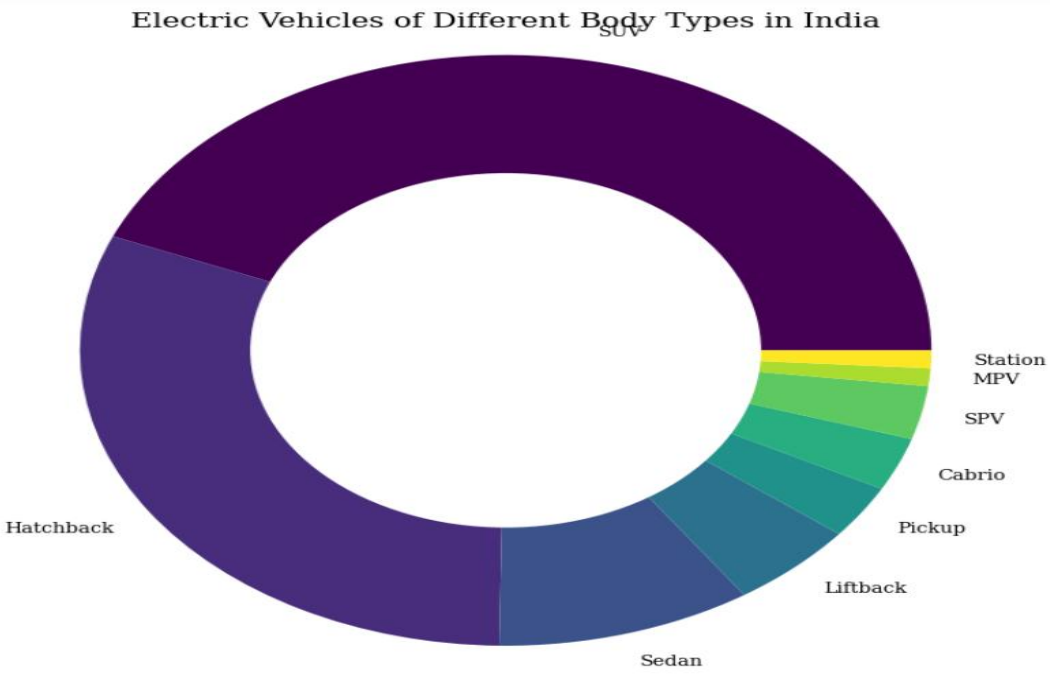
Analysis of EVs based on brands

Observation: Tesla, Audi, Volkswagen, Nissan, Skoda tops the list of EVs with the maximum number of models in the Indian automobile market.



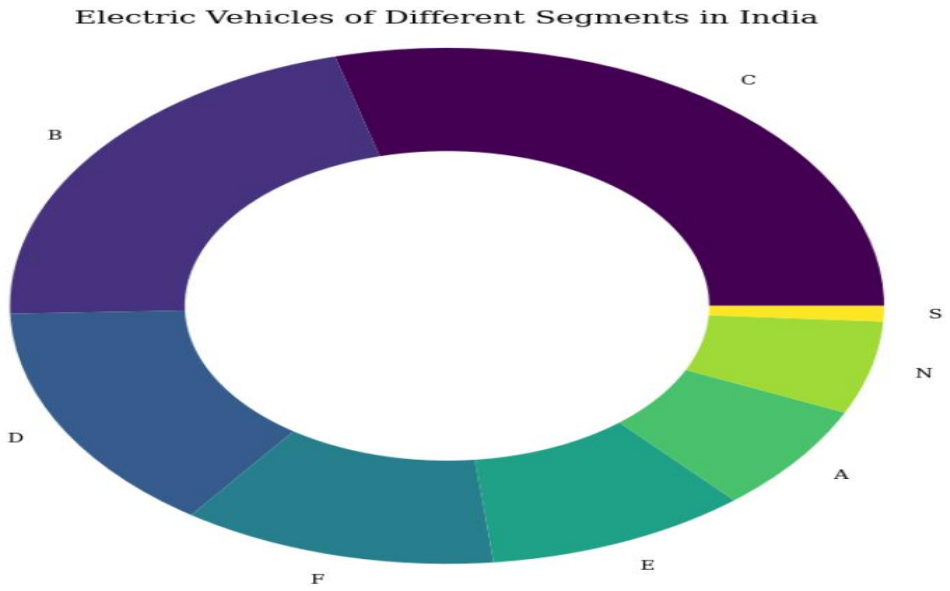
Anaysis of different body types of EVs¶

Observation: SUV and Hatchback body types form the majority while Station and MPV the minority.



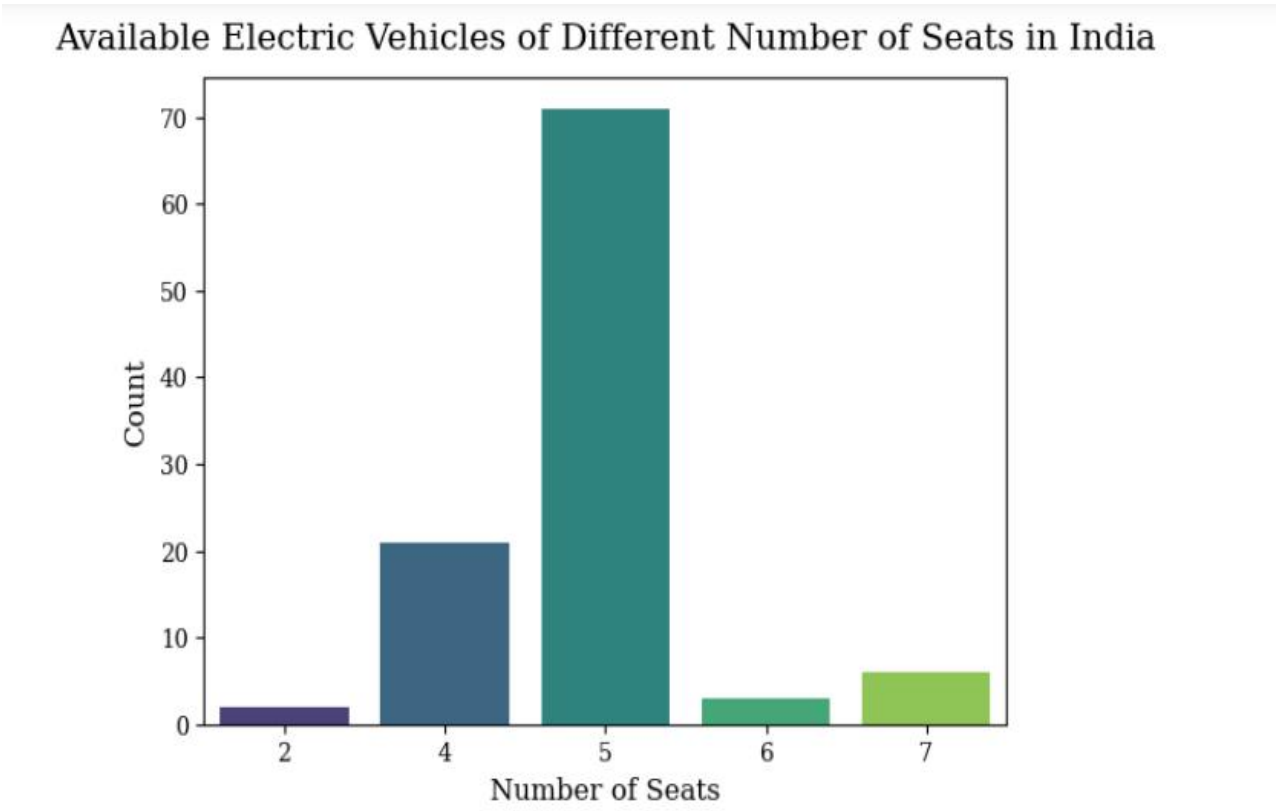
Analysis of different segments of EVs

Observation: B and C body segments form the majority while S and A the minority.



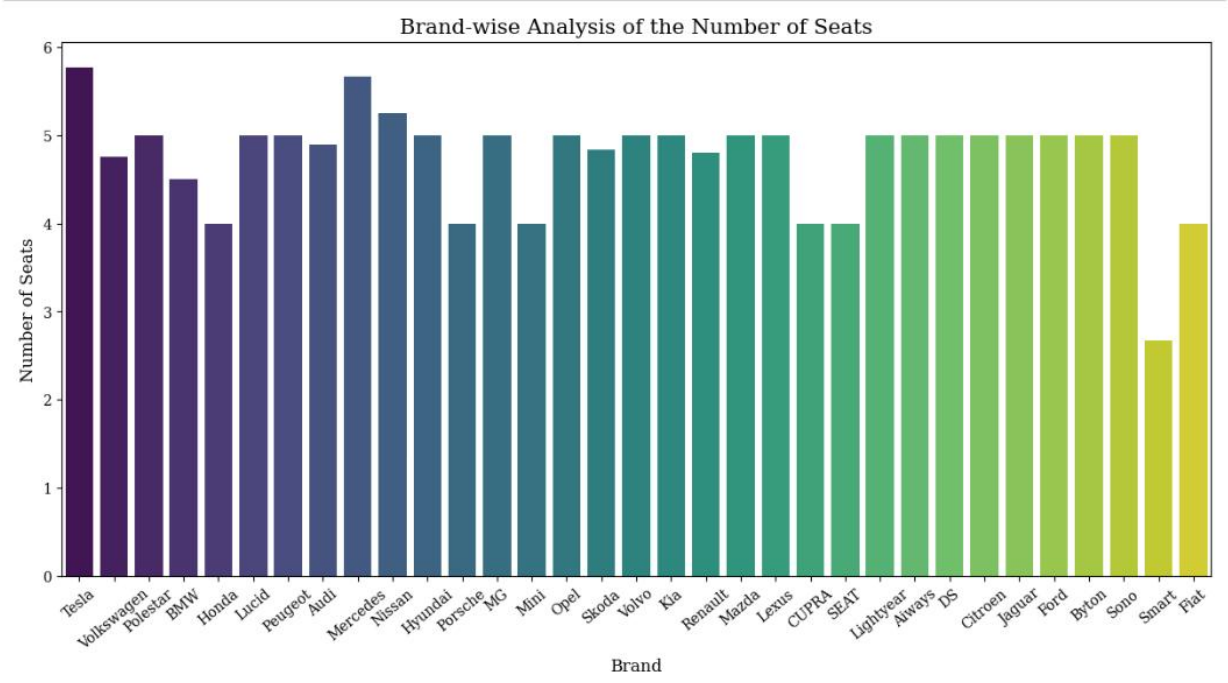
Analysis of EVs of different number of seats

Observation: EVs with 5 sitters dominate the market while EVs with 2 sitters are less in number.



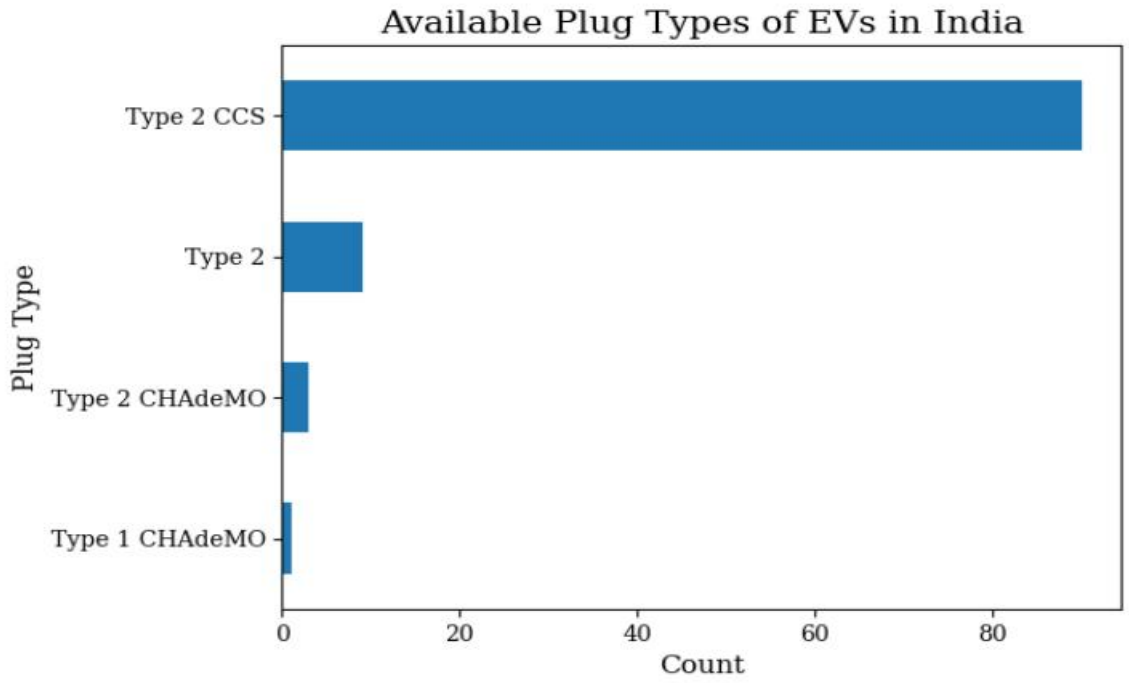
Analysis of the number of seats by each brand

Observation: Based on the number of seats, Tesla, Mercedes and Nissan have the maximum number of seats and Smart the minimum

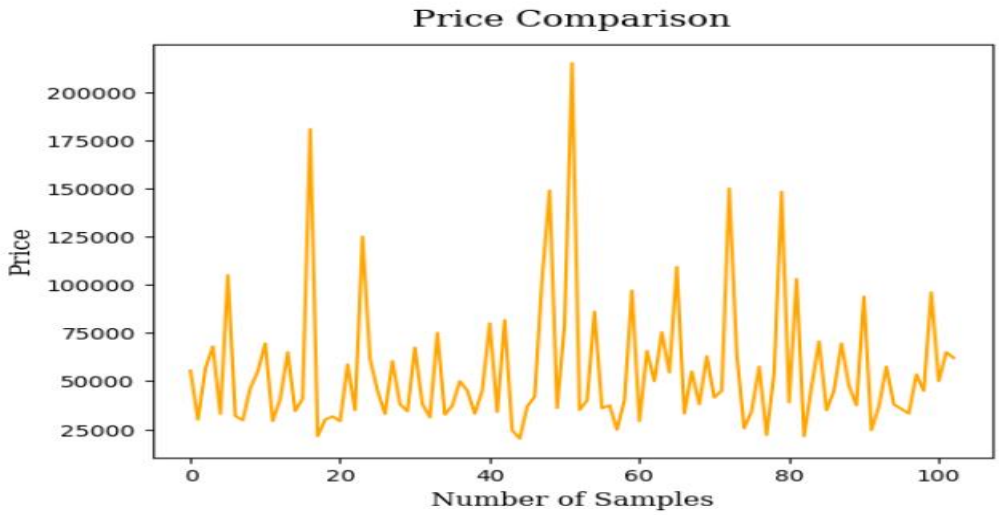


Analysis of different plug types

Observation: EVs with plus type of 'Type 2 CCS' seem to dominate the market.

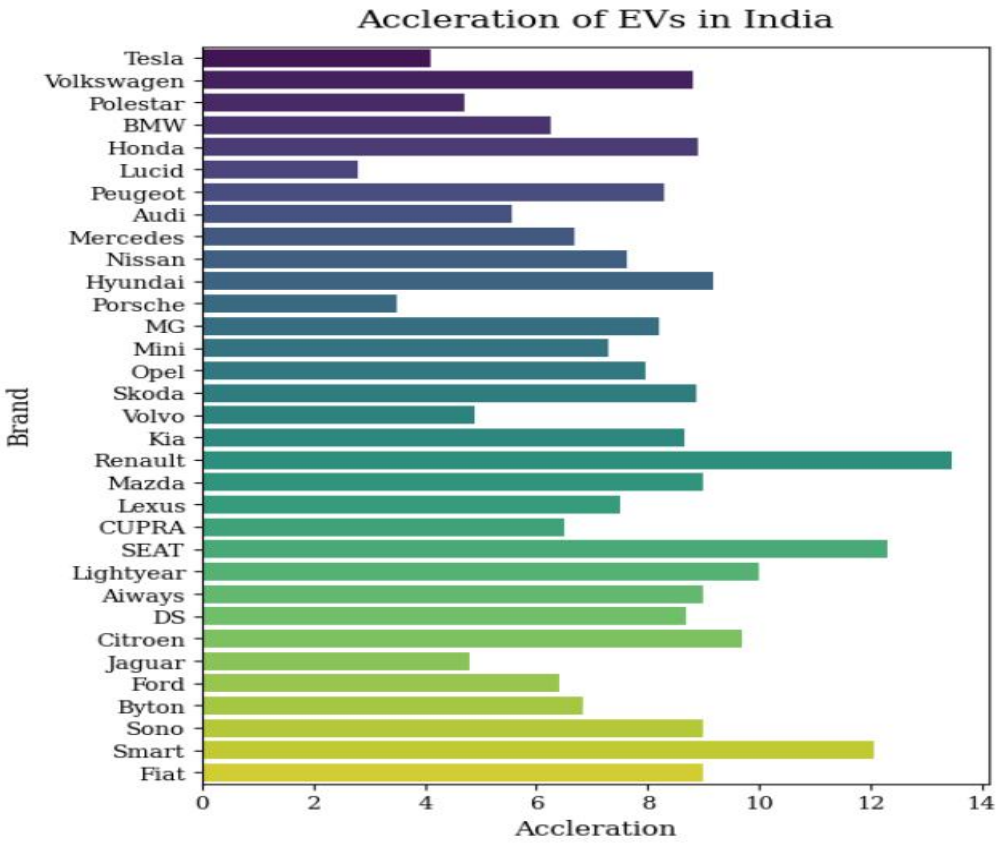


price comparisons in Electric Vehicles



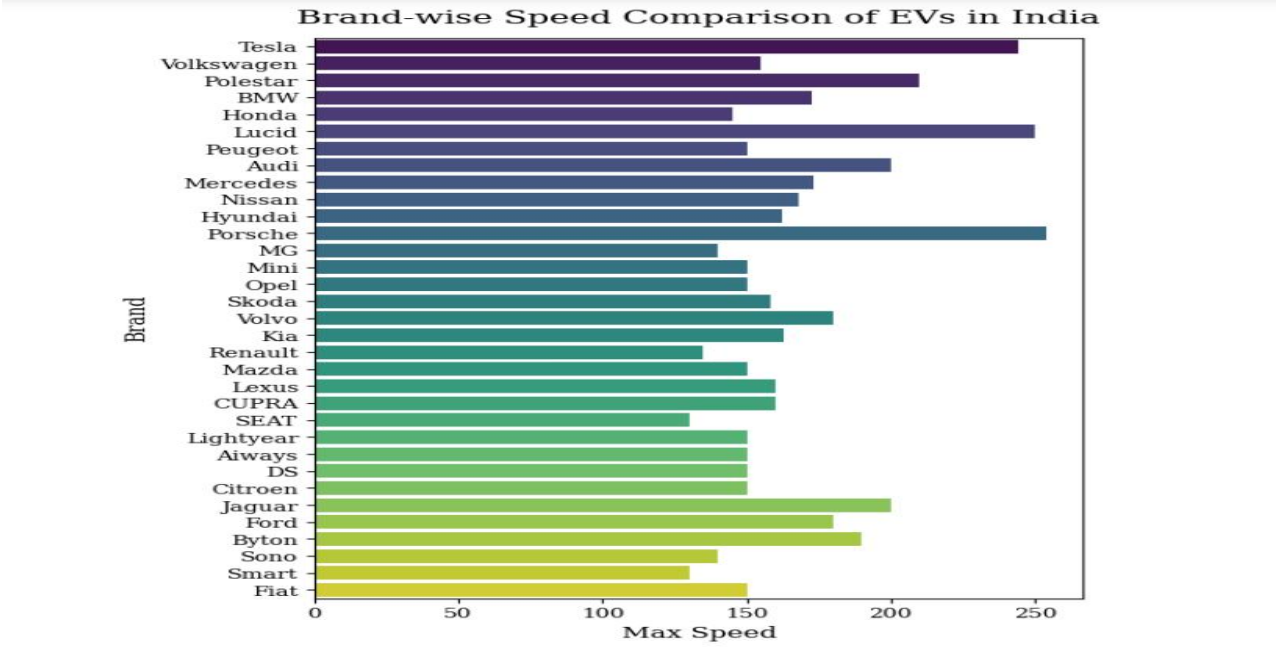
Analysis of EVs based on accleration

Observation: Based on accleration, EVs from Renault, Seat and Smart are the top performers while Tesla, Lucid and Porsche dont make it to the same.



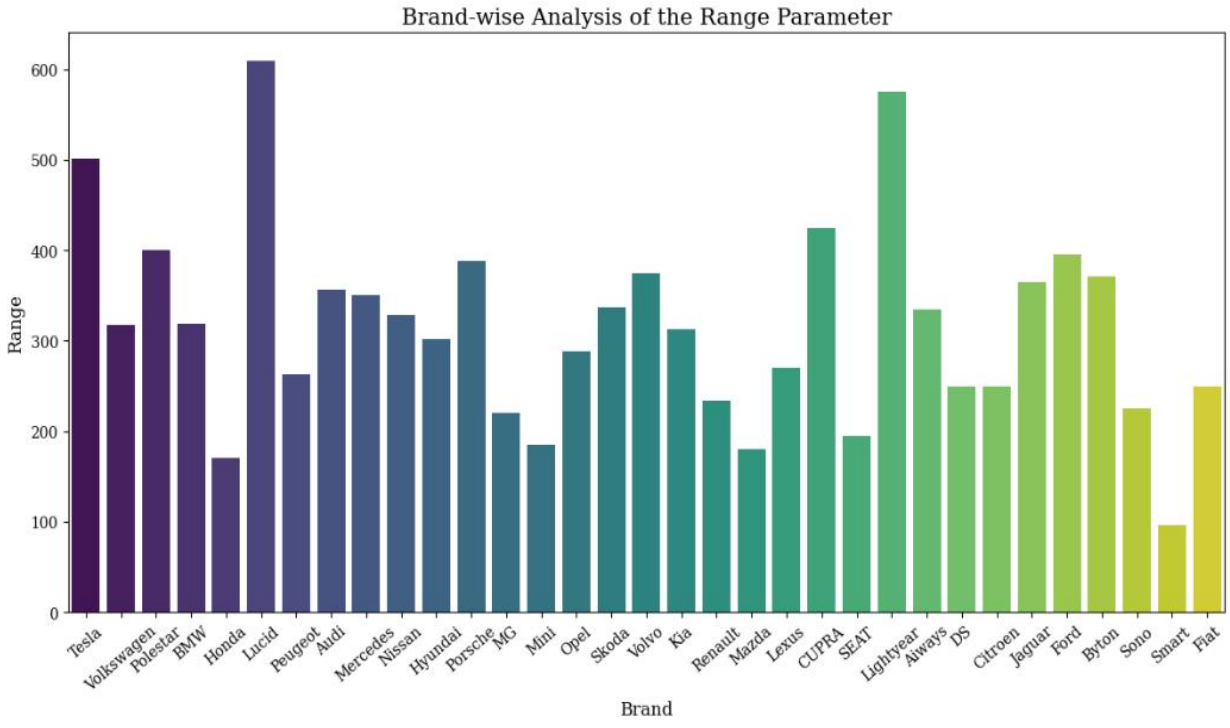
Analysis of EVs based on speed

Observation: Based on speed parameter, EVs from Tesla, Lucid and Porsche are the top performers while Renault, Smart and SEAT dont make it to the same.

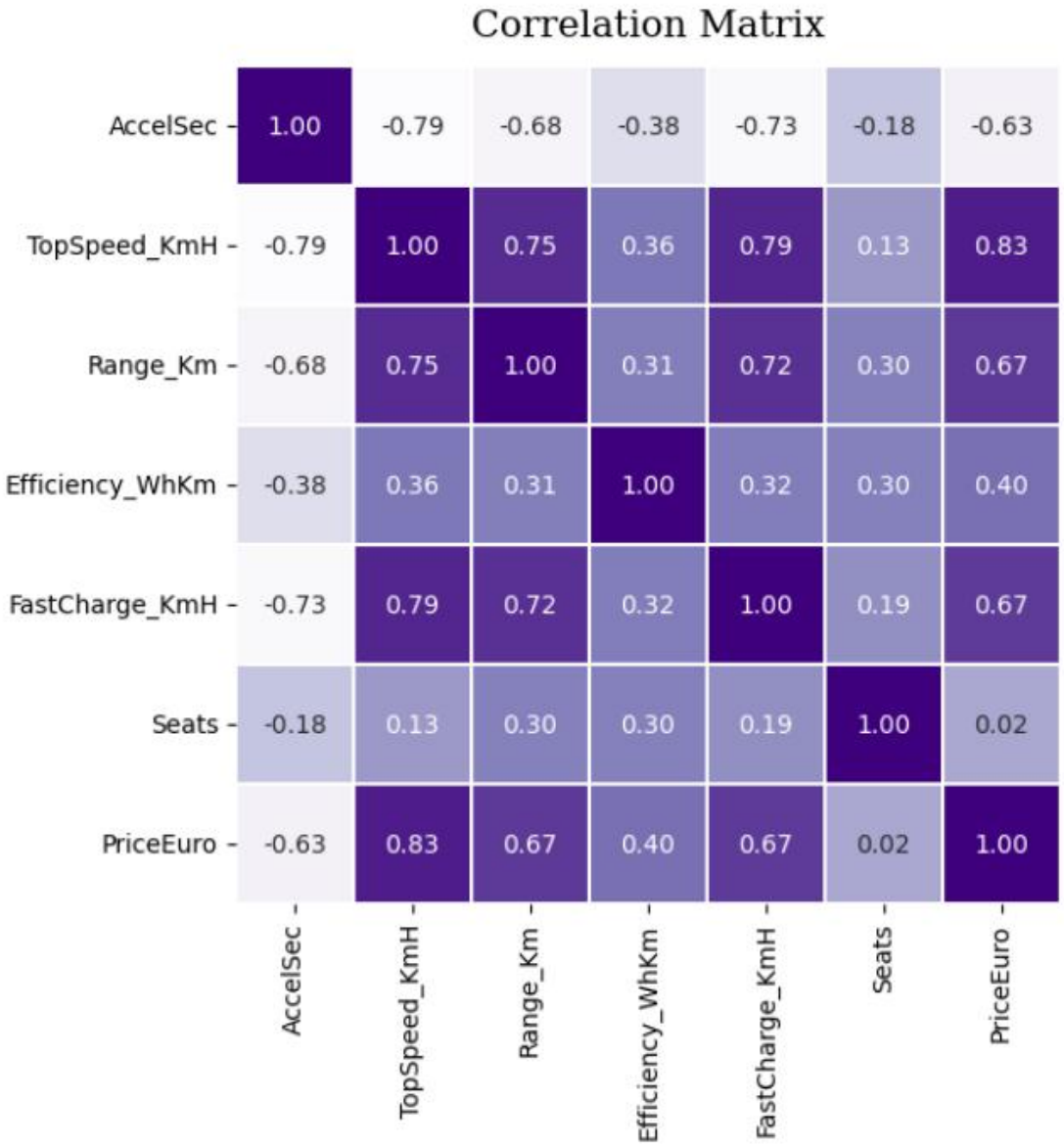


Analysis of EVs based on the range parameter

Observation: Based on range (Km), Lucid, Lightyear and Tesla have the highest range and Smart the lowest



Correlation matrix for the features in one of the dataset used.



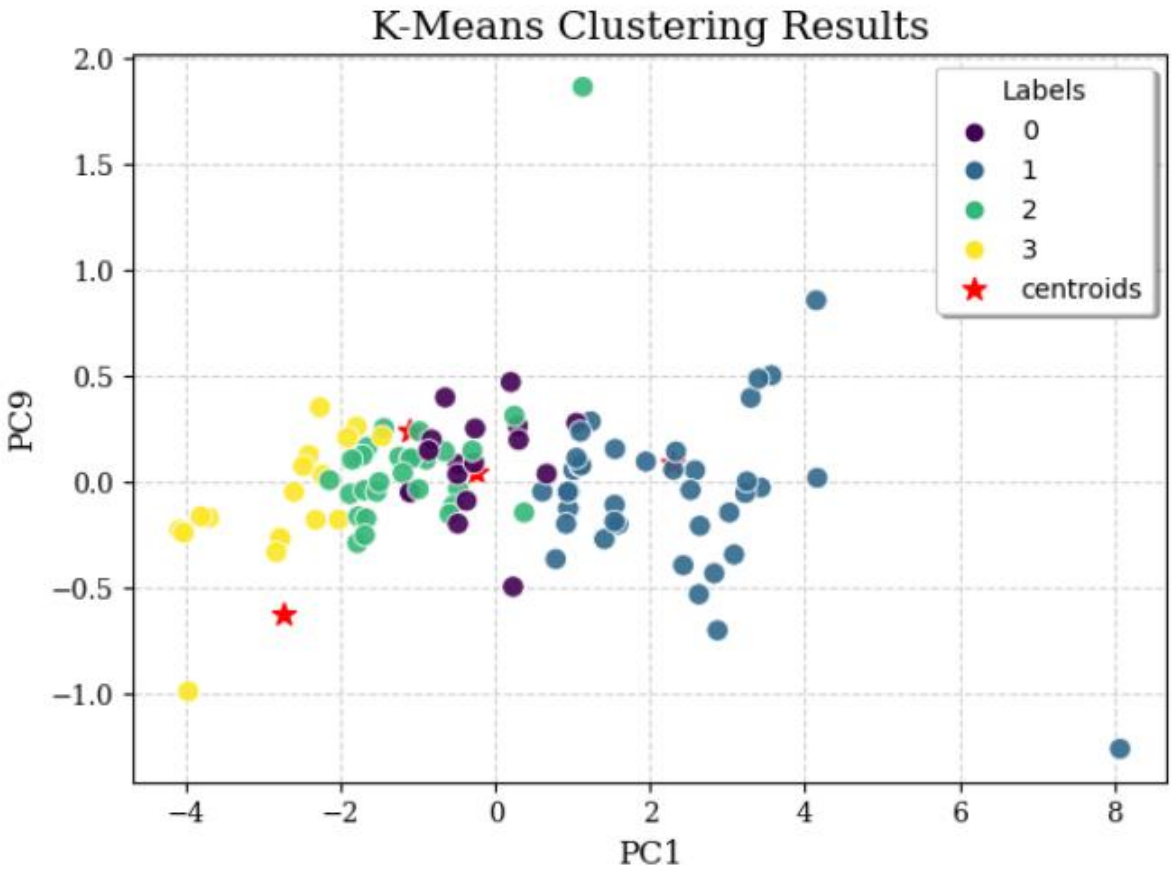
Segment Extraction

Clustering

Clustering is an unsupervised machine learning technique of grouping similar data points into clusters. The sole objective of this technique is to segregate datapoints with similar traits and place them into different clusters. There are several algorithms to perform clustering on data such as k-means clustering, hierarchical clustering, density-based clustering etc

K-Means Clustering

K-Means Clustering is an unsupervised learning algorithm whose job is to group the unlabelled dataset into different clusters where each datapoint belongs to only one cluster. Here, K is the number of clusters that need to be created in the process. The algorithm finds its applicability into a variety of use cases including market segmentation, image segmentation, image compression, document clustering etc. The below image is the results of clustering on one of our datasets.



The K-Means Algorithm works the following way:

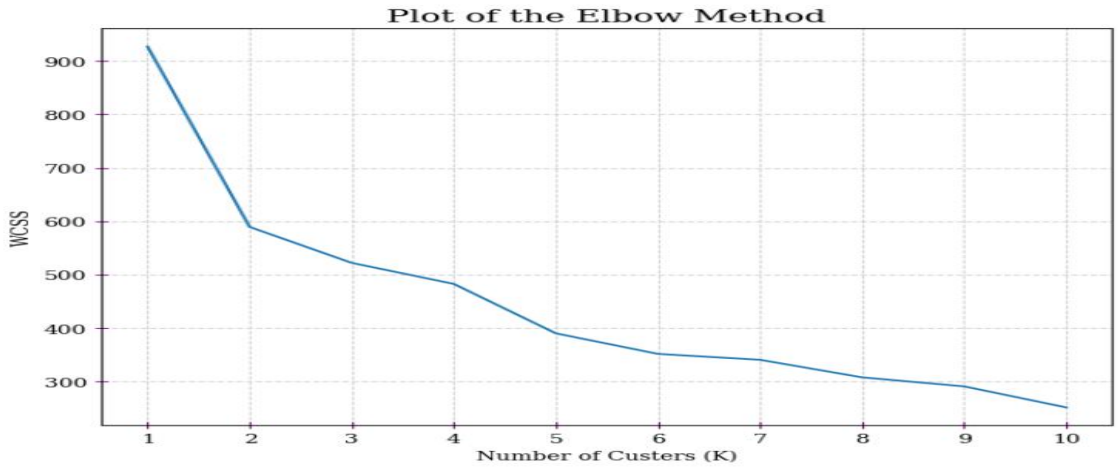
1. Specify the number of clusters, i.e. K
2. Select K random points in the dataset. These points will be the centroids (centres) of each of the K clusters.
3. Assign each data point in the dataset to one of the K centroids, based on its distance from each of the centroids.
4. Consider this clustering to be correct and reassign the Centroids to the mean of these clusters.
5. Repeat Step 3. If any of the points change clusters, Go to step 4. Else Go to step 6.
6. Calculate the variance of each of the clusters
7. Repeat this clustering 'n' number of times until the sum of variance of each cluster is Minimum

Principle Component Analysis

Principal component analysis (PCA) is a linear dimensionality-reduction technique that is used to reduce the dimensionality of large data sets by transforming a large set of variables into a smaller one while preserving most of the information present in the large set.

Elbow Method

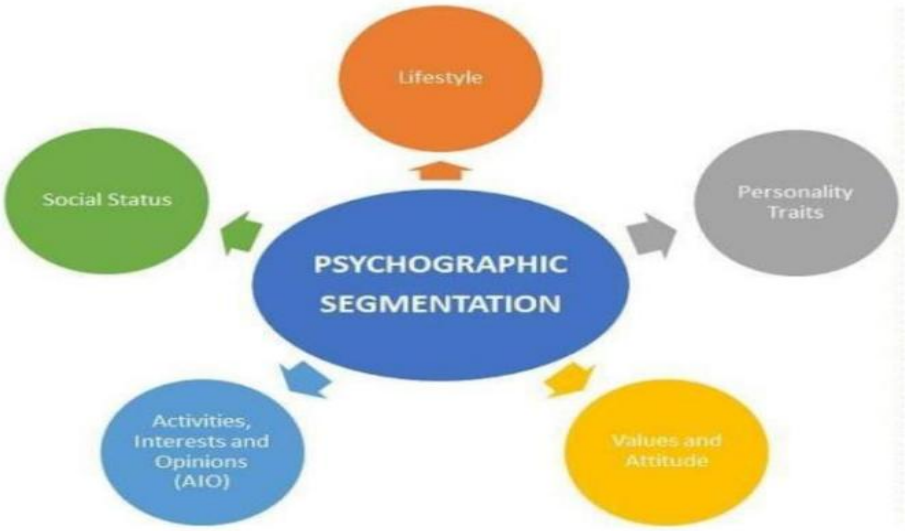
The Elbow method is a way of determining the optimal number of clusters (k) in K-Means Clustering. It is based on calculating the Within Cluster Sum of Squared Errors (WCSS) for a different number of clusters (k) and selecting the k for which change in WCSS first starts to diminish. When you plot its graph, at one point the line starts to run parallel to the X-axis and that point, known as the Elbow Point, is considered as the best value for the k (as 4 in the below figure).



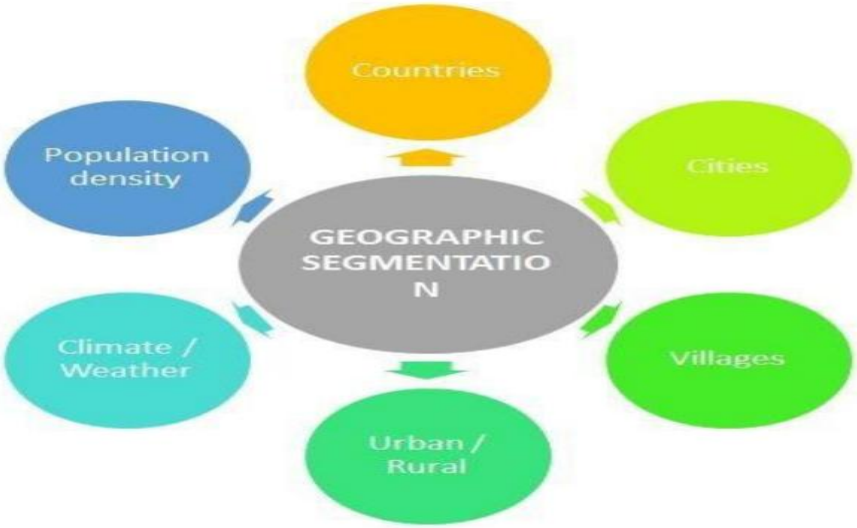
Profiling Potential Segments

Behavioral Segmentation: Segmenting the market based on customer behavior aspects suchas what price range customers usually buy in, what kind of specifications customers look for in their cars, etc.

Psychographic Segmentation: Segmenting the market based on psychological parameters,such as the likes and dislikes of customers, whether they prefer comfort over speed of a vehicle, etc.



Geographic Segmentation: Segmenting the market based on geography. This mainlyincludes characteristics of the market based on the location.



Target Segments

Based on the analysis, the target segment can be narrowed down to EVs having:

- **Psychographic factors** such as Comfort and Value for Money
- **Behavioral factors** such as good Acceleration and viable Price range
- **Geographic factors** such as States which are more market friendly

Customizing the market mix

The marketing mix helps enable the growth of the business in the automotive industry. A company's marketing mix or 4Ps (Product, Place, Promotion, and Price) specify the approaches and strategies that address the target market, based on the details of the marketing plan. The company's aim is tomaximize sales and improve market presence. With astrong position in the market, However, strategic decision-makers must allow for flexibility in relevant strategies.
The automotive market has various opportunities for the growth, such as opportunities for products that integrate advanced computing technologies. However, the company faces threatsin its business environment. Managers can use the SWOT Analysis to determine appropriate adjustments in the marketing mix or 4Ps to deal with these threats and opportunities.

Product Mix

This aspect of the marketing mix pertains to the outputs of the business. Each product line represents a group of outputs or products. The set of all the product lines is called the product mix. the product mix shows limited business diversification. Nonetheless, the company offers awide variety of products, such as different brands, types, and models of automobiles.

1. Automobiles
2. Automobile parts
3. Commercial vehicles
4. Financial services

Prices and Pricing Strategies

The setting of price points and price ranges for the company's products is the main concern inthis aspect of the marketing mix. Pricing affects the perceived value of brands and products, and influences sales in price-sensitive markets. the pricing strategies for its automotive products are as follows:

1. Market-oriented pricing strategy
2. Premium pricing strategy

Promotional Mix

Promotional activities are considered in this aspect of marketing mix of 4Ps. These activities are also known as marketing communications tactics. The combination of these tactics is called a promotional mix or marketing communications mix the following promotional activitiesare used, arranged according to significance in the automotive business:

1. Advertising
2. Direct marketing
3. Personal selling
4. Sales promotion
5. Public relations

Potential Sales in Early Market

Purchasing a vehicle is one of those life accomplishments that top nearly everyone's bucket list. The majority of the customers have a family. For such folks there are a variety of reasons, including market and schooling. Whether you prefer a modernized urban loft or a sprawling suburban home with a white picket fence, most of us hope to find a vehicle that feels like it was made specifically for our family. Here is where our insights come in to assist such people to find a best vehicle at the best-fixed price according to the area and several other factors.

Some of the key points required to focus for the development of EV in India are:

1. Retrofitting conversion of Public Transport (Bus), Taxi and Three-Wheeler (Auto) to PHEV: This is one of the key requirements to move towards sustainable transportation. It will notonly balance emissions but also reduce the load on infrastructure requirement.
2. Charging Infrastructure: Charging infrastructure development will occur with the development of XEV market. However, motivation can be provided by developing grid-connected charging station withthe moderate tariff, promotion to standalone renewable (solar/wind) charging station, add onfacility at petrol pump and bus stops for charging and state transport charging stations and permitting the development of private renewable charging stations
3. Electrical Propulsion System (EPS): Currently no Indian manufacturer provide electrical propulsion system (EPS) manufactured in India, even REVA has a tie-up with Italy for EPS. Hence support and positive atmospherebuild-up in manufacturers in one of the critical tasks. Development of clear policies for supporting the growth of supply, manufacturing, and recycling of propulsion system. Power electronics converter and motor technology development are feasible as technology base is available in India, however currently used cost-effective Li-ion technology of battery development is challenging task as the majority of lithium stock are available in China and USA. In addition, battery replacement/swapping can be one of the promising and viable options in India.
4. Development of Skilled Manpower: Consideration of safety and advanced technology involved, development of certified skilled technician and professionals is one of the requirements.
5. Government Incentives: Another key factor for XEV market to lift up will be identification of strategic incentives for electric vehicles. This will increase adoption rate and decrease main element barrier of the price of electric vehicles to customers. The incentive can be subsidy scheme for electric vehicles bridging gap price between the conventional and electric vehicle

in similar performance range. e.g., if the cost of internal combustion engine car is INR 5 lakh and that of the electric vehicle is INR 6.5 lakh, the government can intend to offer discount or subsidy of the differential cost. In addition, benefit of Discount on VAT//Discount on Registration/Discount on Toll Plaza to motivate sell of EV can be planned.

Most Optimal Market Segment

There are many EV manufacturing companies in the country like Hero Electric, Tata Motors, Ather Energy, Ashok Leyland, Hyundai Kona Electric, etc. Tesla has also arrived; the demand will get higher & higher since it is automotive so the investments and policies and all that would be bigger but it will take some time to perfectly settle in India. The following are the key insights of the project:

- The electric vehicle industry has not done that much good due to the devastating hit of the Covid outbreak but it will take a huge jump in upcoming years.
- The use of EVs will be game-changing in terms of environment, air, noise pollution-free, post electric, and much more
- The company should plan to establish local operations in India either by partnering with a local company or by setting up its own manufacturing/ development unit, potentially combined with imports of specific components.
- The company should start their business from Metro Cities in India and then after considerable business expand to other cities of the same state of the Metro Cities. This will help the company to expand easily as they will be having a prior knowledge of business from Metro Cities and Network of Supply chain will be easy for the company as the time goes in business.