MARKET SEGMENT ANALYSIS OF ELECTRIC VEHICLE MARKET IN INDIA

A PROJECT REPORT

SUBMITTED TO

FEYNN LABS

BY

SAURABH BHADALE

BHARGAV KANTHETI

KUMAR SAMBHAV

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BACKGROUND

In 1996, The first electric vehicle i.e. Three-Wheeler VIKRAM SAFA was developed by Scooters India Pvt Ltd, Lucknow and approximately 400 vehicles were made and sold. These vehicles ran on 72-volt lead acid battery.

In 1999, Mahindra and Mahindra Ltd. Launched its first electric three-wheeler and also launched a new company, based in Coimbatore, in 2001, to make and sell electric vehicles named Bijlee. In 2004, MEML was closed down due to lack of demand

In 2000, BHEL developed an eighteen-seater electric bus. Its power pack consisted of an AC Induction Motor and 96V Lead acid battery pack. Some 200 electric vans were built and run in Delhi, with monetary support from MNES. The major concern with these vehicles was their poor consistency, low life and high cost.

In 2001, Bajaj Auto ltd, Pune, had also demonstrated their 3-seater electric rickshaw. The vehicle used advance PMSM drive system. However, this product has not been commercially launched.

In 2001, REVA, Bangalore, entered the EV sector in the car industry with a vehicle developed by American company (Amerigon). Some 3200 cars had been sold worldwide including approximately 1500 cars that had been sold in India, mostly in Bangalore city.

In 2007, in two-wheeler segment, Hero cycles collaborated with UK based ULTRA Motor to launch a series of bikes. Other companies such as Electrothermal India, TVS Motor, Hero electric etc. are also manufacturing and selling their products. TATA Motors, Maruti Suzuki, Toyota and many other companies started entering Indian market with battery and hybrid electric vehicle products.

A major development that the Indian EV market will witness in 2022 is the entry of several new vehicle models and manufacturers in the two- and three-wheeler categories. These two make up for the majority of the current as well as near-future EV requirements in India and come with detachable batteries.

MARKET OVERVIEW:

The Indian electric vehicle market was valued at USD 1,434.04 billion in 2022, and it is expected to reach USD 15,397.19 billion by 2027, registering a CAGR of 47.09% during the forecast period (2022-2027).

The COVID-19 pandemic had limited domestically produced electric vehicles due to the shutdown of manufacturing facilities and lockdowns. However, as restrictions eased, EV witnessed optimistic growth as consumers became inclined toward affordable eco-friendly transportation supported by governments incentives.

The automotive sector in India is dominated by two-wheelers (scooters, motorbikes) and three-wheelers (autos and rickshaws) that play a significant role in last-mile mobility in the country. Rising government emphasis and focus on private and government players partnership to enhance EV ecosystem in the country. Increasing investments and product launches by major OEMs into the country and their focus on localizing supply chain facilities are expected to create a positive outlook in the market.

Moreover, in India, the level of market maturity also varies according to the state depending on factors, including demographics, income levels, regulatory landscape, and urbanization. For instance, the state of Uttar Pradesh, with one of the lowest urbanization rates, has seen significant uptake of electric two-wheelers. Maharashtra, on the other hand, with a higher urbanization rate, has the highest penetration of electric three-wheelers and passenger cars. Delhi is home to the largest electric commercial vehicle fleet due to a higher demand for electric buses and trucks.

INDIAN GOVERNMENT INITIATIVE:

Considering all above aspects Indian government has taken an initiative & declare the National Mission for Electric Mobility (NMEM2022). The National Mission for Electric Mobility (NMEM) has its two interrelated key objectives:

1. National energy security

2. Growth of domestic manufacturing capabilities in full range of electric vehicle technologies.

In January 2012, the ministry of heavy industries unveiled its ambitious draft action plan for Electric Mobility 2020, which targets almost six to seven million vehicles on the road by 2022. With vision to encourage reliable, affordable and efficient XEVs (all type of electrical vehicles) that meet consumer performance and price expectations through Government – Industry collaboration for promotion and development of indigenous manufacturing capabilities, required infrastructure, consumer awareness and technology.

Thereby helping India to emerge as a leader in the XEV two-wheeler and four-wheeler market in the world by 2022, with total XEV sales of 6–7 million units thus enabling Indian automotive Industry to achieve global XEV manufacturing leadership and contributing towards National fuel security with target of 400,000 passenger battery electric cars (BEVs) by 2022.avoiding 120 million barrels of oil and 4 million tons of CO_2 which will lower vehicle emissions by 1.3 percent by 2022.

The total investment required is INR 20,000–23,000 Cr. There is a slow progress as such till now, however, after the announcement of FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles), there is little push. Linking FAME India and Make in India there is hope that there will be the faster adoption of EV in India as it is a need of an hour.

CHALLENGES AND OPPORTUNITIES OF ELECTRIC VEHICLES IN THE FOLLOWING FIELD

Economic:

The economic challenge is a major challenge of EV in India. In the developing nation EV adoption and large market growth is difficult. Economic challenges have different aspects.

a) Electric Vehicles:

Although gasoline and diesel are costly than electricity due to their high initial investment of EV, the price are more Since the systems of EV is not matured enough and most of the assembly process are to be done manually, mass production of the expensive parts of EV are still not economically justified, causing the selling price to be expensive in order for the company to maintain a healthy profit margin Indian population consist of middle class people and the people may find difficult in high initial investment.

b) Battery:

The materials used in constructing the batteries in EV have to maintain certain quality and it results high-cost High performance battery is produced but cost also becomes higher. The lithium-ion (Li-ion) batteries used in EVs present a very concerning. It has been reported that the extraction of cobalt, the essential component of the rechargeable Li-ion batteries, is linked to child labor with laws and policies introduced to improve the standards of ethical mining, the supply of the mineral will reduce while the demand stays high, resulting in further increase of the price of cobalt Li and Ouyang show that by reducing the battery costs of EV, it would help to decrease the total expenditure of consumers and allow them to afford higher charging price for the battery.

c) Infrastructure:

Infrastructure for charging is necessary and is categorized as public, semi public and private charging infrastructure which are public, semi-public and private charging infrastructure. Public charging infrastructure is open to the public and can usually be found at public parking area while semi-public charging infrastructure is only accessible by a certain group of people. Private charging infrastructure refers to the one that is installed in a private garage or household.

COMPARISON BETWEEN ELECTRIC VEHICLE VS FUEL VEHICLE

As the growing pollution has become a serious concern, **electric cars** are quite a relief. And, according to the research electric cars are better for the environment. Whereas, the fuel vehicle emits harmful gases like carbon due to petrol or diesel. But electric vehicles produce fewer greenhouse gases and air pollution than petrol. That's why interest in purchasing an electric vehicle is increasing. It is important to know how electric vehicles impact nature. As per the research by the European Energy Agency, the carbon emissions of an **electric car** are around 17-30% lower than driving a petrol or diesel car. When low carbon electricity is used, the emissions from electricity generation improve. Currently, there are 8 electric cars on sale in India. Of these, the Storm Motors R3 is the cheapest EV while the Jaguar I-Pace is the most expensive electric car in India. Upcoming electric cars in India include BMW i3, Mahindra XUV300 Electric and Tesla Model 3 are the upcoming models.

Following are the example of electric vehicles

Cars

- Chevy Bolt.
- Honda Clarity.
- Tesla Model S.
- Tesla Model X.
- BMW i3.
- Volkswagen e-Golf.

Two wheelers

- Mahindra Gusto Electric
- Tunwal Mini Lithino 48V
- Ather 450X
- Bajaj Chetak
- Revolt RV400
- Triumph Street Triple

Factors for purchasing electric cars:

Energy saving is the one reason people consider when shifting to **electric vehicle in India**. Though, there are several factors' people should consider while purchasing is the cost of fuel and maintenance and the overall purchase price of the vehicle as per the **electric vehicle market in India.** However, electric cars tend to be more expensive and these vehicles are becoming more common with a variety of model options to choose from. Also, your location is one of the factors for the cost of purchasing and operating the new vehicle along with brand name and type. One more factor that is considered to get the difference between electric and conventional vehicles is how fast and quick a vehicle takes you between two boardings and destination. Where electric vehicles generate more energy that drives cars faster.

The basic difference between **electric vehicles** that also called EV and fuel which is categorized as Standard Internal Combustion Engine Models or ICE is that gasoline used by fuel vehicles and electricity required for electric vehicles. Mile per Gallon or MPG is the concept used to measure the fuel efficiency of ICE vehicles. However, the price of gas or fuel varies from time to time. And, fuel vehicles need to be filled up about every 250-300 miles of the journey. There are a variety of sources available for Electric vehicles to be powered by electricity. The electricity is produced by the burning gas or coal, or from renewable sources,

Market Trends:

Growing Adoption of Electric Buses

The government of India has undertaken multiple initiatives to promote the manufacturing and adoption of electric vehicles in India to reduce emissions pertaining to international conventions and develop e-mobility in the wake of rapid urbanization.

- The National Electric Mobility Mission Plan (NEMMP) and Faster Adoption and Manufacturing of Hybrid & Electric Vehicles in India (FAME I and II) helped create the initial interest and exposure for electric mobility. For instance, in phase two of FAME, the government announced an outlay of USD 1.4 billion through 2022. This phase focuses on the electrification of public and shared transportation through subsidizing 7,090 e-buses, 500,000 electric three-wheelers, 550,000 electric passenger vehicles, and 1,000,000 electric two-wheelers.

To promote the domestic electric vehicle industry, the Indian government has provided tax exemptions and subsidies to EV manufacturers and consumers. As per the phased manufacturing proposal, the government has imposed a 15% customs duty on parts that are used to manufacture electric vehicles and 10% on imported lithium-ion cells. The revised duty under PMP has been proposed from April 2021.

States have also launched policies that support powertrain electrification by stimulating the demand, local manufacturing, research and development (R&D), and infrastructure development. Several states, like Delhi, Kerala, Karnataka, Telangana, and Andhra Pradesh, have formulated their electric vehicle policies, while others are in the process of doing so. For instance,

- According to the Delhi Electric Vehicle Policy 2020, the government plans to have at least 50% e-buses for all new stage carriage buses and aims for 25% of the new vehicles to be electric by 2024. In March 2021, the Delhi government announced its plans to introduce an interest subvention of up to 5% for electric vehicle (EV)

purchases in the state. This initiative has been taken to promote the Delhi government's EV policy offering financial incentives on all categories of e-vehicles, i.e., two-wheelers, three-wheelers, four-wheelers, goods carriers, and electric rickshaws.

- In February 2021, the Delhi government announced a subsidy of INR 30,000 for promoting e-rickshaws as last-mile connectivity in Delhi. This, in turn, has led to the proliferation in their demand in the city, further benefiting the market.

Owing to the above-mentioned instances and developments, rising government initiatives are expected to enhance demand in the market over the forecast period.

India Electric Vehicle (EV) Market, Revenue Share (%), By Vehicle Type, 2021

- Passenger Cars
- Commercial Vehicles
- Two Wheelers
- Three Wheelers
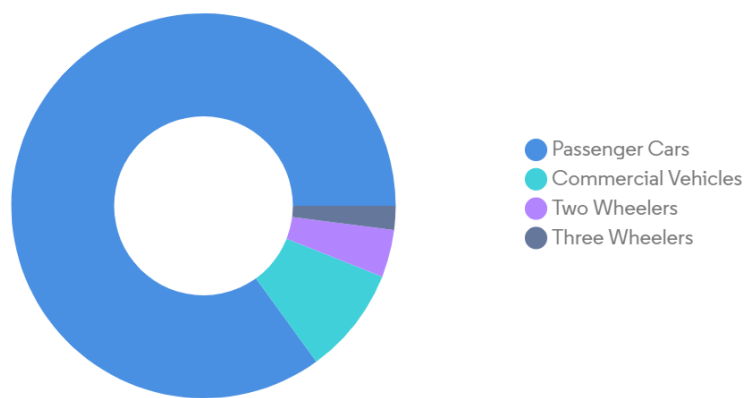
Electric Two-wheeler Vehicles Expected to have Optimistic Growth

Though the COVID-19 pandemic resulted in lockdowns and supply chain disruptions, increasing petrol and diesel prices, government incentives, and an increase in spending for setting up charging infrastructure in the country are expected to drive demand. For instance, In FY 2020, around 152,000 units of electric two-wheelers were sold in the country compared to 126,000 units sold in FY 2019.

In the electric two-wheeler segment, electric motorcycles and scooters are popular modes. Like conventional two-wheelers, they are easier to navigate through congested roads. From a speed point of view, low-speed (up to 25 km/hr.) and medium-speed electric two-wheelers (up to 40 kmph) with conventional lead-acid batteries are projected to dominate the market over the forecast period.

This is mainly because, in terms of upfront cost, they are already on par with ICE vehicles. However, with more companies becoming eligible for FAME-II incentives, several new models are expected to be operated in the market in the coming years. Some of the key two-

wheeler rental companies have already started investing heavily in expanding their fleet of vehicles to cater to the rising demand in the country. For instance,

· In February 2021, Bounce, a bike rental startup in the country, made an announcement that it was planning to launch its electric scooter in the country. However, the expected launch date has not been declared. Price is expected to be around INR 55,000 and an additional INR 1,450 per month for maintenance, including battery maintenance.

Several local major players in the country are investing heavily to enhance their production capacity of electric two-wheelers in the country to cater to enhancing the demand in the country. For instance,

· In February 2021, Ampere Electric made an announcement that it would be investing INR 700 crore in setting up a new electric two-wheeler plant in Tamil Nadu. It is expected to have the potential to start manufacturing 100,000 units in its first year of operation.

Thus, with such growing advancements and developments passenger cars segment is expected to witness steady and consistent growth during the forecast period.

India Two Wheeler Market - Volume Share (%), By Manufacturer, 2021

- Hero Electric
- Okinawa
- Ampere Vehicles
- Ather Energy
- Revolt Intellicorp Pvt Ltd.
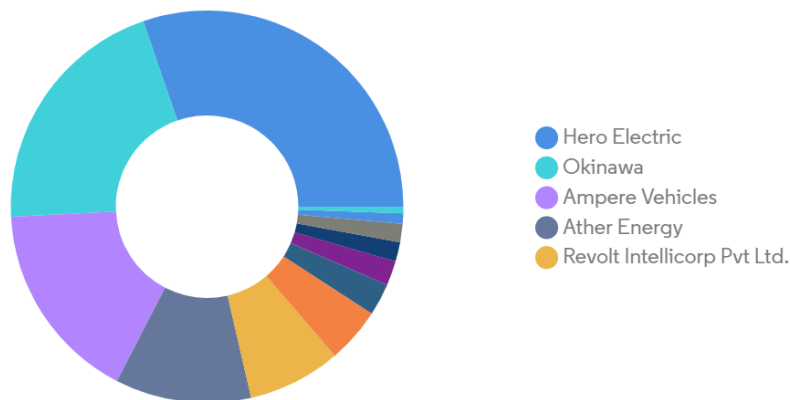
PROBLEM STATEMENT:

We are a team working under an Electric Vehicle Start-up. The Start-up is still deciding in which vehicle/customer space it will be develop its EVs.

We have to analyse 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.

By Using Fermin estimation, we have created some problem Statements:

> ➢ To understand the Indian Automobile Production and Sales. Comparison of EV vehicle gas vehicles and their sells.
> ➢ To identify the opportunities and challenges of using electric vehicles in India.
> ➢ Efficiency vs cost favoured towards EV or Fuel Vehicles.
> ➢ Investment to put forward to build Charging Station
> ➢ Propaganda required to move car users toward EV
> ➢ Unique types of EV need to be built for sustenance of company.
> ➢ EV battery cost required to produce in India.
> ➢ Feasibility of free Solar stations in India and Projection of sales of EV up to 10 years
> ➢ EV Cars price prediction and state wise distribution
> ➢ To Predict the electric Vehicles sales analysis in India

DATA COLLECTION:

Data was scraped from the website following websites.

in data collection, just put we collected data from

data.world

finance.yahoo

kaggle.com

Some screenshots of the Data.

	Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle
0	Tesla	Model 3 Long Range Dual Motor	4.6	233	450	161	940	Yes	AWD	Type 2 CCS	Sedan
1	Volkswagen	ID.3 Pure	10.0	160	270	167	250	Yes	RWD	Type 2 CCS	Hatchback
2	Polestar	2	4.7	210	400	181	620	Yes	AWD	Type 2 CCS	Liftback
3	BMW	iX3	6.8	180	360	206	560	Yes	RWD	Type 2 CCS	SUV
4	Honda	e	9.5	145	170	168	190	Yes	RWD	Type 2 CCS	Hatchback

State/UT-wise	Number of Electric Vehicle Charging Sanctioned
Maharashtra	317
Andhra Pradesh	266
Tamil Nadu	256
Gujarat	228
Uttar Pradesh	207
Rajasthan	205
Karnataka	172
Madhya Pradesh	159
West Bengal	141
Telangana	138
Kerala	131
Delhi	72
Chandigarh	70
Haryana	50
Meghalaya	40
Bihar	37
Sikkim	29

symboling	normalized	make	fuel-type	aspiration	num-of-do	body-style	drive-whe	engine-loc	wheel-bas	length	width	height	curb-weigh	engine-typ	num-of-cy	engine-siz	fuel-syster	bore	stroke	compressi	horsepow	peak-rpm
3	?	alfa-rome	gas	std	two	convertibl	rwd	front	88.6	168.8	64.1	48.8	2548	dohc	four	130	mpfi	3.47	2.68	9	111	5000
3	?	alfa-rome	gas	std	two	convertibl	rwd	front	88.6	168.8	64.1	48.8	2548	dohc	four	130	mpfi	3.47	2.68	9	111	5000
1	?	alfa-rome	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	52.4	2823	ohcv	six	152	mpfi	2.68	3.47	9	154	5000
2	164	audi	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	54.3	2337	ohc	four	109	mpfi	3.19	3.4	10	102	5500
2	164	audi	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	54.3	2824	ohc	five	136	mpfi	3.19	3.4	8	115	5500
2	?	audi	gas	std	two	sedan	fwd	front	99.8	177.3	66.3	53.1	2507	ohc	five	136	mpfi	3.19	3.4	8.5	110	5500
1	158	audi	gas	std	four	sedan	fwd	front	105.8	192.7	71.4	55.7	2844	ohc	five	136	mpfi	3.19	3.4	8.5	110	5500
1	?	audi	gas	std	four	wagon	fwd	front	105.8	192.7	71.4	55.7	2954	ohc	five	136	mpfi	3.19	3.4	8.5	110	5500
1	158	audi	gas	turbo	four	sedan	fwd	front	105.8	192.7	71.4	55.9	3086	ohc	five	131	mpfi	3.13	3.4	8.3	140	5500
0	?	audi	gas	turbo	two	hatchback	4wd	front	99.5	178.2	67.9	52	3053	ohc	five	131	mpfi	3.13	3.4	7	160	5500
2	192	bmw	gas	std	two	sedan	rwd	front	101.2	176.8	64.8	54.3	2395	ohc	four	108	mpfi	3.5	2.8	8.8	101	5800
0	192	bmw	gas	std	four	sedan	rwd	front	101.2	176.8	64.8	54.3	2395	ohc	four	108	mpfi	3.5	2.8	8.8	101	5800
0	188	bmw	gas	std	two	sedan	rwd	front	101.2	176.8	64.8	54.3	2710	ohc	six	164	mpfi	3.31	3.19	9	121	4250
0	188	bmw	gas	std	four	sedan	rwd	front	101.2	176.8	64.8	54.3	2765	ohc	six	164	mpfi	3.31	3.19	9	121	4250
1	?	bmw	gas	std	four	sedan	rwd	front	103.5	189	66.9	55.7	3055	ohc	six	164	mpfi	3.31	3.19	9	121	4250
0	?	bmw	gas	std	four	sedan	rwd	front	103.5	189	66.9	55.7	3230	ohc	six	209	mpfi	3.62	3.39	8	182	5400
0	?	bmw	gas	std	two	sedan	rwd	front	103.5	193.8	67.9	53.7	3380	ohc	six	209	mpfi	3.62	3.39	8	182	5400
0	?	bmw	gas	std	four	sedan	rwd	front	110	197	70.9	56.3	3505	ohc	six	209	mpfi	3.62	3.39	8	182	5400
2	121	chevrolet	gas	std	two	hatchback	fwd	front	88.4	141.1	60.3	53.2	1488	l	three	61	2bbl	2.91	3.03	9.5	48	5100
1	98	chevrolet	gas	std	two	hatchback	fwd	front	94.5	155.9	63.6	52	1874	ohc	four	90	2bbl	3.03	3.11	9.6	70	5400
0	81	chevrolet	gas	std	four	sedan	fwd	front	94.5	158.8	63.6	52	1909	ohc	four	90	2bbl	3.03	3.11	9.6	70	5400
1	118	dodge	gas	std	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	1876	ohc	four	90	2bbl	2.97	3.23	9.41	68	5500
1	118	dodge	gas	std	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	1876	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500
1	118	dodge	gas	turbo	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	2128	ohc	four	98	mpfi	3.03	3.39	7.6	102	5500

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	Brand	Model	Accel	TopSpeed	Range	Efficiency	FastCharge	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats	PriceEuro	
	Tesla	Model 3 Long	4.6 sec	233 km/h	450 km	161 Wh/km	940 km/h	Rapid charging	All Wheel Driv	Type 2 CCS	Sedan	D	5	55480	
	Volkswagen	ID.3 Pure	10.0 sec	160 km/h	270 km	167 Wh/km	250 km/h	Rapid charging	Rear Wheel Dr	Type 2 CCS	Hatchback	C	5	30000	
	Polestar	2	4.7 sec	210 km/h	400 km	181 Wh/km	620 km/h	Rapid charging	All Wheel Driv	Type 2 CCS	Liftback	D	5	56440	
	BMW	iX3	6.8 sec	180 km/h	360 km	206 Wh/km	560 km/h	Rapid charging	Rear Wheel Dr	Type 2 CCS	SUV	D	5	68040	
	Honda	e	9.5 sec	145 km/h	170 km	168 Wh/km	190 km/h	Rapid charging	Rear Wheel Dr	Type 2 CCS	Hatchback	B	4	32997	
	Lucid	Air	2.8 sec	250 km/h	610 km	180 Wh/km	620 km/h	Rapid charging	All Wheel Driv	Type 2 CCS	Sedan	F	5	105000	
	Volkswagen	e-Golf	9.6 sec	150 km/h	190 km	168 Wh/km	220 km/h	Rapid charging	Front Wheel D	Type 2 CCS	Hatchback	C	5	31900	
	Peugeot	e-208	8.1 sec	150 km/h	275 km	164 Wh/km	420 km/h	Rapid charging	Front Wheel D	Type 2 CCS	Hatchback	B	5	29682	
	Tesla	Model 3 Stand	5.6 sec	225 km/h	310 km	153 Wh/km	650 km/h	Rapid charging	Rear Wheel Dr	Type 2 CCS	Sedan	D	5	46380	
	Audi	Q4 e-tron	6.3 sec	180 km/h	400 km	193 Wh/km	540 km/h	Rapid charging	All Wheel Driv	Type 2 CCS	SUV	D	5	55000	
	Mercedes	EQC 400 4MAT	5.1 sec	180 km/h	370 km	216 Wh/km	440 km/h	Rapid charging	All Wheel Driv	Type 2 CCS	SUV	D	5	69484	
	Nissan	Leaf	7.9 sec	144 km/h	220 km	164 Wh/km	230 km/h	Rapid charging	Front Wheel D	Type 2 CHAd	Hatchback	C	5	29234	
	Hyundai	Kona Electric 6	7.9 sec	167 km/h	400 km	160 Wh/km	380 km/h	Rapid charging	Front Wheel D	Type 2 CCS	SUV	B	5	40795	
	BMW	i4	4.0 sec	200 km/h	450 km	178 Wh/km	650 km/h	Rapid charging	Rear Wheel Dr	Type 2 CCS	Sedan	D	5	65000	
	Hyundai	IONIQ Electric	9.7 sec	165 km/h	250 km	153 Wh/km	210 km/h	Rapid charging	Front Wheel D	Type 2 CCS	Liftback	C	5	34459	
	Volkswagen	ID.3 Pro S	7.9 sec	160 km/h	440 km	175 Wh/km	590 km/h	Rapid charging	Rear Wheel Dr	Type 2 CCS	Hatchback	C	4	40936	
	Porsche	Taycan Turbo S	2.8 sec	260 km/h	375 km	223 Wh/km	780 km/h	Rapid charging	All Wheel Driv	Type 2 CCS	Sedan	F	4	180781	
	Volkswagen	e-Up!	11.9 sec	130 km/h	195 km	166 Wh/km	170 km/h	Rapid charging	Front Wheel D	Type 2 CCS	Hatchback	A	4	21421	
	MG	ZS EV	8.2 sec	140 km/h	220 km	193 Wh/km	260 km/h	Rapid charging	Front Wheel D	Type 2 CCS	SUV	B	5	30000	
	Mini	Cooper SE	7.3 sec	150 km/h	185 km	156 Wh/km	260 km/h	Rapid charging	Front Wheel D	Type 2 CCS	Hatchback	B	4	31681	
	Opel	Corsa-e	8.1 sec	150 km/h	275 km	164 Wh/km	420 km/h	Rapid charging	Front Wheel D	Type 2 CCS	Hatchback	B	5	29146	
	Tesla	Model Y Long	5.1 sec	217 km/h	425 km	171 Wh/km	930 km/h	Rapid charging	All Wheel Driv	Type 2 CCS	SUV	D	7	58620	
	Skoda	Enyaq iV 50	10.0 sec	160 km/h	290 km	179 Wh/km	230 km/h	Rapid charging	Rear Wheel Dr	Type 2 CCS	SUV	C	5	35000	
	Audi	e-tron GT	3.5 sec	240 km/h	425 km	197 Wh/km	850 km/h	Rapid charging	All Wheel Driv	Type 2 CCS	Sedan	F	4	125000	
	Tesla	Model 3 Long	3.4 sec	261 km/h	435 km	167 Wh/km	910 km/h	Rapid charging	All Wheel Driv	Type 2 CCS	Sedan	D	5	61480	
	Volkswagen	ID.4	7.5 sec	160 km/h	420 km	183 Wh/km	560 km/h	Rapid charging	Rear Wheel Dr	Type 2 CCS	SUV	C	5	45000	

The above dataset we are used for this EV market segmentation analysis.

DATA PRE-PROCESSING:

(Steps and libraries used)

Importing Libraries: firstly, we will import the libraries for our model, which is part of data pre-processing.

import numpy as np

import pandas as pd

import seaborn as sns

import matplotlib. pyplot as plt

%Matplotlib inline

- ➢ from sklearn.cluster import KMeans
- ➢ Numpy we have imported for the performing mathematics calculation
- ➢ Matplotlib is for plotting the graph, and pandas are for managing the dataset.
- ➢ Seaborn is for data visualization library, it is based on matplotlib.
- ➢ Scikit-learn have sklearn.cluster.KMeans module to perform K-Means clustering. While computing cluster centers and value of inertia, the ;lp

TARGET MARKET:

The target market of Electric Vehicle Market Segmentation can be categorized into Geographic, SocioDemographic, Behavioral, and Psychographic Segmentation.

Behavioral Segmentation: searches directly for similarities in behavior or reported behavior.

Example: prior experience with the product, amount spent on the purchase, etc.
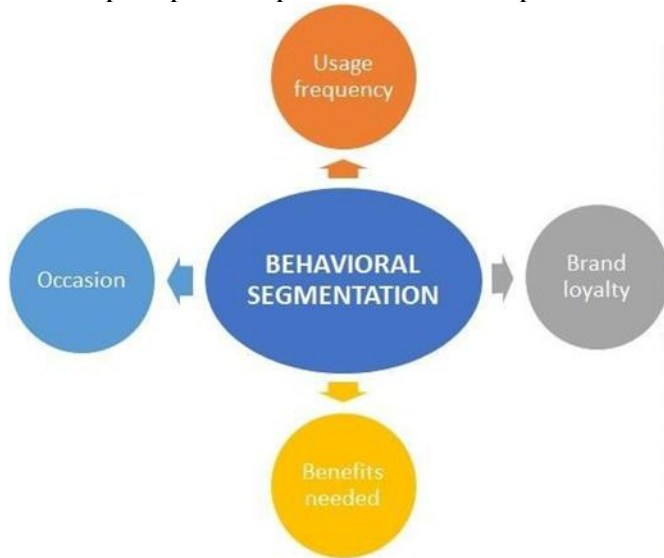
Advantage: uses the very behavior of interest is used as the basis of segment extraction.

Disadvantage: not always readily available.

Psychographic Segmentation: grouped based on beliefs, interests, preferences, aspirations, or benefits sought when purchasing a product. Suitable for lifestyle segmentation. Involves many segmentation variables.

Advantage: generally more reflective of the underlying reasons for differences in consumer behavior.

Disadvantage: increased complexity of determining segment memberships for consumers.
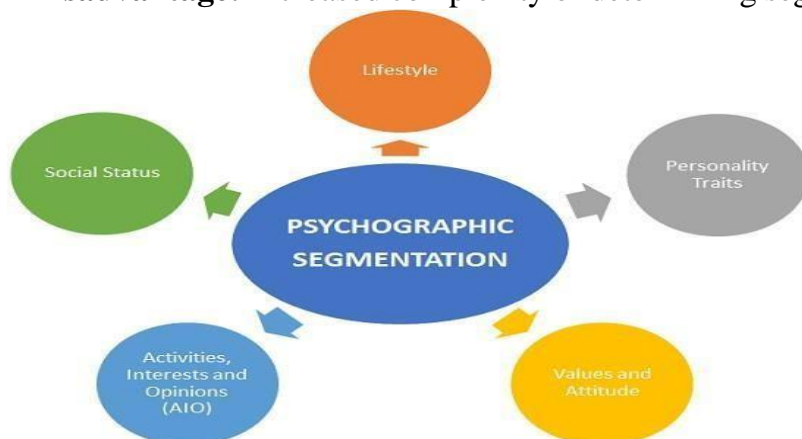
Socio-Demographic Segmentation: includes age, gender, income and education. Useful industries.
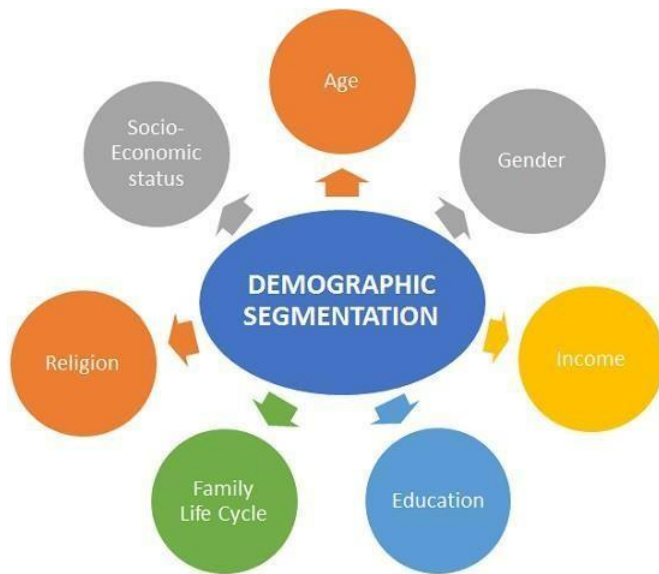
Advantage: segment membership can easily be determined for every customer.

Disadvantage: if this criteria is not the cause for customers product preferences then it does not provide sufficient market insight for optimal segmentation decisions.

Segmenting for Electric Vehicle Market

The market segmentation approach aims at defining actionable, manageable, homogenous subgroups of individual customers to whom the marketers can target with a similar set of marketing strategies. In practice, there are two ways of segmenting the market-a-priori and post-hoc. An a-priori approach utilizes predefined characteristics such as age, gender, income, education, etc. to predefine the segments followed by profiling based on a host of measured variables *(behavioral, psychographic or benefit)*. In the post-hoc approach to segmentation on other hand, the segments are identified based on the relationship among the multiple measured variables. The commonality between both approaches lies in the fact that the measured variables determine the *'segmentation theme'*. The present study utilizes an a-priori approach to segmentation so as to divide the potential EV customers into sub-groups.

Segmentation Bases

Psychographic and Behavioral Characterization

- Perceived usefulness
- Perceived ease of use
- Attitude towards EVs adoption
- Subjective norms
- Knowledge about EVs
- Financial incentives policy
- Adoption intention for EVs

(Test attributes)

Socio-Economic Characterization

- Gender
- Age
- Education
- Income
- Types of vehicles owned
- Numbers of vehicles owned

(Control variables)

Segmentation Process
(Consumer classification for EVs)

Segmentation Labelling
(Consumer Profiling)

It is argued that the blended approach of *psychographic* and *socioeconomic attributes* for market segmentation enables the formulation of sub-market strategies which in turn satisfy the specific tastes and preferences of the consumer groups. Straughan and Roberts presented a comparison between the usefulness of *psychographic, demographic, and economic* characteristics based on consumer evaluation for eco-friendly production

They pinpointed the perceived superiority of the psychographic characteristics over the socio-demographic and economic ones in explaining the environmentally-conscious consumer behavior and thus, the study recommended the use of psychographic characteristics in profiling the consumer segments in the market for eco-friendly products. The present study adds perceived-benefit characteristics guided by blended psychographic and socio-economic aspects for segmenting the consumer market.

EXPLORATORY DATA ANALYSIS:

We start the Exploratory Data Analysis with some data Analysis drawn from the data without Principal Component Analysis and with some Principal Component Analysis in the dataset obtained from the combination of all the data we have. PCA is a statistical process that converts the observations of correlated features into a set of linearly uncorrelated features with the help of orthogonal transformation. These new transformed features are called the Principal Components. The process helps in reducing dimensions of the data to make the process of classification/regression or any form of machine learning, cost-effective

Importing data set in python

df= pd.read_csv(data.csv')

see first five Rows in the dataset

Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats	PriceEuro
Model 3 Long Range Dual Motor	4.6	233	450	161	940	Yes	AWD	Type 2 CCS	Sedan	D	5	55480
ID.3 Pure	10.0	160	270	167	250	Yes	RWD	Type 2 CCS	Hatchback	C	5	30000
2	4.7	210	400	181	620	Yes	AWD	Type 2 CCS	Liftback	D	5	56440
iX3	6.8	180	360	206	560	Yes	RWD	Type 2 CCS	SUV	D	5	68040
e	9.5	145	170	168	190	Yes	RWD	Type 2 CCS	Hatchback	B	4	32997

Finding out the number of null values

```
df.isnull().sum()
```

```
Brand             0
Model             0
AccelSec          0
TopSpeed_KmH      0
Range_Km          0
Efficiency_WhKm   0
FastCharge_KmH    0
RapidCharge       0
PowerTrain        0
PlugType          0
BodyStyle         0
Segment           0
Seats             0
PriceEuro         0
dtype: int64
```

There are no missing values in the dataset hence there is no requirement of any imputation technique.

Descriptive statistics:

	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	Seats	PriceEuro
count	103.000000	103.000000	103.000000	103.000000	103.000000	103.000000
mean	7.396117	179.194175	338.786408	189.165049	4.883495	55811.563107
std	3.017430	43.573030	126.014444	29.566839	0.795834	34134.665280
min	2.100000	123.000000	95.000000	104.000000	2.000000	20129.000000
25%	5.100000	150.000000	250.000000	168.000000	5.000000	34429.500000
50%	7.300000	160.000000	340.000000	180.000000	5.000000	45000.000000
75%	9.000000	200.000000	400.000000	203.000000	5.000000	65000.000000
max	22.400000	410.000000	970.000000	273.000000	7.000000	215000.000000

Above table consists of five number summary the dataset which is, median, 25%, median, 75%, minimum, maximum.

Pair plot of all the columns based on Rapid Charger presence:
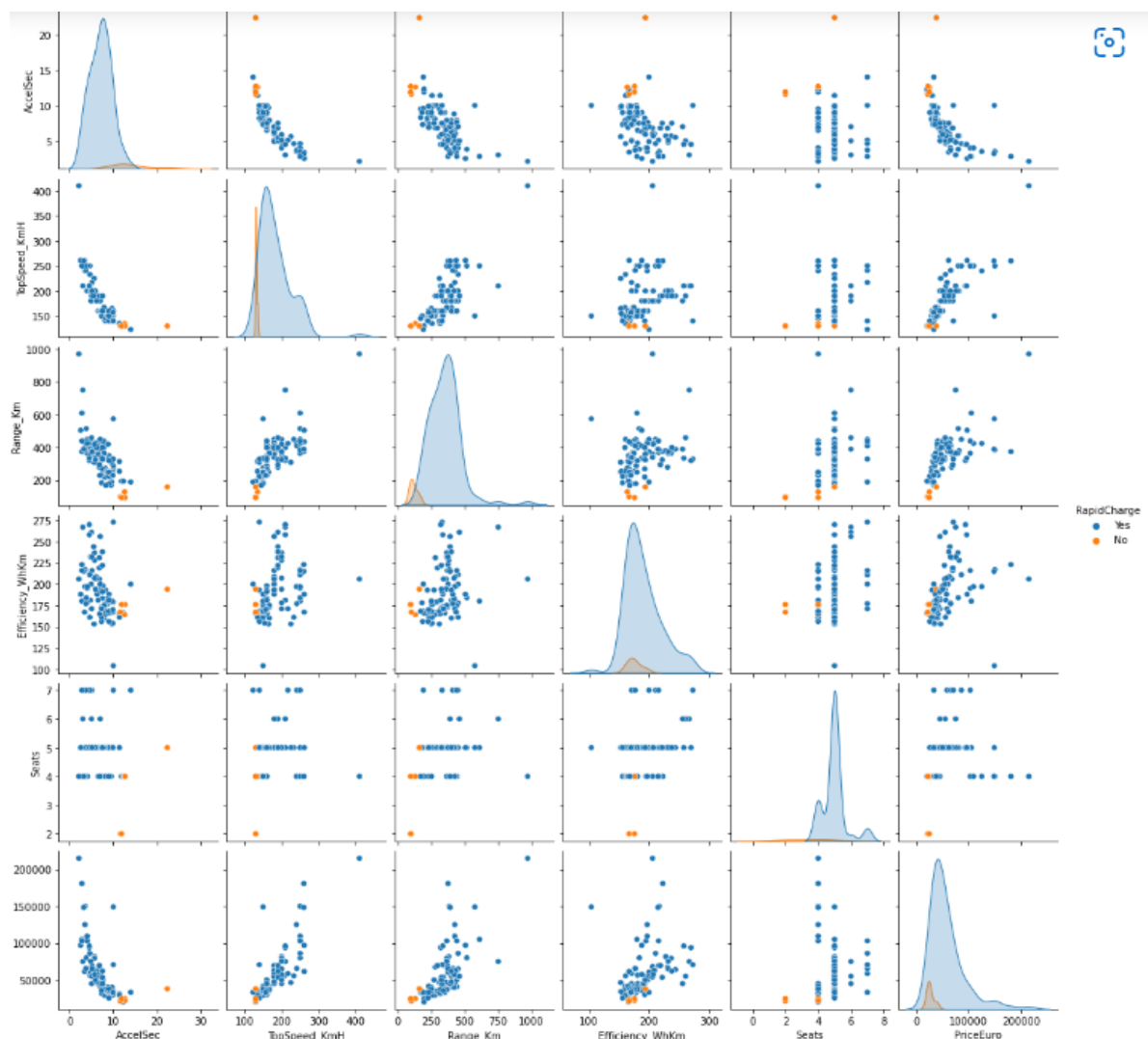
Pair plot is used to plot multiple pairwise bivariate distributions in a dataset.

Heatmap to show the correlation of the data
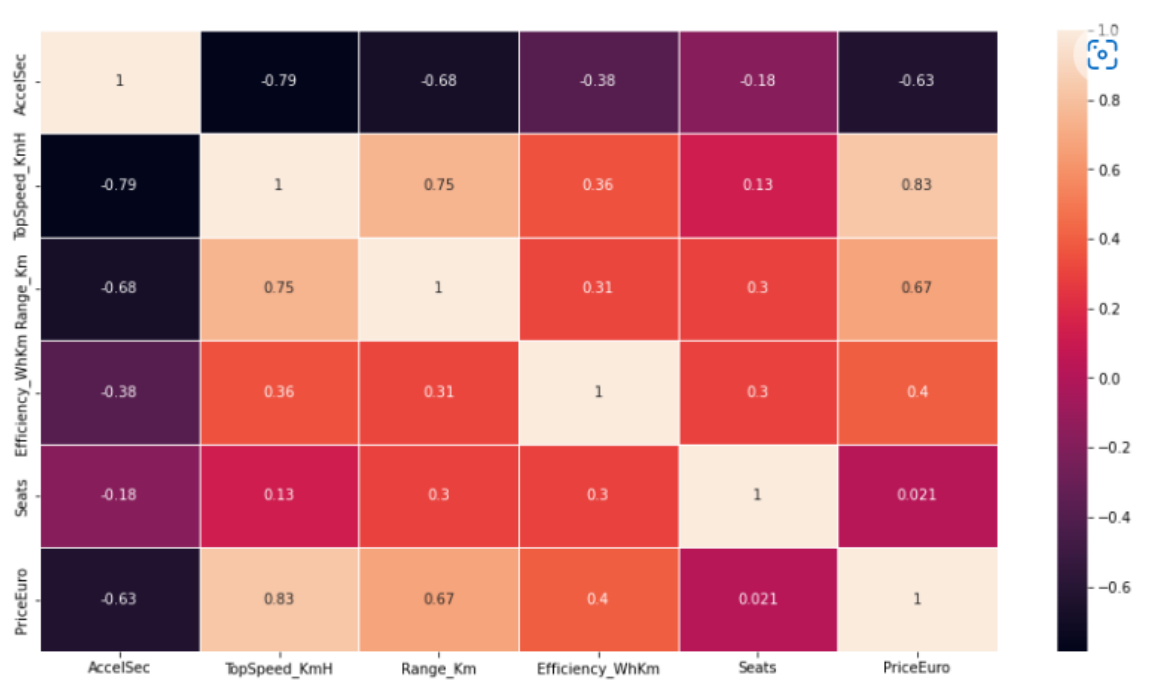
Correlation Matrix: A correlation matrix is simply a table that displays the correlation. It is best used in variables that demonstrate a linear relationship between each other. Coefficients for different variables. The matrix depicts the correlation between all the possible pairs of values through the heatmap in the below figure. The relationship between two variables is usually considered strong when their correlation coefficient value is larger than 0.7

Frequency of the Brands in the dataset:
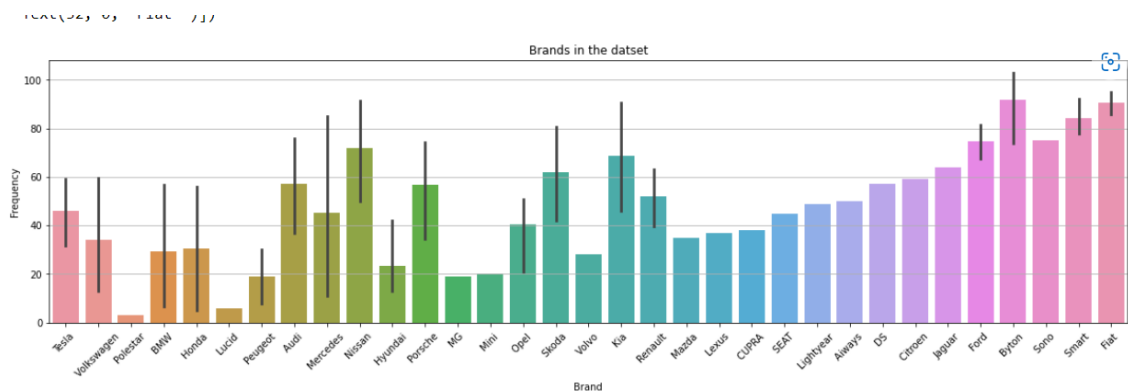
Byton, Fiat and smart are the prominent brands and Polestar being the least

Top speeds achieved by the cars of a brand:
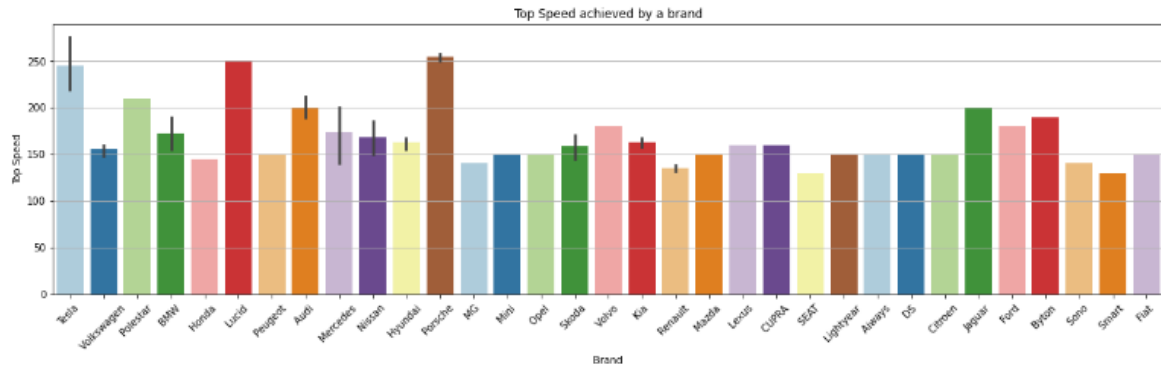
Porsche, Lucid and Tesla produce the fastest cars and smart the lowest.

Range a car can achieve:
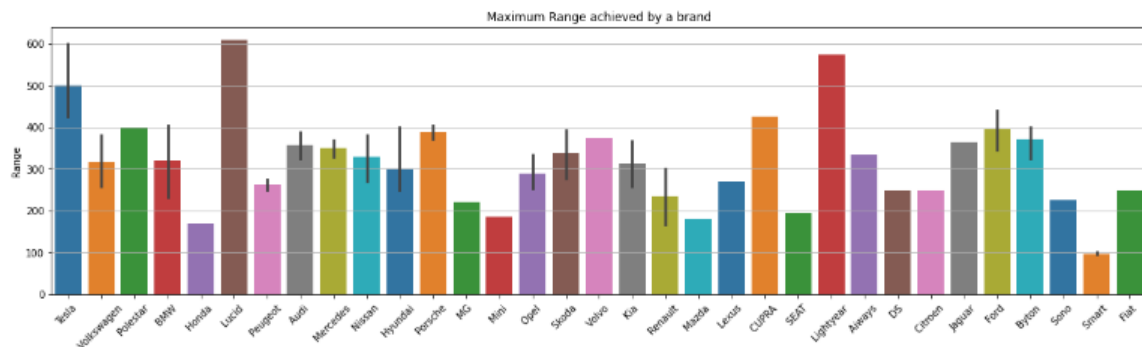
Car efficiency
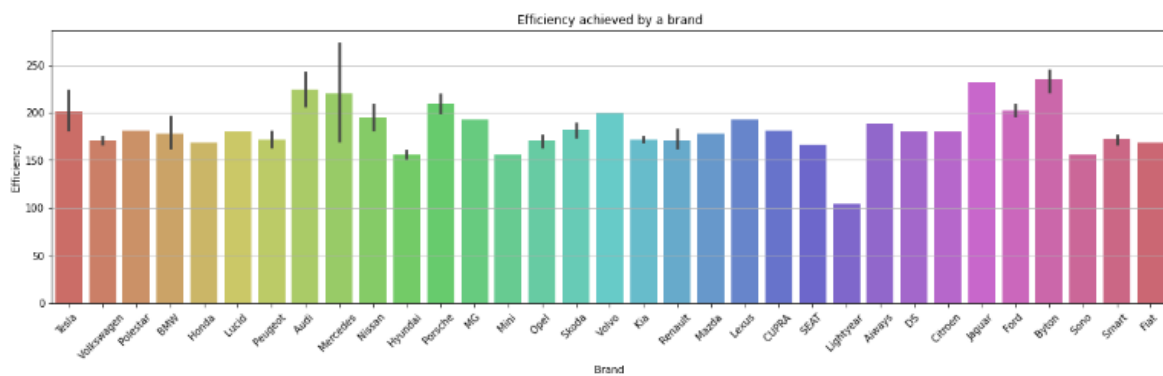
Byton, Jaguar and Audi are the most efficient and Lightyear the least

Number of seats in each car:

Seats in a car
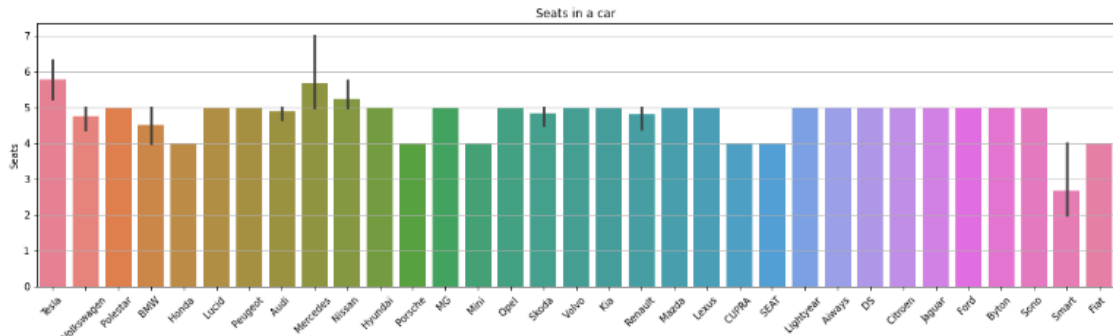
Mercedes, Tesla and Nissan have the highest number of seats and Smart the lowest

Price of cars (in Euro)

Price of a Car
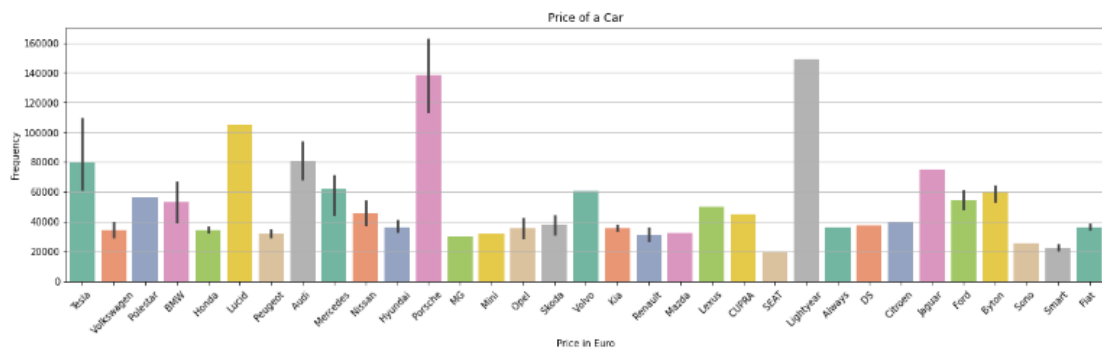
Lightyear, Porsche and Lucid are the most expensive and SEAT and Smart the least

Type of Plug used for charging:

Plug Type
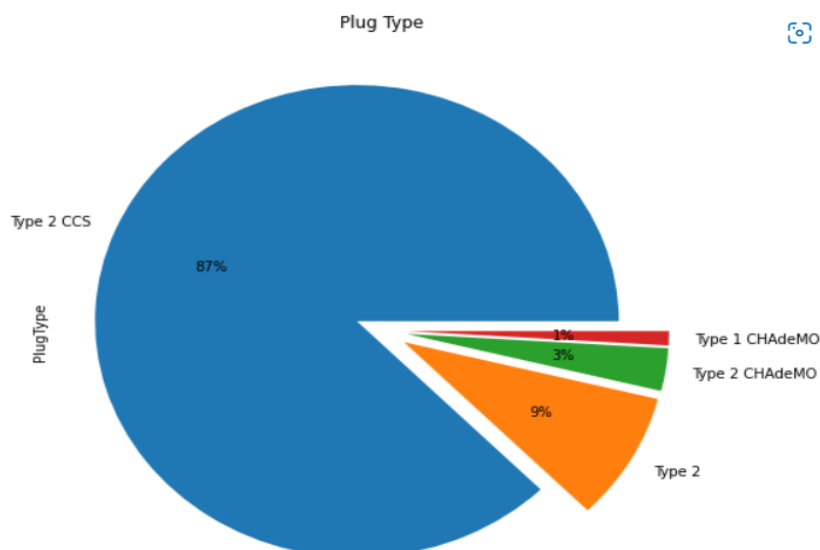
Most companies use Type 2 CCS and Type 1 CHAdeMO the least.

Cars and their body style:
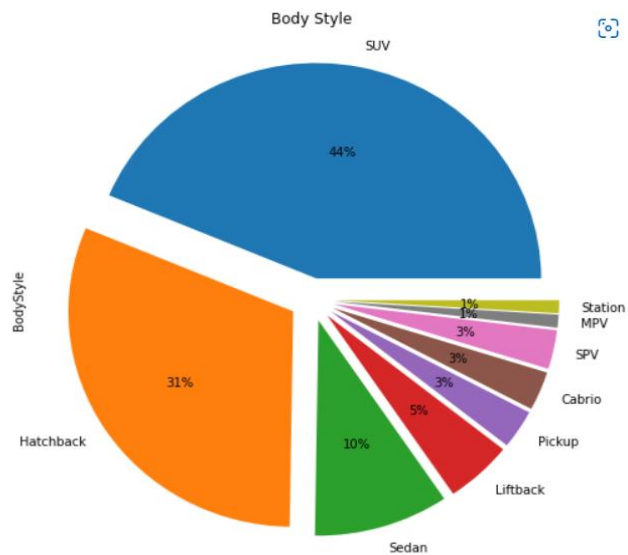
Most cars are eiher SUV or Hatchback

Number of Seats:
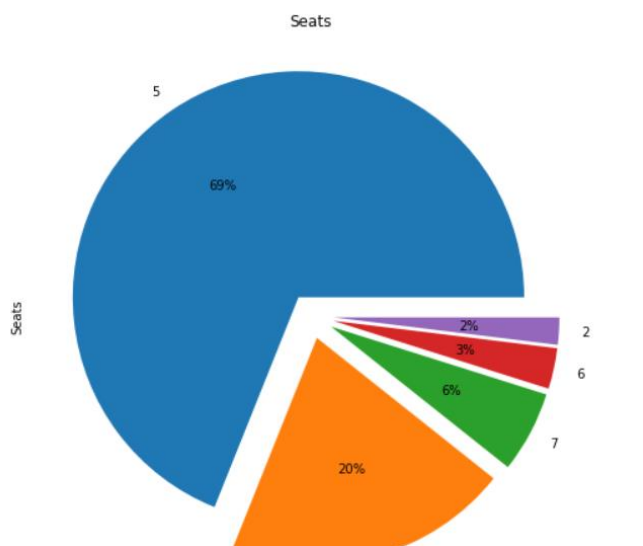
Majority of cars have 5 seats.
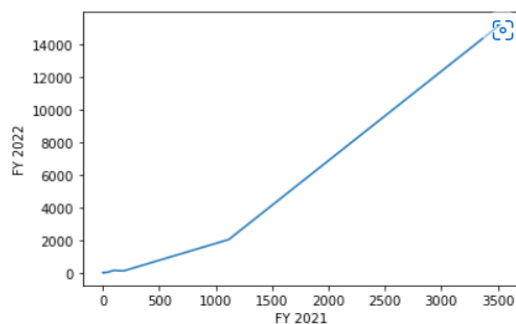
There is a positive change in sales of EV Cars in India

Which Car Has a Top speed?
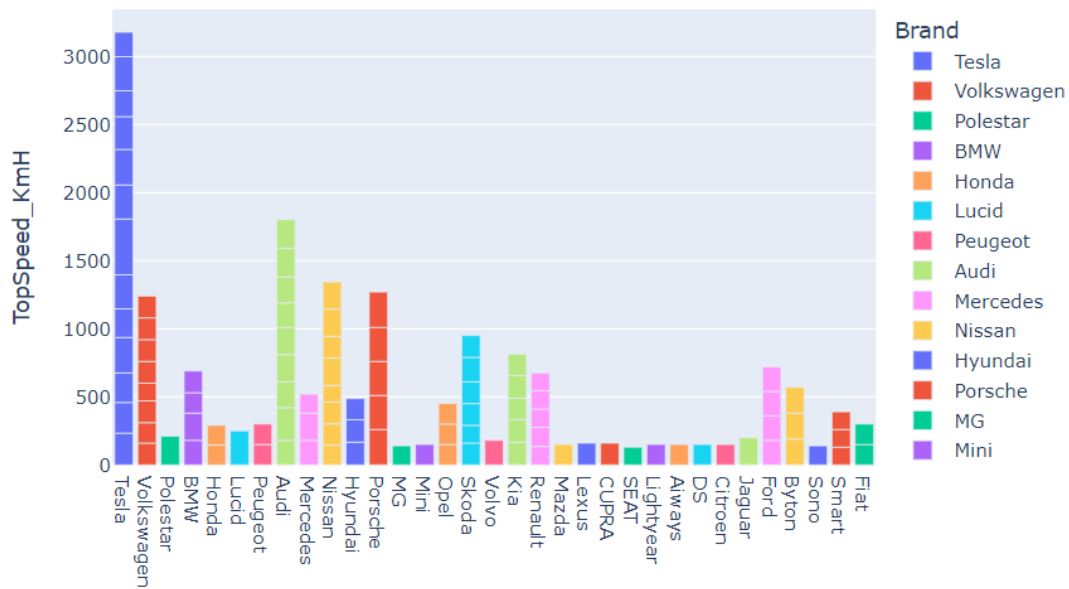
Volkswagen cars have highest speed among available cars followed by Mercedes and Nissan.

Which car has fastest accelaration?
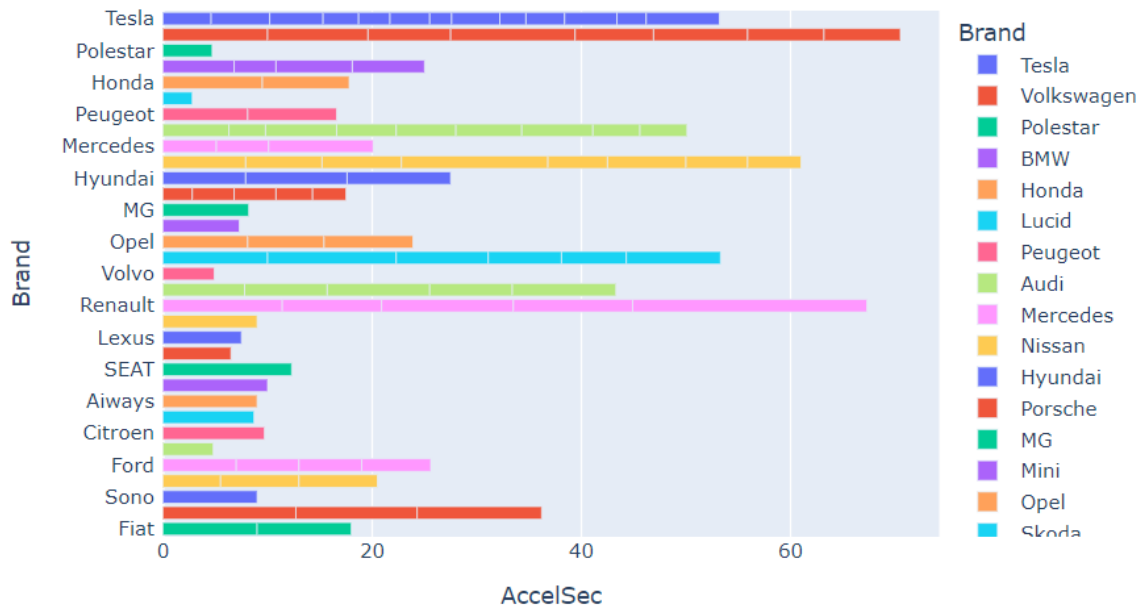
Polestar, Renault, Mercedes cars have highest Acceleration.

Car Price
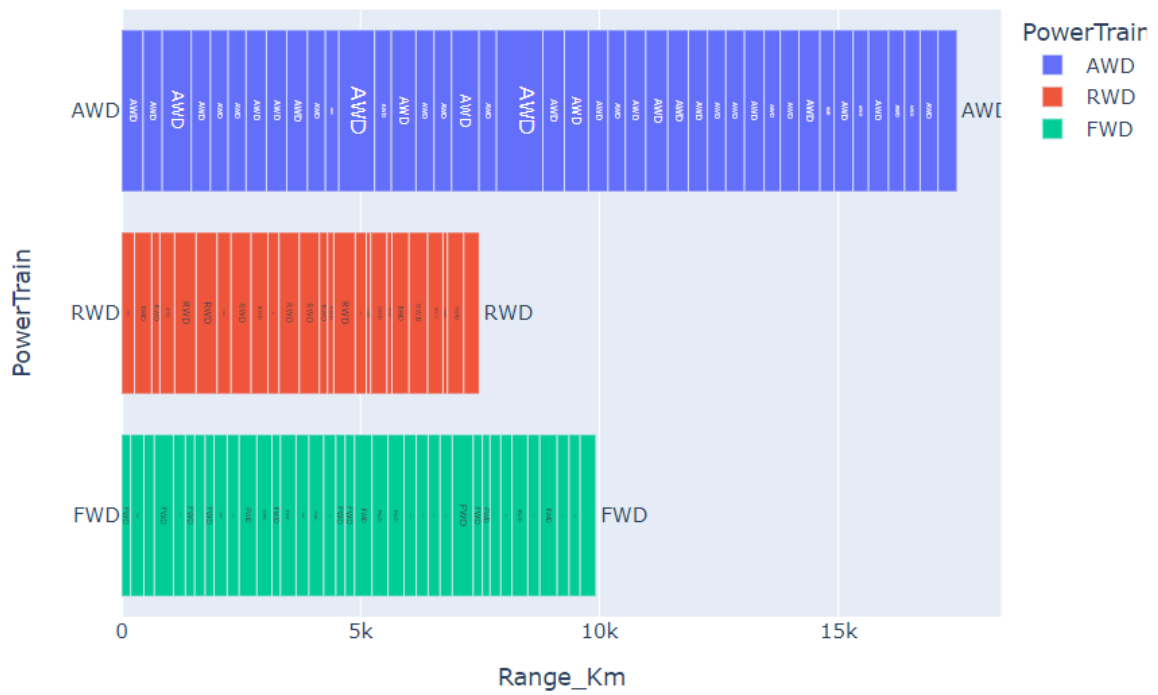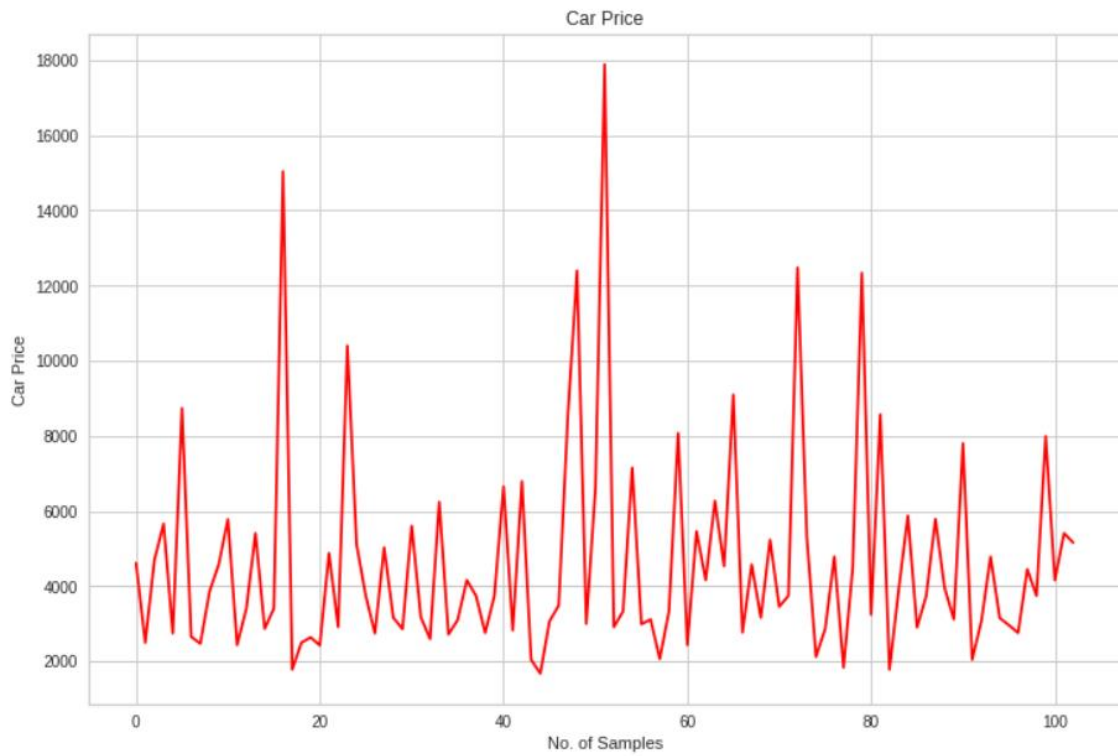
Distribution of cars:
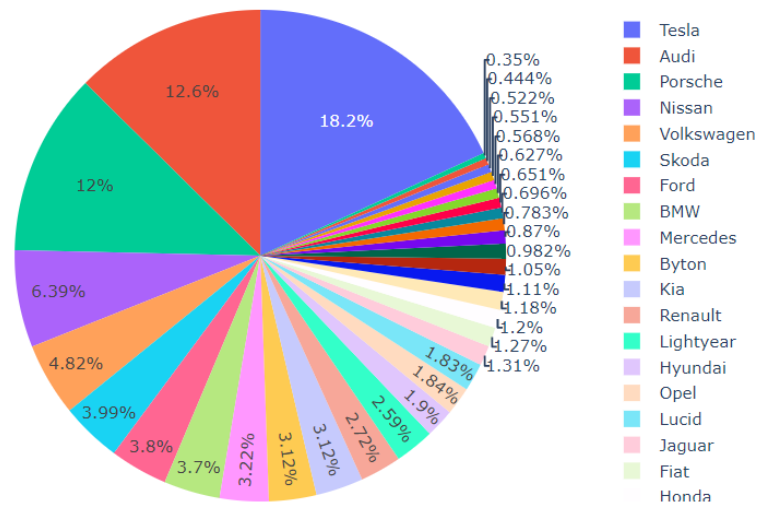
Brand and their range:
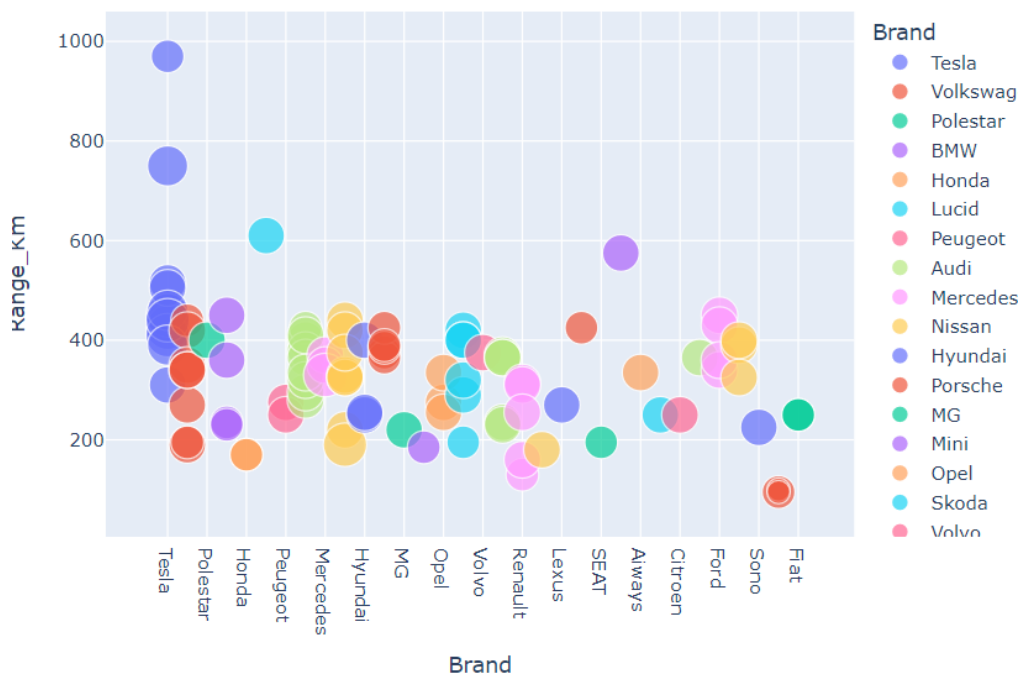
To see the Distribution:
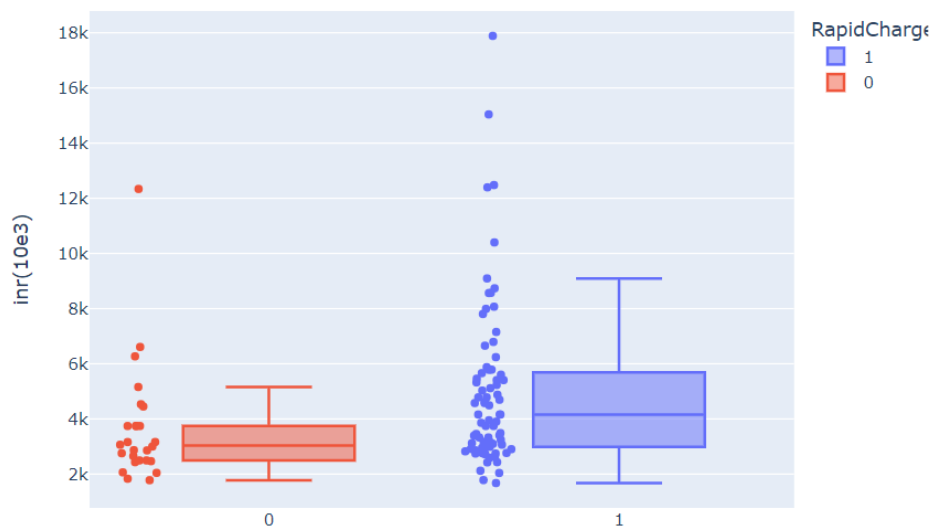
state wise distribution of electrical Vehicles:
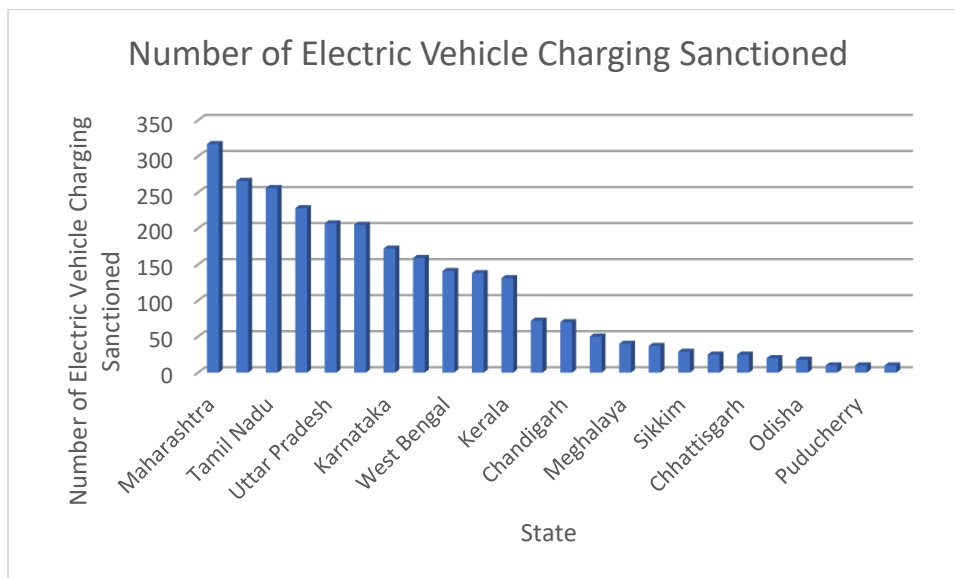
Correlation matrix plot for loadings:
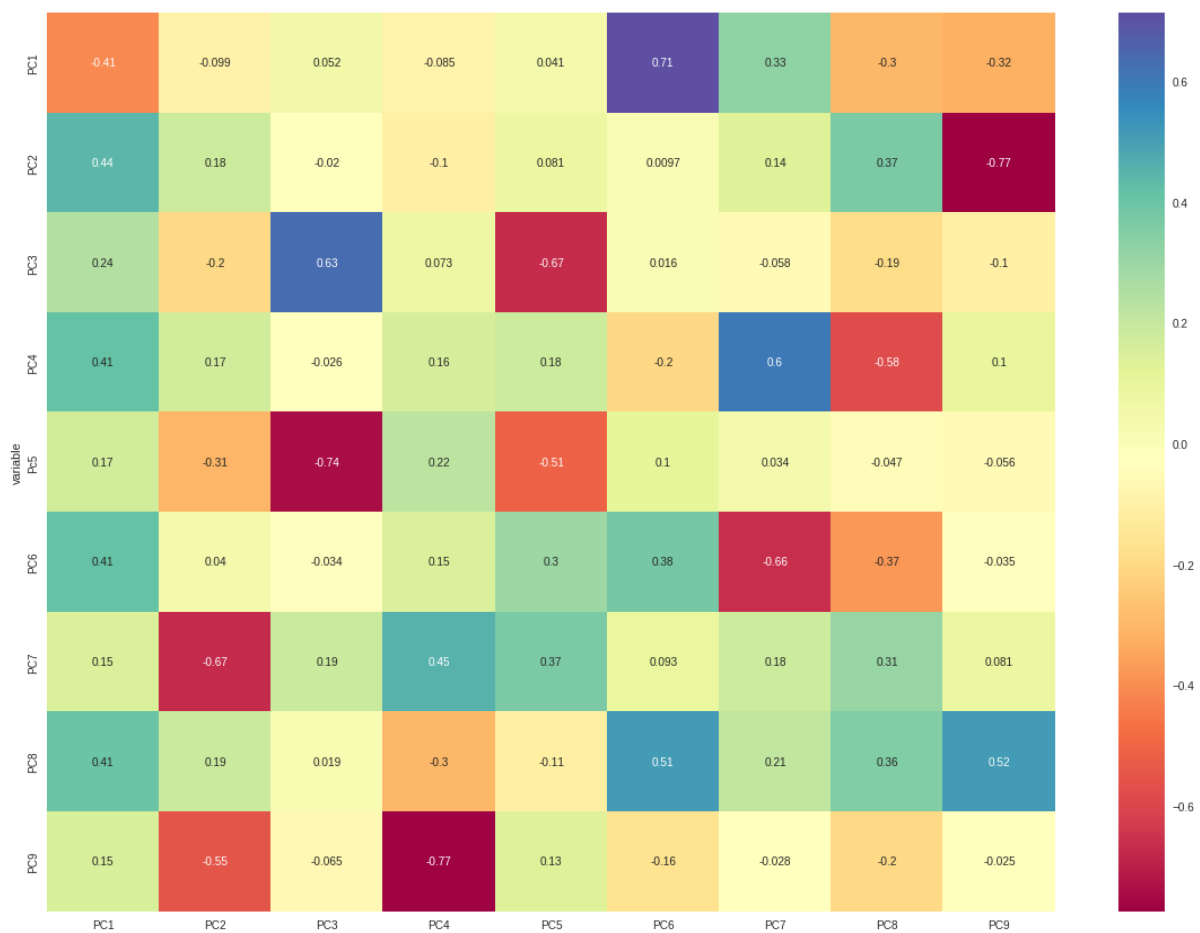
Scree Plot: is a common method for determining the number of PCs to be retained via graphical representation. It is a simple line segment plot that shows the eigenvalues for each individual PC. It shows the eigenvalues on the y-axis and the number of factors on the x-axis. It always displays a downward curve. Most scree plots look broadly similar in shape, starting high on the left, falling rather quickly, and then flattening out at some point. This is because the first component usually explains much of the variability, the next few components explain a moderate amount, and the latter components only explain a small fraction of the overall variability. The scree plot criterion looks for the "elbow" in the curve and selects all components just before the line flattens out. The proportion of variance plot: The selected PCs should be able to describe at least 80% of the vehicles.
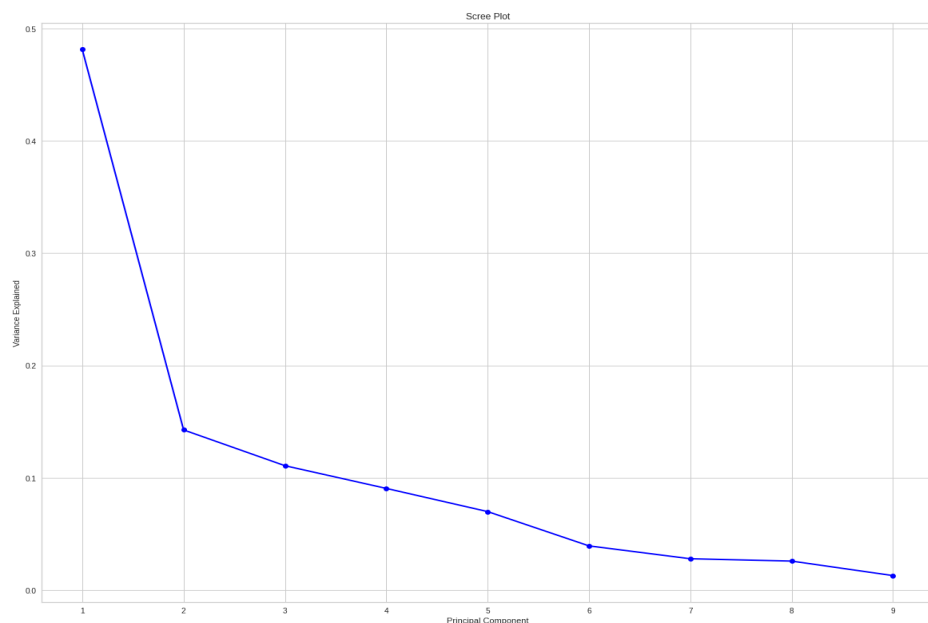
Extracting Segments:

Dendrogram

This technique is specific to the agglomerative hierarchical method of clustering. The agglomerative hierarchical method of clustering starts by considering each point as a separate cluster and starts joining points to clusters in a hierarchical fashion based on their distances. To get the optimal number of clusters for hierarchical clustering, we make use of a dendrogram which is a tree-like chart that shows the sequences of

merges or splits of clusters. If two clusters are merged, the dendrogram will join them in a graph and the height of the join will be the distance between those clusters. As shown in Figure, we can chose the optimal number of clusters based on hierarchical structure of the dendrogram. As highlighted by other cluster validation metrics, four to five clusters can be considered for the agglomerative hierarchic
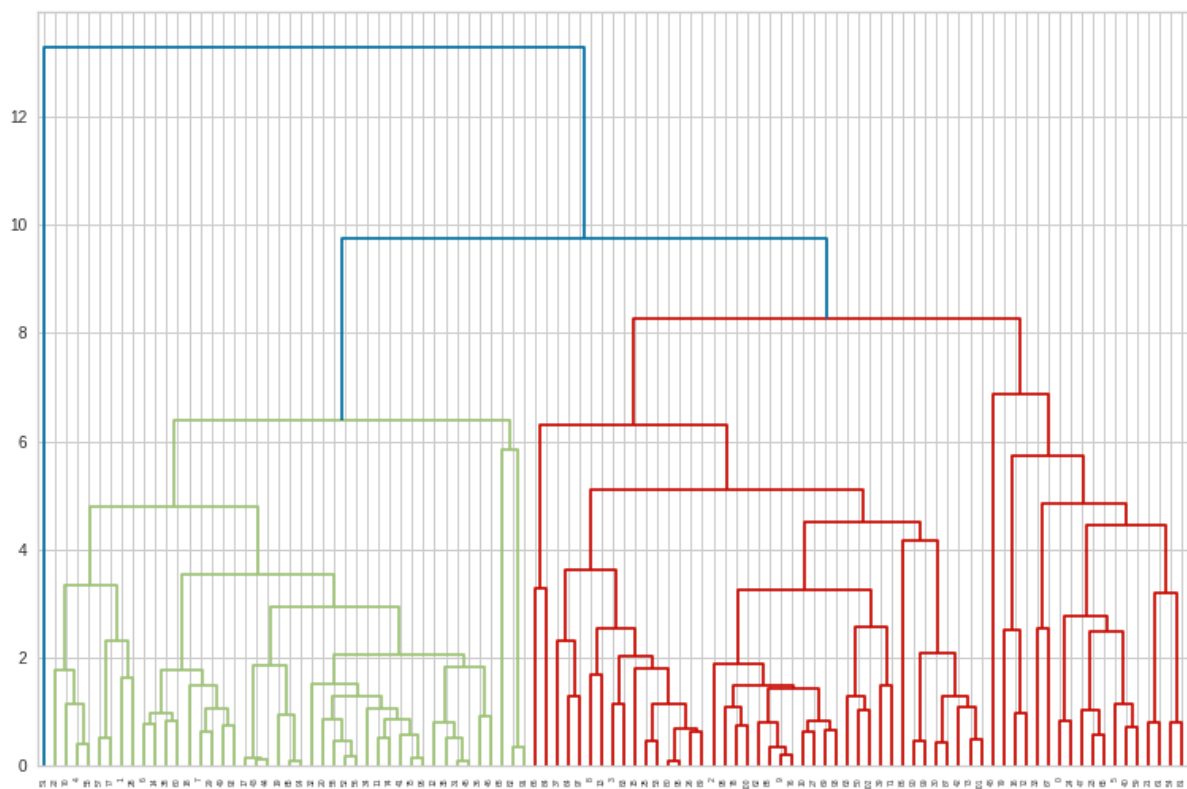
Elbow Method:

The Elbow method is a popular method for determining the optimal number of clusters. The method is based on calculating the Within-Cluster-Sum of Squared Errors (WSS) for a different number of clusters (k) and selecting the k for which change in WSS first starts to diminish. The idea behind the elbow method is that the explained variation changes rapidly for a small number of clusters and then it slows down leading to an elbow formation in the curve. The elbow point is the number of clusters we can use for our clustering algorithm.

The KElbowVisualizer function fits the KMeans model for a range of clusters values between 2 to 8. As shown in Figure, the elbow point is achieved which is highlighted by the function itself. The function also informs us about how much time was needed to plot models for various numbers of clusters through the green line.
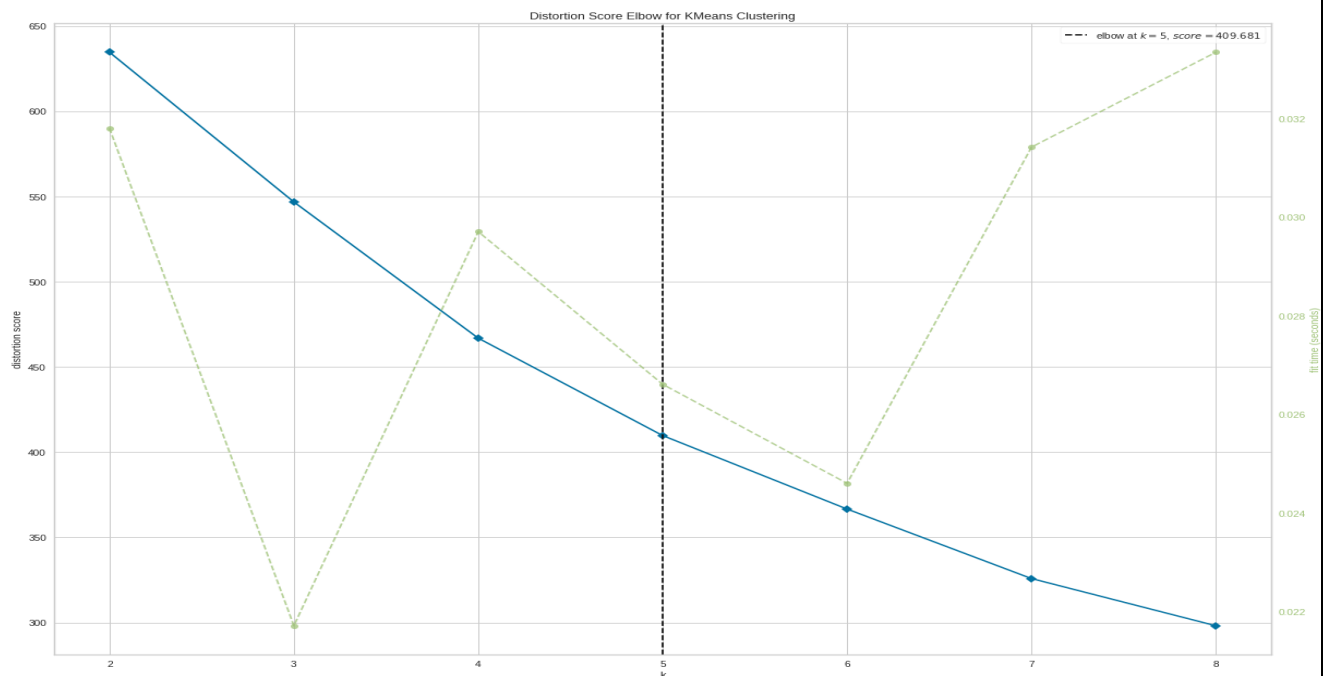
Evaluating the cluters using Distortion
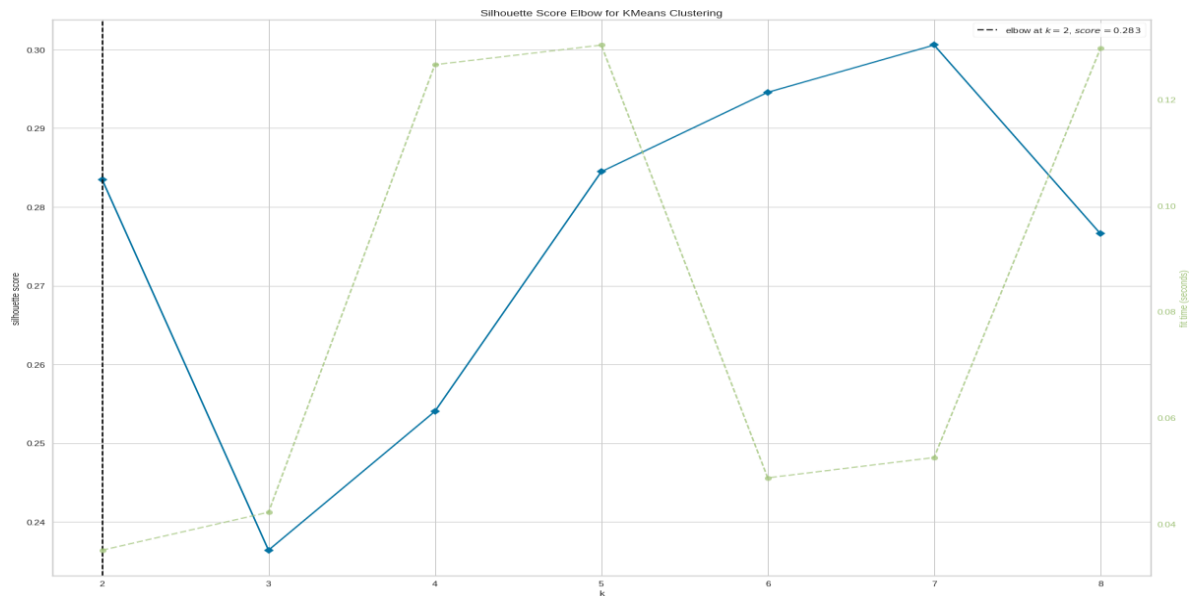
Evaluating the clusters using silhouette
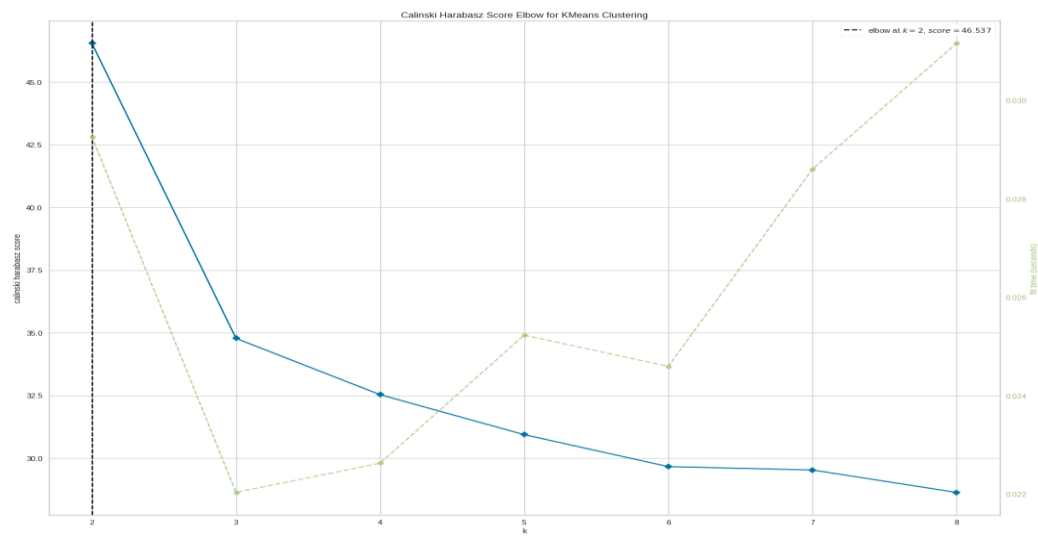
Evaluating the cluters using calinski_{harabas}

Analysis and Approaches used for Segmentation

Clustering

Clustering is one of the most common exploratory data analysis techniques used to get an intuition about the structure of the data. It can be defined as the task of identifying subgroups in the data such that data points in the same subgroup (cluster) are very similar while data points in different clusters are very different. In other words, we try to find homogeneous subgroups within the data such that data points in each cluster are as similar as possible according to a similarity measure such as euclidean-based distance or correlation-based distance.

The decision of which similarity measure to use is application-specific. Clustering analysis can be done on the basis of features where we try to find subgroups of samples based on features or on the basis of samples where we try to find subgroups of features based on samples.

K-Means Algorithm

K Means algorithm is an iterative algorithm that tries to partition the dataset into pre-defined distinct non-overlapping subgroups (clusters) where each data point belongs to **only one group**. It tries to make the intra-cluster data points as similar as possible while also keeping the clusters as different (far) as possible. It assigns data points to a cluster such that the sum of the squared distance between the data points and the cluster's centroid (arithmetic mean of all the data points that belong to that cluster) is at the minimum. The less variation we have within clusters, the more homogeneous (similar) the data points are within the same cluster The way k means algorithm works is as follows:

- Specify number of clusters K.
- Initialize centroids by first shuffling the dataset and then randomly selecting K data points for the centroids without replacement.
- Keep iterating until there is no change to the centroids. i.e assignment of data points to clusters isn't changing.

The approach k-means follows to solve the problem is **expectation maximization** The E-step is assigning the data points to the closest cluster. The M-step is computing the centroid of each cluster. Below is a break down of how we can solve it mathematically,

The objective function is:

$$J = \sum_{i=1}^{m} \sum_{k=1}^{K} w_{ik} ||x^i - \mu_k||$$

(1)

And M-step is :

$$\frac{dJ}{dU_k} = 2\sum_{i=1}^{m} w_{ik}(x^i\text{-}u_k) = 0$$

$$u_k = \frac{\sum_{i=1}^{m} w_{ik}x^i}{\sum_{i=1}^{m} w_{ik}}$$

K means algorithm is very popular and used in a variety of applications such as market segmentation, document clustering, image segmentation and image compression, etc.
The goal usually when we undergo a cluster analysis is either:

1. Get a meaningful intuition of the structure of the data we're dealing with.
2. Cluster-then-predict where different models will be built for different subgroups if we believe there is a wide variation in the behaviors of different subgroups.

The **k-means clustering algorithm** performs the following tasks:

- Specify number of clusters K
- Initialize centroids by first shuffling the dataset and then randomly selecting K data points for the centroids without replacement.
- Compute the sum of the squared distance between data points and all centroids.
- Assign each data point to the closest cluster (centroid).
- Compute the centroids for the clusters by taking the average of the all data points that belong to each cluster.
- Keep iterating until there is no change to the centroids. i.e assignment of data points to clusters isn't changing.

According to the Elbow method, here we take K=4 clusters to train KMeans model. The derived clusters are shown in the following figure

```
1   #K-means clustering
2
3   kmeans = KMeans(n_clusters=4, init='k-means++', random_state=0).fit(t)
4   df['cluster_num'] = kmeans.labels_ #adding to df
5   print (kmeans.labels_) #Label assigned for each data point
6   print (kmeans.inertia_) #gives within-cluster sum of squares.
7   print(kmeans.n_iter_) #number of iterations that k-means algorithm runs to get a minimum within-cluster sum of squares
8   print(kmeans.cluster_centers_) #Location of the centroids on each cluster.
```
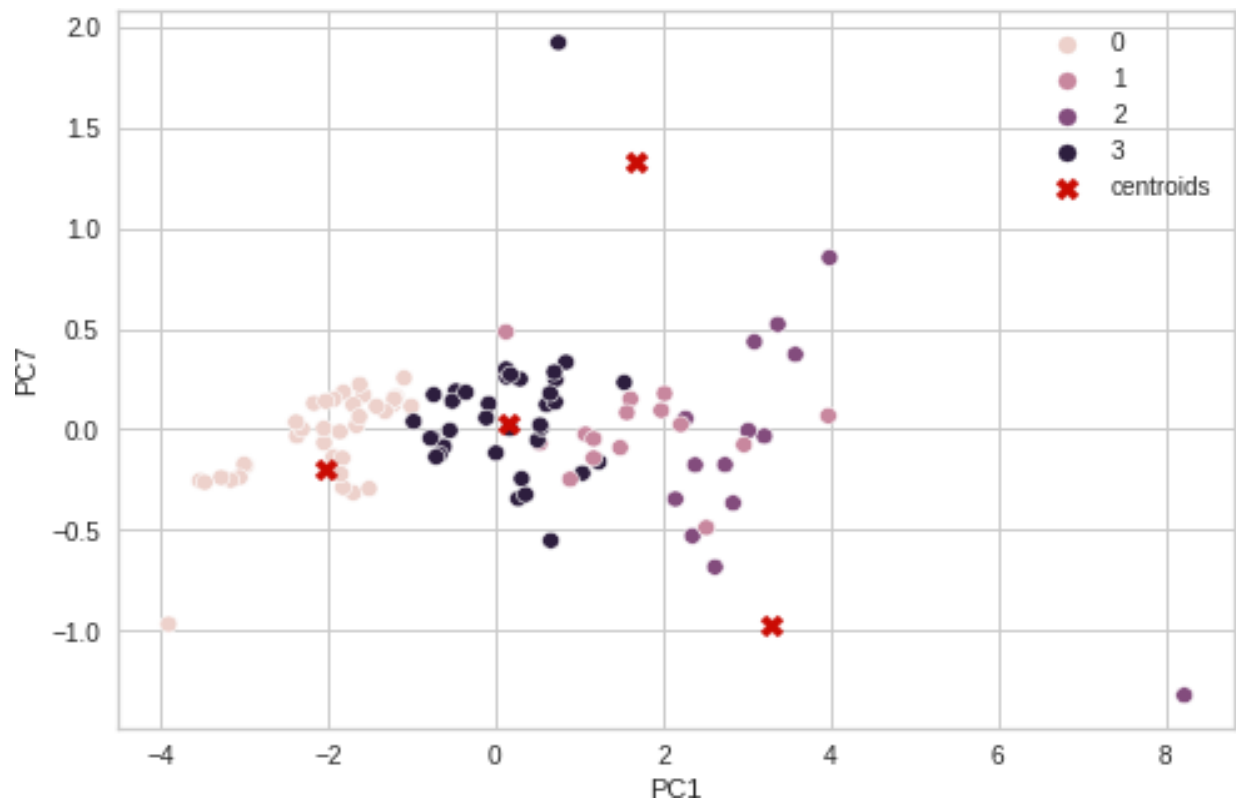

Prediction of Prices most used cars

Linear regression is a machine learning algorithm based on supervised learning. It performs a regression task. Regression models targets prediction value based on independent variables. It is mostly used for finding out the relationship between variables and forecasting. Here we use a linear regression model to predict the prices of different Electric cars in different companies. X contains the independent variables and y is the dependent Prices that is to be predicted. We train our model with a splitting of data into a 4:6 ratio, i.e. 40% of the data is used to train the model.

LinearRegression().fit($X_{train,ytrain}$) command is used to fit the data set into model. The values of intercept, coefficient, and cumulative distribution function (CDF) are described in the figure.

```
[85]  1  X=data2[['PC1', 'PC2','PC3','PC4','Pc5','PC6', 'PC7','PC8','PC9']]
      2  y=df['inr(10e3)']
```

```
[86]  1  X_train, X_test, y_train, y_test = train_test_split(X, y,test_size=0.4, random_state=101)
      2  lm=LinearRegression().fit(X_train,y_train)
```

```
[87]  1  print(lm.intercept_)
```

```
4643.522050485437
```

```
[88]  1  lm.coef_
```

```
array([1144.95884,  530.09473,   54.50586, -843.38276, -306.27756,
       1449.94438,  595.62449, 1005.47168, 1455.75874])
```

```
[89]  1  X_train.columns
```

```
Index(['PC1', 'PC2', 'PC3', 'PC4', 'Pc5', 'PC6', 'PC7', 'PC8', 'PC9'], dtype='object')
```

```
  ▶   1  cdf=pd.DataFrame(lm.coef_, X.columns, columns=['Coeff'])
      2  cdf
```

	Coeff
PC1	1144.9588
PC2	530.0947
PC3	54.5059
PC4	-843.3828
Pc5	-306.2776
PC6	1449.9444
PC7	595.6245
PC8	1005.4717
PC9	1455.7587

After completion of training the model process, we test the remaining 60% of data on the model. The obtained results are checked using a scatter plot between predicted values and the original test data set for the dependent variable and acquired similar to a straight line as shown in the figure and the density function is also normally distribute
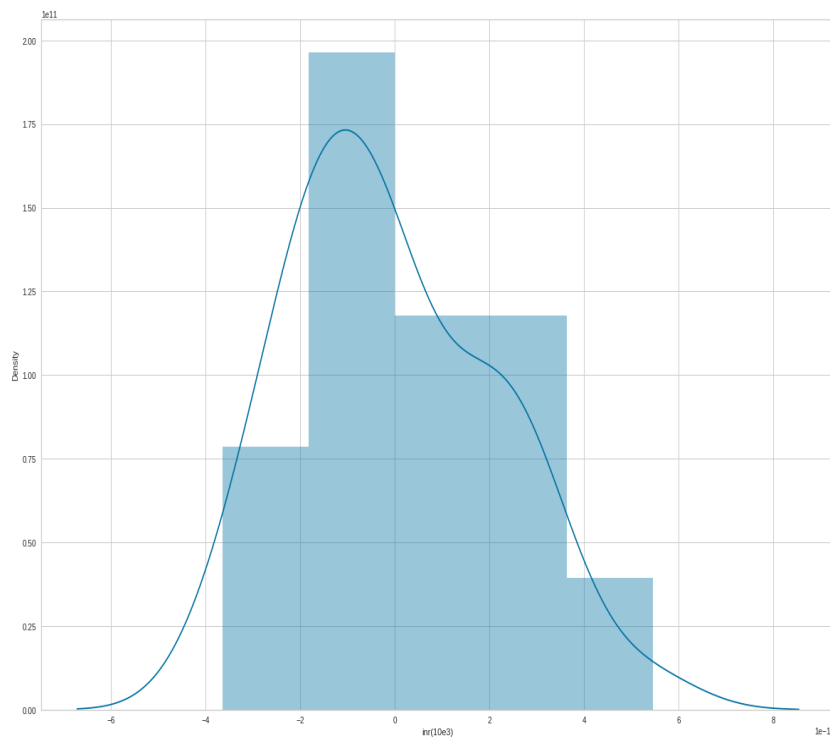
The metrics of the algorithm, Mean absolute error, Mean squared error and mean square root error are described in the below figure:

```
1  print('MAE:',metrics.mean_absolute_error(y_test,predictions))
2  print('MSE:',metrics.mean_squared_error(y_test,predictions))
3  print('RMSE:',np.sqrt(metrics.mean_squared_error(y_test,predictions)))
```

```
MAE: 1.7540254962763616e-12
MSE: 4.588882922020368e-24
RMSE: 2.142167809024393e-12
```

```
1  metrics.mean_absolute_error(y_test,predictions)
```

```
1.7540254962763616e-12
```

```
1  metrics.mean_squared_error(y_test,predictions)
```
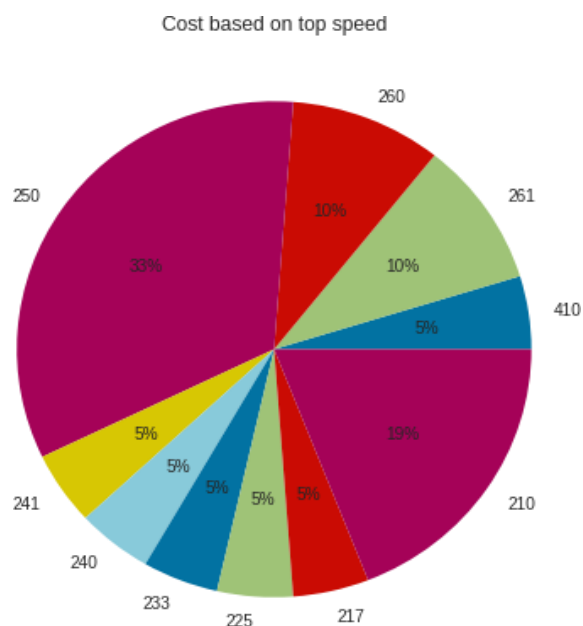
```
4.588882922020368e-24
```

```
1  np.sqrt(metrics.mean_squared_error(y_test,predictions))
```
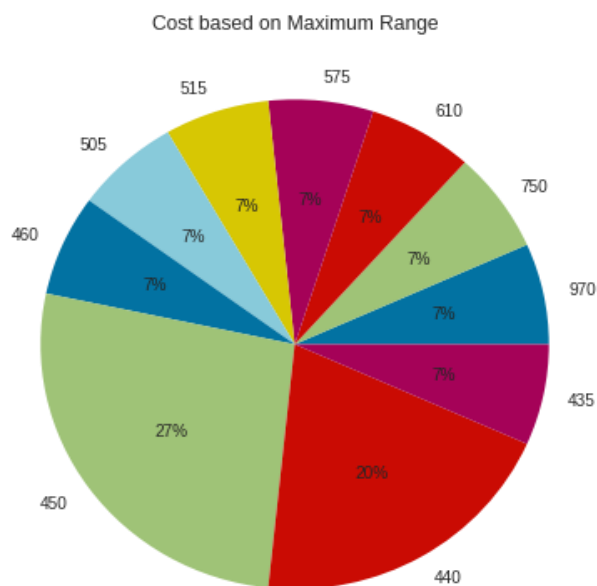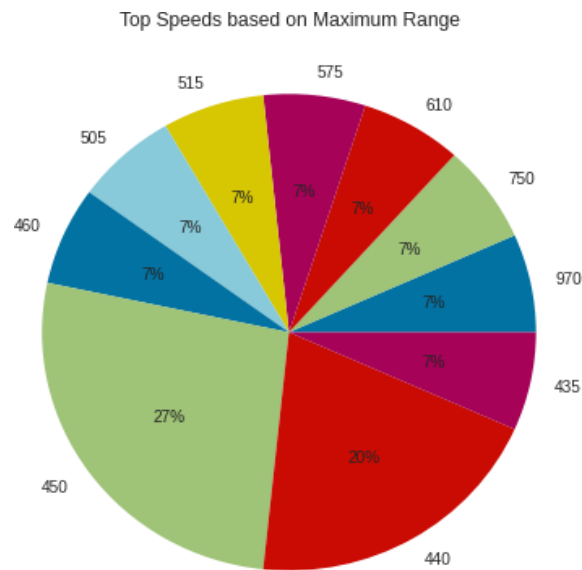
```
2.142167809024393e-12
```

Profiling and Describing the Segments

Sorting the Top Speeds and Maximum Range in accordance to the Price with head () we can view the Pie Chart.

Pie Chart:

Cost based on top speed

Top Speeds based on Maximum Range

Cost based on Maximum Range

Target Segments:

So from the analysis we can see that the optimum targeted segment should be belonging to the following categories:

Behavioral: Mostly from our analysis there are cars with 5 seats.

Demographic:

- Top Speed & *R*ange: With a large area of market the cost is dependent on Top speeds and Maximum range of cars.
- Efficiency: Mostly the segments are with most efficiency.

Psychographic:

- Price: From the above analysis, the price range is between 16,00,000 to 1,80,00,000.

Finally, our target segment should contain cars with most **Efficiency**, contains **Top Speed** and price between **16 to 180 lakhs** with mostly with **5 seats**.

Customizing the Marketing Mix

The marketing mix refers to the set of actions, or tactics, that a company uses to promote its brand or product in the market. The 4Ps make up a typical marketing mix
 -Price, Product, Promotion and Place.

- **rice:** refers to the value that is put for a product. It depends on segment targeted, ability of the companies to pay, ability of customers to pay supply - demand and a host of other direct and indirect factors.
- **Product:** refers to the product actually being sold – In this case, the service. The product must deliver a minimum level of performance; otherwise even the best work on the other elements of the marketing mix won't do any good.
- **Place:** refers to the point of sale. In every industry, catching the eye of the consumer and making it easy for her to buy it is the main aim of a good distribution or 'place' strategy. Retailers pay a premium for the right location. In fact, the mantra of a successful retail business is 'location, location, location'.

- **Promotion:** this refers to all the activities undertaken to make the product or service known to the user and trade. This can include advertising, word of mouth, press reports, incentives, commissions and awards to the trade. It can also include consumer schemes, direct marketing, contests and prizes.

All the elements of the marketing mix influence each other. They make up the business plan for a company and handle it right, and can give it great success. The marketing mix needs a lot of understanding, market research and consultation with several people, from users to trade to manufacturing and several others.

Electronic vehicle Sales in India:

The overall EV sales in April 2022 bounced back to their growth trajectory, clocking 73,046 units. This signifies a month-on-month decrease of 5.3%, but a year-on-year leap of 415%.

Registered EV Sales Trend in India (April 2021–April 2022)
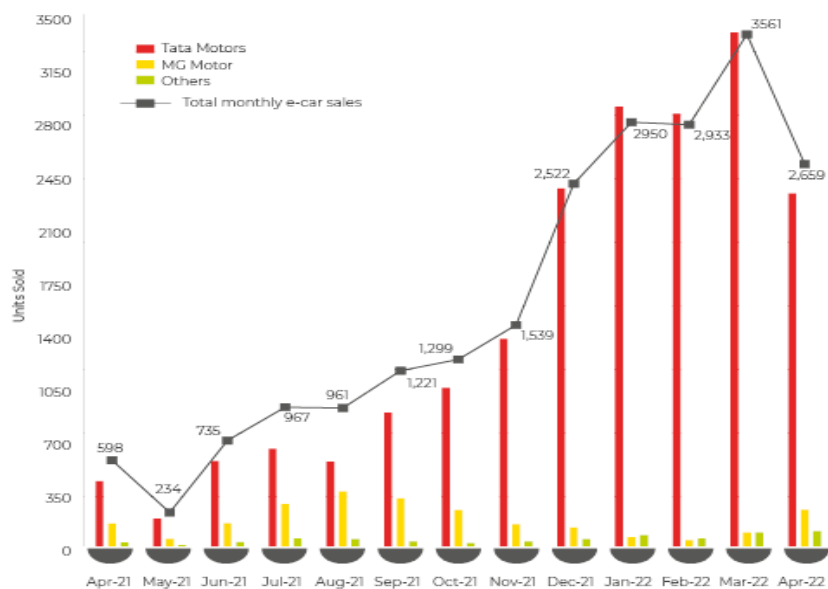
.As depicted in the figure below, EV registrations in April 2022 were driven by electric two-wheelers and passenger-type electric three-wheelers, which together accounted for 92.92% of total registrations in the month. The shares of these categories were followed by E-Cars (3.64%), cargo-type electric three-wheelers (3.17%), and so on.

In 2021, 3,29,190 electric vehicles were sold in India, representing a 168 per cent increase over last year's sales of 1,22,607 units.

Y-o-Y Electric Vehicle Sales Trend

With a combined market share of 90%, 2-Wheelers and low-speed L3 Category 3-Wheelers are the most popular electric vehicles. Due to the pandemic, EV sales declined in April and May, but sales began to pick up in June, with a steady growth rate.
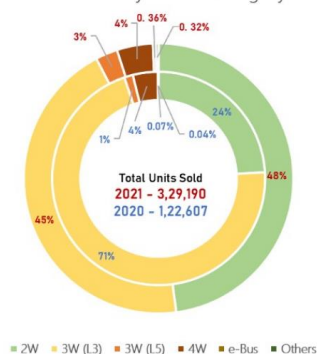
Vehicle segment-wise contribution in 2021

Electric 2Ws – 48%

Electric L3 – 45%

Electric L5 – 3%

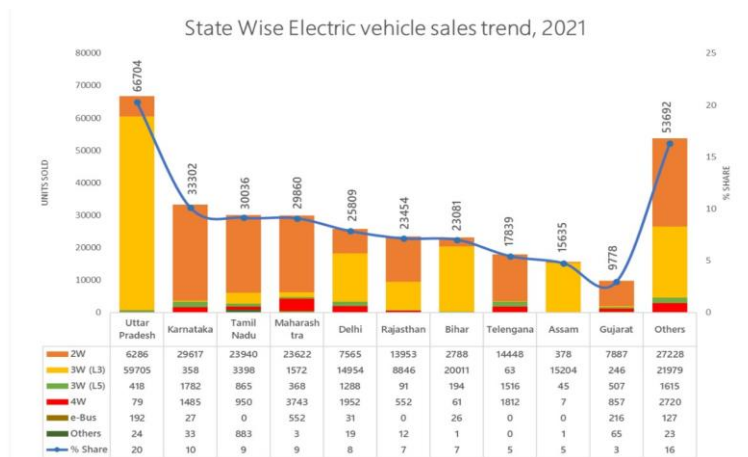Electric 4Ws – 4%

Sales Trend by Vehicle Category

Source : Vahan Website and Telangana regional transport data portal
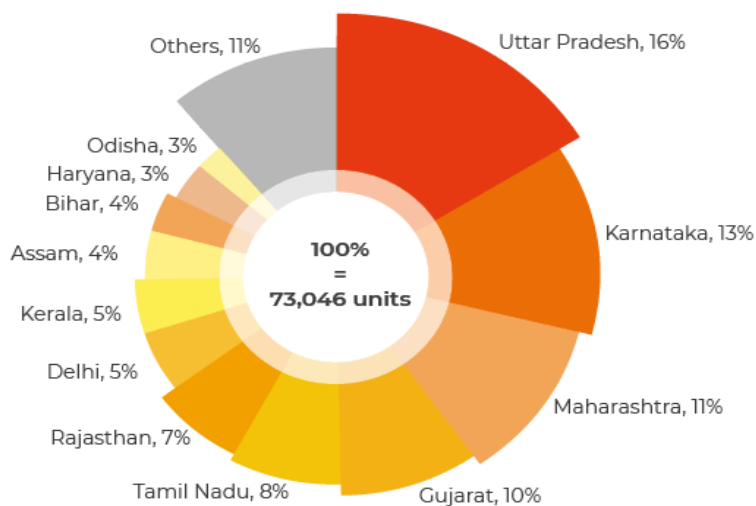
Category-wise EV Sales:

Among all the states and UTs, Uttar Pradesh retained its top spot in EV share with 16% of overall sales, followed by Karnataka with 13% share. Maharashtra fell to the third spot with an 11% share, followed by Gujarat (10%), Tamil Nadu (8%), Rajasthan (7%), and Delhi (5%).

Region-wise Registered EV Sales (State/ UT) – 2021:

State Wise Electric vehicle sales trend, 2021

	Uttar Pradesh	Karnataka	Tamil Nadu	Maharashtra	Delhi	Rajasthan	Bihar	Telengana	Assam	Gujarat	Others
2W	6286	29617	23940	23622	7565	13953	2788	14448	378	7887	27228
3W (L3)	59705	358	3398	1572	14954	8846	20011	63	15204	246	21979
3W (L5)	418	1782	865	368	1288	91	194	1516	45	507	1615
4W	79	1485	950	3743	1952	552	61	1812	7	857	2720
e-Bus	192	27	0	552	31	0	26	0	0	216	127
Others	24	33	883	3	19	12	1	0	1	65	23
% Share	20	10	9	9	8	7	7	5	5	3	16

Totals shown on bars: Uttar Pradesh 66704, Karnataka 33302, Tamil Nadu 30036, Maharashtra 29860, Delhi 25809, Rajasthan 23454, Bihar 23081, Telengana 17839, Assam 15635, Gujarat 9778, Others 53692

Region-wise Registered EV Sales (State/ UT)– April 2022:

100% = 73,046 units

- Uttar Pradesh, 16%
- Karnataka, 13%
- Maharashtra, 11%
- Gujarat, 10%
- Tamil Nadu, 8%
- Rajasthan, 7%
- Delhi, 5%
- Kerala, 5%
- Assam, 4%
- Bihar, 4%
- Haryana, 3%
- Odisha, 3%
- Others, 11%

High

Speed electric Two-Wheeler (HS-E2W):

The overall HS-E2W sales in the country in April 2022 stood at 49,141 units, signifying a slight decline of 0.91% month-on-month, but a whopping 866% Year-on-year leap in registrations. The Top 10 players, as shown below, accounted for 93% of the total registrations witnessed in April 2022.Ola Electric moved to 1st position this month from the previous month's number 2nd position. Further, Hero Electric fell to the third position, with Okinawa taking second place. Bajaj re-entered the Top 10 race after its brief absence last year, pushing Benling to 11th place.

High-Speed E2W Sales Trend:
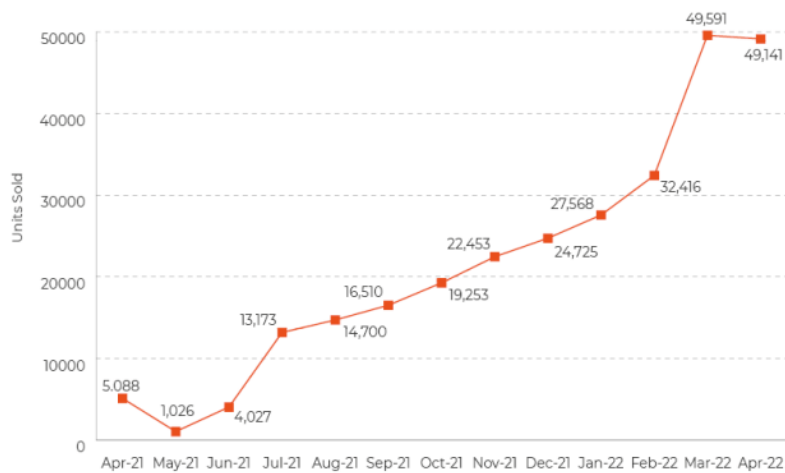
Top High-Speed E2W Players in April 2022:
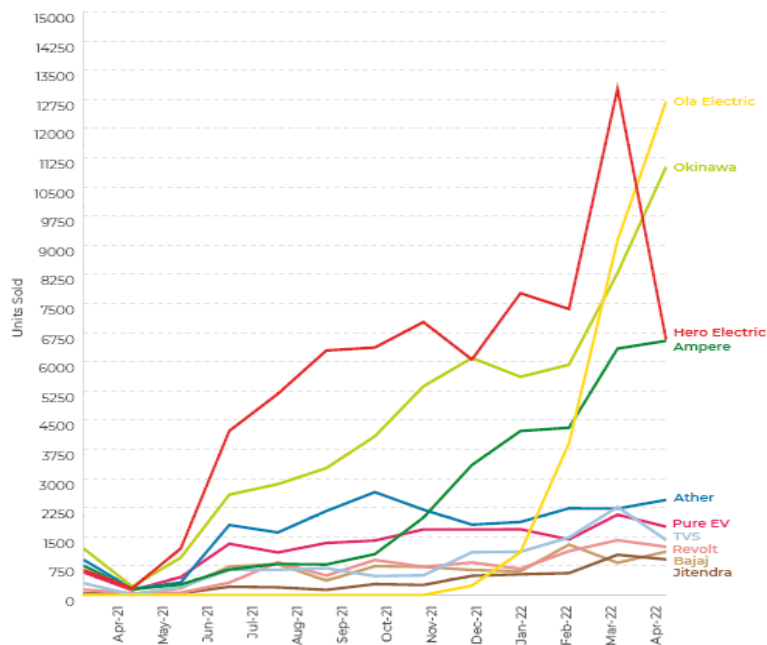

Electric Three-Wheeler (E3W)

The sales of registered E3Ws passenger and cargo-type in April 2022 stood at 18,738 units and 2,316 units respectively, signifying a month-on-month decrease of 9.59% for E3W – Passenger and a month-on-month decrease of 26.38% for E3W – Cargo.

Sales Trend of E3W – Passenger (Left) and E3W – Cargo (Right)
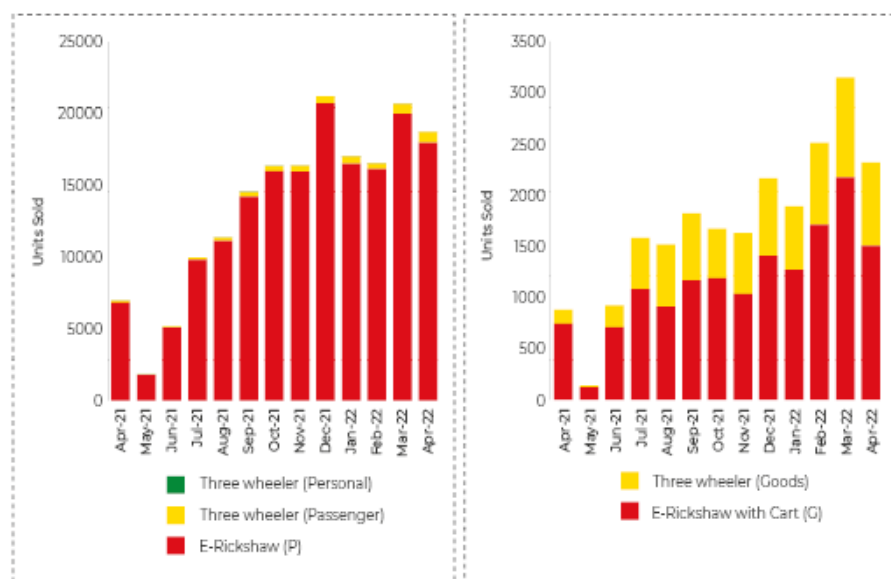
The cumulative sales of the top 7 electric 3-wheeler players across passenger and cargo segments in April 2022 accounted for a 38.4% share of the entire E3W market. YC Electric Vehicle continued to have the highest share of 8.95%, which was followed by Mahindra Electric Mobility (8.94%), Saera Electric Auto (5.56%), Champion Poly Plast (4.37%), Dilli Electric (3.88%), Best Way Agencies (3.4%), and Unique International (3.3%).

**Top E3W Players in April 2022**
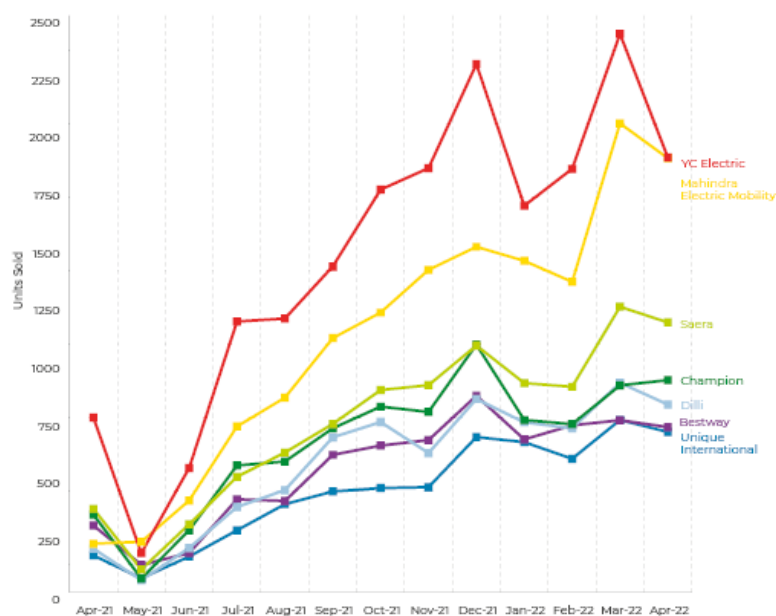
Electric Cars Sales Trend

The cumulative sales of E-cars in April 2022 stood at 2,659 units, witnessing a month-on-month fall of 25.55% but a Year-on-year surge of 344.65% in registrations. Tata Motors has been driving E-car sales the entire year. This month, the Company accounted for 87% of the total registrations. Sales of E-cars by BYD, Audi, and BMW witnessed the pace picking up this month.

Player-wise E-Car Sales Trend:
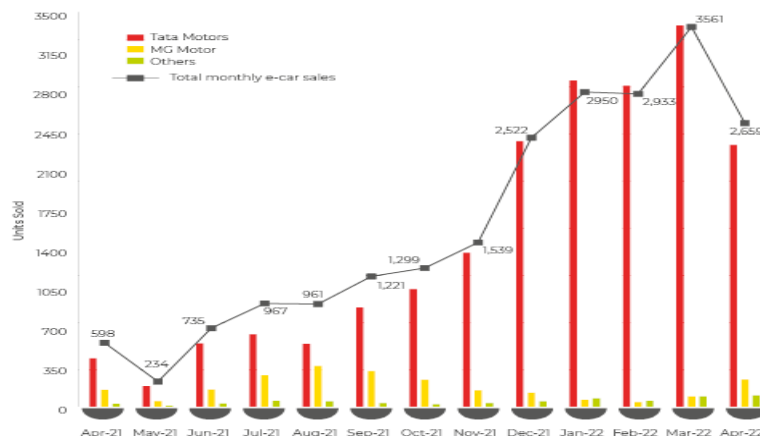
The cumulative sales of E-buses in April 2022 stood at 164 units, with a month-on-month rise of 116% and a Year-on-year increase of 6%. This month's sales were driven by JBM Auto (30%), followed by PMI Electro (29%), Tata Motors (23%), and Olectra Greentech (18%).Player-wise E-Bus Sales Trend
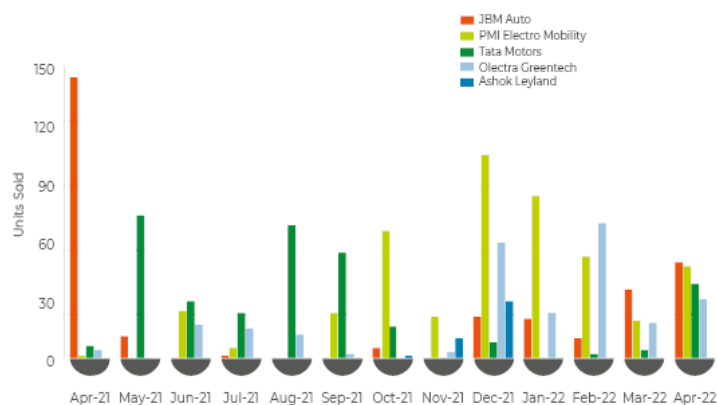
Reverse Engineering Electric Vehicle Battery Chemistry to predict its Price

The purpose of this module is to predict how the EV battery price will fluctuate. This way, the start-up's business plan can maneuver according to predictions. Emulating Tesla's business model to successively reduce the price of their cars.

First Principle Analysis

A typical Lithium-Ion battery contains

- Cobalt
- Nickel
- Lithium
- Carbon
- Separation Polymer (Fancy name for Electrolyte)
- Seal Can

Data Source

To get a quantized dataset for each rare earth metal mentioned above and their price, the companies holding rights to sell this data, demand a high price. A startup with no funding would have to cleverly find a maneuver. So, I will use the TESLA stock price, and associate each stock value with the proportional value of the mineral.

The Source of TESLA stock price is finance.yahoo.com.

Battery Chemistry

Weight of Tesla Battery = 500kg

here use NCA (Nickel Cobalt Aluminum-Oxide)

Weight of Seal Can   = 200kg (40%)

Weight of Aluminum   = 100kg (20%)

Weight of Cobalt   = 028kg (14%)

Weight of Nickel   = 150kg (75%)

Weight of Lithium   = 022kg (11%)

Cost Per Mineral

Avg Car = 2000kg (Tesla Model S has be taken for reference)

Battery = 0500kg

Battery = 25% of Car -- (1)

Tesla Car Price = $100,000 (Tesla Model S)

Average Tesla Share Price (2022) = $1,000

Which tells us, Tesla Car = 100 Tesla Shares

Thus,

Battery = $25,000 or 25 Tesla Shares

From previous metrics of Battery Chemistry,

Seal Can   = 10.00 Shares

Aluminum   = 05.00 Shares

Cobalt   = 03.50 Shares

Nickel   = 18.75 Shares

Lithium   = 02.75 Shares

Predicting Tesla Share price using LSTM

Predicting share price for an unknown time is redundant. So, intentionally we will predict known values and use the mean square error to attenuate the network.Long Short Term Memory is best for this application. Since the data is sequential, it could emulate the behavior of a string.
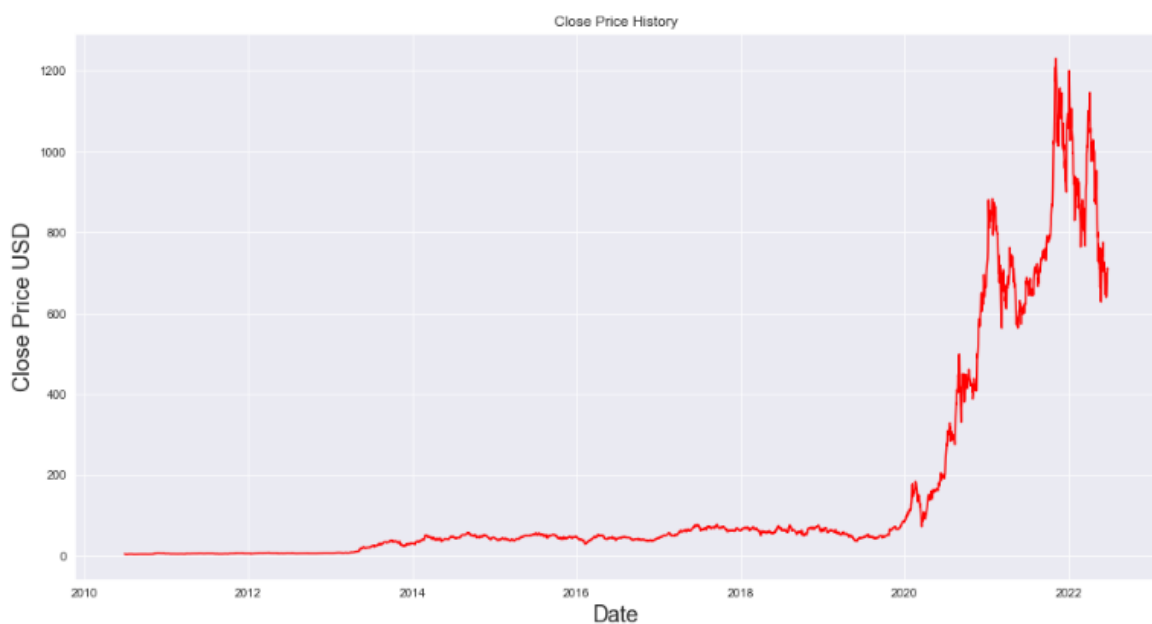
This is our known stock fluctuation. This data is split into test and train.

The Train data will be the data from the beginning upto 2020.

The Test data will be the data from 2020 upto the middle of 2022.

The training is done using the `adam` optimizer and `mean_squared_error`.

The model will follow a batch size of 1, with 10 epochs.

Prediction

After training the model. We can predict future values using the test dataset. Not every point will be valid, so here is how the model fared.
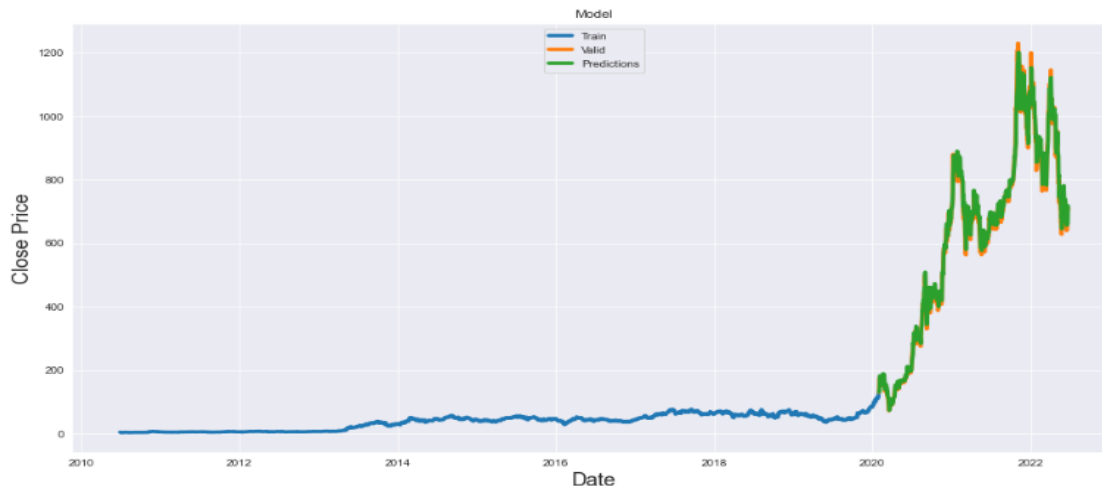
The yellow points are where the model was 100% accurate.

The blue points are the training set.

The green points are testing data, which later during mse calculation, is funneled into the model.

We can use simple calculation from the Battery Chemisty discussed earlier.

Cobalt   = Prediction * 3.5

Nickel = Prediction * 18.75

Lithium   = Prediction * 2.75

Future of electric vehicle in India:

A nationalized mission in the year 2019, started which focuses on the research and development of battery technology to decrease the dependence on China. With this, the government is also inviting foreign players to explore the Indian market, such as Tesla, etc.

These steps are competitive, but to make a fruitful transition to EV, there's an urge to focus on the following Focus Areas

- Charging Infrastructure

- R&D in Battery Tech
- Scour for essential metals
- Make in India EVs
- EV education

India has only 300 charging stations; However, India has **aimed to have 2900 charging stations by the year 2023**. The work of the Indian government has started and we need more **PPP (Public-Private Partnership)** collaboration to achieve this target. Battery technology is really important. The Indian government has not been very forthcoming about **electric vehicle education**. EV courses need to be introduced into the school curriculum. Bachelors and vocational curriculum have to be devised to solve the technology and skilled labour crisis. Another grave challenge would be how well the existing automobile industry can transit towards EV segments.

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GITHUB LINK:

https://github.com/bhadal/EV-Market-segmentation-Analysis.