EV Market Segmentation in India

Feynn Labs Internship project 2

Contributors:

- [Adhiban Siddarth](#)
- [Karakavalasa venkata pranay](#)
- [Malay Vyas](#)
- [Shreyash Banduji Chacharkar](#)
- [Yash Mayur](#)

Note: Click on the name of the person to open github repo
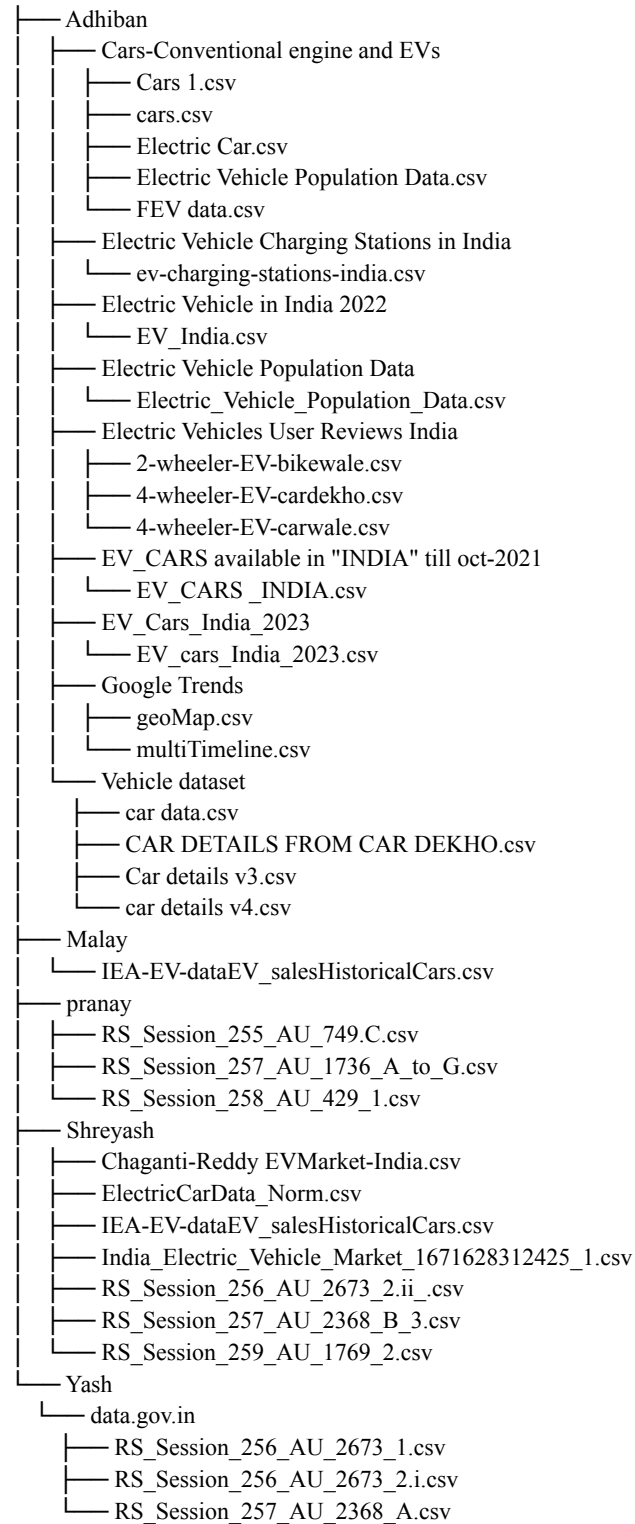
Fermi estimation (problem breakdown):

- **Define the Problem:** Start by clarifying the overarching goal of the project: "Segment the EV market"
- **Identify Key Metrics:** What are the specific metrics or criteria used to segment the market? These could include factors like vehicle type (e.g., passenger cars, trucks), geographic regions, customer demographics, or any other relevant variables.
- **Data Requirements:** Estimate the amount of data needed to effectively segment the market. This would include both the quantity and quality of data. For instance, you might estimate the number of EV sales records required, the diversity of data sources, and the level of data cleanliness needed.
- **Data Collection:** Estimate the time and effort required to collect and preprocess the necessary data. This might involve web scraping, data cleaning, merging datasets, and dealing with missing values.
- **Feature Engineering:** Consider the complexity of feature engineering. Estimate the number of relevant features that need to be created or extracted from the raw data. This could include engineering features from vehicle specifications, user behavior, or external factors like weather or economic indicators.
- **Algorithm Selection:** Estimate the time and computational resources needed to choose and implement suitable machine learning algorithms for market segmentation. This could involve clustering, classification, or regression techniques.
- **Model Training:** Estimate the time and computational resources required to train the machine learning models on the prepared dataset. This can be influenced by the size of the dataset and the complexity of the chosen algorithms.
- **Hyperparameter Tuning:** Estimate the time needed for hyperparameter tuning to optimize the performance of the models. This is an iterative process that involves adjusting model parameters to improve accuracy.
- **Model Evaluation:** Estimate the effort required to evaluate the models' performance using appropriate metrics such as accuracy, precision, recall, or F1-score. Consider cross-validation and validation set preparation.
- **Interpretation and Visualization:** Estimate the time and effort needed to interpret and visualize the results of market segmentation. How will the segments be presented and communicated to stakeholders?

Data Sources:

```
dataset
├── Adhiban
│   ├── Cars-Conventional engine and EVs
│   │   ├── Cars 1.csv
│   │   ├── cars.csv
│   │   ├── Electric Car.csv
│   │   ├── Electric Vehicle Population Data.csv
│   │   └── FEV data.csv
│   ├── Electric Vehicle Charging Stations in India
│   │   └── ev-charging-stations-india.csv
│   ├── Electric Vehicle in India 2022
│   │   └── EV_India.csv
│   ├── Electric Vehicle Population Data
│   │   └── Electric_Vehicle_Population_Data.csv
│   ├── Electric Vehicles User Reviews India
│   │   ├── 2-wheeler-EV-bikewale.csv
│   │   ├── 4-wheeler-EV-cardekho.csv
│   │   └── 4-wheeler-EV-carwale.csv
│   ├── EV_CARS available in "INDIA" till oct-2021
│   │   └── EV_CARS _INDIA.csv
│   ├── EV_Cars_India_2023
│   │   └── EV_cars_India_2023.csv
│   ├── Google Trends
│   │   ├── geoMap.csv
│   │   └── multiTimeline.csv
│   └── Vehicle dataset
│       ├── car data.csv
│       ├── CAR DETAILS FROM CAR DEKHO.csv
│       ├── Car details v3.csv
│       └── car details v4.csv
├── Malay
│   └── IEA-EV-dataEV_salesHistoricalCars.csv
├── pranay
│   ├── RS_Session_255_AU_749.C.csv
│   ├── RS_Session_257_AU_1736_A_to_G.csv
│   └── RS_Session_258_AU_429_1.csv
├── Shreyash
│   ├── Chaganti-Reddy EVMarket-India.csv
│   ├── ElectricCarData_Norm.csv
│   ├── IEA-EV-dataEV_salesHistoricalCars.csv
│   ├── India_Electric_Vehicle_Market_1671628312425_1.csv
│   ├── RS_Session_256_AU_2673_2.ii_.csv
│   ├── RS_Session_257_AU_2368_B_3.csv
│   └── RS_Session_259_AU_1769_2.csv
└── Yash
    └── data.gov.in
        ├── RS_Session_256_AU_2673_1.csv
        ├── RS_Session_256_AU_2673_2.i.csv
        └── RS_Session_257_AU_2368_A.csv
```
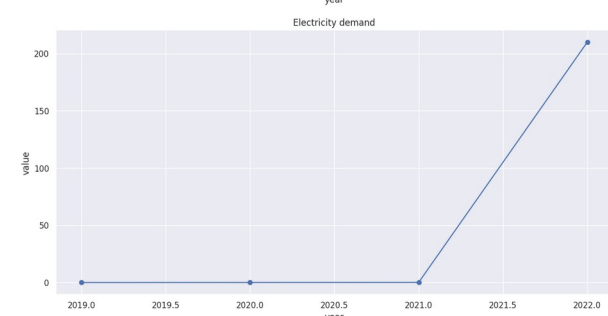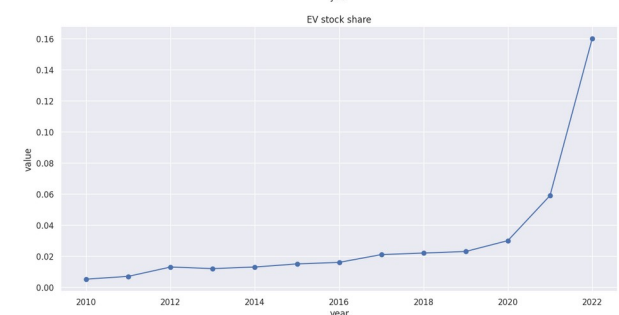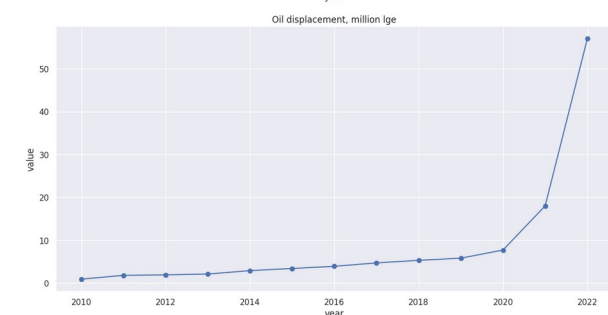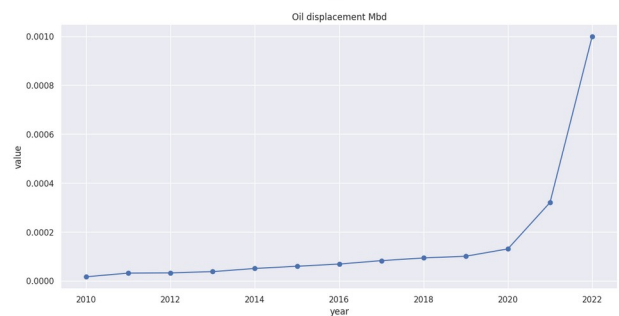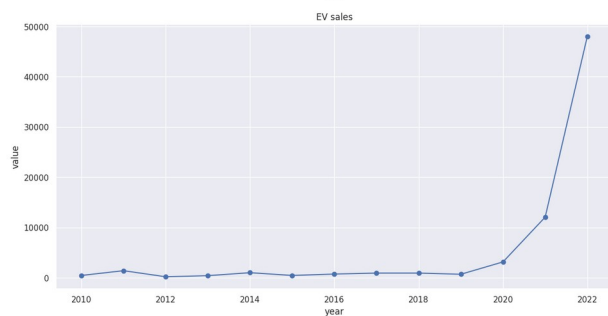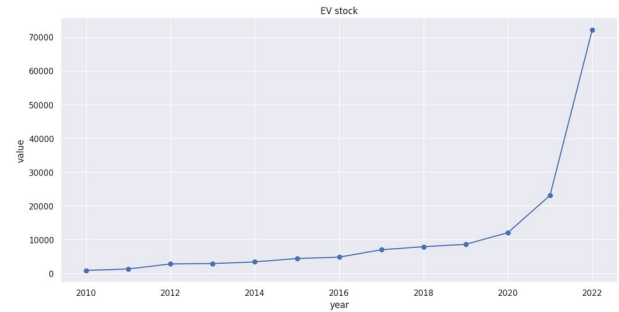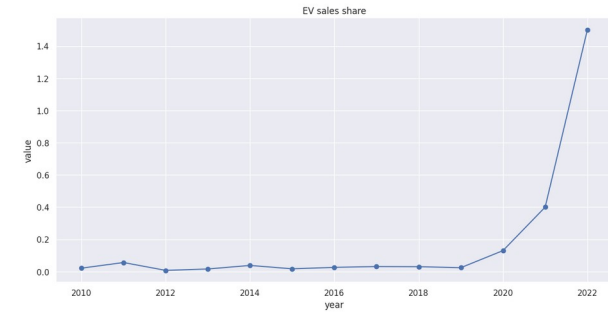
15 directories, 33 files

EV Market Segmentation in India

- V. Adhiban Siddarth

IEA-EV-dataEV_salesHistoricalCars parameters

EV sales share

- The global EV sales share has been increasing exponentially in recent years. In 2022, EVs accounted for 14% of global car sales, up from 4% in 2020.

- This growth is being driven by a number of factors, including government incentives, declining battery prices, and increasing consumer awareness of the environmental benefits of EVs.

- The IEA projects that the global EV sales share will reach 30% by 2030.

EV stock

- The global EV stock (the number of EVs in operation) has also been increasing exponentially in recent years. In 2022, there were over 100 million EVs in operation worldwide, up from just 1 million in 2010.

- This growth is being driven by the same factors that are driving EV sales growth.

- The IEA projects that the global EV stock will reach 250 million by 2030.

EV sales

- The global EV sales have been increasing exponentially in recent years. In 2022, there were over 10 million EVs sold worldwide, up from just 2 million in 2020.

- This growth is being driven by the same factors that are driving EV sales share and EV stock growth.

- The IEA projects that the global EV sales will reach 20 million by 2030.

Oil displacement Mbd

- Oil displacement Mbd (million barrels per day) is the amount of oil that is displaced by EVs. In 2022, EVs displaced 1.5 million barrels of oil per day.

- This is equivalent to about 3% of global oil demand.

- The IEA projects that EV oil displacement will reach 5 million barrels per day by 2030.

Oil displacement, million lge

- Oil displacement, million lge (million liters of gasoline equivalent) is the amount of gasoline that is displaced by EVs. In 2022, EVs displaced 20 million liters of gasoline per day.

- This is equivalent to about 5% of global gasoline demand.

- The IEA projects that EV oil displacement will reach 100 million liters of gasoline per day by 2030.

EV stock share

- The EV stock share is the percentage of the total vehicle stock that is made up of EVs. In 2022, the EV stock share was about 3%.

- This is expected to increase to 10% by 2030.

Electricity demand

- The increase in EV sales and stock is putting a strain on the electricity grid. In order to meet the growing demand for electricity from EVs, the grid will need to be upgraded and expanded.

- This is a challenge, but it is one that can be overcome.

Overall, the data shows that the adoption of EVs is growing rapidly. This is good news for the environment, as EVs help to reduce air pollution and our dependence on oil.

IEA-EV-dataEV_salesHistoricalCars powertrain
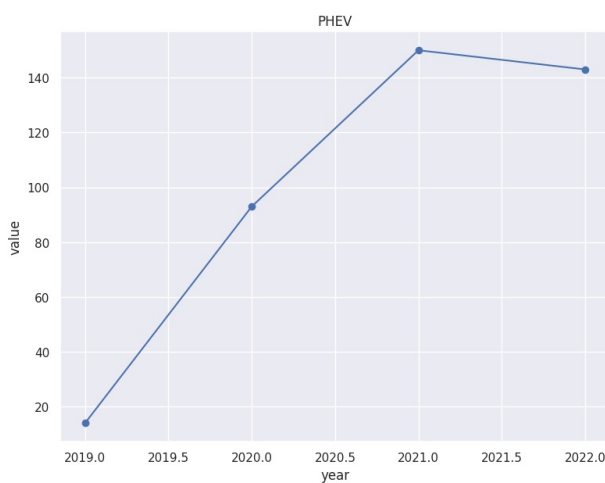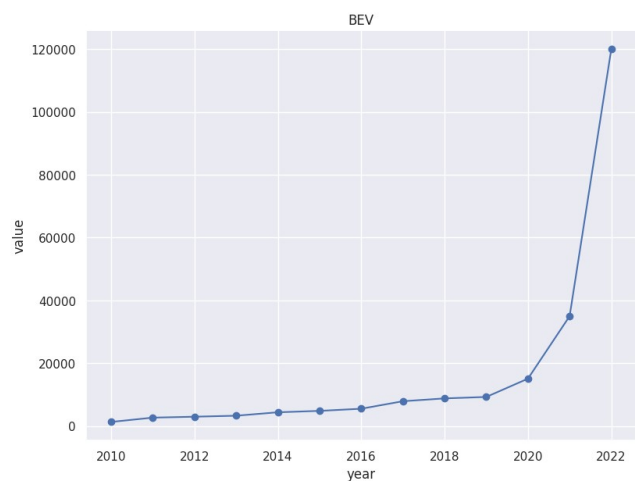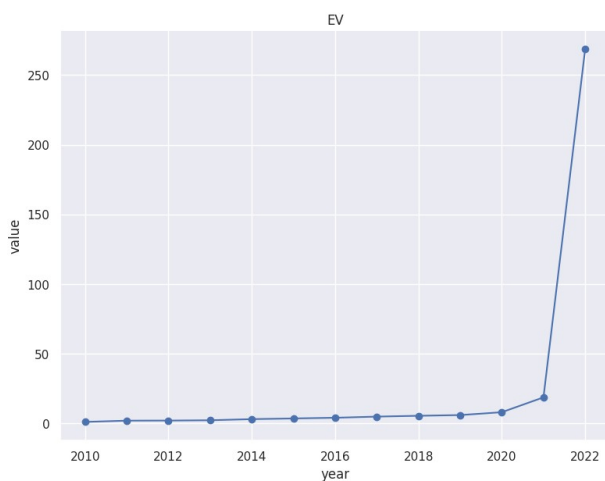
PHEV: Plug-in hybrid

BEV: Battery Electric Vehicle

The above graph shows the sales of plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs) from 2015 to 2022. As you can see, the sales of BEVs have been increasing exponentially over the past few years, while the sales of PHEVs have been decreasing.

There are a few reasons for this trend. First, BEVs are becoming more affordable. The cost of batteries has been declining, and governments are offering incentives to purchase BEVs. Second, BEVs are becoming more capable. They have longer ranges and faster charging times. Third, consumers are becoming more aware of the environmental benefits of BEVs.

As a result of these factors, it is expected that BEVs will become the dominant type of electric vehicle in the future. By 2030, it is estimated that BEVs will account for more than 80% of global electric vehicle sales.

Why BEVs are becoming more popular:

- **Lower operating costs.** BEVs have lower fuel costs than gasoline or diesel vehicles. This is because electricity is cheaper than gasoline or diesel, and BEVs are more efficient.

- **Lower emissions.** BEVs produce zero emissions, which helps to improve air quality.

- **Government incentives.** Many governments offer incentives to purchase BEVs, such as tax breaks and rebates.

- **Improved technology.** Battery technology has improved significantly in recent years, which has led to longer ranges and faster charging times for BEVs.

- **Growing consumer awareness.** More and more consumers are becoming aware of the benefits of BEVs.

Price and Performance:
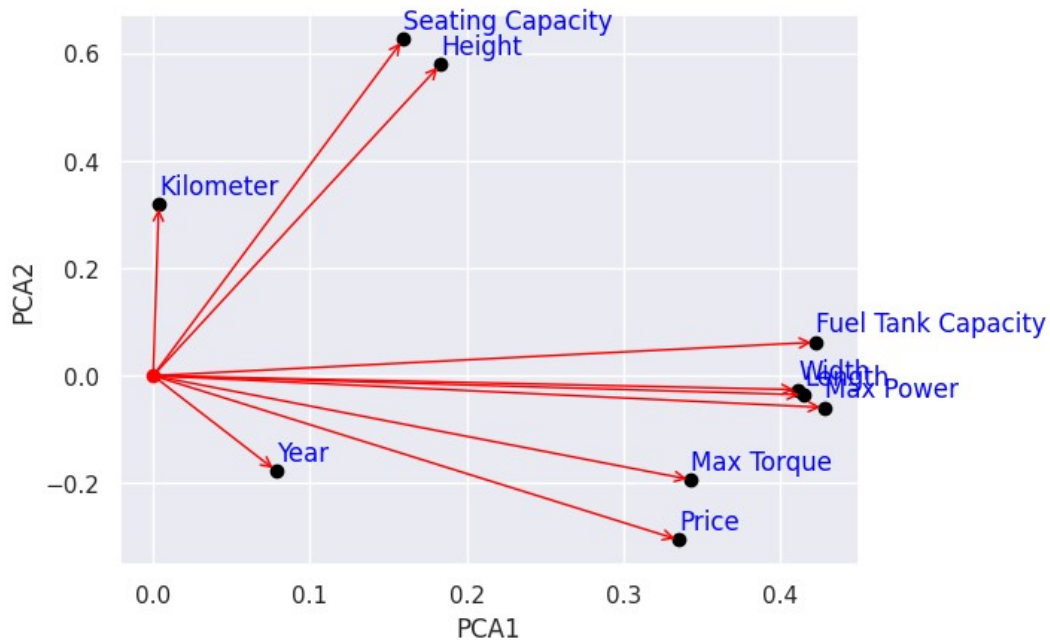
The above PCA graph shows the relationship between the different features of a car. As you can see, the price, max torque, max power, length, width, and fuel tank capacity are all positively correlated with each other. This means that cars with higher prices, max torque, max power, length, width, and fuel tank capacity tend to have higher values for the other features as well. The seating capacity and height are in same direction. This means that cars with more seating capacity are height. The kilometer is in a somewhat different direction from the others because it is not as strongly correlated with the other features.

Overall, the PCA graph shows that the price, max torque, max power, length, width, and fuel tank capacity are the most important features in determining the overall performance of a car. The seating capacity and height are less important, but they can still play a role in determining the overall performance of a car.

Sentiment Analysis:
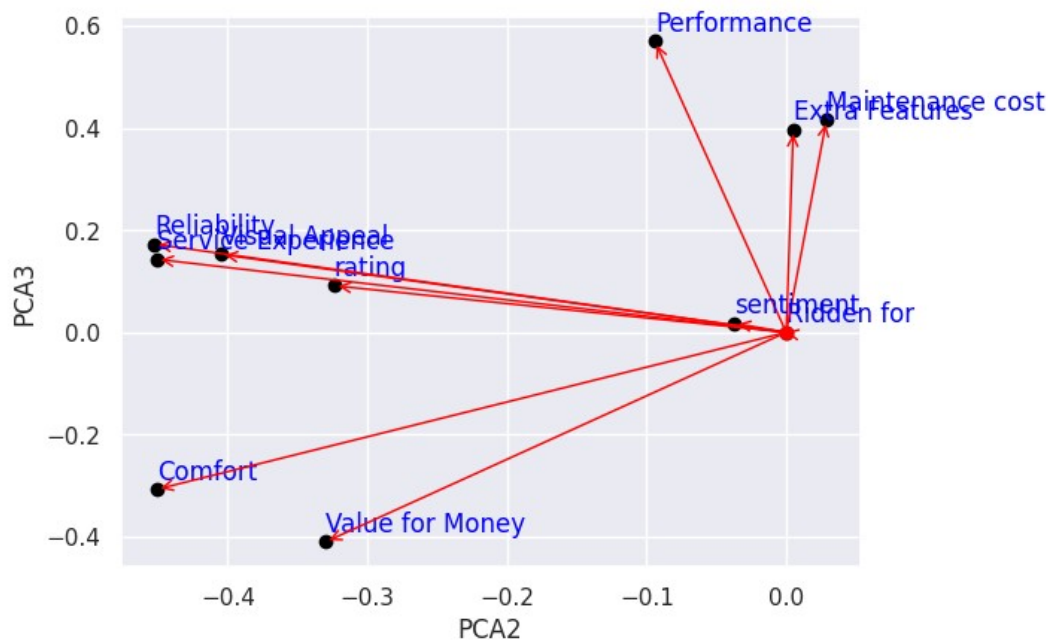
The PCA graph shows the sentiment analysis of car reviews. As you can see, the reliability, service experience, rating, and visual appeal are all positively correlated with each other. This means that cars that are perceived as being reliable, having good service experiences, high ratings, and good visual appeal tend to have higher sentiment scores.

The performance and extra features are positively correlated with the maintenance cost. This means that cars that are perceived as having high performance and extra features tend to have higher maintenance costs.

The comfort and value for money are in the same direction. So people who buy the car with more comfortable thinks that the car is value for money. So if car is more costlier then make sure it is comfortable.

Selling Price decreasing:
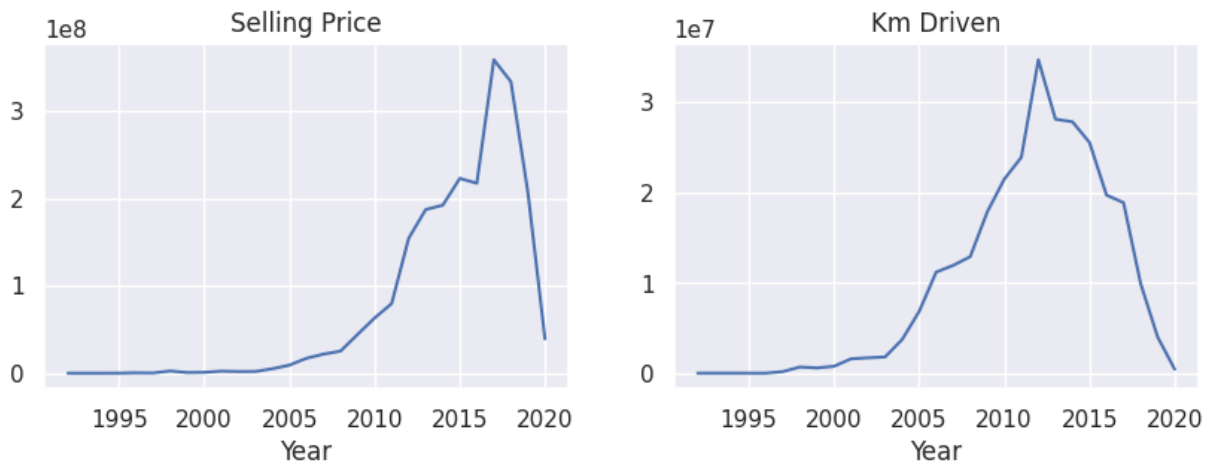
This above graph shows that the Selling price of Petrol/Diesel Vehicle is becomes lower from 2017 to 2020.

The increasing popularity of electric vehicles: Electric vehicles are becoming more popular, and this is putting downward pressure on the prices of petrol/diesel vehicles. Electric vehicles are more efficient than petrol/diesel vehicles, so they are cheaper to operate. They also have lower emissions, which is appealing to some buyers.

The rising cost of petrol/diesel: The cost of petrol/diesel has been increasing in recent years. This has made petrol/diesel vehicles less affordable, which has led to a decrease in demand.

The introduction of new technologies: New technologies, such as lightweight materials and more efficient engines, are making petrol/diesel vehicles cheaper to produce. This is also putting downward pressure on prices.

Government policies: Some governments are offering incentives to purchase electric vehicles, such as tax breaks and rebates. This is making electric vehicles more affordable and accessible, which is also putting downward pressure on the prices of petrol/diesel vehicles.

The COVID-19 pandemic: The COVID-19 pandemic has led to a decrease in the demand for petrol/diesel vehicles. This is because people are driving less due to restrictions on movement and social distancing.

It is likely that a combination of these factors has contributed to the decrease in the selling price of petrol/diesel vehicles. It remains to be seen whether this trend will continue in the future.

In addition to the above reasons, here are some other possible explanations:

The introduction of new competition: The entry of new manufacturers into the market has led to increased competition, which has put downward pressure on prices.

The depreciation of the value of petrol/diesel vehicles: Petrol/diesel vehicles tend to depreciate more quickly than electric vehicles. This is because they are more expensive to produce and maintain.

The availability of cheaper alternatives: There are now a number of cheaper alternatives to petrol/diesel vehicles available, such as used cars and electric vehicles. This has made petrol/diesel vehicles less attractive to buyers.

Overall, there are a number of factors that could be contributing to the decrease in the selling price of petrol/diesel vehicles. It is likely that a combination of these factors is at play.

Km driven of Petrol/Diesel Vehicle is huge dropping from 2013 to 2020:

The rise of ride-hailing and car-sharing services: These services have made it more convenient and affordable for people to get around without owning a car. This has led to a decrease in the number of kilometers driven by personal vehicles.

The increasing popularity of electric vehicles: Electric vehicles are more efficient than petrol/diesel vehicles, so they can travel further on a single charge. This is making them a more attractive option for people who are looking to reduce their fuel costs.

The COVID-19 pandemic: The COVID-19 pandemic has led to a decrease in the number of people commuting to work and school. This has also led to a decrease in the number of kilometers driven by personal vehicles.

The rising cost of petrol/diesel: The cost of petrol/diesel has been increasing in recent years. This has made it more expensive to drive a petrol/diesel vehicle, which has led to a decrease in the number of kilometers driven.

It is likely that a combination of these factors has contributed to the decrease in the km driven of petrol/diesel vehicles. It remains to be seen whether this trend will continue in the future.

In addition to the above reasons, here are some other possible explanations:

Improvements in public transportation: Public transportation has become more efficient and reliable in recent years, making it a more attractive option for people who are looking to reduce their carbon footprint.

A growing awareness of the environmental impact of petrol/diesel vehicles: More and more people are becoming aware of the environmental impact of petrol/diesel vehicles, and are choosing to drive less or switch to more sustainable modes of transportation.

Government policies that incentivize the use of electric vehicles: Many governments are offering incentives to purchase electric vehicles, such as tax breaks and rebates. This is making electric vehicles more affordable and accessible, and is likely to lead to an increase in their popularity in the future.

Overall, there are a number of factors that could be contributing to the decrease in the km driven of petrol/diesel vehicles. It is likely that a combination of these factors is at play.

Mileage:
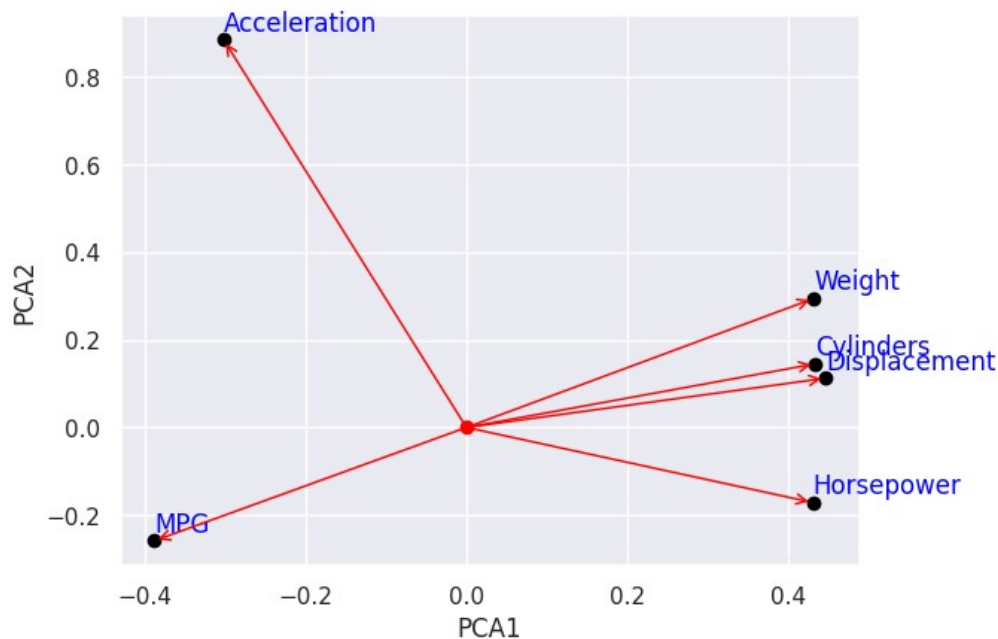
In the case of the PCA graph, the principal components are the weight, number of cylinders, displacement, horsepower, and MPG. The weight, number of cylinders, displacement, and horsepower are all positively correlated with each other. This means that cars with higher values for these features tend to have lower MPG.

The MPG is in the opposite direction to the other features because it is negatively correlated with them. This means that cars with higher MPG tend to have lower values for the other features.

The reason for this is that the weight, number of cylinders, displacement, and horsepower all affect the fuel efficiency of a car. A heavier car will require more fuel to move, and a car with more cylinders will also require more fuel. A larger displacement engine will also require more fuel, and a car with more horsepower will also require more fuel.

The MPG, on the other hand, is a measure of how far a car can travel on a gallon of fuel. So, a car with higher MPG will be able to travel further on a gallon of fuel than a car with lower MPG.

In general, cars with smaller engines and lighter weight will have higher MPG. This is because they require less fuel to move. However, there are other factors that can affect MPG, such as aerodynamics and the type of transmission.

Electric vehicles (EVs) tend to be less in these factors, which is why they give more mileage:

Weight: EVs are typically lighter than gasoline-powered cars because they don't have an engine or fuel tank. This means that they require less energy to move, which results in better fuel efficiency.

In addition to these factors, EVs also benefit from other factors that improve fuel efficiency, such as regenerative braking and aerodynamic design. Regenerative braking is a system that captures energy that would otherwise be lost during braking and uses it to recharge the battery. Aerodynamic design is the process of designing a car that minimizes drag, which also improves fuel efficiency. As a result of these factors, EVs can achieve significantly better efficiency than gasoline-powered cars.

Conclusion:

Develop an EV for the Indian market: The Indian market has unique needs and requirements. Developing an EV that is specifically designed for the Indian market could be a successful business venture.

Focus on the low-cost segment: The average Indian consumer is price-sensitive. Focusing on the low-cost segment of the EV market could be a way to reach a large number of potential customers.

Partner with a government agency: The Indian government is promoting the adoption of EVs. Partnering with a government agency could help you to get access to funding and other resources.

Target fleet operators: Fleet operators, such as taxi companies and delivery services, are potential customers for EVs. Targeting fleet operators could help you to reach a large number of vehicles.

Offer after-sales service and support: The lack of after-sales service and support is one of the biggest barriers to the adoption of EVs in India. Offering after-sales service and support could help you to overcome this barrier.

The government support: The Indian government is promoting the adoption of EVs. This could provide you with access to funding and other resources.

The market size and growth potential: The EV market in India is still small, but it is growing rapidly. This means that there is a lot of potential for growth in the market.

The competition: The EV market in India is becoming increasingly competitive. You will need to find a way to differentiate your startup from the competition.

The regulatory environment: The regulatory environment for EVs in India is constantly changing. You will need to stay up-to-date on the latest regulations in order to comply with them.

The funding requirements: Starting an EV startup in India can be expensive. You will need to secure funding in order to bring your startup to market.

EV Market Segmentation

Malay Vyas

GitHub:https://github.com/MalayVyas/EV_Market

1. Introduction

❖ Global Collaborations: Indian automotive companies are forging partnerships with international firms to tap into cutting-edge EV technology and expertise. Such collaborations are accelerating the development of advanced electric vehicles with a global perspective.

❖ Economic Impact: The growing EV industry is not only contributing to a cleaner environment but also generating employment opportunities. The manufacturing of EV components, battery assembly, and research and development activities are creating jobs, and boosting the country's economy.
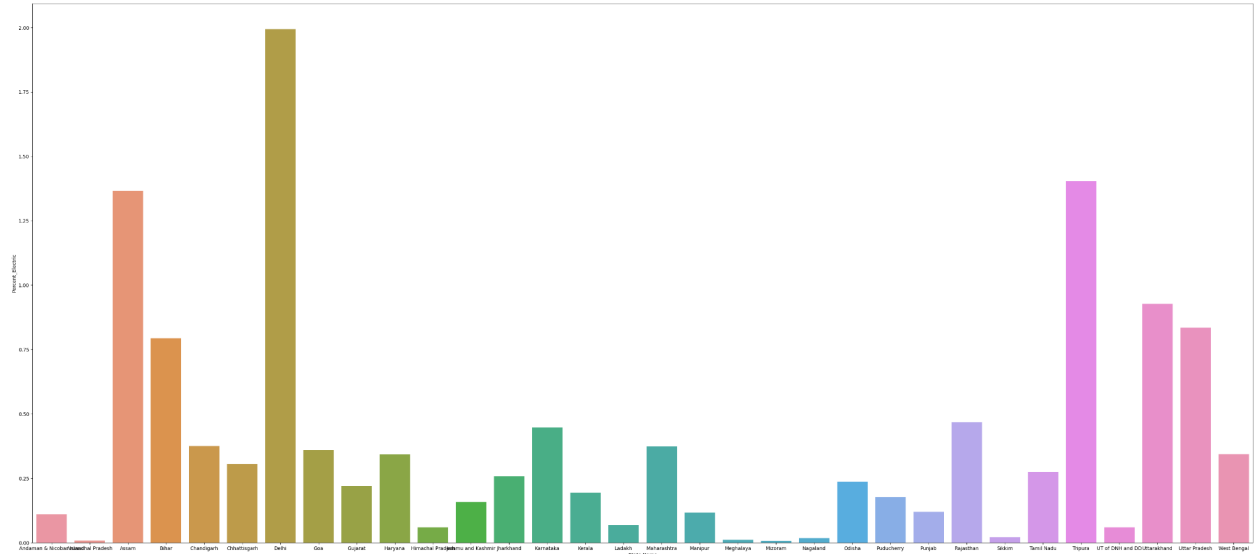
2. Market Analysis

● The Indian electric vehicle (EV) market is one of the fastest-growing iin the world. It is expected to grow at a compound annual growth rate (CAGR) of 94.4% from 2021 to 2030.

● Two-wheelers currently dominate the market, but there is growing demand for electric cars and buses.

● The Indian government is offering several incentives to promote the adoption of EVs, including tax breaks, subsidies, and access to restricted lanes.

● The government has set a target of achieving 30% electrification of the country's vehicle fleet by 2030.

● The EV market in India is expected to be worth around USD 152.21 billion by 2030.
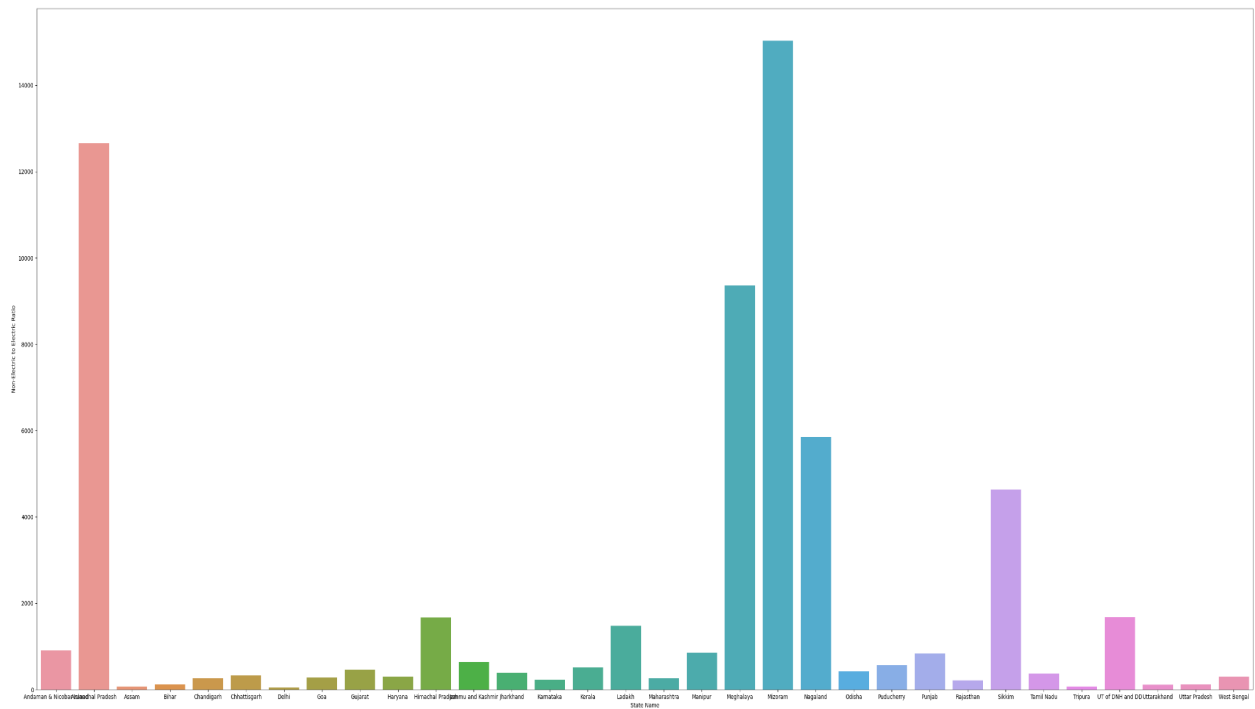
- In 2022, the Indian EV market size was estimated at USD 4.15 billion.
- The two-wheeler segment accounted for the largest share of the market, with 96% of the sales.
- The car segment accounted for 3% of the market, while the bus segment accounted for 1%.
- The government of India has offered several incentives for the purchase of electric vehicles, including a tax rebate of up to INR 1.5 lakh (USD 19,000) for cars and INR 50,000 (USD 6400) for two-wheelers.
- The government has also announced a production-linked incentive (PLI) scheme for manufacturing electric vehicles and components.
- The PLI scheme is expected to attract investments of around INR 45 billion (USD 570 million) and create over 75,000 jobs in the EV sector.
- Promising Trajectory: The electric vehicle market in India is on a promising trajectory, with robust government support, increasing consumer awareness, and a growing infrastructure. This sector is poised for substantial growth in the coming years.
- Environmental and Economic Benefits: The adoption of EVs in India aligns with the nation's commitment to reducing carbon emissions and reliance on fossil fuels. Additionally, the EV sector is creating economic opportunities through job creation and domestic manufacturing.
- Challenges Ahead: Despite its potential, the Indian EV market faces challenges such as affordability, charging infrastructure expansion, and addressing consumer concerns like range anxiety. These issues require ongoing attention and innovative solutions
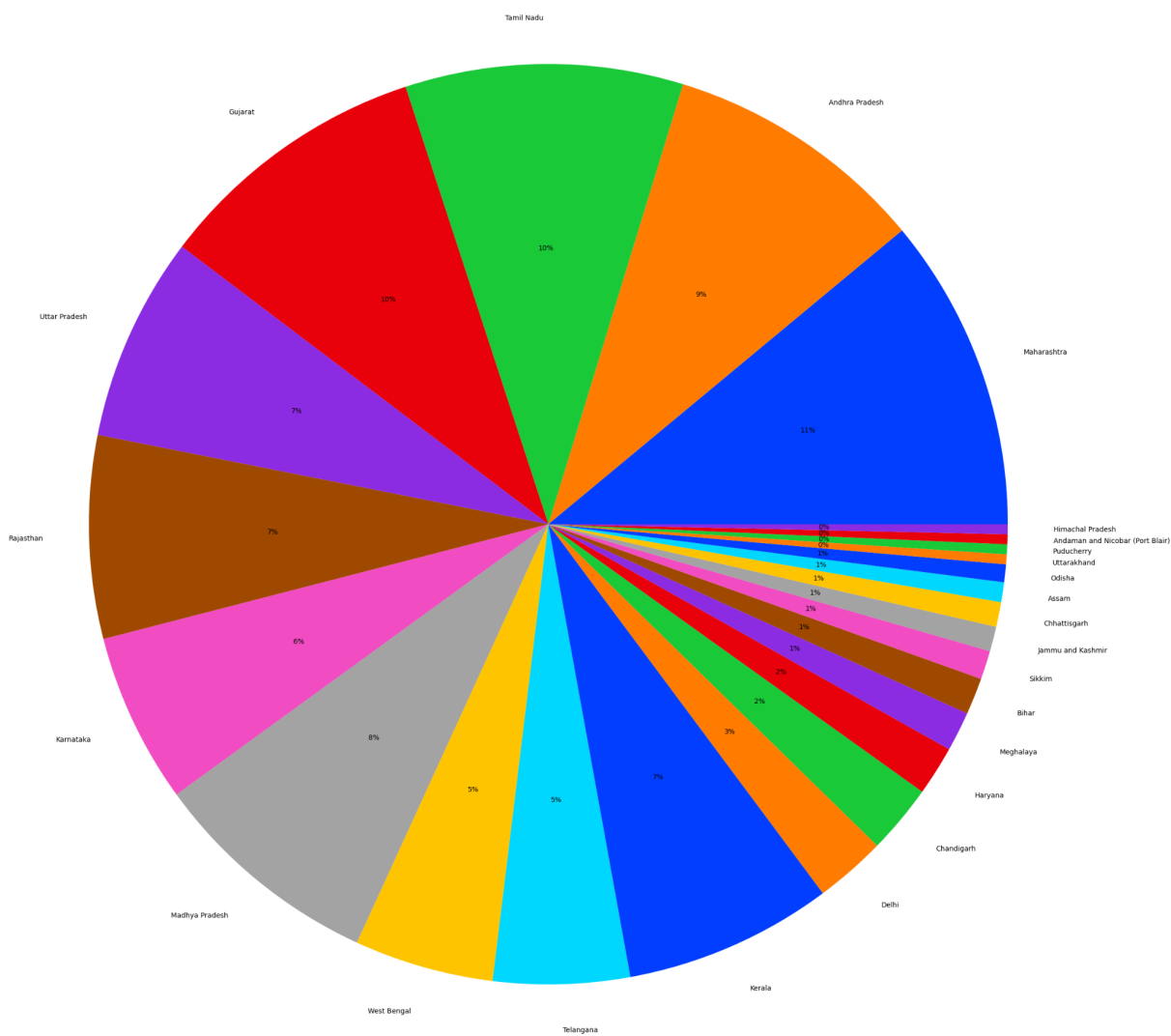
Demographics:

Total Market Share of Electric Vehicles[State Wise]:

Biggest Untouched Markets:

Charging Stations in India:

Tamil Nadu

Andhra Pradesh

Maharashtra
11%

Himachal Pradesh
Andaman and Nicobar (Port Blair)
Puducherry
Uttarakhand
Odisha
Assam
Chhattisgarh
Jammu and Kashmir
Sikkim
Bihar
Meghalaya
Haryana
Chandigarh
Delhi
Kerala
Telangana
West Bengal
Madhya Pradesh
Karnataka
Rajasthan
Uttar Pradesh
Gujarat

10%
9%
10%
7%
7%
6%
8%
5%
5%
7%
3%
2%
2%
1%
1%
1%
1%
1%
0%
0%
0%
0%
0%

Conclusions:

- **The Indian EV market is growing rapidly. The market size was estimated to be USD 1.45 billion in 2021 and is projected to reach USD 113.99 billion by 2029, growing at a CAGR of 66.52% during the forecast period.**

- **The two-wheeler segment is the leading segment in the Indian EV market. It accounted for 83% of the market share in 2021. The three-wheeler segment is the second-largest segment, followed by the four-wheeler segment.**

- **The government of India has been taking several initiatives to promote the adoption of electric vehicles. These initiatives include providing subsidies, tax breaks, and setting up charging infrastructure.**

- **The major challenges for the Indian EV market are the high upfront cost of EVs, the lack of charging infrastructure, and the range anxiety of consumers.**

- **The Indian EV market is expected to grow significantly in the coming years. The government's initiatives, the increasing awareness about the environmental benefits of EVs, and the declining cost of batteries are expected to drive the growth of the market.**

- **In 2021, India sold over 300,000 electric vehicles. The state of Uttar Pradesh is the leading market for electric vehicles in India.**

EV Market Segmentation

Karakavalasa Venkata pranay

GitHub:

Introduction

Electric vehicles have been gaining popularity worldwide as people become increasingly aware of the adverse effects of fossil fuel-powered vehicles on the environment. In India, the rise of electric vehicles has been slower than in some other countries, but there are indications that this trend is changing. In this article, we will explore the rise of electric vehicles in India and consider whether they could be the future of transportation.
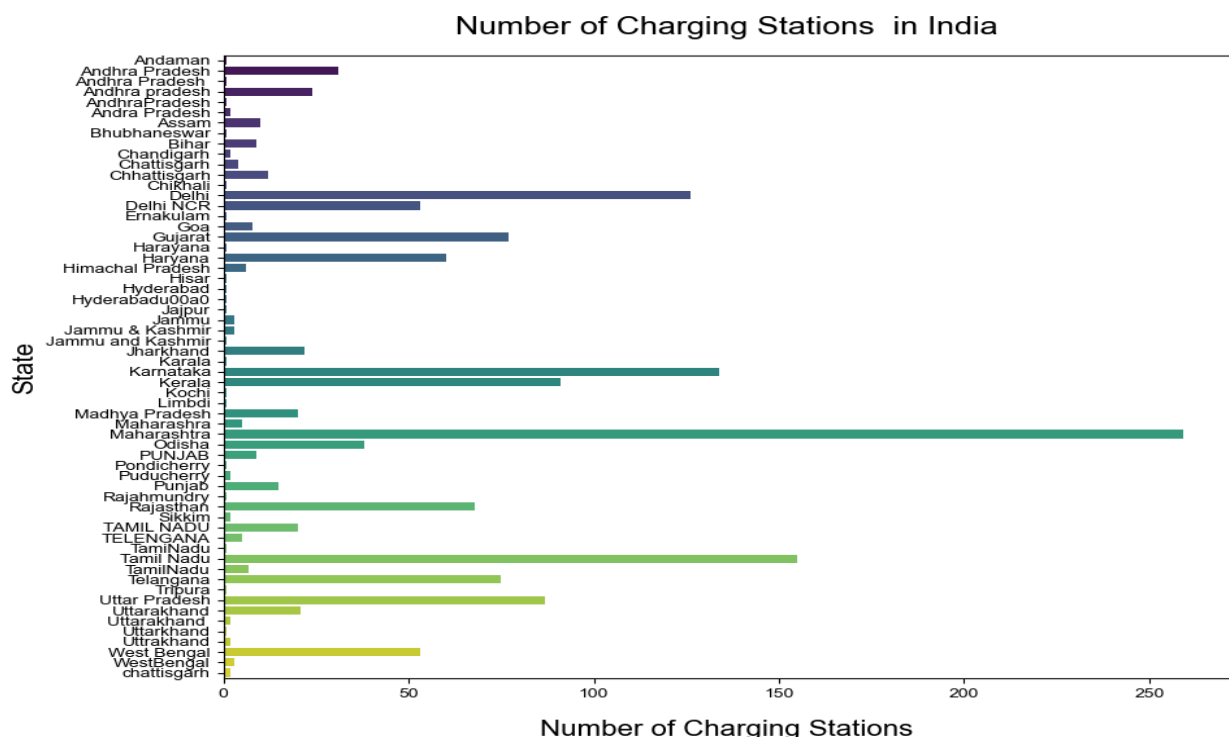
Market Analysis

- The electric vehicle (EV) market has grown in the past year. The 999,949 EVs sold in CY2022 represent a significant 210% year-over-year increase over the 322,871 units sold in CY2021.

- The two- and three-wheeler markets, referred to as the "close to the bottom peaches" of the EV business, is responsible for most of the growth. They are the main drivers of EV sales because they are cheaper than the electric passenger or commercial vehicle segments.

- According to the Economic Survey 2023, India's domestic electric vehicle industry will develop at a 94.4 percent compound annual growth rate (CAGR) between 2022 and 2030, reaching 10 million sales every year by that point.

- Furthermore, it is anticipated that by 2030, the electric automotive industry will generate 50 million direct and indirect jobs.

- **Challenges:** There are several challenges that need to be addressed for electric vehicles to become more prevalent in India. One of the main challenges is the need for charging infrastructure.

- While the government has announced plans to set up charging stations across the country, the progress has been slow, and many potential buyers are deterred by the fear of running out of charge during a long journey.

- Another challenge is the high cost of electric vehicles. While the prices of electric vehicles have been coming down in recent years, they are still more expensive than their petrol or diesel counterparts. This makes them less accessible to the average consumer.

- the range of electric vehicles still needs to be improved, which makes them unsuitable for long-distance travel. While this is less of an issue for urban commuters, it remains a significant concern for those who need to travel long distances.

- there are indications that the future of transportation in India could be electric. The government has set a target of achieving 30% electric vehicle replacement by 2030.

- The government has set a target of achieving 175 GW of renewable energy capacity by 2022, and there are plans to increase this to 450 GW by 2030.

- The Faster Adoption of Manufacturing of Electric Vehicles Scheme-II (FAME-II) and the Production Linked Incentive Scheme are two government programs that have previously been made available to electric car manufacturers (PLI).
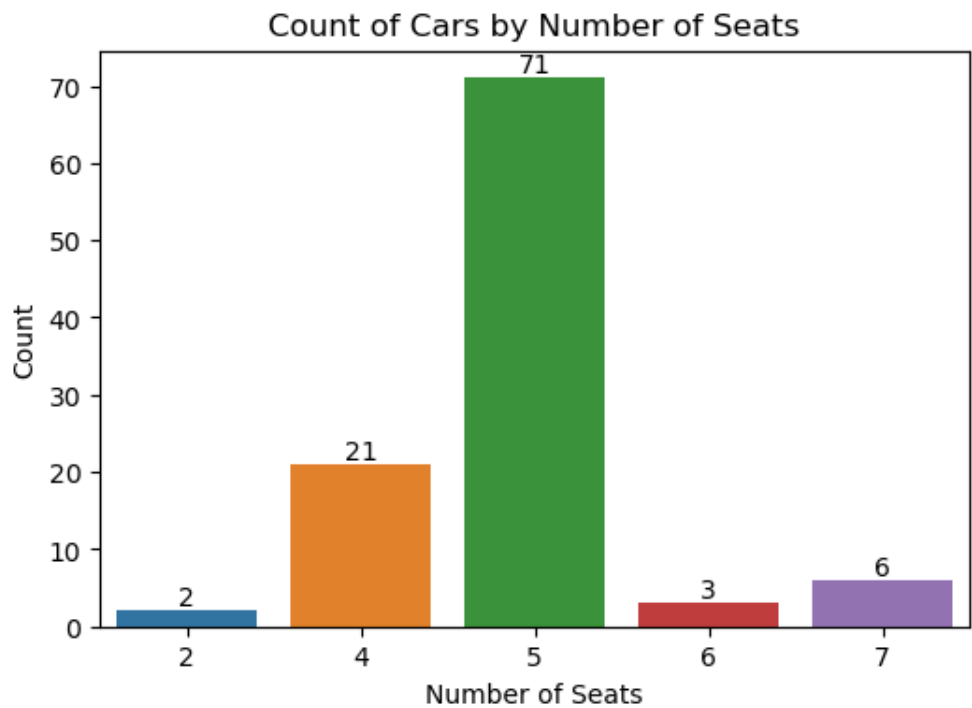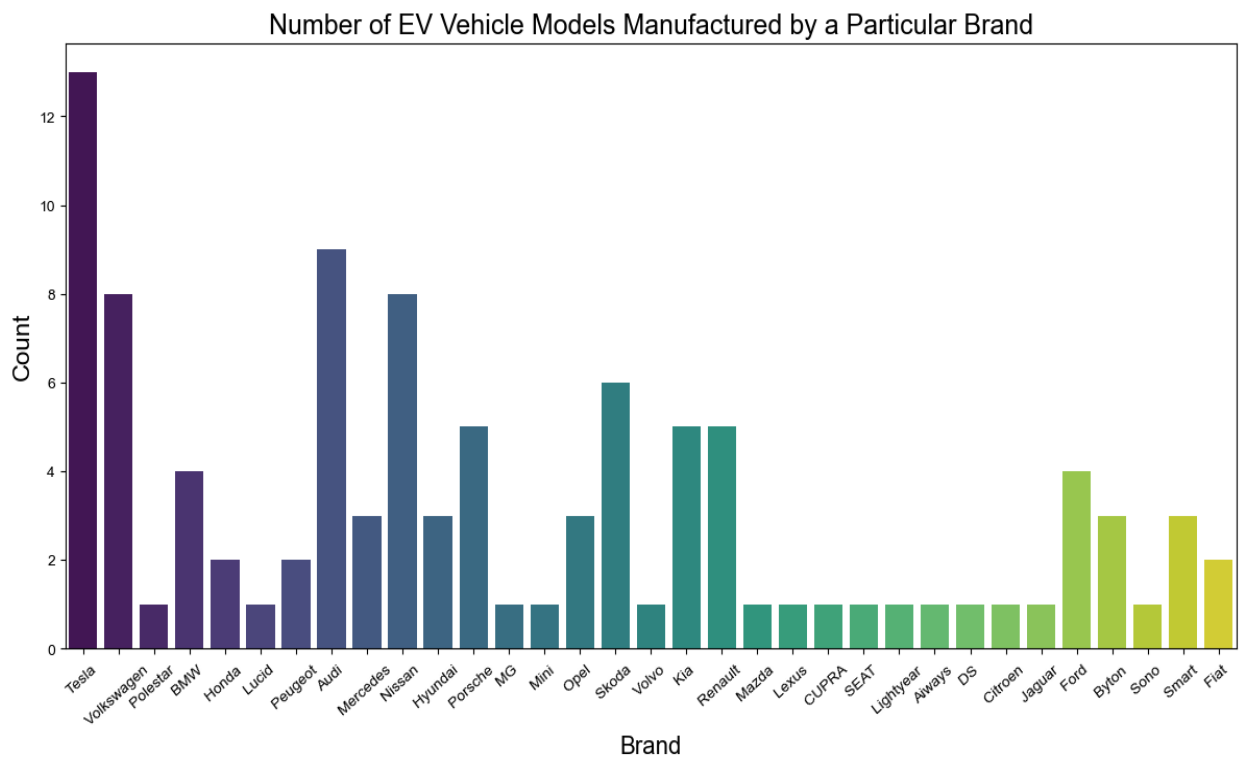
Demographics:

Charging stations in India:

Overall sales in the world:

Number of ev sales in world
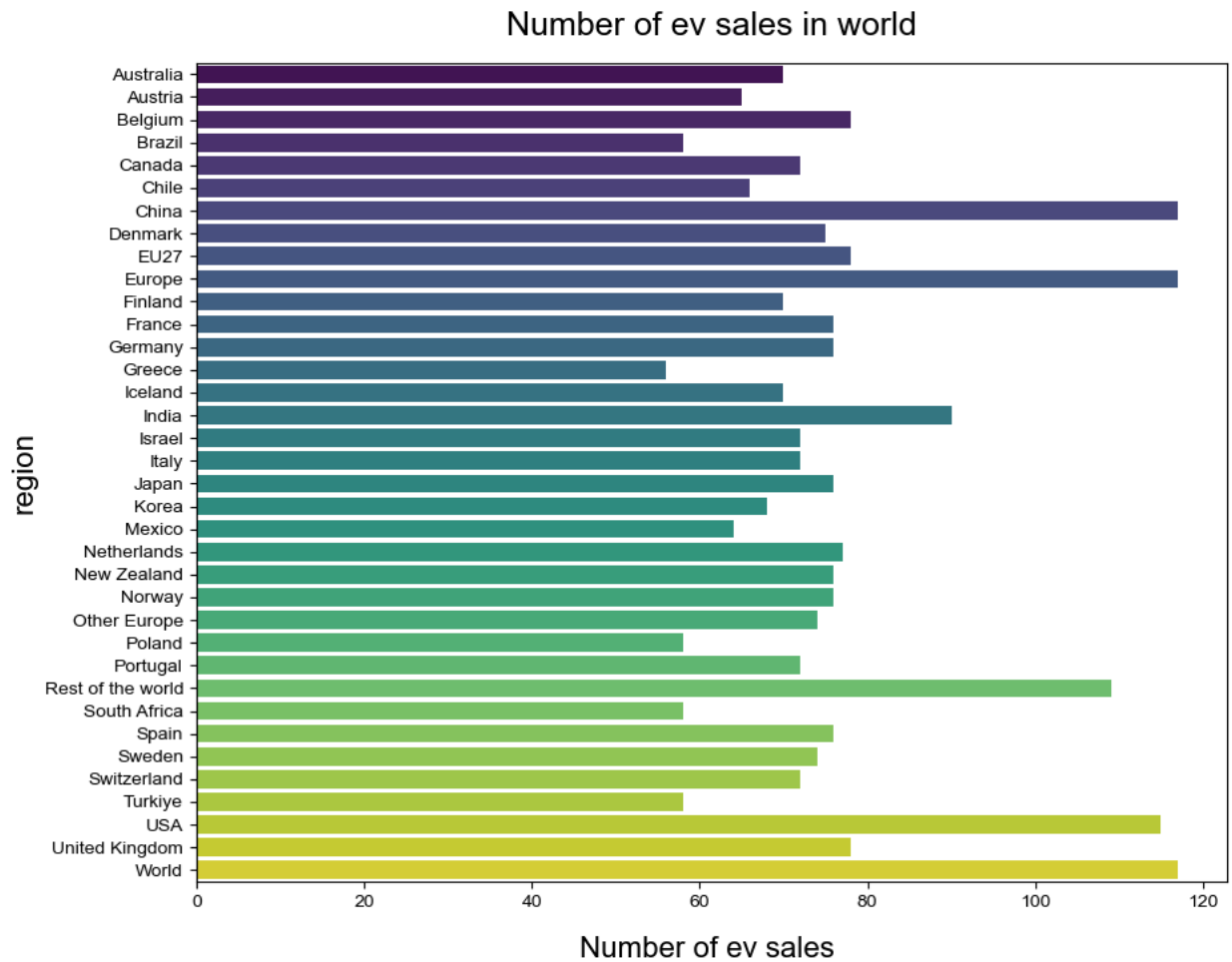
Elcetronic vehicles manufactured by companies:

Number of EV Vehicle Models Manufactured by a Particular Brand

Count of Cars by Number of Seats

Observations:

- Most number of charging stations in India are in Maharastra followed by Karnataka, Dehli and Tamil Nadu which has the popular cities.
- Most of the electronic vehivle sales are done in regions China,USA and Europe compared to the rest of the world.
- Telsa company produces the majority of the electronic vehicles used today.
- 70% of the total electronic vehicles are manufactured in such a way that they contain 5 seats.
- But the most efficient cars are 6 seated cars.
- Almost 60% of the electric cars are Automatic transmission rather than manual.

Conclusion:

The rise of electric vehicles in India is still in its early stages, but there are signs that this trend is changing. The Indian government has been promoting the use of electric vehicles for several years, and initiatives are underway to address the challenges currently hindering their adoption. While there are still hurdles to overcome, the future of transportation in India could be electric, and this could help to reduce the country's carbon footprint and improve air quality in its cities.

Name: Shreyash Banduji Chacharkar

Github link:
https://github.com/ShreyashChacharkar/EV_marketsegment

EV Market Segmentation:

The Indian electric vehicle (EV) market has experienced rapid growth in recent years, driven by government incentives and increasing awareness of environmental sustainability. As one of the largest automobile markets in the world, India holds significant potential for the expansion of EV adoption, with a growing number of manufacturers introducing electric vehicles to cater to the increasing demand.

Market Analysis:

1. **Electric Vehicle Sales Growth**: Electric vehicle (EV) sales in India remained relatively stagnant until 2016. After that, there was a significant uptick in growth, with a remarkable Compound Annual Growth Rate (CAGR) of 40.3%.
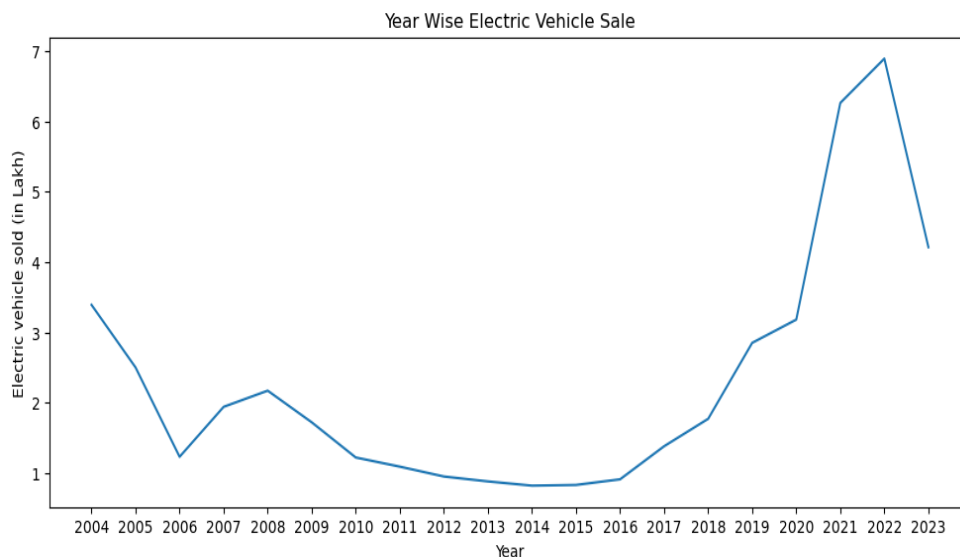

Fig 1: Year wise Electric vehicle production

2. **Seasonal Sales Peaks:** Notably, the highest EV sales occur typically in the months of January, February, March, July, and September. Mainly due Indian customer behaviour at festival.
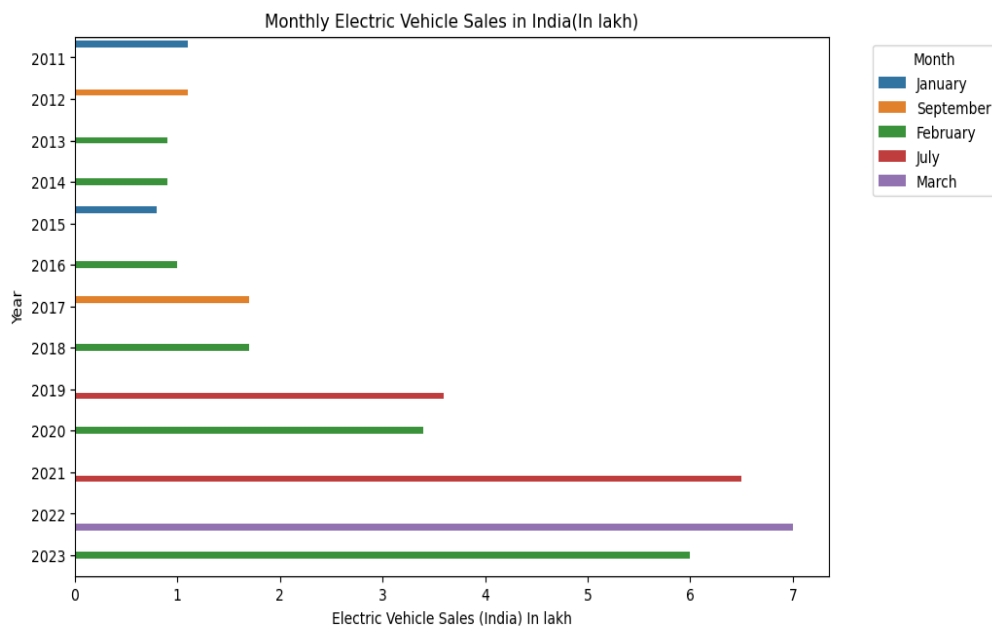
Fig 2 . Electric vehicle sales

3. **Government's FAME Scheme:** The Government of India initiated the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme with the aim of promoting the widespread adoption of electric and hybrid vehicles. FAME II, launched in April 2019 and designed to span three years, involved a substantial allocation of INR 10,000 crore (approximately USD 1.4 billion) to incentivize the production and adoption of EVs.

4. **Charging Infrastructure Development:** The government also dedicated funds to bolster the development of EV charging infrastructure throughout the country. This endeavor encompassed the establishment of public charging stations, with a particular focus on urban areas and highway networks. The allocated amount for charging infrastructure evolved on a yearly basis.

5. **Incentives and Subsidies:** To stimulate the EV ecosystem, the government extended subsidies and incentives to both EV manufacturers and buyers. These incentives comprised reduced GST rates, income tax benefits, as well as subsidies applicable to electric two-wheelers, three-wheelers, and four-wheelers.

6. **Significance of the Delhi-Kolkata Freight Corridor:** The Delhi-Kolkata freight corridor is of paramount importance within India's transportation landscape, facilitating the efficient movement of goods and commodities between the northern and eastern regions of the country. This corridor plays a critical role in the logistics and supply chain industry.
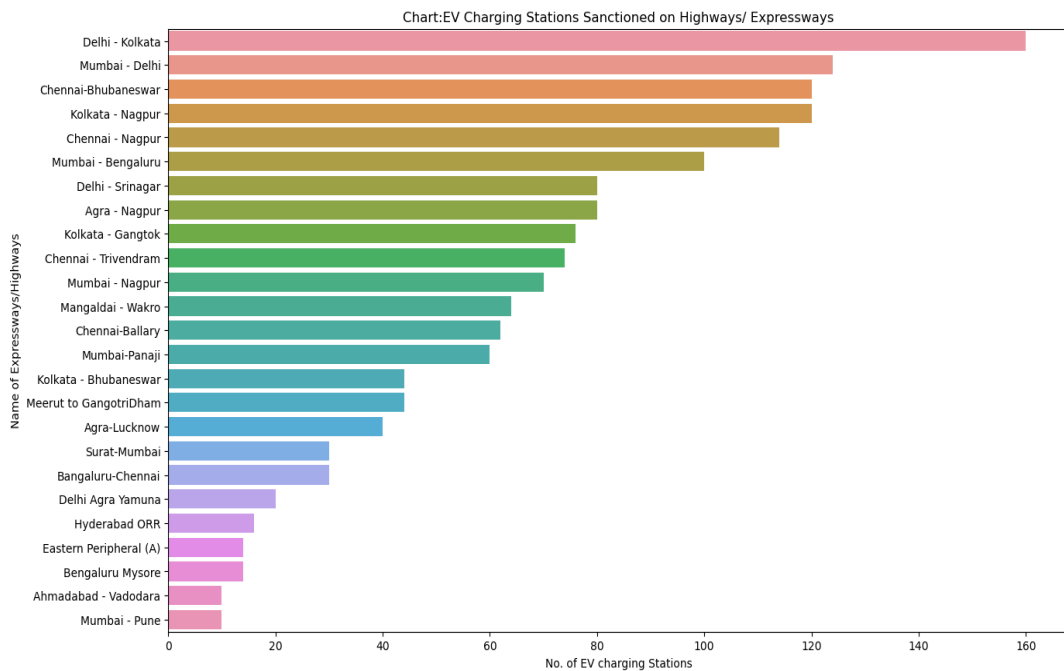

Fig3. Charging Station deployment at Expressway and Highway

7. **Strategic Charging Infrastructure Deployment**: The strategic deployment of a substantial number of EV charging stations along this corridor aligns harmoniously with the government's overarching objective of promoting electric mobility, particularly in the commercial and freight sectors. This is in response to the development and deployment of electric trucks and other heavy-duty vehicles designed to curtail emissions and operational expenses within the logistics industry.

8. **Enhanced Connectivity Through Charging Stations:** The establishment of charging stations in key cities along this corridor, including Delhi, Chennai, Kolkata, and Nagpur, ensures that electric freight vehicles possess the necessary access to charging infrastructure at pivotal transit points. This, in turn, augments the overall connectivity and viability of electric vehicles for long-haul transportation.

9. **Economic Advantages:** The promotion of electric freight vehicles carries inherent economic advantages. Electric vehicles, when compared to traditional diesel-powered counterparts, boast lower operating costs. This, in effect, results in cost savings for businesses engaged in logistics and transportation, subsequently fostering economic growth at a broader scale.
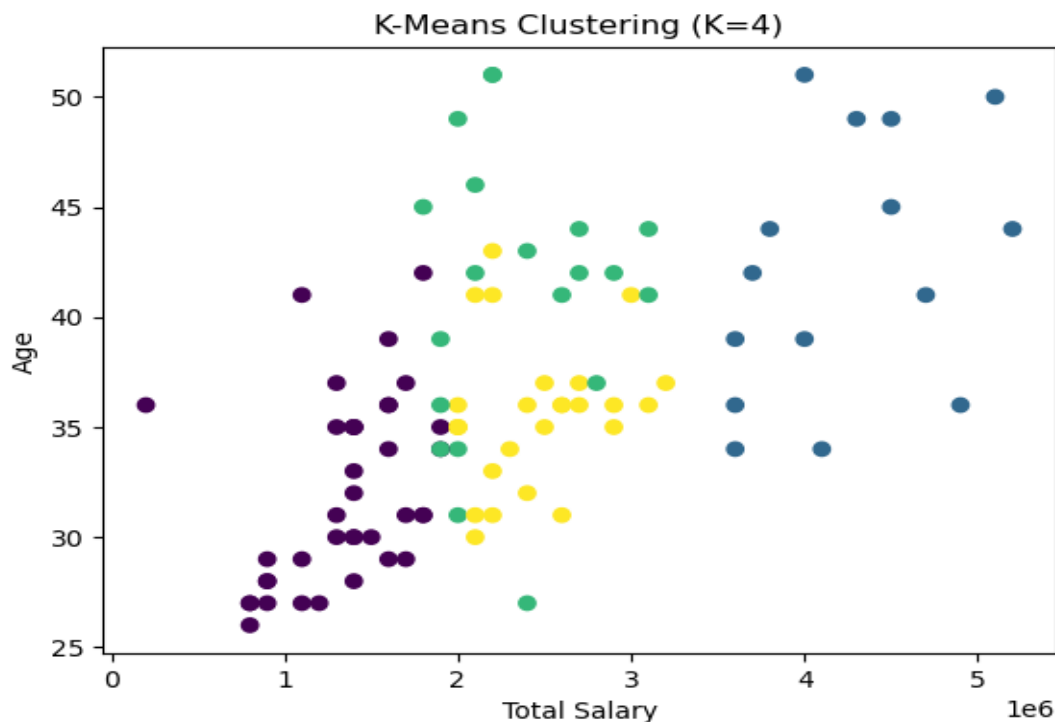

Fig 4 Indian Customer Segmentation

Conclusion:

- Maximum no. of charging stations are installed at Delhi-Kolkata i.e. Nearly 160.
- Chenni, Kolkata, Nagpur, Delhi are top cities through which highway pass which has highest no. of charging station.
- EV sales growth was stagnant until 2016 after that it grows significantly with 40.3% CAGR
- Maximum Sales can be observed in either January, February, March or July, September month.

EV Market Segmentation

-Yash Mayur

Github Link - https://github.com/ysmayur1992/Feyyn_Labs_Project_3

1) Introduction:

The automotive sector in India is dominated by Non-Electric Vehicles since decades. Majority of public buying fossil fuel engine based vehicles because of the its low prices, low maintenance cost and ease of availability of infrastructure for receiving facilities of petrol and diesel are another factor for popularity of these vehicles .

Electric Vehicles have become a new point of attraction in India. Many big automotive brands like TATA, Mahindra and other international companies are introducing their unique products in EV markets.

In this project, we have researched, analyzed and came up with space and specific range of products which will help us to produce our unique Electric Vehicle to compete with these brands and help Indian public to cope up with technological advances in vehicles with economical prices and this will help our startup to grow EV business shoulder to shoulder with the bigger automotive companies

2) Market Info:
a) General Usage Info:

- Electric Vehicles (EVs) currently account for less than 1% of total vehicle sales in India the market is growing rapidly and expected to be worth around at least INR 475 billion by 2025. Two-wheelers account for the largest share of this market at 62%, followed by three-wheelers at 37%.
- The Indian EV market varies significantly by state, depending on factors including demographics, income levels, regulatory landscape and urbanization. The state of Uttar Pradesh, for instance, with one of the lowest urbanisation rates, has seen significant uptake of electric two-wheelers.
- The four-wheeler segment currently has the lowest EV penetration of 0.12% (3,400 units of electric passenger cars sold in 2020) but may grow to 5% by 2025 in an optimistic scenario.

b) Battery Info:

- Lead-acid batteries currently dominate the market but demand for Lithium-ion battery models is expected to grow rapidly under government incentives and demand from bike and scooter.
- Current and desired driving range of different EV categories in India set by Government of India is presented in the following table.
- Table:

Vehicle Category	Battery Capacity (KwH)	Energy Consumption (kwh/km)
E-bike	1.2	0.016
2 WLS	2.2	0.025
2 WCS	3.0	0.030
2 WHP	4.6	0.035
Electric Cars	40	0.157
LPV	49	0.209

- The calendared lifetime of a battery used in an EV is dictated by the electrode materials. It is further determined by the number of charge and discharge cycles, charging speed, and temperature of operation.
- Batteries are generally retired from automotive application when they can retain only about 80% of their initial stated capacity, and proper treatment of retired EV batteries will both reduce their life-cycle greenhouse gas emissions and maximize their economic value.
- Before recycling, there are practical second-life applications of EV batteries. EV batteries that retain 80% of their original capacity might not be suitable for EVs, but are appropriate for less demanding applications such as grid-scale renewable energy storage.
- This strategy aligns with Government of India's target of installing 175 GW of renewable energy capacity by 2022. It is estimated that these batteries can serve as energy banks until they deteriorate to 60% of their initial capacity35 and this extends their economic life by another 10 years.

3) Market Segmentation Analysis

For this segmentation 5 types of datasets were used from different sources such as from government websites, car research platforms, and market research

a) Visualization Analysis:

(a) Geographic and Demographic Research:

- South India being a Tech Hub is a backbone of EV demands.
- In earlier part, we analyzed that south Indian states has good number of charging stations available.

- Popular car brand's manufacturing plants and main head headquarters' are in south India as well, which plays an important role for ease of survey and fulfill consumer's demands by these top companies
- Delhi had highest number of charging stations (analyzed earlier), but still EV popularity is relatively low.
- North east India is gaining popularity in EV despite less infrastructure.
- Other states and regions especially North, West, East and Central India has a balanced numbers and competitive demands.
- We did not get any survey information on Daman and Diu and Lakshadweep, so these 2 regions are not analyzed properly.
- **On availability of charging stations, we observed:**
- First observation, only limited number of charging station is available in India as of 2023.
- Delhi being capital has more number of charging station as compared to other metro cities.
- South Indian metro cities have balanced number, but still many cities are missing from south India.
- Mumbai being the economic capital of India have only 1 charging station in Navi Mumbai (private charging stations not counted or being missed).

(b)   Psychographic and Behavioral Research:

Relationship of car prices and fuel types and majority people purchase capacity
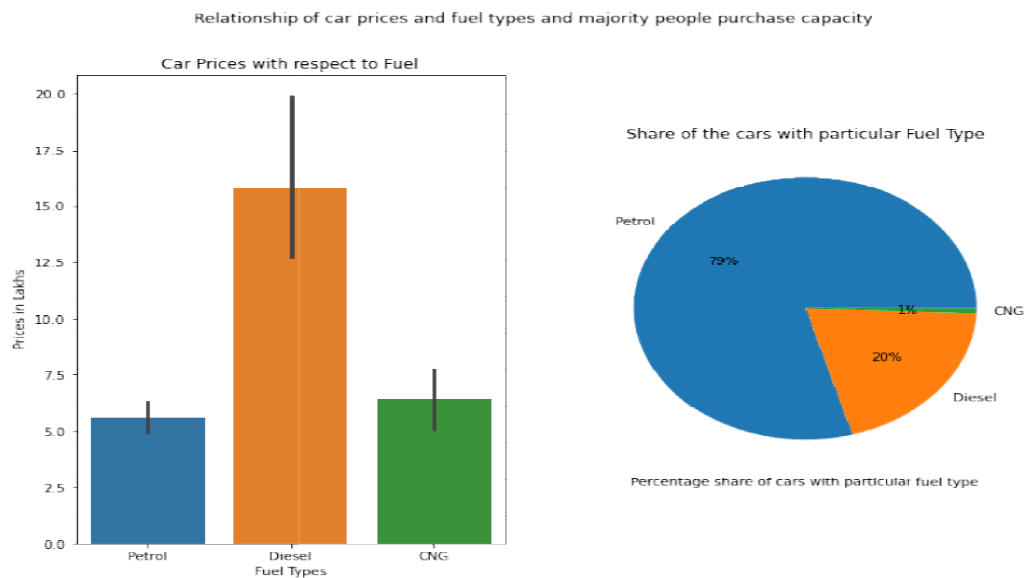
- Petrol cars are the most popular cars occupying 79% of its share in its competition. it is understandable because petrol cars are cheaper than Diesel cars and CNG cars.

- Diesel cars, despite being costly, it occupies a noteworthy share of 20% of the popularity.

- Diesel cars are more popular than CNG, this is because current diesel engines have greater performaces than both petrol and CNG engines.

- Diesel cars are also very much long lasting running cars as compared to both bot the other cars, that's why it has more popularity.

- CNG cars have lowest popularity, just because this car lacks competitive performance, and engine durability. CNG cars only have good fuel economy, because CNG is cheap.

- Vehicle Price is a big concern, First Majority of public buying petrol cars because of the its cheap price.

- Second majority of public buying diesel cars, the public interested for high performance and long lasting low maintenance car.
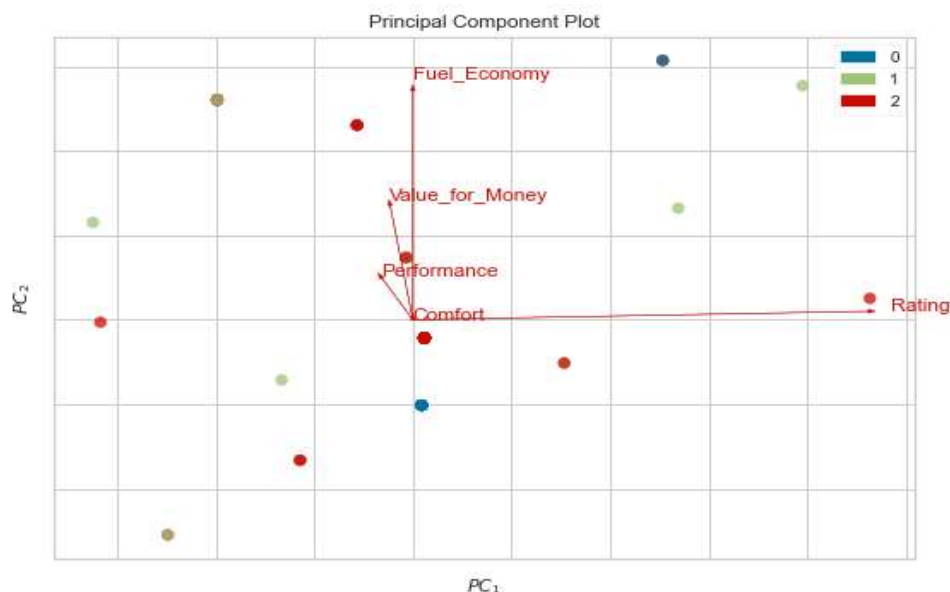
b) Segmentation Analysis:

In Segmentation analysis, we analyzed segments on public reviews from car research platform (carwale.com). Below are the results:

(Note: The detailed analysis explanation on segmentation is in the code file please refer github link for code file)

Psychographic and Behavioral Research:

❖ Principal Component Analysis

- PC1 and PC2 are the 2 componants captured highest of information contained in segmentation variables.

- The above Principal Component Plot shows clearly:

  o According to first principal Componant(PC1) we assess the fact that value for money, the performance and the Fuel economy feature of the EV has similar percentage and closest positive ratings.

❖ Segment Extraction:


AIC and BIC Scores for Gaussian Mixture Model
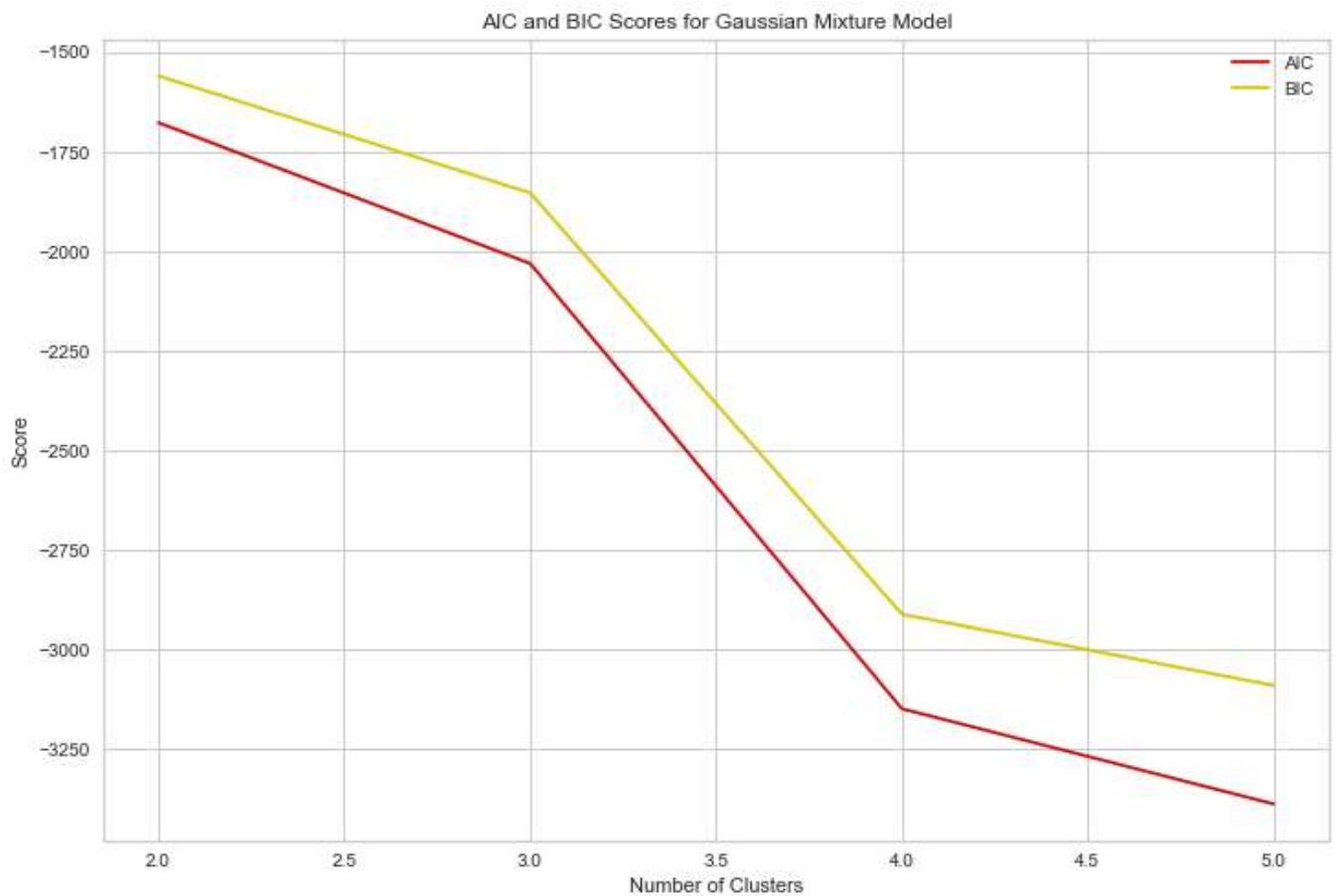
- From the plot above, we can clearly see that the 4 and 5 market segment solution have some stability here 4 market segment solution makes some stabilty and the curves flatten for a while

❖ Describing Segments:

X - Segment Number and Y - Sentiments
segment number
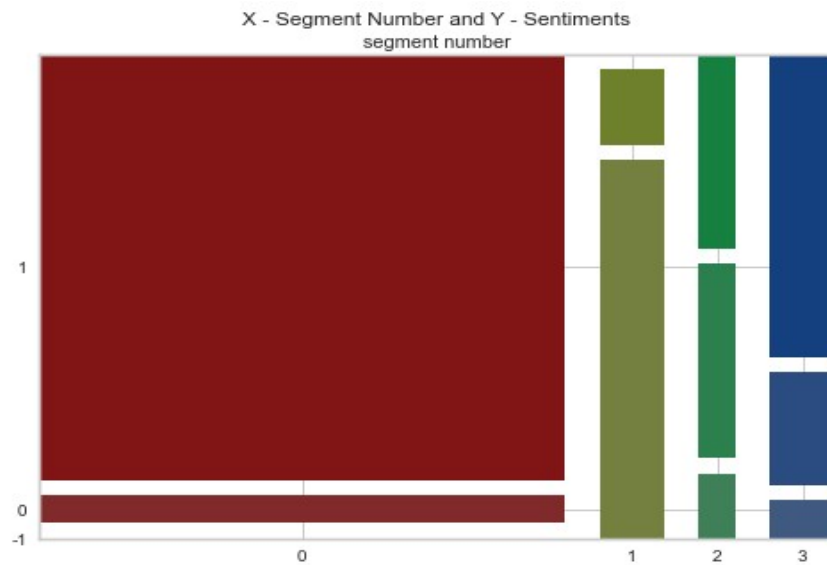
- Members of segment 1 (depicted in the first column) expresses most positive responses of EVs the top left boxes being colored in red.

- In stark contrast, members of segment 2 expresses Negative Thoughts (as indicated by the pale green bar boxes).

- Segment 3 provides info about people expressing balanced responses (as indicated by dark green color).

- Segment 4 have majority of positive responses (as indicated by dark blue).

❖ Selecting The Segments:
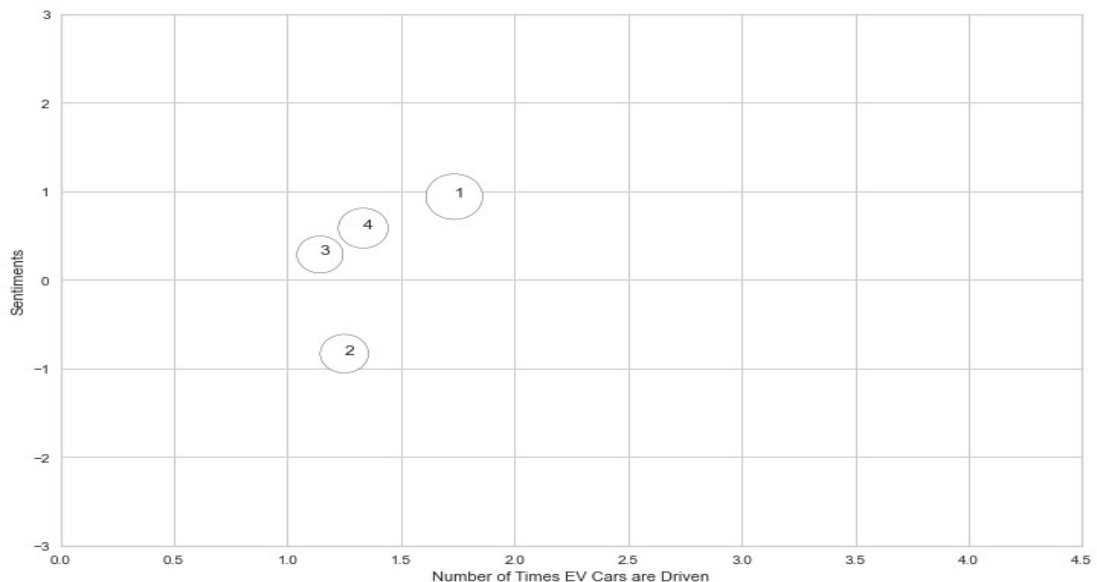
- Market segments 1 are located in the attractive quadrant of the segment evaluation plot. Members of these two segments like EVs and recommend others to buy it. These segments need to be retained, and their feedbacks must be considered seriously.

- Market segment 3 and 4 also provides positive sentiments towards EVs but there driving frequency is less. Therfore, There feedbacks are also important and need special attention as well for the betterment in the Electric Vehicle.

- 3)Market segment 2 is located at least attractive position, members in this segment not having positive attitude towards EV, Thus making them unattractive as a potential market segment.

(c) Economical Research:

- Another dataset was consider for economical analysis to check for best technical specification and we come up with the best range for price, battery capacity, driving range, power, and the total charging time require.
- Below is the excel spreadsheet table of ranges:

1. Price range
2. Battery Capacity
3. Driving Range
4. Power (Performance)
5. Charging time

946000 Lakhs - 3950000 Lakhs
26.0 KwH - 107.8 KwH
315.0 KMs - 857.0 KMs
73.75 BHP - 516.29 BHP
1.5 Hours - 9.0 Hours

- We come up with a competitive range of price. Our product price range should be within range or more economical if possible.

- We defined a range of Kilo-Watt Hour battery capacity.

- The defined batteries should produce significant range of power as defined.

- We have to see if we can improve more on driving range provided, but our driving range should be at maximum of given range. Time taken to charge a battery should be within the range

4) Conclusion:

a) Geographic and Demographic analysis:

- We analyzed that south India region is more technologically advanced with good availability of charging infrastructure and Electric vehicles becoming more popular. Big Brands who already launched their products and have their manufacturing plants in south India. It is possible that we can create space for our EVs but it will be very difficult
- North Eastern states have growing popularity specially Sikkim, this is a good place for us to create space for our EVs
- Once our EV popularity grows up, we can target to East Indian states and central Indian states.

b) Psychographic and Behavioral analysis:

- From Reviews Dataset from carwale.com, I did market segmentation on people's reviews on EVs whether they have positive approach towards it. we found that 3 out 4 have positive approach and are likely to buy new EV. Those who have done small test drive are likely to buy. Those who already driving regularly are recommending others to buy it.
- Competitive prices, more features and good performance in EVs are key points to be considered, as in the analysis i come up with the observation of the people more tended to buy low priced and low maintenance cost vehicles.

c) Economical Analysis:

- From the information in the dataset about current details on electric cars. I came up with a dictionary of different specifications and its ranges.
- I came to the conclusion that, if we want to successfully come to the competition with other products, we need to follow this ranges.
- For the price range our product price should be within the maximum range of price and will keep on optimizing so we can keep our vehicle price low.
- Keeping an eye on price, we should deliver with maximum battery capacity and good quality battery following the guidelines of Government of India, so that the power sustain capability will improve and we will be capable of producing environment friendly vehicles.
- We have to balance our battery capacity with the performance power and driving range as well.
- Fast-charging mechanism should be implemented for better and faster charging ability and to keep the charging time within the range.

Final Thoughts on Startup Strategy

1) In case of E-Bikes we can target some East Indian states like Uttar Pradesh, Bihar and West Bengal as the economic condition of majority of people is low so a good competitive E-bike with good amount of features and reasonable price range will be a good choice. Central Indian States like Madhya Pradesh will also a good choice to introduce E-Bikes

2) In case of E-Cars North-East India and Central India should be the first choice region as they have good popularity of EVs. East Indian states would be the second choice after the popularity of the startup improves and we are safe to grow our business.

3) North Indian states are not recommended right now because of the analysis results. People are not buying EVs despite having lots of charging infrastructure.

4) South Indian states should be kept for future as there are already many international brands launched their EVs at competitive prices and tones of features. So South India will not be a safe option right now.