Electric Vehicle Market

Segmentation and Analysis

A Project Report Submitted in partial fulfillment of the

Requirements for the award of the degree of

Master Of Science

in

(Data Science & Big data Analytics)

By

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CERTIFICATE

This is to certify that project entitled **"Electric Vehicle Market Segmentation and Analysis"** Submitted by **'Mr. Viraj Vilas Parab'** Exam Seat Number**: 43238426** for the partial fulfillment of the requirement for award of degree Master of Science in Data Science and Big Data Analytics, to the University of Mumbai, is a bonafide work carried out during academic year 2022 - 2023

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DECLARATION

I declare that this submission represents my ideas in my own words and where other ideas or words have been declared that I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will cause disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ABSTRACT

The electric vehicle (EV) market has been rapidly growing in recent years, and understanding its market segmentation and analysis is essential for businesses and policymakers to develop effective strategies and policies.

This study aims to identify the different segments of the EV market, analyze market trends, forecast future growth potential, and recommend strategies for businesses.

The study collected and analyzed data using secondary sources. Key findings include the identification of several market segments and the increasing popularity of EVs among consumers.

The study's significance lies in its contribution to the field of EV market segmentation and analysis and its potential practical applications for businesses.

General Terms:

This project on EV market segmentation and analysis is helping the EV industry to better understand market trends and consumer preferences, ultimately contributing to the development and promotion of EVs for a more sustainable and prosperous future.

Keywords:

Electric vehicles, Market segmentation, Cluster analysis, data science, machine learning

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Code of Vehicles Prices EDA:[Click here]

Code of Petrol and Diesel Prices Forecasting: [Click here]

Chapter 1: INTRODUCTION

- Background:

The global transition towards sustainable energy sources and reduced carbon emissions has become a pressing concern in recent years. As the negative impacts of climate change become increasingly evident, there is a growing recognition of the need to adopt cleaner and more environmentally friendly alternatives. One significant area of focus is the transportation sector, which is responsible for a significant portion of greenhouse gas emissions. In response to this challenge, electric vehicles (EVs) have emerged as one of the most promising solutions to mitigate the effects of climate change and reduce our dependence on fossil fuels.

- Purpose:

The surge in demand for electric vehicles in recent years underscores the significance of this market segment. For EV manufacturers and policymakers, gaining insights into market trends and consumer preferences is crucial for developing and promoting EVs effectively.

- Scope:

This analysis provides valuable insights to EV manufacturers and other stakeholders in the EV ecosystem. By analyzing data such as sales figures, manufacturers can gain insights into the performance, and pricing that consumers are looking for in EVs.

Fig. 1.1

- Applicability:

The state-wise market segmentation analysis I conducted is highly applicable to EV manufacturers. It provides valuable insights into regional variations in demand, infrastructure, and consumer preferences. This enables manufacturers to target specific states with tailored marketing strategies and product offerings, maximizing their chances of success in those markets.

The EDA on two-wheelers and four-wheelers prices is directly applicable to EV manufacturers as well. By analyzing pricing data, market trends, and competitive landscape, I provide manufacturers with a comprehensive understanding of the pricing dynamics in the EV market. This allows them to make informed decisions regarding pricing strategies and product positioning.

The forecasting of petrol and diesel prices for 2024 adds significant value to my project. EV manufacturers can utilize this information to anticipate future pricing trends of conventional fuels. This knowledge allows them to demonstrate the cost advantages of electric vehicles over traditional fossil fuel-powered vehicles, promoting the adoption of EVs.

- Achievements:

Through my project, I have achieved several noteworthy outcomes for EV manufacturers:

i. **Informed Decision-Making**: My project equips EV manufacturers with valuable insights for making informed decisions. The state-wise market segmentation, EDA on prices, and fuel price forecasting provide manufacturers with the necessary information to strategically choose target states, set competitive pricing, and align their product offerings with market demand. This enhances their decision-making capabilities and increases their chances of success in the EV market.

ii. **Enhanced Market Penetration**: By leveraging the insights from my project, EV manufacturers can enhance their market penetration. The state-wise market segmentation analysis allows manufacturers to identify regions with high growth potential and favorable conditions for EV adoption. This enables them to focus their resources and marketing efforts on those areas, resulting in increased market share and expanded customer base.

iii. **Competitive Advantage**: The analysis and forecasting provided by my project give EV manufacturers a competitive edge. By understanding the pricing dynamics and fuel price trends, manufacturers can position their electric vehicles competitively against traditional vehicles. They can emphasize the cost savings, sustainability benefits, and long-term value proposition of EVs, making them more attractive to consumers and gaining a competitive advantage in the market.

iv. **Business Planning**: The findings and insights from my project support EV manufacturers in their business planning endeavors. The state-wise market segmentation and pricing analysis assist in developing effective marketing strategies and product positioning. The fuel price forecasting aids in long-term business planning, allowing manufacturers to anticipate market conditions and align their strategies accordingly.

Chapter 2: Renewed Interest in Electric Vehicles

- Early Initiatives:

The first electric vehicle initiative in India can be traced back to the early 20th century when the Crompton Greaves company introduced electric vehicles in Mumbai and Kolkata for taxi services.

The government of India also promoted electric vehicles during the 1970s oil crisis to reduce dependence on imported oil.

- Reintroduction and Policy Support:

In recent years, the Indian government has taken significant steps to promote EV adoption and reduce pollution in cities.

The National Electric Mobility Mission Plan (NEMMP) 2020 was launched in 2013 to encourage the adoption of electric and hybrid vehicles.

The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme was introduced in 2015 to provide incentives and subsidies for EVs and their components.

Various state governments, including Delhi, Maharashtra, Karnataka, and Telangana, have implemented their own EV policies and initiatives.

- Rise of Electric Two-Wheelers:

Electric two-wheelers have gained popularity in India due to their affordability and suitability for urban commuting.

Companies like Hero Electric, Ather Energy, Bajaj Auto, and TVS have introduced electric scooters and motorcycles in the Indian market.

The government's FAME II scheme, launched in 2019, provides subsidies for electric two-wheelers, making them more accessible to consumers.

- Push for Electric Cars:

Electric cars have also started gaining traction in the Indian market, although their adoption is relatively slower compared to two-wheelers.

Companies like Tata Motors, Mahindra & Mahindra, and MG Motors have introduced electric car models in India.

The government has set a target of achieving 30% electric vehicle penetration by 2030, with a major focus on electric cars.

- Charging Infrastructure:

The development of charging infrastructure is a crucial aspect of promoting EV adoption.

Several companies and startups have started building electric vehicle charging stations across major cities in India.

The government has initiated the installation of charging stations on highways, in metro cities, and public parking spaces to support EV charging.

- Government Incentives and Policies:

The Indian government offers various incentives, including tax benefits, subsidies, and lower GST rates, to encourage the adoption of electric vehicles.

State governments also provide additional incentives, such as registration fee waivers and free parking, to promote EV usage.

Chapter 3: The Electric Vehicle and The Environment

To meet the call for a sustainable development, introduced in the Brundtland Commission “Our Common Future” (1987) and further elaborated at the Rio Conference (1992) and at the Kyoto Conference (1997), also within the area of transportation, development of clean car technologies as well as selection of alternative-fuels are of most importance (Nadis & MacKenzie, 1993).

Electric vehicles produce no tailpipe emissions, and they are 10-30 % more energy efficient than conventional vehicles. Although electric vehicles themselves produce zero emissions, power plants producing the power to charge the vehicles may produce pollution depending on the major source of power used.

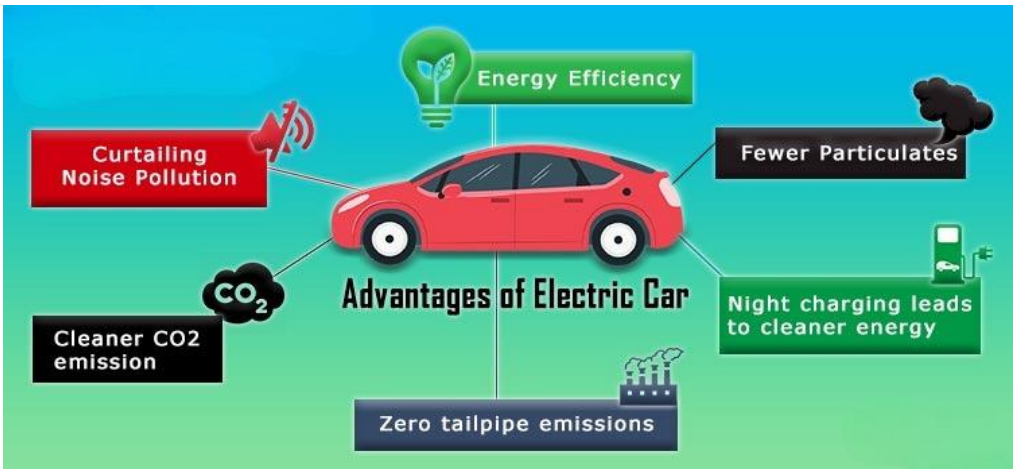

Fig. 3.1

Still, electric vehicles are the cleanest car technology of today. Moreover, electric vehicles have fewer moving parts and a simpler engine, which makes maintenance cheaper than in conventional and other alternative-fueled vehicles.

Also, sound pollution is minimized. Other benefits of electric vehicles are, at least for most countries, that they reduce dependence of foreign oil states, increase air quality, and, thereby, reduce damages on man and nature.

Chapter 4: Future Electric Vehicles

The major difficulty with electric vehicles of today is that they have relatively short driving ranges compared to conventional and other alternative-fueled vehicles (Table 1). The problem is the storage of energy in the batteries.

Table 1. Today's and tomorrow's batteries for electric vehicles.

Battery Type	**Specific Energy**	**Specific Power**	**Energy Efficiency**
	(wh/kg)	**(W/kg)**	**(%)**
Combined Energy Units	179	330	
Lead/Acid	40	130	65
Lead/Cobolt	80	240	
Lithium/Iron-Disulfide	>130	>120	
Lithium/Polymer	120	160	
Lithium/Ion	64	1,500	
Nickel/Cadmium	56	200	65
Nickel/Iron	55	130	60
Nickel/Metal Hydride	80	200	65
Sodium/Sulfur	100	120	85
Zinc/Air	120	120	60
Zinc/Bromide	70	100	65

Until now, lead/acid batteries have been the most common type of battery in electric vehicles. The problem with this type is, besides its toxicity, that in order to have sufficient capacity, it would have to carry 300 to 400 or so extra kilograms of weight. The driving range of these vehicles is (today), depending on driving style, topography, and used other electrically powered components in the vehicle, limited to between 140 and 280 kilometer per charge. Nickel/cadmium, nickel/iron, and sodium/sulfur batteries have all received considerable attention but have not turned out as very promising due to high operating temperatures, loss of considerable amount of energy if left unused, and corrosion (Sperling,

1996). Both zinc/air and zinc/bromide batteries are high in energy but low in power density and the former is also relatively expensive.

For the immediate future, nickel/metal hydride and lithium-based batteries are the most promising contenders because of their long life, non-toxicity, relative cheapness, and high performance. Other interesting options are lead/cobalt, combined energy units (ultracapacitors and aluminium/air or zinc/air and lead/acid and nickel metal hydride batteries) because of their ability to rapidly charge without overheating, high performance, faster acceleration, and climbing ability. Also fuel cells are of interest because they are energy efficient, non-polluting, quiet operating, have long range and fast re-fueling.

One key to the future of electric vehicles is improved battery performance. Although still inferior to gasoline engines in cost and range on a single charge, the new types of batteries; nickel/metal hydride, lithium-based, lead/cobalt, and combined energy units, hold promise for the future. Most major car manufacturers already have concept vehicles for the future but most needed here is a technological breakthrough with respect to battery technology like from transportation by horse to auto, from steam to diesel power, or from diesel to electricity.

Chapter 5: Earlier Research

- Government Initiatives:

The Government of India launched the National Electric Mobility Mission Plan (NEMMP) 2020 in 2013, aiming to achieve national goals for electric vehicle adoption.

The Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) scheme was launched in 2015 to promote the adoption of EVs and establish charging infrastructure across the country.

- Market Analysis and Potential:

Various studies have analyzed the market potential and growth prospects of EVs in India, considering factors such as consumer demand, charging infrastructure, and policy support.

Research has focused on estimating the market size, analyzing consumer preferences, and identifying barriers and opportunities for EV adoption in different vehicle segments.

- Battery Technology and Charging Infrastructure:

Research efforts have been directed towards developing indigenous battery technology suitable for Indian conditions, including lithium-ion and advanced lead-acid batteries.

Studies have explored the deployment of charging infrastructure, including public charging stations, residential charging solutions, and battery swapping models.

- Environmental Impact and Sustainability:

Research has examined the potential environmental benefits of EVs in terms of reducing greenhouse gas emissions and air pollution, particularly in densely populated cities with high vehicular pollution levels.

Life-cycle assessments have been conducted to evaluate the overall environmental impact of EVs, considering factors such as manufacturing, battery disposal, and electricity generation sources.

- Policy and Regulatory Framework:

Studies have analyzed the policy landscape and regulatory framework surrounding EVs in India, including incentives, subsidies, tax benefits, and vehicle standards.

Research has explored the role of government policies in driving EV adoption and the effectiveness of existing support mechanisms.

Chapter 6: OBJECTIVES

1) Analyze the state-wise market segmentation of electric vehicles, identifying the most promising regions for EV manufacturers in terms of market demand, infrastructure, and government support.

2) Conduct an exploratory data analysis (EDA) on two-wheeler and four-wheeler prices in the EV market, uncovering best favorable price range for the start ups to start with.

3) Utilize Linear Regression to predict petrol and diesel prices for the year 2024, leveraging historical price data.

4) Provide insights and recommendations for EV manufacturers based on the market segmentation analysis, pricing trends, and forecasted fuel prices.

Chapter 7: APPROACH

1. **Data Collection:** The data is being used from:

   a) https://evreporter.com/indias-region-wise-ev-market-jan-may-2022/

   b) https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1778958

   c) https://www.ndtv.com/fuel-prices/diesel-price-in-all-state

   d) https://www.currentresults.com/Weather/India/average-annual-temperatures.php

   e) https://www.studyiq.com/articles/per-capita-income-of-india/

   f) https://www.bijlibachao.com/news/domestic-electricity-lt-tariff-slabs-and-rates-for-all-states-in-india-in.html

   g) https://www.aqi.in/in/dashboard/india

   h) https://www.bikewale.com/electric-bike/#pageno=2&pagesize=30&fueltype=807

   i) https://www.cardekho.com/electric-cars

2. **Data Integration:**

Data integration is the process of combining data from different sources or tables to create a comprehensive dataset that can be analyzed effectively. This step is important because data from various sources may contain complementary information and combining them can provide a more holistic view of the problem or phenomenon being studied.

During data integration, tables or datasets are merged based on common attributes or keys. For example, if one table contains EV market data by region and another table contains average annual temperatures by region, the two tables can be merged using the region as the common attribute. This integration allows for the analysis of the relationship between EV market trends and temperature patterns.

The goal of data integration is to create a unified dataset that contains all relevant information needed for analysis and decision-making.

3. Data Cleaning:

In this project, I performed data cleaning to ensure that the dataset was accurate, consistent, and ready for further analysis.

I encountered several challenges during the data cleaning process, such as handling missing data and normalizing the data.

To address missing data, I employed techniques like imputation of incomplete records. Additionally,

I performed data normalization using techniques such as standard scaling to bring different variables to a similar scale.

4. Data Analysis:

During the data analysis phase, I examined, transformed, and modeled the data to uncover meaningful insights, patterns, and relationships.

I utilized various statistical and data mining techniques to analyze the data and extract valuable information. Descriptive statistics provided a summary of the data, while data visualization techniques helped in identifying patterns, trends, and outliers.

I created various plots and charts to visualize different aspects of the data, such as bar charts, line plots, scatter plots, and heatmaps. Through exploratory data analysis, I identified patterns and relationships that served as valuable insights for decision-making or market strategies.

I also conducted statistical analysis, including correlation analysis to determine relationships between variables and make predictions.

5. Data Preprocessing:

As part of data preprocessing, I performed necessary steps to prepare the data for analysis. One specific preprocessing step involved removing a string column from the dataset to ensure compatibility with the K-means clustering algorithm.

Since K-means clustering requires numerical data, I removed the non-numeric column to ensure that the dataset only contained suitable numeric columns for clustering.

Data preprocessing played a crucial role in ensuring the accuracy and reliability of the results obtained in subsequent analysis steps. It also enhanced the performance of machine learning algorithms used in the project.

6. Modeling:

- **K-Means Clustering:**

K-means clustering is not only popular but also widely adopted in various fields due to its simplicity and effectiveness in data analysis. As an unsupervised machine learning algorithm, K-means clustering offers valuable insights into the structure and patterns within a dataset.

The primary objective of K-means clustering is to partition a given dataset into K distinct clusters, where K represents the desired number of clusters defined by the user. Each cluster is represented by a centroid, which acts as the center point for the data points assigned to that cluster. The algorithm iteratively assigns data points to the nearest centroid based on their similarity, typically measured using the Euclidean distance metric.

One of the strengths of K-means clustering lies in its ability to handle large datasets efficiently. By iteratively updating the positions of the centroids, K-means minimizes the within-cluster sum of squared distances (WCSS) and maximizes the between-cluster distance. This process results in well-separated and compact clusters, allowing for better understanding and interpretation of the data.

Additionally, K-means clustering can be applied to various types of data and has been utilized in diverse domains, including customer segmentation, image processing, document clustering, anomaly detection, and more. Its simplicity and ease of implementation make it accessible even to users without an extensive background in machine learning.

However, there are some considerations to keep in mind when using K-means clustering. Firstly, the algorithm requires the specification of the number of clusters (K) in advance, which can be challenging if the optimal number of clusters is unknown. Techniques such as the elbow method or silhouette analysis can be employed to determine an appropriate value for K.

Secondly, the initialization of cluster centroids can impact the final clustering results. The algorithm is sensitive to the initial placement of centroids, which may lead to different cluster assignments and, subsequently, varying outcomes. Techniques such as k-means++ initialization or running the algorithm multiple times with different initializations can mitigate this issue.

Moreover, K-means clustering assumes that the clusters have a spherical shape and an equal number of data points. It may struggle with datasets that contain irregularly shaped or overlapping clusters. In such cases, alternative clustering algorithms like DBSCAN (Density-Based Spatial Clustering of Applications with Noise) or hierarchical clustering might be more suitable.

In summary, K-means clustering is a versatile and widely used algorithm for data clustering and grouping. Its simplicity, efficiency, and ability to reveal underlying patterns make it a valuable tool in exploratory data analysis and data mining tasks. Understanding its strengths, limitations, and appropriate usage scenarios is essential for obtaining meaningful and accurate insights from the data.

```
df2.head()
```

	2wheeler	3wheeler	4wheeler	Bus	Total	EVSTATIONS	PCINCOME	PetrolPrices	DieselPrices	Avg.annualhightempcelsius	Avg.annuallowtempcelsius	Avgunitrate	AirQualityIndex	Cluster	States
0	27000	113400	0	1860	142260	207	65431	96.53	89.71	33.0	18.0	6.50	105	4	UttarPradesh
1	105300	2700	10800	1022	119822	317	202130	109.24	95.59	34.0	17.0	6.74	120	0	Maharashtra
2	5400	39550	0	0	44950	37	46292	107.24	94.04	31.0	20.0	8.05	179	3	Bihar
3	1958	0	0	0	1958	141	121463	106.03	92.76	32.0	22.0	9.21	152	3	WestBengal
4	2327	945	608	58	3938	235	98418	108.67	93.93	32.0	19.0	6.74	65	3	MadhyaPradesh

Fig. 7.1

In this we tried to cluster the states with similarities over all data

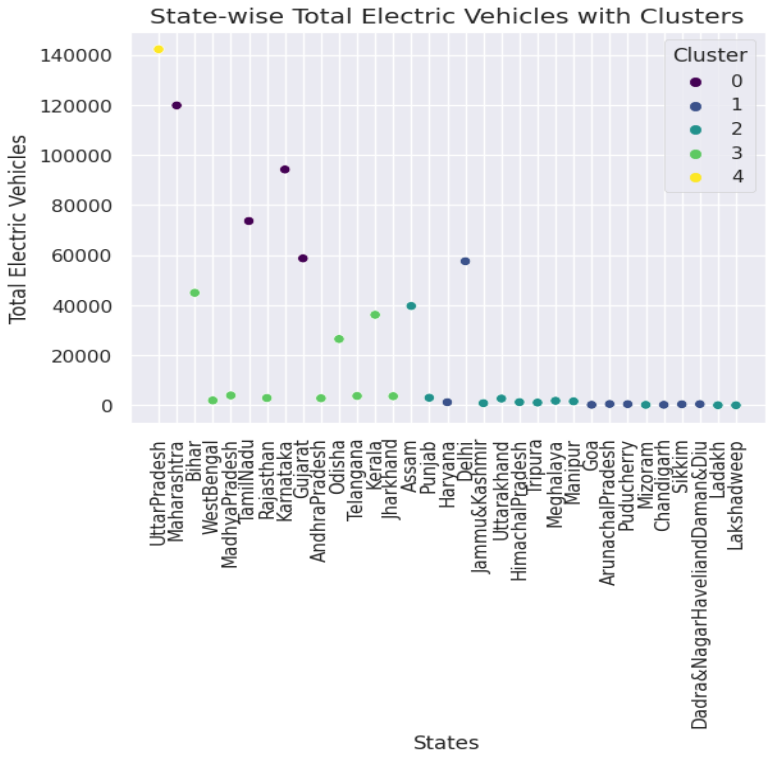

Fig. 7.2

Cluster 1: Maharashtra, Tamil Nadu, Karnataka, Gujarat

Cluster 2: Haryana, Delhi, Goa, Arunachal Pradesh, Puducherry, Chandigarh, Sikkim, Dadra and Nagar Haveli and Daman and Diu

Cluster 3: Assam, Punjab, Jammu & Kashmir, Uttarakhand, Himachal Pradesh, Tripura, Meghalaya, Manipur, Mizoram, Ladakh, Lakshadweep,

Cluster 4: Bihar, West Bengal, Madhya Pradesh, Rajasthan, Andhra Pradesh, Odisha, Telangana, Kerala, Jharkhand

Cluster 5: Uttar Pradesh

Here we can see the distribution of states in each cluster which provides insights into how states are grouped based on the total number of electric vehicles

The states from different regions are having similar characteristics as they are grouped in the same cluster, which indicates common factors influencing electric vehicle adoption or usage

- **LINEAR REGRESSION:**

Linear regression is a widely used statistical technique for forecasting and predicting future outcomes based on historical data. When it comes to predicting petrol and diesel prices, linear regression models can be a valuable tool. By analyzing historical data on petrol and diesel prices and identifying patterns and relationships, a linear regression model can estimate the future prices of these fuels.

One of the key advantages of linear regression is its simplicity and interpretability. The model provides a clear understanding of the relationship between the independent variable (historical prices) and the dependent variable (future prices).

It calculates the coefficients for each independent variable, allowing analysts to determine the strength and direction of the relationship. For petrol and diesel price forecasting, the historical prices serve as the independent variables, while the future prices are the dependent variable.

Linear regression models also enable the identification of trends and seasonality in the historical data. By incorporating time as a variable, the model can capture seasonal patterns and cyclical fluctuations in petrol and diesel prices. This information can be valuable for understanding the recurring price patterns that may occur due to factors like changes in demand during certain seasons or holidays.

Moreover, linear regression models can account for other relevant variables that may impact petrol and diesel prices. These variables could include global oil prices, inflation rates, exchange rates, government policies, and other economic indicators. By including these factors as independent variables in the regression model, it becomes possible to capture their influence on petrol and diesel prices and improve the accuracy of the forecasts.

It is important to note that while linear regression provides a solid foundation for petrol and diesel price forecasting, it is essential to regularly update the model with new data and validate its performance.

The model should be assessed for its accuracy and robustness, and adjustments should be made as necessary to account for changing market dynamics and external factors. Combining the power of linear regression with an understanding of market trends and other relevant factors can help generate more accurate and reliable predictions for petrol and diesel prices, aiding decision-making processes for businesses and consumers in the energy sector.

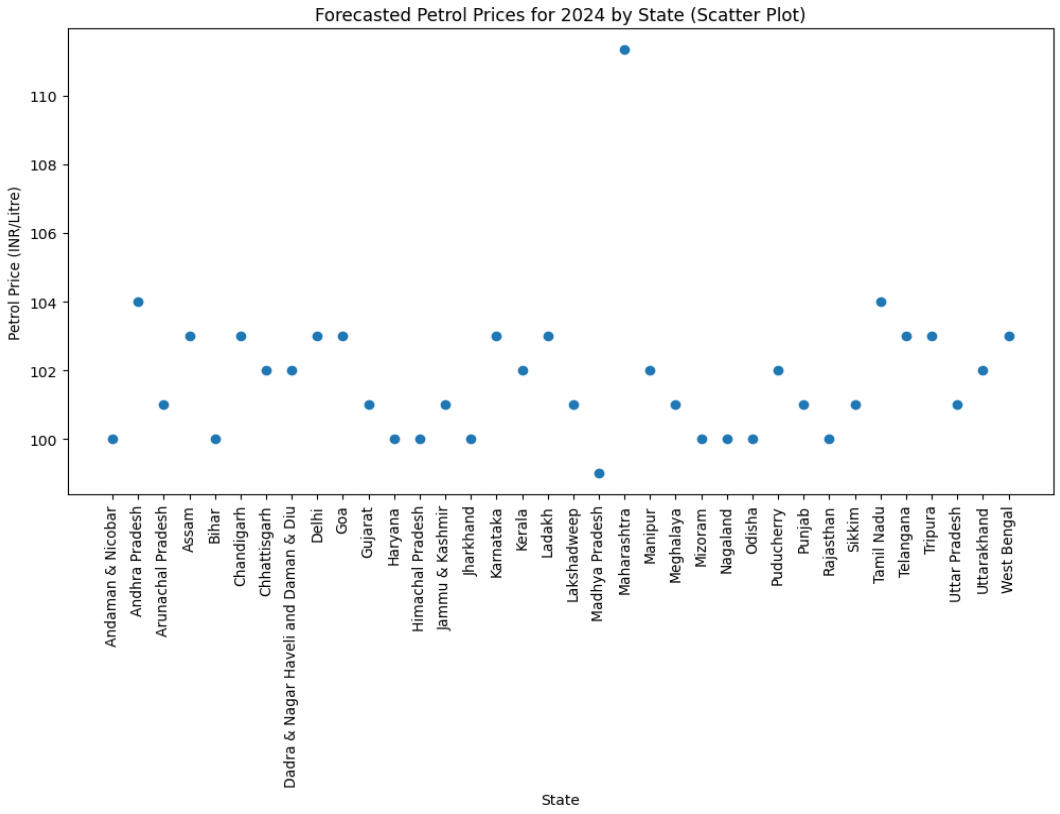

Fig. 7.3

Here we can see the distribution of forecasted Petrol prices over the States where we get that all prices are below Rs.104 except the price for Maharashtra State

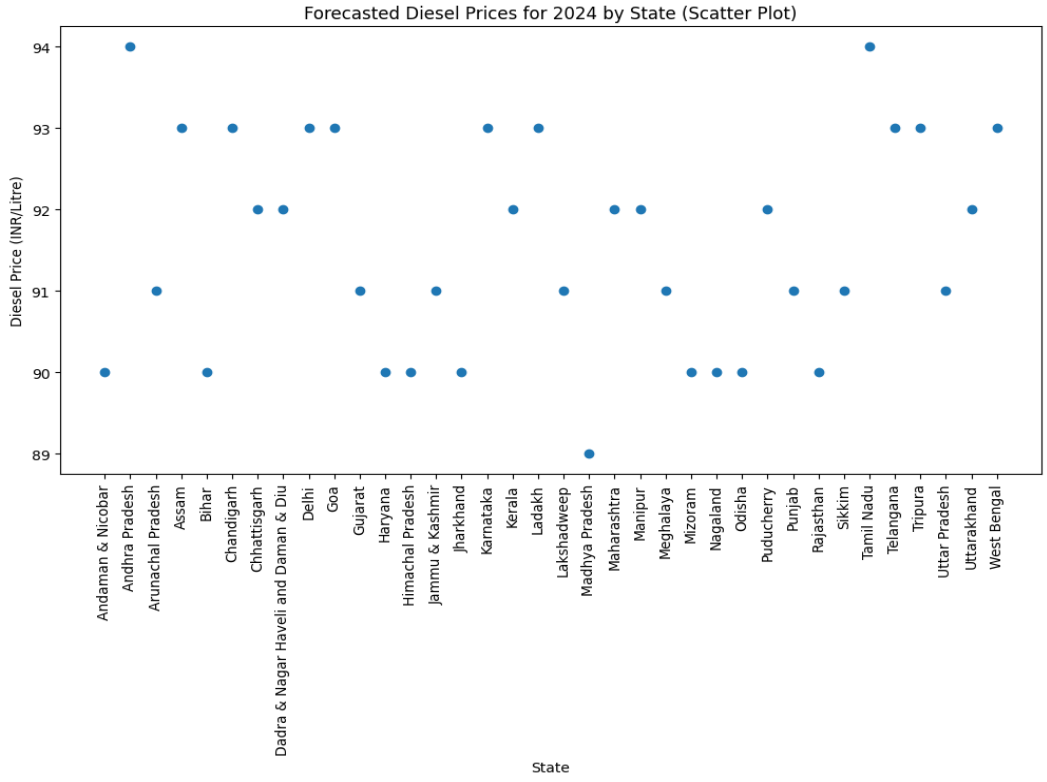

Fig. 7.4

The distribution of forecasted Diesel prices across different states reveals an interesting pattern. The prices are found to be fairly evenly distributed within the range of Rs. 90 to Rs. 93, indicating a similarity in the projected costs across several regions. However, when examining the extremes, Madhya Pradesh stands out with the lowest forecasted price of Rs. 89 for 2024, while Andhra Pradesh and Tamil Nadu exhibit the highest forecasted price of Rs. 94 for the same year.

This distribution of forecasted prices suggests that the majority of states can expect relatively similar Diesel prices in 2024, with a tight range of Rs. 90 to Rs. 93. This could indicate a certain level of stability and uniformity in pricing policies or market conditions that influence Diesel costs across these regions.

On the other hand, the outliers, such as Madhya Pradesh, Andhra Pradesh, and Tamil Nadu, exhibit forecasted prices that deviate from the general range. Madhya Pradesh stands out with a lower-than-average price of Rs. 89, potentially indicating specific factors that contribute to a more favorable pricing situation in that state, such as lower taxes or efficient supply chains.

Conversely, Andhra Pradesh and Tamil Nadu demonstrate higher-than-average forecasted prices of Rs. 94. These states may face unique circumstances, such as increased taxes, transportation costs, or higher demand, which could drive up the Diesel prices compared to other regions.

Analyzing the distribution of forecasted Diesel prices across states can provide insights into the potential variations and trends within the market. Understanding these variations can help businesses, consumers, and policymakers make informed decisions, ranging from fuel budgeting to strategic resource allocation.

It is important to note that the forecasted prices are based on available data and predictive models, which consider historical trends, market factors, and other variables. However, actual Diesel prices in the future can be influenced by unforeseen events, such as global oil price fluctuations, geopolitical factors, economic changes, or policy shifts. Therefore, continuous monitoring and analysis of market dynamics are crucial to adapt to any potential shifts in Diesel pricing patterns.

Chapter 8: DATA VISUALIZATION & OBSERVATION

Part 1:

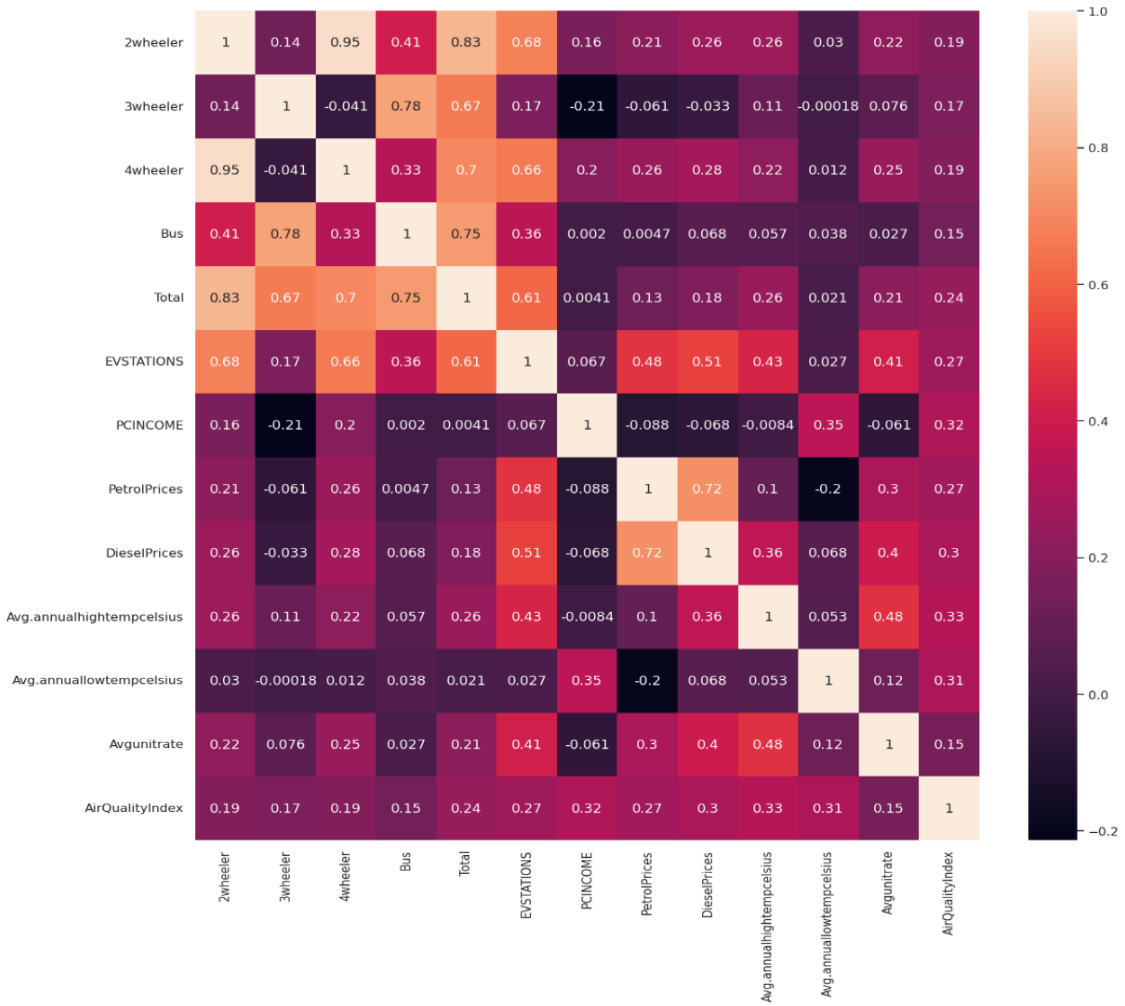

Fig. 8.1

- Heatmaps are used to show relationships between two variables, one plotted on each axis.
- As we can see here if the value is near to 1 then there is positive correlation between the variables
- If the value is near to -1 then there is negative correlation between the variables
- As shown from this plot, all features are sufficiently independent.

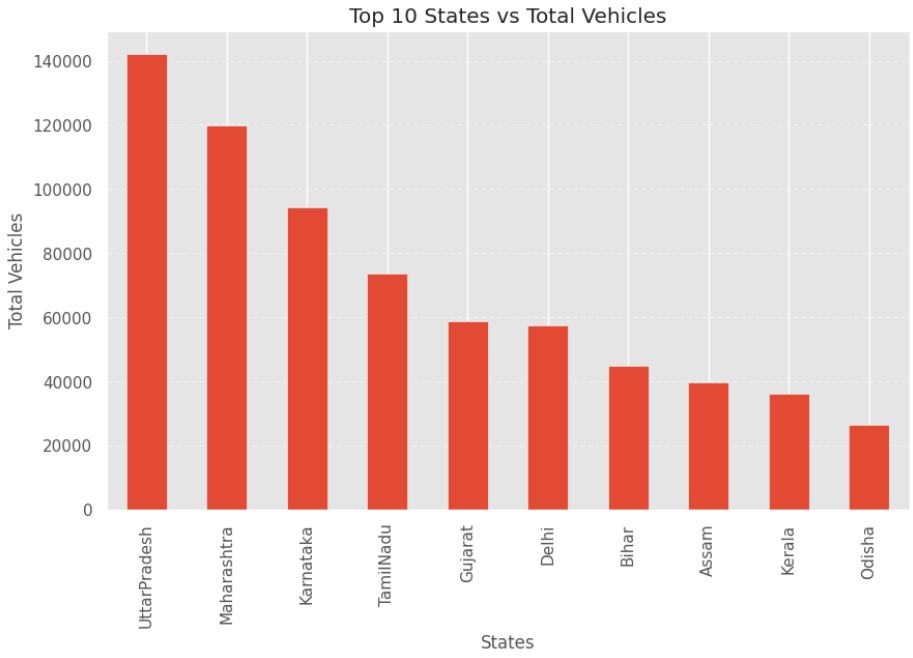

Fig. 8.2

Overall, UttarPradesh and Maharashtra have more number of Electric Vehicles followed by Karnataka and TamilNadu

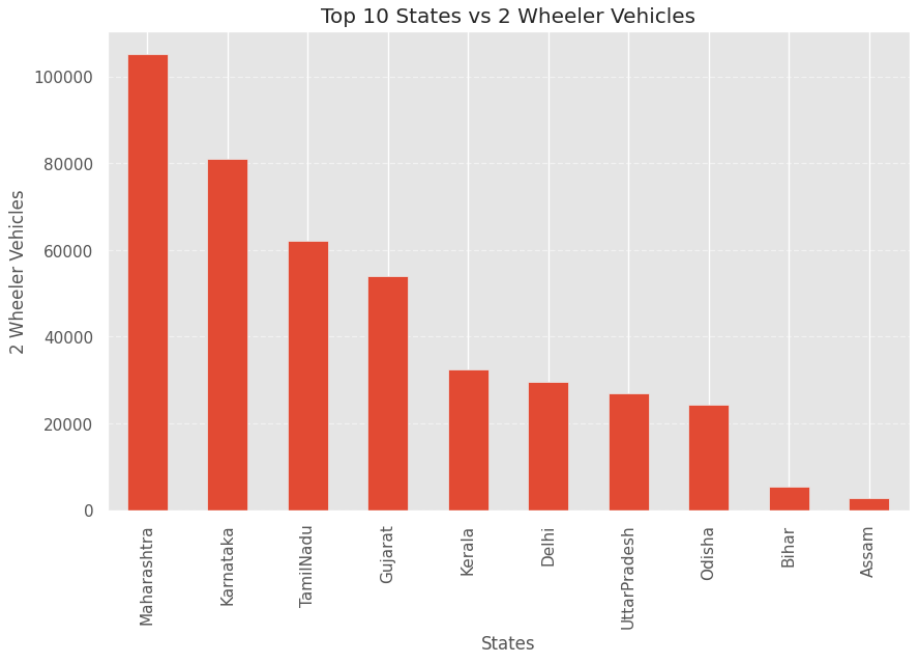

Fig. 8.3

Maharashtra have the most electric vehicles in the segment of 2 Wheelers followed by Karnataka and Tamil Nadu

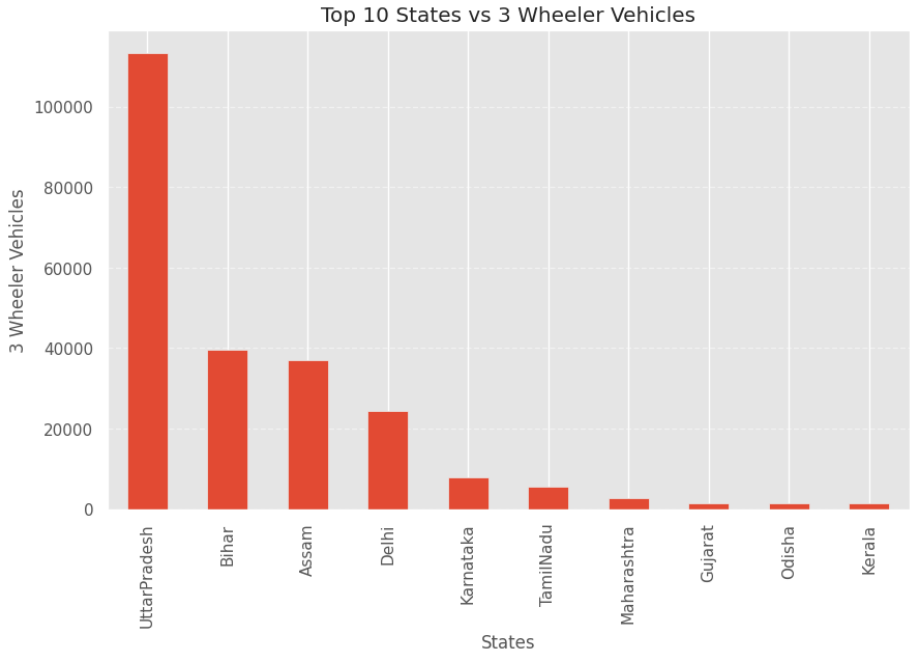

Fig. 8.4

In the segment of 3 Wheelers, Uttar Pradesh is dominating the other states by a greater margin

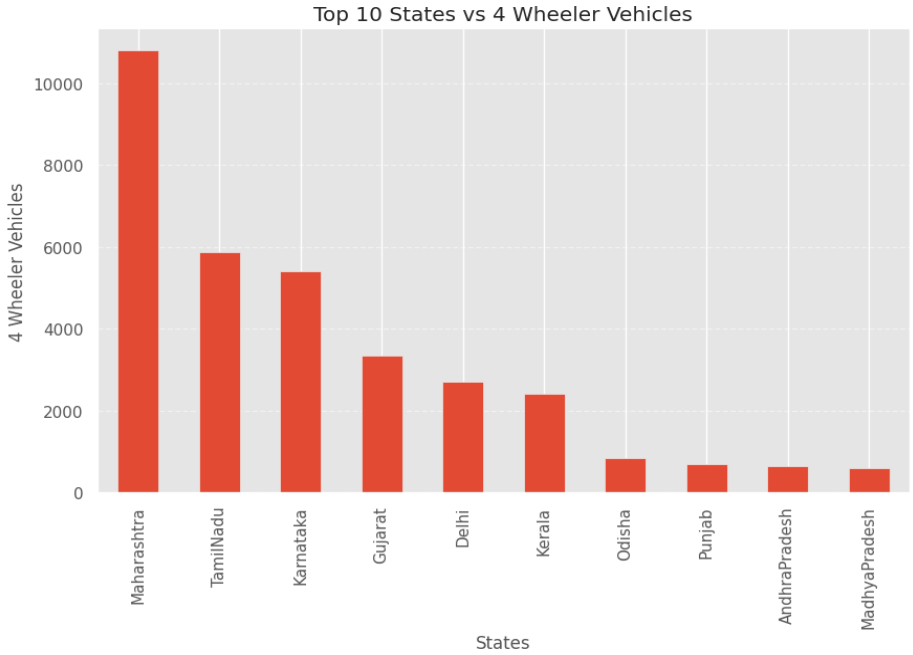

Fig. 8.5

Maharashtra is rich in the segment of 4 Wheelers

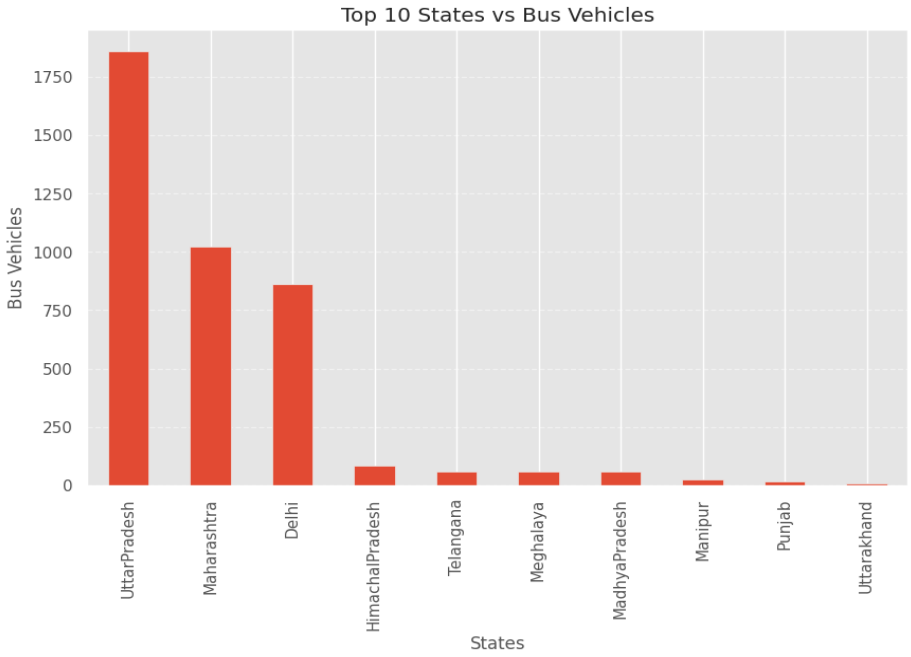

Fig. 8.6

Considering the number of electric buses, the sequence will be Uttar Pradesh followed by Maharashtra and Delhi

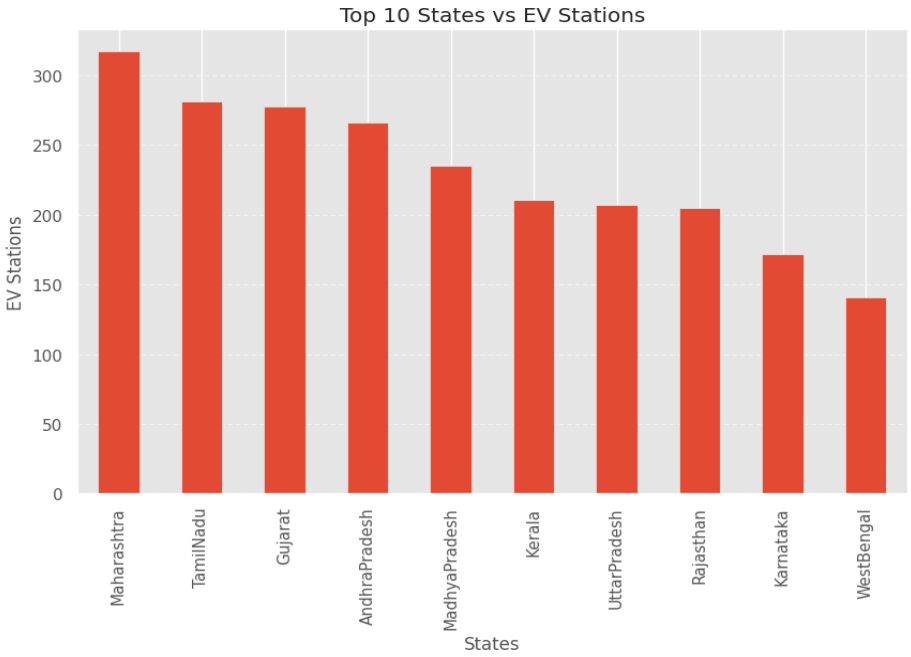

Fig. 8.7

Maharashtra has the most EV stations compared to the other states.

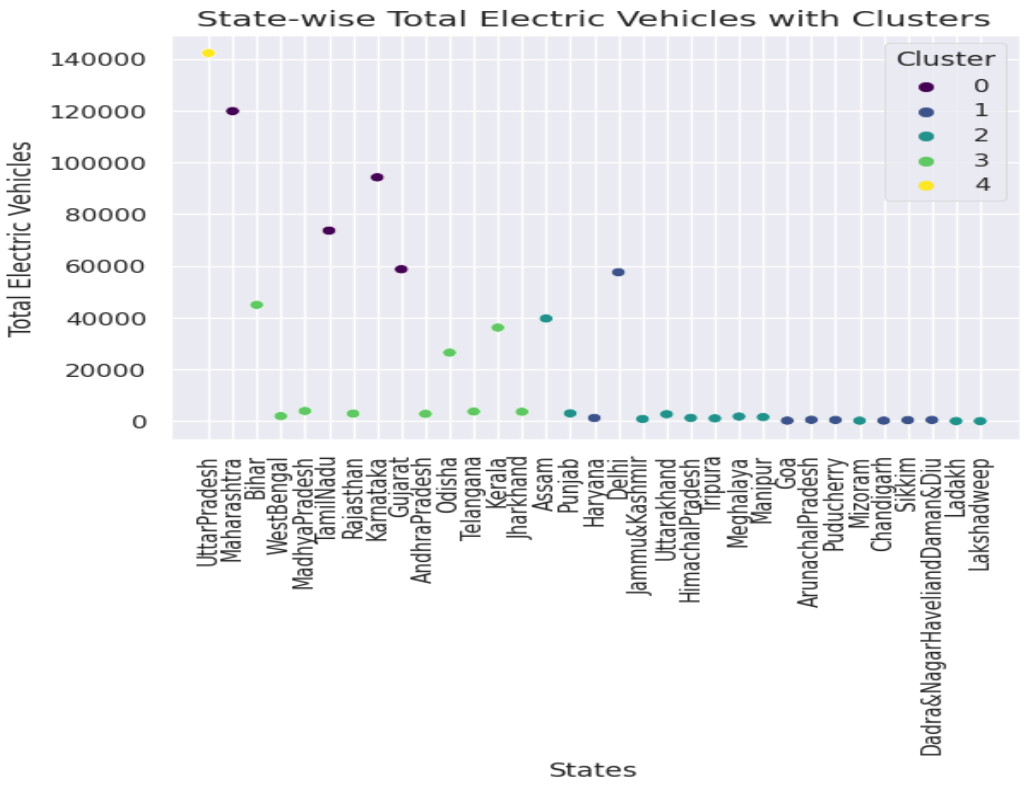

Fig. 8.8

- The plot shows different clusters represented by different colors. Here we can see the distribution of states in each cluster which provides insights into how states are grouped based on the total number of electric vehicles
- Here we can see the states from different regions are having similar characteristics as they are grouped in the same cluster, which indicates common factors influencing electric vehicle adoption or usage

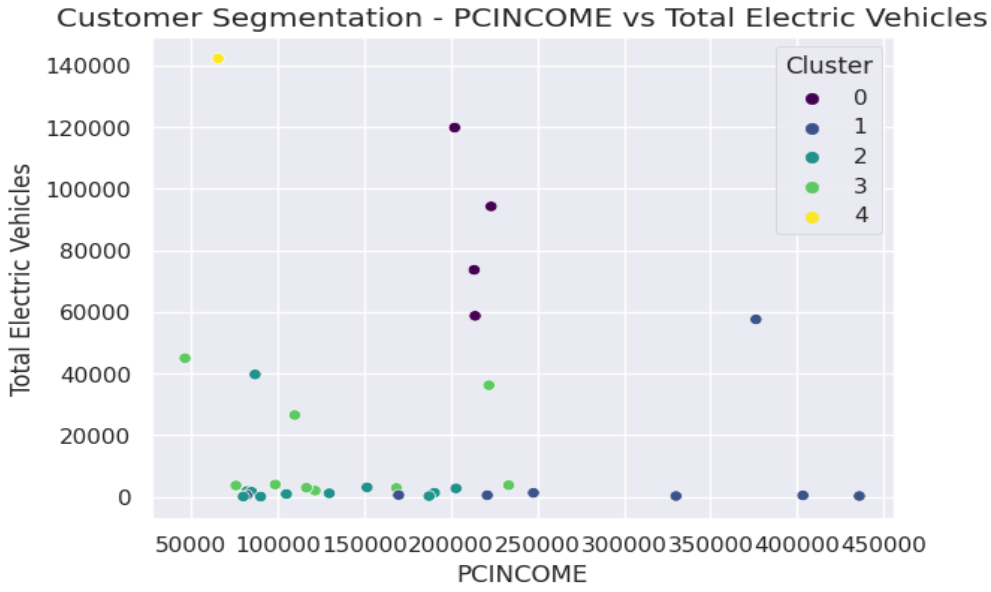

Fig. 8.9

- We can observe the distribution of States based on the income (PCINCOME) and the total number of electric vehicles in it (TOTALEVVEHICLES)
- We can identify patterns such as lower-income states tending to own more electric vehicles

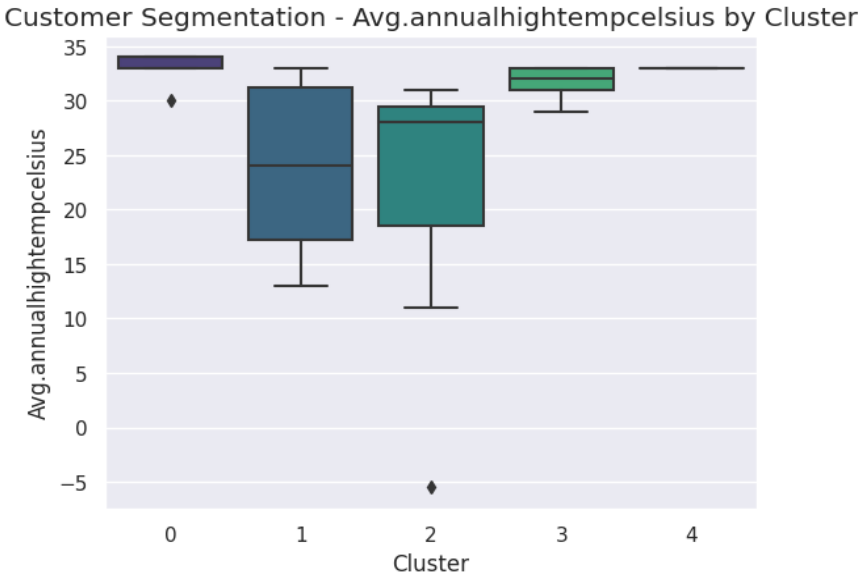

Fig. 8.10

- We can see the distribution of the average annual high temperature in Celsius for each state cluster
- At optimal temperatures, EVs are performing better than their rated range, peaking at 115% at 70F or 21.5C. So, most EV owners are exceeding the rated range of the vehicle in prime temperature conditions. As you turn up or down the temperature, however, the loss of range is apparent
- So, here we can focus on the clusters 1 and 2 as they have the states having annual high temperature near to the 21.5C

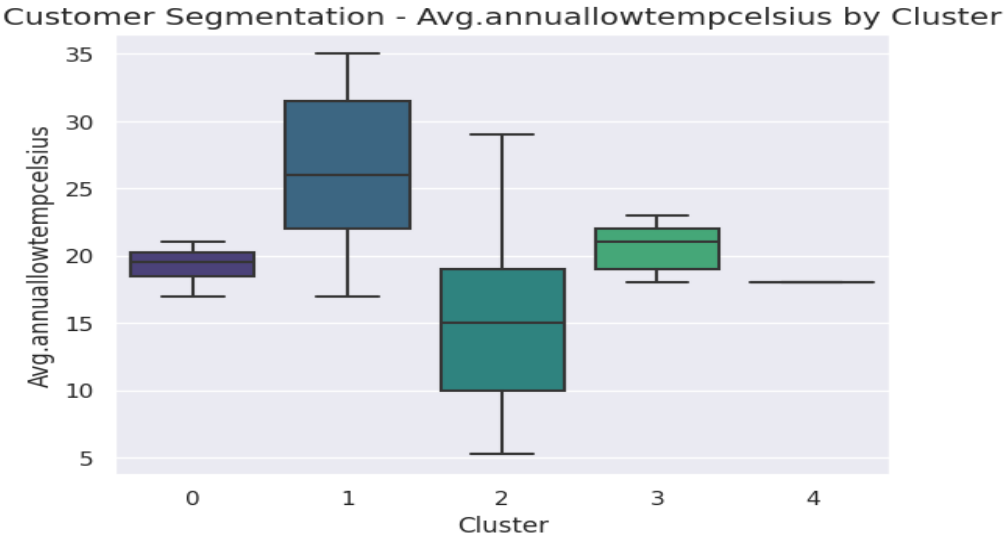

Fig. 8.11

- We can see the distribution of the average annual low temperature in Celsius for each state cluster
- At optimal temperatures, EVs are performing better than their rated range, peaking at 115% at 70F or 21.5C. So, most EV owners are exceeding the rated range of the vehicle in prime temperature conditions. As you turn up or down the temperature, however, the loss of range is apparent
- So, here we can the cluster 3 is the most favourable cluster

Fig. 8.12

- We can see the distribution of Total Electric vehicles for each state cluster
- 5th cluster has less number of states than others but it has the highest number of Electric vehicles followed by 1st cluster
- Cluster named 1 and 2 have outliers that means there is one state in both the cluster which has significantly more EVs than the rest in the corresponding cluster

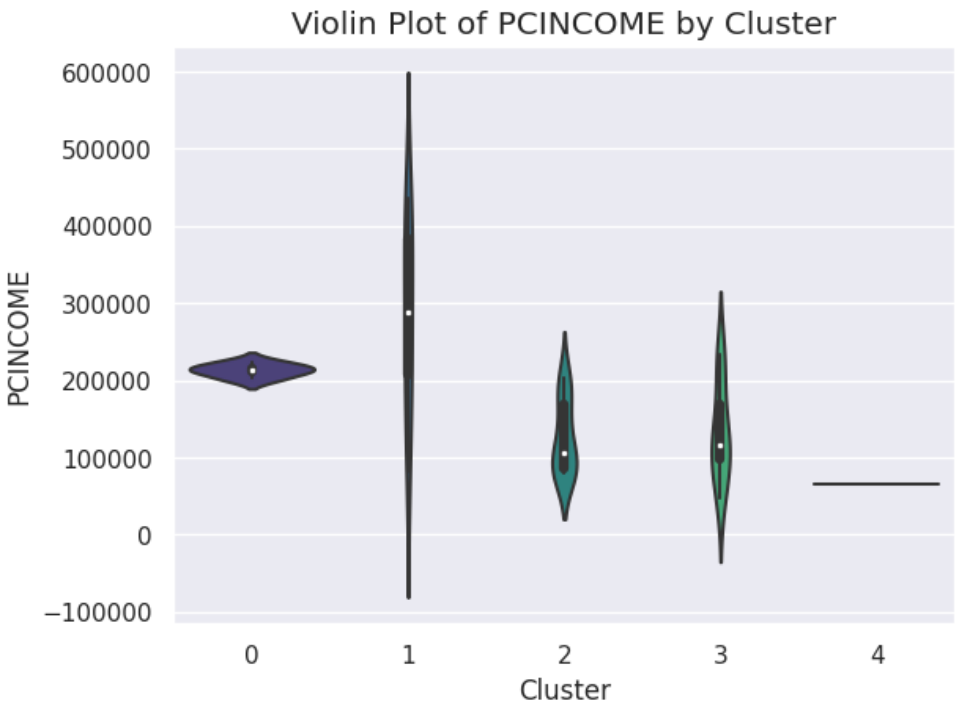

Fig. 8.13

- With this violin plot we can see the distribution of a PCINCOME among different clusters or segments, similar to a box plot, but with additional information about the density of values.
- Such as in the 1st cluster the density is maximum at Rs.2,00,000 which means in the 1st cluster the states having Per Capita income Rs.2,00,000 are more

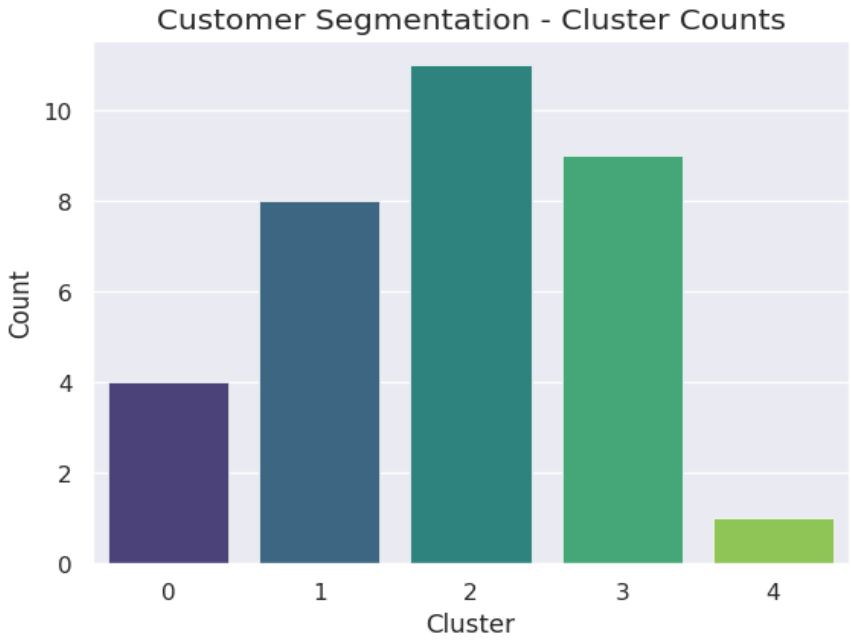

Fig. 8.14

Here we can see the counts of states in each cluster, providing an overview of the size and composition of each segment

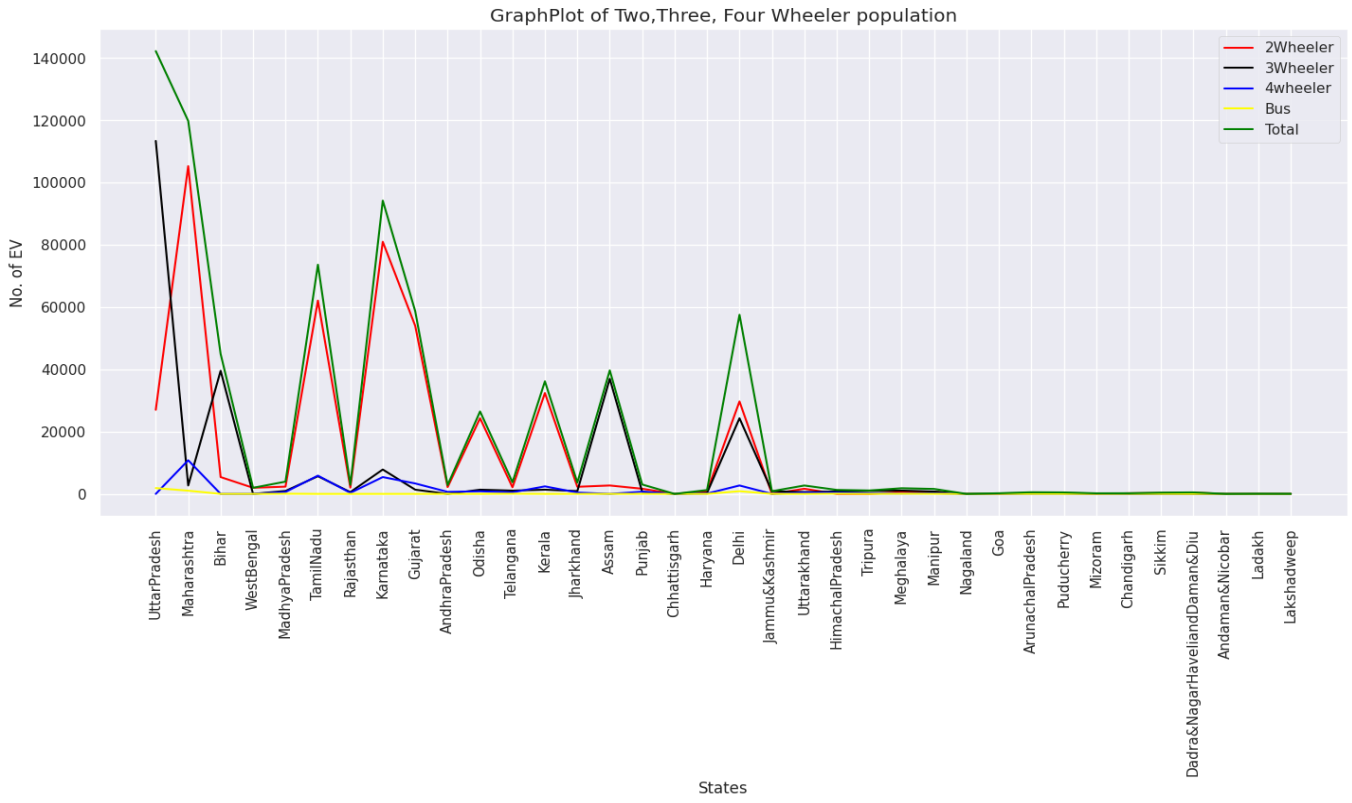

Fig. 8.15

UttarPradesh, Maharashtra, Karnataka, Tamil Nadu and Delhi are the states where we can see significant number of Electric Vehicles followed by Assam, Kerala and Odisha

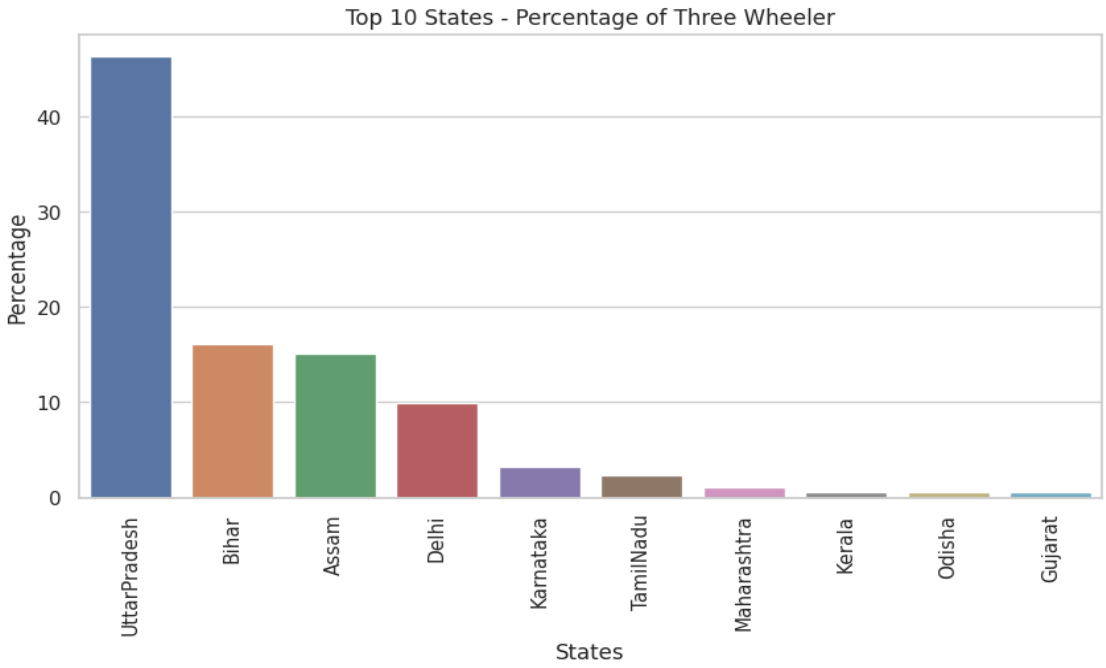

Fig. 8.16

In the segment of 3 Wheelers, Uttar Pradesh is dominating the other states by a greater margin

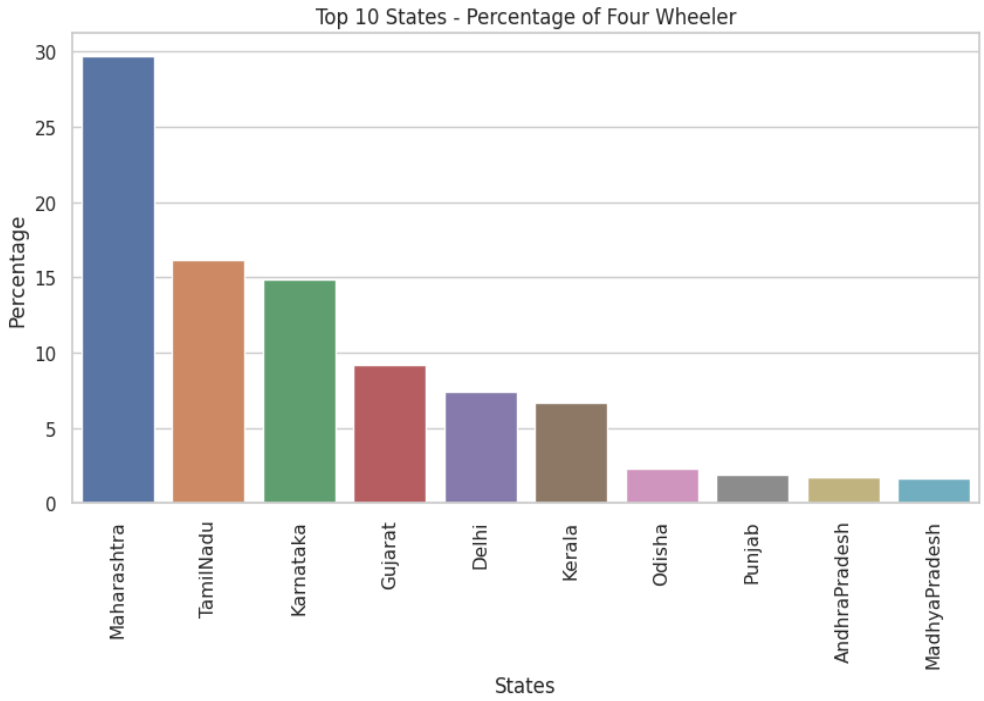

Fig. 8.17

Maharashtra is rich in the segment of 4 Wheelers

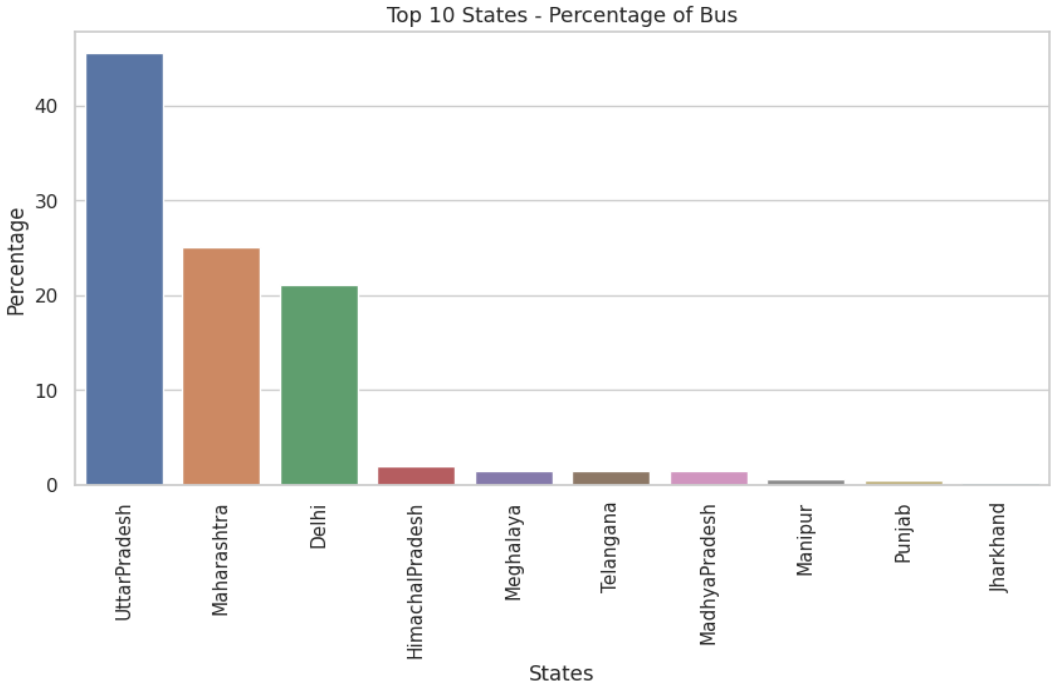

Fig. 8.18

Considering the percentage of Electric buses, the sequence will be Uttar Pradesh followed by Maharashtra and Delhi

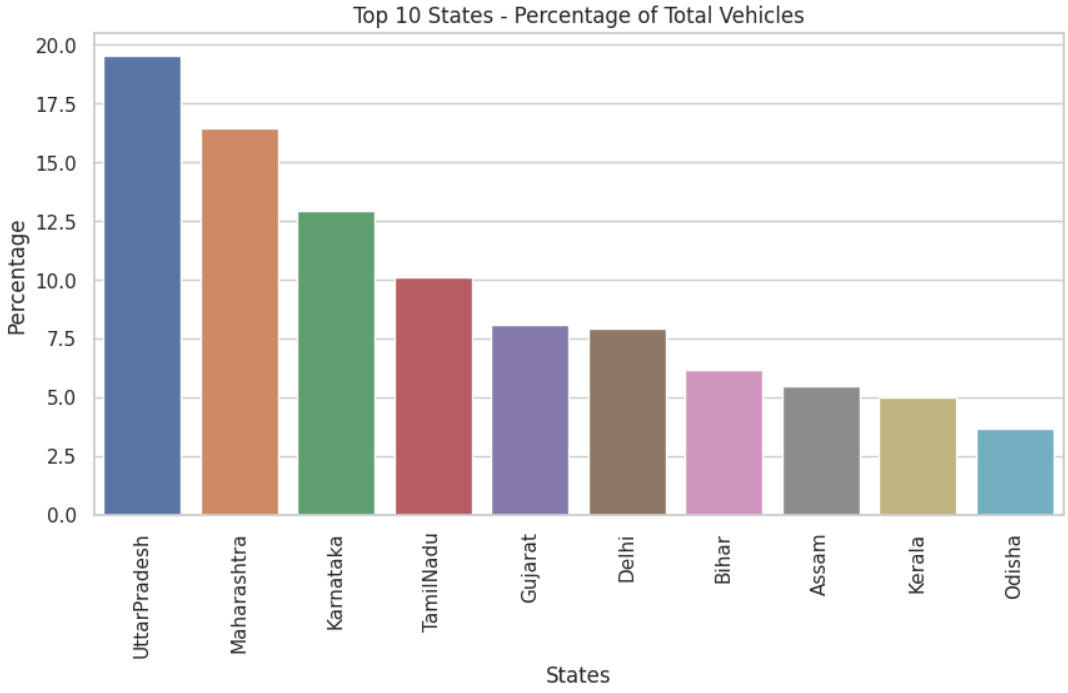

Fig. 8.19

Overall, UttarPradesh and Maharashtra are having more percentage of Electric Vehicles followed by Karnataka and TamilNadu

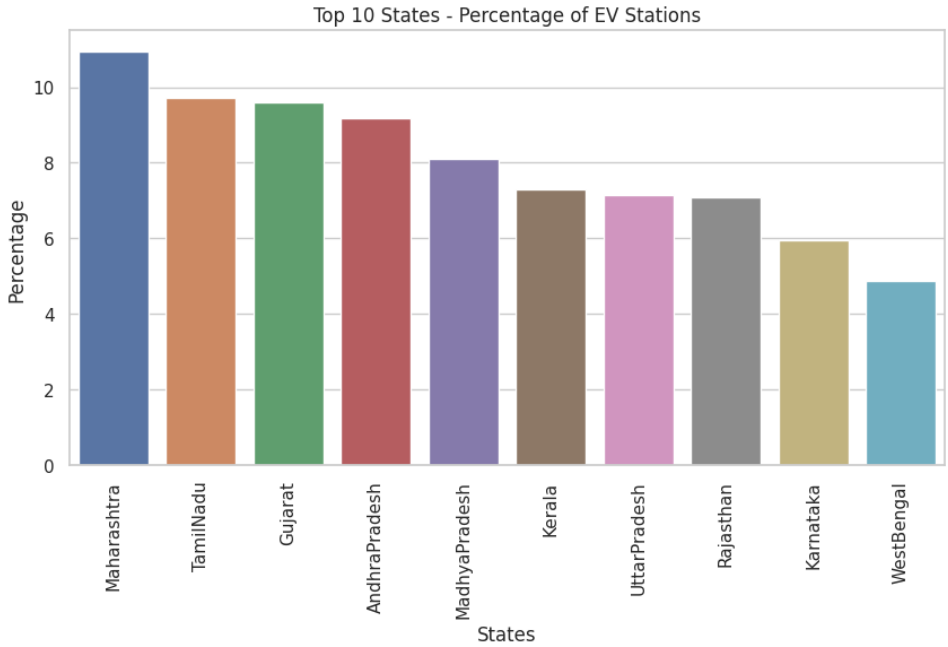

Fig. 8.20

Maharashtra have the most EV stations comparing to the other states

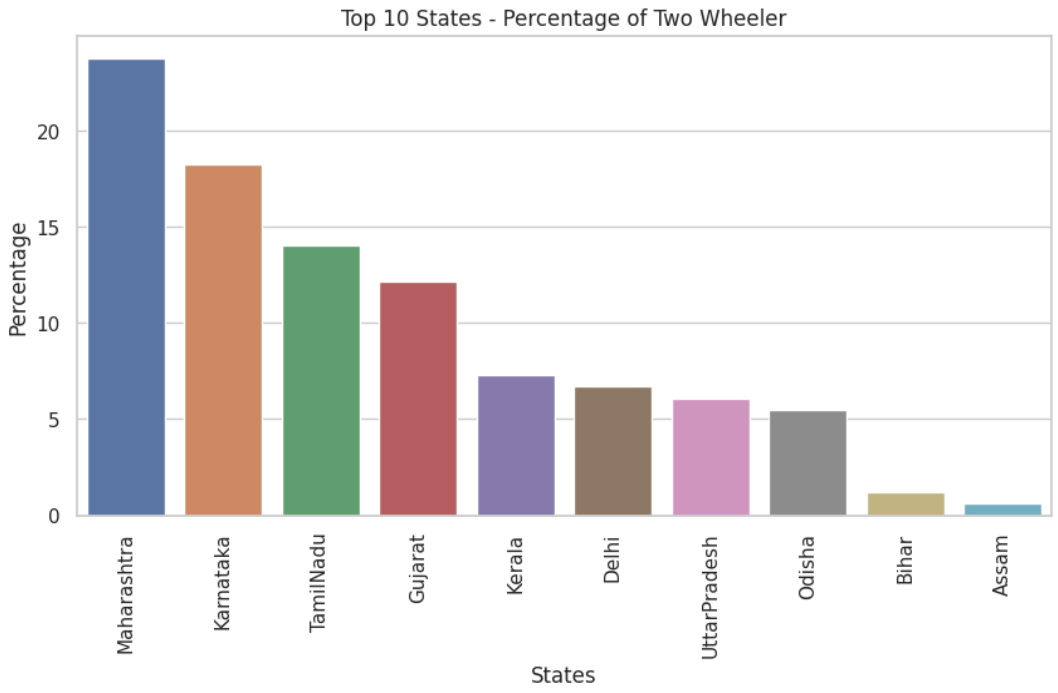

Fig. 8.21

Maharashtra have the most percentage of electric vehicles in the segment of 2 Wheelers followed by Karnataka and Tamil Nadu

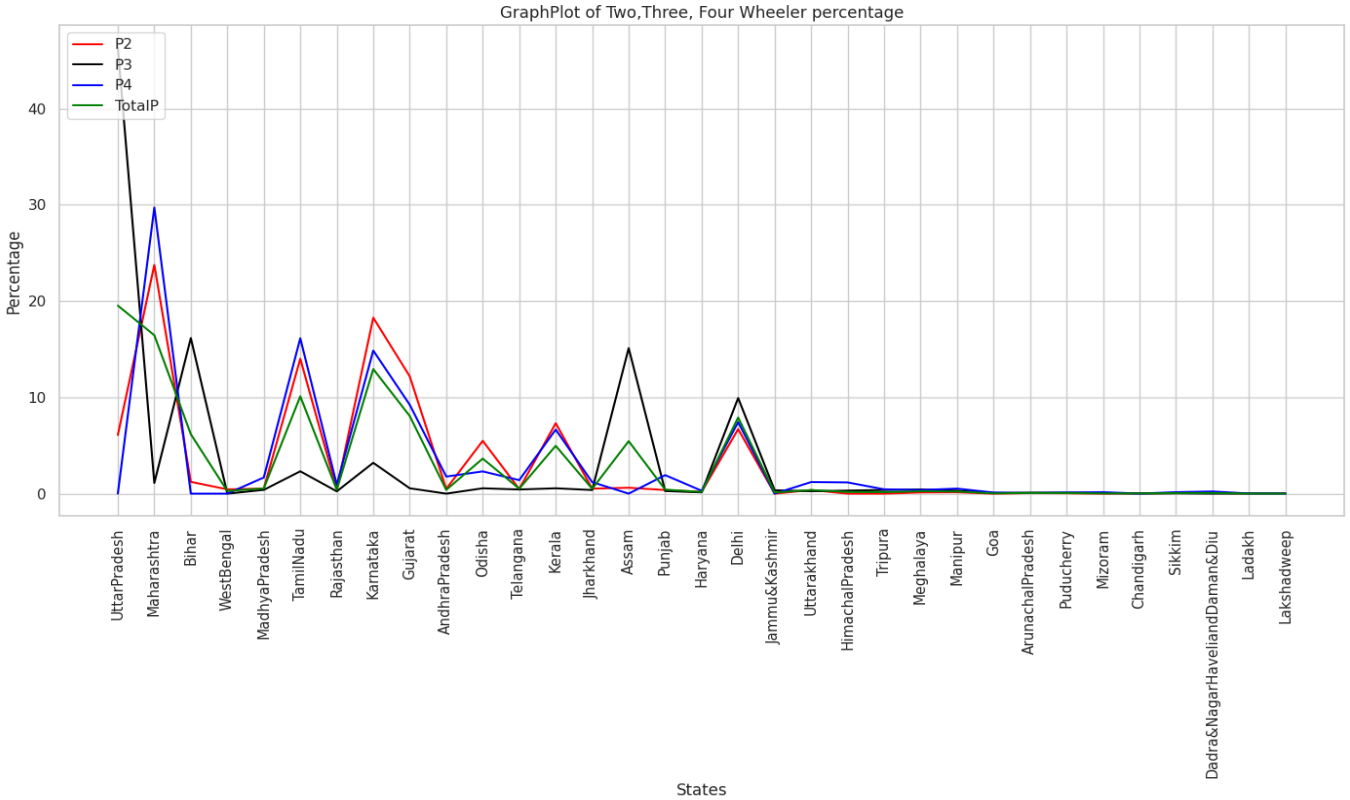

Fig. 8.22

Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu and Delhi are the states where we can see significant percentage of Electric Vehicles followed by Assam, Kerala and Odisha

Part 2:

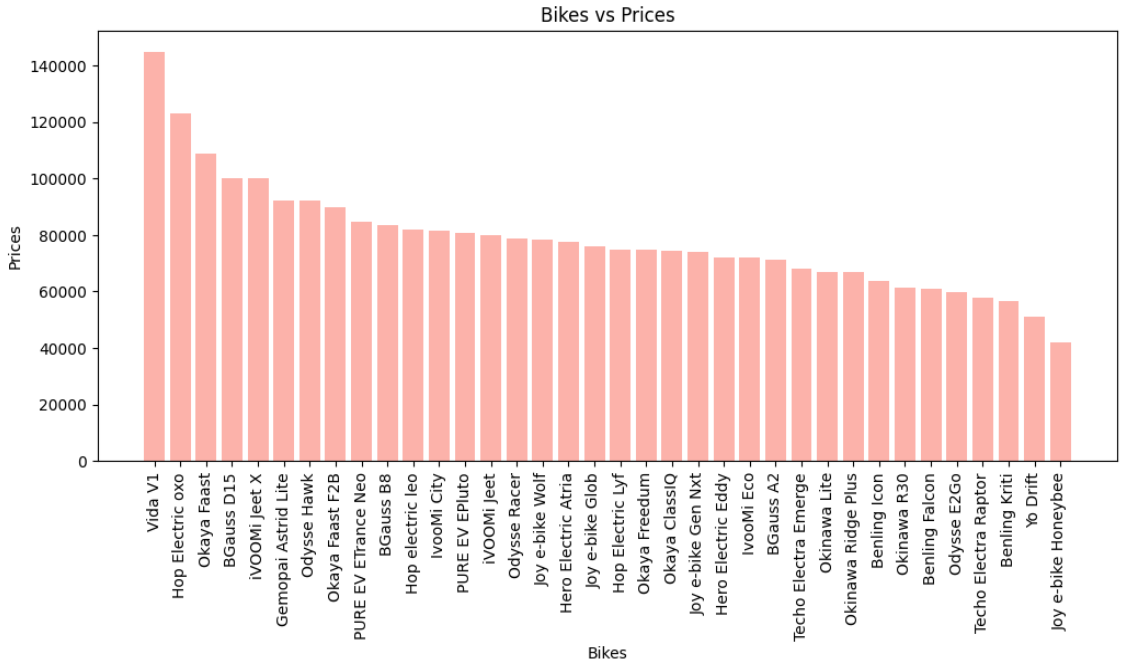

Fig. 8.23

Bike named 'Vida V1' has the highest price and that goes upto the bike named 'Joy e-bike Honeybee' which having the least price

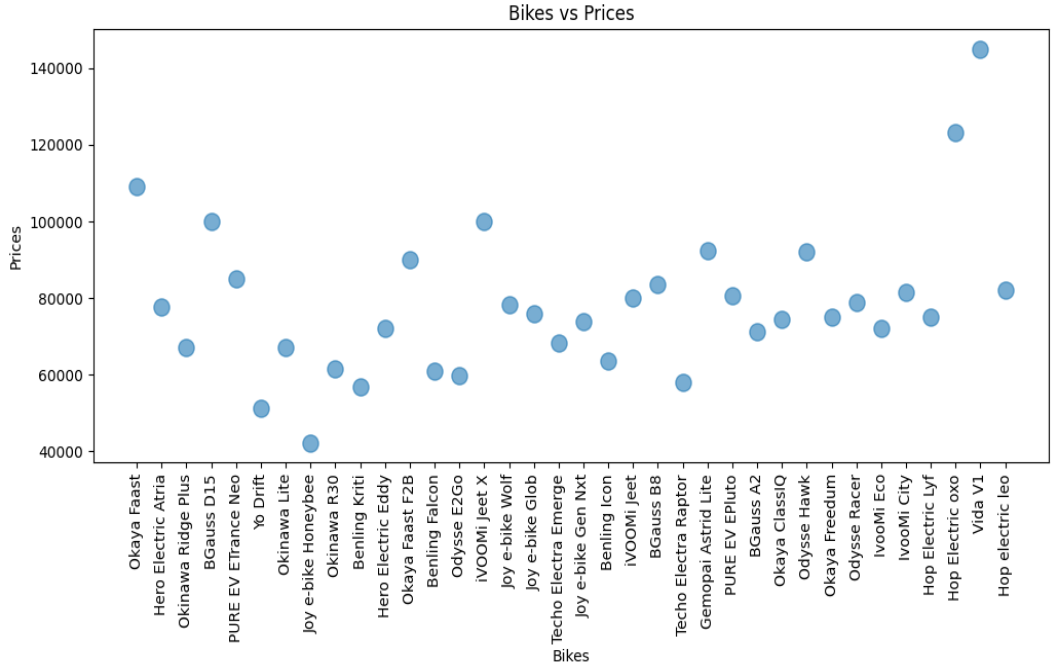

Fig. 8.24

Here we can see the distribution of bikes with respect to their corresponding prices

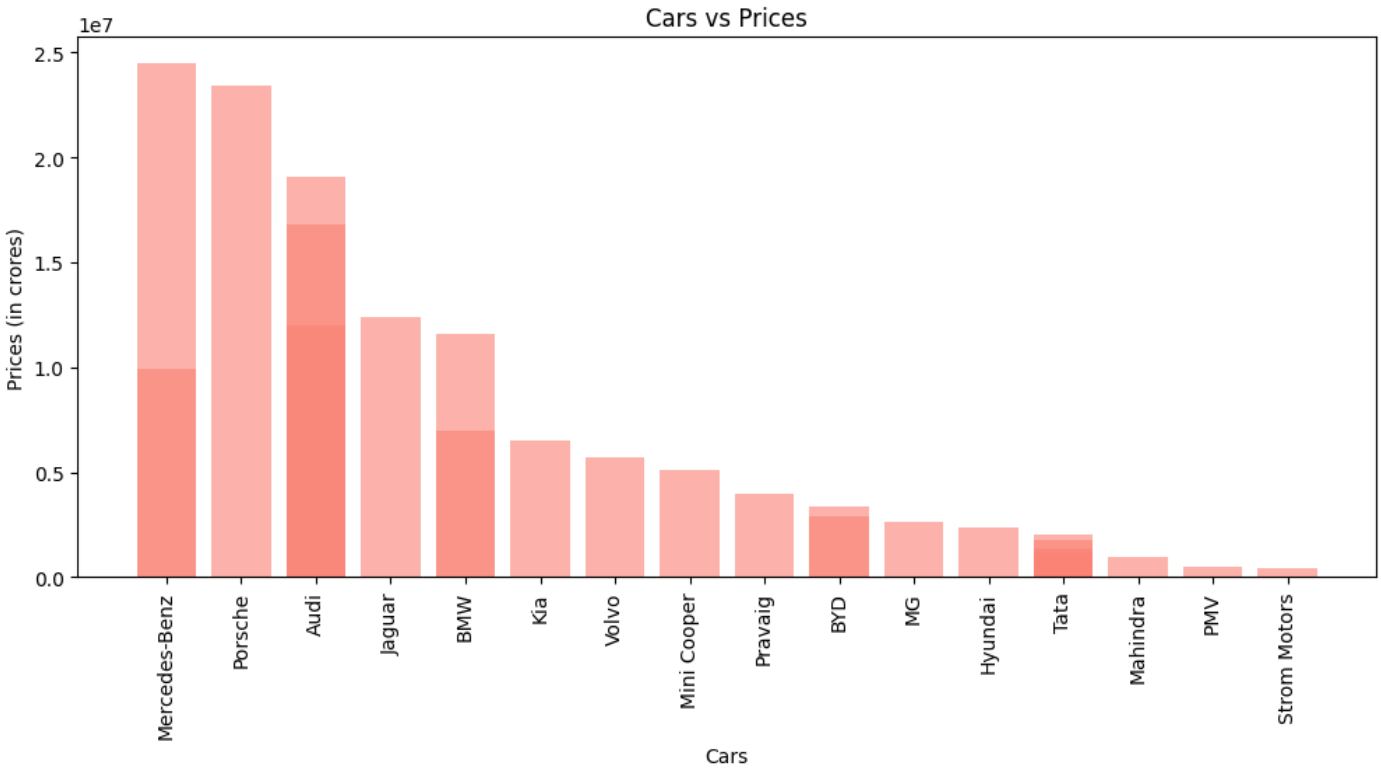

Fig. 8.25

- Most of the bikes are in the range of Rs.40,000 to Rs.1,00,000 whereas the highest priced is bike is above Rs.1,40,000
- Car of 'Mercedes-Benz' has the highest price and that goes upto the car of 'Storm Motors' which having the least price

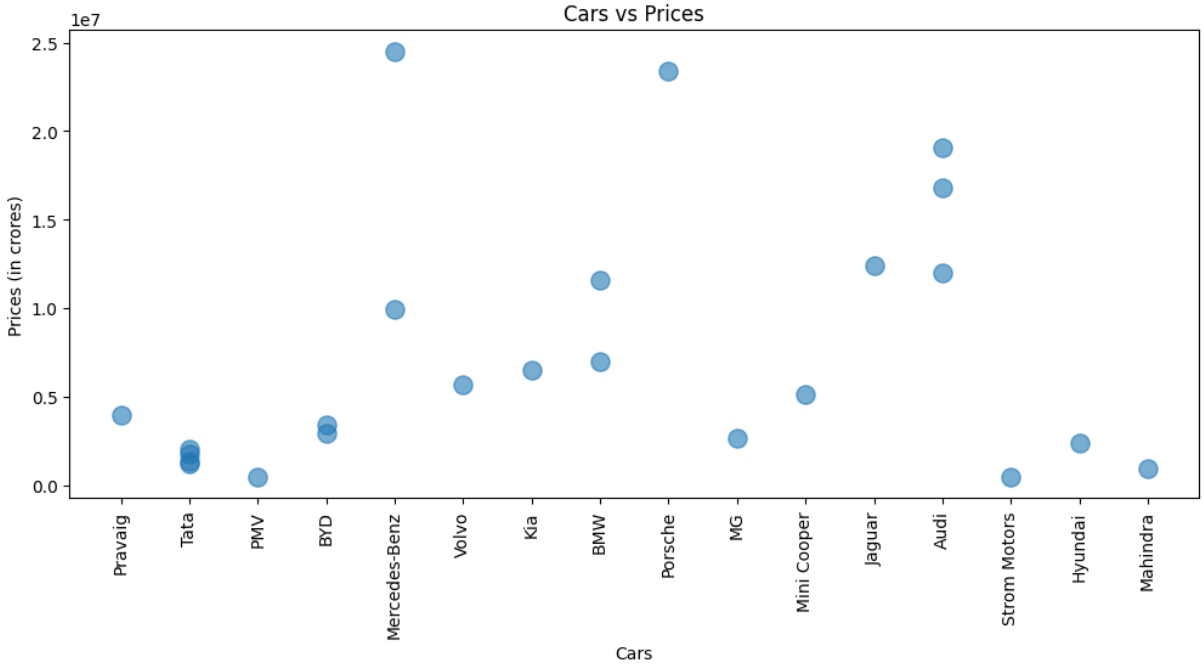

Fig. 8.26

- Here we can see the distribution of cars with respect to their corresponding prices
- Most of the cars are below the range of Rs.1.5 crore whereas the highest priced is car is near to Rs.2.5 crore

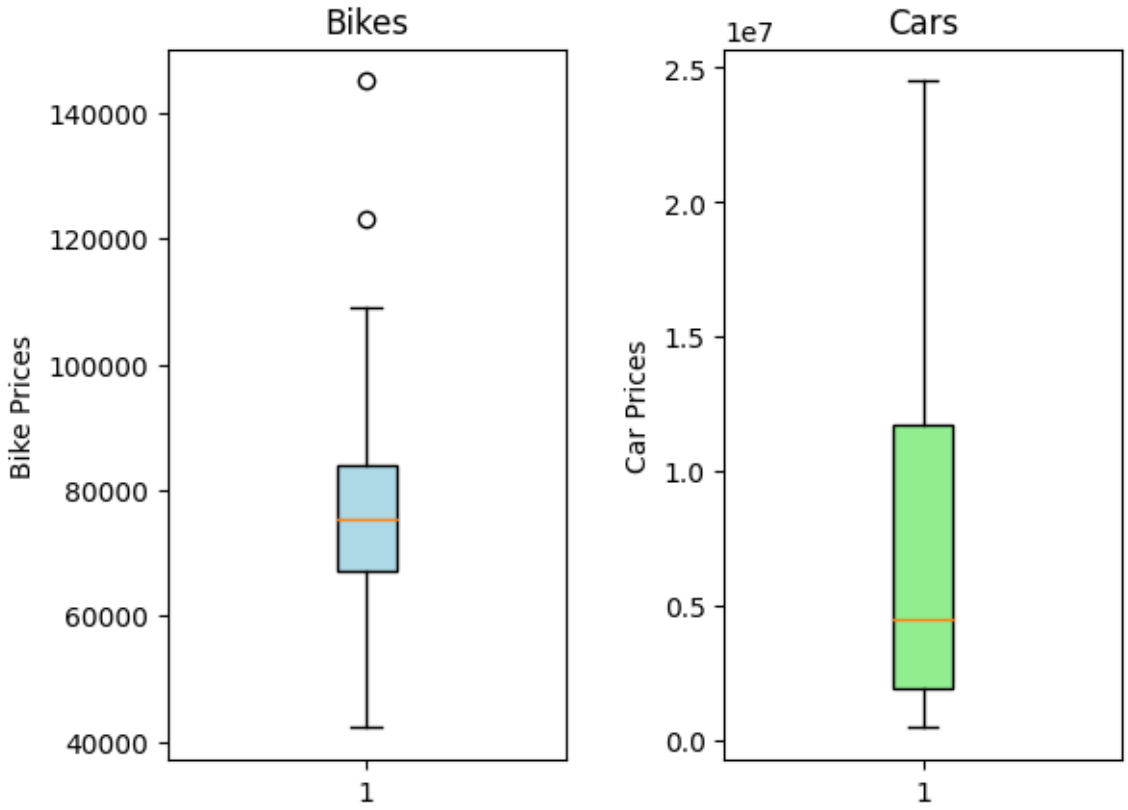

Fig. 8.27

- From the first box plot as we can see that there are 2 outliers basically not the extreme outliers we can conclude that there are 2 bikes which are at higher prices while remaining are in the range of RS.68,000 to Rs.82,000
- In the second box plot there are no outliers present
- Also from the length of the boxes we can conclude that longer box of car prices indicates a larger range of prices within the interquartile range, which indicates greater variability in prices for the category while there is less variability in the bike prices

Part 3

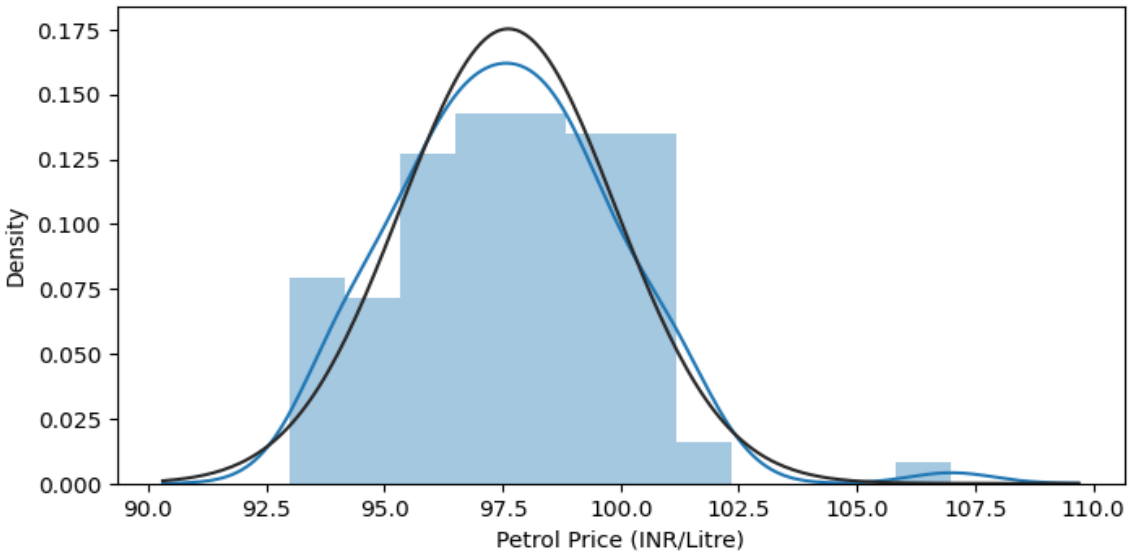

Fig. 8.28

- A histogram and KDE plot can help us understand the distribution of a variable, such as Petrol Prices in our dataset
- We can observe the shape and spread of the distribution, by which we can conclude the range of petrol prices is mostly in between Rs.93 to Rs.101

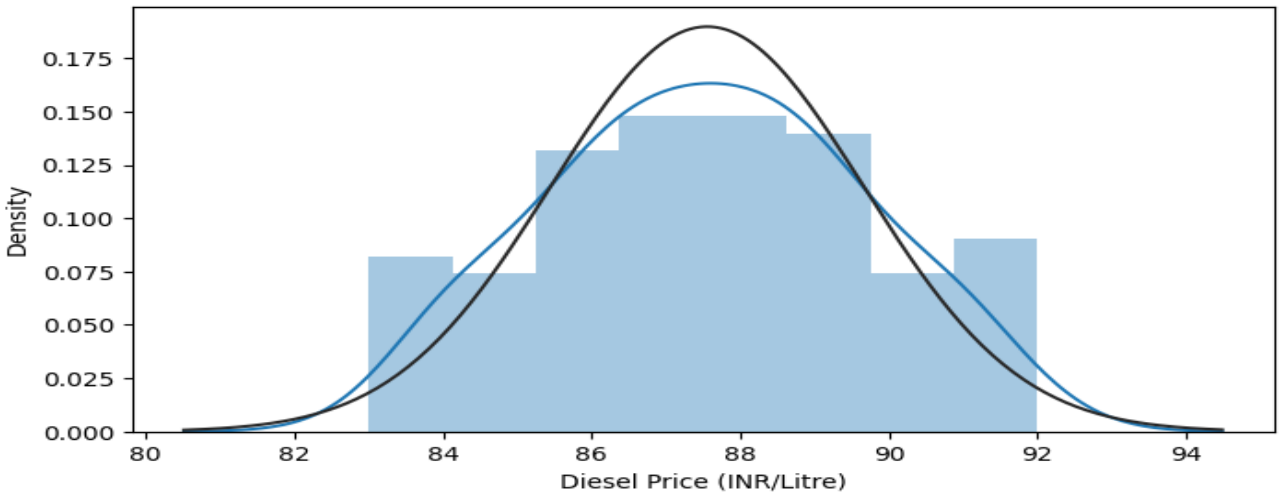

Fig. 8.29

- A histogram and KDE plot can help us understand the distribution of a variable, such as Diesel Prices in our dataset
- We can observe the shape and spread of the distribution, by which we can conclude the range of diesel prices is likely equally distributed, but we can see diesel prices of most of the states are in the range of Rs.85.5 to Rs.90

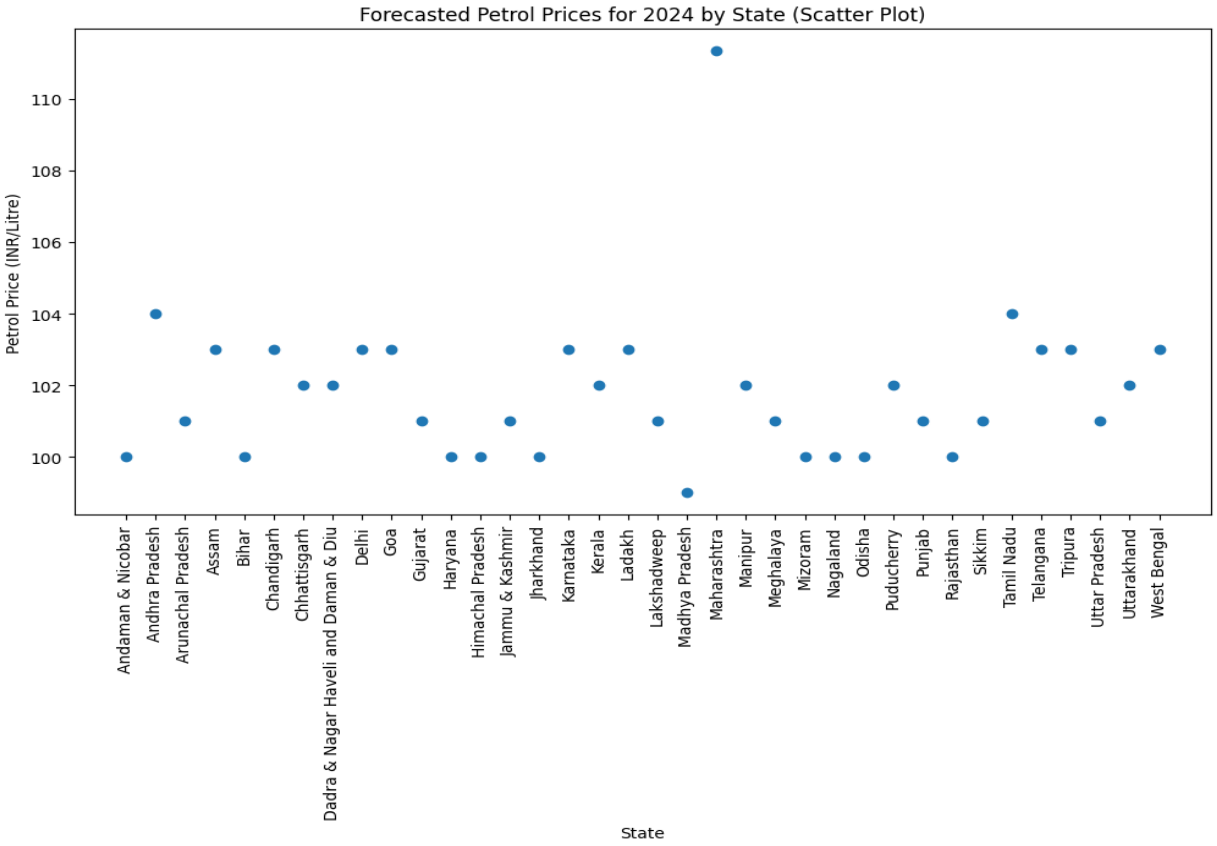

Fig. 8.30

Here we can see the distribution of forecasted Petrol prices over the States where we get that all prices are below Rs.104 except the price for Maharashtra State

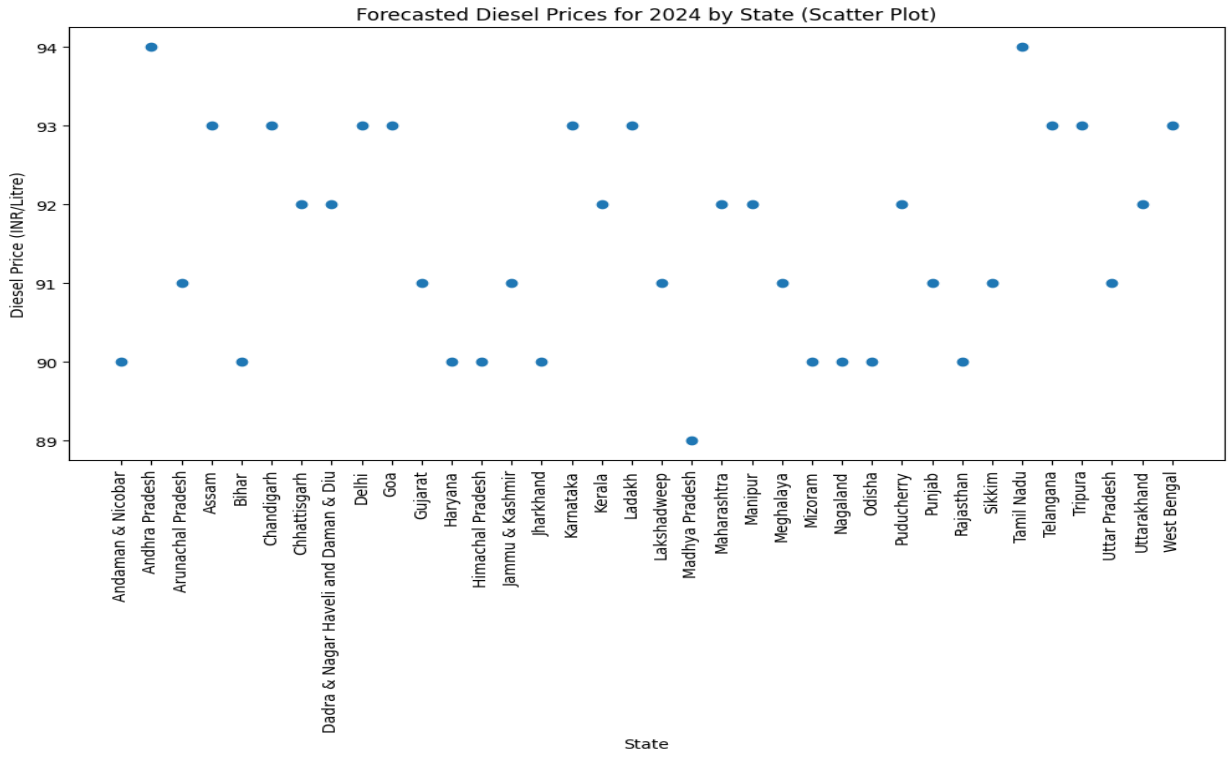

Fig. 8.31

The distribution of forecasted Diesel prices across different states reveals an interesting pattern. The prices are found to be fairly evenly distributed within the range of Rs. 90 to Rs. 93, indicating a similarity in the projected costs across several regions. However, when examining the extremes, Madhya Pradesh stands out with the lowest forecasted price of Rs. 89 for 2024, while Andhra Pradesh and Tamil Nadu exhibit the highest forecasted price of Rs. 94 for the same year.

This distribution of forecasted prices suggests that the majority of states can expect relatively similar Diesel prices in 2024, with a tight range of Rs. 90 to Rs. 93. This could indicate a certain level of stability and uniformity in pricing policies or market conditions that influence Diesel costs across these regions.

On the other hand, the outliers, such as Madhya Pradesh, Andhra Pradesh, and Tamil Nadu, exhibit forecasted prices that deviate from the general range. Madhya Pradesh stands out with a lower-than-average price of Rs. 89, potentially indicating specific factors that contribute to a more favorable pricing situation in that state, such as lower taxes or efficient supply chains.

Conversely, Andhra Pradesh and Tamil Nadu demonstrate higher-than-average forecasted prices of Rs. 94. These states may face unique circumstances, such as increased taxes, transportation costs, or higher demand, which could drive up the Diesel prices compared to other regions.

Analyzing the distribution of forecasted Diesel prices across states can provide insights into the potential variations and trends within the market. Understanding these variations can help businesses, consumers, and policymakers make informed decisions, ranging from fuel budgeting to strategic resource allocation.

It is important to note that the forecasted prices are based on available data and predictive models, which consider historical trends, market factors, and other variables. However, actual Diesel prices in the future can be influenced by unforeseen events, such as global oil price fluctuations, geopolitical factors, economic changes, or policy shifts. Therefore, continuous monitoring and analysis of market dynamics are crucial to adapt to any potential shifts in Diesel pricing patterns.

Chapter 9: From Colab Notebook to Webpage

My website provides easy accessibility to all the plots from the data analysis, along with a convenient and brief analysis.

Fig. 9.1

Using five buttons on the homepage, users can quickly navigate to the specific content they are interested in, including the objectives of our analysis, exploratory data analysis (EDA) plots with insights, market segmentation plots, forecasting scatter plots, and a conclusion page that includes both partwise and overall conclusions.

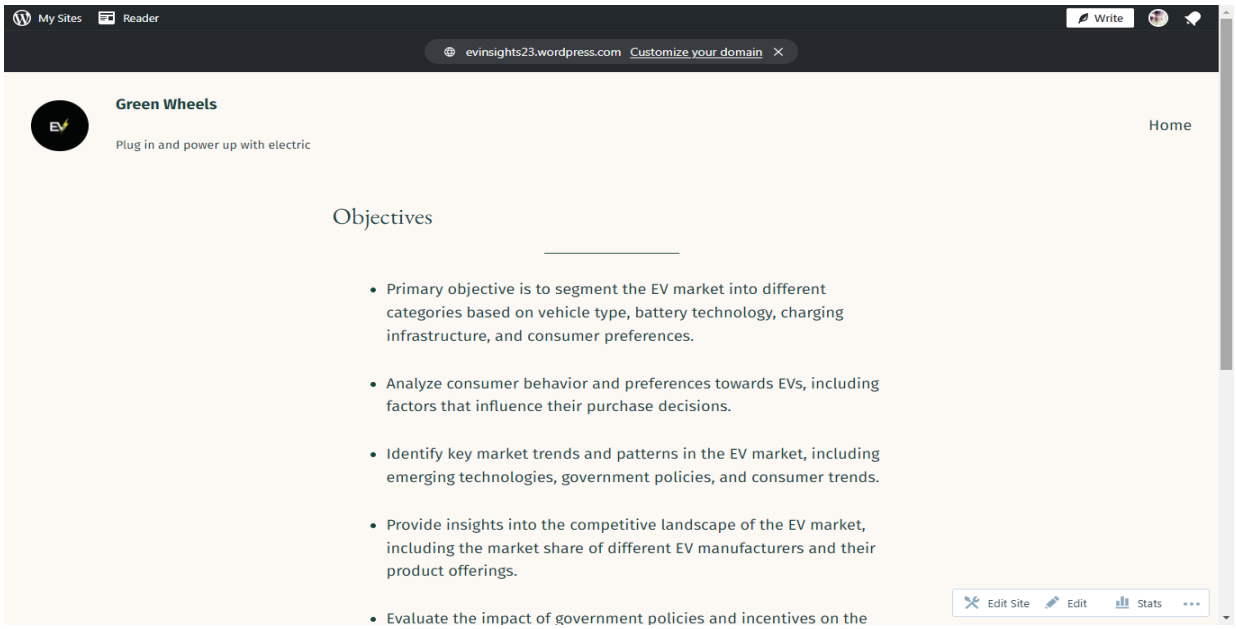

Fig. 9.2

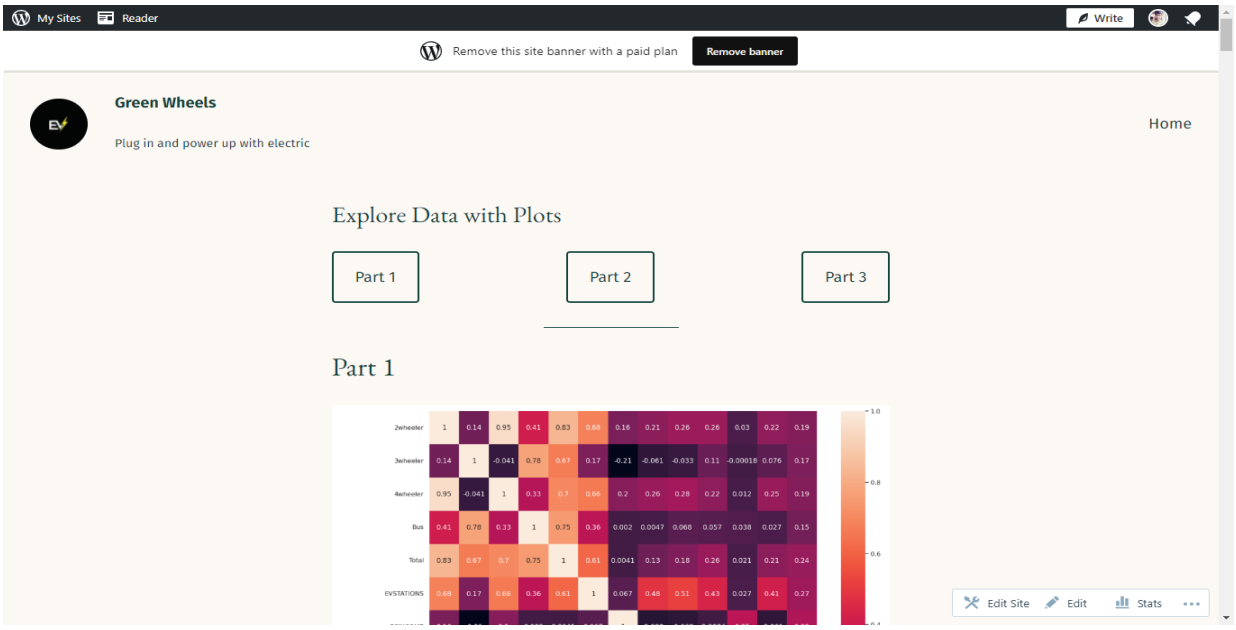
My Sites
Reader
Write
Remove this site banner with a paid plan
Remove banner
Green Wheels
Plug in and power up with electric
Home
Explore Data with Plots
Part 1
Part 2
Part 3
Part 1
Edit Site
Edit
Stats

Fig. 9.3

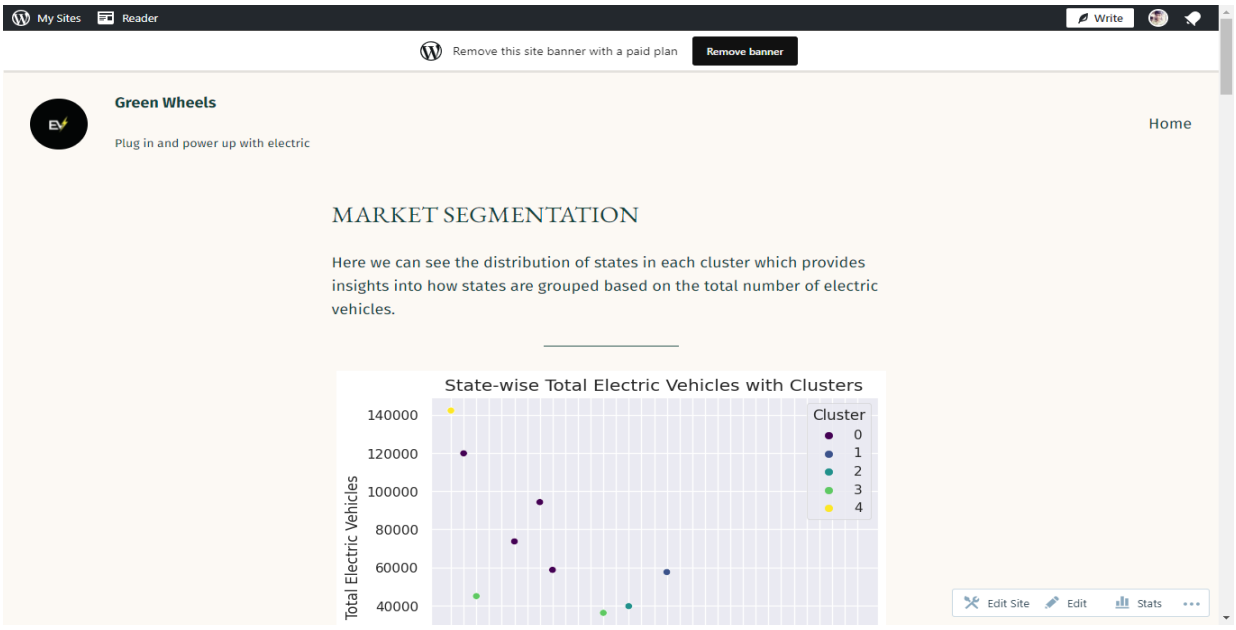
My Sites
Reader
Write
Remove this site banner with a paid plan
Remove banner
Green Wheels
Plug in and power up with electric
Home
MARKET SEGMENTATION
Here we can see the distribution of states in each cluster which provides insights into how states are grouped based on the total number of electric vehicles.
State-wise Total Electric Vehicles with Clusters
Total Electric Vehicles
140000
120000
100000
80000
60000
40000
Cluster
0
1
2
3
4
Edit Site
Edit
Stats

Fig. 9.4

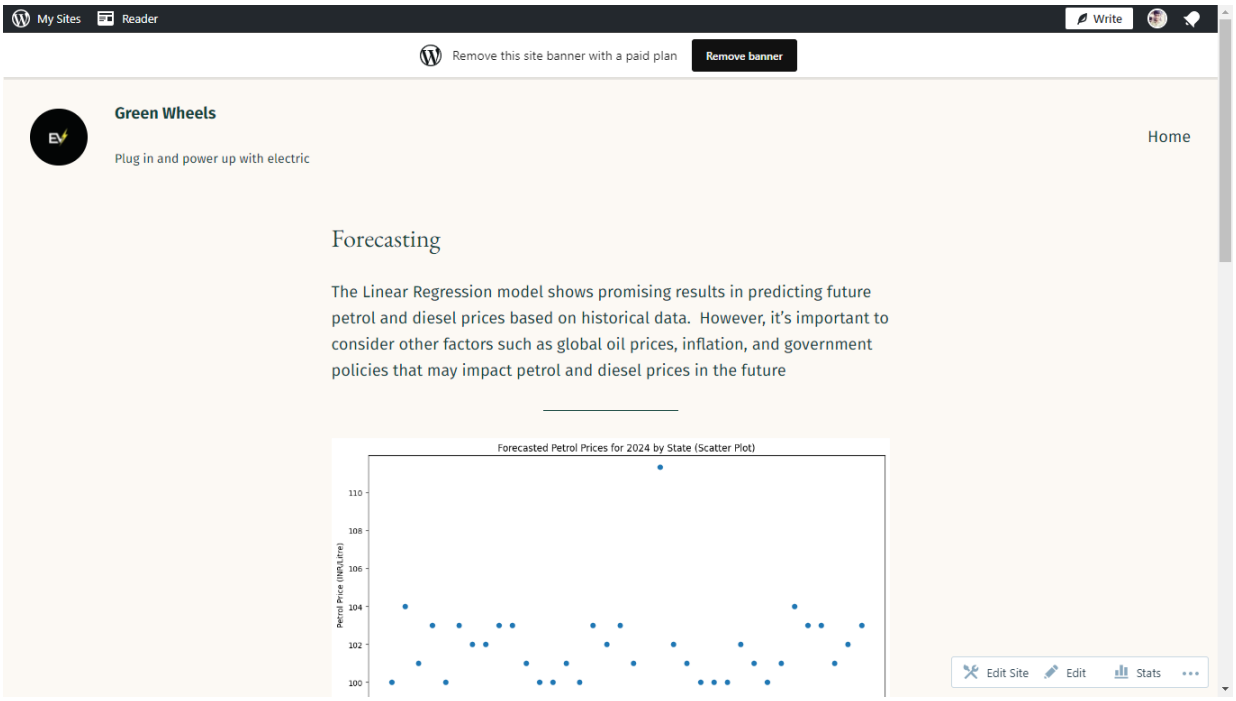

Fig. 9.5

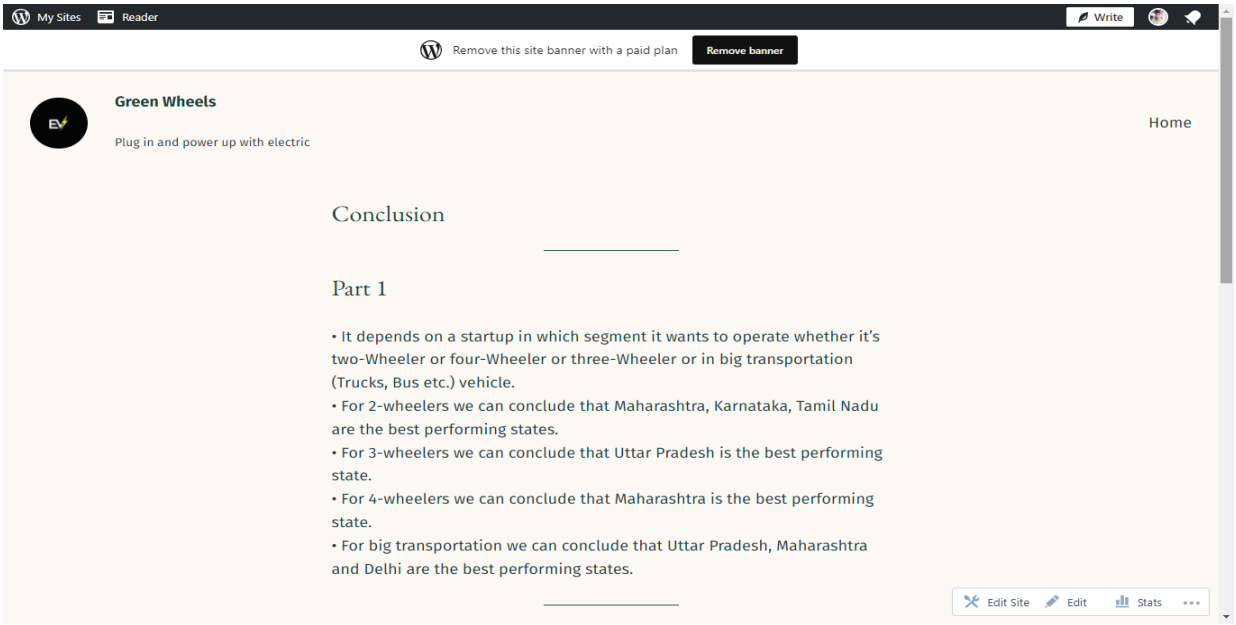

Fig. 9.6

With the website, users can efficiently explore my analysis and gain insights from the data in a user-friendly manner.

- **Why WordPress?**

I used WordPress to create this static website due to its versatility and numerous features that enhance the website-building process. WordPress provides a user-friendly interface that allows me to easily manage and update the content on my website. Its intuitive dashboard and visual editor make it simple to add and edit pages, upload images, and customize the overall design.

One of the primary reasons for choosing WordPress is its extensive plugin ecosystem. With thousands of plugins available, I can effortlessly incorporate additional functionality into my website. Whether I need to optimize my website for search engines, add contact forms, integrate social media sharing, or implement advanced analytics, there is a plugin available to meet my specific needs. This flexibility saves me time and effort in development, as I can leverage existing plugins instead of building custom features from scratch.

Another advantage of using WordPress is the wide range of professionally designed themes. These themes provide a solid foundation for the visual appearance of my website, with responsive layouts that ensure a seamless user experience across different devices. I can easily customize these themes to match my brand identity and create a unique look for my website without extensive coding knowledge.

Furthermore, WordPress has a robust community of developers and users who contribute to its continuous improvement. This active community means that there is a wealth of resources, tutorials, and support available to assist me in any challenges I may encounter. I can rely on the community for updates, security patches, and best practices, ensuring that my website remains secure and up to date.

Overall, WordPress offers a comprehensive solution for creating static websites, combining user-friendly management, a vast plugin ecosystem, customizable themes, and a supportive community. By utilizing WordPress, I can build a visually appealing and functional website efficiently, saving time and resources while still achieving a professional online presence.

Static websites can offer several advantages over a PowerPoint (PPT) presentation when it comes to showcasing the analysis and plots. Here are a few advantages of a static website:

- **Enhanced accessibility**: A static website can be accessed from any device with an internet connection, allowing users to view the analysis and plots conveniently. In contrast, a PPT presentation typically requires specific software and may not be accessible on all devices.

- **Improved organization and navigation**: With a static website, we can structure and organize the content in a hierarchical manner, making it easier for users to navigate through different sections and access specific plots or insights. PPT presentations, on the other hand, generally follow a linear slide-by-slide format, which may not provide the same level of flexibility and ease of navigation.

- **Flexibility in content presentation**: A static website allows us to present a variety of content types, such as text, images, interactive visualizations, and downloadable files, all in one place. This flexibility enables us to provide a richer and more engaging experience for users compared to a PPT presentation, which is primarily limited to slides containing static content.

- **Ease of updates and revisions**: Making updates or revisions to a static website is relatively straightforward. We can easily add or modify content, update plots, or incorporate new insights without having to recreate the entire presentation. In contrast, modifying a PPT presentation may involve more effort and time, as each slide needs to be individually edited.

- **Shareability and collaboration**: Sharing a static website is typically easier than sharing a PPT file. We can simply provide a URL or hyperlink to the website, allowing others to access and explore the analysis at their convenience. Additionally, a static website can facilitate collaboration by enabling multiple users to access and provide feedback on the same platform, whereas collaborating on a PPT presentation may involve sharing and merging multiple files.

Link to the website: https://evinsights23.wordpress.com/

Chapter 10: System Requirement Specification

Ø Hardware Requirements:

Processor: Processor Intel(R) Core(TM) i3-1005G1 CPU @ 1.20GHz, 1190 Mhz, 2 Core(s), 4 Logical Processor(s)

RAM: 8.00 GB

Ø Software Requirements:

Platform: Colab, Wordpress

Application Software: Python

Browser: Chrome (Version 113.0.5672.127 (64-bit))

Chapter 11: CONCLUSION

Part 1:

- It depends on a startup in which segment it wants to operate whether it's two-Wheeler or four-Wheeler or three-Wheeler or in big transportation (Trucks, Bus etc.) vehicle.
- For 2-wheelers we can conclude that Maharashtra, Karnataka, Tamil Nadu are the best performing states.
- For 3-wheelers we can conclude that Uttar Pradesh is the best performing state.
- For 4-wheelers we can conclude that Maharashtra is the best performing state.
- For big transportation we can conclude that Uttar Pradesh, Maharashtra and Delhi are the best performing states.

Part 2:

- The price range of bikes is between Rs.40,000 to Rs.1,50,000
- The price range of cars is between Rs.4,50,000 to Rs.2,45,00,000
- Electric 3 wheelers are available between price range of Rs. 1.5 lakh to Rs. 3 lakhs depending on the brand and their features.

Part 3:

- Here we get the future forecasting of petrol and diesel prices using Linear Regression model.
- By having insight into not only current data but projections of what could happen in the future, businesses can make better adjustments.
- Forecasts help businesses optimise their strategies and alter their current operations to change potential outcomes.

Overall, the analysis conducted in this project suggests that the EV market has significant growth potential, and companies operating in this market should focus on developing innovative products, expanding their geographic reach and building strong partnerships to stay competitive in this rapidly evolving market.

Chapter 12: FUTURE WORK

There are several potential areas for future work:

1. **Market Research**: Conducting further market research to gain deeper insights into consumer preferences and behaviors related to electric vehicles, as well as trends in the automotive industry.

2. **Technological Advancements**: Tracking advancements in battery technology, charging infrastructure, and other related areas that could impact the growth and adoption of electric vehicles.

3. **Competitive Analysis**: Analyzing the competitive landscape of the electric vehicle market, including market share, product offerings, pricing strategies, and marketing tactics.

4. **Policy Analysis**: Monitoring government policies and regulations related to electric vehicles, such as incentives for consumers and manufacturers, and the development of charging infrastructure.

5. **Consumer Education**: Educating consumers on the benefits of electric vehicles, addressing common misconceptions, and promoting awareness of available incentives and programs.

6. **Sustainability**: Evaluating the environmental impact of electric vehicles throughout their lifecycle, including production, use, and disposal, and identifying ways to minimize this impact.

Overall, there are many potential areas for future work related to the electric vehicle market, and continued research and analysis will be crucial in understanding the evolving landscape and identifying opportunities for growth and improvement.

Chapter 13: REFERENCES

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e) https://www.studyiq.com/articles/per-capita-income-of-india/

f) https://www.bijlibachao.com/news/domestic-electricity-lt-tariff-slabs-and-rates-for-all-states-in-india-in.html

g) https://www.aqi.in/in/dashboard/india

h) https://www.bikewale.com/electric-bike/#pageno=2&pagesize=30&fueltype=807

i) https://www.cardekho.com/electric-cars