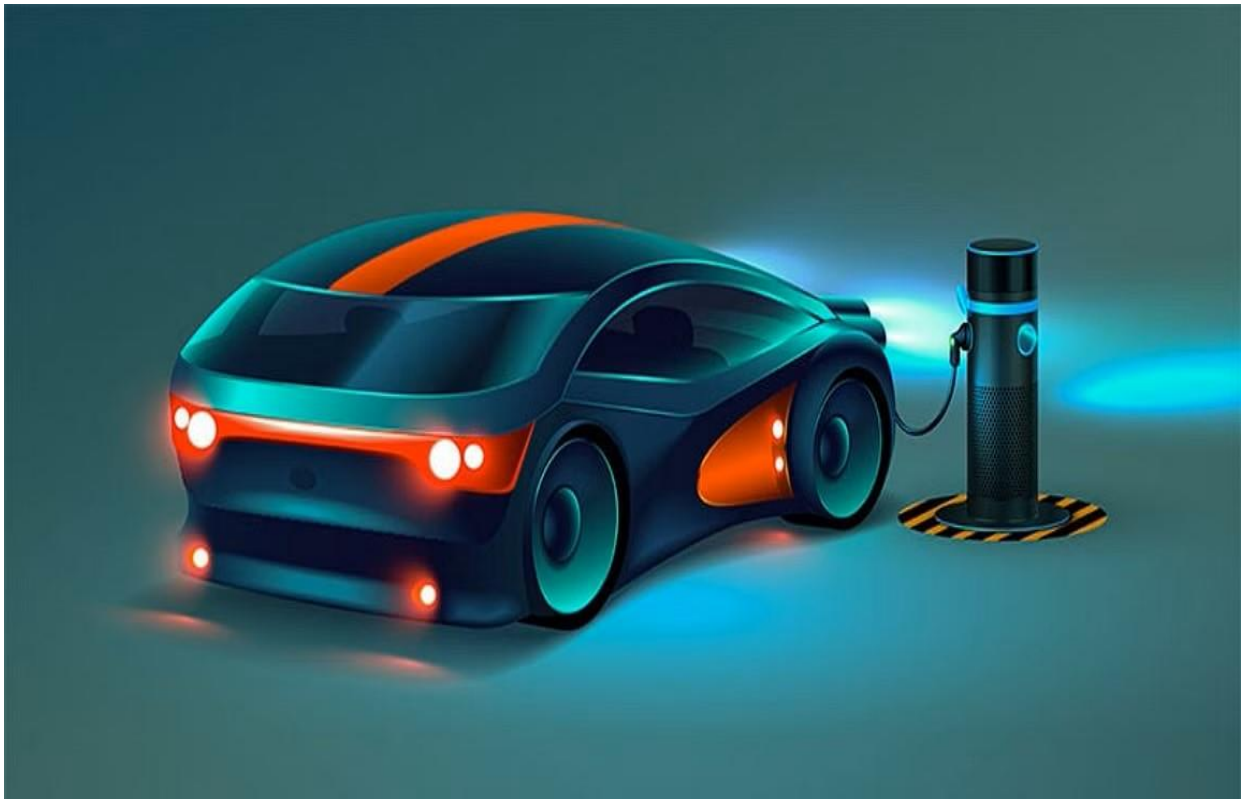
Link - https://github.com/PrajwalRaut8/Feynn_Labs_EV_Market



Market Segmentation Analysis of Electric Vehicles Market in India

Prajwal Raut | 13/11/2023

Problem Statement

- The tasks involved in this analysis encompass the exploration of various market segments, considering factors such as Geographic, Demographic, Psychographic, Behavioral, and other relevant categories based on the available datasets. The primary goal is to derive actionable insights that will guide the startup in formulating a feasible strategy for entering the Indian EV market.
- The report will showcase a detailed Segmentation Analysis, delving into the distribution and preferences within different market segments. The analysis will go beyond conventional parameters, utilizing available datasets to identify potential niches and opportunities. Through rigorous data collection and analysis, the report aims to provide valuable recommendations on the most promising segments for the startup to target, thereby optimizing its market penetration strategy.

Fermi Estimation

Initial Assumption: Approximately 8-10% of the population in India will own electric vehicles by the close of 2023.

In-depth Estimation:

Employment Rate Calculation:

The employment rate is determined by the ratio of the available labor force to the population of people in the working age group.

Assuming a global Indian population of about 1.5 billion, let's consider those over 18 and under 60 as the working-age population, accounting for roughly 60% of the total. This results in an estimated 0.9 billion Indians in the working class. Assuming a 45% employment rate in 2023, approximately 405 million Indians would be employed.

Considering only the middle to upper-class individuals can afford electric vehicles, let's assume 40 million fall into this category. Out of these, not everyone will purchase an electric vehicle, so assuming only 10 million are willing buyers.

Variables and Formulas:

Let (E(x)) be the employment rate of the year (x) (in %).

Let (P(x)) be the population of the year (x).

Let (A(x)) be the number of available labor force in the year (x).

Let (r) be the ratio of Indians between the age of 18 and 60 to the total population of India.

The formula for the employment ratio for the year (x) is given by:

$E(x) = (A(x) * 100)/P(x) * r)$

Gathering More Information:

Estimation for the population of the year 2022 can be obtained by calculating the annual population increase.

P (2019) = 1.3676 billion

P (2020) = 1.3786 billion

P (2021) = 1.39199 billion

The mean increase is approximately 12.195 million, leading to an estimated population of 1.44185 billion in 2022.

Assuming A(x) is constant every year at 471,688,990 and (r = 0.6), (C = 0.75), the employment rate for 2022 (E (2022)) is calculated to be 42%.

Conclusion:

Based on this analysis, I can project an employment rate of 42% by the end of 2024, translating to 170 million employed individuals. Out of this workforce, assuming 10% can afford electric vehicles, Here I estimate that approximately 17 million people will own EVs by the end of 2024.

Data Collection

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

- https://pib.gov.in/PressReleasePage.aspx?PRID=1842704
- https://www.kaggle.com/datasets/praveenchoudhary1217/electric-vehicle-sales-in-india
- https://www.kaggle.com/datasets/divyanshusingh18/ev-cars-india-2023

Data from those links are extracted by Google play scraper available on libraries package. There are multiple datasets get extracted from those websites in CSV and Excel formats. There are also some pdfs which contain valuable information regarding the EV market. I have extracted data from those pdfs as well.

Columns in Dataset:

Dataset 1: EV_cars_India_2023

Car_name: Name or model of the electric vehicle.

Car_price_in_Lakhs: Price of the car in lakhs (a unit of currency).

Batter_cap: Battery capacity of the car.

Drive_range_in_km/full charge: The range the car can travel on a single full charge in kilometers.

Power_in_Bhp: Power of the car measured in brake horsepower (Bhp).

Charge_time: Time taken to charge the car's battery.

Transmission: Type of transmission in the vehicle (e.g., automatic, manual).

Dataset 2: Ev Sales

YEAR: Year of observation.

2 W: Number of electric two-wheelers sold.

3 W: Number of electric three-wheelers sold.

4 W: Number of electric four-wheelers sold.

BUS: Number of electric buses sold.

TOTAL: Total number of electric vehicles sold in that year.

Dataset 3: EV_India

Sr. No.: Serial number or identifier.

State Name: Name of the state in India.

Total Electric Vehicle: Total count of electric vehicles in the respective state.

Total Non-Electric Vehicle: Total count of non-electric vehicles in the respective state.

Total: Total count of all vehicles (electric and non-electric) in the respective state.

Data Preprocessing

Steps taken for preprocessing every dataset:

For dataset 1:

1. Convert the Car_price into numerical value and also change the name to Car_price_in_lakhs.
2. Convert the Batter_cap into numerical value.
3. Convert the Drive_range into numerical value and also change the name to Drive_range_in_km/full charge.
4. Conver the Power into numerical value and also change the name to Power_in_Bhp.
5. Replaced the NaN values with mean.

For dataset 3:

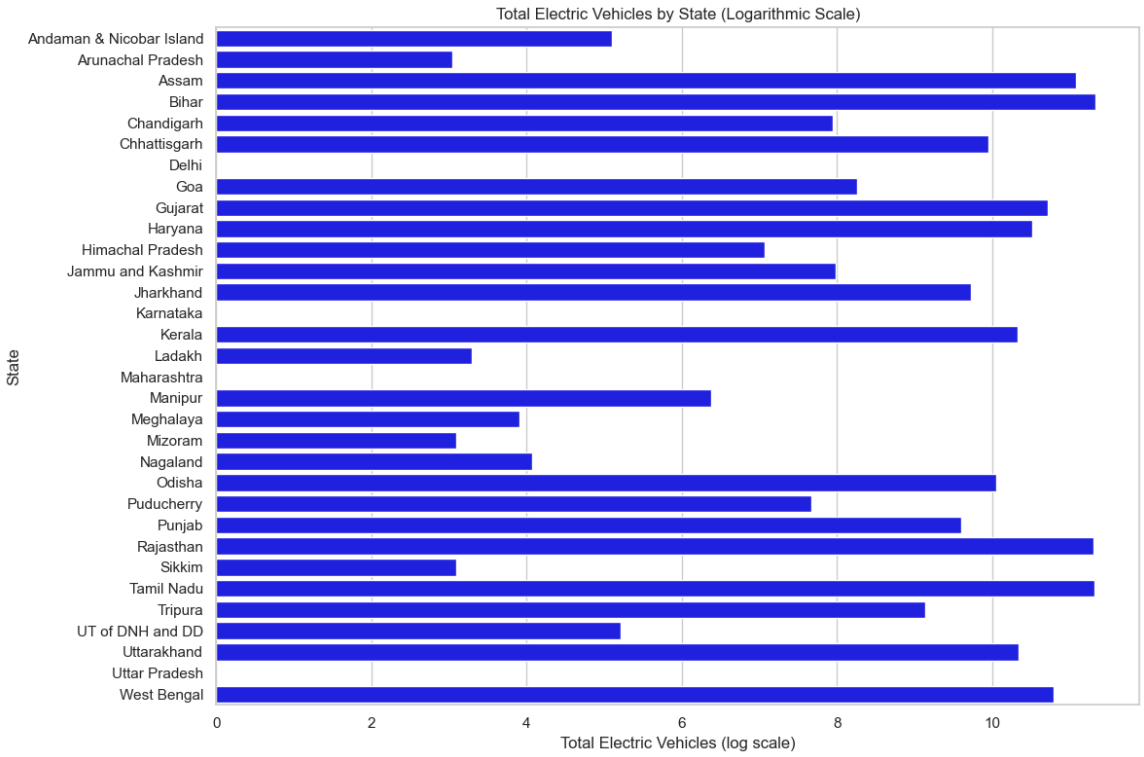
1. NaN values or rows were dropped since they didn't contribute to the findings.
2. Total Electric Vehicle, Total Non-Electric Vehicle and Total columns were converted into numeric values.

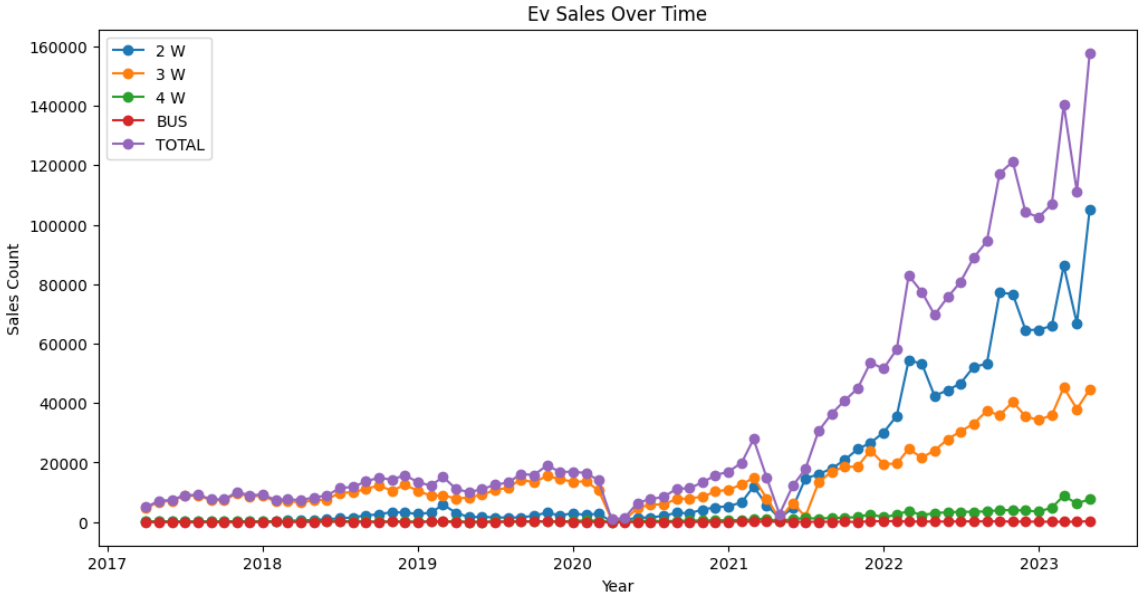
Exploratory Data Analysis

Exploratory Data Analysis (EDA) is a comprehensive investigation aimed at revealing the inherent patterns and structures within a dataset. It holds significant importance for organizations as it unveils intricate trends, correlations, and associations that might not be immediately obvious.

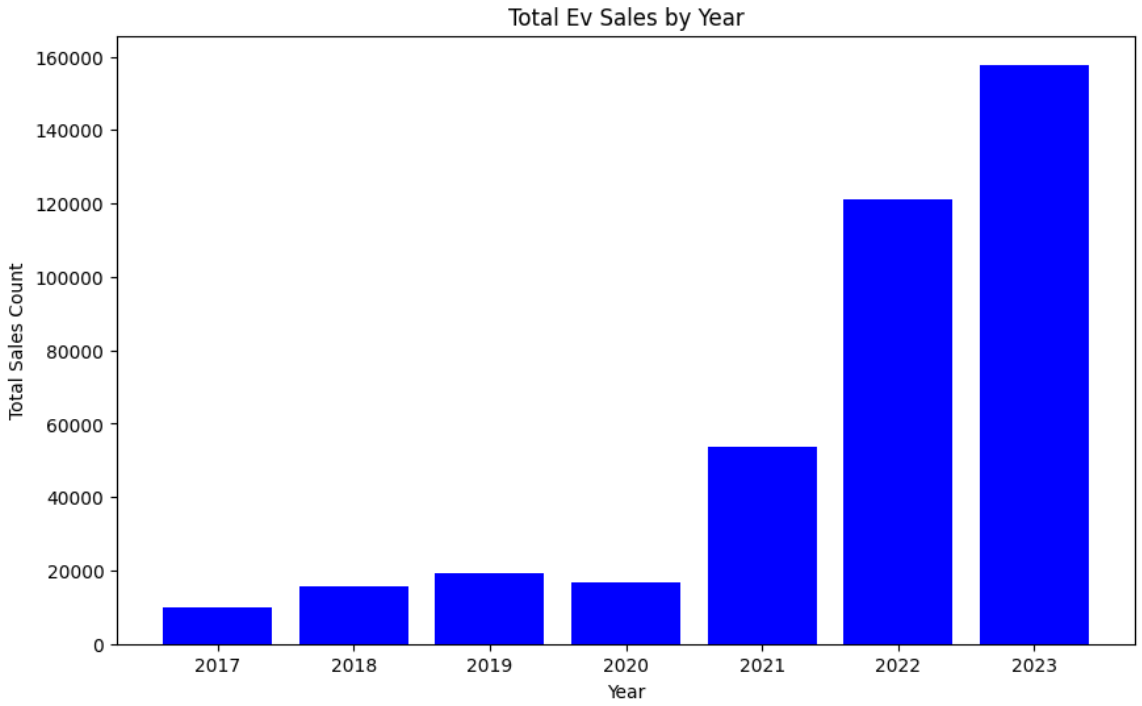
Our analysis involved a multifaceted approach, encompassing univariate, bivariate, and multivariate techniques. Univariate analysis delves into understanding data trends or patterns within a single variable or column of a dataset. Bivariate analysis, on the other hand, examines the relationship between two variables or columns, offering insights into potential connections or dependencies. Lastly, multivariate analysis extends this exploration to encompass the interactions and correlations among more than two variables or columns, enabling a more comprehensive understanding of complex relationships within the dataset.

As we can see in the below graph *Bihar, Rajasthan and Tamil Nadu* have seen rise in purchase of Electric Vehicles.

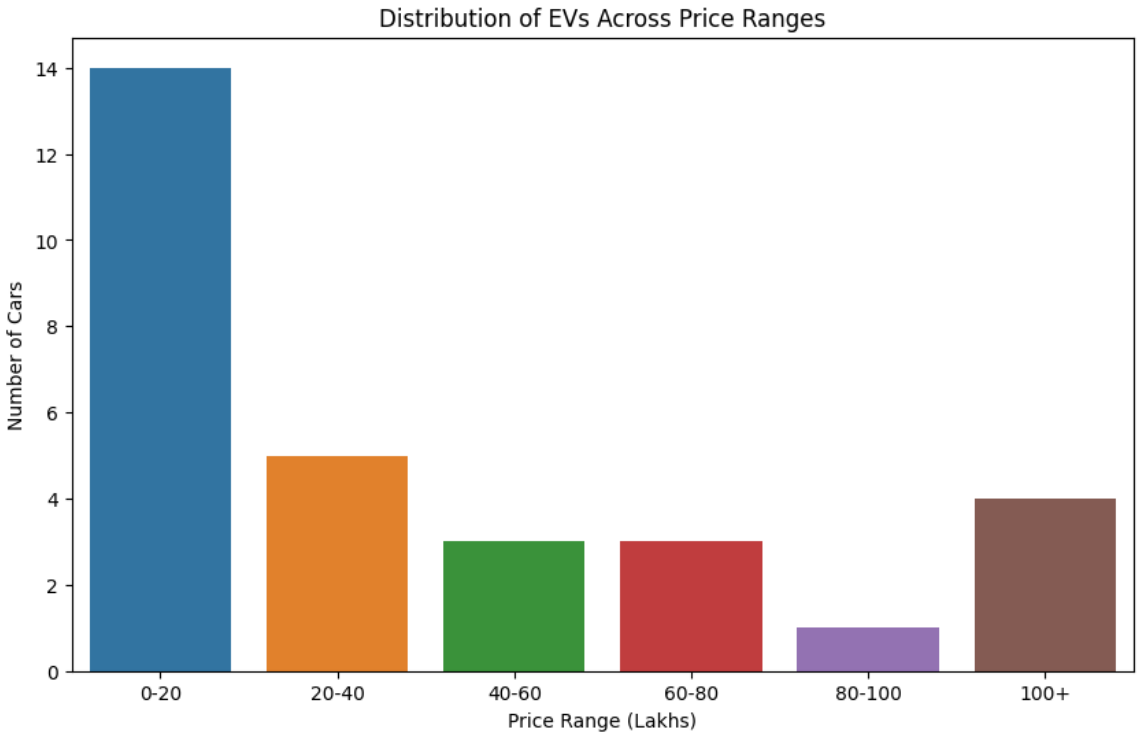




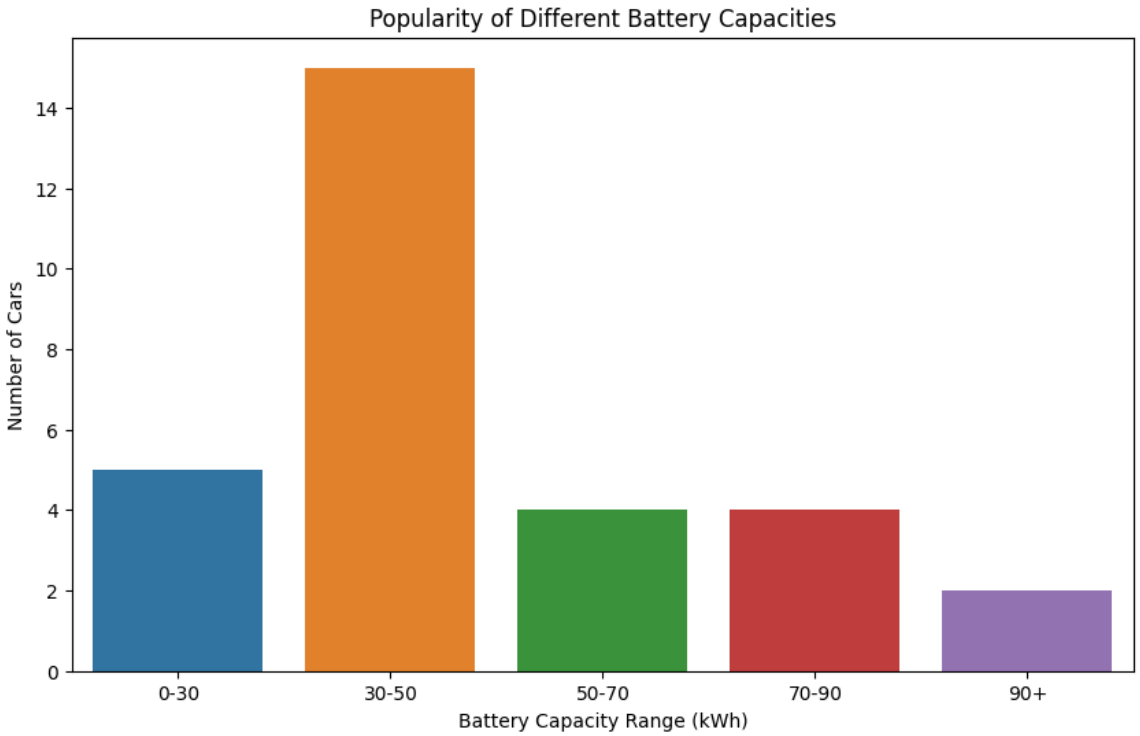
The above diagram shows the sales of 2 wheelers, 3 wheelers, 4 wheelers, buses and the total number of electric vehicles being sold throughout the years. It can be observed that the sales of 2 wheelers has been maximum throughout the years.



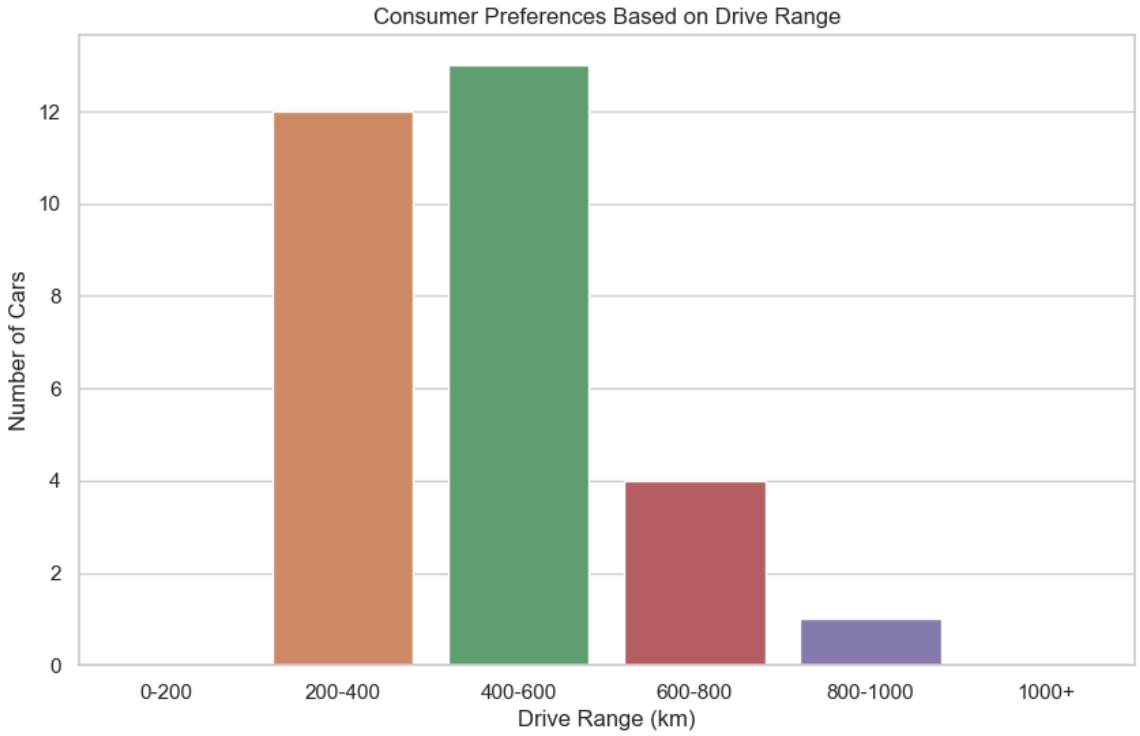
The above diagram shows the sales of electric vehicles in India throughout the years from 2017 to 2023 and it can be seen that the sales of electric vehicles have been increasing and will continue to increase even in 2024.



The above diagram shows the number of cars and their price ranges, most of the cars are in between 0-20 lakhs which seems to be more affordable for everyone.

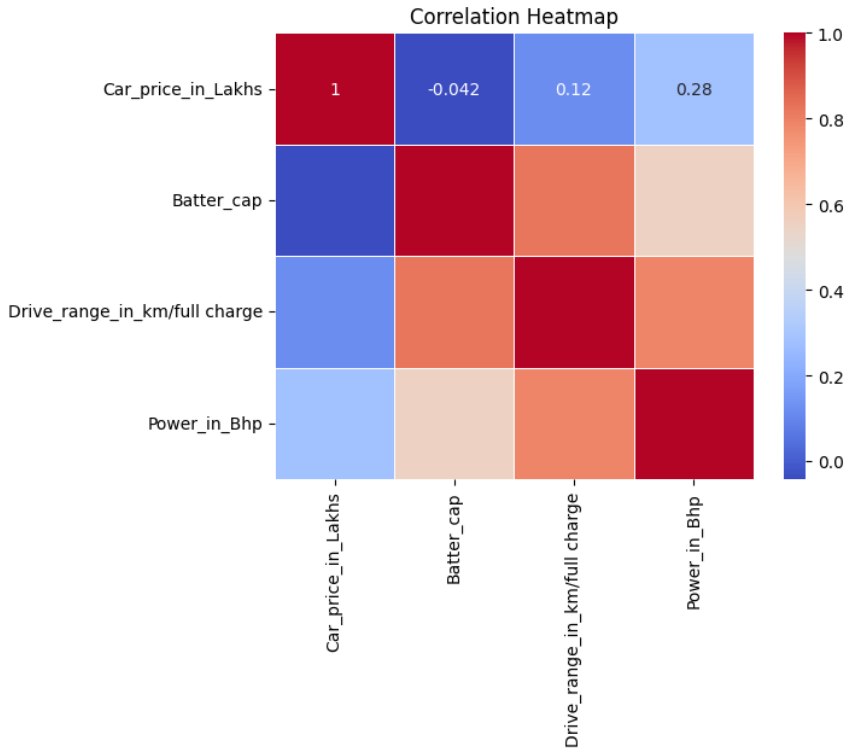


The above diagram shows the distribution of battery in cars and it can be seen that the cars with most popularity have battery capacity of 30-50 kWh.



The above graph shows that the consumers prefer cars with the drive range of 400-600 km.

Correlation matrix of one of the datasets used:



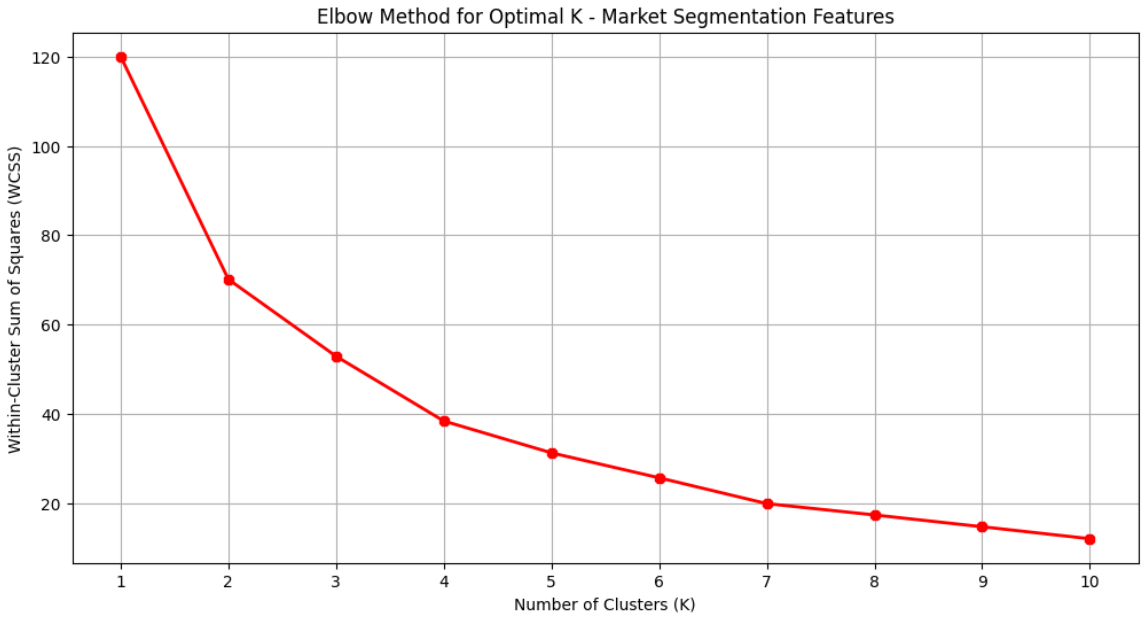
Segment Extraction

K-Means Clustering stands out as a prominent Unsupervised Machine Learning Algorithm utilized extensively for addressing Classification Problems. It effectively categorizes unlabeled data into distinct groups, referred to as clusters, based on similar characteristics and shared features among data points.

Consider an assortment of N unlabeled multivariate datasets encompassing diverse features like water availability, pricing, city attributes, and more. Clustering is the technique applied to organize datasets into various clusters by identifying common patterns and features. This process occurs in Unsupervised Learning, allowing the classification of multivariate data without external guidance, purely based on inherent patterns within the dataset.

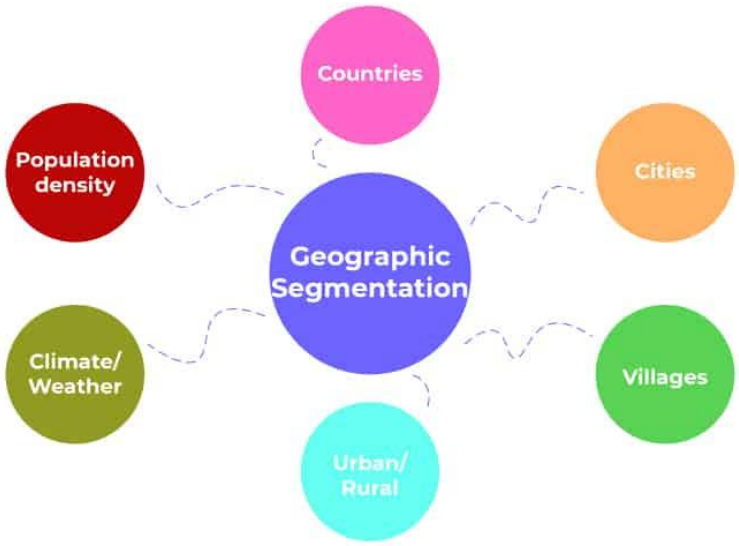
The Elbow Method involves exploring the variation in the number of clusters (K) from 1 to 10. For each K value, the Within-Cluster Sum of Square (WCSS) is computed, representing the sum of squared distances between each data point and its cluster's centroid. When plotting the WCSS against the K value, the resulting graph typically resembles an 'elbow'.

As the number of clusters increases, the WCSS value generally decreases. At K = 1, the WCSS value reaches its maximum. Upon analyzing the graph, a distinct point is observed where the graph's descent notably slows down, resulting in an elbow-like bend. This inflection point marks the optimal K value or the ideal number of clusters for the dataset.



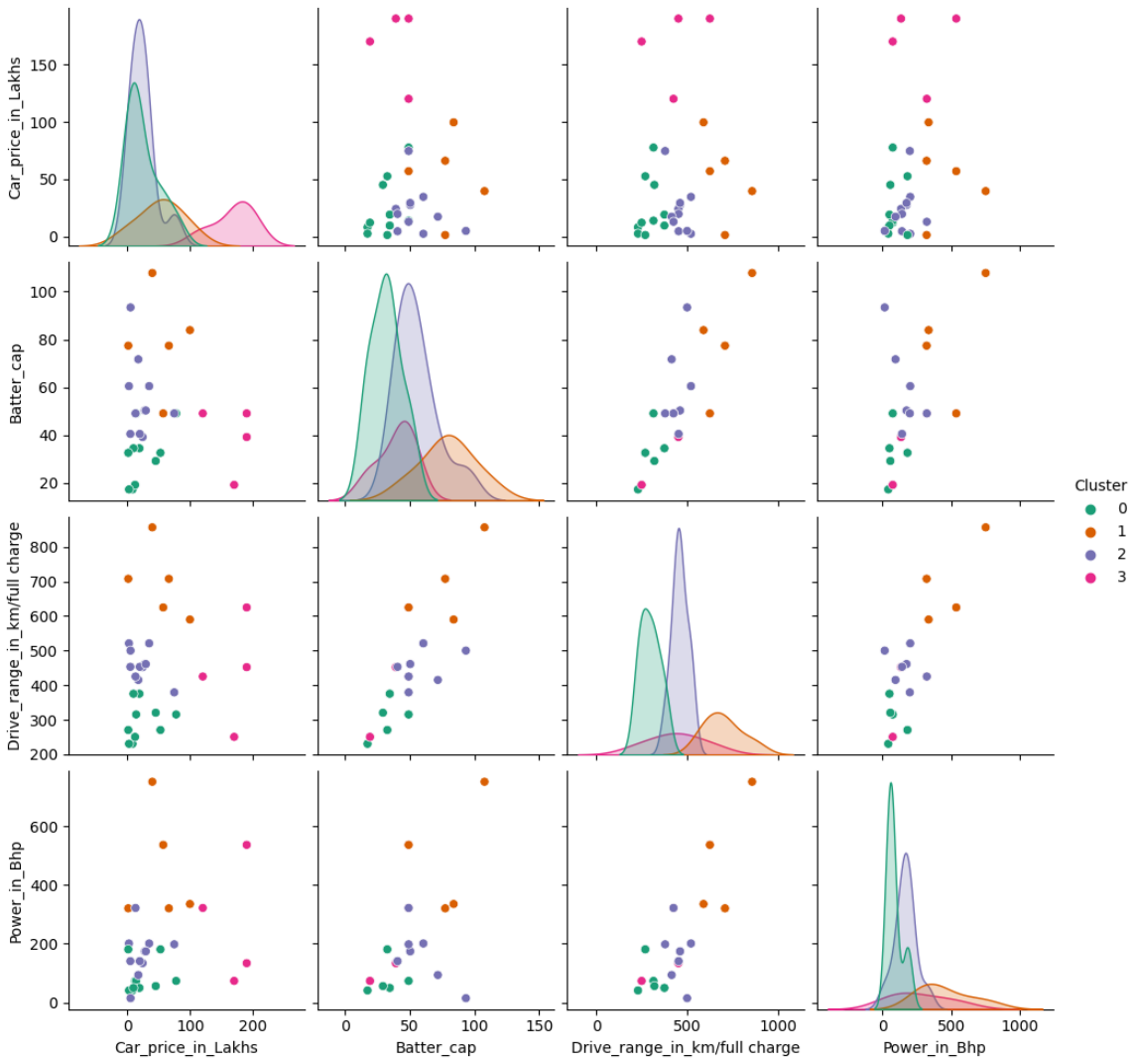
Profiling Potential Segments

Geographic Segmentation: Categorizing consumers based on their location, urban vs. rural areas, states, or regions with varying preferences or accessibility to charging infrastructure.



Behavioral Segmentation: Identifying segments based on purchasing behavior, usage patterns, loyalty to brands, preferences for specific features (drive range, vehicle type, charging time), etc.

Behavioral Factors:



It can be inferred from the above graphs that most of the cars are in between 10-40 Lakhs and commonly used batteries have the capacity of 20 – 60 kWh and the drive range of 250-500 km/full charge.

Major behavior factors to consider : Car_price_in_Lakhs, Batter_cap, Drive_range_in_km/full charge, Power_in_Bhp

Target Segments for Electric Vehicles:

Based on the comprehensive analysis conducted, the identified target segments for Electric Vehicles (EVs) can be narrowed down to those demonstrating:

1. **Geographic Factors:**
    - States or regions exhibiting a more favorable market landscape for EV adoption.
2. **Price Range:**
    - Segments categorized by affordability, indicated by the **Car_price_in_Lakhs**.
3. **Battery Capacity:**
    - Segmentation by battery capacity (**Batter_cap**), catering to diverse needs of consumers with varying drive range preferences.
4. **Drive Range:**
    - Differentiated by the **Drive_range_in_km/full charge** to align with consumer preferences for varied distances.
5. **Power Rating:**
    - Segments focusing on **Power_in_Bhp**, indicative of acceleration or performance attributes.

In conclusion the analysis reveals a consumer inclination towards EVs with **battery capacities** ranging between 30-50 kWh and a preferred drive range of 400-600 km. Cars within the 0-20 lakhs **price** bracket dominate the market, indicating affordability as a crucial factor. The sales trend showcases a consistent preference for 2-wheelers, while the **states** Bihar, Rajasthan, and Tamil Nadu exhibit a notable surge in EV purchases, indicating growing market acceptance in these regions. Overall, these insights emphasize evolving consumer preferences and promising geographic areas for increased Electric Vehicle adoption in India.

Customizing the Marketing Mix in the Automotive Industry

In the competitive landscape of the automotive industry, customizing the marketing mix is pivotal for business growth. The 4Ps framework—Product, Place, Promotion, and Price—strategizes approaches tailored to target markets to amplify sales and bolster market presence. Flexibility in strategies is imperative despite holding a robust market position. Opportunities in the industry, such as integrating advanced computing technologies, are countered by inherent threats, requiring SWOT Analysis for strategic adjustments.

Product Mix: Diverse Offerings, Strategic Focus

The product mix, while showcasing limited diversification, presents a broad spectrum of products including automobiles, automobile parts, commercial vehicles, and financial services. Pricing strategies encompass market-oriented and premium pricing, aiming to sway perceived brand value and drive sales.

Promotional Mix: Communicating Value

Promotional activities, comprising advertising, direct marketing, personal selling, sales promotion, and public relations, play a pivotal role in the automotive business, communicating brand value and offerings effectively.

Place/Distribution: Access and Availability

Distribution channels encompass official websites, dealerships, and automotive shows, strategically placed to reach target customers and facilitate access to automotive products and information.

Early Market Potential:

Addressing Customer Needs Understanding the aspirations of potential vehicle buyers, the focus revolves around assisting customers in finding vehicles aligned with their specific needs, ensuring affordability and suitability.

Key Areas for Electric Vehicle Development in India

Development areas for electric vehicles in India include retrofitting public transport to PHEVs, government incentives, charging infrastructure, electrical propulsion systems, skilled manpower development, and awareness campaigns highlighting the environmental benefits.

Optimal Market Segment Analysis: Growth in EV Demand

Multiple EV manufacturing companies in India, coupled with rising demand, point towards an optimistic market segment. Insights highlight a potential shift towards electric vehicles and emphasize environmental benefits.

Strategic Recommendations for Market Penetration

The project suggests strategic initiatives such as establishing local operations, especially in metro cities, to navigate supply chains effectively and capitalize on growth opportunities.

Conclusion:

In conclusion, the future of the automotive industry emphasizes the significant role of electric vehicles. The "Go Green Go Electric" initiative promotes a sustainable transition towards electric mobility, aligning with environmental consciousness and future automotive trends.