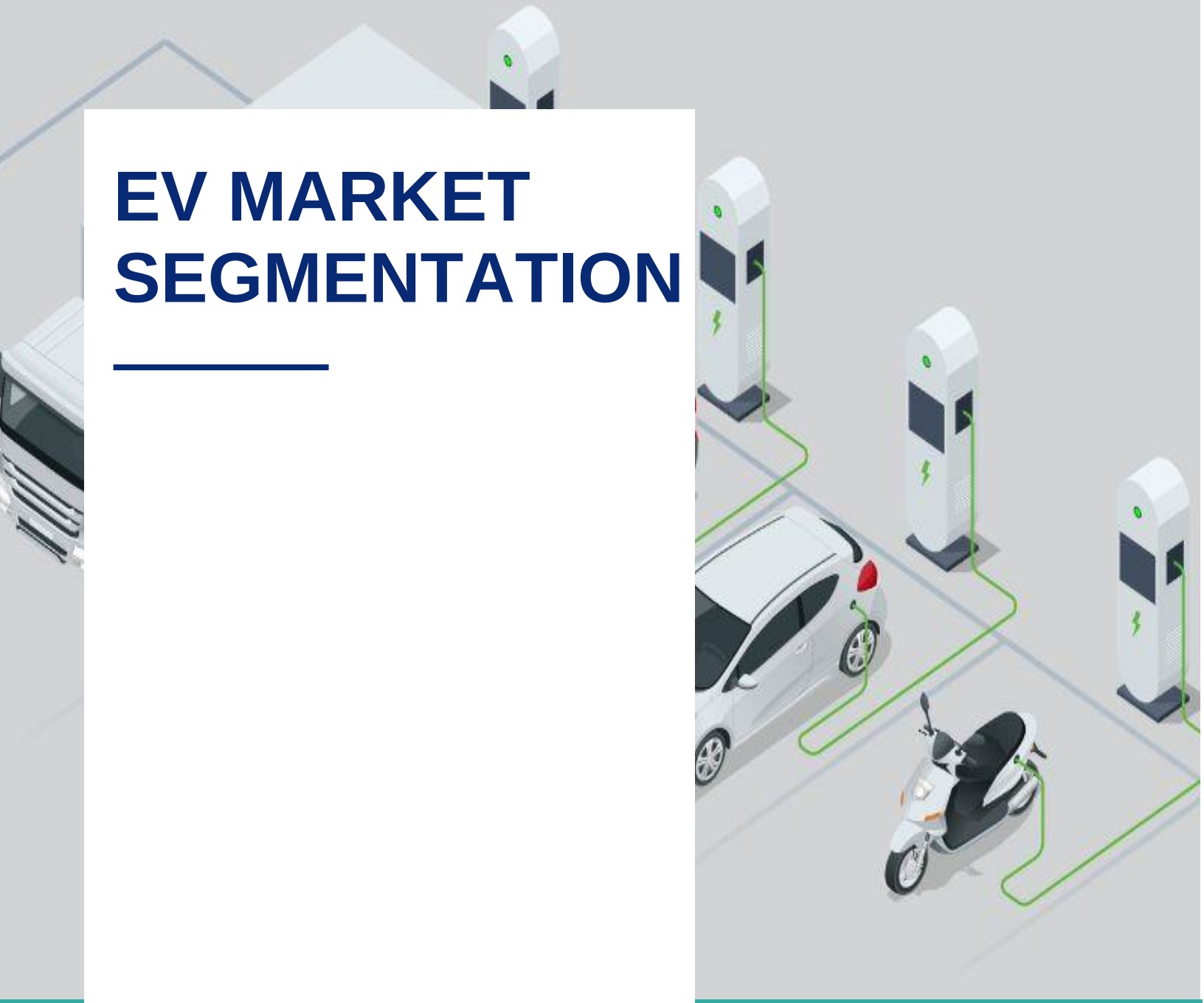
EV MARKET SEGMENTATION



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Authored by: Nirmal

Logo Name

1. Introduction

The electric vehicle (EV) market is changing dramatically as the world becomes more aware of climate change and environmental issues. Electric vehicles (EVs), which run on electricity rather than traditional fossil fuels such as gasoline or diesel, are viewed as a cleaner and more sustainable way to cut carbon emissions. With breakthroughs in battery technology and government initiatives that promote greener transportation, global demand for electric vehicles has increased. Major automakers, both established brands and startups, are increasingly focusing on building a diverse range of EVs that serve to a variety of market groups, from low-cost models to luxury electric vehicles. In addition, charging infrastructure is fast developing, making it easier for consumers to embrace EVs.

In India, the EV market is beginning to grow as people become more concerned about air pollution, particularly in major cities. The government is playing an important role in encouraging more electric vehicles through initiatives such as the Faster Adoption and Manufacturing of Electric Vehicles (FAME) program. Indian automakers are also starting to create more electric vehicles, and EV charging stations are being built to make it easier for consumers to use them.

The increase in the number of electric vehicles in India has the potential to have far-reaching consequences for both the environment and the economy. By reducing its reliance on imported crude oil, India can save money on energy and minimize its exposure to global oil price changes. Furthermore, the EV industry has the potential to generate new jobs in manufacturing, R&D, battery technology, and infrastructure. As more Indian consumers become aware of the advantages of electric vehicles, such as cheaper operating costs, government incentives, and environmental benefits, the EV industry is likely to expand rapidly in the next years, influencing the country's transportation landscape.

This report aims to provide a comprehensive analysis of market segmentation within India's electric vehicle sector, identifying the most suitable type of EV to ensure the success of a new startup in this rapidly evolving market.

2. Problem Statement

The electric vehicle (EV) market in India is growing fast, and many companies are attempting to figure out how to penetrate this market. Our startup is looking for the perfect type of electric vehicle to create. To accomplish so, we need to understand the various elements that individuals consider when purchasing an EV. Price, battery capacity, driving range, charging time, and vehicle type are all important considerations. By extensively examining these features, we can determine which form of EV will appeal most to Indian consumers.

In our analysis, we focus on different sorts of electric vehicles (EVs), such as 2-wheelers, 3-wheelers, 4-wheelers and bus, to see which would be the most profitable for the organization to create. The goal is to evaluate how different vehicle types perform in terms of sales and market trends in order to make an informed judgment about which EV sector has the most potential for growth. This research will also focus on essential criteria like as price, battery capacity, drive range, power, charge time, top speed, body type, and category, allowing us to adequately analyse each type of EV to make a rigid decision.

This research is critical for developing a strategy that will maximize the startup's success. By focusing on the most profitable EV type, the business may enter the market with a product that not only meets demand but also allows the company to develop and compete more effectively. This data-driven approach ensures that resources are allocated efficiently and that the firm meets its financial and business objectives.

3. Sales Report

The sales report was created to analyse the performance of various electric cars (EVs) in the Indian market from 2017 to 2024. The report examines sales patterns for two-wheelers, three-wheelers, four-wheelers, and electric buses across time. This analysis is crucial for determining which category of EVs has experienced the highest growth and may be the most profitable for the firm to invest in.

The 2-wheeler segment has consistently dominated the market (**Fig 1**), accounting for more than 2 million sales and being the largest by volume. This suggests that two-wheelers are in high demand in India due to their low cost and convenience for urban commuting. In contrast, the 4-wheeler segment, although growing steadily, shows lower sales figures, with around 209,000 units sold. This reflects the relatively higher price point and different consumer base for electric cars compared to 2-wheelers.

The report also shows significant growth in the 3-wheeler market, with sales approaching 2 million units, owing mostly to commercial and last-mile transportation demands. Buses, although being the smallest category, have had a consistent growth in sales, indicating a growing interest in electrifying public transit. This extensive sales study will help the organization decide on the most profitable EV type to create and market.

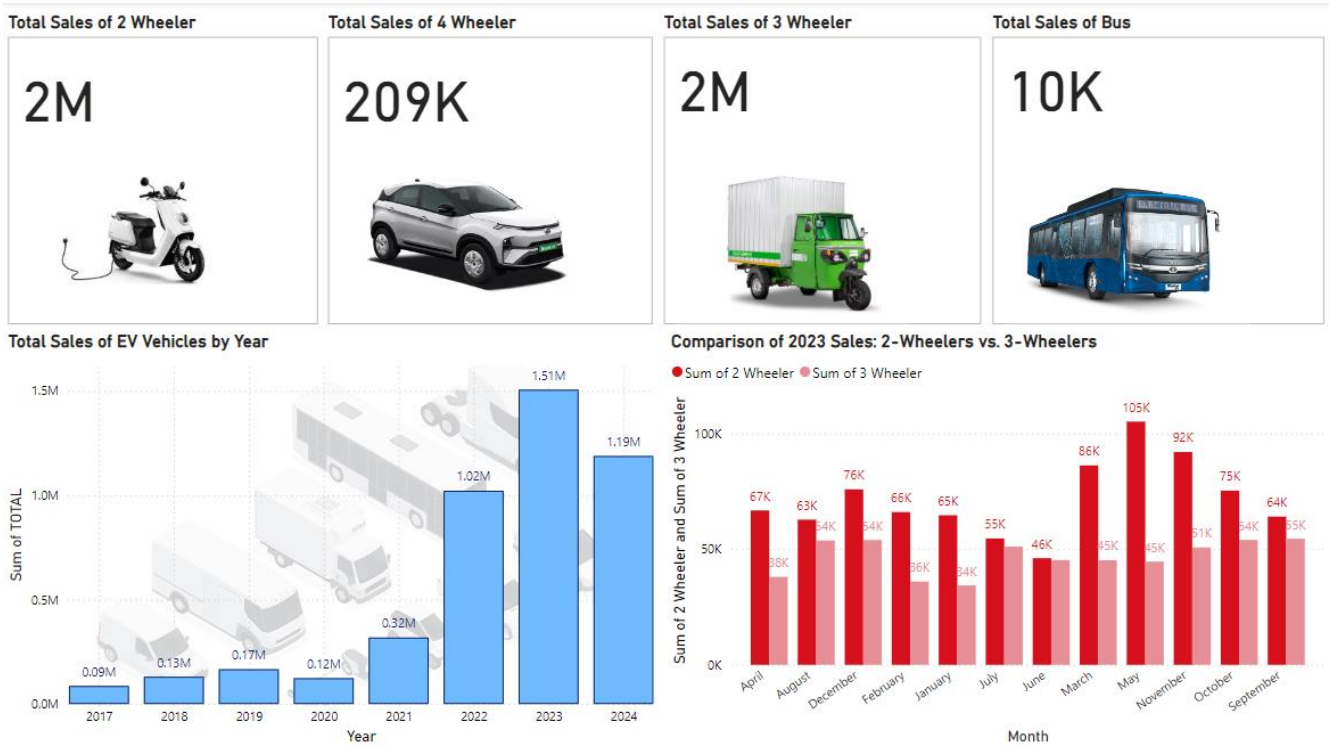


Fig 1. Total units sold until August 2024

There was a consistent increase in the sales from 2017 but declined steadily by 2020. However, there was a significant growth afterwards, with year 2023 recording the highest sales across all the years.

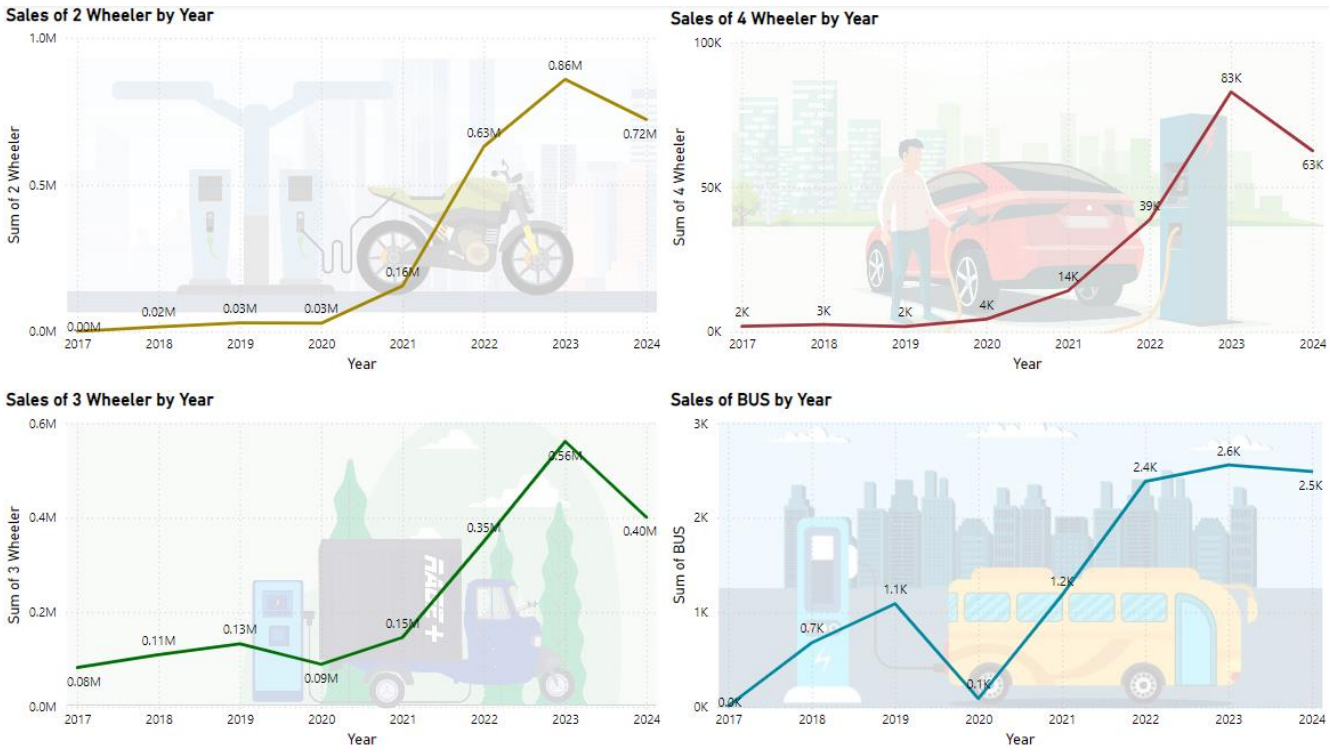


Fig 2. Sales of each electric vehicle by year

From **Fig 2**, we observe detailed sales trends for different electric vehicle types—2-wheelers, 4-wheelers, 3-wheelers, and buses—by year, providing significant insights into the Indian EV market.

2-Wheeler Sales: The figure shows a substantial increase in 2-wheeler sales beginning in 2020 and peaking in 2023 at 860000 units. This upward trend indicates rising demand for affordable and efficient modes of transportation, particularly in cities.

4-Wheeler Sales: The 4-wheeler segment had consistent development, with sales rising from 2,000 units in 2017 to a high of 83,000 in 2023. This suggests an expanding but still specialized sector in which electric vehicles are gaining traction at a slower rate than two-wheelers.

3-Wheeler Sales: Sales of electric 3-wheelers have increased significantly, particularly since 2021, peaking at 560000 units in 2023. This growth demonstrates the appeal of three-wheelers for business purposes, particularly in logistics and urban transportation.

Bus Sales: While still the smallest market, electric buses have showed consistent growth, reaching 2.6 thousand units in 2023. This points to a sluggish but steady adoption of electric buses for public transportation systems.

From overall report, it can be understood where the highest demand lies. With these figures, startups will now get a small glimpse into which EV type has the greatest market potential. In the further analysis, we will determine the optimal specifications that the vehicle's features should possess, supporting startups business goals effectively.

4. Vehicle Segmentation

In this section, we will derive insights into sensible specifications that a startup company can consider to achieve their desired goals. This analysis was conducted using Scatterplots, Principal Component Analysis (PCA) and K-Means clustering algorithm. Furthermore, we analysed customer feedback to learn about their disappointments and find areas for improvement. This method will help us solve these difficulties and improve the products, resulting in more profitable outcomes.

Our dataset has 118 observations and includes variables such as Model Name, Price, Battery Capacity, Drive Range, Power, Charge Time, Top Speed, Body Type, and Category. It focuses primarily on two-, three-, and four-wheelers, eliminating electric buses because they are unprofitable, as seen by continually low sales since 2017 (**Fig 2**). Bus production requires a high level of investment, making it a less viable option for entrepreneurs.

4.1. Exploratory Data Analysis

Key attributes such drive range, power, battery capacity, and charge time were taken into account, and a scatter plot was generated to assess their relationship to car prices. Many 4-wheelers are typically very expensive, ranging from 10 lakhs to 70 lakhs, as compared to other 2 categories (**Fig 3**) and have a greater driving range, power, battery capacity, and longer charge times.

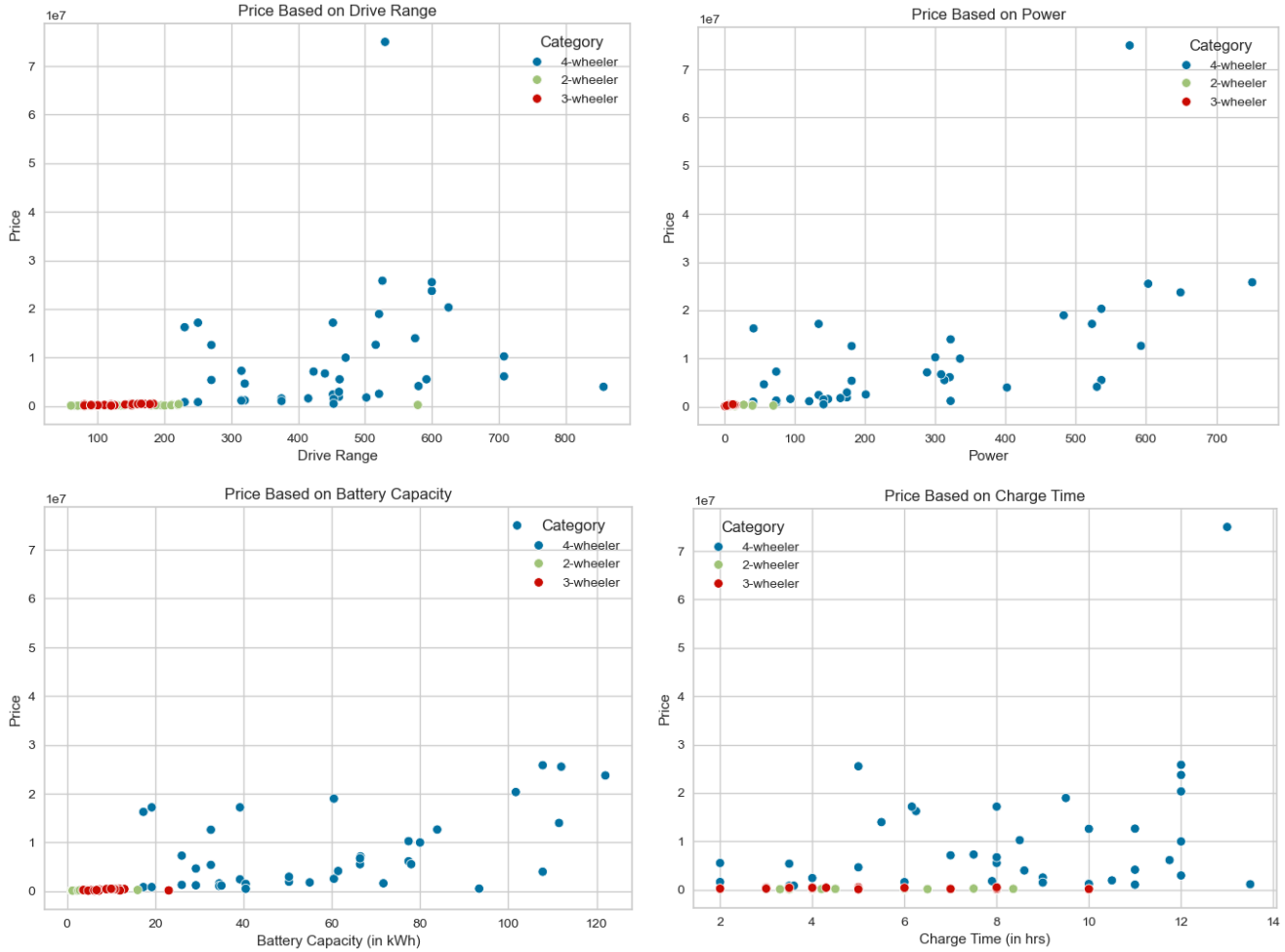


Fig 3. Relationship between price and other specific features based on EV categories

2-wheelers and 3-wheelers are clustered at the lower end of price and other attributes except for charge time. This indicates that they have generally lower driving range below 300 km and lower price than 4-wheelers, under 1 million, which is 10 lakhs. The average price of a 4-wheeler is Rs. 94,55,940 in India. 2-wheelers are the cheapest with average price being Rs. 1,09,853 while 3-wheelers being marginally higher at Rs. 2,61,250. There are a few vehicles from 3-wheeler and 2-wheeler categories that require longer time for charging as seen in the 4th graph.

4.2. Principal Component Analysis

In this, we have removed certain irrelevant features because they play no role in deciding the optimal specifications we target for. A subset of features we chose for PCA are Price, Battery Capacity, Drive Range, Power, Charge Time, and Top Speed.

We apply PCA after preprocessing the data using StandardScaler which is used to scale the features on a common range, from 0 to 1. The final output is given in **Fig 4**.

	Standard deviation	Proportion of Variance	Cumulative Proportion
PC1	2.24	0.71	0.71
PC2	0.83	0.10	0.81
PC3	0.78	0.09	0.90
PC4	0.62	0.05	0.95
PC5	0.38	0.02	0.97
PC6	0.35	0.02	0.99
PC7	0.30	0.01	1.00

Fig 4. PCA results

Results from principal components analysis indicate that the first three components capture 90% of the variance in the data. The loadings indicate how the original variables are combined to form principal components. Loadings guide the interpretation of principal components. In our example, the two segmentation variables with the highest loadings (in absolute terms) for principal component 3 are Charge time and Price **(Fig 5**).

feature	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Price	0.33	0.46	0.64	0.41	0.17	-0.24	-0.15
Battery_Capacity	0.41	-0.09	0.12	-0.41	-0.07	-0.45	0.66
Drive_Range	0.41	-0.21	-0.11	-0.43	0.35	-0.22	-0.65
Power (in bhp)	0.41	0.11	0.17	-0.24	-0.69	0.47	-0.18
Charge_Time (in hrs)	0.29	0.67	-0.67	0.07	0.07	0.01	0.08
Top_Speed	0.41	-0.26	0.03	0.18	0.50	0.63	0.29
Category	-0.36	0.46	0.29	-0.62	0.33	0.29	0.07

Fig 5. Factor loadings

Charge Time and Price are two important attributes that influence the overall composition of EV features. Specifically, these two features show strong associations in the data, indicating that they are critical for determining the market direction. EVs with competitive pricing and short charging times may have a great market appeal in the company's future product plan. These data can help guide product development, ensuring that the chosen EV type is in line with industry trends and maximizes profit potential.

4.3. K-means Clustering

In K-means clustering, we generally plot clusters based on 2 criteria, Elbow method and Silhouette analysis to determine optimal number of clusters. Applying both techniques relatively indicate that 3 clusters are appropriate.

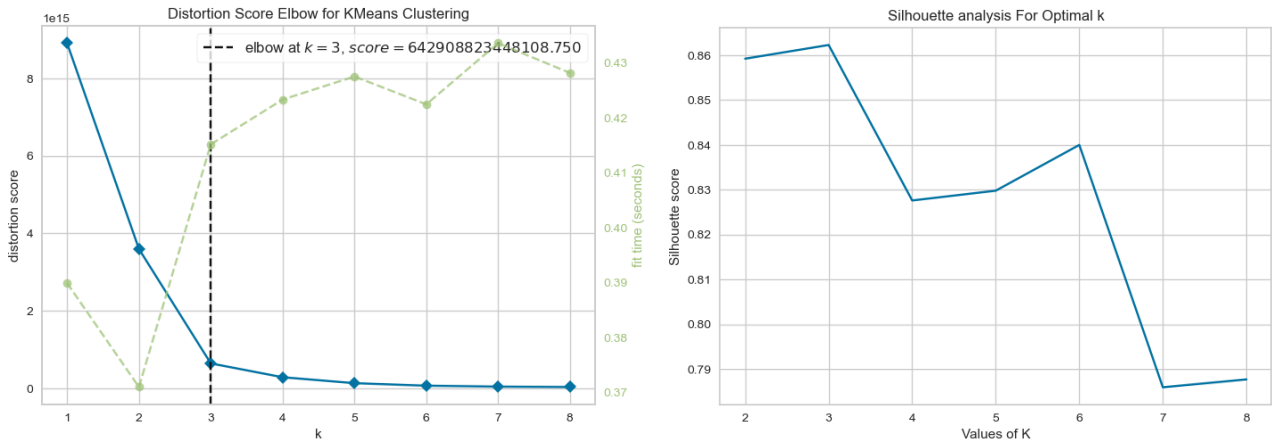
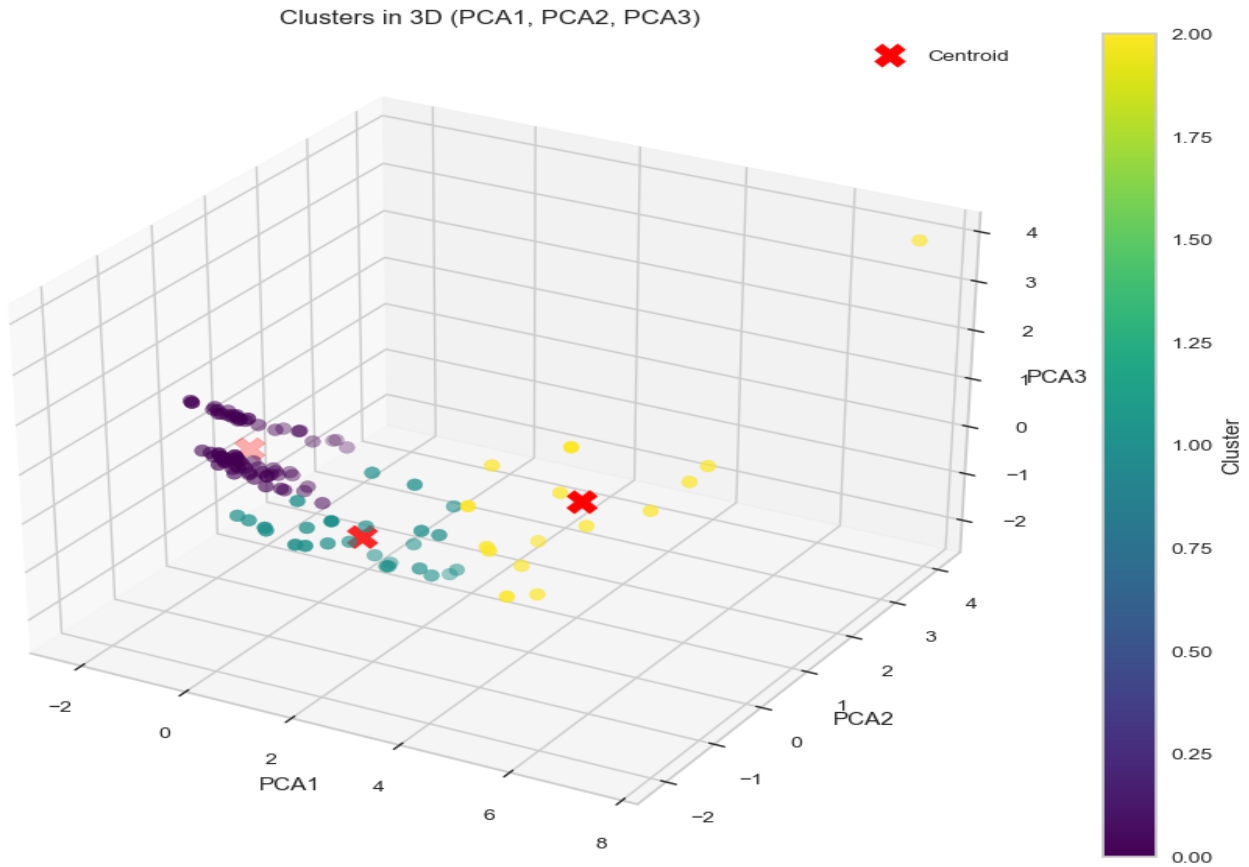


Fig 6. Cluster validation techniques

In our case (**Fig 6**), the distortion score was really high, therefore we decided to do a silhouette analysis to determine whether employing three clusters is adequate. Silhouette score is very high for k= 3, suggesting that the data points are well-clustered. Therefore, we choose 3 clusters in the end.



Cluster	Price	Battery_Capacity	Drive_Range	Power (in bhp)	Charge_Time (in hrs)	Top_Speed	Category
0	167668	5	119	6	5	55	2
1	4064654	42	378	143	7	160	1
2	18183776	87	577	497	10	223	1

Fig 7. Cluster analysis using K-means

As we can see the summary of our analysis in **Fig 7**, all clusters are distinct. However, clusters 1 and 2 provide data for 4-wheeler but other specifications vary between the two clusters. Cluster 0 entails data about specifications for 2-wheeler.

From our summary, it is obvious that 4-wheelers are more expensive than 2-wheelers with higher specifications. While 2-wheelers tend to be more affordable. Based on the factor loadings shown in **Fig 5**, Charge Time and Price are the most important aspects to consider. As a result, we can choose two-wheeler that is reasonably priced and has a shorter charge time as compared to 4-wheeler that is highly priced and has longer charge times. The initial price for 2-wheeler is set at Rs. 1,67,668, which seems to be fair and reasonable and the charging time for a full charge is 5 hours as observed in **Fig 7**.

In conclusion, startups should prioritize manufacturing 2-wheelers over 4-wheelers. Because two-wheelers are becoming increasingly popular in many regions due to their low cost, fuel efficiency, and convenience of use in urban areas. In addition to that, they are also ideal for city commuting, which might be a substantial market niche.

5. Sentiment Analysis

We've now determined the type of car that entrepreneurs should focus on developing. Moving onto the next step which is analysis of past customer feedback, generally called as **Sentiment Analysis**. By evaluating previous customer feedback, we could identify weaker areas and make improvements to ensure startups give high-quality service to their clients. We used mosaic plots and bar charts to delve deeper into features people were dissatisfied with. More importantly, we leveraged word cloud to gain insights into the concepts that faced the most criticism.

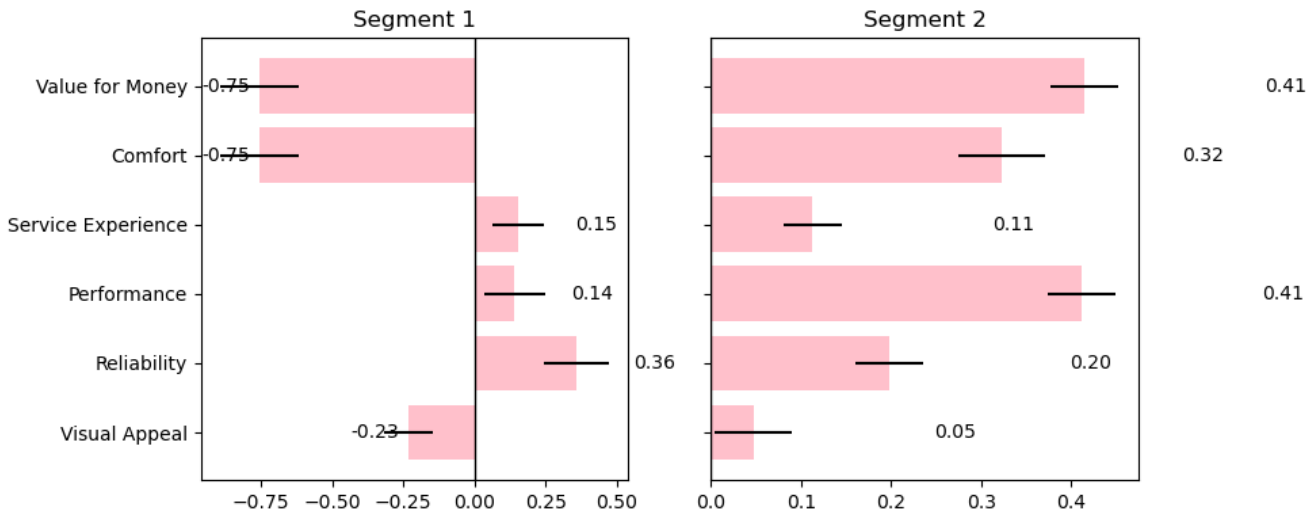


Fig 8. Regression coefficients of the two-segment mixture of linear regression models for 2-wheeler dataset

From **Fig 8,** Members of Segment 1 favored 2-wheeler for its service experience, performance, and reliability, but they are less impressed by aspects such as value for money, comfort, and visual appeal. In contrast, members of Segment 2 value 2-wheeler for their value for money, comfort, service experience, performance, reliability, and visual appeal.

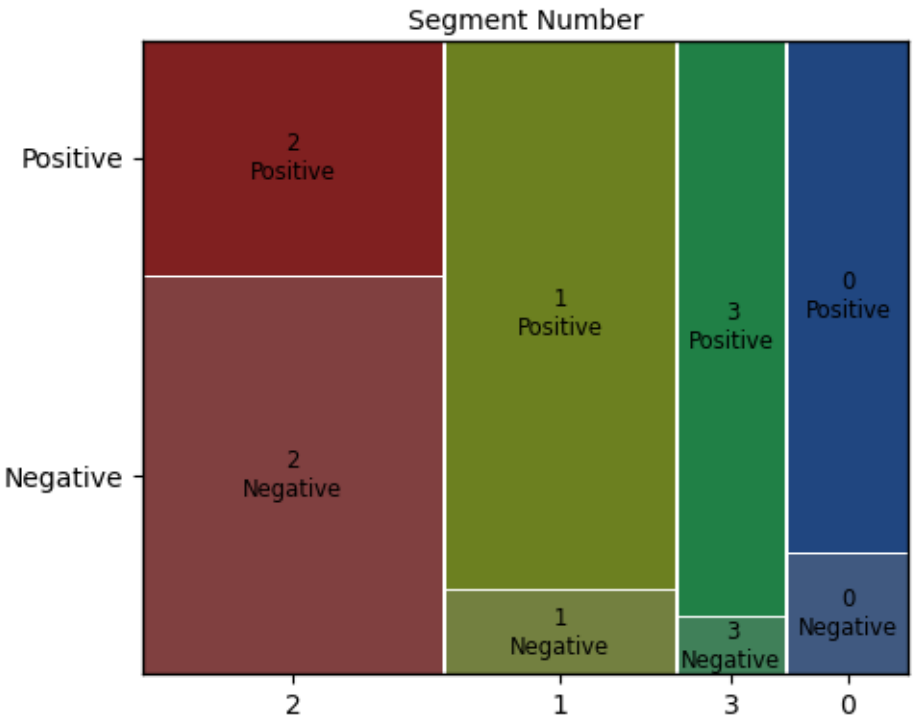
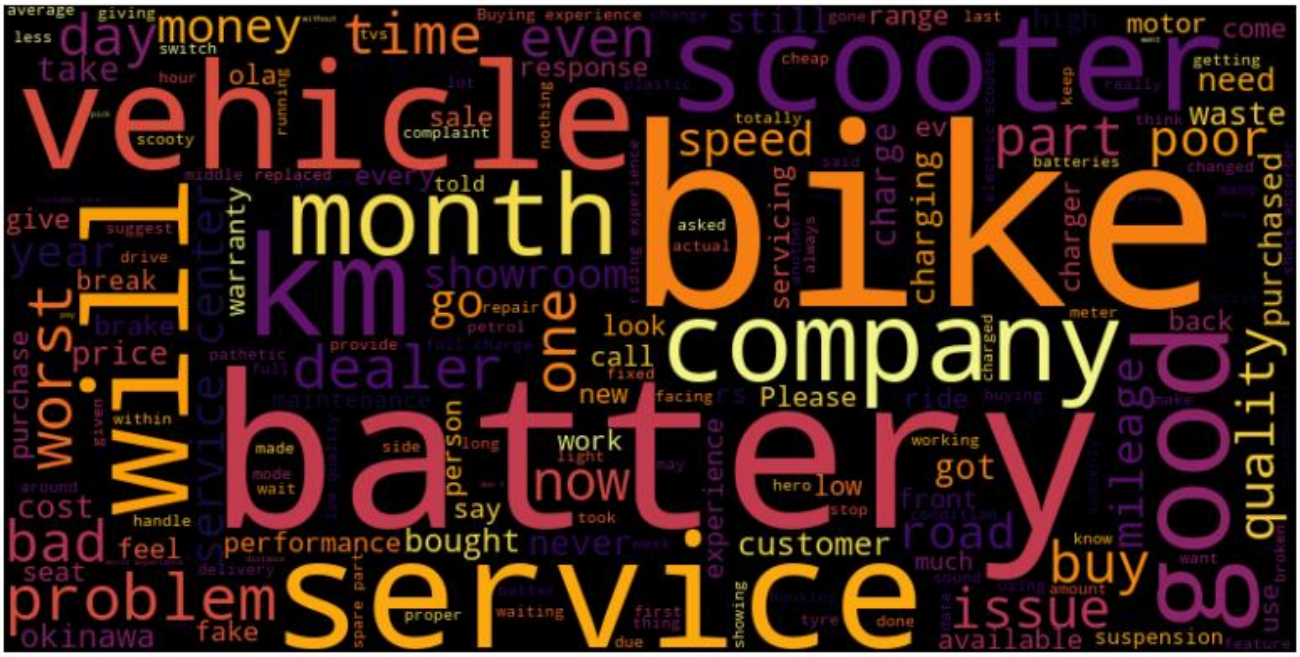


Fig 9. Positive/Negative Comments based on segment number

Most members of segment 2 have negative reaction towards their purchase of 2-wheeler as seen in **Fig 9**. They might not have liked the quality, performance or other factors. Understanding people's preferences, behaviour, and interests is critical for maintaining efficient business operations.



This word cloud has been created over negative reviews solely. From the visual, we can make out that majority of the people were dissatisfied with service of their dealers, followed by battery, company and vehicle itself. To guarantee seamless business operations for startups, it is crucial to emphasize improving dealer relationships and providing adequate customer support. Furthermore, addressing concerns about battery performance and vehicle quality will help build confidence and consumer loyalty, resulting in long-term market success.

6. Marketing Mix

The Marketing Mix, also known as the 4Ps (Product, Price, Place, and Promotion), is a key framework used by businesses to develop and implement efficient marketing strategies. These components are critical in determining how a product fits customer wants, reaches its target market, and provides value for the business.

This section of the report on marketing mix analysis for the electric vehicle industry focuses on how each of the four Ps can be customized for various market segments. We divided the market into segments according to vehicle characteristics using K-means clustering. With this strategy, we will be able to match the marketing mix to the most promising customer groups, which will direct company's strategic choices about product development, price, and market placement.

6.1 Product

The product should be 2-wheeler, as this segment shows low cost and might be suitable for urban commuting. Key features include:

- Charge time: Aim for a charging time of 4-5 hours to ensure convenience.
- Drive Range: Offer a more satisfying drive range of 119 km per charge, meeting weekly needs of urban consumers.
- Power: Offer 6 bhp which is ideal for lightweight vehicles like scooters or bikes designed for urban commuting.
- Top Speed: A top speed of 55 km/h is more reasonable for city driving.
- Battery Capacity: Battery capacity of 5 kWh best aligns with the characteristics of a budget-friendly 2-wheeler, focusing on energy efficiency and cost-effectiveness.

6.2 Price

The price is significantly lower around Rs. 1,67,668 than in the other clusters, which reflects the focus on affordability. This pricing strategy is essential for breaking into the mass market, particularly in developing nations like India where people are on a budget and searching for less expensive mobility options.

6.3 Place

The distribution strategy (Place) for these two-wheelers might target urban areas, small towns, and locations with a high demand for low-cost electric cars. A focus on places with existing EV infrastructure, like as charging stations, would be beneficial, particularly in densely populated cities where commuting is common.

6.4 Promotion

Promotion methods should emphasize the low cost of ownership, environmental friendliness, and practical benefits of electric two-wheelers, such as ease of usage in congested urban settings. Key promotional strategies include:

- Paid advertising
- Content marketing
- Sponsorships
- Referral marketing
- Coupons and deals

7. Conclusion

In conclusion, the rapidly expanding electric vehicle (EV) industry in India represents a big opportunity for startups. After doing a thorough review of sales statistics, customer sentiment, and marketing methods, we determined that 2-wheelers are the most promising industry for their organization to focus on.

The sales data reveals 2-wheelers have the biggest number of sales in the market, demonstrating significant demand due to their low cost and convenience for urban transportation. Despite the increasing expansion of three- and four-wheelers, two-wheelers remain the most lucrative alternative due to their low cost and great demand. Our marketing mix strategy suggests promoting our two-wheelers as economical, efficient, and environmentally friendly alternatives suitable for urban contexts. Startups can efficiently reach their target market and enhance their success by focusing on places with current EV infrastructure and implementing a variety of promotional strategies.

Overall, focusing on 2-wheelers with the recommended features and price strategy will allow startup companies to enter the market with a competitive product that fits consumer wants and is consistent with their company objectives.