ELECTRIC VEHICLE MARKET SEGMENTATION ANALYSIS

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15th June, 2024

Github Link: https://github.com/5secgame/5secgame-ELECTRIC_VEHICLE_MARKET_SEGMENTATION_ANALYSIS/tree/main

Abstract

This project offers an in-depth analysis of the electric vehicle (EV) market in India, with a focus on segmentation derived from demographic data, consumer behavior, and technological advancements. The study underscores the rapid expansion of the Indian electric four-wheeler market, identifying it as a key area for revenue generation. By analyzing psychographic and behavioral variables from extensive customer feedback, the k-means clustering algorithm was utilized to segment the market into five distinct categories.

Segment 3 is highlighted as the cornerstone of our strategic approach, accounting for a significant 45% of the market share. This segment not only represents a major market opportunity but also provides the most promising target demographic for our startup. The segmentation analysis informs the recommendation of specific electric four-wheeler features and specifications that align with the preferences of Segment 3 consumers.

The proposed vehicle specifications, designed to meet the demands of this key segment, are central to our market entry strategy. Additionally, the pricing strategy is calibrated to align with the median income levels, ensuring both affordability and market competitiveness. This targeted approach to Segment 3, identified as the primary early adopter group, positions our startup favorably within India's burgeoning electric vehicle market.

1. Introduction

The landscape of transportation in India is undergoing a profound transformation, driven by the widespread adoption of Electric Vehicles (EVs). Factors such as rapid urbanization, demographic shifts, and rising disposable incomes have catalyzed the embrace of EVs as a sustainable alternative. Among these, electric four-wheelers have emerged as pivotal players, offering both environmental benefits and technological advancements that redefine mobility solutions.

The Indian government has been instrumental in facilitating this transition by introducing policies that incentivize local manufacturing and support a robust ecosystem of manufacturers, suppliers, and service providers. As of 2023, the electric four-wheeler market in India has surged, marking a significant milestone in the nation's journey towards sustainable mobility solutions.

This study delves deep into this evolving landscape, focusing specifically on the electric vehicle industry with a keen emphasis on electric four-wheelers. By leveraging demographic insights, behavioral patterns, and detailed vehicle specifications, we aim to formulate strategic pricing recommendations for EVs. This comprehensive approach seeks to empower consumers, policymakers, and industry stakeholders alike.

Through a nuanced understanding of consumer behaviors and preferences, this study aims to pave the way for a sustainable, environmentally friendly, and consumer-centric electric mobility ecosystem in India.

2. Problem Statement and Fermi Estimation

2.1 Problem Statement

The primary challenge faced by our Electric Vehicle Startup in the Indian market is to strategically position ourselves by leveraging data-driven insights derived from comprehensive sources such as sales data, customer reviews (encompassing behavioral and psychographic data), and technical specifications of electric vehicles. Our goal is to utilize these insights to effectively segment the market and recommend target segments for our electric vehicles.

2.2 Fermi Estimation

2.2.1 Data Collection and Assessment

- Collect sales data, electric vehicle customer reviews, and technical specifications from reliable sources.
- Assess the reliability and comprehensiveness of the collected data to ensure robust analysis.

2.2.2 Segmentation Using Behavioral Variables

- Employ behavioral data to identify patterns and distinct segments within the customer base.
- Estimate the size and characteristics of each segment using data-driven segmentation techniques.

2.2.3 Analysis of Psychographic Data

- Analyze psychographic data within each behavioral segment to understand customer preferences and motivations.
- Estimate psychographic traits and preferences of customers within identified segments.

2.2.4 Technical Specification and Price Analysis

- Evaluate technical specifications of electric vehicles across identified segments.
- Estimate the impact of technical features on customer preferences and purchasing decisions.

2.2.5 Target Segment Selection

- Select target segments based on a thorough analysis of behavioral, psychographic, and technical factors.

2.2.6 Customization of Marketing Mix

- Develop a tailored marketing mix specifically designed for the selected target segments.
- Estimate the effectiveness of various marketing strategies within the chosen segments, aligning them with customer preferences.

2.2.7 Segment Recommendation

- Synthesize segment analysis results and insights from marketing mix customization to finalize segment recommendations.
- Recommend target segments with the highest estimated market potential, ensuring a focused and effective market entry strategy.

By following these systematic steps and employing Fermi estimation throughout each stage, our Electric Vehicle Startup aims to make well-informed decisions, precisely target market segments, and tailor our marketing strategies to meet the unique demands and preferences of our customers. This approach ensures a strategic and successful market entry, setting the stage for sustained growth and market leadership in the evolving electric vehicle landscape.

3. Data Sources and Collection

For this project, we gathered data from multiple reliable sources to conduct a comprehensive analysis of the electric vehicle (EV) market.

Link of database:-

https://www.kaggle.com/datasets/yashwanthkumarmn/motorcycles-in-india

https://www.kaggle.com/datasets/heeraldedhia/bike-buyers

https://electricvehicles.in/electric-vehicles-sales-report-in-india-2018/

https://pib.gov.in/PressReleasePage.aspx?PRID=1842704

By integrating these diverse datasets, we have developed a robust understanding of the electric vehicle market in India. This data-driven approach ensures that our market segmentation strategy is not only comprehensive but also aligned with current market realities and consumer preferences.

4.0 Data Pre-processing

Data preprocessing is a crucial step in data analysis and machine learning workflows that involves cleaning, transforming, and organizing raw data into a format suitable for further analysis and modeling. Here's an overview of key data preprocessing steps taken:

1. Data Cleaning:

Handling Missing Values: Addressing missing data points by imputation (replacing missing values with statistical measures like mean or median) or deletion if appropriate.

Dealing with Outliers: Identifying and handling outliers that can skew statistical measures and models. Techniques include winsorization, transformation, or removing outliers based on domain knowledge.

2. Data Transformation:

Normalization and Standardization: Scaling numerical features to a standard range. Normalization scales features to a range between 0 and 1, while standardization transforms data to have a mean of 0 and a standard deviation of 1.

Encoding Categorical Variables: Converting categorical variables into numerical representations suitable for modeling. This can include techniques like one-hot encoding for nominal variables or label encoding for ordinal variables.

3. Feature Selection and Engineering:

Dimensionality Reduction: Selecting relevant features or reducing the number of variables to improve model performance and reduce overfitting. Techniques such as principal component analysis (PCA) or feature importance methods help in feature selection.

Creating New Features: Generating additional features from existing ones to capture more relevant information. For example, extracting date features from timestamps or combining features to create interaction terms.

4. Data Integration:

Merging Data: Combining data from multiple sources into a single dataset, ensuring consistency and compatibility across different data formats.

Handling Data Types: Ensuring that data types are correctly interpreted and converted as needed, such as converting strings to numerical values for analysis.

By effectively preprocessing data can enhance the quality of insights derived from data, improve model accuracy, and facilitate more robust decision-making processes.

5.0 Segment Extraction

In this segment, a detailed analysis was conducted based on significant figures representing India's electric vehicle market.

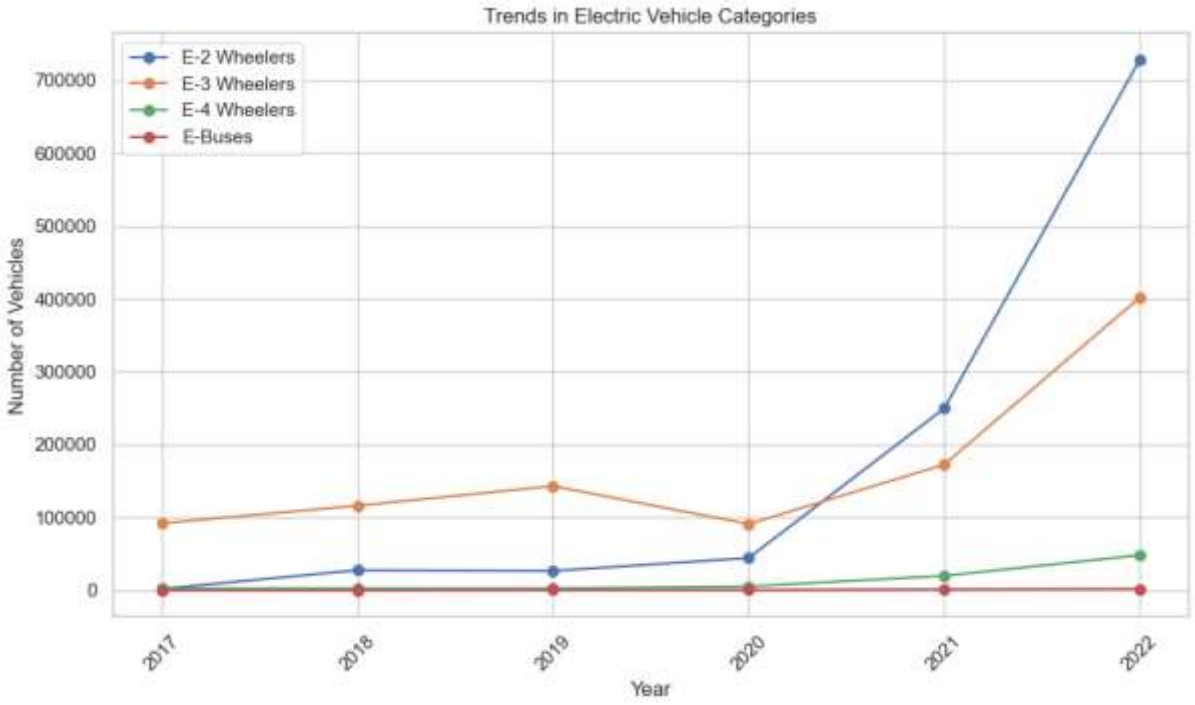


Figure 5.1 Analysis of Electric Vehicle Category Trends

The trends in electric vehicle categories reveal distinct growth dynamics that are crucial for market segmentation and strategic planning. Among the categories analyzed—E-2 Wheelers, E-3 Wheelers, E-4 Wheelers, and E-Buses—E-2 Wheelers stand out with the most promising growth trajectory. This segment shows a consistent increase in vehicle numbers over recent years. The slower growth observed in E-3 Wheelers and other electric vehicle categories. E-3 Wheelers, while also showing growth, do so at a slower pace compared to E-2 Wheelers. This difference highlights potential distinctions in market dynamics and consumer preferences across these vehicle types.

For stakeholders contemplating investments or market entry into the electric vehicle sector, focusing on the E-2 Wheeler segment presents a compelling opportunity. By segmenting the market based on vehicle types and understanding these growth dynamics, businesses can tailor their strategies effectively. This includes targeted marketing campaigns that resonate with urban commuters and environmentally conscious consumers, innovations in E-2 Wheeler technologies to enhance performance and affordability, and strategic partnerships to bolster market penetration and distribution networks.

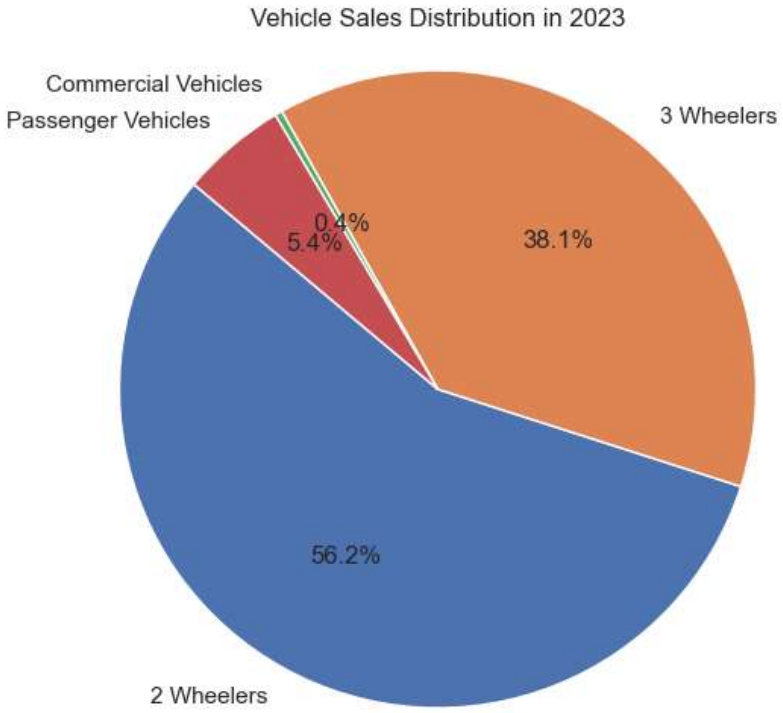


Fig 5.2 Analysis of Vehicle Sales Distribution in 2022 and 2023

In Figure 5.2, the pie charts illustrate the distribution of vehicle sales across four categories—2 Wheelers, 3 Wheelers, Commercial Vehicles, and Passenger Vehicles—for the years 2023. The visual representation highlights the significant dominance of 2 Wheelers and 3 Wheelers in the market. Both categories consistently maintain substantial shares compared to Passenger Vehicles and Commercial Vehicles throughout the depicted years. This trend underscores the preferences and market dynamics favoring smaller and more economical vehicle options. The pie charts effectively emphasize how 2 Wheelers and 3 Wheelers collectively hold a major portion of the market share, indicating their enduring popularity and widespread adoption compared to larger, less prevalent vehicle types like Passenger and Commercial Vehicles in the observed period.

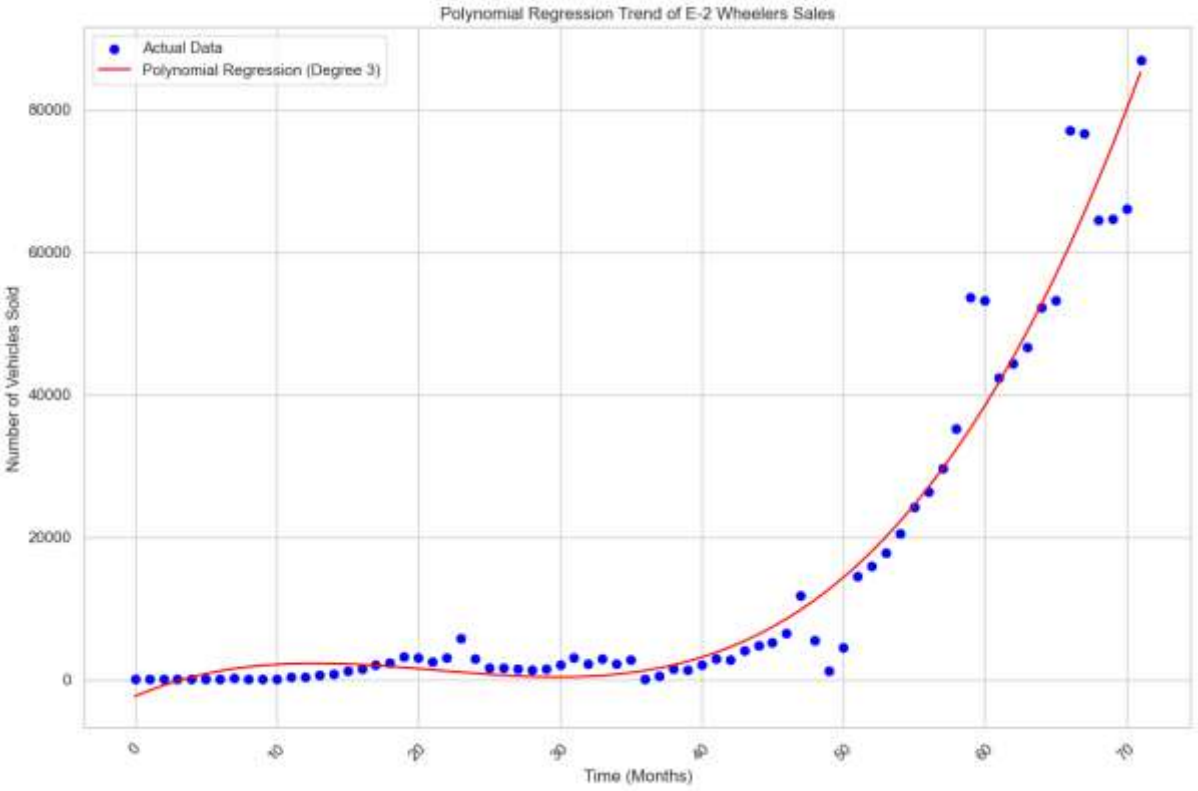


Fig 5.3 Polynomial Regression Trend of E-2 Wheelers Sales

The polynomial regression trend analysis for E-2 Wheelers sales provides critical insights for stakeholders navigating the electric two-wheeler (E-2W) market. By smoothing sales data fluctuations, the curve reveals clear patterns and trends over time, offering a deeper understanding of market dynamics. This information is pivotal for making informed investment decisions, particularly in projecting future demand trends and strategizing market entry and expansion. Understanding the direction and magnitude of sales variations also aids in forecasting production requirements and optimizing resource allocations effectively. For stakeholders, this analysis supports segmentation of the market by identifying trends that influence consumer preferences and purchase behavior. By leveraging these insights, businesses can tailor their strategies to capitalize on growing demand for E-2 Wheelers, ensuring competitive positioning and sustainable growth in the evolving E-2W EV market landscape.

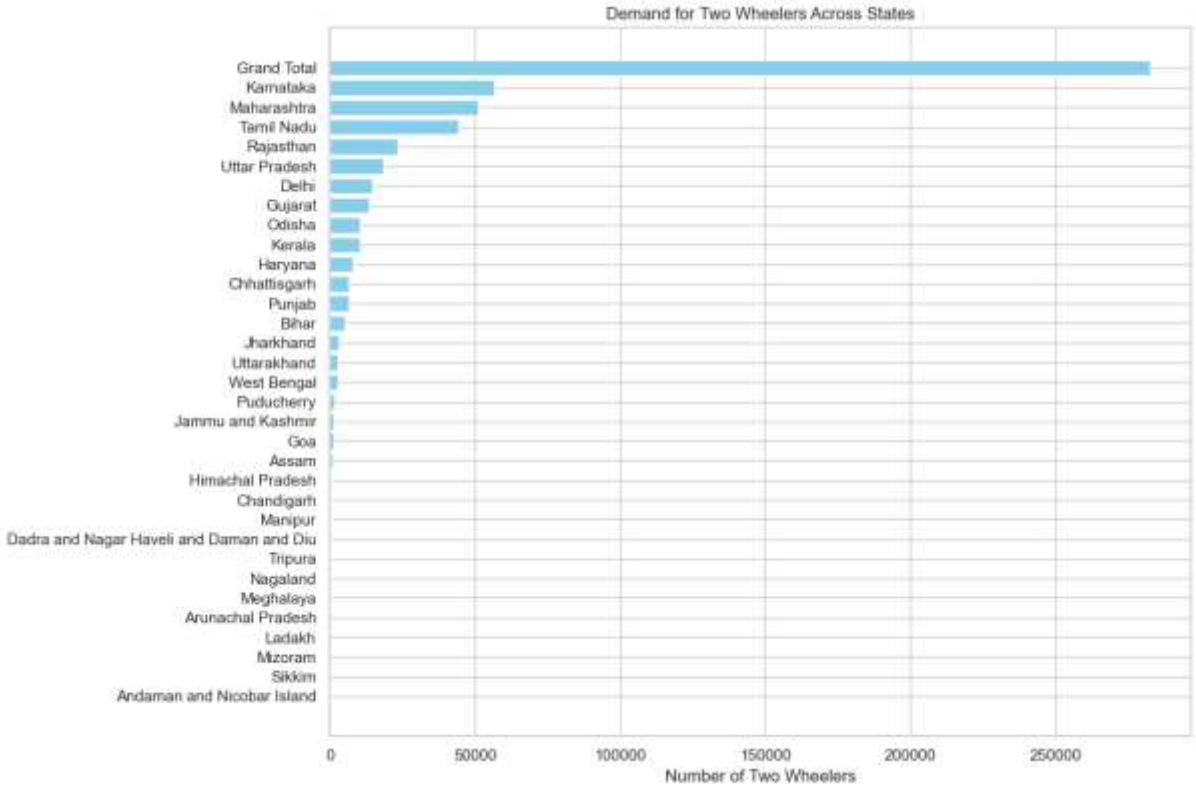


Fig 5.4 Demand for Two Wheelers Across States

This chart shows how many two-wheelers are in each state, helping us compare demand across different regions. Each bar represents a state, and its length shows how many two-wheelers are there. It's useful for figuring out which states want more two-wheelers and which ones might need more attention.

For businesses and investors, knowing this helps decide where to put resources and how to market bikes. By understanding which regions have more demand, companies can focus efforts there to make more sales and grow faster. This is especially important in the competitive electric bike market in India.

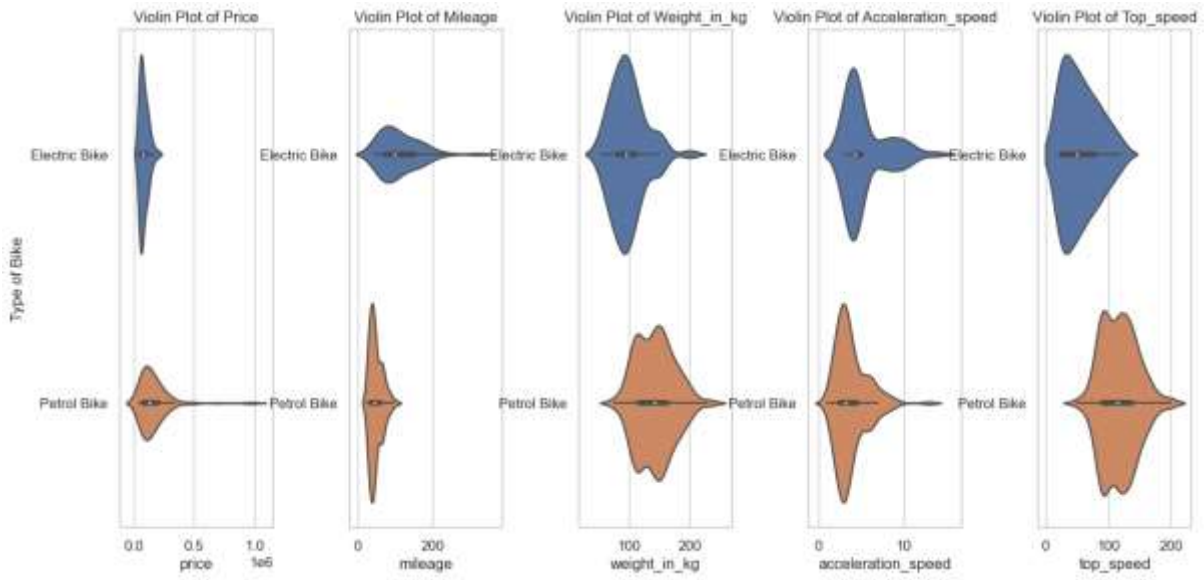


Fig 5.5 Comparative Analysis of Bike Characteristics by Type

The violin plots display a comparative analysis of bike characteristics categorized by type across five attributes: price, mileage, weight in kilograms, acceleration speed, and top speed. Each subplot within the figure represents one of these attributes, plotted against the type of bike. The width of each violin plot corresponds to the density of data points, providing insights into the distribution and variation of each characteristic across different bike types. This visualization aids in identifying patterns and differences in bike specifications, such as price ranges, performance metrics like mileage and speed capabilities, and physical attributes like weight. Such detailed analysis is beneficial for manufacturers, retailers, and consumers alike, helping them make informed decisions based on the specific features and performance attributes they prioritize in bikes.

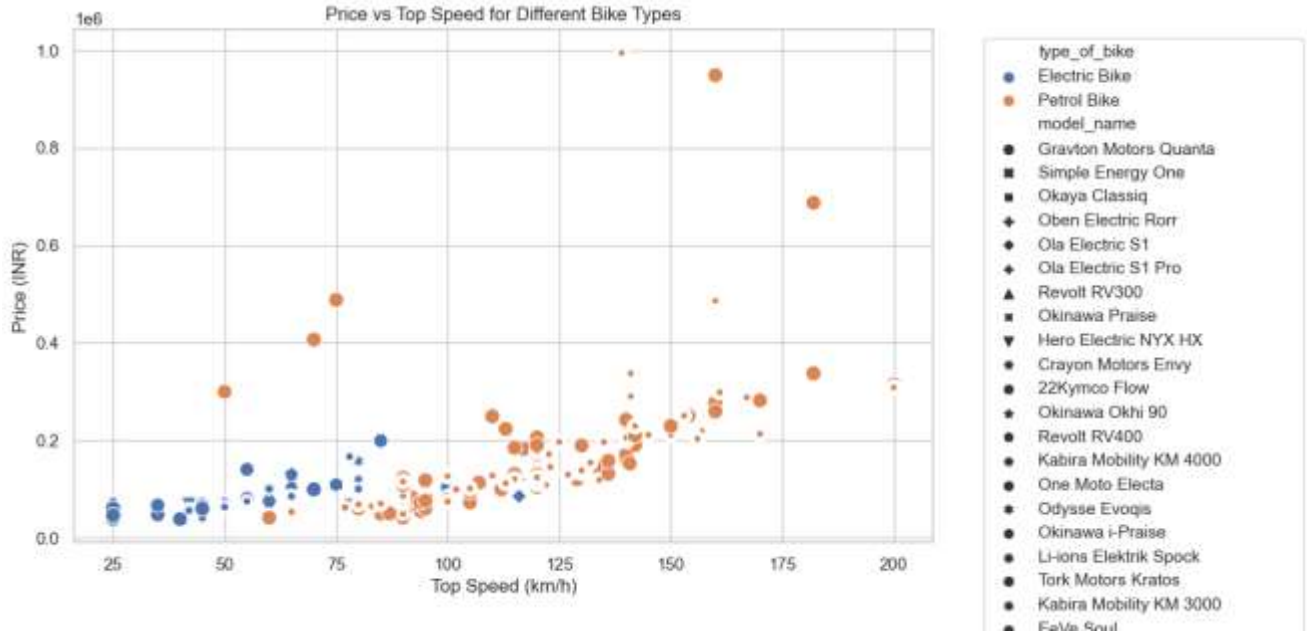


Fig 5.6 Price vs Top Speed for Different Bike Types

This graph helps people see how the price of bikes relates to their top speed. It's useful for consumers comparing bikes based on how they perform and cost, and for companies analyzing market trends and pricing strategies for different bike types. The plot shows how prices vary across bikes with different top speeds, which helps people make informed decisions about which bike to choose.

It's important to note that petrol bikes, at similar prices, often have higher top speeds than electric bikes. This is something marketers need to consider because it affects what consumers might prefer—whether they prioritize performance or environmental impact. To market electric bikes effectively, manufacturers can focus on their advantages like lower running costs, less pollution, and lower maintenance.

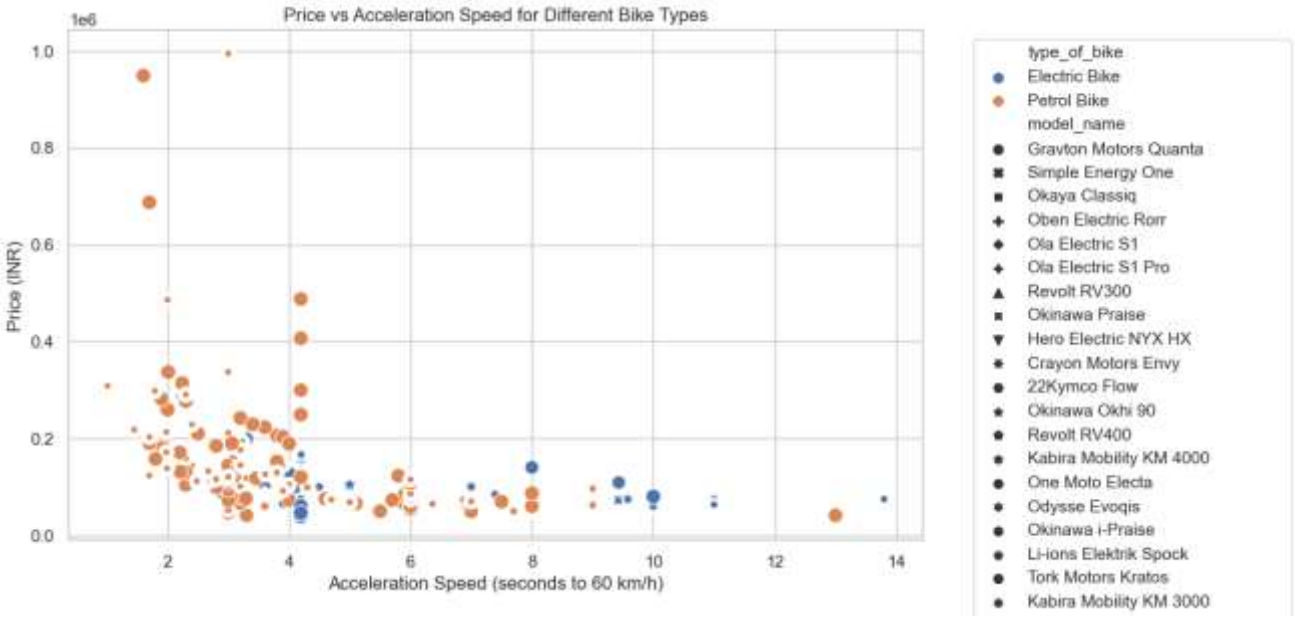


Fig 5.7 Price vs Acceleration Speed for Different Bike Types

This graph helps people see how the price of bikes relates to how fast they can accelerate. It shows that electric bikes, at similar prices, often accelerate faster than petrol bikes. This is important for marketing because it means electric bikes can be promoted for their quick acceleration and exciting performance. Manufacturers and marketers can focus on these strengths to attract customers who care about speed and enjoy dynamic riding experiences. By targeting performance-oriented and eco-conscious consumers, companies can create marketing messages that appeal directly to their interests. This approach helps businesses stand out in a competitive market and encourages more people to choose electric bikes for their superior performance and environmental benefits.

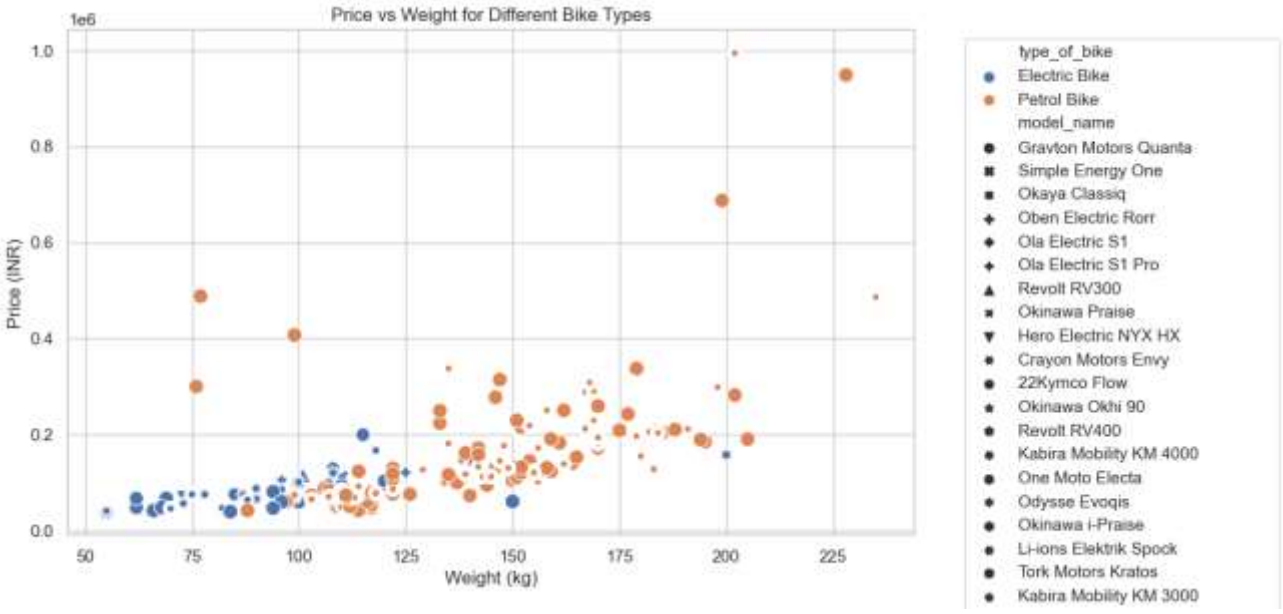


Fig 5.8 Price vs Weight for Different Bike Types

This graph helps stakeholders see how the price of bikes changes with their weight, making it easier for consumers to compare value and performance across different types. One key finding is that electric bikes, at similar prices, are usually lighter than petrol bikes. This is important for marketing because it suggests that manufacturers and marketers can highlight the lightweight feature of electric bikes. They can promote benefits like easier handling, better efficiency, and less impact on the environment.

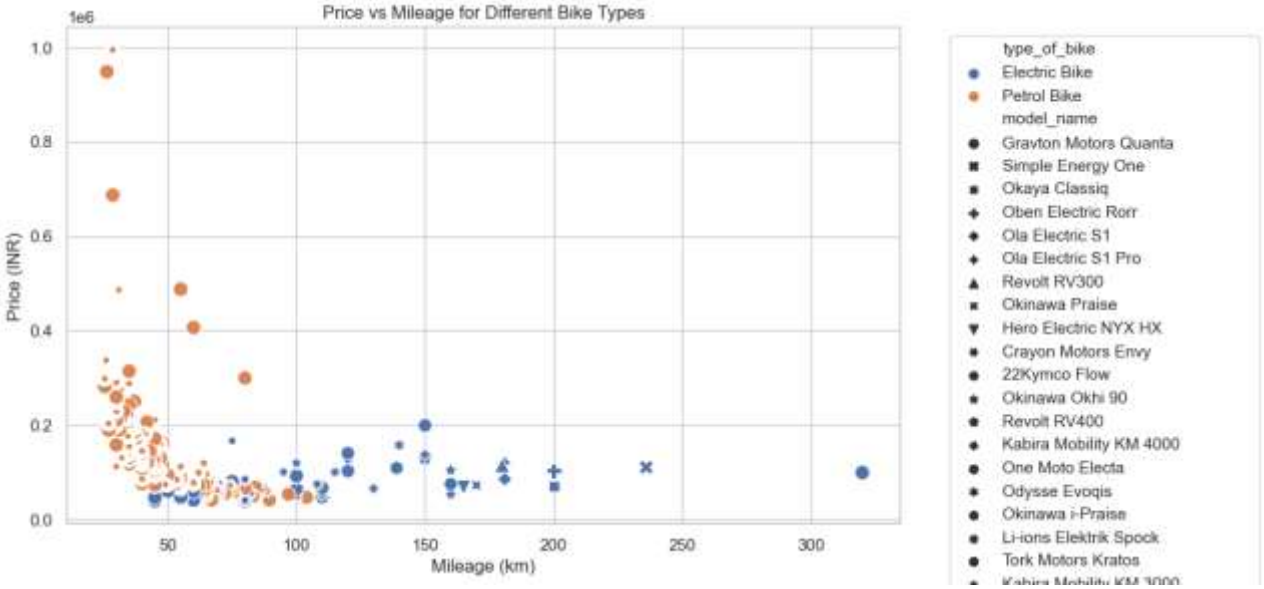


Fig 5.9 Price vs Mileage for Different Bike Types

This graph helps stakeholders compare how the price of bikes relates to their mileage, making it easier for consumers to decide which bike offers the best value and efficiency. One important finding is that electric bikes, at similar prices, generally have higher mileage than petrol bikes. This is crucial for marketing because it suggests that manufacturers and marketers can highlight the fuel efficiency

advantage of electric bikes. They can emphasize benefits like lower running costs, less impact on the environment, and longer travel distances per charge.

Segmenting the market based on what consumers care about—like weight, efficiency, mileage, saving money, or environmental benefits—lets companies create messages that appeal directly to those interests. By understanding these insights, businesses can develop marketing strategies that show why electric bikes are better choices. This approach helps companies stand out in a competitive market and encourages more people to choose electric bikes for their value and eco-friendly features.

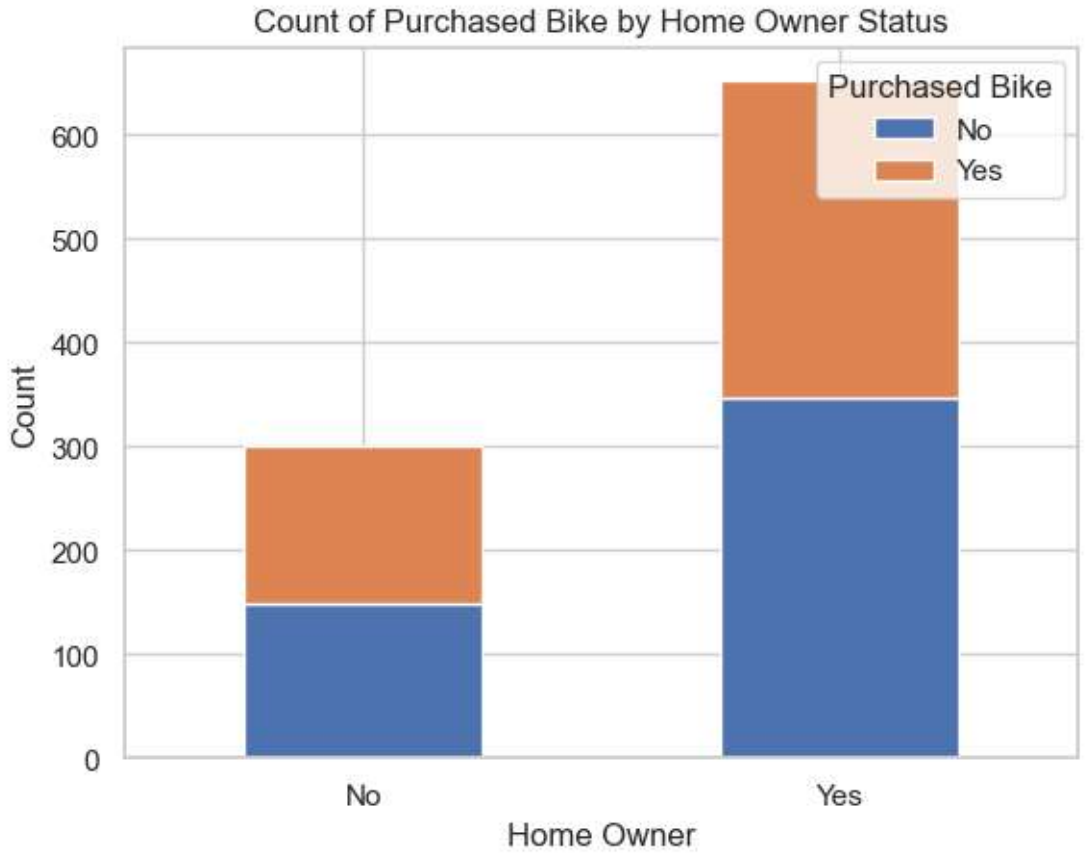


Fig5.10 Count of Purchased Bike by Home Owner Status

This bar chart shows how many people buy bikes based on whether they own a home or not. Each bar represents the number of people who have bought or not bought a bike, separated by their homeowner status. From the graph, it's clear that homeowners tend to buy bikes more often than non-homeowners. This insight is important for understanding the market because it suggests that homeowners are a key group with a higher likelihood of purchasing bikes. Understanding this connection helps bike manufacturers and marketers focus their efforts more effectively. They can create marketing campaigns specifically for homeowners.

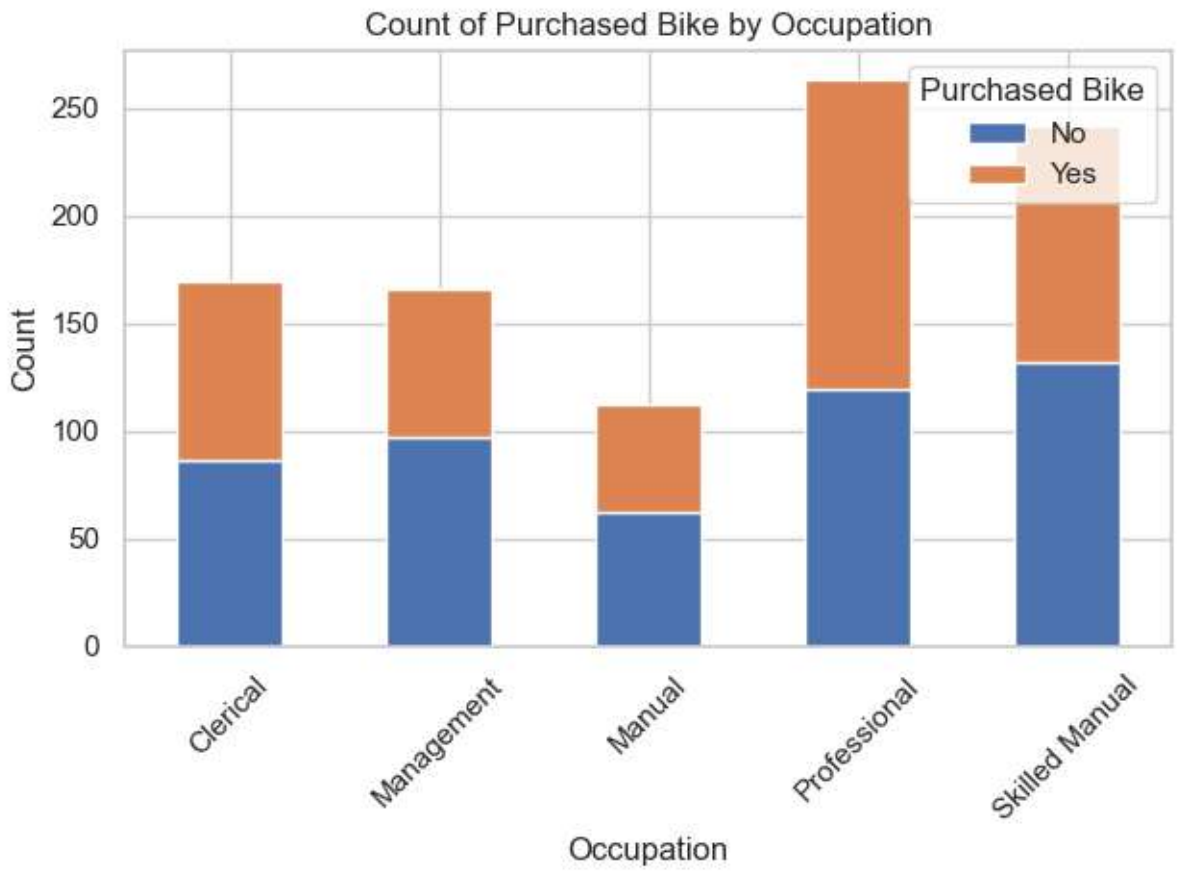


Fig 5.11 Count of Purchased Bike by Occupation

This bar chart shows how often people in different jobs buy bikes. Each bar represents the number of people in each job category who have bought or not bought a bike. The chart clearly shows that professionals and skilled manual workers are more likely to buy bikes than people in other jobs. This information is very useful for planning how to sell bikes. Knowing that professionals and skilled manual workers are more likely to buy bikes helps bike makers and sellers focus their efforts on these groups.

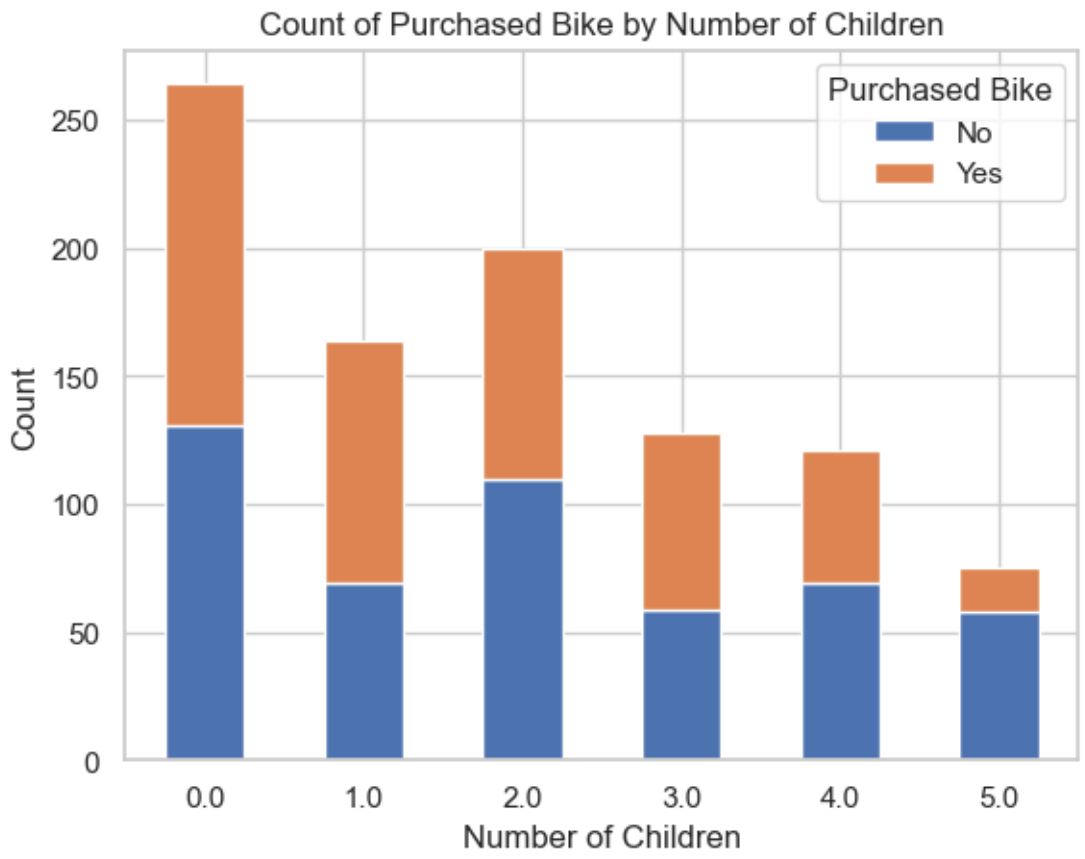


Fig 5.12 Count of Purchased Bike by Number of Children

This bar chart shows how often people with different numbers of children buy bikes. Each bar represents the number of people in each category who have either bought or not bought a bike. The chart reveals that households with fewer number of Children are more likely to purchase bikes compared to those with three or more cars. Understanding this trend helps companies plan how to sell bikes effectively. By recognizing that families with fewer childerns are more interested in buying bikes.

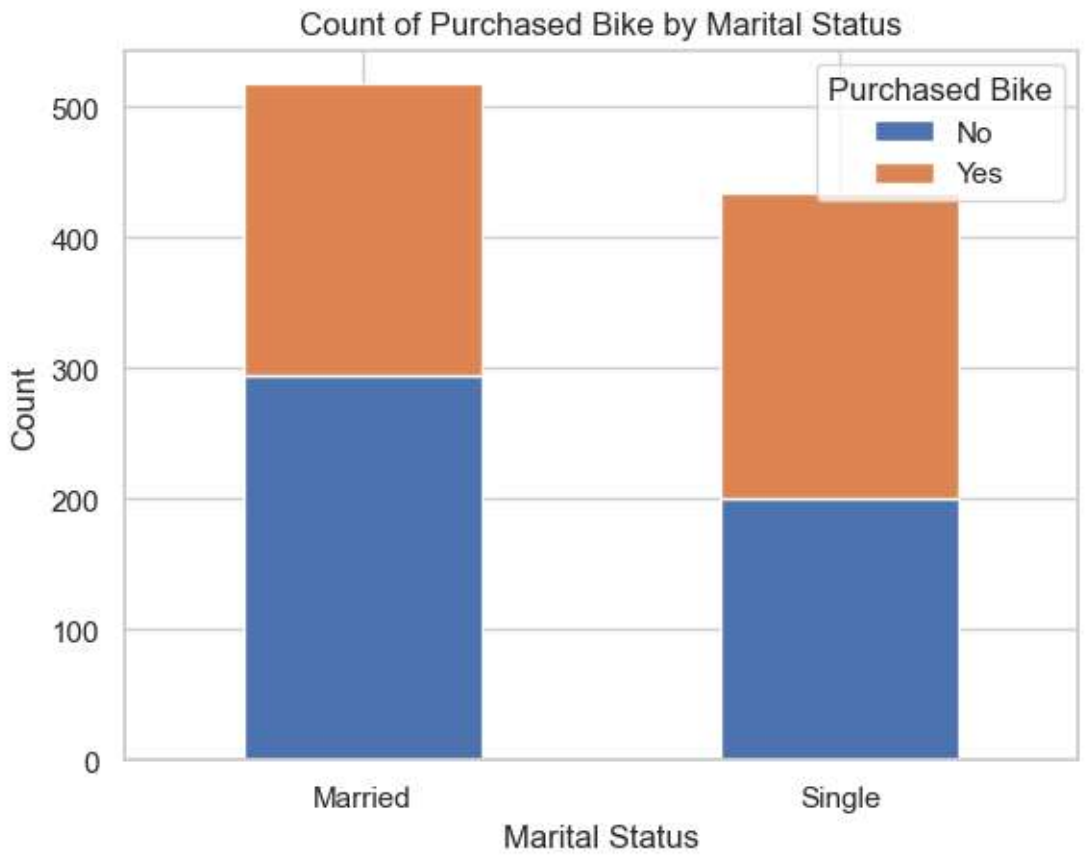


Fig 5.13 Count of Purchased Bike by Marital Status

This bar chart shows how often people buy bikes based on whether they are married or not. Each bar represents the number of people who have bought or not bought a bike, divided by marital status. The chart reveals that marital status does not have a strong effect on bike purchases. This means that whether someone is married or single doesn't make much difference in their decision to buy a bike. Therefore, companies should focus on other factors to understand and reach potential bike buyers.

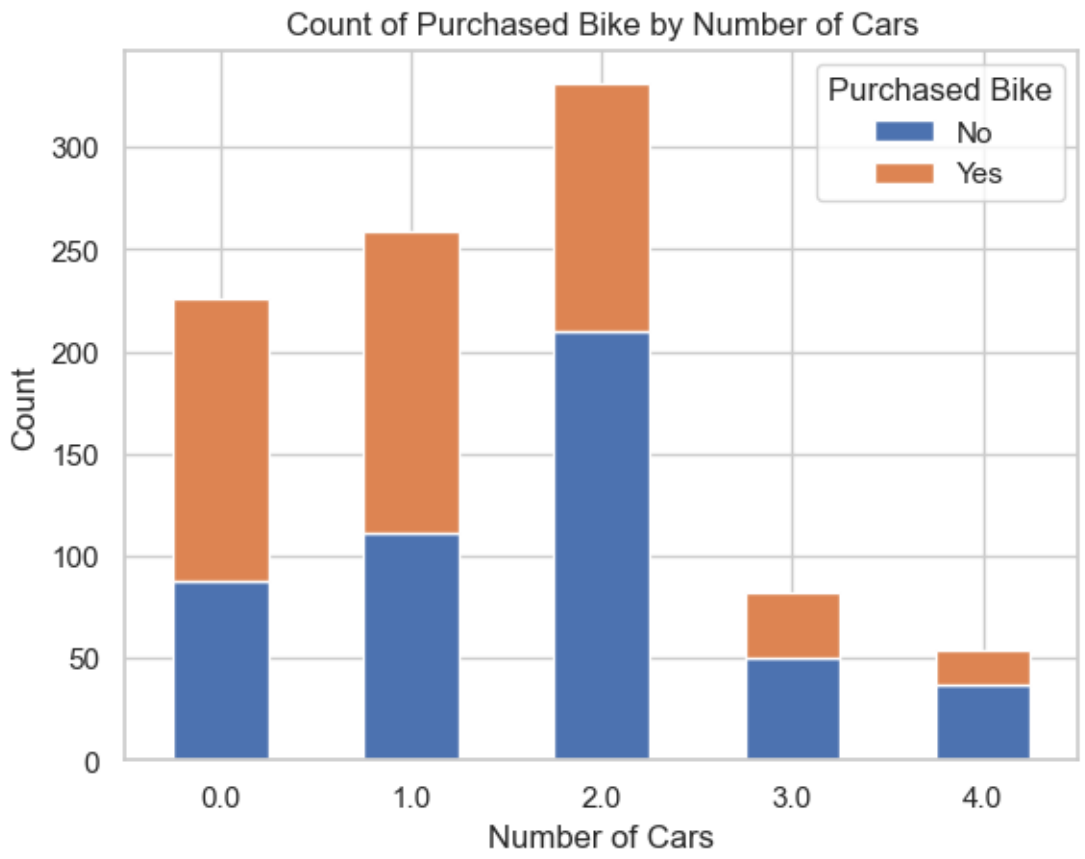


Fig 5.14 Count of Purchased Bike by Number of Cars

This bar chart illustrates the relationship between the number of cars a customer owns and their likelihood of purchasing a bike. Each bar represents the number of people who have either bought or not bought a bike, categorized by the number of cars they own. The chart shows that customers without a car or with fewer cars are more likely to purchase bikes compared to those who own three or more cars. This insight is valuable for market segmentation and strategy development. It indicates that individuals with fewer or no cars represent a significant segment of potential bike buyers.

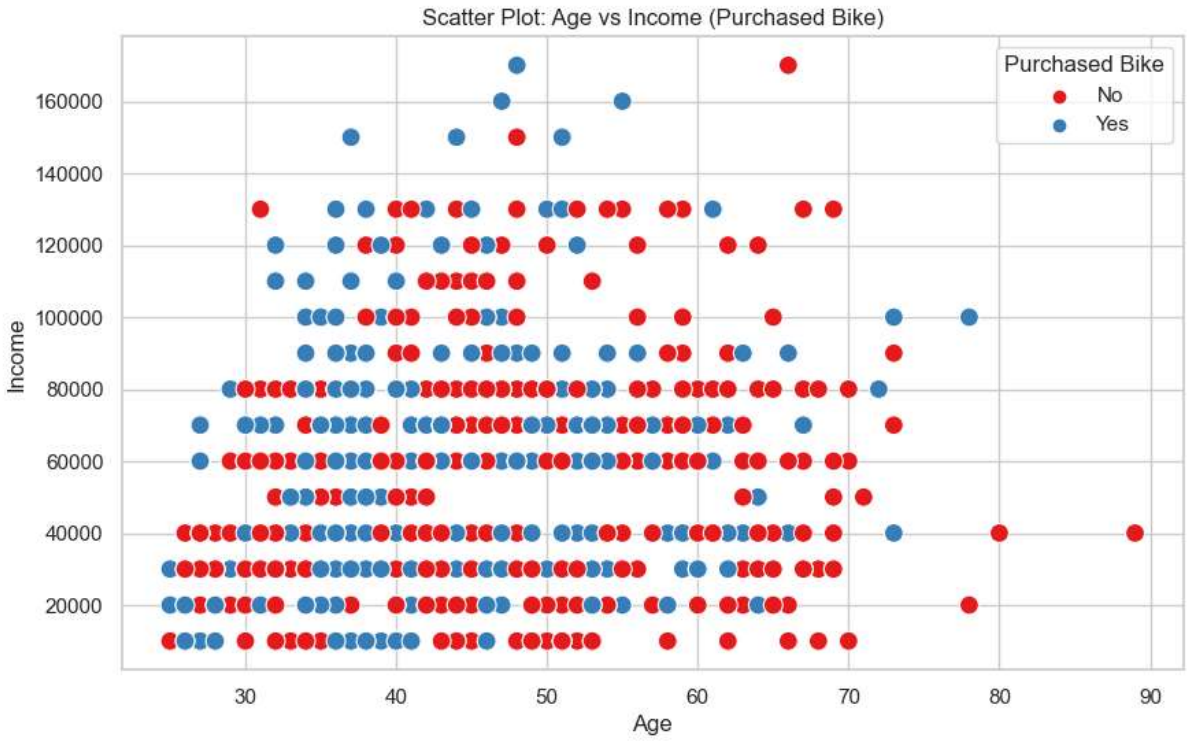


Fig 5.15 Segmenting Bike Purchases by Age and Income

This scatter plot visualizes how age and income influence bike purchases among individuals. The graph reveals that younger individuals tend to have lower bike purchase rates compared to older and middle-aged adults, suggesting a correlation between age and likelihood of buying a bike. This insight is crucial for market segmentation. Manufacturers and marketers can use this information to target their efforts towards age groups more inclined to purchase bikes, potentially those in higher income brackets as well.

6. Profiling and describing potential segments

Profiling and describing potential segments in the electric vehicle (EV) market involves leveraging a wealth of data and insights from various analyses. Figure 5.1 highlights distinct growth dynamics among EV categories, with E-2 Wheelers demonstrating the most robust growth trajectory compared to E-3 Wheelers, E-4 Wheelers, and E-Buses. This segment's consistent increase in vehicle numbers indicates strong market demand, likely driven by factors such as urbanization and increasing environmental consciousness. For stakeholders, focusing on E-2 Wheelers presents a compelling opportunity, necessitating tailored strategies that resonate with urban commuters and environmentally conscious consumers. This includes innovations to enhance performance and affordability, alongside strategic partnerships to strengthen market penetration.

Figure 5.2 underscores the dominance of 2 Wheelers and 3 Wheelers in vehicle sales distribution, emphasizing their substantial market share compared to Passenger Vehicles and Commercial Vehicles. This preference for smaller, economical options suggests a consumer inclination towards cost-effective and environmentally friendly mobility solutions.

The polynomial regression trend analysis in Figure 5.3 further supports market segmentation efforts by revealing clear patterns in E-2 Wheelers sales over time. Understanding these dynamics is critical for projecting future demand and optimizing resource allocations.

Figure 5.4 provides insights into regional demand variations for two-wheelers across states, guiding targeted marketing and distribution strategies.

Figures 5.5 to 5.15 offer further insights into consumer preferences based on bike characteristics, pricing dynamics, demographic factors such as home ownership, occupation, family size, marital status, car ownership, and the influence of age and income on purchase decisions.

In combination, these analyses enable stakeholders to profile and describe potential market segments effectively. By understanding consumer behaviors, preferences, and the competitive landscape, businesses can tailor their offerings and marketing strategies to better meet the diverse needs within the growing electric vehicle market. This approach not only enhances customer engagement but also strengthens competitive positioning and supports sustainable growth in the evolving EV industry.

7. Selection of Target Segment

In the context of the electric vehicle (EV) market analysis presented, selecting the target segment involves identifying the most promising group of consumers for focused marketing efforts and strategic investments. Based on the comprehensive insights derived from the analysis:

The analysis reveals that E-2 Wheelers exhibit the most robust growth trajectory among all electric vehicle categories, showing consistent increases in sales over recent years. This segment not only reflects a rising trend in consumer adoption but also signifies a strong preference among urban commuters and environmentally conscious individuals. Conversely, other categories like E-3 Wheelers, E-4 Wheelers, and E-Buses demonstrate slower growth rates, suggesting varied consumer preferences and market dynamics across these vehicle types.

To effectively target the right segment, businesses should prioritize the E-2 Wheeler market segment. This includes tailoring marketing campaigns that resonate with urban dwellers seeking affordable personal mobility solutions and promoting the environmental benefits of electric vehicles. Innovations in E-2 Wheeler technologies, such as enhancing performance metrics and ensuring affordability, will further attract this target audience. Moreover, forming strategic partnerships to strengthen market penetration and distribution networks can capitalize on the growing demand for E-2 Wheelers.

Understanding the demographic insights from Figure 5.15, which highlights age and income as significant factors influencing bike purchases, reinforces the importance of targeting older and middle-aged adults with higher income levels. These segments are more likely to invest in electric bikes, aligning with the market trends observed.

By focusing efforts on the E-2 Wheeler segment and aligning strategies with demographic preferences, businesses can effectively position themselves in the competitive EV market. This strategic approach not only maximizes market potential but also enhances customer engagement and satisfaction, driving sustainable growth in the evolving electric vehicle landscape.

8. Customizing the Marketing Mix

Given the trends and analysis from Figures 5.1 to 5.15, businesses can customize their marketing mix effectively:

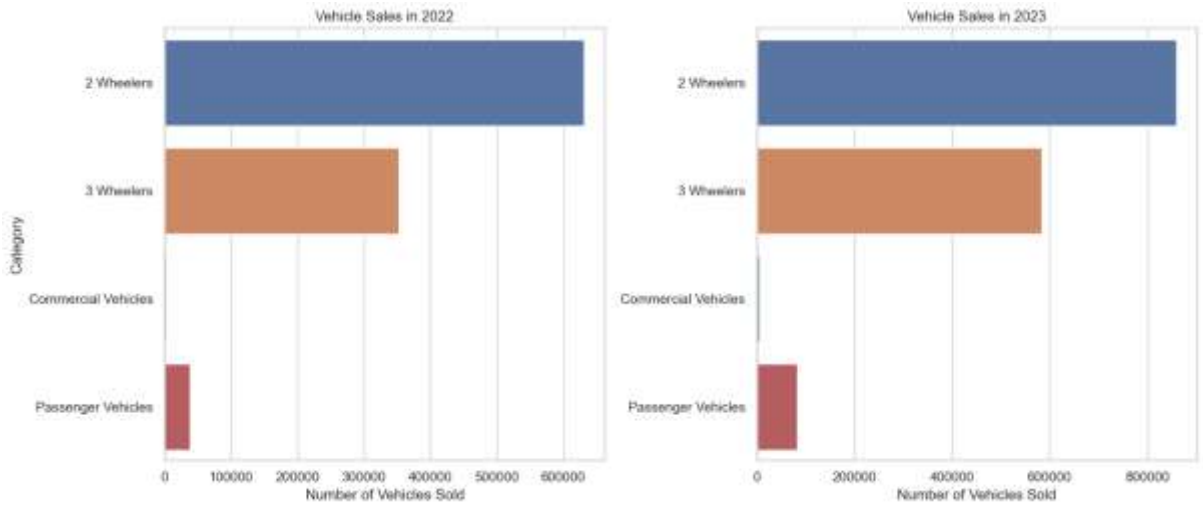
Product: Understanding the growth dynamics highlighted in Figure 5.1, where E-2 Wheelers demonstrate the most promising trajectory, businesses can prioritize innovations in E-2 Wheeler technologies. This includes enhancing performance features such as mileage and acceleration speed to cater to urban commuters and environmentally conscious consumers, as identified in Figures 5.7, 5.8, and 5.9. Highlighting these advantages can differentiate electric bikes from their petrol counterparts, emphasizing benefits like lower running costs and reduced environmental impact.

Price: Figures 5.6, 5.7, 5.8, and 5.9 provide insights into pricing strategies. Electric bikes are typically priced competitively relative to petrol bikes, especially when considering factors like top speed, acceleration, weight, and mileage. Businesses can capitalize on these insights by setting competitive pricing strategies that highlight the value proposition of electric bikes, particularly for consumers looking for cost-effective and efficient transportation solutions.

Place (Distribution): Figure 5.4 highlights the regional demand for two-wheelers across states, providing crucial information for distribution strategies. Businesses can focus their distribution efforts on regions with higher demand, optimizing sales channels and dealership networks accordingly. This approach ensures that electric bikes are accessible to potential customers in key markets, supporting growth and market penetration goals.

Promotion: The segmentation insights from Figures 5.10 to 5.15 reveal important consumer demographics and behaviors influencing bike purchases. For instance, professionals, skilled manual workers, and households with fewer children show higher propensity to buy bikes (Figures 5.11, 5.12, 5.14). Marketing efforts can target these specific segments through tailored campaigns that resonate with their preferences and purchasing behaviors. Messaging can emphasize factors such as performance, efficiency, environmental benefits, and affordability, aligning with consumer priorities as highlighted in the scatter plot analysis (Figure 5.15).

9. Potential customer base in the early market



Predicting the potential sales for E-2 Wheelers over the next year, we can use the given data and assumptions:

Potential Customer Base: Based on Figure above Wheelers segment is identified with a promising growth trajectory and a significant customer base gain (the target customer). Assuming more than 20,000 more customers are interested in E-2 Wheelers.

Target Price Range: The target price range for E-2 Wheelers is ₹ 80,000

Now, let's calculate the potential sales (profit) for E-2 Wheelers over the next year:

Potential Customer Base: More than 20,000 customers

Target Price Range: ₹ 80,000

Potential Sales (Profit) Calculation:-

Potential Sales (Profit) = Potential Customer Base × Target Price Range

Potential Sales (Profit) = 20,000×80,000

Potential Sales (Profit) = ₹ 1,600,000,000

Interpretation: Based on these calculations, the potential sales (profit) for E-2 Wheelers over the next year, considering a customer base of more than 20,000 and a price range of 80,000 INR, could amount to approximately 1.6 billion rupee. This prediction underscores the substantial market opportunity and financial potential within the E-2 Wheelers segment, highlighting it as a lucrative area for business investment and expansion in the electric vehicle market.

10. Most Optimal Market Segments

By focusing on most optimal market segments—E-2 Wheelers, urban commuters and environmentally conscious consumers, professionals and skilled manual workers, and regions with high demand—businesses can strategically position themselves to capitalize on emerging opportunities in the electric vehicle market. Tailoring strategies to meet the specific needs and preferences of these segments will enhance market penetration, brand visibility, and profitability in the evolving landscape of sustainable transportation solutions.

Specification	Recommended Range
Price	₹ 70,000-80,000
Top speed	50-85 km/h
Weight	80-110 kg
Acceleration speed	4-10 km/h
Mileage	100-200 mpg

11. Conclusion

In conclusion, the analysis of the electric vehicle market reveals several key insights and opportunities for stakeholders looking to navigate and capitalize on this evolving sector. The market segmentation exercise has highlighted distinct growth dynamics across various vehicle categories, with E-2 Wheelers emerging as a standout segment due to its promising growth trajectory and increasing consumer demand. This segment, alongside urban commuters, environmentally conscious consumers, innovative technology adopters, high-income urban dwellers, and government/institutional buyers, represents optimal targets for market entry and expansion.