

ELECTRIC VEHICLE MARKET SEGMENTATION

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1. Introduction:

In recent years, the Electric Vehicle (EV) market in India has experienced a significant surge, marking a paradigm shift in the country's automotive landscape. The growing need for sustainable and eco-friendly transportation options, coupled with increased environmental awareness, has made the adoption of electric vehicles a pressing necessity. This shift aligns with global efforts to reduce carbon emissions, combat climate change, and achieve a more sustainable future. The increasing prevalence of environmental concerns, depletion of fossil fuels, and a rising focus on energy efficiency have fueled the demand for electric vehicles as a viable and cleaner alternative to traditional internal combustion engine vehicles. India, with its burgeoning population and expanding urbanization, faces unprecedented challenges related to pollution and traffic congestion. In this context, electric vehicles have emerged as a strategic solution, addressing both environmental concerns and the need for efficient urban mobility. Government initiatives and policies play a pivotal role in fostering the growth of the EV market in India. The Indian government has implemented various schemes, incentives, and subsidies to encourage the production, adoption, and manufacturing of electric vehicles. These measures aim to create a conducive environment for electric mobility by addressing challenges such as high initial costs, limited charging infrastructure, and range anxiety. Furthermore, advancements in technology, including improvements in battery technology and charging infrastructure, have bolstered the appeal of electric vehicles. The cost of lithium-ion batteries, a crucial component of EVs, has been steadily decreasing, making electric vehicles more economically viable for consumers. The need for sustainable transportation options has catalyzed a shift in consumer preferences towards electric vehicles. Electric cars, two-wheelers, and e-rickshaws are gaining popularity as consumers become more environmentally conscious and seek energy-efficient alternatives. In conclusion, the growing need for sustainable transportation, coupled with supportive government policies, technological advancements, and changing consumer preferences, positions the expansion of the Electric Vehicle market in India as a pressing and inevitable development. The increasing momentum towards electric mobility reflects a great opportunity to do business in this segment.

2. Problem Statement:

The Problem involves strategically establishing our Electric Vehicle (EV) startup within the dynamic landscape of the Indian market. Our approach hinges on harnessing the power of data-driven insights extracted from a multifaceted analysis encompassing sales data, comprehensive customer reviews that delve into both behavioral and psychographic aspects, and a meticulous examination of the technical specifications of electric vehicles. Our primary goal is to leverage these insights to discern patterns, preferences, and trends within the market, ultimately allowing us to craft a nuanced and effective market segmentation strategy. Market segmentation is a crucial aspect of our endeavor, involving the categorization of potential customers based on shared characteristics, behaviors, and needs. By meticulously analyzing sales data, we aim to identify patterns of consumer behavior, including factors influencing purchasing decisions and the key features that resonate with buyers. The exploration of customer reviews provides a deeper understanding of the emotional and psychographic aspects influencing consumer choices, shedding light on preferences, values, and lifestyle considerations.

3. Fermi estimation:

3.1. Demographic Insights:

- Identify demographic characteristics such as age, income levels, and educational backgrounds of potential EV customers.
- Understand how these factors influence the preferences and purchasing power of different segments.

3.2. Geographic Segmentation:

- Analyze regional variations in preferences and requirements for electric vehicles.
- Consider factors like urbanization levels, infrastructure development, and environmental concerns across different regions.

3.3. Lifestyle and Psychographic Data:

- Explore lifestyle choices, values, and aspirations of potential customers.
- Understand the psychographic profiles, including attitudes towards sustainability, technology adoption, and environmental consciousness.

3.4. Usage Patterns:

- Categorize potential customers based on usage patterns such as daily commuting, weekend travel, and commercial usage.
- Evaluate the specific needs and challenges each category faces, tailoring offerings accordingly.

3.5. Feasibility Analysis:

- Assess the willingness and ability of different segments to adopt electric vehicles.
- Investigate factors influencing consumer decisions, such as concerns about range, charging infrastructure, and overall cost.

3.6. Customer Reviews and Feedback:

- Gather and analyze customer reviews to understand experiences and perceptions related to existing electric vehicles.
- Extract valuable insights into what customers appreciate, dislike, and prioritize in their EV choices.

3.7. Competitive Landscape:

- Evaluate the current and potential competitors in the market.
- Identify gaps in the offerings of existing competitors and areas where our startup can differentiate itself.

3.8. Charging Infrastructure Accessibility:

- Investigate the current status of charging infrastructure in different regions.
- Understand the accessibility and convenience of charging stations for potential customers.

3.9. Government Policies and Incentives:

- Stay informed about government policies and incentives promoting electric vehicle adoption.
- Leverage available schemes and align strategies with governmental initiatives supporting sustainable transportation.

3.10. Technological Specifications:

- Scrutinize the technical specifications of existing electric vehicles.
- Identify innovative features and improvements that can be incorporated into our EV offerings.

3.11. Affordability and Financing Options:

- Explore the affordability of electric vehicles for different income groups.

- Investigate potential partnerships or financing options that make EVs more accessible to a broader consumer base.

3.12. Environmental Concerns and Awareness:

- Assess the level of environmental awareness among different segments.
- Tailor marketing messages to highlight the environmental benefits of electric vehicles.

4. Data References and Collection:

To conduct a comprehensive market segmentation analysis for our Electric Vehicle (EV) startup in India, we will adopt a data-driven approach by collecting diverse insights from various sources. Demographic data, sourced from census records and market research firms, will provide insights into age, income levels, and educational backgrounds. Geographic segmentation will be informed by GIS data, city planning reports, and regional surveys to understand preferences and infrastructure variances. Lifestyle and psychographic data will be gathered through market research studies and social media analytics, supplemented by surveys and interviews to capture consumer values and aspirations. Usage patterns will be analyzed using transportation department data, ride-sharing platforms, and user surveys. Feasibility analysis will involve surveys, focus groups, and interviews to gauge the willingness of different segments to adopt EVs. Customer reviews from online platforms and social media, alongside competitive landscape assessments, will offer insights into consumer sentiments and existing market dynamics. Charging infrastructure accessibility will be studied through government reports, charging network databases, and utility company information, ensuring an understanding of infrastructure gaps. Government policies and incentives will be monitored through official channels and industry associations, while technological specifications will be tracked through EV manufacturers' data and industry publications. Affordability insights will be gathered from financial reports, banking institutions, and consumer spending research, and environmental concerns and awareness will be addressed through environmental reports, awareness surveys, and social responsibility indices. This holistic strategy aims to derive actionable insights for effective market segmentation and entry strategies tailored to the diverse and dynamic Indian EV market.

Some names of Sources:

bikewala.com, Kaggle.com, Academia.com, data.gov.in, Statista.com

5. Data Pre-processing:

In the data pre-processing phase of this project, a systematic approach was undertaken using prominent Python libraries such as numpy, pandas, matplotlib, seaborn, and nltk. The primary objective was to handle sales data initially scattered across 10 separate Excel sheets. Leveraging the capabilities of pandas, these sheets were consolidated into a unified dataset, laying the groundwork for subsequent analyses. A critical emphasis was placed on the accuracy of electric vehicle maker names, achieved through meticulous replacement operations.

Following the consolidation of data, essential aggregation operations were performed specifically on electric two-wheeler sales data. This step provided a comprehensive perspective on market trends and insights into the performance of this specific vehicle category. Subsequently, the focus shifted towards data preparation for market segmentation, involving the merging of customer reviews and responses with corresponding electric vehicle technical specifications. To maintain data integrity, null values were strategically handled using specific logical values, ensuring a complete and reliable dataset.

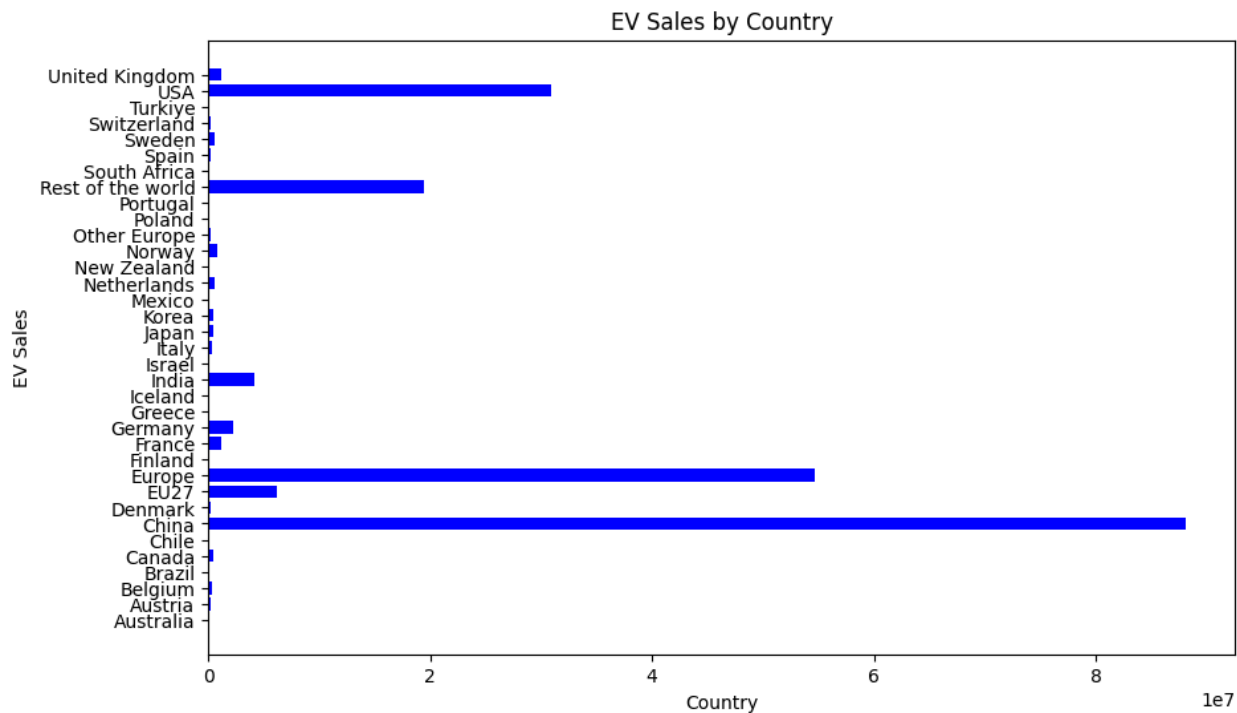
In-depth sentiment analysis of customer reviews was conducted by harnessing the natural language processing capabilities of nltk. This analysis yielded valuable qualitative insights into customer sentiments, offering a nuanced understanding of their perceptions. Subsequent to sentiment analysis, behavioral variables such as Visual Appeal, Reliability, Performance, Service Experience, Extra Features, Comfort, Maintenance Cost, and Value for Money were meticulously isolated and prepared. These variables played a fundamental role in laying the groundwork for the market segmentation analysis, providing a granular understanding of customer preferences and attitudes toward electric vehicles. The comprehensive approach to data pre-processing set the stage for robust and insightful analyses in subsequent phases of the project.

6. Segment extraction:

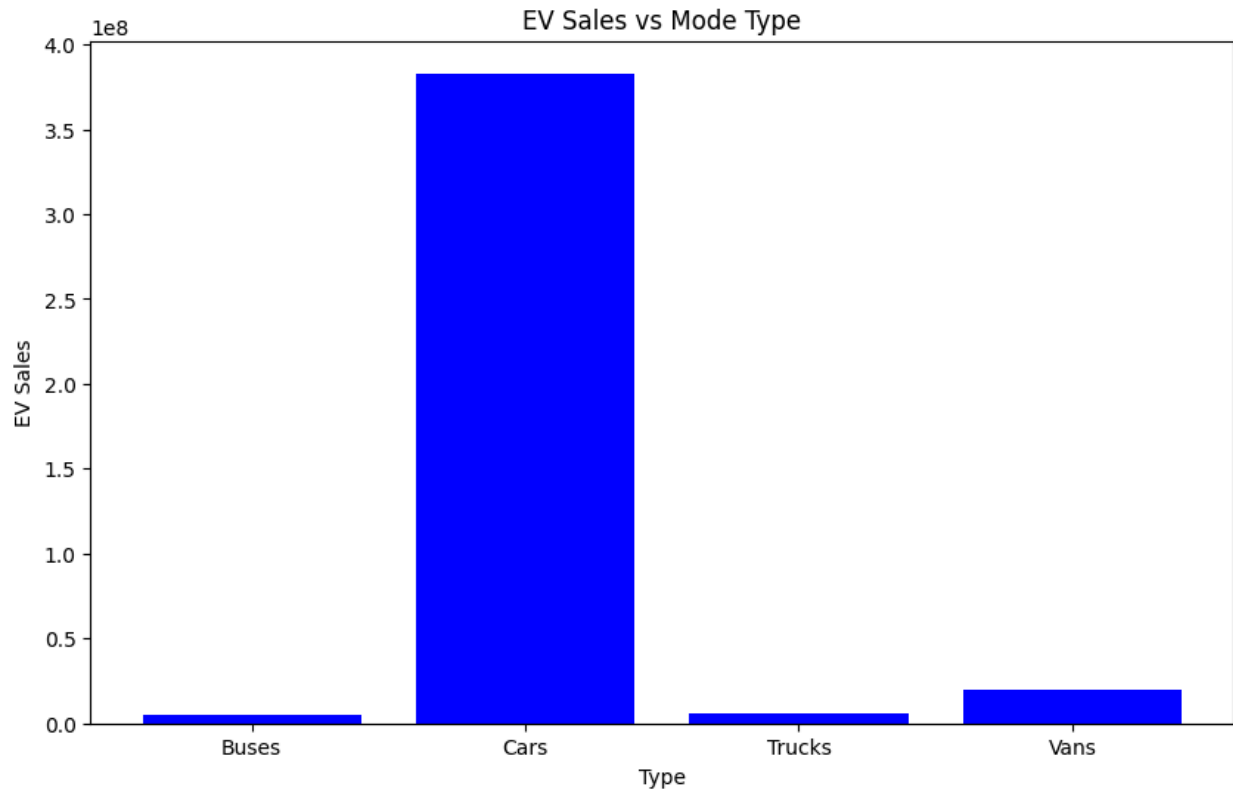
6.1 Global Market Overview:

The global Electric Vehicle (EV) market has experienced a notable surge in recent years, signaling a transformative shift in the automotive industry. The trajectory

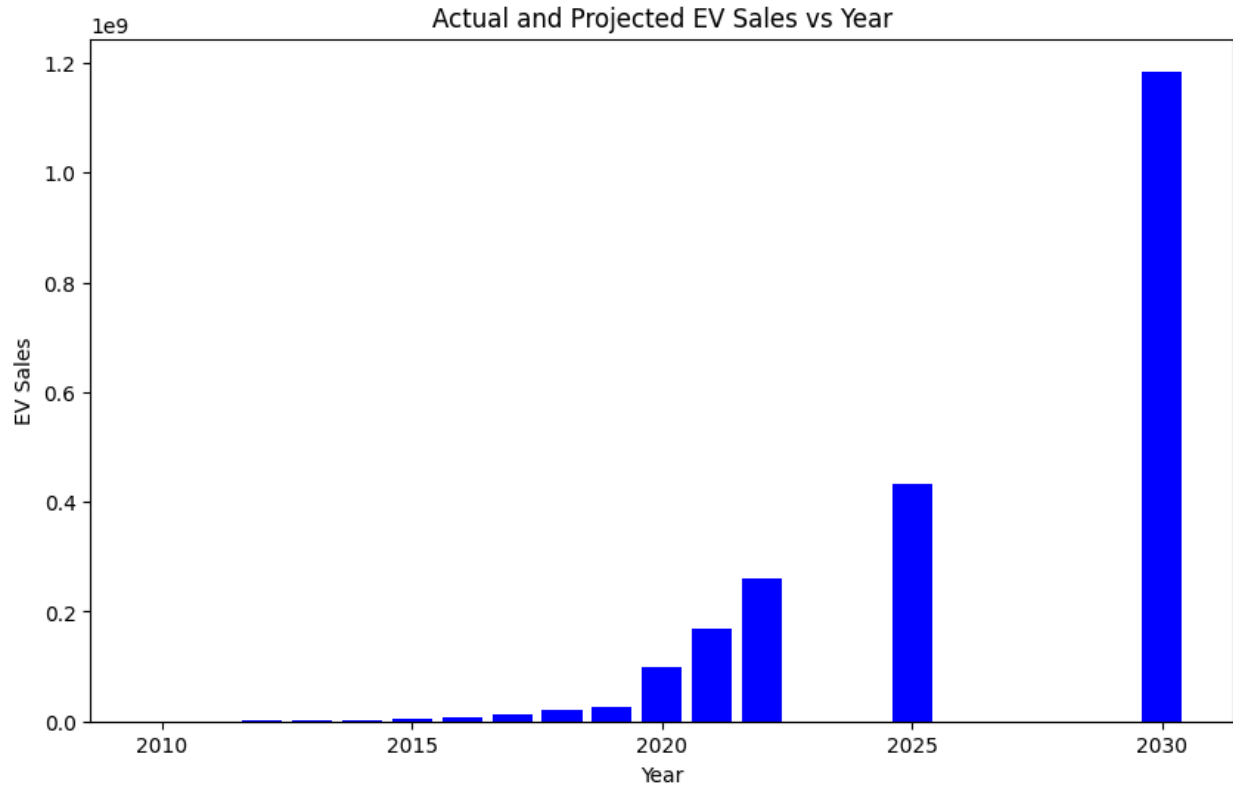
of increasing EV sales year by year underscores the growing acceptance and adoption of electric mobility on a global scale. Key factors contributing to this upward trend include a heightened awareness of environmental sustainability, advancements in battery technology, and supportive government policies promoting clean energy alternatives.



China has emerged as the global leader in Electric Vehicle (EV) sales, driven by robust government support and incentives. Europe follows closely behind, propelled by stringent emission standards and ambitious sustainability targets. The United States, while making strides, currently lags behind China and Europe in terms of EV adoption. China's proactive policies have stimulated both domestic production and international investment. Europe's commitment to reducing carbon emissions has led to a surge in EV sales and a growing portfolio of electric models. In the U.S., increasing awareness, technological advancements, and government incentives contribute to a steady rise in EV popularity. The global EV landscape is dynamic, with China leading, Europe closely behind, and the U.S. actively participating in the shift toward sustainable transportation.

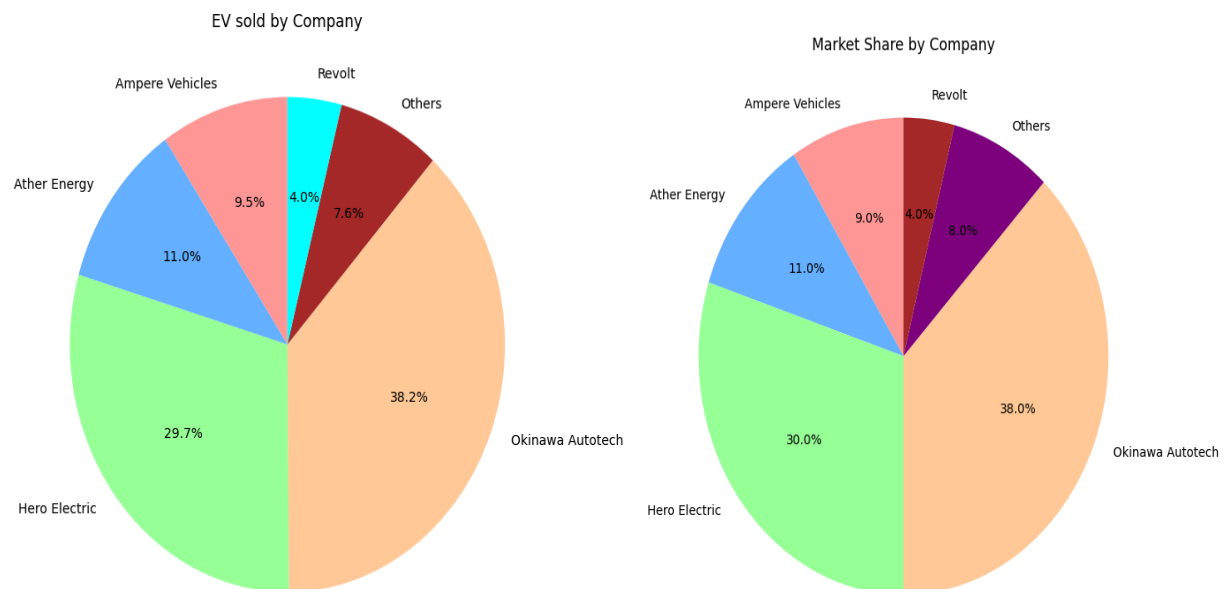


Car types within the EV segment, notably electric cars, have emerged as the predominant choice across the world. Electric cars, with their diverse models and expanding range capabilities, have become increasingly popular among consumers seeking eco-friendly alternatives to traditional internal combustion engine vehicles. Major automakers are actively investing in the development and production of electric cars, contributing to the diversity and competitiveness of the global EV market.



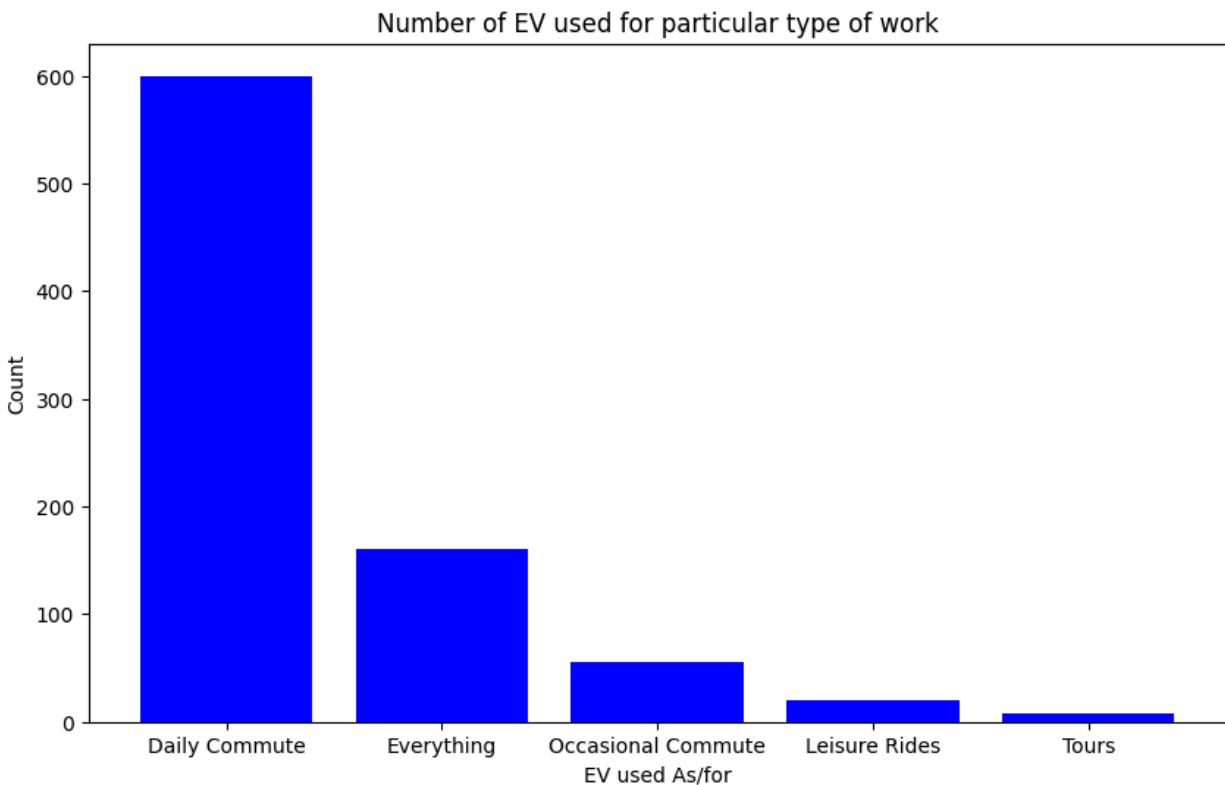
The global Electric Vehicle (EV) market is experiencing a consistent upward trajectory, with sales increasing year by year. Driven by environmental concerns, advancements in technology, and supportive government policies, consumers worldwide are increasingly embracing EVs as a sustainable alternative. This trend reflects a growing shift towards cleaner transportation options and underscores the expanding appeal of electric mobility on a global scale.

6.2 Competitors and Competition in Market:

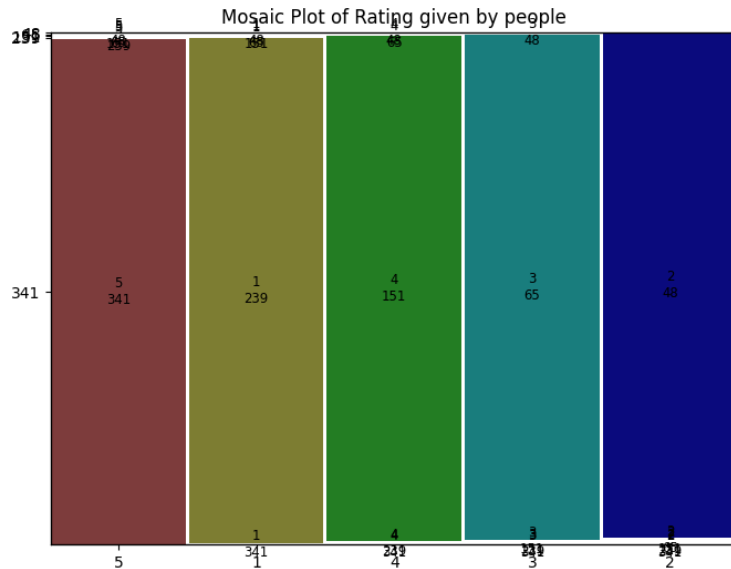


The pie chart depicting the Electric Vehicle (EV) market share by different companies provides a snapshot of market segmentation within the EV industry. It visually highlights the distribution of market influence among various companies, showcasing the competitive landscape. This segmentation insight is crucial for understanding consumer preferences, industry dynamics, and the strategic positioning of different players in the evolving EV market. It serves as a valuable tool for businesses to tailor their approaches based on the market share held by key players, ultimately influencing their decision-making and market strategies.

7. Psychographic Segmentation:

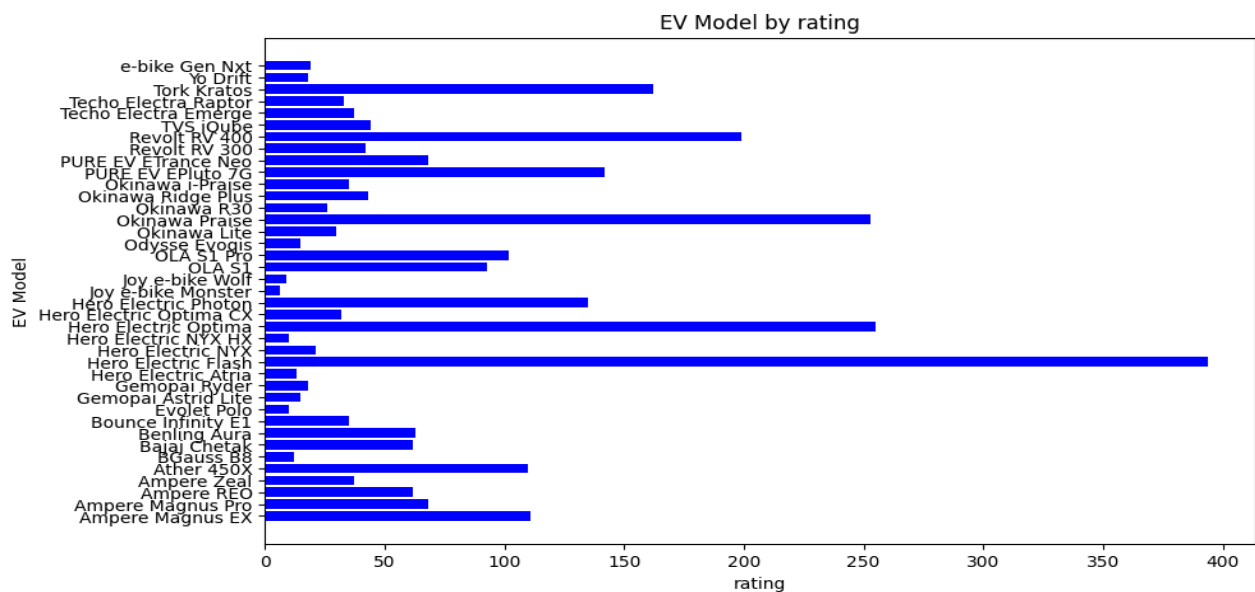


The bar chart depicting Electric Vehicle (EV) usage for different types of work offers valuable insights into market segmentation. It delineates the diverse applications of EVs across various sectors, such as commercial, personal, and industrial use. This segmentation reveals nuanced preferences and demands within the market, guiding manufacturers and stakeholders in tailoring their offerings. Understanding how EVs are employed in different work domains aids in strategic decision-making, allowing for targeted marketing and the development of specialized electric vehicles that align with specific industry needs.



Rating given by number of people

The increasing acceptance of Electric Vehicles (EVs) is evident in a growing trend where more people are embracing sustainable and eco-friendly transportation options. Advancements in technology, coupled with heightened environmental awareness, contribute to the expanding popularity of EVs. Governments globally promoting EV adoption through incentives further fuel this acceptance. The growing charging infrastructure and improved battery technologies address concerns, making EVs a viable and attractive choice for a broader consumer base. The upward trajectory in EV acceptance underscores a significant paradigm shift towards cleaner and more sustainable mobility solutions.

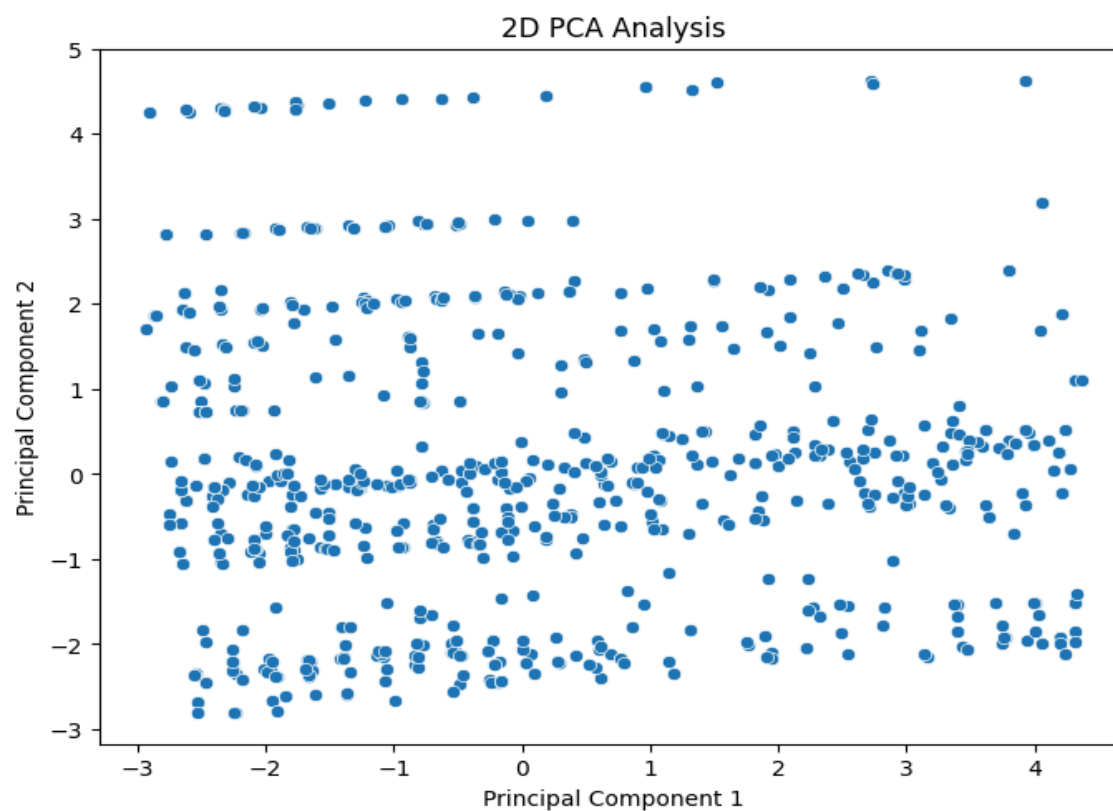
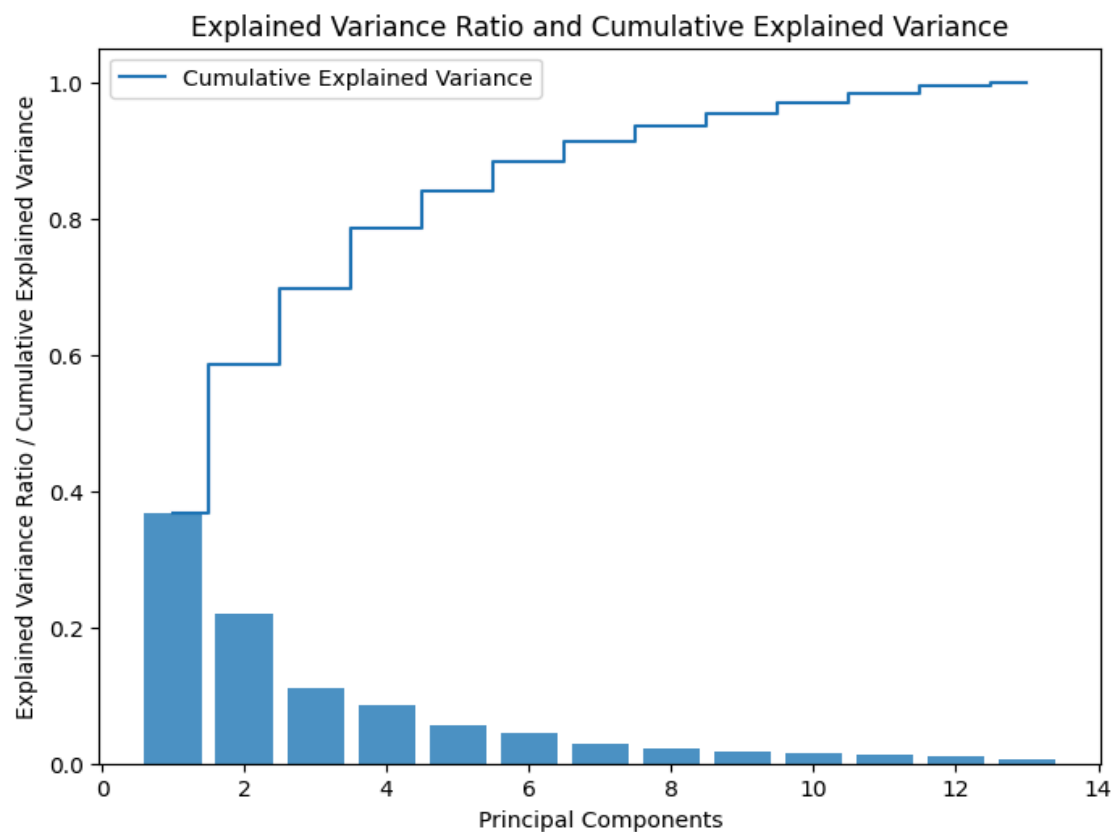


Analyzing the preferred electric vehicle models offers crucial insights for market segmentation. By identifying the most liked models, businesses can strategically tailor their offerings to meet specific consumer preferences. This data-driven approach enhances the effectiveness of product development and marketing strategies, aligning with the desires of target audiences and maximizing market penetration.

7.1 PCA Analysis of Dataset:

Principal Component Analysis (PCA) was applied to the Electric Vehicle (EV) dataset of consumer characteristics for market segmentation. This multivariate statistical technique helped distill the complex dataset into essential components, revealing underlying patterns and relationships among consumer features. By reducing dimensionality, PCA identified key variables influencing consumer behavior, aiding in the creation of meaningful segments. The analysis pinpointed which characteristics contribute most to consumer preferences, enabling businesses to refine marketing strategies. The derived principal components offer a streamlined view of the dataset, enhancing our understanding of distinct consumer segments within the EV market. This insightful segmentation, guided by PCA, serves as a foundation for targeted approaches, facilitating more effective product positioning and tailored marketing efforts.





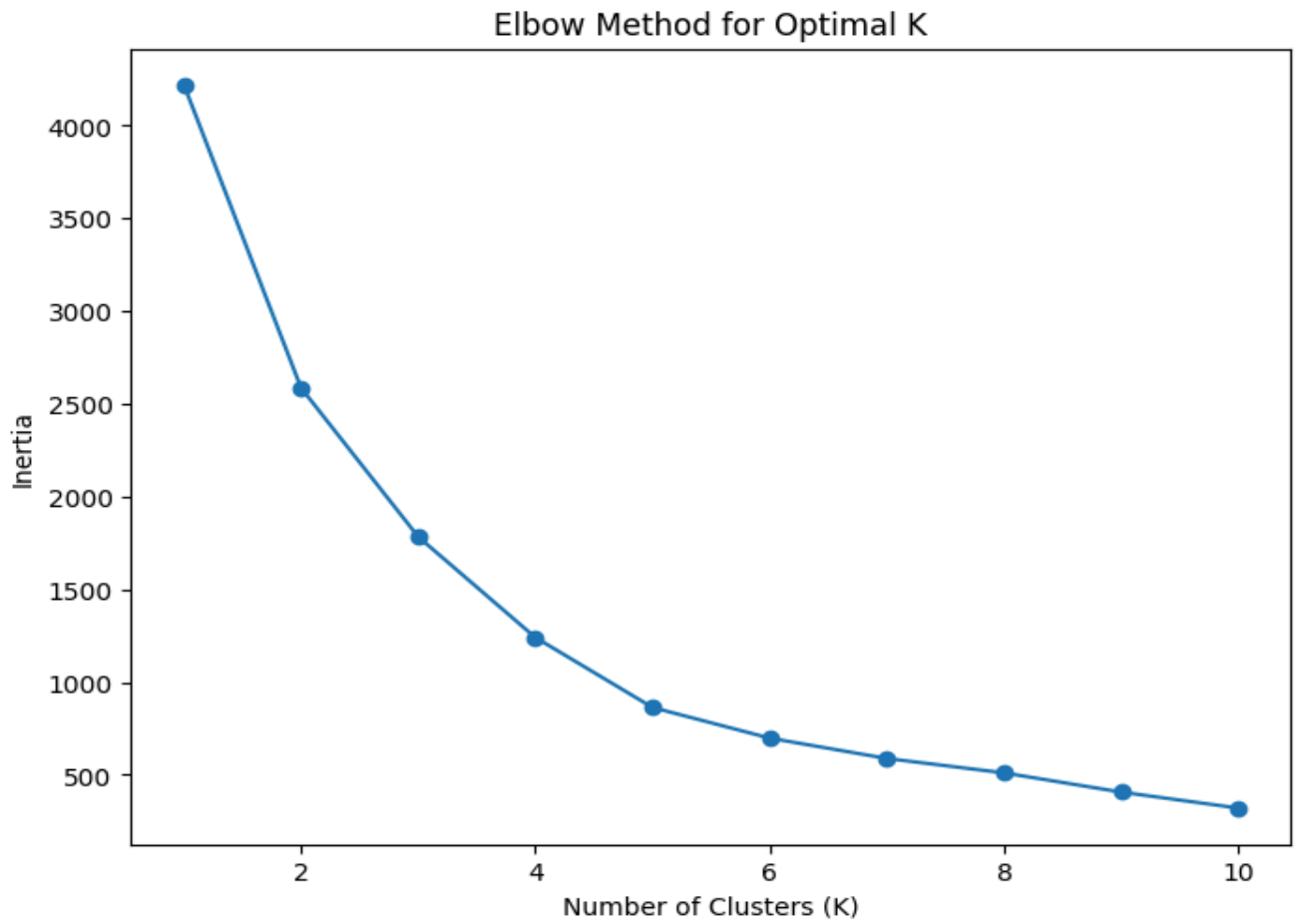
This shows the heatmap of PCA Analysis of different features in the EV dataset

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13
rating	-0.414936	-0.031918	-0.017000	0.027656	0.007900	-0.117736	0.236185	-0.236272	0.239850	-0.453183	0.615132	0.241611	-0.023604
Visual Appeal	-0.394018	0.002407	0.002178	-0.074686	-0.096487	-0.055798	-0.370078	0.781990	0.225671	0.063629	0.081016	0.126491	0.027067
Reliability	-0.424232	-0.043593	-0.022743	0.005275	-0.043039	-0.008804	0.101864	-0.124550	0.100653	0.391186	0.174485	-0.772064	-0.008813
Performance	-0.275491	-0.021327	-0.467429	-0.231273	-0.238954	-0.506464	0.037483	-0.026758	-0.393246	-0.262689	-0.324967	-0.064099	-0.050857
Service Experience	-0.417474	-0.043819	0.011697	-0.036685	0.005066	-0.005664	0.208108	-0.256275	0.152159	0.555158	-0.319724	0.528805	-0.007638
Value for Money	-0.295467	-0.140347	0.439595	0.151337	0.136493	0.241005	0.492801	0.295068	-0.346673	-0.267467	-0.266720	-0.075096	-0.041512
Comfort	-0.336546	0.004268	0.351821	0.150302	0.035319	0.082676	-0.697284	-0.384906	-0.224715	-0.173027	-0.125556	-0.003280	0.041213
Maintenance cost	-0.171214	-0.022388	-0.556142	-0.230236	0.263391	0.714722	-0.074796	-0.025720	-0.086735	-0.109190	-0.018595	0.010320	0.039064
Price	-0.073161	0.505079	-0.034891	0.080635	0.401362	-0.129279	0.029231	-0.028920	0.513134	-0.268282	-0.419042	-0.161439	-0.124043
Riding Range (km)	-0.041741	0.561283	0.017366	0.003711	0.063956	0.024000	-0.004304	0.059819	-0.392372	0.203822	0.270515	0.097143	-0.629703
Top Speed (kmph)	0.000297	0.312148	0.246574	-0.451807	-0.674922	0.307910	0.078715	-0.090810	0.187066	-0.147720	-0.117889	-0.046026	-0.005749
Weight (kg)	-0.026956	0.017358	-0.299206	0.774747	-0.470842	0.194913	0.013480	0.013719	0.100974	-0.058362	-0.109893	0.012031	-0.152770
Battery Charging Time (hrs)	-0.068747	0.553717	-0.049033	0.171512	-0.002045	-0.023939	0.101315	0.045087	-0.250928	0.090553	0.121562	0.047738	0.745490

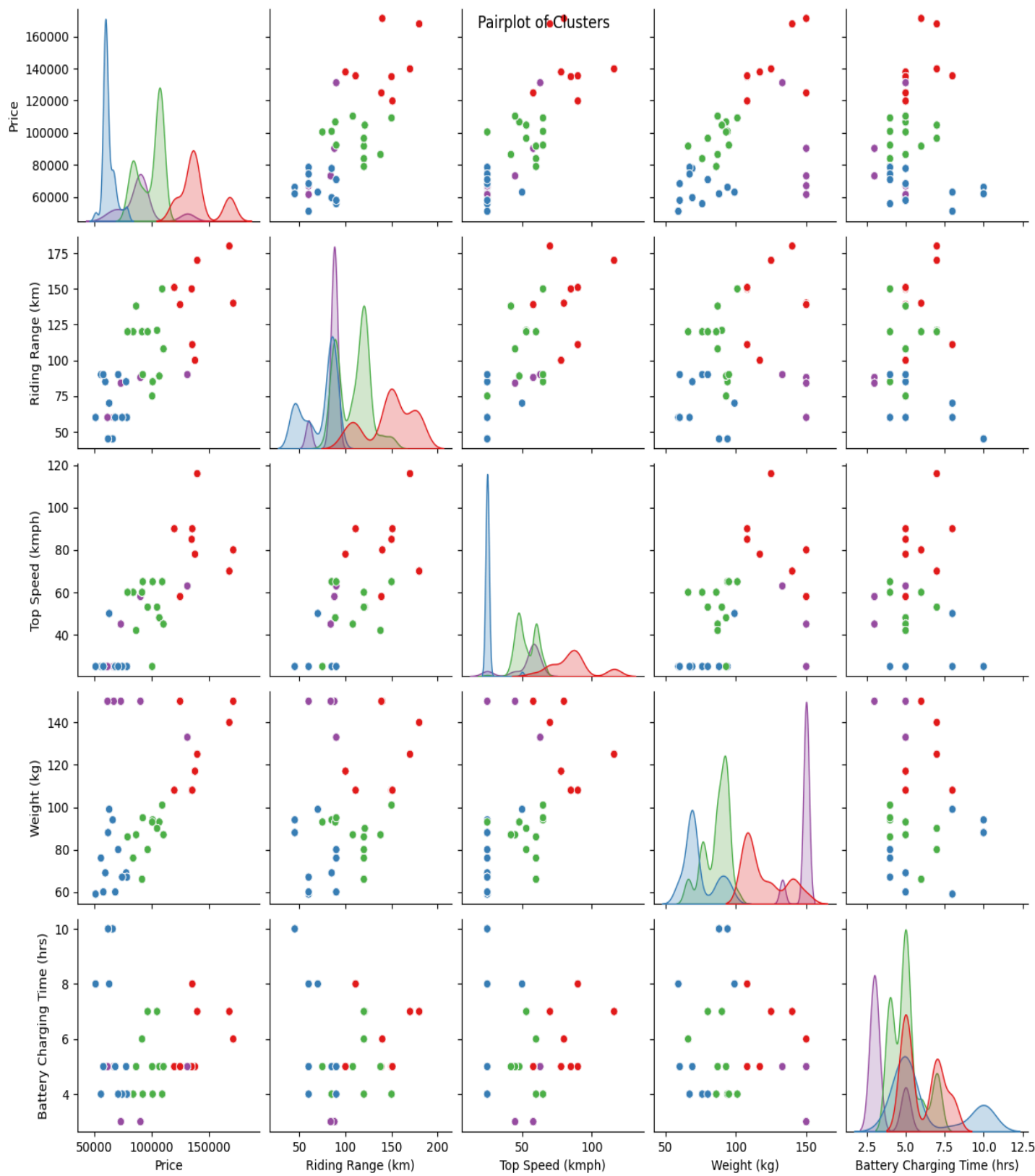
7.2 Vehicle Features Segmentation using K means clustering:

Electric Vehicle (EV) features such as Price, Top Speed, Battery Charging Time, Weight, and Riding Range. In this analysis, K-means identifies distinct clusters of EVs based on similarities in these key attributes. The algorithm partitions the dataset into k clusters, where each cluster represents a group of EVs with similar characteristics.

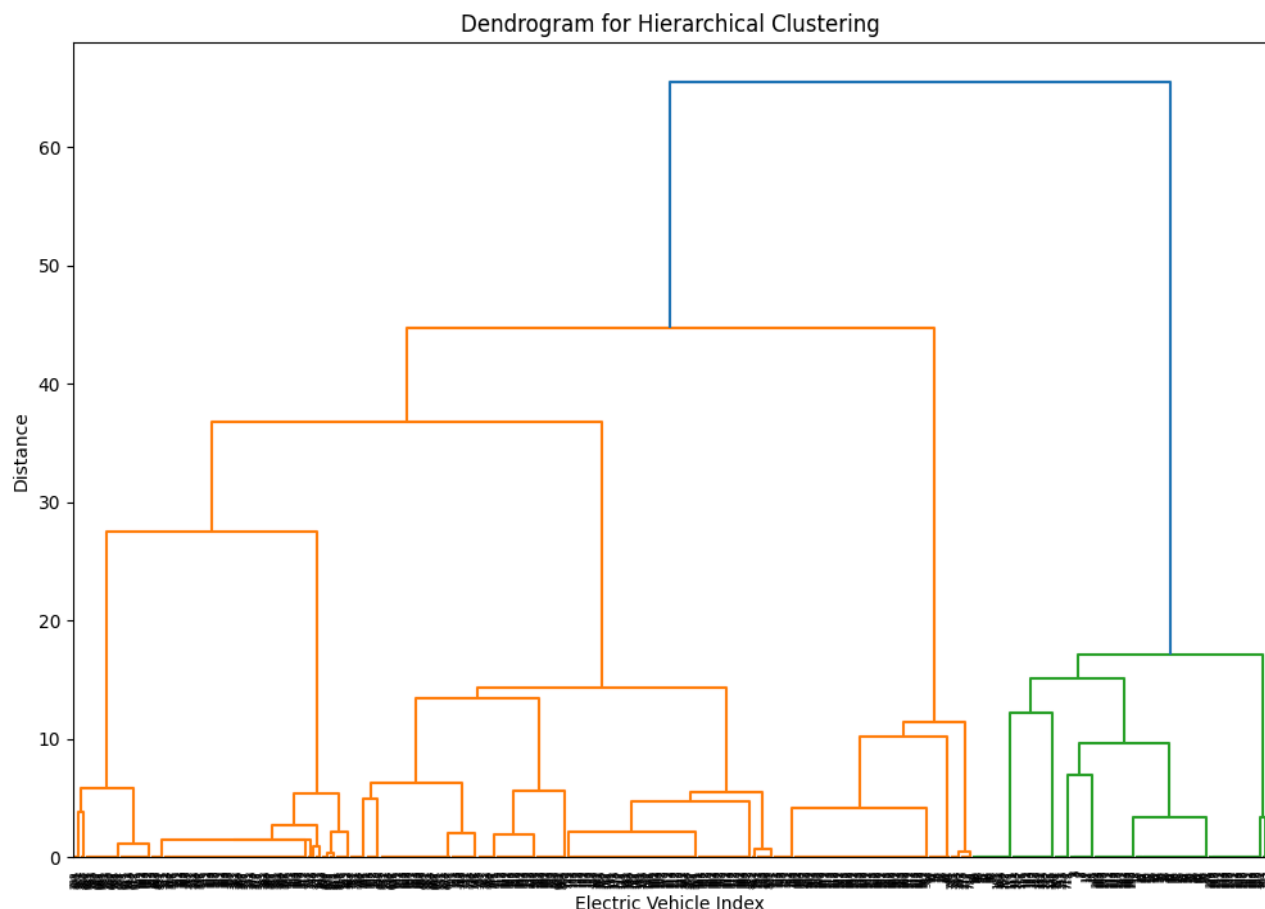
By employing K-means on Price, Top Speed, Charging Time, and Riding Range, the algorithm aims to uncover patterns and group EVs that appeal to similar consumer preferences. The resulting clusters provide valuable insights into market segments with shared preferences for specific combinations of features, helping businesses tailor marketing strategies, pricing models, and product development to target distinct consumer groups effectively.



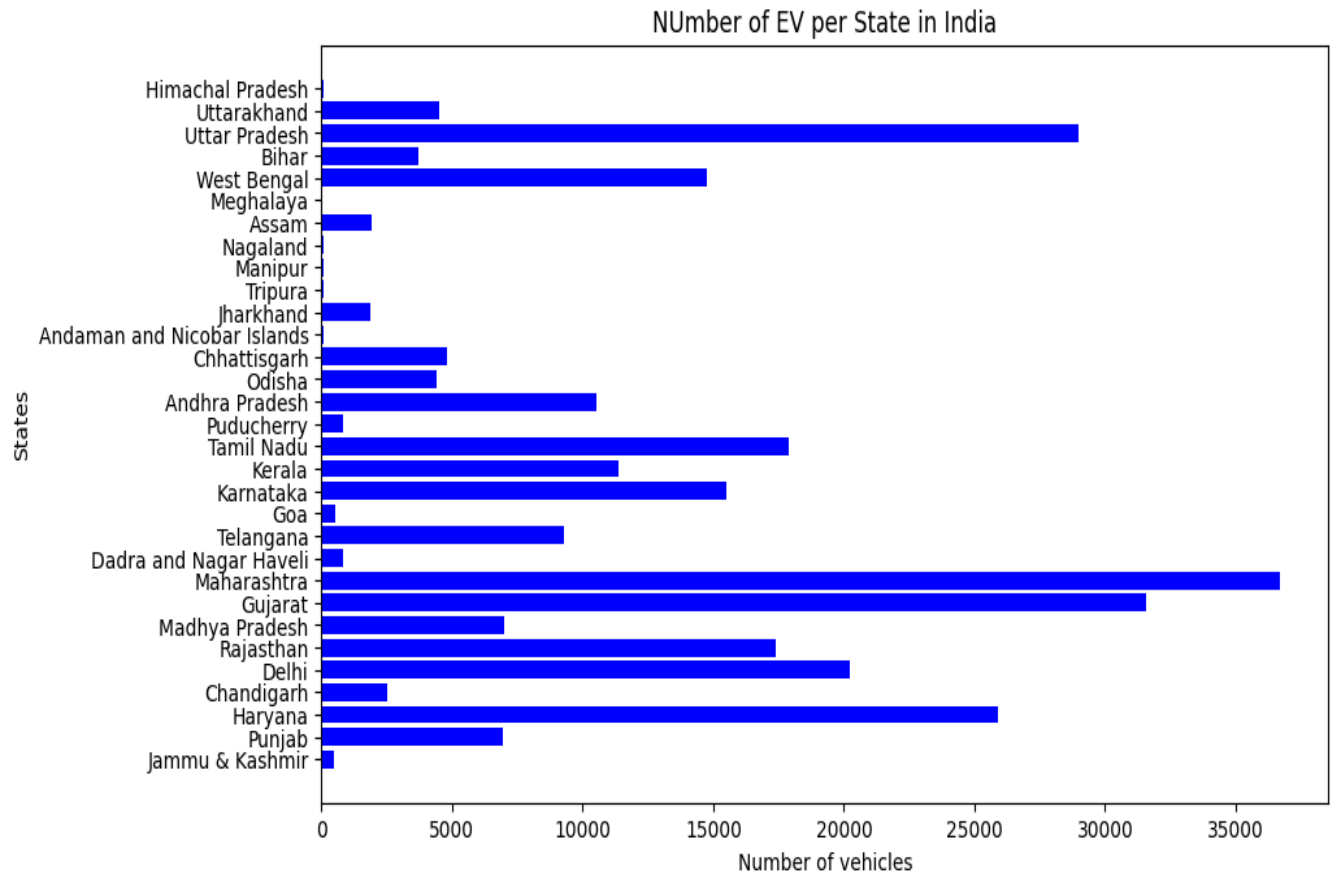
Choosing the most optimal number of clusters using the Elbow method



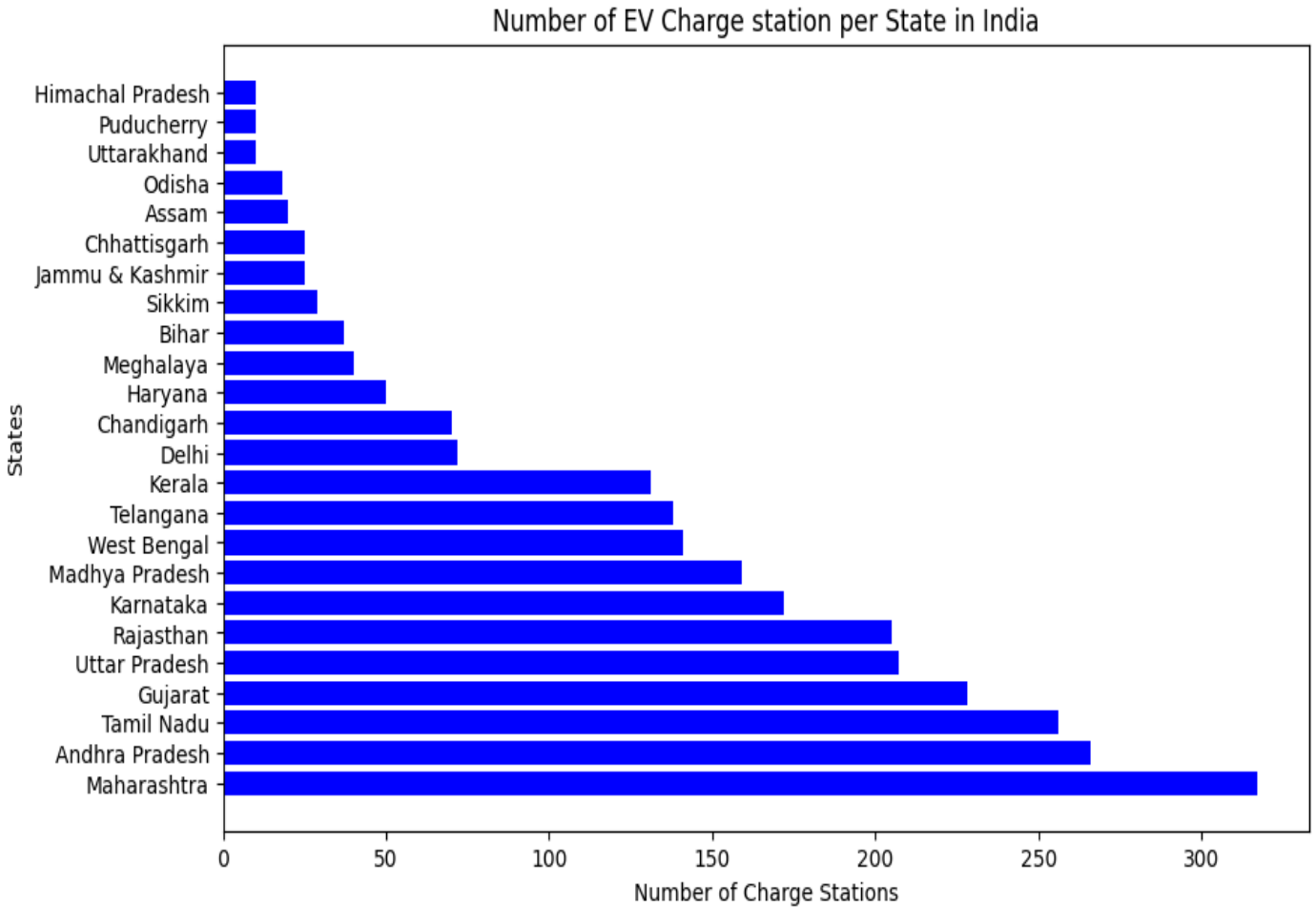
Hierarchical clustering is highly useful for market segmentation in the context of Electric Vehicles (EVs) due to its ability to reveal both broad market segments and fine-grained distinctions within those segments. This method helps businesses gain a comprehensive understanding of consumer preferences, allowing for more targeted and effective market strategies. The hierarchical structure provides a visual representation of the relationships between different clusters, enabling stakeholders to identify major segments based on key EV features such as price, top speed, charging time, and riding range. This understanding helps in crafting overarching marketing strategies tailored to each major segment's preferences, the hierarchical approach allows for the exploration of sub-clusters or niche markets within broader segments. This is crucial for recognizing subtle variations in consumer preferences and behavior, leading to more precise product development and marketing efforts. For instance, within a segment of price-conscious consumers, the hierarchy might reveal sub-clusters with specific preferences for range and charging time.



8. Demographic Segmentation:

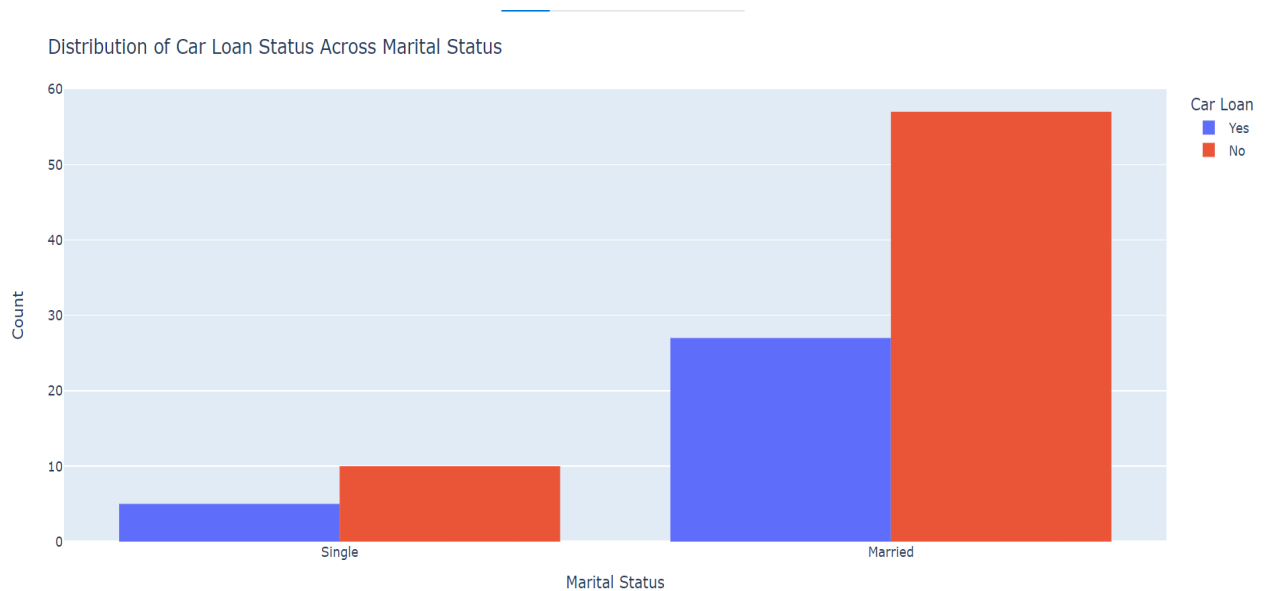


This clearly shows that we should first target our business in states like Maharashtra, Gujarat, and Uttar Pradesh as in these states there are the most number of EV consumers.

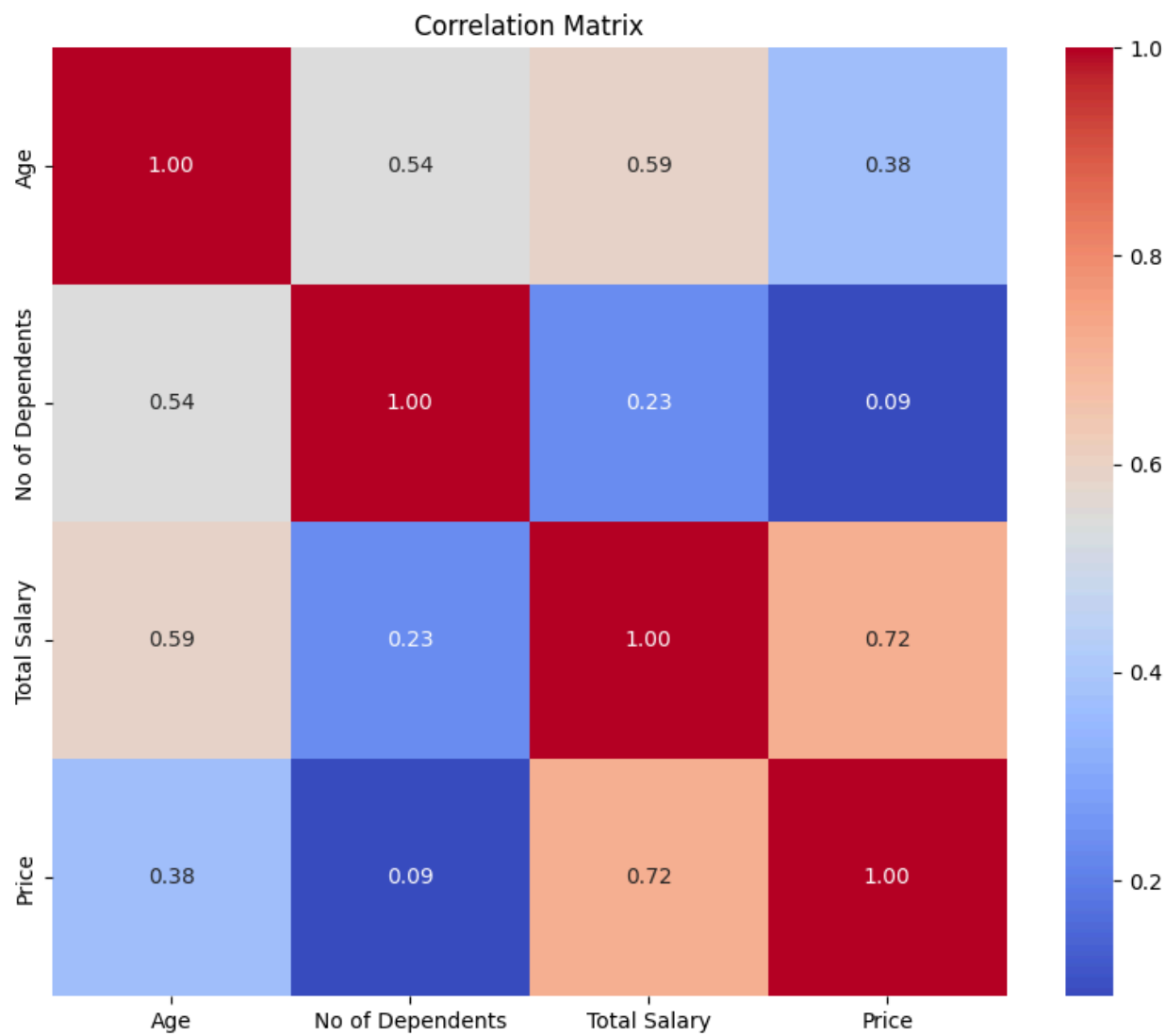


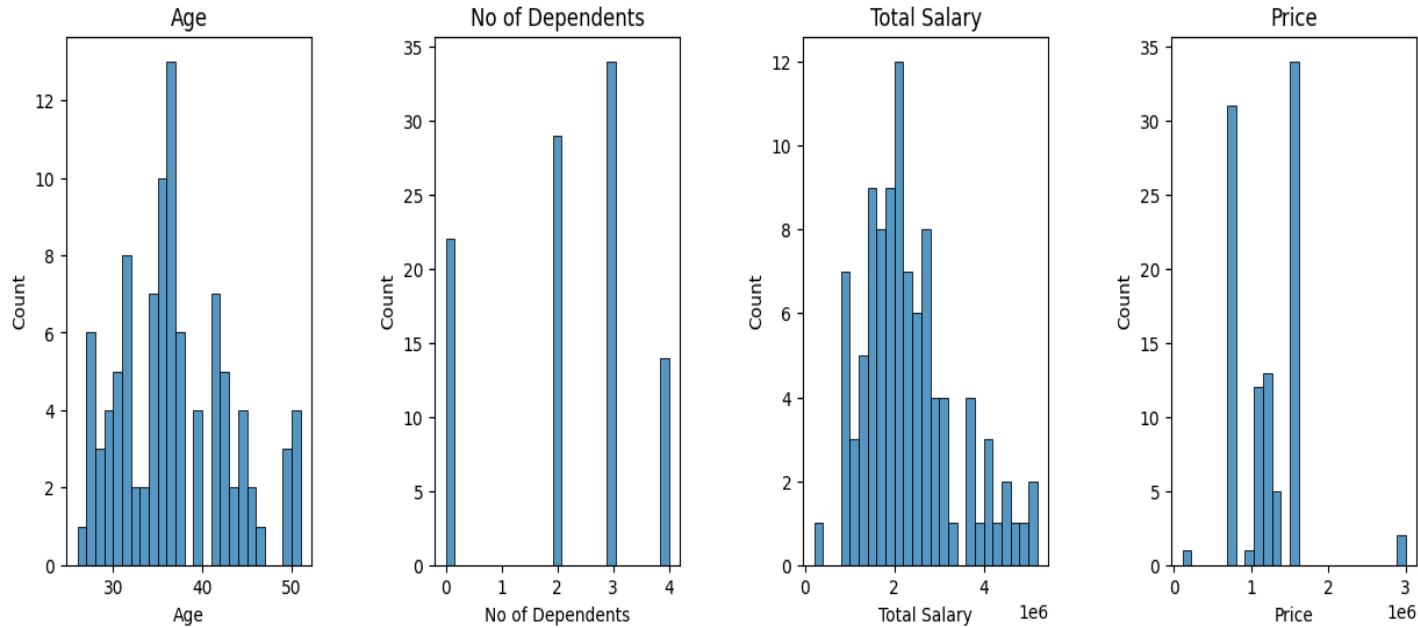
We can deduce that states such as Tamil Nadu, Andhra Pradesh, Rajasthan, and Karnataka have a substantial number of EV charging stations. This suggests a potential increase in EV sales in these regions, presenting an opportunity for us to capitalize on this infrastructure advantage and boost our sales in these states.

9. Behavioral Segmentation:



Based on the observed plot, a clear trend emerges indicating that married individuals are more inclined to purchase Electric Vehicles (EVs) compared to their single counterparts. Additionally, among the married demographic, a higher ratio of individuals appears to opt for EVs without taking a loan as opposed to those who finance their purchases. This pattern suggests a potential market segmentation strategy, where marketing efforts and product offerings can be tailored to target the preferences and behaviors of married individuals interested in purchasing EVs. Understanding the preference for non-loan purchases within the married segment could lead to the development of specific marketing campaigns or financing options that resonate with this group, ultimately optimizing the approach to boost EV sales among the married population. This targeted segmentation approach may enhance the effectiveness of sales strategies and contribute to the overall success of EV marketing initiatives.





By analyzing the provided plots, we can derive strategic insights to inform decision-making in various aspects of the Electric Vehicle (EV) market. Firstly, the data allows us to identify the age group that demonstrates the highest interest in EV purchases, enabling us to tailor marketing efforts and product features to better resonate with this particular demographic. Additionally, the analysis of the number of seats in EVs reveals valuable information on the preferred vehicle capacity, guiding manufacturers in optimizing their product offerings to align with market demands.

10. Selecting Target Segment:

Upon thorough analysis of the segmentation data, it is evident that a strategic focus on specific customer profiles will be instrumental in driving Electric Vehicle (EV) sales. The decision to target married individuals arises from a discernible trend indicating a higher inclination toward EV purchases within this demographic. This group has demonstrated a notable interest in adopting electric mobility, making it a prime audience for targeted marketing efforts and product promotions.

Additionally, the emphasis on those who utilize EVs for their daily commute is derived from the observed patterns indicating a significant portion of the market engaging in daily EV use. Tailoring marketing messages and features to align with the practical

benefits of EVs for daily commuting needs can effectively resonate with this segment, potentially driving higher conversion rates.

Furthermore, narrowing down the age group to individuals between 35-39 years old is strategic based on the observed data patterns. This cohort exhibits a notable interest in EVs, and focusing on this age range allows for more precise targeting in marketing campaigns and product development. Understanding the preferences and priorities of this age group enables the creation of offerings that cater specifically to their needs, increasing the likelihood of successful engagement and conversion.

In conclusion, targeting married individuals who use EVs for daily commuting and fall within the age range of 35-39 years is a strategic decision derived from the segmentation analysis. This targeted approach ensures that marketing efforts are directed towards a demographic with a higher likelihood of EV adoption, optimizing the effectiveness of sales strategies in the competitive electric vehicle market.

11. Customising Marketing Mix:

Customization aligns with the core elements of the Marketing Mix, also known as the 4Ps: Product, Price, Place, and Promotion.

11.1. Product:

Customizing the product involves tailoring the features of EVs to meet the specific needs and preferences of the identified target segment. In this case, focusing on designing EVs with 3 and 4 seating spaces addresses the family-oriented nature of the demographic, enhancing the practical appeal of the product. Manufacturers can also consider incorporating features that cater to daily commuting needs, emphasizing reliability, efficiency, and comfort.

11.2. Price:

The pricing strategy is crucial in catering to the financial capacity of the target audience. Setting the EV price range between 40,000 to 1,50,000 aligns with the observed income bracket of the demographic. This pricing customization ensures that the EVs are positioned as affordable yet competitive options, making them accessible to a wider range of potential customers.

11.3. Place:

The distribution strategy, or Place, involves making the product available where the target customers are most likely to purchase. Considering the income and lifestyle characteristics of the identified segment, and establishing distribution channels in areas with a higher concentration of the target demographic is strategic. This could include urban and suburban areas where commuting needs are prevalent.

11.4. Promotion:

Customizing the promotion strategy involves tailoring marketing messages and campaigns to resonate with the identified preferences and priorities of the target segment. Emphasizing the family-friendly features of the EVs, highlighting affordability, and showcasing the practical benefits for daily commuting are key elements in promotional efforts. Leveraging digital platforms, social media, and targeted advertising channels that align with the media consumption habits of the target audience can further enhance the effectiveness of promotional campaigns.

12. Potential Early Customer Base:

The observed Segmentation indicates a clear pattern in the Electric Vehicle (EV) market, suggesting that the potential early customer base is concentrated in states like Maharashtra, Gujarat, and Uttar Pradesh. These regions exhibit a higher number of EV sales, indicating a growing interest and adoption of electric mobility among the local population. This geographical segmentation provides valuable insights for businesses looking to establish an initial customer base and focus their early marketing and sales efforts in these states.

Simultaneously, the presence of a substantial number of EV charging stations in Tamil Nadu, Andhra Pradesh, Rajasthan, and Karnataka highlights the importance of considering infrastructure support for potential EV customers. These states, with robust charging infrastructure, represent strategic opportunities to target early adopters who are likely to be attracted to areas with convenient and accessible charging facilities. Therefore, businesses can prioritize marketing initiatives and sales efforts in these

regions to tap into the existing charging infrastructure and cater to the needs of consumers who value the convenience of readily available charging stations.

This information guides businesses to allocate resources efficiently. They can concentrate their initial efforts on states with high EV sales, capitalizing on the existing market demand, while also strategically expanding into regions with well-established charging infrastructure to create a seamless experience for early adopters. This dual approach enhances the likelihood of successful market penetration and establishes a strong foundation for the broader adoption of electric vehicles in the evolving automotive landscape.

Potential Revenue = Potential Customer Base * Your Target Price Range
= 40,000*80,000 = 3,20,00,00,000

13. Conclusion:

In summary, our extensive analysis of the electric vehicle market in India has uncovered significant opportunities for market entry and growth. The identified consumer base in states such as Maharashtra, Gujarat, and Uttar Pradesh, along with the presence of a considerable number of charging stations in Tamil Nadu, Andhra Pradesh, Rajasthan, and Karnataka, presents a robust market segment ripe for exploration. Recognizing this, our strategic decision involves tailoring the specifications of our electric vehicles to precisely meet the preferences of the identified consumer base.

This approach is rooted in a comprehensive understanding of market segmentation, consumer behavior, and technical specifications. By aligning our products seamlessly with the demands of the market, we aim to create a compelling value proposition that resonates with the diverse preferences of potential customers. This strategic alignment not only enhances the appeal of our electric vehicles but also positions our offerings as tailored solutions within the dynamic landscape of the Indian electric vehicle market.

These insights serve as a clear guide for our market entry strategy, emphasizing precision and relevance in both product development and marketing strategies. Armed with a deep understanding of the market dynamics and consumer needs, we can make informed decisions that address specific preferences and challenges within the electric vehicle ecosystem. Looking ahead, this strategic approach provides us with a solid foundation, ensuring that our products are well-received and effectively positioned within India's evolving electric vehicle landscape.

GitHub Link: <https://github.com/piyush1703/EV-Market-Segmentation>