Segmentation Analysis for Electric Vehicle Market in India

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INTRODUCTION

India's electric vehicle (EV) market is experiencing a significant uptick in sales, reflecting the nation's commitment to sustainable transportation. As a startup operating within this burgeoning industry, it is essential to understand the driving forces behind this growth and segment the market effectively. Through comprehensive segmentation analysis, we aim to identify key market segments, consumer preferences, and strategic pathways for market entry. By leveraging data-driven insights, our startup can capitalize on emerging opportunities and contribute to India's transition towards a greener and more sustainable future.

A. Brief Overview EV market in India

The electric vehicle (EV) market in India has witnessed significant growth in recent years, driven by a combination of factors including government initiatives, technological advancements, and increasing environmental awareness. India has emerged as one of the key markets for electric vehicles globally, with growing support from policymakers and incentives to promote adoption. While the market is still in its nascent stage, there has been a notable increase in EV sales across various segments, including two-wheelers, three-wheelers, and electric cars. Additionally, the establishment of charging infrastructure and investments in research and development are further propelling the growth of the EV ecosystem in India. Despite challenges such as affordability, range anxiety, and infrastructure constraints, the EV market in India presents immense opportunities for innovation and investment, positioning the country as a key player in the global shift towards sustainable mobility.

B. Importance of segmentation analysis in market entry strategy

Segmentation analysis is vital for guiding market entry strategies in India's dynamic electric vehicle (EV) industry. It involves dividing the market based on geographic, demographic, psychographic, and behavioural factors to understand consumer preferences and behaviours better. This allows companies to tailor their marketing efforts and product development to specific segments, maximizing growth opportunities and minimizing competition. By targeting niche segments and mitigating market entry risks, startups can establish a strong presence and drive sustainable growth in the EV industry.

C. Purpose and score of this report

This report aims to analyse the Indian electric vehicle (EV) market and develop a concise market entry strategy for our startup. Focusing on segmentation analysis, it will identify key market segments, consumer preferences, and strategic opportunities within the EV industry. The report will provide actionable insights to guide our startup's market entry decisions, including geographic targeting, pricing strategies, and distribution channels, tailored specifically to the Indian market landscape.

Market Analysis

A. Growth, trends and forecasts [4]

The Indian electric vehicle (EV) market has surged, reaching USD 1.45 billion in 2021 and projected to hit USD 113.99 billion by 2029, with a remarkable CAGR of 66.52% from 2022 to 2029. Despite pandemic challenges, the industry grew by 11.34% in 2020. Uttar Pradesh led EV sales in 2021 (66,704 units), followed by Karnataka and Tamil Nadu. Mahindra & Mahindra's plan to launch 16 BEVs by 2027 highlights the sector's growth. With ambitious targets for EV adoption and carbon

India Electric Vehicle Market Size, 2018-2029 (USD Billion)
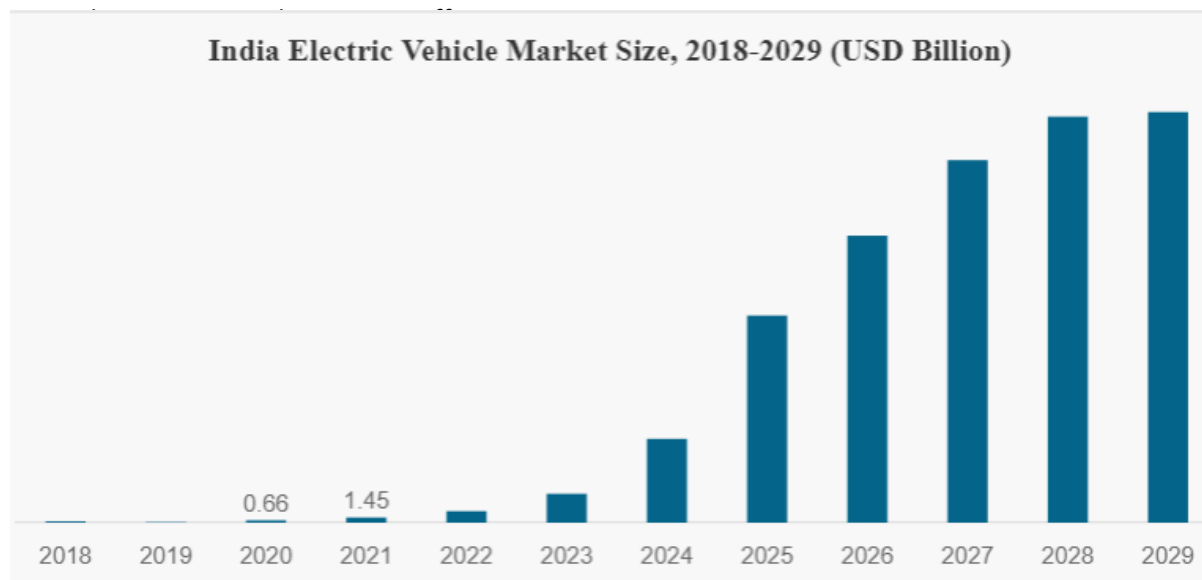
B. Competitive landscape analysis

The Indian electric vehicle (EV) market has surged, reaching USD 1.45 billion in 2021, with projections soaring to USD 113.99 billion by 2029 at a CAGR of 66.52%. Despite pandemic challenges, the sector grew by 11.34% in 2020. Uttar Pradesh led 2021 EV sales (66,704 units), followed by Karnataka and Tamil Nadu. Mahindra & Mahindra plans to launch 16 EV models by 2027, bolstering growth. India targets 70% EV penetration by 2030, aligning with a broader goal of achieving net-zero carbon emissions by 2070. This presents lucrative opportunities for investment and innovation. Tata Motors Dominance in EV market.

- **Tata Motors** captured a significant 72% share of India's electric vehicle (EV) market during the first half of 2023.
- The company achieved this market dominance by selling **34,000** electric vehicles, showcasing remarkable growth and performance.
- High sales numbers of Tata's Tiago, Nexon, and Tigor models contributed to its success in the EV market.
- Among all EV car models, Tata's Tiago emerged as the highest-selling EV car in India, followed closely by the Nexon and Tigor models.

EV RETAIL SALES BY CARMAKERS												
Manufacturer	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tata Motors	2,471	3,917	7,303	4,492	6,002	5,479	5,461	4,771	4,312	5,538	5,024	4,806
MG Motor India	435	362	517	350	464	1,158	1,237	1,202	891	929	935	950
Mahindra	0	7	259	537	389	412	380	405	359	273	518	662
BYD	140	242	300	164	146	184	118	104	151	141	139	168
Citroen	0	0	209	240	324	336	223	118	141	172	126	49
Hyundai	117	50	48	54	170	160	116	186	213	195	165	123
Kia	48	30	23	38	47	39	29	28	35	52	37	30

C. Analysis of current players and their strategies

    1. Tata Motors

- Tata Motors Ltd. is creating specialized dealerships in India dedicated to electric vehicles to strengthen its position in the growing EV market.
- Tata intends to allocate approximately $2 billion towards the development of battery-powered models by 2027.
- Tata reported a 65% increase in electric passenger vehicle sales in India last month compared to the previous year, including the Tigor, Nexon, and Tiago EV models.

D. Identification of key challenges and opportunities

Opportunities-

- **Growing Demand**: The increasing environmental consciousness among the newer generation and rising fuel prices have led to a surge in demand for electric vehicles (EVs) in India, creating a significant market opportunity for domestic manufacturers to capture market share.
- **Government Support**: Substantial investment in charging infrastructure, along with incentives and subsidies offered to EV buyers, such as reduced road tax and incentives under schemes like FAME, provide a conducive environment for EV adoption and production.
- **Low-Cost Manufacturing**: India's extensive manufacturing capabilities and access to natural resources enable the production of cost-effective and high-quality EVs, attracting multinational corporations to establish bases in the country.
- **Skilled Workforce**: India's large pool of skilled and unskilled labour presents an opportunity to enhance production quality through training and skill development programs, supporting the growth of the EV manufacturing sector.
- **Domestic Battery Manufacturing**: With extensive lithium reserves, India is well-positioned to capitalize on battery manufacturing for EVs, reducing dependence on foreign batteries and potentially lowering EV prices.

Challenges –

- **Lack of Charging Infrastructure**: The inadequate charging network poses a significant hurdle for EV scalability, requiring substantial investment in charging stations across various locations to enhance accessibility.

- **High Initial Cost**: Despite long-term cost benefits, the high initial expenditure for EVs, primarily due to expensive batteries and components, necessitates subsidies and initiatives to make EVs more affordable in price-sensitive markets.
- **Supply Chain Challenges**: The establishment of a robust supply chain for EV manufacturing is crucial to avoid delays and price hikes. Building a reliable supply chain will require time and investment.
- **Limited Availability of Lithium**: Despite extensive reserves, efficient extraction and production of lithium are essential to meet the demand for EV batteries and reduce reliance on foreign sources.
- **Lack of Skilled Workforce**: While India has a large workforce, there is a shortage of skilled workers specialized in EV manufacturing, highlighting the need for training and capacity-building initiatives.

Segment Analysis-

A. Geographic Segmentation-
Total Sales of Two-Wheelers Across Indian States in 2022-
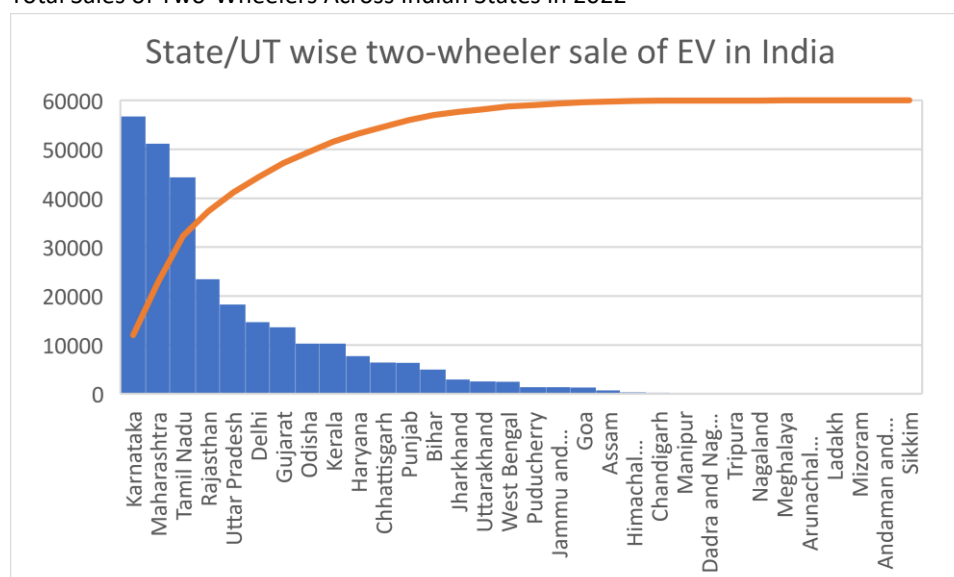
In the dynamic landscape of the Indian two-wheeler segment in 2022, notable sales figures across various states further underscore its enduring significance. *Uttar Pradesh* emerges as a frontrunner in this domain, boasting sales of 18,295 units, closely followed by *Karnataka* and *Maharashtra* with 56,737 and 51,149 units respectively. This data underscores the widespread popularity and essential role of two-wheelers in Indian transportation, with a grand total of 282,542 units sold across the nation in 2022.

Total Sales Across All Vehicle Segments in India
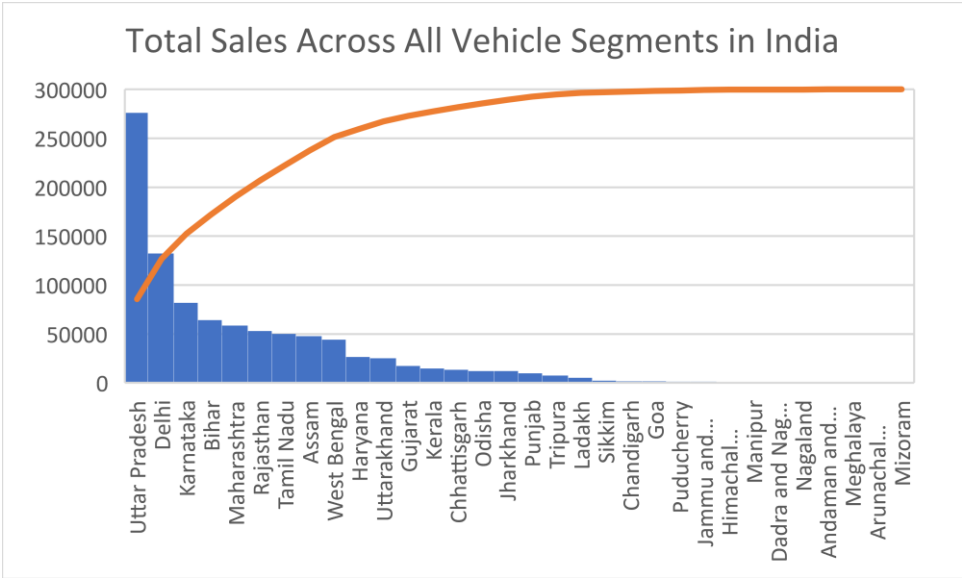
The data encompasses sales of two-wheelers, three-wheelers, four-wheelers, goods vehicles, public service vehicles, special category vehicles, ambulances/hearses, construction equipment vehicles, and others. *Uttar Pradesh* leads the country with the highest total sales across segments, followed by *Karnataka*, *Maharashtra*, and *Delhi*.

Electric Vehicle (EV) Market Segment Share Across All Categories in 2023 [2]-
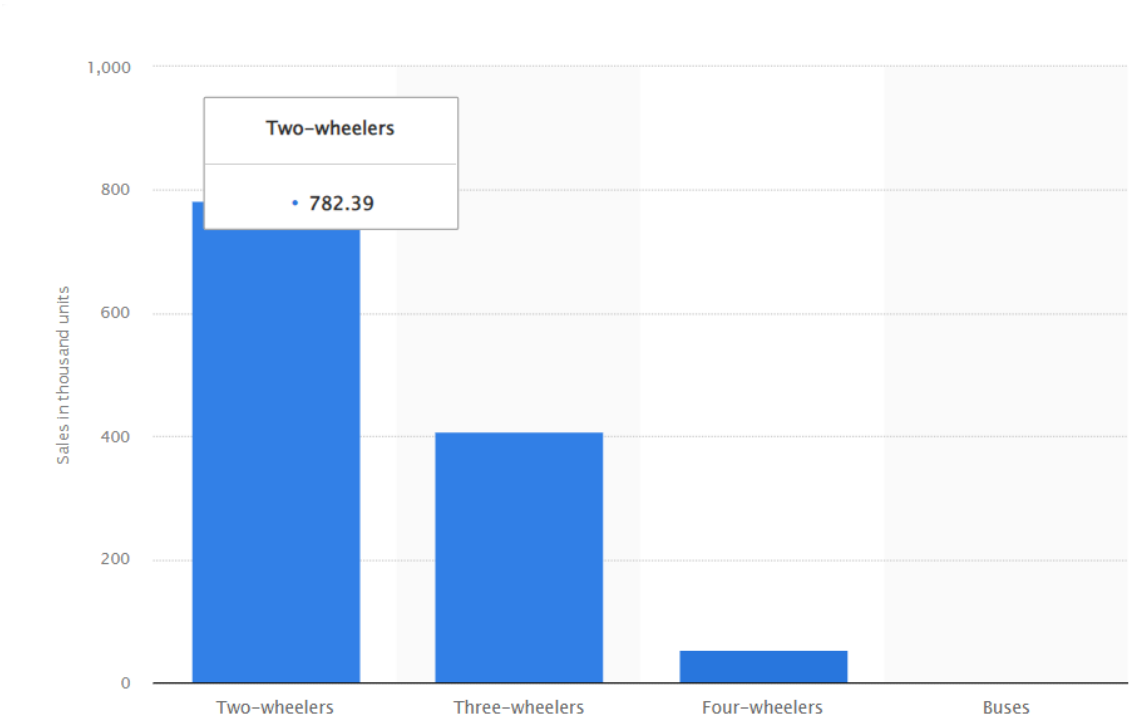
Geographic segmentation is a marketing strategy that involves dividing a market into different geographical units such as regions, countries, states, cities, or neighborhoods. This approach recognizes that consumer needs, preferences, and behaviors vary based on their location. By understanding the unique characteristics and requirements of different geographic segments, businesses can tailor their marketing efforts, product offerings, and distribution channels to effectively target and serve specific geographic markets.

India's electric vehicle (EV) market is experiencing rapid growth, with 1,640 operational public EV chargers nationwide. Nine major cities account for approximately 940 charging stations, highlighting urban-centric EV infrastructure development. The government, along with private and public agencies, is actively involved in expanding public charging infrastructure, resulting in a substantial increase of 678 charging stations between October 2021 to January 2022 in these cities. Additionally, revised guidelines aim to ensure affordability and accessibility, with the Department of Heavy Industry sanctioning **1576** public charging stations for key highways and expressways.
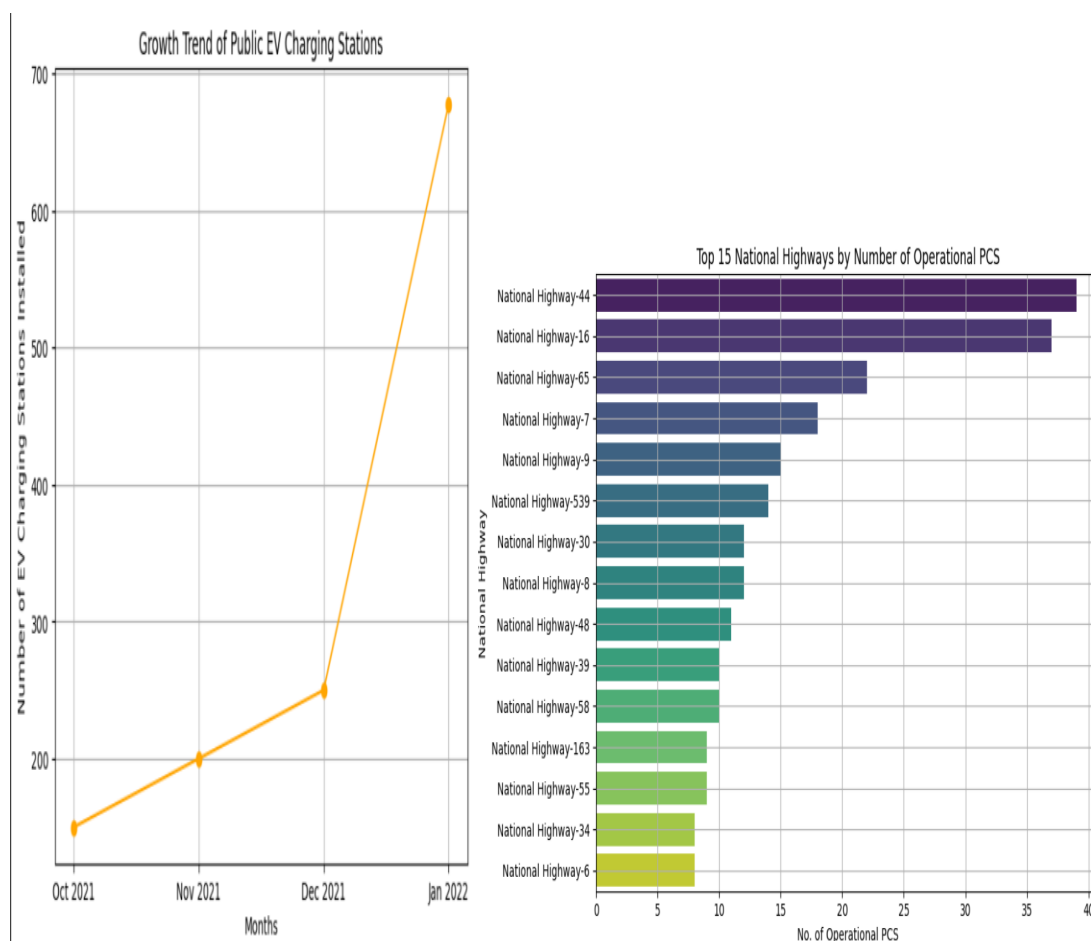
*Inferences-
* From ~250 to 660 charging stations, almost 160% increment
* Since we do not have actual data but in the upcoming years the growth may see be much higher.
* Right now, ~40 PCS are working on National Highway-44, 35+ on NH 16

Oil marketing companies are set to install 22,000 EV charging stations, with significant contributions from IOCL, BPCL, and HPCL. These efforts underscore a strategic approach to promote widespread EV adoption, emphasizing accessibility and convenience across cities and transportation routes nationwide.

EV Charging Stations Installed by Oil Marketing Companies
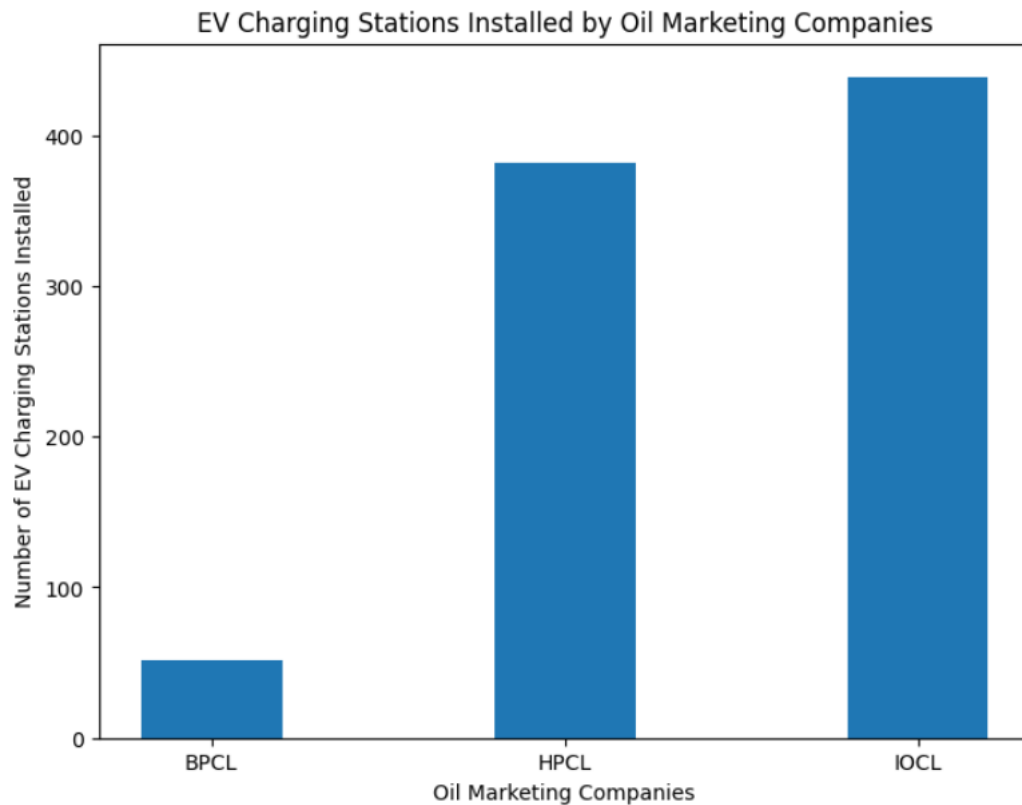
*Inferences-
* Companies like IOCL and HPCL have installed ~800 Charging stations so far
* Planning to achieve 22000 marks in near future*

B. Demographic segmentation-

Demographic segmentation in the EV market involves categorizing consumers based on factors like age, income, education, and location. This segmentation allows companies to understand the unique preferences and behaviors of different consumer groups. For instance, younger, urban consumers with higher incomes may prefer premium EVs with advanced features, while middle-aged families in suburban areas may prioritize affordability. By targeting specific demographic segments, companies can tailor their products and marketing strategies to better meet the needs of different customer groups, ultimately driving higher adoption rates and market penetration for electric vehicles.

1. Analysis of demographic data related to vehicle ownership-
    By taking reference of the report by Ph.D. student under the guidance of professor of *IIT ROORKEE*. [5] These are the findings that we came up with -
    The demographic data related to electric vehicle (EV) ownership reveals insightful trends regarding consumer preferences and adoption patterns. Analysis indicates that factors such as age, education level, gender, profession, ownership of house, type of house, household structure, experience with EVs, and vehicle ownership significantly influence EV type preferences. Interestingly, while gender and age do not have a significant impact on EV type preferences, factors like education, possession of a driving license, profession, ownership of house, and experience with EVs play crucial roles.
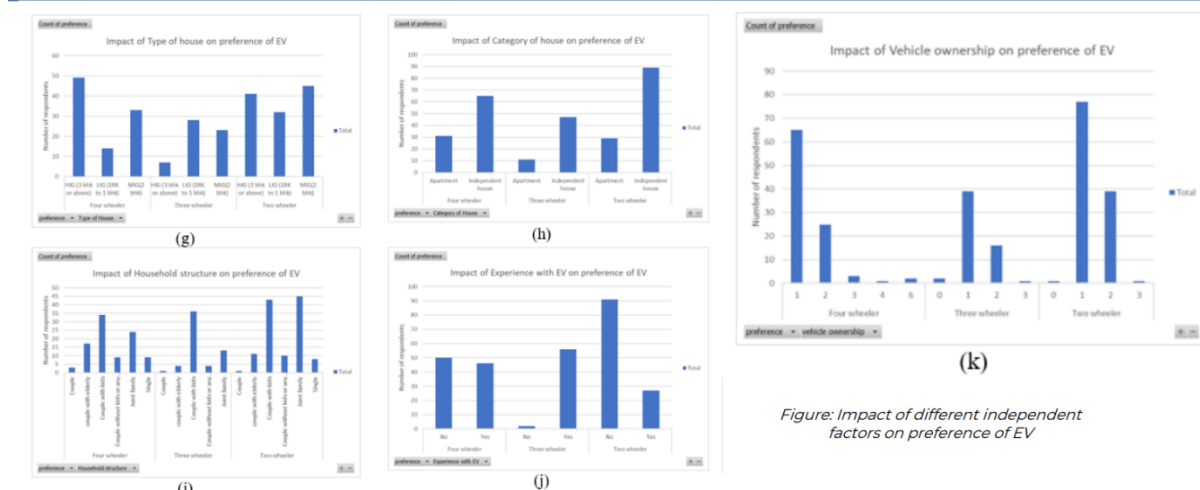
(g)

(h)

(k)

(i)

(j)

Figure: Impact of different independent factors on preference of EV

These findings provide valuable insights for government policymakers and manufacturers to tailor their strategies and promotional schemes to target specific demographic segments effectively, thereby fostering greater adoption of EVs across diverse consumer groups.

Likelihood Ratio Tests				
Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	194.31	0.000	0	
Age (A1)	204.69	10.384	8	0.239
Education (A2)	234.31	39.999	10	0.000**
Gender (A3)	194.38	0.071	2	0.965
Diving license holder (A4)	204.56	10.251	2	0.006**
Profession (A5)	240.18	45.869	10	0.000**
Ownership of House (A6)	200.21	5.897	2	0.052*
Type of House (A7)	201.99	7.680	4	0.107
Category of House (A8)	197.59	3.284	2	0.194
Household structure (A9)	209.50	15.187	12	0.231
Experienced an EV (A10)	228.71	34.397	2	0.000**
Vehicle ownership (A11)	203.49	9.177	10	0.515

Significant at the level of 90% confidence
* Significant at the level of 95% confidence

	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	550.67			
Final	196.26	354.410	42	0.00

2. Inferences -

- *Demographic factors such as age, education level, gender, profession, ownership of house, type of house, household structure, experience with EVs, and vehicle ownership significantly influence EV type preferences.*
- *Individuals living in high-income group (HIG) and middle-income group (MIG) households show a higher inclination towards purchasing four-wheelers and two-wheelers.*
- *Conversely, individuals in low-income group (LIG) households are more inclined towards three-wheelers.*
- *Factors like education, possession of a driving license, profession, ownership of house, and experience with EVs play crucial roles in shaping EV adoption patterns.*
- *Gender, age, category of the house, and vehicle ownership **do not** significantly impact EV type preferences.*
- *Government policymakers and manufacturers can utilize these insights to develop targeted strategies and promotional schemes aimed at different demographic segments to foster greater adoption of EVs.*

- *Promoting four and two-wheelers among people belonging to medium and high-income groups, while emphasizing three-wheelers for those in low-income groups, could be an effective approach to encourage EV adoption across diverse consumer groups.*

C. Psychographic Segmentation-

Psychographic segmentation delves into the psychological characteristics and lifestyle preferences of consumers, allowing businesses to craft tailored marketing strategies. By understanding individuals' values, interests, and behaviors, companies can effectively resonate with their target audience. This approach complements demographic segmentation, offering nuanced insights into consumer motivations and purchase decisions. Leveraging psychographic segmentation enables businesses to create more personalized and impactful marketing campaigns, fostering stronger connections with customers and driving brand loyalty.

1. How Psychographic factors can affect the choice of an individual in adapting the Electric vehicle- Here I will be taking reference of the research article which did deeply analysis in EV adaption behaviour in India. Take a look at the questionnaire to understand the individual behaviour –

Constructs	Items
Environmental Enthusiasm	1. I think we need to address environmental problems 2. I think we owe it to our future generations to provide them with a quality environment 3. I feel bad about the degrading environment 4. I am willing to pay extra money for things to protect the environment
Technological Enthusiasm	1. I get excited about a new product in the market 2. I like to buy new products early after their launch
Anxiety (Perceived risk)	1. I would not be able to charge the electric vehicle at home 2. There are not enough charging stations in and around the places I travel to 3. Electric vehicles take too long to charge
Social Image	1. Driving an EV would make people perceive me as a person who cares about the environment 2. Driving an EV would make me feel like a responsible citizen of the society 3. It will give me a feeling of satisfaction to drive an EV

2. Segmentation and results (Solely based on Research paper [1])

Socio-demographic variable		Cluster 1 (Idlers)	Cluster 2 (Indifferents)	Cluster 3 (Leads)
Gender	Male	76.23%	77.32%	78.20%
	Female	23.77%	22.68%	21.80%
Age	18 – 22 years	14.35%	16.19%	16.54%
	23 – 28 years	64.36%	59.79%	60.90%
	29 – 35 years	18.81%	20.96%	18.80%
	36 years and above	2.97%	2.75%	4.51%
Annual household income (INR)	Less than 2 lakhs	10.40%	12.37%	12.30%
	2 lakhs – 6 lakhs	33.17%	38.14%	35.34%
	6 lakhs – 12 lakhs	35.15%	30.93%	31.58%
	Above 12 lakhs	21.29%	18.56%	21.05%
Education	Undergraduates	11.39%	13.40%	13.53%
	Postgraduates	40.10%	45.02%	47.37%
	Doctorates	48.51%	41.58%	39.10%
Knowledge of electric vehicles	Little or no knowledge	84.65%	70.45%	46.62%
	Good amount of knowledge	15.35%	29.55%	53.38%
Experience with electric vehicles	No EV experience	35.15%	28.87%	27.07%
	Experienced EV	64.85%	71.13%	72.93%

Employing the K-Means algorithm on psychographic factors revealed distinct clusters of respondents based on their attitudes towards electric vehicles-

- **Similar Socio-demographic Characteristics**: Across the three clusters, there is a relatively uniform distribution of gender, age, annual income, and education levels, indicating that these factors alone may not strongly influence perceptions towards electric vehicles.
- **Knowledge Disparity among Clusters**: Cluster 3 (leads) stands out with approximately 53% of respondents possessing a good amount of knowledge about electric vehicles, compared to only 15% in cluster 1 (idlers). Conversely, around 85% of idlers have little to no knowledge about EVs, while only 47% of leads share this lack of awareness.
- **Importance of Awareness Campaigns:** The significant difference in knowledge levels between clusters underscores the critical role of awareness campaigns in shaping perceptions and fostering wider acceptance of electric vehicles. By spreading accurate information, negative perceptions can be diminished, leading to increased interest and adoption of EVs

- **Promoting EV Acceptance**: These findings emphasize the need for targeted educational initiatives aimed at enhancing public understanding of electric vehicles. Such efforts can bridge the knowledge gap among different clusters, ultimately contributing to the broader acceptance and adoption of EVs in the market.

Data collection

A. Data collection from Kaggle

1. https://www.kaggle.com/datasets/deadprstkrish/ev-cars-user-reviews-india?select=2-wheeler-EV-bikewale.csv (*primary)
2. https://www.kaggle.com/datasets/deadprstkrish/ev-cars-user-reviews-india?select=4-wheeler-EV-carwale.csv (*primary)
3. https://www.kaggle.com/datasets/geoffnel/evs-one-electric-vehicle-dataset?select=ElectricCarData_Clean.csv (*secondary)
4. https://www.kaggle.com/datasets/kkhandekar/electric-vehicles-india (*secondary)
5. https://www.kaggle.com/datasets/deadprstkrish/ev-cars-user-reviews-india?select=4-wheeler-EV-cardekho.csv (*secondary)
6. https://www.kaggle.com/datasets/karivedha/indian-consumers-cars-purchasing-behaviour (*secondary)
7. https://www.kaggle.com/datasets/fathimaibrahimkunju/electric-vehicle-in-india-2022 (*secondary)

B. Data collection from government site OGD (Open government data) (* Secondary) [3]
[*Note- There were too many small datasets, a detailed analysis is given below]

Data analysis on India Primary datasets [In-depth]
1) Exploratory data analysis on dataset- https://www.kaggle.com/datasets/deadprstkrish/ev-cars-user-reviews-india?select=4-wheeler-EV-carwale.csv (*primary)

Dataset Overview-

- The dataset contains customer reviews for electric vehicles in the 4-wheeler segment, focusing on various aspects such as exterior design, comfort, performance, fuel economy, and value for money.
- Reviews vary in sentiment, with some customers expressing satisfaction and positive experiences with the cars, while others highlight concerns or issues they have encountered.
- Features like exterior design and comfort appear to be important factors for customers, as they are frequently mentioned in the reviews.
- Performance and fuel economy also receive attention, indicating customers' interest in the driving experience and efficiency of the electric vehicles.
- The dataset includes information about the condition of the cars (e.g., new or not purchased) and the distance driven, providing additional context for the reviews.
- Ratings provided by customers offer a quantitative measure of their satisfaction level across different aspects of the electric vehicles.
- The dataset features reviews for specific models, such as the Hyundai Kona, suggesting a focus on individual electric vehicle models within the 4-wheeler segment.

	Null Values	Unique Values
review	0	129
Exterior	0	6
Comfort	0	6
Performance	0	6
Fuel Economy	0	6
Value for Money	0	6
Condition	0	3
driven	0	5
rating	0	5
model_name	0	3

Null Values:

- There are no null values present in any of the columns in the dataset, indicating that all fields have been populated with information.

Unique Values:

- The 'review' column contains *129 unique reviews*, suggesting diversity in customer feedback and opinions.
- The columns 'Exterior', 'Comfort', 'Performance', 'Fuel Economy', 'Value for Money' each have *6 unique values*, indicating a range of ratings or sentiments expressed by customers across these aspects.
- The 'Condition' column has 3 unique values, likely indicating the condition of the vehicles mentioned in the reviews (e.g., new, used). The 'driven' column contains 5 unique values, which may represent different ranges or categories of distance driven (e.g., few hundred kilometres, few thousand kilometres).
- The 'rating' column also has 5 unique values, presumably representing different numerical ratings given by customers. The 'model_name' column has 3 unique values, suggesting that the dataset focuses on reviews for specific electric vehicle models.

|	Exterior	Comfort	Performance	Fuel Economy	Value for Money	rating
count	129.000000	129.000000	129.000000	129.000000	129.000000	129.000000
mean	4.472868	4.418605	4.418605	4.418605	4.162791	4.341085
std	0.968871	1.036051	1.150392	1.122899	1.345076	1.389110
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25%	4.000000	4.000000	4.000000	4.000000	4.000000	4.000000
50%	5.000000	5.000000	5.000000	5.000000	5.000000	5.000000
75%	5.000000	5.000000	5.000000	5.000000	5.000000	5.000000
max	5.000000	5.000000	5.000000	5.000000	5.000000	5.000000

- Consistency in Ratings: The ratings across different aspects such as exterior, comfort, performance, and fuel economy tend to be consistently high, with means ranging from 4.42 to 4.47 out of 5. This suggests that customers generally perceive the electric vehicles positively across various features.

- Perceived Value: While customers rate aspects like exterior, comfort, and performance highly, the mean rating for "Value for Money" is slightly lower at 4.16. This indicates that some customers may perceive the cost relative to the features or benefits offered as less favourable compared to other aspects of the electric vehicles.
- High Satisfaction: The median (50th percentile) and the 75th percentile ratings for all aspects are at the maximum value of 5, indicating that a significant proportion of customers give top ratings to the electric vehicles in the dataset. This suggests a high level of satisfaction among customers overall. Variance in Ratings: The standard deviations for each aspect are relatively low, indicating limited variability in ratings across customers. This suggests a degree of agreement or consensus among customers regarding their evaluations of the electric vehicles.
- Potential Improvement Areas: Despite generally positive ratings, the presence of minimum ratings of 0 for some aspects indicates instances where customers have rated certain features poorly. Understanding the reasons behind these low ratings could help identify areas for improvement in the design or performance of the electric vehicles.

EDA -
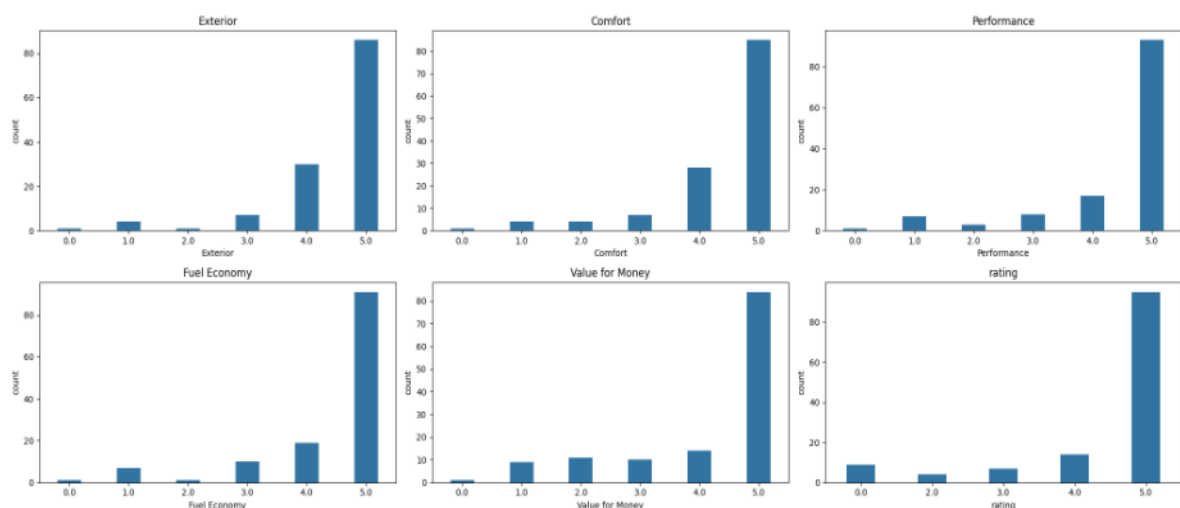
- The features of electric vehicles (EVs), including exterior design, comfort, performance, and other aspects. Customers consistently express contentment with these attributes, suggesting a positive overall perception of EVs in terms of their design, functionality, and driving experience
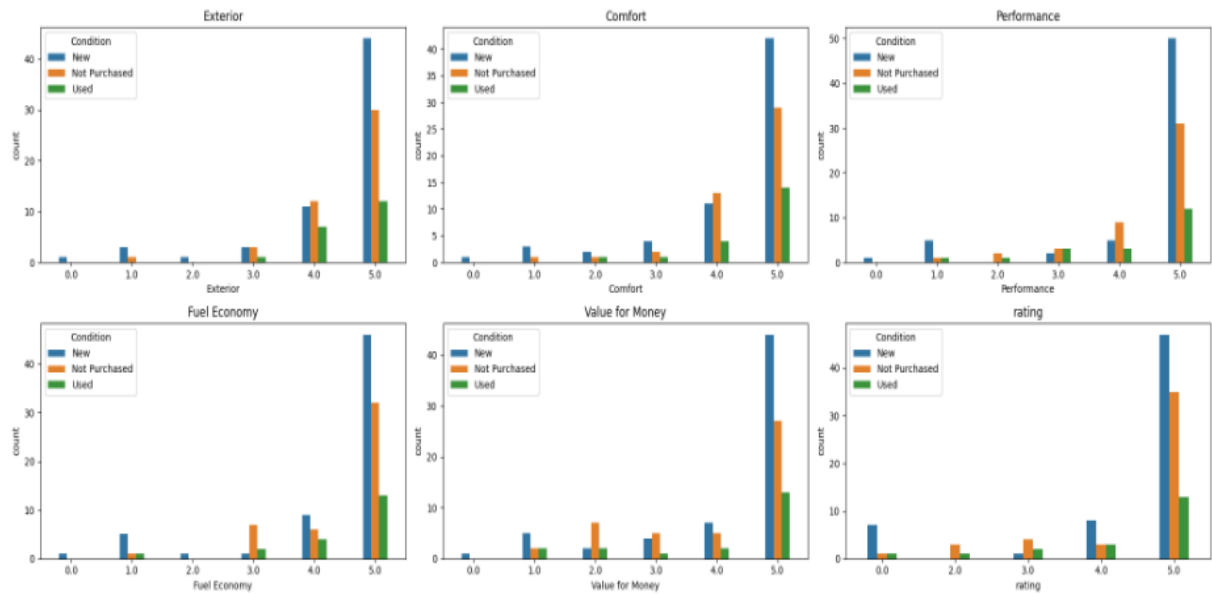
- Users exhibit more positive sentiments towards newly purchased vehicles, indicating a correlation between satisfaction and the freshness of ownership.
- Even for electric vehicles (EVs) that users have not yet purchased, their opinions lean towards the positive, suggesting a favourable inclination towards considering EVs for future acquisition
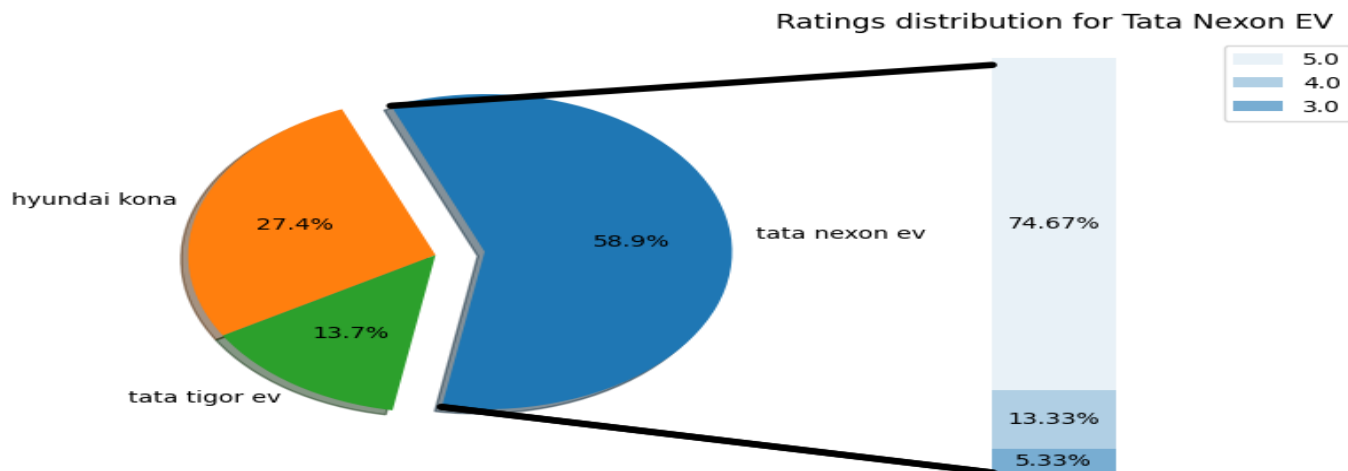

- Tata's Nexon EV dominates the market, capturing over 50% of the electric vehicle (EV) market share among all EV companies.
- Within Tata's Nexon EV, a significant majority, approximately 75% of users, provide a 5-star rating, indicating overwhelmingly positive feedback and satisfaction from users.
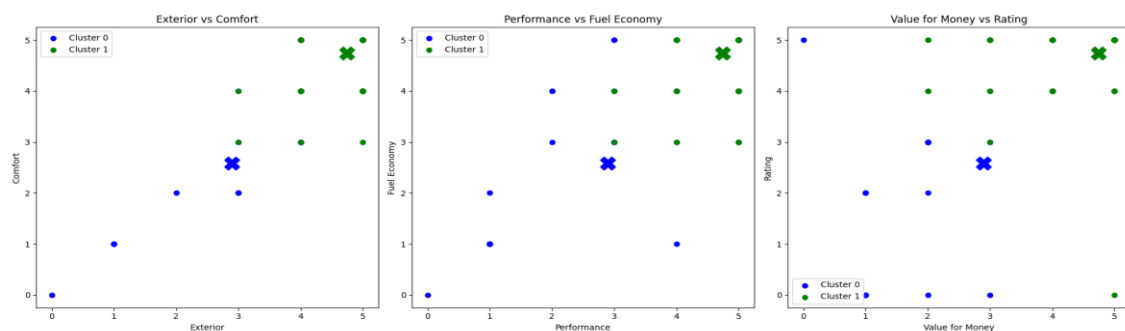
Model training [K means clustering] –
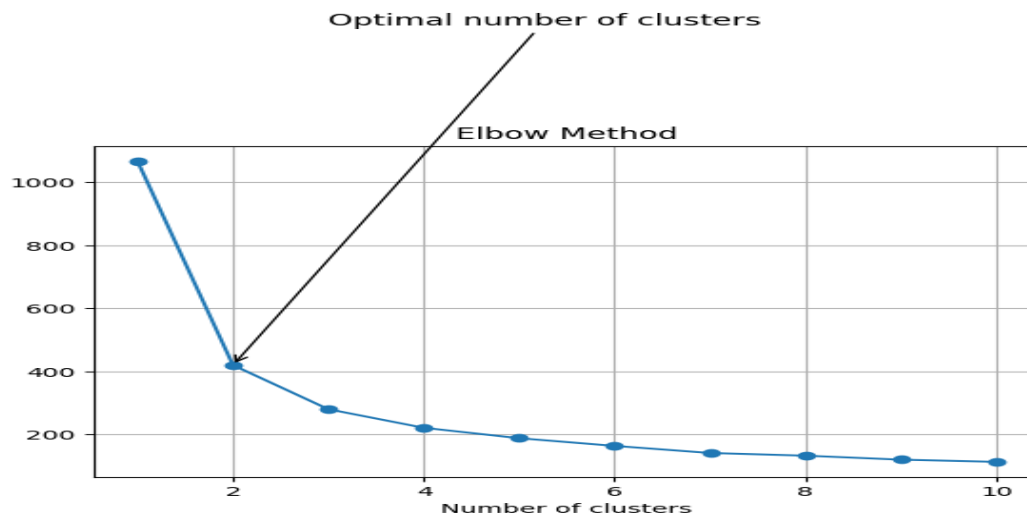
- The elbow method plot for K-means clustering reveals a clear elbow point at k=2, where the within-cluster sum of squares (WCSS) sharply decreases. Beyond this point, the decline in WCSS becomes more gradual, indicating diminishing returns in terms of reducing intra-cluster variance. This suggests that the optimal number of clusters for the given dataset is likely 2, as adding more clusters does not significantly improve the clustering performance.
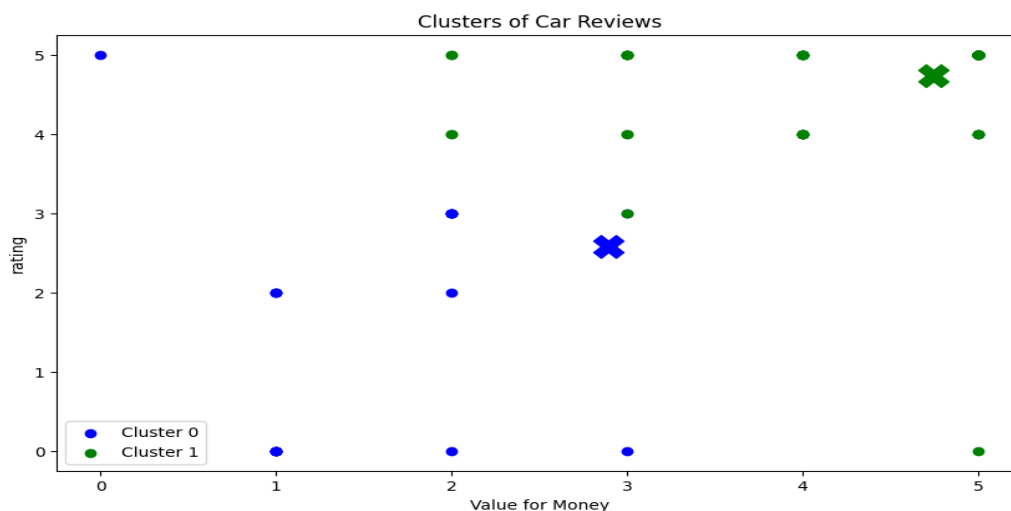
- Cluster 1 indicates positive sentiments expressed by individuals towards the EV models, reflecting a favourable perception among users.
- Conversely, cluster 0 portrays negative sentiments, suggesting dissatisfaction or criticism regarding the EV models among users.

2) Exploratory data analysis on dataset -
   https://www.kaggle.com/datasets/deadprstkrish/ev-cars-user-reviews-india?select=2-wheeler-EV-bikewale.csv (*primary)

|	review	Used it for	Owned for	Ridden for	rating	Visual Appeal	Reliability	Performance	Service Experience	Extra Features	Comfort	Maintenance cost	Value for Money	Model Name
0	We all checked the bike's capacity to be 150 k...	Daily Commute	Never owned	NaN	1	3.0	4.0	NaN	NaN	NaN	4.0	NaN	1.0	TVS iQube
1	Performance is very poor on this bike. The cha...	Everything	> 1 yr	< 5000 kms	1	3.0	1.0	NaN	1.0	NaN	3.0	NaN	3.0	TVS iQube
2	I purchased this in April 2022 and the sales s...	Daily Commute	< 3 months	< 5000 kms	3	4.0	4.0	NaN	2.0	NaN	5.0	NaN	2.0	TVS iQube
3	If any issues come in scooty parts not availab...	Daily Commute	6 months-1 yr	5000-10000 kms	1	1.0	1.0	NaN	1.0	NaN	1.0	NaN	1.0	TVS iQube
4	Don't buy this vehicle unless you have a near ...	Daily Commute	6 months-1 yr	< 5000 kms	1	3.0	4.0	NaN	1.0	NaN	3.0	NaN	2.0	TVS iQube

Data Overview -

Varied Usage Patterns:

- Users employ the electric vehicle (EV) for diverse purposes, including daily commuting, occasional rides, and longer-term ownership, as indicated by the "Used it for" and "Owned for" columns.
- A subset of users mentions riding the EV for specific durations, ranging from less than three months to over a year, suggesting varying levels of experience with the vehicle.

Performance Concerns:

- Some users' express dissatisfaction with the performance of the EV, citing issues such as poor acceleration or overall vehicle performance. This is evident from reviews highlighting concerns about performance.
- Reliability and Maintenance: While reliability and maintenance-related features are mentioned in the dataset ("Reliability", "Maintenance cost"), they appear to have missed or incomplete information, suggesting a potential area for data improvement or refinement.
- Visual Appeal and Comfort: Users provide ratings for visual appeal and comfort, indicating their subjective assessments of these aspects of the EV. Positive ratings for visual appeal and comfort suggest that these features are valued by users and may influence their overall satisfaction with the EV
- . Value for Money: The "Value for Money" feature receives mixed reviews, with some users expressing satisfaction with the EV's cost-effectiveness, while others raise concerns about the perceived value relative to the purchase price.
- Service Experience: Users also share their experiences with service-related aspects, such as service quality or availability of spare parts, which can significantly impact their overall satisfaction with the EV. Model-Specific Insights:

EDA. –
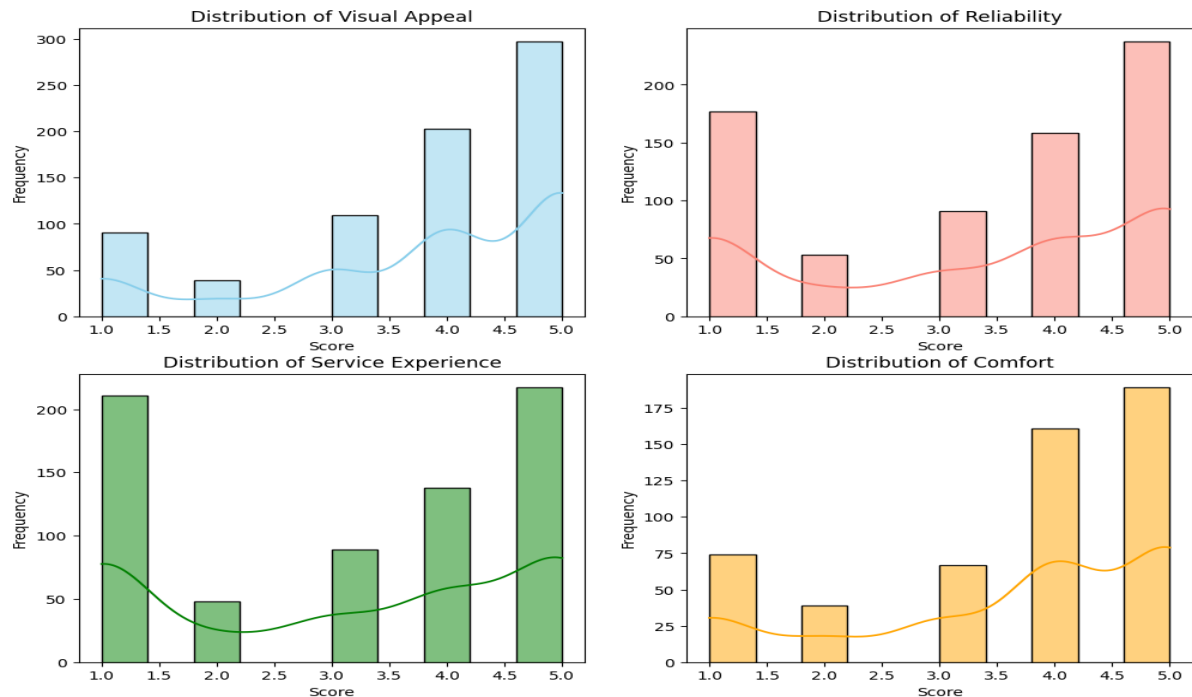
- Users consistently assign a 5-star rating to the visual appeal of electric vehicles (EVs), indicating a widespread appreciation for their aesthetic design and appearance.
- Service emerges as a predominant concern among EV users, regardless of the specific model. This underscores the significance of service quality and support infrastructure in shaping user satisfaction and overall experiences with EVs.
- The attractiveness and comfort offered by EVs are key factors that attract users to these vehicles. These features play a pivotal role in influencing consumer preferences and fostering adoption of EV technology.
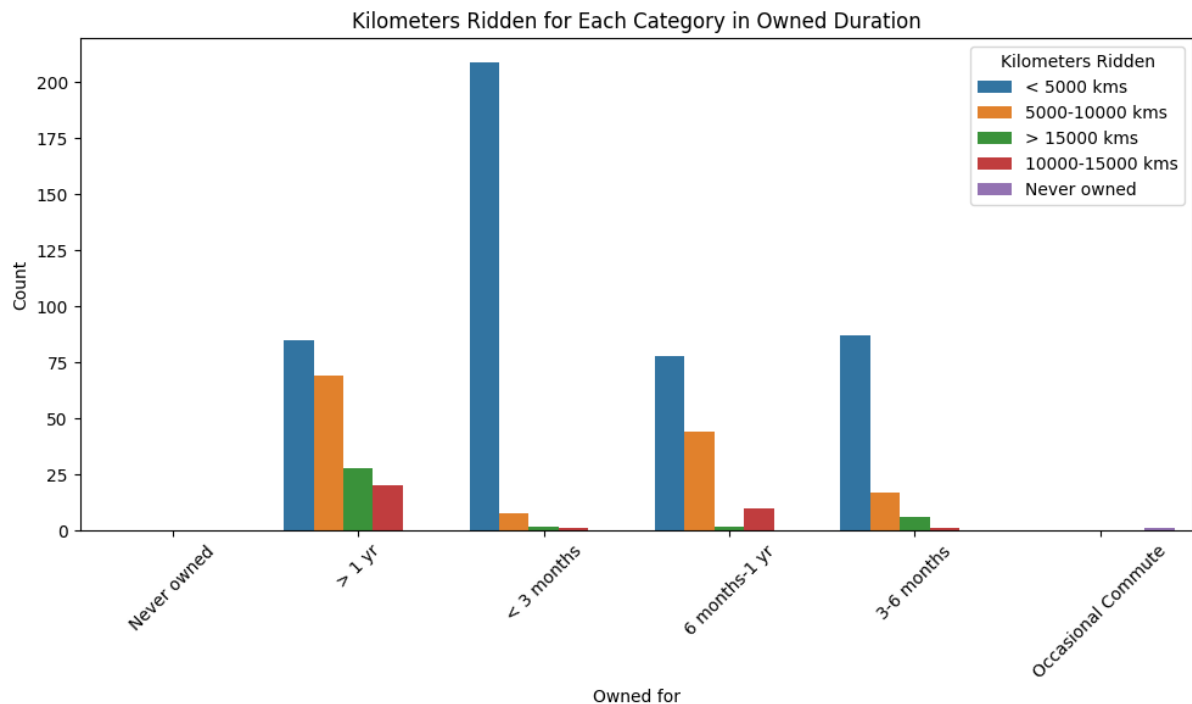

- There exists a diverse range of users who have owned electric vehicles (EVs) for over a year (> 1 year). Among this group, there are individuals who have travelled significant distances, surpassing 15,000

kilometres within the ownership period. Conversely, there are also users who have travelled comparatively shorter distances, with some not exceeding 5,000 kilometres in a year. This variability in usage patterns underscores the different driving habits, needs, and preferences among EV owners.


Distribution of "Used it for" Categories
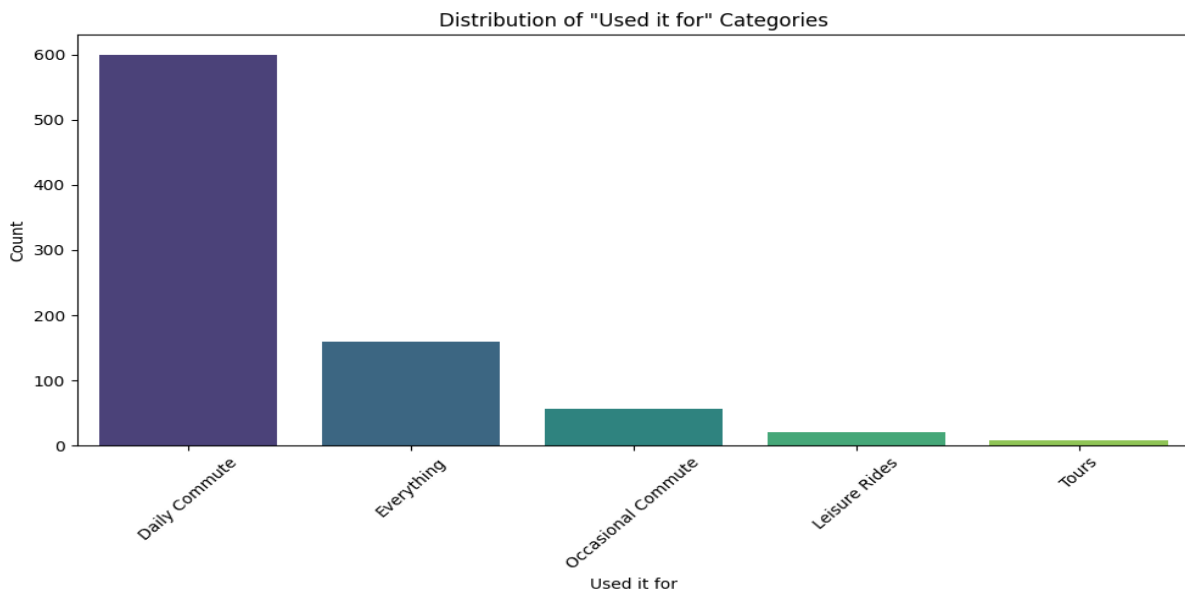
- The majority of users prefer electric vehicles (EVs) for daily commuting purposes, indicating a prevalent inclination towards using EVs as a convenient and sustainable mode of transportation for regular travel needs.
- Conversely, there is a noticeable reluctance among users to utilize their EV bikes for tours or long-distance trips. This preference may stem from various reasons, including the perception that bikes may not be the preferred choice for extended travel, as well as considerations related to range anxiety, charging infrastructure, and comfort during long rides.

Distribution of EV Models - All

Distribution of EV Models - Top 6
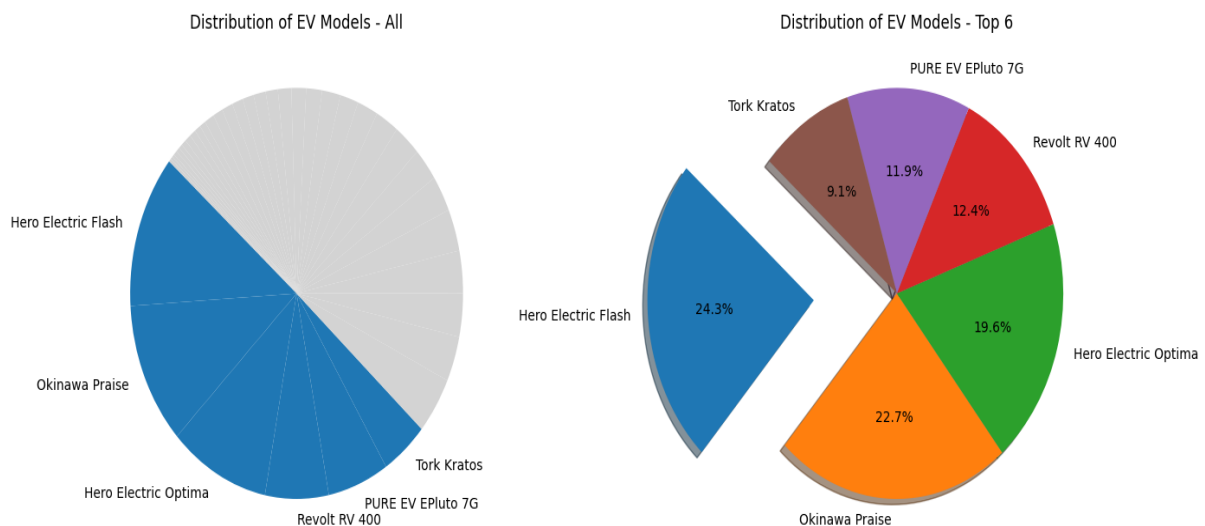
- Analysis indicates that a significant portion of the electric two-wheeler sector is dominated by six prominent models, namely Hero Electric Flash, Okinawa Praise, Hero Electric Optima, Revolt RV 400, PURE EV EPluto 7G, and Tork Kratos.
- These six models collectively account for approximately 50% of the market share in the electric two-wheeler segment, highlighting their substantial presence and popularity among consumers.

- Within this group of top models, Hero Electric Flash emerges as the frontrunner, commanding around 25% of the market share among the top six models. This underscores the strong market position and widespread acceptance of the Hero Electric Flash model within the electric two-wheeler market.

Model Training [K means clustering]-
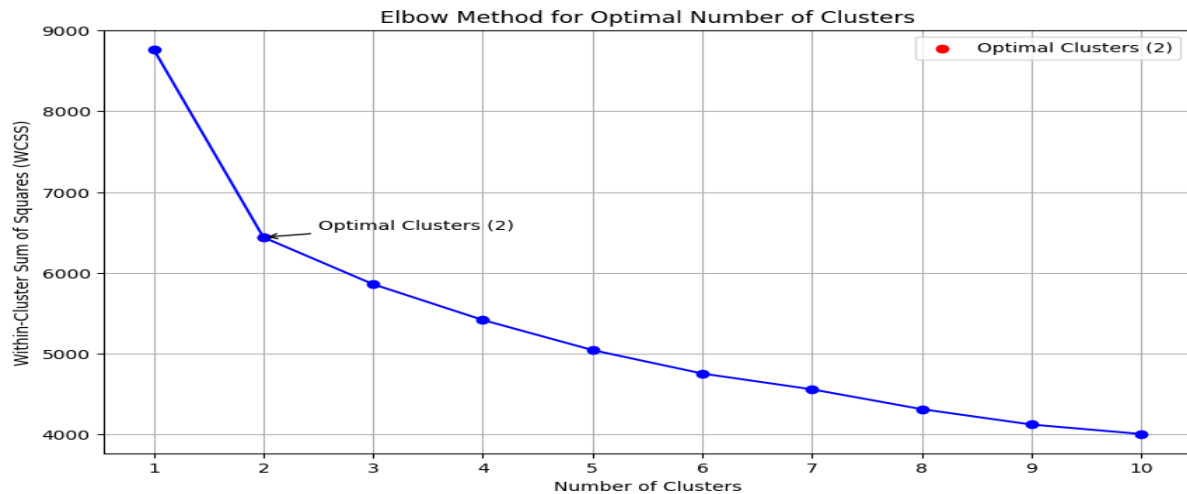

- 2 clusters are recommended by the elbow graph

Segment extraction-
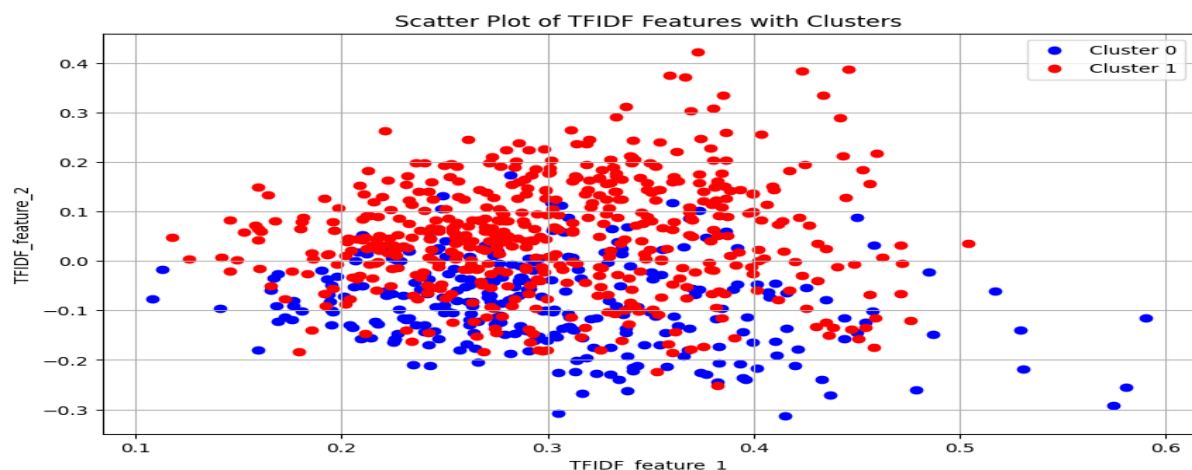
- The sentiment analysis of reviews has effectively categorized the data into two discernible clusters, enabling a nuanced understanding of user feedback.
- These clusters encapsulate diverse sentiment patterns conveyed by users through their reviews, signifying the multifaceted nature of their experiences and opinions.
- This segmentation strategy offers a focused approach to analyse user sentiments and preferences, facilitating deeper insights into their perceptions and satisfaction levels.
- By delving deeper into these distinct segments, we can uncover valuable insights into the underlying factors influencing user satisfaction and shaping their overall perceptions of the product or service.

Clusters with Different Features
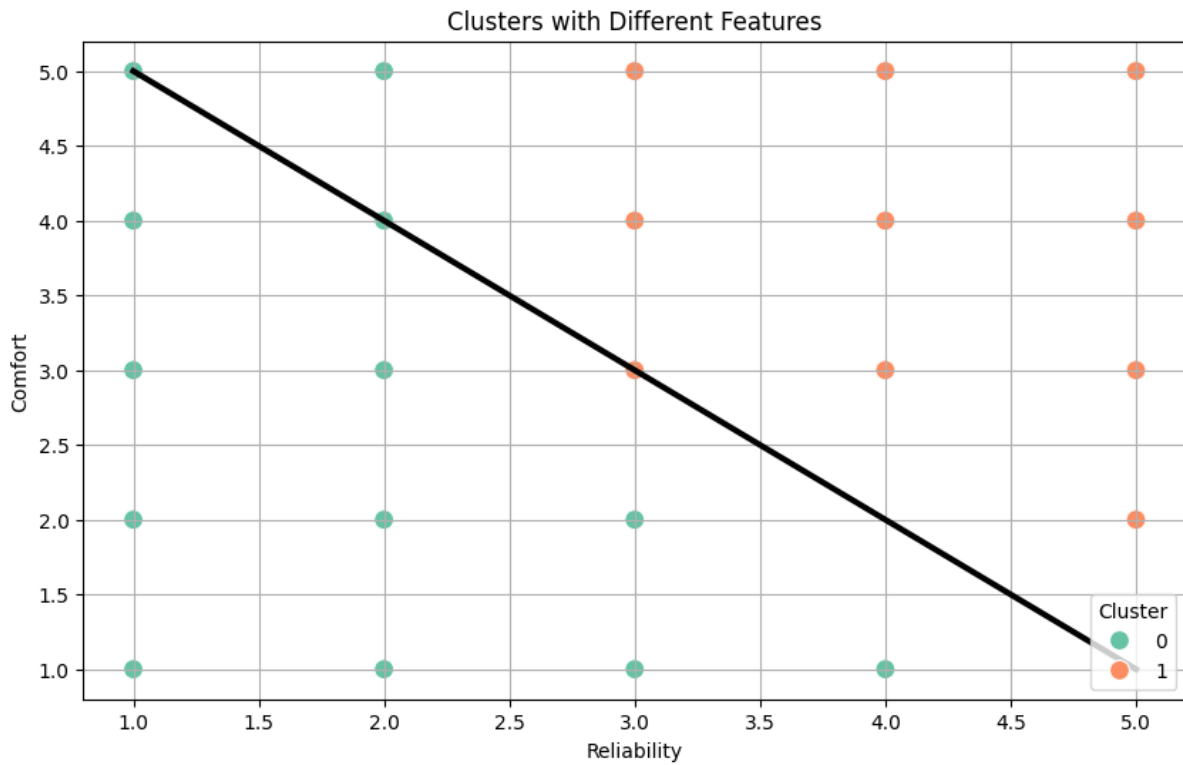
- The clusters identified through analysis appear to be closely aligned with the ratings provided by users for electric vehicle (EV) two-wheelers.
- Cluster 1 predominantly consists of reviews with higher ratings, typically 3 or above, suggesting positive sentiment towards the EV models.
- In contrast, Cluster 0 primarily comprises reviews with lower ratings, often less than 3, indicating negative or less favourable sentiment towards the EVs.
- This alignment between clusters and user ratings indicates that the clustering process effectively captures and segregates reviews based on the perceived satisfaction levels of users with the EV two-wheelers.

Clusters with Different Features
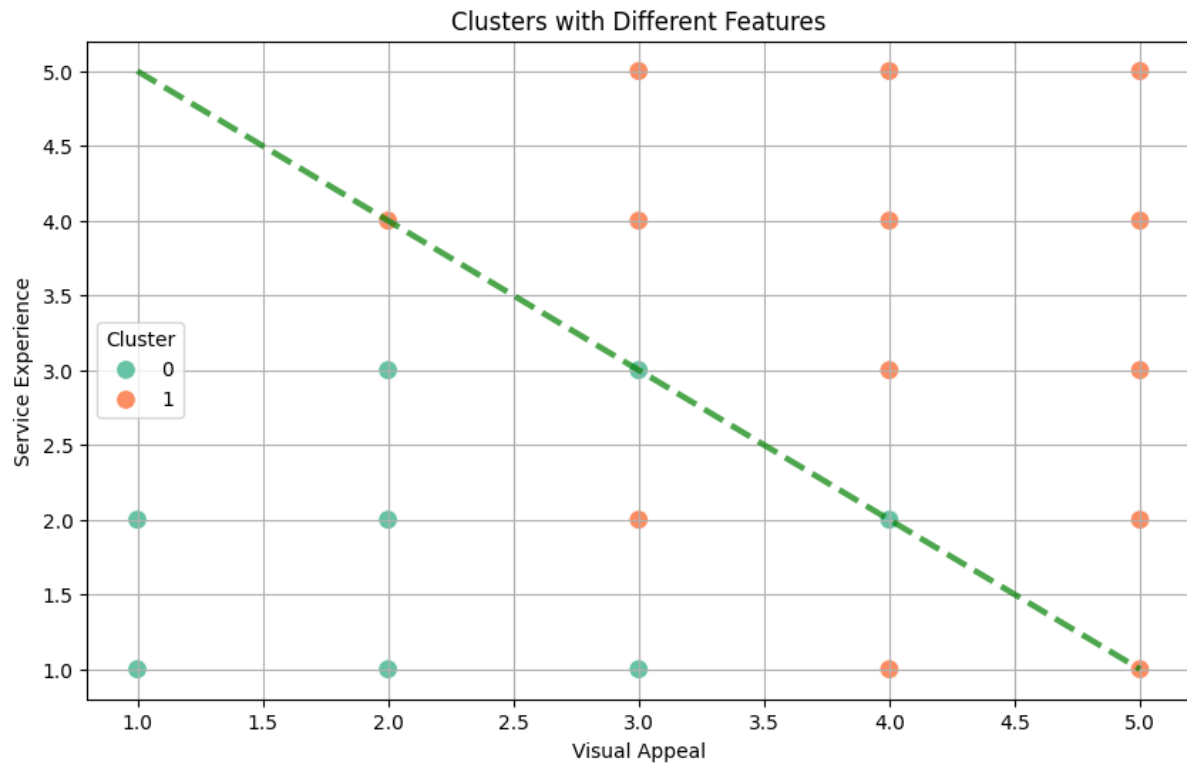
Service Experience Clusters:

- The segmentation based on service experience reveals two distinct clusters, with Cluster 1 representing higher ratings (3 or more) and Cluster 0 indicating lower ratings (less than 3).
- Users in Cluster 1 likely have positive experiences with the service aspects of EV two-wheelers, while those in Cluster 0 may express dissatisfaction or encounter issues with service quality or support.

Visual appealing:

- Analysis of visual appeal ratings also results in the formation of two clusters, with Cluster 1 characterized by higher ratings (3 or more) and Cluster 0 exhibiting lower ratings (less than 3).
- Users in Cluster 1 are likely impressed by the aesthetic design and appeal of the EV models, whereas those in Cluster 0 may perceive the visual aspects less favourably or find room for improvement.

Model Name vs TFIDF_feature_1
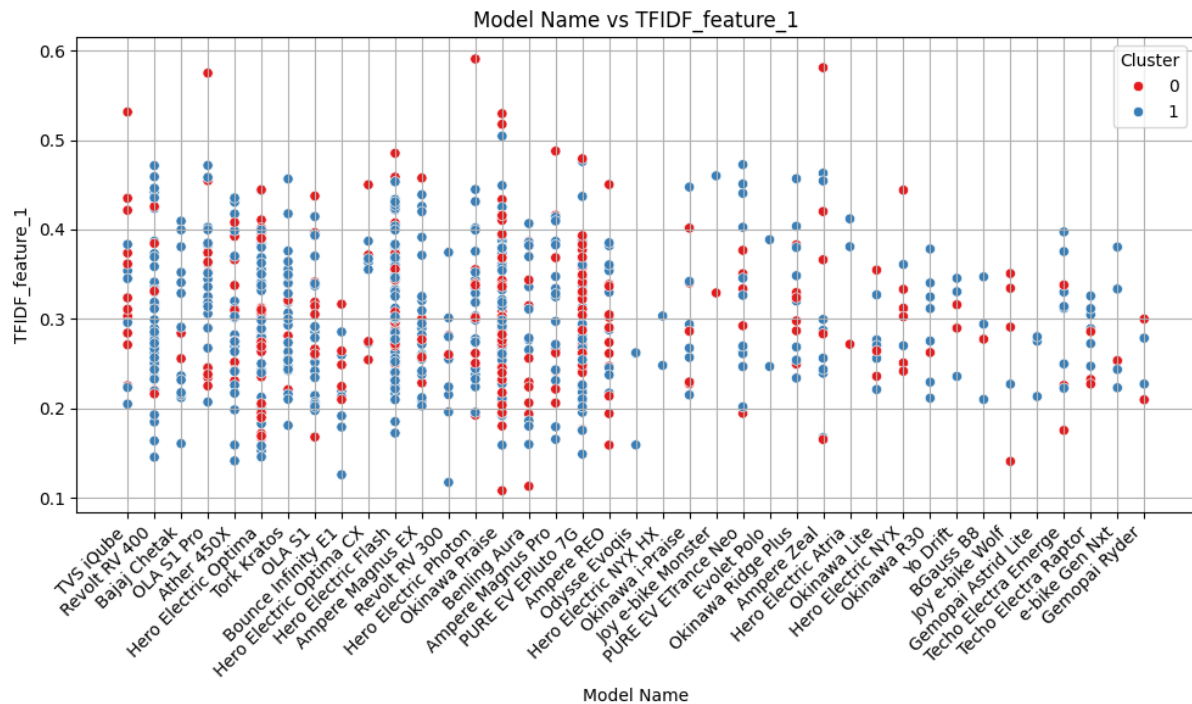
Positive Sentiments:

- Models such as Revolt RV 400, Hero Electric Flash, Tork Kritos evoke positive sentiments among users in the two-wheeler segment.
- These models likely receive favourable reviews and higher ratings from users, indicating satisfaction with various aspects such as performance, design, and service experience.

Negative Sentiments:

- Conversely, models like Okinawa Praise and PURE EV EPluto 7G appear to elicit negative sentiments among users.
- Users may express dissatisfaction or encounter issues with these models, leading to lower ratings and less favourable reviews.
- Negative sentiments could stem from factors such as performance issues, reliability concerns, or perceived shortcomings in features or service support.

Data analysis on India Secondary datasets-

Analysing the performance of states in installing charging stations provides valuable insights for strategic planning in launching EV models. States with a higher number of operational charging stations signify a more developed EV infrastructure and potentially higher demand for EVs. By prioritizing these states for product launch, we can capitalize on existing infrastructure and consumer readiness, maximizing market penetration and accelerating the adoption of EVs. Additionally, understanding regional disparities in charging station distribution enables targeted marketing and resource allocation, facilitating effective market entry strategies tailored to each state's unique characteristics and requirements.

Grand Total of Vehicles Across States (Sorted)
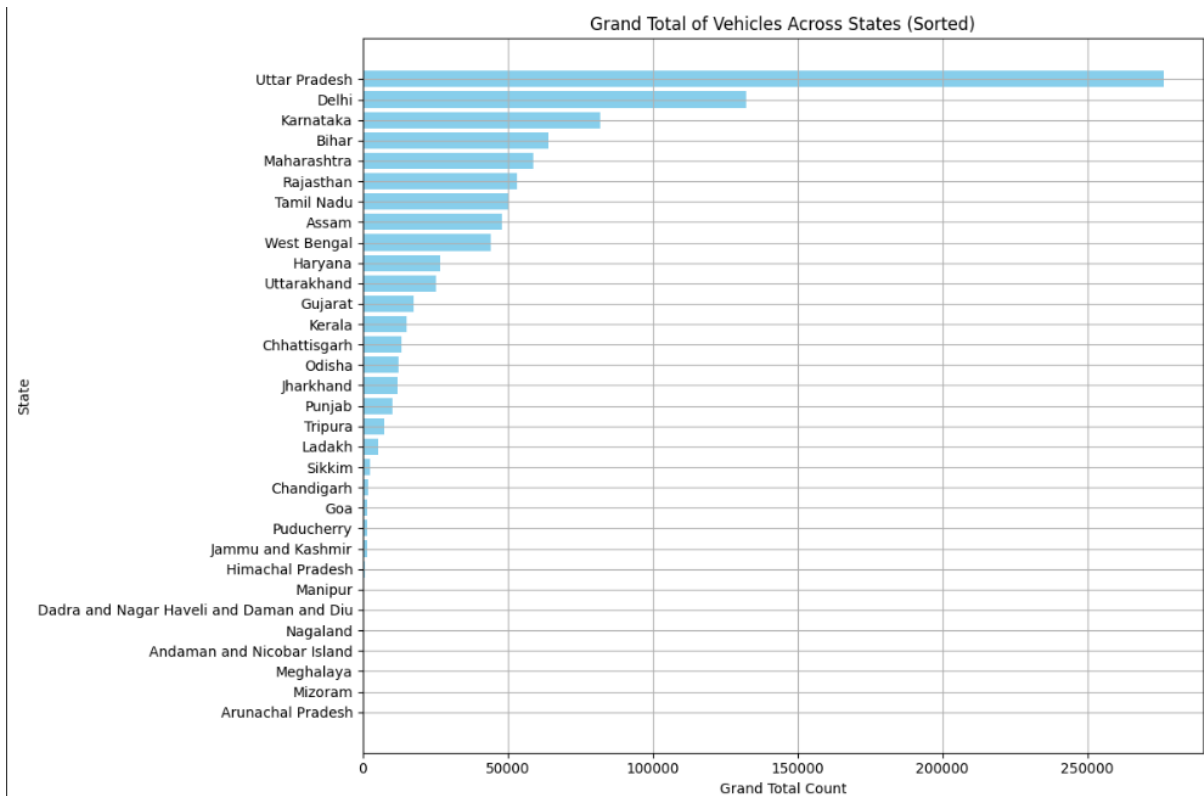
- *Uttar Pradesh has the highest number of Electric vehicle sales in India*
- *2nd rank has been reserved by Delhi, which has sale almost half of UP*
- *This above bar chart represents the whole data which includes all the segments like Two-wheeler, Three-wheeler, etc. etc.*

Furthermore, aligning our launch strategy with states exhibiting robust sales figures for two-wheelers and three-wheelers can further optimize our market entry approach. States with significant sales volumes in these segments likely demonstrate a higher consumer acceptance and preference for EVs, indicating a receptive market environment for our product offerings.


Total Count of Two-wheelers and Three-wheelers Across States
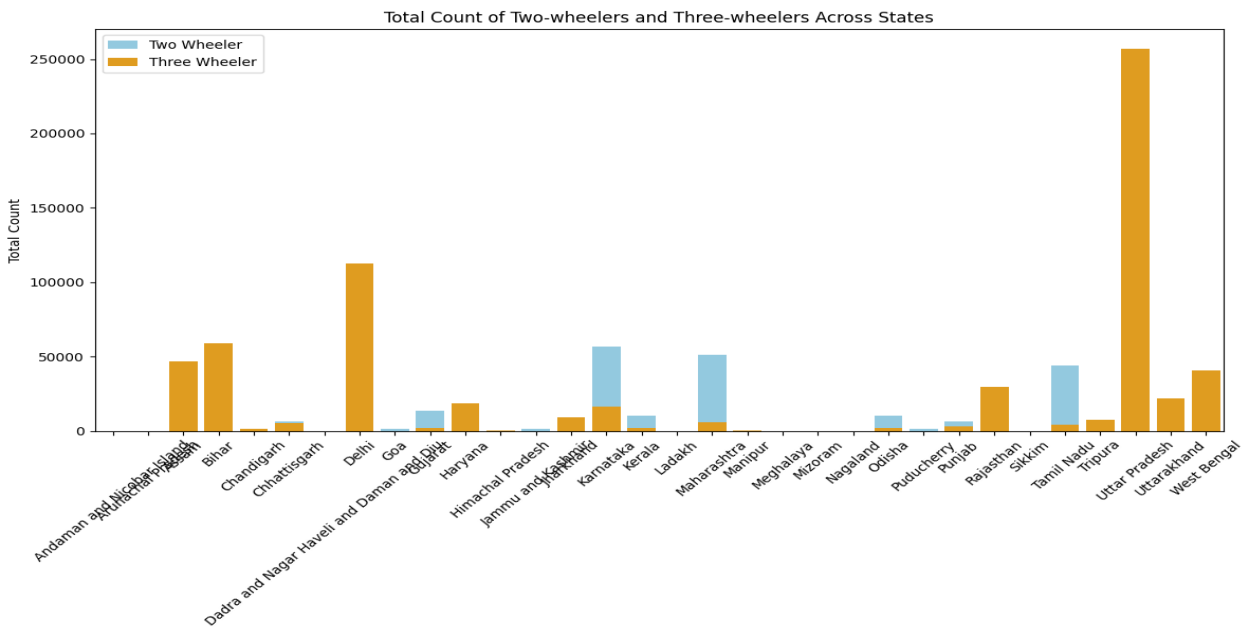
- Uttar pradesh has also secured first rank in India in three weeler segment, with record break sales of ~250000
- In the two wheer segment Maharashtra tops the position close to 50000 sales
- After UP , Delhi secured 2nd placae in Three wheeler also
- There is almost not EV sales in North east states like Mizoram, Manipur, Meghalaya

Amidst the challenges posed by the COVID-19 pandemic, various sectors of the economy experienced significant disruptions, with sales and economic activities contracting across the board. The automotive industry, in particular, faced a sharp decline in sales as consumer confidence waned, supply chains were disrupted, and mobility restrictions were imposed to curb the spread of the virus. However, amidst this adversity, the resilience of the electric vehicle (EV) segment emerged as a beacon of hope.

Despite the overall downturn in automotive sales, the EV sector exhibited remarkable resilience and adaptability in navigating the challenges brought about by the pandemic. While traditional vehicle sales plummeted, EV sales demonstrated a more robust recovery trajectory, buoyed by several factors. Heightened awareness of environmental sustainability, government incentives promoting EV adoption, and advancements in EV technology all played pivotal roles in driving consumer interest and demand for electric vehicles.


Sales of Electric Vehicles (EVs) Over Time

Percentage Increase: 155.16%
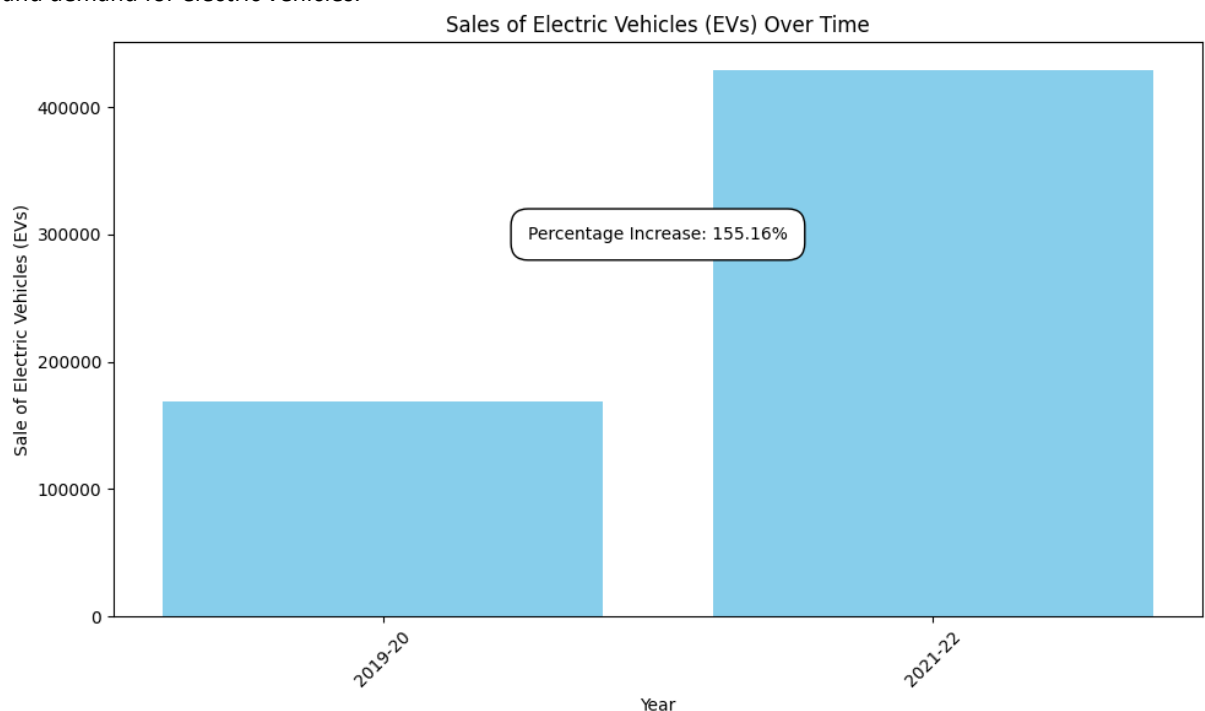
- *A jump of ~155% in EV sales from 2019-20 to 2021-22*

The number of registered organizations operating EV charging stations holds significant implications for companies planning to launch EVs in a particular state. A higher count of registered organizations signifies a more mature EV infrastructure ecosystem, with greater accessibility to charging facilities for EV owners. For companies looking to introduce EVs in a specific state, the presence of a well-established charging network offers several strategic advantages.

In essence, the number of registered organizations operating EV charging stations serves as a key indicator of the readiness and receptiveness of a state towards EV adoption. For companies planning to launch EVs, leveraging states with a mature charging infrastructure can provide a strategic

advantage, enabling them to tap into a well-established market ecosystem, accelerate adoption rates, and drive business growth in the burgeoning EV industry

Number of ROs where EV Charging Facility Available by State/UT
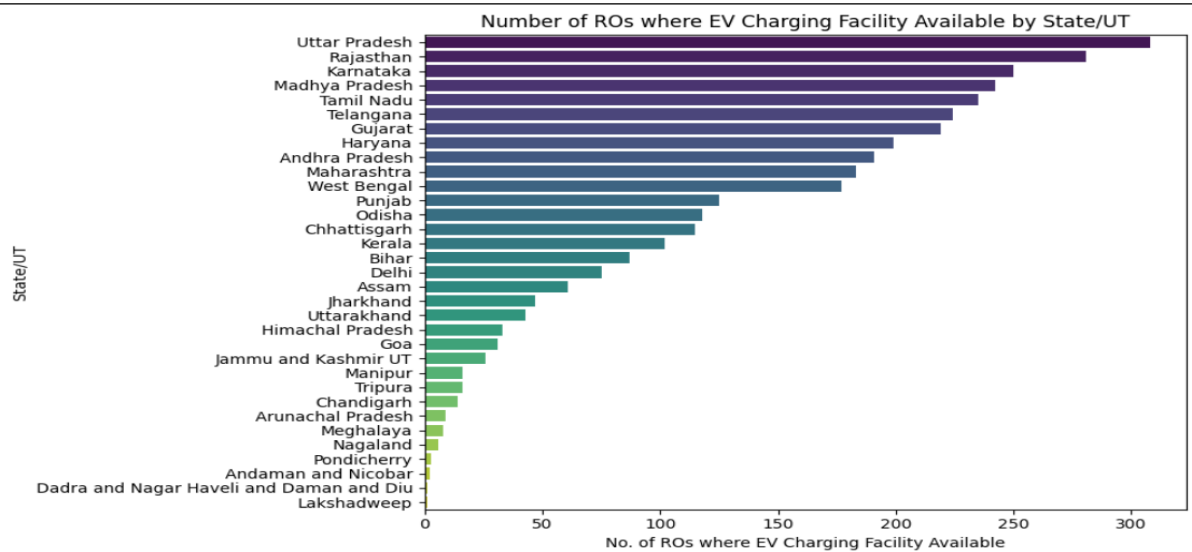
FAME 1, or Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles, stands as India's pioneering initiative aimed at accelerating the adoption and production of electric vehicles (EVs) across the nation. Launched on April 1, 2015, this scheme marked a significant milestone in India's journey towards sustainable mobility by earmarking a substantial budget of ₹895 crore for its implementation.

For EV companies seeking to strategically enter the market, FAME 1 provided valuable insights into regions with optimal policy support and financial incentives, guiding their decision-making process in identifying the most conducive regions and opportune times for launching their EV models. By aligning their market entry strategies with the provisions and timelines of FAME 1, EV companies could leverage the scheme's incentives and support mechanisms to maximize their market penetration and capitalize on the burgeoning demand for electric mobility solutions.

Number of Operational Charging Stations Under FAME-I by State/UT
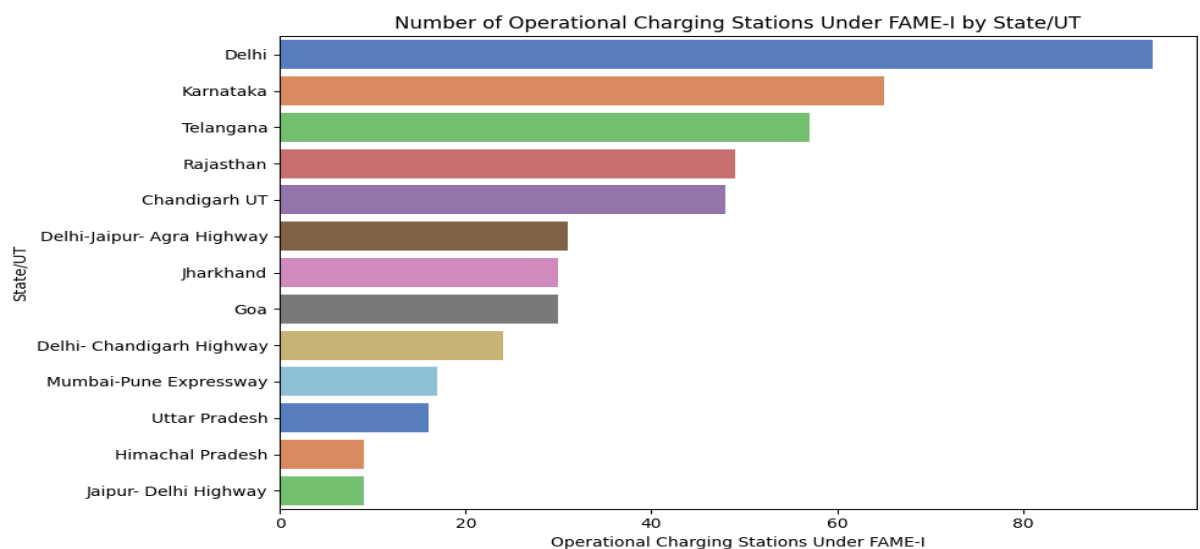
- Delhi tops in installing charging stations under FAME-1 in State/UTs
- Followed by Karnataka with approx. 60 charging stations
- Followed by Telangana

Introducing FAME II, the Faster Adoption and Manufacturing of Electric Vehicles in India, represents a concerted effort by the Ministry of Heavy Industries to address pressing concerns surrounding fuel security

and environmental pollution. By promoting the electrification of public transportation, including shared transport, FAME II aims to usher in a new era of sustainable mobility.

Under the FAME II scheme, electric vehicles (EVs) are entitled to generous incentives designed to accelerate their adoption and proliferation across the country. Notably, EVs receive an incentive of INR 10,000 for each kilowatt-hour (kWh) of battery capacity, with e-buses qualifying for a maximum demand incentive of INR 20,000 per kWh. Additionally, the scheme offers subsidies that are 50% higher than the original allocation, with a maximum subsidy capped at 40% of the vehicle's cost.


Number of Operational Charging Stations Under FAME-II by State/UT
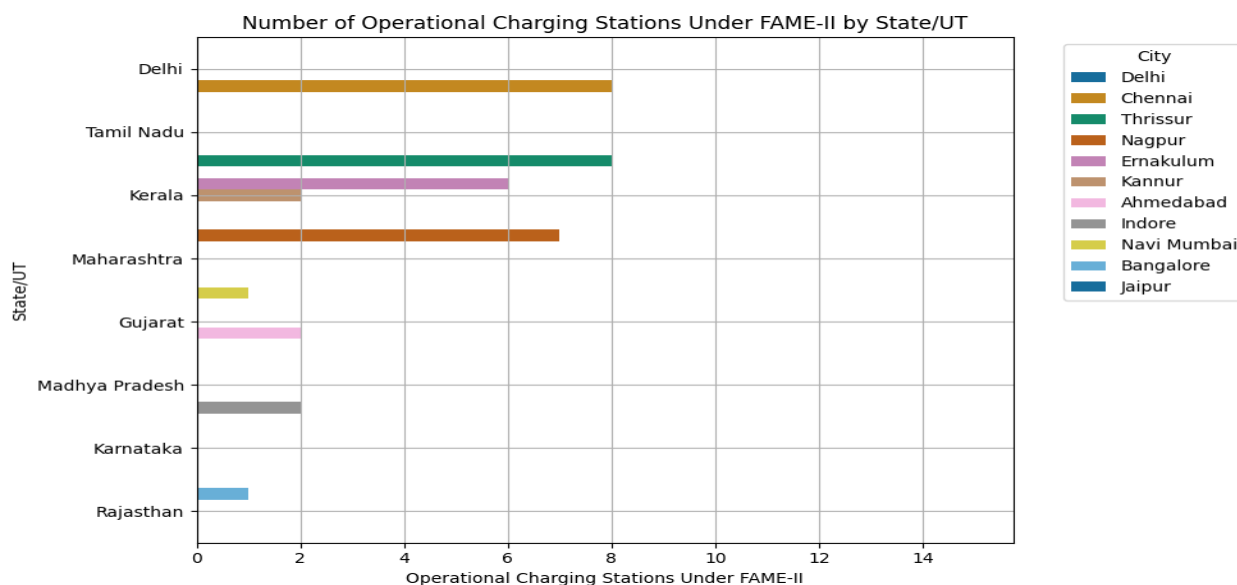
- *Under FAME-2, Delhi and Tamil Nadu tie with 8 charging stations*
- *Followed by Maharashtra's Nagpur, around 7 charging stations*
- *At 3rd position, we have Ernakulum from Kerala with 6 charging stations*

The government's commitment to promoting electric mobility is evident in its substantial investment in the sector. Over the years, significant budget allocations have been made to support initiatives aimed at accelerating the adoption of electric vehicles (EVs) and building the necessary infrastructure. In the latest budget announcement, the government unveiled a robust financial plan, reaffirming its dedication to advancing the EV ecosystem. These budgetary provisions underscore the government's proactive stance towards fostering sustainable transportation solutions and driving India's transition to a cleaner, greener future.

Budget Allocated vs Fund Utilized by Financial Year
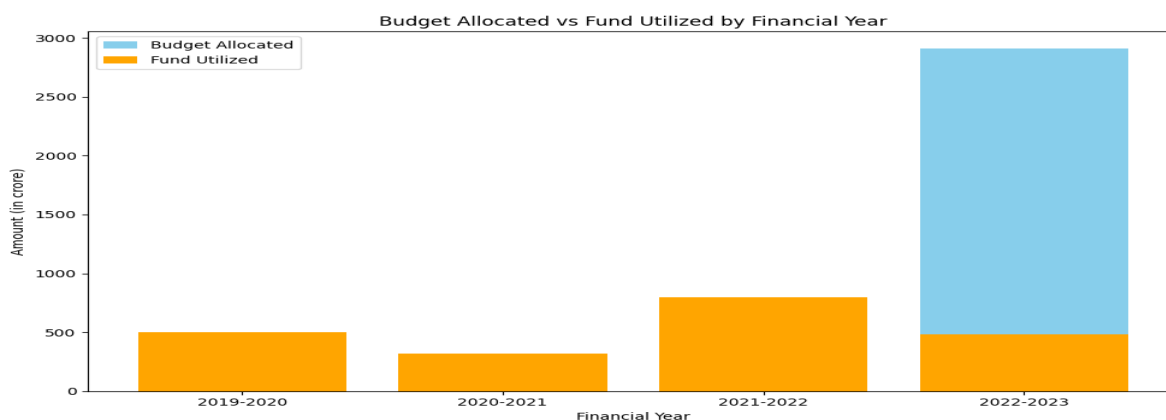
- Since we are lacking with the allocated budget for past 4 years, but in 2023 government allocated 2500 Cr for EVs
- And have utilized ~ 500 Cr
- Probably, till 2024 the utilized amount would have gained a descent number

Transitioning to the operational charging stations along highways, these play a crucial role in bolstering the infrastructure necessary for widespread EV adoption. These strategically positioned charging stations cater to the needs of long-distance travellers, alleviating range anxiety and facilitating inter-city EV travel. As the network of operational charging stations on highways continues to expand, it enhances the feasibility and convenience of electric mobility, encouraging more drivers to switch to EVs.

Top 15 National Highways by Number of Operational PCS
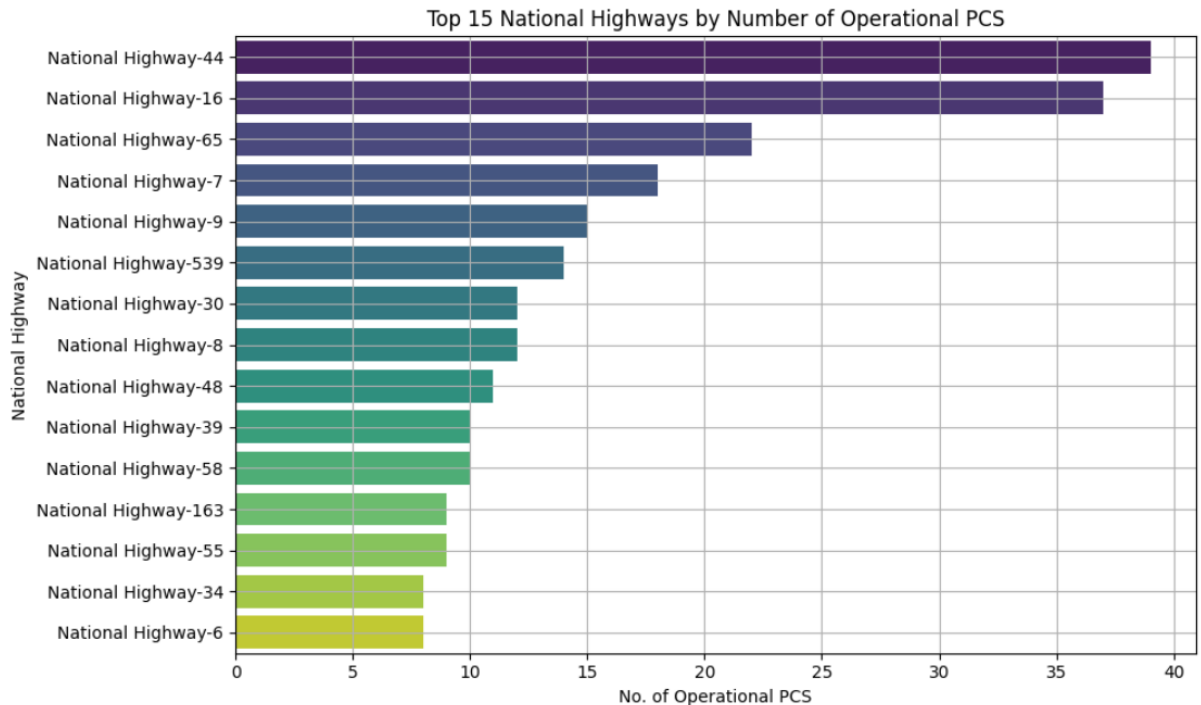
- National Highway-44 (from Srinagar to Kanyakumari), longest national highway in India, secured first spot in operational public charging stations, ~38 PCS
- Followed by NH-16, with ~36 PSC

Conclusions

1. Four-wheeler dataset [Carwale]

Feature Excellence Drives Satisfaction:

- The exceptional features of electric vehicles (EVs), such as *exterior design, comfort*, and *performance,* consistently garner positive feedback from users. This underscores the importance of prioritizing product excellence to enhance customer satisfaction and drive sales.

Fresh Ownership Yields Positive Sentiments:

- Users demonstrate a strong preference for newly purchased EVs, indicating a correlation between satisfaction and the freshness of ownership. *EV companies should capitalize on this sentiment by delivering high-quality products and ensuring a positive ownership experience*.

Positive Perceptions Influence Future Adoption:

- Even users who have not yet purchased EVs express positive sentiments, signalling a favourable inclination towards considering EVs for future acquisition. This presents an opportunity for EV companies to capitalize on the growing interest in EVs and expand their customer base.

Tata Nexon EV Leads the Market:

- Tata's Nexon EV emerges as the leader in the EV market, excelling across all key features such as *economy*, *comfort*, and *performance*. EV companies can learn from Tata's success and prioritize these aspects to enhance their competitive edge and attract more customers.

Opportunity for Strategic Positioning:

- With Tata's Nexon EV capturing over 50% of the market share, EV companies should strategically position their products to capitalize on emerging trends and consumer preferences. Understanding the factors driving Tata's success can guide EV companies in developing targeted marketing strategies and product offerings.

Customer Satisfaction Fuels Growth:

- The overwhelmingly positive feedback and high ratings received by Tata's Nexon EV underscore the importance of prioritizing *customer satisfaction*. EV companies should focus on delivering exceptional products and *services* to foster loyalty and drive long-term growth.

Addressing Sentiment Clusters:

- Identifying sentiment clusters can provide valuable insights into customer preferences and concerns. EV companies should address the issues highlighted by *cluster 0* while leveraging the positive sentiments of *cluster 1* to refine their product offerings and marketing strategies.

In conclusion, by emphasizing feature excellence, prioritizing customer satisfaction, and leveraging market insights, EV companies can capitalize on the growing demand for electric vehicles and drive sustainable growth in the competitive EV market landscape.

2. Two-wheeler dataset [Bikewale]

Visual Appeal Drives User Satisfaction:

- The consistent assignment of 5-star ratings to the visual appeal of electric vehicles (EVs) highlights the significant role of aesthetic design in shaping user satisfaction and preferences. EV manufacturers should prioritize visual appeal in their product design to attract and retain customers.

Service Quality is Paramount:

Service emerges as a predominant concern among EV users, emphasizing the critical importance of robust service infrastructure and high-quality support systems. EV companies must focus on enhancing service experiences to build trust and loyalty among customers.

Attractiveness and Comfort Influence Adoption:

- The attractiveness and comfort offered by EVs are key factors driving user adoption, underscoring the importance of these features in influencing consumer preferences. EV manufacturers should continue to prioritize these aspects to enhance the overall ownership experience and attract a broader customer base.

Diverse Usage Patterns Require Flexibility:

- The diversity in usage patterns among EV owners, ranging from daily commuting to long-distance travel, highlights the need for versatile EV models that cater to varying needs and preferences. EV companies should develop flexible and adaptable products to accommodate diverse user requirements effectively.

Opportunities in Daily Commuting:

- The preference for EVs for daily commuting presents significant opportunities for EV companies to target this segment with tailored products and services. By addressing the specific needs of daily commuters, EV manufacturers can capitalize on this growing market segment and drive sales growth.

Challenges in Long-Distance Travel:

- The reluctance among users to utilize EV bikes for tours or long-distance trips underscores the challenges associated with range anxiety, charging infrastructure, and comfort during extended rides. EV companies should focus on addressing these challenges to expand the utility and appeal of EVs for long-distance travel.

Market Segmentation Insights:

- Sentiment analysis and clustering reveal valuable insights into user perceptions and preferences, enabling targeted analysis and strategic decision-making for EV companies. By understanding user sentiment clusters, EV manufacturers can refine their product offerings and marketing strategies to better align with customer expectations.

Positive Sentiments Drive Success:

- Models such as Revolt RV 400 and Hero Electric Flash evoke positive sentiments among users, driving satisfaction and loyalty. EV companies should leverage the success of these models and replicate their key features to enhance competitiveness and market share.

Addressing Negative Sentiments:

- Models receiving negative sentiments, such as *Okinawa Praise* and *PURE EV EPluto 7G*, present opportunities for improvement and innovation. EV companies should address user concerns and invest in product enhancements to overcome challenges and regain consumer confidence.

In conclusion, by prioritizing *visual appeal*, *service quality*, and *user comfort*, while addressing diverse user needs and leveraging market segmentation insights, EV companies can capitalize on emerging opportunities and drive sustainable growth in the competitive EV market landscape.

3. Final conclusion-

Market Opportunity Analysis:

- The data highlights a significant market opportunity for our EV company in India's burgeoning electric vehicle (EV) market. With *Tata Motors* capturing a substantial market share, there is room for competition and growth, especially in segments where consumer preferences align with our product offerings.

Product Differentiation Strategy:

- Understanding the features and attributes that drive user satisfaction, such as *visual appeal*, *performance*, and *service quality*, allows us to tailor our EV models to meet consumer expectations. By focusing on key areas where our products excel, such as *comfort* and *performance*, we can differentiate ourselves from competitors and attract customers.

Regional Sales Focus:

- State-level sales dynamics reveal opportunities to target specific regions for market penetration. By analysing sales figures and preferences across states like *Uttar Pradesh*, *Karnataka*, and *Maharashtra*, we can devise targeted marketing and distribution strategies to maximize sales and brand visibility in these high-potential markets.

Charging Infrastructure Investment:

- The rapid growth of charging infrastructure presents a critical opportunity for our EV company to enhance customer convenience and address range anxiety concerns. *Collaborating with companies like IOCL and HPCL to expand the charging network aligns with our goal of providing reliable and accessible charging solutions to customers nationwide*.

<u>Demographic Targeting and Market Segmentation:</u>

- Understanding demographic influences on EV adoption, such as *income level*, *education*, and *profession*, allows us to segment the market effectively and tailor our products and marketing strategies to different consumer segments. By targeting *medium and high-income groups for four and two-wheeler sales,* and emphasizing *three-wheelers for low-income groups*, we can optimize our market reach and appeal.

In conclusion, leveraging insights from market analysis, product differentiation, regional sales focus, charging infrastructure investment, and demographic targeting strategies, our EV company is well-positioned to capitalize on the growing opportunities in India's EV market. By aligning our product offerings and marketing efforts with consumer preferences and market dynamics, we can establish a strong foothold and drive success in the evolving EV landscape.

Technical work-

https://github.com/codedestructed007/FeyNN-labs-Internship/blob/main/Electric_vehicle_segmentation.ipynb

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