EV Market in India

Market segmentation analysis on electrical vehicle market in India

Team Members:

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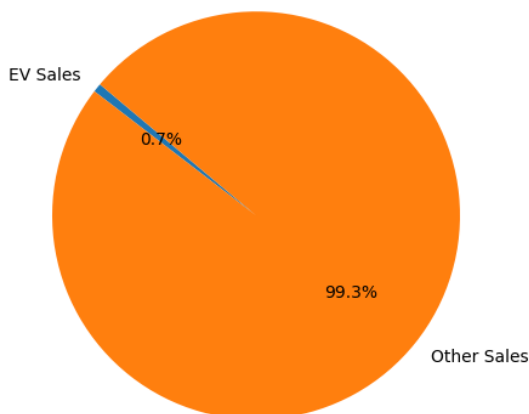
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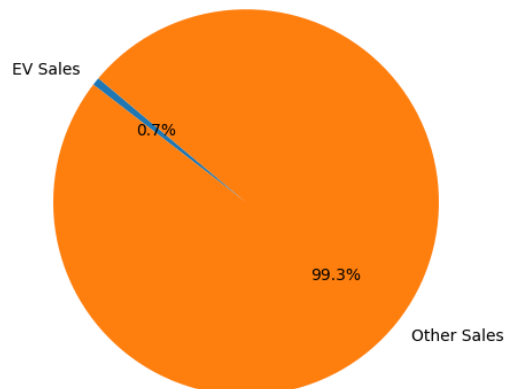
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1. Introduction

The electric vehicle (EV) market in India has experienced rapid growth in recent years. This trend has inspired numerous established corporations and emerging startups to capitalize on this growth by introducing innovative electric vehicle models with diverse characteristics. The increasing demand for electric vehicles (EVs) is leading to a rise in the number of companies entering the market.For a successful launch of an EV startup in India, it's vital to choose the right approach and prioritize the right clientele.
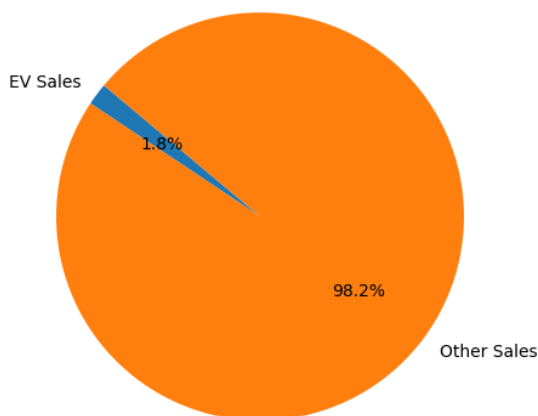
Growth of EV sales in India over the years

Sales Distribution for 2019.0 — EV Sales 0.7%, Other Sales 99.3%

Sales Distribution for 2020.0 — EV Sales 0.7%, Other Sales 99.3%

Sales Distribution for 2021.0 — EV Sales 1.8%, Other Sales 98.2%

Sales Distribution for 2022.0 — EV Sales 4.8%, Other Sales 95.2%

Sales Distribution for 2023.0 — EV Sales 6.4%, Other Sales 93.6%

Sales Distribution for 2024.0 — EV Sales 6.7%, Other Sales 93.3%

EV Sales in Different Periods
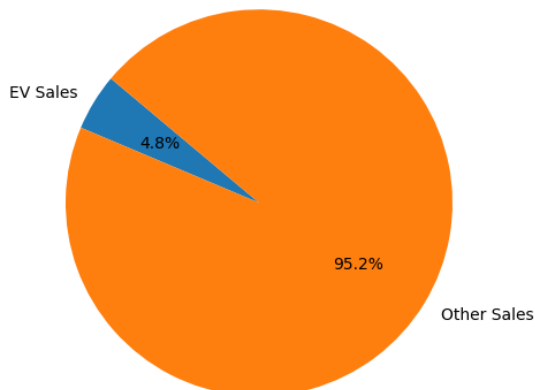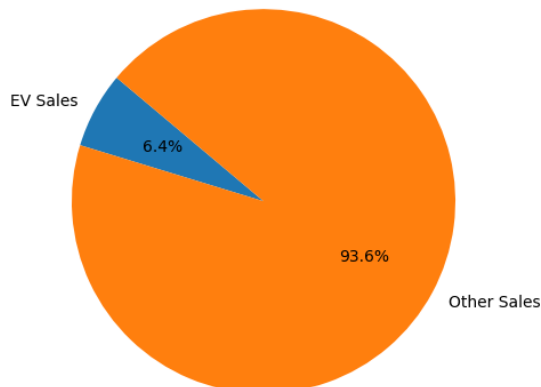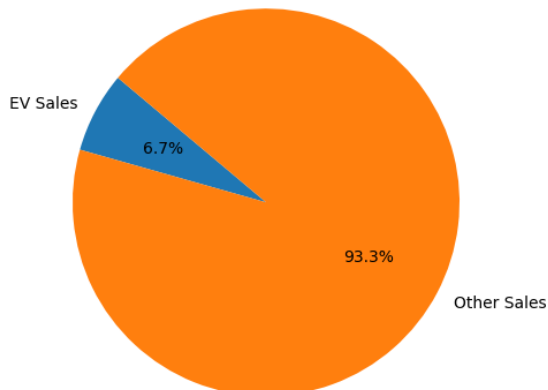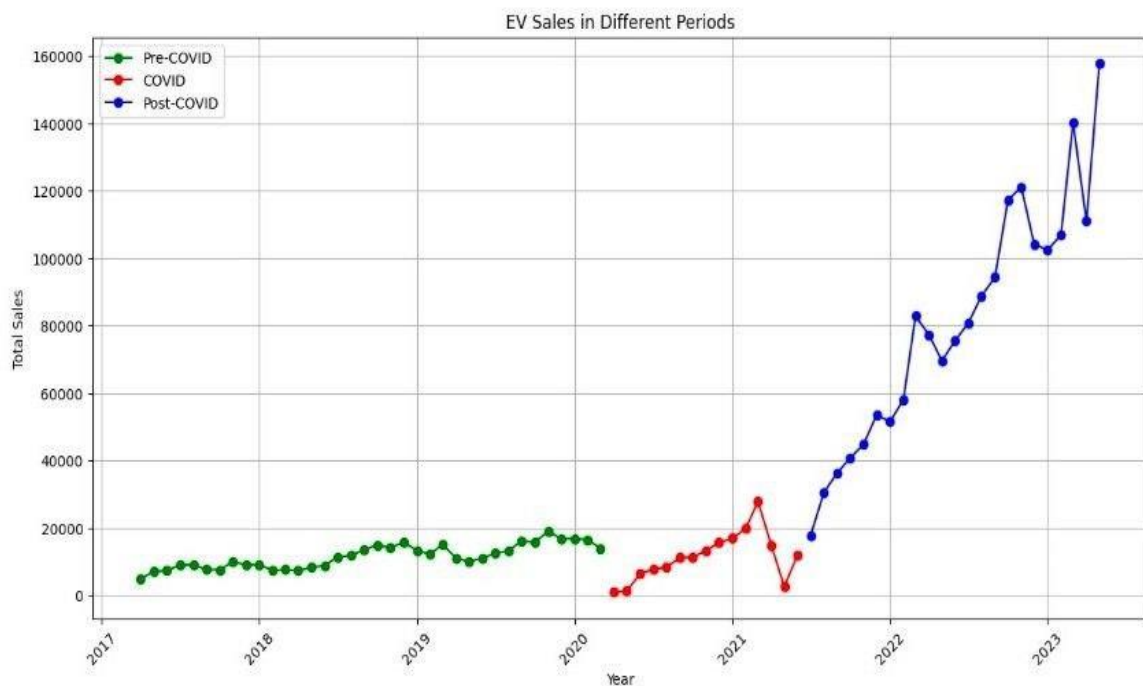
The electric vehicle (EV) market is revolutionizing the automotive industry, driven by the global shift towards sustainable transportation. As concerns about climate change and environmental sustainability grow, the adoption of EVs has gained significant momentum. In this fast-evolving landscape, understanding the market segmentation of electric vehicles becomes crucial for businesses, investors, and policymakers alike. The EV market segmentation helps understand the diverse landscape of electric vehicles.

It categorizes EVs based on factors like vehicle type, range, price, and target audience. Segments include compact EVs for urban commuting, luxury EVs for affluent buyers, and long-range EVs for road trips. This segmentation assists manufacturers and consumers in making informed decisions, promoting the growth and development of the EV market.

2. Problem Statement

The Indian auto market is currently dominated by traditional petrol and diesel vehicles. Despite the global rise in electric vehicle (EV) usage due to their environmental benefits and cost savings, India is facing significant challenges in encouraging widespread adoption. The challenges include a shortage of charging stations, steep upfront costs, concerns about the range of the vehicle per charge, and a widespread lack of familiarity and confidence in electric vehicles.

To address these challenges and promote EV adoption, it is essential to:

1. Develop a Comprehensive Market Analysis: Understand the current market dynamics, customer preferences, and potential in India.
2. Identify Key Segments: Segment the market based on geographic, demographic, psychographic, and behavioral factors to pinpoint the most promising target customers.
3. Formulate a Strategic Entry Plan: Develop a strategy for market entry that includes location selection, target customer segments, and competitive pricing strategies.
4. Enhance Infrastructure: Address the uneven distribution of charging stations and ensure adequate infrastructure support across different regions and highways.
5. Increase Consumer Awareness: Promote the benefits of EVs and build consumer trust through effective marketing and education campaigns.

3. Data Collection

Sources:

- Kaggle
- https://cleanmobilityshift.com/ev-dashboard/
- https://www.kaggle.com/datasets/praveenchoudhary1217/electric-vehicle-sales-in-india
- https://www.kaggle.com/datasets/shishu1421/vehicle-registered-in-india

4. Data Preprocessing

- Excel: To convert raw data into meaningful form
- NumPy: Used for performing numerical operations.
- Pandas: To read or load the datasets.
- Matplotlib: To create static, animated, and interactive visualizations

The data available has to be processed using several techniques in to be ready for the market segmentation analysis like,

Pivot table in Excel:

	A	B	C	D	E	F
1	Year	Month	State	Vehicle Type	Total sales	EV sales
2	2024	jan	Goa	Others	3	0
3	2024	jan	Goa	Others	1	0
4	2024	jan	Goa	Others	4	0
5	2024	jan	Goa	Bus	43	10
6	2024	jan	Goa	Others	3	0
7	2024	jan	Goa	Others	22	0
8	2024	jan	Goa	Others	1	0
9	2024	jan	Goa	Others	1	0
10	2024	jan	Goa	Others	281	0
11	2024	jan	Goa	Others	27	0
12	2024	jan	Goa	2W_Personal	4885	832
13	2024	jan	Goa	2W_Personal	1	0
14	2024	jan	Goa	2W_Personal	1	0
15	2024	jan	Goa	4W_Shared	436	0
16	2024	jan	Goa	4W_Personal	1895	86
17	2024	jan	Goa	Others	14	0
18	2024	jan	Goa	2W_Shared	191	0
19	2024	jan	Goa	2W_Personal	1	0
20	2024	jan	Goa	Others	1	0
21	2024	jan	Goa	3W_Goods	1	0
22	2024	jan	Goa	3W_Shared	8	0
23	2024	jan	Goa	3W_Personal	1	0
24	2024	jan	Goa	Others	1	0
25	2024	jan	Meghalaya	Others	1	0
26	2024	jan	Meghalaya	Bus	12	0
27	2024	jan	Meghalaya	Others	30	0
28	2024	jan	Meghalaya	Others	3	0
29	2024	jan	Meghalaya	Others	2	0
30	2024	jan	Meghalaya	Others	30	0

Sheet2 **Sheet1** +

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Converted this unordered table into meaningful data,

	Row Labels	Sum of Total sales	Sum of EV sales	Ratio
1	Row Labels	Sum of Total sales	Sum of EV sales	Ratio
2	⊞ Andhra Pradesh	3611903	74028	0.020496
3	⊞ Arunachal Pradesh	103821	37	0.000356
4	⊞ Assam	2096568	129770	0.061896
5	⊞ Bihar	4555690	187842	0.041232
6	⊞ Chhattisgarh	2051288	69283	0.033775
7	⊟ Delhi	2209510	181012	0.081924
8	⊞ 2020	424025	12378	0.029192
9	⊞ 2021	459208	25815	0.056216
10	⊞ 2022	608520	62265	0.102322
11	⊟ 2023	653527	73487	0.112447
12	⊟ jan	59531	5576	0.093665
13	2W	35973	3285	0.091318
14	3W	2820	1950	0.691489
15	4W	17993	331	0.018396
16	Bus	170	5	0.029412
17	Others	2575	5	0.001942
18	⊟ feb	48772	5268	0.108013
19	2W	29396	2800	0.095251
20	3W	2761	1934	0.700471
21	4W	14823	510	0.034406
22	Bus	52	0	0
23	Others	1740	24	0.013793
24	⊟ mar	54331	7970	0.146693
25	2W	30396	3782	0.124424
26	3W	3423	2609	0.762197
27	4W	18638	1544	0.082842
28	Bus	56	13	0.232143
29	Others	1818	22	0.012101
30	⊟ apr	48012	5187	0.108035

< > Sheet2 Sheet3 Sheet1 +

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Replaced the unavailable data with zero

```
EV_share = EV_share.fillna(0)
```

5. Segmentation using KMeans Clustering Algorithm

5.1 Correlation of the Features

A correlation matrix is simply a table that displays the correlation. It is best used in variables that demonstrate a linear relationship between each other. The matrix depicts the correlation between all the possible pairs of values through the heatmap in the below figure. The correlation matrix between the features is attached in the Figure below:
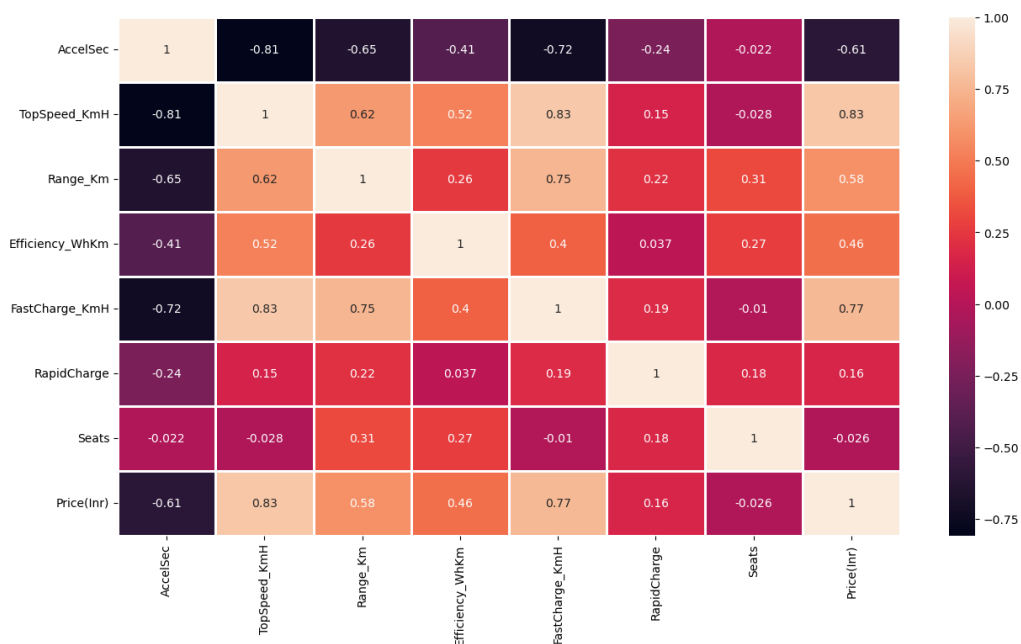
5.2 KMeans Clustering

K Means algorithm is an iterative algorithm that tries to partition the dataset into pre-defined distinct non- overlapping subgroups (clusters) where each data point belongs to only one group. It tries to make the intra- cluster data points as similar as possible while also keeping the clusters as different (far) as possible. It assigns data points to a cluster such that the sum of the squared distance between the data points and the cluster's centroid (arithmetic mean of all the data points that belong to that cluster) is at the minimum. The less variation we have within clusters, the more homogeneous (similar) the data points are within the same cluster. The way k means algorithm works is as follows:

· Specify number of clusters K.

· Initialize centroids by first shuffling the dataset and then randomly selecting K data points for the centroids without replacement.

· Compute the sum of the squared distance between data points and all centroids. Assign each data point to the closest cluster (centroid).

- Compute the centroids for the clusters by taking the average of the all data points that belong to each cluster.

- Keep iterating until there is no change to the centroids. i.e assignment of data points to clusters isn't changing.

The approach k-means follows to solve the problem is expectation maximization The E-step is assigning the data points to the closest cluster. The M-step is computing the centroid of each cluster.

5.3   Determining the Number of Clusters

The Elbow method is a popular method for determining the optimal number of clusters. The method is based on calculating the Within-Cluster-Sum of Squared Errors (WSS) for a different number of clusters(k) and selecting the k for which change in WSS first starts to diminish. The idea behind the elbow method is that the explained variation changes rapidly for a small number of clusters and 6 then it slows down leading to an elbow formation in the curve. The elbow point is the number of clusters we can use for our clustering algorithm.

The Elbow method was used to identify the optimal number of clusters in the dataset. This technique involved running K-means clustering with a varying number of clusters and selecting the number that resulted in an elbow point in the plot of the sum of squared distances. The appropriate number of clusters was found to be
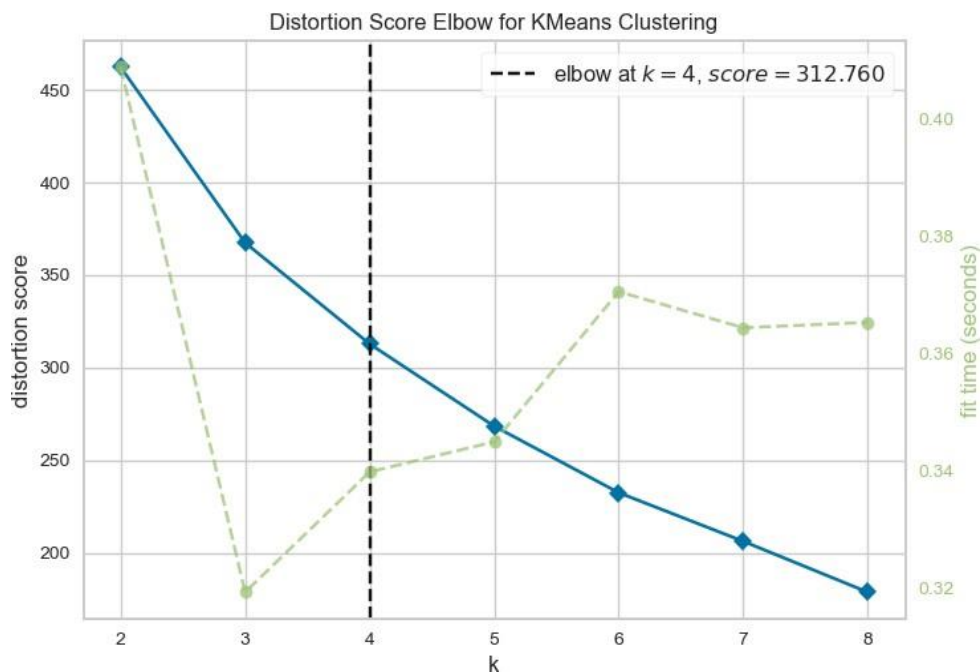
5.4   PCA implementation and visualization

Principal Component Analysis (PCA) was employed to visualize the clusters in a lower-dimensional space. This technique reduced the dimensionality of the data while retaining the most significant information. The clusters were then plotted using PCA for visualization purposes.

Principal Components Analysis on the Fuel Type Vehicle Registration Dataset
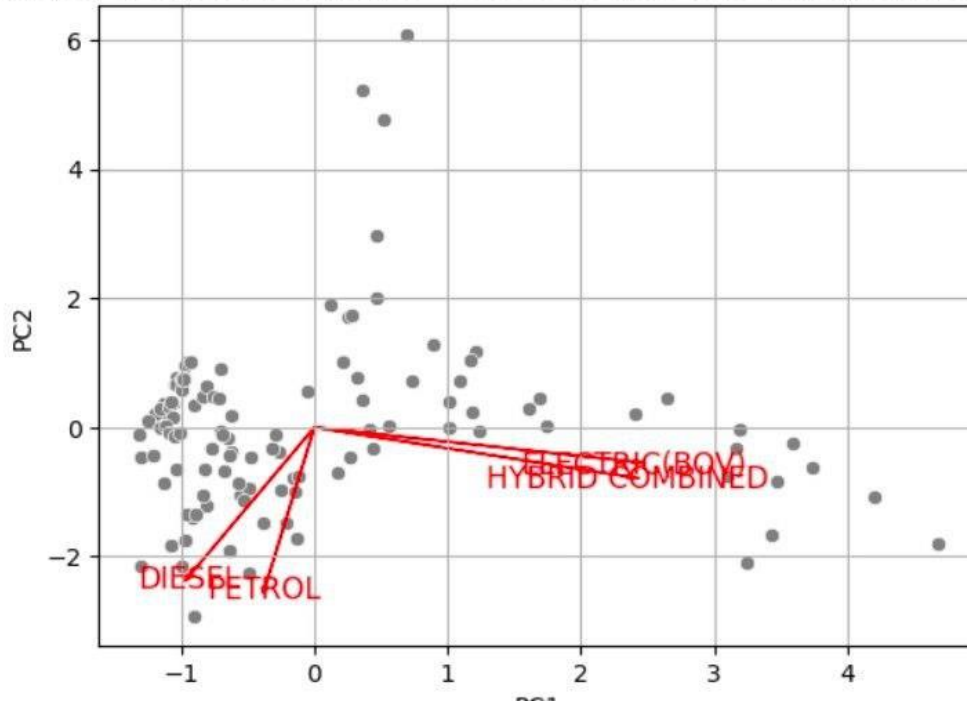
5.5   Dendrogram

This technique is specific to the agglomerative hierarchical method of clustering. The agglomerative hierarchical method of clustering starts by considering each point as a separate cluster and starts joining points to clusters in a hierarchical fashion based on their distances. To get the optimal number of clusters for hierarchical clustering,

We make use of a dendrogram which is a tree-like chart that shows the sequences of merges or splits of clusters. If two clusters are merged, the dendrogram will join them in a graph and the height of the join will be the distance between those clusters. As shown in Figure, we can chose the optimal number of clusters based on hierarchical structure of the dendrogram.

5.6   Forecasting

Forecasting is the process of making predictions about future events based on historical data, trends, and analysis. It involves using various statistical, mathematical, and computational methods to estimate future conditions or outcomes in a given area, such as sales, weather, economic performance, or demand for a product. The aim of forecasting is to provide insights that can help in decision-making, planning, and strategy formulation by anticipating future developments.

6. Conclusion

Each of the team members collected and worked on different data set to obtain distinct conclusion after the market segmentation.

Aadhithya Sunil: https://github.com/Aadhi7310/EV_sales

Source: Kaggle, Government of India

- In a price comparison between the same model of electric vehicle and a gasoline vehicle, the EV tends to be roughly 30% more expensive.
- Those who drive daily and think that switching to an electric vehicle (EV) will help them save on fuel costs often prefer to invest in EVs instead of petrol or diesel options.
- There is a significant demand for electric three-wheeled vehicles, such as rickshaws, across various states. The shift to electric vehicles is growing a lot in this category.
- Electric vehicle sales make up a minor fraction of overall car sales at the moment, but this is anticipated to rise in the near future.

Observations from the segmentation data,

- The data was manipulated across 28 states categorized to 5 different vehicle types such as 2 wheelers, 3 wheelers, 4 Wheelers, Bus and others.
- Others include vehicle for agricultural purposes, Ambulance etc.
- The raw data was converted to 140 rows as mentioned above to see which type of vehicle has the demand at which state.
- The obtained data was divided into 4 segments using K-means clustering.

Explaining segments,

- Segment 0: This segment comprises of the majority and they haven't shown major sales of EV vehicles compared to the total vehicle sale. This segment was further segmented since it consists of more than 60% of the data which showed the 4 wheelers and 2 wheelers market at most of the states have shown major growth in forecasting this segment was further divided into marketable section and section with no growth.

- Segment 1: The segment in which EV sales where the properly dominating other vehicles, this segment mostly comprises of three-wheeler vehicles. But there is no point in targeting this segment since the market is already saturated here there no minimal scope of improvement.

- Segment 2: This segment was more similar to segment 0 but still shows bigger share for the EV market this is the most optimal market segment we can target for since the growth will be rapid from here this segment consist of three-wheeler market which has not reached the saturation yet unlike segment one and also some states are showing improvement in their two-wheeler and bus sales.

- Segment 3: Similar to the segment 1, this segment consists of three-wheeler vehicles only which has still got room for growth but in a couple of years this segment will also join the segment 1 as per the current trends

Payal Aggarwal:

- The optimal number of clusters for the given data comes out to be 2.
- As the total salary increases the amount of money spent on the car increase.
- The amount of money spent is also proportional to age as age increases, money spent also increase

.

The data visualisation and analysis completely tells about the trend that high salaried, old people prefers the Electric vehicles but keeping in mind the rising prices of petrol and diesel and increasing awareness about vehicle pollution in the younger people influence their decision to buy EVs.So the prefer market segment must be the mid tier which caters to both the need of young as well as old people.

Conclusion:

The market segmentation analysis of the EV market in India provided valuable insights into consumer preferences and behaviors. The analysis revealed distinct clusters within the dataset, representing different consumer segments based on demographic, geographic, psycographic, and behavioral factors. This information can guide marketing strategies, product development, and target market selection to enhance EV adoption in India.

The electric vehicle (EV) market segments in India are experiencing significant growth and potential. Several key factors contribute to the development and adoption of EVs in the country.

The findings suggest the need for targeted campaigns to address specific segments' concerns and preferences. The analysis also highlighted the importance of factors such as affordability, perception of economic viability, and regional variations in driving EV adoption.

Increasing Awareness: There is a growing awareness among Indian consumers regarding the environmental benefits of EVs, including reduced emissions and lower pollution levels. This awareness is driving the demand for EVs, especially among environmentally conscious individuals and organizations.

Urban Commuting and Ride-Sharing: India's urban areas, particularly major cities, are witnessing a surge in demand for EVs for commuting and ride-sharing purposes. The lower operating costs and the ability to 15 navigate through congested traffic make EVs an attractive option for urban dwellers.

Srinithya Madhamshetty: https://github.com/srinithya23203/EV-market-segmentation

1. Trend Analysis

- **Overall Growth**: EV sales in India have been on the rise, particularly after 2020. This indicates growing acceptance and enthusiasm for EVs among Indian consumers.

- **Impact of COVID-19**: Although there was a dip in sales at the start of the pandemic in 2020, the market bounced back quickly, showing resilience and adaptability.

2. Segment-wise Analysis

- **Pre-COVID (April 2017 - March 2020)**:

  o **Sales Growth**: Steady increase in sales month by month.

  o **Key Drivers**: 2-wheelers and 3-wheelers were the major contributors, reflecting strong demand from both consumers and commercial users.

- **COVID Period (April 2020 - March 2021)**:

  o **Sales Impact**: Sales initially dropped but soon recovered as the market adapted to the new normal.

  o **Key Drivers**: The recovery was mainly driven by 2-wheelers and 3-wheelers, showcasing their resilience.

- **Post-COVID (April 2021 - May 2023)**:

  o **Sales Growth**: Rapid growth with significant spikes, especially in the later months.

  o **Key Drivers**: All vehicle types saw growth, but 2-wheelers and 4-wheelers showed the highest increase, indicating wider acceptance.

3. Vehicle Type Sales Trend

- **2-Wheelers**: The most popular segment, driven by their affordability and efficiency for personal use.

- **3-Wheelers**: Steady sales growth, popular for commercial use in transporting goods and passengers.

- **4-Wheelers**: Significant growth after 2020, showing increasing interest in personal EVs.

- **Buses**: A smaller segment but with potential for growth, especially through government and institutional purchases.

4. Market Strategy Recommendations

- **2-Wheelers**:

  o **Target Audience**: Urban commuters and individual consumers.

  o **Strategy**: Highlight affordability, low maintenance costs, and mileage. Partner with cities to expand EV infrastructure like charging stations.

- **3-Wheelers**:

  o **Target Audience**: Commercial users and small businesses.

  o **Strategy**: Offer fleet purchase incentives, robust after-sales support, and emphasize cost-efficiency for delivery and passenger transport.

- **4-Wheelers**:

  o **Target Audience**: Urban middle class and ride-sharing platforms.

- **Strategy**: Develop a range from budget to premium vehicles, emphasize safety and range. Partner with ride-sharing companies.

- **Buses**:

  - **Target Audience**: Government and public transportation services.

  - **Strategy**: Focus on government tenders, highlight long-term fuel and maintenance savings, and emphasize environmental benefits.

2.**Dataset**:India EV 2W sales data

Source: Kaggle

Conclusion

1. Market Leaders and Sales Performance

- **Top Performers**: OLA ELECTRIC leads the market with the highest total sales over the observed period, followed by TVS and ATHER. This indicates that OLA ELECTRIC is the dominant player in the market, with significant sales compared to other makers.

- **Market Share**: The market share analysis shows that OLA ELECTRIC and TVS command a significant portion of the market, suggesting their strong brand presence and customer base.

2. Sales Trends

- **Growth Trends**: OLA ELECTRIC shows a consistent upward trend in sales, with peaks in the later months, indicating growing popularity and market penetration. TVS also exhibits a strong upward trend, especially towards the end of the period.

- **Declines**: Makers like OKINAWA and HERO ELECTRIC experience fluctuations with notable declines in certain months, which could suggest seasonal variations or other market dynamics affecting their sales.

3. Clustering Insights

- **Sales Patterns**: By clustering makers based on their sales patterns, distinct groups can be identified. For example, high-growth makers like OLA ELECTRIC might cluster together, while makers with more stable but lower sales might form a different cluster.

- **Cluster Characteristics**: Understanding the characteristics of each cluster can help in identifying common strategies and market behaviors within each group.

4. Forecasting Future Trends

- **Future Sales Predictions**: Forecasting models suggest that if current trends continue, OLA ELECTRIC and TVS are likely to maintain or even increase their market dominance, while other makers may need to adapt their strategies to capture a larger market share.

Abhinash Borra: