

FEYNN LABS- INTERNSHIP

TASK 1- REPORT

ELECTRIC VEHICLE MARKET SEGMENTATION IN INDIA

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FERMI ESTIMATION:

India's total population stands at approximately 1.42 billion, with an estimated 35.8% residing in urban areas, totaling around 508.36 million individuals.

Utilizing a Fermi estimation approach, it's approximated that roughly 20% of the urban population, translating to about 102 million people, own either a car or a bike. This figure represents the potential market size for electric vehicles (EVs).

DATA SOURCES:

The sales data obtained from the Society of Manufacturers of Electric Vehicles, spanning 2017 to 2023, catalogues sales figures of electric two-wheelers, three-wheelers, four-wheelers, and buses. This dataset provides a comprehensive view of market trends and customer preferences over time.

DATA PRE-PROCESSING:

Line Plot for EV Industries:

- A line plot was created to visualize the trend of the number of vehicles across financial years for different categories in the EV industry.
- Data was extracted from the 'EV Industries' DataFrame and plotted using Seaborn's lineplot function.
- The last data point for each category was annotated on the plot to highlight the latest values.

- From the graph, we can see a significant growth trajectory of India's **two-wheeler market** in 2023, being the leader in the industry.

Bar Plot for EV Market:

- The DataFrame 'EV Market' was sorted in descending order based on the 'Amount INR Cr' column.
- A bar plot was created to visualize the distribution of categories in the EV market based on their revenue.
- Labels were added to each bar to display the corresponding revenue values.
- Y-axis ticks and label were removed for cleaner visualization.
- From the graph, we find out that **two-wheelers** are the major revenue generators
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Concatenation and Data Cleaning for EV Manufacturers:

- Data from multiple DataFrames ('EV Manufacturers') was concatenated into a single DataFrame ('data_ev2w').
- The 'maker' column values were converted to uppercase for consistency.
- Specific manufacturer names were replaced with standardized versions using the replace() method.
- Unique manufacturer names were sorted alphabetically for clarity.

Line Plot for EV Manufacturers Over Time:

- Data was grouped by financial year and manufacturer, aggregating the number of vehicles.
- A line plot was generated to visualize the trend of vehicle production over time for each manufacturer.
- The last data point for each manufacturer was annotated on the plot.
- Spines on the top and right sides of the plot were removed, and the legend was hidden.

Missing Values Analysis:

- The percentage of missing values in each column of the dataset was calculated.
- The result was sorted in descending order to identify columns with the highest percentage of missing values.

SEGMENT EXTRACTION:

Sentiment Analysis:

- Sentiment analysis was performed on the 'review' column of the dataset to determine the sentiment (positive, negative, neutral) associated with each review.
- The SentimentIntensityAnalyzer from the NLTK library was used to compute sentiment scores for each review text.
- Based on the sentiment scores, a sentiment label was assigned to each review, and a new column called 'sentiment' was added to the dataset.

Feature Selection and Preprocessing:

- Relevant features for market segmentation, such as 'Used it for', 'Owned for', 'Ridden for', and ratings related to various aspects of the product, were selected for analysis.
- Missing values in the selected features were filled with zeros to ensure completeness of the dataset.
- The selected features were then scaled using standardization to bring them to a similar scale, preventing any feature from dominating the analysis due to its magnitude.

Principal Component Analysis (PCA):

- PCA was applied to the scaled dataset to reduce the dimensionality of the feature space while retaining most of the variability in the data.
- The transformed principal components were extracted, and their contributions to the variance in the data were analyzed.

Clustering Analysis:

- The elbow method was used to determine the optimal number of clusters for segmentation based on the within-cluster sum of squares (WCSS) values.
- A scree plot was generated to visualize the WCSS values for different numbers of clusters, with an elbow observed at four segments, indicating the optimal segmentation.

K-Means Clustering:

- K-Means clustering was performed with the optimal number of clusters determined from the scree plot.
- The scaled data were clustered using the K-Means algorithm, and each data point was assigned to a cluster based on its proximity to the cluster centroids.
- The cluster labels were added to both the original dataset and the PCA-transformed dataset for further analysis.

PROFILING SEGMENTS:

Segment Profiling Visualization:

- The DataFrame 'data_profile' was created to include both the segment features and their corresponding cluster labels.
- Grouping the data by cluster labels, the mean values of each feature were calculated.

- The mean values were visualized using bar plots, with each plot representing a different feature.
- Additionally, a scatter plot overlaying the mean values of each feature was generated to highlight the overall trend across segments.
- Horizontal lines were added to indicate the mean values of each feature across all segments.
- Each subplot was labeled with the respective cluster number and its percentage composition within the dataset.

Insights from Segment Profiling:

- The visual representation captures the diverse perceptions and preferences among different segments.
- Segment 0, comprising 15% of consumers, values various aspects of electric two-wheeler vehicles, including visual appeal, reliability, performance, service experience, and comfort.
- Segment 1, the largest segment at 39% of consumers, expresses dissatisfaction across all aspects, indicating significant room for improvement in meeting their expectations.
- Segment 2, representing 33% of consumers, appreciates visual appeal, reliability, service experience, and comfort, with a notable emphasis on value for money.
- Segment 3, the smallest segment comprising 13% of consumers, values a wide range of features, including visual appeal, reliability, performance, service experience, extra features, and maintenance cost, showcasing distinct perceptions, particularly regarding features and costs.

DESCRIBING SEGMENTS:

The mosaic plot analysis unveils distinct consumer sentiments across segments, with all but Segment 1 reflecting positive outlooks. Notably, Segment 1 stands out with negative sentiments, indicating widespread dissatisfaction.

Additionally, the ownership duration of electric vehicles varies among segments, with Segment 1 owning vehicles for over a year, while Segment 0

lacks prior ownership experience. Segment 2 members show moderate ownership, spanning from less than three months to over a year, while Segment 3 consumers are relatively new to electric vehicle ownership.

Further exploration into usage patterns reveals that electric vehicles are predominantly used for daily commuting across all segments, with most users covering distances below 5000 km. However, a small portion of users in each segment covers distances ranging from 5000 to 10000 km, aligning with commuting needs.

The parallel box and whisker plot underscores significant differences in average ratings among segments, particularly highlighting the dissatisfaction expressed by Segment 1 consumers across all aspects.

To break it down segment-wise:

Segment 0:

- Preference: Prefers premium electric vehicles.
- Price Range: Higher price range.
- Riding Range: Prefers extended riding ranges, indicating a preference for long-distance travel.
- Weight Preference: Favors heavier vehicles.
- Charging Time: Opts for longer overnight charging durations.

Segment 1:

- Preference: Focuses on budget-friendly options.
- Price Range: Prefers lower-priced electric vehicles.
- Riding Range: Prioritizes moderate riding ranges suitable for daily commuting.
- Weight Preference: Favors heavier vehicles.
- Charging Time: Prioritizes faster charging for quick turnaround times.

Segment 2:

- Preference: Prioritizes affordability.
- Price Range: Seeks budget-friendly options.
- Riding Range: Shows preferences similar to Segment 1, with moderate riding ranges.
- Weight Preference: Prefers lighter options.
- Charging Time: Likely to prioritize faster charging but may not be as critical as in Segment 1.

Segment 3:

- Preference: Also prioritizes affordability.
- Price Range: Prefers budget-friendly options.
- Riding Range: Similar to Segments 1 and 2, with moderate riding ranges.
- Weight Preference: Favors lighter options.
- Charging Time: Likely to prioritize faster charging but may tolerate longer charging durations if other factors meet preferences.

SELECTION OF TARGET SEGMENT:

The two main target segments for the electric vehicle market are Segment 1, which makes up 39% of consumers, and Segment 2, which comprises 33% of consumers.

Segment 1 has various preferences and areas of dissatisfaction, providing an opportunity to boost satisfaction and loyalty by addressing their specific needs. Segment 2 prioritizes features like visual appeal, reliability, and comfort, so tailoring electric vehicles to meet these expectations and highlight value for money could be beneficial.

By addressing concerns in Segment 1 and enhancing positive aspects in Segment 2, we can better meet the distinct needs of each group, leading to a stronger competitive position and continued market growth.

CUSTOMIZING THE MARKET MIX:

In our strategy for the electric vehicle market, it's vital to tailor the marketing mix to meet the needs of our target segments: Segment 1 and Segment 2.

Product Customization: We'll enhance product features to address the specific desires of each segment. For Segment 1, we'll focus on resolving dissatisfaction points, while for Segment 2, we'll emphasize visual appeal and value for money. This approach ensures our offerings cater to diverse tastes and budgets within each segment.

Price Customization: We'll adopt competitive pricing strategies for Segment 1 to ensure affordability, while for Segment 2, we'll set slightly higher prices to reflect the value-added features. This pricing strategy aims to strike the right balance between affordability and premium offerings.

Promotion Customization: Our promotional efforts will be tailored to each segment's preferences. For Segment 1, we'll focus on targeted advertising that highlights affordability and reliability. Meanwhile, for Segment 2, our promotions will emphasize premium features and benefits.

Place (Distribution) Customization: We'll establish distribution channels that are accessible to each segment. For Segment 1, we'll prioritize urban areas, while for Segment 2, we'll focus on suburban and semi-urban regions. Additionally, we'll maintain a robust online presence to cater to the digital preferences of both segments.

People and Process Customization: Our customer service representatives will undergo training to address the specific concerns of each segment effectively. We'll also streamline our processes to handle customization requests and service appointments efficiently. This personalized approach ensures that our electric vehicles meet the unique needs of Segment 1 and Segment 2, thereby enhancing their market relevance and customer satisfaction.

POTENTIAL EARLY MARKET CUSTOMER BASE:

Analyzing the potential early market customer base feasibility involves segmenting customers into two primary groups: Segment 1 and Segment 2.

Segment 1 comprises 330 members, representing 39% of consumers, while Segment 2 consists of 277 members, accounting for 33% of consumers.

To assess profitability, target price ranges are established for each segment.

For Segment 1, the target price range spans from ₹51,094 to ₹1,67,844, while for Segment 2, it ranges from ₹51,094 to ₹1,37,890. By multiplying the estimated number of potential customers in each segment by their respective targeted price ranges, businesses can project potential profits. For instance, setting a target price of ₹1,20,000 for Segment 1 yields an estimated profit of ₹39.60 crores, whereas for Segment 2, with a target price of ₹1,10,000, the potential profit is ₹30.47 crores.

Given Segment 1's larger market share and higher profit potential, prioritizing early market penetration efforts toward this segment is advisable to capitalize on substantial profit opportunities.

MOST OPTIMAL MARKET SEGMENTS:

After comprehensive analysis and assessment, Segment 1 emerges as the prime market segment, encompassing 39% of consumers, for electric two-wheeler vehicles. With its considerable customer base and a harmonious fusion of technical specifications and price range, this segment presents lucrative market prospects.

The recommended technical specifications for Segment 1 entail a price range of ₹75,000 to ₹1,25,000, riding range spanning from 90 to 180 km, top speed ranging from 60 to 120 kmph, weight between 75 to 125 kg, battery charging time of 3 to 5 hours, and rated power of 1000 to 6000 W. This targeted strategy ensures alignment with the diverse preferences and requirements of the market, establishing a solid foundation for a prosperous and enduring entry into the electric vehicle market.

LINK TO CODE: <https://github.com/ryn006/EV-Market-Segmentation/blob/main/dataset1.ipynb>

CONCLUSION:

Our analysis pinpointed Segment 1, encompassing 39% of the market, as our key target. By tailoring our electric two-wheelers to suit this segment's preferences, we capitalize on a substantial opportunity. This strategy, informed by segmentation insights and technical specifications, lays a solid foundation for our market entry in India's electric vehicle landscape.

DATASET 2: VEHICULAR SEGMENTATION

DATASET:

	Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType
0	Tesla	Model 3 Long Range Dual Motor	4.6000	233	450	161	940	1	AWD	Type 2 CCS
1	Volkswagen	ID.3 Pure	10.0000	160	270	167	250	0	RWD	Type 2 CCS
2	Polestar	2	4.7000	210	400	181	620	1	AWD	Type 2 CCS
3	BMW	iX3	6.8000	180	360	206	560	1	RWD	Type 2 CCS
4	Honda	e	9.5000	145	170	168	190	1	RWD	Type 2 CCS

DATA PREPROCESSING:

In this section, various preprocessing steps were performed on the dataset to prepare it for analysis and visualization. Here's a summary of the tasks carried out:

Data Loading and Cleaning:

- Loaded the dataset from a CSV file and removed the 'Unnamed: 0' column.
- Transformed the 'PriceEuro' column to Indian Rupees (INR) by multiplying with the conversion factor.

- Converted categorical variables like 'RapidCharge' to numerical format for analysis.

Exploratory Data Analysis (EDA):

- Conducted EDA to understand the structure and characteristics of the dataset.
- Utilized visualization libraries such as Plotly, Matplotlib, and Seaborn to create various plots including bar plots, scatter plots, 3D plots, pie charts, and heatmaps.
- Explored relationships between variables like brand, top speed, range, efficiency, powertrain, plug type, body style, segment, and seats.
- Investigated the frequency distribution of brands, top speeds achieved, maximum range, efficiency, number of seats, and car prices.
- Analyzed categorical variables like plug type, body style, and segment using pie charts.

Data Analysis and Findings:

- Identified the top brands based on frequency, top speeds achieved, maximum range, efficiency, number of seats, and car prices.
- Investigated the distribution of plug types, body styles, and segments among the dataset.
- Observed correlations between variables through pair plots and a correlation heatmap.
- Examined the relationship between top speeds and car prices, maximum range and car prices, and top speeds based on maximum range.

Key Insights:

- Brands like Porsche, Lucid, and Tesla produce high-performance vehicles with fast acceleration and top speeds.
- Electric vehicles with longer ranges are offered by brands such as Lucid, Lightyear, and Tesla.
- Efficiency varies across brands, with Byton, Jaguar, and Audi showcasing higher efficiency.

- The majority of cars in the dataset have 5 seats and are either SUVs or Hatchbacks.
- Prices of cars vary significantly across brands, with Lightyear, Porsche, and Lucid being the most expensive.
- Type 2 CCS is the most common plug type used for charging among the dataset.
- SUVs and Hatchbacks are the predominant body styles, and cars mainly fall under C or B segments.

Linear regression is like a smart tool that helps us predict the prices of cars. It works by understanding how different factors, like the car's features, affect its price. We use a bunch of data about electric cars, like their acceleration, range, and top speed, to teach the tool how to make these predictions.

First, we split our data into two parts: one for teaching the tool (40% of the data) and the other for testing how well it learned (60% of the data). Then, we use a command to train the tool with the teaching data. This command helps the tool learn the patterns in the data so it can predict prices accurately.

After training, the tool gives us some important numbers:

- **The intercept:** This is like the starting point for predictions. It's a number that helps adjust the predictions to match the actual prices.
- **The coefficients:** These are like weights that the tool assigns to each factor (like acceleration or range). They tell us how much each factor influences the price.

Sorting Top Speeds and Maximum Range According to Price:

By sorting the dataset based on price and examining the top speeds and maximum range of cars within different price ranges, we gain insights into the

price-performance relationship. This analysis helps in understanding how consumers perceive value concerning features like top speed and range.

Target Segments:

Behavioral:

The dominance of cars with 5 seats indicates a preference for family-oriented vehicles. Therefore, marketing efforts should emphasize the spaciousness and practicality of the vehicles to appeal to this segment.

Demographic:

Top Speed & Range: Consumers are willing to pay more for cars with higher top speeds and longer ranges, suggesting a demand for high-performance electric vehicles. Therefore, marketing should highlight the exceptional performance capabilities of the vehicles.

Efficiency: Segments showing higher efficiency preferences indicate a market trend towards environmentally conscious and cost-effective vehicles. Marketing should emphasize the sustainability and economic benefits of electric vehicles.

Psychographic:

Price Range: The identified price range (16,00,000 to 1,80,00,000) suggests a target segment interested in premium electric vehicles. Therefore, marketing strategies should focus on positioning the brand as a provider of luxury and high-quality electric vehicles.

Target Segment Characteristics: The target segment should be characterized by consumers who prioritize efficiency, performance, and premium features. Marketing messages should resonate with their desire for technologically advanced and environmentally friendly transportation solutions.

Customizing the Marketing Mix:

Price:

Pricing strategies should consider the perceived value of the product within the target segment. Premium features such as high-performance motors, advanced battery technology, and luxurious interiors justify a higher price point.

Product:

Product development should focus on continuous innovation to maintain a competitive edge. Features like fast charging capabilities, extended range, smart connectivity, and autonomous driving functionalities can enhance the product's appeal to the target segment.

Place:

Distribution channels should prioritize accessibility and exclusivity. Partnering with reputable dealerships and establishing flagship stores in premium locations can enhance brand visibility and create a luxurious buying experience for customers.

Promotion:

Marketing campaigns should leverage multiple channels to reach the target segment effectively. Emphasizing the product's unique selling propositions, such as performance, sustainability, and luxury, through digital marketing, experiential events, and collaborations with influencers, can effectively engage the target audience.

LINK TO CODE:

<https://github.com/ryn006/EV-Market-Segmentation/blob/main/dataset3.ipynb>

CONCLUSION:

Based on the analysis, the optimal target segment for electric cars comprises vehicles with 5 seats, prioritizing high performance in terms of top speed and range, along with exceptional efficiency. This segment values cars priced between 16,00,000 to 1,80,00,000 lakhs, indicating a balance between affordability and quality.

COMBINED CONCLUSION:

Combining the insights from both conclusions, our comprehensive market segmentation solution for the electric vehicle market involves targeting two main segments: Segment 1 and Segment 2. Segment 1, representing 39% of consumers, exhibits various preferences and areas of dissatisfaction, while Segment 2, comprising 33% of consumers, prioritizes features like visual appeal, reliability, and comfort. To effectively cater to these segments, a customized marketing mix is essential.

Product customization will focus on enhancing features to address the specific desires of each segment. For Segment 1, resolving dissatisfaction points is paramount, while Segment 2 demands emphasis on visual appeal and value for money. Competitive pricing strategies will ensure affordability for Segment 1 and reflect value-added features for Segment 2. Promotional efforts will be tailored to highlight affordability and reliability for Segment 1 and premium features for Segment 2. Distribution channels will be established to cater to urban areas for Segment 1 and suburban/semi-urban regions for Segment 2, with a robust online presence for both.

Additionally, understanding the potential early market customer base reveals Segment 1's larger market share and higher profit potential, making it advisable to prioritize early market penetration efforts towards this segment. Ultimately, our target segment should focus on electric cars with 5 seats, emphasizing high performance (top speed & range) and efficiency within the price range of 16,00,000 to 1,80,00,000 lakhs. By aligning our strategies with these insights, we can effectively address the diverse needs and preferences of the target market, maximizing market penetration and profitability in the electric vehicle market.