**EV VEHICLE SEGMENTATION**

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# INTRODUCTION

The Electric Vehicle (EV) market encompasses the production, sale, and adoption of vehicles that run primarily or entirely on electric power, as opposed to traditional internal combustion engines fuelled by gasoline or diesel. EVs utilize electric motors powered by rechargeable batteries or other sources of electricity, offering a cleaner and more sustainable alternative to conventional vehicles.

Trend Shaping the EV Landscape:

A notable trend shaping the EV landscape in India is the influx of new foreign players alongside established Indian companies transitioning to EVs. Companies such as Tesla, renowned for its groundbreaking electric car models, have set their sights on the Indian market, signalling a paradigm shift in the country's automotive industry. Tesla's entry into India has sparked considerable anticipation and excitement, underscoring the growing global recognition of India's potential as a key market for EVs. In addition to Tesla, several other foreign players have also ventured into the Indian EV market, bringing with them advanced technologies and innovative offerings. Companies like Nissan, with its expertise in electric vehicles, and Hyundai, known for its commitment to sustainability, have made significant strides in introducing EV models tailored to the Indian consumer preferences.

Market Segmentation:

Market segmentation is a fundamental concept in marketing that involves dividing a heterogeneous market into smaller, more homogeneous segments based on certain characteristics such as demographics, psychographics, behaviour, or geographic location. By identifying and understanding the distinct needs, preferences, and behaviours of various customer segments, companies selling EV can tailor their products, services, and marketing strategies to effectively target and serve each segment.

1. **FERMI ESTIMATION (BREAKDOWN OF PROBLEM STATEMENT)**

Understanding the landscape of India's electric vehicle (EV) market is pivotal for a startup contemplating entry. This involves delineating market segments, such as passenger cars, commercial vehicles, and two-wheelers, while grasping the market dynamics, key players, and regulatory frameworks shaping the industry. Overcoming data collection challenges, including availability and reliability, is paramount for effective market segmentation. Prioritizing segmentation factors like geographic location, income levels, and lifestyle preferences aids in targeting specific consumer groups accurately.

Estimating segment sizes is crucial for resource allocation and strategic planning, requiring an understanding of population distribution and relevant demographic data. Feasibility assessments are essential to gauge the viability of entering each segment, considering market size, growth potential, competition, and regulatory hurdles. Selecting target segments based on criteria like market size, growth potential, and strategic fit ensures optimal resource utilization and market penetration.

Developing a structured strategy entails defining product differentiation, marketing approaches, distribution channels, pricing strategies, and partnerships tailored to each segment's needs. Crafting a detailed implementation plan with clear timelines, milestones, and performance metrics ensures effective execution. Flexibility to adapt to evolving market dynamics and continuous evaluation are imperative for success in India's rapidly evolving EV market.

ESTIMATING INDIAN EV MARKET SIZE:

With a 0.1% penetration rate of India's 1.4 billion population buying EVs this year, if each EV averages ₹8 lakh, the Indian EV market in 2024 could be roughly ₹11.2 lakh crore. This is a ballpark figure, and the actual market size could range between ₹5.6 lakh crore and ₹16.8 lakh crore depending on market variations.

## DATA COLLECTION

## For the purpose of conducting market segmentation analysis in the Electric Vehicle (EV) market, a dataset was collected from Kaggle. The dataset contains information on 8128 customers and includes the following 13 features:

## Name: The name of the vehicle model.

## Year: The manufacturing year of the vehicle.

## Selling Price: The price at which the vehicle was sold.

## Kilometres Driven: The total distance travelled by the vehicle in kilometres.

## Fuel: The type of fuel used by the vehicle that are petrol, diesel.

## Seller Type: The type of seller that are individual, dealer.

## Transmission: The transmission type of the vehicle that are manual and automatic

## Owner: The number of previous owners of the vehicle.

## Mileage: The fuel efficiency of the vehicle in kilometres per Liter (kmpl).

## Engine: The engine capacity of the vehicle in cubic centimetres (cc).

## Max Power: The maximum power output of the vehicle's engine in horsepower (BHP).

## Torque: The torque produced by the vehicle's engine.

## Seats: The number of seats in the vehicle.

The dataset provides a comprehensive overview of customer preferences, vehicle specifications, and transaction details, which are essential for conducting segmentation analysis and identifying distinct customer segments within the Indian Vehicle Market. The inclusion of features such as selling price, mileage, engine capacity, and transmission type enables a thorough examination of factors influencing purchasing decisions and market trends in the Vehicle Industry.

## 3 DATA PRE-PROCESSING

Data pre-processing is a crucial step in preparing the dataset for segmentation analysis, ensuring data quality, consistency, and suitability for further analysis.

3.1 LIBRARIES USED

* **Pandas:** Pandas is a powerful data manipulation library in Python, widely used for handling structured data and performing various data operations such as reading, cleaning, filtering, and transforming tabular data.
* **Scikit-learn:** Scikit-learn is a comprehensive machine learning library in Python, offering a wide range of tools and algorithms for data preprocessing, modelling, and evaluation. It provides efficient implementations of encoding techniques (for categorical data) and scaling methods that is Standard Scaler here.

3.2 STEPS IMPLEMENTED

* **Dropping Entries with Missing Data:**

Missing data can adversely affect the accuracy and reliability of segmentation analysis. Entries with missing values in any of the selected features were dropped from the dataset to ensure data completeness.

* **Postfix Removal from Columns:**

Some columns contained postfixes such as "BHP" (Brake Horsepower) and "CC" (Cubic Centimetres), which needed to be removed to convert the data to numerical format.

* **Conversion of Float Columns to Integer:**

Columns such as mileage, engine, max\_power, and seats were originally stored as float data types. To facilitate further analysis, these columns were converted to integer data types.

* **Encoding Categorical Data:**

Categorical data, such as transmission and owner, were encoded using techniques such as one-hot encoding or label encoding to convert them into numerical format suitable for analysis.

* **Feature Selection:**

Out of the original 13 features, only 7 features were selected for segmentation analysis based on their relevance and significance in predicting customer segments.

Selected Features: 'selling\_price', 'mileage', 'engine', 'max\_power', 'seats', 'owner', 'transmission'

* **Scaling of Features:**

To ensure uniformity and comparability of features, the selected features were scaled using the StandardScaler method, which standardizes the features by removing the mean and scaling to unit variance.

## 4 SEGMENT EXTRACTION

Segment extraction in market segmentation analysis involved employing the Elbow Method to determine the optimal number of segments, which indicated 4 segments as the most suitable choice based on the within-cluster sum of squares (WCSS) reduction. Subsequently, the K-means clustering algorithm was utilized to partition the pre-processed dataset into 4 distinct segments, enabling the identification of customer groups with shared characteristics or behaviour’s. Additionally, the K-nearest neighbour’s (KNN) algorithm, including its variant KNN++, was applied to assign data points to segments based on their nearest neighbour’s in the feature space, facilitating the extraction of meaningful clusters. By combining these techniques, we successfully extracted segments within the electric vehicle market, providing valuable insights for targeted marketing strategies and product development initiatives tailored to diverse customer preferences and needs.

1. **PROFILING AND DESCRIBING POTENTIAL SEGMENTS**

The aim of the profiling step is to gain insight into the market segments resulting from the extraction process. Profiling becomes essential when employing data-driven market segmentation techniques. While the segmentation solution may determine segments based on consumer benefits sought, the specific characteristics of these segments remain unknown until data analysis is conducted.

Following the application of the K-means clustering algorithm to segment the electric vehicle market dataset, the resulting clusters were analysed to profile and describe potential segments based on their characteristics and behaviour’s. The dataset was partitioned into four segments, with the following distribution of entries: Segment 0 (1208 entries), Segment 1 (610 entries), Segment 2 (2122 entries), and Segment 3 (3966 entries).

1. **SELECTION OF TARGET SEGMENT**

In the Indian electric vehicle (EV) market, choosing the target segment involves considering key factors such as consumer preferences, market size, and competitive landscape. With India's growing adoption of EVs and supportive government policies, segments offering a balance of market opportunity, competitive advantage, and strategic fit are prioritized. This includes assessing demographic profiles, purchasing behaviour, and lifestyle preferences to identify segments aligned with the company's strengths and resources. Targeting segments with desirable features like an average vehicle price, four seats, and good engine specifications caters to the preferences of Indian consumers, facilitating market penetration and long-term growth. By aligning with these criteria, companies can effectively allocate resources and drive success in the dynamic Indian EV market.

1. **CUSTOMISING THE MARKET MIX**

Let’s assume a new EV vehicle company with good market analysing made a good business in the market, and were able to target 40 percent of the Indian market.

Indian market size for Vehicles by applying Fermi Estimation:

Range between ₹5.6 lakh crore and ₹16.8 lakh crore

Potential Customer Base (PCB): 0.5 million Your Target Price Range (TPR): ₹8 lakh to ₹12 lakh

Therefore,

Lower Bound of Potential Profit (PP\_LB):

PP\_LB = 0.5 million \* ₹8 lakh = ₹4,000 crore

Upper Bound of Potential Profit (PP\_UB):

PP\_UB = 0.5 million \* ₹12 lakh = ₹6,000 crore

Therefore, the potential profit in the early market could range **between ₹4,000 crore and ₹6,000 crore**, depending on market variations.

The most optimal market segment to open in the market as per the Market Research and Segmentation is **Segment 3.**