EV MARKET SEGMENTATION

BY ROSHAN JACOB TOM

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DATASET USED

- EV CHARGING STATIONS
- TOTAL SALES TILL 2023
- EV_ CARS SALES DATA

	Year	Two Wheeler	Three Wheeler	Four Wheeler
0	2020	152000	140683	168300
1	2021	143837	88378	134821
2	2022	231338	384215	429217

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charging_stations
```

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	Region	2W	3W	4W	Bus	Chargers
0	Uttar Pradesh	9852	42881	458	197	207
1	Maharashtra	38558	893	1895	186	317
2	Karnataka	32844	568	589	57	172
3	Tamil Nadu	25642	396	426	0	256
4	Gujarat	22359	254	423	22	228
5	Delhi	11756	5287	1578	186	72
6	Bihar	2388	10783	89	36	37

	Top speed (km/hr)	Price (INR)	Full charging time (HR)	Fuel Type	Battery capacity [kWh]	Range (km/hr)	Kerb weight (KG)	Fast Charging	Drive Type	Wheelers type	Number of Seats	Type of brakes	Max Torque (N-M)	Income
0	85.00000	1.340000e+05	4.500000	Electric	4.000000	150.000000	108.000000	Yes	Belt Drive	Two wheeler	2.0	Disc	170.00000	Medium (Lakhs)
1	65.00000	4.072549e+06	4.200000	Electric	2.700000	180.000000	101.000000	Yes	Hub Drive	Two wheeler	2.0	Disc	346.74958	Medium (Lakhs)
2	100.00000	1.924990e+05	5.000000	Electric	4.000000	180.000000	1506.382114	No	FWD	Two wheeler	2.0	Disc	28.00000	Medium (Lakhs)
3	105.00000	2.074990e+05	5.000000	Electric	4.000000	180.000000	1506.382114	Yes	FWD	Two wheeler	2.0	Disc	38.00000	Medium (Lakhs)
4	100.00000	1.029990e+05	2.000000	Electric	4.400000	200.000000	110.000000	Yes	Belt Drive	Two wheeler	2.0	Disc	346.74958	Medium (Lakhs)
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
182	129.76259	4.072549e+06	7.344911	NaN	41.355385	293.126929	1506.382114	NaN	FWD	NaN	NaN	disc (front + rear)	346.74958	Medium (Lakhs)
183	129.76259	4.072549e+06	7.344911	NaN	41.355385	293.126929	1506.382114	NaN	FWD	NaN	NaN	disc (front + rear)	346.74958	Medium (Lakhs)
184	129.76259	4.072549e+06	7.344911	NaN	41.355385	293.126929	1506.382114	NaN	FWD	NaN	NaN	disc (front + rear)	346.74958	Medium (Lakhs)
185	129.76259	4.072549e+06	7.344911	NaN	41.355385	293.126929	1506.382114	NaN	FWD	NaN	NaN	disc (front + rear)	346.74958	Medium (Lakhs)
186	129.76259	4.072549e+06	7.344911	NaN	41.355385	293.126929	1506.382114	NaN	FWD	NaN	NaN	disc (front + rear)	346.74958	Medium (Lakhs)

187 rows × 14 columns

INFERENCE

2.1 ML Model Used

In my second project, K-Means clustering was applied for market segmentation. Specifically, K-Means was used to group Electric Vehicle (EV) data into clusters, as highlighted in the code snippets. You determined the optimal number of clusters using the elbow method and subsequently created 3 clusters for analysis.

Why K-Means?

- K-Means is highly effective for market segmentation because it helps identify natural groupings in the data based on key features like vehicle price, range, battery capacity, and charging time.
- It enables the grouping of similar vehicles, which can then be targeted by different marketing strategies based on their characteristics.

2.2 Conclusion & Insights from the Research

- **Cluster Analysis**: Three primary clusters were identified in your segmentation:
    - Cluster 0: Composed mainly of low-priced, lower-range EVs, suitable for consumers looking for cost-effective solutions.
    - Cluster 1: A premium segment with high-price EVs, such as luxury cars and buses.
    - Cluster 2: Mid-range EVs, balancing cost and performance.
- **Vehicle Range & Charging Time**: The analysis showed a correlation between vehicle range and charging time, with mid-range and high-range EVs requiring more charging time but providing better performance.
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- **Market Segments**: These clusters allowed you to distinguish between customer segments, such as budget-conscious buyers, premium buyers, and those seeking mid-range performance.

2.3 Improvements with Additional Time & Budget

Given more time and budget, the project could benefit from:

- **Expanded Datasets**: Purchase additional datasets with columns such as **customer demographics (age, income level, region)** and **purchase behavior**. These can provide richer insights into the target market.

    - **Desired Columns**: Customer region, past vehicle ownership, preferred features (e.g., design, comfort, environmental impact), and charging infrastructure usage would be valuable.

- **Additional Models to Try**:
    - **Hierarchical Clustering**: To see if the natural hierarchies within the data can yield finer distinctions between segments.
    - **DBSCAN**: To capture non-spherical clusters or outliers in the dataset that K-Means might miss.
    - **Random Forest Classifier**: Post-segmentation, a model like Random Forest could predict customer segments based on new data points.

2.4 Analyzing Market Segments

Market segmentation can be broken down into several key categories:

1. Geographic Segmentation
This method involves grouping customers based on their geographic location. Factors such as region, climate, and proximity to amenities like charging stations influence consumer preferences. Understanding geographic segmentation helps businesses target where to sell, advertise, and expand.

Charging Stations by State: The availability of charging stations in various states can heavily impact EV purchasing decisions. Consumers in states with more charging stations are more likely to buy EVs compared to those with fewer stations.

2. Demographic Segmentation
Demographic segmentation divides the market according to factors such as age, income, occupation, education, and family size. This type of segmentation is widely used as it provides insights into customer behavior and spending capacity.

Income: Income level significantly influences purchasing decisions. Higher-income individuals tend to prefer luxury vehicles, while lower-income buyers seek cost-effective solutions.

Family Size: Family size also plays a role in vehicle choice. Larger families may opt for four-wheeler, while smaller families or individuals might prefer two-wheeler.

3. Psycho-graphic Segmentation

Psycho-graphic segmentation focuses on consumers' lifestyles, interests, attitudes, and behaviors. This approach helps companies understand the reasons behind consumers' decisions.

Lifestyle: Time-conscious consumers may prioritize vehicles with shorter charging times.

Interests: Some customers may have a preference for specific manufacturers, like Tata Motors, based on brand loyalty.

Behavior: Consumer behavior varies based on specific needs. For example, some may prioritize vehicles with long-range capabilities per charge.

Customizing the Marketing Mix

The marketing mix consists of four key elements (4Ps) that companies use to promote their products or services:

Price: Determined by production costs, target market, supply and demand, and other factors, pricing strategies can vary depending on the business plan.

Product: The product must meet a minimum performance level to satisfy consumer expectations.

Place: The point of sale is crucial. Strategic locations can enhance visibility and ease of purchase.

Promotion: Promotional activities, including advertising, consumer schemes, and direct marketing, help raise awareness and drive sales.

Each element of the marketing mix influences the others, forming the foundation of a successful business plan.

2.5 Target Segment

Target marketing involves identifying key segments and focusing efforts on those most aligned with the product or service. This strategy helps attract new customers, increase sales, and grow the business.

Based on the data, factors such as range, top speed, full charging time, income, and vehicle type are key drivers behind consumer decisions when purchasing an EV. These categories create distinct market segments, each with its own preferences and motivations.

2.6 Estimated Market Size (Non-Segmented)

- Based on available data, the number of electric vehicles and chargers in India provides an approximation of market size. For example, the total number of EVs across segments is **303,292 vehicles**, with **2,563 charging stations**.

- A more detailed estimate of the market size could be drawn by factoring in annual sales data and EV adoption rates, which could exceed **300,000 EVs** annually in a rapidly growing market.

2.6 Top 4 Variables for Market Segmentation

Based on your analysis, the most influential variables for creating market segments are:

- **Price (INR)**: Directly linked to income levels and the ability to purchase higher-end or budget vehicles.
- **Range (km/hr)**: Determines how practical a vehicle is for daily commutes versus long trips.
- **Battery Capacity (kWh)**: A strong indicator of the performance and longevity of the vehicle.
- **Charging Time (HR)**: A key factor for convenience and usability.

2.7 Recommendations and Learnings

EV adoption in India has significantly increased in recent years, driven by rising fuel prices and the efficiency of electric vehicles.

Globally, the electric vehicle market is projected to grow from 8,151 thousand units in 2022 to 39,208 thousand units by 2030, with a compound annual growth rate (CAGR) of 21.7%. Growing demand for low-emission vehicles, along with government support in the form of subsidies and tax rebates, is encouraging manufacturers to expand their EV offerings worldwide.

Governments are also investing in EV infrastructure, such as charging stations and hydrogen fueling stations, and offering incentives to buyers, creating opportunities for original equipment manufacturers (OEMs) to expand their reach and revenue.

From this analysis, we see that different market segments—based on geography, demographics, and psychographics—play a critical role in shaping consumer purchasing behavior. For example, geographic segmentation shows that consumers in states with more charging stations are more likely to purchase EVs, while those in states with fewer stations may be hesitant.

Demographic segmentation highlights that consumer preferences vary based on education, financial status, and vehicle purpose. Consumers looking to transport goods across regions may prioritize range and cargo space, while others may focus on affordability and cost-effectiveness.

Lastly, psychographic segmentation emphasizes that while some consumers seek satisfaction from a premium product, others may opt for a more budget-friendly option that meets their basic needs.