

Market Segmentation Analysis of Electric Car Data

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Abstract:

This dataset contains information about different electric vehicles (EVs). It includes the **brand** and **model** of each vehicle, along with details about how fast they can accelerate, their **top speed**, and how far they can go on a full charge. The dataset also shows how much energy each vehicle uses to travel one kilometer, and how fast they can be charged using a fast charger. It tells us if the car can use **rapid charging**, what kind of **charging plug** it uses, and the type of **powertrain** (like all-wheel drive or rear-wheel drive). Other information includes the car's **body style** (such as Sedan, Hatchback, SUV, or pickup), the **market segment** it belongs to, the number of **seats** in the vehicle, and the **price** in euros. This dataset helps to compare different electric vehicles based on their features, efficiency, and price.

Data: <https://drive.google.com/file/d/1wcKiAffm2y7Al-yCDquMLzNMr-Oc8Rg/view?usp=sharing>

Code link:

<https://drive.google.com/file/d/199sNgCp2iIDlyG0FIDqkqtjBbeK0YciG/view?usp=sharing>

1. Introduction

The electric vehicle (EV) market is expanding rapidly, with a broad variety of models offering different features and benefits. To effectively serve customers, it's crucial to segment the market based on consumer needs and preferences. This report segments the EV market based on key vehicle features such as acceleration time, range, efficiency, charging speed, and price, helping to identify distinct customer groups.

2. Data Overview

The data provided includes specifications of several EV models, including:

Brand: The vehicle's manufacturer (e.g., Tesla, Porsche, Audi)

Model: The specific model name of the vehicle

AccelSec: Time taken to accelerate from 0 to 100 km/h (lower values indicate faster acceleration)

TopSpeed_KmH: Maximum speed of the vehicle in km/h

Range_Km: The driving range on a full charge, measured in kilometers

Efficiency_WhKm: Energy consumption per kilometer (Wh/km), with lower values indicating higher efficiency

FastCharge_KmH: Kilometers added per hour with fast charging

RapidCharge: Indicates if the vehicle supports rapid charging

PowerTrain: Type of drivetrain (AWD, RWD, FWD)

PlugType: Type of charging plug compatible with the vehicle

BodyStyle: The vehicle's body design (e.g., Sedan, SUV)

Segment: Market segment category (e.g., A, B, C)

Seats: Number of seats

PriceEuro: Price in Euros

3. Segmentation Criteria

To segment the market effectively, we will use the following criteria based on the data:

Performance: Acceleration, Top Speed, and Efficiency

Charging and Range: Range and Fast Charge capability

Price: Affordability and positioning

Vehicle Type: Body Style, PowerTrain, and Seats

Technology: Rapid Charge and PlugType compatibility

Market Segmentation Analysis Step-by-Step

Step 1: Deciding Whether to Segment the Market

Before dividing the market into groups, we must check if it is necessary and if the EV market is suitable for long-term business.

Is the market suitable?

The EV market is growing fast due to environmental concerns, government support, and new technology.

Different people have different needs—some want affordable cars, others want high speed or long battery life.

Segmentation helps focus on the right customers.

Can we commit to this market for the long term?

The EV market needs long-term investments in battery technology, charging stations, and marketing. Segmentation helps companies focus on the most profitable customer groups.

Step 2: Identifying the Ideal Target Customer

To sell EVs successfully, we must define the best customer group.

What does the ideal customer look like?

People looking for an eco-friendly and energy-efficient car.

Customers willing to invest in smart and advanced features.

Budget-conscious buyers looking for a simple and affordable EV.

Families looking for a safe and spacious vehicle.

High-performance car lovers who want speed and luxury.

Step 3: Collecting Data

We have collected data from a csv file name Electric-car-data and overview of data is below:

```
df.head()
```

	Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_kWhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats	PriceEuro
0	Tesla	Model 3 Long Range Dual Motor	4.6	233	450	161	940	Yes	AWD	Type 2 CCS	Sedan	D	5	55480
1	Volkswagen	ID.3 Pure	10.0	160	270	167	250	Yes	RWD	Type 2 CCS	Hatchback	C	5	30000
2	Polestar	2	4.7	210	400	181	620	Yes	AWD	Type 2 CCS	Liftback	D	5	56440
3	BMW	iX3	6.8	180	360	206	560	Yes	RWD	Type 2 CCS	SUV	D	5	68040
4	Honda	e	9.5	145	170	168	190	Yes	RWD	Type 2 CCS	Hatchback	B	4	32997

We collect data on different factors to divide customers into groups.

1. Segmentation Variables (Used to divide groups):

Performance: Speed, acceleration time.

Energy Efficiency: Battery life, energy consumption.

Charging Capabilities: Fast-charging speed, type of charger.

Price Sensitivity: Affordable vs. premium EVs.

Vehicle Type: Sedan, SUV, compact cars.

2. Descriptor Variables (Used to describe customer groups):

Who is buying? Families, professionals, students, tech lovers.

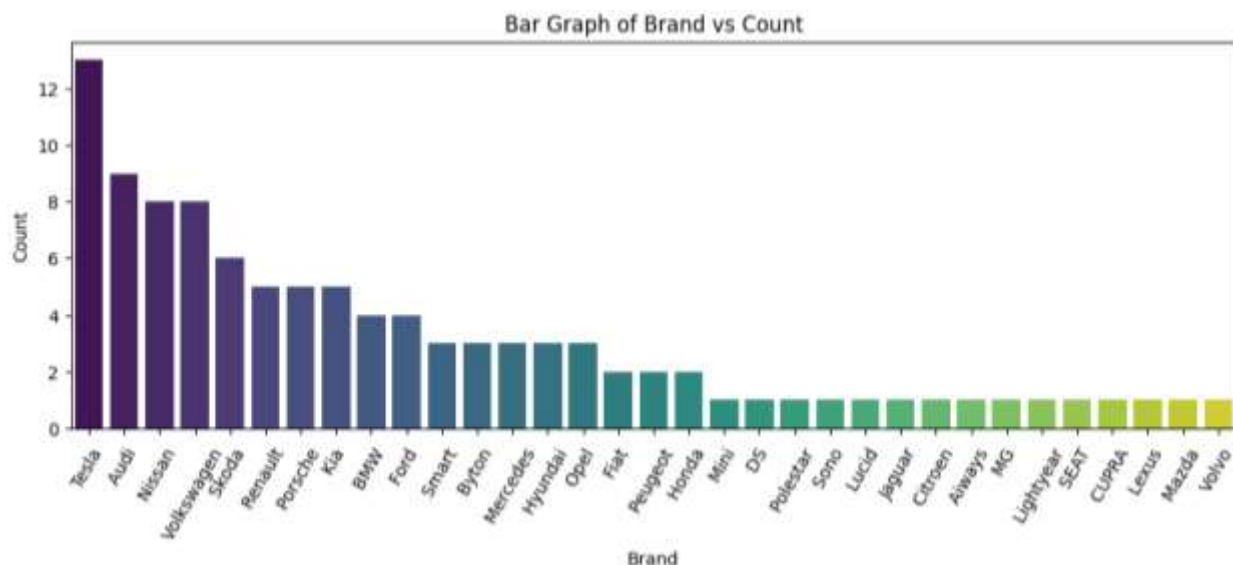
Technology preferences: Smart features, app connectivity, auto-driving features.

Step 4: Exploring the Data

Once data is collected, we clean and prepare it for analysis.

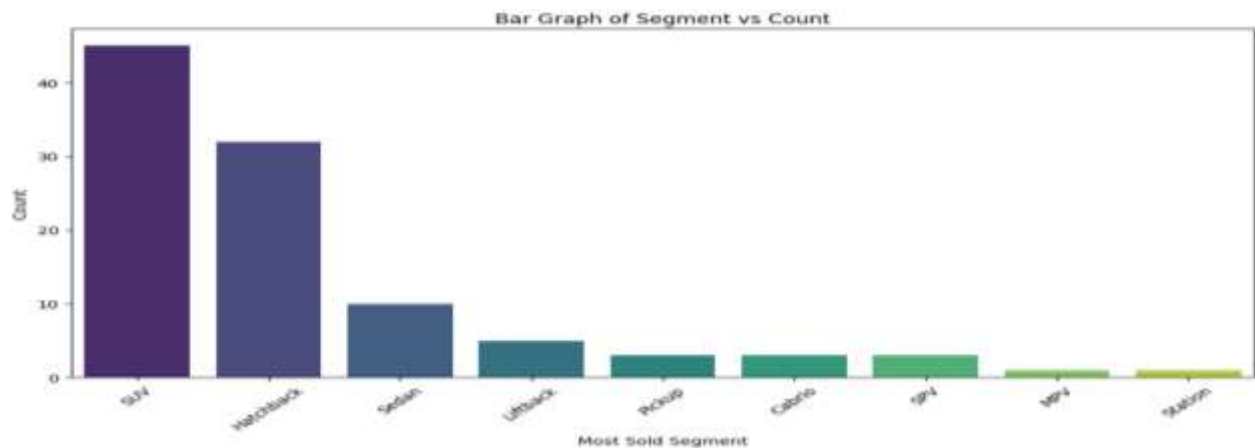
Key Steps in Data Cleaning:

1. Convert 'FastCharge_KmH' to numeric, replacing non-numeric values with NaN
2. Convert 'RapidCharge' to binary (Yes -> 1, No -> 0)
3. Create Bar Plot of brand with their number of vehicles

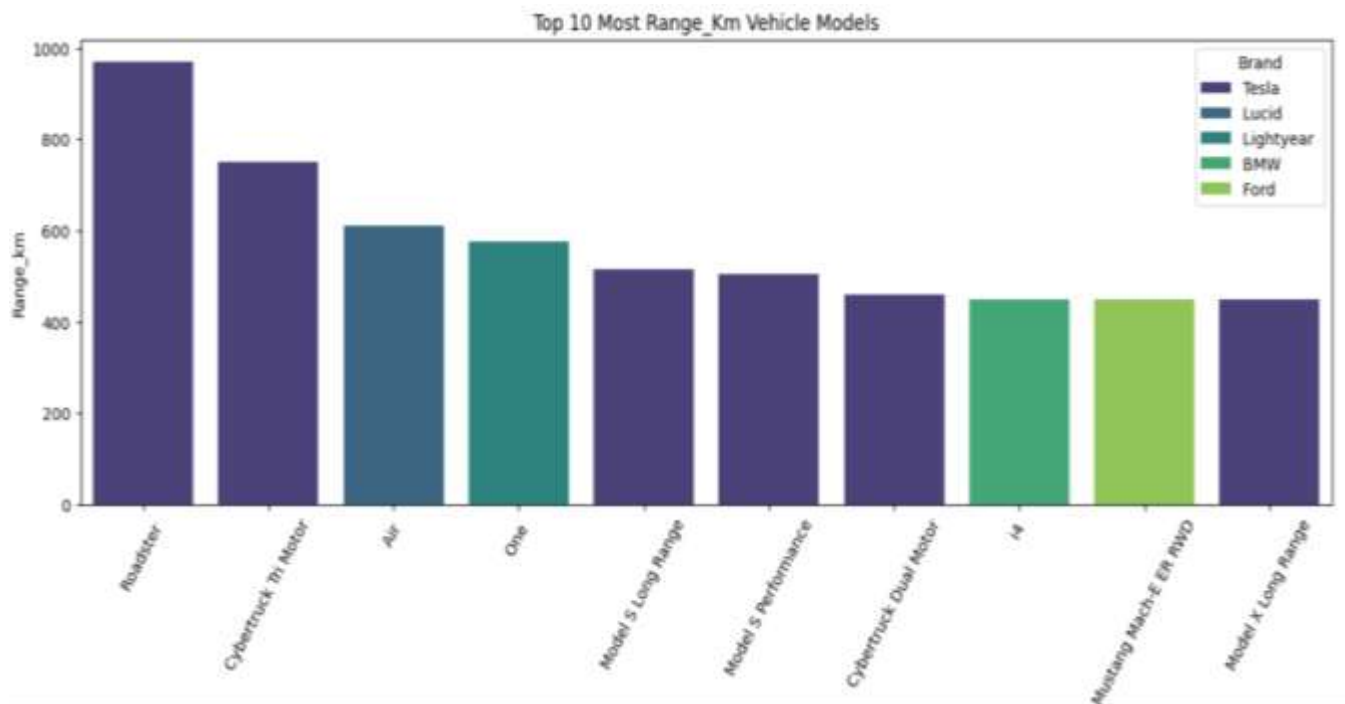


As we can see in bar plot most of the cars are from Tesla brand ,Audi,Nissan,Volkswagen and Skoda respectively.

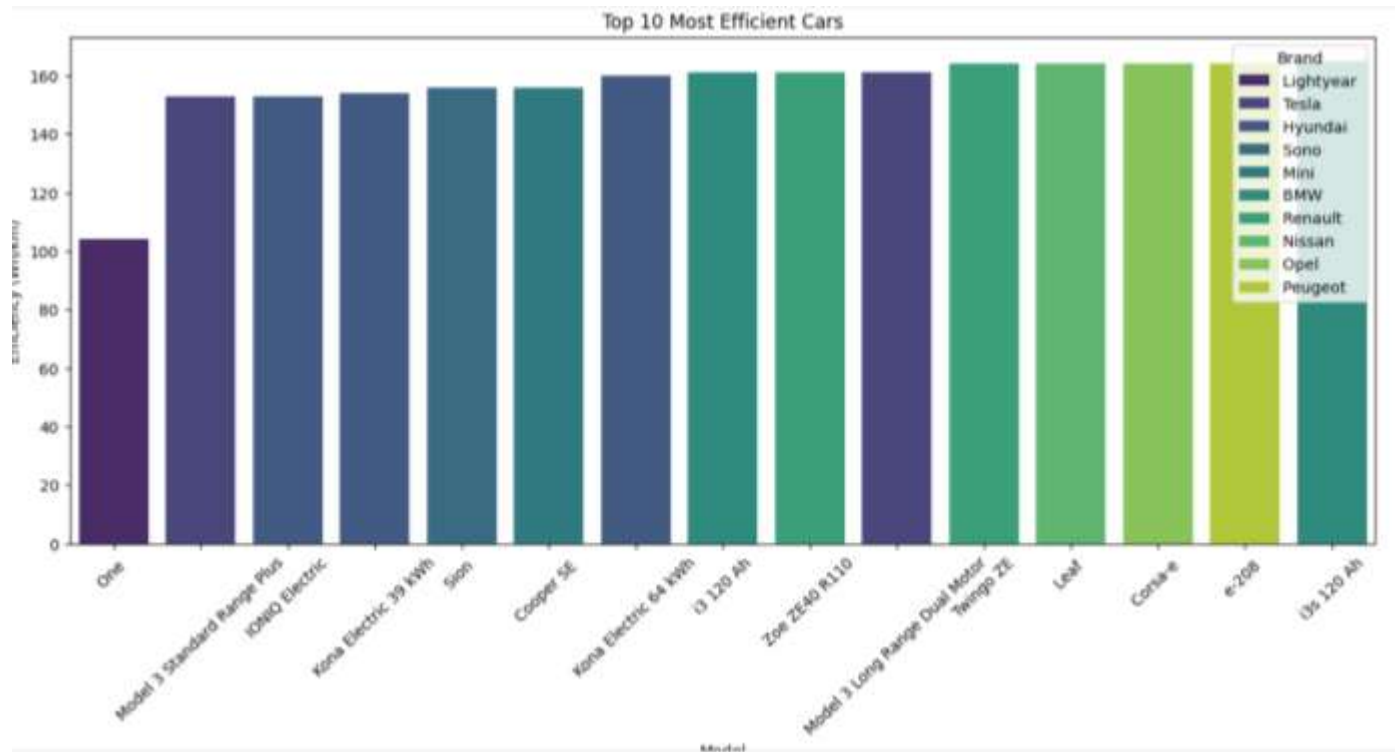
4. We create bar plot of EV Segment where we observed most people buy SUV vehicles.



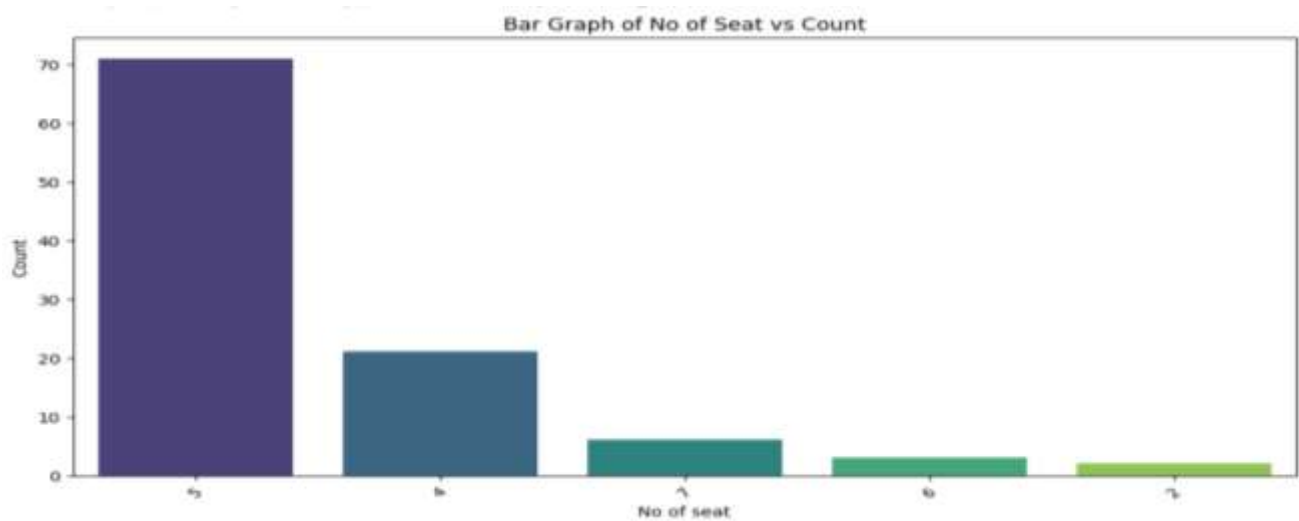
5. We can see in the below plot Tesla brand giving more driving range (upto 970 km) on a full charge than Lucid, Lightyear and BMW.



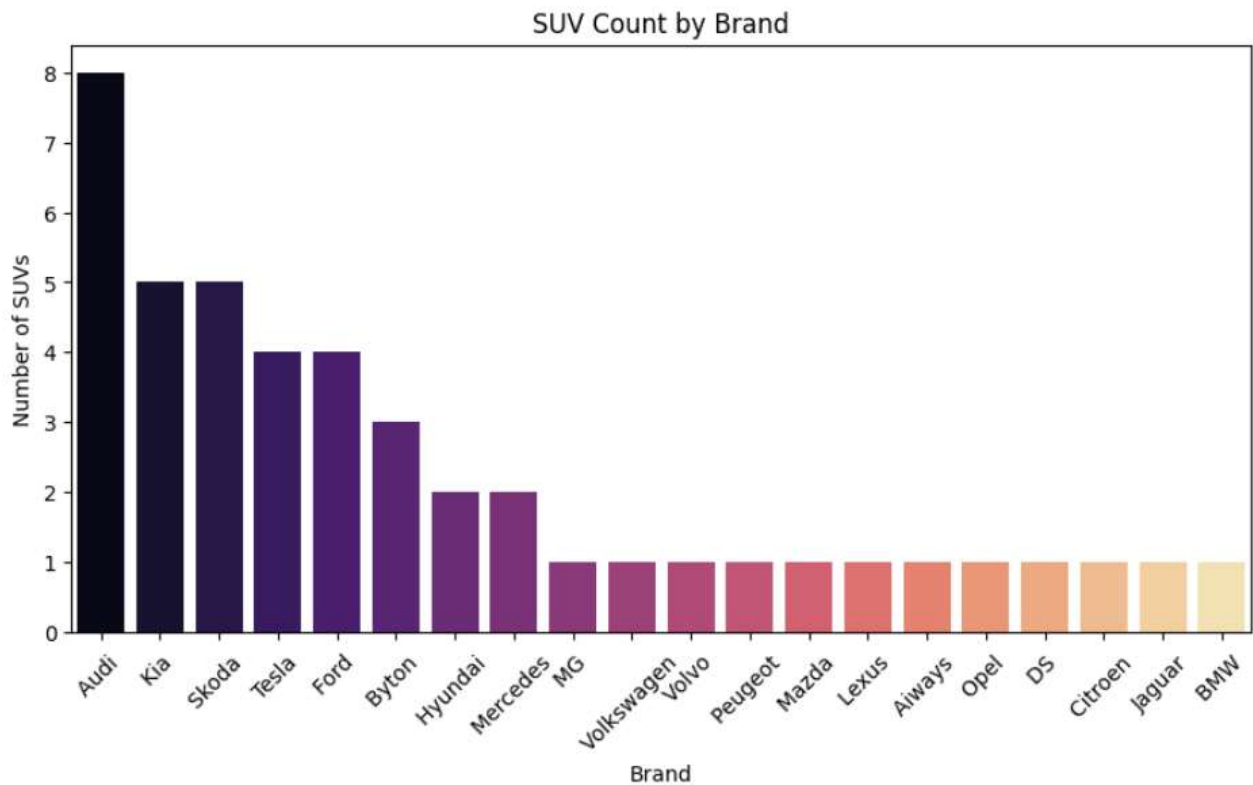
6. When we plot graph between model and efficiency we can observe Car model One from Ligthyear brand giving highest efficiency followed by Model 3 Standard Range Plus from Tesla and IONIQ Electric from Hyundai respectively.



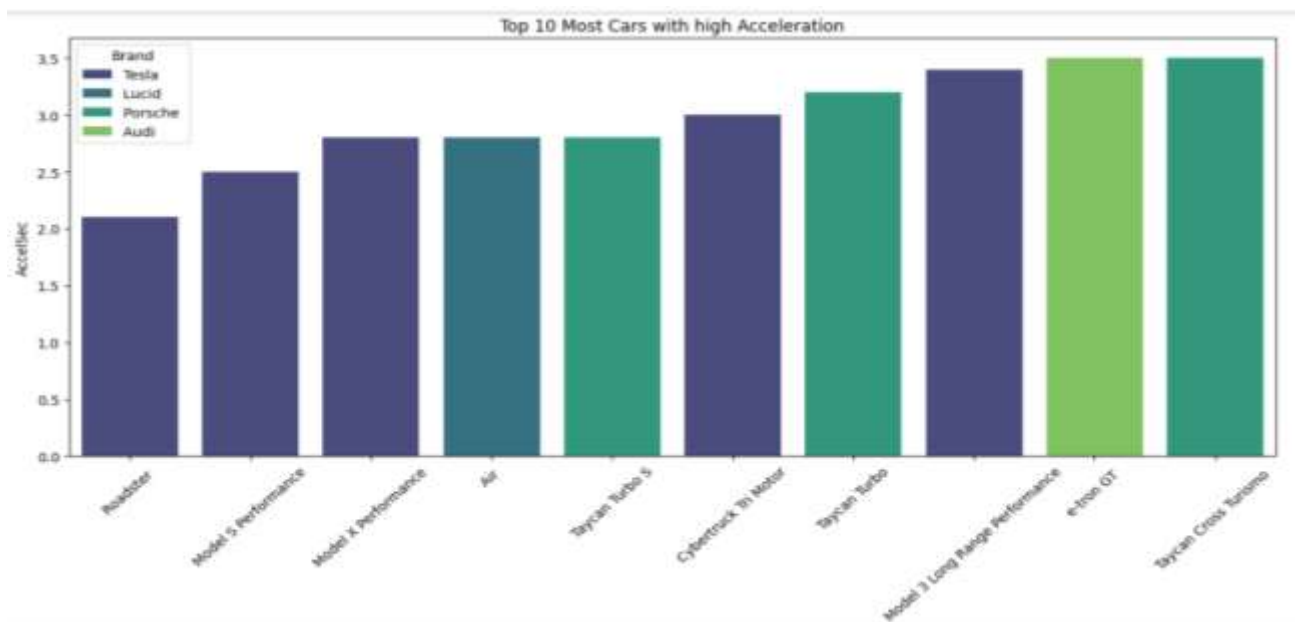
7. When we plot graph based on seating, we see that most of the people like 5 seater cars.



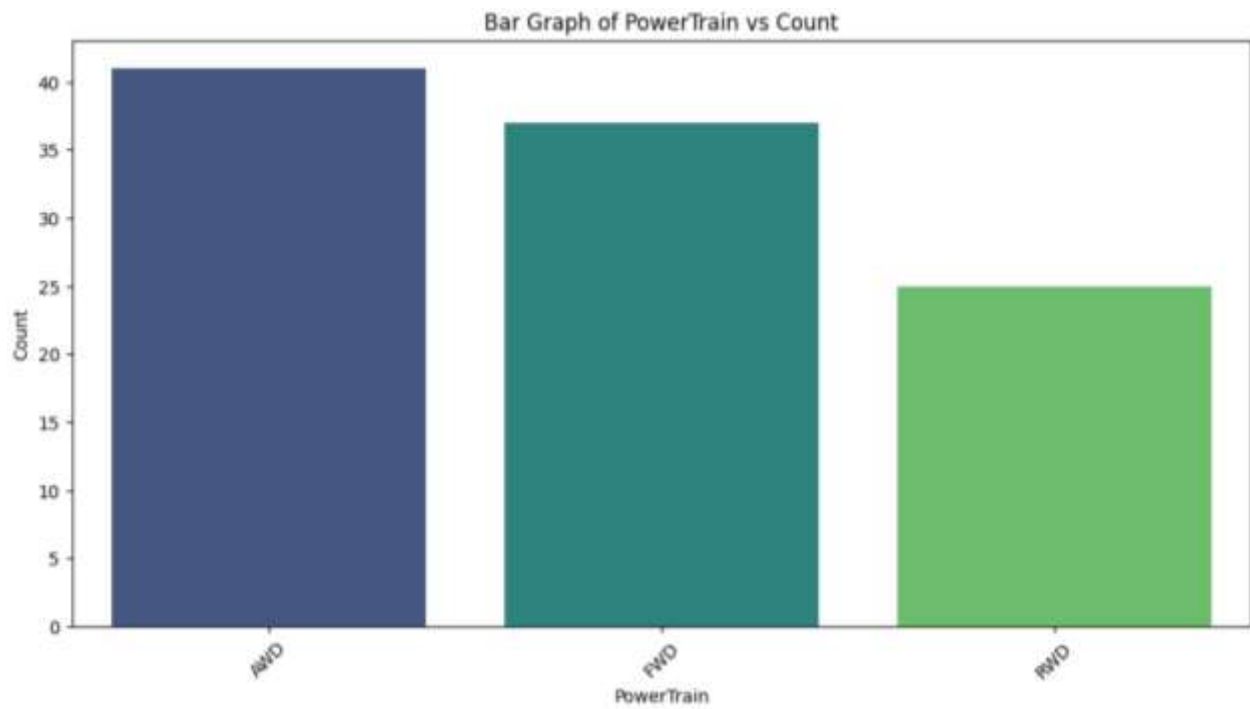
8. We can see from the below graph that Audi brand making more SUV cars followed by other car brands Kia and Skoda and so on.



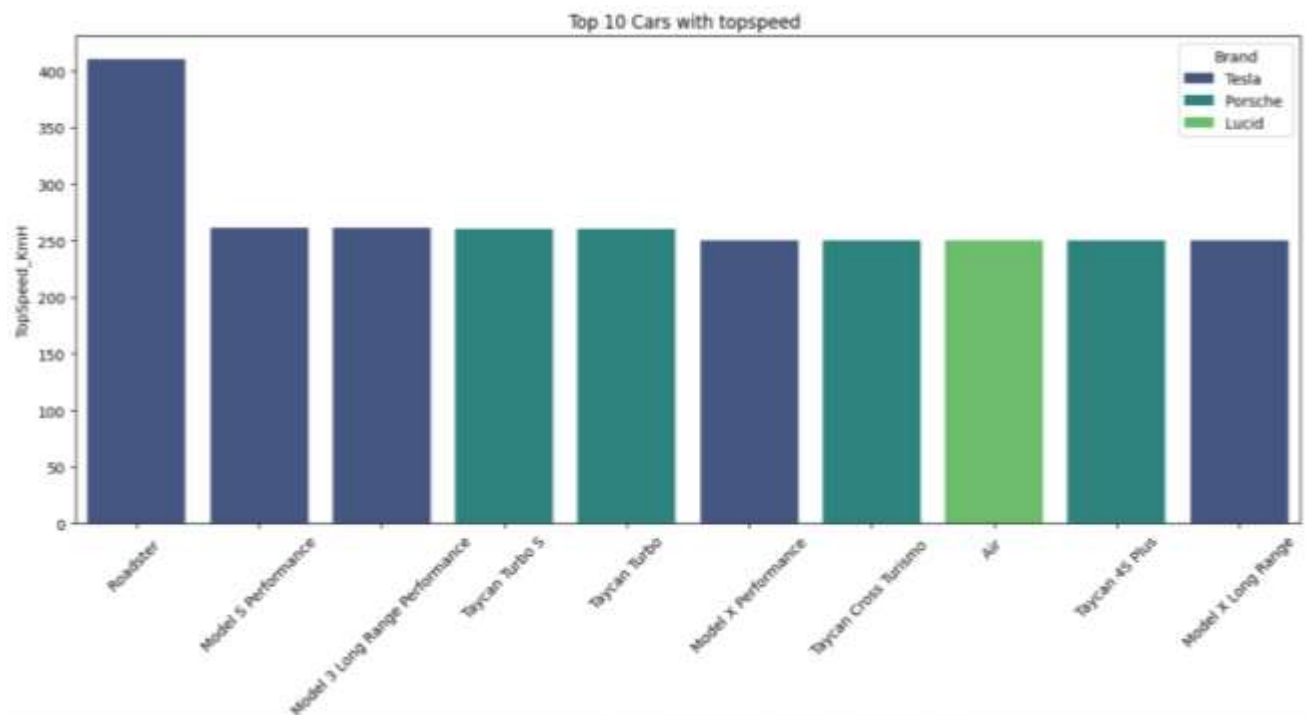
9. As we can see from the below Acceleration Graph Tesla brand have faster acceleration cars.



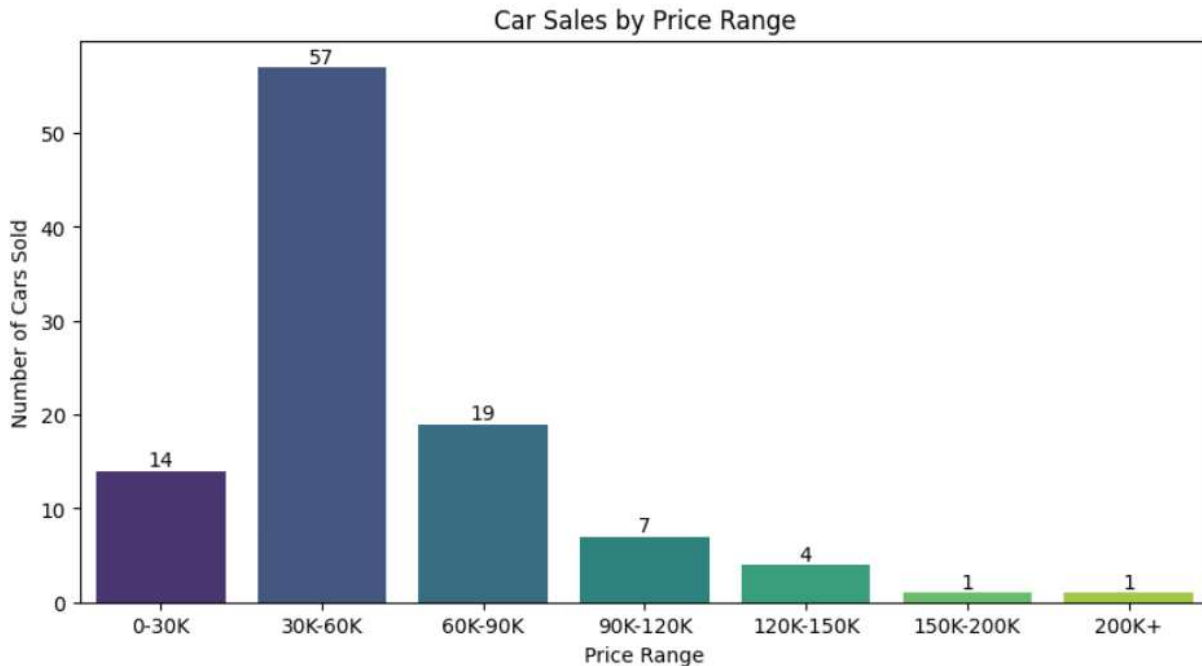
10. From the below graph we can say most people like All Wheel Drive(AWD) cars.



11. From the below bar plot we have observed Tesla Car Brand is manufacturing top speed cars



12. As we can see in the below graph most people are purchasing cars between 30k-60k price range.



What we learn from the data:

Which factors matter most to different buyers.

How price, battery life, and performance are related.

The most common features in different price ranges.

Step 5: Creating Market Segments

1. For market Segments we fill missing values in FastCharge_KmH with the median (since it's a numerical feature)
2. Encode categorical features using one-hot encoding (["PowerTrain", "PlugType", "BodyStyle"])
3. Ordinal Encoding for Segment
4. Drop non-relevant columns for clustering (["Brand", "Model", "Segment", "Price Range"])
5. We divide customers into groups based on their preferences and needs using different methods:

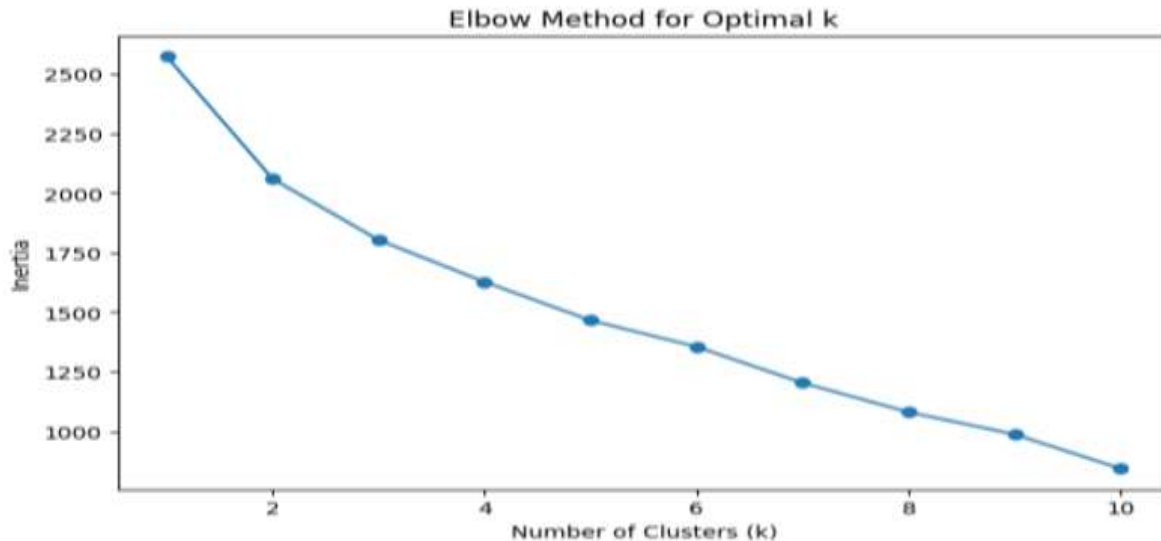
Clustering (Grouping similar customers together):

Apply a clustering algorithm like K-means to identify market segments.

K-means clustering is applied to the preprocessed data to segment the market into clusters

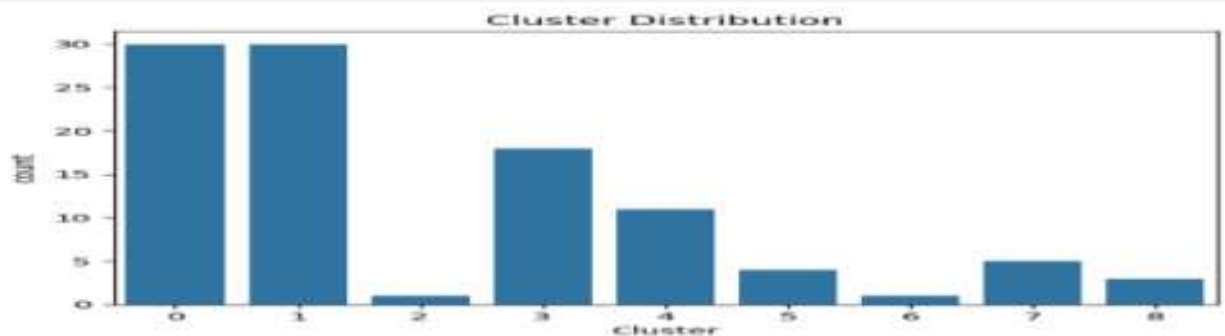
Methods to Determine Optimal Number of Clusters:

Elbow Method: The Elbow Method helps to identify the optimal number of clusters by plotting the **within-cluster sum of squares (WCSS)** for different values of k . The point where the WCSS curve starts to flatten (forming an "elbow") is usually the best number of clusters.

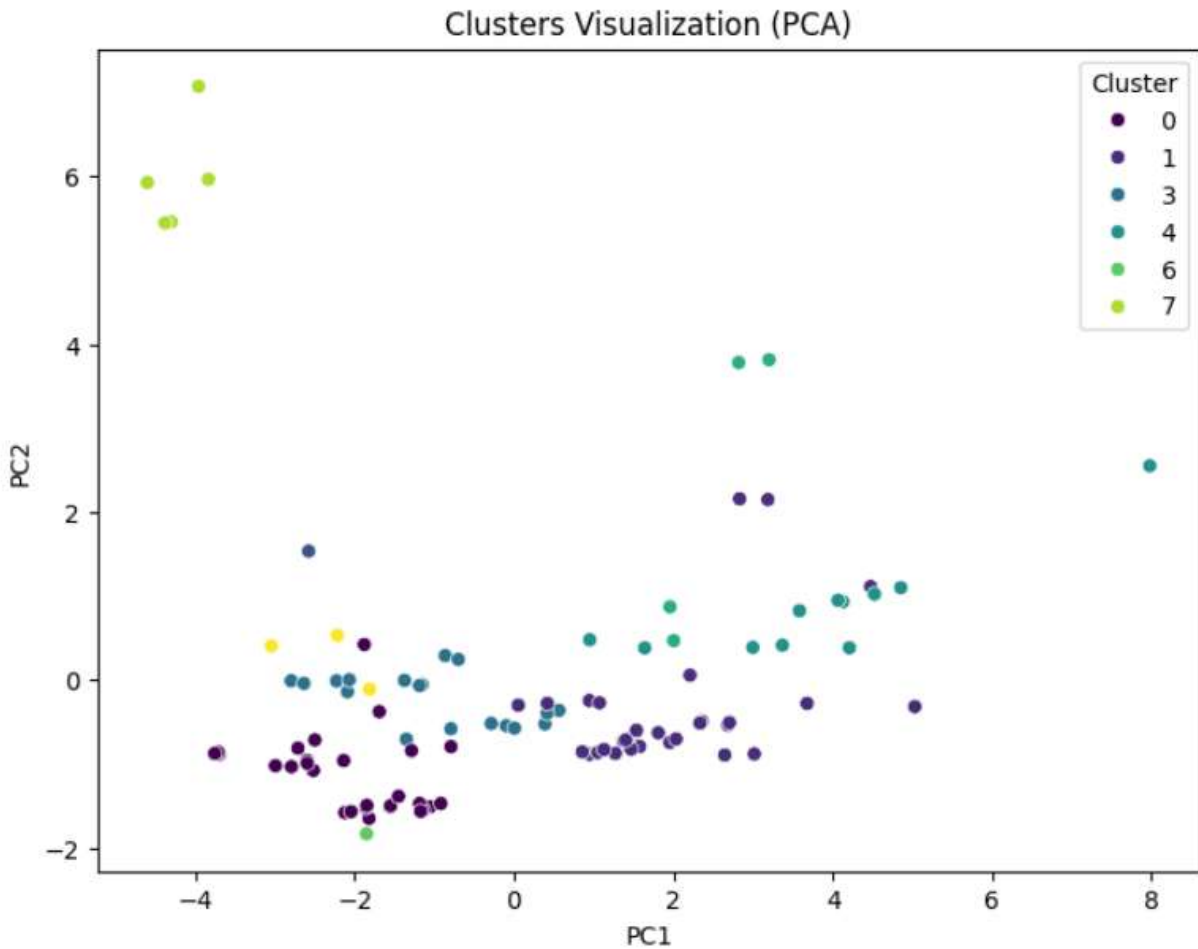


Silhouette Score: The silhouette score measures how similar each point is to its own cluster compared to other clusters. A higher silhouette score indicates better-defined clusters.

Analysis: The resulting segments are analyzed to see how the average features (e.g., price, range, top speed) differ across clusters.



Visualization: A PCA (Principal Component Analysis) is performed to reduce the dimensionality of the features, making it easier to visualize the clusters in a 2D scatter plot.



Step 6: Understanding Each Customer Group

0. Budget Compact EVs: Affordable, shorter range (170-275 km), primarily front-wheel drive, lower acceleration. Eg. Volkswagen e-Up! , SEAT Mii Electric.

1. Performance Luxury EVs: High-end vehicles with excellent range (325-750 km), premium pricing, strong acceleration. Eg. Tesla Model S Long Range ,Tesla Model Y Long Range Performance.

2. Specialized Powertrain Configuration: Unique electric vehicle with distinctive plug or drive characteristics. Eg. Nissan e-NV200 Evalia.

3. Mid-Range RWD Electric Vehicles: Rear-wheel drive, moderate price range, balanced performance and range. Eg. Volkswagen ID.3 Pro, Ford Mustang Mach-E.

4. High-Performance SUVs: Large electric SUVs with exceptional range, rapid acceleration, premium segment. Eg. Porsche Taycan Turbo S, Tesla Roadster.

5. Premium Electric Segment: High-end vehicles with advanced features, longer range, significant pricing. Eg. Tesla Model S Performance, Lightyear One.

6. Multi-Passenger Configurations: Electric vehicles designed for larger passenger capacity, unique segment. Eg. Opel Ampera-e.

7. Low-Cost Limited Range EVs: Minimal range, basic configurations, most economical electric vehicles. Eg. Smart EQ forfour, Renault Kangoo Maxi ZE.

8. Specific Plug Type Vehicles: Electric vehicles with distinctive charging interface or specialized connectivity. Eg. Nissan Leaf, Nissan Leaf e+.

Step 7: Describing the Segments in Detail

Electric Vehicle Segments

1. High-Performance Buyers (Clusters 1 & 4)

- Features: Fast acceleration (2.1-4.6 sec), high price (€55,000-€215,000)
- Characteristics: Long range (365-970 km), AWD, SUV/luxury models
- Typical Examples: High-end Tesla, Porsche-like electric vehicles

2. Eco-Friendly Consumers (Clusters 0 & 7)

- Features: Low cost (€20,000-€40,000), shorter range (170-275 km)
- Characteristics: Efficient urban vehicles, front-wheel drive
- Typical Examples: Hyundai Kona, budget electric models

3. Family-Oriented Buyers (Clusters 6)

- Features: Large seating capacity (6-7 seats), moderate range
- Characteristics: Practical design, balanced performance
- Typical Examples: Larger electric MPVs, family-friendly EVs

4. Budget-Conscious Buyers (Cluster 7)

- Features: Lowest price range (€20,000-€25,000), minimal features
- Characteristics: Very limited range, basic configurations
- Typical Examples: Entry-level electric city cars

5. Tech Enthusiasts (Clusters 2 & 5)

- Features: Premium pricing, advanced charging, unique configurations
- Characteristics: Specialized plug types, smart features
- Typical Examples: Technologically advanced electric vehicles

6. Mid-Range Practical Buyers (Cluster 3)

- Features: Balanced rear-wheel drive, moderate pricing
- Characteristics: Reasonable range (270-450 km), good daily performance
- Typical Examples: Mainstream electric sedans and compact cars

7. Specialized Charging Buyers (Cluster 8)

- Features: Unique charging interfaces, specific connectivity
- Characteristics: Distinctive plug types, niche market vehicles
- Typical Examples: Electric vehicles with non-standard charging options

Step 8: Choosing the Best Target Segments

After analyzing the segments, we select the best ones to focus on:

Eco-Friendly Buyers – More people are choosing green energy.

Tech Enthusiasts – The demand for smart cars is growing.

Family Buyers – Large families need spacious, safe EVs.

Step 9: Creating a Marketing Plan for Each Group

Eco-Friendly Buyers:

Advertise energy savings and government incentives.

Promote long battery life and low emissions.

Tech Enthusiasts:

Highlight smart features like self-driving and fast charging.

Offer app-based car management systems.

Family-Oriented Buyers:

Focus on safety, space, and comfort.

Create finance plans for families.

Step 10: Monitoring Performance

To check if the marketing strategy is working, we track key success factors:

Sales numbers for each segment.

Customer feedback and reviews.

Market trends and competitor analysis.