Electric Vehicle Market Analysis

- Parv Kaul

Problem Statement

The task is to analyze the Electric Vehicles (EV) Market, focusing on segmentation to identify key market opportunities. The aim is to propose a feasible strategy to penetrate the EV market by targeting customer segments based on geographic, demographic, psychographic, and behavioral factors. The analysis considers EV types, region-wise preferences, pricing strategies, and customer behavior to understand market dynamics better.

- What type of EV the company will produce? EV bikes, scoties, hatchbacks, sedans, SUV etc.
- Who are the target customer? i.e. what is age group, income group, professionality, geography etc of the customer.

Data Collection

Data for this analysis was collected from multiple sources, including:

- Kaggle: Datasets providing information on EV specifications, market trends, and customer demographics.
- Web Surfing: Official government and industry reports, articles, and market insights sourced from platforms like PIB, EV Reporter, and industry blogs.

Datasets include:

- EV types, specifications, and manufacturers.
- Customer demographics, including age, income, and profession.
- Geographic data showing regional EV adoption and charging infrastructure distribution.

Dataset 1 Preview:

	Year	Month_Name	Date	State	Vehicle_Class
0	2014.0	jan	1/1/2014	Andhra Pradesh	ADAPTED VEHICLE
1	2014.0	jan	1/1/2014	Andhra Pradesh	AGRICULTURAL TRACTOR
2	2014.0	jan	1/1/2014	Andhra Pradesh	AMBULANCE
3	2014.0	jan	1/1/2014	Andhra Pradesh	ARTICULATED VEHICLE
4	2014.0	jan	1/1/2014	Andhra Pradesh	BUS

	Vehicle_Category	Vehicle_Type	EV_Sales_Quantity
0	Others	Others	0.0
1	Others	Others	0.0
2	Others	Others	0.0
3	Others	Others	0.0
4	Bus	Bus	0.0

Dataset 2 Preview:

	Age	Profession	Marrital Status	Education	No of Dependents
0	27	Salaried	Single	Post Graduate	0
1	35	Salaried	Married	Post Graduate	2
2	45	Business	Married	Graduate	4
3	41	Business	Married	Post Graduate	3
4	31	Salaried	Married	Post Graduate	2

	Wife Working	Salary	Wife Salary	Total Salary	Make	Price
0	No	800000	0	800000	i20	800000
1	Yes	1400000	600000	2000000	Ciaz	1000000
2	No	1800000	0	1800000	Duster	1200000
3	Yes	1600000	600000	2200000	City	1200000
4	Yes	1800000	800000	2600000	SUV	1600000

Dataset Preview

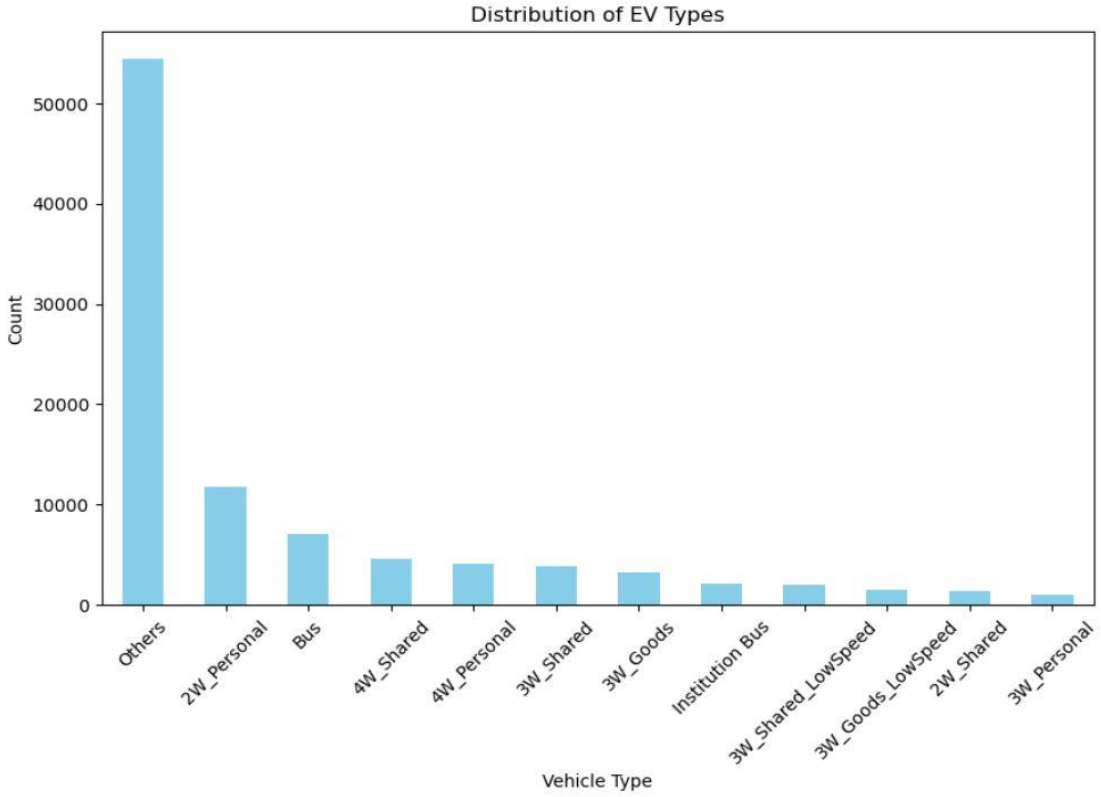
Data Preprocessing

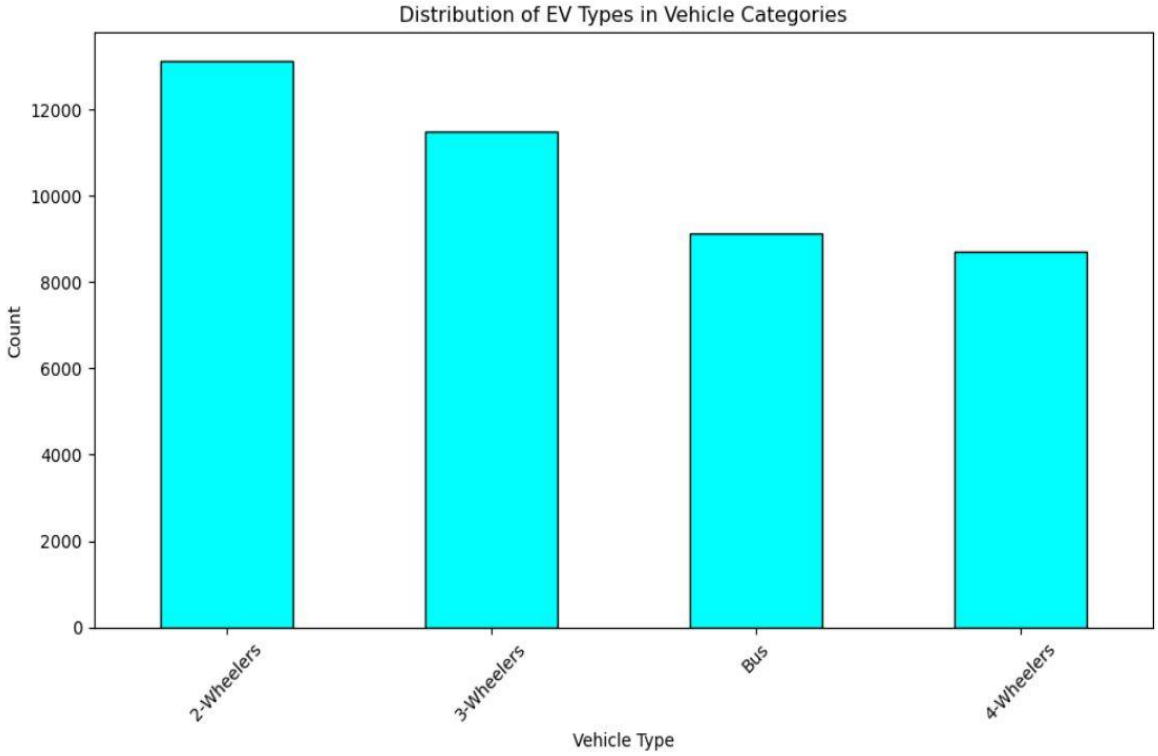
1. Data Cleaning: Handling missing values, duplicates, and irrelevant entries.
2. Feature Encoding:
    a. Ordinal encoding for specifications like "PowerTrain."
    b. Label encoding for categorical fields like "RapidCharge" and "Profession."
3. Scaling: StandardScaler was used to normalize features for better model performance.
4. Merging Datasets: Integrated key columns like Vehicle_Type, Age, Total Salary, and Profession for further analysis.

Exploratory Data Analysis (EDA)

1. Vehicle Type Distribution:

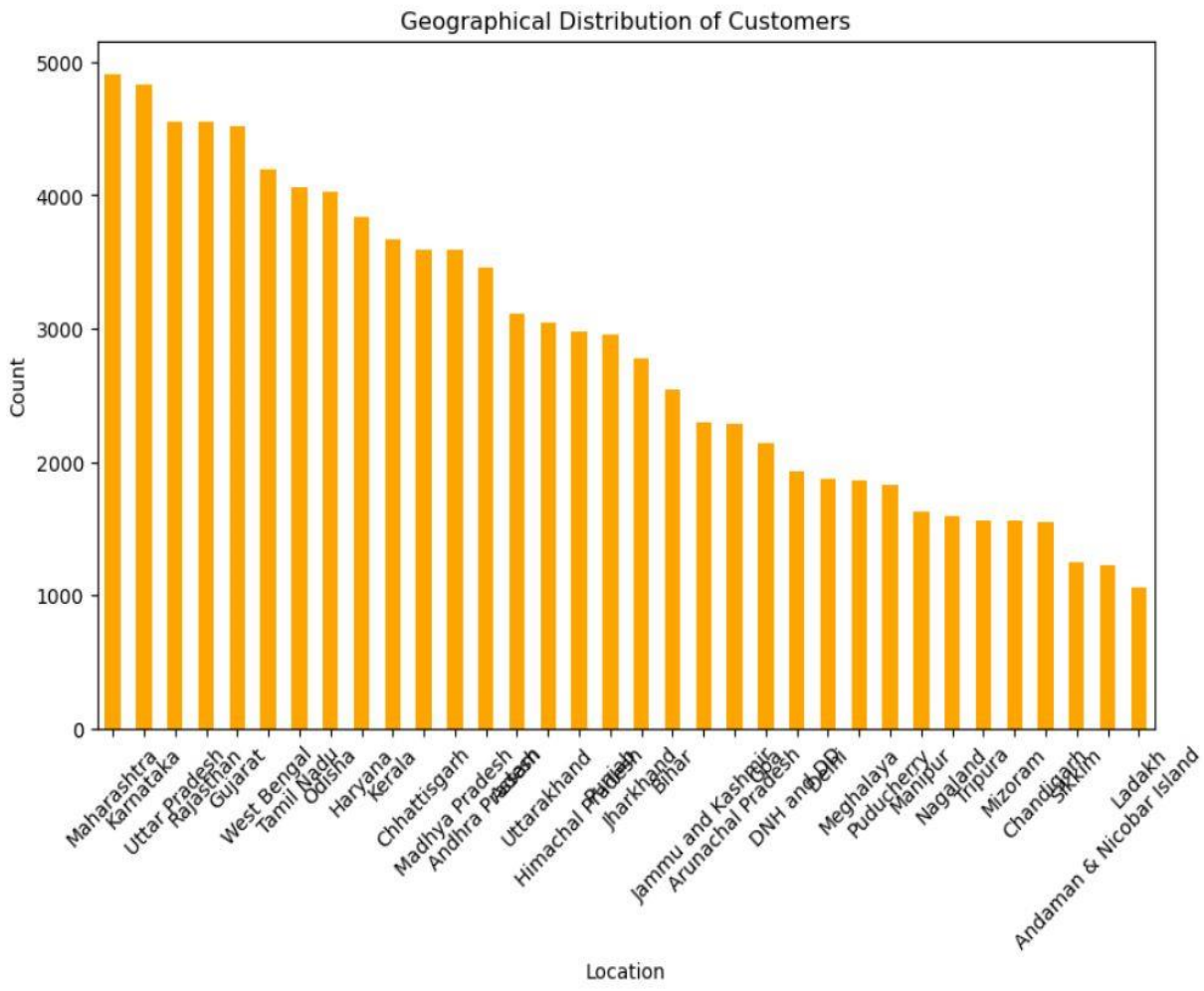
a. EVs are categorized into two-wheelers, three-wheelers, four-wheelers, and buses.
b. Visualization shows a higher concentration of two-wheelers and four-wheelers.

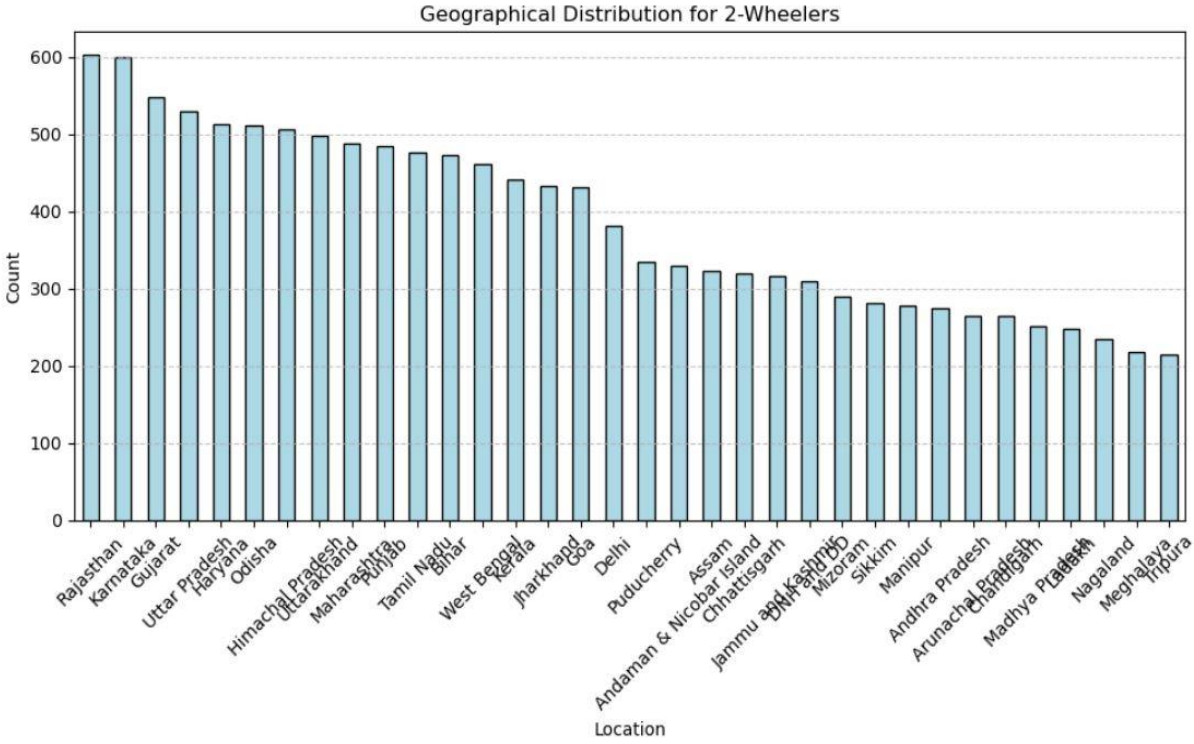

Distribution of EV Types
Count
50000
40000
30000
20000
10000
0
Others
2W_Personal
Bus
4W_Shared
4W_Personal
3W_Shared
3W_Goods
Institution Bus
3W_Shared_LowSpeed
3W_Goods_LowSpeed
2W_Shared
3W_Personal
Vehicle Type

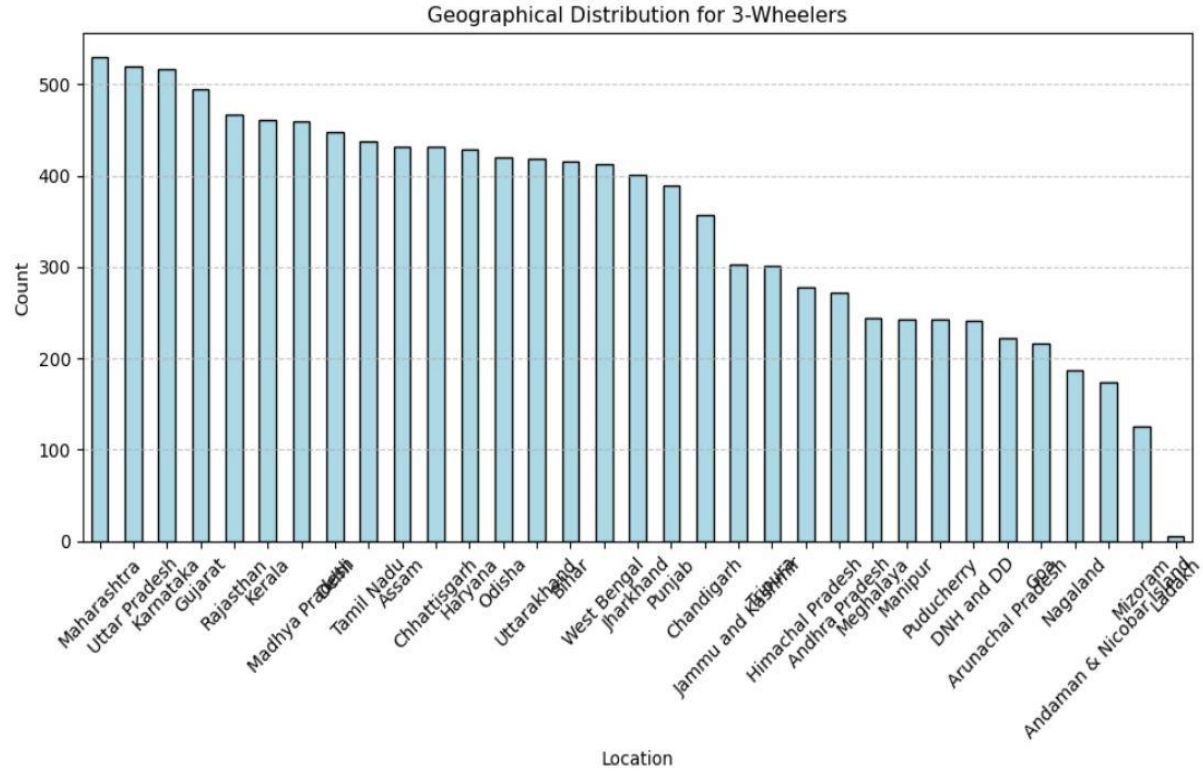

Distribution of EV Types in Vehicle Categories
Count
12000
10000
8000
6000
4000
2000
0
2-Wheelers
3-Wheelers
Bus
4-Wheelers
Vehicle Type

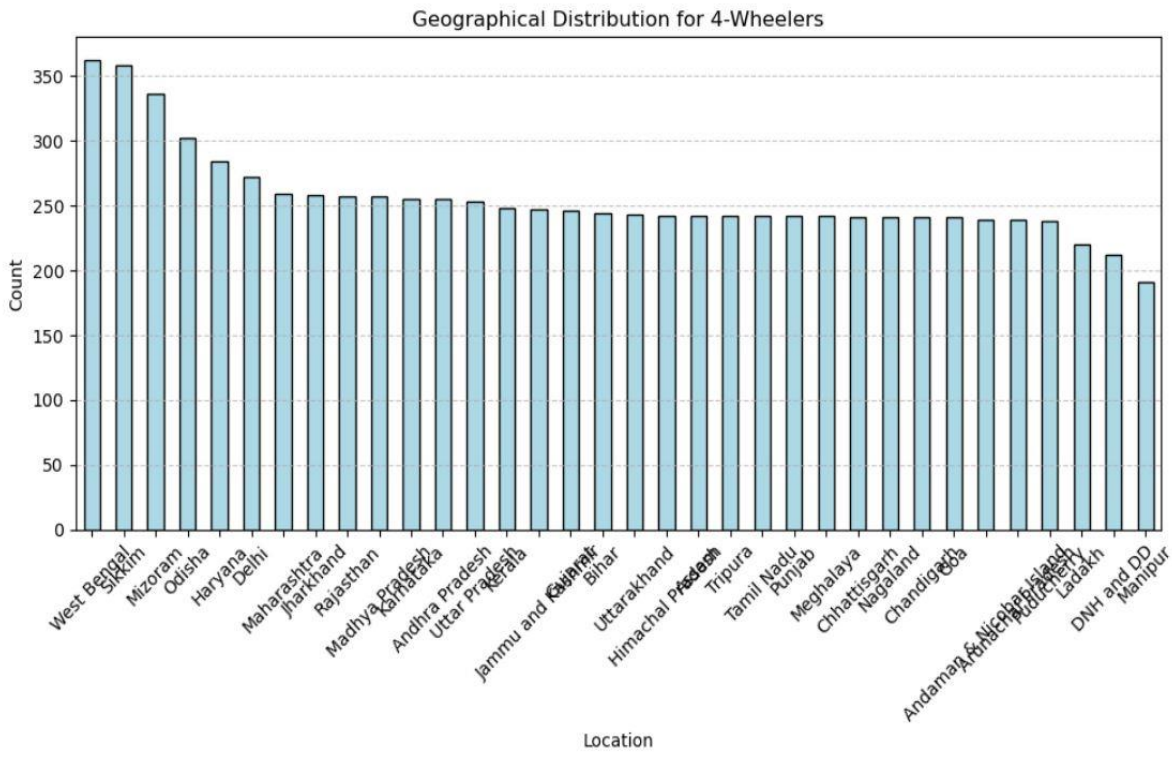
2. Geographic Distribution:

a. States like Maharashtra, Karnataka, and Tamil Nadu exhibit the highest EV adoption rates.
b. Charging infrastructure is concentrated in urban areas, leaving rural regions underserved.



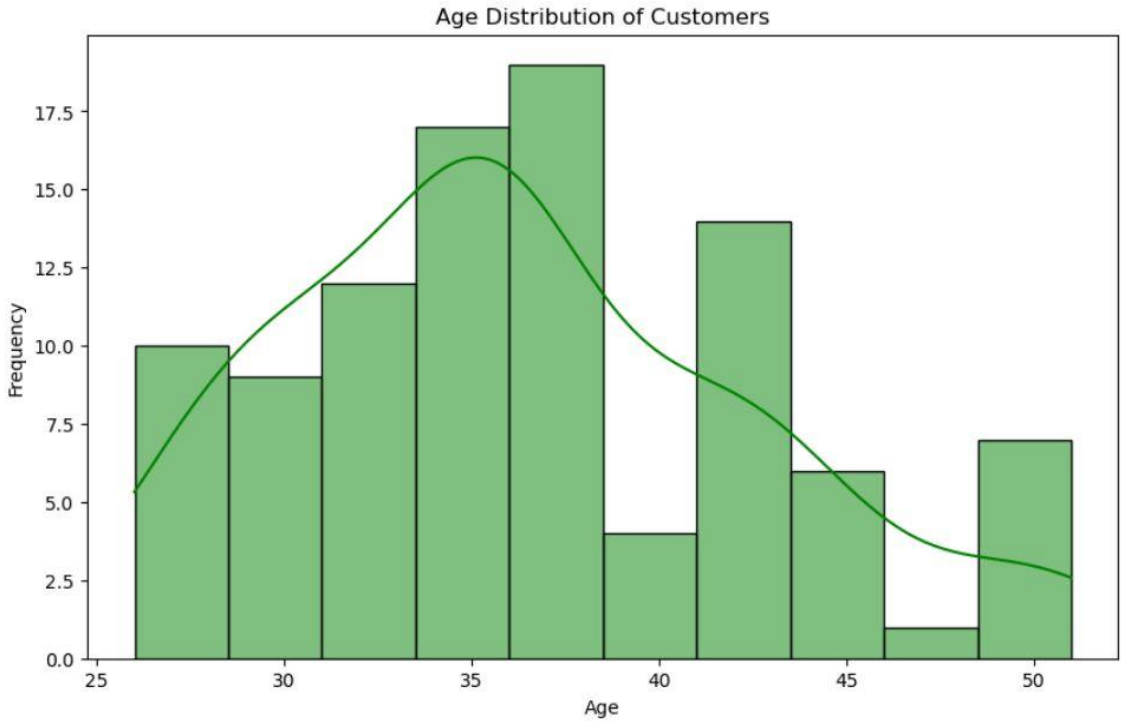

Geographical Distribution for 2-Wheelers
Count
Location
0
100
200
300
400
500
600
Rajasthan
Karnataka
Gujarat
Uttar Pradesh
Haryana
Odisha
Himachal Pradesh
Uttarakhand
Maharashtra
Punjab
Tamil Nadu
Bihar
West Bengal
Kerala
Jharkhand
Goa
Delhi
Puducherry
Assam
Andaman & Nicobar Island
Chhattisgarh
Mizoram
Sikkim
Manipur
Andhra Pradesh
Chandigarh
Madhya Pradesh
Nagaland
Meghalaya
Tripura


Geographical Distribution for 3-Wheelers
Count
Location
0
100
200
300
400
500
Maharashtra
Uttar Pradesh
Karnataka
Gujarat
Rajasthan
Kerala
Tamil Nadu
Assam
Chhattisgarh
Haryana
Odisha
Bihar
West Bengal
Jharkhand
Punjab
Chandigarh
Himachal Pradesh
Andhra Pradesh
Meghalaya
Manipur
Puducherry
DNH and DD
Goa
Arunachal Pradesh
Nagaland
Mizoram
Andaman & Nicobar Island



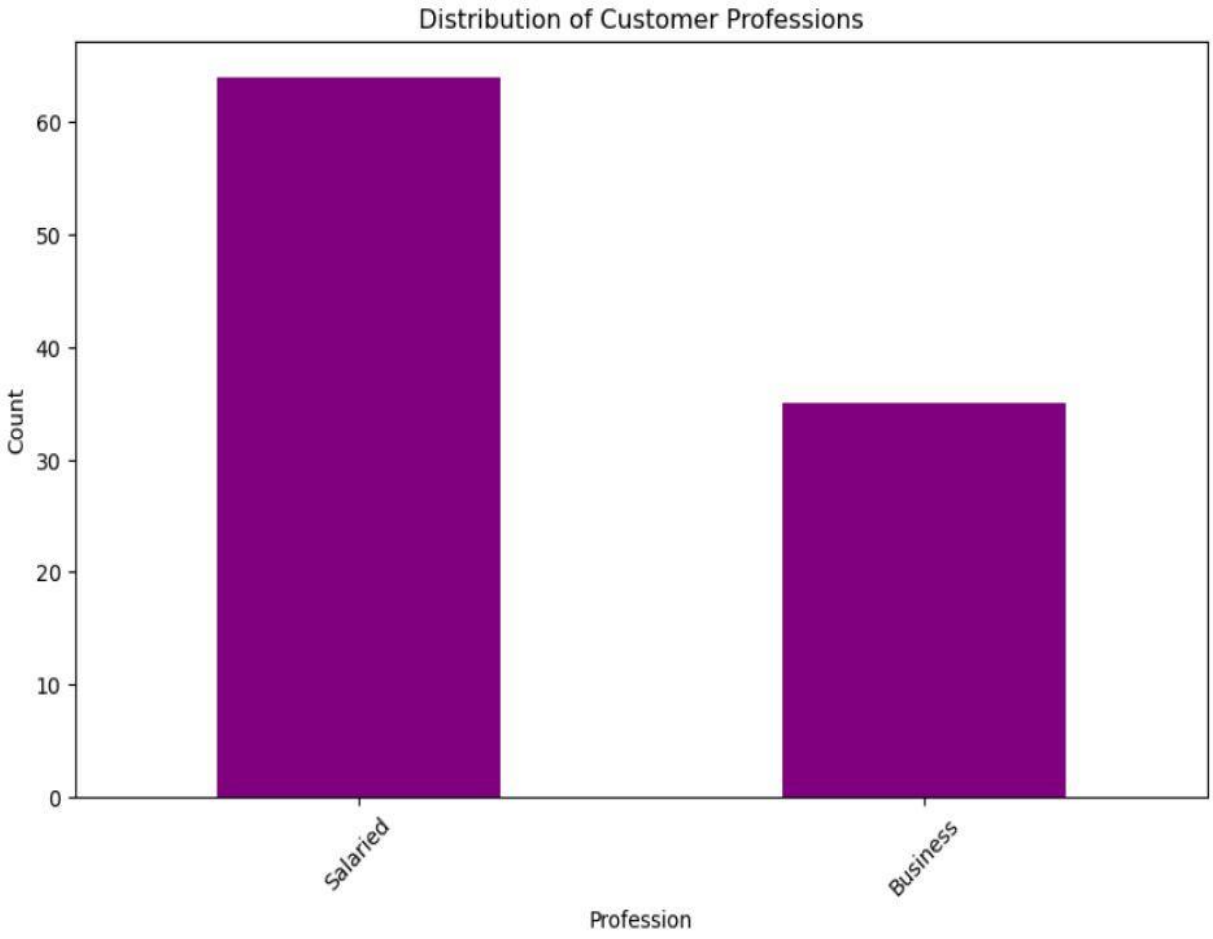
3. Demographics:

a. Younger customers (aged 25–35) are more likely to adopt EVs due to environmental awareness and affordability.
b. Higher-income groups (earning above ₹10 LPA) dominate EV ownership.



4. Customer Professions:

a. A significant portion of customers are professionals in IT and business sectors.



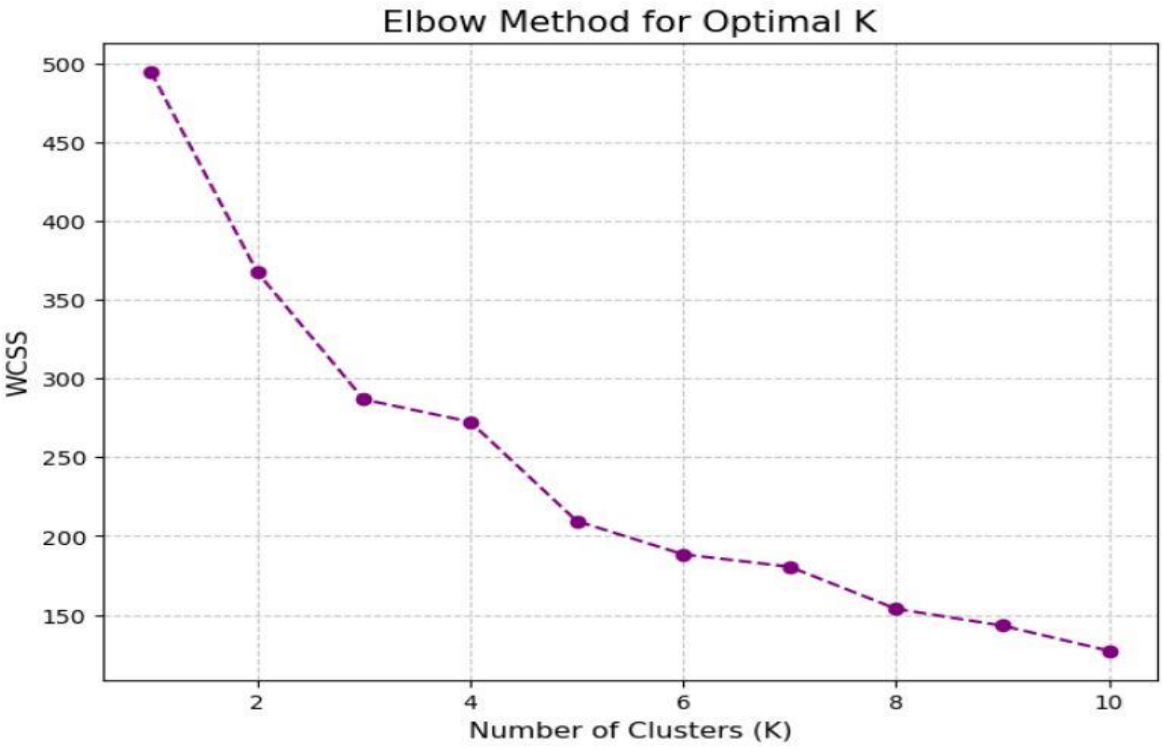
Segment Extraction

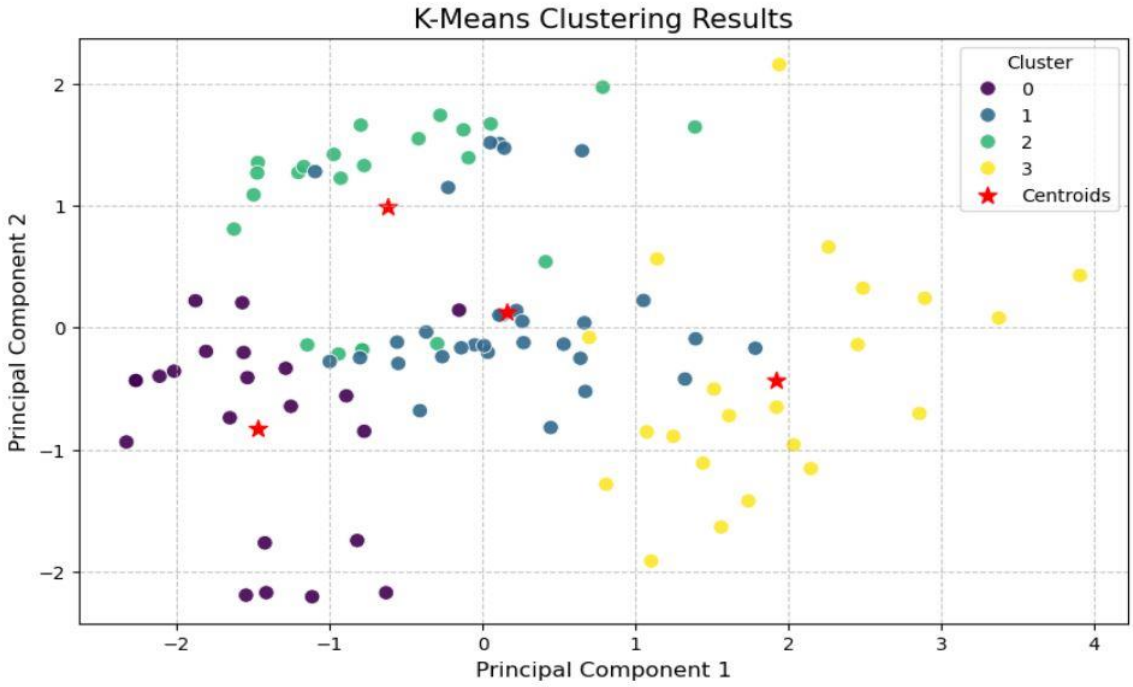
Using K-Means Clustering, the dataset was segmented based on:

1. Demographic Features: Age, profession, and income.
2. Geographic Features: State and urban/rural classification.
3. Behavioral Features: Vehicle type preference, charging needs, and price sensitivity.

Optimal Clusters Identified:

- Four segments based on the elbow method, each showing distinct preferences and purchasing behaviors.






```
Cluster Sizes:
Cluster
1    31
2    24
0    22
3    22
Name: count, dtype: int64
```

Target Segments

1. **Psychographic Factors**:
    a. **Comfort and Value for Money**: High priorities for customers.
    b. Customers value vehicles with fast charging and long range over top speed.
2. **Behavioral Factors**:
    a. EVs in the price range of ₹20–30 Lakh, with acceleration between 7.5–10 seconds, attract most buyers.
    b. Efficiency and affordability are critical.
3. **Geographic Factors**:
    a. Focus on Maharashtra, Karnataka, Tamil Nadu, and Rajasthan due to higher EV adoption and established charging networks.

Market Mix:

- **Product:** Emphasize vehicles with superior comfort, efficiency, and competitive pricing.
- **Price:** Introduce a market-oriented pricing strategy, leveraging government subsidies.
- **Promotion:** Use online platforms, public events, and strategic advertising to build awareness.
- **Place:** Focus initially on urban areas before expanding into semi-urban and rural markets.

Potential Customer Base in the Early Market and Profit Estimation

Using demographic and income group data, the following estimations were derived for the early market:

- Potential Customer Base: Approximately 2 million customers fit the target segment, which includes individuals in urban areas, earning above ₹10 LPA, and seeking EVs priced in the ₹1.5–2 Lakh range.
- Target Price Range: Average selling price estimated at ₹25 Lakh.
- Potential Profit:

$$\text{Profit} = \text{Potential Customer Base} \times \text{Average Price}$$

$$\text{Profit} = 2{,}000{,}000 \times 150{,}000 = 30{,}000 \text{ Crore}$$

This figure highlights the lucrative potential of targeting early adopters in business-centric cities.

The Most Optimal Market Segments

Based on market research and segmentation, the most optimal market segments to launch include:

- **Demographic Segmentation:** Focus on the 25–40 age group, with a preference for professionals in IT, business, and entrepreneurial roles.
- **Geographic Segmentation:** Start with urban areas in Maharashtra, Karnataka, Tamil Nadu, and Rajasthan, leveraging higher EV adoption and robust infrastructure in these states.
- **Behavioral Segmentation:** Target customers who value:
    - Long Range in Single Charge.
    - Competitive pricing in the ₹1.5 - 2 Lakh range.
    - Efficient charging solutions.

This segmentation ensures a focused strategy, maximizing market penetration and customer satisfaction

GitHub Profile Link

The code, datasets, and analysis have been well-documented and are available on GitHub. Please visit the following link for access:

https://github.com/parvkaul09/EV-Market-Analysis

This repository contains:

- Python scripts for data preprocessing, visualization, and clustering.
- Detailed explanations of segmentation techniques.
- Raw and processed datasets for reproducibility.
- Visualizations and additional insights from the analysis.