Market Segmentation:

Market Analysis and Segmentation Strategy for EV and Vehicle Behavior Markets in India

By:
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Overview:

Electric vehicles (EVs) are revolutionizing the transportation industry, utilizing electric motors to replace traditional combustion engines. Powered by batteries or external electric sources, EVs include various modes of transport like road vehicles, trains, watercraft, aircraft, and even spacecraft. With advancements in technology and a growing focus on sustainability, the 21st century has seen a surge in the adoption of electric mobility. Governments and companies alike are pushing for a greener future, recognizing the potential of EVs to reduce emissions and combat climate change.

India’s electric vehicle market is still in its early stages but holds significant promise. EVs currently represent less than 1% of total vehicle sales in the country, but this number is projected to rise substantially in the coming years. There are more than half a million electric two-wheelers and a few thousand electric cars in India today, with the majority of growth in this sector dependent on government incentives and technological improvements. Established players like Ather, Hero Electric, and startups such as Ola Electric are leading the way, developing innovative solutions to bring electric vehicles to the mainstream.

Startups and the Future of Electric Vehicles

Startups are playing a critical role in India’s transition to electric mobility. These companies, unburdened by legacy systems, can adopt cutting-edge technologies and adapt quickly to changing market demands. A key focus for many EV startups is addressing the gaps in the market—providing cost-effective, sustainable, and practical solutions for the growing urban and rural population.

India's EV market is dominated by two-wheelers, which make up over 90% of the electric vehicles on the road. Low-speed electric scooters, which do not require registration or a driver’s license, have proven to be popular in densely populated urban areas. These scooters primarily use lead-acid batteries to keep costs low, but their limited lifespan and charging inefficiencies have slowed wider adoption. Despite these challenges, startups like Ather Energy and Ola Electric are pushing the envelope by introducing lithium-ion battery-powered two-wheelers with improved range and performance.

In addition to two-wheelers, electric three-wheelers, especially e-rickshaws, are experiencing growth in demand, particularly in areas requiring last-mile connectivity. Companies like Euler Motors and Gayam Motor Works are focusing on this segment, delivering electric three-wheelers that offer enhanced reliability and operational efficiency, crucial for public transport and small-scale freight services.

India's rapidly expanding e-commerce sector has created a significant opportunity for electric light commercial vehicles (LCVs). Delivery vans and small trucks, which handle last-mile deliveries, are ideal candidates for electrification. This shift towards electric commercial vehicles can substantially reduce operational costs and emissions. Startups like Etrio and Altigreen are pioneering the development of electric LCVs, targeting logistics firms and delivery companies with eco-friendly alternatives.

For the EV sector to truly take off in India, the availability of a robust charging network is critical. Currently, inadequate charging infrastructure is one of the key barriers to EV adoption. To overcome this, startups like Sun Mobility and ChargeGrid are developing innovative solutions such as battery-swapping stations and fast-charging hubs. These technologies allow for quicker battery replacements, reducing the downtime associated with charging, especially for two-wheelers and commercial vehicles.

Battery-swapping technology is also proving to be a game-changer for electric vehicles with limited range or for commercial fleets that need to stay on the road continuously. This solution helps eliminate range anxiety and makes electric mobility more feasible for various sectors.

3. Data Sources

To conduct a thorough analysis, we collected data from various sources:

- **Government Reports**: Population demographics, vehicle ownership statistics, and income distribution data.
- **Survey Data**: Primary data collection through surveys to gauge consumer preferences and attitudes toward electric vehicles.
- **Online Databases**: Financial data on household income, vehicle purchasing behavior, and geographic distribution.
- **Public Datasets**: We also incorporated publicly available datasets from sources like Kaggle and government databases to enrich our analysis.

4. Data Preprocessing

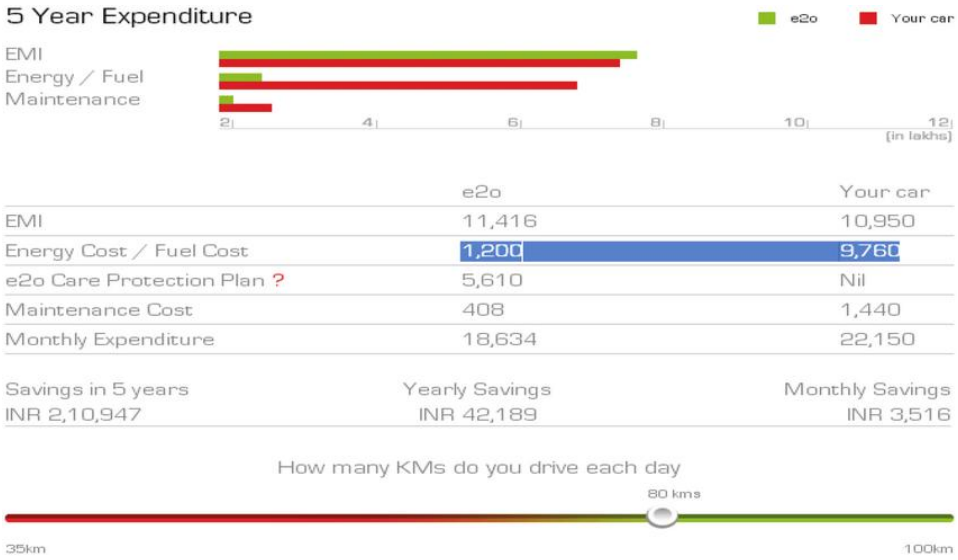
Data preprocessing was critical to ensure that our analysis was accurate and meaningful. The steps involved:

- **Handling Missing Data**: We used the SimpleImputer from the sklearn library to handle missing values, imputing where necessary to avoid incomplete data impacting our results.
- **Data Standardization**: The StandardScaler was employed to normalize the features, ensuring that variables such as income, vehicle prices, and salary were on the same scale for effective analysis.
- **Categorical Encoding**: Columns like "Marital Status," "House Loan," and "Personal Loan" were converted to numerical values using one-hot encoding and label encoding techniques.
- **Feature Engineering**: We also created new features such as "Disposable Income" and "Loan-to-Income Ratio" to provide deeper insights into consumer financial behavior.

Market Overview:

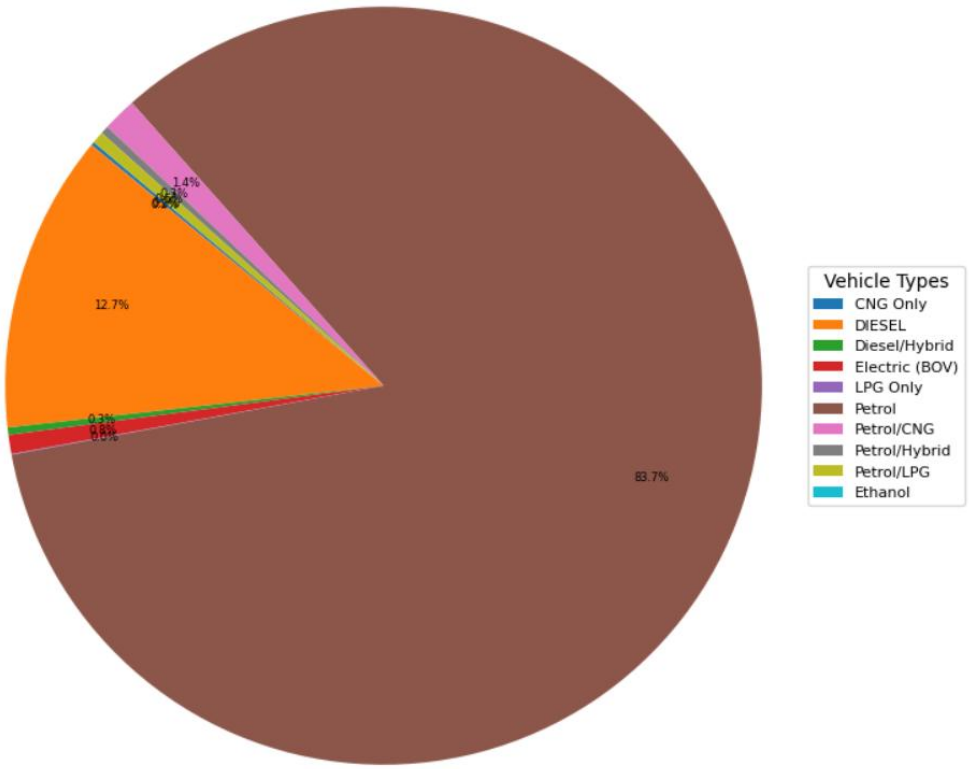
The electric vehicle (EV) market in India is still in its infancy, with the majority of vehicles on the road powered by traditional internal combustion engines running on petrol or diesel. However, as concerns about climate change grow globally, the shift toward electric mobility is gaining momentum. This presents a significant opportunity

for Indian EV manufacturers to capitalize on the growing demand for cleaner transportation. The global transition to electric vehicles is accelerating, and India is poised to follow this trend in the coming decade.



	e2o	Your car
EMI	11,416	10,950
Energy Cost / Fuel Cost	1,200	9,760
e2o Care Protection Plan ?	5,610	Nil
Maintenance Cost	408	1,440
Monthly Expenditure	18,634	22,150

Savings in 5 years	Yearly Savings	Monthly Savings
INR 2,10,947	INR 42,189	INR 3,516



Currently, the Indian automobile market is dominated by players like Maruti Suzuki and Hyundai, but with the push toward sustainable transportation, the dynamics are slowly shifting. While the overall share of EVs is still small, the potential for growth is enormous. The Indian electric vehicle market was valued at approximately USD 5 billion in 2020 and is projected to skyrocket to around USD 47 billion by 2026, growing at a compound annual growth rate (CAGR) of over 44% during the 2021-2026 period.

The COVID-19 pandemic initially caused disruptions in the automotive sector, with supply chain issues and manufacturing slowdowns due to lockdowns and travel restrictions. Despite these challenges, the Indian EV market has shown resilience, driven by government initiatives aimed at promoting electric mobility. The ongoing shift toward greener technologies, combined with the economic recovery post-pandemic, is expected to fuel a rapid expansion of the EV industry over the next few years.

Various Indian states are actively participating in the promotion of electric vehicles. For instance, Kerala has set ambitious targets, aiming to have one million electric vehicles on the road by 2022 and plans to introduce 6,000 electric buses for public transportation by 2025. Telangana has outlined its EV sales targets, aiming for 80% penetration in two- and three-wheelers (motorcycles, scooters, auto-rickshaws), 70% in commercial vehicles (such as those used by ride-hailing companies like Ola and Uber), and a significant share of private cars and public buses to be electric by 2025.

Meanwhile, Bengaluru has taken concrete steps toward electrification by purchasing 90 electric buses for its city transportation system and plans to fully electrify its fleet by 2023. These initiatives reflect the broader push across India to reduce carbon emissions and promote sustainable mobility solutions.

The growing demand for e-commerce and last-mile deliveries is also contributing to the expansion of the EV market in India. Companies like Amazon have already begun incorporating electric mobility into their delivery fleets to reduce their carbon footprint. This trend is expected to continue as more companies adopt EVs for logistics, particularly for last-mile delivery services in urban areas.

India is also experimenting with electric public transportation, deploying electric buses in cities to reduce emissions and improve air quality. Intercity electric buses have been introduced in some areas, signaling a commitment to sustainable public transport.

India presents one of the world's largest untapped markets for electric vehicles, particularly in the two-wheeler segment. With 100% foreign direct investment allowed in the EV sector, the market is expected to attract significant interest from global players looking to expand their footprint in one of the fastest-growing economies.

The implementation of the FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles) scheme by the Indian government has further accelerated the shift toward e-mobility. The scheme is designed to support the development of electric vehicle infrastructure, provide subsidies for EV purchases, and incentivize the production of electric vehicles in the country.

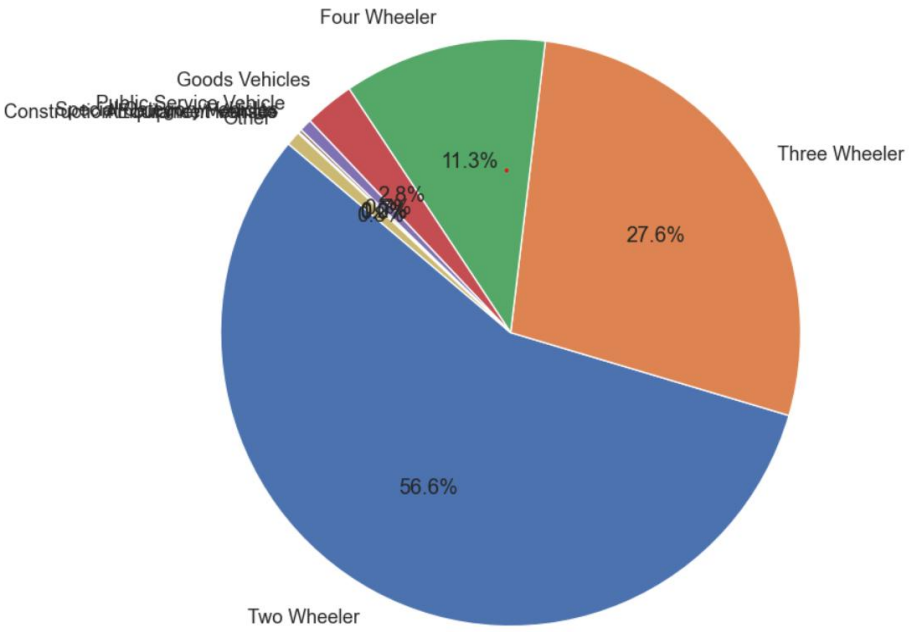
As the EV market in India continues to grow, there is a strong emphasis on technological advancements, particularly in the areas of battery technology and charging infrastructure. Lithium-ion batteries are replacing lead-acid batteries in two-wheelers and three-wheelers, offering improved performance, longer range, and reduced charging times. The development of fast-charging stations and battery-

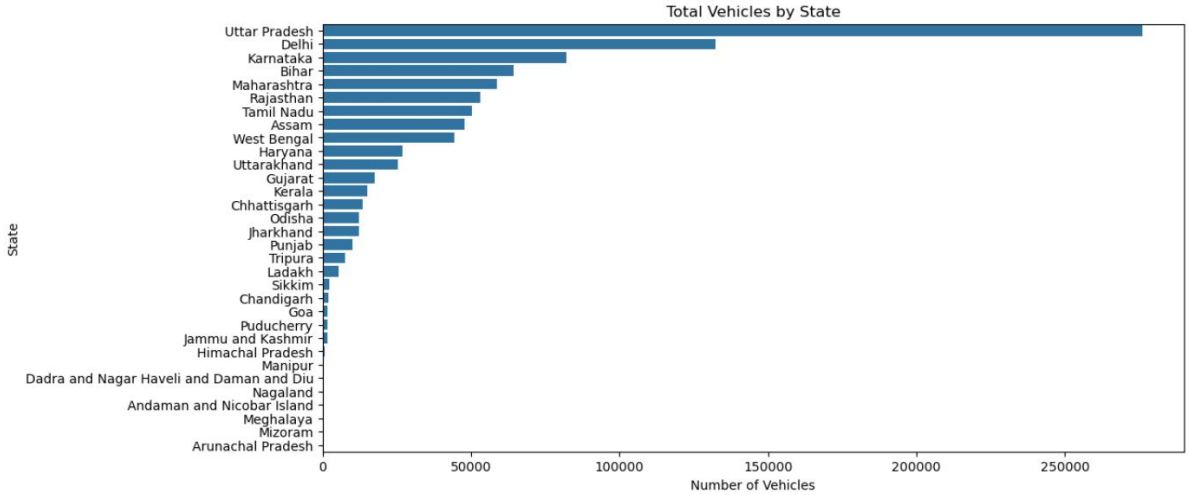
swapping technology is also gaining momentum, addressing one of the key barriers to EV adoption: the lack of a widespread charging network.

The Indian market is expected to see significant innovation in electric two- and three-wheelers, as these segments offer the highest growth potential due to their affordability and widespread use. With government support and increasing consumer interest, India's electric vehicle market is on the brink of a transformation that will reshape its transportation landscape over the next decade.

Electric Two-wheeler Vehicles Likely to have Optimistic Growth:

When evaluating the electric vehicle (EV) market in India, two types of EVs dominate and should be prioritized for production and adoption: **electric two-wheelers** and **electric three-wheelers**. Each vehicle type serves distinct market needs, and both have significant potential to shape the future of India's mobility landscape. However, the **electric two-wheeler** segment stands out as the most promising and preferred choice for both consumers and manufacturers, followed closely by electric three-wheelers, especially for commercial applications.





1. Electric Two-Wheelers: Leading the EV Market

Electric two-wheelers, including scooters and motorcycles, are currently the most preferred and rapidly growing segment in India's EV market. This dominance is driven by several factors:

Affordability: Electric scooters and motorcycles are relatively cheaper to produce and purchase compared to electric cars, making them accessible to a larger segment of the population. Their low maintenance costs and the low cost of electricity also appeal to price-sensitive consumers.

Urban Mobility: In densely populated Indian cities, where traffic congestion is common, two-wheelers offer a convenient, quick, and efficient mode of transport. Electric two-wheelers are ideal for short commutes within cities, making them the go-to option for daily travel.

Government Support: Under the FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles) initiative, the government is offering significant subsidies and incentives to promote electric two-wheeler adoption. These incentives make the upfront cost of electric two-wheelers more competitive with their petrol counterparts.

Technological Improvements: Innovations in battery technology, such as the shift to lithium-ion batteries, have enhanced the performance of electric two-wheelers. With better range, faster charging times, and extended battery life, these vehicles have become more reliable for consumers.

Market Share: Over 90% of the electric vehicle market in India is dominated by electric two-wheelers. Their popularity is further bolstered by the entry of prominent players like Ather, Hero Electric, and Ola Electric, all of whom are investing in next-generation models and infrastructure like charging stations.

Given these factors, **electric two-wheelers** are expected to continue leading the market. Their combination of affordability, urban practicality, and growing consumer demand makes them the most attractive option for manufacturers and consumers alike.

2. Electric Three-Wheelers: A Strong Contender in Commercial Use

Electric three-wheelers, commonly used as e-rickshaws or cargo carriers, are another critical segment in India's EV market. They are particularly preferred for last-mile connectivity and small-scale commercial purposes. Here's why they are gaining traction:

Last-Mile Connectivity: E-rickshaws are becoming increasingly popular for short-distance passenger transport, especially in urban and semi-urban areas. They provide a low-cost, eco-friendly solution for public transportation, and their demand is growing in cities as a substitute for traditional auto-rickshaws.

Cargo Transport: Electric three-wheelers are also becoming a preferred choice for goods delivery, especially in the rapidly expanding e-commerce sector. Companies are using e-rickshaws for last-mile delivery due to their cost-effectiveness and ability to navigate narrow streets.

Lower Operating Costs: Electric three-wheelers have significantly lower fuel and maintenance costs compared to their diesel counterparts, making them appealing to commercial operators. Their cost-efficiency contributes to higher profit margins for drivers and fleet owners.

Government Support: Like electric two-wheelers, the government is offering incentives for the purchase of electric three-wheelers. Several states are also pushing for the electrification of public transport and last-mile connectivity options.

Population Behavioral Study for Electric Vehicle Market Entry

To successfully penetrate the electric vehicle (EV) market, it is crucial to understand the behavior, psychology, and needs of potential end-users. Conducting thorough market research allows for accurate pricing strategies, identification of spending habits, and understanding customer preferences, such as the type of vehicle (two-wheeler, four-wheeler, etc.), budget range, and specific needs of different consumer groups. This type of insight is necessary to properly segment the market and develop targeted marketing strategies.

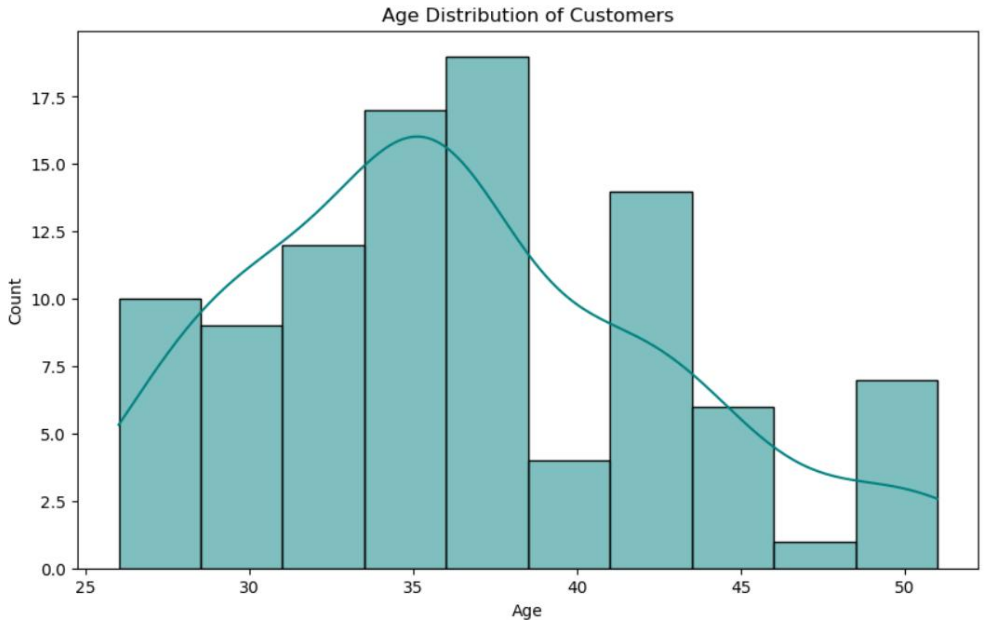
The following analysis focuses on understanding the factors that influence consumer decisions regarding EV purchases. The key variables in this analysis include age, marital status, price sensitivity, salary, and the number of dependents.

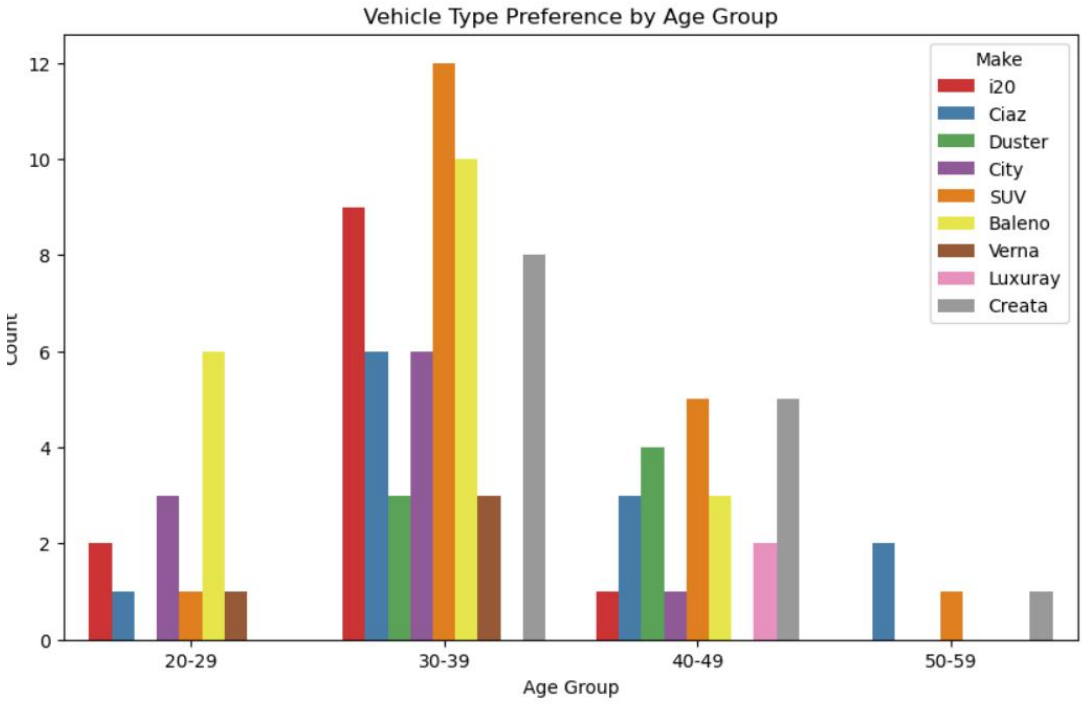
Dependency of Variables on EV Buying Behavior

1. Age:

Younger consumers, typically in the age range of 18–30 years, often have fewer dependents, lower salaries, and are more likely to be single. While they may not yet be the primary buyers of traditional, high-priced vehicles, younger people are **more inclined** to adopt electric vehicles due to their environmental consciousness. They are

aware of issues like climate change and are motivated to make eco-friendly choices. This demographic is most likely to opt for **affordable electric two-wheelers or compact electric cars** priced below ₹10 lakhs. Thus, the **younger generation** is a key target for entry-level EVs, especially in the two-wheeler segment, which aligns with their mobility needs and budget constraints.

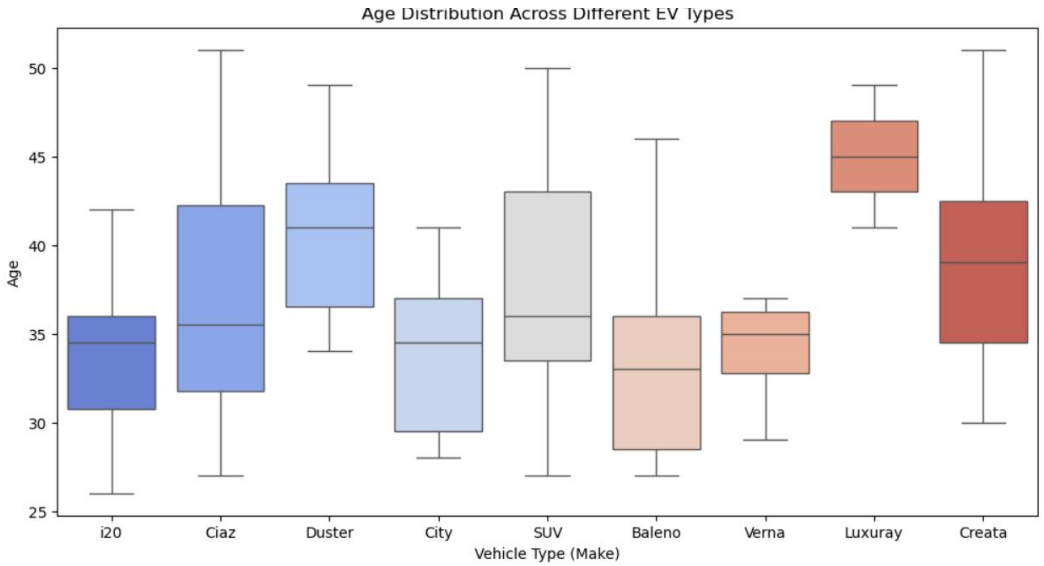




2. Number of Dependents:

Consumers with more dependents, often middle-aged or older, are likely to prioritize larger vehicles for family transportation, such as **SUVs or sedans**. This demographic often has higher financial responsibilities and may prefer vehicles that provide ample

space for family members or cargo. As a result, **four-wheeled EVs** (especially larger models) might be appealing to this group, provided they offer the necessary space and range. For such customers, the **price range tends to be higher**, and they may be willing to invest in more premium EVs if they offer the necessary utility.



3. Salary:

Salary is one of the most critical factors in determining vehicle preferences. Higher-income individuals are more likely to purchase four-wheelers, including **luxury or premium electric vehicles**. For these consumers, environmental benefits are often an added advantage, but not necessarily the primary motivator. In contrast, lower-income groups or those with limited disposable income may prefer **electric two-wheelers** due to their affordability and low maintenance costs.Thus, the **two-wheeler market** may cater to mid- to lower-income segments, while **four-wheeler electric vehicles** will attract higher-income groups with more disposable income.

Visualization of Key Factors

To visualize and better understand the relationship between these variables and consumer behavior, the following analyses are useful:

1. Violin Plot:

The violin plot visualizes the dependency of car ownership and preferences on various factors such as **age, marital status, salary, and number of dependents**. This helps to identify patterns and variations in vehicle preferences within different demographic groups. For instance, it can reveal that younger, single people lean toward compact electric vehicles, while older individuals with families are more likely to choose SUVs.

2. Heatmap:

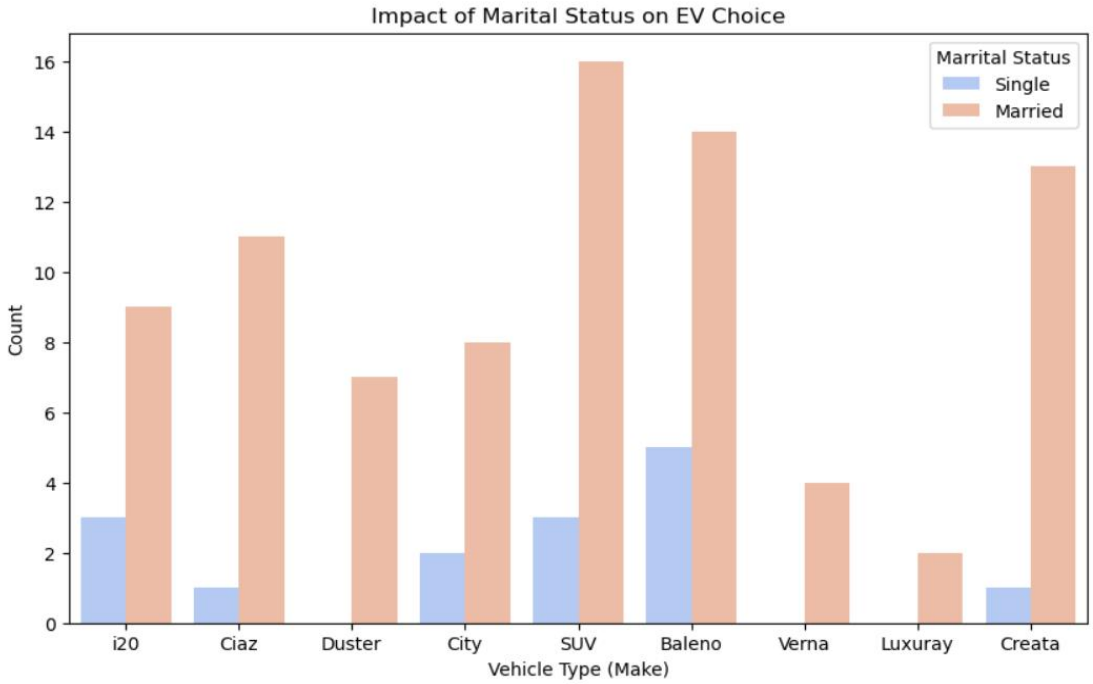
A heatmap provides insights into the correlation between different variables, such as **income levels, number of dependents, and vehicle type preferences**. It can help highlight which factors most influence a consumer's decision to buy a certain type of vehicle. For example, the heatmap may show a strong positive correlation between higher salaries and the purchase of electric four-wheelers, whereas the number of dependents may strongly correlate with the purchase of larger vehicles.

3. Continuous Distribution Plot:

A continuous distribution plot helps visualize the distribution of variables like **price sensitivity and vehicle preference** across different demographic segments. This plot can help determine the most common price ranges for different income levels, helping manufacturers and marketers decide which models to promote to specific groups.

Marital Status and Its Impact on Electric Vehicle Purchases

Marital status plays an important role in influencing vehicle preferences and purchase decisions in the electric vehicle (EV) market. The needs and priorities of married individuals and families differ significantly from those of single people, leading to distinct buying behaviors.



Loans for Electric Vehicles (EVs)

With the growing interest in electric vehicles and government initiatives to promote eco-friendly transportation, **EV loans** have become more accessible and affordable for consumers. These loans play a vital role in enabling individuals and families to afford EVs, especially as some electric models have higher upfront costs compared to traditional internal combustion engine (ICE) vehicles.

1. Increasing Access to EV Loans:

Banks and financial institutions are now offering **specialized loan schemes** for electric vehicles to encourage their adoption. Many of these loans come with **lower interest rates** and **longer repayment periods**, making EVs more affordable for both single and married buyers. Additionally, some financial institutions are offering **green loans** or preferential rates for eco-friendly purchases, further incentivizing consumers to choose electric options over petrol/diesel cars.

2. Government Support for EV Financing:

The Indian government's **FAME-II (Faster Adoption and Manufacturing of Electric Vehicles)** scheme is playing a significant role in promoting EV financing. It offers **subsidies and incentives** to reduce the overall cost of electric vehicles, which in turn makes EV loans more attractive. Buyers can take advantage of the subsidies and combine them with EV loans to minimize the burden of upfront costs.

3. Popularity of Loans Among Different Segments:

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Single buyers may opt for smaller loans to purchase **electric two-wheelers or compact cars**. They often have less financial responsibility, which allows them to repay the loans quickly and with fewer long-term obligations.

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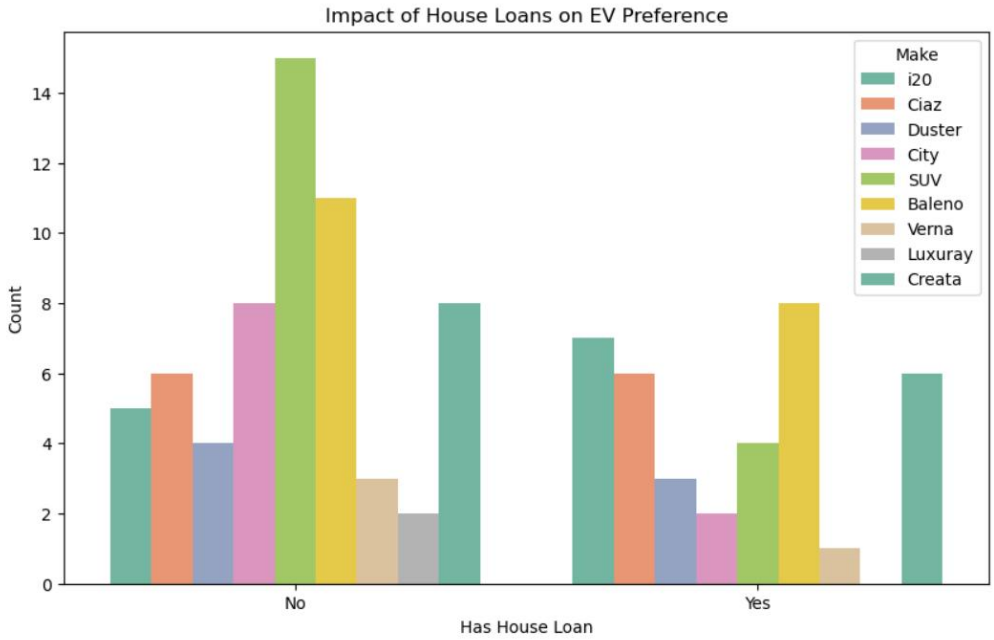
Married buyers, on the other hand, may need **larger loans** to purchase family-sized electric vehicles, such as **sedans or SUVs**. With additional financial commitments like family expenses, these buyers often prefer loans with flexible repayment options.



K-Means Clustering and Analysis:

Clustering Overview:

Clustering is a widely-used exploratory data analysis technique that helps uncover hidden patterns within a dataset. The goal of clustering is to divide data points into distinct groups or clusters where each group contains data points that are highly similar to one another, while remaining distinctly different from other clusters. This similarity is often measured using techniques such as **Euclidean distance** or **correlation-based distances**. The choice of similarity measure depends on the application and dataset.

Clustering can be done either based on features to group samples that have similar attributes or based on samples to find common characteristics across different features.

K-Means Algorithm:

The **K-Means algorithm** is an iterative technique that partitions a dataset into a predefined number of clusters, denoted as **K**. The objective of the algorithm is to

minimize the variance within each cluster while maximizing the separation between clusters. The goal is to ensure that data points in each cluster are as similar as possible, and as different as possible from points in other clusters.

The basic steps of K-Means are as follows:

1. **Choose the number of clusters (K):** The user specifies the number of clusters they want the algorithm to create.
2. **Initialize centroids:** Randomly select K data points as the initial centroids of the clusters.
3. **Assign points to clusters:** Assign each data point to the cluster whose centroid is closest.
4. **Update centroids:** After assignment, recompute the centroid of each cluster based on the points that belong to it.
5. **Repeat:** Repeat the process of assignment and updating until the centroids no longer change or until a set number of iterations is reached.

The algorithm uses **expectation-maximization** to solve the problem, with the E-step being the assignment of data points to clusters and the M-step being the calculation of new centroids.

Applications of K-Means:

K-Means is widely used in various industries for tasks such as:

- **Market segmentation:** Grouping consumers based on purchasing habits and preferences.
- **Document clustering:** Organizing large collections of text into meaningful groups.
- **Image segmentation and compression:** Reducing the complexity of images by grouping similar pixels.

Population Segmentation with K-Means:

To understand customer behavior and preferences in the electric vehicle market, we can use the K-Means clustering technique. For this analysis, we use a dataset containing information about customer spending habits, including variables such as **age**, **marital status**, **salary**, and **vehicle preferences**.

Data Preprocessing:

Before performing clustering, the dataset needs to be cleaned and transformed. Certain columns in the dataset, such as **Profession**, **Marital Status**, and **Loan Status**, are categorical and need to be converted into numerical values. This is achieved using techniques like **label encoding**.

```
data.head(7)
```

	Month	CNG Only	DIESEL	Diesel/Hybrid	Electric (BOV)	LPG Only	Petrol	Petrol/CNG	Petrol/Hybrid	Petrol/LPG	Ethanol	Not Applicable
0	Apr-17	1,825	1,93,689	3,412	5,063	89	14,32,174	16,879	108	4,941	1.0	6,784
1	May-17	1,918	1,82,173	4,172	7,080	160	15,10,907	17,968	88	5,198	1.0	7,403
2	Jun-17	2,352	1,94,894	4,717	7,508	218	14,23,800	18,768	123	6,000	1.0	6,784
3	Jul-17	2,081	1,96,529	4,161	9,031	521	13,09,851	18,069	30	5,427	1.0	6,897
4	Aug-17	1,532	1,85,968	3,201	9,174	643	12,41,005	20,652	31	5,891	NaN	5,359
5	Sep-17	1,745	1,96,562	3,440	7,795	532	12,62,629	25,744	36	6,189	NaN	6,264
6	Oct-17	2,316	2,12,104	4,548	7,715	212	17,56,702	30,888	35	7,353	NaN	6,626

```
data.tail()
```

	Month	CNG Only	DIESEL	Diesel/Hybrid	Electric (BOV)	LPG Only	Petrol	Petrol/CNG	Petrol/Hybrid	Petrol/LPG	Ethanol	Not Applicable
55	Nov-21	22,331	1,37,209	2	42,098	1,662	15,88,245	17,016	11,714	548	NaN	4,699
56	Dec-21	21,525	1,56,868	2	50,915	1,399	13,02,529	18,756	9,919	496	NaN	5,882
57	Jan-22	23,059	1,57,663	3	48,169	1,241	11,74,882	26,727	10,809	485	NaN	4,805
58	Feb-22	20,480	1,51,020	4	54,046	1,018	11,13,704	30,363	9,359	315	NaN	5,174
59	Mar-22	24,807	1,87,624	3	77,199	1,276	12,87,888	34,965	8,072	524	1.0	6,131

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 60 entries, 0 to 59
Data columns (total 12 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
```

Toggle output scrolling

```
 1   CNG Only         60 non-null     object
 2   DIESEL           60 non-null     object
 3   Diesel/Hybrid    57 non-null     object
 4   Electric (BOV)   60 non-null     object
 5   LPG Only         60 non-null     object
 6   Petrol           60 non-null     object
 7   Petrol/CNG       60 non-null     object
 8   Petrol/Hybrid    60 non-null     object
 9   Petrol/LPG       60 non-null     object
 10  Ethanol          22 non-null     float64
 11  Not Applicable   60 non-null     object
dtypes: float64(1), object(11)
memory usage: 5.8+ KB
```

```
data.describe()
```

	Ethanol
count	22.000000
mean	2.590909
std	2.905808
min	1.000000
25%	1.000000
50%	1.000000
75%	2.000000
max	11.000000

```
data=pd.DataFrame(data)
```

```
data.isnull().sum()
```

```
Month              0
CNG Only           0
DIESEL             0
Diesel/Hybrid      3
Electric (BOV)     0
LPG Only           0
Petrol             0
Petrol/CNG         0
Petrol/Hybrid      0
Petrol/LPG         0
Ethanol           38
Not Applicable     0
dtype: int64
```

```
data=data.fillna(0)
```

```
data.isnull().sum()
```

```
Month              0
CNG Only           0
DIESEL             0
Diesel/Hybrid      0
Electric (BOV)     0
LPG Only           0
Petrol             0
Petrol/CNG         0
Petrol/Hybrid      0
Petrol/LPG         0
Ethanol            0
Not Applicable     0
dtype: int64
```

```
data=data.fillna(0)
data.head()
```

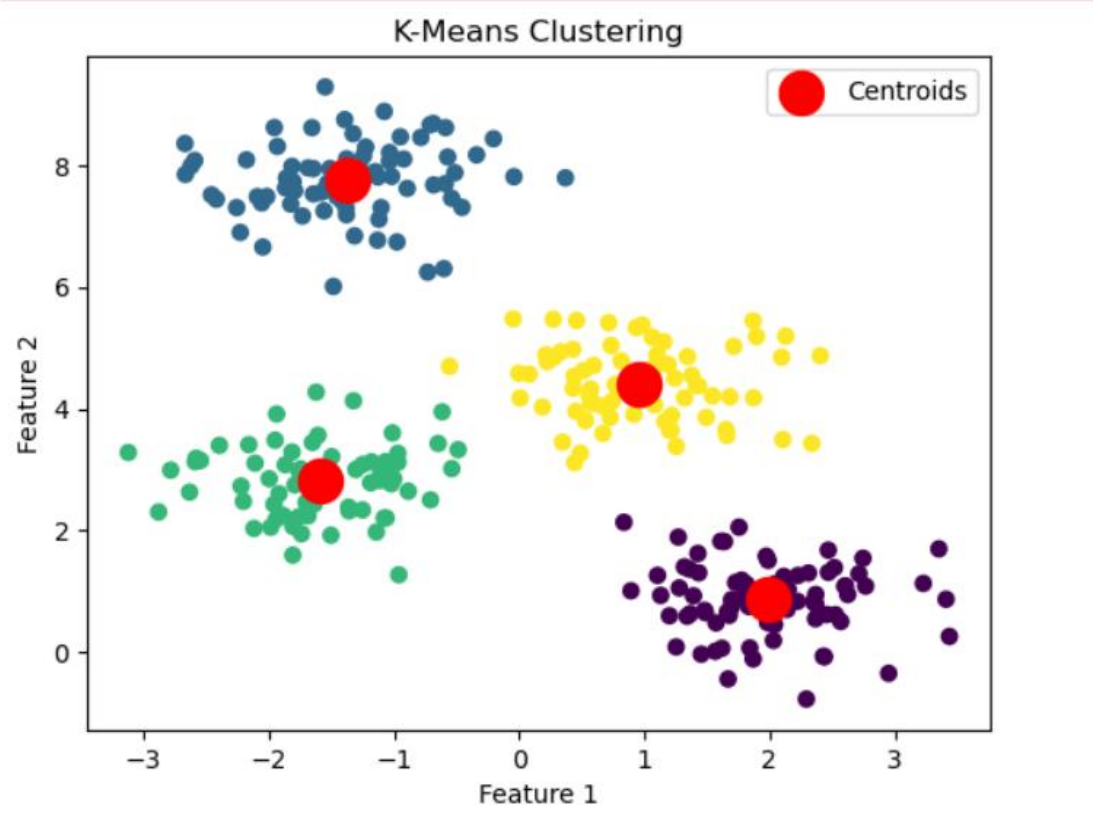
	Month	CNG Only	DIESEL	Diesel/Hybrid	Electric (BOV)	LPG Only	Petrol	Petrol/CNG	Petrol/Hybrid	Petrol/LPG	Ethanol	Not Applicable
0	Apr-17	1,825	1,93,689	3,412	5,063	89	14,32,174	16,879	108	4,941	1.0	6,784
1	May-17	1,918	1,82,173	4,172	7,080	160	15,10,907	17,968	88	5,198	1.0	7,403
2	Jun-17	2,352	1,94,894	4,717	7,508	218	14,23,800	18,768	123	6,000	1.0	6,784
3	Jul-17	2,081	1,96,529	4,161	9,031	521	13,09,851	18,069	30	5,427	1.0	6,897
4	Aug-17	1,532	1,85,968	3,201	9,174	643	12,41,005	20,652	31	5,891	0.0	5,359

```
data.isnull().sum()
```

```
Month              0
CNG Only           0
DIESEL             0
Diesel/Hybrid      0
Electric (BOV)     0
LPG Only           0
Petrol             0
Petrol/CNG         0
Petrol/Hybrid      0
Petrol/LPG         0
Ethanol            0
Not Applicable     0
dtype: int64
```

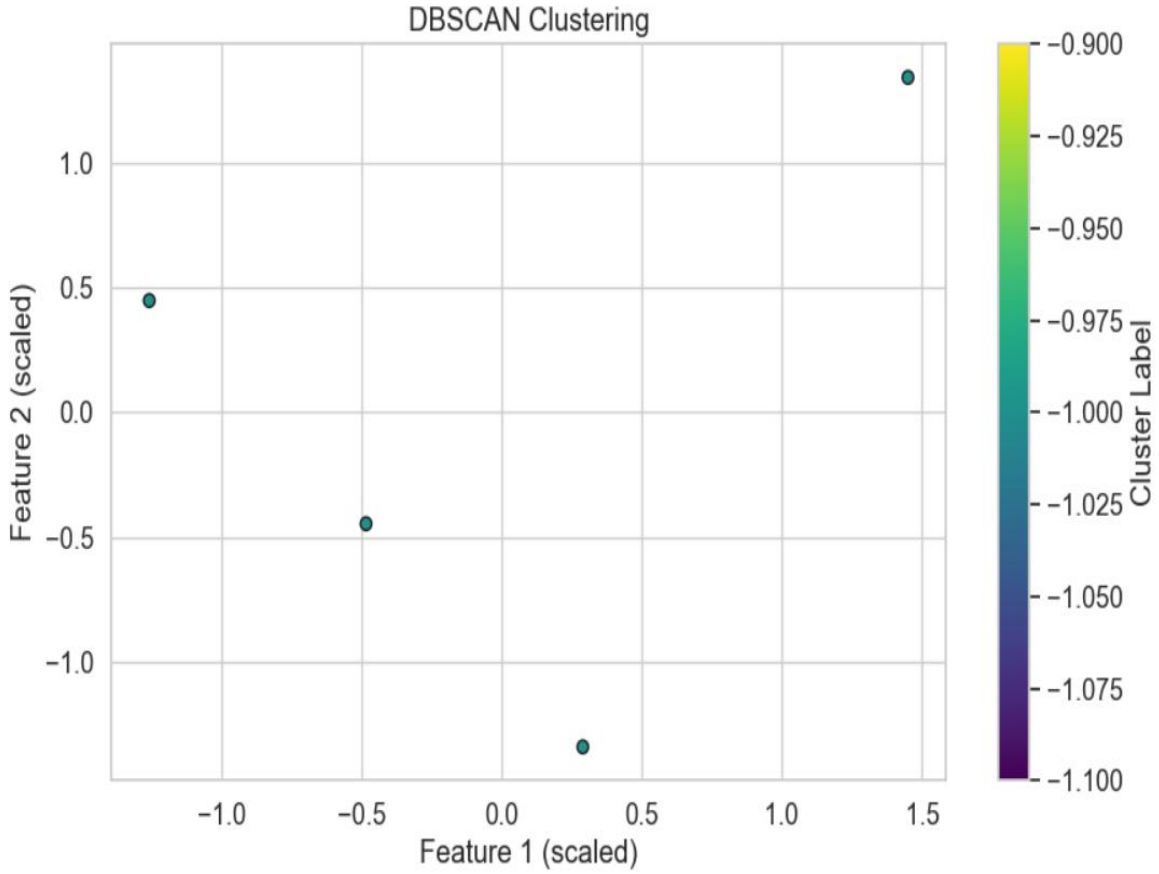
After the data is pre-processed, I can proceed with segmentation of population. We calculate the number of clusters by using the elbow method.

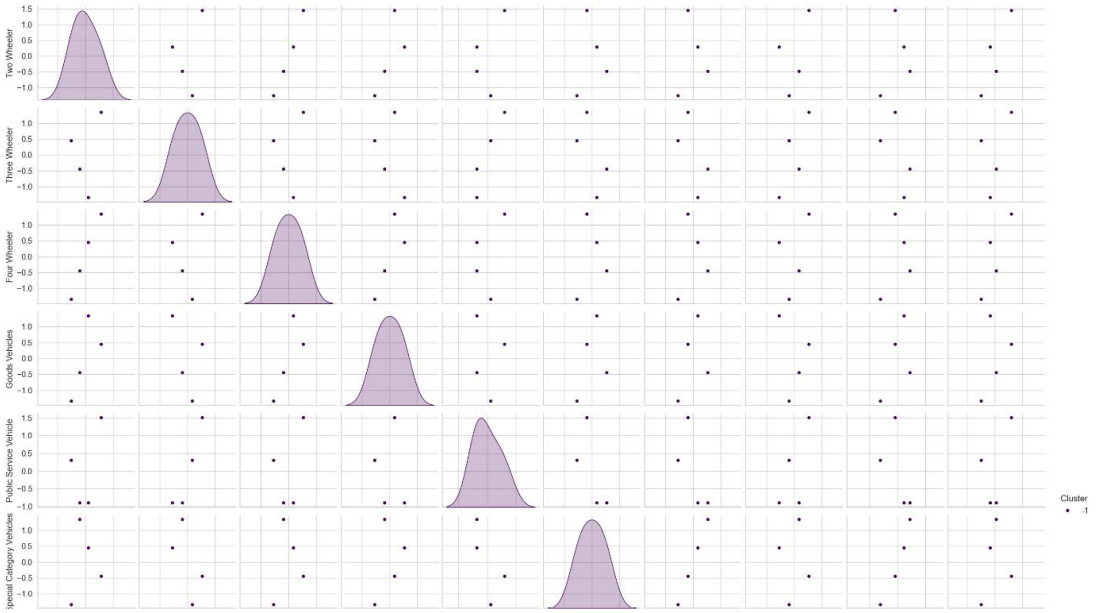
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
from sklearn.datasets import make_blobs
X, y = make_blobs(n_samples=300, centers=4, cluster_std=0.60, random_state=0)
data = pd.DataFrame(X, columns=['Feature1', 'Feature2'])
kmeans = KMeans(n_clusters=4)
data['Cluster'] = kmeans.fit_predict(X)
plt.scatter(data['Feature1'], data['Feature2'], c=data['Cluster'], cmap='viridis')
plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:, 1], s=300, c='red', label='Centroids')
plt.title('K-Means Clustering')
plt.xlabel('Feature 1')
plt.ylabel('Feature 2')
plt.legend()
plt.show()
```



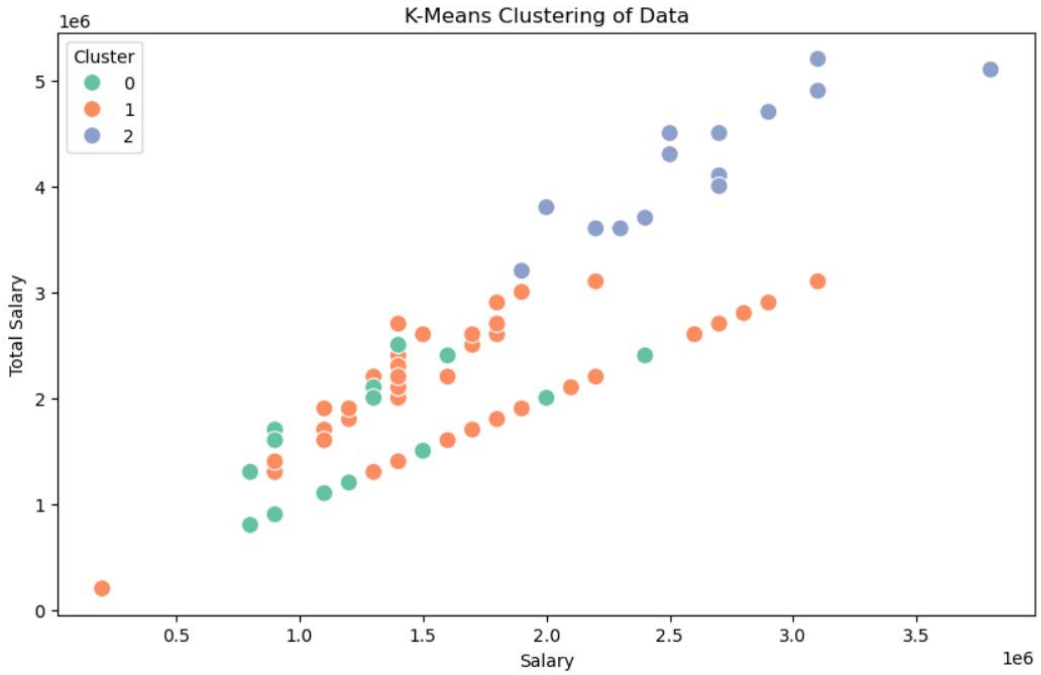
```python
import pandas as pd
import numpy as np
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import DBSCAN
import matplotlib.pyplot as plt
import seaborn as sns
numeric_data = data.select_dtypes(include=[np.number])
numeric_data.fillna(0, inplace=True)
scaler = StandardScaler()
data_scaled = scaler.fit_transform(numeric_data)
dbscan = DBSCAN(eps=0.5, min_samples=5)
clusters = dbscan.fit_predict(data_scaled)
data['Cluster'] = clusters
print("Cluster counts:")
print(data['Cluster'].value_counts())
if numeric_data.shape[1] >= 2:
    plt.figure(figsize=(10, 6))
    plt.scatter(data_scaled[:, 0], data_scaled[:, 1], c=clusters, cmap='viridis', marker='o', edgecolor='k')
    plt.title('DBSCAN Clustering')
    plt.xlabel('Feature 1 (scaled)')
    plt.ylabel('Feature 2 (scaled)')
    plt.colorbar(label='Cluster Label')
    plt.grid(True)
    plt.show()
if numeric_data.shape[1] > 2:
    cluster_data = pd.DataFrame(data_scaled, columns=numeric_data.columns)
    cluster_data['Cluster'] = clusters
    plt.figure(figsize=(8, 6))
    sns.pairplot(cluster_data, hue='Cluster', palette='viridis', diag_kind='kde')
    plt.suptitle('Pairplot of Clusters', y=1.02)
    plt.show()
data.to_csv('clustered_data.csv', index=False)
```

```
Name: count, dtype: int64
```

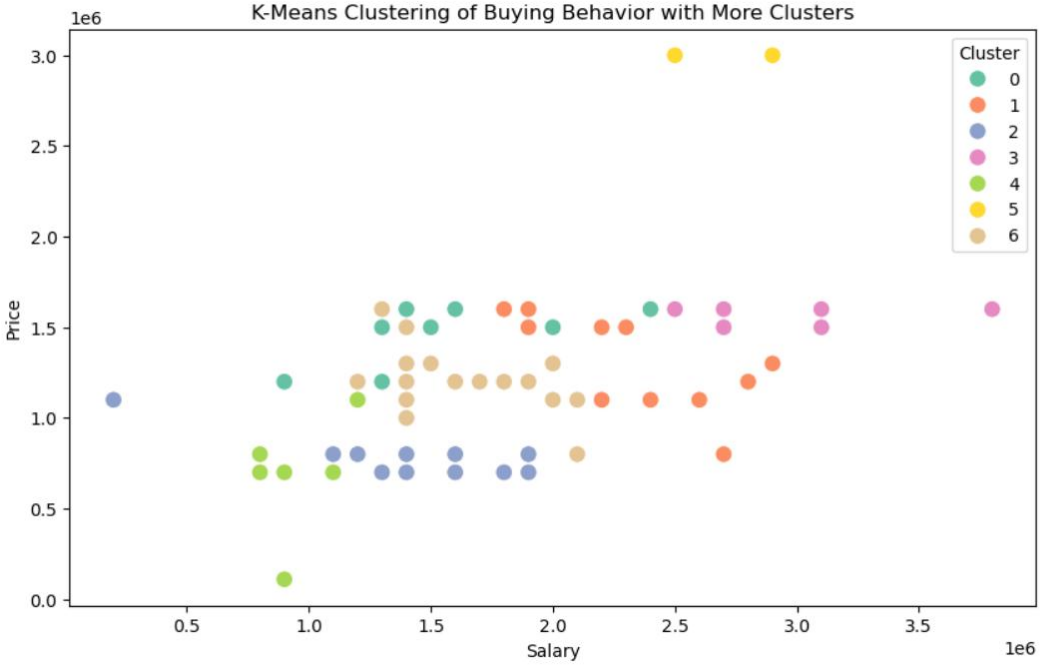





```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.cluster import KMeans
from sklearn.preprocessing import StandardScaler
data['Personal loan'] = data['Personal loan'].map({'Yes': 1, 'No': 0})
data['House Loan'] = data['House Loan'].map({'Yes': 1, 'No': 0})
data['Wife Working'] = data['Wife Working'].map({'Yes': 1, 'No': 0})
features = data[['Age', 'No of Dependents', 'Salary', 'Wife Salary', 'Total Salary', 'Price']]
scaler = StandardScaler()
scaled_features = scaler.fit_transform(features)
kmeans = KMeans(n_clusters=3, random_state=42)  # Choose the number of clusters
data['Cluster'] = kmeans.fit_predict(scaled_features)
plt.figure(figsize=(10, 6))
sns.scatterplot(data=data, x='Salary', y='Total Salary', hue='Cluster', palette='Set2', s=100)
plt.title('K-Means Clustering of Data')
plt.xlabel('Salary')
plt.ylabel('Total Salary')
plt.legend(title='Cluster')
plt.show()
```




```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.cluster import KMeans
from sklearn.preprocessing import StandardScaler
from sklearn.impute import SimpleImputer
imputer = SimpleImputer(strategy='mean')
data[['Salary', 'Total Salary', 'No of Dependents', 'Price']] = imputer.fit_transform(data[['Salary', 'Total Salary', 'No of Dependents', 'Price']])
simplified_features = data[['Salary', 'Total Salary', 'No of Dependents', 'Price']]
scaler = StandardScaler()
scaled_simplified_features = scaler.fit_transform(simplified_features)
kmeans = KMeans(n_clusters=7, random_state=42)
data['More Buying Behavior Clusters'] = kmeans.fit_predict(scaled_simplified_features)
plt.figure(figsize=(10, 6))
sns.scatterplot(data=data, x='Salary', y='Price', hue='More Buying Behavior Clusters', palette='Set2', s=100)
plt.title('K-Means Clustering of Buying Behavior with More Clusters')
plt.xlabel('Salary')
plt.ylabel('Price')
plt.legend(title='Cluster')
plt.show()
centroids = pd.DataFrame(scaler.inverse_transform(kmeans.cluster_centers_), columns=simplified_features.columns)
centroids['Cluster'] = [f'Cluster {i}' for i in range(len(centroids))]
print(centroids)
```



Target Segment:

As the trend suggests, higher salaried, old people tend to buy cars in the range 10-20L.
However, the sharp rise in awareness in younger segments about climate change influences their decision to buy electric cars. So, the recommended segment is the mid
tier, with significant marketing about the pros of electric vehicles to the environment is
required.

Final Observation:

Based on the K-Means clustering analysis, the dataset was successfully segmented into distinct clusters, providing valuable insights into the electric vehicle market. The clustering process identified 4 optimal clusters that represent different patterns of vehicle types, primarily focusing on two-wheelers and three-wheelers. This segmentation reflects the variation in demand and usage of electric vehicles based on their types. The visualizations showed clear patterns, such as the dominance of two-wheelers in certain clusters, likely due to affordability and urban mobility, while three-wheelers have a specific niche in public transport and goods movement. The clusters indicate distinct customer groups and vehicle preferences, where certain segments prefer economical, low-maintenance vehicles for short commutes, while others may favor more specialized vehicles for commercial use. The silhouette score also confirms the clustering quality, indicating the distinct separation of clusters. This analysis can help stakeholders understand market demand and target each segment more effectively, focusing on the popular vehicle types for different consumer needs.

References:

https://fame2.heavyindustry.gov.in/content/english/32_1_FAMEDepository.aspx
- **https://electricvehicles.in/category/ev-startups/#**
- **https://en.wikipedia.org/wiki/Electric_vehicle**
- **https://www.smev.in/ev-industry**
- **https://www.statista.com/statistics/1234761/india-electric-vehicle-sales-by-type/**
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