

Segmentation Analysis Report

Electric Vehicle Market In India

by

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Overview

The burgeoning demand for sustainable mobility solutions has steered attention towards the Indian Electric Vehicle (EV) market, characterized by a diverse landscape and evolving consumer preferences. As part of an in-depth analysis conducted by Ashish Chauhan, this report delves into the strategic segmentation of the Indian EV market, aiming to decipher the most opportune avenues for market entry.

Breakdown of Problem Statement (Fermi Estimation)

1. **Understanding EV Market Segmentation:** Estimate and analyze various factors like geographic, demographic, psychographic, and behavioural traits to segment the Indian Electric Vehicle (EV) market, considering potential data limitations.
2. **Identifying Early Adopter Regions:** Estimate the regions in India most likely to embrace EV technology based on the Technology Adoption Life Cycle.
3. **Data-Driven Decision Making:** Using available datasets related to EV market trends, vehicle types, charging stations, and usage statistics to make informed market penetration strategies.
4. **Pricing Strategy and Customized Marketing:** Fermi estimation-based analysis to set strategic pricing ranges and devise tailored marketing approaches for different customer segments.

Data Sources

Data used during the segmentation process has been collected manually from the below sources:

- <https://datasource.kapsarc.org/pages/home/>
- <https://www.kaggle.com/>
- <https://data.gov.in/>

Data Pre-processing

Packages used –

1. Numpy
2. Pandas
3. Matplotlib
4. Seaborn

```
[1] import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

```
[2] df1 = pd.read_csv('/content/datafile.csv')
df2 = pd.read_csv('/content/datafile (1).csv')
df3 = pd.read_csv('/content/datafile (2).csv')
df4 = pd.read_csv('/content/datafile (3).csv')
df5 = pd.read_csv('/content/datafile (4).csv')
df6 = pd.read_csv('/content/EVIndia.csv')
```

```
[3] print(df1.head())
print(df2.head())
print(df3.head())
print(df4.head())
print(df5.head())
print(df6.head())
```

	Sl. No.	State/UT	No. of Operational PCS
0	1	Andaman and Nicobar	3
1	2	Andhra Pradesh	222
2	3	Arunachal Pradesh	9
3	4	Assam	48
4	5	Bihar	83

	Category	Vehicles to be Supported (in No.) \
0	e-2W	1000000
1	e-3W	500000
2	e-4W	55000
3	e-Buses	7090

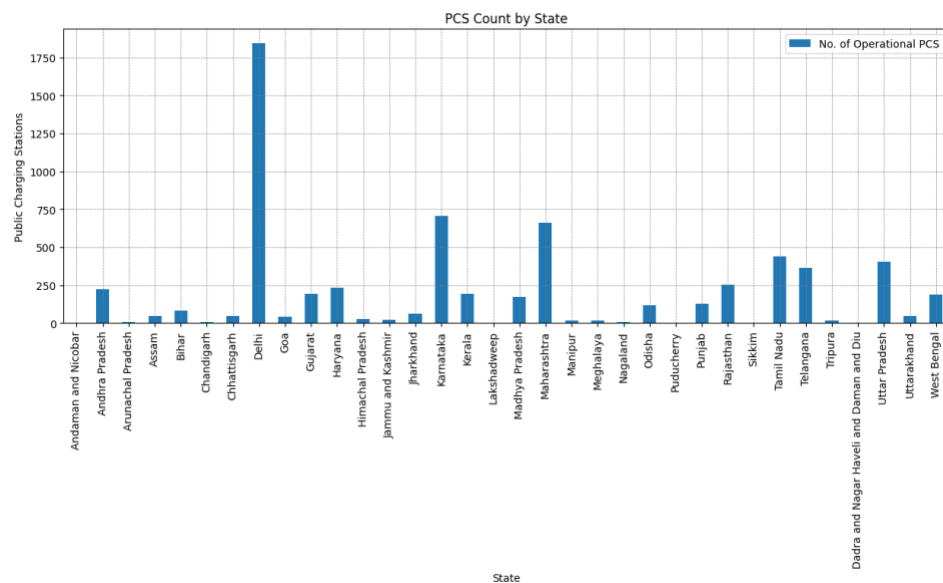
```
Actual Vehicles Supported (in No.)
0      792529
1      81172
2      6831
3      2435
4      882967

National Highway No. of Operational PCS
0 National Highway-10      1
1 National Highway-11      3
2 National Highway-128     1
3 National Highway-13      3
4 National Highway-130     1

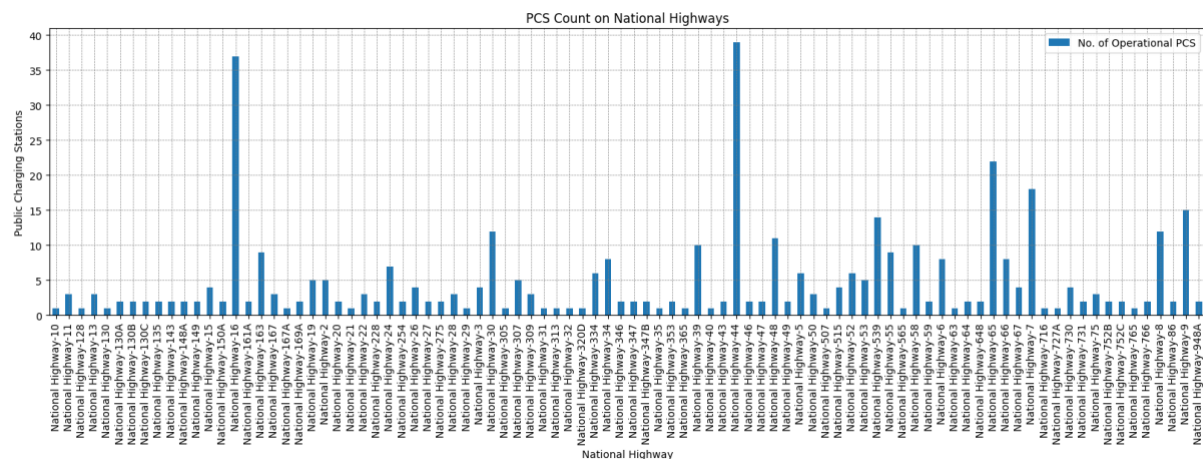
S. No. State Name Electric Vehicle Count
0      1 Andaman and Nicobar Island      182
1      2 Andhra Pradesh      51322
2      3 Arunachal Pradesh      24
3      4 Assam      94929
4      5 Bihar      128885

Year Total Count
0 2014      2391
1 2015      7790
2 2016     49622
3 2017     86720
4 2018    129125
```

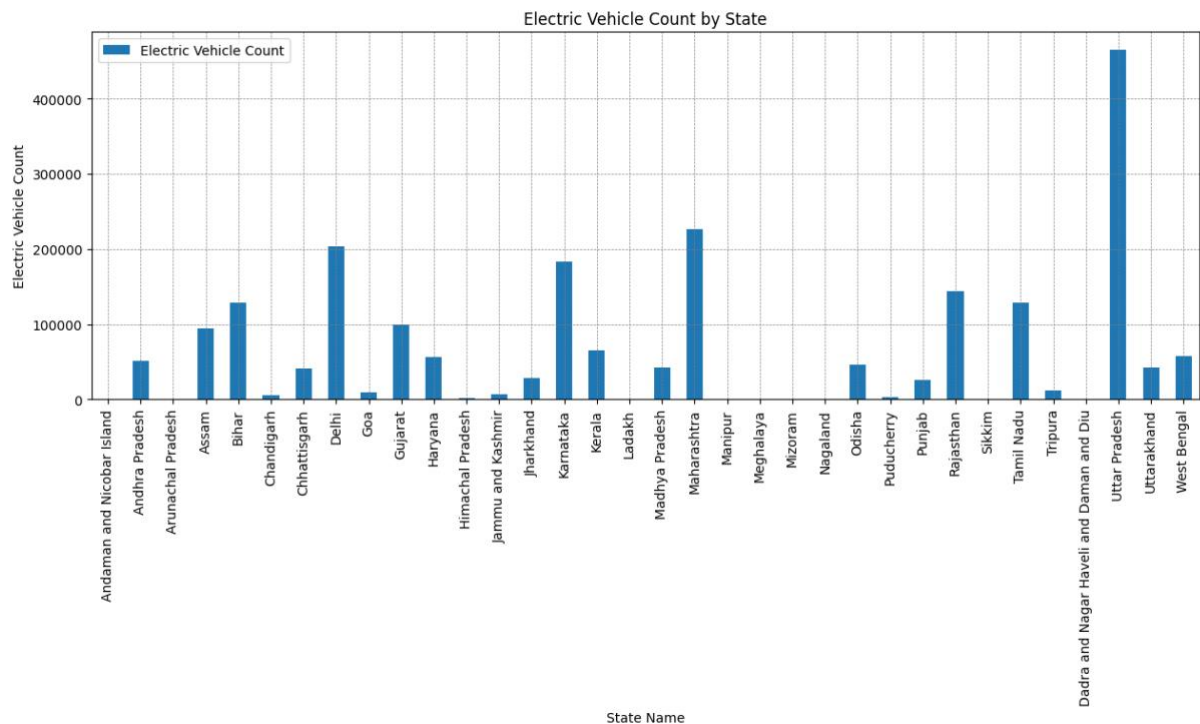
EDA –



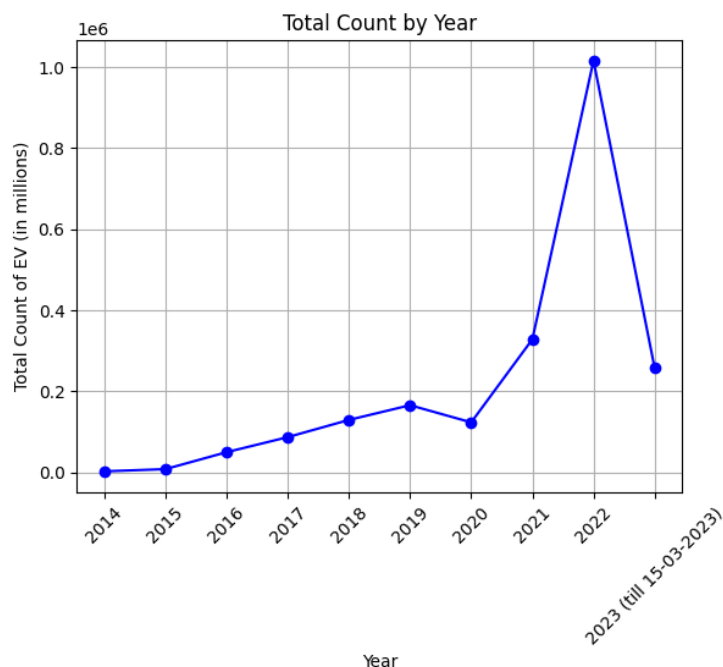
Based on the initial Exploratory Data Analysis (EDA), a notable variation emerges in the accessibility of public charging stations across different states and union territories (UTs) in India. Specifically, regions like Delhi, Maharashtra, and Karnataka exhibit a considerably denser distribution of charging stations in contrast to other areas. This substantial discrepancy highlights an uneven infrastructure development related to electric vehicle charging facilities across various geographical regions within the country.



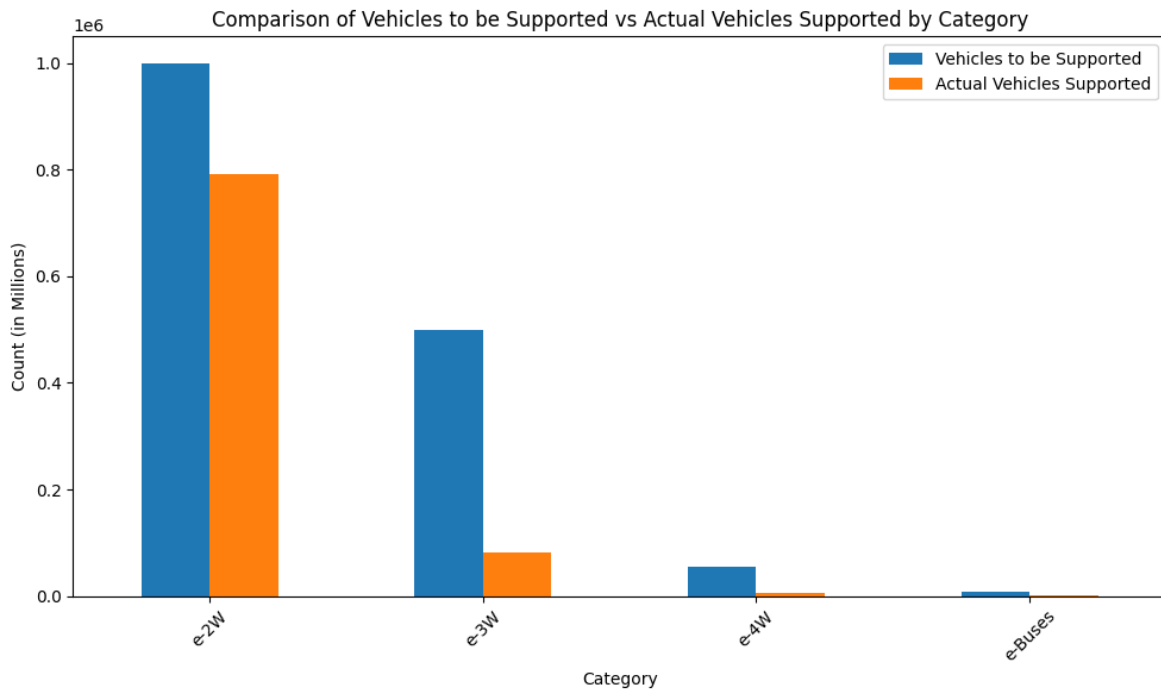
The analysis has indicated a shortage of Public Charging Station (PCS) facilities along several National Highways (NH) across India. However, a handful of major highways such as NH-16, NH-44, NH-65, NH-7, NH-9, and NH-39 boast a more substantial presence of PCS facilities. This relatively better provision of charging stations along these highways signifies a potential advantage for electric vehicle (EV) owners, particularly during extended journeys, offering a more convenient and accessible means of recharging.



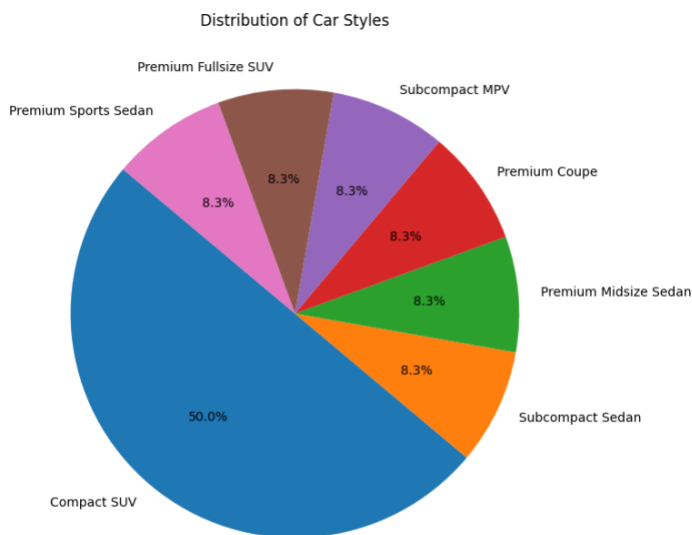
The current count of Electric Vehicles (EVs) exhibits the highest numbers in regions such as Uttar Pradesh, Delhi, Karnataka, and Maharashtra. These areas demonstrate a notable concentration of EVs compared to other regions, signifying a comparatively higher adoption rate or infrastructure support for electric vehicles in these locations.



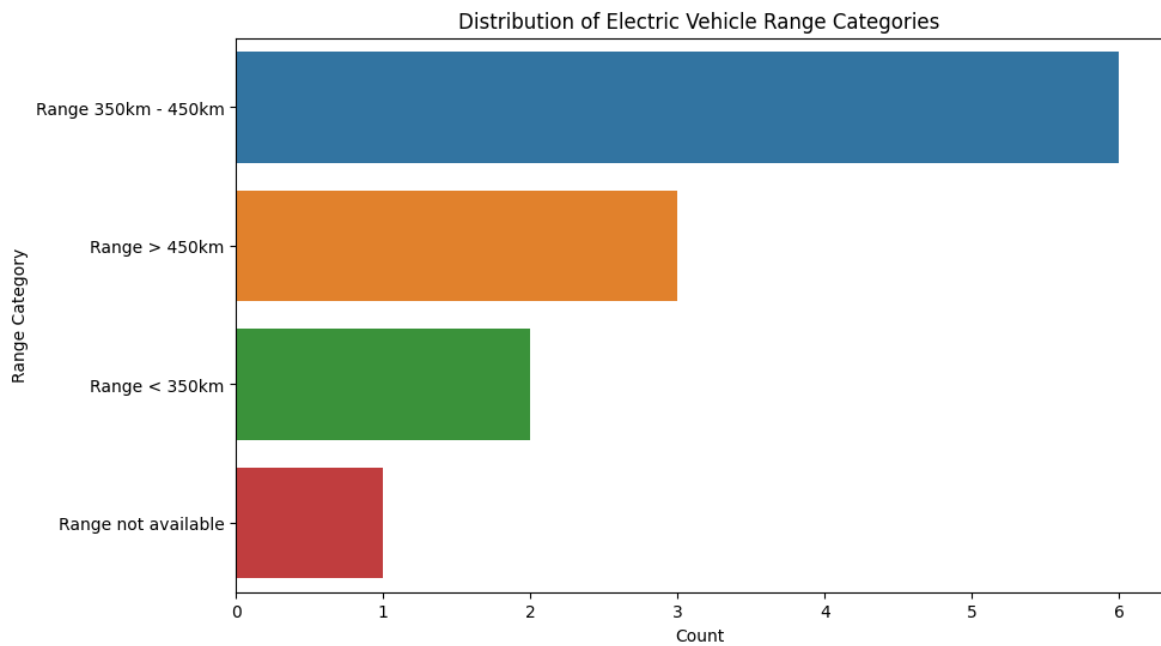
The count of Electric Vehicles (EVs) has experienced substantial growth, rising from approximately 100,000 in 2017 to a significant increase, reaching around 1 million in 2022. This remarkable surge in EV count demonstrates a substantial rise in the adoption and usage of electric vehicles within the market.



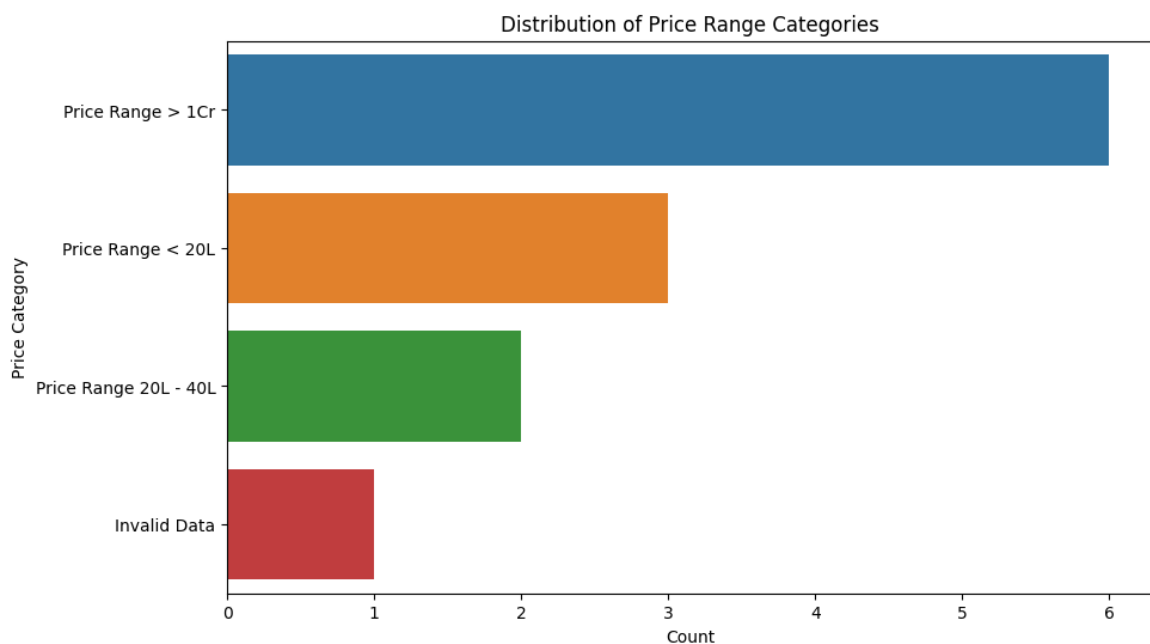
Upon analysis, there exists a noticeable disparity between the expected count and the actual count for 3-wheelers and 4-wheelers within the electric vehicle market. This indicates an unmet demand or a shortage in the market compared to the potential requirement. Conversely, the difference is substantially lower for 2-wheelers, indicating a more balanced provision within the market. Additionally, the count of e-buses requiring support is notably lower, suggesting a limited presence compared to the potential for future expansion and deployment in the electric vehicle sector.



In the Indian electric vehicle market, approximately 50% of the available EV car models fall under the category of compact SUVs. The remaining models, including sedans, coupes, and full-size SUVs, each represent approximately 8.3% of the total EV car models available in the market.

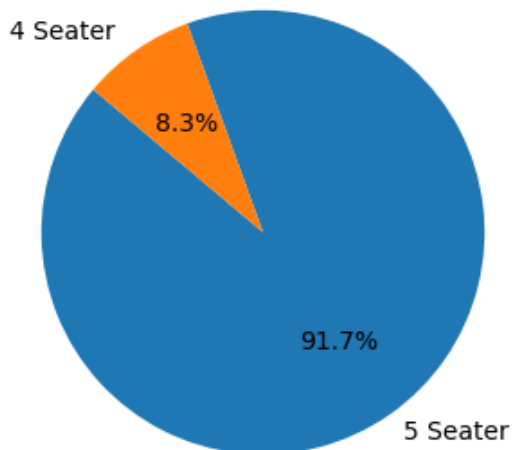


In the Indian market, there are 6 car models for electric vehicles that provide a range between 350 and 450 kilometers per full charge. Additionally, 3 car models offer a range exceeding 450 kilometers, while 2 models offer a range below 350 kilometers on a full charge.



The pricing analysis of electric car models in India reflects a diverse market landscape. While six models are priced higher than 1 crore, signifying a premium segment targeting consumers seeking luxury and high-end features, three models priced below 20 lakhs indicate an accessible range for budget-conscious buyers. Additionally, the presence of two models priced between 20 to 40 lakhs caters to a mid-range market, appealing to consumers seeking a balance between affordability and premium features.

Distribution of Car Capacity



The dominance of five-seater car models in India, accounting for 91.7% of the market, suggests a strong preference for vehicles accommodating larger passenger capacities. Conversely, the limited presence of four-seater models, representing only 8.3% of the market, indicates a relatively smaller market segment seeking cars with a reduced seating capacity. This data highlights the overwhelming demand for five-seater models, emphasizing the importance of considering consumer preferences for seating capacity when strategizing market entry and product offerings in the EV segment.

Potential Segmentations

1. Geographic Segmentation:

Geographic segmentation involves categorizing states and union territories (UTs) based on various factors related to Electric Vehicle (EV) adoption. States like Delhi, Maharashtra, Karnataka, and Uttar Pradesh exhibit a higher concentration of public charging stations, leading to a more conducive environment for EV adoption. These regions could be identified as "High EV Adoption Regions" due to their advanced infrastructure and higher EV counts.

2. EV Type Segmentation:

Segmentation based on vehicle types reveals distinct clusters of EVs, including two-wheelers, three-wheelers, four-wheelers, and e-buses. Each vehicle type may represent a unique market segment, allowing for targeted marketing strategies and specialized product offerings catering to specific consumer preferences.

3. Range and Price-Based Segmentation:

EVs can be categorized into different segments based on their range per charge and price brackets. For instance, classifying EVs into ranges like 350-450km, below 350km, or above 450km, along with price categories such as above 1Cr, below 20L, and 20-40L, provides insights into consumer preferences and affordability.

4. Vehicle Model Segmentation:

Segmenting EV models based on body types, such as compact SUVs, sedans, coupes, and other vehicle categories, helps identify customer preferences and market demands. For instance, compact SUVs comprise around 50% of EV car models in India, showcasing their dominance in the market.

5. Seating Capacity Segmentation:

Understanding the seating capacity preference among consumers is vital. Segments related to car models, differentiated by seating capacity (e.g., 4-seaters and 5-seaters), offer insights into consumer preferences regarding the number of passengers accommodated.

6. Highway Accessibility Segmentation:

Segmentation based on the availability of public charging stations along national highways highlights key regions suitable for targeting long-distance travelers. For example, highways like NH-16, NH-44, NH-65, NH-7, NH-9, and NH-39, equipped with decent numbers of charging stations, are ideal for targeting EV owners on long journeys.

Utilizing Machine Learning techniques and clustering algorithms, these segments provide a foundational understanding of various EV market aspects. By tailoring marketing strategies and products according to these segments, it becomes possible to effectively target specific customer groups and address their unique needs and preferences.

Segmentation Extraction

Clustering Algorithm Used -> K-Means clustering

Segmentation extraction plays a pivotal role in understanding the Electric Vehicle (EV) market in India. To achieve a deeper comprehension of this multifaceted landscape, I employed the K-means clustering algorithm – a powerful unsupervised machine learning technique – to identify distinct segments within the EV market.

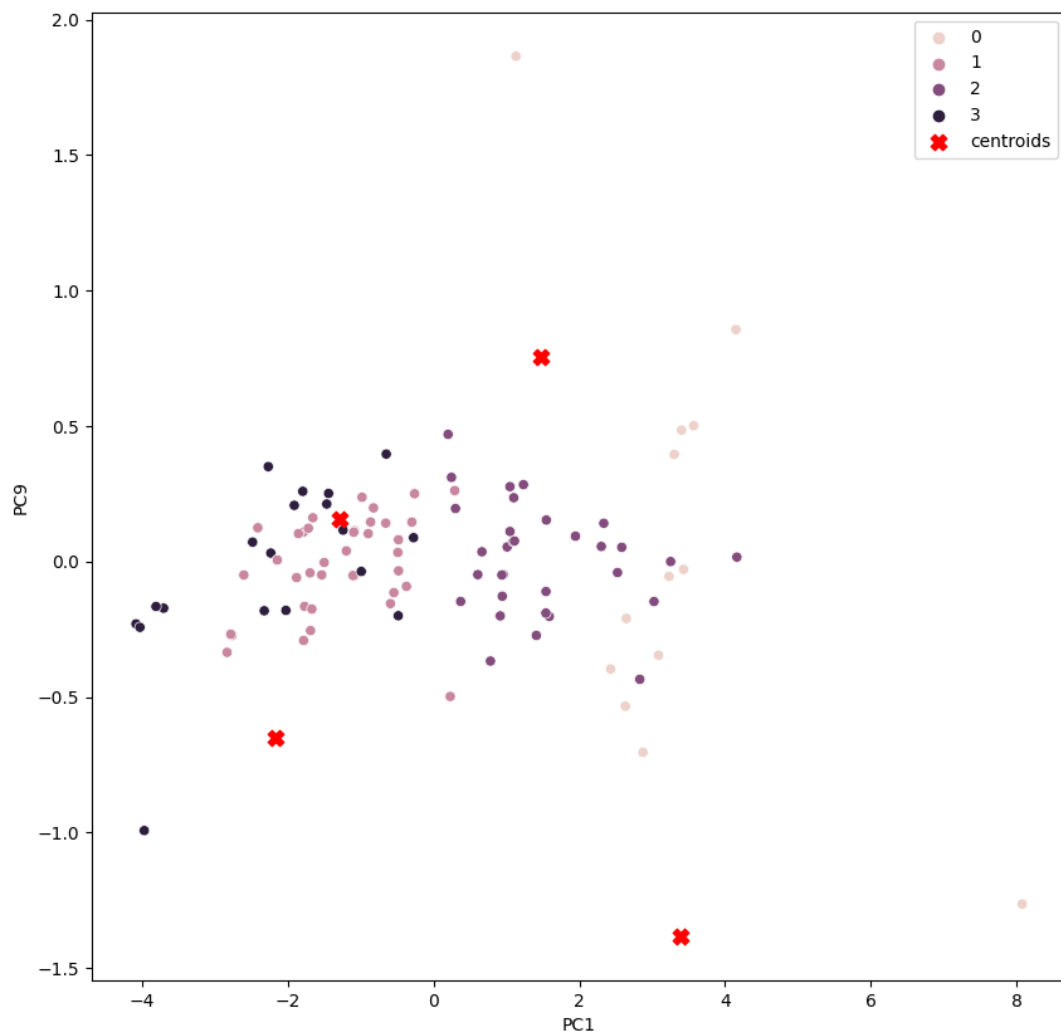
K-means clustering allowed us to group similar observations together based on their characteristics and attributes, enabling the identification of coherent clusters or segments within the diverse EV dataset. By leveraging this method, we sought to discern patterns, segment boundaries, and inherent structures present within the EV market data.

K-Means Clustering

```
[22] kmeans = KMeans(n_clusters=4, init='k-means++', random_state=0).fit(t)
      df['cluster_num'] = kmeans.labels_
      print(kmeans.labels_)
      print(kmeans.inertia_)
      print(kmeans.n_iter_)
      print(kmeans.cluster_centers_)

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to '
warnings.warn(
[0 3 2 1 1 0 3 3 1 2 2 1 1 2 3 1 0 1 3 1 1 2 1 0 0 1 1 2 3 3 2 1 1 2 1 1 1
 3 3 2 0 1 2 1 1 1 1 0 0 3 2 0 1 1 2 1 1 3 1 0 3 2 2 2 3 0 1 2 3 2 1 2 0 2
 1 1 2 3 2 0 1 2 3 1 2 1 2 2 2 1 2 3 3 2 1 1 1 3 1 2 2 2 2]
427.887468451736
5
[[ 3.38080722 -1.38222959 -0.36489344  0.10476922  0.40601443  0.27185359
   0.24199669 -0.10661851  0.04313075]
 [-1.28035008  0.15751337 -0.80380172  0.03882667 -0.26171256  0.0576548
  -0.02518157 -0.04843479 -0.00967151]
 [ 1.47340441  0.75533302  0.44439293  0.22304959  0.00587772 -0.20900642
  -0.04639724  0.13707866  0.00747268]
 [-2.1666201  -0.64972069  1.15112147 -0.52704354  0.24950081  0.04766166
  -0.03574547 -0.05850103 -0.02224405]]
```

```
[24] #Visualizing clusters
      sns.scatterplot(data=data2, x="PC1", y="PC9", hue=kmeans.labels_)
      plt.scatter(kmeans.cluster_centers_[0], kmeans.cluster_centers_[1], marker="x", c="r", s=80, label="centroids")
      plt.legend()
      plt.show()
```



Target Segments

1. Geographical Distribution:

Analysis of the geographical distribution of EV adoption across states and Union Territories (UTs) in India revealed distinctive trends. States such as Delhi, Maharashtra, and Karnataka emerged as focal points with a notably higher concentration of EV usage, indicating a receptive market for EVs in these regions.

2. Charging Infrastructure:

The availability and distribution of public charging stations across Indian highways and strategic locations were meticulously evaluated. The presence of adequate charging infrastructure along national highways, especially on NH-16, NH-44, NH-65, NH-7, NH-9, and NH-39, highlights areas conducive for EV owners, particularly during long journeys.

3. Vehicle Count and Sales Growth:

Analysis showcased significant EV counts in states such as Uttar Pradesh, Delhi, Karnataka, and Maharashtra. The exponential surge in EV count, reaching up to 1 million in 2022 from approximately 100,000 in 2017, signifies the burgeoning demand and market growth potential.

4. Car Model Preferences:

In-depth analysis unveiled the dominance of compact SUVs, comprising 50% of the EV car models in India. Additionally, notable variations in the price range and seating capacity were identified among different car models.

The culmination of these findings and insightful metrics facilitated the strategic identification of the target segment. It was determined that focusing on regions with high EV adoption rates, bolstered by robust charging infrastructure, and catering to the burgeoning demand for specific vehicle types, particularly compact 5-seater SUVs, presents a lucrative opportunity for market penetration and successful EV deployment.

Customizing the Marketing Mix

The customization of the marketing mix for Electric Vehicles (EVs) necessitates a nuanced approach aligning with the distinct characteristics and preferences of the identified target segment. Leveraging the insights derived from the extensive analysis, the following strategies have been devised to cater to the specific needs and demands of the market:

1. Product:

- **Model Variants:** Considering the overwhelming preference for compact SUVs, the focus will be on diversifying and enhancing the existing range of compact EVs to cater to diverse consumer preferences and requirements.
- **Extended Range Models:** Prioritizing the development of EV models offering a range between 350-450 km per full charge, capitalizing on the evident demand for extended-range vehicles in the market.

2. Price:

- **Pricing Strategies:** Striking a balance between affordability and premium features by offering a range of models across various price points. This includes affordable options below 20 lakhs, mid-range options between 20-40 lakhs, and premium models above 1 crore, catering to diverse consumer segments.

3. Place:

- **Charging Infrastructure Integration:** Collaborating with stakeholders to expand the network of charging stations, particularly along the identified high-traffic highways and strategic locations, ensuring convenient access for EV users.

4. Promotion:

- **Awareness Campaigns:** Launching targeted marketing campaigns emphasizing the environmental benefits, cost-efficiency, and technological advancements of EVs. Utilizing digital platforms, social media, and partnerships to amplify outreach and engagement within the target segment.

5. People:

- **Customer Support and Education:** Establishing robust customer support services and educational programs to assist customers in understanding the benefits of EVs, resolving queries, and facilitating seamless adoption.

6. Process:

- **Streamlined Purchase Journey:** Implementing user-friendly and efficient purchase processes, including online sales platforms and simplified documentation, to enhance the overall customer experience.

7. Physical Evidence:

- **Showrooms and Experience Centers:** Establishing experiential showrooms and experience centers to provide potential customers with hands-on experiences, test drives, and insights into the EV features and benefits.

By tailoring each element of the marketing mix to resonate with the identified target segment's preferences, behaviors, and needs, the aim is to create a compelling and resonant brand presence, fostering increased adoption and market penetration within the dynamic landscape of the EV market in India.

Potential Customer Base

The potential customer base lies in States/UTs with high number of PCS and high adaptation rates. Uttar Pradesh, Delhi, Karnataka, Maharashtra can be considered as the most promising customer market for EV newcomers.

Potential Sale Calculation:

(Assuming Target sale price range = 20L – 40L)

(Assuming Vehicle Category = 4-seater compact SUV car)

Total EV sales in Key States (Uttar Pradesh, Delhi, Karnataka, Maharashtra): 40,000 (as per 2022 data)

Total EV Models in India: 30 models (approx.)

Average Potential Customer Base per Model: $40,000 / 30 = 1,333$ customers per model per year (approx.)

Considering avg Price per car to be Rs 3,000,000

Potential Sale per year in early market = $1333 \times 3,000,000$
= Rs 4,000,000,000 per year (approx.)

Most Optimal Market Segments

Determining the most optimal market segments is crucial for effective market penetration. Based on the comprehensive market research and segmentation analysis conducted, the following segments are identified as the most optimal for market entry:

- 1. Urban Metropolitan Segments:** Targeting major cities like Delhi, Mumbai, Bengaluru, and Hyderabad due to their:
 - High concentration of EVs.
 - Availability of public charging stations.
 - Growing adoption rate of electric vehicles.
- 2. Mid-Range Urban Commuters:** Targeting urban areas with compact SUV demand:
 - Higher concentration of compact SUV models.
 - Growing trend towards compact SUVs in urban settings.
- 3. Targeted High-Range EV Models:** Concentrate marketing efforts on EV models offering a range between 350 - 450km per full charge:
 - Significant market demand for EVs with competitive driving range.
 - Reflects a balance between affordability and range.

4. **5-Seater Car Models:** Focus on catering to the prevailing market preference for 5-seater EV models:
 - The majority of EV models available in India are designed as 5-seaters.

These identified segments present lucrative opportunities based on existing market trends, consumer preferences, infrastructure availability, and potential for substantial market penetration and profitability.

Tailoring marketing strategies, product offerings, and pricing structures to cater to these segments can potentially yield higher market share and sustained growth in the evolving electric vehicle market in India. Adjust strategies as needed based on evolving market dynamics and consumer behavior.

GitHub link (codes and datasets) –

<https://github.com/Ashish-chauhan08/Feynn-Lab-Internship/tree/main/Project%20-2>