# EV Segmentation

Abhinav Mishra

Problem Statement

The project is to analyse the electric vehicle market in India and solve the potential market segments for companies to target. The datasets used are collected from kaggle.com. The Analysis of the favourable market in India for Electric Vehicle startups using Segmentation analysis and machine learning algorithms. The goal was to analyse the Electric Vehicle market in India using Segmentation analysis and come up with a feasible strategy to enter the market, targeting the segments most likely to use Electric vehicles. The datasets used are collected from the Indian government data website data.gov.in and from kaggle.com. Eventually, we were able to build a machine-learning model to analyse and segment the current situation of the EV market in India.

Analysis on EV charging stations

During our analysis on the EV charging stations the data I used was from Kaggle.com. In the analysis I found out that most charging stations are situated in New Delhi which implies that the infrastructure is establishing very fast in this city, the graph is shown below.
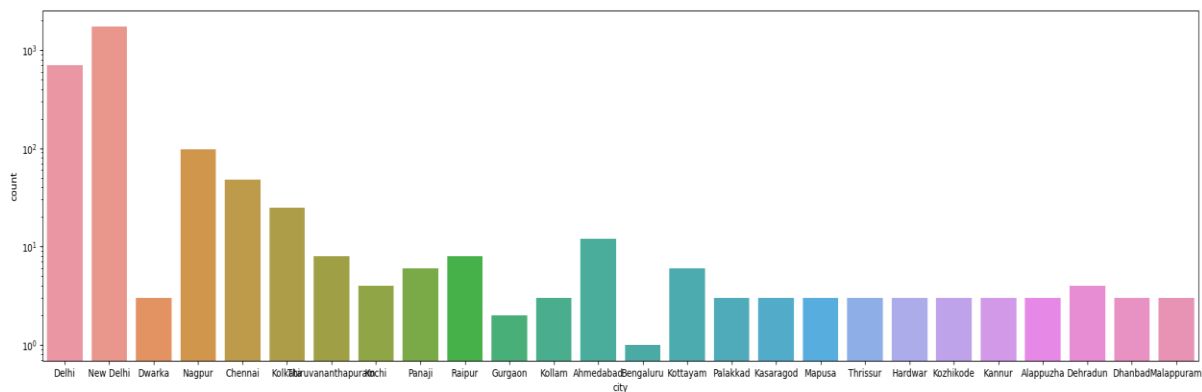
The next thing that was worth noting is the charging stations that are compatible for all the vehicle types.
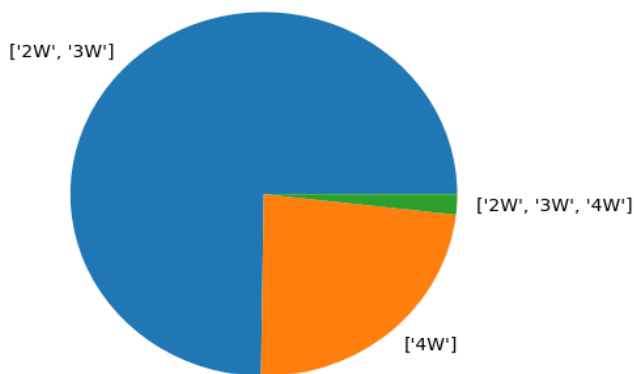
The pie chart above shows that the charging stations that are compatible for all vehicle types are too less, and the maximum number of charging stations are for 2-wheelers and 3-wheelers.

These analyses were done by using matplotlib and seaborn library of pandas.

Analysis after Segmentation

After using ML's Kmeans clustering technic three clusters were formed and the most prominent or important cluster was the first cluster that is visible below in 2 charts.
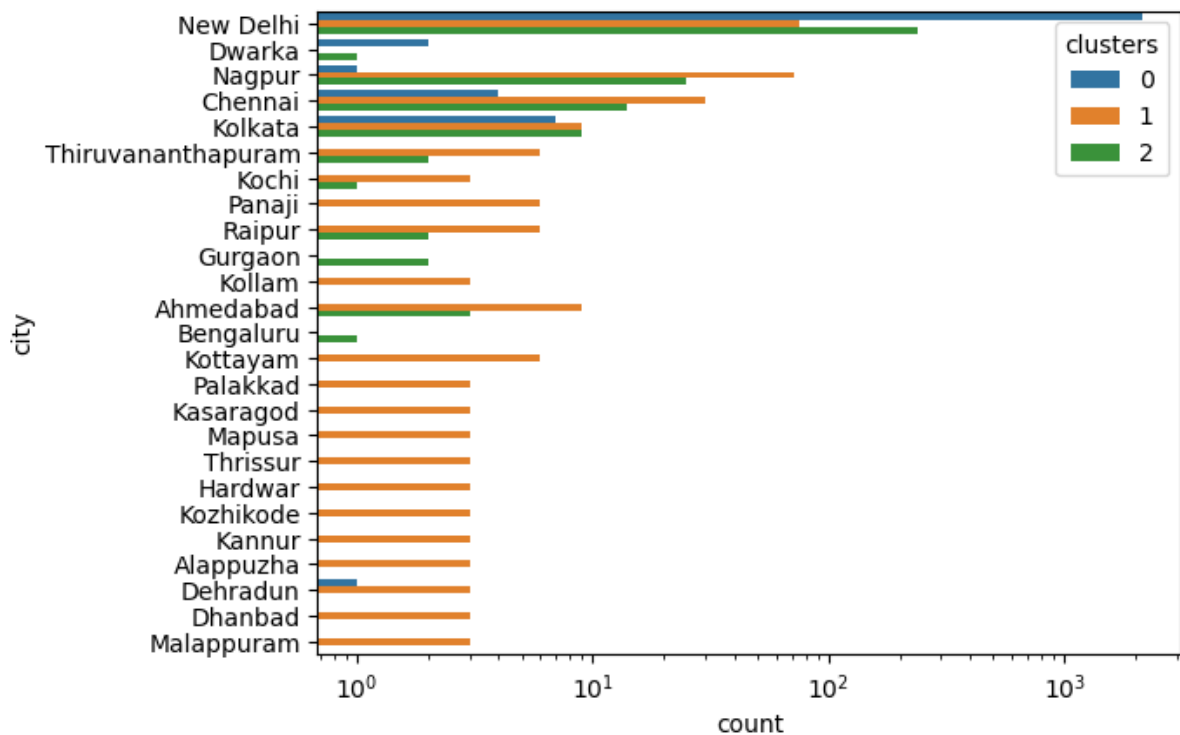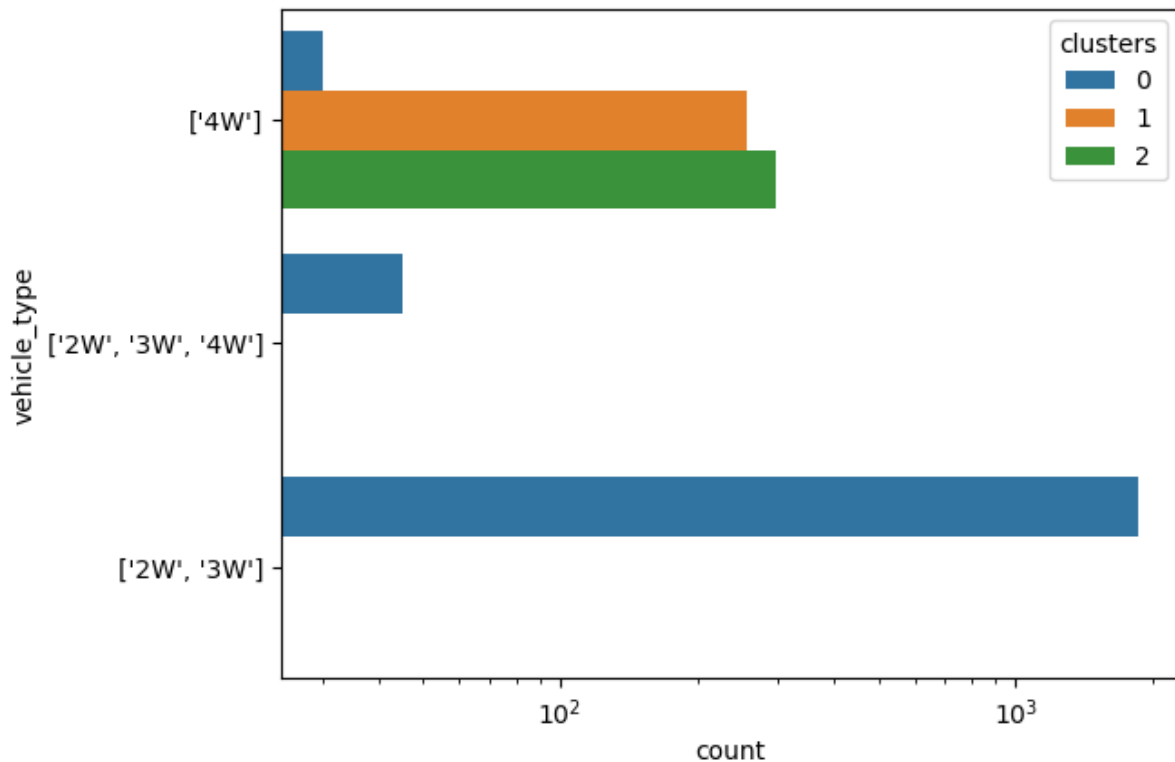
Conclusion

New Delhi, Kolkata, Nagpur and Chennai are present in all the three clusters that simply means that these cities are in advanced developmental phase with respect to the availability of charging stations. The other cities that are present in only one cluster needs infrastructure development for charging stations so that EV market can grow there. In the analysis there is a section where station type is mentioned and, in that section, battery swapping type is too less and to increase the users of vehicles those need battery swapping type charging stations, that type must also be developed. 4-Wheeler charging stations need to be increased in order to grow the EV market.

All in all, this analysis predicts that 2nd and 3rd clusters are the segments where development is needed and stake holders need to focus on these areas that are present in those clusters.

Github link

https://github.com/ab04ab9752/EV-segmentation

FINAL CONCLUSION

By Aashin Ceaser

Problem Statement:

With the growing concerns over environmental sustainability and the need to reduce carbon emissions, electric vehicles (EVs) are becoming increasingly popular globally. However, the adoption of EVs and the development of supporting charging infrastructure vary significantly across different regions and states/union territories (UTs) within India.

The objective of this analysis is to segment the states/UTs in India based on their current state of electric vehicle adoption and charging infrastructure availability. By identifying distinct market segments, stakeholders such as policymakers, automotive manufacturers, and charging station operators can devise targeted strategies and allocate resources more effectively to promote EV adoption and address the charging infrastructure needs in different regions.

The analysis will utilize the following data:

- State/UT-wise total number of vehicles registered

- State/UT-wise total number of electric vehicles registered

- Proportion of electric vehicles in each state/UT

- Number of operational public charging stations in each state/UT

- Number of electric vehicle (EV) chargers sanctioned in each state/UT

Using this data, the analysis will employ k-means clustering, a popular unsupervised machine learning technique, to group the states/UTs into distinct market segments based on their similarities in electric vehicle adoption and charging infrastructure availability.

The analysis aims to address the following key questions:

1. How many distinct market segments exist in India based on electric vehicle adoption and charging infrastructure?

2. Which states/UTs belong to each market segment?

3. What are the characteristics of each market segment in terms of the proportion of electric vehicles, operational charging stations, and sanctioned EV chargers?

4. How can the identified market segments guide stakeholders in developing targeted strategies and policies to promote EV adoption and charging infrastructure development in different regions?

By understanding the market segmentation, stakeholders can prioritize their efforts and resources in regions with high potential for EV adoption or areas that require urgent attention to improve charging infrastructure. The analysis will provide valuable insights for policymakers, automotive companies, charging station operators, and other relevant stakeholders to make informed decisions and drive the transition toward sustainable mobility in India.

Conclusion:

The segment evaluation plot shows the distribution of states/UTs across different clusters based on the proportion of electric vehicles (EV) and the number of EV charging stations sanctioned. From the given information, it appears that Segment 1 (Cluster 1) and Segment 3 (Cluster 3) are considered the target segments for promoting electric vehicle adoption and developing charging infrastructure.

Segment 1 (Cluster 1) consists of 13 states/UTs, including Andaman and Nicobar Island, Arunachal Pradesh, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Ladakh, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Puducherry, and Dadra and Nagar Haveli and Daman and Diu. These states/UTs have a relatively low proportion of electric vehicles (average of 0.20) and a low number of operational public charging stations (average of 32) and sanctioned EV chargers (average of 9).

Segment 3 (Cluster 3) includes three states/UTs: Karnataka, Maharashtra, and Uttar Pradesh. These states have a moderate proportion of electric vehicles (average of 0.98) but a relatively high number of operational public charging stations (average of 471) and sanctioned EV chargers (average of 166).

Based on the analysis, the following conclusions can be drawn:

1. Segment 1 represents a market segment with low EV adoption and charging infrastructure, indicating the need for focused efforts to promote electric vehicle adoption and develop charging infrastructure in these states/UTs.

2. Segment 3 represents a market segment with moderate EV adoption but relatively well-developed charging infrastructure. Efforts should be made to further increase EV adoption in these states while maintaining and expanding the charging infrastructure.

3. Stakeholders, automotive manufacturers, should prioritize their strategies and allocate resources accordingly for these two target segments.

4. For Segment 1, initiatives could include incentives for EV purchases, awareness campaigns, and targeted development of charging infrastructure in these states/UTs.

5. For Segment 3, efforts could focus on sustaining the growth of EV adoption through continued infrastructure development, favorable policies, and encouraging the adoption of EVs in commercial and public transportation sectors.

6. The remaining clusters (Clusters 0, 2, and 4) represent different stages of EV adoption and charging infrastructure development, which may require tailored approaches based on their specific characteristics.

Overall, the market segmentation analysis provides valuable insights for stakeholders to develop targeted strategies and allocate resources effectively to promote electric vehicle adoption and support the development of charging infrastructure in different regions of India.

Git Hub Link:

[aashinceaser/EV-Market-Segmentation-analysis--Feyyn-Labs (github.com)](https://github.com)

Thank You

EV-Market

Name- Aun Bin Saba

Github link- https://github.com/Aunsaba/Ev-Market/blob/main/Aun_Bin_Saba_Ev_Sales_state.ipynb

Problem Statement:

You are a team working under an Electric Vehicle Startup. The Startup is still deciding in which vehicle/customer space it will be develop its EVs.

You have to analyse the Electric Vehicle market in India using Segmentation analysis and come up with a feasible strategy to enter the market, targeting the segments most likely to use Electric vehicles.

Data Set:

I am using a dataset for EV Vehicle Sales as per Indian State and UT from 2019-2024.

Data Dictionary:

Column Name	Column Description
State	**Indian State and Union Territories**
EV Sale 2019	**Total EV Sales for all vehicles as per State and UT wise for 2019**
EV Sale 2020	**Total EV Sales for all vehicles as per State and UT wise for 2020**
EV Sale 2021	**Total EV Sales for all vehicles as per State and UT wise for 2021**
EV Sale 2022	**Total EV Sales for all vehicles as per State and UT wise for 2022**
EV Sale 2023	**Total EV Sales for all vehicles as per State and UT wise for 2023**
EV Sale 2024	**Total EV Sales for all vehicles as per State and UT wise for 2024 till March.**

Data Extracted From: Vahan Dashboard by Govt of India.

Web link- https://vahan.parivahan.gov.in/vahan4dashboard/vahan/view/reportview.xhtml

- **Dataset Contains 33 rows and 7 columns**
- **Example of top 5 Rows of Dataset**

	State	EV SALES (2019)	EV SALES (2020)	EV SALES (2021)	EV SALES (2022)	EV SALES (2023)	EV SALES (2024)
0	ANDAMAN & NICOBAR ISLAND	2	36	92	23	26	12
1	ANDHRA PRADESH	2162	1647	9688	29374	32838	15430
2	ARUNACHAL PRADESH	1	5	2	2	21	13
3	ASSAM	10866	8357	15632	40704	60798	18378
4	BIHAR	12380	12447	23083	55752	88216	30912

Fig- Top 5 rows

- **Data 5-point Summary:**

	count	unique	top	freq	mean	std	min	25%	50%	75%	max
State	33	33	ANDAMAN & NICOBAR ISLAND	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN
EV SALES (2019)	33.0	NaN	NaN	NaN	5056.787879	10467.043263	0.0	54.0	1160.0	5818.0	55799.0
EV SALES (2020)	33.0	NaN	NaN	NaN	3777.939394	6237.091294	0.0	82.0	1366.0	5604.0	31270.0
EV SALES (2021)	33.0	NaN	NaN	NaN	10048.060606	14395.353208	1.0	326.0	4643.0	10438.0	66708.0
EV SALES (2022)	33.0	NaN	NaN	NaN	31061.484848	40695.040711	2.0	1007.0	14055.0	40704.0	162870.0
EV SALES (2023)	33.0	NaN	NaN	NaN	46426.939394	62991.951095	6.0	1128.0	21433.0	73649.0	278184.0
EV SALES (2024)	33.0	NaN	NaN	NaN	17399.212121	23214.295204	2.0	460.0	10569.0	26490.0	98156.0

Fig- Data Summary

- **EV Sales Year Wise:**
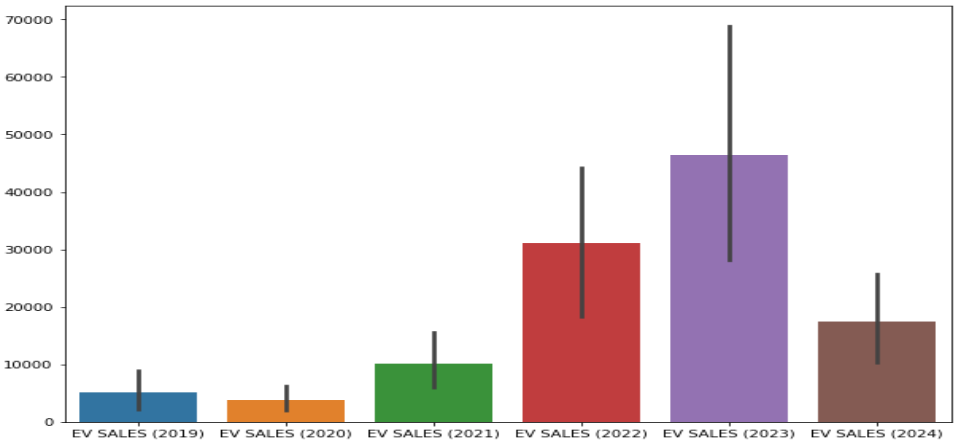

```
The total EV Sales in 2019 in India: 166874
The total EV Sales in 2020 in India: 124672
The total EV Sales in 2021 in India: 331586
The total EV Sales in 2022 in India: 1025029
The total EV Sales in 2023 in India: 1532089
The total EV Sales in 2024 in India: 574174
```

Fig- EV Sales year-wise

Based on the plot and data analysis, we can observe that the sales of EV vehicles have gradually increased over the years. However, the sales of EV vehicles in 2020 were significantly impacted due to the COVID-19 lockdown and the global economic crisis, resulting in a **25%** decrease in sales compared to 2019. Nevertheless, the EV market has made a remarkable recovery since then, with a **166%** increase in sales in 2021, followed by a **209%** increase in 2022. As of March, the sales have continued to grow steadily, with a **50%** increase in both 2023 and 2024.

This shows that the EV market is growing rapidly, and it is the right time to enter the market with at least a 50% growth rate.

- **State Wise EV Sales for 2019 & 2020:**

```
State                                State
UTTAR PRADESH              55799      UTTAR PRADESH              31270
DELHI                     23221      BIHAR                     12447
WEST BENGAL               13533      DELHI                     12378
BIHAR                     12380      WEST BENGAL               10079
ASSAM                     10866      KARNATAKA                  9699
MAHARASHTRA                7317      ASSAM                      8357
RAJASTHAN                  6634      MAHARASHTRA                7132
KARNATAKA                  6146      TAMIL NADU                 5696
UTTARAKHAND                5818      RAJASTHAN                  5604
HARYANA                    5108      TRIPURA                    3421
LADAKH                     3687      LADAKH                     3360
TAMIL NADU                 3444      HARYANA                    2982
CHHATTISGARH               2744      UTTARAKHAND                2394
ANDHRA PRADESH             2162      ANDHRA PRADESH             1647
JHARKHAND                  1931      JHARKHAND                  1516
TRIPURA                    1459      CHHATTISGARH               1489
ODISHA                     1160      KERALA                     1366
PUNJAB                      961      GUJARAT                    1122
GUJARAT                     946      ODISHA                      903
CHANDIGARH                  507      PUNJAB                      832
KERALA                      483      CHANDIGARH                  369
MANIPUR                     251      HIMACHAL PRADESH            181
PUDUCHERRY                   81      MANIPUR                     104
JAMMU AND KASHMIR            76      PUDUCHERRY                   88
HIMACHAL PRADESH             54      GOA                          82
GOA                         41      JAMMU AND KASHMIR            74
NAGALAND                    29      ANDAMAN & NICOBAR ISLAND     36
UT OF DNH AND DD            19      UT OF DNH AND DD             24
MEGHALAYA                   13      NAGALAND                     11
ANDAMAN & NICOBAR ISLAND     2      ARUNACHAL PRADESH             5
MIZORAM                      1      MEGHALAYA                     3
ARUNACHAL PRADESH            1      MIZORAM                       1
MADHYA PRADESH               0      MADHYA PRADESH                0
Name: EV SALES (2019), dtype: int64   Name: EV SALES (2020), dtype: int64
```

Fig State-wise EV Sales for 2019,2020

Based on the chart provided, we can see that Uttar Pradesh has the highest EV sales, followed by Delhi and then West Bengal. In 2020, Uttar Pradesh still remained on top with the highest EV sales, followed by Bihar and then Delhi. Interestingly, both Uttar Pradesh and Delhi had a decrease in sales compared to the previous year, while Bihar only had two units less than in 2020.

According to the latest data, there were no sales of electric vehicles in Madhya Pradesh in both 2019 and 2020.

- **State-wise EV Sales for 2021,2022:**

State	EV SALES (2021)	State	EV SALES (2022)
UTTAR PRADESH	66708	UTTAR PRADESH	162870
KARNATAKA	33304	MAHARASHTRA	136040
TAMIL NADU	30030	KARNATAKA	95856
MAHARASHTRA	29914	RAJASTHAN	78248
DELHI	25815	GUJARAT	68994
RAJASTHAN	23464	TAMIL NADU	66998
BIHAR	23083	DELHI	62257
ASSAM	15632	BIHAR	55752
MADHYA PRADESH	10438	ASSAM	40704
GUJARAT	9765	KERALA	39618
ANDHRA PRADESH	9688	MADHYA PRADESH	36809
KERALA	8734	ANDHRA PRADESH	29374
HARYANA	8660	ODISHA	28443
WEST BENGAL	6409	HARYANA	25862
ODISHA	5626	CHHATTISGARH	22365
UTTARAKHAND	5325	UTTARAKHAND	15560
PUNJAB	4643	PUNJAB	14055
CHHATTISGARH	4215	JHARKHAND	13682
JHARKHAND	3741	WEST BENGAL	11151
TRIPURA	2434	GOA	5687
JAMMU AND KASHMIR	1146	JAMMU AND KASHMIR	4690
GOA	1096	TRIPURA	4178
CHANDIGARH	734	CHANDIGARH	2721
PUDUCHERRY	405	PUDUCHERRY	1481
HIMACHAL PRADESH	326	HIMACHAL PRADESH	1007
MANIPUR	114	MANIPUR	341
ANDAMAN & NICOBAR ISLAND	92	UT OF DNH AND DD	141
UT OF DNH AND DD	29	MEGHALAYA	41
LADAKH	6	LADAKH	40
MEGHALAYA	5	MIZORAM	36
NAGALAND	2	ANDAMAN & NICOBAR ISLAND	23
ARUNACHAL PRADESH	2	NAGALAND	3
MIZORAM	1	ARUNACHAL PRADESH	2

Name: EV SALES (2021), dtype: int64   Name: EV SALES (2022), dtype: int64

Fig EV Sales for 2021 & 2022

According to the latest data, Uttar Pradesh had the highest sales of EV vehicles in 2021, followed by Karnataka, Tamil Nadu, and Maharashtra. In 2022, the highest sales are expected to be in Uttar Pradesh, followed by Maharashtra, Karnataka, and Rajasthan.

Madhya Pradesh has shown a rapid rise in EV vehicle sales, going from 0 to 10438 and ranking in the top 10 for 2021. Additionally, they are expected to reach approximately 36800 EV vehicle sales in 2022. This indicates that after the lockdown, Madhya Pradesh has drastically shifted its focus from conventional vehicles to EV vehicles.

- **EV Vehicle Sales State-wise for 2023 &2024(March):**

State	EV SALES (2023)	State	EV SALES (2024)
UTTAR PRADESH	278184	UTTAR PRADESH	98156
MAHARASHTRA	194383	MAHARASHTRA	76951
KARNATAKA	152635	KARNATAKA	60351
RAJASTHAN	93765	TAMIL NADU	37645
TAMIL NADU	90294	RAJASTHAN	32593
GUJARAT	88617	BIHAR	30912
BIHAR	88216	KERALA	28148
KERALA	75793	DELHI	27895
DELHI	73649	MADHYA PRADESH	26490
MADHYA PRADESH	67928	GUJARAT	25062
ASSAM	60798	ODISHA	19804
ODISHA	44551	ASSAM	18378
CHHATTISGARH	38220	ANDHRA PRADESH	15430
ANDHRA PRADESH	32838	CHHATTISGARH	14088
HARYANA	30488	PUNJAB	13096
PUNJAB	25738	HARYANA	11733
WEST BENGAL	21433	WEST BENGAL	10569
JHARKHAND	21126	JHARKHAND	6691
UTTARAKHAND	16796	UTTARAKHAND	4704
JAMMU AND KASHMIR	9749	GOA	4430
GOA	9481	JAMMU AND KASHMIR	3889
CHANDIGARH	6408	TRIPURA	2534
TRIPURA	6312	CHANDIGARH	1896
PUDUCHERRY	2638	PUDUCHERRY	1429
HIMACHAL PRADESH	1128	MEGHALAYA	460
MANIPUR	399	HIMACHAL PRADESH	421
MIZORAM	166	MIZORAM	155
UT OF DNH AND DD	161	UT OF DNH AND DD	123
MEGHALAYA	114	MANIPUR	100
LADAKH	28	LADAKH	14
ANDAMAN & NICOBAR ISLAND	26	ARUNACHAL PRADESH	13
ARUNACHAL PRADESH	21	ANDAMAN & NICOBAR ISLAND	12
NAGALAND	6	NAGALAND	2
Name: EV SALES (2023), dtype: int64		Name: EV SALES (2024), dtype: int64	

Fig EV Sales for 2023 & 2024 State-wise

According to the latest data, Uttar Pradesh had the highest sales of EV vehicles in 2023, followed by Maharashtra and Karnataka. In 2024, the highest sales are expected to be in Uttar Pradesh, followed by Maharashtra, and Karnataka.

Delhi, despite having a smaller population and area than many other states, has a higher rate of electric vehicle (EV) sales. This is due to several factors, such as the high density of population, high literacy rate, high Human Development Index (HDI), high per capita income, and government schemes that support the purchase of EVs, such as offering subsidies and waiving registration charges. Additionally, the presence of a dense network of charging stations further boosts the EV market in Delhi.

- **Correlation Plot:**
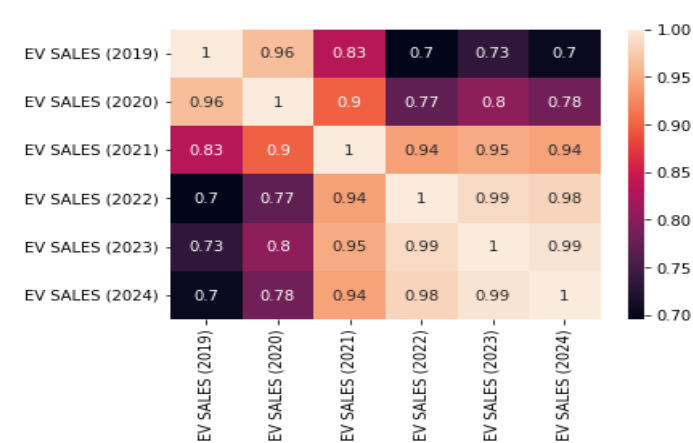
The heat plot above shows a strong positive correlation between EV sales on a year-wise basis, with the highest correlation observed for 2023 and 2024.

- **For Market Segmentation I use K-means Clustering and Silhouette score**

```
KMeans(n_clusters=10, random_state=1)
```

Kmeans inertia is: `1381359233.1071427`

Now checking Silhouette's score

For 10 segments is: `0.5172843984884157`

For 9 segments are: `0.5248809161908143`

For 8 Segments are: `0.5434450733121651`

For 7 Segments are: `0.557375745694542`

For 6 Segments are: `0.5786266100712436`

For 5 Segments are: `0.6025869509642731`

For 4 Segments are: `0.6548215143568001`

For 3 Segments are: `0.6595707593606914`

For 2 Segments are: `0.7285065172698892`

After comparing the Silhouette Scores, I have selected two segments as they have high scores.

We distribute whole dataset into 2 Segments:

1st Segment Comprise of:

```
Market_seg
1    55799
0    23221
Name: EV SALES (2019), dtype: int64

Market_seg
1    31270
0    12447
Name: EV SALES (2020), dtype: int64

Market_seg
1    66708
0    30030
Name: EV SALES (2021), dtype: int64
```

```
Market_seg
1     162870
0      78248
Name: EV SALES (2022), dtype: int64

Market_seg
1     278184
0      93765
Name: EV SALES (2023), dtype: int64

Market_seg
1      98156
0      37645
Name: EV SALES (2024), dtype: int64
```

For 2019 **71%** of EV Sales in Segment1.
For 2020 **72%** of EV Sales in Segment1.
For 2021 **69%** of EV Sales in Segment1.
For 2022 **68%** of EV Sales in Segment1.
For 2023 **75%** of EV Sales in Segment1.
For 2024 **73%** of EV Sales in Segment1.

And my Segment Comprise of 3 States:
```
State
MAHARASHTRA                     1.0
UTTAR PRADESH                   1.0
KARNATAKA                       1.0
PUDUCHERRY                      0.0
MANIPUR                         0.0
MEGHALAYA                       0.0
MIZORAM                         0.0
NAGALAND                        0.0
ODISHA                          0.0
ANDAMAN & NICOBAR ISLAND        0.0
MADHYA PRADESH                  0.0
RAJASTHAN                       0.0
TAMIL NADU                      0.0
TRIPURA                         0.0
UT OF DNH AND DD                0.0
UTTARAKHAND                     0.0
PUNJAB                          0.0
LADAKH                          0.0
ANDHRA PRADESH                  0.0
KERALA                          0.0
JHARKHAND                       0.0
JAMMU AND KASHMIR               0.0
HIMACHAL PRADESH                0.0
HARYANA                         0.0
GUJARAT                         0.0
GOA                             0.0
DELHI                           0.0
CHHATTISGARH                    0.0
CHANDIGARH                      0.0
BIHAR                           0.0
ASSAM                           0.0
ARUNACHAL PRADESH               0.0
WEST BENGAL                     0.0
Name: Market_seg, dtype: float64
```

Segment1 Comprise of only 3 States Maharashtra, Uttar Pradesh, and Karnataka.

Conclusion:

According to the study mentioned above, the electric vehicle market has immense potential and is currently in its initial stages with a high growth rate. The market is particularly favorable for those who are interested in entering the electric vehicle market, as it is observed that the first segment, comprising only three states - Maharashtra, Uttar Pradesh, and Karnataka, contribute to a significant percentage of the total EV sales. This trend indicates that it is better to focus on these three states initially, as they account for an average of **72%** of the EV sales market share, making it easier for entrepreneurs to establish their businesses in these regions. Therefore, it is an opportune time to venture into the electric vehicle market.

ELECTRIC VEHICLE MARKET SEGMENTATION ANALYSIS

AKASH K G

Introduction

India is experiencing a significant shift in its transportation landscape, driven by the widespread adoption of Electric Vehicles (EVs). The nation's rapid urbanization, growing population, and increased income levels have fuelled the embrace of EVs as an eco-friendly alternative.

By combining behavioural segments, psychographic data, and detailed vehicle specifications, stakeholders such as policymakers, automotive manufacturers, and charging station operators can devise targeted strategies and allocate resources more effectively to promote EV adoption and address the charging infrastructure needs in different vehicle category.

Problem Statement and Fermi Estimation

Problem Statement

The Objective of this analysis is to understand perception on India's electric vehicle market so that which vehicle category can be profitable business. The analysis focuses on behavioural segmentation derived from sales data, customer reviews (encompassing behavioral and psychographic data), and technical specifications of electric vehicles. Our objective is to employ these insights to effectively segment the market and recommend target segments for our electric vehicles.

Fermi Estimation

Data Collection and Assessment

- Gather sales data, electric vehicle customer reviews, and technical specifications.
- Evaluate the reliability and comprehensiveness of the collected data.

Segmentation Using Behavioural Variables

- Utilize behavioural data to identify patterns and segments within the customer base.

- Estimate the size and characteristics of each segment using data-driven techniques.

Target Segment Selection

- Select target segments based on a thorough analysis of behavioural, psychographic, and technical factors.

By following these systematic steps, employing Fermi estimation at each stage, our Electric Vehicle Start up aims to make informed decisions, precisely target market segments, and tailor our marketing approach to meet the unique demands and preferences of our customers, ensuring a successful market entry and sustained growth.

CONCLUSION

This project presents a comprehensive analysis of India's electric vehicle market, focusing on segmentation derived from sales data, customer reviews, and technical specifications. The study highlights the robust growth trajectory of India's two-wheeler market, establishing it as a primary revenue source. Utilizing behavioural variables from customer reviews, a rigorous market segmentation analysis was conducted employing the standard k-means algorithm. The analysis effectively partitioned the market into four distinct segments. In the context of selecting the most optimal market segment for our electric two-wheeler vehicles, thorough analysis and evaluation have pointed to Segment 1 as the ideal choice. Representing 39% of consumers, this segment boosts significant opportunities and a large customer base, making it a strategic target for market penetration.

In summary, our in-depth analysis of India's electric vehicle market led us to identify Segment 1 as the optimal target. With a significant 39% consumer base, this segment represents a substantial market opportunity. By tailoring our electric two-wheeler specifications to meet the preferences of this segment, we ensure this product align seamlessly with the demands of a large customer base. This strategic decision is grounded in a thorough understanding of market segmentation, consumer behavior, and technical specifications.

GITHUB LINK

https://github.com/Akashkg03/EV-Market-Segmentation-Analysis