Project

Market Segmentation Of Electric Vehicles

Team Members

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"Market segmentation is the sub-dividing of market into homogeneous subsets of customers, where any subset may conceivably be selected as a market target to be reached with a distinct marketing mix."

--Philip Kotler

Problem Statement :

Our team is currently working with an Electric Vehicle Start-up, which is in the process of determining the specific vehicle/customer space it will focus on for developing its electric vehicles (EVs). But problem may lie in from where to start, what kind of segmentation to make to have maximum impact. So, in this report we have tried to divide the market on demographic and potential market, where EV sector is already booming In order to assist the Start-up in making an informed decision, our task is to conduct a comprehensive analysis of the Electric Vehicle market in India, employing segmentation analysis. By utilizing this approach, we aim to identify and evaluate different market segments based on various factors and characteristics. Our objective is to develop a viable strategy that enables the Start-up to enter the market successfully, with a particular emphasis on targeting the segments that are most inclined to adopt and utilize Electric vehicles.

Electric Vehicle:

An electric vehicle (EV) is a type of vehicle that is powered by one or more electric motors, using electricity as its primary source of energy for propulsion. Unlike conventional internal combustion engine vehicles, electric vehicles do not rely on fossil fuels such as gasoline or diesel for power.

Electric vehicles can be classified into two main types:

1. Battery Electric Vehicles (BEVs): These vehicles are fully electric and operate solely on electricity. They are equipped with a large battery pack that stores electrical energy, which is then used to power the electric motor(s) that drive the vehicle. BEVs do not have an internal combustion engine and produce zero tailpipe emissions.
2. Plug-in Hybrid Electric Vehicles (PHEVs): PHEVs combine an electric motor and a conventional internal combustion engine. They have a smaller battery pack compared to BEVs, which allows them to run on electric power for a limited range before switching to the internal combustion engine. PHEVs can be charged from an external power source and provide the flexibility of using either electric power or fuel.

Electric vehicles have several key components:

1. Electric Motor: The electric motor is responsible for converting electrical energy into mechanical energy to propel the vehicle. It generates torque, which drives the wheels and provides acceleration.
2. Battery Pack: The battery pack stores electrical energy in the form of chemical energy. It typically consists of numerous individual battery cells connected together to provide the necessary voltage and capacity. Lithium-ion batteries are commonly used in electric vehicles due to their high energy density and efficiency.
3. Power Electronics: Power electronics control the flow of electrical energy between the battery, motor, and other components. They manage the conversion of DC (direct current) from the battery to AC (alternating current) required by the electric motor.
4. Charging System: Electric vehicles can be charged from external power sources, such as charging stations or home charging units. The charging system includes connectors, cables, and onboard charging equipment that regulate the flow of electricity from the power source to the battery.
5. Regenerative Braking: Electric vehicles often incorporate regenerative braking systems, which convert the kinetic energy generated during braking into electrical energy. This energy is then used to recharge the battery, improving overall efficiency and extending the vehicle's range.

Electric vehicles offer numerous advantages, including reduced emissions, energy efficiency, and cost savings over time. As technology advances and charging infrastructure expands, electric vehicles are becoming an increasingly viable and popular option for sustainable transportation.Electric vehicles (EVs) offer several advantages compared to conventional internal combustion engine vehicles. Here are some key advantages of electric vehicles:

1. Environmental Benefits: EVs produce zero tailpipe emissions, reducing air pollution and greenhouse gas emissions. They contribute to combating climate change and improving air quality, particularly in urban areas. EVs also have the potential to be powered by renewable energy sources, further reducing their carbon footprint.
2. Energy Efficiency: Electric vehicles are more energy-efficient than traditional vehicles. They convert a higher percentage of the energy stored in their batteries to power the wheels, whereas conventional vehicles waste a significant amount of energy as heat. This higher efficiency contributes to lower energy consumption and reduced dependence on fossil fuels.
3. Cost Savings: Although the upfront cost of electric vehicles may be higher than that of conventional vehicles, EV owners can benefit from long-term cost savings. Electric vehicles have lower operating costs due to lower fuel costs (electricity is generally cheaper than gasoline or diesel) and reduced maintenance requirements (fewer moving parts and no oil changes).
4. Performance and Acceleration: Electric motors provide instant torque, delivering quick acceleration and a smooth driving experience. Electric vehicles can often outperform conventional vehicles in terms of acceleration and responsiveness.
5. Noise Reduction: EVs operate more quietly than internal combustion engine vehicles, resulting in reduced noise pollution. This feature is particularly beneficial in urban areas, where noise from vehicles can be a significant nuisance.

6. Energy Independence: Electric vehicles reduce dependence on fossil fuels for transportation. By transitioning to electric mobility, countries can enhance their energy security and decrease their reliance on oil imports, potentially leading to a more sustainable and resilient energy system.

7. Innovation and Technological Advancements: The development of electric vehicles has spurred technological advancements in areas such as battery technology, charging infrastructure, and energy management systems. This progress not only benefits the automotive industry but also has wider implications for renewable energy integration and smart grid solutions.

It is important to note that the advantages of electric vehicles can vary depending on factors such as the source of electricity generation, battery technology, charging infrastructure availability, and the overall lifecycle environmental impact. Nonetheless, the growing adoption of electric vehicles represents a significant step towards more sustainable and environmentally friendly transportation systems.

Electric Vehicle Registered State-Wise
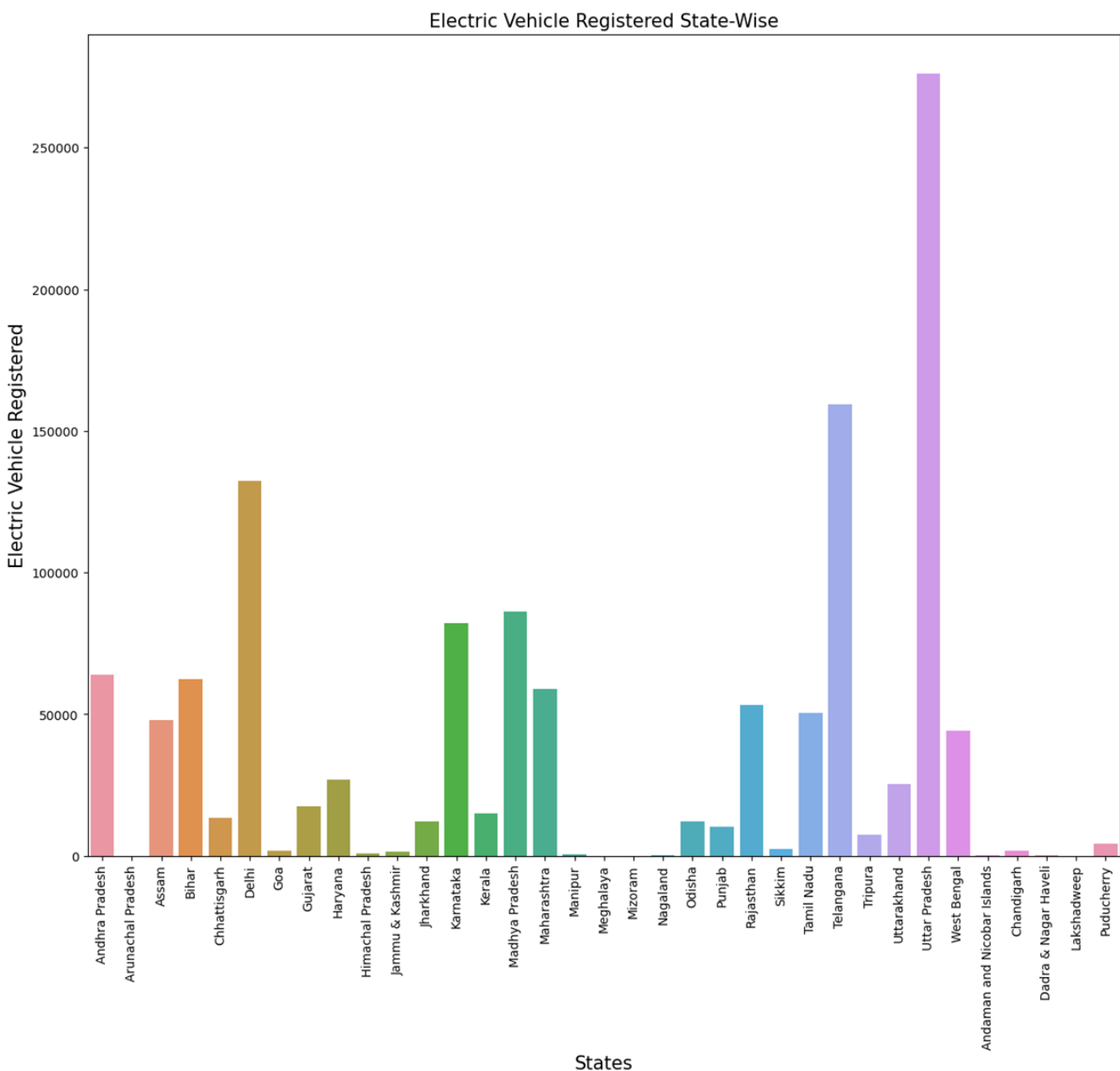
Market Segmenttaion for Electric Vehicles :

The electric vehicle (EV) market can be segmented based on various factors. Here are some common market segmentation approaches for electric vehicles:

Vehicle Type:

Passenger Cars: This segment includes EVs designed for personal use, ranging from compact cars to luxury vehicles. Commercial Vehicles: This segment comprises EVs used for commercial purposes, such as electric buses, delivery vans, and trucks.

Range and Battery Capacity:

Short Range: EVs with a limited driving range, typically suited for urban commuting and shorter trips. Medium Range: EVs with a moderate driving range, suitable for longer commutes and occasional road trips. Long Range: EVs with an extended driving range, often preferred by frequent travelers and those seeking maximum range flexibility.

Price and Market Segment:

1. Affordable/Entry-Level: EVs with a relatively lower price point, targeting cost-conscious consumers and first-time EV buyers.
2. Mid-Range: EVs with a moderate price range, appealing to a broader customer base seeking a balance between affordability and features.
3. Luxury/High-End: EVs with premium features, advanced technology, and a higher price point, targeting affluent consumers who prioritize luxury and performance. Geographic Segmentation:

Regional Focus:

Segmentation based on specific geographical areas or markets, considering factors such as infrastructure, incentives, and consumer preferences. For example, EVs designed specifically for urban environments or tailored to specific regions with high EV adoption rates.

Customer Lifestyle and Preferences:

1. Urban Commuters: EVs designed for efficient and eco-friendly commuting in densely populated urban areas.
2. Outdoor Adventurers: EVs equipped with off-road capabilities, longer range, and enhanced durability, appealing to customers with active lifestyles and a need for versatility.
3. Tech Enthusiasts: EVs with advanced technology features, connectivity options, and smart vehicle integration, targeting customers who value innovation and cutting-edge features.

Charging Infrastructure:

1. Home Charging: EVs designed for customers who have access to home charging facilities, with potential for overnight charging and convenience.
2. Public Charging: EVs optimized for longer journeys and reliance on public charging stations, emphasizing fast charging capabilities and interoperability with various charging networks.

Fermi Statement of Problem:

1. Total vehicles: Starting with the total vehicles in India being the third largest nation in terms of road network, totals to approx. 330 million.
2. Total 4 wheelers: Approx 7 million 4 wheelers are registered in India. These are those that comes under LMV.
3. Total 2 wheelers: Total 210 million vehicles are 2 wheelers that are registered in India. It includes both 2-wheeler transport and 2-wheeler non-transport.

4. Total Electric Vehicles: Out of these 330 million only 2541372 are electric vehicles which accounts to only 0.77% of total registered vehicles and most of them are dominated by the 2-wheeler segments.
5. Average Number of EVs per person : If we divide the number of EVs available from population, we will get the 0.001805465, which is very low. But given the policy adopted by many states govt. the number is expected to rise, ranging to 25% by 2025 and approx. 80-90% by the end of 2050. Since India has the largest population with third largest road network, with friendly EV policy in many state, the percentage of EVs is expected to rise by 25% in 2025.

Approch to the data cleaning and analysis :

1. Importing Libraries: Start by importing the necessary libraries in Python, such as pandas, matplot, seaborn and numpy, which provide powerful tools for data manipulation and analysis.
2. Loading the Data: Use pandas to load your dataset into a pandas DataFrame. The data can be in various formats, such as CSV, Excel, or a database.
3. Understanding the Data: Gain a basic understanding of the dataset by examining its structure, dimensions, and the types of variables it contains. Use pandas functions like head(), info(), and describe() to explore the data and identify any initial data quality issues.
4. Handling Missing Values: Missing values are common in datasets and need to be addressed. Use pandas functions like isnull(), fillna(), or dropna() to identify missing values and decide on the appropriate strategy for handling them. This may involve imputing missing values, deleting rows or columns with too many missing values, or other techniques based on the specific context.
5. Dealing with Outliers: Outliers are extreme values that can skew your analysis or models. Identify outliers using statistical measures like z-scores or visualization techniques such as box plots. Decide whether to remove outliers or transform the data, depending on the nature of your analysis and the impact of outliers on the results.
6. Data Formatting: Ensure that the data is in the desired format for analysis. This may involve converting variables to the correct data types, standardizing date formats, or transforming categorical variables into a consistent format.
7. Handling Duplicates: Identify and handle any duplicate records in the dataset using pandas functions like duplicated() and drop_duplicates(). Duplicate records can distort analysis results and lead to biased conclusions.
8. Feature Engineering: Create new variables or transform existing variables to derive meaningful features that can enhance your analysis. This may involve calculations, aggregations, or combinations of existing variables to provide additional insights.

Data Validation: Validate the cleaned dataset to ensure that it meets the necessary quality standards. Check for logical inconsistencies, data integrity issues, or any anomalies that may have occurred during the cleaning process.
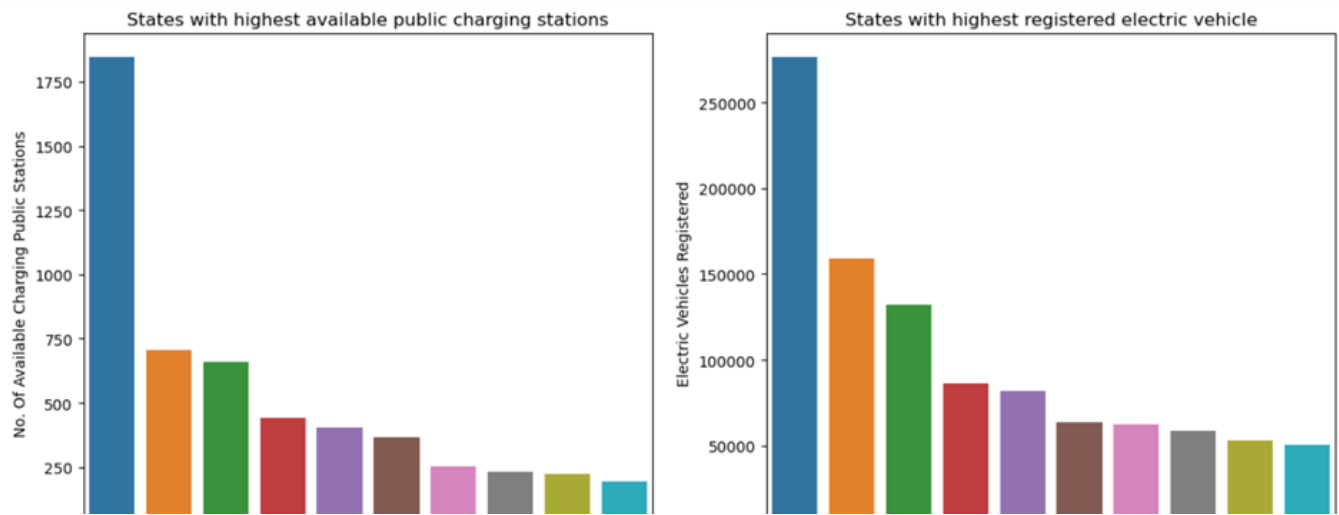
Class-wise data:

Vehicle Class	2WIC	2WN	2WT	3WN	3WT	4WIC	HGV	HMV	HPV	LGV	LMV	LPV	MGV	MMV	MPV	OTH
BUS	0	0	0	0	0	0	0	0	342	0	0	395	0	9	47	100
E-RICKSHAW(P)	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0
E-RICKSHAW WITH CART (G)	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0
GOODS CARRIER	0	0	0	0	0	0	1647	0	0	3483	0	0	183	0	0	0
LUXURY CAB	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
MAXI CAB	0	0	0	0	0	0	0	0	0	0	0	633	0	0	0	0
M-CYCLE/SCOOTER-WITH SIDE CAR	0	109	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOPED	0	13906	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOTOR CAB	0	0	0	0	0	0	0	0	0	0	1	3177	0	0	0	1
MOTOR CAR	0	0	0	0	0	0	0	0	0	0	30162	1	0	0	0	0
MOTOR CYCLE/SCOOTER-SIDECAR(T)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MOTORISED CYCLE (CC > 25CC)	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THREE WHEELER (GOODS)	0	0	0	0	114	0	0	0	0	0	0	0	0	0	0	0
MOTOR CYCLE/SCOOTER-USED FOR HIRE	0	0	879	0	0	0	0	0	0	0	0	0	0	0	0	0
THREE WHEELER (PERSONAL)	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0

Fuel wise data:

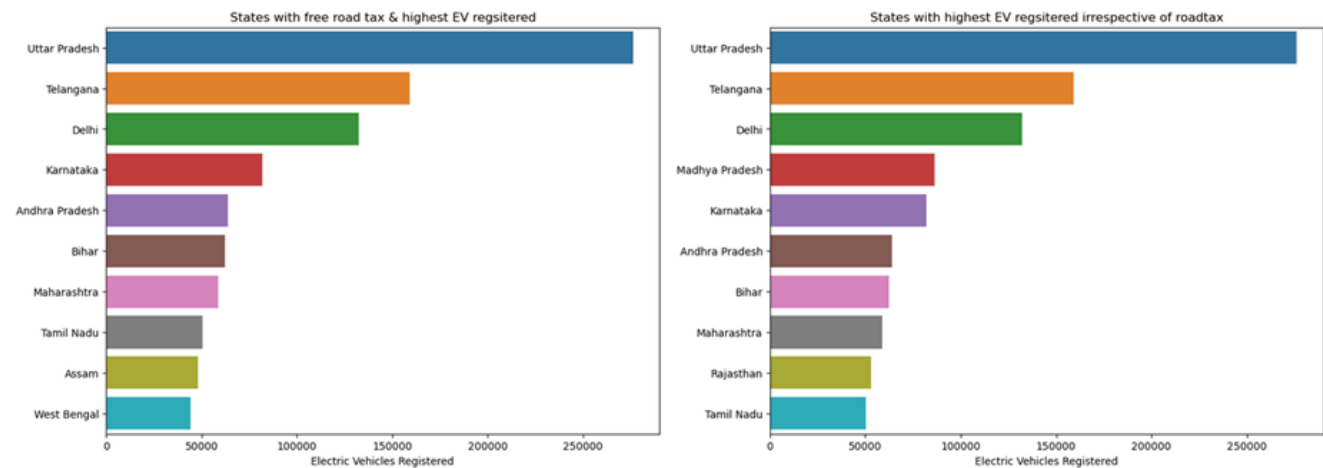| Fuel Category	2WIC	2WN	2WT	3WN	3WT	4WIC	HGV	HMV	HPV	LGV	LMV	LPV	MGV	MMV	MPV	OTH
DIESEL	0	39	1	14	693	0	1662	14	303	3538	5236	3146	217	36	47	152
ELECTRIC(BOV)	0	3	15	0	30	0	0	0	40	0	87	10	0	0	0	0
LPG ONLY	0	5	0	0	0	0	0	0	0	0	12	0	0	0	0	0
NOT APPLICABLE	0	11	0	0	37	0	0	0	0	12	29	1	0	0	0	0
PETROL	1	111902	864	20	4658	1	14	0	2	267	25575	1066	4	0	0	16

Analysis:

We have first done analysis of EVs on state level overall, without further classifying the EV segment and later we have break down the EV segment and try to come up with the reason for low or high EV market. We have first done analysis of EVs on state level overall, without further classifying the EV segment and later we have break down the EV segment and try to come up with the reason for low or high EV market. So, we analysed this further, and graph is shown below:

States with highest available public charging stations

States with highest registered electric vehicle

So, we can see more or less, the correlation of charging station was true. Now see it on road tax:

EV registraion with road tax exmption vs EV registraion without road tax exmption
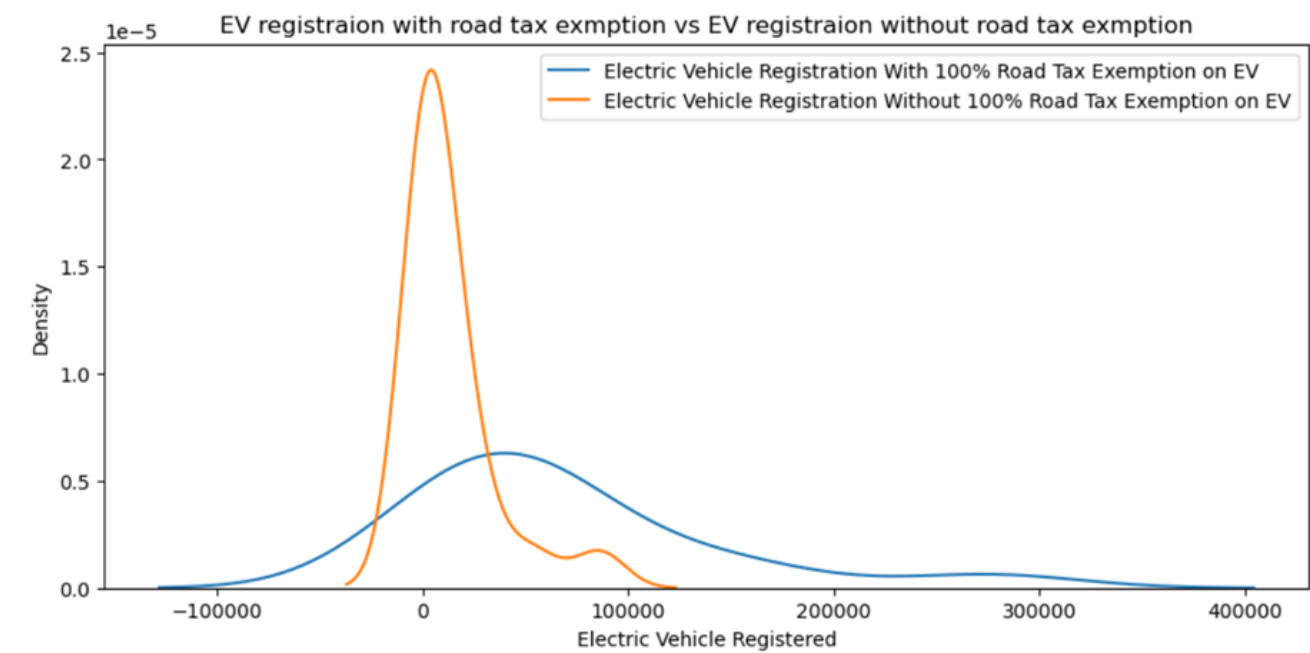
Again if there is 100% road tax exemption, it will lead to purchase of more electric vehicle. Let's compare both of them on a graph simultaneously to reach the conclusion.


States with free road tax & highest EV regsitered

States with highest EV regsitered irrespective of roadtax

Let's take categorical variable into action and see whether the cost of electricity in the state has to play any role in the purchase or not as according to a survey most people approx. 80% of people in India prefer overnight charging at home.
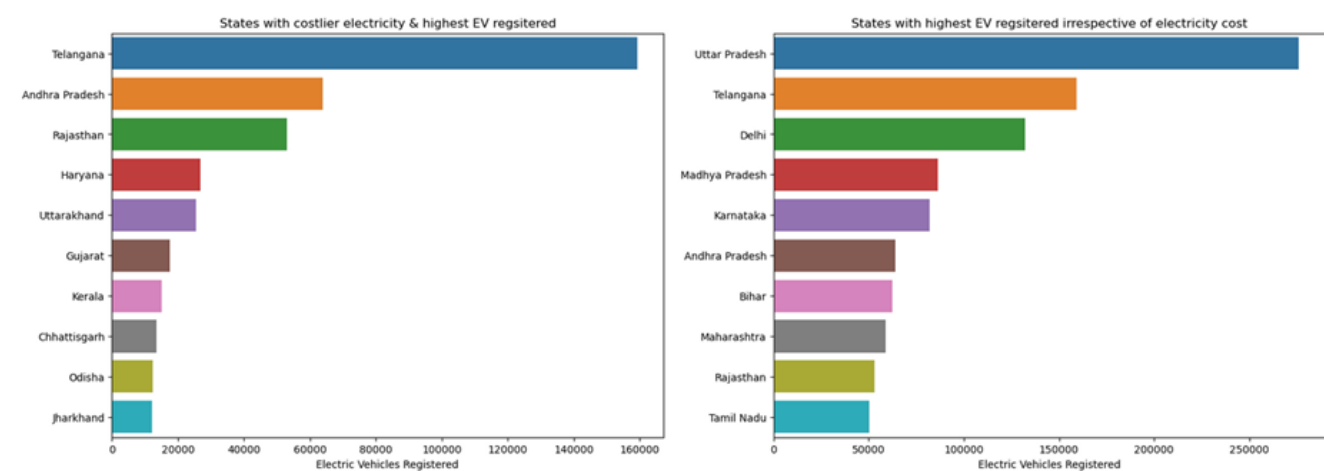
So, according to the graph there is no direct relation between state with costlier or cheaper electricity and electric vehicle registered. Now we will dive deeper. We have combined the methods of geographic and demographic first. So, we come up with the state & UT level analysis:

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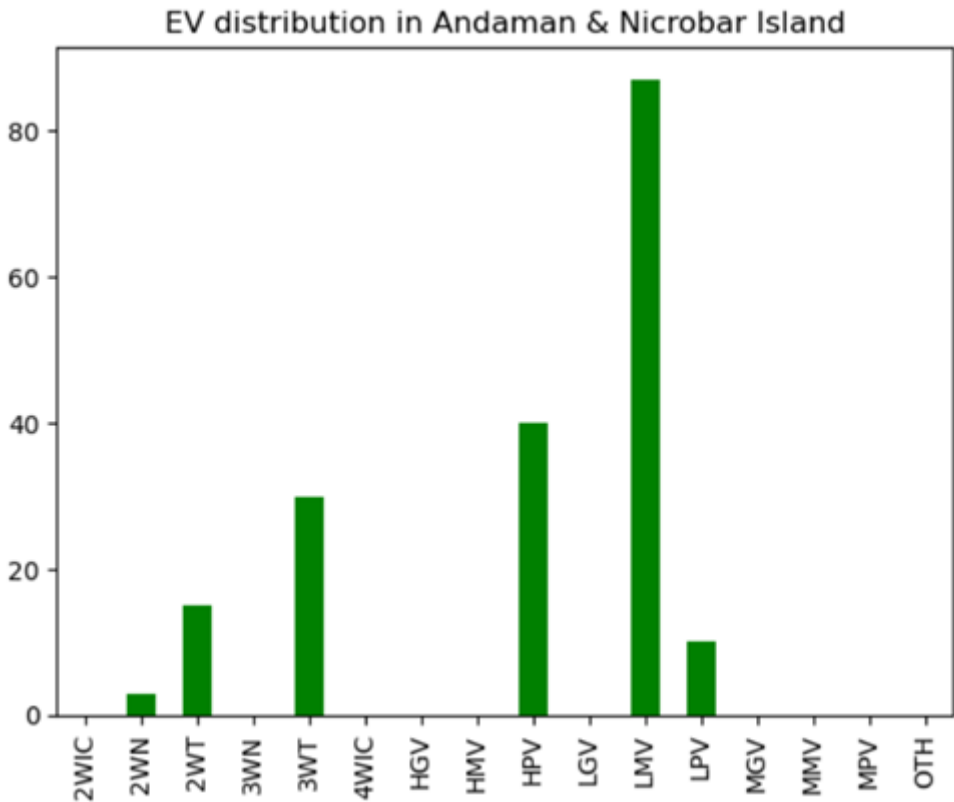
So, as we can see that LMV electric vehicle is registered most in the Andaman region. Cost of electricity is cheaper, with only 3 public stations available and cost of electricity is lower, here people may prefer to charge at home. Though unemployment being high among rural and urban woman, gpd per capita of the

island is high (5th in India), and this may cause them to buy more LMV electric vehicle than 2 & 3 wheeler EV.

Diesel vehicle distribution in Andaman & Nicrobar Island

Petrol vehicle distribution in Andaman & Nicrobar Island
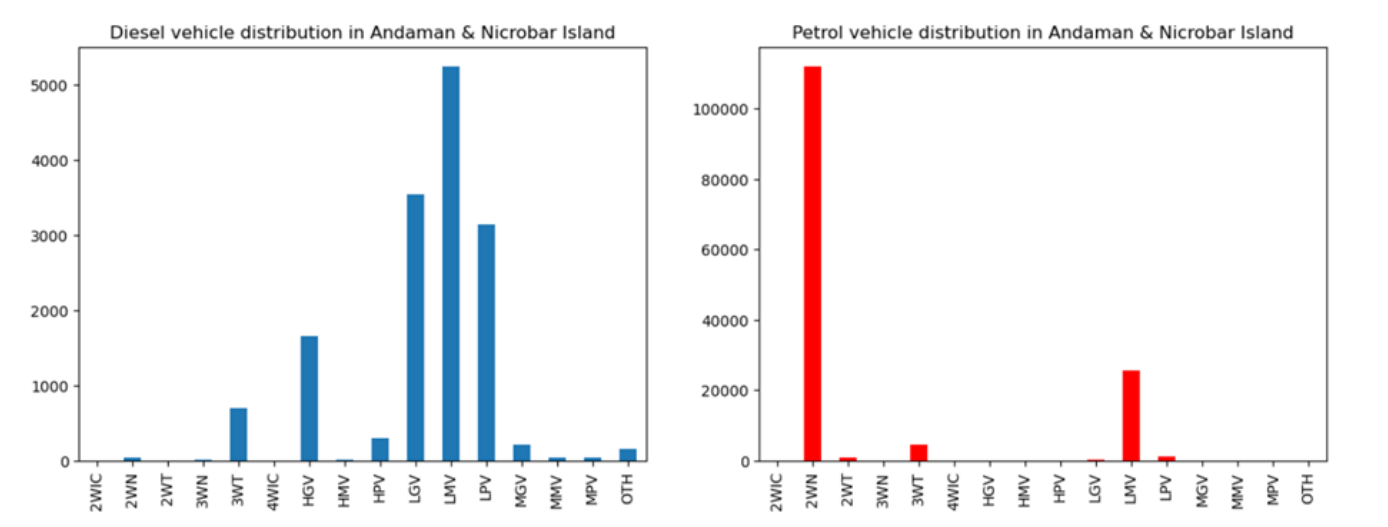
Although the LMV segment is much contributed by petrol and diesel segment, yet it is the most lucrative option for any new market entrant of EV here followed by 2WT.
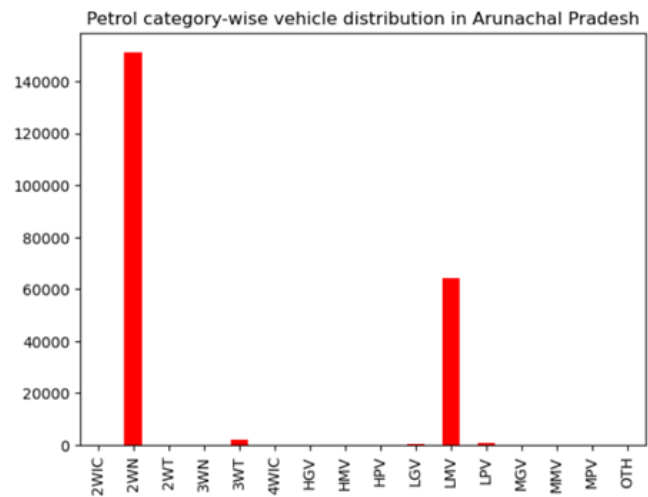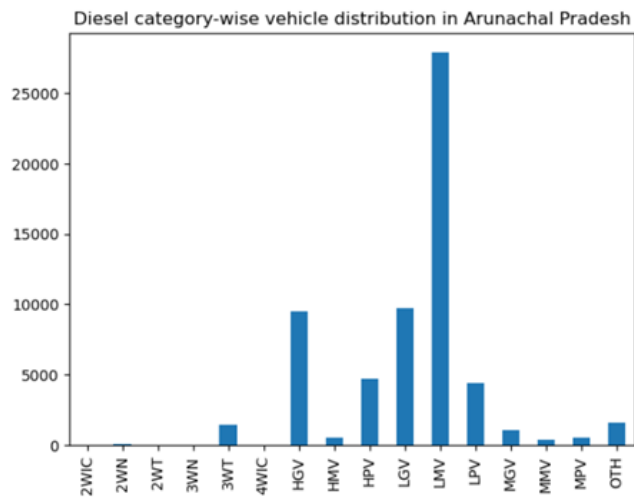
Andhra Pradesh:

EV category-wise distribution in Andhra Pradesh
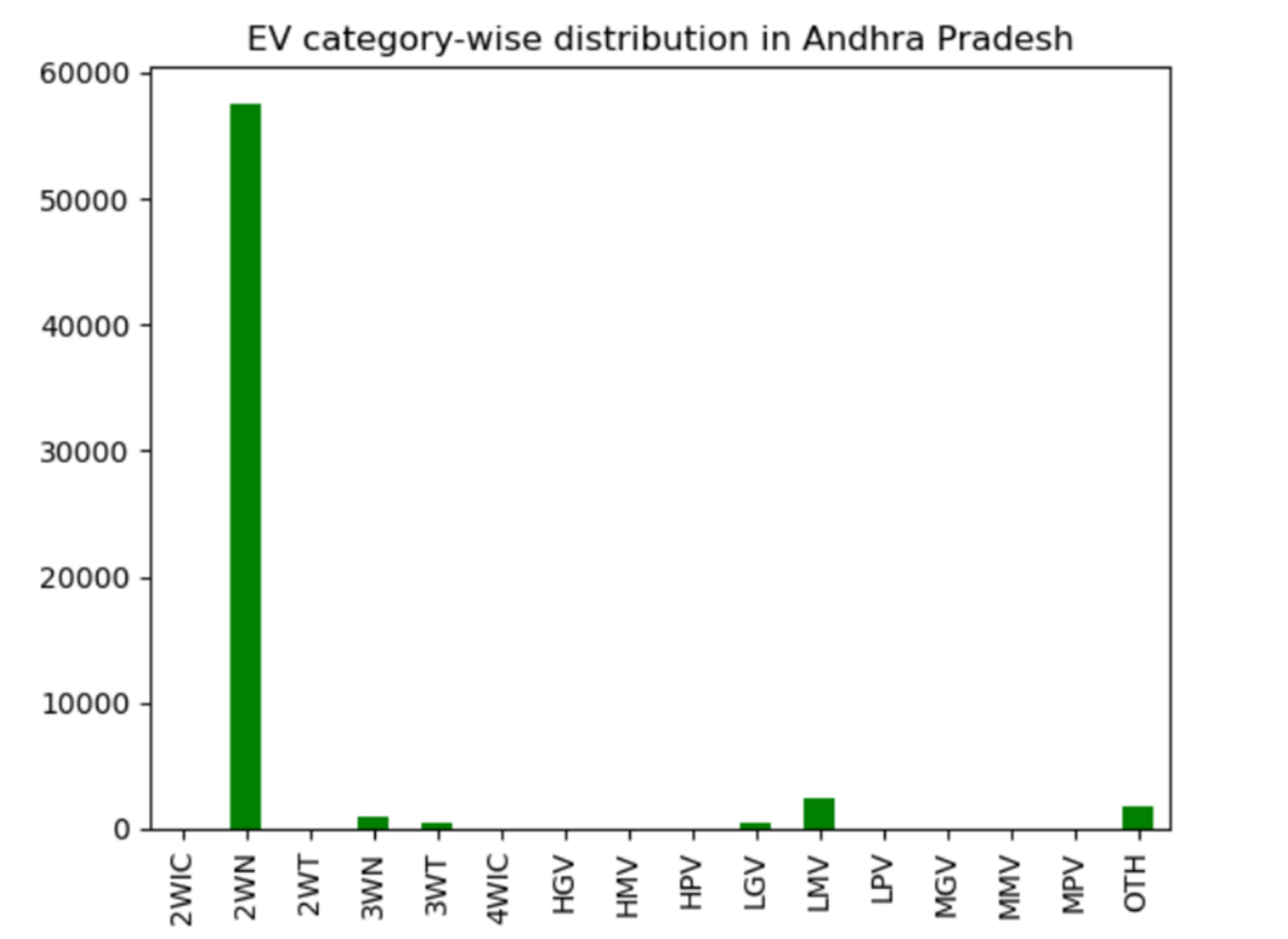
Here the market is dominated by the 2 Wheeler Non-transport. People here have very low literacy rate, 6th lowest in complete India and GDP per capita also low at the 18th number in complete India. This could be the reason of sale of more 2TW. But with the road registration free, and electricity cost is also not higher and availability of power is high at 7th position in India, in coming future this might attract the market enterants and can shift people purchase towards electric vehicles.

Though currently 2W has been dominated by the Petrol segment, but this segment has highest number of electric vehicle, as compared to any other electric vehicle, more than 10 times. Any market entrant should focus on this segment in this area followed by LMV.

Arunachal Pradesh:
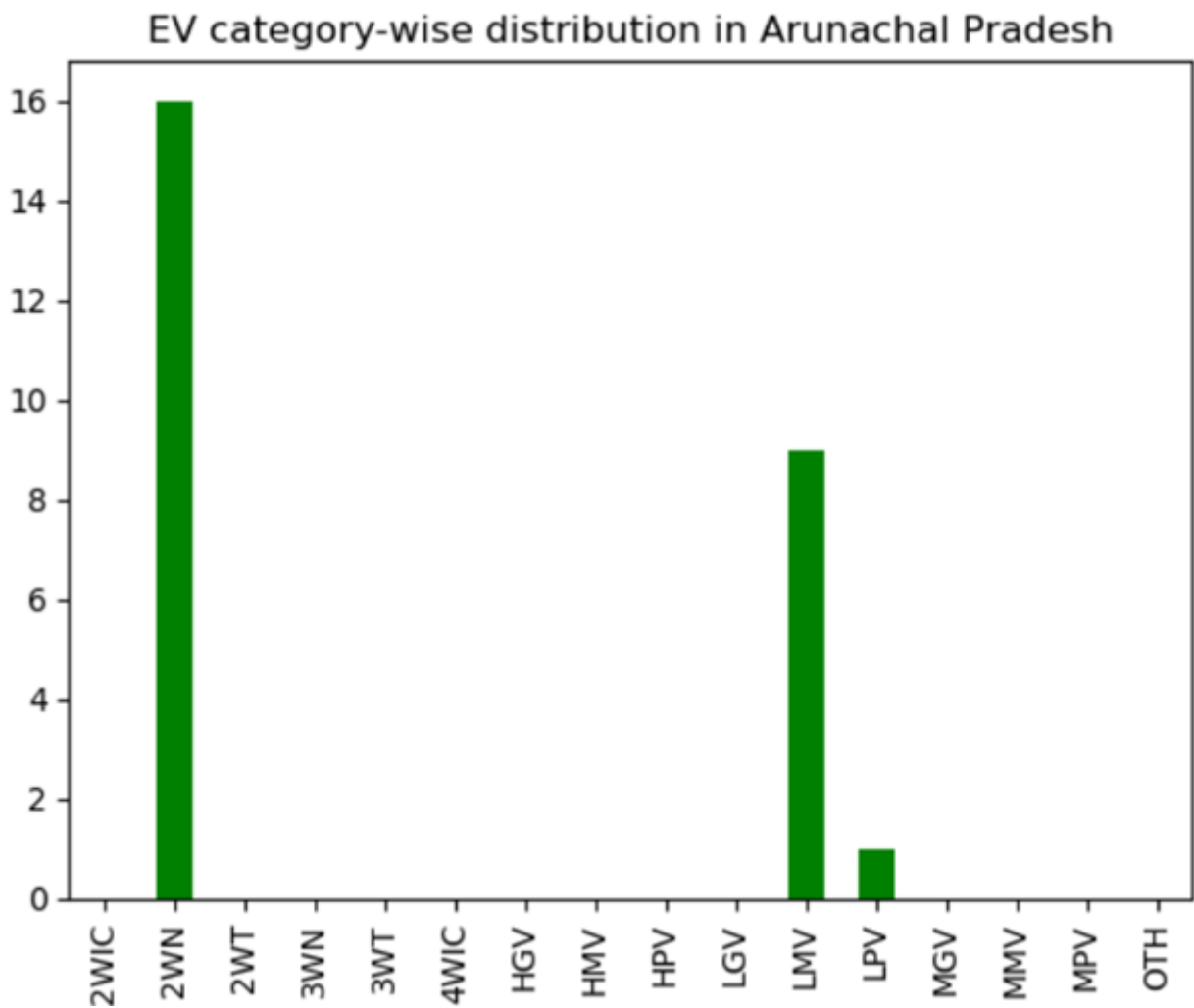
Here sale of EV is very low, may be lowest across all Indian region, only 16 for 2WN and 9 for LMV and 1 for LPV. The reason could be that first being hilly area with low population. Other being it has 2nd lowest literacy rate in India, only better tha Bihar. Plus road tax is not free for EVs and cost of electricity is also not low. Also, with the road length of 21555.0 KM, it has only 9 public charging stations.From the data, power of availability is also very low. All these factors are hindering here to growth of EV market here.

Diesel category-wise vehicle distribution in Arunachal Pradesh

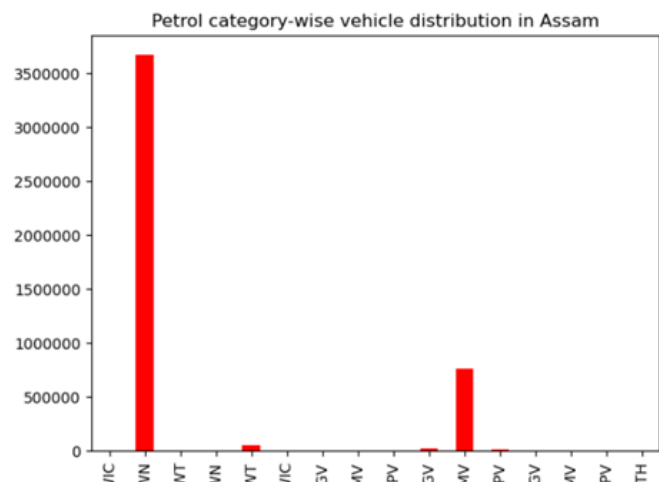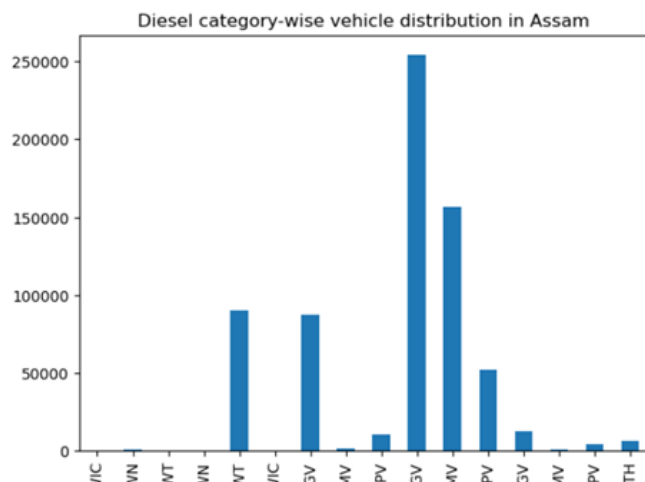Petrol category-wise vehicle distribution in Arunachal Pradesh

So, from the graph it is clear that this state is not yet market condition feasible for EV data. May be company try their vehicles here when it would be time for late entrants or laggard to enter.
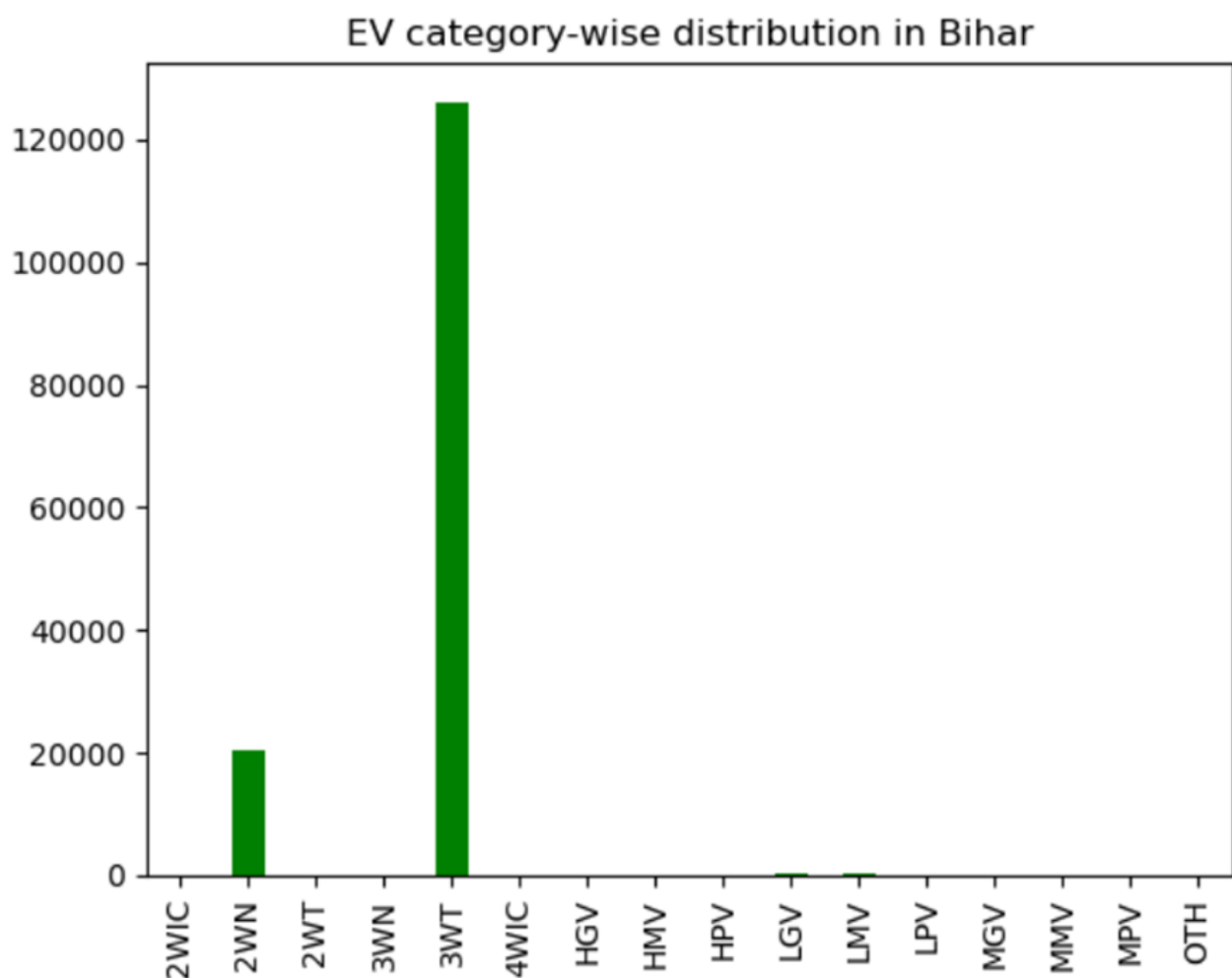
Assam:

EV category-wise distribution in Assam
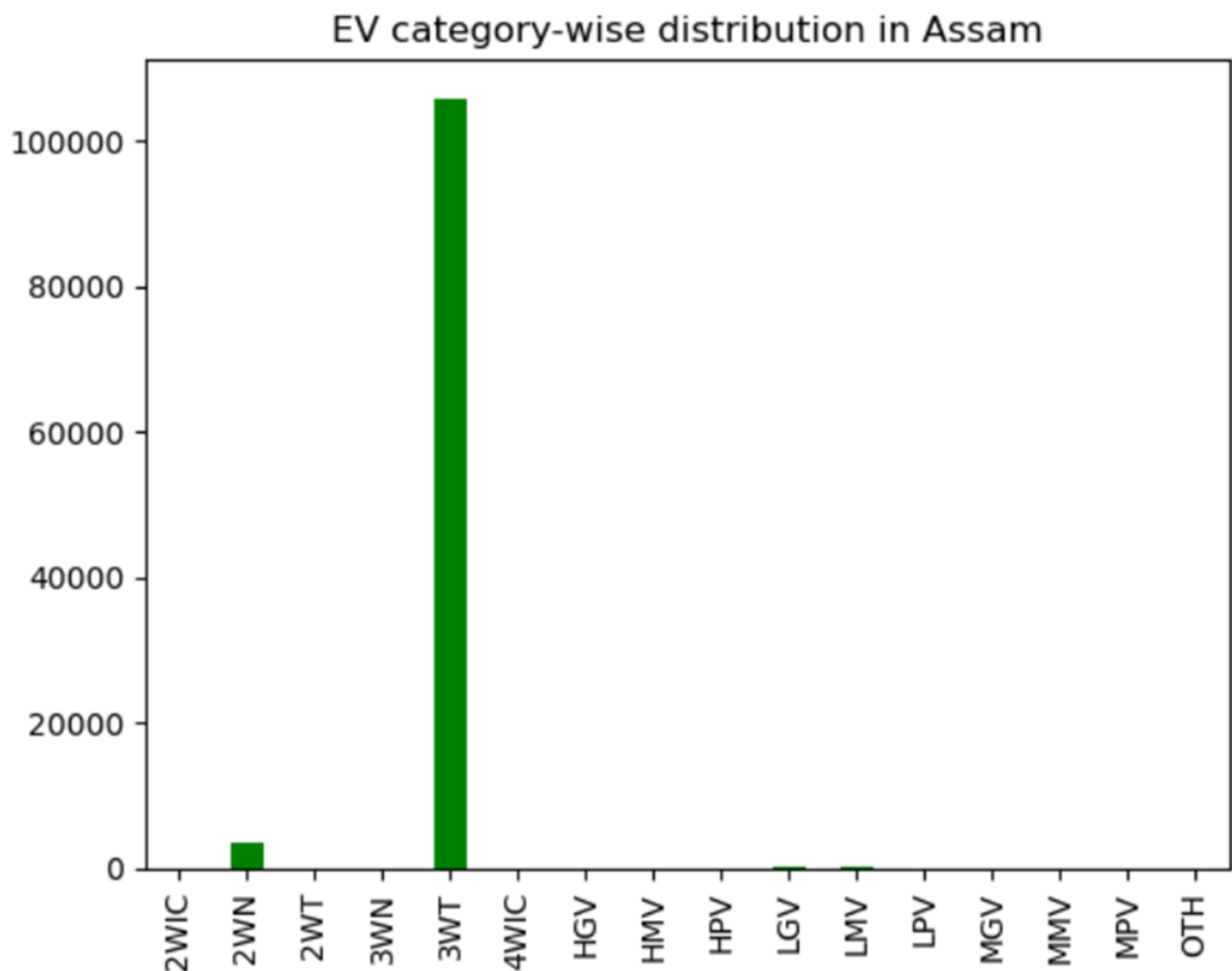
So, people here prefer 2WN of Petrol and amount is very high, more than 1000 times greater of EV. So, any EV market entrant should focus on commercial three-wheeler which is highest among all three segments.
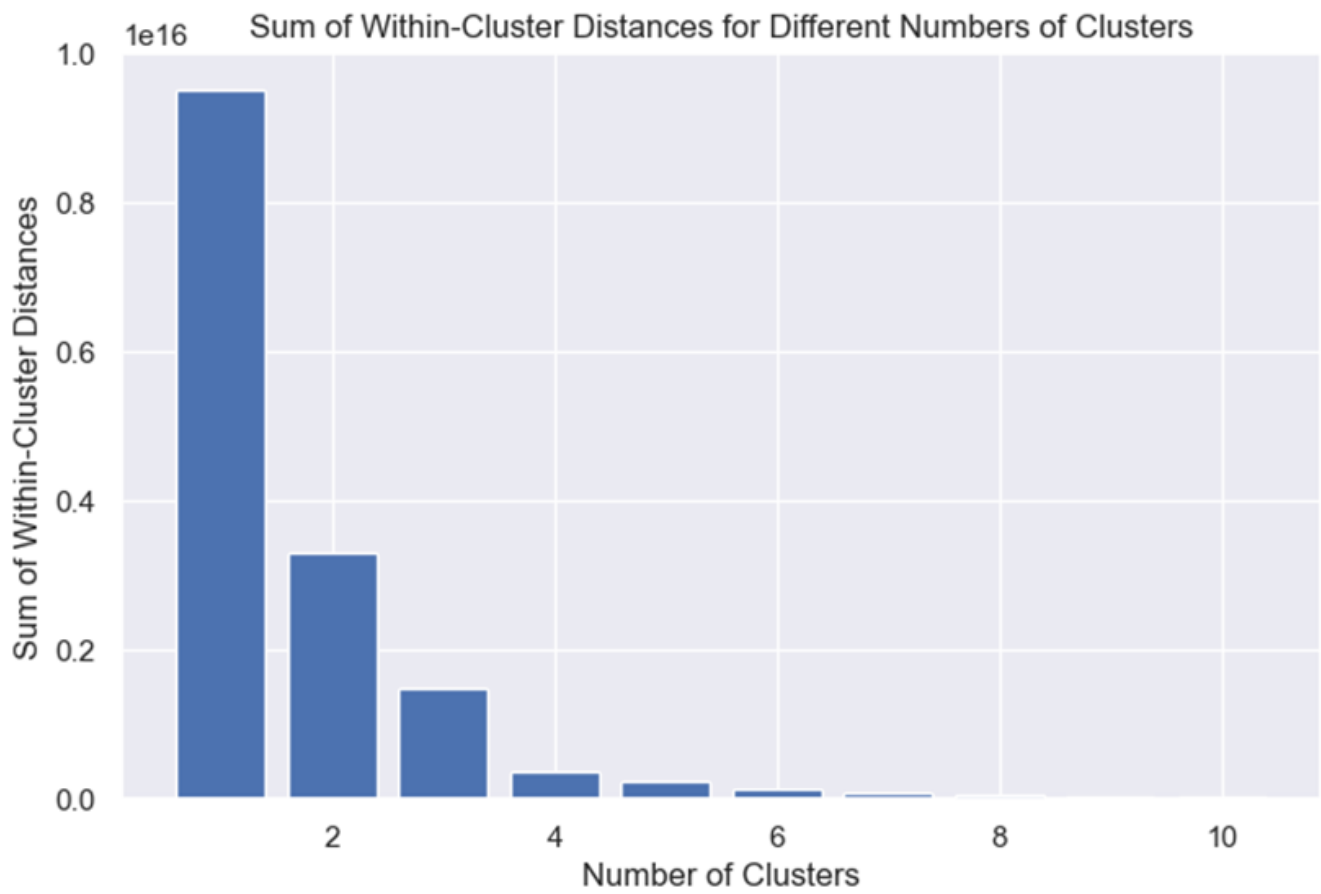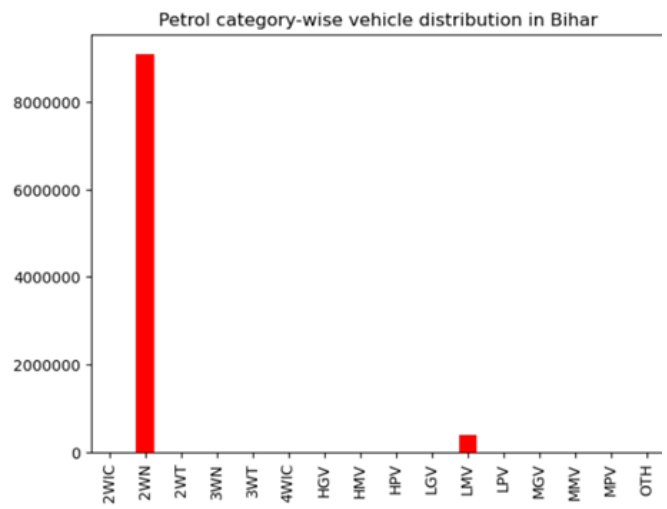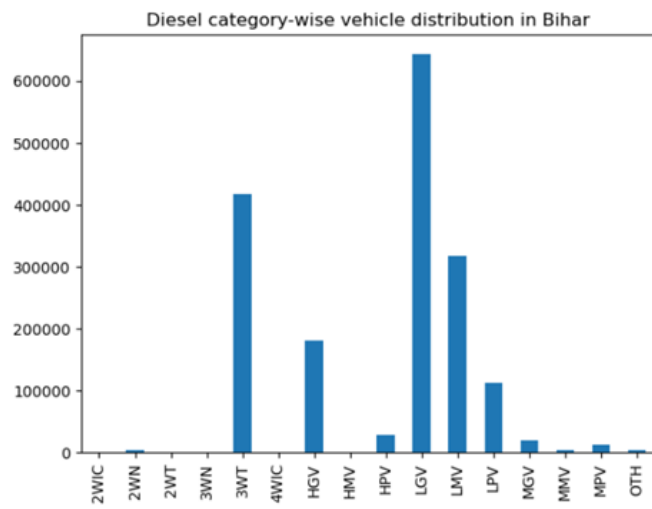
Diesel category-wise vehicle distribution in Assam

Petrol category-wise vehicle distribution in Assam

Bihar:
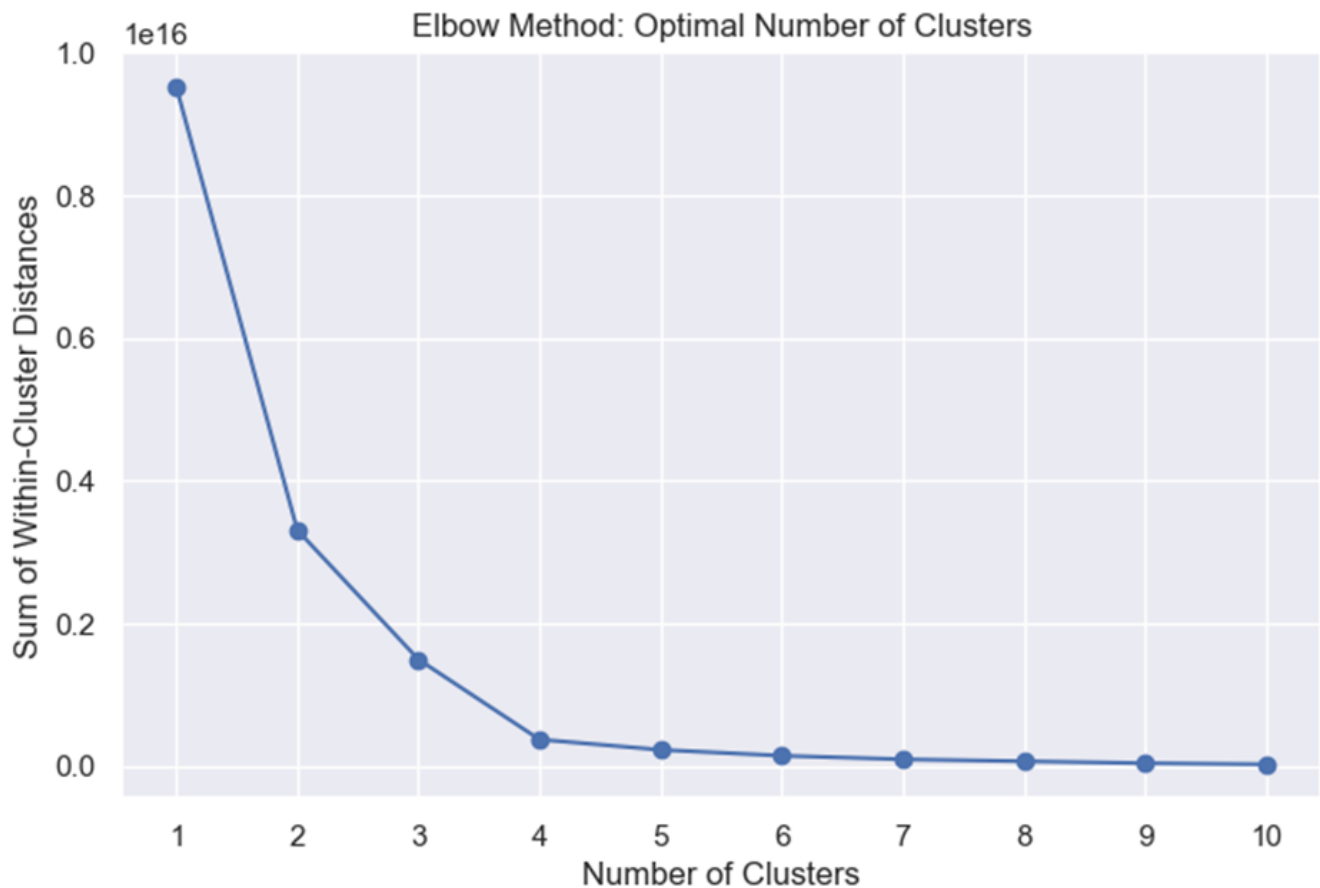

EV category-wise distribution in Bihar

Like Assam, here also like Assan, 3WT is most popular among EV segment. In a population of 104099, there are only 436 LMV. There could be several reasons for people not owning the EV. First could be the income level, it features at lowest GDP per capita among all states. Here literacy rate is also lowest. People might not be aware about the benefits of butying EV, even if they have money. They might see no point in buying EV as electricity cost is also high. But in future, this may attract the EV segment, especially in cities, as govt. wants to increase EV buying as the road tax of EV vehicles are free and there are 83 public charging stations available. Like Assam here is also tax exemption for electric 2W and electric 4W.

Market Segmentation Using KMeans Clustering:

Diesel category-wise vehicle distribution in Bihar

Petrol category-wise vehicle distribution in Bihar

Sum of Within-Cluster Distances for Different Numbers of Clusters

So, we will go for 4 clusters of KMeans clustering.

Elbow Method: Optimal Number of Clusters

This state has highest number of 2WN, because of demographic reasons discussed earlier. Potential market does exist in sector of 2 wheelers, as amount of it is very high, and some attractive offers may be given by EV makers to move them to EV side.

Market Segmentation Using Hierarichal Clustering:

Hierarchical Agglomerative Clustering
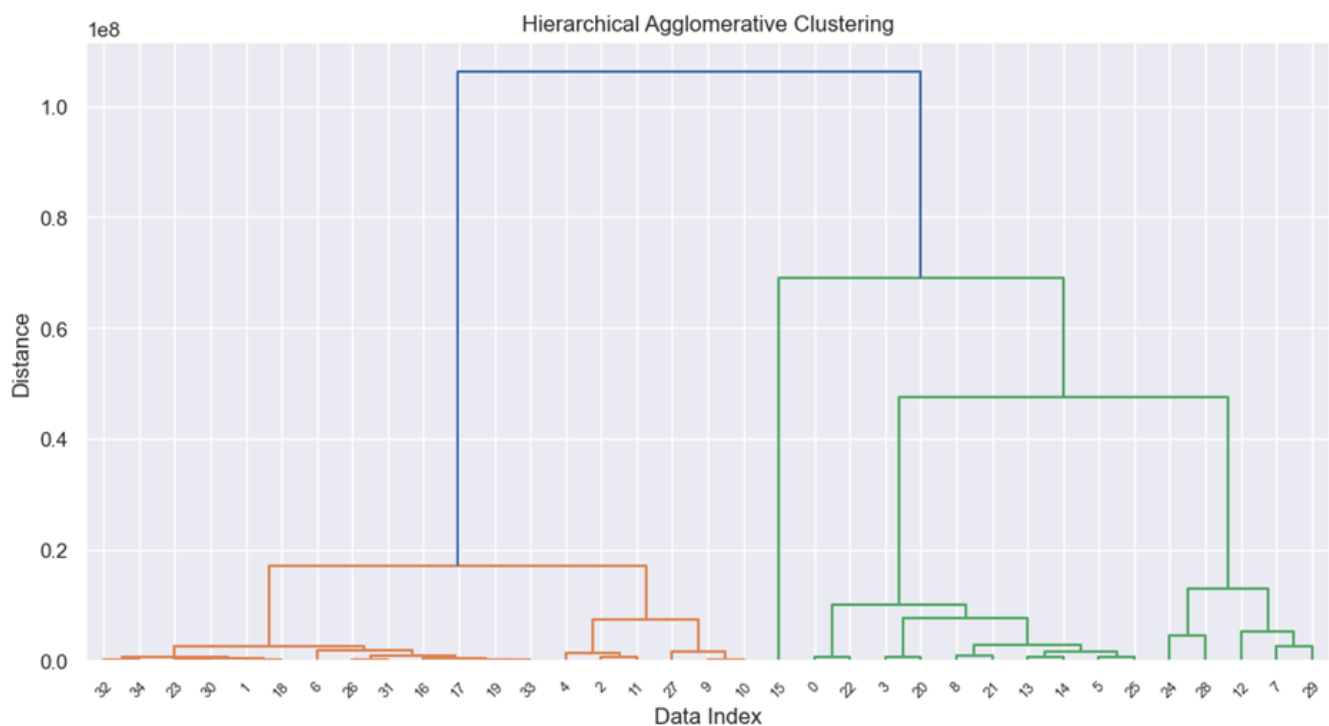
So, again it shows that we should 4 go for 4 clusters. Let's perform two other methods, Mixtures of Distribution and Mixtures of Regression model.

Next we will plot the graph showing the all clusters, based on PCA
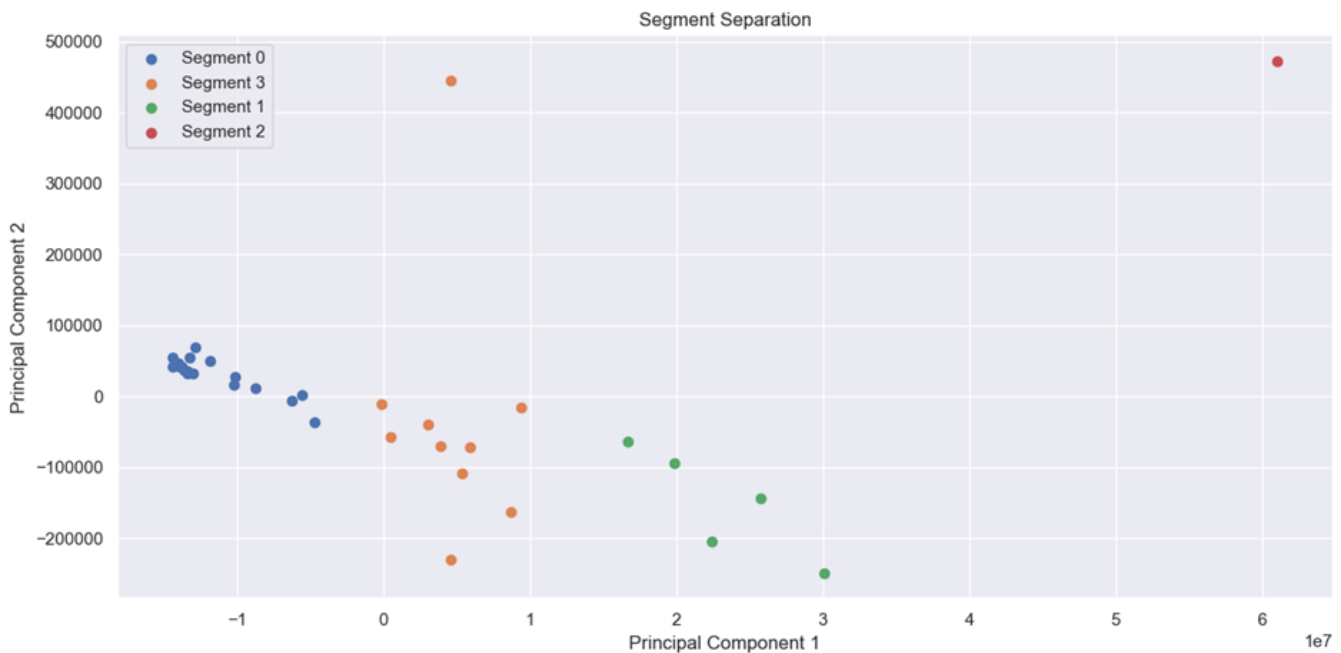
So, the graph shows all the 4 clusters.

Conclusion :

1. Here an organization has two approaches to enter the market. One based on combining the demographic and geographic variables and target state-wise. For example, a totally new entrant might focus on states like Andhra Pradesh, Chhattisgarh, Chandigarh, Delhi, Goa, Jharkhand, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odissa, Punjab, Uttar Pradesh and West Bengal. Most of them are feasible because of three things: 100% road tax exemption on EV, high cost of road tax of diesel and petrol vehicles and third being GDP per capita of the states. A subsidy provided by govt. on purchase of EV is also a dominant factor. There are other factors which are indirectly related like deposit in banks, lower unemployment rate etc. So, here we have tried to combine the demographic factors with geographic factors. Talking about geographic region, northeastern states and hilly areas like Uttarakhand and Himachal Pradesh, market is currently very low, reason being the high cost of the electric vehicles and lacking infrastructure for EVs. So, any company entering here first should be ready to invest in infrastructure. The reason a new entrant may want to start from here because they want to avoid competition in the EV established market of states like Delhi, Karnataka, Uttar Pradesh etc. Continuing this idea if a new entrant company is prepared to face the challenge and has budget, they should definitely target people in states of Delhi, Karnataka, Uttar Pradesh, Maharashtra etc. As people are already aware of market and company can target late majority and laggards here.

2. Second way of classification is data driven cluster analysis. Total four segment has been made. 19 data points belong to one cluster, 5 data points belong to other, 10 data points to 3rd and 1 point to last cluster. Even in one data point it can cater a lot of customers. So, we shouldn't ignore the 1 data point cluster. The summary is that a manager should make the segment first on Gross Domestic Product of the state. This should be the major criteria of segmentation as 54.29% of the total data points falls in this region. Second segmentation is based on total amount of deposit in state, 28.57% of data falling in this region. Third segmentation is based on number of working people in state, 14.29% of data falling in this region, and last is based on total length of roads in state 2.86% of total data points.

3. Electric vehicles (EVs) have emerged as a superior choice over traditional vehicles in the face of skyrocketing petrol prices. With the increasing cost of petrol, EVs offer substantial savings on fuel expenses due to their efficiency in utilizing electricity as a fuel source. Moreover, EV owners benefit from stable and predictable energy prices, as electricity costs tend to be less volatile compared to petrol. In addition to cost savings, EVs require lower maintenance and operating costs due to their simplified mechanics and regenerative braking systems. Governments worldwide are also incentivizing the adoption of EVs through subsidies and tax credits. Ultimately, choosing an electric vehicle not only provides financial advantages but also contributes to a cleaner and greener future.

4. Based on this estimation, by 2030, around 80% of the total two-wheelers in India are projected to be electric. Similarly, by 2050, around 80% of the total four-wheelers in India are projected to be electric. This estimation indicates a significant potential for the EV market to grow in the coming years as the adoption of EVs gains momentum.

Now comes the marketing mix. All the four factors product, price, place and promotion can be combined . Here exists mostly 3 kind of products, 2 WN, 3WT and LMV. Now here the help of demography could be considered. If the states has mostly 3WT vehicles, it is generally used for public transport, and drivers might not have high power to purchase. So, the cost of 3W should be affordable. And if the product is LMV and purchasing subsidy is provided by govt and with road tax exemption is there, an entrant company might charge higher. Now consider the place & promotion. If we consider segmentation using clusters method, suppose we are targeting third cluster, number of working people in state. So, to do promotion, an EV company may make their charging station near where a majority of office going people park their vehicle. There could be many ways of going about this, this could be one of the ways.

Data Collection :

- Kaggle
- PetrolDieselPrice
- Reserve Bank of India - Handbook of Statistics on Indian States. [online] Available at: https://www.rbi.org.in/Scripts/AnnualPublications.aspx?head=Handbook+of+Statistics+on+Indian+States (https://www.rbi.org.in/Scripts/AnnualPublications.aspx?head=Handbook+of+Statistics+on+Indian+States). [Accessed 13 Jun. 2023].
- pib.gov.in. (n.d.). 966,363 electric vehicles presently on road across the country. [online] Available at: https://pib.gov.in/PressReleasePage.aspx?PRID=1797676 (https://pib.gov.in/PressReleasePage.aspx?PRID=1797676) [Accessed 13 Jun. 2023].
- India's best electric vehicles news portal. (2021). Electric vehicles road tax exemption & subsidies of each state in India. [online] Available at: https://electricvehicles.in/electric-vehicles-road-tax-exemption-subsidies-of-each-state-in-india/ (https://electricvehicles.in/electric-vehicles-road-tax-exemption-subsidies-of-each-state-in-india/) [Accessed 14 Jun. 2023].
- Bijli Bachao. (2017). Domestic Electricity LT Tariff Slabs and Rates for all states in India in 2016. [online] Available at: https://www.bijlibachao.com/news/domestic-electricity-lt-tariff-slabs-and-rates-for-all-states-in-india-in.html (https://www.bijlibachao.com/news/domestic-electricity-lt-tariff-slabs-and-rates-for-all-states-in-india-in.html) [Accessed 15 Jun. 2023].
- EV Policy: State-wise EV Subsidies in India. [online] Available at: https://www.talkingtrendo.com/ev-policy-state-wise-ev-subsidies-in-india/ (https://www.talkingtrendo.com/ev-policy-state-wise-ev-subsidies-in-india/) [Accessed 15 Jun. 2023].

Github links :

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1. https://github.com/ChevulamaddiRahul/EDA-and-Regression-on-EV-Dataset (https://github.com/ChevulamaddiRahul/EDA-and-Regression-on-EV-Dataset)
2. https://github.com/ardranijesh/Electric-Vehicle-Industry (https://github.com/ardranijesh/Electric-Vehicle-Industry)
3. https://github.com/utkrisht14/Feynn-Labs-/blob/main/Market_Segmentation_EV.ipynb (https://github.com/utkrisht14/Feynn-Labs-/blob/main/Market_Segmentation_EV.ipynb)