

EV Market in India

by Karan Singh

Code implementation : [EV-market-in-India-using-Segmentation-analysis](#)

Abstract

The global electric vehicle (EV) market is experiencing rapid growth, with a global market share of 8.3% in 2021. India, as the fifth-largest automobile industry in the world, is also witnessing significant progress in the EV market. The Indian government aims to achieve substantial EV sales penetration by 2030 to reduce carbon emissions and decrease oil imports. The EV market in India is expanding at a CAGR of 36%, and various states have shown significant growth in EV sales. Hero Electric, Okinawa, and Ather Energy dominate the electric two-wheeler market, while Tata Motors holds a commanding position in the passenger vehicle segment. The government has implemented several key policy initiatives to promote EV adoption, including the FAME India Scheme and the PLI Scheme. These initiatives have created numerous business opportunities in the mobility, infrastructure, and energy sectors. The EV industry in India has the potential to add millions of direct and indirect jobs by 2030. To achieve a complete transition to EVs, substantial investments in EVs, battery infrastructure, and charging infrastructure are required. Several prominent automobile companies, including Kia, Maruti Suzuki, and Hyundai, have plans to enter the Indian EV market. However, the mass shift to EVs necessitates the development of adequate charging infrastructure and vehicles with longer ranges. With the government's support and the implementation of various initiatives, India aims to achieve 100% EV adoption by 2030.

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1. Introduction

To support India's vision of widespread EV adoption, the establishment of a robust network of public charging stations and community charging infrastructure in key metro cities is crucial. However, currently, the country faces significant challenges in bridging the gap between increasing EV adoption, particularly in the two-wheeler segment, and the availability of adequate charging infrastructure.

The Ministry of Power has categorized EV charging infrastructure into five broad areas, as per their guidelines. These categories include:

1. **Slow Charging Stations:** These stations typically provide a charging capacity of up to 3.3 kW and are suitable for overnight charging or extended parking scenarios. Slow charging stations are commonly installed in residential areas, workplaces, and parking facilities, enabling EV owners to charge their vehicles during extended periods of inactivity.
2. **Fast Charging Stations:** Fast charging stations offer higher charging capacities, usually ranging from 7 kW to 22 kW. These stations are designed to provide a quicker charging experience, reducing the overall charging time for EVs. Fast charging stations are typically located in public areas, commercial complexes, shopping centers, and highway rest stops, allowing EV users to replenish their vehicle's battery in a relatively short span of time.
3. **High-Fast Charging Stations:** High-fast charging stations are designed to provide even higher charging capacities, typically above 50 kW. These stations are capable of delivering a substantial amount of energy to an EV's battery within a short duration, significantly reducing the charging time. High-fast charging stations are generally installed along major highways, intercity travel routes, and strategic locations to cater to long-distance travelers.
4. **Battery Swapping Stations:** Battery swapping stations offer an alternative solution to charging infrastructure by allowing EV owners to exchange their depleted batteries with fully charged ones. This eliminates the need for waiting at charging stations and facilitates a quick battery replacement process. Battery swapping stations can be particularly useful for commercial fleet operators or individuals who require rapid turnaround times.
5. **Wireless Charging Infrastructure:** Wireless charging infrastructure utilizes inductive or resonant technologies to charge EVs without the need for physical cable connections. This emerging technology allows EV owners to charge their vehicles by simply parking over designated charging pads or plates, which transfer energy wirelessly to the vehicle's battery. Wireless charging infrastructure is primarily in the developmental stage but holds potential for convenient and hassle-free charging experiences in the future.

The development and deployment of a comprehensive EV charging infrastructure network across these categories are crucial to address the growing demand for charging

facilities as EV adoption accelerates in India. Currently, there is a pressing need for a significant push in charging infrastructure to meet the requirements of the expanding EV market.

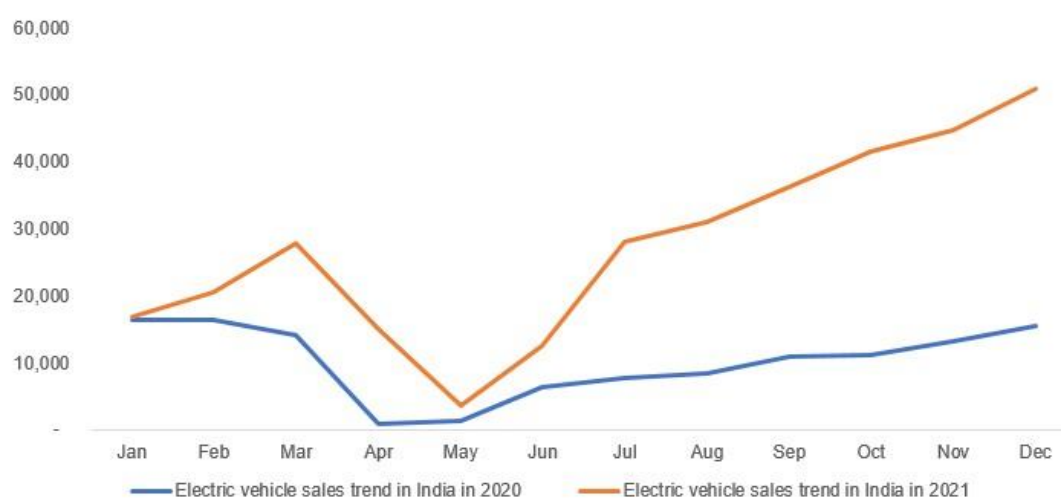
To address these challenges, the Indian government has initiated various measures to promote the establishment of charging infrastructure. The Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) India Scheme provides financial incentives to support the deployment of charging stations. Additionally, the government has encouraged public and private entities to participate in the development of charging infrastructure through partnerships and collaborations.

However, creating a vast network of charging stations and community charging infrastructure in key metro cities remains a complex and formidable task. It requires significant investment, coordination between stakeholders, and effective planning to ensure the availability of charging facilities in convenient locations. Public-private partnerships, innovative business models, and the involvement of various stakeholders such as power distribution companies, real estate developers, and EV manufacturers are crucial to overcoming these challenges and accelerating the growth of charging infrastructure.

2. Electric Vehicle Market Research

The global electric vehicle (EV) market is developing at a rapid pace. According to EV volumes, overall electric vehicle reached a global share of 8.3% (including battery electric vehicles [BEVs] and Plug-in hybrid electric vehicles [PHEVs]) in 2021 from 4.2% in 2020 with 6.75 million vehicles on the road. This is an increase of 108% as of 2020. EVs are gaining attention across the globe as they help reduce emissions and depletion of natural resources. The Indian EV market is also evolving fast as close to 0.32 million vehicles were sold in 2021, up 168% YoY. Ongoing electric vehicle adoption in India is based on the Paris agreement to reduce carbon emissions, to improve the air quality in urban areas and reduce oil imports.

2.1 EV Market trend in India



Source: EV reporter

The Indian automobile industry holds a prominent position globally and is expected to further strengthen its position, aiming to become the third largest industry by 2030. This growth is driven by various factors, including the rising population and increasing demand for vehicles. However, the dependence on conventional energy resources, especially crude oil, is not sustainable in the long run. India currently imports nearly 80% of its crude oil requirements, which not only puts a strain on the economy but also contributes to environmental issues such as pollution and carbon emissions.

To address these challenges and promote sustainable transportation, the Indian government, through NITI Aayog, has set ambitious targets for electric vehicle adoption. By 2030, they aim to achieve EV sales penetration of 70% for all commercial cars, 30% for private cars, 40% for buses, and 80% for two and three-wheelers. These targets align with the global goal of achieving net-zero carbon emissions by 2070. By transitioning to electric vehicles, India can significantly reduce its reliance on fossil fuels and make substantial progress towards a greener and more sustainable future.

The growth potential of the Indian EV industry is substantial. According to the India Energy Storage Alliance (IESA), the industry is expected to expand at a compound annual growth rate (CAGR) of 36%. This growth can be attributed to various factors, including favorable government policies, increasing public awareness about environmental issues, and technological advancements in electric vehicle technology. The government's push for electric mobility has resulted in a significant increase in the registration of EVs in recent years. Over the past three years, India has registered 0.52 million EVs, as reported by the Ministry of Heavy Industries.

In terms of regional EV sales, Uttar Pradesh emerged as the leader in 2021, with a total of 66,704 units sold across all segments. This can be attributed to factors such as favorable policies and incentives provided by the state government. Karnataka and Tamil Nadu followed with 33,302 units and 30,036 units sold, respectively. Each state has its own strengths in different segments. For example, Uttar Pradesh dominated the three-wheeler segment, Karnataka led the two-wheeler segment, and Maharashtra took the lead in the four-wheeler segment.

The growth of the EV industry in India presents numerous opportunities for various stakeholders. From an investment perspective, the transition to electric vehicles requires significant funding. According to NITI Aayog, a total investment of US\$267 billion (Rs. 19.7 lakh crore) in EVs, battery infrastructure, and charging infrastructure is required for a complete transition to electric mobility. This presents opportunities for investors, businesses, and entrepreneurs to participate in the growth of the EV ecosystem.

Furthermore, the growth of the EV industry has the potential to create a significant number of jobs. The Ministry of Skill Development and Entrepreneurship (MSDE) estimates that the EV sector could generate 10 million direct jobs and create an additional 50 million indirect jobs by 2030. This would have a positive impact on the economy by providing employment opportunities and contributing to economic growth.

In terms of policy initiatives, the Indian government has introduced several programs to promote EV adoption. The Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) India Scheme, launched in 2015, aims to stimulate the growth of hybrid and electric vehicles in the country. The FAME-II scheme, with a budget of US\$1.3 billion (Rs. 10,000 crore), supports the adoption of electric two-wheelers, three-wheelers, passenger vehicles, and buses. The government extended the scheme until 2024, highlighting its commitment to accelerating the transition to electric mobility.

To support the development of battery infrastructure, the government introduced the Production Linked Incentive for Advanced Chemistry Cell Battery Storage (PLI-ACC) scheme. With an outlay of US\$2.45 billion (Rs. 18,100 crore) over five years, the scheme aims to incentivize the establishment of battery manufacturing facilities in India. This will help reduce dependence on imported batteries and promote domestic manufacturing capabilities.

Additionally, the government has implemented other initiatives such as tax exemptions, reduction of customs duty on key battery components, and state-wise incentives to further encourage the adoption of electric vehicles.

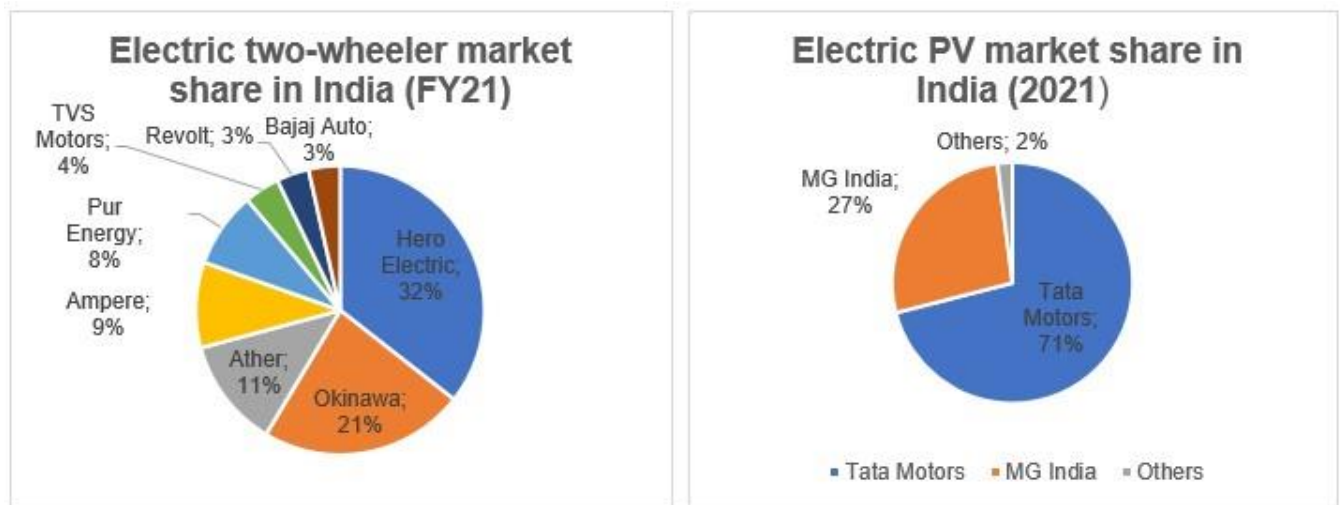
In conclusion, the Indian EV industry is on a growth trajectory, driven by favorable government policies, increasing environmental consciousness, and the need to reduce dependence on fossil fuels. The ambitious targets set by the government and the support provided through various initiatives have resulted in robust growth in EV sales. The industry presents a range of business opportunities across different segments, including manufacturing, infrastructure development, and renewable energy. With the potential to create millions of jobs and contribute to a cleaner and more sustainable future, the Indian EV industry is poised for significant expansion in the coming years.

2.2 State -Wise-EV Sales Trend



Source: EV Reporter

Hero Electric, Okinawa and Ather Energy controls the electric two-wheeler market in India with a combined market share of 64%. Hero Electric has a market share of 36% followed by Okinawa with 21%. Ather Energy with an 11.1% market share is slowly gaining market share, as the company is currently expanding its distribution network across India. In the passenger vehicle segment, Tata Motors enjoys a commanding position in electric vehicle space with a market share of 71%, led by their two key models, Nexon and Tigor EV. MG Motors India enjoys the second position and offers the longest-range EV (MG EZS provides 439 KM range on a single charge). Other Indian manufacturers have announced their models and is expected to be launched in the future.



Source- Cardekho, gaadiwaadi, e-vehicle info.,Rushlane.

2.3 Government Initiative

In India, the transportation industry has become one of the most significant sources of air pollution. To reduce the impact of greenhouse gas emissions from various vehicles, the Indian government has implemented several measures at both the national and state levels. Worldwide, Electric vehicle sector has grown significantly during the previous decade. China has been the EV industry's pioneer, with significant advancements in battery production capacity, charging infrastructure, and new EV model development. China's enormous manufacturing capability allows them to make EVs at a reduced cost. When it comes to electric vehicles, India has a low adoption rate. There is still much work to be done regarding model types, charging infrastructure, and financial incentives for EV makers. The Indian government maintained its support for the EV industry in the 2022 budget by bringing initiatives for electric vehicles. India now dominates the 2W and 3W markets and is among the top five in passenger cars and **commercial vehicles**^[1] (CV). Despite this, the country's EV share remains minimal. In 2012, over 1,04,806 EVs were registered in India. Electric buses are progressively becoming commonplace sources of transportation. Over 400 electric buses were sold in FY2021. This figure touched roughly 900 in FY2022. The government recommended many measures to improve the market penetration of EVs in India. In this write-up we will discuss government initiatives for [electric vehicles in India](#).

2.3.1 Initiatives For The Stakeholders For Electric Vehicles

The Government of India has taken significant steps to establish India as a global leader in the electric vehicle (EV) industry. With a focus on reducing pollution, decreasing reliance on fossil fuels, and fulfilling international climate change commitments, the government has introduced various initiatives to promote the adoption of EVs and drive the development of EV-related infrastructure. These initiatives aim to create a conducive environment for the transition to electric transportation, recognizing the potential of electric vehicles in shaping a sustainable future.

The government is implementing cheaper road fees, scrapping, and refit incentives to help meet the government's aim of 30% EVs by 2030. The growing expense of oil imports,

rising pollution, and India's worldwide duties to tackle climate change are driving reasons behind the country's recent initiatives to expedite the transition to e-mobility.

The government is promoting the installation of EV charging stations by providing capital subsidies through the FAME India Program Phase II and state-level measures. So far, the Indian government has announced the following incentives.

- FAME-II
- PLI SCHEME,
- Battery Switching Policy,
- Special Electric Mobility Zone, and
- Tax Reduction on EVs.

2.3.2 FAME-II Initiatives For EVs

FAME-II: Promoting Electric Mobility The Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) India project, launched in 2015, has been a critical component of India's electric mobility efforts. Under the FAME-II initiative, which commenced in April 2019 with a budget of INR 10,000 crore, support is provided to accelerate the adoption of electric two-wheelers, three-wheelers, passenger vehicles, and buses. The program has been extended until March 2024 to further drive EV adoption.

2.3.3 PLI Scheme: Boosting Productivity

The Production Linked Incentive (PLI) scheme has been introduced to enhance productivity and reduce costs for electric vehicle manufacturers. The scheme offers financial incentives and subsidies to manufacturers, including direct subsidies to EV buyers. The scheme also encompasses the development of cell battery and vehicle component industries. With an outlay of INR 18,100 crore, the PLI scheme encourages domestic manufacturing and value addition in the EV sector.

2.3.4 Battery Swapping Policy: Facilitating Efficiency

The Battery Swapping Policy aims to standardize battery specifications across EVs in India. This initiative promotes battery swapping as a viable alternative to on-the-spot recharging, particularly for time-sensitive services such as delivery and intercity transportation. Uniform battery configurations enable seamless battery exchanges, increasing efficiency and reducing charging time. Battery swapping also benefits manufacturers by ensuring availability of machine spare parts and reducing costs through economies of scale.

2.3.5 Duty Reduction on EV Components: Promoting Localization

To support domestic manufacturing, the government has reduced customs duties on key EV components. Import duties on nickel ore, nickel oxide, and ferro nickel, essential for lithium-ion batteries used in EVs, have been significantly reduced. This reduction in customs duties

promotes local EV battery manufacturing and reduces production costs, encouraging the localization of supply chains.

2.3.6 Special E-Mobility Zones: Encouraging EV Usage

The government plans to establish special e-mobility zones where only electric vehicles or their equivalent will be allowed to operate. These designated zones aim to reduce traffic congestion caused by private vehicles and encourage the adoption of EVs. Similar initiatives have proven successful in European countries and China, promoting the market share of EVs and creating a cleaner, more efficient transportation system.

2.3.7 State-Level Initiatives: Enhancing the Ecosystem

Many states in India have implemented their own EV policies to support national efforts towards sustainable mobility. These initiatives include financial incentives for EV purchases, exemptions from road taxes and registration costs, low-interest loans for EV purchases, and the development of charging infrastructure. States are also procuring electric vehicles for last-mile delivery services and public transit, further driving the adoption of EVs and expanding their usage.

Conclusion

The Indian government's initiatives for electric vehicles showcase a strong commitment to sustainable transportation. Through measures such as FAME-II, the PLI scheme, battery swapping policy, duty reduction on EV components, special e-mobility zones, and state-level initiatives, the government aims to accelerate the transition to electric mobility. These initiatives not only support environmental goals but also drive economic growth, promote domestic manufacturing, and enhance the overall ecosystem for electric vehicles in India. With concerted efforts from stakeholders and the continued implementation of supportive policies, India is on track to achieve its vision of a greener and more sustainable transportation future.

2.4 Public charging infrastructure

To support India's vision of widespread EV adoption, the establishment of a robust network of public charging stations and community charging infrastructure in key metro cities is crucial. However, currently, the country faces significant challenges in bridging the gap between increasing EV adoption, particularly in the two-wheeler segment, and the availability of adequate charging infrastructure.

The Ministry of Power has categorized EV charging infrastructure into five broad areas, as per their guidelines. These categories include:

- Slow charging stations
- Fast Charging Stations
- High fast charging stations
- Battery Swapping Stations
- Wireless charging infrastructure

1. **Slow Charging Stations:** These stations typically provide a charging capacity of up to 3.3 kW and are suitable for overnight charging or extended parking scenarios. Slow charging stations are commonly installed in residential areas, workplaces, and parking facilities, enabling EV owners to charge their vehicles during extended periods of inactivity.
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3. **High-Fast Charging Stations:** High-fast charging stations are designed to provide even higher charging capacities, typically above 50 kW. These stations are capable of delivering a substantial amount of energy to an EV's battery within a short duration, significantly reducing the charging time. High-fast charging stations are generally installed along major highways, intercity travel routes, and strategic locations to cater to long-distance travelers.
4. **Battery Swapping Stations:** Battery swapping stations offer an alternative solution to charging infrastructure by allowing EV owners to exchange their depleted batteries with fully charged ones. This eliminates the need for waiting at charging stations and facilitates a quick battery replacement process. Battery swapping stations can be particularly useful for commercial fleet operators or individuals who require rapid turnaround times.
5. **Wireless Charging Infrastructure:** Wireless charging infrastructure utilizes inductive or resonant technologies to charge EVs without the need for physical cable connections. This emerging technology allows EV owners to charge their vehicles by simply parking over designated charging pads or plates, which transfer energy wirelessly to the vehicle's battery. Wireless charging infrastructure is primarily in the developmental stage but holds potential for convenient and hassle-free charging experiences in the future.

The development and deployment of a comprehensive EV charging infrastructure network across these categories are crucial to address the growing demand for charging facilities as EV adoption accelerates in India. Currently, there is a pressing need for a significant push in charging infrastructure to meet the requirements of the expanding EV market.

To address these challenges, the Indian government has initiated various measures to promote the establishment of charging infrastructure. The Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) India Scheme provides financial incentives to support the deployment of charging stations. Additionally, the government has encouraged public and private entities to participate in the development of charging infrastructure through partnerships and collaborations.

However, creating a vast network of charging stations and community charging infrastructure in key metro cities remains a complex and formidable task. It requires significant investment,

coordination between stakeholders, and effective planning to ensure the availability of charging facilities in convenient locations. Public-private partnerships, innovative business models, and the involvement of various stakeholders such as power distribution companies, real estate developers, and EV manufacturers are crucial to overcoming these challenges and accelerating the growth of charging infrastructure.

In conclusion, while India's EV adoption is on the rise, the development of a comprehensive charging infrastructure network is vital for its success. Addressing the gaps in charging infrastructure and implementing a coordinated approach involving all stakeholders will be instrumental in supporting India's EV dream and facilitating the widespread adoption of electric vehicles.

2.5 Business Opportunities

The EV push in India opens a plethora of business opportunities across three key segments – mobility, infrastructure and energy. These include opportunities in EV franchising, EV OEM market, battery infrastructure, solar vehicle charging and battery swapping technology among several others. According to NITI Aayog, the complete transition to EVs requires a total investment of US\$ 267 billion (Rs.19.7 lakh crore) in EVs, battery infrastructure and charging infrastructure.

According to the Ministry of Skill Development and Entrepreneurship (MSDE), the EV industry could add 10 million direct jobs by 2030 which would create 50 million indirect jobs in the sector. Several automobile companies have plans to participate in the EV industry as listed in the table below:

- **FAME India Scheme:** Faster Adoption & Manufacturing of (Hybrid &) Electric Vehicles (FAME) India was launched in 2015 for promoting growth and early adoption of hybrid and electric vehicles in the country. FAME-II scheme was launched in India with a budget outlay of US\$ 1.3 billion (Rs. 10,000 crore) to support 1 million e-two-wheelers, 0.5 million e-three-wheelers, 55,000 e-passenger vehicles and 7,000 e-buses. The government extended the scheme until 2024, as announced in Union Budget 2022-23.
- **PLI Scheme:** The government introduced Production Linked Incentive for Advanced Chemistry Cell Battery Storage (PLI-ACC) scheme. The scheme is expected to boost India's battery infrastructure. As per the Union Budget, the total outlay for the scheme is US\$ 2.45 billion (Rs 18,100 crore), which would be disbursed to beneficiaries over five years once the manufacturing facility is set up.
- **Battery Swapping Policy:** A wide-spread charging infrastructure is essential for EV adoption. In this regard, on April 22, 2022, NITI Aayog released a draft battery swapping policy which will be valid until March 31, 2025. The policy will be implemented over a period of 1-2 years from the date of launch of the policy and will cover all metropolitan cities with a population greater than four million. The second phase will be implemented over 2-3 years from date of launch of the policy and will cover all UT's and major cities with a population greater than 5,00,000.
- **Other Initiatives-**

- Tax exemption of up to Rs.1,50,000 (US\$ 1,960) under section 80EEB of income tax while purchasing an EV (2W or 4W) on loan.
- Reduction of customs duty on nickel ore (key component of lithium-ion battery) from 5% to 0%.
- State- wise reduction of road tax and other incentives.

2.6 Current EV Companies in Indian market

The push for electric vehicles in India presents various business opportunities in the mobility, infrastructure, and energy sectors. These opportunities include EV franchising, participation in the EV original equipment manufacturer (OEM) market, battery infrastructure development, solar vehicle charging solutions, battery swapping technology, and more. The complete transition to EVs in India requires a substantial investment of approximately US\$ 267 billion (Rs. 19.7 lakh crore) in EVs, battery infrastructure, and charging infrastructure.

According to the Ministry of Skill Development and Entrepreneurship (MSDE), the EV industry has the potential to generate 10 million direct jobs by 2030, along with an additional 50 million indirect jobs in the sector. Prominent automobile companies, such as Kia, Maruti Suzuki, Tata Motors, Hyundai, Hopcharge, MG Motors, and Mahindra & Mahindra, have announced their plans to participate in the Indian EV industry through various initiatives ranging from manufacturing EVs for global markets, launching EV models in India, securing government orders for electric buses, expanding EV charging infrastructure, and introducing a diverse range of EV models.

These initiatives reflect the growing interest and commitment from both domestic and international players in leveraging the business opportunities presented by the Indian EV market, which is poised for significant growth in the coming years.

| Company | EV Related Plans |
|----------------------|---|
| Kia | Manufacture small SUV EVs in India for global markets in 2025. |
| Maruti Suzuki | Launch its first EV model in India by 2025. |
| Tata Motors | Secure an order worth US\$ 678 million (Rs 5,000 crore) from the government for electric buses and plan to launch 10 more EVs in India. |
| Hyundai | Launch IONIQ 5 EV in India by the second half of 2022. |
| Hopcharge | Create the world's first on-demand doorstep fast charge service through their Gurgaon-based startup. |

| Company | EV Related Plans |
|-----------------------|---|
| MG Motors | Partner with Bharath Petroleum to expand the EV charging infrastructure in India. |
| Mahindra and Mahindra | Target to launch 16 EV models across its SUV and LCV categories by 2027. |

2.7 Factors affecting EV startups in India

Factors Affecting an EV start up in India For an EV start up there are some other factors which may affect its business. To analyse these factors we have divided our segments state wise. Some of the factors considered in our report are: 1. Percentage of Tax Exemption given by the respective State/UT 2. Subsidy Amount(in INR) given by the respective State/UT 3. Fuel(Petrol and diesel) prices in the respective State/UT 4. Pollution/Air Quality of the respective State/UT An EV company can put up their showroom in the region where the state is giving maximum Tax Exemption and Subsidy as this would be helpful in business point of view. It can also put up their showroom where the fuel prices are high as people in those states/UT's would be looking for another alternative than paying huge prices for the fuel. In environment point of view an EV company start their business in the region whose air quality is not good or poor, people over there would be also willing to decrease the pollution rate by switching their means of transport from fuel to electric, This would be helpful for both company and the environment. Based on these factors and their dependencies some datasets are prepared manually to analyse which region would be helpful for an EV start up in India. The information present there is not 100% accurate, but maximum care has been taken for the information to be error free. 20 State wise tax relaxati

3. Data Sources

1. [Kaggle](#)
2. [Firstpost](#)
3. [jmkResearch](#)
4. [Economic Times](#)
5. [Indian Brand Equity Foundation \(IBEF\)](#)
6. [AMRIT.niti.gov.in](#)

4. Data Pre-Processing

1. Categorical Variables

Two pre-processing procedures are often used for categorical variables. One is merging levels of categorical variables before further analysis, the other one is converting categorical variables to numeric ones, if it makes sense to do so. Merging levels of categorical variables is useful if the original categories are too differentiated (too many).

2. Numerical Variables

In distance-based methods of segment extraction, the range of values of a segmentation variable determines its relative influence. If one of the segmentation variables is binary (with values 0 or 1 indicating whether or not a customer views on the product of fast food), and a second variable indicates the expenditure in dollars per person per day (with values ranging from zero to \$1000), a one-dollar difference in spend per person per day is weighted equally as the difference in liking to dine out or not.

3. Univariate Variables

We take one feature and based on that we will try to classify what the output is going to be. In McDonald's dataset, we took age as feature and classified based how much they are liked. From our data all the persons who gave positive feedback '4' and above their age is around '20' and the data are fit (overlapped) one guy from age.

4. Bivariate Variables

Bivariate analysis is slightly more analytical than Univariate analysis. When the data set contains two variables and researchers aim to undertake comparisons between the two data set then Bivariate analysis is the right type of analysis technique.

5. Multivariate Variables

Multivariate analysis is a more complex form of statistical analysis technique and used when there are more than two variables in the data set. Here we can apply PCA to reduce the dimensions.

4.1 Libraries Used

To analyze the EVs (Electric Vehicles) market segmentation, you have imported several libraries in your Python code. Here are the details of each import statement :

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import os
import warnings
```

1. Pandas :

pandas is a powerful data manipulation and analysis library in Python. It provides data structures and functions to efficiently manipulate and analyze structured data.

2. NumPy:

NumPy is a fundamental package for scientific computing in Python. It provides support for large, multi-dimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays efficiently.

3. Matplotlib :

Matplotlib is a popular data visualization library in Python. The **pyplot** module provides a MATLAB-like interface for creating various types of plots and visualizations.

4. Seaborn :

Seaborn is another data visualization library in Python. It is built on top of **matplotlib** and provides a high-level interface for creating attractive and informative statistical graphics.

5. os:

os is a Python built-in module that provides a way to interact with the operating system. It offers various functions for working with files, directories, and paths. Importing it allows you to use its functions to perform operations related to file and directory manipulation.

6. warnings:

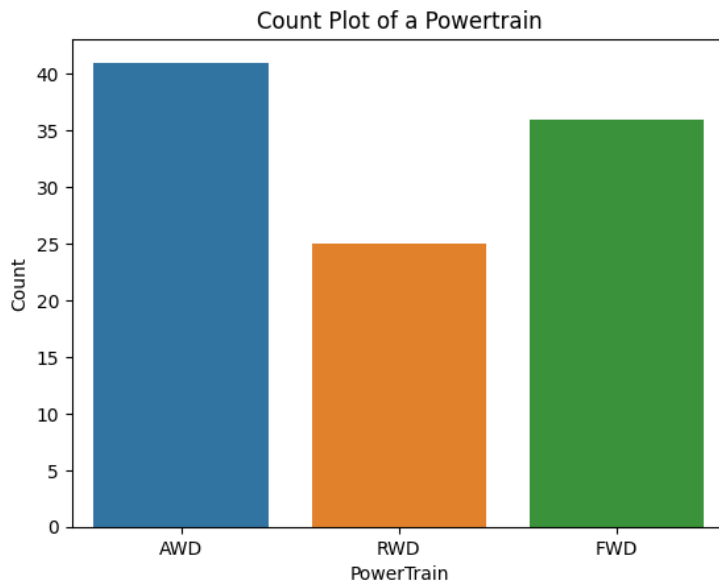
warnings is a Python built-in module that allows you to control the warning messages generated by the interpreter. By importing it, you can customize the warning handling behavior, such as filtering or displaying specific types of warnings.

These libraries provide a powerful toolkit for data analysis, manipulation, visualization, and interaction with the operating system. By utilizing them, you can perform various tasks related to analyzing the EVs market segmentation effectively.

4.1 Visualizations

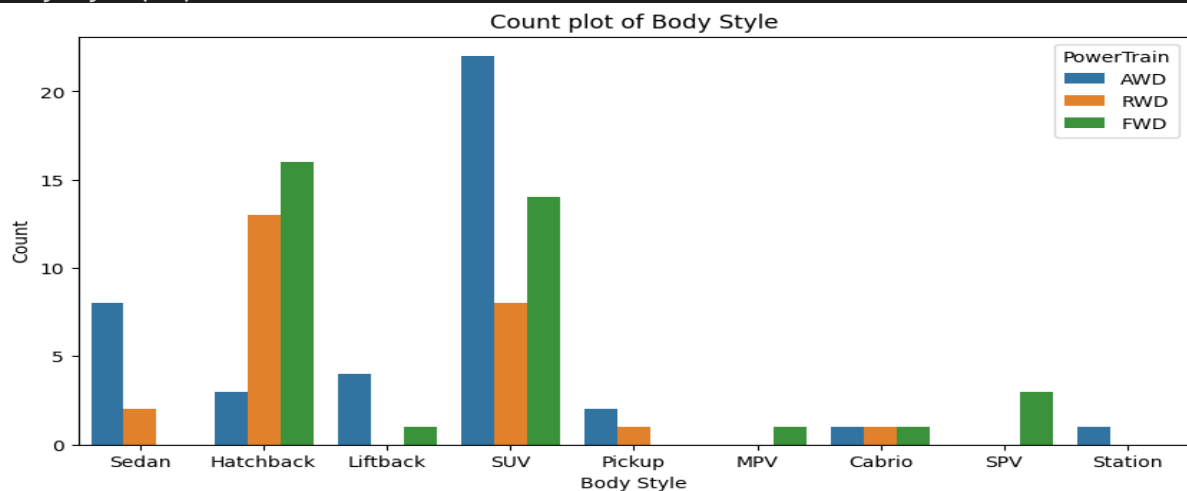
```
def train(dataframe):
    sbn.countplot(x=dataframe['PowerTrain'])
    plt.title('Count Plot of a Powertrain')
    plt.xlabel('PowerTrain')
    plt.ylabel('Count')

train(df)
```



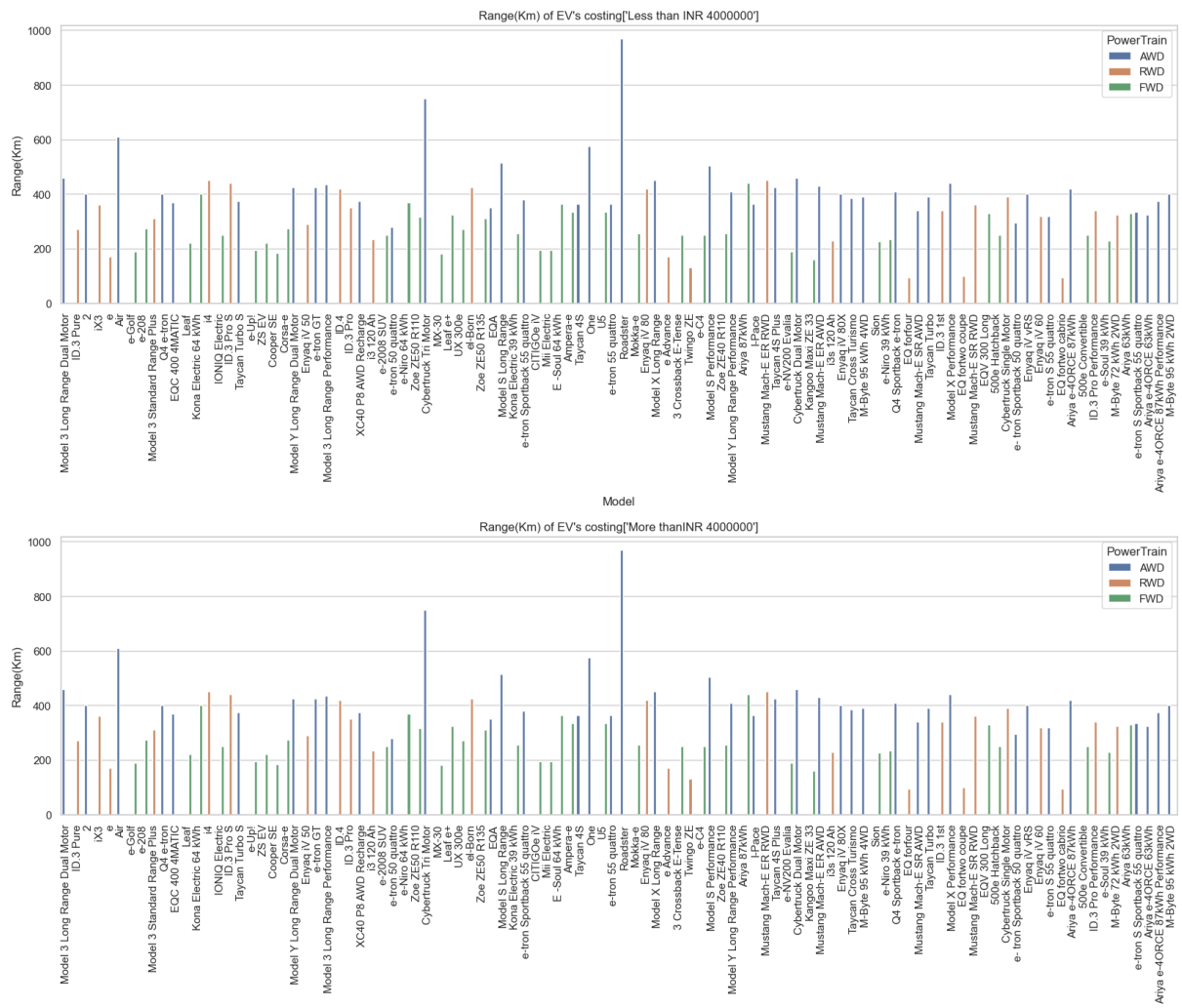
```
def bodystyle(dataframe):
    plt.figure(figsize=(10,5))
    sbn.countplot(x='BodyStyle', data=dataframe, hue='PowerTrain')
    plt.title('Count plot of Body Style')
    plt.xlabel('Body Style')
    plt.ylabel('Count')
    plt.show()

bodystyle(df)
```

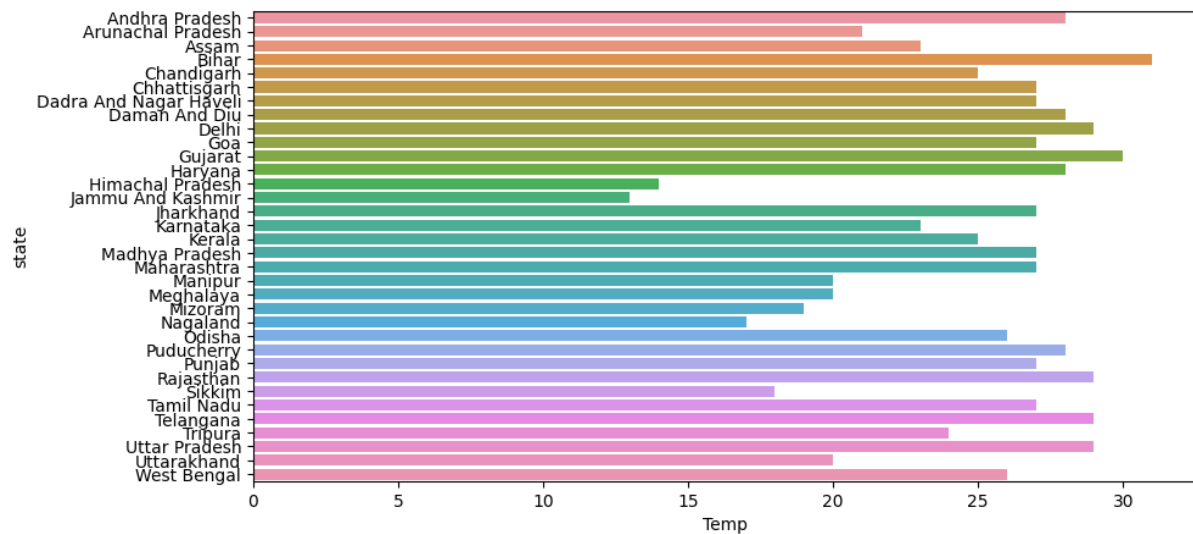


```
def range(dataframe, price):
    plt.figure(figsize=(20,5))
    sns.set_theme(style="whitegrid")
    sns.barplot(x= 'Model',y= 'Range_Km', data=df, hue=df['PowerTrain'])
    plt.title('''Range(Km) of EV's costing{'''.format(price))
    plt.ylabel('Range(Km)')
    plt.xlabel('Model')
    plt.xticks(rotation = 90)
    plt.show()

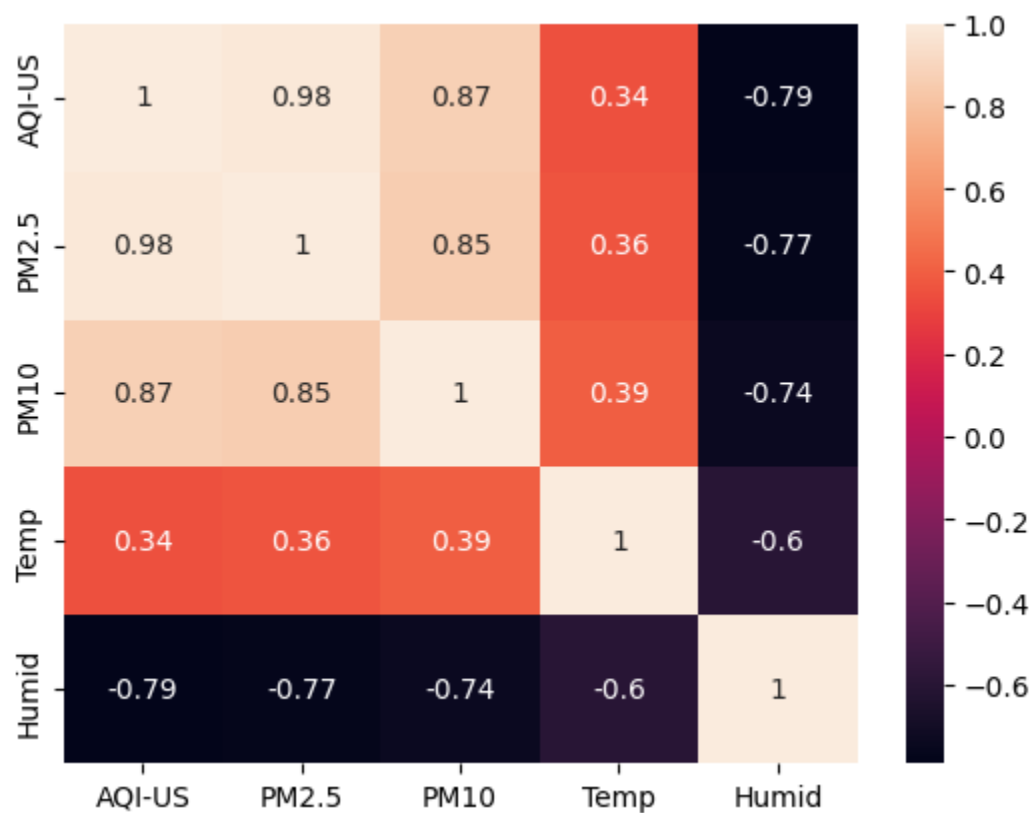
range(df_1, t1)
range(df_2, t2)
```



```
plt.figure(figsize=(10, 5))
sns.barplot(x="Temp", y="state", data=df)
plt.show()
```



```
# Plot the correlation matrix using a heatmap
sns.heatmap(correlation_matrix, annot=True)
```



5. Segment Extraction

1. Geographic Segmentation:

- Segments customers based on their geographic location or residence.
- **Advantages:** Allows targeting specific areas, tailor promotions to local preferences, and use local advertising channels.
- **Disadvantages:** People in the same location may have different opinions and preferences.

2. Socio-Demographic Segmentation:

- Segments customers based on socio-demographic factors such as age, gender, education, income, etc.
- Examples: Gender for cosmetics, income for luxury items, age for vacation destinations.
- Provides clear insights into customer characteristics but may not be the best fit for product preferences.

3. Psychographic Segmentation:

- Segments customers based on psychological criteria like interests, beliefs, aspirations, preferences, and benefits.
- More complex than geographic and socio-demographic segmentation.
- Requires multiple segmentation variables due to the varied nature of factors influencing psychographic criteria.
- Clusters customers with common psychographic profiles to maximize profits.

4. Behavioural Segmentation:

- Segments customers based on their behaviours, both online and offline.
- Uses data on immediate online behaviour, positive feedback, past offline behavior, or negative feedback.
- Identifies similarities in customer behaviour to create targeted segments.
- Allows for personalized marketing approaches based on observed behaviours.

5. **Two-wheelers:** Electric two-wheelers have gained significant traction in the Indian market due to their affordability and suitability for daily commuting. There is a growing demand for electric scooters and motorcycles, especially in urban areas with high traffic congestion and rising fuel prices.

6. **Three-wheelers:** Electric three-wheelers, commonly known as e-rickshaws or e-auto-rickshaws, are becoming increasingly popular as a sustainable alternative to traditional fossil fuel-powered auto-rickshaws. They are commonly used for short-distance transportation in cities and towns.

7. **Last-mile delivery:** The e-commerce boom in India has created a need for efficient and eco-friendly last-mile delivery solutions. Electric vehicles can offer a cost-effective and environmentally friendly option for delivery companies to navigate congested urban areas and reduce carbon emissions.
8. **Commercial fleet vehicles:** Electric vehicles are well-suited for commercial fleet operations, such as taxis, ride-sharing services, and delivery fleets. By targeting these segments, an EV startup can cater to the transportation needs of businesses while reducing their carbon footprint.
9. **Public transportation:** The Indian government has been actively promoting the adoption of electric buses in public transportation systems. Electric buses can help reduce pollution and improve the overall air quality in cities. Developing electric buses and associated charging infrastructure can be a potential segment for an EV startup.
10. **Electric infrastructure solutions:** As the demand for electric vehicles increases, there is a need for robust charging infrastructure. An EV startup can focus on developing charging stations, battery swapping solutions, or innovative charging technologies to support the growing EV ecosystem in India.
11. **Customized and niche segments:** There may be opportunities in targeting specific niche segments, such as electric luxury cars, off-road electric vehicles, or electric vehicles for specific industries like agriculture or logistics.

12. Targeting First-time Buyers:

- **Growing Middle-Class:** India's middle-class population is expanding, with many individuals aspiring to own a personal vehicle. Releasing budget-friendly EVs can cater to this segment's needs and attract first-time buyers who are price-conscious.
- **Urban Commuters:** In densely populated cities, where daily commuting is a challenge, affordable electric vehicles can provide a convenient and cost-effective solution. Startups targeting urban commuters with budget-friendly EVs can tap into this potential customer base.

13. Localization and Cost Optimization:

- **Local Manufacturing:** By establishing local manufacturing facilities, startups can reduce production costs, import duties, and logistics expenses. This, in turn, enables them to offer budget-friendly EVs to the Indian market.
- **Partnerships:** Collaborating with local suppliers and leveraging domestic resources can further optimize costs. Startups should explore partnerships that facilitate cost-effective production, ensuring competitive pricing for their budget-friendly EVs.

Overall, segmentation criteria help identify identifiable characteristics within a data sample, allowing for the grouping of individuals into market segments. By analyzing common interests

and needs within these segments, organizations can maximize their profits by tailoring their marketing strategies accordingly.

6. Profiling and describing potential segments

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7. Selection of target segment

Here are some potential target segments that can be considered:

1. **Urban Commuters:** Targeting urban commuters in densely populated cities can be a lucrative segment. Affordable electric vehicles that offer convenience and cost-effectiveness for daily commuting can attract this customer base.
2. **Last-mile Delivery:** With the growth of e-commerce, there is a need for efficient and eco-friendly last-mile delivery solutions. Electric vehicles can cater to this segment by providing cost-effective and environmentally friendly options for delivery companies.
3. **Commercial Fleet Vehicles:** Electric vehicles are well-suited for commercial fleet operations such as taxis, ride-sharing services, and delivery fleets. Targeting this segment allows an EV startup to cater to the transportation needs of businesses while reducing carbon emissions.
4. **Public Transportation:** The Indian government is actively promoting the adoption of electric buses in public transportation systems. Developing electric buses and associated charging infrastructure can be a potential segment for an EV startup.
5. **Customized and Niche Segments:** There may be opportunities in targeting specific niche segments such as electric luxury cars, off-road electric vehicles, or electric vehicles for specific industries like agriculture or logistics. By catering to unique customer needs, an EV startup can differentiate itself in the market.
6. **Targeting First-time Buyers:** With the expanding middle-class population in India, many individuals aspire to own a personal vehicle. Releasing budget-friendly EVs can attract first-time buyers who are price-conscious.
7. **Localization and Cost Optimization:** Establishing local manufacturing facilities and leveraging domestic resources can reduce production costs and enable startups to offer budget-friendly EVs. Strategic partnerships with local suppliers can further optimize costs.

8. Customizing the Marketing mix

Customizing the marketing mix refers to tailoring the various elements of the marketing mix to suit the specific needs and preferences of a target market or customer segment. The marketing mix consists of four key components, often referred to as the "4Ps": product, price, place, and promotion. Customizing these elements allows businesses to create targeted and effective marketing strategies.

Here's an overview of how each element can be customized:

1. Product:

- **Features and benefits:** Adjust the features, functionalities, and benefits of the product to meet the specific needs and preferences of the target market.
- **Packaging and branding:** Design the packaging and branding elements to appeal to the target market's tastes, values, and preferences.
- **Product variants or customization:** Offer different variants or customization options to cater to different segments or individual preferences within the target market.

2. Price:

- **Pricing strategy:** Determine the most suitable pricing strategy based on the target market's willingness to pay, perceived value, and competitive landscape.
- **Discounts and promotions:** Customize discounts, promotions, or pricing bundles that align with the target market's purchasing behavior and preferences.
- **Payment options:** Offer flexible payment options or financing plans that cater to the target market's financial situation and preferences.

3. Place:

- **Distribution channels:** Select distribution channels that are convenient and accessible to the target market, considering factors such as online platforms, retail locations, or direct sales.
- **Physical presence:** Establish a physical presence in locations that are relevant and easily reachable for the target market, such as specific regions or neighborhoods.
- **Inventory management:** Optimize inventory management to ensure the availability of the product at the right time and in the right locations for the target market.

4. Promotion:

- **Advertising and messaging:** Develop advertising campaigns and messages that resonate with the target market's values, aspirations, and communication preferences.
- **Marketing channels:** Utilize marketing channels that are effective in reaching and engaging the target market, such as social media, influencer marketing, or traditional advertising mediums.

- Sales promotions: Create sales promotions, events, or partnerships that appeal to the target market's interests and drive engagement.

Customizing the marketing mix requires a deep understanding of the target market, including their demographics, psychographics, behaviors, and preferences. Market research, customer surveys, and feedback are valuable tools to gather insights and inform the customization process. By customizing the marketing mix, businesses can better meet the unique needs and desires of their target market, leading to more effective marketing strategies and improved customer satisfaction.

9. Link to code implementation in GitHub

Code Implementation : [EV-market-in-India-using-Segmentation-analysis](#)

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