“Energizing Evolution: Electric Vehicle Market Segmentation in India’’

By :

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Problem Statement :

Being a part of Electric vehicle startup. We have to analyse EV 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.

Overview of EV:

An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. It can be powered by a collector system, with electricity from extravehicular sources, or it can be powered autonomously by a battery (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator).

EVs come in various forms, from fully electric to hybrid models, each with its unique advantages and use cases. Battery Electric Vehicles (BEVs) operate exclusively on electricity, producing no emissions during operation. Plug-in Hybrid Electric Vehicles (PHEVs) combine both electric and gasoline power, offering flexibility for longer journeys. Hybrid Electric Vehicles (HEVs) use both electric and internal combustion engines but do not require external charging.

These vehicles are equipped with advanced battery systems that store electrical energy, which is then converted into kinetic energy to drive the vehicle's wheels. This conversion process is highly efficient, translating a significant portion of the energy from the grid into propulsion. As a result, EVs tend to have excellent energy efficiency, which can lead to cost savings for consumers and reduce the overall carbon footprint.

History of Electric Vehicles:

- **Early Development:** EVs have a rich history dating back to the 19th century when inventors like Thomas Davenport and Robert Anderson developed early electric cars.

- **Resurgence:** EVs experienced a resurgence in the late 20th century, with models like the GM EV1 and Toyota RAV4 EV.

- **Modern Era:** In recent years, advancements in battery technology and a growing emphasis on sustainability have led to the mass production of EVs by various automakers worldwide.

Why We Need Electric Vehicles:

- **Environmental Benefits:** EVs significantly reduce greenhouse gas emissions and air pollution, contributing to efforts to combat climate change and improve air quality.
- **Energy Efficiency:** EVs are highly energy-efficient, converting a larger portion of energy from the grid into propulsion.
- **Reduced Operating Costs**: EVs have fewer moving parts and lower fueling costs compared to ICE vehicles.
- **Resource Conservation:** EVs decrease dependence on fossil fuels and promote the use of renewable energy sources.

Types of Electric Vehicles:

1. **Battery Electric Vehicles (BEVs):** Operate solely on electricity stored in high-capacity batteries.
2. **Plug-in Hybrid Electric Vehicles (PHEVs):** Combine an electric motor and a gasoline engine.
3. **Hybrid Electric Vehicles (HEVs):** Use both an electric motor and an internal combustion engine.

Advantages of Electric Vehicles:

- **Zero Emissions:** Produce no tailpipe emissions, reducing air pollution and greenhouse gas emissions.
- **Energy Efficiency:** Highly efficient energy utilization, resulting in cost savings.
- **Low Operating Costs:** Reduced maintenance and fueling expenses.
- **Quiet Operation:** Silent and smooth rides due to the absence of engine noise.

Disadvantages of Electric Vehicles:

- **Limited Range:** Some EVs have limited driving ranges, causing range anxiety.
- **Charging Infrastructure:** Availability and convenience of charging stations vary by region.
- **Upfront Cost**: Initial purchase prices can be higher than ICE vehicles.
- **Charging Time:** Charging an EV may take longer than refueling a gas vehicle.

Challenges to Make Electric Vehicles Mainstream:

- **Charging Infrastructure**: Expanding the charging network to enhance convenience.
- **Range Anxiety:** Developing longer-range batteries to address consumer concerns.
- **Cost Reduction:** Lowering the upfront cost of EVs through economies of scale.
- **Battery Recycling:** Establishing sustainable battery recycling processes.

Future of Electric Vehicles:

The future of electric vehicles is undeniably bright. Ongoing research and development are focused on enhancing battery technology, increasing driving ranges, reducing costs, and expanding charging infrastructure. EVs are positioned to play a pivotal role in shaping the future of transportation, with a strong emphasis on reducing environmental impact and achieving sustainable mobility.

In conclusion, the history of Electric Vehicles is a testament to human innovation and determination to create a cleaner and more sustainable mode of transportation. From their early beginnings to the modern electric cars we see today, EVs have come a long way and are poised to transform the automotive industry and contribute to a more sustainable future for the planet

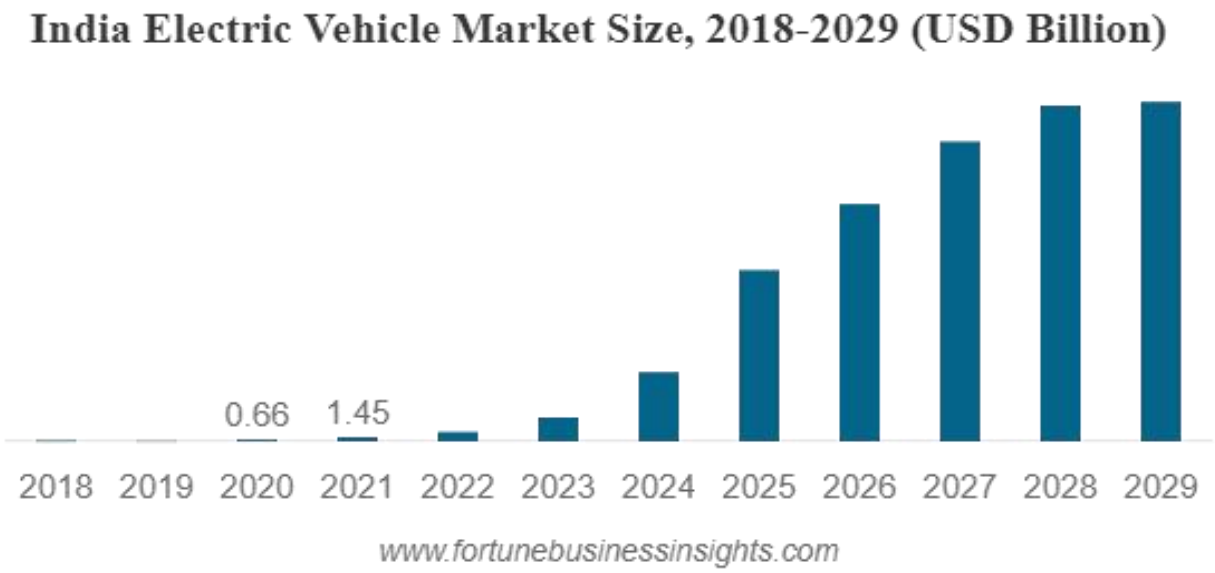
Overview of India EV market:

Key Market Insights:

The India electric vehicle market size was USD 1.45 billion in 2021 and is projected to grow from USD 3.21 billion in 2022 to USD 113.99 billion in 2029, growing at a CAGR of 66.52% during the 2022-2029 forecast period. Based on our analysis, Indian electric vehicle industry exhibited a rise of 11.34% in 2020 as compared to 2019. The COVID-19 pandemic has been unprecedented and staggering, with Indian electric vehicles experiencing lower-than-anticipated demand across the nation compared to pre-pandemic levels.

India's electric vehicles recorded strong growth in 2021, supported by the government's implementation of favorable policies and programs. Uttar Pradesh held the maximum share in EV sales in 2021, India. The total units sold across all segments reached 66,704, followed by Karnataka with 33,302 units &Tamil Nadu with 30,036 units. Uttar Pradesh led the three-wheeler segment, while Karnataka and Maharashtra led the two-wheeler and four-wheeler segments. For instance, Mahindra & Mahindra also plans to launch 16 BEV, 8 each in the SUV and light commercial vehicle segment by 2027.

The Indian automobile industry ranked fifth largest globally and is expected to become the third largest by 2030 as the demand for electric vehicles is growing tremendously due to population rise. So dependence on conventional energy resources is not suitable as India imports nearly 80% of its crude oil requirements. Moreover, NITI Aayog aims to achieve 70% penetration of EVs in all types by 2030, indenting to attain net zero carbon emissions by 2070. According to the Ministry of Heavy Industries, around 0.52 million EVs were registered in India in the last three years



COVID-19 IMPACT:

Decline in Automotive Production and Sales to Hamper the Market Growth

The Covid-19 pandemic was significantly challenging for electric vehicle manufacturers in India. Temporarily closed manufacturing facilities disrupted the supply chain, and the shortage of raw materials greatly affected the growth of this industry; the semiconductors crisis has adversely affected the production of these vehicles in India.

In India, around 4600 electric four-wheelers (e-4W) were sold in 2020. Due to COVID-19-induced lockdowns and reduced manufacturing output, the growth was slower than expected despite the anticipated growth from the FAME II subsidies provided by the Indian government on new electric vehicle purchases.

However, this market is witnessing a steady recovery boosted by Indian government initiatives, hefty subsidies, and incentives at the state level. For instance, in 2021, e-4W sales increased by around 287.1% 2021. Furthermore, electric bus sales were relatively neutral, and FAME II-backed e-bus deployment will support the market growth.

Rising Demand for Electric Micro-mobility in the Region is propelling the Market Growth

The rising demand and adoption of electric micro-mobility vehicles such as electric two-wheelers and electric three-wheelers is an ongoing trend in the market. Indian market is highly price-sensitive, and the majority of the Indian populace prefers two-wheelers for their daily transport due to rapidly growing traffic congestion. Therefore, in India low cost of electric two-wheelers and three-wheelers compared to four-wheelers, coupled with the high suitability of two-wheelers to Indian road traffic conditions, is anticipated to boost the adoption of electric two-wheelers and three-wheelers during the forecast period.

For instance, the cost of electric two-wheelers in India is nearly USD 600 to USD 3,755, which is significantly lower than the cost of electric four-wheelers. Some of India's most popular two-wheeler models include Revolt RV 400, Tork Kratos, and others.

To satisfy the increasing demand, various domestic electric two-wheeler brands are also penetrating the market to grab revenue growth opportunities in rapidly growing automotive electrification in India.

Moreover, the Indian government's push toward e-mobility adoption by providing FAME India subsidies and inclining consumer preference towards electric micro-mobility is expected to boost the market in future years.

DRIVING FACTORS

Rising Fuel Prices to Boost the Market Growth during the Forecast Period

Surging fossil fuel prices in India are one of the major factors that are anticipated to drive the demand for electric vehicles in the region. The purchasing cost of fossil fuel-powered vehicles is lower than EVs. However, their operating cost is high due to surging gasoline and diesel prices. In contrast, the operating cost of electric type of vehicles is significantly less than that of fossil fuel-powered vehicles. Therefore, shifting consumer preference towards adopting electric vehicles as a response to rising fossil fuel prices is predicted to enhance the market's growth over the forecast period.

Additionally, the government’s focus on fighting climate change by tightening emission control norms and introducing scrapping policies for conventional vehicles is anticipated to drive market growth in years to come.

Consistently Declining Cost of Electric Vehicle Battery to Drive the Market Growth

Indian automotive market is price-sensitive; therefore, a consistent decline in the cost of lithium-ion batteries positively influences the market growth. An essential driver for EV adoption is battery cost reduction, thereby reducing the total cost of operation (TCO) parity and the high upfront costs of EVs in India. Battery costs have declined by around 85% over the last decade, which has witnessed broader EV adoption in all vehicle categories. In addition, the battery cost in 2010 was USD 1200 per kWh and has declined drastically to USD 130-150 per kWh in 2021 due to scale in operations, changes in cell chemistries, and many other parameters.

RESTRAINING FACTORS

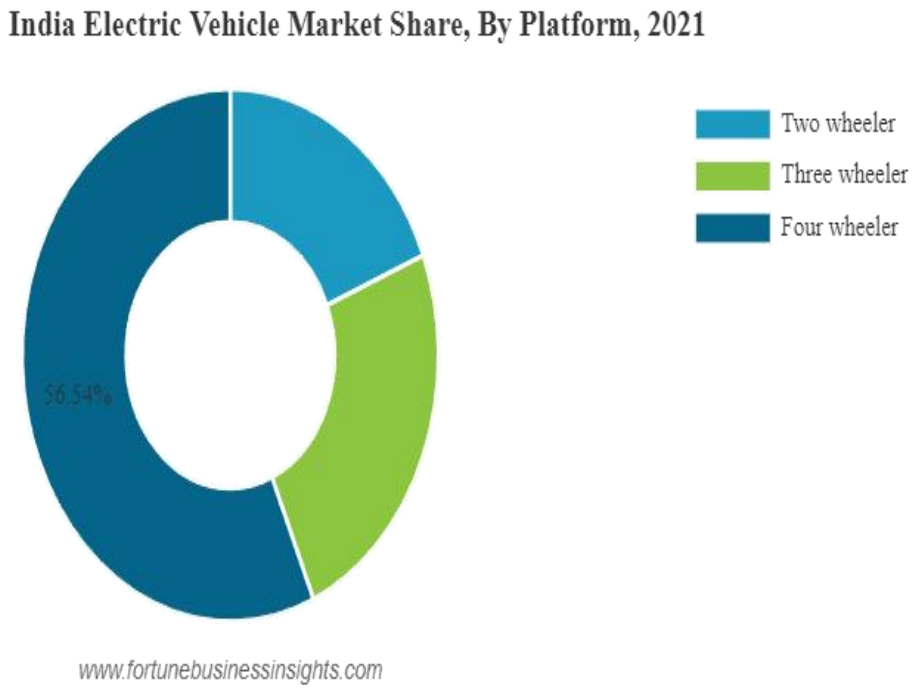
Safety Concerns among the Populace Regarding Fire Hazards are likely to Restrict the Market Growth Slightly

Penetration of electric vehicles is still low in India compared to other nations. The region's consumer awareness is also significantly low. Therefore, recent fire incidents in electric two-wheelers of the leading players such as Ola Electric, Pure EV, and Okinawa raised questions over the safety of using these vehicles. The government of India also investigated the EV models from these leading brands to find the root cause and those accountable for these safety lapses.

Subsequently, these players recalled their EV models to avoid further fire hazard possibilities. For instance, Ola Electric recalled nearly 1,441 units of its electric two-wheelers, and Okinawa also recalled 3,215 units of its electric scooter Praise Pro to fix battery-related issues. Moreover, Pure EV recalled nearly 2,000 units of its Epluto 7G and Etrance+ models. Furthermore, India's lack of a well-established EV ecosystem is one of the major obstacles to adopting electric vehicles in the region.

SEGMENTATION

By platform analysis



LIST OF KEY COMPANIES PROFILED:

BMW Group (Germany)

Daimler AG (Germany)

Toyota(Japan)

Volkswagen (Germany)

Renault Group (France)

Ford Motor Company (U.S.)

Mahindra & Mahindra (India)

TATA motors (India)

Hyundai (South Korea)

MG Motors (U.K.)

Ola Electric (India)

KEY INDUSTRY DEVELOPMENTS:

In January 2022, Hero Electric signed a strategic contract with Mahindra Group. Under this partnership, Mahindra will manufacture two of Hero Electric's most popular electric scooters – the Optima and NYX – at its Pithampur plant in Madhya Pradesh. The Mahindra Group has been pioneering electric three- and four-wheelers for many years while driving the transition to EV across the consumer and B2B segment.

In January 2022, Bajaj Auto announced the launch of a new EV production unit in India, which can manufacture 5 lakh EVs per year at total capacity. The new Bajaj Chetak EV will be built with localized components to reduce dependence on imported parts. The new Chetak could launch with an affordable price tag compared to the current Chetak.

Data collection :

1. https://www.kaggle.com/datasets/kkhandekar/electric-vehicles-india/data
2. https://www.kaggle.com/datasets/deadprstkrish/ev-cars-user-reviews-india?select=4-wheeler-EV-carwale.csv

The below image is the dataset 1 that used in analysing the Current available EV vehicle in India:

```
import pandas as pd
import numpy as np
```

```
[3] df=pd.read_csv("/content/data.csv")
```

This dataset gives the currently available electric vehicles in India

It includes: 1.vehicle style 2.Range 3.Transmission 4.vechile type 5.price range 6.Boot space 7.Base Model 8.Top Model

```
[4] df
```

	Unnamed: 0	Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats	PriceEuro
0	0	Tesla	Model 3 Long Range Dual Motor	4.6	233	450	161	940	Yes	AWD	Type 2 CCS	Sedan	D	5	55480
1	1	Volkswagen	ID.3 Pure	10.0	160	270	167	250	No	RWD	Type 2 CCS	Hatchback	C	5	30000
2	2	Polestar	2	4.7	210	400	181	620	Yes	AWD	Type 2 CCS	Liftback	D	5	56440
3	3	BMW	iX3	6.8	180	360	206	560	Yes	RWD	Type 2 CCS	SUV	D	5	68040
4	4	Honda	e	9.5	145	170	168	190	Yes	RWD	Type 2 CCS	Hatchback	B	4	32997
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
98	98	Nissan	Ariya 63kWh	7.5	160	330	191	440	Yes	FWD	Type 2 CCS	Hatchback	C	5	45000
99	99	Audi	e-tron S Sportback 55 quattro	4.5	210	335	258	540	Yes	AWD	Type 2 CCS	SUV	E	5	96050
100	100	Nissan	Ariya e-4ORCE 63kWh	5.9	200	325	194	440	Yes	AWD	Type 2 CCS	Hatchback	C	5	50000
101	101	Nissan	Ariya e-4ORCE 87kWh Performance	5.1	200	375	232	450	Yes	AWD	Type 2 CCS	Hatchback	C	5	65000
102	102	Byton	M-Byte 95 kWh 2WD	7.5	190	400	238	480	No	AWD	Type 2 CCS	SUV	E	5	62000

103 rows × 15 columns

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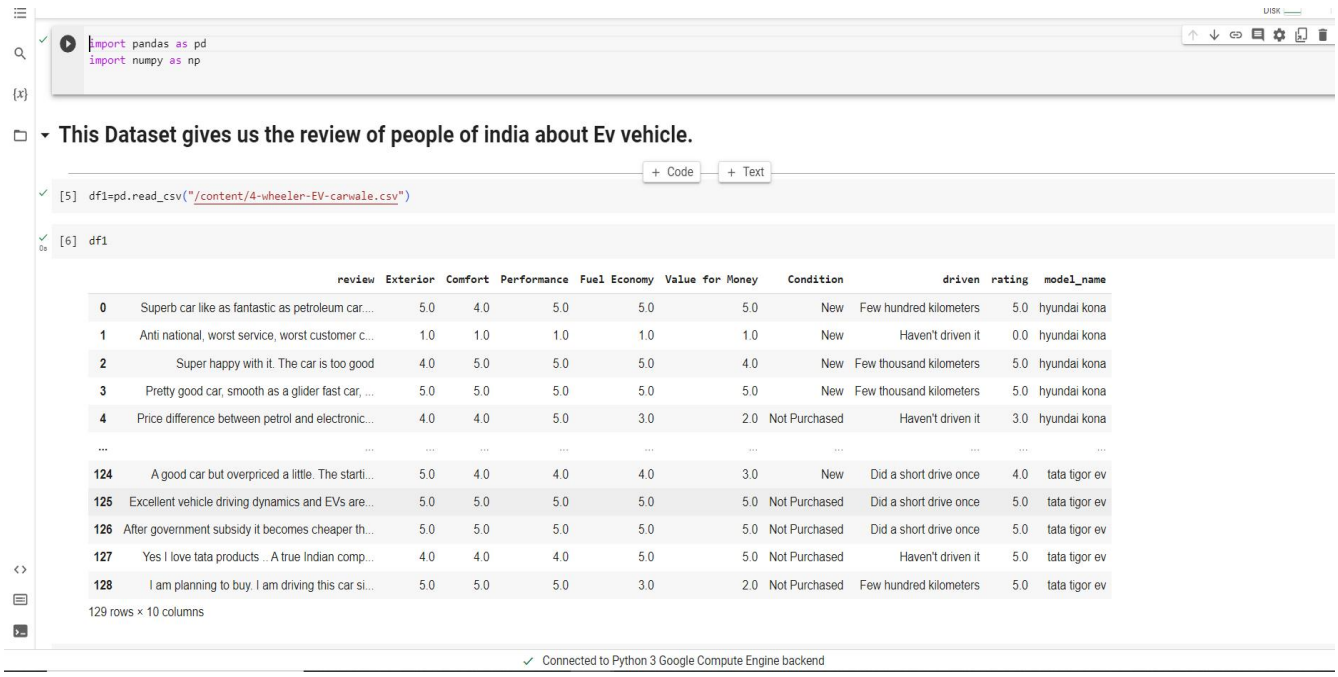
This below image used is from dataset 2 that gives us review of India people about EV vehicle



```
import pandas as pd
import numpy as np
```

This Dataset gives us the review of people of india about Ev vehicle.

+ Code + Text

```
[5] df1=pd.read_csv("/content/4-wheeler-EV-carwale.csv")
```

```
[6] df1
```

	review	Exterior	Comfort	Performance	Fuel Economy	Value for Money	Condition	driven	rating	model_name
0	Superb car like as fantastic as petroleum car....	5.0	4.0	5.0	5.0	5.0	New	Few hundred kilometers	5.0	hyundai kona
1	Anti national, worst service, worst customer c...	1.0	1.0	1.0	1.0	1.0	New	Haven't driven it	0.0	hyundai kona
2	Super happy with it. The car is too good	4.0	5.0	5.0	5.0	4.0	New	Few thousand kilometers	5.0	hyundai kona
3	Pretty good car, smooth as a glider fast car, ...	5.0	5.0	5.0	5.0	5.0	New	Few thousand kilometers	5.0	hyundai kona
4	Price difference between petrol and electronic...	4.0	4.0	5.0	3.0	2.0	Not Purchased	Haven't driven it	3.0	hyundai kona
...	...	...	...	...	...	...	...	...	...	...
124	A good car but overpriced a little. The starti...	5.0	4.0	4.0	4.0	3.0	New	Did a short drive once	4.0	tata tigor ev
125	Excellent vehicle driving dynamics and EVs are...	5.0	5.0	5.0	5.0	5.0	Not Purchased	Did a short drive once	5.0	tata tigor ev
126	After government subsidy it becomes cheaper th...	5.0	5.0	5.0	5.0	5.0	Not Purchased	Did a short drive once	5.0	tata tigor ev
127	Yes I love tata products .. A true Indian comp...	4.0	4.0	4.0	5.0	5.0	Not Purchased	Haven't driven it	5.0	tata tigor ev
128	I am planning to buy. I am driving this car si...	5.0	5.0	5.0	3.0	2.0	Not Purchased	Few hundred kilometers	5.0	tata tigor ev

129 rows × 10 columns

✓ Connected to Python 3 Google Compute Engine backend

Market Segmentation

Target Market:

The target market of Electric Vehicle Market Segmentation can be categorized into Geographic, SocioDemographic, Behavioral, and Psychographic Segmentation.

1.**Geographical segmentation**: involves dividing the market for electric vehicles into different regions or geographical areas based on various factors. This segmentation allows businesses, policymakers, and researchers to understand and target specific markets with tailored strategies and approaches.

Advantage: Customized product offerings, efficient resource allocation, policy agreement
Disadvantage: Missed Opportunities, Supply Chain Challenges, Data and Research Requirements.

2.Behavioral Segmentation: searches directly for similarities in behavior or reported behavior.

Example: prior experience with the product, amount spent on the purchase, etc.

Advantage: uses the very behavior of interest is used as the basis of segment extraction.
Disadvantage: not always readily available.

3.Psychographic Segmentation: grouped based on beliefs, interests, preferences, aspirations, or benefits sought when purchasing a product. Suitable for lifestyle segmentation. Involves many segmentation variables.
Advantage: generally more reflective of the underlying reasons for differences in consumer behavior.
Disadvantage: increased complexity of determining segment memberships for consumers.

4.Socio-Demographic Segmentation: includes age, gender, income and education.
Useful in industries.

Advantage: segment membership can easily be determined for every customer.
Disadvantage: if this criteria is not the cause for customers product preferences then it does not provide sufficient market insight for optimal segmentation decisions.

Question

1.What type of EV the company will produce?

Ans: From the above data research and segmentation anyalsis it is clear that the current demand is EV car and In India Tata motors is leading company.

2.Who are the target customer?

Ans Here I use the **Ministry of Road Transport & Highways** (MoRTH) data that given below :

That gives us the EV vehicle used in India state wise and along with EV charging station

ANNEXURE-I

The number of electric vehicles currently being used on the roads of India, State wise as on 14-07-2022

Sr. No.	State Name	Total Electric Vehicle	Total Non-Electric Vehicle	Total
1	Andaman & Nicobar Island	162	1,46,945	1,47,107
2	Arunachal Pradesh	20	2,52,965	2,52,985
3	Assam	64,766	46,77,053	47,41,819
4	Bihar	83,335	1,04,07,078	1,04,90,413
5	Chandigarh	2,812	7,46,881	7,49,693
6	Chhattisgarh	20,966	68,36,200	68,57,166
7	Delhi	1,56,393	76,85,600	78,41,993
8	Goa	3,870	10,71,570	10,75,440
9	Gujarat	45,272	2,06,05,484	2,06,50,756
10	Haryana	37,035	1,07,78,270	1,08,15,305
11	Himachal Pradesh	1,175	19,64,754	19,65,929
12	Jammu and Kashmir	2,941	18,69,962	18,72,903
13	Jharkhand	16,811	64,86,937	65,03,748
14	Karnataka	1,20,532	2,68,70,303	2,69,90,835
15	Kerala	30,775	1,57,74,078	1,58,04,853
16	Ladakh	26	38,302	38,328
17	**Maharashtra**	**1,16,646**	**3,10,58,990**	**3,11,75,636**
18	Manipur	586	4,99,324	4,99,910
19	Meghalaya	49	4,59,001	4,59,050
20	Mizoram	21	3,15,626	3,15,647
21	Nagaland	58	3,39,129	3,39,187
22	Odisha	23,371	98,45,073	98,68,444
23	Puducherry	2,149	12,13,735	12,15,884
24	Punjab	14,804	1,24,63,019	1,24,77,823
25	Rajasthan	81,338	1,73,27,388	1,74,08,726
26	Sikkim	21	97,189	97,210
27	Tamil Nadu	82,051	2,98,42,376	2,99,24,427
28	Tripura	9,262	6,50,026	6,59,288
29	**UT of DNH and DD**	**183**	**3,07,671**	**3,07,854**
30	Uttarakhand	31,008	33,12,041	33,43,049
31	Uttar Pradesh	3,37,180	4,00,92,490	4,04,29,670
32	West Bengal	48,767	1,41,34,171	1,41,82,938
Grand Total		**13,34,385**	**27,81,69,631**	**27,95,04,016**

Note:-

1. The details given are for the digitized vehicle records as per centralized Vahan4.
2. The complete data of Andhra Pradesh, Madhya Pradesh, Telangana, and Lakshadweep is not available in Vahan4 hence they are not included.

(Figure 1: state wise EV)

ANNEXURE-II

Under Phase-I of FAME India Scheme – Ministry of Heavy Industries has sanctioned520 EV Charging Stations out of which 479 charging stations have been installed as on 01st July, 2022 as follows:

State/ UT	Charging Stations	Highway	Charging Stations
Chandigarh	48	Delhi -Chandigarh	24
Delhi	94	Mum-Pune	17
Rajasthan	49	Delhi- Jaipur- Agra	31
Karnataka	65	Jaipur-Delhi Highway	9
Jharkhand	30		
Uttar Pradesh	16		
Goa	30		
Telangana	57		
Himachal Pradesh	9		
Total	**398**		**81**

(Figure 2: Ev charging station)

By taking these data into consideration, we don't need any specific age, group, income of people.

We can target Electric Vehicle directly through geographic.

As the above data shows (Figure 1) that around 13 lac EV is used in India and Maharashtra has the most used EV vehicle.

CONCLUSION:

In conclusion, the optimal market segment for Electric Vehicles (EVs) in India is a dynamic and multifaceted choice that depends on various factors, including market conditions, consumer preferences, and the strategic goals of the startup. India's diverse and rapidly evolving market offers numerous opportunities for EV adoption across different segments.

The key to success lies in conducting thorough market research to identify segments with the highest potential for growth and demand. While urban commuters, delivery services, fleet operators, environmentally conscious consumers, and government fleets are among the promising segments, the specific choice should align with the startup's strengths, resources, and long-term vision.

Furthermore, addressing the unique challenges and needs of the Indian market, such as charging infrastructure development, government incentives, and affordability, will be instrumental in making EVs more accessible and appealing to consumers.

As the EV industry continues to evolve, startups should remain flexible, adaptable, and responsive to changing market dynamics. By staying attuned to consumer preferences, leveraging technological innovations, and collaborating with key stakeholders, startups can make a meaningful impact in driving EV adoption in India and contributing to a more sustainable and environmentally friendly transportation future.