Project Dissertation Report on

RESEARCH AND BENCHMARKING OF ELECTRIC VEHCILE INDUSTRY IN INDIA

Submitted By

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Submitted to:

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DELHI SCHOOL OF MANAGEMENT

Delhi Technological University

MAY 2022

CERTIFICATE

This is to certify that the work titled **'Research and benchmarking of electric vehicle industry in India'** as a part of the Final year Major Research Project submitted by Smriti Pandey (2K20/DMBA/128) in the 4th Semester of MBA, Delhi School of Management, Delhi Technological University during January-May 2022 is her original work and has not been submitted anywhere else for the award any credits/degree whatsoever.

The project is submitted to Delhi School of Management. Delhi Technological University in partial fulfilment of the requirement for the Award of the degree of Master of Business Administration.

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DECLARATION

I hereby declare that the work titled **'Research and benchmarking of electric vehicle industry in India'** as part of the final year Major Research Project submitted by me in the 4th Semester of MBA, Delhi School of Management, Delhi Technological University, during January-May 2022 under the guidance of **Dr. Saurabh Agarwal**, is my original work and has not been submitted anywhere else.

The report has been written by me in my own words and not copied from elsewhere. Anything that appears in this report which is not my original work has been duly and appropriately referred/cited/acknowledged.

Smriti Pandey
(Roll No 2K20/DMBA/128)

ACKNOWLEDGEMENT

Before I get into the thick of things, I would like to add a few words of appreciation for people who have been a part of this project right from its inception. This project's writing has been one of the significant academic challenges I have faced. This project would not be completed without the support, patience, and guidance of the people involved. It is my deepest gratitude to them.

It gives me incredible pleasure to present my Major research project report on **'Research and benchmarking of electric vehicle industry in India'** It has been my privilege to have such project guides who have assisted us from this project's commencement. This project's success results from sheer hard work and determination put in by me with my project guide. I now take this opportunity to thank **Dr. Saurabh Agarwal**, who acted as my mentor despite his many academic and professional commitments. His wisdom and insight inspired and motivated me without his understanding and support this project would not have been exciting, and neither would have reached productivity.

I also feel the heartiest sense of accountability to my family members & friends, who helped me collect data & resource material even in processing and drafting the manuscript. This project is devoted to all those people who helped us while doing this project.

Smriti Pandey
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EXECUTIVE SUMMARY

In this project, I conducted descriptive research on the automobile industry's research and benchmarking, followed by research on the EV industry around the world and in India, the industry's drivers, challenges, restraints, major market players, government initiatives, and the industry's future. In this descriptive study, none of the variables were influenced in any way. Only research observations were made. As a result, I have no control over the nature or behavior of the variables. Following that, I conducted an EV industry survey among people aged 20 to 49 years old using a questionnaire (attached as an annexure). All of the respondents were middle- or upper-middle-class working professionals. And attempted to analyze the respondents' responses regarding their perception of EV and willingness to buy an EV in the future. As a result, I've worked hard to identify the challenges that may arise in the growth of EV in India such as lack of charging infrastructure, operational change that an automobile company has to make in their manufacturing to develop EV, high cost of capital, etc. As a result, it can serve as a guide for both current and emerging players in the EV industry.

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Chapter 1

INTRODUCTION

1.1 Background

An electric vehicle (EV) is a type of automobile that is propelled by one or more electric motors. It can be powered by a collector system, electricity from extravehicular sources, or by a battery on its own. Road and rail vehicles, surface and underwater vessels, electric aircraft, and electric spacecraft are examples of EVs.

EVs first appeared in the mid-nineteenth century, when electricity was one of the preferred methods of motor vehicle propulsion, providing a level of comfort and ease of operation that gasoline cars of the time could not match. For about a century, internal combustion engines were the dominant propulsion method for cars and trucks, but electric power remained common in other vehicle types, such as trains and smaller vehicles of all types.

EVs have seen a resurgence in the twenty-first century as a result of technological advancements and a greater emphasis on renewable energy and the potential reduction of transportation's impact on climate change, air pollution, and other environmental issues. Electric vehicles are listed as one of the 100 best modern solutions to climate change by Project Drawdown.

Government incentives to encourage adoption were first implemented in the late 2000s, including in the United States and the European Union, resulting in a growing market for the vehicles in the 2010s. Increasing public interest and awareness, as well as structural incentives, such as those built into the green recovery from the COVID-19 pandemic, are expected to significantly boost the electric vehicle market. Lockdowns have reduced the amount of greenhouse gases emitted by gasoline or diesel vehicles during the COVID-19 pandemic. In 2021, the International Energy Agency stated that governments should do

more to meet climate targets, including policies for heavy electric vehicles. Electric vehicle sales could rise from 2% of global sales in 2016 to 30% by 2030. Much of this growth is expected in markets such as North America, Europe, and China; according to a 2020 literature review, growth in the use of electric 4-wheeled vehicles appears economically unlikely in developing economies, but growth in electric 2-wheeled vehicles is likely. There are more two-wheel and three-wheel EVs than any other type.

1.2 Research and benchmarking of electric vehicle industry in India

In India, the electric vehicle industry is in its infancy. It accounts for less than 1% of total vehicle sales but has the potential to grow to more than 5% in a few years. On Indian roads today, there are over 5 lac electric two-wheelers and a few thousand electric cars. Volumes in the industry have been fluctuating, owing primarily to government incentives. Many serious players (Hero Eco, Ather, Electrotherm, Avon, Lohia, Ampere, and others) are continuing the mission and attempting to impose positive change under the banner of SMEV.

Over 90% of electric vehicles on Indian roads are low-speed electric scooters (less than 25km/hr) that do not require registration or licenses. To keep prices low, almost all electric scooters use lead batteries; however, battery failures and battery life have become major limiting factors for sales, in addition to government subsidies. Many manufacturers have attempted, but with limited success, to install charging stations. Electric three-wheelers have been developed by companies such as Lohia and Electrotherm. Ampere and Hero have both entered the Electric Cycles market. There are numerous E-Rickshaw players springing up across the country, selling a large number of E-Rickshaws for last-mile connectivity.

Except for the incentives, the industry is almost ready to take off. With FAME-2, the industry is expected to see a quantum leap in volume and technology. EVs sees a huge

opportunity in terms of lowering the carbon footprint, reducing reliance on crude oil imports, creating jobs, and establishing a new technology knowledge hub in India.

1.3 Objectives of the Study

The objective of my study is intended toward the following direction:

- Doing a literature review about the research and benchmarking methods in automobile industry
- To study and understand about the EV industry in India
- To study about the emerging markets players of EV in India
- Studying about the drivers, restrain, opportunity and challenges faced by the EV industry
- Studying about the government initiative penetrating EV industry
- Doing a survey analysis about EV

1.4 Scope of Study

In this project I have covered about the EV industry around the world and about the EV industry in India, emerging markets players, drivers, restrain, opportunity and challenges. I conducted an EV industry survey among people aged 20 to 49 years old using a questionnaire (attached as an annexure). All of the respondents were middle- or upper-middle-class working professionals.

Chapter 2

LITERATURE REVIEW

A benchmarking approach is a practical method for achieving continuous quality and performance improvements (Dattakumar & Jagadeesh, 2003). Benchmarking in car services allows the company to constantly monitor and assess its performance for operating techniques in comparison to other best-in-class industries. Because achieving customer satisfaction is the primary goal of service industries, the AHP should be derived from the customer's perspective, and thus the benchmarking process can be customer-oriented. However, for continuous improvement, top management should choose the improvement actions and relative weights because they are the decision makers. The process is critical for continuous improvement in an industry's service and expense levels, with some of the benefits of benchmarking for Car Service industries including:

- Improvement in the service provider's market position
- Improvement in the level of customer satisfaction
- Identify information that will improve throughput and lower expenses
- Improvement in information flow between all departments
- Improvement in customer service and quality control
- Reduced overall expenses
- Improvement in team spirit and morale

On the basis of the structural model for CSFs, a benchmarking model is developed, which is a useful tool for improving performance to a feasible level in a short period of time with minimal effort and resources. The proposed structural framework and benchmarking model for Indian automobile car Service Company "A" findings will serve as a guideline for successful market adoption. The proposed benchmarking model can be applied to various service or other environments, capturing their unique environment and reflecting their own precedence considerations. The proposed benchmarking model for an Indian car service company is depicted in the flow chart below.

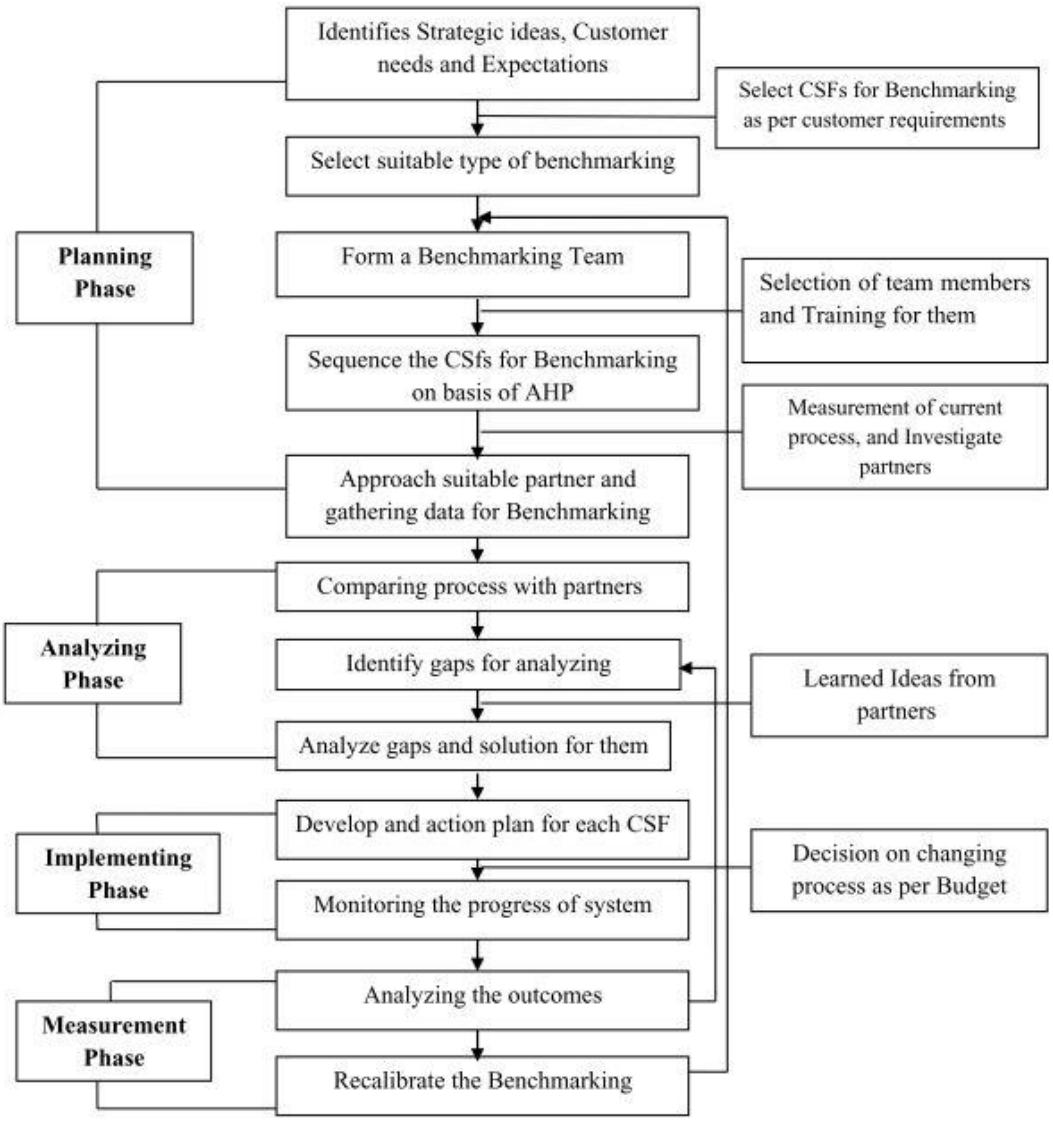

Fig 2.1 Benchmarking process

Understanding the factors that determine a firm's competitive advantage has helped to assess its competitiveness in the Indian automobile industry. Efforts have been made to create a competitiveness index for a sample of fourteen firms for the 2005-06 fiscal year, which represents approximately 85 percent of each industry segment, namely passenger vehicles, commercial vehicles, three-wheelers, and two-wheelers. Approximately half of the sample firms outperformed the industry average across all segments of the automobile industry. The marginal difference in competitiveness between different firms reveals the fierce competition among firms in India's automobile industry.

There are several interpretations of the concept of competitiveness, which necessitate some distinctions. The most basic distinction is between microeconomic and macroeconomic concepts. Competitiveness can be measured from a variety of angles, including products, firms, industries, and sectors of the economy or national economies. There are various measures or indicators of competitiveness at each level of aggregation. The second competitiveness issue is the distinction between one-dimensional and multi-dimensional concepts, which refers to the number of dimensions it integrates and measures. The number of dimensions included in its measurement can be interpreted as a measure of the concept's complexity (Siggel 2003). We are primarily concerned with the firm-level multidimensional concept of domestic market competitiveness.

Buckley et al. made an interesting attempt to capture more than one dimension of firm competitiveness (1988). According to him, "a firm is competitive if it can produce superior quality products and services at lower costs than its domestic and international competitors." Competitiveness is synonymous with a company's long-term profit performance, ability to compensate its employees, and ability to provide superior returns to its owners." The most well-known attempt to assess the multidimensionality of the concept of competitiveness was made by Porter (1990) in his "Diamond Framework." He identified four major determinants of enterprise competitiveness as strategy, structure, and rivalry, demand conditions, factor supply conditions, and conditions in related industries. Although there are numerous factors that influence firm competitiveness, Porter classified those only under the four facets mentioned above.

According to Gelei (2003), firm competitiveness is defined as "the basic capability of perceiving changes in both the external and internal environment and the capability of adapting to these changes in such a way that the profit flow generated guarantees the firm's long-term operation." According to him, firm competitiveness is primarily determined by two factors. For starters, it is determined by a company's ability to identify those value dimensions that are important to their customers. These are the main features of the complex product and service package that a customer expects from the firm. The second determinant of firm competitiveness is the sum of resources and capabilities that enable a firm to create and deliver the identified important value dimensions for the customer. These are referred to as core competencies by Prahalad and Hamel (1990).

The UK Government's White Paper on Competitiveness (Department of Trade and Industry 1994) offers a multi-notion definition at the company level, stating that "competitiveness is the ability to

produce the right goods and services of the right quality, at the right price, at the right time." It entails meeting customers' needs more efficiently and effectively than competitors.

ADB published yet another significant discussion on the concept of firm competitiveness (2003). It states that competitiveness can be defined as a firm's ability to survive in a competitive environment, and being competitive implies succeeding in an environment where firms try to stay ahead of each other by lowering prices, increasing the quality of their existing products and services, and developing new ones. The competitiveness of a firm can thus be examined as a function of factors such as (i) its own resources, (ii) its market power, (iii) its behavior toward rivals and other economic agents, (iv) its ability to adapt to changing circumstances, (v) its ability to create new markets, and (vi) the institutional environment, which is largely provided by the government, including physical infrastructure and the quality of government policies.

Because competitiveness is linked to a large number of variables, defining it is a research problem in and of itself. Measuring competitiveness is also difficult because it is a broad, relative concept with no direct relationship to economic performance indicators. Because of the multidimensionality of the definition of competitiveness, it is critical to develop a composite index that can measure it mathematically. Keeping this in mind, an effort has been made to develop a competitiveness composite index that can measure a firm's competitive position in the industry and its ability to maintain it in the medium to long run.

Chapter 3

RESEARCH METHODOLOGY

Descriptive research

The descriptive research method focuses on describing the nature of a demographic segment rather than on "why" a specific phenomenon occurs. In other words, it "describes" the research topic without explaining "why" it occurs. The term descriptive research then refers to the research questions, study design, and data analysis performed on that topic. We call it an observational research method because none of the variables in the research study are influenced in any way.

In this project, I conducted descriptive research on the research and benchmarking of the automobile industry, followed by research on the EV industry around the world and in India, the drivers of the industry, challenges, restraints, major market players, government initiatives, and the industry's future. None of the variables in this descriptive study were influenced in any way. Only observations from the research were made. As a result, the I have no control over the variables' nature or behavior. Following that, I conducted a survey on the EV industry using a questionnaire (attached as an annexure) among people aged 20 to 49 years old. All of the respondents were working professionals from the middle or upper middle class. And attempted to analyze the responses of the respondents regarding their perception of EVs and their willingness to purchase an EV in the future. Based on that, I have worked hard to identify the challenges that may arise in the growth of EV.

Chapter 4

4.1 Trends and developments in electric vehicle markets

Global

After a decade of rapid growth, the global electric car stock reached 10 million in 2020, a 43 percent increase over 2019 and a 1 percent stock share. In 2020, battery electric vehicles (BEVs) represented two-thirds of new electric car registrations and two-thirds of the stock. China has the largest fleet, with 4.5 million electric vehicles, but Europe had the largest annual increase, reaching 3.2 million in 2020.

The economic ramifications of the Covid-19 pandemic had a significant impact on the global market for all types of automobiles. New car registrations fell by about one-third in the first half of 2020 compared to the previous year. This was partially offset by higher activity in the second half, resulting in a 16 percent year-on-year drop overall. Notably, despite declining conventional and overall new car registrations, global electric car sales share increased by 70% to a record 4.6 percent in 2020.

In 2020, approximately 3 million new electric vehicles were registered. Europe led the way for the first time, with 1.4 million new registrations. China came in second with 1.2 million registrations, while the United States registered 295 000 new electric vehicles.

A variety of factors contributed to an increase in electric vehicle registrations in 2020. Notably, on a total cost of ownership basis, electric vehicles are gradually becoming more competitive in some countries. Several governments provided or extended fiscal incentives to protect electric vehicle purchases from the downturn in car markets.

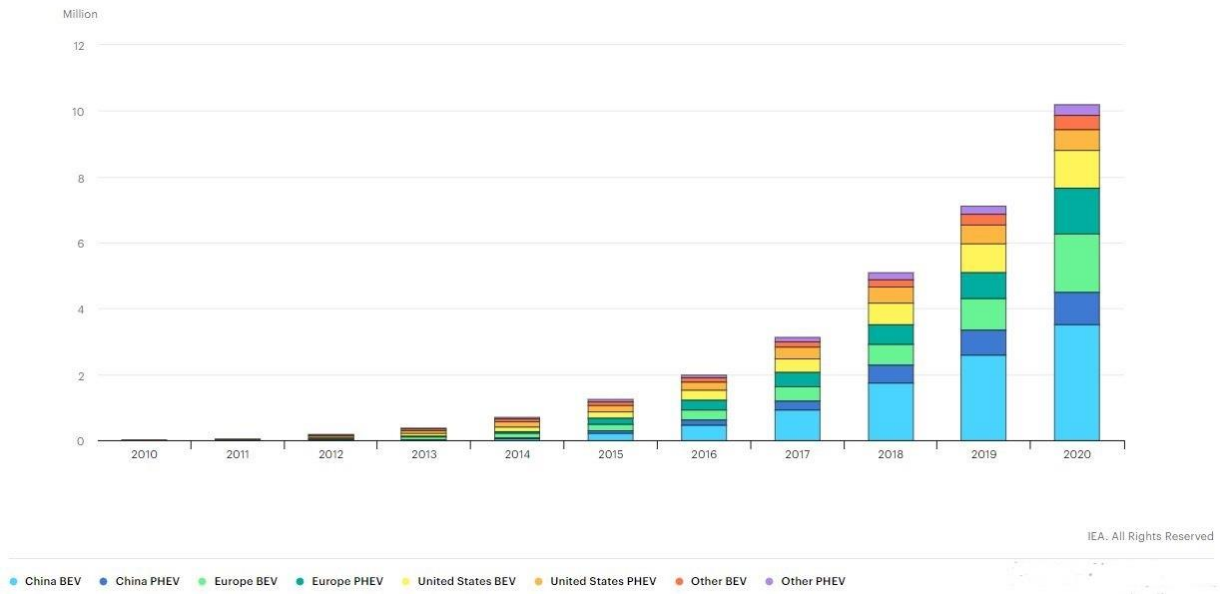

Fig 4.1 Global electric passenger car stock, 2010-2020

Europe

In 2020, the European car market will have shrunk by 22%. Nonetheless, new electric car registrations more than doubled to 1.4 million, representing a 10% sales share. Germany registered 395 000 new electric cars in the large markets, while France registered 185 000. Registrations in the United Kingdom more than doubled to 176 000. In Norway, electric cars reached a record high sales share of 75%, up roughly one-third from 2019. Electric car sales exceeded 50 percent in Iceland, 30 percent in Sweden, and 25 percent in the Netherlands.

Despite the economic downturn, the increase in electric car registrations in Europe reflects two policy measures. First, the year 2020 was set as the target year for the European Union's CO2 emissions standards, which limit the average carbon dioxide (CO2) emissions per kilometre driven for new cars. Second, as part of stimulus packages to combat the effects of the pandemic, many European governments increased EV subsidy schemes.

In Europe, BEV registrations accounted for 54% of all electric car registrations in 2020, continuing to outnumber plug-in hybrid electric vehicle registrations (PHEVs). However, the number of BEV registrations more than doubled from the previous year, while the number of PHEV registrations tripled. BEVs were especially popular in the Netherlands (82 percent of all electric car registrations), Norway (73 percent), the United Kingdom (62 percent), and France (60 percent).

China

The pandemic had a smaller impact on China's overall car market than in other regions. Total new car registrations fell by about 9%.

In the first half of 2020, new electric car registrations were lower than the overall car market. This trend shifted in the second half as China reined in the pandemic. As a result, the company's sales share increased to 5.7 percent, up from 4.8 percent in 2019. BEVs accounted for roughly 80% of new electric vehicle registrations.

In China, key policy actions have dampened the incentives for the electric car market. Purchase subsidies were set to expire at the end of 2020, but following indications that they would be phased out more gradually prior to the pandemic, by April 2020, and in the midst of the pandemic, they had been cut by 10% and extended through 2022. In response to the pandemic's economic concerns, several cities relaxed car license policies, allowing more internal combustion engine vehicles to be registered in order to support local car industries.

United States

In 2020, the US car market fell by 23%, though electric car registrations fell less than the overall market. In 2020, 295 000 new electric vehicles were registered, with approximately 78 percent of them being BEVs, down from 327 000 in 2019. Their sales share increased to 2%. Federal incentives decreased in 2020 due to the expiration of federal tax credits for Tesla and General Motors, which account for the majority of electric vehicle registrations.

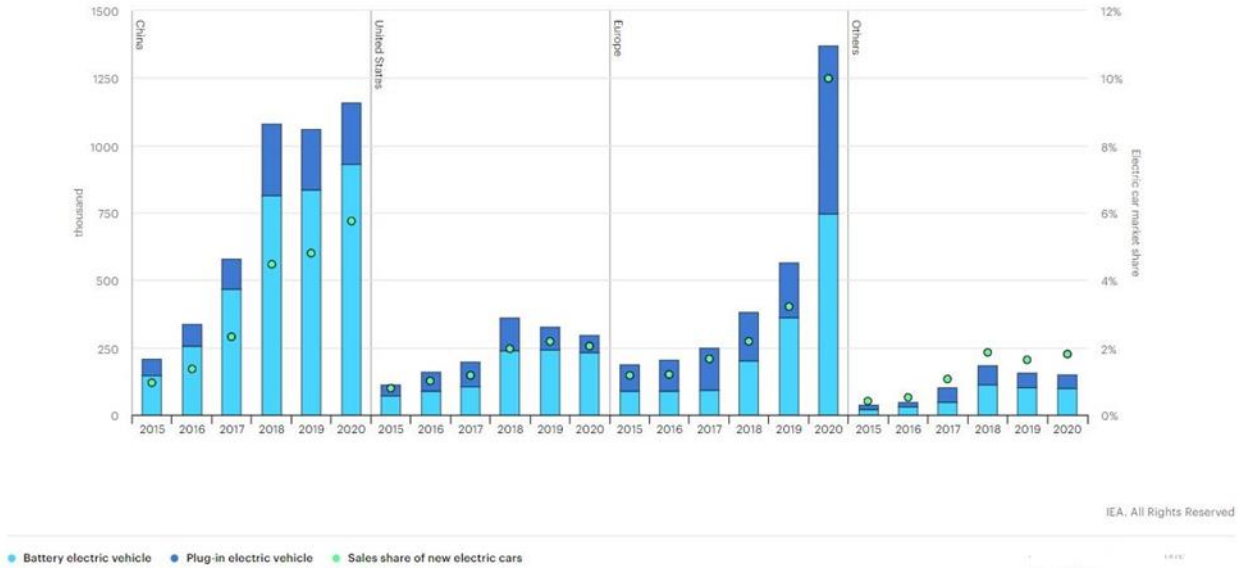

Fig 4.2 Global Electric car registrations and market share, 2015-2020

India

The Indian automotive industry is the fifth largest in the world, with a goal of becoming the third largest by 2030. Relying on traditional modes of fuel-intensive mobility to serve a large domestic market will not be sustainable. To address this, federal policymakers are developing a mobility option that is "Shared, Connected, and Electric," with the goal of reaching 100 percent electrification by 2030.

India stands to benefit on multiple fronts by shifting to electric vehicles (EVs): it has a relative abundance of renewable energy resources as well as skilled labor in the technology and manufacturing sectors.

According to an independent study conducted by the CEEW Centre for Energy Finance (CEEW-CEF), the EV market in India will be worth US$206 billion by 2030 if India maintains steady progress toward its ambitious 2030 target. This would necessitate a total investment of more than US$180 billion in vehicle manufacturing and charging infrastructure. According to another report from the India Energy Storage Alliance (IESA), the Indian EV market will grow at a CAGR of 36% until 2026. During the same time period, the EV battery market is expected to grow at a CAGR of 30%.

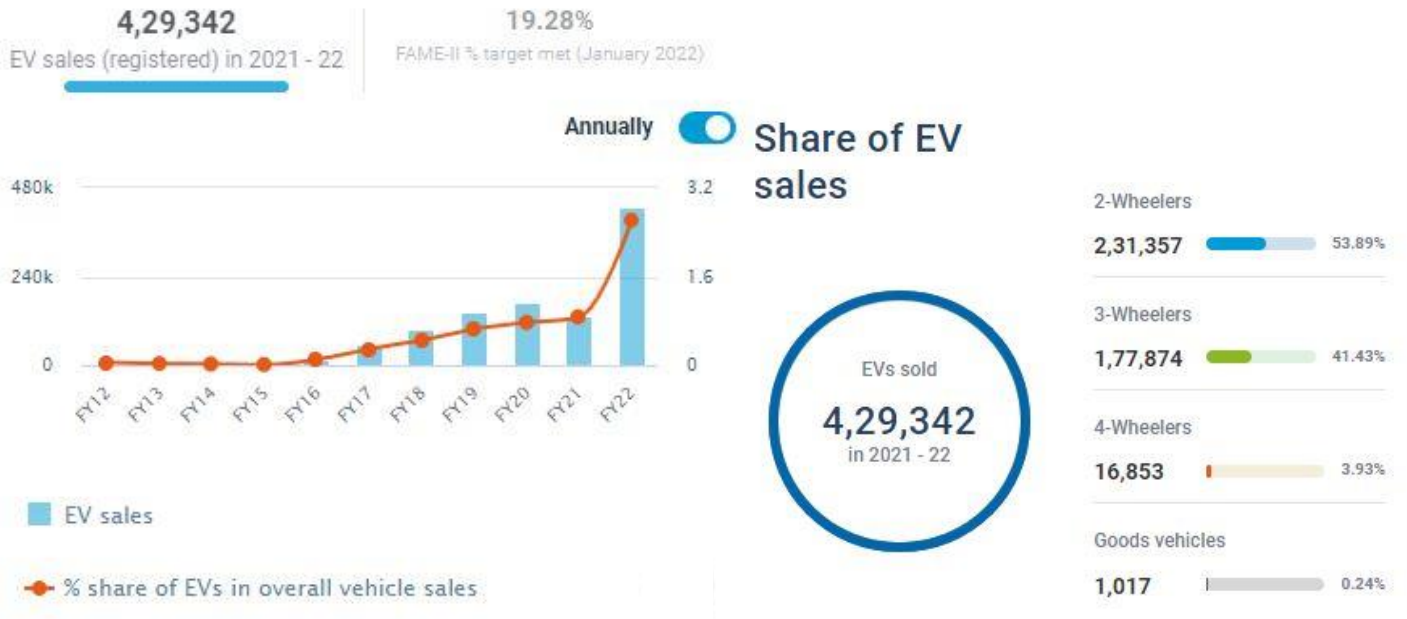

Fig 4.3 EV sales in India

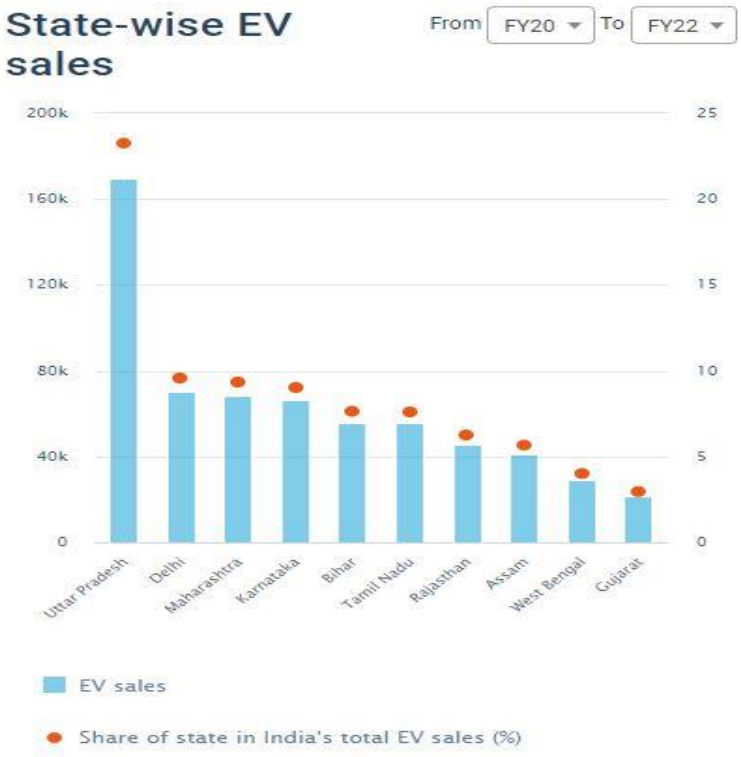

Fig 4.4 EV sales state-wise

Emerging market players in India

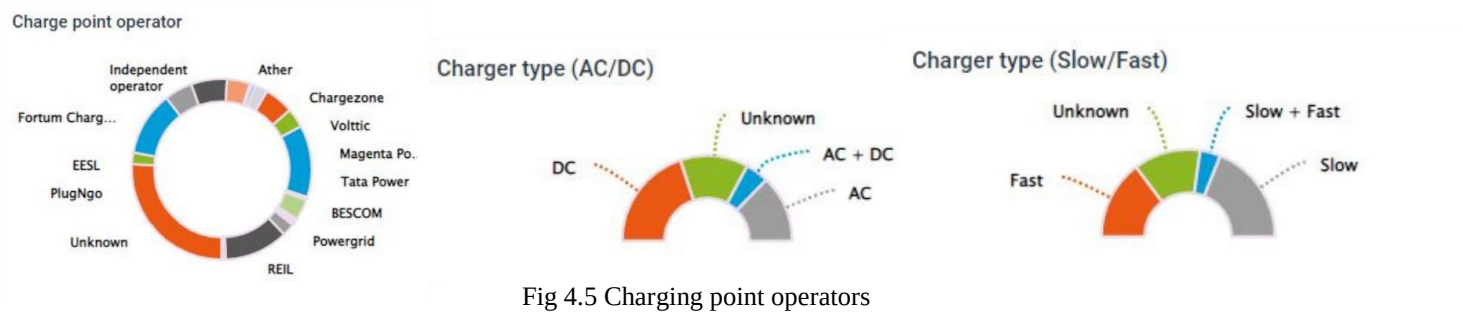

Fig 4.5 Charging point operators

Many leading battery manufacturers, including Amara Raja Batteries, have taken these incentives as a cue to direct new investments into green technologies, including lithium-ion batteries.

In April 2022, Eren Groupe, a European renewable energy company, acquired one of the world's most energy dense batteries, Pravaig, developed by a Bengaluru-based battery startup, for its storage applications. With a high density, the battery provides more power per atom, proving to be more cost-effective than alternatives such as sodium-ion or aluminum air. The battery's developers also stated that it takes only 30 minutes to fully charge a battery.

This new acquisition by a European company will not only boost domestic manufacturing, but will also pave the way for making EVs more affordable, given that batteries typically account for 35-40% of the total cost.

Many leading industry players, such as OLA Electric Mobility Pvt, Ather Energy, and Mahindra Electrics, are rapidly expanding their market presence in response to the opportunity that India's EV industry presents. Furthermore, certain states, such as Karnataka and Tamil Nadu, are enacting innovative and timely investor-friendly policies, in addition to constructing necessary infrastructure.

Tesla Inc., an American electric vehicle and clean energy company, recently established its subsidiary, Tesla India Motors and Energy Pvt Ltd, in Bengaluru.

Ather Energy, India's first intelligence EV manufacturer, relocated its $86.5 million factory from Bengaluru (Karnataka) to Hosur in February 2021. (Tamil Nadu). The factory of Ather Energy is said to have an annual production capacity of 0.11 million two-wheelers.

Ola Electric, the subsidiary of the unicorn Indian ride-hailing start-up, also announced in March 2021 that it would be establishing the world's largest electric scooter plant in Hosur (a two and a half-hour drive from Bengaluru) over the next 12 weeks, at a cost of US$330 million and with the goal of producing 2 million units per year. By 2022, Ola Electric hopes to ramp up production to 10 million vehicles per year, accounting for 15% of the world's e-scooters.

Meanwhile, Ola Electric reportedly clocked INR 11 billion (US$149.26 million) in sales over a two-day purchase window, indicating market interest in electric two-wheelers in India. Scooters can be reserved on Ola Electric's website, and the next sales window opens on November 1. The electric scooters are made at the Ola Future factory in Tamil Nadu, near Krishnagiri.

Greaves Cotton announced its entry into the multi-brand electric vehicle retail segment on September 9, 2021, under the brand name AutoEVMart. According to reports, this platform will provide consumers with a diverse range of electric vehicles to choose from, including Ampere Electric and other EV brands. Thus, AutoEVMart will serve as an electric vehicle marketplace in India, offering e-two-wheelers and e-three-wheelers, among other things, as well as EV accessories. Greaves Cotton envisions Bengaluru's first-of-its-kind multi-brand retail stores for clean tech or electric mobility.

Sterling and Wilson Pvt Ltd (SWPL), India's leading engineering, procurement, and construction company, recently announced its entry into the Indian electric mobility segment. It has formed a 50-50 joint venture with Enel X to launch and build innovative charging infrastructure in India on April 1, 2021.

Positive developments have also occurred in the expansion of charging infrastructure across the country, with states such as Andhra Pradesh, Uttar Pradesh, Bihar, and Telangana setting ambitious targets for the deployment of public charging infrastructure in order to increase the uptake of electric vehicles in the country.

Local fiscal sops, better logistics, an investor-friendly government policy, business facilitation through easier access to authorities, supply chain connectivity, and the availability of suitable land are the primary reasons why these states outperform others.

Karnataka was the first state to implement a comprehensive EV policy and has emerged as a hotspot for EV businesses in India, particularly in EV and EV ancillary manufacturing, as well as

R&D. Tamil Nadu is also progressing at a commendable rate, thanks to its supply ecosystem, larger land parcels, proximity to ports, and proactive investor support via administrative portals such as Guidance Tamil Nadu.

Nevertheless, while growth in the EV industry is on an upward tick, it has much ground to cover to be able to realize the government's ambitious 2030 target. The COVID-19 pandemic not only slowed the industry's progress, but also dampened overall market demand.

Still, market sentiment has retained positivity in some segments. In FY 2020, EV sales for two-wheelers in India increased by 21 percent. For EV buses, the sales for the same period increased by 50 percent. In contrast, the market for electric cars remained grim, registering a five percent decline. As for total EV sales, after suffering an initial setback in 2020, sales appear to be slowly picking up. In January 2021, 15,910 units of EVs were sold in India, and out of these, the maximum units were sold in Uttar Pradesh, followed by Bihar and Delhi.

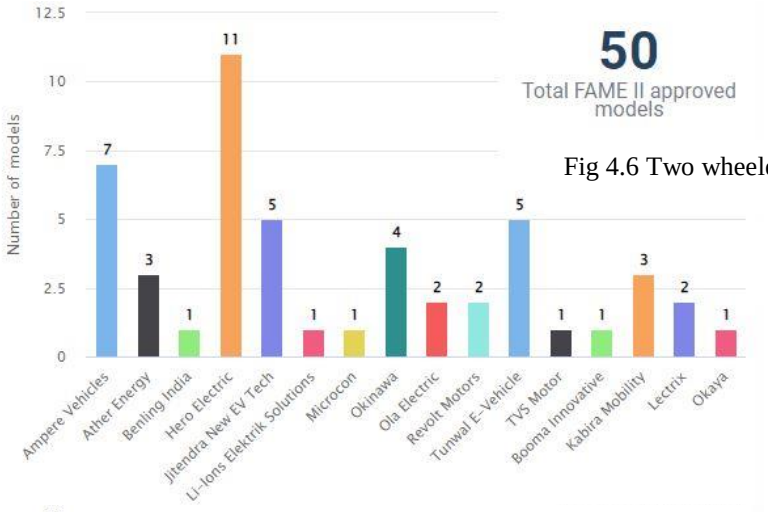

Fig 4.6 Two wheelers

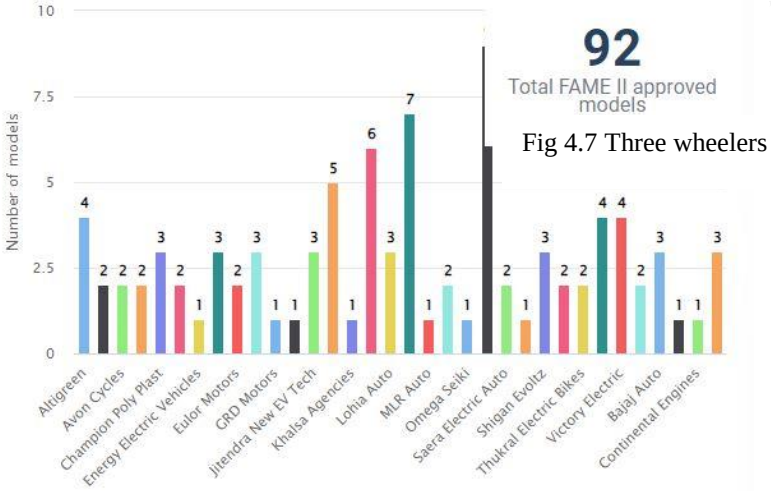

Fig 4.7 Three wheelers

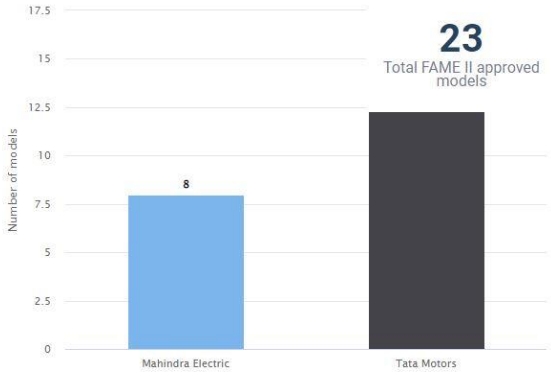

Fig 4.8 Four wheelers

Projections

Niti Aayog, the federal think tank, published a report titled "India's Electric Mobility Transformation" in April 2019, estimating EV sales penetration in India at 70% for commercial vehicles, 30% for private vehicles, 40% for buses, and 80% for two- and three-wheelers by 2030. These targets, if met, could result in a net reduction of 14 exajoules of energy and 846 million tons of CO2 emissions over the lifetime of the deployed vehicles. Electric vehicles sold until 2030 have the potential to save 474 million tons of oil equivalent, or US$207.33 billion, over their lifetime.

The global Electric Vehicle Market is expected to grow at a 21.7 percent CAGR from 8,151 thousand units in 2022 to 39,208 thousand units by 2030. Factors such as rising demand for low-emission commuting and government subsidies and tax breaks for long-range, zero-emission vehicles have compelled manufacturers to provide electric vehicles globally. As a result, there is a growing market demand for electric vehicles. Countries all over the world have set emission reduction targets based on their own capacity.

Increased investments by governments around the world in the development of EV charging stations and Hydrogen fueling stations, as well as buyer incentives, will create opportunities for OEMs to expand their revenue stream and geographical presence. The Asia Pacific market is expected to grow steadily due to the high demand for low-cost, low-emission vehicles, whereas the North American and European markets are rapidly expanding due to government initiatives and the growing high-performance Passenger vehicle segment. However, the relatively low number of EV charging stations and hydrogen fuel stations, higher initial investment costs, and performance constraints may stymie the global electric vehicle market's growth.

COVID-19 Impact on the Electric Vehicle Market:

The pandemic in early 2020 had a moderate impact on the EV charging business due to lockdowns. The demand for EV charging stations increased in 2021 as a result of the growing demand for EVs and related markets during the pandemic as a result of government incentives around the world. However, the COVID-19 pandemic had a negative impact on the extraction of materials such as steel, copper, and aluminum. Raw material prices, such as copper, have continued to rise, with the copper price reaching USD 10,000 per ton for the first time in ten years in May 2021.

Top EV manufacturers, on the other hand, have rapidly increased their EV sales over the last two years. Due to declining sales, Tesla, for example, laid off employees in October 2020. However, as a result of its earlier expansion into China, its overall revenue increased. In 2021, the company performed well and had little impact as a result of COVID-19. Due to Chinese lockdowns, its sales fell again in early 2022. This market was less affected by the pandemic due to the strong push from governments around the world to phase out ICE vehicles.

Driver: Lower cost of EV batteries to support the demand for low-cost EVs.

The cost of EV batteries has decreased over the last decade as a result of technological advancements and the mass production of EV batteries in large quantities. As EV batteries are one of the most expensive components of the vehicle, this has resulted in a decrease in the cost of electric vehicles. In 2010, the cost of an EV battery was around USD 1,100 per kWh. However, by 2020, the price had dropped to around USD 137 per kWh, and it was as low as USD 120 per kWh in 2021. In China, the price of these batteries can be as low as USD 100 per kWh. This is due to lower manufacturing costs for these batteries, lower cathode material prices, increased production, and so on. The prices of EV batteries are expected to fall to around USD 60 per kWh by 2030, significantly lowering the prices of EVs and making them cheaper than conventional ICE vehicles.

Restraint: Insufficient EV charging infrastructure

The number of EV charging stations in various countries around the world is limited. As a result, the availability of public EV charging for electric vehicles decreases, lowering adoption. Despite the fact that various countries are in the process of installing EV charging infrastructure, most countries, with the exception of a few states, have not been able to install the required number of EV charging stations. With a well-developed EV charging network around the world, demand for EVs is expected to rise. The majority of countries have yet to develop such charging networks. The Netherlands has the highest density of EV chargers per 100 km. The Netherlands has the highest density of charging stations per 100 km, with approximately 19-20 charging stations per 100 km. China is the next best, with approximately 3-4 charging stations per 100 kilometers. The UK has approximately 3 charging points per 100 kilometers, but the country is rapidly expanding

its charging stations as part of its 2030 plans to phase out ICE vehicle sales. Germany, the United Arab Emirates, Japan, Singapore, South Korea, Sweden, France, the United States, and Russia have also accelerated the transition to EVs by installing a large number of charging stations.

Opportunity: Government initiatives pertaining EVs

Countries all over the world have set targets for reducing vehicle emissions between 2030 and 2050. They have begun to promote the development and sale of EVs as well as related charging infrastructure.

1. NEMMP (National Electric Mobility Mission Plan 2020): The Department of Heavy Industry (DHI) launched it in 2013 as a roadmap for the faster manufacture and adoption of EVs in India.
2. The Ministry of Power has clarified that charging electric vehicles is considered a service, which means that operating EV charging stations will not necessitate a license. It has also issued a policy on charging infrastructure in order to accelerate the adoption of EVs. On January 14, 2022, the revised consolidated Guidelines & Standards for Charging Infrastructure for Electric Vehicles were promulgated. These guidelines, which are exhaustive in scope, include provisions for a) individual EV owners and b) public charging station (PCS) infrastructure. It addresses issues such as land use and access, power tariffs, state and federal government roles, and timelines for providing connectivity for PCS installation, among others.
3. The Ministry of Road Transport and Highways has announced that green license plates will be issued to both commercial and private battery-powered vehicles. It has also announced that all battery-powered, ethanol-powered, and methanol-powered transportation vehicles will be exempt from the commercial permit requirement.
4. The Department of Science and Technology has launched a large-scale competition to develop Indian Standards for Electric Vehicle Charging Infrastructure.
5. Niti Aayog: The cabinet has approved the National Mission on Transformative Mobility and Battery Storage, and the Mission's inter-ministerial steering committee will be chaired by the CEO of Niti Aayog. The Mission intends to establish a five-year Phased Manufacturing Program (PMP) to support the establishment of large-scale, export-competitive integrated battery and cell-manufacturing giga plants in India, as well as the

localization of production across the entire electric vehicle value chain. The think tank released a draught battery swapping policy on April 20, 2022, and invited comments from relevant stakeholders by June 5, 2022.

Challenge: Insufficient standardization of EV charging infrastructure

Variation in charging loads, for example, has emphasised the need to standardize electric vehicle charging stations. Certain voltages may be incompatible with EV charging stations. AC charging stations, for example, provide a voltage of 120V AC via level 1 charging stations and 208/240V AC via level 2 charging stations, whereas DC charging stations provide fast charging via 480V AC. Governments must standardise charging infrastructure in order to create a favourable ecosystem and increase EV sales. Different countries have different fast charging standards. Japan employs CHAdeMO; Europe, the United States, and Korea employ CCS; and China employs GB/T. Since the country has not reached standardization in fast charging methods, the Indian government has mandated the installation of CHAdeMO and CCS methods. This mandate, however, increased the cost of installing charging stations. As a result, the government changed the guidelines in July 2019 and allowed charging station developers to use their preferred method. Tesla, based in the United States, employs high-performance superchargers that are exclusive to Tesla and cannot be used by other EVs. The lack of standardization across countries may have an impact on charging station installation and stifle the growth of the electric vehicle charging station market. The use of these disparate charging standards around the world is a barrier to EV charging station standardization. While businesses are moving toward using a common socket or multiple types of sockets in charging stations, there is still a long way to go in standardizing all charging points. Standardization of charging points would make charging EVs in public easier and result in faster growth of EV demand globally.

4.2 Survey Analytics

Objective - A Survey was done among a set of population in order to understand from the consumer's perspective; the growth and potential market of the Electric Vehicle Industry. Survey Analytics is used through **Google Forms** (included in Annexure1) by collecting individual responses where a common set of questionnaires was provided to each participant and the summary of the responses was generated and visualized to see the broader perspective of the EV Industry in Indian Markets.

The future of mobility is approaching a tipping point. Electric Vehicles (EVs) are invariably mentioned as a part of the solution whenever oil prices rise or climate change is debated and discussed. EVs are not yet mainstream, despite several new Indian companies entering various parts of the EV value chain, significant capital invested in the space, and large-scale execution efforts. It is 2021, and it appears that we have finally reached the tipping point for EVs to take off. But what does the working class feel about the same? Are the Projections really a match with what the perception of the Indian customers is? To cover these aspects of this research, A Survey was conducted among **231 respondents** who are potentially/currently working class and might have their inputs on EV becoming Mainstream in the Indian Markets.

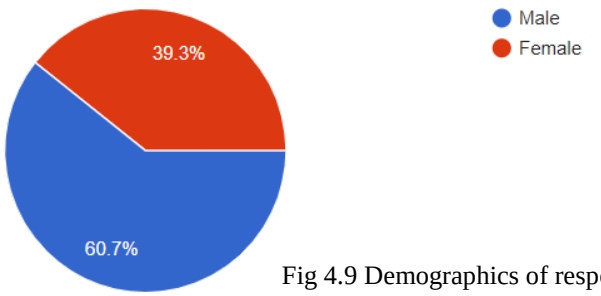

Fig 4.9 Demographics of respondents

Demographics: Among these 231 respondents, 39.3% were females whereas 60.7% were males. The survey conducted was among the adult population varying from 20 to 50 years of age, which clearly depicts the fact that majority of these respondents might be working class or have a potential working future which makes them a suitable target audience for this particular survey.

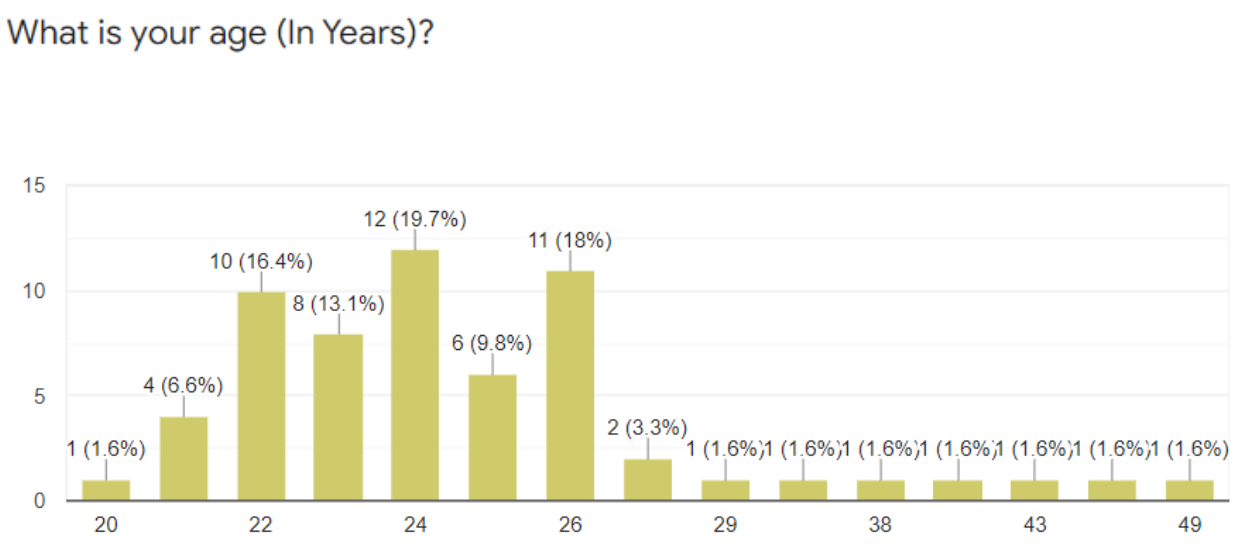

Fig 4.10 Age group of respondents

When the respondents were asked about their potential amount that they would like to invest on an EV, 36.1% people said that 8 - 12 Lakh of amount is desirable to get an EV for their personal commute, whereas 26.2% said that 4 - 8 Lakh shall be a good investment amount on Electric Vehicle. It is clear from the above responses that the majority of the potential customers expect the vehicles to be somewhere between 2 - 3 Lakh to a maximum of 8 Lakh (26.2% + 18%), on pushing their limits, people might go beyond 12 Lakh which comes in the minority here in these responses, Very few might cross the 20 Lakh margin (3.4%) which is the price point at which companies like Hyundai and BMW are planning to come with their top models. Majority of the respondents do not own an electric vehicle as clearly seen in the below figure - when asked about their ownership of any personal or family vehicle in EV.

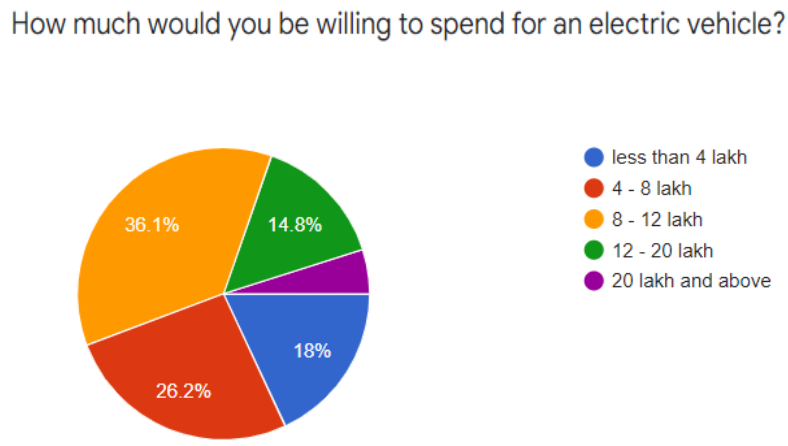

Fig 4.11 Spending analysis of respondents

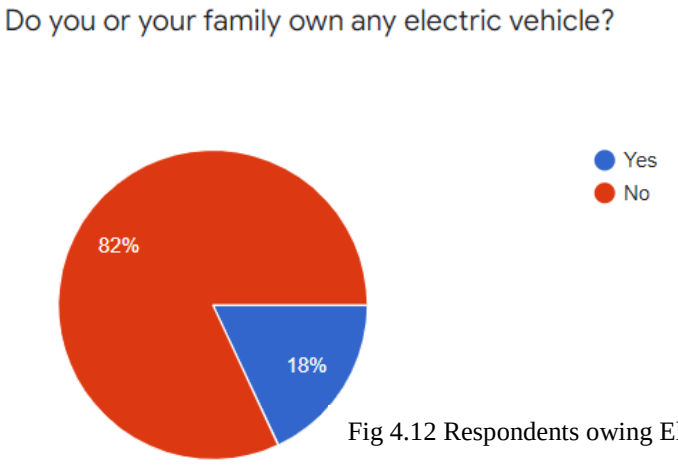

Fig 4.12 Respondents owing Electric vehicle

Brand visibility is also an important aspect when it comes to sales prediction for the future of EV Industry by companies, because for new entrants, the task will be twice as hard, since they not only have to penetrate the market but also make an impact of a low demand product. This can be taken as both an opportunity and threat. Our respondents were asked about a few of the popular brands in the EV market to test out their visibility in the audience. The companies in this test include - Tata, MG, Mahindra, Hero MotoCorp, Hyundai, Ashok Leyland, Maruti Suzuki, Exide Industries, Tesla, Mercedes etc.

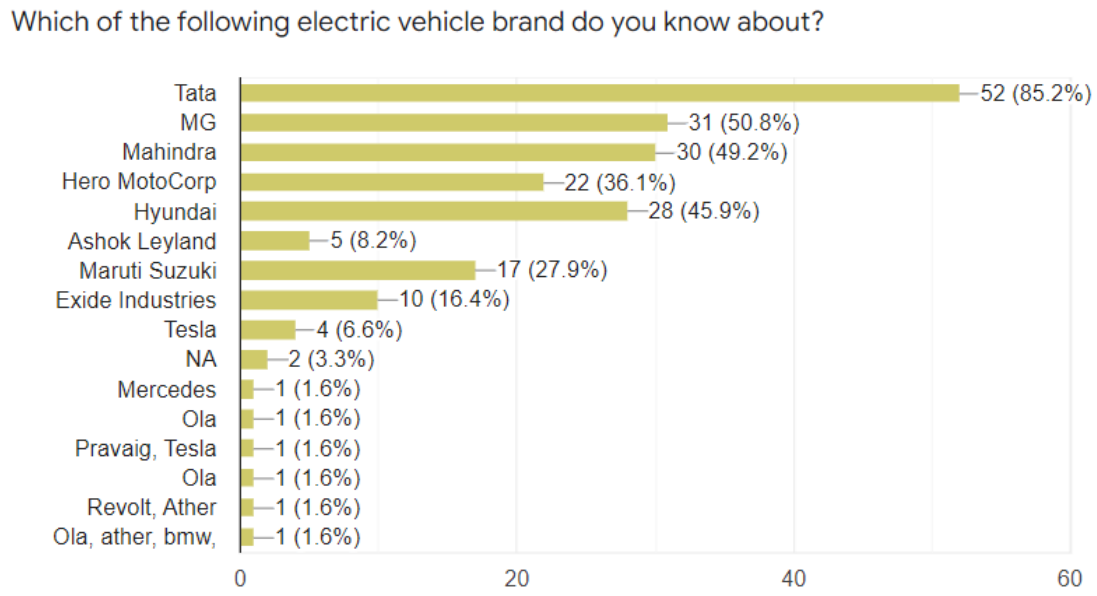

Fig 4.13 Brand visibility

It is clear that many of the dominant players in the industry are already making an impact like TATA who have already raised the heights by bringing their Nexon to the market and clearly the respondents also have seen the results by the brand. MG, Hero, Mahindra, Hyundai and Suzuki are also making a great effort for the same, the results clearly depict it.

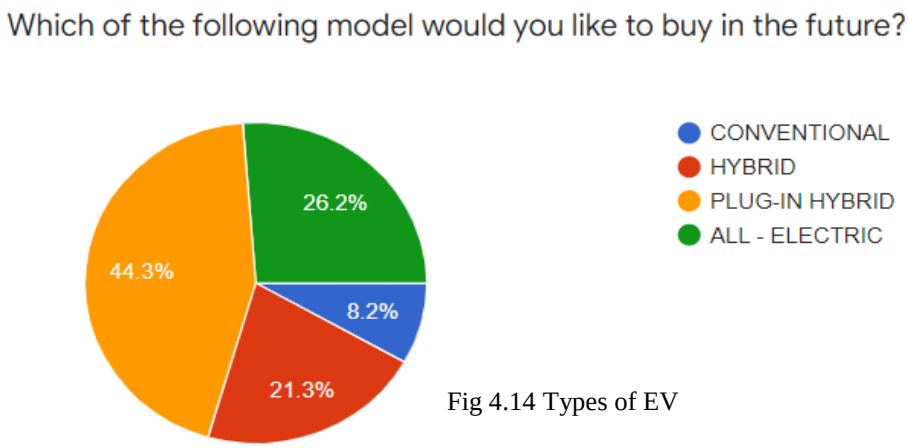

Fig 4.14 Types of EV

People are keen on choosing EV as their one true vehicle but they are reluctant to go all EV because of some factors in their minds, it could be due to lack of infrastructure in the country, it could be due to unknown potential of the performance of the vehicle and the reliance on the mileage for daily commute, there are other alternatives like CNG vehicles too, which are also in the fuel efficient and affordability domain, EV has to become a trend in order for the opinions of the potential buyers to change.

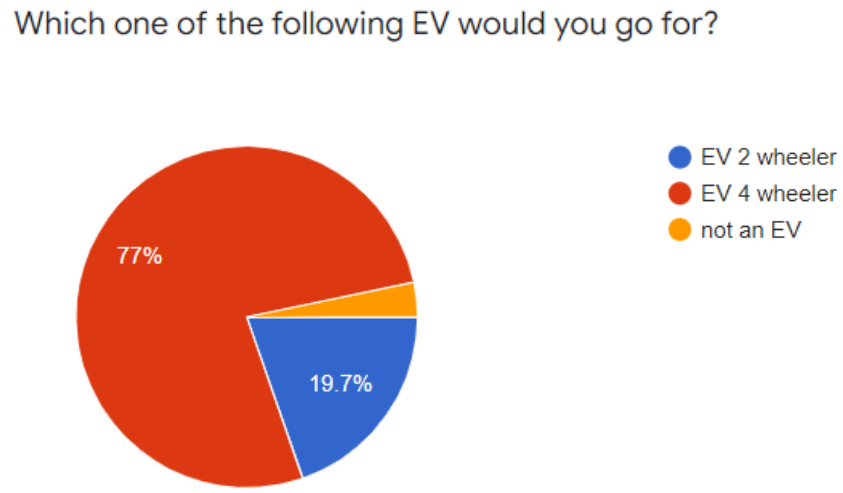

Fig 4.15 Types of vehicle

Chapter 5

CONCLUSION

India has recorded 295 million motor vehicles on roads that are registered and working in the Fiscal Year 2020 in a report by Statista. Where the Center of Energy Finance has predicted a 48 Million figure of registered EVs by 2030, the number currently stands around 966 thousand and this is due to working metro cities like Delhi, Bangalore and Mumbai are having most of the figure. So, the predictions seem inaccurate and have many variables to it which the research paper has focused upon, we may conclude the affecting variables through this concluding statement of this research.

Lack of Charging Infrastructure: According to a MarketWatch report, India will require approximately 4 lakh charging stations to meet the demand for 20 lakh EVs on the road by 2026. As of March 2021, the country had 1,800 charging stations. According to an independent study conducted by CEEW Centre for Energy Finance, it would take approximately 29 lakh public charging stations by 2030 to support EV adoption under the NITI Aayog's base case target. Around 21 lakhs (71 percent) of these chargers would be low capacity chargers used to support two- and three-wheelers. Aside from installing more charging stations, a lack of space is a barrier because people need a place to charge their EVs.

When it comes to development, the electric charging infrastructure faces several gaps and challenges. In India, AC001 and DC001 chargers are the most common choices for public charging stations, while most 2W, 3W, and 4W models do not.

Another major issue is a lack of support for grid development to accommodate the increased load. According to industry estimates, increased use of EVs by 2030 will increase electricity demand by 100 TWh. There are also other challenges, such as a lack of land, a lack of instruments to lease government-owned and agency-owned land to set up public charging stations, and a lack of affordable renewable energy, which means charging EVs puts a strain on the already stressed coal-powered electricity grid.

However, according to a study conducted by the CEEW Centre for Energy Finance, the transition to the EV market presents a once-in-a-lifetime opportunity for multiple market stakeholders. This massive market opportunity has the potential to be a key driver of India's post-COVID economic recovery, creating jobs and economic value throughout the value chain, both in existing businesses and in new sectors.

To overcome the challenges of becoming a 100 percent electric vehicle nation by 2030, the Indian government is taking a number of steps. However, it remains to be seen whether these measures are sufficient to achieve the goal within the timeframe specified. To encourage early adopters to choose EVs and alleviate range anxiety, a balanced ratio of EVs on the road and charging stations is required.

EV Type: Another important factor to consider here is the type of EV that the market demands and consumers want. This is another major threat to the EV industry growth in this market, people have various expectations from the EVs, when people are preferring EV they either are looking to save their money on fuel or looking out for high technology luxury experience, But the Indian market has fixed a range of the vehicles they have launched that are too expensive for the population looking for a cheaper fuel saving experience and too less in features for the premium luxury class, so the variety of the right vehicles have not come up yet.

Operational Change in Daily lives: There are two methods by which an EV can be charged, the fast charging and the regular charging, till the infrastructure is becoming a mainstream concept, the fast charging facilities shall be available on limited stations. With a regular Indian power supply of 220V the vehicles have a charging time of 6 hours, in any outbreak or emergency situation, this will be a lot of time for any individual owner.

Not only the ownership, the manufacturing will also be affected due to the emergence of EV and if it becomes mainstream by 2040, the companies will have to put large setup costs to change their operations from producing motor vehicles to all electric vehicles. With that comes the cost of charging infrastructure as well, the cost of setting up an EV charging station in India ranges from Rs. 1 lakh to Rs. 40 lakhs, depending on the type of chargers used and the amount of money

involved. The estimate below is based on a more general scenario and a supply of 250KVA EV Stations.

Availability of Batteries is also a big question for the manufacturing industry. With the new government initiative, India is gradually but steadily beginning to manufacture EV parts in the country, with batteries being the first of the lot. Companies involved in this initiative include

- TATA Group
- Maruti Suzuki
- Hero MotoCorp
- EXIDE
- Amara Raja Batteries

But if the predictions are to be true, it might be possible that the market demand may not be fulfilled at the rate of growth and production of the vehicles.

Uncertain Policy Landscape: The EVs come loaded with features like self-driving, cruise control, reflector mirror functions and many more, the government will have to take necessary actions towards these particular features and the crimes that might come associated with it. There is currently no dedicated legislation in India to regulate self-driving cars. Even the 2019 amendment to the Motor Vehicle Act has had no discernible effect on self-driving or autonomous vehicles. The question of personhood and agency is a recurring one in the context of AI. There has been very little debate in India about the accountability of AI. Notably, in 2018, NITI Aayog released a policy paper titled National Strategy for Artificial Intelligence, which discusses how AI can be implemented in sectors such as healthcare, agriculture, and automobiles, but this paper also fails to address the issue of AI liability. The main question now is whether India should follow the British model, in which the owner is liable even if the mistake is committed by the AI, or whether India should follow the German model, in which the manufacturer of the car is liable when the AI makes a mistake.

Projections vs. Market Demand: We saw in the survey and in the analysis that the projections for the Cars in the Electric Vehicle industry are a slight mismatch if we get into details. The concept of EV was brought up to change the fuel consumption aspect of the owners but the affordability,

willingness of the potential customers and demand seems to say that what companies are planning and what the market needs are two different things.

The Indian automobile market is well-known for its low-cost vehicles. You can find affordable options in all segments, including hatchbacks, sedans, SUVs (Sport Utility Vehicles), and MPVs (Multi-Purpose Vehicles). The same is true for the rapidly evolving electric vehicle market.

Consumers in India have been resistant to EVs due to high costs—a petrol model from Maruti, the country's largest car manufacturer, costs Rs3.15 lakh, while the most affordable EV costs around Rs10 lakh.

More Indians prefer petrol, diesel, or gas-powered vehicles. They do not appear to be ready to buy and use electric cars due to their slow pick-up, slow speed, and the lack of electric charging stations in their area. Ola's ambitious Electric Vehicle project in Nagpur hit a major snag just nine months after its launch, with Ola drivers wanting to return their electric cars and switch back to petrol or diesel variants. The reasons for this are high operating costs and long wait times at charging stations. So we can still say that it will take a lot of effort to get India ready for the EV industry, and the companies' projections appear to be a difficult target for the time being.

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4. questionpro.com

Annexure

Electric Vehicles in India

Dear Respondent,

My name is SMRITI PANDEY, currently pursuing MBA from Delhi School of Management, Delhi Technological University. This questionnaire is a part of my research project titled "Research and Benchmarking of EV industry in India "

I assure you that information collected from your end will be used only for research and academic purposes and your personal information will not be shared otherwise with anyone under any circumstances.

In case of any doubts, kindly contact at:
smritipandey_2k20dmba128@dtu.ac.in

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*Required

Kindly specify your gender. *

- ○ Male
- ○ Female
- ○ Other:

What is your age (In Years)?*

Your answer

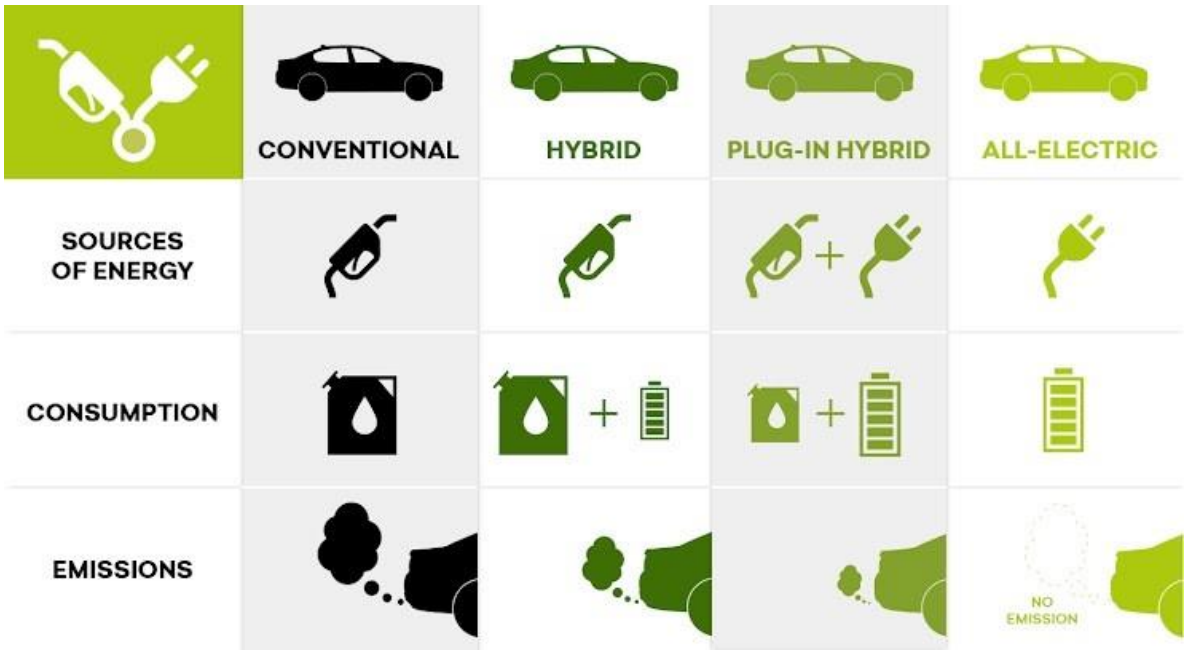
Do you or your family own any electric vehicle?*

- ○ Yes
- ○ No

Which of the following electric vehicle brand do you know about?*

- ☐ Tata
- ☐ MG
- ☐ Mahindra
- ☐ Hero MotoCorp
- ☐ Hyundai
- ☐ Ashok Leyland
- ☐ Maruti Suzuki
- ☐ Exide Industries
- ☐ Other:

Which of the following model would you like to buy in the future?*



- ○ CONVENTIONAL
- ○ HYBRID
- ○ PLUG-IN HYBRID
- ○ ALL - ELECTRIC

Which one of the following EV would you go for?*

- ○ EV 2 wheeler
- ○ EV 4 wheeler
- ○ not an EV

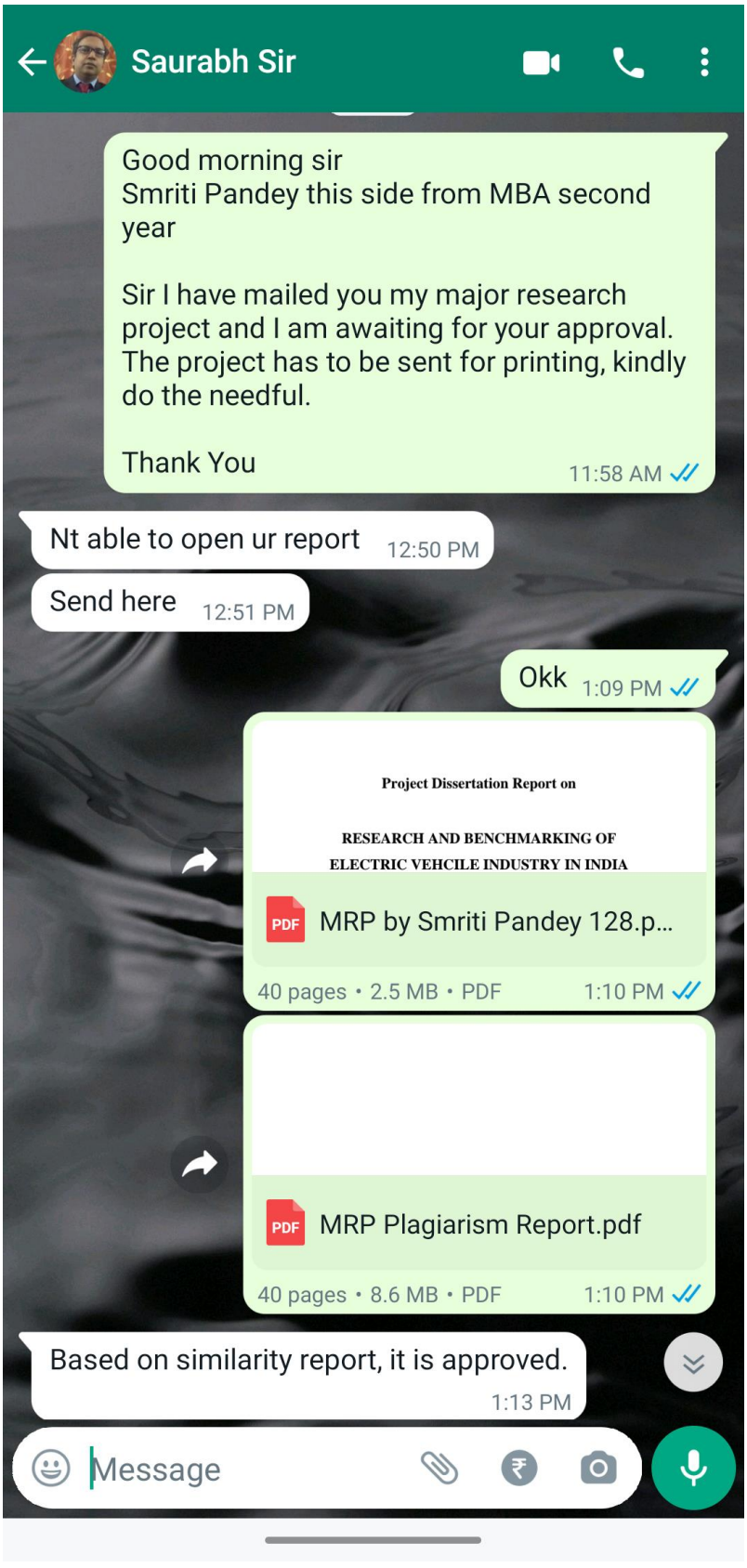
How much would you be willing to spend for an electric vehicle?*

- ○ less than 4 lakh
- ○ 4 - 8 lakh
- ○ 8 - 12 lakh
- ○ 12 - 20 lakh
- ○ 20 lakh and above

What all factors are important to you when purchasing an electric vehicle?*

- ☐ Appearance
- ☐ Comfort
- ☐ Fuel efficiency
- ☐ Charging time
- ☐ Brand
- ☐ Speed
- ☐ Affordability
- ☐ Ecofriendly
- ☐ Cost less than fuel

Submit Clear form


Saurabh Sir
Good morning sir
Smriti Pandey this side from MBA second year
Sir I have mailed you my major research project and I am awaiting for your approval. The project has to be sent for printing, kindly do the needful.
Thank You
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Nt able to open ur report 12:50 PM
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