A Project Report On

ADOPTION OF EV: LANDSCAPE AND OPPORTUNITIES OF INDIAN AUTOMOBILE INDUSTRY

Submitted for the partial fulfilment of the requirement for the degree of

MASTER OF BUSINESS ADMINISTRATION
(INTERNATIONAL TRANSPORTATION & LOGISTICS MANAGEMENT)

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Date: 10 /04/2023

CERTIFICATE

This is to certify that the Project titled "ADOPTION OF EV: LANDSCAPE AND OPPORTUNITIES OF INDIAN AUTOMOBILE INDUSTRY" submitted by AMAL K S register number 2105305037 student of MBA (ITLM) / is a bonafide record of his Project report and submitted to the School of Maritime Management, Indian Maritime University, Kochi campus, under the supervision of Dr. Aravind. T.S, Faculty IMU, Kochi campus. It is also certifying that the above work has not previously formed or submitted for the award of any degree, diploma, associateship, fellowship or other similar titles, and it is an independent work done by the candidate.

Dr. Aravind. TS

(Project Guide)

SELF DECLARATION

I, **AMAL K S** (Registration No: 2105305037) student of School of Maritime Management, INDIAN MARITIME UNIVERSITY-COCHIN hereby declares that this project report titled **"ADOPTION OF EV: LANDSCAPE AND OPPORTUNITIES OF INDIAN AUTOMOBILE INDUSTRY"** submitted in partial fulfilment of the requirement for the degree of Master of Business Administration in International Transportation & Logistics Management is my original work carried under the guidance of Dr. Aravind TS.

I also confirm that the report is only prepared for my academic requirement, not for any other purpose. It might not be used with the interest of the opposite party of the corporation.

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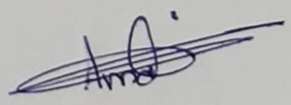
Date: 01-04-2023

Place: Kochi



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My thanks and appreciation to my Institution in developing the project and people who have willingly helped me out with their abilities.

I perceive as this opportunity as a big milestone in my career development. I will strive to use gained skills and knowledge in the best possible way, and I will continue to work on their improvement, in order to attain desired career objectives. Hope to continue cooperation with all of you in the future.

I also thank my family and friends for the continuous support in completing my project work.

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EXECUTIVE SUMMARY

The adoption of Electric Vehicles (EVs) is a significant trend in the Indian automobile industry. The Indian government has set ambitious targets for EV adoption to reduce carbon emissions and promote sustainable transportation. The EV market in India is currently in its nascent stage but has huge potential for growth. The Indian automobile industry faces several challenges, such as high upfront costs, limited charging infrastructure, and range anxiety among consumers. However, there are several opportunities for growth, such as government incentives and subsidies, partnerships with foreign companies, and increasing consumer awareness of EVs' benefits. The Indian automobile industry has taken steps to promote EV adoption, such as launching EV models, setting up charging infrastructure, and collaborating with technology companies: The government has also introduced various policies to incentivize EV adoption, such as tax exemptions, subsidies, and research and development grants.

The global issue of environmental pollution is causing concern, with toxic emissions from internal combustion engines being a major contributor. To reduce the impact of fossil fuel emissions, the use of electric vehicles (EVs) is being promoted worldwide through incentives from governments. Factors hindering consumer adoption of EVs include high cost, lack of charging infrastructure, and concerns over time and range. The Indian government aims to have only EVs on the road by 2030. This article examines the factors that influence consumer adoption of EVs in India, using survey data from existing car owners analysed through Structured Equation Modelling (SEM). The study found that attitude is a strong influence on EV adoption.

India is actively promoting the adoption of electric vehicles (EVs) as part of its efforts to reduce air pollution and oil imports. The government has introduced several measures to encourage EV adoption, such as subsidies, tax exemptions, and mandates for government purchases. Despite these efforts, EV adoption has been slow due to a lack of charging infrastructure, limited model options, and high upfront costs. However, the market is expected to grow in the coming years as more charging infrastructure is built, battery prices continue to decline, and automakers introduce new models. Overall, the Indian automobile industry has a significant opportunity to embrace the adoption of EVs and become a leader in sustainable transportation. While there are challenges to overcome, there are also numerous opportunities for growth and innovation.

OBJECTIVES OF THE STUDY

- To identify the current landscape of EV adoption in the Indian automobile industry, including market trends, consumer behavior, and government policies.

- To analyze the opportunities and challenges facing the Indian automobile industry in the adoption of EVs, including technological, economic, and environmental factors.

- To examine the strategies and initiatives taken by the Indian automobile industry to promote EV adoption, such as launching new EV models, building charging infrastructure, and collaborating with technology companies.

- To evaluate the impact of government policies and incentives on EV adoption in India, including tax exemptions, subsidies, and research and development grants.

- To provide recommendations and insights for the Indian automobile industry on how to overcome challenges and leverage opportunities for successful adoption of EVs, such as developing innovative business models, improving charging infrastructure, and promoting consumer awareness.

RESEARCH METHODOLOGY

The study will be undertaken by collecting secondary data. Secondary data refers to data that has already been collected and analysed by someone else for a different purpose. This type of data can come from a variety of sources, including government agencies, research institutions, and private organizations.

Examples of secondary data include:

- Published research studies or reports
- Census data and other public records
- Company financial reports
- Marketing research studies
- Social media analytics
- Existing datasets in various fields of study

Secondary data can be a valuable resource for researchers as it can provide access to data that may not be feasible or practical to collect on their own. Additionally, secondary data can allow for comparisons across different studies or datasets, which can enhance the validity of research findings. However, secondary data also has limitations. It may not precisely fit the research question or goals of the researcher, or the quality of the data may be questionable. Therefore, researchers need to critically evaluate the secondary data they use and ensure that it is appropriate and reliable for their research purposes.

Qualitative Analysis

Qualitative analysis is a research methodology used in social sciences, humanities, and other fields that involves the study of non-numerical data such as words, images, and observations. This type of analysis aims to understand the meaning and context of the data collected, and is typically used to explore complex phenomena that cannot be easily quantified. Qualitative analysis often involves collecting data through methods such as interviews, focus groups, observation, and document analysis. Researchers then analyse this data through techniques such as coding, categorizing, and interpreting themes and patterns. Qualitative analysis can provide rich and detailed insights into the experiences, perspectives, and behaviours of individuals and groups, and is often used to generate hypotheses and develop theories that can be further tested through quantitative research.

The study relies mostly on published secondary data.

CHAPTER: 1

INTRODUCTION

INTRODUCTION OF STUDY

Over the last decade, there has been a significant shift in global climate due to a sharp increase in greenhouse gas (GHG) emissions, particularly carbon dioxide (CO2), which accounts for 65% of GHG emissions. CO2 emissions come primarily from burning fossil fuels for electricity and industrial processes, while 11% of CO2 emissions come from land use changes for agriculture, and 16% are from methane (CH4) emissions from waste management and agricultural processing. Nitrous oxide (NO) and fluorinated gases also contribute to GHG emissions, with 6% and 2%, respectively. The transportation sector is a major contributor to CO2 emissions, accounting for 14% of total emissions and projected to increase significantly in the coming years. To address this, the Global Electric Vehicle Summit has been established with the aim of promoting electric vehicles (EVs) to reduce emissions EVs are powered by batteries that can be charged from renewable sources, making them more environmentally friendly than vehicles powered by fossil fuels. In addition, EVs are easier to maintain and cheaper than internal combustion engine (ICE) vehicles once they reach the break-even point. Overall, EVs are six times more efficient than ICE vehicles, and their adoption as the mainstream mode of transportation could have a significant positive impact on the environment.

The automobile industry worldwide is currently experiencing a major change in moving towards more sustainable and energy-efficient options. India is also contributing to this shift by investing in electric mobility. The Indian government is motivated by various factors such as the economic burden of oil imports, increasing pollution, inflation due to the Russia-Ukraine conflict, and commitments to combat climate change. At the same time, there is also a growing demand from consumers for electric vehicles. These factors are driving India's policies to accelerate the adoption of e-mobility.

Electric motors propel the EVs and the rechargeable battery or other portable energy storage device maintains power supply. These vehicles are energy efficient, generating less greenhouse gas (GHG) emissions and reduced noise. The different categories of EVs are as follows: Hybrid electric vehicles (HEVs) have both an engine and an electric motor, and their batteries are charged by the braking system. Plug-in hybrid electric vehicles (PHEVs) are similar to HEVs but have larger batteries that can be charged by plugging into an electric charging point. Battery electric vehicles (BEVs) rely solely on electric motors and batteries for propulsion, and they require external charging points to recharge. BEVs are also referred to as plug-in vehicles or EVs.

By 2030, the Indian automotive market is expected to become the third largest in the world in terms of volume. However, the reliance on traditional, fuel-intensive mobility options is not feasible for the country's large domestic market. To tackle this challenge, policymakers in the government are working on a mobility solution that is "Shared, Connected, and Electric." They have set an ambitious goal of achieving complete electrification of the market by 2030. India has the potential to benefit from electric vehicles due to its renewable energy resources and skilled workforce. According to a study by CEEW-CEF, India's electric vehicle market could be worth US$206 billion by 2030 if the country continues to make progress towards its target. Electric vehicle industry is still in its early stages despite the country's ambitious goals. However, India has the world's biggest potential market for EVs, particularly for two-wheelers. Foreign investors can put money into this sector without any government approval as 100% foreign direct investment is permitted under the automatic route.

The global use of electric vehicles (EVs) is growing at a fast pace, and they are considered to be an important factor in achieving net-zero emissions worldwide. The Electric Vehicles Initiative (EVI) was created in 2010 as a policy by several governments to promote the adoption of EVs and reduce greenhouse gas (GHG) emissions from the transportation sector. As of 2021, there are more than 16.5 million electric cars in use globally, and this number is expected to triple in the coming years. The Clean Energy Ministry (CEM) has launched a new campaign called EV 30@30, which aims to accelerate the adoption of electric vehicles (EVs) by implementing new policies, incentives, and discounts. CEM is a part of the Electric Vehicles Initiative (EVI), which is a policy framework established by multiple governments including Canada, China, Finland, France, India, Japan, Mexico, the Netherlands, Norway, and Sweden. The goal of the EV 30@30 campaign is to have 30% of all new vehicle sales be EVs by 2030. Currently, there are around 450 electric car models available in the market, and despite the COVID-19 pandemic, EV sales are growing rapidly in Europe, China, and the USA. In 2022, both government and consumer spending on EVs increased. China is currently the dominant player in the EV market with 9.5 million EVs, thanks in part to government subsidies that make EVs cheaper compared to other countries. India, on the other hand, is one of the highest greenhouse gas (GHG) emitting countries, ranking third globally with an average annual CO2 emission of 2660 million tons. The transport sector is responsible for 90% of these emissions, which is why transitioning to electric mobility (e-mobility) is considered a promising solution to decarbonize. India has set a target of replacing 30% of its transport sector with EVs by 2030.

CHAPTER: 2

LITERATURE REVIEW

Analysis of electric vehicle trends, development and policies in India

Vedant Singh, Virender Singh, S Vaibhav

Case Studies on Transport Policy 9 (3), 1180-1197, 2021

India lags behind other countries in the adoption of electric vehicles (EVs) due to the absence of a clear policy or strategy, unlike the USA, China, Norway, and Germany, which have provided significant subsidies and incentives to encourage the transition to EVs and reduce air pollution and fossil fuel consumption. The aim of this paper was to analyse the global evolution of EVs and policies and strategies for their development, and to review the Indian EV market and research status, as well as the challenges and opportunities in this sector. A SWOC analysis was conducted to identify strengths, weaknesses, opportunities, and challenges. The study recommends that policy makers, government, and businesses incentivize the deployment of EVs in India to reduce greenhouse gas emissions. The paper suggests that the Indian government should allocate more research funds for the development of EVs and charging infrastructure, and coordinate activities of the state and EV-related businesses to support the growing Indian EV industry.

Interpretive structural modeling approach for development of electric vehicle market in India

AK Digalwar, Ganneri Giridhar

Procedia Cirp 26, 40-45, 2015

The automobile industry in India is experiencing significant growth due to technological advancements and rising living standards. However, this growth is putting pressure on limited resources such as crude oil, natural gas, and fossil fuels. Unless an alternative solution is found, the supply and demand will continue to worsen. Electric vehicles (EVs) are a potential alternative solution to the crisis, but the EV market in India is still in its early stages compared to other countries. This article focuses on the key factors that are critical to promoting and developing the EV market in India, using an Interpretive Structural Model (ISM).

Electric vehicle scenario in India: roadmap, challenges and opportunities

PK Preetha, Prabaharan Poornachandran

2019 IEEE international conference on electrical, computer and communication technologies (ICECCT), 1-7, 2019

The traditional transportation system in India, which relies on conventional vehicles, has faced numerous challenges such as air pollution, health hazards, rising oil prices, insufficient fossil fuel reserves, heavy expenditure on oil imports, and energy insecurity. Electric vehicles (EVs) are being considered as a potential solution to these issues. The goal of this study is to examine the electric vehicle policies of the Indian government and state governments to determine their relevance and impact on EV adoption in India. The study utilizes exploratory research to analyze the current state of the EV industry in India, which is still in its early stages of development. The Indian government has implemented policies such as "NEMMP 2020," "FAME-I," "FAME-II," and a Vehicle Scrappage policy, while 17 state governments have also implemented their own EV policies. These policies provide various incentives, infrastructure development, funding, research and development, production, and sales, which are expected to generate strong demand for EVs, leading to the conversion of conventional vehicles to EVs and transforming the region into an EV hub at par with other developed EV countries. However, a lack of policies and technologies for the disposal and reprocessing of Li-ion batteries may limit the prospects of EVs in India in the future and requires attention.

Global electric vehicle adoption: implementation and policy implications for India

Pabitra Kumar Das, Mohammad Younus Bhat

Environmental Science and Pollution Research 29 (27), 40612-40622, 2022

The current transportation system in India, which relies heavily on conventional vehicles, is facing various challenges such as air pollution, health hazards, increasing oil prices, insufficient indigenous fossil fuel reserves, high expenditure on oil imports, and energy insecurity. To overcome these shortcomings, electric vehicles (EVs) are being considered as an alternative. The purpose of this study is to provide an overview of the EV policies of the Indian government and state governments to assess their relevance and impact

on the adoption of EVs in India. The research method used in this study is exploratory. At present, the EV industry in India is in its early stages and is growing. The government of India has formulated policies such as "NEMMP 2020," "FAME-I," "FAME-II," and the Vehicle Scrappage policy. Seventeen of its state governments have also formulated EV policies. These policies provide various incentives, facilitate infrastructure development, allocate funds for research and development, production, and sales. This will have a significant impact on generating demand for EVs, converting conventional vehicles to EVs, resulting in E-mobility transformation, and creating an EV hub in the region that is comparable to other EV-developed countries in the world. However, a future limitation of EV prospects in India is the lack of policy and technology availability in the area of disposal and reprocessing of Li-ion batteries, which needs to be addressed.

Modeling the key barriers to the development of EV industry in India: using ISM and MICMAC analysis

Nishit Parmar, Akash Misra, Keval Ved, Om Lad

Int. Res. J. Eng. Technol 8 (4), 1030-1046, 2021

The world is currently experiencing a crisis of global warming caused by increasing levels of air pollution that result from human activities. One of the major contributors to air pollution is road transportation, and it is important to transform traditional internal combustion engines into more sustainable alternatives, such as pure electric vehicles (EVs). However, the adoption of EVs in India has not been easy, and the EV industry in India is still in its early stages of development. Despite the existence of companies in India that produce EVs locally, such as Tata Motors and Mahindra and Mahindra, these manufacturers still face many challenges in terms of sales and adoption of their EV models. This study aims to analyze the barriers that hinder the development of the EV industry in India using an ISM-based approach to determine the level of influence of each barrier. The study is focused on analyzing the barriers that affect the EV industry in India, and also briefly discusses the global EV scenario.

Electric vehicles in India: Market analysis with consumer perspective, policies and issues

Pritam K Gujarathi, Varsha A Shah, Makarand M Lokhande

Journal of Green Engineering 8 (1), 17-36, 2018

In the early 2000s, several new companies emerged to take advantage of the lack of major car manufacturers in the electric vehicle (EV) market, including Tesla Motors in the US, Think in Norway, BYD in China, and REVA in India. These new manufacturers had an impact on the global auto industry by releasing one or more EV models. However, the Indian EV market is still in its early stages, with much progress to be made. The article examines the current state of the Indian EV market, including market players in the two- and four-wheeler segments and recent developments, as well as the state of road transportation in India. The article also discusses government policies and initiatives and includes a case study from a consumer's perspective to understand the ground reality. The article examines EV charging tariffs, as well as challenges facing the Indian market's growth and discusses necessary policies and promotions, along with feasible options and a look at the global scenario.

Growth of E-Vehicle and De-Growth of Automobile Industry in India

K Natarajan

A Journal of Composition Theory. ISSN, 0731-6755, 2020

2020

The Indian automobile industry has experienced a growth in sales of 9.5% year-on-year to 4.02 million units in 2017, making it the 4th largest in the world. The commercial vehicles manufacturing sector was ranked 7th largest in 2018. The market is dominated by the two-wheelers segment due to the increasing middle-class population and youth. The industry is also a significant auto exporter with a positive export growth expectation in the near future. Despite being one of the largest employers in the country, the industry has faced negative growth recently. However, the industry is expected to contribute highly to the country's manufacturing facilities, with an aim to increase manufacturing's share in India's GDP from 15% to 25% by 2022 with the production of electric vehicles. Although India's electric vehicle industry is relatively new compared to the

international markets such as the US, China, and Europe, the government's major thrust is expected to bring about a significant change. This article discusses the reasons for the de-growth of the Indian automobile industry and the growth of e-vehicles in India and other international markets.

Predicting Electric Vehicle (EV) Buyers in India: A Machine Learning Approach

Sushil Kumar Dixit, Ashirwad Kumar Singh

The Review of Socionetwork Strategies 16 (2), 221-238, 2022

Electric vehicles have been around for a while, but recent technological advancements have made them more promising in terms of addressing various challenges faced by society, including reliance on fossil fuels, environmental issues, and urbanization. Despite the positive attitudes of consumers and government support, the adoption of EVs has been challenging, and marketers are struggling to find genuine buyers. To address this, a machine learning model has been developed to predict whether a person in India is likely to "Buy" or "Won't Buy" an electric vehicle. This involved conducting a text analysis of online content related to EVs to identify frequently occurring words and gain an understanding of consumer interests and concerns. The model found that age, gender, income, environmental concerns, vehicle cost, running cost, vehicle performance, driving range, and mass behavior are significant predictors of EV purchase in India. However, education, employment, and government subsidy are not significant predictors of uptake.

Adoption of EV: Landscape of EV and opportunities for India

R Hema, MJ Venkatarangan

Measurement: Sensors 24, 100596, 2022

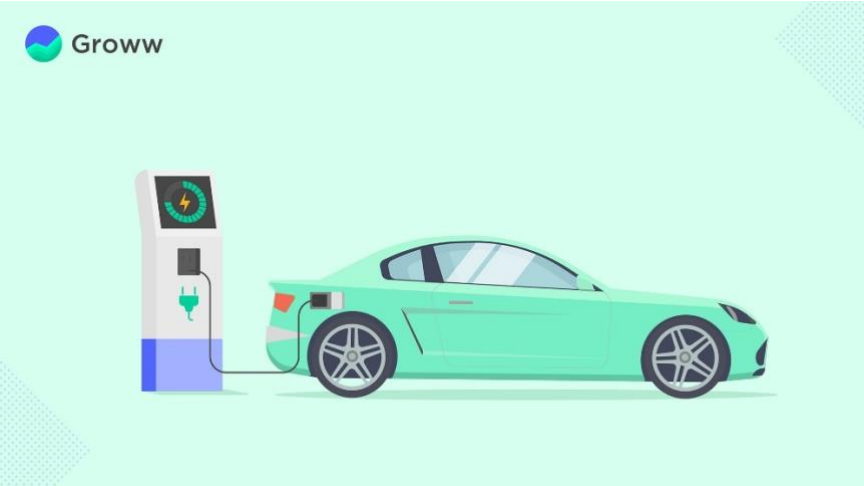
Electric vehicles (EVs) are an important technology in today's world due to their environmental friendliness, low running costs, and zero emissions. They have the potential to reduce dependence on fossil fuel-based internal combustion engine (ICE) vehicles and become a mainstream transportation system in major countries. Compared to ICE vehicles, EVs have an overall fuel efficiency of 77%, which is six times more efficient. However, limited travel range, charging

infrastructure, and high pricing are major challenges that have hindered EV adoption. This paper examines the need for advancement in EV technology and discusses the drawbacks of current EV technologies, with a focus on the Indian market. As EV sales growth in India has tripled in recent days, the study identifies factors that impede EV growth and discusses recent research and innovative commercial projects related to charging infrastructure, battery energy storage, and energy management technologies that require advancement at an affordable price and convenience equivalent to ICE vehicles. Finally, the study discusses various EV technology outlooks and aims to identify the needs and develop an advanced EV technology model that is best suited to the Indian public for sustainable development.

CHAPTER: 3

LANDSCAPE OF INDIAN ELECTRIC VEHICLE INDUSTRY

3.1 INTRODUCTION



The electric vehicle (EV) industry in India is witnessing a major transformation, with more and more automobile manufacturers entering the space. The Indian automobile industry is one of the largest in the world and is currently dominated by traditional gasoline and diesel-powered vehicles. However, with growing concerns about air pollution, climate change, and the need for sustainable transportation, the EV industry in India is expected to grow significantly in the coming years. The Indian government has been taking steps to promote and incentivize the adoption of electric vehicles in the country. One of the significant initiatives is the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, which provides incentives to EV manufacturers and buyers. Under the FAME scheme, the government offers subsidies of up to INR 1.5 lakh on the purchase of EVs. This has made EVs more affordable and accessible to the general public.

Several automobile manufacturers in India have started manufacturing EVs to cater to the growing demand. Tata Motors, one of the largest automobile manufacturers in India, launched its first EV, the Tigor EV, in 2018. The company has since expanded its EV portfolio to include models such as the Nexon EV and the Altroz EV. Another established automobile manufacturer, Mahindra & Mahindra, has been manufacturing EVs in India for over a decade. The company's electric vehicles, such as the eKUV100 and the eVerito, are popular among Indian consumers.

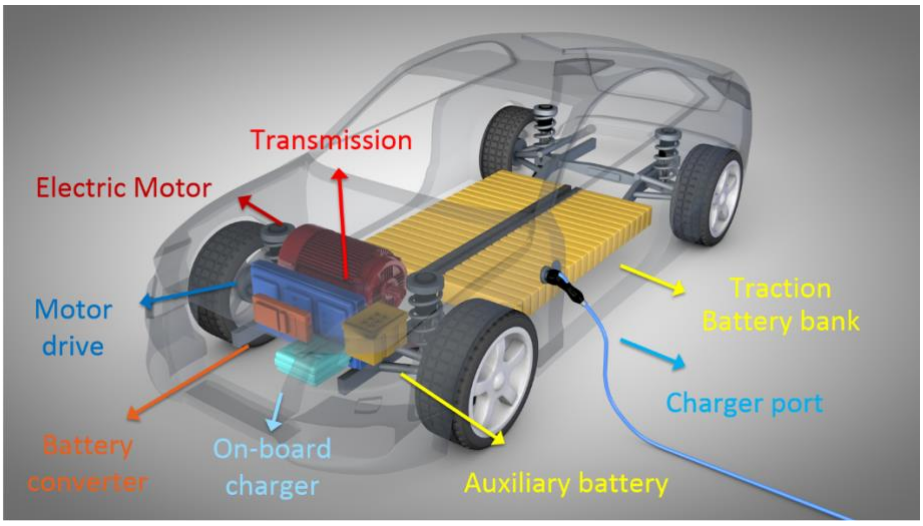
In addition to established automobile manufacturers, new startups have also entered the Indian EV industry. Ather Energy, a Bangalore-based startup, has been gaining traction in the Indian market with its electric scooters. The

company's flagship model, the Ather 450X, has received several awards and has been well-received by Indian consumers. Revolt Motors, founded by Micromax co-founder Rahul Sharma, has launched its electric motorcycle, the RV400, which is the first Al-enabled motorcycle in India Ola Electric, the electric vehicle arm of ride-hailing giant Ola, has announced plans to launch its own range of electric scooters.

However, the growth of the EV industry in India is not without its challenges. One of the significant challenges is the lack of proper charging infrastructure. As of now, India has around 1,500 public charging stations across the country, which is a major number compared to the growing number of EVs on the roads. This has led to range anxiety among EV owners, which is a significant deterrent to the adoption of EVs. However, the government has announced plans to set up more charging stations in the country, and private companies such as Tata Power and Reliance are also investing in charging infrastructure. Another challenge facing the EV industry in India is the high cost of EVs. Despite the government's incentives, EVs are still more expensive than conventional vehicles due to the high cost of batteries. This has made EVs inaccessible to a significant portion of the Indian population. However, the cost of EVs is expected to come down as battery technology improves and production volumes increase.

In conclusion, the EV industry in India is poised for significant growth in the coming years. With the government's initiatives and the increasing number of automobile manufacturers and startups entering the space, the EV industry is expected to disrupt the traditional automobile industry in India. However, to achieve this growth, the industry must address the challenges of charging infrastructure and high costs. The key to the success of the EV industry in India will be to continue to incentivize and promote the adoption of EVs and invest in charging infrastructure to support the growing number of EVs on the roads.

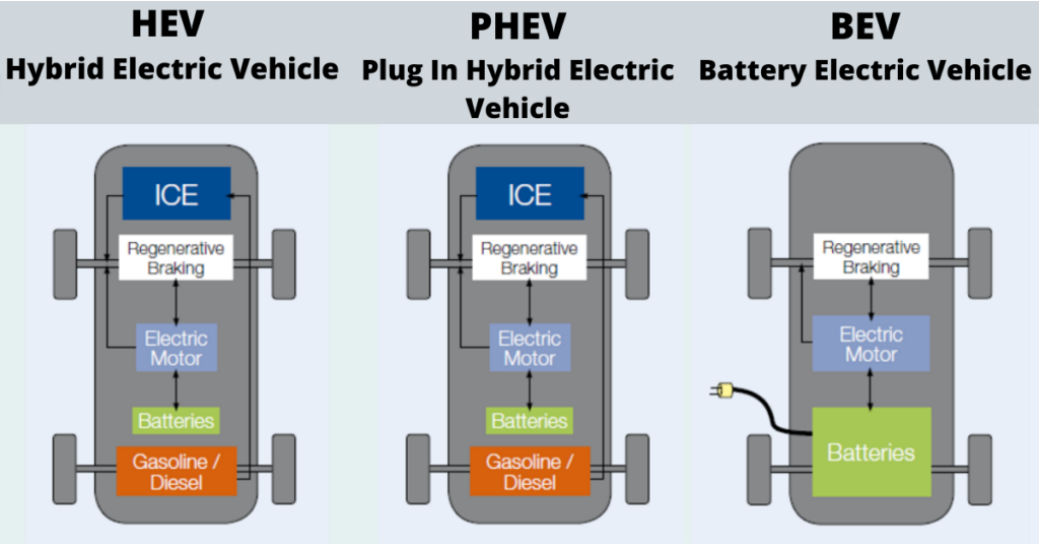
3.2 A BRIEF OVERVIEW OF TECHNOLOGY EMPLOYED IN ELECTRIC VEHICLE.



An Electric Vehicle (EV) is made up of numerous components connected with clusters of wires, as shown in Figure 1. The essential components on the EV side include the Battery Module, Battery Management System, Power Electronics Controller, Cooling System, Traction Motor, Transmission Systems, Wheels, and Chassis. The Power Electronic Converter is responsible for transforming and regulating electric power in EVs, making it an efficient energy management system that manages electric power within the EV. This includes an on-board charger, converter, and inverter. The battery module, which is made up of several lithium cells coupled in series and parallel, provides enough power to the EV. Current EV batteries have an energy capacity of 20-130 kWh, and they account for a significant amount of the vehicle's weight and volume, representing one-fourth of the total weight. The Battery Management System (BMS) is an electronic system that ensures the battery is functioning correctly by regularly monitoring the battery pack's temperature, voltage, and current limits to ensure its safe operation. The BMS can detect and prevent thermal runaway caused by overcharging, which may result in an explosion. The BMS can also enforce the battery's maximum charge and discharge limits, depending on the temperature, and keep track of the battery's State of Charge (SoC) and State of Health (SoH). The Cooling System manages the EV's temperature by circulating ethylene glycol coolant between the batteries and electronics to regulate the temperature. The traction motor's essential features

are efficiency, torque, power-to-weight ratio, cost, and reliability, with common types of motors used in EVs being Permanent Magnet Synchronous Motor (PMSM), Brushless DC Motor (BLDC), Induction Motor (IM), and Switched Reluctance Motor (SRM). The EV's transmission system includes a traction motor, inverter, and battery, with the gearbox transferring the power generated by the traction motor to the drive wheel. The EV uses a single-speed transmission because the motor is used in a wide range of conditions. The wheel design has a significant impact on the efficiency of the EV, and Tesla's aero wheel has been shown to improve efficiency by 3% or 10 miles. The Chassis is the frame of the EV where all of its components are installed, ensuring the vehicle's safety and longevity.

3.3 TYPES OF ELECTRIC VEHICLE

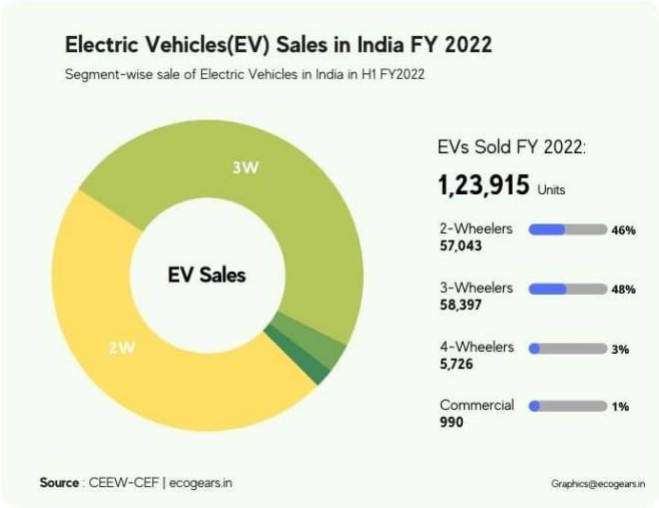


The Indian market for electric vehicles (EVs) has received significant attention and continues to grow. There are three main types of powertrains used in EVs: Battery Electric Vehicles (BEVs), Hybrid Electric Vehicles (HEVs), and Plug-in Hybrid Electric Vehicles (PHEVs), as illustrated in Figure 2. BEVs are solely powered by an electric motor, with the battery units being charged by an external power source. HEVs, on the other hand, use both an internal combustion engine (ICE) and an electric motor for propulsion. The ICE utilizes petrol or diesel for driving power, while kinetic energy generated during braking is converted into electric energy and stored in the battery. This stored energy is then used to power the electric motor. HEVs start off using the electric motor and then switch to the ICE for operation. PHEVs also use both an ICE and an electric motor, but the user can choose to operate either the battery or ICE. However, the battery can only be charged using an external power source. Among these three types of EVs, BEVs are particularly significant in the Indian market for passenger cars.

3.4 CURRENT SITUATION OF ELECTRIC VEHICLE (EV) USAGE IN INDIA IS BEING EXAMINED

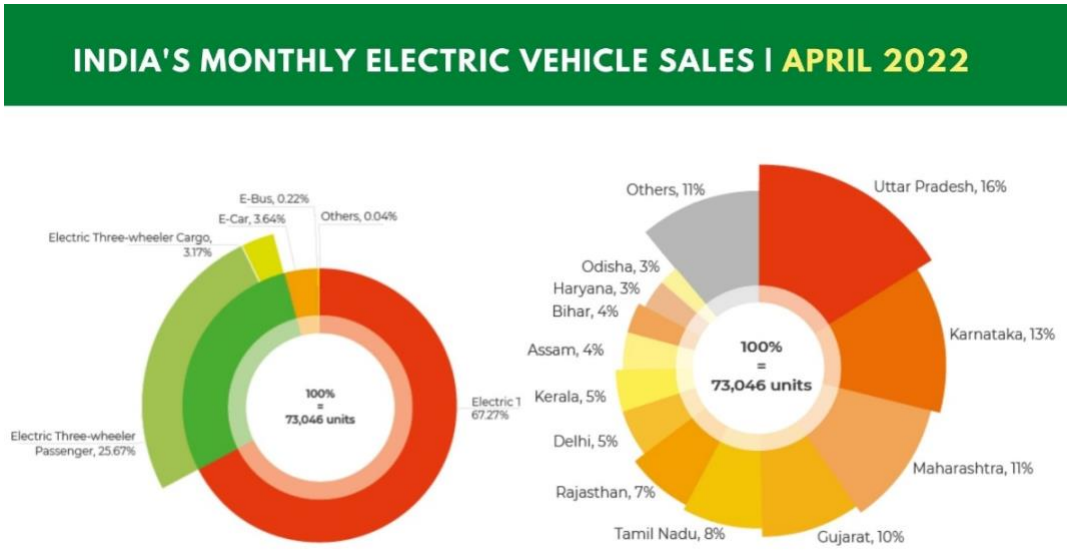
The recent increase in crude oil prices, which is believed to be a result of external conflicts like the Russia-Ukraine conflict, has led to a push for electric vehicles (EVs) to become the mainstream mode of transportation in India. This push has been accelerated by the strict emission norms, scrap policy, and environmental awareness of the Indian government. As a result, consumers are increasingly choosing EVs due to government promotions in the form of tax policies and incentives. The Indian automobile industry is the fourth-largest in the world, and local companies such as Tata Motors and Mahindra and Mahindra Ltd. have recently launched their EV segments. The industry also welcomes global EV automakers such as Hyundai, Kia, MG, and BMW. The variety of options available in the EV market has contributed to its rapid growth in India in a short period of time. The EV market in India includes both Plug-in Hybrid Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs), but BEVS have shown higher sales and are projected to comprise 75% of the market by 2030.

EV PROCUREMENT RATE IN INDIA



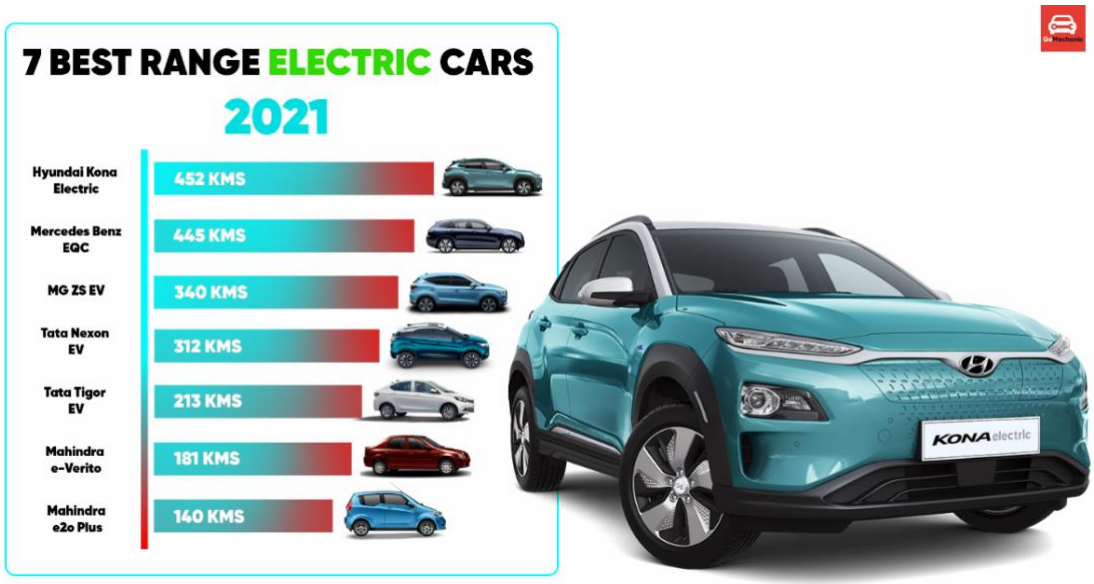
Over the past decade, the electric vehicle industry in India has undergone significant changes, including the introduction of new trends, innovative and efficient models, and the rapid development of charging infrastructure, tax-saving schemes, and incentives that have attracted many consumers: Additionally, the adoption of electric vehicles has played a crucial role in reducing the country's reliance on fossil fuels and making a significant impact on greenhouse gas

emissions. Sales data for the EV segment during the first half of FY 2022 in India is presented in Figure 3, sourced from the Centre for Energy Finance at the Council on Energy, Environment & Water and Centre for Energy Finance (CEEW-CEF), showing a total of 121,815 EV sales. Among the different segments of the EV market, 3-wheelers have shown the highest sales at 48%, followed by 2-wheelers at 47%, with passenger car 4- wheelers accounting for only 4% of sales in the first half of FY 2021, despite the availability of numerous innovative technologies. Commercial vehicles have shown only 1% of sales in FY 2022. The four-wheeler EV market in FY 2021 has fallen short of expectations due to a lack of knowledge about EV growth, insufficient charging infrastructure, high costs compared to ICE engines, and a lack of technological updates. Figure 4 presents state-wise sales of EVs during the first half of FY 2022 in India, with Uttar Pradesh leading at 16%, followed by Karnataka at 13%, Maharashtra at 11%, and Gujarat at 10%, among others.



Most of the electric vehicles available in the 4 wheeler market segments use either lithium polymer or lithium-ion batteries. The highest battery capacity is found in the EV6-Kia model, which has a capacity of 77.4 kWh and can travel up to 528 km on a single charge. The Jaguar I-Pace model has a battery capacity of 90 kWh and can travel up to 445 km, while the i4 and iX models from BMW PHEV have battery capacities of 83.9 kWh and 71 kWh respectively, and can travel 450-500 km. Indian models, such as the Nexon EV and Tigor EV by Tata, have lithium

polymer batteries with capacities of 40.5 kWh and 30.2 kWh respectively, and can travel up to 400 km. The E-Verito by Mahindra is a BEV model with a battery capacity of 21.1 kWh and can travel up to 181 km. These electric vehicles are priced between Rs. 15 lakhs to 3 crores and come with additional instrumentation clustering features. Currently, more than 8,70,141 electric vehicles have been registered in India, with BEVs being more popular among middle-income customers and accounting for 8% higher sales than PHEV models. Moreover, India aims to achieve a 30% EV sales penetration by 2030 as part of its national target.



In India, two-wheeler electric models are highly popular among consumers. These segments in the Indian market typically use either lithium-ion or lead acid batteries. The OLA S1 Pro has the highest travel range in this segment, with a battery capacity of 3.97 kWh and the ability to travel up to 180 km on a single charge. The Okhi90-Okinawa has a battery capacity of 3.6 kWh and can travel up to 160 km, followed by the RV400-Revolt with a 3.624 kWh battery capacity and a travel range of 150 km. The TVS iQube ST has a battery capacity of 4.56 kWh and a travel range of 140 km. The Atria-Hero model has the least battery capacity in this segment, with a battery capacity of 1.53 kWh and a travel range of 85 km.

Numerous research studies are currently underway for advanced electric vehicle (EV) technologies. The popularity of EVs began with two-wheelers, four-wheelers, and three-wheelers. Due to the government's policies and incentives and technological advancements that have reduced the cost of EVs, people are increasingly embracing EVs. As a result, many passenger vehicles and trucks are now being equipped with EV technology to meet future demand and trends.

3.5 DEPLOYMENT OF CHARGING INFRASTRUCTURE

The deployment of charging infrastructure is a significant concern in addition to the development of electric vehicle (EV) technology in India. The current EVs in India have a limited travel range, so it is necessary to install charging infrastructure in major cities and on national highways. The Central Electricity Authority (CEA) and the Ministry of Power (MoP) have taken necessary measures for the deployment of grid-integrated charging stations, and there are now 1742 charging stations installed throughout the country. The MoP regulations state that one charging station should be placed in each 3m x 3m square of the field, and on both sides of the road on highways, there should be one charging station every 25 km. Major cities such as Surat, Pune, Ahmedabad, Bengaluru, Hyderabad, Delhi, Kolkata, Mumbai, and Chennai have a total of 940 charging stations out of the 1742 charging stations installed across the country. Companies such as Delta Electronics India, Mass Tech controls pt. ltd., ABB India, Amara Raja, Exicom, and P2 Power Solutions are among the leading charging infrastructure companies in India. Additionally, EESL, REIL, Tata Power, OPG (Okaya Power Group), EVQ Point, Brightblu, Magenta group, Fortum, Numocity, EVQ-Point, and volttic are the top EV charging station aggregators in India. To encourage the adoption of EVs in rural areas, state governments should allocate more funds for EV charging stations. Increasing the number of charging stations will alleviate the range anxiety among EV users in rural areas. To increase the number of charging stations in rural areas, one option is to increase federal investment in charging infrastructure, while the other is to enhance the functionality of electric cooperatives.

CHAPTER: 4

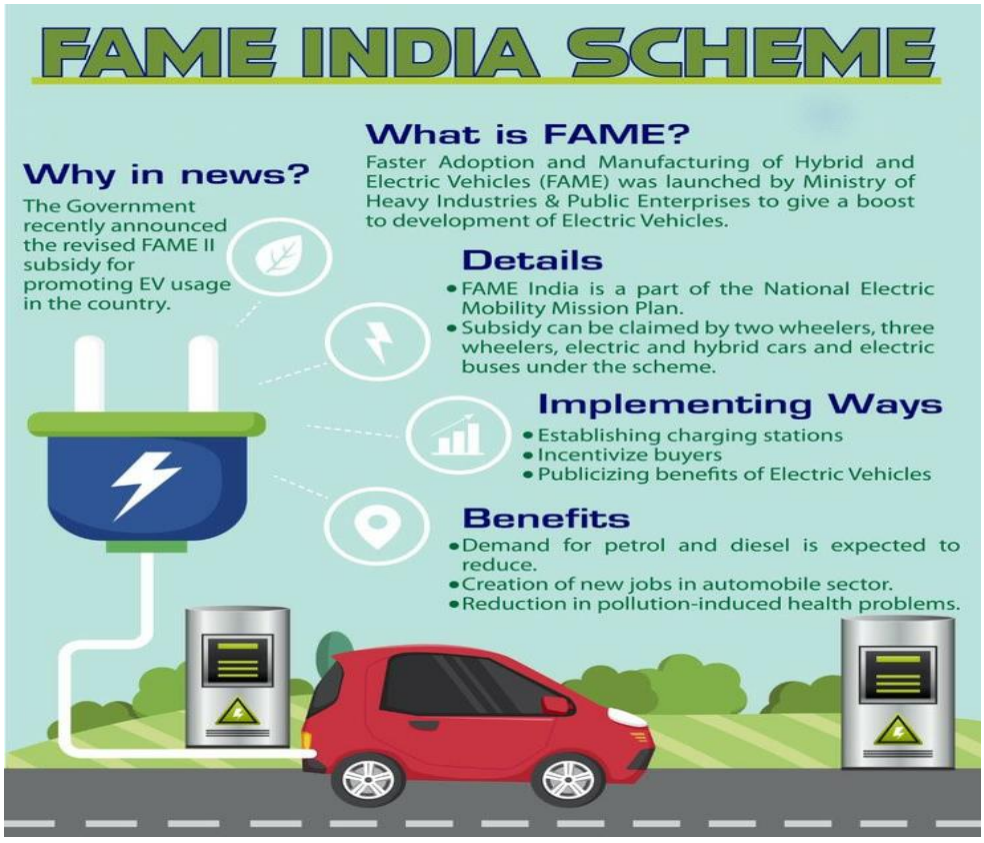
EV POLICY INITIATIVES IN INDIA

In India, the growth of electric vehicles (EVs) is being propelled by a combination of initiatives at both the central and state levels. The central government has introduced the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME-II) policy, while individual state governments have also implemented various EV-specific policies. These policies can be broadly classified into two categories: demand side and supply side. The FAME policy at the central level and the EV policy in Delhi offer financial incentives to customers, which help reduce the purchase price of EVs and close the price gap between EVs and traditional internal combustion engine (ICE) vehicles. In contrast, several state governments have focused more on supply-side incentives to attract investment in the EV sector within their respective states, thereby creating employment opportunities. The combination of demand incentives from the central FAME-II subsidy and state-level measures should significantly reduce the upfront cost differential for EVs. Additionally, measures such as reducing the Goods and Services Tax (GST) on EVs and EV chargers to 5% have also been implemented to promote the EV industry. The next section will examine the range of policy initiatives aimed at driving EV growth in India and identify areas where improvements can be made.

4.2 CENTRAL GOVERNMENT FAME – 2 POLICY

The Indian government's Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME-II) policy is a critical initiative aimed at promoting the growth of electric vehicles (EVs) in the country. This policy is the successor to the original FAME policy launched in 2015, which provided subsidies and incentives to accelerate the adoption of EVs in the country. FAME-II was introduced in 2019 with a budget of Rs 10,000 crore ($1.3 billion) over a three-year period, and it aims to encourage the adoption of EVs and promote the domestic manufacturing of electric vehicles and related components. The policy's primary focus is on creating demand for EVs in India by offering financial incentives to buyers. Under FAME-II, the government provides incentives to buyers of EVs, including electric two-wheelers, three-wheelers, and four-wheelers. The incentives are provided to buyers of these vehicles to offset the higher purchase cost compared to traditional petrol and diesel vehicles. Additionally, the policy provides financial incentives to manufacturers to produce EVs and their components domestically. One of the critical components of FAME-II is the creation of a network of charging infrastructure

across the country. The policy mandates the installation of charging stations every 25 km on both sides of national highways and at every 3x3 km grid in cities with a population of over 1 million. This infrastructure rollout is crucial for the success of EVs as it will alleviate range anxiety among users and help promote the adoption of EVs in the country. FAME-II also focuses on promoting the domestic manufacturing of EVs and their components, including batteries, motors, and controllers. The policy provides financial incentives to manufacturers to set up factories in the country and produce EVs and related components locally. This measure will not only promote local manufacturing but also create employment opportunities in the country. One of the significant achievements of the FAME-II policy has been the growth of EV sales in the country. In conclusion, the Indian government's FAME-II policy is a crucial initiative aimed at promoting the adoption of EVs in the country. The policy's focus on creating demand, promoting local manufacturing, and creating a network of charging infrastructure has helped to promote the growth of EVs in India. However, there are still some challenges that need to be addressed to ensure the success of the policy, including addressing the high cost of EVs and improving the charging infrastructure across the country.



4.3 STATE LEVEL EV POLICIES IN INDIA

In recent years, India has taken several steps to promote electric vehicles (EVs) in the country. Along with the central government's policies, several state governments have introduced their own policies to promote the adoption of EVs. These state-level policies play an essential role in supporting the growth of the EV industry and help to address the unique challenges and opportunities specific to each state.

One of the earliest state-level policies was introduced by the Delhi government, which aimed to reduce air pollution in the city. The Delhi government introduced the Electric Vehicle Policy in 2018, which provided incentives for the purchase of electric two-wheelers, three-wheelers, and four-wheelers. The policy also aimed to set up charging infrastructure across the city and required all new commercial vehicles to be electric by 2026. The Delhi government also reduced the road tax for electric vehicles by half, and electric vehicles are exempt from the odd-even rule, which limits the use of vehicles on alternate days based on license plate numbers.

Maharashtra is another state that has taken significant steps to promote the use of EVs. The state government introduced the Maharashtra Electric Vehicle Policy in 2018, which aims to make the state a hub for EV manufacturing and create employment opportunities. The policy offers incentives to EV manufacturers, charging infrastructure providers, and buyers. Under the policy, the state government provides subsidies for the purchase of electric two-wheelers, three-wheelers, and four-wheelers, and electric vehicles are exempt from road tax and registration fees. The policy also aims to set up charging infrastructure across the state, with a target of 2,500 public charging stations by 2025.

Karnataka is another state that has introduced several measures to promote the use of EVs. The state government introduced the Electric Vehicle and Energy Storage Policy in 2017, which aims to create an ecosystem for EV manufacturing and adoption. The policy offers incentives for the purchase of electric two-wheelers, three-wheelers, and four-wheelers, and electric vehicles are exempt from road tax and registration fees. Tamil Nadu, the state known for its automobile manufacturing, has also taken significant steps to promote the adoption of EVs. The Tamil Nadu government has introduced several measures to attract investment in the EV industry, including tax incentives, subsidies for

EV manufacturers, and the establishment of a dedicated EV park in Chennai.

In conclusion, state-level policies play an important role in promoting the adoption of EVs in India. These policies offer incentives for EV manufacturers, charging infrastructure providers, and buyers and help to create an ecosystem for EV manufacturing and adoption. As the EV industry continues to grow, it is essential for state governments to continue to introduce and implement policies that promote the adoption of EVs and address the unique challenges and opportunities specific to each state.

CHAPTER: 5

FINDINGS AND SUGGESTIONS

The electric vehicle (EV) industry in India has been growing steadily in recent years. The Indian government has set a target of achieving 30% electric vehicle penetration by 2030, which has led to increased investment and interest in the EV industry.

5.1 FINDINGS

- Growing demand for EVS: There is a growing demand for EVS in India, driven by concerns about air pollution, rising fuel costs, and government policies promoting EV adoption.

- Government initiatives: The Indian government has launched several initiatives to promote the adoption of EVs. These include incentives for EV manufacturers, tax exemptions, and subsidies for buyers of EVs.

- Increasing investment in the EV industry: Indian automobile manufacturers are increasing their investments in the EV industry to meet the demand for EVs and stay competitive in the market.

- Challenges in EV adoption: The challenges facing the EV industry in India include high costs, limited availability of charging infrastructure, limited consumer awareness and education, and concerns about battery range.

- Limited availability of EV models: The number of EV models available in the Indian market is currently limited, which limits consumer choice and hampers the growth of the EV industry.

5.2 SUGGESTIONS

- Increase investment in charging infrastructure: The Indian government and private sector players should invest in charging infrastructure to alleviate range anxiety and promote EV adoption.

- Encourage local manufacturing: The Indian government should encourage local manufacturing of EV components and batteries to reduce costs and increase the availability of EVs in the Indian market.

- Incentivize R&D: The government should incentivize research and development in the EV industry to encourage innovation and the development of new EV models.

- Promote consumer education: There is a need to educate consumers about the benefits of EVs and address their concerns about range, charging, and cost.

- Encourage public transport electrification: The government should focus on electrifying public transport, which can have a significant impact on reducing air pollution and promoting the adoption of EVs.

- Collaborate with technology companies: Indian automobile manufacturers should collaborate with technology companies to leverage their expertise in developing EVs and related technologies.

- Explore opportunities in the global market Indian automobile manufacturers should explore opportunities to export EVs and related components to other countries.

Overall, the adoption of EVs presents significant opportunities for the Indian automobile industry, but several challenges must be addressed to achieve its full potential. The government, automobile manufacturers, and other stakeholders must work together to overcome these challenges and promote the adoption of EVs in India.

CHAPTER: 6

CONCLUSION

In conclusion, the adoption of electric vehicles (EVs) presents a significant opportunity for the Indian automobile industry. The Indian government has set an ambitious target of achieving 30% electric vehicle penetration by 2030, which has led to increased investment and interest in the EV industry. The landscape of the EV industry in India is evolving, with growing demand for EVs, government initiatives to promote EV adoption, and increasing investments from Indian automobile manufacturers. However, the adoption of EVs in India also presents several challenges, such as high costs, limited availability of charging infrastructure, and limited consumer awareness and education. To overcome these challenges, the Indian government and automobile manufacturers must work together to invest in charging infrastructure, incentivize research and development, promote consumer education, and collaborate with technology companies to develop EVs and related technologies. Overall, the adoption of EVs has the potential to revolutionize the Indian automobile industry and contribute to a cleaner and greener future. The Indian automobile industry has the opportunity to take advantage of this growing market and become a global leader in the EV industry. India has the potential to become the largest untapped market for electric vehicles (EVs) in the world. However, there are currently various obstacles hindering the growth of the EV market, which underscores the need for a sophisticated charging infrastructure. The "Make in India" initiative encourages companies to manufacture parts locally, including lithium-ion batteries, which are crucial components that must be produced in India. To accelerate the adoption of EVs, a new business model that allows for both charging and swapping solutions to efficiently utilize infrastructure is needed. Recent laws, such as the battery swapping legislation, are driving the development of a well-established EV infrastructure across the country, which aligns with India's focus on green energy generation and decentralized energy distribution. The lack of official infrastructure and adaptive technologies for EVs currently impacts the sales of EVs in India. However, the implementation of advanced technologies such as digital twins, powertrain evolution, optimal charging infrastructure, fast charging infrastructure, battery management, and the integration of EVs with the grid using virtual methods and blockchain technology can help make EVs a mainstream mode of transportation in India. In the next decade, the EV market is projected to undergo significant development, thanks to the availability of accessible and inexpensive infrastructure that supports all consumer groups, as well as a solid finance ecosystem. With the support of governmental incentives and technological

breakthroughs, EV technology is expected to become an unavoidable breakthrough in the near future. By addressing the challenges and leveraging the opportunities presented by the adoption of EVs, the Indian automobile industry can play a crucial role in driving India's transition to a sustainable and eco-friendly future.

CHAPTER: 7

BIBLIOGRAPHY

➢ WEBSITES

Society of Manufacturers of Electric Vehicles (SMEV) - https://smev.in/
Ministry of Heavy Industries and Public Enterprises - https://dhi.nic.in/ev-home/
NITI Aayog - https://niti.gov.in/electric-vehicles
Electric Mobility Association of India (EMAI) - https://www.emai.in/
The Energy and Resources Institute (TERI) - https://www.teriin.org/
International Energy Agency (IEA) - https://www.iea.org/countries/india
Automotive Research Association of India (ARAI) - https://www.araiindia.com/
India Energy Storage Alliance (IESA) - https://indiaesa.info/
Clean Energy Access Network (CLEAN) - https://www.thecleannetwork.org/
Centre for Energy Finance (CEF) - https://cef.ceew.in/

➢ WEB PUBLICATIONS

Vidhi, R., & Shrivastava, P. (2018). A review of electric vehicle lifecycle emissions and policy recommendations to increase EV penetration in India. Energies, 11(3), 483.

Singh, V., Singh, V., & Vaibhav, S. (2021). Analysis of electric vehicle trends, development and policies in India. Case Studies on Transport Policy, 9(3), 1180-1197.

Preetha, P. K., & Poornachandran, P. (2019, February). Electric vehicle scenario in India: roadmap, challenges and opportunities. In 2019 IEEE international conference on electrical, computer and communication technologies (ICECCT) (pp. 1-7). IEEE.

Ali, M. S., & Tongia, R. (2018). Electrifying Mobility in India: Future prospects for the electric and EV ecosystem.

Electric Vehicles - Modelling and Simulations" edited by Suman Dutta and Sourav Mondal

Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market" edited by S. Sundar Kumar Iyer and K. S. Reddy

Electric Vehicles: Prospects and Challenges" edited by Dr. J. K. Sharma and Dr. Amit Kumar