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INDIA'S ELECTRIC VEHICLE (EV) LANDSCAPE: EXPERT PERSPECTIVES ON READINESS AND ENVIRONMENTAL SUSTAINABILITY

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Abstract:

The aim of the study was to investigate India's readiness for electric vehicles (EVs) and their potential to improve environmental sustainability. As concerns about climate change and pollution grow, the shift to EVs has become a pressing global need. With its rapidly growing population and increasing urbanization, India presents both distinct difficulties and possibilities in this area. This empirical study looks at several aspects of India's EV ecosystem, including as infrastructure and policy support, as well as consumer adoption and manufacturing capacities. Based on focus group analysis on 13 experts from varied field like Automobile, Government, Academician and Industry. The structured analysis unfold the key factors that are affecting the adoption of Electric Vehicles. The key identified factors were cost, Environmental concern, perceived performance, range anxiety, and lack of infrastructure for charging. This report intends to shed light on the current challenges in India's journey toward a greener and more sustainable transportation future by a detailed examination of present trends, obstacles, and potential.

Key Words: E*lectric Vehicles (EVs), Sustainability, Ecosystem, *Automobile, Consumer.

INTRODUCTION:

India, being a nation with a significant population, is currently confronted with a substantial challenge in the form of air pollution. The primary contributor to air pollution in India stems from many factors related to transportation, including the utilization of substandard fuel, the presence of outdated cars, insufficient maintenance practices, congested traffic patterns, subpar road conditions, and outdated automotive technology and traffic management systems. The primary emissions originating from autos consist of hydrocarbons, nitrogen dioxide(NO_2), lead, carbon monoxide (CO), sulphur dioxide (SO_2), and particulate matter. The primary factor contributing to the significant proportion of vehicle pollution in India may be attributed to the country's substantial automotive sector. The Indian automobile industry now holds the position of being the fifth biggest globally, and it is projected to ascend to the third largest position by the year 2030. A compound annual growth rate (CAGR) of 36% is predicted by India Energy Storage Alliance (IESA) of EV market in India With the increase in population and the

corresponding surge in demand for automobiles, it becomes evident that relying on traditional energy supplies is not a viable long-term solution for India, primarily due to the country's heavy reliance on imported crude oil, which accounts for around 80% of its requirements. Hence, NITI Aayog is endeavouring to attain a 70% market share of electric vehicle sales for all commercial automobiles, 30% for private automobiles, 40% for buses, and 80% for two and three-wheelers by the year 2030. This aligns with the objective of attaining a state of net zero carbon emissions by the year 2070.

India's transportation sector plays a major role in worsening environmental challenges, including air pollution and greenhouse gas emissions. With rise in the global pollution levels, huge efforts are being put to restrict CO_2 emissions and save the environment. An important direction in this direction is to adopt electric vehicles (EVs). As transportation is a major factor for CO_2 emissions, it is highly essential to move towards a sustainable solution. Indian government has introduced an ambitious regulations and policies that aimed at combining EVs into the market (IEA, 2019) to be in the pace with global advancements in EV technology.

As per Indian Brand Equity Foundation (IBEF, 2022), the EV sector is rapidly expanding. The EV global market share has shoot up from 4.2% in 2020 to about 8.3%, showing higher recognition of their role in natural resources conservation and emissions reduction. A significant growth has been seen in India in terms of EV market, with 0.32 million units sold in 2021, a very high i.e., about168% growth seen compared to previous year. The Paris Agreement has primarily influenced the EV adoption largely that aims at reducing dependencies on oil imports there by reducing carbon emissions.

Even though EVs provide higher environmental benefits by reducing harmful emissions, pollutants and carbon footprints, it is still the need of the hour to do academic research on the perspective of consumers. To gain the consumer preferences and perceptions, along with to identify the major barriers and difficulties that prevents the adoption of EVs in India, needs deeper understanding.

This research has been done to examine the readiness of India in adopting EV and its capacity to improve environment sustainability. Empirical evidence was used that provides key information into the important factors shaping the acceptance of EVs in India.

The objectives of this research are:

- To evaluate the current state of electric car infrastructure and charging networks in India.
- To check the efficiency of having incentives and government policies in increasing the use EVs.
- To comprehend customers apprehension towards the adoption of e-vehicle.
- To evaluate the potential environmental advantages of widespread electric vehicle adoption in India.

LITERATURE REVIEW

Literature review was conducted on EV adoption in two distinct stages. The first phase studied the initiatives and policies related to EV and in the second phase the challenges on EV adoption from Indian perspective was analysed.

(i) A comparative analysis of Indian and other nations' policies and scheme.

Conventional automobiles have been identified as major contributors to global warming and environmental air pollution. Various modes of transportation release particulate matter due to factors such as brake wear, tire friction, and the natural degradation of road surfaces. Diesel

vehicles, in particular, have a more severe impact on air quality than gasoline cars, while both fuel-based vehicle types emit significantly more pollutants compared to electric vehicles (EVs). According to the European Environment Agency (EEA, 2018), governments have implemented economic measures, such as road taxes, to discourage the purchase and use of high-emission vehicles. In India, a green tax is applied during the re-registration of vehicles that have been in use for 15 years or more, aiming to curb pollution and promote the transition to EVs (IEA, 2019). Research by Sierzchula et al. (2014) in the United States found that tax exemptions, refunds, and federal and state incentives played a crucial role in boosting EV sales. Similarly, a study by Karagiannopoulos and Solsvik (2019), along with Nikel (2019), revealed that in Norway, 60% of vehicles sold in 2019 were electric, largely due to government-backed financial incentives and extensive investment in charging infrastructure (Figenbaum & Kolbenstvedt, 2013; Sierzchula et al., 2014). India has also introduced several programs to promote electric and hybrid vehicles. One notable initiative is the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme, designed to accelerate EV adoption by offering financial incentives for manufacturing expansion. Additionally, the Ministry of Heavy Industries and Public Enterprises (2020) launched the National Electric Mobility Mission Plan (NEMMP), a strategic roadmap aimed at strengthening fuel security, providing cost-effective and sustainable transportation, and positioning India as a leading global EV manufacturer.

Further, research conducted by Kumar and Dash (2013) showed a possible demand for EVs in India. However, the need of infrastructure to support extensive adoption of EV was it also highlighted.

(ii) Barriers and Challenges in Electric Vehicles' adoption.

In India, the affordability of EVs is a major challenge as the average household income is low (World Bank, 2018). Bloomberg (2018) study showed that most of the car purchased in 2018 had price less than ₹7 lakhs showing low financial capabilities of consumers (Adepetu & Keshav, 2017).

Currently, the average cost of an electric vehicle (EV) in India is Rs. 15 lakhs, which is significantly more than the average cost of a typical fuel-based car, which is Rs. 5 lakhs. This price disparity poses a significant challenge for the ordinary Indian customer. Likewise, the electric two-wheeler category has a somewhat substantial price premium. Furthermore, banking institutions have displayed a hesitancy in providing financial support for emerging technologies that lack a clear or predictable resale value. Based on existing research and expert opinions, the problems associated with the adoption of electric vehicles (EVs) in India, namely in the four-wheeler segment, have been identified and are shown in Table 1.

Table1: Challenges in the adoption of E-Vehicles

S.No	Barriers and Challenges in Adoption of EV	Source and Year	Description
1	Cost or Price	Adepetu and Keshav (2017)	The pricing range of electric automobiles, such as the Tata Tiago (ex-showroom price: Rs. 8.69 lakhs), to models from MG and Hyundai in 2020 (priced at Rs. 27.99 lakhs), exhibits significant variety. In contrast, conventional cars, including those manufactured by Maruti, Tata Motors, and Hyundai, have a price range of 6 lakhs to 20 lakhs.
2	Range Anxiety	Mishra (2013); Thakkar(2018); Singh (2020)	Range anxiety refers to the distance an automobile is capable of traveling following a single recharge. In the Indian context, the distance between charging stations ranged from 200km to 400km prior to 2023.
3	Lack of charging infrastructure	Animesh Singh,NDTV, (Oct,2021); Naik(2020)	At now, the ratio of charging facilities to electric cars is at 100 per 1,000. In the hypothetical scenario if all vehicles in the registry were electric vehicles (EVs), the ratio of charging stations to vehicles would decrease to 0.5 per 1,000 vehicles. In order to accommodate a fleet of one million electric vehicles (EVs) inside each city in India, it is predicted that a total of around two million charging stations, comprising both fast and slow charging options, will be necessary.
4	Lifetime cost and disposal cost	Adepetu and Keshav (2017)	There is a degree of ambiguity regarding the potential resale value and the associated expenses of battery replacement beyond the vehicle's restricted lifespan, in a context where the prevailing norm is to retain ownership of the automobile for extended periods of time.
5	Environmental Concerns	Axsen & Kurani (2013)	Environmental considerations serve as a significant source of motivation for a considerable number of customers. Individuals may choose for electric vehicles (EVs) as a means to mitigate their carbon emissions and actively participate in fostering a more environmentally sustainable ecosystem. The component in question can also be influenced by

			government incentives and laws aimed at encouraging environmentally efficient automobiles.
6	Perceived Performance	Franke & Krems F. (2013)	Consumers may harbor apprehensions regarding the performance of electric cars (EVs) in relation to conventional internal combustion engine (ICE) automobiles. Various factors, like as acceleration, speed, and the entire driving experience, might exert an impact on individuals' purchase decisions.
7	Service and maintenance	Sharma (2019)	The current state of maintenance and availability of accessories for electric vehicles remains in its early stages. It is anticipated that as the market expands, this system will undergo significant development.
8	Battery Technologies and Manufacturing Capabilities	Sharma (2019)	The cost of batteries per kilowatt-hour (kWh) is now seeing a downward trend. Nevertheless, India heavily depends on imported components and significant expertise in this field. The cost of batteries is expected to decrease as Indian innovation expands. According to market analysts, the electric vehicle (EV) battery business in India is projected to possess a potential worth of $300 billion by the year 2030. At present, the Indian market is being targeted by several battery manufacturers, including the collaborative effort of ISRO-BHEL, Amara Raja, HBL, Eon Electric, and Exide.

Source: Authors compilation

One significant obstacle impeding the extensive adoption of EVs in India pertains to the limited accessibility of services for battery disposal, automobile maintenance, and repairs. These factors have a notable impact on the decision-making process of consumers (Naik, 2020).

Various factors influence the choice of the automobile, such as comfort, reliability, technology, budget, environmental concerns, acceptance by society and necessary infrastructure availability (Bhalla, 2018). During the covid era, Govt. of India has started different initiatives to promote EVs and change consumer thinking.

Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme is one such initiative that gives incentives for buying hybrid and electric vehicles with also investing

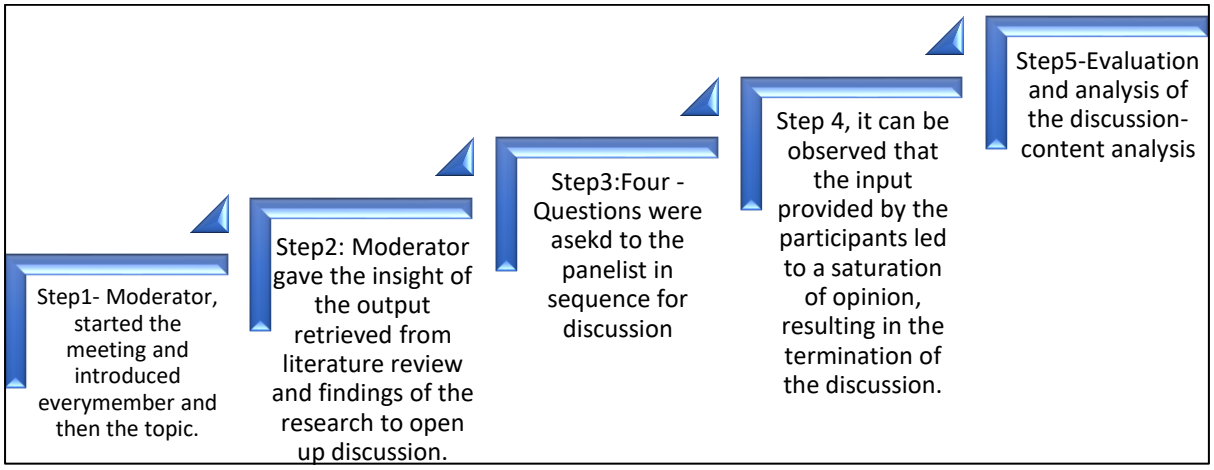
in infrastructure development of charging. Financial incentives and awareness campaigns have also been implemented to enhance the adoption of EV, showing the benefits of pollution reduction and low dependency on fossil fuels.

Even with these efforts, a considerable gap still remains in academic research on the key points which affect the decision of consumer while buying EVs. This gap in knowledge showed the need for further research to understand and address the issues hindering the higher acceptance of EVs in India.

3. RESEARCH METHODOLOGY

The primary aim of this research was to explore the potential for India's automotive industry to transition to electric vehicles (EVs) as a strategy for reducing carbon emissions and promoting environmental sustainability. Understanding the key factors influencing EV adoption in India requires an in-depth examination of the subject. To achieve the study's objectives, data was collected, analyzed, and synthesized using both primary and secondary sources. Primary sources are essential for understanding the core factors that shape consumer decision-making regarding EV adoption, while secondary sources help analyze government laws and policies designed to encourage the shift toward electric mobility. For this research, insights were gathered from 13 participants via Google Meet, employing a focus group methodology. Focus groups, a qualitative research approach, involve structured discussions led by a moderator, bringing together individuals from diverse backgrounds to share their perspectives. The study's participants included four experts from automotive manufacturing companies, three representatives from regulatory agencies, three professionals from the industrial sector, and three academic researchers specializing in the EV market. The use of focus groups as a research method proves beneficial, as it enables the collection of expert opinions and provides valuable insights into the challenges and opportunities associated with EV adoption in India (Khanna et al., 2018).

The steps in Fig. 1 below reflect the directions for conducting the survey:



Source: Author's

4. Analysis and Interpretation: To align with the study's objectives, four open-ended questions were formulated. These questions were designed to facilitate in-depth discussions within the focus group, aiming to explore the challenges, strategies, and policies related to electric vehicles (EVs). The following questions were presented to the experts:

Q1.What is the current state of electric vehicle (EV) charging infrastructure in India, and what are the main types of charging stations, including fast and slow charging options?

Q2. What government policies and incentives are currently in place in India to promote the adoption of electric vehicles (EVs)?

Q3. What are the primary determinants that influence the decision-making process of Indian customers in regards to the adoption or non-adoption of electric vehicles?

Q4. What are the present levels of air pollution and greenhouse gas emissions in India that may be attributable to the transportation sector?

In order to achieve the goals of our study, we employed a content analysis methodology. This technique was chosen because to its ability to systematically analyze the audio and video material, as well as understand the information exchanged during Google Meet sessions.

Q1. What is the current state of electric vehicle (EV) charging infrastructure in India, and what are the main types of charging stations, including fast and slow charging options? *Public Charging Stations*: Several firms, like Tata Power, EVRE, and Fortum, have created diverse public charging networks. The placement of these charging stations is commonly seen in urban centers and along key transportation routes, facilitating extended journeys.

Home Charging: A significant number of electric vehicle (EV) owners in India exhibit a preference for the installation of home charging stations due to the convenience they offer. Home charging stations, namely those utilizing AC charging, are frequently characterized by slower charging speeds. However, they seem to be well-suited for overnight charging and fulfilling the everyday commuting requirements of electric vehicle owners.

The prevalence of fast charging stations is increasing in metropolitan areas and along major transit routes. These charging stations have enhanced charging speeds and have the capability to substantially decrease the duration of charge. The primary method employed for fast charging involves the utilization of Direct Current (DC) chargers.

The availability of slow charging stations, referred to as Level 1 or Level 2 chargers, is widespread for both residential and public use. These chargers have a reduced charging rate in comparison to fast chargers, making them well-suited for overnight charging and shorter daily travels. Typically, AC (Alternating Current) chargers are employed for this purpose.

Q2. What government policies and incentives are currently in place in India to promote the adoption of electric vehicles (EVs)?

The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) Scheme aims to expedite the acceptance and production of hybrid and electric vehicles.- The Future of Automotive Mobility and Electrification (FAME) is a notable governmental endeavor with the objective of facilitating the widespread acceptance and utilization of electric cars (EVs) and hybrid automobiles within the Indian market.

The program provides financial incentives to producers, purchasers, and suppliers of charging infrastructure.

The FAME II initiative, which was introduced in 2019, expanded the program's coverage and benefits by include subsidies for electric two-wheelers, three-wheelers, and buses.

In order to enhance affordability, purchasers of electric vehicles were granted subsidies.

Goods and Services Tax (GST) reduction-The reduction of the GST on electric cars (EVs) to a lower rate of 5% was implemented with the aim of enhancing the competitive price of electric vehicles in relation to conventional automobiles.

Income Tax Benefits: Individuals who choose to purchase electric vehicles (EVs) are eligible for income tax incentives and exemptions, effectively reducing the overall cost of vehicle ownership. These financial benefits aim to encourage more consumers to transition to EVs by making them more affordable.

Several states in India have introduced state-level incentives to promote the adoption of electric vehicles (EVs). These incentives include additional subsidies, exemptions from registration fees, and waivers on road taxes, making EV ownership more cost-effective for consumers.

Public procurement has been utilized by the government as a means to promote the adoption of EVs inside government fleets and public transportation systems. This strategic approach aims to showcase the practicality and feasibility of EVs while simultaneously mitigating pollution levels.

The adoption of electric cars is expected to be driven by the phasing out of internal combustion engine (ICE) vehicles, as declared by several state governments.

Incentives for the Manufacturing of Electric Vehicles and Batteries:

Furthermore, the government implemented incentives not only for consumers purchasing automobiles, but also for businesses engaged in the production of electric vehicles and batteries, with the aim of fostering local manufacturing.

There have been concerted endeavors to build standardized protocols for electric vehicle (EV) charging infrastructure, with the aim of ensuring seamless interoperability and enhanced user convenience.

Q3. *What are the key factors influencing Indian consumers' decisions to adopt or not adopt electric vehicles?*

Consumer attitudes and behaviors toward purchasing electric vehicles (EVs) are shaped by multiple factors. Based on content analysis, the following five key factors play a significant role in influencing consumer decisions:

1. Cost:
The cost of traditional internal combustion engine vehicles is generally lower compared to EVs. Consumers consider different factors while evaluating affordability that includes government incentives, long-term fuel savings, maintenance and initial buying price.

2. Infrastructure:
Consumer adoption of EVs is also influenced by accessibility and availability to charging infrastructure. Lack of charging infrastructure can lead to stopping switching to EVs. The ease of accessibility can influence the confidence of EV owner.

3. Range Anxiety:
The EV driver’s concern to run out of battery is termed as Range anxiety. The battery efficiency and driving range are crucial factors in the decision making of consumers. The potential buyers access the EV’s range related to their daily travel needs before buying the EVs.

4. Environmental Concerns:
Environmental awareness can motivate a considerable number of consumers. Many opt for electric vehicles (EVs) to reduce their carbon footprint and contribute to a more sustainable

and eco-friendly future. The desire to minimize air pollution and dependence on fossil fuels plays a crucial role in influencing EV adoption.

The component in question can also be influenced by government incentives and laws aimed at encouraging environmentally efficient automobiles.

5. ***The perception of performance***: Consumers may harbor apprehensions regarding the performance of electric vehicles in relation to conventional internal combustion engine (ICE) automobiles. Various factors including as acceleration, velocity, and the entire driving experience might exert an impact on individuals' purchase decisions. The presence of positive experiences and evaluations from early adopters has the potential to mitigate worries over performance.

Q4. What is the current impact of the transportation sector on air pollution and greenhouse gas emissions in India?

The Impact of Transportation on Air Pollution in India

India faces significant challenges in maintaining air quality, with a substantial portion of air pollution attributed to the transportation sector. Various pollutants released by vehicles contribute to environmental degradation and public health concerns.

Key Air Pollutants from the Transportation Sector:

1. **Particulate Matter (PM2.5 and PM10):**

- The transportation sector, particularly diesel vehicles, is a major source of fine particulate matter (PM2.5), which poses severe health risks.

2. **Nitrogen Oxides (NOx):**

- Emissions from diesel-powered vehicles significantly contribute to air pollution and the formation of ground-level ozone, which negatively impacts human health and the environment.

3. **Volatile Organic Compounds (VOCs):**

- Vehicles release VOCs, which contribute to the formation of secondary pollutants such as smog and ground-level ozone.

4. **Carbon Monoxide (CO):**

- Although CO emissions from vehicles have reduced due to advancements in cleaner vehicle technologies, the transportation sector remains a source of this pollutant.

Greenhouse Gas (GHG) Emissions from the Transportation Sector in India:

1. **Carbon Dioxide (CO_2):** Due to the combustion of fossil fuel such as diesel and gasoline, the transportation industry is a major contributor to CO_2 emissions in India.

2. **Methane (CH_4) and Nitrous Oxide (N_2O):** Along with CO_2, CH_4 and N_2O are also emitted by vehicles mostly from the rural transportation and agricultural systems, there by leading to greenhouse gas emissions.

3. For reducing greenhouse gas emission and air pollution in India, efforts are on to mitigate the environmental impact of transportation.

Effort by India for a reduced Greenhouse Gas Emission and Air Pollution in Transportation.

India is constantly working to enhance fuel efficiency standards and higher the acceptation of EVs as part of its long-term strategy to low greenhouse gas and air pollution emission in the transportation sector.

Key Initiatives and Measures:

1. **Promotion of Electric and Hybrid Vehicles:**

The **Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME)** aims at encouraging the higher use of hybrid and EVs by providing financial support and incentives.

2. **Expansion of Public Transportation:**

Public transportation networks along with Bus Rapid Transit corridors and metro rail are being expanded to reduce dependencies on private vehicles.

3. **Implementation of Bharat Stage VI (BS-VI) Standards:**

Stricter emission regulations and use of cleaner fuels has been manded by enforcing BS-VI emission norms leading to lower vehicular pollution.

4. **Encouraging Non-Motorized Transport:**

Walking and cycling is being promoted by several metros for a reduced traffic congestion and emission there by promoting sustainability.

5. **Investment in Green Mobility Infrastructure:**

To facilitate the transition to a cleaner transportation, most of the funding has been moved towards electric buses, EV charging infrastructure and mass rapid system.

India’s commitment to clean transport ecosystem and sustainability in mobility can be highlighted by this.

5. CONCLUSION

With huge population in India and the importance of transportation in the daily lives, both the EV industries and government have higher responsibilities in taking care of environment sustainability promotion and addressing pollution. Continued efforts in policy development, infrastructure expansion, and technological innovation will be essential in accelerating the transition toward cleaner and more sustainable transportation solutions.

It is essential that the government continue to vigorously promote the laws, tax benefits, and incentives that are linked with the purchase of electric vehicles (EVs). Despite the existence of policies like as FAME, tax advantages, and incentives, India still has a long way to go before it can be considered transformed. Additionally, the method taken by manufacturers needs to be consistent. It is the responsibility of every promoter, whether they are dealers, service centers, or organizers of events and exhibitions, to educate customers at every level. The collective effect of these factors will very probably alter how consumers see conventional engines. In addition to this, they need to make people aware of the dangers that conventional engines pose to their health, particularly those individuals who live in major urban areas. It is necessary to find solutions to problems faced by customers, as these are preventing the expansion of the EV market. A few problems, such as range anxiety, the expense of electric vehicles (EVs), and the cost of replacing batteries, among others, need to be addressed with deeper information that is then passed on to the customer, which will change their view. All of these different activities

will unquestionably assist us in achieving our goal of having a cleaner and more verdant environment.

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