Fosterage and Sustenance of Electric Vehicles: A Comparative Study of India and Norway

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Abstract

The transportation sector across the globe has witnessed massive changes from the conventional "ICE (Internal Combustion Engine)" vehicles to battery driven electric vehicles (EVs) in the last two decades. While sustainability is the need of the hour and there exists a plethora of research analysing sustainable fuel alternatives and EVs, one cannot disregard the colossal influence of consumer behaviour and responsiveness towards this growing trend. Its adoption, however, has been challenged by the dilemma that as long as the number of charging stations is insufficient, manufacturers will not be incentivised to enter the EV market. Subsequently, a low number of EVs will fail to stimulate sufficient demand for charging stations, resulting in a 'chicken or the egg' quandary. In the case of India, the shift to EVs has been gradual as opposed to Norway, which has seen much rapid response and infrastructure readiness. By delving into questions surrounding technological factors and the legal-political schemes that impact prospective owners' choices towards EVs, the research carried out will help ascertain the factors responsible for the growth of EV market in two distinct economies. This paper presents a comprehensive review of literature based on consumer preferences for EVs aiming to better inform policy-makers as well as give direction to further research. An attempt is also made to analyse Norway's success story from the Indian standpoint and delve deeper into the interrogation to better understand what factors influence consumer preferences in the Indian market.

Keywords: Electric Engine, Internal Combustion Engine, Innovative Engine Technology, BEVs (Battery Electric Vehicles), PHEVs (Plug-in Hybrid Electric Vehicle), Consumer Behaviour, Sustainability, Infrastructure, Policy Measures, Legal Political Schemes.
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Introduction

Cars have progressively assumed the role of being the centrepiece or 'the leading object' of modern transportation systems (Lefebvre, 1971). Apart from providing the possibility to travel practically anywhere at any time, cars are seen as symbols of freedom and social status. They have also come to

be associated with one's choice and preference that forms one's overall identity (Ingeborgrud & Ryghaug, 2019). In this regard, transitions to sustainable transport simply cannot ignore auto mobility (Kemp et al., 2012).

Simply, EV is an acronym for "electric vehicles" that are partially or fully operated by batteries. Electric motors propel the EVs, and the rechargeable battery maintains the power supply. The EV market largely includes "Hybrid Electric Vehicle (HEV)", "Battery Electric Vehicle (BEV)" and "Plug-in Hybrid Electric Vehicle (PHEV)". HEVs are mainly powered by electricity and fuel having an electric motor. Its battery is charged from the electricity generated by the braking system. PHEVs are similar to HEVs although have a smaller engine and larger batteries. The batteries can recharge either by the braking system or by plugging into an "external electric charging point". As a matter of fact, BEVs do not have an engine of their own and instead use electric motors for propulsion, where batteries act as the energy storage device. These batteries can be charged with the help of eternal power points.

Notedly, Scholars have time and again highlighted the benefits of electric vehicles as it mainly involves the use of electricity that has proven to be more affordable when compared to its gas/fuel counterparts. Not only has this decreased fuel requirement drastically but also reduced emissions and has overall made operations more cost effective (Sovacool et al, 2009).

The benefits of EVs have become congruent with the general demands for fuel efficiency, greater performance and low emission in vehicles. Furthermore, the global depletion of "fossil fuels" coupled with growing levels of pollution has only contributed to the growth of the "electric vehicle market" in recent years. While there have been subsequent waves of interest in developing and testing electrically powered personal vehicles, it is only recently that they have attracted substantial attention from policy makers and scholars. EVs have also started to challenge the market of petrol and diesel cars. Thus, the future of cars has progressively become synonymous with the growing potential of the electric vehicles market in the global economy.

Norway, a country that is the biggest producer of crude oil in Western Europe has achieved success in making a transition from non-renewable fossil fuels to renewable energy sources. With a land area close to the size of the state of Maharashtra, the government of Norway has been striving to create urban centres that are free of pollution, congestion and noise. In 2017, the parliament of Norway set a non-binding goal to ensure that all cars sold should be zero emission by 2025. The government of Norway has also allowed for car making companies to use Norway as a testing ground for the sale of its EV cars. As per a CNN report, Volkswagen's luxury brand Audi was the market leader in 2020, selling 9,227 units of its e-tron model, followed by Tesla's Model 3, which sold 7,770 units. Volkswagen's ID.3 came third at 7,754.

It is interesting to note that Norway's government has made provisions to permit electric cars to run on bus lanes and exempt them from tolls. Moreover, parking lots offer a free charge, and new charging stations are continuously being built on the nation's highways that are a mix of regular charging stations and fast-chargers. Therefore, these inputs not only demonstrate the willingness of the government to boost the EV market but also reflect the people's willingness to adapt to this change. Additionally, data suggests that the purchase of EVs has almost increased to twice its size annually since 2012, and this trend is predicted to continue as the government still emphasises on the purchase of EVs (Aasness & Odeck, 2015).

Thus, it is this growth and importance given to the EV market in Norway that makes for a fascinating case in point to analyse the factors that have helped aid this process.

As in the case of India, roads are the most preferred and accessible mode of transportation, with more than 60% of the population using personal or shared vehicles to commute (Statista, 2020), not surprisingly it also has the third-largest road network in the world. According to a report by RBSA Advisors, the Indian EV market, though in its early stages, is estimated to grow at a "CAGR" of 90 per cent from 2021 to 2030. In terms of penetration, EV sales accounted for a mere 1.3 per cent of the total transport sales in India during 2020-21, however, the market is growing steadily and is expected to touch $150 billion by 2030 (India's EV market to grow by 90% to touch $150 billion by 2030: Report, 2022). This underlines a laudable market potential for new as well as players to expand operations substantially.

With India signing the "Paris Convention" in 2015 and the government consequently directing efforts towards the growth of EVs in the automobile sector, switching to electric vehicles for sustainable and affordable transportation, EVs have increasingly become a subject of popular discourse. India, being an inherently socio-economically and culturally diverse country, poses numerous questions surrounding how the economy and primarily the consumers respond to the promptly advancing EV ecosystem. In this case, a number of barriers prevent their widespread uptake that not only include additional cost of new "innovative technology" but also are the cause of relative inconvenience. The insufficient infrastructural facilities and lack of consumer understanding about the viability of the technology pose as important challenges to the universal acceptance and adoption of EVs.

In India, the shift to EVs has been gradual as opposed to Norway, which has seen much rapid response and infrastructure readiness. By delving into questions surrounding cultural acceptance, conditions and prices of fuel market, demographic grounds and the legal-political schemes that impact prospective owners' choice decisions towards EVs, the research carried out will help ascertain what helps the EV market grow.

Review Of Literature

Based on a thematic review of the literature, we observed that out of various factors, two primary factors namely – technology and policy measures play a "pivotal role" in the fosterage and sustenance of EVs in India. Therefore, we will first emphasis upon reviewing the literature on 'technological factors' and then move to the 'policy measures' that have added to the trajectory of growth of EVs in India and Norway.

Technological Factors

Of late, nation states have been seeing a trend of technology and infrastructure forming the core foundation and spearheading change in almost all sectors of the economy. The case of EV market penetration is no anomaly to this. "Technology and infrastructure" have been seen to progressively assume a vital role with regards to the reception and openness towards EVs.

In terms of infrastructure, the chief concern is of accessibility and availability of charging stations. Presently, there are about 1028 public functioning charging stations in India. This number is expected to witness massive growth due to the growing demand of EVs, however, it requires a massive push. The "electric vehicle charging infrastructure" is predominantly categorised into two categories — 'Slow Chargers (3-4kW)' and

'Fast Chargers (50-100 kW)'. In an interview with Inc42 Media, Chaturvedi MD and CEO of Volttic EV Charging explains:

"On an average, a public charging station will require almost 100 KW of load and if we are targeting one charger on 50 EVs, almost 20,000 EV charging stations are required with demand up to 2000 MW."

According to the "Bureau of Energy Efficiency of India", the challenge to EVs meeting necessary standards for electric battery manufacture capability is also one of the reasons the Indian government revised its target of EV adoption from 100% to 30%. India imported lithium-ion batteries worth $1.23 billion in 2018–19 (Gupta, 2020) shedding light on the urgent need of having to establish alternate sources of cost-effective EV technology for automobile manufacturers.

According to a report by Niti Aayog, the 30% target of EV adoption by 2030 is dependent on the availability of power to sustain that growth. While the power-generating capacity in India was 334.4 GW in January 2018 (world's fifth-largest) and is growing at a CAGR of 7% (FY10–FY17), among the different sources of power, thermal non-renewable sources (80% coal) contributes the maximum (70%) to this total installed capacity. With the government planning to touch 175 GW of renewable energy by 2022, from the current 57 GW, it hopes to have 40% of the energy needs met by renewable energy, including nuclear and hydro energy.

In India, an extremely price sensitive economy, the high purchase cost of EVs remains a salient impediment in its path towards the adoption of electric vehicles. Based on automotive survey data (Source: Bloomberg NEF, 2018), it can be inferred that two-thirds of the cars purchased in the year 2018 were below the price tag of Rs.7 lakhs (Adepetu and Keshav, 2017). So far, an average EV cost of Rs. 15 lakhs compared to the average traditional fuel-based vehicle cost of Rs. 5 lakhs. Similarly, there is a comparatively high price premium on the electric two-wheeler segment. Thus, the cost of EVs is too high for an average Indian consumer. In addition to this hiccup, there is also a general reluctance observed in lending institutions to finance new technology whose resale value is uncertain or not forthcoming.

Lastly, it can be noted that a major challenge inhibiting the acceptance of EVs in India is the unavailability of service/repair network, compelling the "vehicle owner" to be dependent on the "Original Car Manufacturer Service System (OCMSS)", thereby restricting the possibility of availing alternative services. Even though the "EV system" is not as complex as the ICE (Internal Combustion Engine) driven car's repair and maintenance costs are considerably low, and even the "service sector" in India is in its emerging stage which inversely impacts consumer decision-making when it comes to buying EVs.

Contrary to India, in Norway, home charging plays an important role. Figenbaum and Nordbakke (2017) find that at least 80% of all "BEV (Battery Electric Vehicle)" owners charge their vehicle at home. This can be explained by the high availability of private space across the comparatively sparsely populated country. An additional factor appears to be the varying costs of charging by location. In general, public fast-charging is more expensive than charging at home. E.g., Norsk Elbilforening (2016) indicates that the former is about three to four times costlier than the latter. As in the case of Oslo it had free public charging in 1300 stations until 2019 (Manthey, 2019).

We can also note that the Norwegian government has already established fast-charging stations

every 50 kilometres on all main roads, including the world's most advanced fast-charging station. All-in-all, this leads us to expect that any effects of "public charging infrastructure" we measure in Norway might be elevated in more densely populated nations.

As for 2009, to allow for profitability of charging points beyond the then few EV-dense locations, the Norwegian government started to strongly subsidise electric car charging infrastructure development across the country (Figenbaum and Kolbenstvedt, 2013; Lorentzen et al., 2017). Similar local initiatives were established by the administrations of Oslo, Akershus and the East and West Agder County Councils (Figenbaum and Kolbenstvedt, 2013). These initiatives significantly decreased barriers for initial development of EVs during early years of diffusion. Lower up-front costs made charger placement less dependent on local EV adoption. It can also be observed that the first major initiative to this end was the subsidised establishment of fast chargers across rural southern Norway starting in 2015 (ENOVA, 2015; Lorentzen et al., 2017). It was followed by a large-scale agenda across the Norwegian countryside in 2017 (ENOVA, 2017).
There are currently around 16,000 charging points in Norway, an increase from around 3,000 since 2011. This represents more than 9% of the total charging stations in Europe – all the more impressive when you consider that Norway makes up only 0.7% of the total population of Europe. Subsequently, a centre piece of Norway's EVSE investment strategy is the provision of grants for housing associations. For the capital Oslo, an EVSE grant of a maximum of 20% of the cost of EVSE purchase and installation is given as up to €450 per charging point and €91,000 per housing association. Therefore, infrastructure coupled with an incentive based approach has been seen as a major prerequisite to the success story of EVs in Norway.

Policy Measures

Legal barriers and policy measures refer to the various policies, government schemes and legalities encouraging or dissuading entry of electric vehicles. Good policies thus, can then become proponents of growth of an industry in a specific country.

The example of India serves as a testimony to policy makers believing that 'good policy equals better growth'. According to a KPMG report, it is estimated that by 2030 there will be a 100% incremental adoption of electric vehicles while projections of the "Indian EV market" growing at a CAGR of 36 percent till 2026 are also being made "India Energy Storage Alliance (IESA)".

It is evident across studies that the government is constantly promoting the EV industry through multiple channels although facing difficulties to bring adequate infrastructure. By launching e-AMRIT – https://www.e-amrit.niti.gov.in/ – at the COP26 Summit in Glasgow, which is a one-stop destination for all information on electric vehicles, the government is trying to increase awareness about this new market to consumers. While the government pledges to have only EVs (Electric Vehicles) on road by the year 2030, replacing all the vehicles operational-cum-powered by diesel and petrol (Kumar et al., 2020), the mere fact that Toyota had to close the manufacturing of electric and "hybrid cars" for the Indian market, mentioning scarce charging infrastructure (Naik, 2020) raises doubts on this ambitious commitment. Therefore, "Charging infrastructure" as discussed in the previous section can be seen as one of the serious bottlenecks in electric vehicles' adoption in India.

On one hand, the Ministry of Power has issued a policy on charging infrastructure and has clarified that charging electric vehicles will be a service that

would enable electricity stakeholders to set up the charging infrastructure easily, on the other hand, ISRO (Indian Space Research Organisation) has commercialised the indigenously developed lithium-ion battery technology and has already selected 14 companies to transfer technology that will promote localisation of the technology, thus lowering the TCO (Total Cost of Ownership) for EVs.

Schemes launched by the Indian government such as "Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME)" are boosting productions in India. The Indian government can also save 1 lakh crore rupees on crude oil imports if the 30 per cent target of EV penetration is achieved.

For Norway, there are strong incentives to purchase and drive EVs, but the common story of these incentives making Norway the global forerunner in electro-mobility (Bjerkan et al. 2016) is rather a very simplistic view. The Norwegian story illustrates that economic incentives alone cannot explain or ensure large sales, many economic incentives were introduced during the 1990s or early 2000s, without any significant effects on the market: EVs remained a niche market (Figenbaum et al. 2015).

By analysing multiple studies, it can be said that since the early 1990's, Norway has developed substantial and comprehensive EV incentive programmes, setting a world record, as 69% of its total cars sold are electric. Norway's strategy for the deployment of electric cars has proven successful in substituting petroleum with electric vehicles. This is underscored by Norway's most sought-after car, the VW Golf, shifting gears towards a greener fuel source, going from 90% diesel driven to 97% pure electric in less than a decade. Studies point out that in Norway, it's more cost-efficient to run an EV car compared to its equivalent petrol or diesel models. Their early adoption of the 'polluter pays' principle, deterring drivers from owning high emission cars with hefty taxes has been instrumental in encouraging Norwegians to go electric. As they move towards full electrification, Norwegians now see EVs not as a mere radical alternative, but as an essential way to commute.

It is interesting to note that the Norwegian BEV (Battery Electric Vehicle) incentive model is that ICE (Internal Combustion Engine) cars are taxed heavily compared to most other European countries. BEVs (Battery Electric Vehicles) and FCEVs (Fuel Cell Electric Vehicles) are completely exempted from import tax and VAT. In addition, "Electric Vehicles Operating Costs" are significantly lower than for a similar "ICE (Internal Combustion Engine)" vehicle. The result is that the TCO (Total Cost of Ownership) for BEVs compares favourably with ICE cars, even more so with increased yearly driving distance. In the words of Sheller (2014), it is possible to observe not only a technological transition, but a transition of practises, networks, and discourses; in other words, an unfolding transition of mobility culture (Hopkins and Stephenson, 2014).

Furthermore, an interesting observation with EVs is that the more one drives, the more profitable the EV proves to be when compared to a traditional car, even if one expects a bigger loss in the electric car value. A Nissan LEAF, owned for 5 years and drives 15,000 miles per year was assumed to be competitive in costs compared to a VW Golf in 2011, even without full use of incentives such as access to bus lanes, free parking etc. (Green Car Strategy Paper, 2011). In conclusion, incentive-based policy measures have seen to contribute to the growth of the "EV market" in Norway, coupled with fast paced infrastructure development and market growth.

Research Gap

During the review of literature, we identified research gaps in linking the factors responsible for the adoption of EVs in a diverse economy. Unlike the other researches, we have not centred around the sustainability facet of EVs. We aim to explore the synergies between policy-technological incentives and its subsequent impact on consumer behaviour.

Objectives of The Study

- The first objective of the study is to analyse the technological and policy related measures that directly impact consumer perception and induce or inhibit them from transitioning to EVs.

- The second objective of the study is to highlight various technological and policy related measures that have made EVs a success in Norway and can be inherited by a culturally diverse country like India.

- The third objective of the study is to draw synergies between two distinct countries having unique EV markets in terms of scalability and consumer readiness.

Hypothesis of the Study

H_0: The employment of bleeding-edge technological factors such as the latest infrastructure and improved vehicle manufacturing are keys to spearhead EV penetration in the Indian market.

H_1: The employment of bleeding-edge technological factors such as the latest infrastructure and improved vehicle manufacturing do not constitute the necessary conditions to spearhead EV penetration in the Indian market.

H_0: Implementing incentive-based and concessionary policy measures aimed at reducing costs of operation of EVs play a vital role in boosting EV adoption and acceptance in the Indian market space.

H_1: Implementing incentive-based and concessionary policy measures aimed at reducing costs of operation of EVs do not play a vital role in boosting of EV adoption and acceptance in the Indian market space.

H_0: The Norwegian policy measures for the propagation of EVs can be replicated in India to boost its EV market.
H_1: The Norwegian policy measures for the propagation of EVs cannot be replicated in India to boost its EV market.

Research Methodology

The research methodology adopted for conducting this study includes thematic review of literature to find out the research gap and conduct a comparative research study between Norway and India.

Data Collection

The data collected from the secondary sources has given comprehensive information and a concise insight regarding fosterage and sustenance of electric vehicles around the globe as well as in Indian and Norway.

Analysis and Interpretation of Data

The challenges in adoption of "Electric Vehicles" all around the world, specifically in Norway and prospectively in India are investigated through secondary data from industry and academia.

The secondary data are collected, analyzed and compiled to draw conclusions for the study. The data available on Norwegian Electric Vehicle Association (www.elbil.no) and the Norwegian Green Vehicle Organization (www.gronnbil.no) primarily served the data to conduct this study.

Analysis and Discussion

From a strategic point of view, government incentives and consumer characteristics are the two most crucial areas of concern when studying about the ways to increase the mass adoption of Electric Vehicles in India. In the present situation, the mass adoption of EVs in India can not only be increased but also qualitatively improved. Through the course of our study, we find that the towering increase in the use of EVs in Norway is the result of numerous targeted economic incentives, some of which include exemption from toll charges and purchase duties and allowance use transit lanes can be of consideration when formulating the Indian EV policy.

Results also indirectly show the need for providing higher subsidy to enhance the attractiveness of PHEVs to Indian commuters is crucial for the mass adoption of battery-based cars. Additionally, the relative importance of subsidising the "cost price" is much higher than providing for an open "public charging facility" for promoting PHEVs in the Indian market.

Lastly, the findings show that the harmony among stakeholders has been missing serving as a major loophole in the Indian EVs ecosystem. There are discrete efforts by diverse multiple organisations, however, it nonetheless requires collaboration for improved adoption of EVs. Because the changeover to electric vehicles is such a significant decision in terms of encouraging a shift in consumer habits as well as long-term investments, a collaboration of stakeholder efforts will be the logical way to go forward.

Research Findings

The findings of our research study highlight the fact that advance electric engine technology, various targeted incentives specific to cost and production along with conducive public policies and programmes have substantially influenced the introduction of EVs in the global environment. The following three factors for the advancement of EVs have been identified:

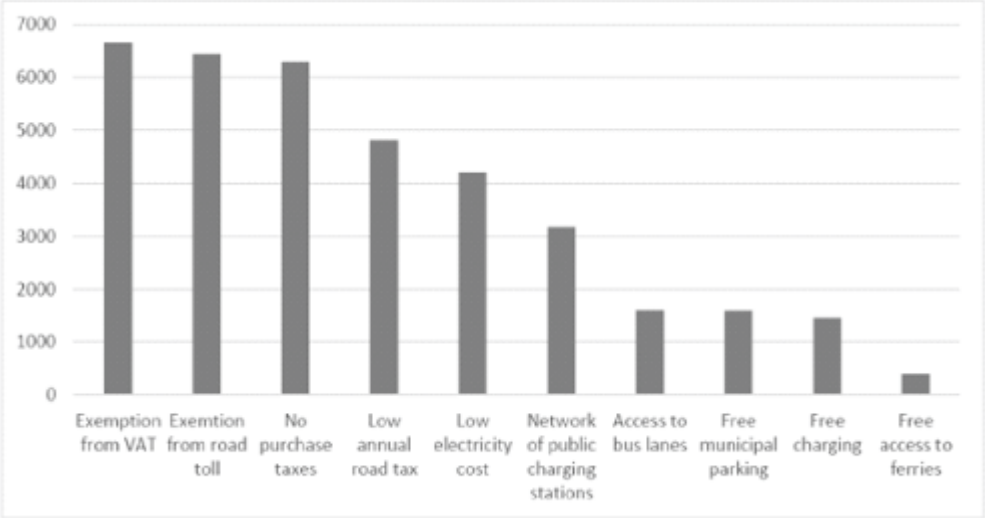
Employment of Cutting Edge Technology

The employment of cutting edge technology such as the latest charging infrastructure and efficient manufacturing of EV cars has led to a boost in the EV market. The findings of this research study indicate that installing "public charging stations" to increase the choice probability of "PHEVs (Plug-in Hybrid Electric Vehicles)" among prospective owners is of grave importance when it comes to analysing consumer preferences and purchase intention. It is found that availability of "charging infrastructure" will give impetus to EV manufacturing and the subsequent visibility of EV cars on the road will in turn incentivize the government to set up more charging stations.

Conducive Policy Measures, Incentives and Programmes

It has been identified that various conducive policy measures, incentives and programmes local to markets of countries and their monetary and fiscal environment ranging from Exemption from VAT to free access to ferries have played a significant role in determining the ease for EV adoption.

Figure 1: EV Incentives according to Norwegian EV Owners (2017)



Source: Norwegian EV Owners Survey 2017

The table shows that the main findings remain more or less constant over the years for the response towards EV incentives. These findings also correlate with research from the Norwegian Institute of Transport Economics that finds "Policies that address the purchase price of a BEV are found to be most effective in the way that they contribute significantly to BEV market shares".

By removing incentives, EVs may become less attractive to consumers both practically and symbolically, as they currently are more expensive than fuel run cars. Moreover, a wider sharing of positive user experiences with EVs as along with its local and global long-term environmental benefits such as energy production getting cleaner could also contribute to push to the forefront the idea of electro mobility, the much-needed transition of the transport system.

Replication of Norway's EV Strategies in India

The findings of our research study also through light upon the attempt which is made to analyse Norway's success story from the Indian standpoint and delve deeper into the question of what factors influence consumer preferences in the Indian market.

While Oslo is renowned to be the EV capital of the world, replicating the Norwegian EV strategy in an emerging economy, like that of India will indubitably prove to be detrimental to the large-scale adoption of EVs. Norway features optimal prerequisites for EV diffusion and its population is coherently wealthy. Strong subsidies have supported diffusion throughout the last three decades and its hydroelectric energy is affordable, accessible and eco-friendly. On the other hand, given that Norway ranks among the countries with the highest home charging availability worldwide, this effect is even stronger in countries where fewer individuals have access to home recharging facilities. In Norway, the purchase and use of EVs is largely different from that observed elsewhere in the world, and thus, cannot be simply reproduced by imitating.

The research findings further bring into spotlight the hitherto neglected aspect of the source of energy that forms the foundation of fosterage of EVs; the short-term effects of EVs in India are more often than not viewed in isolation with the availability of actual power capacity of India,

simply meaning that while adopting EVs seems like an attractive option currently, the long-term electric power demands it generates outweighs the current renewable energy sources in India. Power generation scenario renders EV viability at the verge of unsustainability. The current electricity generation scenario in India is dominated by coal-fired thermal power plants. Hence, to achieve a sustainable and eco-friendly transition from I.C. engine vehicles to electric vehicles, shifting to renewable energy sources of power generation is a necessity as well as a precondition to any efforts being diverted towards the EV scenario in India.

Conclusion

Fosterage and sustenance of EVs in India mainly depends upon two important aspects viz. technological up-gradation and conducive public policy. In order to sustain EVs as a viable transport technology in the future, socio-technical elements of EV policies coupled with user perception and practices should be studied. It is predicted that EV incentives will change as the number of EVs grows, and subsequently, the onus of maintaining transport infrastructure, i.e. the payment of tolls will lie on the shoulders of EV car owners. Technology will continue to upgrade and newer designs and models will be introduced. Hence we find that the government's willingness to invest in technology coupled with timely implementation of incentive driven polices will help India move in the right direction allowing for the necessary up-gradation and expansion of the EV market as a whole.

Recommendations

Vehicle manufactures are advised to prioritise reducing battery charging time, improving tailpipe fumes reduction and increasing electric range to make next-generation PHEVs more alluring to Indian commuters. It will be advantageous for the government to conduct a pilot layout of charging stations in major cities as a model, and then incentivise investment from important manufacturers through subsidies, to reduce difficulty in setting up charging stations. The government can also use legal measures, such as taxing use of conventional vehicles or punishments to persuade “laggards”, or, even drastically banning the production and sale of vehicles powered only by depleting fossil fuels.

Limitations

The study conducted was based on secondary data thereby making it difficult to obtain information strictly specific to consumer perception and behaviour with respect to EV adoption.

Scope For Future Research

In this study we exclusively focused on two main factors influencing diffusion of electric vehicles, namely the technological and policy measures. The subsidiary factors which may play role in the diffusion of EVs (electric vehicles) are suggested to be taken in to consideration by future researchers to extend the scope of this study. Therefore, future researchers may identify and analyse the uncharted new influential factors of diffusion of electric vehicles with respect to consumer responsiveness and the aggregative wave of public opinion.

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