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Transitioning from Fuel Based Automobiles to Electric Vehicles: A Conceptual Model for India

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Abstract

Pollution of Environment is becoming a global concern in view of its far reaching consequences on living beings. As far as air pollution is concerned, emissions from fossil fuel based internal combustion engines are a major contributor. To address this concern, world over there is a movement to promote electric vehicles with many countries even incentivizing this transition. India has been a slow mover in this respect. For India, this paper assumes great relevance as major Indian cities have been classified as being among the topmost polluted urban centres and thereby affecting the health of its citizens. Diseases due to environmental pollution have also been on the increase. Taking note of these concerns, the Government of India has given a push for having Electric Vehicles only by 2030. This paper examines the different factors that could affect the transition to electric vehicles based on the literature available from previous studies globally and builds a conceptual model.

Keywords: Behavioral Intention, Electric Vehicle, Enabling Infrastructure, Environmental Concern, Perceived Monetary Benefit, Social Influence

1. Introduction

India has been characterised over the years by a shift towards private vehicles thereby clogginng the major arterial roads across all major cities. The Government for its part has been actively building metro networks across important cities of India. By and large the city bus transport has not been well run and managed thereby causing people to switch to private transport and in turn causing air pollution. As pollution is scaling new peaks across the metros, the Government is now pushing for Electric Vehicles to conserve the environment.

The automotive industry is on the cusp of a paradigm shift. Increased awareness and concerns on environmental pollution due to fossil fuel-based vehicles could result in a total transformation of the way the transport sector operates. Due to sustained campaigns, the sector in India is taking its initial baby steps in transitioning to Electric Vehicles (EV) from an era of fossil fuel based internal combustion engines.

EVs are propelled by electric motors and power supply is maintained through rechargeable batteries. The EVs produce less noise, are energy efficient and generate less of greenhouse gas emissions (GHG). According to a report on the transport sector by International Energy Agency Jacob Teter (2019), the transportation sector contributes to 24% of direct CO_2 emissions and that road vehicles contribute three quarters of transport emissions.

Table 1, details the benefits of the different types of EVs.

In India also, there is a growing concern regarding air pollution and reduction of the carbon footprint. The Government of India has made it clear that by 2030 only Electric Vehicles should ply on the road. Only this step, it

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Table 1. Classification of electric vehicles

EV Category	Source of Power	Characteristics
Hybrid Electric Vehicles (HEV)	Vehicles running on combustion engine with an electric motor.	Reduced Emissions and better fuel mileage than similar sized conventional vehicles
Plug - in Hybrid Electric Vehicles (PHEV)	Vehicles with a smaller internal combustion engine, and with powerful rechargeable batteries	Fuel efficient, inexpensive to run, flexible fuel option and lower emissions compared to similar sized HEVs and conventional vehicles.
Battery Electric Vehicle (BEV)	Vehicles powered through battery packs.	No emissions and least expensive to maintain

Adopted from: Egbue & Long (2012)

is felt would reduce its import fuel bill as well reduce the emissions. Consequently, this would also act as a hedge against price and currency fluctuations in fuel pricing. The Government of India budget presented in July, 2019 has also given a strong push to the transition to EVs from fuel based vehicles.

Table 2. Gives the segment wise sales figures for EVs in India for the past 2 years

Vehicle Segment	Financial Year 2019	Financial Year 2018
Electric 2 wheelers	1,26000	54800
Electric 3 wheelers	6,30000	NA
Electric 4 wheelers	3600	1200
Total	7,59000	56000

Source: Adopted from Autocar

On analyzing (Table 2), it is clear that India has a long way to go in the adoption of EVs. Even within the different segments, adoption of 3 wheelers seems relatively better than two wheelers while car owners have more or less ignored the option of driving electric four wheelers.

2. Literature Review

The studies relating to India in the field of EVs are very few and most of the research has been done in Europe and North America.

EVs have a very low rate of adoption in India and people are not experienced with reference to the operating an EV. (Rezvani, Jansson & Bodin, 2015) state that people in India are unaware of even the cost of owning and maintaining an EV.

As per Delang & Cheng (2013) price as a factor affects adoption of Electric Vehicles significantly.

Hence high prices of EVs could hinder the growth of adoption while monetary incentives could stimulate the demand.

As there is a growing concern on environmental effects of fuel-based vehicles, there are also studies conducted in respect of the research on environmental concerns in relation to the behavioral intention to adopt Electric Vehicles. Based on extensive literature review globally, this paper narrows down its focus to four important variables affecting the Behavioural Intention to Adopt Electric Vehicles and builds a conceptual model therein.

2.1. Enabling Infrastructure (EI)

Donna Chen, et al. (2013) stated that EV adoption rates would depend on the access to charging stations. (Garrett, et al., 2015) State that BEVs have limitations such as lesser range, poor public recharging infrastructure and recharge times which are long. Henry A Bonges et al. (2016) indicate that unless a potential buyer of EV is not assured of constantly available and compatible charging stations they will not purchase and also suggested many improvements to the existing charging stations to make them more efficient. As per Till Gnann et al. (2018), potential users of EVs ask for public charging facilities before buying and also expect the speed of charging to be similar to conventional refueling. The deployment of charging infrastructure is an imperative for the growth of electric vehicles indicate Shekar Viswanathan et al. (2018) and that currently the distribution network is not well designed as per study done in San Diego, USA. Wajahat Khan et al. (2019) suggest that for EVs to get widely accepted, quick charging of EVs is an imperative since charging time is a key obstacle to be overcome. Based on the Literature, it is therefore conceptualized that Enabling

Infrastructure is significantly related to the intention to adopt Electric Vehicles.

2.2. Perceived Monetary Benefit (PMB)

The comparatively higher price for EVs as compared to conventional vehicles has acted as a deterrent in its adoption. Hence previous studies have advocated the need for a structured mechanism for incentivizing EV adoption.

In a study (Beresteanu & Li, 2011) summarized that tax incentives led to an increased adoption of hybrid vehicles. (Wang & González, 2013) concluded that the cost of other fuel vehicles was eight times higher than that of electric vehicles. In a study of over 3000 respondents based in United States, it was found that the total cost of ownership for an EV is lower and that it compensated for the premium cost (Dumortier et al. 2015). Aasness & Odeck (2015) stated that lower operational and maintenance costs encourage EV adoption. It is therefore concluded from the previous studies that the perceived monetary benefits influence the intention to adopt electric vehicles. Shaohui Ma, et al. (2017) advocate that subsidies if provided would significantly encourage households to opt for a plug-in hybrid or an EV as per their study conducted in China.

2.3. Environmental Concern (EC)

(Yeung, 2004) indicated that Environmental concern is an affective feature of customers that includes their concerns and worries on the quality of the environment. With awareness on pollution gradually building, studies now report that environmental benefits influence the adoption intentions of consumers. As per (Sinnappan & Abd Rahman, 2011), EVs are more likely to be adopted by those consumers who have a stronger concern for the environment. According to (Schuitema, Anable, Skippon & Kinnear, 2013), consumers who are pro-environment are possible EV adopters. In a comparative study of German consumer groups, (Peters & Dütschke, 2014) reported that for the adoption of EVs, environmental benefits are important motivators. (Junquera et al. 2016) indicated that consumers caring about the environment may be more aware of the negative contributions of gasoline cars and therefore may have a lower level of sensitivity to the price of an EV. Based on the previous studies it is prophesized that Behavioural intention to adopt electric cars is significantly linked to Environmental concern.

2.4. Social Influence (SI)

(Kahn, 2007) indicated that an individual's decision is expected to be influenced by the surrounding social network. (Axsen, Orlebar & Skippon, 2013) in their study found that social influence plays a vital role in EV promotion. (He, Wang, Chen, & Conzelmann, 2014) in their study have demonstrated the influence of social network on HEV adoption. As per (Chen & Tung, 2014), people perform a certain action due to social influence. Pettifor, et al. (2017) studied systematically the relationship between social influence and choice of vehicles and concluded that when people are considering buying vehicles, they are influenced by the behaviour and beliefs of those around them. Hence it is prophesized that Social Influence can play a significant role in the adoption of EVs.

Based on the above review of the literature, the (Figure 1) research model is proposed:

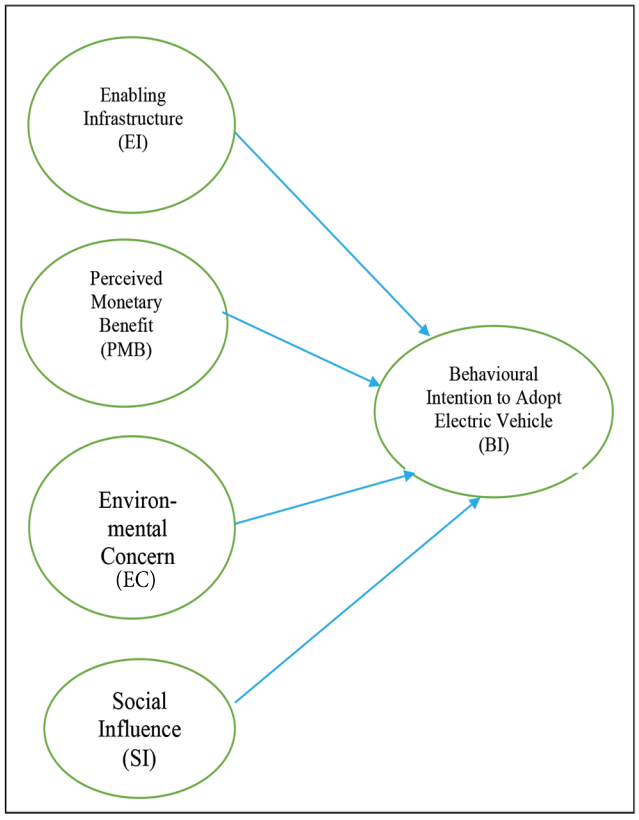

Figure 1. Showing the conceptual Research model for behavioral intention to adopt electric vehicles.

3. Discussion and Conclusion

India is just as yet taking its baby steps towards EV adoption with the industry itself in a nascent stage. The ecosystem for the adoption of electric vehicles is just about evolving and mass adoption looks a little way ahead.

It is very clear from the above model that even as concern for environment is gradually increasing, the constraints in terms of the high cost of EVs and the absence of enabling infrastructure, adoption of electric vehicles requires a big push. Vehicle owners in India look forward to incentives for making the transition backed by proper infrastructure. If the above points are taken care of, then social influence can further propel the cause of EV adoption.

The Government of India vide its Budget presented in July, 2019 has made transition to EVs a thrust area and announced a series of measures towards achieving the objective (Malyaban Ghosh, 2019). It has indicated a lowering of GST from 12% to 5% on EVs thereby lowering the price of EVs. Customs duty on imported lithium ion batteries has been waived. Makers of components of EV will be offered investment linked tax exemptions. Additionally, for customers taking loans to purchase of EVs, income tax rebates of up to Rs. 1.5 lacs have been announced. All these measures are expected to spur production and consumption of EVs.

To act as a role model and to convey the intent, the Prime Minister's Office (PMO) has installed the maximum number of charging stations among ministries and departments in India.

In conclusion, it may be stated that a big push is needed in India for the transition from fossil fueled vehicles to EVs. It involves making every vehicle owner environmentally conscious, creating an enabling infrastructure, incentivizing the transition and also making it a social movement thereby influencing all prospective car owners.

4. Scope for Further Research

The field of EVs is an emerging area giving ample scope for future research. The above model may be tested empirically for validity. Studies on EV user satisfaction may be undertaken.

5. Limitations of the Research

The paper builds a conceptual model which is not tested. After testing, the model could throw up a different set of results.

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