India, Road ahead towards Electrifying transport system: Astudy on identifying Consumer Characteristics towards EV adoption

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Abstract

The transportation system in India is getting electrified. The shift towards Electric vehicles is inevitable. Many developed countries are slowly transiting towards e-mobility. There is an immediate requirement to look into the need for sustainable transportation because of increase in carbon levels polluting the environment and depleting energy resources. Sustainable transport system takes into consideration the environmental aspect along with the economic and social sustainability. Hence, the environmental sustainability has been prioritized by Sustainable transport system. Electrifying transport system has been the obvious choice to achieve sustainability and as a shift towards zero oil consumption.In developing countries like India, the adoption of Electric vehicles can be realized by supportive government policies. Electric vehicles are transforming significantly due to support policies from the government through subsidies and provision for charging infrastructure. India has growing automobile market from the vehicle sales and it is increasing significantly. Electric Vehicles are not new to India and now it has been reintroduced. There has been struggle for consumer acceptance mainly because of cost, range and charging infrastructure. With improvement in technology, government policies and incentives, the consumers and the manufacturers are ready to adopt Electric vehicles. This paper looks at various measures taken by the Indian government, which facilitates e-mobility. This research article also empirically tests key consumers characteristics influencing Electric vehicle adoption.

Key words: Consumer, Electric vehicles, Government Policy, Regulation, Sustainability.

Introduction

Transportation system is vital for the development of any nation. Increase in population and thereby industry leading to the development of economy emphasizes on the need for infrastructural improvement. This results in increased and improved transportation. Vital services in the economy like employment, health, education, social activity, entertainment etc. can be accessed through good and rapid transportation system. Transportation system links vital services with market and it brings in growth in the economy. In India, public transport is the key; however it has its own set of limitations. It is viewed as a low-cost, low-emission alternative to the automobile that may effectively meet vast and growing transportation demands in crowded metropolitan locations (Currie et al. 2007). Rapid growth in transportation system has led to increase in vehicles, pollution, accidents, traffic congestion and related health hazards.

The transportation sector consumes more than 60% of the world's oil resource (Reddy et al., 2001; Samimi, 1995). Currently, the vast majority of the transport system is entirely dependent on the oil resources, depleting the oil reserves. The existing transport system uses energy right throughout its lifecycle, severely impacting the environment. (Teufel et al., 1993, OECD, 1993) The literature from Energy Sources has indicated that the fuel used to run vehicles indicates 80 – 90% of total life cycle energy use. With growth in population, industrialization, urbanization and hence economy, there will be further increase in consumption of energy. (Ramanathan & Parikh, 1999). Transport sector is primarily responsible for these anthropogenic contributors of air pollutants into the atmosphere (Golob et al., 1998). According to Anabale., 2005 awareness about environmental concern provides additional benefits that can be targeted to change towards sustainable transport system. Looking at the depleting energy resources leading to energy crisis, per capita energy use and impact on the pollution, there is an urgent need to look at Environmentally Sustainable transport system. Addressing Sustainability issues is also shifting towards mode selection and shift towards Electric vehicles.

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Electric Vehicles as a means to Sustainable transport system:

The ever growing demand for oil can be attributed to the transport sector. Hence, it has created a need for sustainable transport system due to growing energy crisis. Hence, electrifying transport system has been the obvious choice to achieve sustainability and as a shift towards zero oil consumption.

Electric vehicles are transforming significantly, since they were earlier introduced. Continuing technological developments in battery technology from nickel based to lithium ion and has regained the popularity. Therefore, Electric vehicles are innovative technologies which have the potential of transforming the transport sector leading to decrease in greenhouse gas emissions and solving energy crisis.(Brady and O'Mahony 2011; Hawkins et al., 2013).

According to O.Van Vliet et al., 2010 &Tanaka., 2011 Electric vehicles (EVs) are considered as a disruptive innovative sustainable technology, where the engine of the vehicle operates from the energy stored in battery pack. Hence, EVs have tremendous capacity to increase the energy efficiency and energy security, and thereby reducing the carbon intensity of personal vehicle transport (Tanaka., 2011).

Types of EV: Vehicles that power their engine by alternative sources of energy like biofuels and electricity are known as Alternative fuel vehicles (Jansson, 2011). Therefore Electric Vehicles are the obvious choice. The types of Electric Vehicles are plug-in hybrid electric vehicles (PHEVs), extended-range battery electric vehicles (E-REVs), battery electric vehicles (BEVs) and hybrid electric vehicles (HEVs). According to Proff & Kilian, 2012 a battery driven electric vehicle (BEV) has an all-electric drive train energized by a large capacity battery that can be recharged externally.

The following section discusses various policies by the Indian Government towards EV.

Electric Vehicle Policies (India)-2020-21 type Description

1. Vehicle Regulation: Carbon emissions standards for LDVs in 2022.
2. Incentive for EV adoption: Under FAME II scheme provides incentives for public and shared three-wheelers, LDVs, buses and private two-wheelers.
3. Target: Target of 30% EV sales by 2030 across all modes.
4. Incentive for charging stations: 10% of the budget is dedicated for the deployment of Electric vehicle support equipment.

Targets for public charging facility: Targets for public chargers in cities and along highways.

Hence, there are policies indicating the intentions of the government towards Electric vehicles.

EV sales in India: As per the New Policies Scenario (Government of India, 2018), the estimated EV sales is 30% by 2030. Electrification of vehicles is primarily in two wheelers reaching 40%, 14% passenger cars and 11% buses. During, 2018 government policy measures like standardization, public fleet procurement, incentives and charging infrastructure deployment were initiated. India's Energy Efficiency Services Limited (EESL) is working towards replacing nearly 5 lakh government cars in the next 3-4 years. During Sept 2017, EESL released the first tender for about 500 Electric cars and then followed by the second tender for 10,000 electric cars. The first lots of 10,000 electric cars were ordered for government use in Jan 2019. Hence, the Indian Government and market is ready for EV adoption and necessary measures are being taken for charging infrastructure.

Supporting policies:

The Faster Adoption and Manufacturing of Electric Vehicles (FAME) were constituted in 2019.Under this scheme there is upfront purchase of Electric vehicle and budget deployment for charging infrastructure. FAME II has allocated USD 1.4 billion over a period of three years to encourage purchase of EV from public procurement program. It also emphasizes the use of public and shared transportation, incentivizing electric three & four wheelers. For two wheelers categories, the incentives are targeted towards purchase of private vehicles with advanced battery technology like lithium ion.

Electrifying Public transport system: Eleven cities with over 1 million populations were selected to procure about 400 electric buses meant for public transport system. These cities were allowed to call tenders to purchase or pay per operation on per km basis. Indian companies, Tata Motors, Goldstone-BYD and Ashok Leyland were selected to deliver 520 buses. Kolkata, Indore and Chennai are among the Indian cities having electric buses in operation using overnight slow charging and fast charging facilities.

Charging infrastructure policies:

As per the Gazette by the Indian government, 2019, the Faster Adoption and Manufacture of Electric vehicles (FAME II) scheme, there is provision for charging infrastructure. In cities of above 4 million populations and at a distance of every 25km, a target of 2700

charging stations are being set. And, also ultra-fast charging stations at a distance of every 100km.

10% of the budget about Rs 10 billion was allocated to Electric vehicle supply equipment deployment under FAME II policy. Also, to reserve 20% of parking space in building complex and provision for charging infrastructure under the bylaws.

Battery Swapping: The Businesses that provide charging and swapping facilities are termed as Energy Operators. These so called Energy Operators facilitate the process of slow charging and fast charging at suitable locations. They also provide services like purchase of batteries, setting up charging stations, swapping services and provide charged batteries on lease. Setting up of charging infrastructure would facilitate the EV adoption process.

In Bangalore city, there have been 136 car battery charging stations at 70 different locations installed by BESCOM and more 140 to be added. Another 103 stations to be set up by NTPC. Therefore, Bangalore city will have highest charging stations network with each station having four charging points. The cost of charging will be Rs 7.28 and Rs 8.90 per unit from vehicle owners. With the infrastructure readiness and battery swapping facilities the EV will diffuse into the city transport system.

Literature Review

Global EV adoption practices:

There have been policies for EV adoption across many countries. Few of the countries are creating a favorable environment through policies and incentives, while many other countries are still at an initial stage. The United States, one of the world's largest BEV markets, has plans to deploy EVs with concrete incentives at the state and federal levels, public investment and loan programmes for the deployment of charging infrastructure, and aggressive R&D investment in the crucial areas of grid modernization, vehicle grid integration, and power systems interoperability. In the European Union, 609,629 alternate fuel vehicles (AFVs) or non-ICE cars were registered, a notable rise from previous years.

In the context of developing countries:

The growth of the EV industry has also received significant attention from some emerging nations. To encourage manufacturers to make EVs, the Indian government, for instance, released the National Electric Mobility Mission Plan. As per the Ministry of Heavy Industries & Public Enterprises (MHIPE), India's goal is to produce 6–7 million EVs by 2020.

Electric Vehicle Adoption in India:

India, has growing automobile market from the vehicle sales increasing from 20.5 million in 2015-16 to 23.5million in 2020. As per the literature (Choudhary. A, 2014) because of fuel crisis there is need for electric mobility in developing countries. Electric Vehicles are not new to India and now it has been reintroduced. There has been struggle for consumer acceptance mainly because of cost, range and charging infrastructure. With improvement in technology, government policies and incentives, the consumers and the manufacturers are ready to adopt Electric vehicles.

Under the National Electric Mobility Mission Plan (NEMP) 2020, it encourages manufacturers to produce EVs. There are several mobility firms like Mahindra Electric, Ather Energy, Ola Electric, Bosch and Sun Mobility. There are also funds allotted to drive research & development, innovation in the area of lithium –ion and solid state battery technology. Many players have launched pilot projects in areas like grid impacts, system interoperability and electrification of public transport. "Air ambience fund" was created in Delhi, which is a kind of tax collected from diesel sales. This fund is used in creating subsidies to encourage adoption of EV.

The tax levied on EV (5%) is less than ICEV (12.5%) in Delhi city. The excise duty for conventional vehicles is 12.5% whereas for EV it is 6%.

There are several government policies which focus on use of cleaner fuel to reduce vehicular emissions (Mishra D, 2014). Niti Aayog, the strategic wing of the Indian government identified three critical elements for bringing in a paradigm shift in the Indian mobility structure: i.e. shared, electrified and connected.

Indian subcontinent is the fastest growing automobile market in world. The demand and aspiration for electro mobility is even greater for developing countries. The dependence on fossil fuel is reducing drastically in developing countries like India and China as 80% of the growth in global car fleet is been projected, Choudhary. A, 2014. Electric vehicles are reintroduced, however, the struggle for acceptance continues with the consumer acceptances which are driven by cost consciousness, lack of charging infrastructure and EV availability. Hence, it is primarily important to know the key consumer characteristics that influence adoption.

Generation of Hypothesis: The demographic variables in this study include gender, age of the respondents, education qualifications, income, sector (IT, education and retail) are generated from earlier literature (Peters & Dutschke et al., 2014). Men are often found to be experimental with new technology, they are often the early adopters. They take risk in trying out new products. In the context of developing countries, the younger generations are also found to be eager and enthusiastic compared to the older generation, who are risk averse. Since, the initial cost of the EV is higher compared to internal combustion engine vehicle. Hence, income is an important factor to be considered in determining the adoption of EV. There has been extensive research done and empirically

tested for education influencing in decision making process. Education drives in rational decision making process, which is logical and data driven process. Employees from the IT sector are not only educated, but also knowledgeable about the current technology. The IT sector, Retail sector and the Education sector contributes significantly to the economy. Hence, it is important to consider the sector as one of the significant factor.

These variables are found to be significant in the context of developed countries. However, it is important to be tested in the developing countries.

Hence, the generation of hypothesis:

H1: There is no significant difference between the genders in their intention to adopt EV.

H2: There is no significant difference between age group and their intention to adopt EV.

H3: There is no significant difference between Income categories & their intention to adopt EV.

H4: There is no significant difference between Qualification and their intention to adopt EV.

H5: There is no significant difference between Sector and their intention to adopt EV.

Data Analysis and Interpretations

The data for determining the Electric car adoption was from the sampling frame of www.indiandatabases.com, which led to sample of 401 respondents. The respondents were from Information technology, Retail and Education sector. The data was collected through Google forms and tested on WarpPLS. WarpPLS is a GUI (graphical user interface).It is used for both variance-based and factor-based structural equation modeling which uses the partial least squares and factor-based methods. WarpPLS, software package used in this study to analyse data and test the relationships.The following tables mention the profile of the respondents

Measurement scale on Electric Car Adoption

The measurement scale to measure Electric car adoption consisted of 8 items is a 7 point Likert scale from Pavlou & Fygenson, 2006 and Grohmann, 2009.

Table 1: Table showing the gender of the respondents

Gender	Number of respondents
Female	167
Male	234
Total	401

Table 2: Table showing Age of the respondents

Age	No of respondents
18-24 years	56
25-44 years	217
45-64 years	114
>65 years	14
Total	401

Table 3: Table showing sector of the respondents

Sector	No of Respondents
Education	90
Information technology	228
Retail	83
Total	401

Table 4: Construct and its items

Construct	Item (7 Point Likert scale, 1-Strongly disagree, 7-Strongly Agree)	References
Electric car Adoption-EA	EA1- Assuming I had the opportunity, I would intend to buy an electric car.	Pavlou & Fygenson, 2006; Grohmann, 2009
	EA2- Given that I had the opportunity, I predict that I would buy an electric car	
	EA3- I will probably buy an electric car in the near future.	
	EA4- Access to charging will motivate to buy Electric car.	
	EA 5- Improvement in Battery will motivate to buy Electric car.	
	EA 6- To reduce the impact on Environment will make me buy Electric car.	
	EA7- Electric cars have a smoother and quitter ride.	
	EA 8- Planning to, or would consider purchasing an Electric car, or replacing current car with an Electric car.	

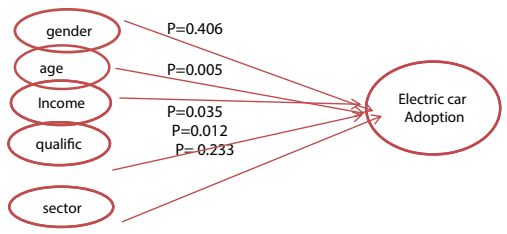
The variables in this study include gender, age of the respondents, education qualifications, income, sector (IT, education and retail) were several independent variables tested on the dependent variable of Electric car adoption. Gender and job sector of the respondents was found to be insignificant, while the other variables income, qualification and age were found to be significant on Electric car adoption. Supporting the findings by Peters & Dutschke et al., 2014 that Electric Vehicles are valued by particular groups, such as woman are likely to get involved with EVs in an initial market phase. Men are very experimental, who would want to try new technology. Once adopted in critical mass, the technology tends to get diffused among the general public. Therefore, in the initial stages of technology adoption, the marketers target the right people to get critical acceptance.

The respondents were from IT, Retail and Education sector. The path coefficient and 'p' value indicate that this particular independent variable is significant towards Electric car adoption. ANOVA test done on the sector indicated that IT employees are more inclined towards adopting Electric cars. This in fact is a valuable insight to the marketers to target their products to the IT employees. The table below shows the p value of the independent variables in relation with Electric car adoption.

Table 5: PLS path coefficient with independent variables

Path	'p' value	Hypothesis
Gender	0.406	not significant
Age	0.005	significant
Income	0.035	significant
Qualification	0.012	significant
Sector	0.233	not significant

Figure 1: Conceptual Model and p values



Implications:

Electric vehicle adoption varies worldwide, as it impacted by demand from the consumer, market prices, government policy, regulation and support infrastructure. The various regulatory measures will facilitate EV adoption by subsidizing the cost and providing the much needed charging infrastructure. The demand for Electric Vehicles is being expected to be strong and Electric car adoption at the personal front will have multiple benefits to the economy and environment. Empirical results have indicated that gender and sector of the respondents are not significant factors. Thereby the marketers can optimize their marketing strategies accordingly to maximize sales. Long term implications will be phasing out of internal combustion engine vehicles.

Conclusion

Electric vehicles are the future of India's Mobility. Electric vehicles have advantages over conventional vehicles in terms fuel consumption and emissions and are environmentally sustainable. However, the adoption is with barriers as for any typical disruptive innovative technology. In India, a strong push in the form of government policies can make way for quick Electric vehicle adoption. The cost of EV will decrease with government supporting policies like subsidies. Technology to bring in fast charging and government support to build charging stations at strategic location will bring down costs and increase the options available for transportation electrification in India. By 2025 the total cost of EV's will be on par with the conventional vehicles. Further, empirical analysis in the Indian context revealed that Gender and Sector of the respondents are insignificant towards Electric car adoption

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