REGIONAL DIFFERENCES IN CONSUMER PREFERENCES FOR ALTERNATIVE ENERGY TRANSPORT WITH FOCUS ON ELECTRIC VEHICLE

Nirupama Prakash[*]

Rashmi Kapoor[**]

Yashpal Malik[***]

Ajay Kapoor[****]

ABSTRACT

This paper presents results of a research study on regional differences in consumer preferences for alternative energy Transport with special focus on electric vehicle (EV). The study was conducted in eleven cities (Rohtak, Lucknow, Jaipur, Coimbatore, Chennai, Bangalore, Trivandrum, Cochin, Hyderabad, Mumbai, Pune) from eight states (Delhi NCR, Uttar Pradesh, Rajasthan, Tamil Nadu, Karnataka, Kerala, Telangana, Maharashtra) in three geographical regions of India (North India, South India, West India) by covering 1759 respondents belonging to different age groups. Statistical Package for Social Sciences (SPSS®) was used for analysis of data. Findings indicate that, in general, fueled vehicles are still preferred over electric vehicles. However, there is a strong interest in electric vehicles. It was observed that there is no significant difference in consumer's attitude towards new technology from different zones of India, however, respondents from South India and West India share the same perception towards the environment factor that "Cars, minivans, vans, pickups, and SUVs are an

[*] Director, Amity Institute of Social Science, Amity University Sector 125, Noida, Uttar Pradesh 201303, India.

[**] Research Associate, Swinburne University of Technology, Hawthorn VIC 3122, Australia.

[***] Research Associate, Amity Institute of Social Science, Amity University Sector 125, Noida, Uttar Pradesh 201303, India.

[****] Pro Vice-Chancellor. International Research. Engagement, Swinburne University of Technology, Hawthorn VIC 3122, Australia.

important source of air pollution" whereas perception of respondents from North India reflect that "cars, minivans, vans, pickups and SUVs are not the important source of air pollution". The research also highlights that environmental factors play an important role in consumer purchase decision-making in North India. This is highlighted in case of those respondents who are ready to pay a premium of 10-15 per cent if the product meets their requirement. To highlight the important variables, factor analysis was used. It was found that the important factors are fuel efficiency, safety and vehicle power in comparison to purchase price, reliability, vehicle size, operating costs, vehicle model, fuel type, vehicle emissions and pollution. Nearly 84 per cent of total respondents are willing to purchase an electric motor vehicle once they become available in the market with the above mentioned features.

Keywords: Regional Differences, Electric Vehicle, Alternative Fuel Vehicles, Consumer Perceptions, Environmental Policy, Willingness-to-Pay

Background

Global Market - Electric Vehicle

Approximately 88 million buses, trucks and passenger cars are manufactured every year worldwide. Most of the vehicles are dependent on fossil fuels such as petrol, diesel, CNG, LPG. In Future air pollution, carbon emission, and perceived energy shortage are some of the reasons which increases the chances for Electric Vehicle to become the market leader. But there are some limitations of electric vehicle such as, long duration of charging time, battery maintenance, high purchase cost, short driving ranges and limited charging facilities which have become the roadblock for electric vehicle manufacturers (Perkowski, 2014).

Across the world, different approaches have been adopted to promote electric vehicles by many countries. Some offer investment support for technology, some offer infrastructural related investments and some give incentives to the buyers. As a result of such initiatives, 7,40,000 battery operated electric cars were sold in the world market till December 2014. (Shahan, 2015). As a comparison, the total number of cars in the world is 1.2 billion (Voelcker, 2014).

Why Are Electric Vehicle Becoming Popular

Lower operating and maintenance costs

Electric Motor vehicles are efficient because the energy is stored and used for driving a vehicle with negligible energy waste. A fuel based car delivers only 20% of the total fuel energy to the tyres for driving, whereas for a battery and motor based vehicle this figure is 80%. The other advantage with Electric Vehicle is that they do not consume energy when the engine is at rest, therefore saving fuel when the vehicle is waiting at traffic light or is struck in a traffic jam. The cost per mile for electric vehicle is also less as compared to standard automobile vehicle. The estimated cost to drive an electric vehicle is around $ 0.02 to $ 0.04 per mile, in comparison to the standard automobile vehicle which is around $ 0.08 to $ 0.20 (Shah, and Sandalow 2009). With no internal combustion engine, gear box and complex transmissions the driving system is simpler for an electric vehicle and the maintenance costs are much smaller.

No Environment Pollution

Electric Vehicles do not release any harmful gases during their operations. They also do not release greenhouse gases. However, they do require electricity and so the source of electricity plays an essential role in reducing the emission level. If the electricity is generated from renewal sources then there is no pollution but if not then the electric vehicle shifts the pollution to the point where electricity is being generated. An advantage though is that bigger plants can be made more efficient and less polluting through their economy of scale. For Example, France generates electricity from nuclear power plants, California is dependent on nuclear plants and hydroelectric while India, China and Germany, mostly depend on coal to generate electricity (Sperling and Deborah, 2009).

Electric Vehicle Models in the World

The below mentioned list in **table 1** is classified on the basis of the speed capabilities of electric cars, low speed for local, city cars with good speed, High speed for highway capable and Race cars.

Table 1: Car models available in the world

Model	Top Speed (km/h)	Market release (Year)
NICE Mega City	64	2006
Mahindra e2o	82	2013

Stevens Zecar	90	2008
BMW Brilliance Zinoro 1E	130	2014
Bolloré Bluecar	130	2011
Ford Focus Electric	135	2011
Lightning GT	200	2013
Nissan Leaf	150	2010
Renault Fluence ZE	135	2010
Renault Zoe	135	2012
Smart electric drive	125	2009
Tesla Model SP85 kW·h	214	2012
Venturi Fétish	200	2006
Volkswagen e-Golf	145	2014
Volkswagen e-Up!	130	2013
Detroit Electric SP:01	249	2014

Source-From website of above mentioned Companies

Some Shortcomings of Electric Vehicles

Cost

Cost for batteries of electric cars are very high. For a few hundred kilometer range the cost of battery is tens of thousands of dollars. Battery replacement is also an additional cost to the customer which the customer has to change in between 3-10 years depending on the vehicle use ("What is", 2015).

Availability of charging infrastructure

Electric vehicles require electricity to charge its batteries. With the current technology it takes a few hours to upto eight hours to fully charge an electric vehicle. This is very different than a fuel car in which fuel can be filled in minutes. The long charge time and short range produces several issues. Solutions include charging overnight and in car parks, not many of these are available. Customers require charging stations which are convenient, affordable and compatible at their home and offices so that the vehicle can be charged during its non-used hours ("Developing Infrastructure", 2015).

Electric Vehicle in China

Various electric vehicle models such as, Audi and BMW from Germany, Nisan and Toyota from Japan, Tesla and General Motors from US, BYD and Roewe from China, were launched in 2014. In 2014, China manufactured 78,000 electric vehicles and 76,000 such vehicles were sold in the market, marking a growth of 350% & 320% respectively as compared to previous year.

Growing demand of charging stations has attracted the government attention as well. During 2010 to 2014, the number of charging stations in China jumped from 76 to 723 at the CAGR (Compound Annual Growth Rate) of 75.6% ("China Electric", 2015). For a comparison there are approximately 99,000 filling stations in China till Dec 2014 ("China Filling", 2015).

Electric Vehicle in Europe

Ernst & Young - market analysts, predicted that Europe will become the first mass market for electric cars by 2022. A Survey opinion of 300 European automotive leaders, revealed that the industry is confident of growth over the next 12 months. Europe is expected to lead the way in uptake of electric cars, China and Japan will occupy the 2nd and 3rd position in this market respectively. In 2015, more than 36,000 electric vehicles have been registered in the European market (Ayre, 2015).

Electric Vehicle in Bhutan

Bhutan government has set an ambitious goal to become the world leader by introducing a very large proportion of government fleet of electric vehicle in their country. 50 electric vehicles of Nissan LEAF are on the roads and order has been placed for another set of 22 such vehicles, so total 77 EV are sold in Bhutan market and represents 10 % of total car available on the Bhutan roads. EV Fleet targets in Bhutan are police car, protocol service cars, public transport in Thimphu, school buses, electric vans for transporting tourist, government ministry and cabinet fleet (Tshering, 2014).

In line with the goals, in 2014, The Prime Minister of Bhutan introduced two models of electric vehicle –Reva from Mahindra and LEAF from Nissan, and in order to attract or win buyers, he suspended import duty as well. For example, Nissan offered a discount of almost 50 percent on

the first 77 cars sold in Bhutan (Car sold for $14,516 each). Post completion of the offer, the vehicle will be sold at $28,000. Bhutan government has planned to reduce the imports of fossil fuel to 70 percent by 2020 and the government does not want to promote economic development at the cost of its environment (Sundas, 2015).

Electric Vehicle in India

The growth potential of electric/ hybrid cars is yet to be realized in India, probably because they are considered to be not only expensive to buy, but also to maintain. The Indian Government has also launched National Electric Mobility Mission Plan (NEMMP) 2020 to promote electric vehicles in the Indian market. If this plan is implemented successfully, then Indian government will be able to save 9500 million tons of fossil fuel which is worth of Rs. 62,000 crore ("National Electric", 2015). Indian Government has planned to invest approximately Rs. 14,000 crores in next 5 to 6 years with additional investment of Rs. 8,000 crore, which will be pooled from automakers ("In a Nutshell", 2013).

The following section enlists top 5 electric/hybrid cars models in India (Naik, 2015):

1. Mahindra e2o - Mahindra launched first electric model named e20 in 2013 in Indian market. The product was manufactured in Bengaluru plant. The price range for Mahindra e20 is Rs. 4.79 lakh - Rs. 5.34 lakh.

2. Toyota Prius - Toyota launched its first hybrid car in 2012 in India. Petrol and electricity are the two energy sources for engine. The price of this model in the Indian market is very high because of import duty and the price range is between Rs. 38.10 lakh - Rs. 39.80 lakh

3. Toyota Camry Hybrid - Camry Hybrid delivers a mileage of 19.6Km/l (ARAI figure) – claimed by Toyota with Price of Rs. 31.19 lakh

4. BMW i8 - In August 2014, BMW started deliveries of i8 model in the Indian market and sold 1,741 units till December, 2014. The cost of this product is Rs. 2.29 crore.

5. Maruti Suzuki Ciaz Hybrid - Maruti Suzuki Ciaz launched its Smart Hybrid Vehicle in India in September 2015 with the price range of Rs. 8.23 lakh - Rs. 10.17 lakh.

The Challenges

- Electric auto industry in India is extremely small. Mahindra REVA is the only manufacturer of Electric Vehicle in India under four wheel category. In the two wheeler market, the manufacturers are Lohia Auto, Hero Electric, Yo Bykes, and Ampere (Top 5, 2013).
- The challenge for the manufacturers is to attract a premium for electric vehicles from Indian consumers. On the other side, Indian government is facing challenges in providing the essential infrastructure to promote EVs such as charging stations across the country (Charging station, 2015).
- The Government of India has planned to introduce around 6-7 Million of EVs and Hybrid vehicles by 2020. The government has touched ecological concerns, marketing strategies, policies, the resale value of batteries and EVs, EVs gender sensitivity, concern of the Residents Welfare Association, policy decision, support from the Government, R& D, and all pertinent issues of EVs in India. It is also estimated that the government will provide between Rs. 13,000 - 14,000 crore to provide the necessary infrastructure over a period of 5-6 years. ("Government earmarks", 2015).

Mass use of electric vehicles has two major advantages- Cut in dependency on imported fuel and cut in pollution level. Use of Thermal power helps in the first point as we have a good reserve of lignite and coal; but, it certainly takes away the benefits of electric cars regarding pollution level. On the other hand Hydel power does not come without permanent damage to ecology and increasing risk of natural disaster. Though, nuclear power is free from these disadvantages, concerns regarding safety and political opposition will remain major roadblocks. But, India has huge potential in wind and solar energy. We are already among the top five or six countries and probably will be within top three (after USA and China) in this decade. Also it is less time consuming to install wind or solar power projects. So, we can expect the balance to shift towards cleaner sources of electricity in the future (Making electric, 2013).

Electric or hybrid has some limitation in India, which are mentioned below (Making electric, 2013)-

- No continuous supply of electricity in India
- No charging points in markets and petrol pumps.
- Govt. will lose tax income on petrol/diesel, if these cars get popular in India.

- Expensive electricity.
- General awareness among public in India about hybrid and electric cars.
- High battery cost
- High maintenance cost of these cars, as it cannot be serviced/ repaired by the roadside mechanic.

Possible Measures to Push the Electric Vehicle Sales

Electric vehicles are definitely the need of the hour not just due to the rising cost of fuel, but also due to the fact that natural resources are not expected to last long. Government and manufacturers should think of marketing it as the cheapest mode of transport to attract the consumers. There are some of the possible measure which can push the sale of Electric vehicle in coming future.

1. The cost of Batteries is expected to drop significantly –Tesla is working on battery model with will reduce the cost of the EV batteries significantly. Presently the average cost of EV battery varies between $US250-400/kWh which is going to come down at $US100/kWh in near future (Vorrath, 2015).

2. Apple is likely to launch electric cars - Apple is likely to launch an electric car in near future. Morgan Stanley says that if Apple joins the EV game, it would modify the industry landscape considering Apple's scale, innovation and integration capability (Vorrath, 2015).

3. Progress is expected to happen around the range/charging issues - Another important barrier to EV mass uptake is that after including the cost of batteries and infrastructure, the range of electric vehicles has been limited to around 100 miles i.e. I60 km since the first EV was driven. However, Morgan Stanley is of the view that Tesla and GM plan to launch models with driving ranges more than 200 miles (320km). Progress will be made about the range and Charging issues (Vorrath, 2015).

Table 2: Potential EV Examples

OEM	Brand	Model	Potential Launch Year	Available Details
General Motors	Chevrolet/Opel	Chevrolet Bolt	2016	>200 miles range – US$ 30,000
Hyundai Motors	Hyundai	Undisclosed Midsize Sedan	2016	Powered by LG Chem
Tesla	Tesla	Model IIII	2017	>200 miles range – US$ 35,000
Volkswagen	Audi	Two Models: undisclosed	2018	NA
Apple	Undisclosed	Undisclosed	2020	NA
BMW	BMW	Undisclosed	2015	Possible transforming all models on to electric platform over time (unofficial)

Source: http://reneweconomy.com.au/2015/five-things-you-didnt-know-about-the-electric-vehicle-market-97757

It is expected that the new government policies will help in developing networks for battery recharging in major cities and major travel routes. Morgan Stanley also refers to a policy which was unveiled by Beijing Municipal in February 2015 in order to provide 30 per cent investment subsidy for building public charging stations (Vorrath, 2015).

Consumer Preferences

The success of alternative fuel for vehicles is dependent upon a multiple factors, including cost of the vehicle and its performance. Among various issues related to fuel infrastructure, adequate refueling availability is one of the most fundamental to successful commercialisation (Melaina and Bremson, 2008). To find out the consumer preferences, it is really important to understand the demographic and socioeconomic characteristics. There are, for instance a number of studies on key

demographic and socioeconomic characteristics used to model demand for AFVs (Alternative Fuel Vehicles) using either revealed and stated preference approach or both (Potoglou and Kanaroglou 2008).

Studies show that concerns of convenience and particular costs take preference over environmental and geopolitical related concerns and it is has been noticed that within our society there is an absence of progressive social and eco-friendly idealism (Augustine, Sandidge and Williams 2011). Others show that even though the several technologies related to alternative fuel vehicle will emerge commercially in the coming years, but there is a potential requirement of increasing the consumer acceptance through various initiatives such as, awareness about types of vehicle fuel, the need of reducing pollution, and the significance of reducing our need on gasoline as an primary energy source (Nixon and Saphores 2011). This is in line with the purpose of the current study, which is to determine the critical issues of concern for the Indian population, so that post resolving the issues Electric Vehicles can become the 1st choice over the conventional vehicle in the coming years.

The study, "Giving green to get green? Incentives and consumer adoption of hybrid vehicle technology", highlights the response of hybrid vehicle sales to the different incentives offered by the United States from 2000 to 2006 (Gallagher and Muehlegger, 2011). They focus on three questions: Is consumer behavior affected by state incentives?; How consumers respond differently to different types of tax incentives?; and do consumers react to increasing gasoline prices and, if so, how does the effect of rising gasoline prices compare to that of state incentives? The paper provides the context to distinguish the effect of different types of incentives and the effect of rising gasoline prices. This information is relevant to our current study on electric vehicle in terms of understanding respondent's perception of transport policy of the state and Central Government regarding electric vehicles.

In the study "Understanding Household Preferences for Alternative-Fuel Vehicle Technologies" (Nixon and Bremson, 2011**)** researchers explored four type of alternative-fuel vehicles (AFVs) for consumer preferences: compressed natural gas (CNG) vehicles, hydrogen fuel cell (HFC), electric vehicles (EVs) and hybrid electric vehicles (HEVs). Soaring fuel prices and growing

concerns about air pollution and global warming have heightened public interest in AFVs. To understand these issues, the authors included various variables in the questionnaire and assessed their importance region wise.

As per the study done by Deloitte Touche Tohmatsu Limited, out of those surveyed in China, 93 per cent out of them are interested in purchasing of electric vehicle; in Europe it is 69 per cent, in the USA it is 54 per cent and in Japan it is 48 per cent. For the potential first mover's customers in US, only 12 people said that, they would be the first customers to buy an electric vehicle, compared to China which is 50 per cent, in Europe it is 16 per cent and only 4 per cent in Japan (Lucas, 2011).

Examples which are mentioned above show that there are regional differences in consumer preferences. Different strategies have been adopted by the various governments to promote electric vehicles. To understand the regional consumer preferences, this paper studies socio-economic indicators like income level, age group, gender, and other indicators like new technology, vehicle performance, and environment factors in the selection of alternative fuel vehicles on a regional level. The results are based on a study conducted from November 2013 to October 2014. This study was conducted by involving 1759 respondents belonging to different age groups in three regions in India, i.e. North India, South India and West India. Professionals, academicians, and students expressed about their views on a range of transportation-related issues and their level of acceptance of electric vehicle.

It was found that the most promising target group for the adoption of Alternative Energy Transports (AETs) is that of young, well-educated and environmentally aware people, who have the option of charging their car at home, who do not travel long distance in the city and need a small car. Depending on the vehicle alternatives, environmental awareness and budget constraints for purchasing the second vehicle, reputation and reliability of the vehicle, joint decision in buying, willingness to pay substantial amounts for the cost of environmental friendly fuel, driving range, pollution, vehicle-tax exemptions are also important factors influencing the purchase of an Alternative Energy Transportation (AETs).

To examine the important factors which influence the buyer's decision, factor analysis was used. To reach out the important variables, principal component analysis from Eigenvalues was considered. It was observed that the most important factors are vehicle efficiency and safety, vehicle design and price, economy. In addition to factor analysis, one-way analysis of variance (ANOVA) technique was also used to determine whether there are any significant differences between variables - vehicle emissions & pollution and innovative technology irrespective of the regions. It was observed that there is no significant difference between the mean score of respondents from different zones of the country when consumer attitude towards new technology is concerned.

The objective of the current work is to determine regional differences in consumer preferences towards use of electric vehicles. The following sections describe the responses from various respondents who participated from multiple cities of India and shared their opinions and preferences towards electric vehicle. Data on various issues which affects transportation and the environment was also analyzed. Important factors which can drive the growth of electric vehicle was analyzed and consumers' willingness to pay premium for such vehicle. Conclusion and recommendations are also highlighted at the end of this paper.

Materials and Methods

The survey, which was conducted in multiple cities of North India, South India and West India includes demographic characteristics of respondents, Attributes of vehicles, impact on environment, issues related to technology and detailed information on daily travel. **Table 3** highlights the socio - demographic variables, i.e. gender, age group, monthly income and education level for understanding the consumer preferable attributes at regional level. Across the regions, it was observed that South India had least respondents (3.1 per cent) of 31-60 age group but most respondents (26.9 per cent) of 18-30 age group. For monthly income also the data revels that South India had least respondents (5.5 per cent) of monthly income of 50,000 – 100,000 but most respondents (21.3 per cent) of monthly income of 25,000 – 50,000. North India had maximum bachelors (20.3 per cent) and masters (16.1 per cent) degree holders.

Table 3. Region wise Demographic Information of the Respondents

		North India		South India		West India	
		Frequency	Total %	Frequency	Total %	Frequency	Total %
Gender	Male	344	19.9%	335	19.4%	274	15.9%
	Female	324	18.8%	210	12.2%	241	13.9%
Age Group of the respondents	18-30	355	20.7%	462	26.9%	237	13.8%
	31-60	285	16.6%	54	3.1%	233	13.6%
	61 and Above	43	2.5%	3	.2%	44	2.6%
Education	Bachelor's	350	20.3%	212	12.3%	242	14.0%
	Master's	278	16.1%	110	6.4%	235	13.6%
	Student	51	3.0%	212	12.3%	37	2.1%
Monthly income	25,000 – 50,000	299	19.5%	328	21.3%	287	18.7%
	50,000 – 100,000	231	15.0%	84	5.5%	207	13.5%
	Above 1 Lakh	46	3.0%	34	2.2%	21	1.4%
Cells highlighted in green color represents the highest percentage across regions							

Apart from demographic information such as age, gender, education and monthly income, respondents were also asked to share their views on transportation issues faced by them. Questions were asked about the environment, technology used and environmental impact of motor vehicles. Vehicle related questions included their vehicle ownership and factors that might influence their purchase decision.

Data Analysis

The descriptive responses were collected and the questionnaires were analyzed by using frequency distribution and cross tabulation in the *Statistical Package for the Social Sciences*

(SPSS version 22) software. Frequency tables and cross tabulation were constructed to display results with respect to each of the research questions.

Results

Transportation Issues

To understand the transport related issues, the respondents were asked questions related to the problems faced by them. This included questions on congestion and noise; vehicle emissions and pollution; traffic speed; global warming; fuel import etc. This helped to develop a better understanding of respondents' attitude toward transportation. **Table 4** presents the region wise responses on various transport related issues. In South and West India the biggest concern was traffic noise. For North India traffic congestion was the major issue, followed by traffic noise. Importing oil from foreign countries was the least important transport issue in all the regions, which reflects that respondents are not much concerned about the source of fuel.

Table 4: Break-up of Major Transport Issues Based on Regions

	North India		South India		West India	
Factors	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Traffic congestion that you experience while driving, N = 1736	415	23.9%	231	13.3%	301	17.3%
Traffic noise that you hear at home, work, or school, N = 1742	404	23.2%	314	18.0%	337	19.3%
Vehicle emissions that affect local air quality, N = 1735	381	22.0%	212	12.2%	260	15.0%
Unsafe	330	19.0%	214	12.3%	243	14.0%

communities because of speeding traffic, N = 1735						
Vehicle emissions that contribute to global climate change, N = 1728	381	22.0%	261	15.1%	273	15.8%
Importing much of our oil from foreign countries, N = 1730	296	17.1%	208	12.0%	206	11.9%
Cells highlighted in green color represents the highest percentage and cells highlighted in yellow color represents the lowest percentage across regions						

Impact on Environment

From the observations in **Table 5**, it can be inferred that North India respondents are more concerned about the transport issues than West India in each factor. Respondents from North India are marginally (.09 per cent) higher than West India respondents in terms of total percentage and supported the statement that, "cars, minivans, vans, pickups and SUVs are not an important source of air pollution". Similarly 17.4 per cent North India respondents change to respondents from North India agree with the statement that, "Government rules allow minivans, vans, pickups, and SUVs to pollute more than passenger cars, for every gallon of gas used". With 19.8 per cent of total respondents, South India takes lead in all regions for the statement that, "Cars, minivans, vans, pickups, and SUVs are an important source of the greenhouse gases" that many scientists believe are warming the earth's climate. 14.6 per cent of total respondents from North India agreed with the statement that, "Government rules require minivans, vans, pickups, and SUVs to meet the same miles-per-gallon standards as passenger cars". Finally, 20.1 per cent of the respondents agreed that, "Exhaust from cars, minivans, vans, pickups, and SUVs is an important source of the pollution that causes asthma and makes asthma attacks worse".

To analyze further, 26.2 per cent respondents agree and 9.9 per cent disagree with the statement that "Cars, minivans, vans, pickups, and SUVs are not an important source of air pollution anymore". This clearly shows that there are more respondents who think Cars, Vans etc. don't pollute the environment. In the next variable, "Government rules allow minivans, vans, pickups, and SUVs pollute more than passenger cars, for every gallon of gas used" 17.4 per cent agree and 15.5 per cent disagree which shows that there is no significant result difference in the views. Then in variable, "Government rules require minivans, vans, pickups, and SUVs to meet the same miles-per-gallon standards as passenger cars" 14.6 per cent agree and 15 per cent disagree which shows a negligible difference in the thoughts of respondents. The above results highlights that there are significant per cent of people who do not understand the impact of motor vehicles on the environment.

Respondents were asked about how frequently they go for the products which are developed with new technology. It was found that 49 per cent respondents will prefer to wait for review and then buy if if the reviews are favorable. 35 per cent respondents will wait until the new technology has been widely accepted and proven before considering it. Only 12 per cent will purchase very soon after the technology is launched.

When it was asked do you think transport policy of the state and Central Government should encourage Electric Vehicles, 25.7 per cent respondents replied in positive, but only for public transport. 63.4 per cent respondents replied in affirmative both for public and private transport. 10.9 per cent respondents did not find the current policies as useful to promote electric vehicles in the market.

Table 5: Region-wise view-impact on Environment of Various Transport Modes

Variables		North India (%)	South India (%)	West India (%)
"Cars, minivans, vans, pickups, and SUVs are not an important source of air pollution anymore". N = 1709	Agree	26.2%	11.3%	25.3%
	Disagree	9.9%	17.1%	2.9%

"Government rules allow minivans, vans, pickups, and SUVs to pollute more than passenger cars, for every gallon of gas used". N = 1700	Agree	17.4%	13.3%	15.6%
	Disagree	15.5%	9.7%	12.6%
"Cars, minivans, vans, pickups, and SUVs are an important source of the greenhouse gases that many scientists believe are warming the earth's climate". N = 1705	Agree	17.3%	19.8%	13.8%
	Disagree	12.0%	6.2%	9.1%
"Government rules require minivans, vans, pickups, and SUVs to meet the same miles-per-gallon standards as passenger cars". N = 1702	Agree	14.6%	12.6%	10.2%
	Disagree	15.0%	9.5%	12.7%
"Exhaust from cars, minivans, vans, pickups, and SUVs is an important source of the pollution that causes asthma and makes asthma attacks worse". N = 1709	Agree	16.2%	20.1%	9.0%
	Disagree	12.6%	4.9%	11.3%
Cells highlighted in green color represents the highest percentage across regions				

Reasons in Support of Electric Vehicles in Future

It is evident from **Table 6** that out of total respondents, 21.3 per cent of North India respondents change as explained above agreed that saving money on the cost of operation is an important factor, followed by South India (16.3 per cent) and West India (16.0 per cent). 24.5 per cent of North India respondents said that electric vehicles can play an important role in reducing the harmful impact (pollution) on the environment followed by West India (20 per cent) and South India (12.6 per cent). 21.2 per cent of North India respondents said that it is important to reduce the dependence on gasoline followed by South India (17.5 per cent) and West India (14.1 per cent). 19.8 per cent of North India respondents were interested to drive a vehicle with more advanced or innovative technology and said that it is an important factor which they will consider in the future for buying the electric vehicle followed by South India (15.5 per cent) and West India (12.9 per cent). Overall, North India respondents are more selective as compared to South India and West India. To verify this statement, we looked at the demographic data. It can be inferred this deviation is because North India respondents have a high percentage of bachelors (20.3 per cent) and masters (16.1 per cent) degree holders compared to other regions. Also, North India had the

most respondents from age group of 31-60 as compared to other regions which might be the reason for the preference of the variables.

Table 6: Responses in Support of Electric Vehicles in Future-Regional Preferences

	North India		South India		West India	
Factors	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
"Saving money on the cost of operation (using electricity rather than gasoline)". N = 1723	367	21.3%	281	16.3%	276	16.0%
"Reduced impact on the environment". N = 1723	422	24.5%	217	12.6%	345	20.0%
"Reduced dependence on gasoline". N = 1723	365	21.2%	301	17.5%	243	14.1%
"Driving a vehicle with more advanced or innovative technology". N = 1723	341	19.8%	267	15.5%	222	12.9%
Cells highlighted in green color represents the highest percentage across regions						

When asked to list some of the important factors which would restrict a customer from buying the Alternative Energy Transportation (AETs), the common issues were related to recharge

stations, higher price, availability of desirable vehicle size, reliability, ongoing maintenance, operating costs and the ability to carry occasionally heavy loads as explained in **Table 7**. In each case, it was found that these factors are more important for the North India region rather than South India or West India.

Table 7: Factors Supporting Purchase of Electric Vehicles-Regional Preferences

	North India		South India		West India	
Factors	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
"A higher purchase price than for a comparable conventional vehicle". N = 1708	440	25.8%	308	18.0%	306	17.9%
"The need to plug the vehicle in to recharge the battery". N = 1711	395	23.1%	257	15.0%	322	18.8%
"Concerns about limited access to plug-in locations". N = 1702	359	21.1%	236	13.9%	272	16.0%
"Availability of desirable vehicle size or style". N = 1707	314	18.4%	243	14.2%	208	12.2%
"Reliability of the vehicle". N = 1704	338	19.8%	221	13.0%	228	13.4%
"On-going maintenance and	297	17.4%	236	13.8%	203	11.9%

operative costs (including battery replacement)". N = 1705						
"The ability to carry heavy loads". N = 1710	279	16.3%	227	13.3%	228	13.3%
Cells highlighted in green color represents the highest percentage across regions						

Factors Important for Purchase of Personal Vehicles

The respondents showed their concerns for fuel efficiency, safety, vehicle power, vehicle reliability, size of the vehicle, expected operating costs (for maintenance and repair), the reputation of a particular vehicle make or model, fuel type (e.g. petrol, diesel, CNG), vehicle emission and pollution as explained in **Table 8.** For North India region, fuel efficiency, vehicle power, purchase price, vehicle size, operating cost, reputation and fuel type are important as compared to South India where safety, reliability and vehicle emission and pollution are important. Most of the respondents shared that they would consider all the above mentioned points while deciding to purchase of a new vehicle.

Table 8: Factors Important for Purchase of Personal Vehicles

	North India		South India		West India	
Factors	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Fuel efficiency, N = 1747	516	29.5%	469	26.8%	413	23.6%
Safety, N = 1748	436	24.9%	475	27.2%	320	18.3%
Vehicle power, N = 1745	409	23.4%	294	16.8%	318	18.2%
Purchase price, N = 1744	325	18.6%	264	15.1%	272	15.6%
Reliability, N =	357	20.6%	367	21.1%	260	15.0%

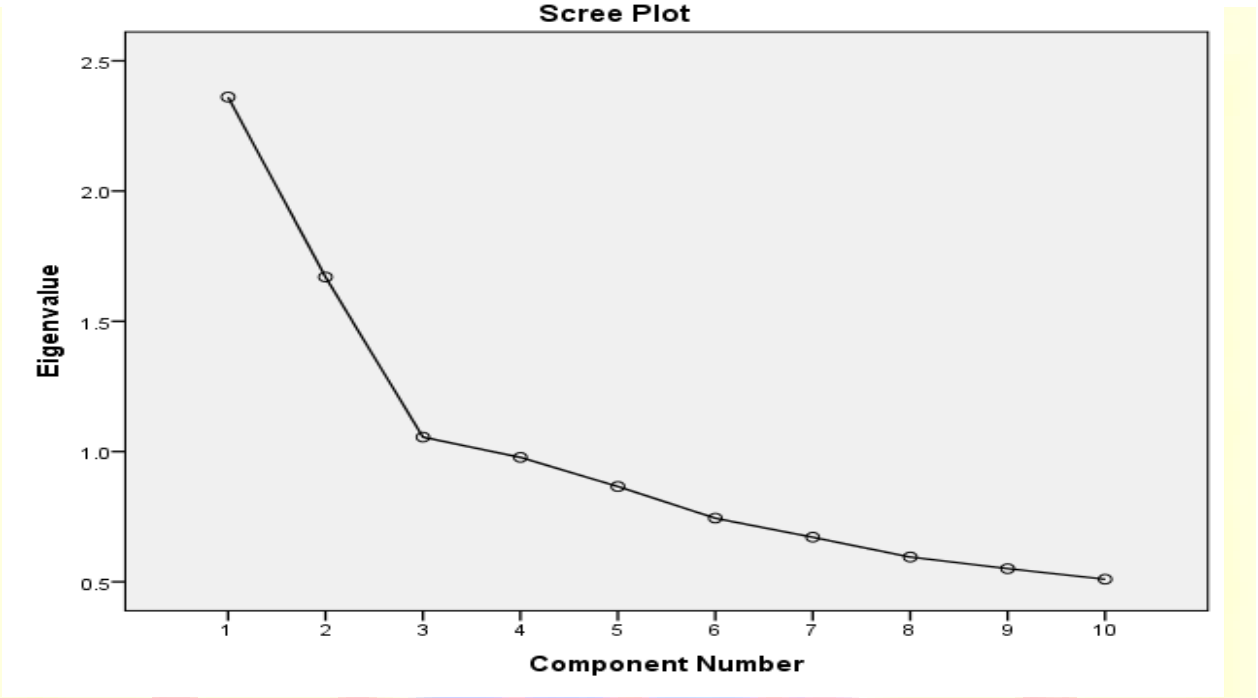
1736						
Vehicle size, N = 1738	226	13.0%	152	8.7%	196	11.3%
Expected operating costs, N = 1741	298	17.1%	222	12.8%	169	9.7%
Reputation of particular vehicle make or model, N = 1723	240	13.9%	162	9.4%	164	9.5%
Fuel type (e.g. petrol, diesel, CNG), N = 1740	313	18.0%	230	13.2%	178	10.2%
Vehicle emissions and pollution, N = 1742	254	14.6%	302	17.3%	172	9.9%
Cells highlighted in green color represents the highest percentage across regions						

To examine the important factors which influence the buyer's decision, factor analysis - a data reduction technique was used. It was found that, The Kaiser-Meyer-Olkin value was 0.680, exceeding the recommended value of 0.6 (Kaiser 1970, 1974) and Bartlett's Test of Sphericity (Bartlett 1954) reached statistical significance, supporting the factorability of the correlation matrix and justifies the appropriateness of Factor Analysis.

Principal components analysis revealed the presence of three components with eigenvalues exceeding 1, explaining 24 per cent, 17 per cent, and 11 per cent of the variance respectively. As explained in **Figure 1**, The three key vehicle characteristics that are of interest for understanding trade-offs that people are willing to make are Vehicle Efficiency and Safety,

Vehicle design and price, Economy. It is easier to focus on some key factors rather than having to consider too many variables that may be trivial, and so factor analysis is useful for placing variables into meaningful categories.

Figure 1: Important Factors Explained by Eigenvalue for Purchase of Personal Vehicles



Homogeneity of Variance between variables

ANOVA test was used to find out the relationship between Vehicle emissions & pollution and driving a vehicle with more advanced or innovative technology. In **Table 9** results from ANOVA shows that the variable "driving a vehicle with more advanced or innovative technology" is not significant which is p>.05. So, null hypothesis can be accepted and it can be concluded that there is no significant difference in consumer's attitude towards new technology from different zones of India. There is no significant difference between the mean score of respondents from different zones of the country when consumer attitude towards new technology is concerned. Variable "Vehicle emissions and pollution" shows that the results are significant which is p<.05, so we can reject the null hypothesis and accept the difference hypothesis that there is a significant difference in consumer attitude towards environment belonging to three different zones of India.

Table 9: ANOVA

Variables	Sig.
Driving a vehicle with more advanced or innovative technology (electric vehicle)	non-significant
Vehicle emissions and pollution	Significant

To explore the significance level for variable "Vehicle emissions and pollution" Tukey HSD technique under ANOVA was used. One-way analysis of variance (ANOVA) technique was used to determine whether there are any significant differences between variables. **As per Table 10**, it can be concluded that South India and West India have a significant difference in the score ($p<.05$). Score from South India is significantly different from North India ($p<.05$).

But interesting results are there when West India is compared to North India, it was observed that the differences are not significant ($p >.05$). It can be said that respondents from North India and West India reflect same perception for the environment.

Table 10: Multiple Comparisons

Tukey HSD			
Dependent Variable	(I) Zone	(J) Zone	Sig.
Driving a vehicle with more advanced or innovative technology	South India	West India	non-significant
		North India	non-significant
	West India	South India	non-significant
		North India	non-significant
	North India	South India	non-significant
		West India	non-significant
Vehicle emissions and pollution	South India	West India	significant
		North India	significant
	West India	South India	significant

		North India	non-significant
	North India	South India	significant
		West India	non-significant

Premium for New Technology

It was observed that consumers are willing to pay a premium price that ranges from 10 per cent to 20 per cent for electric vehicle across the regions. From **Table 11**, it is clear that majority of respondents from North India are willing to pay premium amount of 10 -15 per cent. But West India has more respondents for 20 per cent premium segment. So, the regional segmentation of customers appears to be optimistic about the premium cost of electric vehicle.

Table 11: Willing to pay premium to purchase an Electric Vehicle. N=1656

Premium in Percentage	North India	South India	West India
10%	14.1%	8.9%	6.3%
15%	14.9%	13.0%	10.3%
20%	10.4%	8.0%	14.1%
Cells highlighted in green color represents the highest percentage across regions			

Information Source

As explained in **Table 12**, for North India, television, newspaper, radio, magazines and computers are the important source for information related to new technology. Word of mouth is an important factor among South India respondents. North India respondents also get information from important sources like their friends, relatives, family members and various hoardings.

Table 12: Source for Information and New Technology. N=1740

	North India		South India		West India	
Source for Information	Frequency	Total %	Frequency	Total %	Frequency	Total %
Television	402	23.1%	298	17.1%	309	17.8%
Newspaper	398	22.9%	265	15.2%	277	15.9%
Radio	125	7.2%	23	1.3%	103	5.9%
Magazines	239	13.7%	154	8.9%	235	13.5%
Computer	412	23.7%	332	19.1%	304	17.5%
Word of mouth	39	2.2%	100	5.8%	29	1.7%
Other	69	4.0%	46	2.6%	63	3.6%
Cells highlighted in green color represents the highest percentage across regions						

Conclusion

In this paper, regional difference in consumer preferences has been studied along with their implications for alternative fuel vehicles in India.

Consumers are interested for Electric Vehicles—nearly 84 per cent of respondents are willing to purchase an electric motor vehicle once they become easily available in the local market in the next couple of years. After analyzing customer responses and preferences through survey, it was strongly felt that Electric Vehicles could be made more acceptable by focusing on consumer preferences and three important vehicle characteristics i.e. Vehicle Efficiency and Safety, Vehicle Design and Price, Economy.

It was also found that regional differences in levels of preference for electric vehicle exist across the regions. This is due to different levels of infrastructural availability (charging stations) across the regions. Information campaigns or the possibility to test electric vehicles in the field could be especially customised for these consumer groups as per regional differences in their preferences to reduce their unfamiliarity with, and reservations against, electric vehicle.

After a detailed analysis of the survey result, it was concluded that people from North India are willing to purchase an electric vehicle which is fuel efficient, powerful, cost effective and with

less operating cost. For South India respondent's safety, reliability, vehicle emission and pollution are important factors. Also, highly educated, and environmentally conscious consumers, are more prone to buy vehicles based on new technologies in general and electric cars in particular. Hence, marketing strategies could be tailored such that they target specifically these consumer groups (respondents with higher qualification) across regions for effectively increasing the adoption rates (or sales figures) of certain vehicles.

Study found that people from North India face traffic related problems like congestion and noise; vehicle emissions and pollution; global warming on day to day basis and willing to pay the premium price for electric vehicle up to 15 per cent than the conventional vehicle. However, they are not able to find the right vehicle in current market which meets their current requirement.

Recommendations

By targeting motivated consumers, doing right positioning and correct communication strategies for electric vehicle can attract more consumers, even if the price of the product is higher than the conventional vehicles and will have positive results for the next generations. There are multiple challenges in making it a success for which all stakeholders (government, manufacturers, and the end users) need to work together. This includes (but not limited to) subsidies by the government, making it mandatory for public transport, proper marketing and awareness campaigns, proper disposal of rechargeable battery, solar recharge option (in the moving vehicle), and providing battery recharge kiosks.

Therefore, significant investment in research and development is required to ensure the availability of electric vehicles which fulfills the requirement of the people. Government subsidies, procurement programs and development of niche markets, all will have a role to play in encouraging the uptake of the new technology.

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