AN ASSESSMENT OF PERCEPTION OF INDIAN PASSENGER CAR USERS ABOUT THE ECO-FRIENDLY OPTIONS

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Abstract: Considering the current trend of stricter restrictions on transportation sector for both emission and energy consumption as well as the government's initiative to move to cleaner vehicles, has led to an emerging attention on eco-friendly car technologies. Though in Western countries, Eco-friendly cars have received an extensive acceptance, but in contemplation of the Indian market it is still in the nascent phase. The intent of this paper is to assess the perception of Indian car consumers towards eco-friendly cars. The research also identifies the potential barriers for adoption of these cars and demonstrates if environmental concern drives peoples' decision to purchase green cars. To address this, a survey was conducted in the metropolitan cities of India to get an insight of the preferences and apprehensions that consumers consider to shift to eco-friendly car technologies. The results of this study would be valuable for automobile manufacturers, dealers, marketers as well as policy makers.

Index Terms: Eco-friendly cars, consumer's awareness, barriers, sustainable transportation

1 INTRODUCTION

1.1 Indian Automobile Industry

The automobile industry in India which comprises of commercial vehicles, passenger cars, three and two-wheelers, is the fourth largest among the global automobile industry and accounts for 7.1 per cent of the country's Gross Domestic Product (GDP). In the FY 18-19 a total of 30,915,420 vehicles including passenger vehicles, commercial vehicles, three wheelers, two wheelers and quadricycle were produced with a growth of 6.26 percent over the same period last year.
The passenger vehicle sales in India has already crossed the three-million-unit(33,77,436) milestone during FY 2018-19, and is further expected to grow exponentially. At this pace, the PV market in India is expected to become the third largest in the world within the next three-four years. Over 30 million automobiles were produced in FY18-19 of which 11% was contributed by passenger cars. Currently, penetration level of Passenger Cars in the country, is pegged at 20 vehicles per 1000 people, that indicates the high demand continuing over the next 10 years. This will lead to an increasing vehicle population in the severely congested metros and Tier-I cities in India, which are some of the most densely populated cities in the world. The domestic passenger car sales in India is dominated mainly by small and mid-size cars owing to the ease of driving on small sized of Indian roads as well as lower prices compared to their larger counterparts. India is also a prominent auto exporter and has strong export growth expectations for the near future. Overall automobile exports grew 14.5% during 18-19. (All figures from SIAM)

1.2 Pollution in India

In the last few decade India has witnessed a massive economic growth which brings to us an opportunity to rejoice but this same growth has also presented before us adverse consequences. Today, 19 out of the 35 most polluted cities in the world are in India. Since the past two years, India's national capital, New Delhi has been facing the tagline of being one of the most polluted city in the world. India is also in the group of countries that has the highest particulate matter (PM) levels. Its cities have the highest levels of PM10 and PM2.5 (particles with diameter of 10 microns and 2.5 microns). The level of particulate matter are six times more than the WHO "safe" limit of 25 micrograms.

PM10 LEVELS ACROSS INDIA (ANNUAL AVERAGE 2016/2015)						
STATE	**CITY**	**2015 AVERAGE**	**2016 AVERAGE**	**YEARLY AVERAGE POLLUTION LEVELS 2016 or 2015 (RECENT)**	**NAAQS**	**WHO**
Delhi	Delhi	268	290	290	60	20
Haryana {converted from PM2.5 (47% of PM10)}	Faridabad	240	272	272	60	20
Rajasthan	Bhiwadi	NA	262	262	60	20
Bihar {converted from PM2.5 (47% of PM10)}	Patna	NA	261	261	60	20
Uttarakhand	Dehradun	190	238	238	60	20
Uttar Pradesh	Varanasi	145	236	236	60	20
Uttar Pradesh	Ghaziabad	259	236	236	60	20
Bihar {converted from PM2.5 (47% of PM10)}	Muzaffarpur	NA	235	235	60	20
Uttar Pradesh	Hapur	NA	235	235	60	20
Punjab	Amritsar	184	232	232	60	20
Jharkhand	Jharia	230	NA	230	60	20
Haryana {converted from PM2.5 (47% of PM10)}	Gurgaon	129	227	227	60	20
Uttar Pradesh	Bareilly	240	226	226	60	20
Uttar Pradesh	Firozabad	194	223	223	60	20
Jharkhand	Ranchi	220	NA	220	60	20
Rajasthan	Jaipur	170	218	218	60	20
Uttar Pradesh	Kanpur	195	217	217	60	20
Uttar Pradesh	Lucknow	169	211	211	60	20
Uttar Pradesh	Agra	183	197	197	60	20
Uttar Pradesh	Moradabad	168	195	195	60	20

Fig 3. PM_{10} Levels Across India (Greenpeace-India 29 Jan 2018)

Among all the sectors transportation sector is one of the major sources of environmental pollution. The environmental burden of transport is critical owing to its significant use of energy, and burning most of the world's petroleum. This leads to emissions of excess of nitrous oxides and particulates, and is a dominant contributor to global warming through emission of carbon dioxide. Subsector wise, road transport is the biggest contributor to global warming. Environmental regulations have tried to tackle and reduce the individual vehicles emission, however, this has been offset by an increase in the number of vehicles, and more use of each vehicle.

1.3 Advanced Car Technologies

Hybrid electric vehicles (HEV) integrates the perks of both gasoline engines and electric motors. They run on fuel alone without the need of being plugged to an electrical outlet for recharging the battery. These vehicles can be configured to meet different purposes such as increased power, improved fuel economy and additional auxiliary power for electronic devices and power tools. Some variations of hybrid electric vehicles depending on powering of engines are Series Hybrid, Parallel Hybrid, Mild Hybrid and Micro Hybrid. In a series hybrid, the electric motor is responsible for handling all the driving and the gasoline engine only recharges the battery pack such that the car is powered by the electric motor. It is only on longer trips like 50 miles or above that the gas engine provides power. In parallel hybrid both ICE and electric motor provides power to the car. A micro hybrid vehicle has an integrated alternator/starter that uses start/stop technology, where the control unit shuts down the engine when the car slows down and doesn't restart until the driver releases the brake pedal. A mild HEV is much similar to a micro hybrid with the only exception of an alternator/starter that is upgraded with stronger electric components to assist in vehicle propulsion.

Plug-in Hybrid Electric Vehicles (PHEV) have both the internal combustion engine and electric motor that offer the choice of fuel to be used. These vehicles can be powered by either an alternate fuel or conventional fuel such as petrol and also by a battery that can be charged up with electricity by plugging the vehicle into a charging station or an electrical outlet. The amount of electricity a PHEV's battery can store will determine how significantly it can reduce petrol consumption under typical driving conditions.

Electric Vehicles (EV) also called as Battery Electric Vehicles (BEV) are propelled by electric motors that are powered solely be the rechargeable battery packs. They do not have an Internal Combustion engine and no alternative fuel source is used. These vehicles require the battery charging to power the motor.

Fuel cell vehicle (FCV) also called as Zero Emission Vehicle (ZEV) is powered by the most abundant element in the universe that is hydrogen. FCVs emit no harmful tailpipe emissions as water vapor and warm air are their only emissions which do not prove to be harmful to the environment. FCVs contain technologically advanced components than those found in today's cars. The most significant difference is the fuel cell stack that converts hydrogen gas which is stored on board with oxygen from the air into electricity to drive the electric motor.

2 LITERATURE REVIEW

The literature on eco-friendly cars comprising of Alternate Fuel Vehicle, hybrid, plug-in hybrid and electric vehicles has grown dramatically in the past decade considering the ever growing environmental issues, technological advancements and changing policies. This review focuses on understanding consumers' overall environmental awareness that in turn affects their purchase decision, first through the study of consumers' awareness for low involvement and high involvement eco-friendly products. Later, the review studies the published work on eco-friendly cars concerning with market penetration, consumers' perceptions and apprehensions related to these vehicles and their willingness to pay and shift to such cars and then consequently understanding the gap left in previous studies.

2.1 Study of consumers' awareness for Eco-friendly High Involvement Products

(Nguyen, Lobo and Green 2016), concluded that consumers with high knowledge about energy efficient appliances tend to believe that the purchase of such products is important for environmental protection, and they are likely to downplay their perceptions of inconvenience associated with the purchase.

From the research on factors associated with consumer awareness of Energy star label of white major appliances and their choice of purchase for these appliances, (Murray and Mills 2011) affirmed that regions with greater propensities to conserve energy, based on the ACEEE scorecard show greater propensities to purchase Energy Star labelled appliances, suggesting that regional norms do play a significant role in purchase behaviour.

In Liaoning Province of China, (Dianshu, Sovacool and Vu 2010), found consumers' willingness to save electricity or purchase more efficient energy using devices, but is constrained by a mesh of interconnected barriers like high initial price of energy efficient equipment and a dearth of suppliers in many parts of Liaoning.

Reviewing 'factors influencing willingness to pay for the ENERGY STAR's Label, (Ward , et al. 2011) indicate that consumers have a positive and significantly greater Willing-to-Pay
(WTP) for ENERGY STAR qualified goods than for others.

(Sonnenberg, Erasmus and Schreuder 2014) concluded that most consumers highly regard price in their preference structures, despite the relevance of product features with positive environmental consequences that may even pose long term financial benefits hence, an energy-efficient, eco-friendly appliance still requires effective utilization to realize the long-term economic and financial benefits of green technology

2.2 Study of consumers' awareness for Eco-friendly Vehicles

Based on the review of 'Adoption of cleaner vehicles in UK', (Lane and Potter 2007), have reported the factors that influence the car purchasing behaviour of both private and fleet buyers based on regulations, vehicle performance and the existing road and fuel infrastructure in the UK. The study suggests that although fuel economy the most important reported environmental factor influences car choice, the other non-environmental issues like cost, performance, styling, image continue to play a more crucial role while purchasing car.

(Egbue and Long 2012), from their research suggest that that individuals highly connected to technology development and believing that Electric vehicles have superior performance over conventional vehicles will only purchase such vehicles. Incentives such as tax credits in order to subsidize the cost of Electric vehicles and fuel taxes might only have a marginal effect on EV market penetration if consumers do not have much confidence in the technology.

For the US and Korea, (Oliver and Lee 2010) conducted a cross-cultural analysis that compared US and Korean consumers' intention to purchase a hybrid car. They had hypothesized that three constructs were related to intentions to buy a hybrid vehicle: green information seeking, congruence with self-image, and the social value associated owning a hybrid car. The study revealed that conformity to self-image and the tendency to seek information about green products have strong positive relationships with intentions to purchase a hybrid car among consumers from both countries. The social value associated with the direct ownership of a product has a positive influence in both individualist (Korea) and collectivist (US) cultures. In contrast, social value associated with green products, in general, has a negative relationship with US consumer hybrid purchase intentions.

(Carley, et al. 2013) conducted an online survey of residents in 21 of the largest urban areas of US which depicted that as of 2011, stated intent of US urban drivers to purchase Plug in electric vehicles was low. The cost premium, range limitations and recharging time of PEVs were all perceived as disadvantage and hence decreased the intent to purchase. The 'early adopters' that is the consumers with greatest interest to purchase were found to be highly educated, environmentally-sensitive individuals who believed that it was important to reduce dependence on foreign oil and who already owned a conventional hybrid.

In Sweden, (Jansson, Marell and Nordlund 2010), conducted a survey of 3000 car owners and 1000 alternate fuel vehicle (AVF) owners to examine the determinants of green curtailment behaviours and consumer adoption of innovations marketed as green (eco-innovations), as well as analyse factors explaining these two types of green behaviours. The results showed that values, beliefs, personal norm and car habit strength were all significant determinants of both curtailment behaviour and eco-innovation adoption. Personal norm proved to be the strongest predictor across the models and beliefs were positively associated with willingness to curtail (WTC), but negatively with willingness to adopt (WTA). Additionally, previous adoption was found to be a strong determinant of future willingness to adopt an eco-innovation, but not for curtailment behaviour.

(Ozaki and Sevastyanova 2011) in their research on "Going Hybrid", administered a survey to the consumers in UK the results of which were used in exploratory factor analyses to find out the motive for hybrid car purchases. Five motivational constructs of Financial Benefits, Environmentalism, Compliance with community norms, Attractiveness of the new technology and independence from oil producers were considered in the study. The survey was done in collaboration with Toyota GB to study motivations to purchase Prius. The study concluded that financial incentives strongly affect the purchasing decision whereas an interest in technology was found as the second strongest factor.

(Hevelston, et al. 2015), compared consumer preference in the US and China for conventional, hybrid electric, plug-in hybrid electric (PHEV), and battery electric (BEV) vehicle technologies using data from choice based conjoint survey fielded in both countries. Results suggested that the expected average U.S. consumer WTP for BEV technology is $10,000–$20,000 lower than equivalent conventional technology (depending on range, fast charging availability, and model specification) ceteris paribus (given the same body, brand, performance, and operating cost). In contrast, average Chinese consumer WTP for BEV technology is within $10,000 of equivalent conventional vehicles and in some cases (e.g.: with sufficient range and fast charging capability) is larger. It also suggests that Chinese respondents are more receptive to BEVs than American respondents regardless of subsidies.

(Hidrue, et al. 2011), used a stated choice experiment to estimate how much consumers are willing to pay for EVs with different design features. Respondents were asked to choose between their preferred gasoline vehicle and two electric versions of that preferred vehicle using five attributes of electric vehicles: driving range, charging time, fuel cost saving, pollution reduction, and performance. Results concluded that a person's willingness to buy an electric vehicle increases with youth, education, green life style, believing gas prices will rise significantly in the future, and living in a place where a plug is easily accessible at home. It also propels if a person has a tendency to buy a small or medium sized vehicle and/or is likely to be in the market for a hybrid vehicle for their next car purchase. Respondents were willing to pay from $35 to $75 for a mile of added driving range and $425 to $3250 per hour reduction in charging time. It also suggested that battery cost must drop significantly before electric vehicles will find a mass market without subsidy.

(Ko and Hahn 2013), analysed the preferences of Korean consumers for EVs based on battery price, holding tax, subsidies type, subsidies level, battery swap ability and availability of recharging infrastructure. The results show that the consumers endow greater value for EV with swappable battery than EV with unswappable battery, and prefer lump-sum payment of the subsidies to the instalment payment of subsidies. Moreover, it is shown that with greater anticipated subsidies level and more availability of recharging infrastructure, the higher the utility of the consumers is, that is the expected results.

(Krupa, et al. 2014), tried to better understand factors influencing the potential for PHEV market penetration for which a survey was administered to 1000 stated US residents, using Amazon Mechanical Turk. Results indicated that 86% of consumers felt that potential fuel cost savings would be important in considering a compact PHEV purchase, whereas only 55.1% reported that cutting GHG emissions was important. However, their results also showed that those most concerned about energy independence and climate change had 71.2 and 44.4 times greater odds, respectively, of being willing to consider purchasing a compact PHEV than those least concerned, and consumers with more left-leaning political views were significantly more likely to consider purchasing a compact PHEV than those on the right.

In Nanjing, China, (Zhang, Yu and Zou 2011) from their research suggest that consumer choice for an EV is significantly influenced by the number of driver's licenses, number of vehicles, government policies and fuel price. The timing of consumers' purchases of an EV is determined by educational qualification, annual income, number of vehicles, government policies, the opinion of peers and tax incentives. The acceptance of purchase price of EVs is influenced by age, academic degree, number of family members, number of vehicles, the opinion of peers, maintenance cost and degree of safety.

(Krause, et al. 2013), through their research 'Perceptions and Reality: Public knowledge of plug-in electric vehicles in 21 U.S. cities' measured people's perceptions about how electric vehicles compare to conventional gasoline vehicles on several basic cost and operating dimensions, specifically purchase price, fuel costs, driving range, and maintenance costs. The results of analysis indicate that demographic and attitudinal variables are important factors predicting respondents' stated likelihood of purchasing either type of PEV as their next vehicle. Misperceptions about purchase price and expected fuel and maintenance savings are likewise significant, although their impacts differ between BEVs and PHEVs.

(Skippon and Garwood 2011), through their research allowed fifty-eight peoples to have a direct experience of driving a battery electric vehicle post which they were provided with an attitudinal questionnaire. Their analysis suggest that drivers are clear that BEVs offer environmental benefits, and emit less CO2 than conventional vehicles. However, that more participants agreed with the latter than with the former might suggest that some drivers are unclear that emitting less CO2 is an environmental benefit. Participants appeared to understand

2.3 Analysing the gap

In recent decades many studies have focused on the market analysis of cleaner passenger car technologies like Hybrid vehicles, Plug in Hybrid Electric Vehicles (PHEV) and Battery Electric Vehicles (BEV) from consumers' perspective including their demand preferences, willingness to pay, forecasting, and effect of countries' policies. Most of these previous studies have been effectuated in developed countries and regions of the world like United Kingdom, Sweden, Germany, Canada, USA and some in developing regions of China. Many studies have analyzed the demand markets in Europe for environmentally friendly vehicles from multiple perspectives. More recent studies have also analyzed misconceptions about electric vehicles, incentives that would drive customers to purchase EV and similar factors.

Compared with USA, European countries as well as China the passenger car segment with cleaner technologies in India has been not been substantially explored. Although there are numerous studies analogous to the Environmental friendly vehicles pertaining to the automotive industry development, charging stations, changing government policies and technologies, from the Indian perspective inadequate amount of studies have been undertaken to analyze the cleaner passenger cars segment from consumers' viewpoint.

Furthermore, the previous researches have also left the scope of studying the effect of fuel prices, car ownership cost, incentives, effect of regulatory standards in the customers' eco-friendly car purchasing behaviour and decisions.

3 Research Objectives, Scope and Hypothesis

3.1 Objectives:

1) To identify the factors influencing the decision to buy eco-friendly cars.
2) To ascertain success of eco-friendly cars in India.

3.2 Scope of the Research

The aim of this study is to perceive the customers' awareness level about environmental friendly advanced passenger cars and their perceptions toward buying these green vehicles. The present study has been conducted encompassing respondents from the metropolitan cities of India. The study is confined to passenger cars only. The study may be beneficial to the Automobile OEMs, marketers and dealers to formulate enhanced marketing campaign and policies for modern cars, based on the comprehensive knowledge about the awareness level of consumers pertaining to such cars.

3.3 Hypothesis

H01: Higher price and battery charging infrastructure should not be a barrier for buying an electric car.

H02: Hybrid/electric cars will not be successful in India

4 Research Methodology

4.1 Questionnaire Design

With reference to the study conducted in different countries and regions on consumers' purchase intentions of hybrid and electric cars, the structured questionnaire in this research primarily consists of consumers' demographic characteristics, socio-economic parameters, environmental awareness level, factors considered by consumers while buying cars, perceptions about electric and hybrid cars, and factors inhibiting their purchase decision towards these eco-friendly options. Demographics and socio-economic parameters included age, education, gender, occupation and income groups. Questions on awareness level of environment comprised of statements that required respondents to determine on how strongly they agreed or disagreed with them. To evaluate customers' car purchasing behaviour, respondents were asked about their present fuel cars, earlier purchased cars and their future purchase decisions. To estimate perceptions about eco-friendly cars and barriers for buying these vehicles, respondents were provided with questions each with five alternatives to choose from.

4.2 Data Collection

An internet based survey technique was used to collect data from the sample population. The survey was administered to people residing in metropolitan cities of India namely Mumbai, Delhi, Kolkata, Chennai and Bengaluru and nearby areas to get a representative sample of 61 individuals. Before deploying the actual survey a pilot test was conducted within a close group to ensure that the questions included were easy to comprehend and respond as well as to ensure the accuracy of the alternatives furnished in the questions.

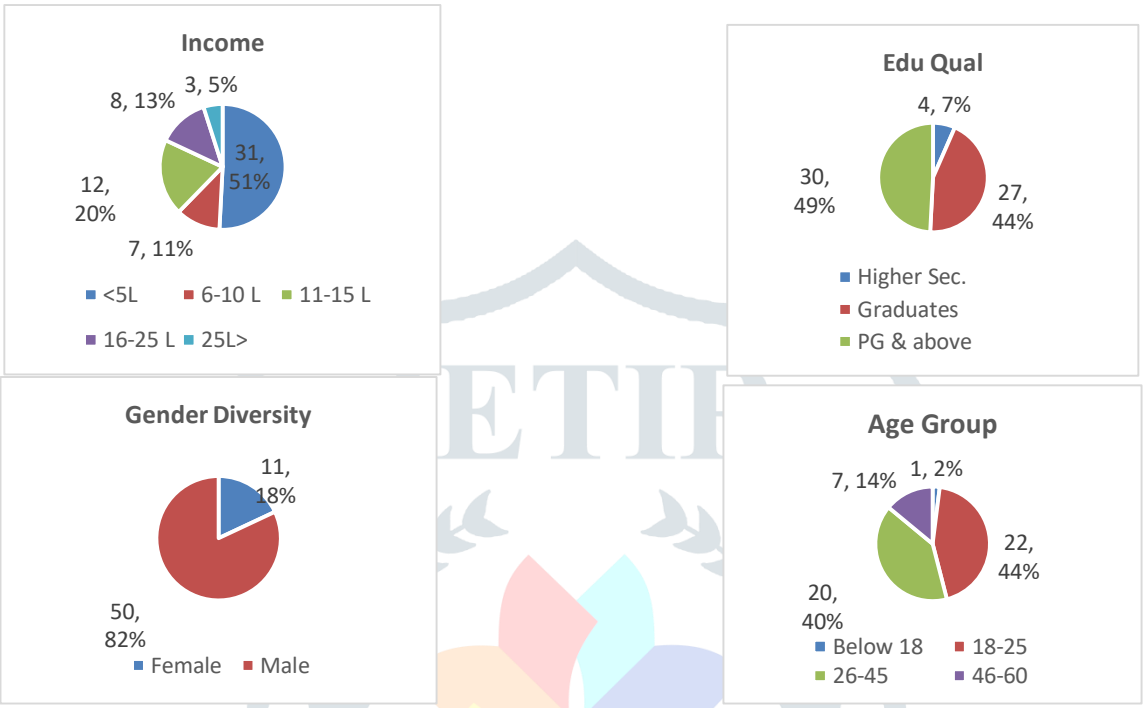
4.3 Data Analysis

The primary data collected by way of an internet based survey was then analyzed using Excel tools to arrive at the conclusions.

5 RESULTS

5.1 Sample Description

The sample has a larger representation of males as compared to females. The overall sample is considerably young with respondents being majorly from the age groups of 18 to 45. The age of the respondents can be ascribed to the fact that majority of the respondents are graduated, post graduated and above. It may also be noteworthy to see that the sample collected may not necessarily be representative about the overall Indian population but majorly represent current and prospective car owners. Detailed demographic patterns of the sample are provided in following charts

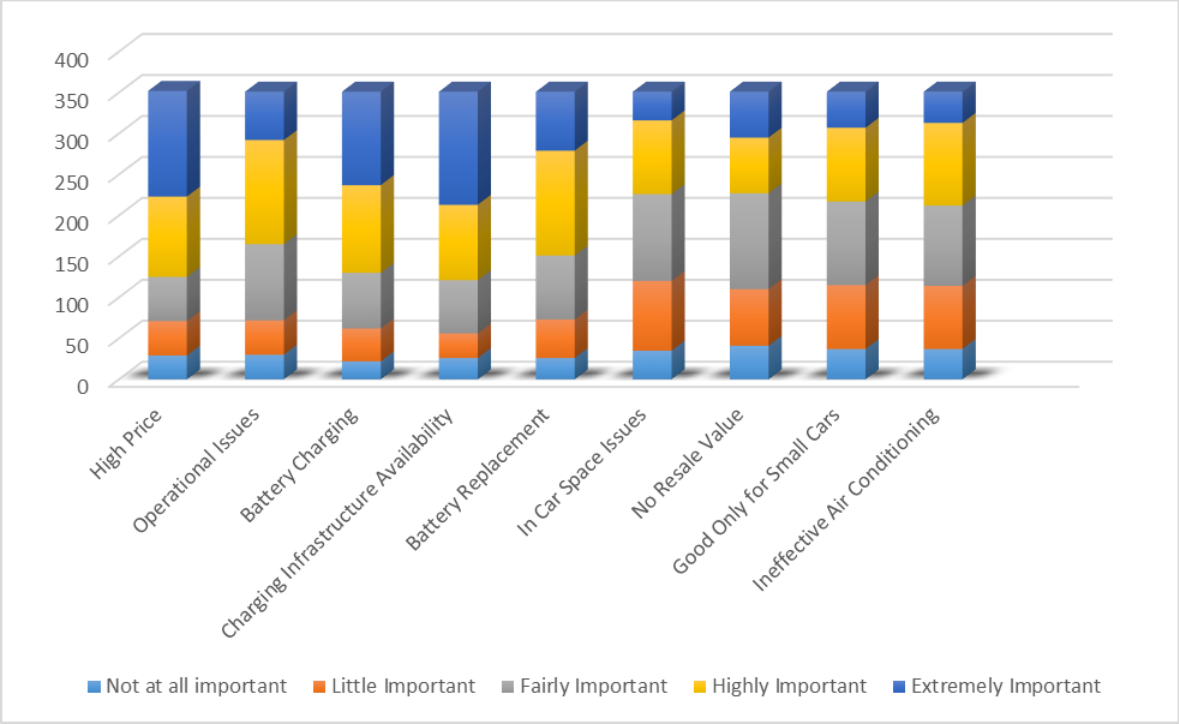


5.2 Purchase Decisions

H01: High price and charging infrastructure are not the main deterrents for buying an eco-friendly car.

To investigate what are the barriers for success of electric cars in India participants were presented a variety of inhibiting factors and asked to select the degree of importance these factors would have on the failure of electric cars acceptance.

Statistical analysis showed that most felt that higher price and battery charging infrastructure could be main barriers for success of electric car in India. Hence the null hypothesis is rejected and alternate hypothesis is accepted.

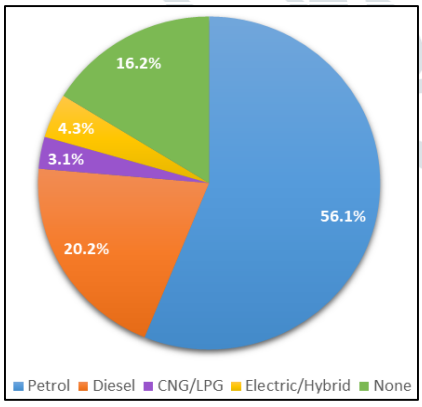


Reasons for Failure of Electric cars in India

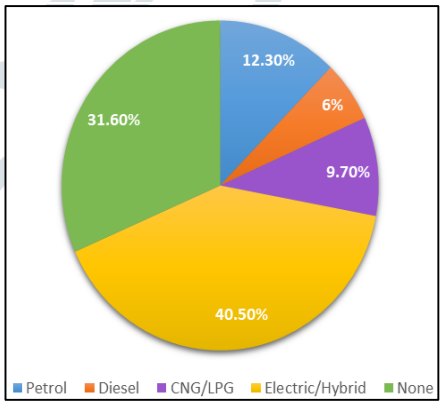
5.3 Willingness to go for Electric car

H02: Electric/Hybrid cars will not be successful in India

Participants were queried regarding their next car with five alternatives (1=Petrol; 2=Diesel; 3=CNG/LPG; 4= Hybrid; 5=Electric) to choose from. Excel analysis showed that consumers are acquainted with the fact that electric and hybrid proves to be a better fuel option that petrol, diesel, CNG or LPG. and by 2030 there will be ten-time increase in number of eco-friendly cars. Thus the null hypothesis is rejected and alternate hypothesis that the eco-friendly cars will be successful in India is accepted.



Currently owned Fuel Car



Future Fuel Car

6 Conclusion

The purpose of this paper was to explore overall perceptions of passenger car consumers about eco-friendly cars. My analysis computes new insights into the demand for electric and hybrid vehicles and confirms some earlier findings in this regard. We observed that a person's propensity to purchase an electric/hybrid car increases with youth, education and occupation. Consumers do believe that conventional cars augment pollutants levels and a lifestyle modification is required to avert further atmospheric deterioration, yet currently fuel efficiency and price are given a priority in buying decision. It was also found that a majority of consumers who currently own petrol/diesel cars have a positive view in shifting to electric and hybrid cars. Consumers also viewed that a boost from government and low operational cost of electric cars would be the primary reason for success of this technology. Evidence provided in this study also indicate that charging infrastructure availability, high price, long charging time as well the extended issue of battery replacement remains to be the consumers' primary concern for electric cars.

7 Future Research

The current study was limited to the metropolitan cities of India. Further research is required to include consumer groups from all regions of India to see if the results from this study are replicable to the whole of India. Since eco-friendly cars yet to gain a substantial share in the automotive market, an in-depth study covering all regions would provide a substantial base to overcome the major shortcomings faced by consumers. In addition to an internet based survey further analysis could also consider direct face-to-face interviews to get a more enhanced perspective.

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