



FACTORS AFFECTING THE ADOPTION OF ELECTRIC VEHICLE FOR PERSONAL USE VEHICLE

Dr. Amisha Gupta
(Professor)

Dr. Bhavneet Kaur
(Professor)

Abheet Jain
(Student PGDM)

Tushar Trivedi
(Student PGDM)

Jagan Institute of Management Studies, Rohini Sec-5, New Delhi, India

Abstract

The technological advancements in the transportation sector have significantly contributed to the nation's growth, but also immensely contributed to greenhouse gases and air pollution. Therefore, this study acquires importance in figuring out the variables which influence the reception of electric vehicles in India. A portion of the variables/hindrances investigated from the writing for the reception of EVs are socio-technical barriers like EV battery range constraints, less number of charging stations, improper government strategies, supportability, user responses, demographic factors, and so on. Therefore, this study acquires importance in figuring out the variables which influence the reception of electric vehicles in India. A portion of the variables/hindrances investigated from the writing for the reception of EVs are socio-technical barriers like EV battery range constraints, less number of charging stations, improper government strategies, supportability, user responses, demographic factors, and so on. Statistical techniques can be utilized to recognize the impact of each considered reception. Quantitative instruments can be utilized for the investigation of the case. Accordingly, the distinguishing proof of key variables/boundaries and comparing moves can be made for the effective reception of electric vehicles.

I. Introduction

The introduction of EVs in the market is a significant advancement and they are engaged with the scattered process of development. This process sets that the reception of developments will in general follow a time series model beginning with a few trailblazers and early adopters who buy the item somewhat early, trailed by most customers, and finishing while lagging customer/consumer choose to take on the innovation. In this manner, early adopters are the principal target group of the present research study since they are normally able to follow through on a greater expense or face sub-optimal execution for the most recent innovation. Inescapable reception of development, as a rule, requires an extensive stretch of time, in any event, when it enjoys clear benefits.

Air pollution is one of the serious challenges, particularly as particulate matter across the globe. The global greenhouse emission is around 15% and is projected to expand up to 45-half by 2030 (Mathew.N, Dr. Varaprasad.G, 2020). The transportation sector has been viewed as a significant contributor to pollution and greenhouse emissions particularly in India. For the reduction of ozone-depleting substance emission, lessening air contamination and reliance on petroleum products is especially significant. Thus, this gives wariness to the ongoing transportation to require changes in the current transportation framework. Around 33% of the all-out contamination records to the transportation sector and the excess is from various sorts of industries.

The transportation sector is answerable for the emission of various kinds of gases out of which carbon dioxide (CO₂), nitrogen dioxide (N₂O), nitrogen oxides (NO₂), argon (AR), carbon monoxide (CO), Sulphur dioxide (SO₂) are the principal constituents and a portion of the above-recorded ones are extremely destructive for the human wellbeing, climate, and living animals.

Hence, India began taking on different methodologies to battle these extreme climatic circumstances emerging out of air contamination. The introduction of electric vehicles has been the greatest methodology taken on by the Government of India to moderate environmental change and decrease the greenhouse effect. A large portion of the nations have begun or very nearly taking on electric vehicles to combat air contamination and lessen the carbon footprint.

An electric vehicle (EV) is an automobile where an electric motor is the essential and primary source of propulsion. EVs utilize electrical energy stored in the batteries which can be recharged. EVs give an extraordinary advantage of zero hurtful emission from the tailpipe and non-prerequisite of petrol fuel which can give many advantages over interior burning (IC) motor vehicles. No greenhouse gasses or air contaminations are delivered by the EVs. The upstream contamination which is produced by the generation of electricity, which is utilized for charging of EVs is fundamentally exceptionally less when contrasted with conventional vehicles. Unfortunately, the mindfulness and accessibility of electric vehicles across the globe are much limited. The EV industry in India is in a developing stage and the Government is likewise advancing EVs with the assistance of various schemes and policies. However, the reception of EVs has not taken off well in spite of the Governmental strategies and motivating forces for purchasers. As this innovation is in the advancing stage, it would be especially pertinent to figure out the significant elements and boundaries which impact the reception of EVs. (Ahmed.A, 2021)

The Customer also wants a better and cheaper alternative for daily commuting. With the introduction of CNG, customers switched to the bi-fuel alternative and installed CNG kits which have a considerable initial investment. Having on this companies likewise started providing factory-fitted CNG kits due to which it witnessed an exponential rise in sales figures. The cost of running came out to be half of diesel and one-third of petrol.

The same factor can also be a game turner for entry-level hatchbacks ad compact sedans offering EV, which can provide a high sales figure as eventually the running cost of EV is as low as Rupee 1 per km backed up by low maintenance cost making it highly economical.

II. Literature Review

Consisting of natural gas industry/fuel suppliers, governments, equipment suppliers, consumers, and NGOs, need to be involved. A number of economic factors, including the purchase cost of NGVs (OEM, converted, or bi-fuel vehicles) compared with gasoline/diesel vehicles, natural gas fuel price at the pump compared with gasoline/ diesel, the profitability of operating refuelling stations, and selling/installing vehicle equipment, can affect consumers' and investors' decisions to enter the NGV market. Establishing retail natural gas fuel prices of 40–50% below gasoline and diesel prices and providing sufficient incentives to keep the payback period at 3–4 years or less are the keys to the wide adoption of NGVs. (Yeh.S, 2007)

Although the environmental factor is undoubtedly one of the main considerations for governments promoting NGVs, some of the emission results have been disappointing or even poorer than those of gasoline vehicles, due to poor conversion, maintenance, and system integration of NGVs (Dondero and Goldemberg, 2005; Zhaoa and Melaina, 2006)

The NGV sector has shown tremendous growth over the last 15 Year in most of the gas producing countries to offer product which has behind it a tried and tested technology which Guarantees the environment protection, is inexpensive and affordable. CNG is clearly a powerful weapon for the countries in the battle to replace oil in the transportation sector, to reduce air pollution and to address the challenge posed by climate change CNG has several advantages over both diesel and gasoline fuel, including considerable mission and

cost reductions, and making the countries more energy sovereign by reducing the dependency on oil. (Khan.M.I, Yasmin.T, Shakoor.A, 2015)

Comparison of TCOs of the electric variants of 2W, 3W, cars, and buses with their ICE counterparts was reported. The results suggest that the TCO per km of e-2W is less than their ICE counterparts. Also, the TCO per km of e-2W with LIB is less compared with lead-acid powered 2W. At a typical daily travel distance, the TCO per km of e-3W is less than the ICE variants. Because of the high initial purchase cost, the TCO per km of both hatchback and sedan e-cars is higher than their ICE counterparts. With increasing vehicle utilization, the gap in TCO per km of e-cars and their ICE counterparts decreases.

Financial incentives or innovative business models to reduce the initial purchase cost can also help in reducing the TCO per km of e-cars. Because of high vehicle utilization, e-cars are more economical when used in fleets as compared with personal use. Also, the electrification of fleet cars can help in the efficient planning of charging infrastructure. Like e-cars, the initial purchase cost of e-buses is higher than their ICE counterparts. (Kumar.P and Chakrabarty.S, 2020)

Rising concerns about the harmful effects of emissions of diesel and gasoline have made CNG a very promising alternative fuel for the road transportation.

The factors influencing BEV adoption intentions were divided into three categories: (1) demographic factors including individual variables (e.g. gender, age, education, income, and occupation) and family variables (e.g. vehicle ownership, accessibility to plugin vehicles at home, population, and the number of driving licenses); (2) situational factors such as technical features, cost, environmental attributes, and government policy; and (3) psychological factors such as experience, attitudes, emotions, perceived behavioral control, societal influence, and symbolic value. (Li.W, Long.R, Chen.H, Geng.J, 2017)

Eco-innovation products based on clean technology require government intervention until they reach a growth phase in their product life cycle. Government incentive programs encourage the participation of product or service providers and induce competition, which helps to bring more competitive products to market. (Kim.S, Lee.J and Lee.C, 2017)

As this study points to, interpersonal influence in the form of norms and the neighbor effect at the same time making EVs more visible may influence attitudes and thus adoption positively. Drawing on this, policymakers and car manufacturers could make sure that EVs and charging points are clearly labeled and promoted so that they are noticed more than they are now. Although public charging infrastructure might not be very important once an EV is adopted, the psychological importance before actual adoption should not be underestimated. Future research could investigate these relations further and thus define what types of visible cues are more effective for what segments and geographical areas. (Westina.K, Janssona.J, Nordlunda.A, 2018)

Based on the analysis, electric vehicle manufacturers and Government of India have to invest more on social acceptance of the vehicle by creating more infrastructural facilities, putting more thrust on technology that can create trust in vehicles. The result clearly depicts that the population is well aware of the environmental benefits. Now responsibility lies on shoulders of Government and manufacturers that parallel to investing in manufacturing of vehicles. (Bhalla.P, Li.I.S, Nazneen.A, 2018)

The authors suggested improving collaboration among the various stakeholders to provide seamless connectivity and eliminate the numerous deterrents to faster adoption of EVs. Adopting a dual perspective to gather insights, the authors complemented the existing consumer-biased literature on EVs. Specifically, the authors applied the PPM framework. Energy cost and charge time hurt the intention of use. While charging station availability, EV sales and driving range had a positive effect on the same intention of use. Also, the rate of technological innovation of charging technology had a negative effect on the selection of charging technology. Finally, the import of electronic components negatively affected the relative purchase price of EVs. (Bhattacharyya.SS and Thakre.S, 2020)

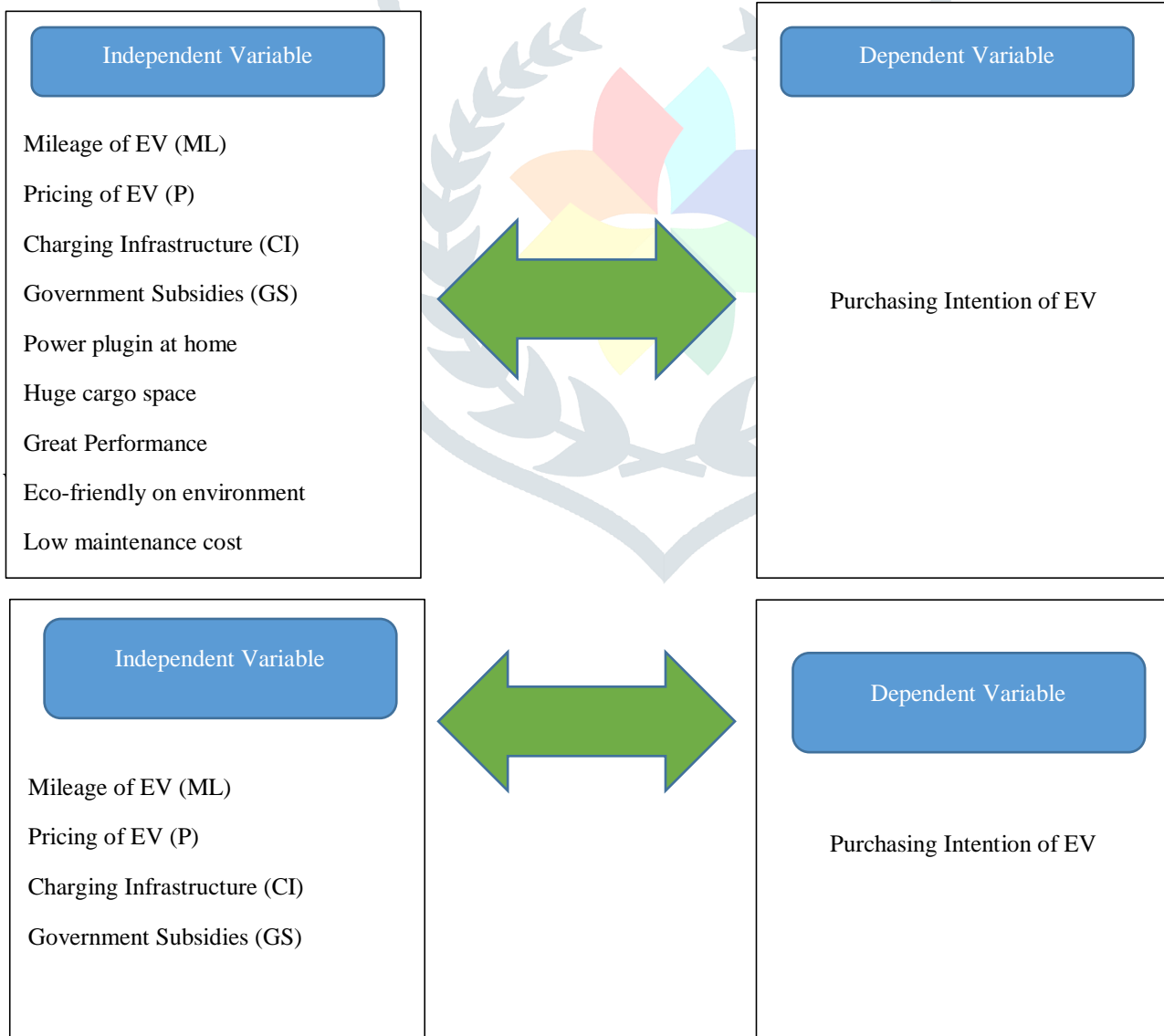
EV adoption suggests that high purchase price is a major impediment to EV uptake. EV driving range is identified as another major impediment to EV adoption. Depending on the driving needs of consumers, for short commutes within urban areas or for longer trips, potential range anxiety gives rise to the literature's findings that PHEVs serve as a solution to limitations in driving range. With adequate charging infrastructure, however BEVs may be preferred by consumers. (Coffman.M, Bernstein.P and Wee.S, 2016)

The high acquisition price and limited driving range are also the major barriers in EV adoption. Consumer characteristics like age, gender and education are more significant in determining their purchasing intention, but most of the research is based on the survey of early adopters and individuals with less EV awareness. In this regard, real data with quantitative analysis on social network rather than merely on individuals will provide some more evidence on the variables influencing EV adoption. Overall, we conclude that socio demographic and psychological factors have a positive impact in predicting consumers EV adoption. However, contextual factors, including policymaking and charging infrastructure were found to directly affect consumers' intention to purchase an EV and thereby considered most significant in determining rate of EV adoption. Continued advancement in EV technology and charging infrastructure will increase EV adoption. (Singh.V, Singh.V, Vaibhav.S, 2020)

III. Discussion

Going through the Literature Review we came across multiple factors which can have an impact on the purchase intention or adoption of an Electric vehicle as a personal use vehicle. The factors which came out from the picture are Mileage, Pricing, Charging infrastructure, the flexibility of charging (power plug-in) at home, cargo area, impact on the environment, and low maintenance cost. We will be having quantitative research on three variables which are the price of the vehicle, charging infrastructure provided, and range of vehicle per charge. Government policies such as rebates and subsidies will be taken as a moderate variable.

IV. Conceptual framework:



VI. Objectives:

1. To study the impact of price on the purchase of EV (Electric Vehicle).
2. To study the impact of mileage on the purchase of EV.
3. To study the impact of charging infrastructure available in the city on the purchase of EV.
4. To study the impact of government subsidies on the purchase of EV.

VII. Define Variables:

1. As per the author price means Purchase cost, the three items were adapted from the study of [Mr. Mathew.N, Dr. Varaprasad.G](#) (2020), to explore how the high purchase cost negatively affects Indian consumers' decision to buy electric vehicles.

P1: I can afford an electric vehicle.

P2: I think the price of electric vehicles in India is reasonable now.

P3: In general, the price of electric vehicles are more expensive than a conventional vehicle

2. As per author mileage, the four items refer to [Mr. Mathew.N, Dr. Varaprasad.G](#) (2020), which measured how the mileage/driving range of electric vehicles has a positive effect on Indian willingness to purchase an electric vehicle.

ML1: The driving range is one of the problems of electric vehicles.

ML2: I want to reduce the electric vehicle times of charges.

ML3: I have been paying attention to the breakthrough in driving range technology of electric vehicles.

ML4: The higher driving range of the electric vehicles will provide me with more satisfaction.

3. As per the author charging infrastructure, the three items were taken from [Mr. Mathew.N, Dr. Varaprasad.G](#) (2020), it mainly collected one piece of information about access to residential recharge infrastructure. We used those three items to test the good construction of charging infrastructure, which has a positive effect on Indian willingness to purchase electric vehicles.

CI1: I am satisfied with the current situation of public charge-points for electric vehicles in India.

CI2: I think the charge-point location is convenient in India.

CI3: I don't think the existing charge points will support my long-distance driving of the electric vehicle.

4. As per the author, government subsidies, the three items were taken from [Mr. Mathew.N, Dr. Varaprasad.G](#) (2020), it mainly collected one piece of information about how government subsidies change consumer behaviour. We used those three items to test the good construction of charging infrastructure, which has a positive effect on Indian willingness to purchase electric vehicles.

GS1: I am satisfied with the current government subsidies.

GS2: I feel there is a scope for improvement in the current government subsidies.

GS3: I think the current government subsidies do not attract me to purchase an electric vehicle.

VIII. Hypothesis:

1. There is a negative impact of price on the purchase of EV.
2. There is a positive impact of mileage on the purchase of EV.
3. There is a negative impact of the shortage of charging infrastructure available in the city on the purchase of EVs.
4. There is a positive impact of government subsidies on the purchase of EVs.

IX. Types of Categorical variables used on our Independent Variable:

1. Range of EV – INTERVAL
2. Charging infrastructure – INTERVAL
3. Pricing of EV – INTERVAL
4. Government policies subsidies – INTERVAL

X. Research Methodology:

The qualitative approach is adopted which is suitable for the causal research method with the intent to capture effective behavioural responses of individuals.

The primary source of data for this research was obtained from structured Close-ended questionnaire instrument-based questions with key individuals who can be potential buyers of electric vehicles. The questionnaire was floated against which 123 responses were received.

These responses were taken from potential consumers across Delhi NCR.

The questionnaire is divided into two parts. The first part focused on the data related to demographic characteristics of the respondents: this covered gender, age, occupation, number of family members, and location. The second part of the questionnaire measures the model variables. There were one dependent and four independent variables.

This helped us to understand the points which influence various individuals toward the adoption of EVs. The research was further supplemented through scientific literature reports. The data was collected from 12th March 2022 to 2nd April 2022.

Reliability Statistics

Cronbach's Alpha	N of Items
.648	5

Table: I

A generally accepted rule is that α of 0.6-0.7 indicates an acceptable level of reliability. Since the value is 0.648 so the Cronbach's Alpha is accepted.

Statistics

		Age	Gender	Location
N	Valid	121	121	121
	Missing	0	0	0
Mean		24.81	1.36	

Table:II

The above table shows that the 121 responses belonging to different age groups, varied locations in Delhi/NCR, and both the gender categories considered were entered in the SPSS and there is no missing value. The mean age for the data collected is around 25 years. Most of the data were from Delhi consisting of a major share of 55.34 percent and the rest were scattered across North India majorly consisting of areas of Haryana, Uttar Pradesh, and Rajasthan.

		Mileage	Pricing of EV	Charging Stations	Government Subsidies
Mileage	Pearson Correlation	1	.327**	.324**	.324**
	Sig. (2-tailed)		.000	.000	.000
	N	121	121	121	121
Pricing of EV	Pearson Correlation	.327**	1	.146	.146
	Sig. (2-tailed)	.000		.110	.110
	N	121	121	121	121
Charging Stations	Pearson Correlation	.350**	.151	.457**	.457**
	Sig. (2-tailed)	.000	.098	.000	.000
	N	121	121	121	121
Government Subsidies	Pearson Correlation	.324**	.146	.457**	1
	Sig. (2-tailed)	.000	.110	.000	
	N	121	121	121	121

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	77	63.6	63.6	63.6
	Female	44	36.4	36.4	100.0
	Total	121	100.0	100.0	

Table: III

The above table shows that out of 121 responses there are 77 Male candidates which is 63.6 percent and 44 Female candidates which is 36.4 percent.

Correlation

Table: IV

In the above table, the significance value is less than 0.05 from which we can say our model is a good fit. The correlation observed between the variables are stated as follows:

A positive correlation is observed between "Mileage" and "Pricing of EV"(High Price) which is 0.327. High change in Mileage will effect slight change in Pricing of EV.

A positive correlation is observed between "Mileage" and "Charging Station" in your area (Infrastructure) which is 0.350. High change in Mileage will effect slight change in availability of Charging Stations.

A positive correlation is observed between "Mileage" and "Government Subsidy" which is 0.324. High change in Mileage will effect slight change in Government Subsidy.

A positive correlation is observed between "Pricing of EV"(High Price) and "Charging station" in your area"(Infrastructure) which is 0.151. High change in Pricing on EV will effect slight change in availability of Charging Station.

A positive correlation is observed between "Pricing of EV"(High Price) and "Government Subsidies" which is 0.146. High change in Pricing of EV will effect slight change in Government Subsidy.

A positive correlation is observed between "Charging Station' in your area (Infrastructure) and "Government Subsidies" which is 0.457. The proportionate change in availability of Charging Station will effect slight change in Government Subsidies.

ANOVA

Model		Sum of Squares	Degree of Freedom	Mean Square	F Value	Sig.
1	Regression	29.794	4	7.449	7.917	.000 ^b
	Residual	109.131	116	.941		
	Total	138.926	120			

Table: V

a. Dependent Variable: Purchase intention towards Electric Vehicle

b. Predictors: (Constant), Government Subsidies, Pricing of EV, Mileage, Charging Stations

The above table shows the significance value of 0.000 which is less than 0.05 hence the model is a good fit. Thus, the hypothesis is true and the result is significant.

F Value- A value is greater than 1 for F-ratio yield efficient model. In the above table, the value is 7.917, which is good.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.463 ^a	.214	.187	.970

Table: VI

a. Predictors: (Constant), Government Subsidies, Pricing of EV, Mileage, Charging Stations

In the above table, we can see that R-value represents the correlation between the dependent and independent variables. A value greater than 0.4 is taken for further analysis. In this case, the value is .463, which is good.

R-square shows the total variation for the dependent variable that could be explained by the independent variables. A value greater than 0.5 shows that the model is effective enough to determine the relationship.

Adjusted R-square shows the generalization of the results i.e. the variation of the sample results from the population in multiple regression. It is required to have a difference between R-square and Adjusted R-square minimum. In this case, the value is .187, which is not far off from .214, so it is good.

Coefficients

Model		Unstandardized Coefficients		Standardized	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Coefficients			Lower Bound	Upper Bound
1	(Constant)	1.852	.548		3.380	.001	.767	2.937
	Mileage	.500	.107	.437	4.670	.000	.288	.712
	Pricing of EV	-.060	.096	-.054	-.621	.536	-.251	.131
	Charging Station	-.025	.105	-.023	-.242	.809	-.233	.182
	Government Subsidies	.113	.091	.117	1.241	.217	-.068	.294

Table: VII

a. Dependent Variable: Purchase intention towards Electric Vehicle

From the above table we can interpret the null hypothesis of the following variables:

Mileage Sig. value is 0.000 which is less than 0.05 so the null hypothesis is rejected which means there is an impact of "Mileage" on the purchase decision of EV.

Price Sig. value is 0.536 which is more than 0.05 so the null hypothesis is not rejected which means there is no impact of "Price" on the "Purchase Decision of EV".

Availability of "Charging Station" in your area Sig. value is 0.809 which is more than 0.05 so the null hypothesis is not rejected which means there is no impact of the availability of a "Charging Station" in your area on the "Purchase Decision of EV".

Government Subsidies Sig. value is 0.217 which is more than 0.05 so the null hypothesis is not rejected which means there is no impact of Government Subsidies on the Purchase Decision of EV.

XI. Conclusion

Seeing all the factors combined it can be concluded that these factors can play a vital role in the adoption of electric vehicles which are; the feasibility of a charging point at home, the time consumed by a vehicle to fill up its charge, mitigation strategies in the case of a completed depleted powerhouse(batteries), a proper network of charging station across the city to avoid the hindrance of a smooth transition, range of a vehicle always plays a key role in decision making and range more than 600 km which will be equivalent to their IC counterpart. The difference in the purchasing cost of the vehicle to the similar IC variants of the same make and model. Humongous cargo area available which can be a deal break.

The “Purchase Intention” was dependent on the variables availability of “Charging Station”, “Mileage” of the vehicle, “Pricing of EV” and “Government Subsidies” where “Mileage” considers the most important independent factor.

The pricing of EV is higher in comparison to IC counterparts but the government has played a crucial part in balancing the prices as apart from subsidies the RTO charges are quite less and you can get a rebate on it while filling ITR on the other hand heavy taxes are imposed on IC as the tax slabs are quite high which makes EV a considerable option.

According to research, the companies should also focus on building the infrastructure for charging stations as the maximum number of people are not intended to buy EVs because of the lack of charging stations. If the availability of charging stations is adequate in the area then it will help in increasing the sales of electric vehicles.

Companies should also focus on lowering the prices of electric vehicles as they are very costly and despite people's willingness to buy the vehicles they are unable to afford them. So, lowering the prices will increase sales numbers.

Also during the research, we have seen that people are interested in buying both types of electric vehicles which are two-wheeler and four-wheelers. Also, the companies can target and segment their customers on the basis of vehicle type and can easily target potential customers.

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