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Using diffusion of innovation framework with attitudinal factor to predict the future of mobility in the Indian market

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Abstract

Rising temperatures across the world is posing a serious challenge to the longevity of earth's natural cycle. Use of private and conventional cars is growing year by year as standard of living continues to increase and affordability remaining no more of an issue for a significant proportion of the population. However, there has been a growing voice from segments of the society for a behavioural shift towards more sustainable modes of transport like usage of electric vehicles (EVs), mobility sharing and rental services and public transportation powered by electricity. One of the biggest importers of foreign crude oil, India, is reeling under immense pressure to reduce its carbon dioxide emissions and thereby contributing to environment protection. In India, the statistics or stock of EVs continues to remain poor when compared to its counterparts like China. Hence, this study is conducted to predict the influence of factors on purchase intention of consumers with respect to EVs in the Indian context. A questionnaire was prepared and circulated in New Delhi region to gather the responses people hold about this new technology based on the diffusion of innovation framework. The data of 225 respondents was analysed with the help of SPSS and AMOS software. Structural equation modelling technique was applied to test the hypotheses of this research. The results indicate that attitude has the most influential impact on purchase intention followed by related advantages but consumers also believe EVs to be complex in terms of their usability, limited availability and the absence of required public charging infrastructure. The mediating role of attitude between determinants of diffusion and purchase intention was also established except in the case of complexity. This study is contemporary and adds to the limited literature available on EV adoption in the Indian market by integrating attitudinal factor within the DOI framework. It also provides suitable insights to further the development of EVs in the domestic and global market.

Keywords Electric vehicles · CO_2 emissions · Characteristics of diffusion · Attitude · Purchase intention

Introduction

Increased number of anthropogenic activities such as mining, deforestation and burning of fossil fuels through transportation of all kinds is the main suspect in rising greenhouse gas emissions such as carbon dioxide, nitrous oxide and other harmful pollutants. Rising carbon pollutants from transportation sector accounts for almost a quarter of world's total greenhouse gas emissions (Khurana et al. 2020) and this is expected to increase to 50% by the end of year 2030 (Han et al. 2017; IEA 2009). Automobiles, running on petrol, diesel and other unsustainable forms of energy, being the top emitter accounts for almost 75% of world's carbon emissions from the transportation sector (Higueras-Castillo et al. 2021). Increased number of vehicles on roads and ever-increasing use of personal cars (Huang and Ge 2019) is leading to various environmental problems like air pollution, noise pollution and rising heatwaves (Nordlund and Garvill 2003). Experts and researchers are stressing the adverse effects of this on the health of humans, animals and plant species.

For environmental protection, different types of behaviours can be opted and buying green products is one of them (Gordon-Wilson and Modi 2015). Today, people are coming

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forward and taking responsibility for the protection of the environment by demanding more of eco-friendly products. This has resulted in the development of novice environmental ethics translating into changed consumption patterns (Jang et al. 2011). The green movement has expanded rapidly in the developed world (Kahn 2007) but with time an increased receptiveness is seen among consumers about going green in developing nations such as India. Moreover, the demand for such products is no more confined to few environmentally conscious individuals; rather, these goods are slowly penetrating into the mainstream market. EV adoption behaviour is being equated with pro-environmental behaviour and factors associated with this behaviour are being used to predict the EV adoption (Hamzah and Tanwir 2021).

Companies are also observing the changing trend in the market and have been actively responding to the changing societal expectations. They are offering endless number of environment friendly products including alteration of their distribution channels like green supply chain management (Tseng et al. 2013) thereby making consumers to showcase their green ethics in their day-to-day consumption process. Such green decisions by consumers help to reduce the negative effect of their purchases by replacing their non-green products with those that are ecologically sound (Moser 2015).

India stands third in global carbon dioxide emissions only after USA and China (Krishnan and Koshy 2021) and imports more than three-fourths of its domestic crude oil demand from foreign players. In the past, this resource has also been subject to high price volatility (Ghosh and Kanjilal 2014), thereby putting the smooth functioning of the domestic economy in a precarious position. EVs are being given a serious push to lower the country's dependence on this expensive and imported fuel from foreign countries and the impact of its per capita energy consumption.

EVs, a potential eco-friendly technology, can reduce the contribution of automobiles to the global warming and can help countries to meet their intended targets under the Paris Climate Agreement concluded in 2015. Oil, which is a limited and exhaustive resource, must be replaced with another type of energy like electricity, to take care of transportation needs and boost economic development agenda of the future. This will simultaneously improve the local air quality, prevent traffic noise, create new business opportunities (Brady and O'Mahony 2011) and preserve the natural environment for the generations to come, called as sustainable development (WCED 1987).

Efforts are being organised in India like purchase subsidies and facilitating manufacturers to enhance the intake of EVs by consumers. However, the overall scenario of EVs in India looks dismal and the country is being categorised in an early adopter stage (Rogers 2003). The demand for this technology in India has not picked up despite of its positive environmental consequences, government measures in the form of NEMMP (National Electric Mobility Mission Plan) launched in the year 2020 and the underlying FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles) policy. When the domestic market share of EVs in other countries such as USA, Norway and China continues to show upward trend, India is way behind achieving its ambitious target of 30% EVs by 2030 (earlier the goal was to achieve 100% EVs by 2030) even in the forthcoming years.

To highlight some numbers, in 2019, only 156,000 EVs were sold in India. Of these, 152,000 vehicles were electric 2 wheelers and the number of electric cars (ECs) was just 3400 (SMEV 2020). Although this number of ECs increased to 4588 in the next financial year but the picture is far from healthy. The reason being the emergence of COVID-19 pandemic and the resultant economic distress across continents. But, to a surprise, the year 2020 remained a positive with global EV sales growing by 41% as compared to 2019 levels and the EC stock rose to 9% of total car market in 2021 (IBEF 2022).

As per reports, the current market share is barely 1% and of all the vehicles sold in the Indian domestic market, the share of EVs looks bleak with demand largely been confined to electric two-wheelers (produced mainly by start-ups) and three-wheelers (Krishnan and Koshy 2021). In December 2021, the combined total registrations of electric two-wheelers and three-wheelers stand at 90.3% (IBEF 2022) in the electric category. The diffusion has been stagnant in India for a variety of reasons like poor awareness and understanding of the public, scepticism towards EVs and consumers viewing internal combustion engine (ICE) vehicles as more convenient than this new technology (Pradeep et al. 2021).

Another barrier cited for the low diffusion of environment friendly products is the absence of rationality in making a purchase decision (Schuitema et al. 2013). Individuals, based on heuristics or incomplete information they have, assess the total cost of ownership of a product from the perspective of initial purchase price only. By ignoring the long-term lower operational costs or the fuel economy, people tend to make irrational choices and hence, the reason behind the poor penetration of EVs (Turrentine and Kurani 2007).

According to Global EV Outlook Report from 2020, density of these EVs is mainly concentrated in European countries along with USA and China (IEA 2020). China is emerging as the single largest consumer and producer of these green vehicles due to its government's push in the form of various financial and non-financial benefits. The EV ownership in China stands at 900,000 out of the total worldwide stock of 2 million by the end of 2016 (Han et al. 2017). In Europe, Norway is leading the path towards a sustainable future with per capita availability of these vehicles roughly around 21% (Thøgersen and Ebsen 2019).

Jansson et al. (2010) reported that development of green products by business firms will make no good to the society unless consumers are ready to adopt them. Such adoption

also plays a crucial role in reducing the environmental impact in the overall consumption cycle (Goel et al. 2021). Currently, there could be two perspectives to understand the buyer decision making process for EVs (Rezvani et al. 2015). First deals with attributes related to the EVs itself (also called as contextual or instrumental factors) like price, maintenance cost, driving range, charging time, charging infrastructure and performance which affects EV acceptance (Carley et al. 2013; Egbue and Long 2012; Han et al. 2017; Ozaki and Sevastyanova 2011). These studies summarised that the EV attributes exert influence on consumes' green attitude and subsequent acceptance.

On the other hand, consumer-related factors like personality, attitude, emotions, values, norms and beliefs also affect intentions to purchase EVs. All these factors have been used in different theoretical models like theory of planned behaviour, technology acceptance model, innovation diffusion theory, norms activation model and stimulus-organism-response (Ajzen 1991; Egbue and Long 2012; Lane and Potter 2007; Moons and de Pelsmacker 2015; Skippon and Garwood 2011; Stern et al. 1991; Wang et al. 2016). These theories have common approaches to explain the user acceptance of a new technology for its usefulness, consistency with one's values and ease of use (Peters and Dütschke 2014).

Taking care of this previous work, the purpose of this study intends to amalgamate both these perspectives and develop a conceptual framework based on diffusion of innovation (DOI) framework along with attitudinal factor to predict the intentions of Indian consumers in adopting this novel technology. Rogers' DOI model is one of the oldest social science theories and provides the basis for an innovation to spread through a social system (Inwood et al. 2009). In contrast to other frameworks, DOI model condenses specific characteristics of underlying innovation and helps in explaining what make users adopt a new innovation or how they decide when adopting it (Min et al. 2019). It is to be pinpointed out that consumers' consumption pattern is multi-dimensional and depends on various psychological and situational factors. The diffusion is only possible when an individual perceives the product to be new or innovative (Ozaki and Sevastyanova 2011).

Although past studies have investigated purchase intention of consumers in different world markets using this DOI theory but a comprehensive application of this framework is yet to be studied in the Indian context (Verma et al. 2020). Moreover, earlier studies investigated only the direct relation between characteristics of innovation and the subsequent purchase intention (Jansson 2011). This research entails to fulfil these gaps by providing a novel perspective of employing the DOI theory in the Indian Market and then checking the indirect influence on purchase intention with the help of consumer's attitude. To the best of our knowledge, few researchers have tested the empirical significance of this framework in a wholesome manner and their consequent effect on consumers' cognitions towards EVs.

Application of DOI theory in the context of EV adoption would help policy makers to understand and identify the parameters of diffusion—what are they, how they operate and why worthy innovations available in the market are not adopted rapidly (Rezvani et al. 2015). Furthermore, stakeholders will get to know which of the five traits of the innovation best predicts the intention of consumers and whether these five aspects on their own can explain the acceptance of EVs or it leads to development of behavioural attitude initially which then becomes the reason for purchase behaviour. The rest of the paper is as follows: Literature review and hypothesis development are contained in the "Literature review and hypothesis development" section. Research methodology of this paper is in the "Research methodology" section. The data analysis and results are contained in the "Data analysis and results" section while the "Discussion and conclusion" section contains conclusion, discussion and limitations of this research.

Literature review and hypothesis development

Diffusion of innovation framework

The theory propounded by Rogers in 1962 is popularly described as the acceptance of a technology in a social framework. Besides the environmental and technological factors, the innovative attributes of the EV also fascinate the perception of consumers (Peters and Dütschke 2014). A product is easily accepted by the market when it is able to meet or accommodate the demands or desires of varied consumer groups (Larson et al. 2015). As per Jansson (2011), an innovation is initially received by a small segment of the market called as early adopters and then it is gradually diffused and accepted by the majority of the population. Consumers look upon the characteristics of the innovation before purchasing it. The study by Huijts et al. (2012) defined acceptance of a new product or service as a behaviour that stimulates the use of the new technology rather than inhibiting it. In our case, it denotes the purchase and use of EVs. DOI framework clarifies how and why individuals accept innovations and why some innovations successfully drive through the market while other fails (Parry and Olivas-Lujan 2011).

As per Rogers (2003), the five primary attributes that influence purchase decision includes the associated relative advantages, compatibility, complexity, trialability and observability. Besides, behavioural characteristics of adopters also determine the rate and scale of diffusion (Vargo

et al. 2020). All these variables tend to explain the acceptance of an innovation on an individual level (Schuitema et al. 2013). These aspects significantly contribute to the development of positive perceptions towards the adoption of innovative products available in the market.

Some empirical support for this theory has been found out in relation to adoption of cryptocurrency (Bharadwaj and Deka 2021), eco-labelled products (Choshaly 2019) and Uber mobile application (Min et al. 2019). However, limited use of this framework has been done with respect to EVs. Thus, this study contributes to the existing literature on DOI model by taking its application in the context of EVs. Considering the important role that consumer's attitude plays in buying behaviour, the study also examines the role of this factor (Khurana et al. 2020). Integration of DOI factors and attitude would not help in understanding the general perception of consumers towards the adoption of EVs but shed light on specific characteristics of innovation that attracts consumers.

Determinants of DOI framework

Relative advantages

It is the degree to which an individual perceives a particular innovation to be better than its counterparts (Rogers 2003). Tornatzky and Klein (1982) noted that relative advantage is a significant factor in influencing the adoption of innovations. These are the functional benefits that an individual receives from the product (Ozaki and Sevastyanova 2011). In EV's case, it is interpreted in terms of performance, safety, fuel efficiency and overall environmental benefits like reduced air and noise pollution (Zhang et al. 2013). It may also include financial incentives in the form of various tax deductions and exemptions or the purchase subsidy provided by the government to propel the intake of this technology (Lane and Potter 2007).

Since EVs are advanced mobility substitute with potential to become mainstream vehicles anytime in the near future, consumers' understanding of the real benefits associated with this new transport technology is critical. As Rezvani et al. (2015) pointed out, while higher initial purchase price discourages consumers to adopt EVs, the corresponding lower maintenance costs in the form of low fuel consumption (Han et al. 2017) encourage them. The study by Wu et al. (2010) concluded that consumers' intention to adopt hydrogen-powered cars is influenced by these relative advantages.

Consumers take into account several thoughts like reliability, aesthetics and performance before buying a car (Higueras-Castillo et al. 2021). Besides cost competitiveness, these other attributes are also vital to improve the proportion of EVs in the Indian market. The higher the perceived advantages of using an innovation, the greater will be its rate of adoption (M. K. Kim et al. 2018). This feature is found to have positive relationship with the intention to adopt an innovation such as information technology (Agarwal and Prasad 1997; Cheung et al. 2019) and solar energy systems (Guagnano et al. 1986; Labay and Kinnear 1981). Therefore, it is hypothesised that:

H1: Relative advantages have a positive influence on purchase intention towards EVs.

Compatibility

This means congruency between the needs of the consumer and the attributes of the innovative technology. Like other innovations, compatibility of EVs also has an important role to play in the lives, lifestyle and habits of individuals (Moons and de Pelsmacker 2015). Compatibility of using these vehicles in the day-to-day lives and habits of consumers can act as a significant factor for potential adopters. To increase the compatibility criteria of EVs, the most important step would be to provide necessary charging spots in every few distance miles of the city roads (Graham-Rowe et al. 2012; Peters and Dütschke 2014).

Building necessary charging infrastructure can lead to drivers feeling more compatible with this EV technology (Carley et al. 2013; Egbue and Long 2012). An innovation is likely to be adopted when it is viewed as being consistent with the existing thoughts, beliefs and values of the consumers. High level of compatibility increases the adoption rate among the target audience. Previous researchers have found a positive relationship between compatibility and internet banking adoption (Oly Ndubisi and Sinti 2006). As per the consumer value theory, consumers are more likely to make purchase decisions only if the products contain specific values and meet their requirements (Han et al. 2017).

Another aspect under this category includes the perception of consumers towards these vehicles becoming obsolete in the near future due to the improvements being made in this technology with each passing year (Rezvani et al. 2015). Studies have revealed consumers' view of EVs as the car of the future (Flamm and Agrawal 2012). This apprehension together with better future options is, therefore, leading to delay in today's purchase decision (Shih and Schau 2011). On this basis, we hypothesise that:

H2: Compatibility has a positive influence on purchase intention towards EVs.

Complexity

It is the degree to which an individual is able to understand a given product with minimal efforts (Moon et al. 2015). In

other words, it could also be the ease with which an individual can use the given technology. A study of Danish car owners' reveals that their intention to buy an EC decreases with increased perceived difficulty in use and feeling uncertain about electric cars (Thøgersen and Ebsen 2019). Adoption of an innovation is affected by the perceived difficulty of using it, conceptualised as perceived ease of use in technology acceptance model (Davis et al. 1989) and as perceived behavioural control in theory of planned behaviour (Ajzen 1991).

A study on BEVs suggests that a large proportion of consumers still carry a wait-and-see attitude due to consumers' distrust and other risk aspects associated with this technology (She et al. 2017). Innovations differ in their characteristics with some being easily accepted while others take some time before mass commercialization. EVs are different from conventional vehicles in aspects like EVs take long time to recharge (She et al. 2017), scarcity of public charging infrastructure and limited driving range (Junquera et al. 2016). All these factors contribute to perceived risk. Thus, increased difficulty or complexity is a potential barrier to adoption. It has been researched that if a product is perceived to be complex to use, then it negatively influences its adoption rate, example being the solar energy systems (Labay and Kinnear 1981) and online banking (Litter and Melanthiou 2006). Thus, we hypothesise that:

H3: Complexity has a negative influence on purchase intention towards EVs.

Trialability

This aspect concerns whether a product is available to use before actual buying. It has been observed that a positive pre-purchase experience with a certain product led to positive attitude and increases its adoption rate against products that do not offer this service (Liu et al. 2020). It is seen that people with some experience of EVs are more likely to hold a positive attitude and have better chances of purchasing these vehicles in the near future (Larson et al. 2015). Additionally, this aspect of trialability reinforces the speed of innovation adoption among potential consumers. For EV market development, it is essential that awareness among the consumers for this technology is improved.

In India, EVs are scarce on roads and people have limited acquaintance with this technology. This lack of experience is the primary reason behind poor acceptance from consumers. The consequence being poor knowledge about performance, recharging aspects and overall operational costs of EVs in the long run. Some familiarity with this EV technology in the form of pre-purchase driving or riding can assure consumers that EVs are comfortable, quiet, safe and easy to drive (Liu et al. 2020). Moreover, it can positively influence consumers' EV purchase intentions (Xu et al. 2020). This is especially significant in case of high involvement products like purchasing a vehicle.

Furthermore, this trialability aspect becomes less important when the innovation is being adopted by more and more people overtime, as experience or word of mouth from them can be deployed to influence adoption intention of potential consumers in the near future. Since EVs are a non-conventional technology which requires a change in behaviour or habits of the individual, it is hypothesised that trialability plays the role of an important predecessor before actual EV adoption.

H4: Trialability has a positive influence on purchase intention towards EVs.

Observability

It deals with the physical availability or visibility of green vehicles running on roads. Rogers (2003) pointed out that the increasing number of a new innovation is a positive or healthy sign and actually helps potential buyers to come forward and purchase the product. It also amplifies the penetration process in the long run and had a positive impact on the usage of the innovation (Agarwal and Prasad 1997). By observing the actual performance of these vehicles before them, consumers can clarify their pre-dispositions and other negative thoughts they hold towards such vehicles and simultaneously take a decision that is in their best interests (Peters and Dütschke 2014). This aspect also stimulates the thought process within an individual and dialogue between people with similar interests (Jansson 2011).

In India, EVs are scarce on roads with consumers being more aware of electric two-wheelers or electric three-wheelers. Among this also, majority of consumers have some experience with electric three-wheelers as it is a part of routine mobility sharing services. Thus, it is suggested that a higher number of other electric vehicles such as electric passenger cars on roads could lead to development of positive attitude and subsequent purchase intentions among the consumer groups. Hence, we hypothesise that:

H5: Observability has a positive influence on purchase intention towards EVs.

Attitude

The presence of this factor has been notable in previous studies. This factor plays a significant role in purchase intention of consumers towards EVs (Ozaki and Sevastyanova 2011). It is considered an important driver of green purchase behaviour. Attitude can be defined as the assessment or response an individual holds towards a product, brand or

an object (Khurana et al. 2020). Attitude also reflects the way a person evaluates a particular kind of behaviour and her/his feelings towards some object or idea (Y. Kim and Han 2010). It is an important factor in predicting intentions which precedes actual behaviour. When attitude is formed through some constructive image of the specific product, it leads to development of ecological purchase intention.

As per the reasoned action theory, attitude is found to be positively related to adoption intention while undertaking a special behaviour (Fishbein and Ajzen 1977). The study by Kahn (2007) found positive influence of attitude and perceptions on adoption behaviour of consumers. Degirmenci and Breitner (2017) found strong influence of environmental performance of these vehicles on the attitude and subsequent purchase intentions of consumers. Dasgupta and Sahay (2011) noted that consumers' actions or response towards innovations are strongly determined by their attitude. Studies by Han et al. (2017) and Higueras-Castillo et al. (2021) also found consumers having favourable attitude towards hybrid and electric vehicles.

Attitude is added as an additional variable to enhance the predictive power of the proposed research model. Moreover, attitude also acts as a link between the opinions or thoughts an individual has with the ultimate behaviour of the consumers. Consumers might be unaware of the relevant financial and environmental benefits of these vehicles; yet, studies found that adoption of EVs are motivated by consumers' pro-environmental attitudes, values and beliefs (Carley et al. 2013; Egbue and Long 2012; Krupa et al. 2014). In this model, we have conceptualised this construct as a person's own evaluation of inner views towards environment friendly behaviour (Hamzah and Tanwir 2021; Levine and Strube 2012). Thus, we hypothesise that:

H6: Attitude has a positive influence on purchase intention towards EVs.

DOI factors, attitude and purchase intention

The dependent variable here is the purchase intention which is the willingness or the possibility to accept EVs in the near future (Sajjad et al. 2020). It is the extent to which consumers tend to buy a particular product (Cheung et al. 2019). It refers to the openness or the likely thoughts a person holds about a certain product before actual buying (Han et al. 2017). According to Ajzen (1991), consumers' purchase intentions are the best predictors of purchase behaviour. The stronger the purchase intention is, the more likely the consumer is to make the purchase (Wang et al. 2016). However, despite potential benefits that EVs offer like the low maintenance or running costs, zero emissions, absence of air and noise pollution and driving pleasure, the demand for this technology has not shot up in the Indian market (Krishnan and Koshy 2021). Hence, what factors comes into play before actual purchasing needs to be investigated so as to improve consumers' intention towards them (Ozaki and Sevastyanova 2011).

As suggested in earlier studies, revealed behaviour of consumers is what we actually see, just like the visible tip of an iceberg but what we do not see or is rather complicated are the intentions which is the submerged part of the ice below the water. These intentions or stated preferences towards EVs are to be studied so as to predict future buying behaviour (Moser 2015). Grasping from previous literature, it can also be highlighted that intentions are studied in comparison to actual adoption because in EV's case, the market is still developing and the consumer behaviour is infrequent (Rezvani et al. 2015; Sajjad et al. 2020).

Past studies have also noted the indirect impact of certain variables on purchase behaviour (Liu et al. 2020). The study by Shih and Fang (2004) found positive influence of relative advantages on attitude in adopting internet banking. Park and Chen (2007) concluded association between observability and user attitude towards smartphones. Moreover, if the trial is permitted beforehand, it leads to endorsement of attitude thereby making adoption and implementation easy (Choshaly 2019; Rogers 2003). Hence, the role of attitude is emphasised to study the indirect relationship between the DOI factors and the purchase intention.

If aspects of innovation meet the expectations of consumers, then it will lead to development of favourable attitude and ultimately the purchase decision (Schuitema et al. 2013). Few studies have empirically tested such a proposed model outlined in Figure 1. Positive experience with eco-innovation can have a broad influence on environmental attitude (Jansson 2011). Products with green values strengthen people's attitude and promotes environment friendly action in future (Nordlund and Garvill 2003). The strength of this relationship increased after the inclusion of cognitive dimension in the model (Min et al. 2019). Thus, the authors have tried to study the expected relationship between the environment and the technology from the lens of consumers' attitude.

Past studies also added various other constructs to DOI model like social norms (Peters and Dütschke 2014), driving experience (Xu et al. 2020) and environmental consciousness (Verma et al. 2020) with respect to EVs to predict the intention of consumers and to obtain a better explanatory power for the proposed model (Min et al. 2019). In line with previous approaches, this study deploys attitude as an additional variable in between the endogenous and exogenous constructs so as to study diffusion from a consumer perspective.

On the basis of previous literature and the conceptual framework proposed in this study, the following additional hypotheses have been identified to study the indirect influence on purchase intention:

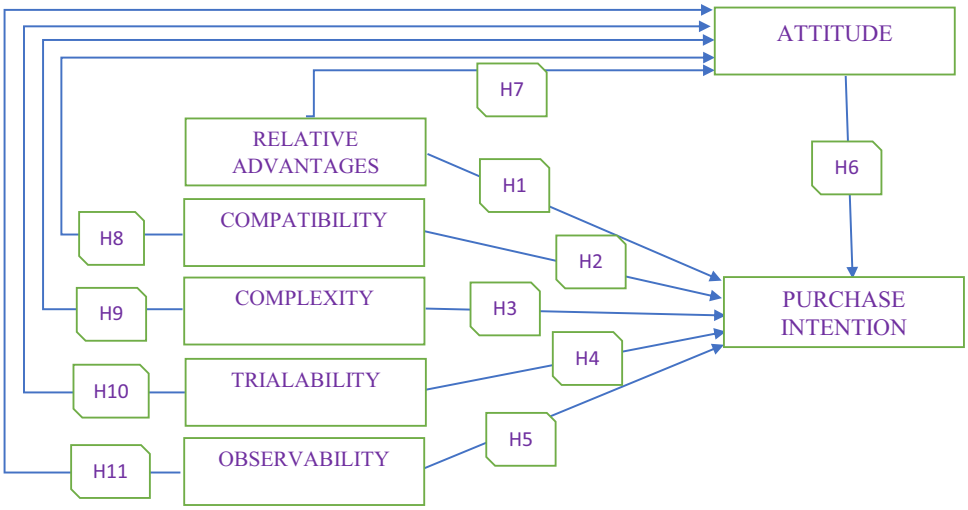

Fig. 1 Conceptual model

H7: Attitude mediates the effect of relative advantages on purchase intention.
H8: Attitude mediates the effect of compatibility on purchase intention.
H9: Attitude mediates the effect of complexity on purchase intention.
H10: Attitude mediates the effect of trialability on purchase intention.
H11: Attitude mediates the effect of observability on purchase intention.

Research methodology

This study used questionnaire survey (quantitative) method for testing the above stated hypotheses in an empirical manner. A total of 298 customers spread across the Delhi NCR region were approached on the basis of purposive convenient sampling (Jaiswal and Kant 2018) to collect the required data on variables identified in this research. The reasons for selecting this region are many like consistent poor air quality and high number of new vehicle registrations every year. The respondents here are customers who are currently driving ICE vehicles for their daily needs. These respondents are aware of EVs, the different models available in the market and the present state of air pollution in Delhi region. The target sample was approached near major parking areas and automobile dealership outlets. Out of the total 298 respondents, responses from 252 were received back, marking a response rate of 84%. However, screening revealed that only 225 responses were duly and appropriately filled and thus useful for further analysis. This sample fits the guidelines proposed by Hair et al. (2015).

Measures used

For studying the diffusion of innovation model along with attitude, constructs used in previous literature were adopted. Each of these variables is indicated by a certain number of measurement items (appended at the end) for which appropriate referencing has also been made. A group of domain and academia experts were approached to evaluate each of the items from the consumers' point of view. Certain items were modified so as to improve the content validity, to bring clarity and that each item is understood in its right spirit (Shalender and Sharma 2021).

Based on their recommendations, items were finalised that tends to fulfil the purpose of this research. All the variables were anchored on a Likert scale ranging between 1 (strongly disagree) and 5 (strongly agree). Dummy variables were used in the case of gender (0 and 1) while for the others, discrete variables were used (1, 2, 3 up to 4). Details of the respondents are being given in Table 1.

Table 1 Demographic profile (n= 225)

Items	Classification	Frequency	Percentage
Gender	Male	128	56.90
	Female	97	43.10
Age	18–27	57	25.30
	28–37	103	45.80
	38–47	55	24.40
	Above 47	10	4.50
Education	Intermediate	9	4.00
	Graduation	109	48.40
	Post-graduation	72	32.00
	Above post-graduation	35	15.60
Annual Household Income	Up to INR 250,000	28	12.40
	250,000–500,000	82	36.40
	500,000–1,000,000	75	33.30
	Above INR 1,000,000	40	17.80

Before collecting the data, pilot testing was done on 50 random respondents to see whether the items are being easily understood by the respondents and were getting interpreted in the right manner so as to take the research in the right direction. Items were also checked for their relevance and comprehensiveness (Shalender and Sharma 2021).

Data analysis and results

Given that our research involves collecting data using face to face survey, common method bias tends to occur which may affect data results (Podsakoff et al. 2003). Therefore, to neutralise the effect of CMB, ex ante and ex post remedies were used. In the former case, anonymity of the respondents was promised and hence, no personal details were asked. The participants were also made sure that their data would be used only for the research purposes. In the latter case, Harman's single-factor test was performed using SPSS. In this, all items from all constructs were included in one general factor to determine whether the majority of the variance could be ascribed to this sole factor. The result produced 28 distinct factors, the largest of which explained only 30.517% of the total variance which is less than the threshold limit of 50% (Harman 1976; Podsakoff et al. 2003). Thus, CMB was not an issue in this research.

This study applied SEM technique to test the first set of hypotheses using AMOS 23 to examine whether the collected data fits well into the model used in this study. SEM is a powerful technique than other tools like multiple regression and can assess the impact of one construct on the other simultaneously. This technique shows a theoretical concept in a structural equation and involves a two-step process (Anderson et al. 1988) in which we test construct's reliability and validity in stage 1 while in stage 2, we examine the relationships between the given constructs and also determine the overall model fit. It is as follows:

Measurement model Guidelines proposed by Hair et al. (1998) have been taken into account for measuring the reliability and validity of the various constructs. It is to be noted that the factor loadings below the limit of 0.5 were supressed and are not used for further analysis (Pradeep et al. 2021). Items with low factor loadings should be removed from the questionnaire as it improves the measurement model of the study (Matsunaga 2010). Moreover, Fornell and Larcker (1981) suggested calculation of Cronbach alpha and composite reliability to test constructs' reliability. The reliability of all the constructs came out to be in the range of 0.726–0.900 and was above the threshold limit of 0.7. The details of the constructs along with their items have been given in Table 2.

Table 2 Results of the measurement model

Constructs	Items	Factor loadings	CA	CR	AVE
ATT	ATT1	.761	.901	.89	.59
	ATT2	.720			
	ATT3	.753			
	ATT4	.827			
	ATT5	.830			
	ATT6	.718			
RA	RA1	.868	.776	.88	.61
	RA2	.801			
	RA3	.720			
	RA4	.702			
	RA5	.753			
COMP	COMP1	.855	.754	.87	.64
	COMP2	.779			
	COMP3	.851			
	COMP4	.708			
COMPLEX	COMPLEX1	.778	.726	.86	.62
	COMPLEX2	.747			
	COMPLEX3	.767			
	COMPLEX4	.852			
TRIAL	TRIAL1	.827	.811	.81	.59
	TRIAL2	.717			
	TRIAL3	.771			
OBSER	OBSER1	.668	.735	.78	.54
	OBSER2	.868			
	OBSER3	.748			
PIN	PIN1	.776	.786	.84	.64
	PIN2	.859			
	PIN3	.766			

Construct validity deals with the accuracy of measurement and is established by two tests: convergent and discriminant validity. By convergent validity, we mean that the items of the same construct should converge strongly and is represented by the score of average variance extracted (AVE). All the AVE values should be more than 0.5 to establish convergent validity. In Table 2, it can be seen that the items have AVE values ranging between 0.54 and 0.64.

Discriminant validity ensures that each of the constructs is unique and does not overlap with other constructs of the model. To calculate discriminant validity, square root of AVE (bold elements) between two constructs is done and if this value is found to be more than the squared correlation between each pair of latent variables (off-diagonal elements), the criteria is being met. In our case, discriminant value has been proved (Fornell and Larcker 1981) in Table 3.

Table 3 Discriminant validity results: Fornell-Larcker criterion assessment

	RA	COMP	COMPLEX	TRIAL	OBSER	ATT	PIN
RA	**0.781**						
COMP	0.387	**0.800**					
COMPLEX	-0.024	0.033	**0.787**				
TRIAL	0.474	0.405	.0900	**0.768**			
OBSER	0.551	0.527	-0.018	0.666	**0.734**		
ATT	0.667	0.650	-0.011	0.690	0.688	**0.768**	
PIN	0.345	0.431	-0.290	0.537	0.537	0.707	**0.800**

Structural model After establishing the reliability and validity aspects, we calculated the goodness of fit indices. The CFA fit model was found to be acceptable on the basis of different fit indices values (Hoang et al. 2006; Maccallum et al. 1996) determined in Table 4 and 5.

Table 4 Fit indices (confirmatory factor analysis)

Fit indices	Recommended	Observed	Result
CMIN/df	Less than 4	1.825	Acceptable
CFI	More than 0.9	.909	Acceptable
GFI	More than 0.9	.931	Acceptable
IFI	More than 0.9	.887	Marginally missed
PNFI	More than 0.5	.699	Acceptable
PGFI	More than 0.5	.693	Acceptable
RMSEA	Less than 0.08	.061	Acceptable
TLI	More than 0.9	.914	Acceptable

Table 5 Fit indices (structural model)

Fit indices	Recommended	Observed	Result
CMIN/df	Less than 4	1.360	Acceptable
CFI	More than 0.9	.951	Acceptable
GFI	More than 0.9	.934	Acceptable
IFI	More than 0.9	.952	Acceptable
PNFI	More than 0.5	.732	Acceptable
PGFI	More than 0.5	.708	Acceptable
RMSEA	Less than 0.08	.040	Acceptable
TLI	More than 0.9	.944	Acceptable

The results of the hypotheses are being given in Table 6. It shows that the path coefficients are significantly loaded and are pointing in the desirable direction, implying that attitude and related advantages have a positive impact on purchase intention towards EVs while complexity negatively influences this intention. Additionally, all these seven variables, namely, relative advantages, compatibility, complexity, trialability, observability, attitude and purchase intention, explained total variance (R^2) of 63%.

To perform the mediation analysis, guidelines proposed by Preacher and Hayes (2008) were used to check the indirect relationship between the given constructs. Mediation helps to check the indirect effect of an exogenous variable on the endogenous variable through its influence on some other variable, known as mediating variable (Hayes 2009). Since the purpose of this study is also to check the indirect influence of different variables on purchase intention, mediation analysis was done via bootstrapping technique using process macro, the results of which are stated in Table 7.

Discussion and conclusion

The proposed model in this study was based on a strong theoretical foundation given by Rogers (2003). This study was undertaken to investigate consumers' purchase intentions towards EVs in the Indian market which is characterised by slow diffusion process and poor awareness of the domestic

Table 6 Hypotheses results (direct effects)

Paths			Estimate	S.E.	C.R.	P	Results
PIN	<---	RA (H_1)	.270	.129	2.097	.036*	Supported
PIN	<---	COMP (H_2)	−.035	.127	−.279	.780	Not supported
PIN	<---	COMPLEX (H_3)	−.349	.102	−3.422	***	Supported
PIN	<---	TRIAL (H_4)	.176	.123	1.429	.153	Not supported
PIN	<---	OBSER (H_5)	−.098	.161	−.608	.543	Not supported
PIN	<---	ATT (H_6)	.888	.223	3.972	***	Supported

Significant at: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 7 Mediating effect table (indirect effects)

Paths	Indirect effects	β	S.E	t-value	LLCI	ULCI	Decision
H7	RA->ATT->PIN	.189**	.028	3.436	.139	.249	Supported
H8	COMP->ATT->PIN	.167***	.025	2.813	.119	.220	Supported
H9	COMPLEX->ATT->PIN	−.002	.026	0.076	−.054	.046	Not Supported
H10	TRIAL->ATT->PIN	.235***	.042	6.773	.157	.323	Supported
H11	OBSER->ATT->PIN	.270***	.039	7.621	.198	.351	Supported

S.E, standard error; LLCI, lower-level confidence interval; ULCI, upper-level confidence interval

consumers. The research contributes to the existing body of EV knowledge by testing the DOI model in its entirety in the Indian context. DOI is a well-recognised theory for explaining the characteristics of the innovation and how it affects the user acceptance for the underlying technology (Bharadwaj and Deka 2021). The aim was to get a deeper insight into what could be the relevant factors that could help catalyse the process of EV penetration in the domestic market. Since EVs is a novel technology and has the potential to reduce transportation-related carbon dioxide emissions, therefore, better understanding of what influences their diffusion is of significant interest. Moreover, this study enriches the existing understanding of technological and market aspects of innovation from the perspective of future adopters.

Theoretical contributions

The goal of this study was to amalgamate DOI framework with attitude so as to predict consumers' environmental psychology towards ecologically friendly product such as EVs (Table 8). The study can provide useful insights for researchers studying EV market penetration in different automobile markets by understanding whether an individual will adopt a particular new innovation or not. It contributes to the original DOI theory from the consumer perspective and bridges the knowledge gap by focussing on adoption of EVs. Moreover, by incorporating attitude, the study showcased a different dimension of this framework by complementing its insufficiency in psychological context.

The results of the study indicates that attitude (H6) has the most significant and positive influence on people's purchase intention followed by relative advantages (H1) offered by these vehicles. The role of relative advantages was found to be influencing consumer intentions both directly and indirectly. This is understandable as the presence of better features like lower operational costs in EVs exercises considerable influence on buying behaviour and is sufficient ground to spark purchase intention among consumers. Another major finding of this research was that Indian consumers, at present, do not feel EVs to be easy to drive or use, thus supporting H3 (Egbue and Long 2012; Graham-Rowe et al. 2012).

Regarding the mediation model, contrary to previous conclusions of Jansson (2011) and Peters and Dütschke (2014), compatibility (H2), trialability (H4) and observability (H5) were found to be having no direct influence on the purchase intention of Indian consumers. But rather their indirect influence was established through attitude (supporting H8, H10, H11), which explains the motive of adding this additional variable in this research. This suggests the peculiarity of the Indian automobile market which is being categorised by consumers who consider several aspects before buying high-involvement products.

Attitude was found to be the most influential in predicting the purchase intention indicating the fact that consumers in India are optimistic and believe in the associated environmental benefits of EVs. The existing literature on green consumerism also suggests that attitudinal factor significantly adds to behavioural intention of consumers (Hamzah and Tanwir 2021; Han et al. 2017; Khurana et al. 2020; Moser 2015). Indian consumers are tilted towards EVs and agree on adopting this technology in times to come as the experience of rising heatwaves is getting worrisome. Hence, it is desirable that automobile makers ping on sustainability aspect of these vehicles so as to inculcate more positive attitudes among different consumer groups. Besides this, consumers are inclined towards other attributes of EVs which are not offered by their conventional vehicles like quietness of vehicles and lower maintenance costs. Hence, policy makers should disseminate these positive traits of EVs rigorously in their advertisements and other digital marketing platforms so as to capture the eyes of potential consumers in the market.

Contrary to previous findings, impact of compatibility, trialability and observability could not be established which is understandable given the fact that features like trialability is nowadays associated with every high involvement product such as cars. Moreover, this trialability/experience before actual purchasing may first affect consumers' psychological trait which ultimately leads to development of behavioural intention towards a product such as EVs (Han et al. 2017). It also leads to more familiarity about the performance and can help consumers to understand that these vehicles can meet their transportation needs and are safe and easy to drive (Xu et al. 2020). It is an effective promotional approach to initiate behavioural shift among the consumers. The study by

Table 8 Questionnaire items

	Appendix	Referencing
RA1	Using an environment friendly car would reduce air pollution in the environment.	Jansson (2011); Xu et al. (2020)
RA2	There are financial advantages for me if I use an environment friendly car.	
RA3	Electric vehicles are more fuel-efficient and cost-effective than traditional fuel vehicles.	
RA4	Electric vehicles are much more environment friendly than traditional fuel vehicles.	
RA5	Electric vehicles produce less noise pollution than conventional vehicles.	
COMP1	Buying an environment friendly vehicle would be suitable in my everyday life.	Degirmenci and Breitner (2017); Liu et al. (2020)
COMP2	The design of electric vehicles matches with my existing vehicle.	
COMP3	I think the number and distribution of charging stations for electric vehicles can meet my charging needs.	
COMP4	I think I can fulfil my transportation needs with an electric vehicle that has a range of 200 kilometres before recharging.	
COMPLEX1	It is difficult to charge an environment friendly car.	Degirmenci and Breitner (2017); Morton et al. (2016)
COMPLEX2	The quiet motor of electric vehicles can lead to accidents.	
COMPLEX3	The infrastructure for electric vehicles needs to grow.	
COMPLEX4	I think electric cars would be complicated to use.	
TRIAL1	Before I decide to buy an environment friendly car, it would be important to test drive it.	Jansson (2011)
TRIAL2	Before I decide to buy an environment friendly car, I would like to experience it for a day or two.	
TRIAL3	Before I decide to buy an environment friendly car, I would like to try a friend's car.	
OBSER1	Watching electric vehicles running on roads affects me in a positive manner.	Jansson (2011)
OBSER2	Physical performance of electric vehicles on roads is important to me.	
OBSER3	People who drive electric vehicles stand out visibly.	
ATT1	I am favourably inclined to switch to an electric vehicle.	Gadenne et al. (2011); Khurana et al. (2020); Ozaki and Sevastyanova (2011)
ATT2	It would be a wise choice to use an electric vehicle instead of a conventional vehicle.	
ATT3	Electric vehicles contribute to environmental sustainability.	
ATT4	I like the idea of purchasing electric vehicles in the near future.	
ATT5	I think electric vehicles can reduce carbon dioxide emissions and environmental pollution.	
ATT6	I am doing the right thing by buying an environment friendly vehicle.	
PIN1	I would like to buy an electric vehicle as my second car.	Liu et al. (2020); Shalender and Sharma (2021)
PIN2	I plan to adopt electric vehicle when adopting a vehicle in the future.	
PIN3	I would consider switching to brands of electric cars for ecological reasons.	

Li et al. (2017) indicated that trialability positively changed the attitudes and intentions of consumers once they drove the EVs. Since EVs is an innovative low carbon product and is in its early stage of diffusion process, it is vital for the stakeholders to motivate consumers to first experience the performance and utility of these vehicles. This is a significant factor in reducing the perceived fear related to this technology (Egbue and Long 2012) and improving the customers' uptake of these vehicles in the near future.

The positive influence of compatibility could not be established indicating that consumers in India are not ready to change their transportation habits in the short term. Imbibing new behaviour takes time especially when it comes to long driving range and recharging this vehicular technology as against refuelling which hardly takes 5 min to fill the gasoline tank. However, this aspect has a positive impact via attitude (Park and Chen 2007) which means that consumers are becoming future ready to alter their existing driving

habits or developing new charging habits. This is a positive signal and will help to increase the penetration process of EVs in the Indian market. If the consumers are in agreement over the usage of these EVs and feel that they can match their existing requirements, the market would gradually welcome this technology (Graham-Rowe et al. 2012). It is desirable if the government and policy makers could come up with new revolution in battery technology which ultimately helps to lower the charging time of electric automobiles.

Likewise, frequent observation of EVs on roads can make consumers to actually discern the performance and viability of these vehicles as a future mobility alternative. Indian automobile market is at its cusp of consumerism and is providing consumers with technically advanced and feature rich vehicles. Globalisation has been responsible for this changing trend and Indian consumers are now demanding vehicles at par with those available in the developed world. More visibility of such vehicles especially in the electric segment is pulling the attention of worldwide consumers and driving the attitude of consumers in the desired domain. The important role of observability on user's attitude suggests that the more visible the effectiveness of the EVs is, the more likely that consumers will start using it. Since EVs offer considerable advantages over ICE vehicles, it is possible that more density and gradual popularity of such vehicles can make a positive influence on the minds of the consumers.

Complexity related to using EVs was found out in terms of their maintenance, charging infrastructure, charging duration and hence the reason for low market penetration. However, this has not become the reason for negative attitude among the consumers. This suggests that consumers in India are more positively skewed towards the adoption of this technology than otherwise. It also indicates that consumers today consider the big picture and they take into account both positive and negative aspects of using EVs before actual buying. Contrary to results provided by Jansson (2011) and Xu et al. (2020), Indian consumers feel EVs as complicated and less convenient than present day ICE vehicles. This is mainly due to the lack of understanding of EVs, negative stereotype in terms of higher upfront cost and several other challenges like dealing with newer characteristics associated with these vehicles and alteration/development of old/new habits (Peters and Dütschke 2014).

As mentioned earlier, a large chunk of existing body on EV purchase intention has been carried out in countries where the market share of this technology is significant or rising sharply like China, Norway and other European countries. This study adds to the pool of EV knowledge by undertaking investigation in a robust automobile market like India, which hold promise to a clean energy-driven future. Indian automobile market, the fifth largest in the world, is developing very rapidly with new players like Tesla entering in to offer different variants for different sections of the population. NITI Aayog, think tank to the Government of India, states that the Indian EV industry would grow at a CAGR of 36% until 2026 and is set to be valued at USD 50 billion by the end of 2030 (IBEF 2022).

Practical contributions

This study takes into account a consumer centric framework and underlines the need for marketers to develop a precise strategy by highlighting upon the tangible contribution of this technology towards the common good. From the above, it can be concluded that consumers believe in the environmental contribution of EVs. To improve consumers' understanding of EVs, it is necessary that appropriate mechanisms like effective brand engagement tools are deployed so as to make this technology consumer friendly. Thus, it is necessary that manufacturers and promoters of this technology advocate the green living among the consumers and indulge in educating the consumers about the environmental contribution they can make so as to alter the cognitive preference towards EVs. This will sensitise the consumers about the current environmental issues and shape their confidence in owning these vehicles.

The demand for EVs in India has not build up on account of high upfront cost which is mainly due to battery technology. This poor demand has been preventing existing entrepreneurs in the market to reap economies of scale on one hand and new entrant into the market on the other (Wang et al. 2016). International cooperation is required in areas of investments in R&D. Partnerships to upgrade the existing battery technology and to overcome range anxiety could open new potentials in EV diffusion process. It is essential that affordable variants are made available in the Indian market which consists of consumers who are price sensitive. Regulatory measures in the form of free parking spaces for these vehicles, no toll taxes and lower registration fees could also be extended.

To lower the complexity issue among the Indian consumers, what is needed is active support from the central and state governments to the citizens and businesses of the country to facilitate the widespread installation of the charging infrastructure throughout the major terminals of city roads and gradually building the network of these recharging stations. For this, public private partnerships (PPP) mode could be harnessed. The government through the Ministry of Power is proposing to allow charging vendors to operate without licence in the domestic market along with slashing up of GST and other corporate taxes that may apply (Goel et al. 2021). This is a step in the right direction to initiate the EV diffusion process in the country.

Government functionaries and other high-ranking officials should act as the lead users of EVs thereby making a conclusive impact on the minds of the Indian consumers

that EV is in fact a user-friendly car and easily driven. This will also send a positive signal among the general public that the government is seriously committed to sustainable development and protection of the environment. For this, a nexus between the law makers (in designing effective green policies), government agencies (to disseminate necessary support and investment) and industry players (to undertake research and development) is desirable so as to make sustainable transportation system a reality (Hamzah et al. 2022).

Convenience of charging anywhere in a speedy manner can help to lower the negative perception of Indian consumers in the near future. Lastly, raising awareness by creating a dedicated website, citizenship campaigns and organising events at the grassroot level where the concept of See Try Feel could be provided can help to enhance the visibility of this vehicular technology (Schuitema et al. 2013). In the longer run, achieving the desired environmental benefits from this technology would depend upon the consumption by end-users. In this regard, better understanding of the consumer-oriented factors can help providers of EVs to initiate policies that better suit the local market conditions and leads to market development in the near future. This will ultimately help in achieving the intended and ultimate target of reducing the global transportation-related carbon emissions and will preserve the nature and biological diversity. Businesses need to correctly position this product in front of the consumers so as to exploit this opportunity for the advancement of its customers and the society at large. At last, collective efforts from multiple stakeholders are needed so as to arrest the growth of environment degradation and climate change phenomena at the earliest.

Limitations and future research direction

The study investigates consumers' intentions towards EVs in a growing Indian automobile market from the perspective of innovation diffusion theory. Although the results of our quantitative analysis bring out some concrete findings and arguments but the study is not free from limitations. Firstly, the focus of this study was on purchase intention of customers rather than their actual behaviour. There is no doubt that intentions are the best predictors of future purchase behaviour (Ajzen 1991) but we cannot take a positive response to these intentions at face value. It is widely acceptable that intentions may not necessarily lead to actual adoption of EVs, hence the attitude-behaviour gap. Thus, future researchers need to study actual behaviour through appropriate techniques like conducting interviews and other survey methods.

Secondly, the current study takes into account consumers' preferences towards all types of EVs which may not pose a true picture of the market conditions. Today, market offers numerous choices to consumers in terms of performance and price, and there is division of ECs into hybrid EVs, battery EVs, plug-In hybrid EVs and extended range EVs (Egbue and Long 2012). Thus, future study can factor in this bifurcation and target the segment accordingly. Furthermore, we cannot generalise the results of this study since a number of respondents were low and the region covered was only the NCT of Delhi. Hence, it is advisable to undertake similar study with a greater number of people from different cities of India. Lastly, other personal factors could be combined in this framework such as environmental beliefs (Krupa et al. 2014), sociological determinants (Morton et al. 2016) or environmental knowledge (Jaiswal and Kant 2018).

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Data availability The authors have the required data being collected from participants for future reference.

Declarations

Ethical approval The authors have demonstrated and adhered to the prescribed ethical standards and have come up with a genuine research study.

Consent to participate Informed consent from all the participants was taken. The participants were made sure that their responses would be kept confidential and be used solely for the purpose of this research. No personal details as such were asked.

Consent for publication The respondents consented to publish that their responses would be analysed and come out in the form of results of this particular study.

Competing interests The authors declare no competing interests.

References

Agarwal R, Prasad J (1997) The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. Decis Sci 28:557–582. https://doi.org/10.1111/j.1540-5915.1997.tb01322.x

Ajzen I (1991) The theory of planned behavior. Organ Behav Hum Decis Process 50(2):179–211

Anderson JC, Kellogg JL, Gerbing DW (1988) Structural equation modeling in practice: a review and recommended two-step approach. Psychol Bull 103(Issue 3):411

Bharadwaj S, Deka S (2021) Behavioural intention towards investment in cryptocurrency: an integration of Rogers' diffusion of innovation theory and the technology acceptance model. Forum

Sci Oecon 9(4):137–159. https://doi.org/10.23762/FSO_VOL9_NO4_7
Brady J, O'Mahony M (2011) Travel to work in Dublin. The potential impacts of electric vehicles on climate change and urban air quality. Transp Res Part D: Transp Environ 16(2):188–193. https://doi.org/10.1016/j.trd.2010.09.006
Carley S, Krause RM, Lane BW, Graham JD (2013) Intent to purchase a plug-in electric vehicle: a survey of early impressions in large U.S. cites. Transp Res Part D: Transp Environ 18:39–45
Cheung ML, Chau KY, Sum Lam MH, Tse G, Ho KY, Flint SW, Broom DR, Tso EKH, Lee KY (2019) Examining consumers' adoption of wearable healthcare technology: the role of health attributes. Int J Environ Res Public Health 16(13):2257. https://doi.org/10.3390/ijerph16132257
Choshaly SH (2019) Applying innovation attributes to predict purchase intention for the eco-labelled products: a Malaysian case study. Int J Innov Sci 11(4):583–599. https://doi.org/10.1108/IJIS-04-2019-0038
Dasgupta M, Sahay A (2011) Barriers to diffusion of innovation: an empirical study in India. Int J Indian Cult Bus Manag 4(3):325–346. https://doi.org/10.1504/IJICBM.2011.040168
Davis FD, Bagozzi RP, Warshaw PR (1989) User acceptance of computer technology: a comparison of two theoretical models. Manag Sci 35(8):982–1003. https://doi.org/10.1287/mnsc.35.8.982
Degirmenci K, Breitner MH (2017) Consumer purchase intentions for electric vehicles: is green more important than price and range? Transp Res Part D: Transp Environ 51:250–260
Egbue O, Long S (2012) Barriers to widespread adoption of electric vehicles: an analysis of consumer attitudes and perceptions. Energy Policy 48:717–729. https://doi.org/10.1016/j.enpol.2012.06.009
Fishbein M, Ajzen I (1977) Belief, attitude, intention, and behaviour: an introduction to theory and research. Philos Rhetor 10:130–132
Flamm BJ, Agrawal AW (2012) Constraints to green vehicle ownership: a focus group study. Transp Res Part D: Transp Environ 17(2):108–115. https://doi.org/10.1016/j.trd.2011.09.013
Fornell C, Larcker DF (1981) Evaluating structural equation models with unobservable variables and measurement error. J Market Res 18(1):39–50. https://doi.org/10.1177/002224378101800104
Gadenne D, Sharma B, Kerr D, Smith T (2011) The influence of consumers' environmental beliefs and attitudes on energy saving behaviours. Energy Policy 39(12):7684–7694. https://doi.org/10.1016/j.enpol.2011.09.002
Ghosh S, Kanjilal K (2014) Oil price shocks on Indian economy: evidence from Toda Yamamoto and Markov regime-switching VAR. Macroecon Finance Emerg Market Econ 7(1):122–139. https://doi.org/10.1080/17520843.2013.856333
Goel S, Sharma R, Rathore AK (2021) A review on barrier and challenges of electric vehicle in India and vehicle to grid optimisation. Transport Eng 4:100057. https://doi.org/10.1016/j.treng.2021.100057
Gordon-Wilson S, Modi P (2015) Personality and older consumers' green behaviour in the UK. Futures 71:1–10. https://doi.org/10.1016/j.futures.2015.05.002
Graham-Rowe E, Gardner B, Abraham C, Skippon S, Dittmar H, Hutchins R, Stannard J (2012) Mainstream consumers driving plug-in battery-electric and plug-in hybrid electric cars: a qualitative analysis of responses and evaluations. Transp Res A Policy Pract 46(1):140–153. https://doi.org/10.1016/j.tra.2011.09.008
Guagnano G, Hawkes GR, Acredolo C, White N (1986) Innovation perception and adoption of solar heating technology. The J Consum Affairs 20(1):48–64. https://doi.org/10.1111/j.1745-6606.1986.tb00367.x
Hair JF, Anderson RE, Tatham RL, Black WC (1998) Multivariate data analysis with readings. Prentice-Hall, Englewood Cliffs
Hair JF, Black WC, Babin BJ, Anderson RE, Tatham RL (2015) Multivariate data analysis (7th edition). Upper Saddle River, NJ, Pearson. https://doi.org/10.1016/j.ijpharm.2011.02.019
Hamzah MI, Tanwir NS (2021) Do pro-environmental factors lead to purchase intention of hybrid vehicles? The moderating effects of environmental knowledge. J Clean Prod 279:123643. https://doi.org/10.1016/j.jclepro.2020.123643
Hamzah MI, Tanwir NS, Wahab SN, Rashid MHA (2022) Consumer perceptions of hybrid electric vehicle adoption and the green automotive market: the Malaysian evidence. Environ Dev Sustain 24(2):1827–1851. https://doi.org/10.1007/s10668-021-01510-0
Han L, Wang S, Zhao D, Li J (2017) The intention to adopt electric vehicles: driven by functional and non-functional values. Transp Res A Policy Pract 103:185–197. https://doi.org/10.1016/j.tra.2017.05.033
Harman HH (1976) Modern factor analysis. University of Chicago Press, Chicago
Hayes AF (2009) Beyond Baron and Kenny: statistical mediation analysis in the new millennium. Commun Monogr 76(4):408–420. https://doi.org/10.1080/03637750903310360
Higueras-Castillo E, Guillén A, Herrera LJ, Liébana-Cabanillas F (2021) Adoption of electric vehicles: which factors are really important? Int J Sustain Transp 15(10):799–813. https://doi.org/10.1080/15568318.2020.1818330
Hoang DT, Igel B, Laosirihongthong T (2006) The impact of total quality management on innovation: findings from a developing country. Int J Qual Reliab Manage 23(9):1092–1117. https://doi.org/10.1108/02656710610704230
Huang X, Ge J (2019) Electric vehicle development in Beijing: an analysis of consumer purchase intention. J Clean Prod 216:361–372. https://doi.org/10.1016/j.jclepro.2019.01.231
Huijts NM, Molin EJ, Steg L (2012) Psychological factors influencing sustainable energy technology acceptance: a review-based comprehensive framework. Renew Sust Energ Rev 16(1):525–531. https://doi.org/10.1016/j.rser.2011.08.018
India Brand Equity Foundation (2022) Automobile industry in India. https://www.ibef.org/industry/india-automobiles. Accessed 20 June 2022
International Energy Agency (2009) World Energy Outlook 2009. IEA, Paris
International Energy Agency (2020) Global EV Outlook 2020. International Energy Agency. https://www.iea.org/reports/global-ev-outlook-2020. Accessed 2 Apr 2022
Inwood SM, Sharp JS, Moore RH, Stinner DH (2009) Restaurants, chefs and local foods: insights drawn from application of a diffusion of innovation framework. Agric Hum Values 26(3):177–191. https://doi.org/10.1007/s10460-008-9165-6
Jaiswal D, Kant R (2018) Green purchasing behaviour: a conceptual framework and empirical investigation of Indian consumers. J Retail Consum Serv 41:60–69. https://doi.org/10.1016/j.jretconser.2017.11.008
Jang YJ, Kim WG, Bonn MA (2011) Generation Y consumers' selection attributes and behavioral intentions concerning green restaurants. Int J Hosp Manag 30(4):803–811. https://doi.org/10.1016/j.ijhm.2010.12.012
Jansson J (2011) Consumer eco-innovation adoption: assessing attitudinal factors and perceived product characteristics. Bus Strateg Environ 20(3):192–210. https://doi.org/10.1002/bse.690
Jansson J, Marell A, Nordlund A (2010) Green consumer behavior: determinants of curtailment and eco-innovation adoption. J Consum Mark 27(4):358–370. https://doi.org/10.1108/07363761011052396
Junquera B, Moreno B, Álvarez R (2016) Analyzing consumer attitudes towards electric vehicle purchasing intentions in Spain:

technological limitations and vehicle confidence. Technol Forecast Soc Chang 109:6–14. https://doi.org/10.1016/j.techfore.2016.05.006
Kahn ME (2007) Do greens drive Hummers or hybrids? Environmental ideology as a determinant of consumer choice. J Environ Econ Manag 54(2):129–145. https://doi.org/10.1016/j.jeem.2007.05.001
Khurana A, Kumar VVR, Sidhpuria M (2020) A study on the adoption of electric vehicles in India: the mediating role of attitude. Vision 24(1):23–34. https://doi.org/10.1177/0972262919875548
Kim Y, Han H (2010) Intention to pay conventional-hotel prices at a green hotel - a modification of the theory of planned behavior. J Sustain Tour 18(8):997–1014. https://doi.org/10.1080/09669582.2010.490300
Kim MK, Oh J, Park JH, Joo C (2018) Perceived value and adoption intention for electric vehicles in Korea: moderating effects of environmental traits and government supports. Energy 159:799–809. https://doi.org/10.1016/j.energy.2018.06.064
Krishnan VV, Koshy BI (2021) Evaluating the factors influencing purchase intention of electric vehicles in households owning conventional vehicles. Case Stud Transport Policy 9(3):1122–1129. https://doi.org/10.1016/j.cstp.2021.05.013
Krupa JS, Rizzo DM, Eppstein MJ, Brad Lanute D, Gaalema DE, Lakkaraju K, Warrender CE (2014) Analysis of a consumer survey on plug-in hybrid electric vehicles. Transp Res A Policy Pract 64:14–31. https://doi.org/10.1016/j.tra.2014.02.019
Labay DG, Kinnear TC (1981) Exploring the consumer decision process in the adoption of solar energy systems. J Con Res 8(3):271–278. https://doi.org/10.1086/208865
Lane B, Potter S (2007) The adoption of cleaner vehicles in the UK: exploring the consumer attitude-action gap. J Clean Prod 15(11–12):1085–1092. https://doi.org/10.1016/j.jclepro.2006.05.026
Larson PD, Viáfara J, Parsons R, v., & Elias, A. (2015) Consumer attitudes about electric cars: pricing analysis and policy implications. Transp Res A Policy Pract 69:299–314. https://doi.org/10.1016/j.tra.2014.09.002
Levine DS, Strube MJ (2012) Environmental attitudes, knowledge, intentions and behaviours among college students. J Soc Psychol 152(3):308–326. https://doi.org/10.1080/00224545.2011.604363
Li W, Long R, Chen H, Geng J (2017) Household factors and adopting intention of battery electric vehicles: a multi-group structural equation model analysis among consumers in Jiangsu Province. China Nat Hazards 87(2):945–960. https://doi.org/10.1007/s11069-017-2803-9
Litter D, Melanthiou D (2006) Consumer perceptions of risk and uncertainty and the implications for behaviour towards innovative retail services: the case of internet banking. J Retail Consum Serv 13(6):431–443. https://doi.org/10.1016/j.jretconser.2006.02.006
Liu R, Ding Z, Jiang X, Sun J, Jiang Y, Qiang W (2020) How does experience impact the adoption willingness of battery electric vehicles? The role of psychological factors. Environ Sci Pollut Res 27(20):25230–25247. https://doi.org/10.1007/s11356-020-08834-w
Maccallum RC, Browne MW, Sugawara HM (1996) Power analysis and determination of sample size for covariance structure modeling. Psycho Methods 1(2):130
Matsunaga M (2010) How to factor -analyze your data right: do's dont's and how-to's. In Int J Psychol Res 3(1):97–110. http://www.redalyc.org/articulo.oa?id=299023509007
Min S, So KKF, Jeong M (2019) Consumer adoption of the Uber mobile application: insights from diffusion of innovation theory and technology acceptance model. J Travel Tour Mark 36(7):770–783. https://doi.org/10.1080/10548408.2018.1507866
Moon H, Park J, Kim S (2015) The importance of an innovative product design on customer behaviour: development and validation of a scale. J Prod Innov Manag 32(2):224–232. https://doi.org/10.1111/jpim.12172
Moons I, de Pelsmacker P (2015) An extended decomposed theory of planned behaviour to predict the usage intention of the electric car: a multi-group comparison. Sustainability (Switzerland) 7(5):6212–6245. https://doi.org/10.3390/su7056212
Morton C, Anable J, Nelson JD (2016) Exploring consumer preferences towards electric vehicles: the influence of consumer innovativeness. Res Transp Bus Manag 18:18–28. https://doi.org/10.1016/j.rtbm.2016.01.007
Moser AK (2015) Thinking green, buying green? Drivers of pro - environmental purchasing behavior. J Consum Mark 32(3):167–175. https://doi.org/10.1108/JCM-10-2014-1179
Nordlund AM, Garvill J (2003) Effects of values, problem awareness, and personal norm on willingness to reduce personal car use. J Environ Psychol 23(4):339–347. https://doi.org/10.1016/S0272-4944(03)00037-9
Oly Ndubisi N, Sinti Q (2006) Consumer attitudes, system's characteristics and internet banking adoption in Malaysia. Manag Res News 29:16–27. https://doi.org/10.1108/01409170610645411
Ozaki R, Sevastyanova K (2011) Going hybrid: an analysis of consumer purchase motivations. Energy Policy 39(5):2217–2227. https://doi.org/10.1016/j.enpol.2010.04.024
Park Y, Chen JV (2007) Acceptance and adoption of the innovative use of smartphone. Ind Manag Data Syst 107(9):1349–1365. https://doi.org/10.1108/02635570710834009
Parry E, Olivas-Lujan MR (2011) Drivers of the adoption of online recruitment—an analysis using innovation attributes from diffusion of innovation theory. In: In Electronic HRM in theory and practice, 8th edn. Emerald Group Publishing Limited, Bingley, pp 159–174. https://doi.org/10.1108/S1877-6361(2011)0000008013
Peters A, Dütschke E (2014) How do consumers perceive electric vehicles? A comparison of German consumer groups. J Environ Policy Plan 16(3):359–377. https://doi.org/10.1080/1523908X.2013.879037
Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP (2003) Common method biases in behavioural research: a critical review of the literature and recommended remedies. J Appl Psychol 88(5):879–903
Pradeep VH, Amshala VT, Kadali BR (2021) Does perceived technology and knowledge of maintenance influence purchase intention of BEVs. Transp Res Part D: Transp Environ 93:102759. https://doi.org/10.1016/j.trd.2021.102759
Preacher KJ, Hayes AF (2008) Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behav Res Methods 40(3):879–891. https://doi.org/10.3758/BRM.40.3.879
Rezvani Z, Jansson J, Bodin J (2015) Advances in consumer electric vehicle adoption research: a review and research agenda. Transp Res Part D: Transp Environ 34:122–136. https://doi.org/10.1016/j.trd.2014.10.010
Rogers EM (2003) Diffusion of innovations, 5th edn. Free Press, New York
Sajjad A, Asmi F, Chu J, Anwar MA (2020) Environmental concerns and switching toward electric vehicles: geographic and institutional perspectives. Environ Sci Pollut Res 27(32):39774–39785. https://doi.org/10.1016/j.enpol.2012.04.055
Schuitema G, Anable J, Skippon S, Kinnear N (2013) The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. Transp Res A Policy Pract 48:39–49. https://doi.org/10.1016/j.tra.2012.10.004
Shalender K, Sharma N (2021) Using extended theory of planned behaviour (TPB) to predict adoption intention of electric vehicles in India. Environ Dev Sustain 23(1):665–681. https://doi.org/10.1007/s10668-020-00602-7

She ZY, Sun Q, Ma JJ, Xie BC (2017) What are the barriers to widespread adoption of battery electric vehicles? A survey of public perception in Tianjin, China. Transp Policy 56:29–40. https://doi.org/10.1016/j.tranpol.2017.03.001

Shih YY, Fang K (2004) The use of a decomposed theory of planned behaviour to study Internet banking in Taiwan. Internet Res 14(3):213–223. https://doi.org/10.1108/10662240410542643

Shih E, Schau HJ (2011) To justify or not to justify: the role of anticipated regret on consumers' decisions to upgrade technological innovations. J Retail 87(2):242–251. https://doi.org/10.1016/j.jretai.2011.01.006

Skippon S, Garwood M (2011) Responses to battery electric vehicles: UK consumer attitudes and attributions of symbolic meaning following direct experience to reduce psychological distance. Transp Res Part D: Transp Environ 16(7):525–531. https://doi.org/10.1016/j.trd.2011.05.005

SMEV (2020) https://www.smev.in/ev-sales. Accessed 31 Jan 2022

Stern PC, Dietz T, Abel TD, Guagnano G, Kalof L (1991). A value-belief-norm theory of support for social movements: the case of Environmentalism. Hum Ecol Rev 6(2):81–97. https://www.jstor.org/stable/24707060

Thøgersen J, Ebsen JV (2019) Perceptual and motivational reasons for the low adoption of electric cars in Denmark. Transport Res F: Traffic Psychol Behav 65:89–106. https://doi.org/10.1016/j.trf.2019.07.017

Tornatzky LG, Klein KJ (1982) Innovation characteristics and innovation adoption-implementation: a meta-analysis of findings. IEEE Trans Eng Manag 29(1):28–45. https://doi.org/10.1109/TEM.1982.6447463

Tseng ML, Chiu ASF, Tan RR, Siriban-Manalang AB (2013) Sustainable consumption and production for Asia: sustainability through green design and practice. J Clean Prod 40:1–5. https://doi.org/10.1016/j.jclepro.2012.07.015

Turrentine TS, Kurani KS (2007) Car buyers and fuel economy? Energy Policy 35(2):1213–1223. https://doi.org/10.1016/j.enpol.2006.03.005

Vargo SL, Akaka MA, Wieland H (2020) Rethinking the process of diffusion in innovation: a service-ecosystems and institutional perspective. J Bus Res 116:526–534. https://doi.org/10.1016/j.jbusres.2020.01.038

Verma M, Verma A, Khan M (2020) Factors influencing the adoption of electric vehicles in Bengaluru. Transport Dev Econ 6(2):1–10. https://doi.org/10.1007/s40890-020-0100-x

Wang S, Fan J, Zhao D, Yang S, Fu Y (2016) Predicting consumers' intention to adopt hybrid electric vehicles: using an extended version of the theory of planned behavior model. Transportation 43(1):123–143. https://doi.org/10.1007/s11116-014-9567-9

WCED (1987) Our common future. World Commission on Environment and Development, Norwegian edn. Tiden Norsk Forlag, Oslo

Wu YH, Trappey VC, Feinberg AR (2010) The diffusion of innovation and perceived risk for the adoption of alternative energy vehicles. In J Innov Learn 8(3):296–314

Xu G, Wang S, Li J, Zhao D (2020) Moving towards sustainable purchase behavior: examining the determinants of consumers' intentions to adopt electric vehicles. Environ Sci Pollut Res 27(18):22535–22546. https://doi.org/10.1007/s11356-020-08835-9

Zhang X, Wang K, Hao Y, Fan JL, Wei YM (2013) The impact of government policy on preference for NEVs: the evidence from China. Energy Policy 61:382–393. https://doi.org/10.1016/j.enpol.2013.06.114